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NUMBER 25

THE SCHIZOPTERIDAE (HEMIPTERA : HETEROPTERA) WITH THE DESCRIPTION OF NEW SPECIES FROM TRINIDAD

BY

MICHAEL G. EMSLEY

PUBLISHED BY THE AMERICAN ENTOMOLOGICAL SOCIETY
AT THE ACADEMY OF NATURAL SCIENCES
PHILADELPHIA

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TABLE OF CONTENTS

Introduction 1

Acknowledgments 5

Biological observations and techniques 5

Morphology of the family 10

- Materials and methods 10
- Nymphal and adult structure 11
  - External anatomy 11
  - Internal anatomy 33

Schizopteridae known from Trinidad 36

- Key to genera 38
  - Genus *Chinannus* 39
  - Genus *Nannocoris* 39
  - Genus *Corixidea* 43
  - Genus *Hoplonannus* 46
  - Genus *Schizoptera* 48
    - Subgenus *Schizoptera* 50
    - Subgenus *Cantharocoris* 58
    - Subgenus *Lophopleurum* 59
    - Subgenus *Odontorhagus* 63
    - Subgenus *Zygophleps* 65

Systematic discussion 67

Annotated catalogue of the Schizopteridae 81

References 108

Index 114

Abbreviations used in the figures 118

Figures 120

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THE SCHIZOPTERIDAE (HEMIPTERA : HETEROPTERA) WITH THE DESCRIPTION OF NEW SPECIES FROM TRINIDAD[1]

BY
MICHAEL G. EMSLEY
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INTRODUCTION

The Schizopteridae are a family of Hemiptera-Heteroptera that have been neglected principally on account of their very small size (0.8 - 2mm), cryptic habits and predominently tropical distribution. Most specimens have been taken incidentally by collectors searching forest litter and light-traps for members of other groups, which accounts for the majority of the one hundred and six species previously known having been described from single specimens or from short series of one sex. Taxonomically this is especially unsound, for sexual dimorphism is widespread throughout the family. Members of the group are known from all continents and some oceanic islands and there is no doubt that further study will reveal that they are widely distributed and abundant in the tropics and subtropics.

The first known schizopterid was *Schizoptera cicadina* described by Fieber in 1860 from Venezuela, and over twenty years elapsed before three more congeneric species were described from Brazil by Reuter in 1882. In 1891 Reuter described five new South American species of *Schizoptera* and *Hypselosoma oculata* from New Caledonia,

[1] Submitted in partial fulfillment of the Doctor of Philosophy Degree of London University in 1964.

which was the first extension of the recorded range of the family outside the New World. Reuter proposed that the ten species then known be placed in the Schizopterina, a subdivision of the family Ceratocombidae erected by Fieber in 1861 to contain the European species of *Cryptostemma* and *Ceratocombus*. In their 1896 catalogue Lethierry and Severin granted the Schizopterina formal subfamily rank, though this was the sense in which the name had been previously used. It was not until 1910 that Reuter elevated them to full family status, though still maintaining their association with the Ceratocombidae.

Between 1891 and the revision of the family by McAtee and Malloch in 1925 the only advances made were descriptions of new genera and species, minor nomenclatorial changes and new locality records by Uhler (1894 a and b), Heideman (1905), Horvath (1905, 1908), Kirkaldy (1906 a and b), Poppius (1910, 1913), Reuter (1912 a), Distant (1913), and Van Duzee (1924). Of these contributions the most significant was the description of *Glyptocombus* by Heideman as the first record of the family occurring in North America, and Distant's new genera from the Seychelles Islands which showed that some remote oceanic islands had been colonized.

The revision of the family by McAtee and Malloch (1925), which still remains the most important single paper on the group as a whole, was based upon specimens deposited in the United States National Museum, though aided by material loaned from the collection of the Zoological Museum in Helsinki. From 1925 to the outbreak of World War II the only contributors were Blatchley (1926) and Bruner (1934) with new species from Florida and Cuba respectively.

China (1946) was the first author to portray genital and abdominal structures adequately. Since then our knowledge has undergone remarkable growth, principally due to the excellence and abundance of the descriptions of new genera and species by Wygodzinsky (1947 a, 1948 b, 1950 a, 1950 b, 1951, 1952, 1958). It is only during this period that the degree of detail in description became sufficient for determinations to be reasonably certain without direct comparison with type material. Though Wygodzinsky has helped to rectify the shortcomings of some of the earlier descriptions by comprehensive redescriptions, many genera and species still remain

beyond recognition. Other interesting discoveries during this period were by Usinger (1946) with a new genus from the oceanic island of Guam, and Carayon's 1949 description of *Pinochius* from the Camaroons, which was the first Ethiopian species. More recently, Esaki and Miyamoto (1959) and Miyamoto (1960) with new species from Japan, and Southwood (1961 a) with new West African species, have added to the evidence that this group of Heteroptera has a world-wide tropical and subtropical distribution and though the individuals are small in size, and therefore often overlooked, taxonomically the group is probably very large.

In the past the Schizopteridae have been associated with the family group which contains *Hypsipteryx, Seychellesanus, Issodomimus, Muatianvuaia, Ceratocombus* (*sensu lato*), *Crescentius* and *Teratocombus* under the bipartite family variously titled Ceratocombidae, Cryptostemmatidae or Dipsocoridae, and it will be shown that this association is sound.

The reasons for the several synonyms of the Cryptostemmatidae (*sensu stricto*) are confusing. There is no doubt that the first described member of the group was *Anthocoris coleoptratus* Zetterstedt, 1819, but it was not recognized as being generically distinct until Signoret in 1852 described it under the junior synonym *Astemma mulsanti* with the rider that if it warranted a new genus then the name *Ceratocombus* would be suitable. Meanwhile Herrich-Schäffer figured *Cryptostemma alienius* in part 135 of Panzer's *Faunae insectorum Germaniae* again, like Signoret, without distinguishing between generic and specific characters. In 1855 Haliday proposed that the new name *Dipsocoris* should replace Herrich-Schäffer's *Cryptostemma,* and McAtee and Malloch (1925) claim the reason for this proposal was that Guérin had given the name *Cryptostemma* to a genus of Arachnid in 1838, and so it was preoccupied, but there is no mention of this in Haliday's paper. As Panzer's work was published over the period 1829-1844 the establishment of the exact date of publication is relevant. Sherborn (1924) and Schenkling (1939) date Herrich-Schäffer's Part 135 as 1835 and so it seems reasonable to accept it. This means that *Cryptostemma* is the valid name of a genus in the family under consideration, for prior to 1931 an illustration associated with a binomial name constitutes an indication [*International Code of Zoological Nomenclature*

(1961) Article 11c, 12, 16 vii] and the characters of the separate taxa do not have to be differentiated [Article 16a vi].

Following the proposal by Haliday in 1855 that the name *Dipsocoris* should replace *Cryptostemma,* Dohrn in 1859 proposed the new family name Dipsocoridae, based presumably on what he considered was then the oldest available genus, for Signoret had not proposed *Ceratocombus* in 1852 but merely suggested the name. As matters now stand a case can be made for returning to the consistent use of the family name Cryptostemmatidae, on the grounds that *Dipsocoris,* the type-genus of Dipsocoridae, is a junior synonym which was rejected by McAtee and Malloch in 1925, that is before 1960 [Article 40]. Article 29 of the Code clearly states that the family-group name should be formed by the addition of the suffix - idae to the stem of the type-genus. There is no doubt that the valid name of the type-genus of the family-group under discussion is *Cryptostemma,* so the use of the family name Cryptostemmatidae commends itself in the interests of consistency. There is no case for applying Article 40(a) on the grounds of "General Acceptance", for the supporters of Cryptostemmatidae include Sahlberg (1869), Rey (1888), Champion (1900), Bergroth (1914), McAtee and Malloch (1925), Usinger (1946), China (1946), Gross (1950, 1951), Wygodzinsky (up to 1955), Linnavuori (1951), Imms (1957), and more recently the editor of the Insecta Section of the Zoological Record. However, the adherents to Dipsocoridae, who are principally the authors of surveys or text books, can make the point that it is still the oldest valid group name [Article 23]. These authors include Kirkaldy (1906 a), Horvath (1911), Reuter (1912 a), Oshanin (1912), Van Duzee (1917), Handlirsch (1925) and Poisson (1951), together with the taxonomists Stys (1958), Miyamoto (1960), Drake (1961) and Wygodzinsky (after 1955).

Most of the papers published on Schizopteridae are taxonomic and are based wholly on external characters, for only recently have non-chitinous structures been described and then by authors surveying organs throughout the Heteroptera. Our knowledge of the biology of Schizopteridae is limited to data from collector's field notes, for there is only one published record of their having been kept alive in the laboratory (Esaki and Miyamoto, 1959).

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BIOLOGICAL OBSERVATIONS & TECHNIQUES

Though the Schizopteridae are known from all the zoogeographical realms except the Palaearctic, the records indicate that they are confined to between the latitudes 38° N. and 42° S. Within these limits they are probably concentrated in the tropics, for though the subtropical regions have been more thoroughly collected, many fewer specimens and species have been taken. The most northerly locality is Plummer's Island, Maryland which experiences freezing temperatures. The most southerly record, at Cascades, Tasmania, is difficult to assess, for Tasmania is climatically very varied and it is doubtful whether the microclimate enjoyed by these small insects is subject to the extremes of temperature and humidity that might be recorded by a Stephenson screen. Wygodzinsky (unpubl.) has taken Schizopteridae in Colombia at altitudes near 9000 feet.

On account of their small size and soil-living habits it is probable that Schizopterids have frequently been transported by man and natural agencies. The soil that surrounds the roots of plants is one of the most likely media for distribution, for the data on several specimens of the similarly litter-inhabiting *Cryptostemma* and *Ceratocombus* in the United States National Museum show that they were taken by the Plant Quarentine Station on the Mexican border at Brownsville. There is a single specimen of *Corixidea* in the same collection taken at Miami, Florida, from a plane that had come from La Guaira, Venezuela via Trujillo, Dominican Republic. So some

anomolous distributions must be expected.

Tullgren funnels, floatation chambers and sieving were all tried during the exploratory phases of collecting. Floatation was unsatisfactory because of the light nature of forest litter and the similar density of the insects sought. Tullgren funnels were abandoned because of the very small number of Schizopterids which were extracted, the small size and number of samples that could be handled, and the time taken for the samples to be treated. The latter factor is important because if any interesting specimens are discovered, further samples from the same locality may have to be collected immediately because of the ephemeral nature of some wet-season habitats. An additional disadvantage of the Tullgren funnel is that alate Schizopteridae are strongly attracted to light, so those in the upper layers of the sample are never extracted. Another factor leading to poor extraction is that Schizopteridae seem ill-adapted to burrowing actively in the soil and are overcome by dessication or heat before they can reach the outlet. The only quick and efficient way of obtaining living material in quantity was by sieving with a 2.0 mm mesh sieve, 12 inches in diameter, over illuminated white cardboard. Just as light-traps give a hundred per cent bias towards individuals that can fly it is likely that the handling of samples prior to and during sieving gives a bias in favour of non-flying forms.

The light-traps used were crude but cheap and efficient. They consisted of a 75 watt tungsten-filament electric-light bulb suspended over a pan of water to which two milleliters of a liquid detergent had been added. If it was anticipated that the trap catch would not be examined until after the following day, then 25 milleliters of 40% formalin was added to the approximately one and a half liters of water in the pan. This gave good preservation of the catch for up to a month or more in a closed vessel, though the pan must be emptied daily. The trap is illustrated and described more fully in Emsley (1960: 114-116).

In Trinidad the only habitats which have yielded many individuals or species have been forest litter and topsoil in damp situations. This concurs with collector's data elsewhere and, apart from a few specimens taken sweeping, the only other habitats recorded are moss, the edges of streams, and under stones, almost always in damp situa-

tions. Information from light traps is interesting because in a well-collected locality in Trinidad only 8 out of the 33 species taken in the trap are known to inhabit forest litter. In spite of ardent collecting by means of sweeping and beating, by searching epiphytes, arboreal mosses and arboreal and terrestrial ant and termite nests, the habitats of the species not found in litter are still unknown. The only reasonable possibility is that they have been overlooked because they occur at exceedingly low frequencies or that they inhabit deep fissures in the soil. Wygodzinsky (1947) records *Trichotonannus* (Cryptostemmatidae) from the nest of *Protermes minutus,* and specimens of *Pachyplagia* from Australia are mounted with ants with the word "inquilines" after the collector's name on the labels.

Quantitative sampling proved impossible on account of the varied nature of the terrain and the uneven distribution of suitable habitats. During the rainy season, which in Trinidad is normally from June until December, the water-logging of the soil makes sieving quite impossible or, if barely possible, yields results quite incomparable with sievings at other times of the year. The use of soil augers similar to those used by soil surveyors was explored, but the density of the insects per unit area is normally so low and so variable that the results of one worker could not justify the effort. During the dry season the insects retreat to the outliers of moist humus which accumulate behind stones in drying-up stream beds. In such favourable situations large breeding communities can be discovered throughout the dry season, so it would seem that there is no dispause and the whole life-history may take place in this habitat.

It is interesting to notice that though members of the Cryptostemmatidae are common in litter and a dozen species have been taken during the last few years from Trinidad, none of these are members of *Cryptostemma,* which is the only previously recorded genus of this family from Trinidad (China, 1946).

For laboratory observation, one-inch plaster of paris cubes were cast and a chamber drilled in one face with a 3/8 inch drill to a depth of 3/8 inch. The drilled surface of the cube was ground flat on a ground-glass plate. When the cavity was occupied by insects it was sealed with a coverslip and the block kept moist.

Oviposition by adult females of *Hoplonannus* and *Schizoptera* occurred in these chambers, the eggs being cemented either into a

crevice in the wall, or to the underside of the cover-slip. Oviposition is assisted by the female pressing its abdomen ventral and anterior to the egg with the hind tarsi. Only one egg was laid at a time and in mature females there were never more than two well-developed eggs in the oviducts at any one time. The two ovaries mature eggs alternately and an alternate series of graded sizes of eggs may be seen in the ovaries and oviducts. Adult males and females have lived in the laboratory in individual cages for periods up to a month without feeding, but, presumably because of malnutrition, captive females have only ever laid one egg and that soon after caging. Judging by the difference in size between the largest and second largest egg in the ovaries, it seems likely that the duration of the oviposition period is considerable. These observations on species lacking an exserted ovipositor suggest that they lay their eggs individually over a reasonably long period of time and cement them to objects in the soil. The genera *Hypselosoma, Glytocombus, Guapinannus* and *Peloridinannus* which possess an ovipositor may differ in their oviposition habits.

The first instar nymph hatches from the egg by breaking the opercular seal with its hatching spine. Five nymphal instars have been recognized.

The Schizopteridae have a characteristic gait which assists considerably in recognizing live specimens in litter-sievings. The body is held high off the substrate with the antennae projecting anterolaterally, and even at rest these facies distinguish them readily from beetles and mites of a similar size. The legs move in the usual insect order of the pro- and metathoracic legs of one side synchronously with the mesothoracic leg of the other, but the movement is slow and oblique. If touched they jump in an apparently random manner. They never run like members of the Cryptostemmatidae.

Brachypterous males and females, whether equipped with metathoracic wings or not, have never been taken in light-traps in situations in which they are known to occur, nor can they be stimulated to fly in the laboratory. In Trinidad all the fully alate species have been taken at light and some have been taken at an altitude of 50 feet in the forest canopy. This does not necessarily mean they are capable of uninterrupted flights of 50 feet for they could achieve this height in a series of bounds.

The jumping mechanism consists of a rugose pad on the inner

face of each metacoxa which can be opposed against the metasternal spine, if one is present. Muscular effort forces the hind coxae backwards and as the coxal pads slip past the spine the movement of the legs is accelerated and the insect is projected forwards and upwards at a trajectory of about 60°. The landing shock of a light insect is very small so it is unlikely that the short compact forelegs are directly associated with this jumping habit. The wider occurrence of metacoxal pads than metathoracic spines suggests that some Schizopterids have lost the ability to jump and may use the pads for some other purpose, such as stridulation.

Under laboratory conditions the antennae and the rostrum are cleaned by being passed between the opposed distal extremities of the protibiae, and the wings and the dorsal surface of the abdomen are cleaned by the ventral surface of the hind tarsi. On meeting in confined enclosures, two individuals turn head to head with their antennae crossed and perhaps with the long hairs on segments III and IV just or just not touching. Recognition is immediate and in all observed instances of whatever the sex and species, individuals have moved away from each other. Caging up to twelve males with one conspecific female and visa versa, in half-inch to three-inch cube cages yields no other response during both daylight and at night under artificial illumination. Perhaps special night lighting might lead to the witness of more activity.

China (1946) suggested that the curious rasp-like specialization of the forewing of *Chinannus trinitatis* might have a stridulatory function, and similar structures also occur on the forewings of *Silhouettanus, Machadonannus* and *Vilhenannus,* but in each case no structures seem capable of being opposed to this "file".

Acoustic equipment capable of detecting sounds at frequencies from 500 to 70,000 cycles was used, but though sounds produced during the cleaning movements of *Chinannus trinitatis* were clearly perceptible, no other sounds were noticed.

The only record of Schizopteridae feeding in captivity is an observation by Esaki and Miyamoto (1959), who fed *Hypselosoma hirashimai* on chironomid larvae.

In laboratory cultures in Trinidad, Collembola, Thysanura, Psocoptera, coleopterous and dipterous larvae, mites and their larvae, and nematodes were offered but they were all ignored.

Femoral muscle of grasshopper and mammalian liver tissue were also offered, but though they were inspected and probed by the stylets of a female *Hoplonannus*, no subsequent feeding was observed. Many genera (e.g. *Hypselosoma, Corixidea*) have a relatively short rostrum, whereas in others (e.g. *Chinannus, Nannocoris*) it is long. Differences in rostral length may be associated with differences in feeding habit.

Genera with both types of rostrum were offered plates of fungi cultured from litter samples but again without response.

MORPHOLOGY OF THE FAMILY

Materials and Methods

Wherever possible alcohol-preserved, dried and prepared slide material was examined, for substantially different facies are revealed by these various techniques. On account of surface reflections and accumulations of detritus, dry material was found the least suitable, and for the examination of genital structures slides were found essential. Dissections were carried out by hand, using needles or finely ground watch-maker's forceps. The most troublesome factor in dissection is the weakness of the attachment of the prothorax and pterothorax and the overall hardness of the integument. To overcome this difficulty it was found convenient to dissect under alcohol with the specimen partially embedded in wax. The drawings were all made using an eyepiece grid and squared paper.

Type material of all the known genera was studied with the exception of *Nesonannus, Peloridinannus, Dictyonannus, Ptenidiophyes, Pachyplagioides, Guapinannus, Itagunannus, Tropistotrochus, Voccoroda, Bironannus, Biturinannus* and *Kokeshia,* but of these unseen genera, only *Nesonannus, Dictyonannus, Ptenidiophyes,* and *Tropistotrochus* are really inadequately described. The material examined consisted of the collections of the British Museum (Natural History), the United States National Museum, the Cambridge University Museum of Zoology, the Paris Museum of Natural History, the Hungarian Museum of Natural History, a part of the collection from the Zoology Museum at Helsinki, and all the species known from Trinidad.

Nymphal and Adult Structure

EXTERNAL ANATOMY

All the known Schizopteridae are compact rotund insects, with the exposed integument variously sculptured with fine pits, tubercles or complex ornamentation. The adults present various patterns of light and dark by the differential sclerotization of the cuticle, and only a few genera, like *Ommatides,* exhibit pigmentation in addition to the red compound eyes and ocelli. The nymphs are soft or hard bodied, setigerous, and rarely pigmented except for occasional irregular patches of red, and the red of the compound eyes.

Head. — The head capsule is characteristically sub-triangular when viewed from the front (Fig. 1) and deflexed when viewed from the side (Fig. 2), so the most anterior part is the anteclypeus (**ac**). The short though distinct gular region and the close association of the head capsule and prothorax may give the impression that the rostrum arises from the postero-ventral part of the head, but in all cases it clearly arises from the morphologically anterior extremity. *Nannocoris* (Fig. 4) and *Dictyonannus* have the long axis of the head capsule parallel to that of the body, but in the first genus there are a pair of ventral gular ridges (**gr**) which are continuous with the bucculae (**b**) and which terminate at a point posterior and ventral to the compound eyes. These gular ridges may represent extensions of the bucculae that are associated with the extension of the head capsule from the deflexed to the porrect condition, or they may be merely adaptations for the reception of the rostrum in repose. Comparisons suggest that porrection of the head capsule has been accomplished by the elongation of the gular region anterior to the compound eyes and antennae.

The morphology of the head capsule (Figs. 1 and 2) is fully comparable with that of other Heteroptera (Southwood, 1953) and has the anteclypeus (**ac**) separated off from the jugae (**j**) by the clypeal folds (**cf**). *Biturinannus, Bironannus* and *Humpatanannus* have the anteclypeus anterodorsally inflated so it projects considerably. In *Schizoptera* and allied genera (Fig. 1) there is a pseudosuture separating the anteclypeus (**ac**) from the postclypeus (**pc**). *Nannocoris tuberculifera* has the vertex inflated into a prominence but without separation by sutures, and other species of the genus

have a conical depression in the frons or vertex. Esaki and Miyamoto (1959) describe an anterior development of the jugae either side of the anteclypeus in male *Hypselosoma hirashimai,* but the jugae are not normally a prominent feature. The mandibular plates (Fig. 2, **mx pl**) are externally very small and exceedingly hard to distinguish. The bucculae (**b**) are usually well developed and conspicuous and in *Ommatides* they are inflated and surround the base of the rostrum as a pair of lateral lobes, a condition which may represent an extreme example of the tendency shown in *Glyptocombus.* The labrum (**l**) has been overlooked in most descriptions because of its membranous and transparent character, but in all the species studied it is elongate and overlies all or most of the first segment of the rostrum.

Whereas the Cryptostemmatidae have numerous macrochaetae, the integument of the head of Schizopteridae is usually lightly sculptured and clothed sparsely with fine decumbent microchaetae, though there may be a few stout and erect macrochaetae on the anteclypeus and bucculae whose pattern is of taxonomic importance. *Bironannus, Biturinannus* and *Humpatanannus* have three very long anteclypeal spines, *Hypselosoma* has a horizontal row of four plus a lower median one, *Glyptocombus* has a dorsal pair plus a lower median one, and *Kokeshia* has one single central spine. *Corixidea, Hoplonannus* and the nymphs of several genera have a conspicuous ocular bristle (Fig. 1, **ob**) on the vertex above each ocellus, and there may also be frontal bristle(s) (Fig. 1, **fb**) above the antenna. In nymphal and adult *Bironannus* and nymphal *Humpatanannus* there are bristles on the compound eye itself but this is exceptional. *Humpatanannus, Machadonannus, Vilhenannus* and *Hypselosoma* are notable in that the dorsal hairs of the nymph are apically bifid or trifid but this condition may be more widespread for the nymphs of only twelve genera are known at present, and the characters of some of these have not been recorded very carefully.

The compound eyes (Figs. 1, 2, and 3, **cp**) vary in size from very small, as in *Dictyonannus* and *Chinannus,* to very large, as in *Hypselosoma* and *Glyptocombus,* but they are always close to the anterior margin of the prothorax. According to their size they do or do not overlap the anterior lateral margin of the prothorax, and in those cases where the eyes are very large they may overlap the

TABLE 1. — The Correlation between the Presence of Ocelli and the Development of the Wings in Schizopteridae

	MALES			FEMALES		
GENERA	Macropterous with hind wings	Macropterous without hind wings	Brachypterous	Macropterous with hind wings	Macropterous without hind wings	Brachypterous
Bironannus	+	x	x	x	x	x
Biturinannus	+	x	x	x	x	x
Ceratocomboides	+	x	x	+	x	x
Chinannus	+	x	x	x	x	–
Corixidea	+	x	x	+	x	x
Dictyonannus	x	x	x	x	x	–
Dundonannus	+	x	x	x	x	–
Glyptocombus	+	x	+	+	x	?
Guapinannus	x	x	x	+	x	x
Hoplonannus	+	x	x	x	x	–
Humpatanannus	+	x	+	x	x	+
Hypselosoma	+	x	+	x	x	–
Itagunannus	–	x	x	x	x	x
Kokeshia	+	x	x	x	x	–
Luachimonannus	x	x	–	?	x	–
Machadonannus	+	x	x	x	x	+
Membracioides	+	x	x	x	x	x
Nannocoris	+	x	x	+	x	x
Nesonannus	?	x	x	x	x	x
Ogeria	x	+	x	x	+	x
Ommatides	+	x	x	x	x	x
Oncerodes	x	x	x	x	x	–
Pachyplagia	–	x	x	x	x	–
Pachyplagioides	–	x	x	x	x	x
Peloridinannus	x	x	x	+	x	+
Pinochius	+	x	x	+	x	+
Ptenidioyphyes	x	x	x	x	x	–
Schizoptera	+	x	?	+	x	–
Schizopterops	x	x	x	x	x	+
Silhouettanus	+	x	x	x	x	x
Tropistotrochus	?	?	?	?	?	?
Vilhenannus	+	x	x	+	x	–
Voccoroda	+	x	x	x	x	–

Key: x = form unknown; ? = information lacking; + = Ocelli present; – = Ocelli absent

whole length of the prothorax. The facets are large and together with the red pigmentation give the appearance of a raspberry. A pair of ocelli (o) though always absent in nymphs, may or may not be present in the adult, and when present they may be well removed from the compound eye as in *Glyptocombus,* or so close, as in some species of *Schizoptera,* that they are easily mistaken for one of the facets of the eye and overlooked. The relationship between the presence of ocelli and the ability to fly was discussed within the Cimicoidea by China and Myers (1929) and the data revelant to the problem in Schizopteridae are presented in Table 1. There are inconsistencies for which there seems no obvious explanation.

The circular patches of differentiated cuticle on the frons and vertex (Fig. 1. cms), which have been described by several authors, are the areas of insertion of the cibarial muscles and may exhibit a sexually dimorphic pattern which is sometimes of taxonomic value. In those cases where this dimorphism exists the males have the pattern of spots extending posteriorly and laterally onto the vertex, whereas in females the insertions are limited to the frons and lower median vertex.

The salivary pump is similar to that of *Orthotylus* described by Southwood (1953) and is probably typical for the Heteroptera.

The rostrum is composed of three or four segments (Figs. 5 and 6, RI, RII, RIII and RIV) and presents considerable diversity of form. Though the first segment is broad and conforms with the contours of the bucculae, the more distal segments are more slender. *Hypselosoma* (Fig. 5), *Kokeshia, Ogeria* and *Chinannus* have a clearly four-jointed rostrum in which all the joints are capable of movement upon each other. *Luachimonannus, Pachyplagia, Silhouettanus* and *Glyptocombus* have four joints but the third and fourth are indistinctly separated and probably incapable of movement. Most Cryptostemmatidae have three well defined joints but *Hypsipteryx* has a very long four-jointed rostrum the apical joint of which is very short. In *Schizoptera* there are several species with an incomplete division of the second joint (Fig. 6). The three-segmented rostrum may distally taper to a point as in *Schizoptera* (Fig. 2) or be apically truncate as in *Corixidea* (Fig. 1). The relative lengths of the segments I : II : III rarely depart far from the ratios 1 : 1.25 : 1.25, but *Nannocoris* (Fig. 4) has the rostrum long

and slender with the second joint up to four times longer than the subequal first and third.

The overall length of the rostrum may be short in genera like *Ptenidiophyes, Ceratocomboides* and *Corixidea* and in repose not extend beyond the procoxae, or it may be longer and even reach the third visible abdominal sternite, as in *Chinannus.*

The stylets lie in the shallow labial groove and are conventional in that the maxillae taper to a fine point, whereas the mandibles are slightly swollen apically, and articulate with the ginglymus at the posterior limit of the sutures separating the mandibular plates and the jugae.

The antennae are mounted well below a horizontal line through the centre of the compound eye on very small antenniferous tubercles which may (*Schizoptera*) or may not (*Glyptocombus*) be set in shallow lateral recesses in the head capsule. Throughout the family the antennae are uniform (Fig. 7) in that they are four-segmented with the first and second joints (A I, A II) subequal and extremely short, and the third and fourth (A III, A IV) subequal and relatively long. The basal pair of segments have a few stout hairs of moderate length whereas the pair of distal segments have the hairs more numerous, longer and finer. Typical segment ratios would be I - 3 : II - 4 : III - 14 : IV - 16. Though reasonably constant within species, the small differences between species, and the difficulty of measuring the relative lengths accurately, make the antennae a far less useful taxonomic character than is suggested by the precise measurements of some authors. The total length of an antenna approaches the length of the body in *Ogeria,* but in most genera it is between one half and two thirds the total length. Though in life the antennae are held at right angles to the long axis of the body, the short basal joints enable them to be swept back close to the sides of the body when passing an obstruction. The similarity of the antennae in the Cryptostemmatidae and Schizopteridae has in the past been the principal character upon which their association within one family has been based, but it could have been argued that this antennal character is a convergent adaptation in insects which inhabit the soil. However, there is a consistent difference between the antennae of the two families, for in the cryptostemmatidae the second joint is always longer than the first and is usual-

ly about twice as long (*Seychellesanus,* Fig. 8), whereas in Schizopteridae it is shorter.

The cervicum has been obliterated by the close integration of the head and prothorax, which are incapable of movement relative to each other.

Thorax. — The development of the prothoracic pleura is one of the most conspicuous features of the Schizopteridae and also in the genera *Seychellesanus, Muatianvuaia, Issodomimus* and *Hypsipteryx* among the Cryptostemmatidae. In all Schizopterid genera the pleura are enlarged ventrally so as to enclose the procoxae, and developed anteriorly to envelope the postero-ventral surface of the head capsule (Figs. 2 and 4). The episternal (**eps**$_1$) and epimeral (**epm**$_1$) components are distinguished by being respectively anterior and posterior to the procoxal articulation (**ca**$_1$). One of the distinguishing features between the two families is that in the Schizopteridae it is the proepisternum that is developed anteriorly (Fig. 2) whereas in the Cryptostemmatidae it is the proepimeron (Fig. 8).

In *Schizoptera* and *Nannocoris* there is a pronotal suture (Fig. 2 **pns**) which runs from the lateral mid-point of the anterior posterior margin. Though it is probably secondary it does serve to separate an apparent pronotum from the propleura and is a useful taxonomic character. The prosternum shows few specialisations and the coxal cavities are closed posteriorly only by a narrow and delicate band of membranous cuticle. The profurcae (Fig. 9, **pf**) are always present but do not show any special features of morphological or taxonomic interest. Most genera have a transverse impressed line across the anterior portion of the pronotum separating off a collar (Figs. 2, 3, 4 and 9) which varies in shape generically and the presence of which is of value in separating suprageneric groups. The larvae of species with a collar in the adult stage may (*Kokeshia, Hypselosoma*) or may not (*Vilhenannus, Luachimonannus*) also exhibit it, or it may develop only in the fifth instar (*Pinochius*).

The pronotum is finely punctured and has a dull velvety appearance due to the sparse investment of fine decumbent microchaetae. Frequently there are small antero-lateral discs of differentiated cuticle, (Fig. 3, **pnms**) which mark the sites of origin of procoxal muscles. The nymphal prothorax may be highly setigerous, as in *Ogeria,* or have a few macrochaetae disposed in a simple but definite pattern as in *Hypselosoma, Kokeshia, Machadonannus* and

Hoplonannus, but caution must be exercised in the use of nymphal characters in current taxonomy for relatively few nymphs are known.

The meso and metathorax are compact and typically heteropterous, but *Corixidea, Hoplonannus, Membracioides* and *Voccoroda* have the dorsum of the postero-lateral metanota covered by a dorsal extension of the metapleura. Wygodzinsky (1952) has termed these sclerites metanotal lobes but they are folds of the metapleura which overlie the junction of the metapostnotum and the base of the first abdominal tergite and should be called hyperpleural lobes (Fig. 13, **hpl**). *Chinannus, Itagunannus* and *Dundonannus* have smaller posterior lobes, which may have a wrinkled surface, but these are true extensions of the metascutum. Neither of these metathoracic conditions seems associated with aptery. The pteropleura (Figs. 10 and 11) are specialized in a similar way to the propleura in that there are episternal and epimeral flaps (**eps**$_2$, **eps**$_3$, **epm**$_2$, **epm**$_3$), separated by the coxal articulations (**ca**$_2$, **ca**$_3$), that form deep chambers in which the larger portions of the coxae are concealed. The meso and metapleural sutures are obsolete above the coxal articulations. *Seychellesanus* (Fig. 8), *Muatianvuaia* and *Issodomimus,* which are members of the Cryptostemmatidae, also have pteropleural flaps, but not as highly developed as in the Schizopteridae so the coxae are well exposed.

All the known Schizopterid larvae have spiracles on the pro and mesothoracic pleura, but in the adult the mesopleurum carries the mesothoracic spiracle (Fig. 11, **sp**$_2$), and the metathoracic spiracle is set dorsally in the suture separating the mesothoracic and metathoracic pleura (Fig. 13, **sp**$_3$). With the reduction of the metepimeron in Schizopteridae the metepisternum is the most posterior part of the lateral pterothorax and is usually posteriorly rounded (Fig. 13), but in *Schizoptera* it is produced into a stout posteroventral spine (Figs. 10 and 11, **eps**$_3$). The meso and metathoracic furcae are not very highly sclerotised and arise from median furcal pits, which in *Schizoptera* are inconspicuous. There are always a pair of stout pleural invaginations of the inter-segmental membrane between the meso and metathoracic pleura (Figs. 10 and 12, **pi**) that project laterally into the thoracic cavity and are continuous dorsally with the suture between the meso and metathoracic terga. The pterothoracic sterna (Fig. 10) are without visible sutures but

are always ornamented and variously developed in different genera. The mesosternum may have a pair of lateral prominences without (*Hypselosoma*) or with (*Itagunannus*) a median process, which though most usually vertical may project posteriorly (*Nannocoris*). The median mesosternal spine may occur on its own (Figs. 10 and 11, S_2S). The metasternum usually has a median spine of varied length (*Schizoptera*, Figs. 10, 11 and 12 S_3S; *Nannocoris*), or a complex forked structure, as in *Dundonannus* and *Vilhenannus*. From the posterior margin of the metasternum arises a more or less well developed process which projects into the abdomen and furnishes good specific characters. It is termed here the metendosternite (Fig. 10 m_3e). Cryptostemmatidae have no such specialisations of the pterosterna. In some species of *Schizoptera* there are three closely associated glands, possibly repugnaterial, which each open by a separate orifice on the metasternum (Fig. 10, **gl**). Near each of these openings is a smooth patch of cuticle which may be an evaporating surface (**evp**). No comparable structures have been observed in other genera.

Legs. — The three pairs of legs are orthodox in gross structure and show no specialisations for functions other than those of locomotion and cleaning. The prothoracic legs (Fig. 15) are the shortest and most compact, and in most Schizopterid genera are the only legs which have a cleaning pecten at the distal extremity of the tibia. Hypsipteryx and other Cryptostemmatidae have a pecten on all three pairs of legs. The legs of Schizopteridae are more or less heavily invested with microchaetae, but as Wygodzinsky (1950 a) has already pointed out, though the peculiar distribution of macrochaetae on the legs of some Schizopteridae has taxonomic value, they seem of little use in erecting suprageneric categories. *Hypselosoma* has two rows of opposable fine spines on the profemora and protibia but though suitably placed for a rapatorial function they seem too flexible to hold even the softest prey. *Humpatanannus* has the profemora grooved longitudinally for the reception of the protibia but again there are no other suggestions of a raptorial function. The opposable inner surface of the metathoracic coxae of all the Schizopterid genera examined have a pair of rugose pads, each of which consists of an inflated callosity densely covered with short slender pegs (Fig. 18, cx_3p). In at least some genera with a prominent metasternal spine

(*Schizoptera, corixidea*) the pads are used in conjunction with it as a jumping organ and in other genera the position of the pads on the coxae varies correspondingly with the length of the spine, so just the tip may be gripped. The pro and mesothoracic coxae have a major articulation at the morphological origin of the pleural suture and a minor, more anterior articulation with the inner wall of the episternal flap. Of the genera examined, only in *Hypselosoma* and *Glyptocombus* has a distinct trochantin been identified, and then only on the prothoracic leg. The metathoracic coxae have only a single pleural articulation and conform to the pagiopodous condition described by Schiödte (1869) and discussed by Kirkaldy (1907, 1908).

The Schizopteridae are notable for the irregular distribution of two and three segmented tarsi, which may differ between genera, between the different pairs of legs, and between the sexes of one species. The diversity of tarsal formula is shown in Table 2. The intra-generic inconstancy within *Ceratocombus* was illustrated by Stys (1958).

It is particularly interesting to notice that almost all of the two-segmented tarsi have the form shown in Fig. 21 which is similar to the nymphal condition. The three-segmented tarsi fall into two quite distinct patterns. Firstly, the pseudo-four-segmented tarsus (Fig. 14), described as four-segmented by Esaki and Miyamoto (1959), which has segments II and III telescoped together so that by transmitted light the double layer where they overlap each other seems a distinct additional segment. This clearly recognizable type of tarsus is definitely known to occur only in *Hypselosoma* and *Silhouettanus*. The second type is conventional and is shown in Figs. 19 and 20.

The pretarsi are complex and have in the past been erroneously described. The apical tarsi of all legs of both sexes and larvae carry a pair of terminal claws (Figs. 14 and 21, **cl**) with or without a basal swelling. The shape of the claws varies generically from strongly curved to almost straight and they may bear basal processes. The unguitractor plate (Figs. 14 and 21, **up**) may subtend a median empodial process from which arises an inflatable vesicle (Figs. 14 and 19, **emp** V). The apparent shape of the vesicle depends upon the mountant used and the condition of the specimen, for if it is transferred to a hypotonic mountant then the vesicle inflates, where

TABLE 2. — The Tarsal and Pretarsal Formulae

	Number of Tarsal Articles						Presence of Empodial Vesicles					
	Male			Female			Male			Female		
	I	II	III	I	II	III	I	II	III	I	II	III
SCHIZOPTERID GENERA												
Hypselosoma	3	3	3	2	2	3	+	+	x	x	x	x
Glyptocombus	3	3	3	2	2	3	+	+	x	x	x	x
Ommatides	3	?	3	–	–	–	?	?	?	–	–	–
Schizoptera	3	3	3	2	2	3	+	+	x	x	x	x
Nannocoris	3	3	3	2	2	3	+	+	x	x	x	x
Corixidea	3	3	3	2	2	3	+	+	x	x	x	x
Voccoroda	3	3	3	2	2	3	+	+	x	x	x	x
Hoplonannus	3	3	3	2	2	3	+	+	x	x	x	x
Membracioides	3	3	3	–	–	–	1	1	x	–	–	–
Oncerodes	–	–	–	?	?	?	–	–	–	?	?	?
Vilhenannus	3	3	3	2	2	3	+	+	x	x	x	x
Machadonannus	3	3	3	2	2	3	+	+	x	x	x	x
Dundonannus	3	3	3	2	2	2	+	+	x	x	x	x
Silhouettanus	3	3	2	–	–	–	+	+	x	–	–	–
Pinochius	3	3	2	2	2	2	+	+	x	x	x	x
Biturinannus	2	2	3	–	–	–	x	x	x	–	–	–
Ceratocomboides	2	2	3	2	2	2	?	?	?	x	x	x
Bironannus	2	2	3	–	–	–	x	x	x	–	–	–
Humpatanannus	2	2	3	2	2	3	x	x	x	x	x	x
Itagunannus	3	3	3	–	–	–	x	x	x	–	–	–
Pachyplagioides	3	3	3	–	–	–	x	x	x	–	–	–
Chinannus	3	3	2	2	2	2	+	+	x	x	x	x
Ogeria	3	3	3	3	3	3	+	+	x	x	x	x
Pachyplagia	2	2	3	2	2	3	x	x	x	x	x	x
Luachimonannus	2	2	3	2	2	3	x	x	x	x	x	x
Kokeshia	2	2	3	2	2	3	x	x	x	x	x	x
Peloridinannus	–	–	–	?	2	3	–	–	–	?	x	x
Guapinannus	–	–	–	2	2	3	–	–	–	x	x	x
Dictyonannus	–	–	–	2	1	1	–	–	–	?	?	?
Schizopterops	–	–	–	3	?	3	–	–	–	?	?	?
CRYPTOSTEMMATID GENERA												
Hypsipteryx	2	2	2	2	2	2	x	x	x	x	x	x
Seychellesanus	–	–	–	2	2	2	–	–	–	x	x	x
Ceratocombus	3	3	3	2	2	2	x	x	x	x	x	x
Muatianvuaia	3	3	2	–	–	–	+	+	x	–	–	–
Issodomimus	3	3	2	–	–	–	+	+	x	–	–	–
Cryptostemma	3	3	3	2	2	2	+	+	x	x	x	x

Key: – = form unknown; ? = information lacking; + = present; x = absent

There are no data on *Nesonannus, Ptenidiophyes* and *Crescentius.*

upon it may burst and present one of many irregular shapes, become invisible or expose the empodial process. If it does not burst it may become platelike, spherical, or bilobed by the middle of the vesicle becoming restricted by the median process. In small nymphs the empodial vesicles are bordering on the powers of resolution of even the better microscopes. Arising from between the unguitractor plate and the bases of the claws of all legs of both sexes, irrespective of whether there is an empodial vesicle or not, are a pair of auxiliae (Figs. 14 and 21, **aux**), which in all the Schizopteridae examined have a capitate tip. In *Hypsipteryx* the auxillae are less conspicuous, short and uniformly tapering, but in other Cryptostemmatidae they have not been observed at all. The distribution of these pretarsal elements is shown in table 2, although some of the information is lacking as often they cannot be seen in unmounted material.

Wings. — Sexual pterygo-dimorphism is a feature of the family that has complicated their taxonomy, for though males are most frequently macropterous there are many genera in which the females have highly sclerotised and modified forewings. Southwood and Leston (1959) have attempted to homogenise the terminology of the heteropterous wing, but to overcome terminological inconsistencies the beetle-like elytra of some Schizopteridae clearly call for a new descriptive term, for which "elytrous" seems suitable. It would replace the use of the term "brachypterous", hitherto applied to elytriform wings, which should then be reserved for those insects with short or abbreviated wings as in some specimens of *Kokeshia*. Similarly, "sub-brachypterous" has little application within the Schizopteridae for though some specimens show abbreviation of the membrane, they then qualify for the term "submacropterous".

Forewing. — The elytrous forewing is similar to that of Vianaidinae (Tingidae) and to the elytron of Coleoptera, in that it is highly sclerotised and convex, but it differs in that the wings overlap a little in the mid-line and in almost all cases the venation can be identified and related to that of the macropterous forms. This may be demonstrated by the comparisons of the forewings of a male and female (*Hoplonannus,* Figs. 23 and 24). Though the hind wings are usually developed in macropterous individuals they may be present, reduced or absent in elytrous examples. Submacropterous forms have the membrane abbreviated, with or without condensation of the corium

and usually have the hindwing fully developed. The macropterous Schizopterid wing does not exhibit the sharp differentiation of the membrane which is typical of Heteroptera, for though in some species of *Schizoptera* there is a rapid change in the degree of sclerotisation at the interface of corium and membrane, there is no sudden change in thickness. In the majority of genera the wing is homogeneously sclerotised throughout but tapers gradually in thickness from base to apex.

The venation of the Schizopteridae has been studied previously only by Gross (1951), for though in his descriptions Wygodzinsky labels some of the veins of the forewings, he does so without presenting evidence to support his interpretations. Gross compared the venation of the Australian genera *Pachyplagia* and *Pachyplagioides* with the triassic fossil *Dunstaniopsis,* but his paper is handicapped by the absence of relevant drawings, and he does not seriously attempt to demonstrate the uniform application of his homologies throughout the whole of the Schizopteridae. In principle he expands the radius at the expense of the posterior veins, whereas in the following interpretation this trend is reversed. The chief hindrance to the interpretation of the venation is the difficulty of obtaining maps of larval wing pad tracheation. Considerable efforts were made to obtain these data, including the Wigglesworth technique (1950) using cobalt napthanate and hydrogen sulphide. Though trachea could be detected in the forewing pads their paths could not be followed with certainty because of their small size, the opacity of the pads, and disturbance of the trachea during handling. The only homological landmarks remaining are the axillary sclerites, the anterior and vannal folds, and the wing-coupling apparatus, though some confirmation of homology can be gained by the comparison of all the known generic patterns with each other and with other Heteroptera.

The macropterous Schizopterid wing (Fig. 23) is typically heteropterous with an anterior fold (**af** = embolial suture = median furrow of Tanaka, 1926) and the vannal fold (**vf** = claval suture = anal furrow of Snodgrass, 1935). The views of leston (1962) and Davis (1961) on the homologies of the heteropterous forewing venation are in agreement that the vein that lies immediately anterior

to the anterior fold is the combined radius and media, and that the vein anterior to the vannal fold is the cubitus. That this is correct is supported by their respective basal articulations with the anterior and posterior portions of the second axillary sclerite (Fig. 22). The two authors also agree that the leading edge of the wing is reinforced not by the costa but by the subcosta. However, they disagree over the homology of the most anterior vein on the vannus. Leston calls it the first vannal; Davis, the post-cubitus. Davis seems to be in error, for though the post-cubitus certainly occurs in the tracheal map of a fulgorid and arises between the cubital and vannal tracheae (Davis' Fig. 1), the comparable map for *Triatoma* (Davis' Fig. 13) clearly shows the cubital and vannal tracheae adjacent and not separated by the origin of a post-cubitus. As would be expected the vannal veins articulate with the third axillary sclerite (Fig. 22).

It is postulated here that the venation of ancestral Schizopteridae was at least as complete as that displayed by *Hypselosoma* and *Glyptocombus* (Figs. 29 and 31), which upon non-alary evidence will be shown to be primitive members of the family. Leston (1962) states "there is no evidence for the existence of such main branches of veins or tracheae as Rs, M1 + 2, M3 + 4, Cu2 or PCu in Heteroptera", but in *Glyptocombus* (Fig. 29) and *Hypselosoma* (Fig. 31) there is a vein forming the anterior margin of the corium and six more that approach the periphery of the membrane, making a total of seven. Leston limits the possible longitudinal veins to a total of six, namely Sc, R, M, Cu, 1V and 2V, so in these two genera either the costa is represented, or one of the veins is bifurcate. As the proximal veins and their relationship with the axillary sclerites are similar in *Glyptocombus,* the other Schizopteridae that have been studied, and those members of Pyrrhocoridae and Coreidae with which they have been compared, it seems unlikely that it is the costa that is the extra vein in either *Hypselosoma* or *Glyptocombus.* The alternative is to assume one of the other veins is bifurcate. In both *Glyptocombus* and *Hypselosoma* (Figs. 29 and 31) the second vein is submarginal, lies just anterior to the anterior fold and forms the perpheral vein of the wing membrane. The figures of tracheation in *Triatoma* and other genera by both Davis and Leston show the subcosta to be a vein that hardly extends onto the membrane, whereas

the submarginal radius frequently forms the peripheral vein of the membrane. It is reasonable to suppose that in *Glyptocombus, Hypselosoma* and in other genera with similar venational patterns the first vein is the subcosta and the submarginal second is the radius, (Figs. 29-32, 42-47, 50, 51, 57). The same relationship would apply in those genera in which the radius leaves the media more proximally and runs distally parallel and close to the subcosta (Figs. 33-41, 48, 49, 52-56).

Only in *Pachyplagia* (Fig. 55) and *Silhouettanus* (Fig. 45) can the actual crossing of the vannal fold by the vannal veins be seen clearly, though such a path can in most genera be inferred from the contours of the veins. However, in Cryptostemmatidae, which will be shown on characters other than wing venation to be closely related to the Schizopteridae, the vannal veins are continuous with those of the membrane. In *Trichotonannus* (Fig. 27) the first and second vannal veins cross the vannal fold as a combined vein, in *Ceratocombus sensu lato* (Fig. 28) they cross separately but close together, and in *Cryptostemma* (Fig. 26) they cross far apart. An additional confirmation that the apical spur of the vannal veins contains a component of the second vannal is the occurrence of the wing coupling apparatus upon its posterior margin (Fig. 23, **wc**).

Without tracheal maps the decision as to whether it is the cubitus, the media or the radius which is bifurcate, and the interpretation of the homologies of the veins on the membrane is speculative, but the hypothesis that is now offered is satisfactorily applicable to all the known genera. It is deemed that the ancestral *Schizopterid* wing had a marginal subcosta, a submarginal first radius which had a bifurcate radial sector lying anterior to a bifurcate media, the cubitus was undivided and there were two simple vannal veins. Such a venation may have had the appearance of figure 25, in which it will be noticed that the radius and media have a common stem.

Consequent upon the loss of the radial sector there has been consecutive tracheal capture, a phenomenon demonstrated by Leston (1962) and Wooton (1965), in which a trachea changes its location on the wing by altering its course so it occupies the adjacent anterior vein. This leaves an atracheate cross vein along the part of its original path that it has vacated. On figures 25-60 the section of the course of veins that are postulated as having become atracheate by

subsequent tracheal capture are shown by dotted lines. By this process the path of the radial sector has been captured by the bifurcate media, the path of the anterior branch of the media by the cubitus, the posterior branch of the media by the first vannal and the cubitus by the second vannal vein. This principle when applied to the venation of all known Schizopterid genera, with the exception of *Ptenidiophyes* and *Nesonannus* for which no venational information is available, is illustrated in Figs. 29-59. The definitive veins are indicated alternately by solid and non-solid lines, so the subcosta, media and first vannal are solid black and the radius, cubitus and second vannal are hollow white. Secondary sclerotisations of the wing in the neighborhood of veins are shown stippled. The drawings are original except where otherwise specified and the venation of *Ceratocombus* (which is similar to *Muatianvuaia* and *Issodomimus*), *Trichotonannus* and *Cryptostemma,* have been included for comparison between the Schizopteridae and Cryptostemmatidae.

There are several noteworthy features. Firstly, the radius forms the periphery of the membrane. Secondly, the subcosta hardly extends beyond the corium, so where there is an abrupt change in texture or thickness on the anterior margin it takes place at the termination of the subcosta. Thirdly, there is a persistent association between the cubitus and the media, and between the first vannal and the cubitus near the corio-membranal interface. Fourthly, the association between the cubitus and the first vannal may extend proximally as far as the trapezoidal cell, in which case only four veins are apparently associated with it (Figs. 32-51), though primitively there are five (Figs. 29-31, 52-56); and fifthly, the association of the radius and the media may be very extensive as in *Machadonannus* (Fig. 42), *Vilhenannus* (Fig. 43), *Dundonannus* (Fig. 44), *Silhouettanus* (Fig. 45) and *Schizopterops* (Fig. 51); of normal heteropterous length *Hypselosoma* (Fig. 31), *Glyptocombus* (Fig. 29), *Ommatides* (Fig. 30), *Pinochius* (Fig. 32), *Humpatanannus* (Fig. 46), *Bironannus* (Fig. 47); *Dictyonannus* (Fig. 50), and *Guapinannus* (Fig. 59); or very much reduced as in *Schizoptera* (Fig. 36), *Nannocoris* (Fig. 38), *Biturinannus* (Fig. 34), *Ceratocomboides* (Fig. 35), *Membracioides* (Fig. 37), *Hoplonannus* (Fig. 38), *Corixidea* (Fig. 41), *Pachyplagioides* (Fig. 48), *Itagunannus* (Fig. 49), *Kokeshia* (Fig. 52), *Chinannus* (Fig. 53), *Ogeria* (Fig. 54), *Pachy-*

plagia (Fig. 55), *Luachimonannus* (Fig. 56) and *Peloridinannus* (Fig. 57).

Thus, on this hypothesis, it is the media that is primitively bifurcate and within the family there are trends towards the reduction of the media, and the close proximity of the subcosta and radius, and the close association of the cubitus and first vannal.

In addition to the purely venational specialisations such as those of *Itagunannus* (Fig. 49), *Guapinannus* (Fig. 59), *Peloridinannus* (Fig. 57) and *Tropistotrochus* (Fig. 58), some genera have special structures developed from the veins. Some examples are the serrated thickening of the cubitus in *Chinannus* (Fig. 53), the inflations of the vannal veins of *Corixidea* (Fig. 41), the subcostal callosities of male *Ogeria,* and the fracture across the forewing of *Guapinannus* (Fig. 59). *Machadonannus* (Fig. 42), *Vilhenannus* (Fig. 43), *Silhouettanus* (Fig. 45) and some other genera have the subcosta heavily sclerotised so the anterior margin is strongly differentiated. *Corixidea* (Fig. 41), *Membracioides* (Fig. 37) and *Hoplonannus* (Fig. 38) have the whole anterior border of the forewing thickened from subcosta to media, a specialisation that reaches its height of development in *Voccoroda* (Fig. 39). Leston has suggested that the transverse plane of weakness brought about by either a transverse fracture such as occurs in the Cryptostemmatidae and *Guapinannus,* or a sudden reduction in sclerotisation as is common in Schizopteridae, enables the wing to be depressed over the posterior end of a rotund abdomen. The venation of *Peloridinannus* is specialised and difficult to homologise with that of the other genera, but it is suggested that the media has retained its bifid character as in *Glyptocombus, Ommatides, Hypelosoma* and *Hypsipteryx* (Figs. 29-31, 60) but has secondary short cross-veins associated with it.

China (1946) suggested that the row of pegs on the forewing of *Chinannus* may have a stridulatory function, and analogous structures also occur in *Machadonannus* and *Vilhenannus,* but no auditory organs have been identified and no special structures have been noticed that could be used as a plectrum against the pegs in order to produce a sound.

Hindwing. — The hindwing is entirely membranous except for the three longitudinal veins that are constantly present. In outline the wing is usually trilobed (Fig. 61), with a pair of marginal inci-

sions coincident with the distal extremities of the anterior and posterior vannal folds (Fig. 62, vf_1 and vf_2). In *Glyptocombus* (Fig. 62) and possibly *Kokeshia* there is an additional jugal lobe (**jug l**), which is also present in the Cryptostemmatid genus *Trichotonannus*. The doubt over the presence of the jugal lobe in *Kokeshia* arises because the figure of Miyamoto (1960) shows the jugal lobe spurlike, but this is probably due to the specimen being damaged. In *Ceratocomboides* (Fig. 63) the incisions are deeper than in other genera but quite homologous. *Hypsipteryx* and many elytrous individuals have reduced hindwings and are probably incapable of flight even if the forewings are fully developed. The middle of the anterior margin of the hindwing is reflexed dorsally so as to engage with the forewing coupling apparatus, but without features correlated with the different types of coupling. Though the hindwing folds readily along the vannal folds when manipulated by hand, in all the specimens examined the hindwing was fully extended and flat when in repose.

Though the venation of the hindwing is relatively constant throughout the whole family, it is most highly developed in *Hypselosoma* and *Glyptocombus* (Fig. 62). Comparison with the interpretations of the venation of other Heteroptera by Leston (1962) and Davis (1961) leaves little doubt about the homologies. The vein immediately anterior to the inverted Y-shaped vannal fold is the cubitus and it articulates basally with the posterior portion of the second axillary sclerite. The vein that forms the anterior margin in other Heteroptera is Sc + R and there seems no reason to suppose the situation here is different, for it articulates basally with the anterior portion of the second axillary sclerite. The most posterior vein lies behind the vannal fold, and the base of the vein shows a tendency to fork, so that in some species there is a spur behind the long vein on the vannus which in *Kokeshia* is of considerable length. This vein is presumably the second vannal, so the principal vein is the first vannal. *Glyptocombus* shows a rather indistinct connection between the cubitus and Sc + R just proximal to the reflexed anterior margin, this is presumably composed posteriorly of M-Cu and anteriorly of M. There is no evidence of the media vein elsewhere, except perhaps as an isolated distal vein in *Kokeshia* (Miyamoto, 1960; fig. 1A).

Wing coupling. — The wing-coupling consists of a tubercle or pair of tubercles at the apex of the vannus on the posterior ventral margin of the combined first and second vannal veins, and is typically heteropterous. The wing-coupling in Homoptera (Ossiannilsson, 1950) involves a deflexion of the posterior margin of the forewing and is in no way similar. The wing-coupling varies considerably in structure in different genera and may take one of several forms. *Ceratocomboides, Glyptocombus, Hypselosoma* and all the Cryptostemmatidae examined have a pair of tubercles, which are approximately equal in size and which have on their opposed faces a number of short stout bristles (Fig. 64). This is the type of coupling most frequently encountered in Heteroptera. The second type of wing-coupling which occurs in *Silhouettanus, Nannocoris, Corixidea* and *Hoplonannus* (Fig. 66) is similar in position but the posterior tubercle is developed into a claw-like hook projecting anteriorly, and the anterior tubercle is padlike and more or less inconspicuous. The coupling of *Schizoptera* is intermediate between the first and second types (Fig. 65). The third type of coupling is more specialized and has the posterior tubercle developed into a tall slender cylinder which curves towards the anterior margin (Fig. 67). The anterior tubercle does not seem to be present at all, but there is a ridge (**r**) continuous with the posterior tubercle, which runs forward and along the posterior margin of the vannal fold. Genera with this type of coupling include *Pinochius, Vilhenannus, Dundonannus, Machadonannus, Biturinannus* and *Humpatanannus.* The ridge is present in *Hypselosoma* in association with a normal bi-tuberculate coupling. In all cases examined the coupling apparatus engages with the anterior margin of the hindwing, the reflexion of which is of sufficient length for the pair of wings to remain engaged when in repose.

Abdomen. — In nymphs there are ten discernible abdominal segments, I to VIII being represented by more or less widely separate terga and sterna, and segment IX by an annular sclerite surrounding the origin of the anal tube, which itself represents segment X.

In both sexes of adult *Glyptocombus* and *Hypselosoma* there are spiracles on segments II to VIII inclusive, but as far as can be ascertained in all other known Schizopteridae, abdominal spiracles are confined to the sterna of VI and VII and to the tergum of VIII (Figs. 68-73). There is the possible exception of *Vilhenannus* which has

been described as having a single spiracle on segment V in addition to the normal complement on VI, VII and VIII (Fig. 71). The nymphs have a single pair of widely separate glands opening between tergites VI and VII and evidence of the position of these glands may frequently be seen on the adult abdomen of both sexes (Fig. 73). The nymphal abdomen has a variable number of macrochaetae which may have bifid, trifid or capitate tips, but the adult abdomen is bristly only in *Hypselosoma* and *Glyptocombus,* though microchaetae are common in these and other genera. There are no trichobothria or comparable structures.

The adult abdomen (Figs. 72 and 73) is strongly sclerotised ventrally and terminally, but is usually membranous, or only lightly sclerotised dorsally. *Ogeria* and *Pachyplagia* are exceptional in their dorsally heavily sclerotised and papillate abdomen.

In the female sternum I is membranous; sternum II may be complete but narrow (*Glyptocombus, Hypselosoma*), lateral only, or indistinguishable; sterna II, IV, V and VI are symmetrical and of subequal width; sternum VII, the last apparent sternite, is large and sometimes shows specific characters on its posterior margin, but these are rarely of taxonomic value (Fig. 72). Thus, the number of visible abdominal segments in the midventral line may be five or six. Sternum VIII is membranous and telescoped above VII, and sternum IX is fused with its tergum around the origin of the semi-membranous anal tube which represents segment X. The oval markings (Figs. 72 and 73, **ams**), which are common laterally on the sterna and terga of female Schizopteridae, are the scars of abdominal muscles which may be concerned with oviposition. The frequency of the occurrence of parasternites and paratergites is much less than in the Cryptostemmatidae.

The male abdomen (Figs. 68-71) is similar to the female in the number of visible segments, but exhibits varying degrees of asymmetry in association with the genitalia. In the least specialized genera like *Hypselosoma* and *Hoplonannus* (Fig. 69) the pregenital segments are essentially symmetrical and only the genital capsule (segment IX) is substantially modified, but in some other genera modifications of the pregenital segments may take place at any of three sites. In *Nannocoris* the VIth, VIIth, and VIIIth abdominal terga may be asymmetrically modified on the right side, and intimately associated with the genitalia, and in *Corixidea* (Fig. 133) the VIIIth tergum is

developed into a process which may in some species reach the metathorax. The second site for specialisation is the side of segments IV, V and VI; *Vilhenannus* (Fig. 71), *Machadonannus* and *Chinannus* (Fig. 68) show this condition, though the function of these specialisations is unknown. The third site for asymmetry is the VIIth sternum which subtends the genital capsule, and which in *Schizoptera* is developed on the right side into most bizarre and spinous processes (Fig. 70).

The function of these asymmetrical pregenital structures is unknown, but in *Schizoptera* and *Chinannus,* though the asymmetrical pregenital structures are on different segments and therefore not homologous, they present the same structural effect, which is that of an inclined cylindrical cavity on the right side of the body. The integument surrounding this cavity may be moulded into most spectacular and specifically constant shapes, but there is always an incomplete cylinder, whose inner surface is highly polished.

Female genitalia. — The ovipositor is the most interesting feature of the female abdomen. It is well developed in *Hypselosoma, Glyptocombus* and *Peloridinannus* and is partially developed in *Guapinannus* and *Luachimonannus.* In the remaining genera only vestiges of the ovipositor remain. The ovipositor of *Glyptocombus* consists of four gonopophyses and is similar to that of the Cryptostemmatidae, all of whose known members have the ovipositor well developed. The relationships of the component parts are shown in Figure 74 and are referable to the descriptions of the hemipterous ovipositor by Scudder (1959, 1961). Tergite VIII subtends a slender lightly sclerotised first genocoxa (**g ex**$_1$) which is associated with the base of the first pair of gonopophyses (**gonph**$_1$). These are separate to their base and articulate proximally with a triangular gonangulum (**gongl**) which is fused to the ventro-lateral surface of tergite IX. The second gonocoxa (**g ex**$_2$) articulates with the gonangulum and the second pair of gonopophyses (**gonph**$_2$), the pair of which are fused together along the midline except for the distal fifth of their length.

The only real difference between the ovipositor of *Glyptocombus* and *Ceratocombus,* as described by Scudder (1959), is the shape and identity of the gonoplac. Scudder described and figured the gonoplacs as small flaps associated with the bases of the second pair of

gonopophyses though he states that in the Heteroptera there is a tendency for them to be reduced or absent. In the particular species of *Glyptocombus* that has been studied, no structures comparable with the gonoplacs of Scudder were discovered, nor were they seen either in the ovipositor of *Seychellesanus* or a local species of *Ceratocombus,* though in other respects these genera were similar. *Luachimonannus* has only the second pair of gonopophyses represented, a condition which seems, from Wygodzinsky's figure (1951, Fig. 65) to pertain also in *Guapinannus.*

Male genitalia. — The male genital capsule is approximately symmetrical in *Hypselosoma* (Fig. 75), but in other genera the symmetry is lost through a clockwise rotation of the capsule (when viewed from above) which leads to a compression of the left side (Fig. 77A). To this asymmetry may be added the development of a spinous process on the left dorsal side of the capsule as seen in *Bironannus* and *Humpatanannus* (Fig. 77, **app. IXth S**) which is considered to be an appendage of the IXth sternum.

The left and right parameres (Fig. 75, **lpm, rpm**) are a typical feature of heteropterous genitalia and in *Hypselosoma* are both somewhat similar, mobile and are mounted symmetrically in the genital capsule. In *Hypsipteryx* (Fig. 76) and most other Cryptostemmatidae, though mounted symmetrically, the individual parameres are quite dissimilar. In most Schizopteridae the parameres are asymmetrically mounted and dissimilar to the point that the left paramere (Fig. 77B, **lpm**) is subtriangular and lies immobile on the floor of the capsule, while the right paramere (**rpm**) is elongate and mounted in a very flexible manner at the posterior margin. The two parameres in Schizopteridae and Cryptostemmatidae are joined by mutual articulations with both the basal plate (Fig. 77B, **bp**) and the genital capsule (Fig. 77a, **IX S**).

The aedeagus (Fig. 77C) is differentiated into phallobase, conjunctiva and vesica and projects centrally from the genital capsule. It is mounted upon the transverse basal plate (Fig. 77B, **bp**) which is always articulated with the two parameres. The vas deferens passes through a basal plate bridge similar to that described by Singh Pruthi (1925), and opens at the tip of the normally elongate vesica (Fig. 77C, **vs**) which is associated with the sperm pump. The sperm pump is a complex structure of which the only constantly recognisa-

ble feature is a flask-shaped bulb (Fig. 77C, **vb**) leading to the base of the aedeagal vesica. Whether the vesica is very short or very long it is always strongly sclerotised, filamentous, and in repose is either coiled like a watch hair-spring as in *Chinannus* (Fig. 77C, **vs**) or at least shows signs of coiling by a corkscrew appearance (*Hypselosoma*). *Corixidea* (Fig. 137), *Ogeria* and *Pinochius* have species in which there is a straight spine-like branch of the vesica, which projects at a tangent from the coil. Between the phallobase and the vesica are a number of small angular sclerites differentiated from the conjunctiva, which in some genera are greatly developed into one or two conspicuous conjunctival appendages. Though present as minor elements of the genitalia in *Hypselosoma,* they are highly developed in *Schizoptera* (Fig. 77C, **rca, lca**).

The anal tube, which throughout the Heteroptera is considered to represent segment X, is in *Hypselosoma* mounted on a median sclerite (Fig. 75, **IX T**) which lies immediately posterior to tergum VII and which joins the upturned sides of the IXth sternum or genital capsule (Fig. 75, **IX S**). It is reasonable to suppose that this sclerite represents the IXth tergum and that the appendages that are articulated at its lateral extremities are morphologically derived from it (app. **IX T**). A similar situation exists in *Hypsipteryx* (Fig. 76). In the drawing of the genital armature of *Nannocoris descolei* by Wygodzinsky (1951:60, Fig. 32) and also in some other species of *Nannocoris* (Fig. 122) there are a pair of articulated appendages mounted on the inner lateral margin of the genital capsule. In these species the IXth tergum cannot be identified, so if it has become incorporated into the genital capsule or suppressed it is possible that these articulated appendages are homologous with those of *Hypselosoma.* There are many species in which neither the IXth tergum nor the articulated appendages can be recognised.

In *Membracioides, Hoplonannus, Nannocoris, Chinannus, Bironannus, Pinochius, Biturinannus, Pachyplagia, Itagunannus, Vilhenannus* and *Machadonannus* there are one or two complex appendages developed from the base of the anal tube (Fig. 77D, 120, 122, 123, 141, **an app**). Whether or not these appendages are morphologically derived from segemet X or from the displaced IXth tergum, it is not possible to say, but in *Nannocoris* they may occur together with the articulated appendages discussed above. These rigid appendages

have been termed "anophoric appendages" and the sclerite upon which they are borne the "anophore" by Wygodzinsky (1950); this terminology will be followed here. Though it is possible that the anophore represents a displaced tergum IX the non-articulated anophoric appendages are unlikely to be homologous with the appendages of the IXth tergum of *Hypselosoma,* and are probably a new structure.

One of the most striking features of Schizopterid genitalia is that though there are always one or more spinous processes projecting anteriorly to the right, they may be derived from any one of four non-homologous structures: tergum VIII, tergum IX(X?), sternum IX, or the conjunctiva. Figure 77 shows a diagrammatic representation of all the genital components known in Schizopteridae as they could appear in one specimen.

INTERNAL ANATOMY

The only previous accounts of internal structures in the Schizopteridae have been the drawings of spermathecae by Wygodzinsky (1950 a, 1951, 1953, 1958) and Miyamoto (1960), the descriptions of the alimentary canal and associated organs by Miyamoto (1961), and the data on the ovariole numbers by Miyamoto (1957).

Alimentary canal. — The general plan of the dissected and displayed alimentary organ system of *Hoplonannus* is shown in figure 78, and is typical also for *Corixidea* and *Schizoptera.* The slender oesophagus (**oes**) is hardly "short" (Miyamoto, 1961), and the malpighian tubules (**mlp t**) do not show sexual dimorphism, but otherwise the gut conforms to the descriptions and drawings of *Kokeshia* and *Hypselosoma* as portrayed by Miyamoto (1961). The oesophagus expands to form a crop which together with the short wide and mildly convoluted hind gut varies in shape considerably with variation in the gut contents. The four malpighian tubules (**mlp t**) are recurrent at their mid-point and are distally associated with the rectum (**r**). The rectal pad, stated by Miyamoto (1961) to occur in *Hypselosoma* and *Kokeshia,* was not identified for no satisfactory histological preparations were made, though these would have been particularly interesting in the light of Goodchild's work (1963 a & b).

In *Hoplonannus* and *Schizoptera* there are two complete sets of salivary glands with ducts opening into the hypopharynx. The an-

terior set, which lie in the posterior part of the head capsule and anterior prothorax, are similar to those drawn by Miyamoto (1961) from *Kokeshia* and *Hypselosoma,* and are composed of a subrectangular principal gland (**p sl g**$_1$) and an elongate vesicular accessory gland (**a sl g**$_1$). These organs as they occur in *Hoplonannus* are shown in figure 78. In addition to these organs, there are a much larger pair of subrectangular principal glands (**p sl g**$_2$) lying under the indirect flight muscles posterior to the phragma in the anterior pterothorax, and there are also a pair of elongate vesicular glands closely applied to the sides of the crop (**a sl g**$_2$). If the function of these glands is salivary secretion then the Schizopteridae have two complete sets of principal and accessory glands, a condition which has not been previously described in Heteroptera. The shape of the thoracic principal salivary gland is similar in all the species studied and the detailed structure can only be made out with difficulty, but it seems to consist of four compact lobes each made of a small number of large nucleated cells. The shape of the thoracic accessory gland varies for in *Hoplonannus* they are apically curled as in figure 78, but in different species of *Schizoptera* they may be 7-shaped or apically bifid. In all cases the accessory gland is composed of a column of large cells with about thirteen large nuclei. Serial sections were attempted but the hardness of the thoracic integument was a difficulty that was not overcome.

Male reproductive system. — The male reproductive system of all the genera studied consists of a pair of smooth globular testes (Fig. 79, **t**) whose follicles cannot be distinguished, a vas deferens (**v d**) from each, and a mesodene accessory gland (**acc gl**) which arises just distal to the bulbus ejaculatorius (**blb ej**) which leads to the aedeagus.

Female reproductive system. — The female system (Fig. 78) in *Hoplonannus* and *Schizoptera* consists of a pair of ovaries each containing four ovarioles (**ovl**), a number which is in agreement with that of *Hypselosoma* and an undetermined genus (Miyamoto, 1957). The two oviducts (**ovd**) unite and the common oviduct (**c ovd**) opens between sternites VIII and IX.

The spermathecal duct (**sp d**) which leads to the spermathecal capsule (**sp c**) opens into the oviduct just before the external opening. A spermatheca has been discovered in all the species examined

both in the Schizopteridae and Cryptostemmatidae and though basically similar in the two families there are characters that are helpful in building supra-generic associations. The basic structure consists of a spherical or elongate capsule (Fig. 80, **sp c**) which opens at one end into the distally sclerotised spermathecal duct (**sp d**) and at the other into the spermathecal bulb (**sp b**), which is a thick-walled cylinder at the apex of which is a thin-walled sphere which may vary in appearance according to mounting conditions. The ducteoles described by Pendergrast (1957) in the bulb of *Ceratocombus australiae* were not observed in any of the specimens examined, which included Trinidadian species of *Ceratocombus*.

The Cryptostemmatidae seem to maintain the spherical shape of the spermathecal capsule as it is seen in *Seychellesanus* (Fig. 82), *Hypsipteryx* (Fig. 83), *Ceratocombus* (Fig. 84), *Cryptostemma* (Fig. 85) and *Trichotonannus* (Fig. 86), whereas in Schizopteridae though some genera are also simple like *Glyptocombus* (Fig. 87), the majority are elongate and curved about their middle (Figs. 80, 81, and 88-100). The spermatheca provides good specific characters as first shown by Wygodzinsky (1950 a and b) with the spermatheca of three species of *Pinochius* (Figs. 97, 99, 100). One must be wary of artifacts due to different preparatory treatments and mounting techniques for these could lead to considerable variation in the appearance of the spermatheca. However, the figure of the spermatheca of *Machadonannus* (Wygodzinsky, 1953, Fig. 33), reproduced here as figure 93, though seeming unlikely to be typical in view of the homogeneity of the spermatheca in the whole family, was drawn in glycerine and is correct. Similarly, the structure of the spermatheca of *Kokeshia* (Miyamoto, 1960, plate 19, Fig. M), reproduced here as figure 81, looks very unusual until compared with the original drawing of the spermatheca of the closely related genus *Pachyplagia* (Fig. 80). The curious apparent structure of the spermathecal bulb in *Kokeshia* was not seen in *Pachyplagia*.

Central nervous system. — The central nervous system (Fig. 78, **eg, sog**) is typically hemipterous with a concentration of the abdominal and thoracic ganglia in the thorax (t_1, t_2, t_3), but the distinction between the pro- and mesothoracic ganglia is still evident and represents a primitive feature.

Egg. — Previous knowledge of the egg is limited to the drawings

of exovariole eggs of *Hypselosoma* (Fig. 102) by Miyamoto (1959), and *Vilhenannus* (Fig. 106), *Dundonannus* (Fig. 103) and *Luachimonannus* (Fig. 101) by Wygodzinsky (1953). The known eggs range in size from 0.4 mm. to 1 mm., and in volume are equal to about a quarter of the abdomen. Bilaterally symmetrically oval in shape, they are apically obliquely operculate without an inset rim, and the exterior is deeply sculptured with a reticulate pattern that extends over the operculum, but which is usually more deep on the adoperculate than the aboperculate surface. The structure of the egg seems similar in both Schizopteridae and Cryptostemmatidae, for the drawing of the egg of *Trichotonannus* by Wygodzinsky (1950 b) (reproduced as Fig. 104) is similar in appearance to the eggs of *Chinannus, Schizoptera* and *Hoplonannus* which are hardly distinguishable from the composite figure 105. The structure of the egg of *Luachimonannus* has been confirmed and the eggs of *Dundonannus* and *Vilhenannus* were drawn prior to mounting so their unusual structure is real and not artifactual.

Hoplonannus has a prominent T-shaped egg burster on the vertex of the first instar larva, and was observed to achieve eclosion by pushing off the entire operculum, which remains narrowly attached to the remainder of the egg by the posterior margin.

THE SCHIZOPTERIDAE KNOWN FROM TRINIDAD

The only published records of Schizopteridae from Trinidad are *Chinannus trinitatis* and *Schizoptera stricklandi,* both described by China in 1946 from a small number of specimens collected by A. H. Strickland, who was then a student of the Imperial College of Tropical Agriculture (now The University of the West Indies). There is an additional unpublished record consisting of two British Museum specimens of *Schizoptera sulcata* taken at light from the grounds of the Imperial College by C. L. Withycombe in 1923. Recent collecting has shown *S. sulcata* to be still abundant at the College but no specimens of *S. stricklandi* have been found there, though it is common elsewhere, probably because the original type locality has been ecologically altered by building development programs.

Trinidad is a continental island which has become divided from the South American mainland only during the last ten to fifteen thousand years and from which it is now separated by a channel six miles

wide and seven fathoms deep. The gross fauna of Trinidad is essentially similar to that of the mainland but, with the exception of recently introduced species, it has few affinities with the islands of the Lesser Antilles. Tobago, an island lying twenty-one miles north-northeast of Trinidad, has had a complex geological history and it is not known when, or even if, it enjoyed a land connection with the mainland. Its fauna is essentially a pauperised Trinidadian one with some as yet unexplained anomalies. The islands of the Lesser Antilles are all volcanic and oceanic though some, like the Grenadines, have been united during the last sixteen thousand years by the depression of the ocean level during the last glacial period.

In general there has been little collecting of Hemiptera in the neotropical region, especially of soil or litter-inhabiting species, but as all the areas that have been sampled at all adequately, namely, Guatemala, Panama and Trinidad, have each shown the fauna to be abundant in species, it is reasonable to suppose that elsewhere where conditions are ecologically suitable the fauna will also be found to be widespread and rich.

In Trinidad, collecting was concentrated in the neighborhood of the William Beebe Tropical Research Station, which is the field station of the New York Zoological Society, situated at an altitude of 250 meters on the southern side of the Northern Range. Further information on the site and its ecology is available in Beebe (1952). With the exception of some parts of the Northern Range, Trinidad is well developed agriculturally and the plains are almost entirely cultivated with sugar-cane which renders the soil generally unsuitable for habitation by insects susceptible to dessication. *Chinannus trinitatis* was found in almost all the situations examined in the Northern, Central and Southern ranges where the forest litter was able to retain some of its moisture during the dry season, which normally extends from January to May. Though apterous and immature forms were taken by sieving forest litter, the majority of the alates were taken at light, and many of these were never associated with their biological habitat. Of the 48 species now known from Trinidad it is remarkable that no less than 33 species were taken from one light trap at one locality. The composition of the catch of this trap has already been considered on a family basis (Emsley, 1962) and it was noted that the Schizopteridae formed the bulk of the catch both in numbers of

individuals and in numbers of species, though the high number of individuals can be attributed to the erratic abundance of one species. Many of these species belong to different species-groups within the genus *Schizoptera,* though their females are not known. The systematic spectrum is very similar to that already known from Panama and Guatemala where again this abundance of closely related species of *Schizoptera* was noticed. All the new Trinidadian material has been compared with the types in the United States National Museum, the British Museum (Natural History) and those in the collection of the Zoological Museum of Helsinki.

Published descriptions of new Schizopteridae have improved greatly during the last twenty years and Wygodzinsky has set a high standard of drawing and description. Some authors like Kellen (1961) and Gross (1951) quote the linear and relative measurements of many anatomical components, but variation due to preparation, intrinsic variation, measuring techniques and human error reduces the value of many of these figures. In particular, the difficulty of determining the boundary between adjacent proximal antennal segments can lead to substantial errors in their measurement and therefore in their proportionate length. The conversion of measurements into terms of the length of a structure that is easily measured, such as the width of one eye, has been employed by some workers, but even this does not overcome the difficulty of the absolute measurement of such structures as forewings in which the base is concealed by the pronotum, and the hind tibia whose measured length varies according to the position in which it is set relative to the femur. Similarly, total length measurements depend upon the contents of the gut and oviducts, and are therefore subject to considerable temporary variation, which in insects of this size may reach twenty per cent or more. In the descriptions that follow there will be non-critical values for total length and accurate values for complete forewing length and head width, both inclusive and exclusive of the compound eye.

Not included in this paper are single undescribed species of *Glyptocombus* and *Ceratocomboides.*

Key to Genera of Trinidad Schizopteridae

1. Rostrum apically truncate (fig. 126) 2
   Rostrum apically pointed (fig. 144) 3
2. Male forewing with anterior and vannal veins thickened in depth, mem-

brane weakly sclerotised (figs. 127, 129, 131); elongate appendage arising on Tergum VIII (figs. 132, 133, 135); female macropterous ..... *Corixidea*

Male forewing with anterior and vannal veins thickened in width, membrane strongly sclerotised (figs. 138, 140); no elongate appendage on Tergum VIII though possibly on Tergum VII (fig. 141); female elytrous (fig. 139) ..... *Hoplonannus*

3. Rostrum three-jointed, compound eyes medium to large, male wing venation as figs. 145, 147 or 111 4

Rostrum four-jointed, compound eyes small, male wing-venation as fig. 53 ..... *Chinannus*

4. Middle joint of rostrum less than twice as long as apical segment (fig. 2); macropterous wing venation as fig. 145 or 147 ..... *Schizoptera*

Middle joint of rostrum more than twice as long as apical segment (figs. 116, 121); macropterous wing venation as figs. 108, 111 or 112 ..... *Nannocoris*

Genus **CHINANNUS** Wygodzinsky, 1948

Chinannus trinitatis (China, 1946)

Chinannus trinitatis was fully described by China (1946) as a species of the little known genus *Ptenidiophyes*, but in 1948 Wygodzinsky very adequately described a new genus *Chinannus* and correctly re-allocated *trinitatis* to it. *C. trinitatis* is the most widespread schizopterid in Trinidad, the macropterous males being commonly taken at light and the brachypterous females are of frequent occurrence in damp humus in all suitable localities.

Genus **NANNOCORIS** Reuter, 1891

The characters previously recorded (Reuter 1891, McAtee and Malloch, 1925) include the porrect attitude of the elongate head capsule (fig. 116), the elongate second joint of the rostrum (fig. 116), the pronotal suture which runs from behind the eye to the posterior propleural margin (fig. 116, **pns**), the sinuate course of the anterior branch of the media (figs. 108, 111, 112), and the rounded posterior margin of the metepisternum. More detailed characters can now be added. The wing coupling consists of a hook and opposed pad, the apex of the mesoscutellum is not evenly pointed but constricted by a lateral step (figs. 117, 118), the tarsal formula of the male is 3.3.3. and female 2.2.3, the pro and mesothoracic tarsi of males have an empodial vesicle in addition to the pair of capitate

auxiliae which are present on all the tarsi of both sexes, the hind wing is tri-lobed, there are five visible abdominal sternites in the ventral mid-line, there are no parasternites or paratergites, a pair of spiracles are carried laterally on sternites VI and VII and on tergite VIII, the VIIIth, VIIth and sometimes VIth abdominal tergites of males are asymmetrical and intimately associated with the genitalia (fig. 123), the paraproctal appendage is well developed and of complex shape, there are no conjunctival appendages or processes arising from the genital capsule, the left paramere is flat, lobate and inconspicuous, the right paramere is elongated. The female genitalia are vestigial, and the spermatheca (fig. 109) is elongate and V-shaped. Only macropterous and sub-macropterous males and macropterous females are known.

Key to Trinidad Nannocoris

1. Head capsule porrect but short, hardly or not projecting posterior to compound eyes (fig. 116) 2
   Head capsule porrect but long, distinctly projecting beyond compound eyes (fig. 121); in male one paraproctal appendage simple, the other geniculate (fig. 122) ..... *N. pricei*
2. Vertex without median conical pit; in male paraproctal appendages filamentous and complex, tergite VIII grossly asymmetrical (fig. 120) ..... *N. arimensis*
   Vertex with median conical pit; in male one paraproctal appendage simple and straight, the other sickle-shaped and bifid, tergite VIII mildly asymmetrical (fig. 123) ..... *N. wrightae*

Nannocoris arimensis n. sp.

Macropterous male. — Body length 1.5 mm.

Color. — Postero-lateral aspects of vertex, pronotum, propleura, pterothorax, corium and vannus dark brown; anteclypeus, frons, genae, bucculae, rostrum, antennae, prosternum and legs light brown; abdomen medium brown; paraproctal appendages distally black; anterior half of membrane cream proximally and smoky distally; posterior half of membrane translucent.

Structure. — Head capsule (fig. 116) short, when dissected (0.27 mm.) hardly extending posterior to eyes, width over eyes 0.33 mm., width between eyes 0.20 mm.; bucculae conspicuous, extending posteriorly as a pair of ridges that terminate posterior to the bases of the antennae; ocelli present close to inner margin of compound eyes; ante-clypeus when viewed from above clearly extending beyond jugae; no median pits in head capsule; rostrum in repose reaching just beyond the mesocoxae, ratio of lengths of segments I-1 : II-2.7 : III-1; antennae of normal proportions, mounted well below the level of the compound eyes. Proepimeron with concavity posterior to coxal articulation (fig. 116, **con**); collar (**pnc**) separated off by a deep smooth-bottomed chan-

nel. Mesoscutellum without median depression (fig. 117); mesosternal spine slender, arising from between the two small ornamented prominences, directed posteriorly parallel to the sternum and apically in contact with the tip of the short blunt vertical metathoracic spine (fig. 110); metendosternite deeply forked and reflected laterally (fig. 110, m_3e). The forewing venation is typically *Nannocoris* (fig. 108) with delicate puncturation along the base of the cubitus, the veins on the vannus and along the posterior margin of the media distal to the embodial suture; the dissected forewing measures 0.95 mm. Abdominal tergite VI (fig. 120) is spinous along the right posterior margin; tergite VII is substantially asymmetrical by reduction and specialisation on the right, tergite VIII is strongly asymmetrical and medially divided; the paraproctal appendages of tergite IX consist of a pair of filamentous structures separate to their bases (fig. 120, **ppa**); the left paramere (**lpm**) is mussel-shaped, and the right paramere (**rpm**) elongate with a hooked tip; the vesica of the aedeagus is coiled about fifteen turns, and has a curious cockscomb-like structure associated with its base (fig. 124).

Material studied. — Holotype ♂ [AMNH, in glycerine], at light, WBTRS, Arima Valley, Trinidad, W. I., April 1963 (M. G. Emsley). Three paratype ♂ ♂ [AMNH, USNM, glycerine], three paratype ♂ ♂ [AMNH, USNM, slides], same data, July 1962.

Nannocoris wrightae n. sp.

Macropterous male. — Body length 1.5 mm.

Color. — Head capsule, thorax and abdomen medium brown, rostrum antennae and legs lighter, forewing at its base as dark as pronotum grading to pale cream apically on the anterior half of the membrane, posterior half of membrane translucent; apices of paraproctal appendages very dark brown.

Structure. — Head capsule short when dissected (0.32 mm), hardly projecting behind the eyes, width over eyes 0.37 mm., width between eyes 0.20 mm., bucculae inconspicuous, ocelli present, anteclypeus when viewed from above clearly extending beyond jugae, conspicuous shallow median conical pit on vertex between compound eyes; rostrum with segmental ratios I-3 : II-11 : III-4; antennae normal, mounted latero-ventrally on head capsule ventral to the compound eyes. Collar well differentiated, proepimeral pit present but inconspicuous. Pterothorax similar to *N. arimensis* n. sp. but with the fork of the metendosternite more widely reflexed and less deeply divided (fig. 114, 115). Forewing with typical *Nannocoris* venation but distinguishable from the previous species by the less abrupt change in texture at the corio-membranal interface, the more extensive puncturation around the vannal and cubitus veins, and there is a small black tubercle at the fork of M and R (fig. 111, **tub**). The posterior margin of abdominal tergite VI is coarsely serrate to the right of the mid-line (fig. 123), tergite VII is substantially asymmetrical and semi-divided in the midline, and tergite VIII is

severely asymmetrical and is intimately associated with genital structures from segment IX. The paraproctal appendage (fig. 123, **ppa**) is highly sclerotised, one branch of which is paddle-like, while the other is elongate and forked to produce two spines, one nearly straight and the other sickle-shaped with the convex margin serrated; the parameres and aedeagal structures are hardly distinguishable from those of *N. arimensis,* but though the "cockscomb" is present on the phallobase, it is much broader (fig. 125). The vesica is coiled about twenty times.

Material studied. — Holotype macropterous ♂ [AMNH, in glycerine with genitalia on slide] at light, WBTRS, Arima Valley, Trinidad, W. I., March 1962 (M. G. Emsley). Paratype ♂ [USNM, on slide, genitalia missing], same data, June 1963.

This species is named after Mrs. Asa Wright for her great effort to conserve the fauna of the Arima Valley in Trinidad.

Nannocoris pricei n. sp.

Macropterous male. — Body length 1.75 mm.

Color. — Head capsule, rostrum, antennae and legs ochreous; thoracic sterna, collar, anterior margin of corium, vannus and anterior half of membrane light brown; central portion of corium darker; posterior half of membrane translucent; pronotum, pro-pleura, mesoscutellum and pteropleura chocolate brown; venter of abdomen medium brown.

Structure. — Head capsule (fig. 121) elongate, when dissected (0.4 mm.) extending substantially behind the eyes, width over eyes 0.37 mm., width between eyes 0.23 mm., bucculae conspicuous, ocelli present, anteclypeus when viewed from above extending substantially beyond the jugae, no median pit on head capsule; rostrum in repose extending to metacoxae with ratio of segments I-1 : II-4 : III-1. Pronotum with deep channel separating the collar (fig. 121, **pnc**), and with a conspicuous conical pit in the channel in the midline. Mesoscutellum (fig. 118) with shallow transverse central depression; meso and metathoracic sterna (fig. 119) without median spines but with a groove for the reception of the rostrum, metendosternite broad but with only small apical processes (m_3e). Forewing (fig. 112) with typical *Nannocoris* venation but with a conspicuous single row of coarse tubercles along both sides of the cubitus and first vannal veins and also inset along the posterior margin of the distal half of M on the corium. The tubercle noticed in the angle of R and M in *N. wrightae* is in this species larger, horseshoe-shaped and furnished with internal hairs (fig. 113). Tergite VI (fig. 122) is symmetrical, tergite VIII is strongly asymmetrical and medially divided; the paraproctal appendage is divided to its base into a pair of elongate highly sclerotised structures, one apically hooked and the other bent through a hundred degrees in the middle and invested with dense fine spines along the concave margin (fig. 122, **ppa**); the parameres are hardly distinguishable from *N. ari-*

mensis, though the left is a little more elongate. The vesica is filiform but is coiled through only one revolution, and the "cockscomb" of the preceding species is not present.

Macropterous female. — Essentially similar to the male but without the specifically characteristic cavity in the channel separating off the collar. The spermatheca is shown in fig. 109. The posterior margin of VII sternite is uniformly serrate.

Material studied. — Holotype macropterous ♂ [AMNH, in glycerine, genitalia and one wing on slide], sieved from forest litter, Maracas valley, Trinidad, W.I., 6.iii.1961 (M. G. Emsley); allotype [AMNH, in glycerine, wing and genital segments on slide], same data, 10.viii.1962, in forest litter (M. G. Emsley). Paratype ♀ [USNM, on slide] WBTRS, Arima Valley, Trinidad, W.I., at light, 6.i.1960 (M. G. Emsley).

This species is named after Dr. John Price who kindly made his forest garden available for collecting.

Genus **CORIXIDEA** Reuter, 1891

Corixidea was originally described as a subgenus of *Schizoptera* and not given generic rank until 1912. It was distinguished from *Schizoptera* by the large eyes, the venation, the thickening of the vannal and anterior corial veins which contrast sharply with the rest of the wing (figs. 127, 129, 131), the short truncately-tipped rostrum (fig. 126), and the rounded posterior angle to the metapleurum (fig. 13, **hpl**).

It is now possible to add that the rostral segments are subequal in length; the tarsal formula is 3.3.3. in males and 2.2.3. in females and the males have a vesicular empodium between the claws of the pro- and meso-thoracic tarsi; the hind wing is trilobed; there is an invasion of the metanotal region by the metapleura which form a pair of lobes posterior to the metascutum; there are no pterosternal spines (fig. 128); there are five visible abdominal sternites in the ventral mid-line; spiracles are borne on sternites VI and VII and tergite VII; tergite VIII has its posterior margin drawn out into a long spinous structure of complex shape which points to the anterior right (figs. 132, 133, **app.** VIII); there are neither paraproctal nor conjunctival appendages; the right paramere, which is articulated at the posterior margin of the genital capsule, is elongate, and the left paramere small, lobate and inconspicuous. The female

genitalia are vestigial. Only macropterous males and females are known.

Key to Trinidad Corixidea (females unknown)

1. Male with central cells of forewing fenestral, vannal veins thickened regularly (fig. 127); process of tergite VIII short, spined distally and along whole of anterior margin (fig. 132). ..... *C. beebei*
   Male with central cells of forewing developed normally, vannal veins thickened irregularly (figs. 129, 131); process of tergite VIII long (figs. 133, 135) 2
2. Both vannal veins grossly irregularly thickened (fig. 129); process of tergite VIII spined apically and anteroproximally only (fig. 133) .... *C. underwoodi*
   Only proximal anterior vannal vein thickened (fig. 131); process of tergite VIII filamentous with a pair of dissimilar lateral processes arising near base (fig. 135) ..... *C. julieae*

Corixidea beebei n. sp.

Macropterous male. — Body length 1.6 mm.

Color. — Head capsule, apex of rostrum, prothorax, pterothorax, vannal veins, veins surrounding the elongate anterior cell, and abdomen, dark chocolate brown; coxae light brown; antennae, base of rostrum, legs distal to coxae, ochreous. Area of corium between vannal and anterior folds white; a stellate patch of tawny brown in centre of corium; membrane uniformly hyaline. There is no sharp linear distinction beween the corium and the membrane.

Structure. — The head capsule is broad, width over the eyes 0.55 mm., width between eyes 0.3 mm. with a dorsal bristle on the occiput just median to the compound eyes, a second, inconspicuous bristle a little lower, and a third bristle midway between and median to the ocellus and the base of the antenna. The rostral segments are in the proportionate lengths I-4 : II-4 : III-5, and in repose the rostrum hardly extends beyond the procoxae. The second medial cell is obscured and the vannal veins are strongly thickened and setigerous (fig. 127). The meso-scutellum has a pair of pits connected by a shallow transverse groove. The abdominal sternites are without special features, but the process of tergite VIII which arises from the posterior margin, is articulated at its base with the genital capsule, and is covered with distally directed black spines that give it a brush-like appearance (fig. 132, **app.** VIII). Tergite IX is simple and fused to the right side of the genital capsule. The genital capsule is developed into a large coarse spine at the right anterior margin (fig. 132, IX S). The left paramere (**lpm**) is triangular and lies flat on the floor of the genital capsule, the right paramere (**rpm**) is elongate and apically hooked. The aedeagus (**vs**) is coiled through one and a quarter turns.

Material studied. — Holotype macropterous ♂ [AMNH, in glycerine], at light, St. Augustine, Trinidad, W.I., 12.xi.1960 (M. G.

Emsley). Two macropterous ♂ paratypes [USNM, AMNH, slides] same data.

This species is named after the late Dr. William Beebe who showed so much interest in these insects during the last years of his life.

Corixidea julieae n. sp.

Macropterous male. — Body length 1.5 mm.

Color. — Essentially similar to *Corixidea beebei* but the light spot at the base of the forewing traverses the base of the corium and vannus and is not bounded by the vannal and anterior folds.

Structure. — Head, rostrum, antennae, pro- and pterothorax and legs indistinguishable from *C. beebei.* Forewings with venation on centre of corium developed normally; the vannal veins not thickened beyond one-third of their length from the base (fig. 131). The appendage of the VIII tergite (fig. 135) is a flagellum-like spine with two subsidiary short spines arising one-third of the distance from the base. The right paramere (fig. 136, **rpm**) is more slender and more regularly curved than that of *C. beebei* and without an apical hook, and the left paramere (fig. 134, **lpm**) is spoon-shaped. The vesica of the aedeagus (fig. 137, **vs**), which is coiled about one-and-a-half turns, gives off a straight lateral spine-like branch three-quarters along its length.

Material studied. — Holotype macropterous male [AMNH, slide], at light in Pangola pasture, University Field Station, St. Augustine, Trinidad, W.I., 26.iv.1962 (M. G. Emsley).

This species is named after my wife who has devoted so much of her time to the preparation of the illustrations in this and other papers.

Corixidea underwoodi n. sp.

Macropterous male. — Body length 1.7 mm.

Color. — Head, rostrum, thorax, abdomen, anterior corial cell and vannal veins, dark brown; legs, antennae, light brown. White patch at base of corium, bounded by anterior fold and proximal half of vannal fold. Boundary between corium and membrane indistinguishable, membrane uniformly hyaline.

Structure. — Head and its appendages, thorax and legs indistinguishable from *C. beebei,* but the vannal veins of the forewings are even more incrassated at their base and are densely invested with short hairs along the opposed dorsal surfaces (fig. 129). The appendage arising from the posterior margin of the tergite VIII is of great length and almost reaches the pterothorax. It is invested basally and apically, with strong distally directed spines (fig. 133, **app. VIII**). Neither the parameres (**lpm, rpm**) nor the vesica show special features, though the apex of the right paramere lacks the apical hook of *C. beebei.*

Material studied. — Holotype macropterous ♂ [AMNH, slide], at light, 1.xii.1960, St. Augustine, Trinidad, W.I., (M. G. Emsley).

This species is named after Dr. Garth Underwood whose guidance in this and other work was most valuable.

Genus **HOPLONANNUS** McAtee and Malloch, 1925

This genus was proposed to contain a unique brachypterous female from Guatemala, but collecting in Trinidad has shown that females that are indistinguishable from the type have males that are similar to *Corixidea*. *Hoplonannus* shares with *Corixidea* the short truncate-tipped rostrum, large eyes, conspicuous cibarial muscle insertion scars, the absence of a collar, the absence of meso- and metasternal spines, the dorsal development of the metapleura, the pretarsal and tarsal formula and metacoxal pads in both sexes, the trilobate hindwing in macropterous forms, the absence of conjunctival appendages and the vestigial ovipositor in females. The principal differences from *Corixidea* are that the heavily sclerotised anterior cells of the forewing grade into the rest of the corium without distinct contrast; the vannal veins, though heavily sclerotised and broad, are not thickened vertically (figs. 138, 140). The abdomen lacks the conspicuous appendages developed from the posterior margin of tergite VIII, but has a short process from the posterior margin of tergite VII (fig. 141, **II T**), and the paraproctal appendage is extensively developed towards the right side of the posterior abdomen (**ppa**). The right paramere (**rpm**) articulates with the posterior margin of the genital capsule and is variously shaped, the left paramere (**lpm**) is triangular, inconspicuous, and lies flat on the floor of the genital capsule. The only forms known are macropterous males and brachypterous females.

Key to Trinidad Hoplonannus

1. Male with right paramere apically asymmetrically bifid (fig. 141), female ultimate sternite with three small spines, the middle one largest (fig. 72) ..... *H. paenebrunneus*

   Male with right paramere apically complex (fig. 142), female ultimate tergite without median spine ..... *H. craneae*

Hoplonannus paenebrunneus n. sp.

Macropterous male. — Body length 1.5 mm.

Color. — Head capsule, terminal joint of rostrum, thorax, abdominal sternites, terminal abdominal tergites, vannus, anterior and central portion of corium, very dark brown; forewing membrane smoky brown. Legs, antennae and base of rostrum ochreous. Vannal fold broadly cream, so with the wings in repose there is a cream V around the meso-scutellum.

Structure. — Head capsule 0.5 mm. wide over eyes, 0.32 mm. between eyes, with a conspicuous ocular bristle median to each compound eye and a less obvious frontal bristle median to the base of each antenna. Ocelli conspicuous. The rostrum, in repose, hardly extends beyond the procoxae and bears conspicuous porrect bristles. The mesoscutellum has a pair of pits connected by a shallow transverse groove, and is conspicuously constricted subapically. The forewing has a venation and sclerotisation as shown in figure 138. The second visible abdominal sternite has a small papilla projecting from the posterior margin on the right hand side, and the third visible segment (V) has a more squat truncated papilla in the middle of the left side of the sternite. The seventh abdominal tergite (fig. 141, **VII T**) is thoroughly sclerotised and has a minute papilla on the anterior margin just left of centre and has a conspicuous thumb-like process developed from the middle of its posterior margin (fig. 141). The right paramere has an apical point and hook rather like a bottle-opener (fig. 141, **rpm**), the left paramere (**lpm**) is inconspicuous. The paraproctal appendage (**ppa**) is large, and strongly deflexed with a subterminal sickle-shaped hook. The vesica of the aedeagus is coiled through one and a half revolutions.

Brachypterous female. — Body length 1.25 mm.

Color. — Similar to the male but brachypterous wings uniformly dark brown.

Structure. — Similar to the male but without ocelli, with the forewings brachypterous without a suture between vannus and corium and without the differentiation of the membrane (fig. 139). The venation is particularly conspicuous on the ventral surface and is directly comparable with the macropterous pattern. In repose the elytra overlap a little in the midline. The posterior margin of the last visible sternum has a single blunt central spine with a smaller one on each side (fig. 72). The spermatheca is as shown in figure 143.

Material studied. — Holotype macropterous ♂ and brachypterous allotype [AMNH, in glycerine] in forest litter, WBTRS, Arima Valley, Trinidad, W.I., 31.iii.1961 (M. G. Emsley). Twelve ♂ paratypes, same locality, one in each month of 1962, at light. Macropterous ♂ and brachypterous ♀ paratype, in litter, Mason Hall, Tobago, West Indies, March 1962 (M. G. Emsley). Numerous other macropterous males and brachypterous female paratypes from various localities in Trinidad in forest litter [AMNH, USNM, BMNH].

Hoplonannus craneae n. sp.

Macropterous male. — Body length 1.6 mm.

Color. — Indistinguishable from *Hoplonannus paenebrunneus.*

Structure. — Separable from *H. paenebrunneus* by the more rounded curvature and deeper reflexion of the anterior margin of the forewing, the greater breadth of the vannal veins and the smaller size of the membranal cells (fig. 140), the shape of the right paramere (fig. 142), and the shape of the paraproctal appendage (fig. 142A). The abdomen lacks the papillae on visible segments two and three and seven.

Brachypterous female. — Body length 1.25 mm. Separable from *H. paenebrunneus* only by the absence of the medium spine on the posterior margin of the VIIth sternite.

Material studied. — Holotype macropterous ♂ [AMNH, in glycerine], in forest litter, Mason Hall, Tobago, West Indies, March 1962 (M. G. Emsley). Allotype [AMNH, in glycerine), and paratype macropterous ♂ [AMNH, on slide], in litter, WBTRS, Arima Valley, Trinidad, W. I., 2.iii.1962 (M. G. Emsley). 2 ♂ and 1 ♀ paratypes [USNM, in glycerine], in litter, WBTRS, 1.ii.1961, 2.iii.1962 (M. G. Emsley). 1 ♀ paratype [AMNH, slide], Guayaguayare, Trinidad, in litter, 5.iii.1961 (M. G. Emsley).

This species is named after Jocelyn Crane who kindly made the facilities of the William Beebe Tropical Research Station available for this study.

Genus **SCHIZOPTERA** Fieber, 1860

The generic features may be summarised as follows: The anteclypeus is sharply delimited posteriorly by a transverse pseudosuture (fig. 144); the antennal proportions approximate to 1:1:6:5: the three-segmented rostrum in repose rarely reaches the mesocoxae, and is apically pointed (fig. 144); the frons and vertex reveal a sexually dimorphic pattern of cibarial muscle scars (fig. 144, left side of head capsule ♂, right side ♀); the prothorax has (except in the subgenus *Orthorhagus*) a distinct collar (fig. 153, 157, 158); the metepisternum has the posteroventral angle produced into a sharp conspicuous spine (figs. 149, 154-156); the mesosternum has an inconspicuous knob, and the metasternum has a conspicuous median ventrally directed spinous process (fig. 149, s_2s, s_3s); the forewing has a characteristic venation (fig. 145), and has the anterior margin sharply reflexed; the wing-coupling consists of a hook and pad; the hindwing

is tri-lobed; the mesoscutellum is more or less subapically constricted (fig. 148); the abdomen has five visible sternites in the mid-ventral line (fig. 152), the most anterior with a pair of anterolateral transverse impressions; sternites III to VII frequently show round lateral abdominal muscle scars (fig. 152); abdominal spiracles are present only upon sternites VI and VII and tergite VIII; the tarsal formula is 3.3.3. in males and 2.2.3 in females, and the males have an empodial vesicle on the pro- and meso-pretarsi in addition to the pair of auxiliae that are present on all the pretarsi of both sexes; the male has sternum VII conspicuously asymmetrical; the male genitalia consists of an aedeagus with a coiled vesica, a pair of asymmetrical parameres and a pair of asymmetrical conjunctival appendages; the anal tube is without paraproctal appendages and is fused to the right wall of the genital capsule (fig. 150). The female has only a vestigial ovipositor and a spermatheca similar to figure 151. The females of some species, and rarely the males, have the forewings highly sclerotised to form elytra (fig. 146).

Schizoptera is the dominant neotropical genus and has very many species which can be grouped into six subgenera on characters identified in the following key:

1. Prothorax without a collar ..... subgenus *Orthorhagus*
   Prothorax with a collar (fig. 153) 2
2. Propleurum with a conspicuous blunt spine (**pps**) on the posterior margin just ventral to the termination of the horizontal pronotal suture (**pns**) (fig. 158) ..... subgenus *Odontorhagus*
   Propleurum without a posterior spine, pronotal suture terminating at humeral angle of pronotum (fig. 157) 3
3. Posterior membranal cell triangular and apically pointed (fig. 147) ..... subgenus *Zygophleps*
   Posterior membranal cell rectangular (fig. 145) 4
4. Metapleurum uniformly sculptured without a shining elevated area, though the ventral margin may have a narrow shining border (fig. 154) ..... subgenus *Schizoptera*
   Metapleurum with an elevated shining area which usually has a differentiated delicate reticulate pattern of sculpturing 5
5. Elevated area extending only half way up metapleuron (fig. 155) ..... subgenus *Cantharocoris*
   Elevated area extending up metapleuron as far as, or almost as far as, the edge of the forewing when in repose (fig. 156) .... subgenus *Lophopleurum*

Subgenus SCHIZOPTERA Fieber, 1860

Characterised by the presence of a collar (fig. 153), the absence of an elevated shining area on the metapleura though the ventral edge of the episternum may be smooth and polished (fig. 154), the lack of a projection from the posterior margin of the propleurum and with the propleural suture running obliquely from the ventral margin of the compound eye to the postero-dorsal angle of the pronotum (fig. 157). At present only macropterous males and females are known which may or may not have ocelli. Females can normally only be identified by circumstantial association with males.

Key to males of Trinidad Schizoptera (Schizoptera)

1. Right conjunctival appendage biramous over distal half (figs. 186, 187, 189, 190) 2
   Right conjunctival appendage uniramous 5
2. Subgenital plate without process visible on right side, apically truncate (fig. 174) ..... *S. (S.) cleofan*
   Subgenital plate with clearly visible process on right side (figs. 168, 170, 171), apically rounded 3
3. Process of right side of subgenital plate a fold in the margin (fig. 168); right paramere stout and apically pointed (fig. 193) ..... *S. (S.) brucei*
   Process of right side of subgenital plate digitiform, solid (figs. 170, 171); right paramere long, arcuate and slender (figs. 196, 229) 4
4. Process of subgenital plate apically reflexed posteriorly (fig. 171); branches of right conjunctival appendage of dissimilar length, apically convergent but not crossed (fig. 190) ..... *S. (S.) anisota*
   Process of subgenital plate directed anterolaterally (fig. 170); branches of right conjunctival appendage of similar length and apically crossed (fig. 186) ..... *S. (S.) psalida*
5. Subgenital plate an almost symmetrical triangle, process on right side inconspicuous (figs. 167, 169) 6
   Subgenital plate strongly asymmetrical, process on right side conspicuous 7
6. Right conjunctival appendage spirally coiled, abruptly reduced in thickness two-thirds distally (fig. 181) ..... *S. (S.) spiralis*
   Right conjunctival appendage twisted and with lateral spines two-thirds distally (fig. 180) ..... *S. (S.) merleae*
7. Subgenital plate with posteriorly directed spine on right side (figs. 172, 243) 8
   Subgenital plate with only laterally directed spine or spines 9
8. Posteriorly directed process of subgenital plate externally serrated (fig. 172); right paramere large and complex (fig. 191) ..... *S. (S.) chelifera*

Posteriorly directed spine of subgenital plate fine and simple (fig. 243), right paramere simple (fig. 273) ..... *S.* (*S.*) *apatosulcata*

9. Subgenital plate with pair of dissimilar lateral spines (fig. 173) ..... *S.* (*S.*) *falcicula*

Subgenital plate with single lateral process (figs. 159-166) 10

10. Right conjunctival appendage coiled through more than one whole turn (figs. 182, 183, 184) 11

Right conjunctival appendage curved through less than a whole turn, or straight 12

11. Right conjunctival appendage with complex capitate tip (fig. 183), subgenital plate as fig. 166 ..... *S.* (*S.*) *caprona*

Right conjunctival appendage with bifid tip, coarsely spined at base (fig. 184); subgenital plate as fig. 162 ..... *S.* (*S.*) *erythiza*

Right conjunctival appendage tapering evenly (fig. 182); subgenital plate as fig. 164 ..... *S.* (*S.*) *susicauda*

12. Right conjunctival appendage straight from just above base (fig. 176); subgenital plate as fig. 159 ..... *S.* (*S.*) *maxima*

Right conjunctival appendage curved over all or most of length 13

13. Right conjunctival appendage unarmed, regularly curved (fig. 185); subgenital plate as fig. 160; right paramere angulate and apically pointed and inflexed (fig. 192) ..... *S.* (*S.*) *rossi*

Right conjunctival appendage armed with spines and irregularly curved (figs. 177, 178, 179) 14

14. Very small species (total length 1.1 mm); subgenital plate as fig. 165, right conjunctival appendage as fig. 177 ..... *S.* (*S.*) *richardsi*

Large species (total length 1.5 mm or more) 15

15. Right paramere produced apically into arcuate cylindrical process (fig. 230); left paramere inconspicuous and rectangular (fig. 235); subgenital plate as fig. 161 ..... *S.* (*S.*) *kennyi*

Right paramere elongate and tapering (fig. 195); left paramere conspicuous and of complex shape (fig. 202); subgenital plate as fig. 163 ..... *S.* (*S.*) *griffithi*

Schizoptera (Schizoptera) maxima n. sp.

Macropterous male. — Body length 1.75 mm.

Color. — Pronotal collar chocolate brown grading to medium brown at base of rostrum and extremities of prothorax; exposed pterothorax, corium, and vannus dark brown; abdomen medium brown; appendages light brown. The membranal cells are cream distally and grade into the corium without a distinct membrano-corial interface, though there is a light patch at the anterior margin of the anterior cell.

Structure. — Ocelli present. Width over eyes 0.55 mm., between eyes 0.28 mm.; forewing 1.5 mm. long, with heavy puncturation along the anterior margin of the first and second vannal veins, the cubitus (including the proxi-

mal posterior angle of the trapezoidal cell) and proximally in the angle between M and R. The seventh sternite is as figure 159, and the genitalia are as figs. 176, 197, 219 and 236. The vesica is coiled about seven turns.

Material studied. — Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W. I., at light, 10.vi.1963 (M. G. Emsley).

Schizoptera (Schizoptera) rossi n. sp.

Macropterous male. — Body length 1.75 mm.

Color. — Head capsule, exposed thorax (except humeral angle of pronotum which is cream), corium and vannus, dark chocolate brown; abdomen medium brown; appendages light brown; membranal cells cream with distal two-thirds smoky; corio-membranal interface very sharp and precise along distal margin of transverse veins.

Structure. — Ocelli present. Width over eyes 0.5 mm., between eyes 0.27 mm., forewing 1.5 mm. long with heavy puncturation along anterior margin of second vannal and cubitus veins including proximal posterior angle of trapezoidal cell, and along both margins of first vannal, medial and radial veins. Seventh sternite as in fig. 160, genitalia as in figs. 185, 192, 224 and 234.

Material studied. — Holotype macropterous male [AMNH, genitalia on slide] and two macropterous male paratypes [USNM, AMNH, slides], WBTRS, Arima Valley, Trinidad, W. I., at light, June 1963 (M. G. Emsley).

Schizoptera (Schizoptera) kennyi n. sp.

Macropterous male. — Body length 1.5 mm.

Color. — Similar to *S. maxima* n. sp.

Structure. — Separable from *maxima* only on genitalia, see figs. 161, 179, 212, 230 and 235.

Material studied. — Holotype macropterous male [AMNH, slide] and three macropterous male paratypes [AMNH, USNM, two glycerine, one slide]; WBTRS, Arima Valley, Trinidad, W. I., at light, 3.vi.1962 (type), paratypes various dates in June, August and September (M. G. Emsley). Two macropterous females [AMNH], indistinguishable from these males on non-genital structures and with the posterior margin of sternite VII as in fig. 299, from the same locality have been provisionally allocated to this species on account of their size, but they could be *maxima* n. sp.

This species is named after Dr. Julian Kenny for his valuable assistance in Trinidad.

Schizoptera (Schizoptera) erythiza n. sp.

Macropterous male. — Body length 1.7 mm.

Color. — Similar to *rossi* n. sp.

Structure. — Indistinguishable from *rossi* n. sp. except for the more heavily and uniformly sclerotised membranal cells which do not contrast with the corium, and the seventh sternite and genitalia, see figs. 162, 184, 194, 209 and 213.

Material studied. — Holotype macropterous male [AMNH, slide], and four macropterous male paratypes [AMNH, USNM, two glycerine, two slides], WBTRS, Arima Valley, Trinidad, W. I., at light, 1.vi.1962 (type), paratypes various dates in July and August (M. G. Emsley). Two macropterous females [AMNH] with identical non-genital characters and with a uniformly rounded apex to the seventh sternite, have been taken from the same locality and have been provisionally allocated to this species. One was taken at light, and the other sweeping lower canopy vegetation.

Schizoptera (Schizoptera) griffithi n. sp.

Macropterous male. — Body length 1.5 mm.

Color and structure. — Indistinguishable from *maxima* n. sp. except for size (forewing 1.25 mm., width over eyes 0.45 mm., between eyes 0.27 mm.); and the membranal cells which are shorter so the posterior membrane is strongly salient (fig. 297), and uniformly pale cream so they are discretely differentiated from the corium; and the genitalia illustrated in figs. 163, 178, 195, 202 and 216. The vesica is coiled four times.

Material studied. — Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W. I., at light, 29.viii.1962 (M. G. Emsley).

Schizoptera (Schizoptera) susicauda n. sp.

Macropterous male. — Body length 1.5 mm.

Color. — Head and exposed thorax uniform dark chocolate brown; abdomen, corium, vannus and membranal cells medium brown; appendages light brown. The membranal cells are not differentiated from the corium and are both strongly sclerotised.

Structure. — Ocelli present. Width over eyes 0.32 mm., between eyes 0.25 mm.; the path of the posterior vein of the posterior membranal cell is strongly curved and posteriorly the membrane is salient (fig. 297). The forewing is 1.3 mm. long, and the seventh sternite and genitalia are as in figs. 164, 182, 207 and 221. The right paramere was broken on the unique specimen.

Material studied. — Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W. I., at light, 30.xii.1961 (M. G. Emsley).

Schizoptera (Schizoptera) richardsi n. sp.

Macropterous male. — Body length 1.1 mm.

Color. — Head, exposed thorax, corium, vannus, membranal cells and abdomen medium brown; appendages light brown.

Structure. — Ocelli present. Small, width over eyes 0.28 mm., between eyes 0.20 mm., forewing relatively broad (length 0.9 mm.), with sculpturing similar to *maxima* n. sp., but more delicate and with the membranal cells as heavily sclerotised as the corium. Post-cellular membrane strongly salient (fig. 297), seventh sternite and genitalia as in figs. 165, 177, 204, 222, and 227.

Material studied. — Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W. I., at light, 27.ix.1961 (M. G. Emsley).

Schizoptera (Schizoptera) caprona n. sp.

Macropterous male. — Body length 1.5 mm.

Color. — Head capsule, exposed thorax except posterior margin of pronotum which is broadly cream, abdomen, corium and vannus dark chocolate brown; appendages light brown. Membranal cells cream with distal half slightly smoky and a distinct corio-membranal interface just distal to the transverse veins.

Structure. — Ocelli present; width over eyes 0.5 mm., between eyes 0.3 mm.; forewing 1.3 mm., with sculpturing similar to *rossi* n. sp.; seventh sternite and genitalia as figs. 166, 183, 206, 220 and 228.

Material studied. — Holotype macropterous male [AMNH, slide] and male paratype [AMNH, slide], WBTRS, Arima Valley, Trinidad, W. I., at light, 4.vi.1962 (M. G. Emsley). A macropterous female [AMNH] indistinguishable from the type on non-genital characters has been provisionally allocated to this species. The posterior margin of the seventh sternite is uniformly rounded.

Schizoptera (Schizoptera) merleae n. sp.

Macropterous male. — Body length 1.4 mm.

Color and structure. — Width over eyes 0.45 mm., between eyes 2.8 mm., length of forewing 1.2 mm. Distinguishable from *susicauda* n. sp. only by the relatively smaller wings which are due to condensation of the membranal cells so the veins are reflected anteriorly more strongly. The whole of the corium

and vannus are strongly punctate except for the distal two-thirds of the trapezoidal cell. The apex of the membrane is strongly salient (fig. 297). The seventh sternite and genitalia are as in figs. 167, 180, 198, 208 and 218.

Material studied. — Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W. I., at light, 6.vii.1963 (M. G. Emsley). Four male paratypes [AMNH, USNM, two slides, two glycerine], June 1962, at light, WBTRS, Trinidad, W. I., (M. G. Emsley).

Schizoptera (Schizoptera) brucei n. sp.

Macropterous male. — Body length 1.6 mm.

Color. — Similar to *caprona* n. sp. but not so dark, and with the membranal cells uniformly pale cream.

Structure. — Ocelli present; width over eyes 0.5 mm., between eyes 0.28 mm.; forewing 1.4 mm. long, and slightly concave along anterior margin, and with strong puncturation along both sides of all the corial and vannal veins except the M-cu crossvein and the antero-distal three-quarters of the trapezoidal cell. The seventh sternite and genitalia are as in figs. 168, 187, 193, 203 and 226.

Material studied. — Holotype macropterous male [AMNH, glycerine] and ten paratype macropterous males [AMNH, BMNH, USNM, four slides, eleven glycerine], WBTRS, Arima Valley, Trinidad, W. I., at light, 31.i.1962 (type) and various dates in February, May, July and October (M. G. Emsley). A female with similar data [AMNH] has been provisionally assigned to this species.

Schizoptera (Schizoptera) spiralis n. sp.

Macropterous male. — Body length 1.5 mm.

Color. — Head capsule, exposed thorax except humeral angles which are lighter, and abdomen, dark brown; appendages and membranal cells uniformly light brown.

Structure. — Ocelli present; width over eyes 0.48 mm., between eyes 0.28 mm.; forewing (1.3 mm. long) is strongly punctate all over except for the apical three-quarters of the trapezoidal cell and a broad band either side of the M-cu cross-vein. The seventh sternite and genitalia are as in figs. 169, 181, 199, 205 and 217. Vesica coiled four times.

Material studied. — Holotype macropterous male [AMNH, glycerine] and two macropterous male paratypes [AMNH, USNM, slides], WBTRS, Arima Valley, Trinidad, W. I., at light, 6.ix.1961 (type), 19.ix.1961, 24.x.1961 (M. G. Emsley).

Schizoptera (Schizoptera) psalida n. sp.

Macropterous male. — Body length 1.65 mm.

Color. — Head capsule, exposed thorax except humeral angle of pronotum which is cream, corium, vannus and abdomen dark brown; appendages light brown; membranal cells uniformly cream.

Structure. — Ocelli present; width over eyes 0.5 mm., between eyes 0.27 mm.; forewing (length 1.55 mm.) with anterior margin slightly concave at base of membrane, with sculpturing indistinguishable from *maxima* n. sp.; seventh sternite and genitalia as in figs. 170, 186, 196, 210 and 225.

Material studied. — Holotype macropterous male [AMNH, glycerine] and eight macropterous male paratypes [AMNH, ANSP, USNM, two glycerine, six slides], WBTRS, Arima Valley, Trinidad, W. I., at light, 8.ix.1961 (type), and various dates in April, July, August and November (M. G. Emsley). Allotype and two female paratypes [AMNH, slides], 10.x.1961, WBTRS, Trinidad, W. I., at light (M. G. Emsley).

Schizoptera (Schizoptera) anisota n. sp.

Macropterous male. — Body length 1.4 mm.

Color. — Indistinguishable from *susicauda* n. sp.

Structure. — Ocelli absent; compound eyes large (width over eyes 0.45 mm., between eyes 0.20 mm.); forewing (length 1.25 mm.) with membrane relatively long so the curvature of the membranal veins is not so great as in *susicauda* n. sp. which it otherwise resembles. Genitalia distinct as in figs. 171, 190, 214, 229 and 232. Vesica coiled about four times.

Material studied. — Holotype macropterous male [AMNH, glycerine] and thirteen macropterous male paratypes [AMNH, BMNH, USNM, two slides, eleven glycerine], WBTRS, Arima Valley, Trinidad, W. I., at light, 8.ix.1961 (type) and various dates in January, March, June and December (M. G. Emsley).

Schizoptera (Schizoptera) chelifera n. sp.

Macropterous male. — Body length 1.25 mm.

Color. — Head capsule, exposed thorax, corium, vannus, membranal cells and abdomen medium brown; appendages light brown.

Structure. — Ocelli present; width over eyes 0.3 mm., between eyes 0.22 mm.; forewing (length 1.1 mm.) sculpturally similar to *maxima* n. sp. but with the membranal cells relatively shorter so the posterior membrane is strongly salient (fig. 297). Seventh sternite and genitalia as in figs. 172, 188, 191, 201 and 215.

Material studied. — Holotype macropterous male [AMNH, slide] and four macropterous male paratypes [AMNH, USNM, two glycerine, two slides], WBTRS, Arima Valley, Trinidad, W. I., at light, 16.ii.1962 (type) and 31.xii.1961, 20.x.1961 and 18.i.1961 (M. G. Emsley).

Schizoptera (Schizoptera) falcicula n. sp.

Macropterous male. — Body length 1.35 mm.

Color. — Similar to *chelifera* n. sp. except for the membrane which grades from an apical pale cream to concolourous brown at the edge of the corium.

Structure. — Ocelli absent; large compound eyes, width over eyes 0.42 mm., between eyes 0.15 mm.; forewing (length 1.2 mm.) with the first and second proximal cells behind the anterior margin conspicuously more coarsely sculptured than the rest of the wing, which is delicately punctate along the anterior margins of the cubitus, first and second vannal veins but not in the trapezoidal cell. The seventh sternite and genitalia are as in figs. 173, 175, 223, 231 and 273.

Material examined. — Holotype macropterous male [AMNH, in glycerine], WBTRS, Arima Valley, Trinidad, W.I., at light, 2.ii.1962 (M. G. Emsley). Seven macropterous male paratypes [AMNH, USNM, six slides, one glycerine], at light, mile 2, Maracas Valley, Trinidad, 12.iv.1961 (J. L. Price). A female from the same locality [AMNH] has been provisionally assigned to this species.

Schizoptera (Schizoptera) cleofan n. sp.

Macropterous male. — Body length 1.5 mm.

Color. — Head capsule, exposed thorax, corium, vannus and abdomen medium brown; membrane apically cream grading to brown at junction with corium so there is no visible differentiation at the membranal interface; appendages light brown.

Structure. — Ocelli absent; eyes large, width over eyes 0.5 mm., between eyes 0.3 mm.; forewing (length 1.3 mm.) with ornamentation separable from *maxima* n. sp. only by the absence of sculpturing inside the trapezoidal cell. Seventh sternite and genitalia as in figs. 174, 189, 200, 211 and 233.

Material studied. — Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W. I., at light, 18.iv.1962 (M. G. Emsley).

Schizoptera (Schizoptera) apatosulcata n. sp.

Macropterous male. — Body length 1.25 mm.

Color. — Head capsule, thorax, corium, vannus and abdomen medium brown; appendages and membranal cells light brown. The membrano-corial interface is indistinct.

Structure. — Ocelli present; width over eyes 0.4 mm., between eyes 0.2 mm.; protrochanter with stout prominent spine (fig. 298); forewing length 1.15 mm., lightly sculptured as *S.* (*L.*) *sulcata*; metapleurum with shining area forming a crescent which approaches the condition seen in the subgenus *Cantharocoris* (fig. 155). The seventh sternite (fig. 243) is similar to those of both *S.* (*L.*) *sulcata* (fig. 241) and *S.* (*C.*) *pseudosulcata* n. sp. (fig. 244), but the other components of the genitalia cannot be distinguished from figs. 273, 276, 281 and 294 which are of other species. The vesica is coiled about three times.

Material studied. — Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W. I., at light, 13.vii.1961 (M. G. Emsley). Three macropterous male paratypes [AMNH, USNM, two glycerine, one slide], same data but various dates in August and September. Numerous other specimens have been taken at the same locality in all the months of the year.

Subgenus CANTHAROCORIS McAtee and Malloch, 1925

The characters of this group are similar to those of the subgenus *Schizoptera* but the metapleurum bears an elevated shining area extending about halfway up its height (fig. 155); the surface of the elevated shining area bears a delicate reticulate pattern which can only be seen by reflected light at certain angles or by transmitted light under high magnification. Only macropterous males are known.

Key to Trinidad Schizoptera (Cantharocoris)

1. Subgenital plate with lateral lobe and fine posteriorly directed spine (fig. 244), right conjunctival appendage simple strongly curved, and minutely spinulose (fig. 294) ..... *S.* (*C.*) *pseudosulcata*

   Subgenital plate with anterolateral lobe and coarse posteriorly directed spine (fig. 245); right conjunctival appendage simple, weakly curved and externally transversely ridged (fig. 282) ..... *S.* (*C.*) *hillae*

Schizoptera (Cantharocoris) pseudosulcata n. sp.

Macropterous male. — Body length 1.25 mm.

Color. — Indistinguishable from *S.* (*Lophopleurum*) *sulcata.*

Structure. — Ocelli present; width over eyes 0.43 mm., between eyes 0.26 mm.; length of forewing 1.1 mm., sculpturing as *S.* (*L.*) *sulcata;* longitudinal veins bounding the posterior membranal cell gently curved but parallel; seventh sternite as fig. 244, right conjunctival appendage as fig. 294, remainder of

genitalia as fig. 273, 276 and 281.

Material studied. — Holotype macropterous male [AMNH, glycerine], WBTRS, Arima Valley, Trinidad, W. I., at light, 23.v.1962. Ten macropterous male paratypes [AMNH, USNM, three slides, ten glycerine], same data but various dates in March, June, September and November (M. G. Emsley).

Schizoptera (Cantharocoris) hillae n. sp.

Macropterous male. — Body length 1.25 mm.

Color. — Similar to both *S.* (*C.*) *pseudosulcata* n. sp. and *S.* (*L.*) *sulcata* but the darker parts are dark chocolate brown which on the wing contrasts markedly with the light brown membranal cells which are distally smoky.

Structure. — Similar to *S.* (*C.*) *pseudosulcata* n. sp. but slightly larger (forewing 1.15 mm.) and with larger eyes (width over eyes 0.47 mm., between 2.4 mm.). The seventh sternite is as fig. 245, but the remainder of the genitalia are indistinguishable from *S.* (*L.*) *torpedo* n. sp. (figs. 270, 274, 278 and 282). The vesica is coiled twice.

Material studied. — Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W. I., at light, 4.vi.1962. Eight paratype macropterous males [AMNH, USNM, one slide, seven glycerine], same data but 8.v.1962, 18.x.1961, and 20.x.1961 (M. G. Emsley).

Subgenus LOPHOPLEURUM McAtee and Malloch, 1925

This is defined by the dorsal extension of the elevated area of the metapleurum reaching as far as the position of the anterior margin of the forewing when in repose (fig. 156). With the exception of an undescribed brachypterous male from Brazil, all the known males are macropterous and the females brachypterous.

Key to Trinidad Schizoptera (Lophopleurum)

1. Subgenital plate with lateral lobe and posteriorly directed fine spine (figs. 238, 241) 2
   Subgenital plate with lateral lobe but without posteriorly-directed fine spine (fig. 242) though there may be a tooth (fig. 239) or postero-lateral teeth (fig. 240) 3
2. Spine of subgenital plate straight (fig. 241); right conjunctival appendage unarmed and strongly curved (fig. 295); right paramere tapering only over distal half (fig. 273) ..... *S.* (*L.*) *sulcata*

Spine of subgenital plate curved (fig. 238); right conjunctival appendage basally straight and weakly externally armed with ridge-like spines (fig. 282); right paramere tapering regularly (fig. 270) ..... *S.* (*L.*) *torpedo*

3. Subgenital plate with lateral lobe apically bifid (fig. 242); right conjunctival appendage strongly curved with few coarsely serrations (fig. 283); right paramere obtusely angulate at two places (fig. 271) .... *S.* (*L.*) *grandis*

Subgenital plate with anterolateral lobe digitiform with single small spine on posterior margin (fig. 239); right conjunctival appendage sinuate and coarsely armed with about five large spines (fig. 284); right paramere constricted and twisted through rightangle at midpoint (fig. 272) ..... *S.* (*L.*) *wygodzinskyi*

Subgenital plate with lateral lobe reflected anteriorly, with a pair of small spines on posterolateral margin (fig. 240); right conjunctival appendage strongly curved and armed with about five large spines (fig. 285); right paramere curved and strongly tapering distally over distal half (fig. 273) ..... *S.* (*L.*) *tenuispina*

Schizoptera (Lophopleurum) sulcata McAtee and Malloch, 1925

This species was described from four macropterous male specimens, the type and two paratypes from Grenada and another paratype from Panama. Specimens are also previously known from St. Vincent and Trinidad. The present series of specimens has been compared with all these specimens and there is no doubt that they are all conspecific. The original description was based upon color and the shape of the seventh sternite but since re-examination this can be expanded.

Macropterous male. — Body length 1.2 mm.

Color. — Head capsule, exposed thorax, corium, vannus dark brown; abdomen medium brown; appendages and membrane light brown, corio-membranal interface distinct.

Structure. — Ocelli present; width over eyes 0.4 mm., between eyes 0.22 mm.; forewing (length 1.05 mm.) covered by delicate puncturation which is more conspicuous along the anterior border of the vannal and cubitus veins (including the postero-proximal corner of the trapezoidal cell), and in the proximal angle between M and R. The posterior membranal cell narrows proximally (cf. *S.* (*C.*) *pseudosulcata*). Seventh sternite as in figure 241, and right conjunctival appendage as figure 295. The other components of the genitalia cannot be distinguished from figures 273, 276, and 281. The vesica is coiled about two and a half turns.

Material studied. — Holotype and two paratype macropterous

males; Balthazar, Grenada (windward side), W. I. (H. H. Smith). One macropterous male paratype, Ancon, Canal Zone, 12.v.1911, at arc light (A. H. Jennings) [USNM no. 27600]. Numerous macropterous males [AMNH, ANSP, BMNH], WBTRS, Arima Valley, Trinidad, W. I., at light and in litter in all months of the year. Numerous macropterous males at light in pangola grass pasture, University Field Station and at lights in suburban residences and at light at Piarco airport, Trinidad, W. I.

Brachypterous females [AMNH, USNM] indistinguishable from these males upon non-genital characters have been taken with the males in single samples of litter, but it is not possible to assign them to this species with certainty. In these specimens the hind wings are absent, the posterior margin of sternite VII is uniformly rounded, and the venation is clearly visible, even though the membrane and vannal fold are not differentiated.

Schizoptera (Lophopleurum) tenuispina

McAtee and Malloch, 1925

This species was described on the body colour and the shape of the seventh sternite of a single specimen from Panama. The new material has been compared with the type and appears to be conspecific. As the unique type was not dissected the genitalia could not be examined, so the validity of this specific assignment can be questioned.

Macropterous male. — Body length 1.2 mm.

Color. — Indistinguishable from *S.* (*L.*) *sulcata.*

Structure. — Distinguishable from *S.* (*L.*) *sulcata* only by the structure of the seventh sternite (fig. 240), and the genitalia (figs. 273, 277, 281, 285).

Material examined. — Holotype macropterous male [USNM no. 27602], Gatun, Canal Zone, 7.iv.1911 (E. A. Schwartz). Numerous examples [AMNH, USNM] in all months of the year at light and occasionally in litter at the WBTRS, Arima Valley, Trinidad, W. I. (M. G. Emsley).

Schizoptera (Lophopleurum) grandis n. sp.

Macropterous male. — Body length 1.6 mm.

Color. — Similar to *S.* (*L.*) *sulcata* but with a light brown band across the posterior margin of the pronotum.

Structure. — Similar to *S.* (*L.*) *sulcata* but larger (width over eyes 0.48 mm., between eyes 0.28 mm., forewing length 1.35 mm.), and with a distinc-

tive seventh sternite (fig. 242) and genitalia (figs. 271, 275, 279 and 283). The vesica is coiled about eight times.

Material studied. — Holotype macropterous male [AMNH, glycerine], WBTRS, Arima Valley, Trinidad, W. I., at light, 18.vi.1961. Ten macropterous male paratypes [AMNH, BMNH, USNM, one slide, nine glycerine], same data but dates in July and August. Eleven macropterous male paratypes [AMNH, BMNH, USNM, in glycerine], Maracas Falls Trace, Maracas Valley, Trinidad, in litter, various dates in July and August 1961. Numerous other specimens from each locality. (All M. G. Emsley.)

Brachypterous females [Allotype AMNH] which are similar to the males on non-genital characters except the brachypterous condition of the forewings (fig. 146), have been taken in litter samples which have also yielded males. No good specific characters which correlate these insects have been detected. Provisionally they have been assigned to *grandis* n. sp. and it is noted that they have reduced hind wings and an unspecialised posterior margin to the seventh sternite.

Schizoptera (Lophopleurum) torpedo n. sp.

Macropterous male. — Body length 1.25 mm.

Color. — Similar to *S.* (*L.*) *sulcata* but with the body darker.

Structure. — Similar to *S.* (*L.*) *sulcata* except for the shape of the seventh sternite (fig. 238) and the genitalia (figs. 270, 274, 278 and 282). The vesica is coiled one and a half turns.

Material studied. — Holotype macropterous male [AMNH, in glycerine], WBTRS, Arima Valley, Trinidad, W. I., at light fifty feet in forest canopy, 19.ix.1961. Two macropterous males [AMNH, USNM], same locality five feet from the ground, 29.ix.1961, 13.ii. 1962 (M. G. Emsley).

Schizoptera (Lophopleurum) wygodzinskyi n. sp.

Macropterous male. — Body length 1.2 mm.

Color. — Similar to *S.* (*L.*) *sulcata,* but the corio-membranal interface is not so discreet.

Structure. — Similar to *S.* (*L.*) *sulcata* except for the shape of the seventh sternite (fig. 239) and the genitalia (figs. 272, 276, 280 and 284). The vesica is coiled just over three turns.

Material studied. — Holotype macropterous male [AMNH, slide],

WBTRS, Arima Valley, Trinidad, W. I., at light, 10.x.1961 (M. G. Emsley).

Named after Dr. P. Wygodzinsky who has made such a valuable contribution to our knowledge of the Schizopteridae.

Subgenus ODONTORHAGUS McAtee and Malloch, 1925

The characters which distinguish this group are the longitudinal position of the pronotal suture and the posteriorly directed spine that emanates from the posterior margin of the propleurum (fig. 158). McAtee and Malloch used the absence of ocelli and the absence of a subapical constriction to the scutellum to separate this group from *Kophaegis,* but these characters are inconstant and the two groups should be synonymised. All the known males and females are macropterous.

Key to Trinidad Schizoptera (Odontorhagus)

1. Vein separating two apical membranal cells of forewing strongly curved anteriorly (fig. 296); emargination of prosterolateral right side of subgenital plate right-angulate (fig. 249) ..... *S. (O.) trinitatis*
   Vein separating two apical membranal cells of forewing moderately curved anteriorly (intermediate between figs. 296 and 297); emargination of right posterolateral side of subgenital plate obtuse (figs. 246, 247, 248) 2
2. Right posterior margin of sternite VI (penultimate) with small process, lateral lobe of subgenital plate expanded distally (fig. 248) .... *S. (O.) kirkpatricki*
   Posterior margin of sternite VI without process, lateral lobe of subgenital plate hardly differentiated posteriorly from posterior margin of subgenital plate (fig. 246) ..... *S. (O.) stricklandi*
   Posterior margin of sternite VI without process, lateral lobe of subgenital plate clearly differentiated from posterior margin of subgenital plate by emargination (fig. 247) ..... *S. (O.) southwoodi*

Schizoptera (Odontorhagus) stricklandi China, 1946

China described this species from three males from Trinidad but did not describe the genitalia, so more characters can now be added, for the new material has been compared with the type and is certainly conspecific.

Macropterous male. — Body length 1.45 mm.

Color. — Head capsule, exposed thorax, corium, vannus and abdomen medium brown; appendages and membranal cells light brown; there is no perceptible corio-membranal interface, the transition being very gradual.

Structure. — Ocelli absent; width over eyes 0.5 mm., between eyes 0.2 mm.; the forewing is 1.25 mm. in length, and the vein forming the posterior margin of the anterior membranal cell is curved anteriorly so the cell is almost equilateral (a condition intermediate between fig. 296 and 297). The seventh sternite is as fig. 246, and the genitalia are as figs. 286, 290 and 293, and the right conjunctival appendage is similar to fig. 295.

Material studied. — Holotype macropterous male and one macropterous male paratype [BMNH], St. Augustine, Trinidad, W. I., xi.1943, ii.1944 (A. H. Strickland). Numerous macropterous males [AMNH, ANSP, USNM], mile 2, Maracas Valley, Trinidad, at light, all months of the year (J. L. Price); University Field Station, Trinidad, April 1962 (M. G. Emsley).

Brachypterous females [AMNH, ANSP] similar to the males except for sexual characters that were taken in the same catches have provisionally been allocated to this species. The posterior margin of the seventh sternum is without special features.

Schizoptera (Odontorhagus) southwoodi n. sp.

Macropterous male. — Body length 1.4 mm.

Color. — Similar in pattern to *S.* (*O.*) *stricklandi* but the dark parts are chocolate brown, and the differentiation between membrane and corium is much more distinct.

Structure. — Similar to *S.* (*O.*) *stricklandi* except there is a most conspicuous band of coarse puncturation along the anterior margin of the first and second vannal veins and the cubitus, and on both sides of the main stem of the media; the forewing is 1.2 mm. in length, and the width over the eyes is 0.42 mm., and between the eyes 0.23 mm. The seventh sternite is as in fig. 247 and the genitalia are as figs. 287, 291 and 292, the right conjunctival appendage is similar to fig. 295.

Material studied. — Holotype macropterous male [AMNH, glycerine] and four macropterous male paratypes [AMNH, USNM, glycerine], WBTRS, Arima Valley, Trinidad, W. I., at light, 21.vii.1961 (type), remainder various dates in January, March, May and August (M. G. Emsley). Numerous other specimens have been taken at light throughout the year at the University Field Station, and at mile 2, Maracas Valley, where they occur with *stricklandi*.

Macropterous females [AMNH, ANSP, USNM] similar to the males except for genital characters have been taken with the males at light, and though they lack distinctive features they are allocated pro-

visionally to this species.

This species is named after Dr. T. R. E. Southwood.

Schizoptera (Odontorhagus) kirkpatricki n. sp.

Macropterous male. — Body length 1.3 mm.

Color and structure. — Similar to *S.* (*O.*) *southwoodi* n. sp. except for the shape of the sixth and seventh sternites (fig. 248) and the right paramere (fig. 288).

Material studied. — Holotype macropterous male [AMNH, glycerine] and fourteen macropterous male paratypes [AMNH, BMNH, USNM, two slides, twelve glycerine], mile 12, Blanchisseuse Pass, 600 meters, at mercury-vapour light, 4.vii.1961 (M. G. Emsley).

Schizoptera (Odontorhagus) trinitatis n. sp.

Macropterous male. — Body length 1.25 mm.

Color and structure. — Similar to *S.* (*O.*) *stricklandi* but the membrane is less long (forewing 1.05 mm.) so the posterior vein of the anterior membranal cell is strongly curved anteriorly towards the wing margin (fig. 296 not 297); and with the forewing sculpturing carried out along the membranal veins; the eyes are larger (width over eyes 0.4 mm., between eyes 0.18 mm.); the seventh sternite is as fig. 249, and the right paramere is as fig. 289; otherwise the genitalia are similar.

Material studied. — Holotype macropterous male [AMNH, glycerine], WBTRS, Arima Valley, Trinidad, W. I., at light, 12.ii.1962. Eleven macropterous male paratypes [AMNH, BMNH, USNM, eight glycerine, three slides], same data as above but various dates in February, May, July and October. (All M. G. Emsley.) A female [AMNH, glycerine], same data, has provisionally been allocated to this species.

Subgenus ZYGOPHLEPS McAtee and Malloch, 1925

Distinguishable from the subgenus *Schizoptera* only by the apical coalescence of the membranal veins (fig. 147). Macropterous males only are known.

Key to Trinidad Schizoptera (*Zygophleps*)

1. Larger species (total length 1.4 mm or more); right conjunctival appendage armed with small spines (figs. 266, 267, 268) 2

Smaller species (total length 1.2 mm or less); right conjunctival appendage unarmed and curved (fig. 269), subgenital plate as fig. 252 .... *S.* (*Z.*)*unica*

2. Right conjunctival appendage forked (fig. 268); subgenital plate with conspicuous curved posteriorly-directed spine developed from lateral lobe (fig. 251) ..... *S.* (*Z.*)*corallia*

Right conjunctival appendage unbranched (figs. 266, 267); lobe of subgenital plate not developed into single spine (figs. 250, 253) 3

3. Right conjunctival appendage curved through a rightangle (fig. 266); lateral lobe of subgenital plate thumb-like and apically rounded (fig. 250) ..... *S.* (*Z.*)*simla*

Right conjunctival appendage curved through almost a whole turn (fig. 267); lateral lobe of subgenital plate apically truncate (fig. 253) .... *S.* (*Z.*)*ultima*

Schizoptera (Zygophleps) unica McAtee and Malloch, 1925

The Trinidadian specimens have been compared with the unique type and cannot be distinguished on such genital and nongenital characters that can be seen in dried material. The original description may now be expanded.

Macropterous male. — Body length 1.15 mm.

Color. — Head capsule, exposed thorax and abdomen medium brown; appendages light brown; the forewing grades regularly from medium brown at the base to light brown at the apex of the membranal cells.

Structure. — Ocelli present; width over eyes 0.4 mm., between eyes 0.2 mm; forewing (length 1.0 mm.) with very coarse puncturation in proximal angle of R and M and just anterior to the vannal veins. Seventh sternite as fig. 252, and genitalia as figs. 257, 261, 265 and 269. The vesica is coiled about two turns.

Material studied. — Holotype macropterous male [USNM no. 27587], Livingston, Guatemala, 7.v.19?? (E. A. Schwarz and H. S. Barber). Two macropterous males [AMNH, one glycerine, one slide], WBTRS, Arima Valley, Trinidad, W. I., at light, 28.viii.1961 (M. G. Emsley).

Schizoptera (Zygophleps) simla n. sp.

Macropterous male. — Body length 1.4 mm.

Color. — Distinguishable from *unica* only by the uniform transparency of membranal cells and the distinction of the corio-membranal interface.

Structure. — Distinguishable from *unica* by the larger size (length of forewing 1.2 mm.) and the larger eyes (width over eyes 0.4 mm., width between eyes 0.17 mm.); and the shape of the seventh sternite (fig. 250) and the geni-

talia (figs. 254, 258, 262 and 266). The vesica is coiled through four turns.

Material studied. — Holotype macropterous male [AMNH, one wing, and terminal abdominal segments on slide, remainder in glycerine], and four macropterous male paratypes [AMNH, USNM, two slides, two glycerine], WBTRS, Arima Valley, Trinidad, W. I., at light, 28.ix.1961 (type), 12.x.1961 and 12.i.1962 (M. G. Emsley).

Schizoptera (Zygophleps) corallia n. sp.

Macropterous male. — Body length 1.5 mm.

Color. — Distinguishable from *unica* only by the dark color of the membranal cells, particularly at the base of the posterior cell.

Structure. — Distinguishable from *unica* only by the larger size (length of forewing 1.35 mm.), by the size of the eyes (width over eyes 0.45 mm., width between eyes 0.25 mm.), and the shape of the seventh sternite (fig. 251), and the genitalia (figs. 256, 260, 264 and 268). The vesica is coiled through at least two turns.

Material studied. — Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W. I., at light, 29.ix.1961 (M. G. Emsley).

Schizoptera (Zygophleps) ultima n. sp.

Macropterous male. — Body length 1.5 mm.

Color. — Indistinguishable from *S.* (*Z.*) *unica.*

Structure. — Distinguishable from *unica* by the larger size (length of forewing 1.3 mm., width over eyes 0.5 mm., width between eyes 0.3 mm.), the shape of the seventh sternite (fig. 253) and genitalia (figs. 255, 259, 263 and 267). The vesica is coiled through three turns.

Material studied. — Holotype macropterous male [AMNH, slide] and one macropterous male paratype [USNM, slide], WBTRS, Arima Valley, Trinidad, W. I., at light, 2.xi.1961 (type), 29.xii.1961 (M. G. Emsley).

SYSTEMATIC DISCUSSION

The systematic relationships both within the family and within the Heteroptera as a whole present interesting problems which will be discussed separately.

INTRA-GENERIC RELATIONSHIPS

Progress in the taxonomy of the Schizopteridae has been retarded

by their sexual dimorphism and polymorphism, for brachyptery and their inability to fly makes the association of the sexes of each species difficult. Only *Pinochius* is known to display pterygo-polymorphism within one sex. The association of the sexes is particularly difficult when only a few specimens are taken by different techniques in a locality where the fauna is imperfectly known. The extent of sexual pterygo-dimorphism and pterygo-polymorphism within the family is shown in Table 1 (p. 13) from which it can be seen that the data are rather limited. It would seem that though sexual pterygo-polymorphism is common, it is usually specifically and perhaps generically constant. Brachyptery is certainly much more common in females than males, but collecting has been neither random nor widespread. Southwood (1961) advances a hormonal theory for the control of pterygo-polymorphism in Heteroptera, but the evidence upon which this is based relates principally to polymorphism within one sex, and it does not seem likely that it is relevant to the situation in Schizopteridae.

Experience in Trinidad has confirmed the impression, left by the collections of Schwarz and Barber in Panama and Guatemala, that in suitable localities in northern South and Central America Schizopteridae are abundant. *Schizoptera* seems to be the dominant genus, though few species have been shown to be widely distributed.

At a locality in the Arima Valley in Trinidad at a single 75-watt tungsten filament lamp thirty-five species of *Schizoptera* were taken during 1961. The claim that these are good species is based upon minor but constant differences in the shape, venation, sclerotisation and color of the wing; the shape of the left and right parameres; the structure of the left and right conjunctival appendages; and the process on the right side of sternite VII. All of the five known subgenera of *Schizoptera* are represented and distinguishable by prothoracic, metathoracic and venational characters as well as the differential development of the components of the genitalia. These are unlikely to be cases of polymorphism for each species, whether rare or common, is constant in the composition of its character complex. Yet, in different subgenera similar specific characters appear. This point is demonstrated by reference to figures 241, 243, 244 and 245, for the species of which these are illustrations of the seventh sternites belong to different subgenera. However, this phenomenon could be produced by multiple allelomorphs.

Though collecting has not been widespread, sufficient has been done to be sure that the acute diversity presented by *Schizoptera* is uncommon in the family. But in the vicinity of the light mentioned above only five species of *Schizoptera* were taken by day, in spite of ardent beating, sweeping and sieving, and those five species are represented by only one male specimen of each.

Soil-inhabiting organisms seem among the most conservative groups, for the Collembola, Thysanura, Diplura and Protura are among the most primitive hexapodous arthropods. Until more is known of the ecology of the Schizopteridae and Cryptostemmatidae it is not even possible to speculate on the factors which have led to such a burst of speciation as demonstrated by *Schizoptera*. If interspecific competition follows normal principles, then either the ecological requirements of these minute insects are very precise and there is sufficient variety in the micro-habitat of the soil to maintain a dynamically balanced population, or we are witnessing recent evolutionary diversification.

INTER-GENERIC RELATIONSHIPS

Even though the Schizopteridae are relatively little known the thirty-three described genera should be sufficient to construct a natural classification, but unfortunately, some of the evidence to be judged is unavailable, either because of the poor descriptions of unique types, or because some genera are known only by brachypterous females which do not reveal venational or genital characters. However, a hypothetical scheme of classification is put forward here which will be tested by future studies when more and better material is available.

On morphological grounds *Hypselosoma* and the closely related genus *Glyptocombus* appear to be the most primitive known members of the Schizopteridae because:

1. Though the members of this family are characterised by asymmetry of the abdomen and genitalia, it must be assumed that they have evolved from more symmetrical ancestors. *Hypselosoma* shows very little asymmetry of the pregenital abdominal segments, and has the most symmetrical parameres and genital capsule of any genus in the family. More advanced Schizopteridae may have up to three of the posterior pregenital segments intimately

associated with the genitalia, or alternatively, may have some of the more anterior segments asymmetrically specialised.

2. The male genitalia of most Heteroptera consist of a pair of parameres, and an aedeagus, which may or may not have conjunctival appendages upon it; *Hypselosoma* has a pair of parameres, an aedeagus with only small conjunctival appendages, and a pair of like appendages arising from the tergite of segment IX, which is median and subtends the anal tube. Other Schizopteridae have more complex and asymmetrical appendages associated with the base of the laterally displaced anal tube. So, though the genitalia of *Hypselosoma* are specialised, they are less specialised than those of other members of the family.
3. The maximum number of pregenital abdominal segments visible in the ventral midline in Schizopteridae is six, and this occurs in *Hypselosoma*. Fusion or loss of sternites in insects is a more common secondary condition than multiplication.
4. The ovipositor is vestigial in many Schizopteridae but in *Hypselosoma* and some other genera it is well developed. If the ovipositor had been evolved from the vestigial condition one would hardly expect it to be so easily homologised with that of other Hemiptera. It is most likely that the functional ovipositor is a primitive feature and it has been lost independently in different evolutionary lines within the family in association with subterranean or cryptic habits.
5. *Hypselosoma,* together with *Glyptocombus,* has abdominal spiracles on the sterna of segments II to V in addition to the normal Schizopterid complement on sterna VI and VII and on tergum VIII. It is likely that the most complete condition is primitive.
6. *Hypselosoma* and *Glyptocombus* have more longitudinal veins than any other member of the Schizopteridae and the venation of nearly all of the genera can be derived from it by omission or coalescence. These two genera, with others, retain the proximal association of the radius and the media which is a primitive feature of the Hemiptera.
7. The hindwing venation of *Hypselosoma* and *Glyptocombus* is more complete than in any other genus for there is a vein connecting Cu and R with some evidence of persistence of the media, and the second vannal vein is well developed.

8. The jugal lobe of the hindwing is a primitive character known in many Heteroptera but in the Schizopteridae it is known to occur only in *Hypselosoma, Glyptocombus* and *Kokeshia* (?).
9. The wing coupling apparatus in Heteroptera usually consists of a pair of tubercles on the second vannal vein at the apex of the vannus, but such a coupling occurs only in *Hypselosoma* and a few other genera, for in the majority of the Schizopteridae the coupling apparatus is specialised by reduction of the anterior tubercle.

Though other genera possess some of these primitive features, no other single genus possesses so many.

Characters like the near-spherical shape of the spermatheca, and the tarsal and pretarsal formula, though undoubtedly primitive have been omitted at this stage as they are of special interest in allying the Schizopteridae and Cryptostemmatidae. On the premise that *Hypselosoma* exhibits primitive Schizopterid facies it is possible to build a tentative family tree (fig. 107) though its reliability is biased towards the better known genera.

Characters of value in considering supra-generic groupings include the wing venation, the complex of male genital and pregenital abdominal structures, the female genitalia and spermatheca, the rostrum, the tarsal and pretarsal formulae and less frequently, the pronotal collar, the pteropleura, the pterothoracic sterna, the head capsule and the chaetotaxy.

The recognition of three subfamilies is suggested, the Hypselosomatinae and Schizopterinae which were both proposed by Esaki and Miyamoto (1959), though poorly defined, and the new taxon Ogeriinae.

The Hypselosomatinae which includes *Hypselosoma, Glyptocombus* and perhaps *Ommatides,* have retained the many primitive features discussed above and have very large eyes and a four-segmented rostrum (fig. 5).

The common features unifying the Schizopterinae are the three-segmented rostrum, the reduction of the veins emanating from the trapezoidal cell from five (figs. 29-31) to four (figs. 32-51), and the vestigial nature of the ovipositor. They share with the Ogeriinae (see below) the more advanced Schizopterid features of the restriction of the abdominal spiracles to the sterna of segments VI and VII and to

the tergum of segment VIII, the reduction of the fore and hind wing venation, the tri-lobed hindwings, the specialised wing couplings, and the elongate V-shaped spermatheca. Within the tribe there are *Nannocoris, Schizoptera,* three conspicuous sub-groups discussed below, and some genera of uncertain affinity.

The *Corixidea* association is neotropical and consists of *Corixidea, Voccoroda, Oncerodes, Hoplonannus* and *Membracioides.* They are united by the truncate rostrum (fig. 1), venational similarities (figs. 37-41), the absence of a pronotal collar, and the hyperpleura (fig. 13). Within this group *Hoplonannus* and *Membracioides* form a pair by the possession of a highly developed paraproctal appendage, which is lacking in *Corixidea* and *Voccoroda.* The condition of *Oncerodes* is unknown.

The *Vilhenannus* association consists of the ethiopian genera *Vilhenannus, Machadonannus* and *Dundonannus,* all of which have the pregenital abdomen similarly and highly specialised, have a basically similar wing venation in which R and M are proximally associated for a considerable distance (figs. 42-44), and have a similarly specialised wing coupling (fig. 67). *Machadonannus* and *Vilhenannus* are closer to each other than either is to *Dundonannus* on account of their characteristically Schizopterinae tarsal formula (Table 2), and the serrate margin to the base of R + M (figs. 42 and 43).

The third association is that of *Humpatanannus, Bironannus, Ceratocomboides* and *Biturinannus.* The first two and the last share a curious inflation of the anteclypeus which bears three prominent spines, and all four share a similar and unique tarsal formula. *Biturinannus* has venational similarities with both *Pinochius* and *Nannocoris* but they are superficial and no great importance is attached to them. *Humpatanannus* and *Bironannus* are unique in the possession of an appendage developed from the ninth sternum. Still within the definition of Schizopterinae are *Pachyplagioides, Itagunannus* and *Silhouettanus* but without obvious affinities.

The Ogeriinae have, like the Hypselosomatinae, a four segmented rostrum and five veins emanating from the trapezoidal cell (fig. 52-56), but they differ substantially in their tarsal formulae, the lack of primitive alary and genital features, and the possession of the more advanced Schizopterid arrangement of abdominal spiracles. A case could be made for the positioning of the Ogeriinae more closely to the

Hypselosomatinae than is shown in the dendrogram, but the accommodation of all the genera on a two plane figure necessitates a compromise.

Within the Ogeriinae can be placed *Chinannus,* and the rather distinct but closely associated group consisting of *Ogeria, Pachyplagia, Luachimonannus* and *Kokeshia.* The venation of all the genera is fully comparable (fig. 52-56), but *Ogeria* and *Pachyplagia* have a complex and similar tuberculate sculpturing of the abdomen.

Outside these groups are *Peloridinannus* and *Guapinannus,* which have venational peculiarities (figs. 57 and 59) and a fully developed ovipositor, and *Tropistotrochus* (fig. 58) which though somewhat similar in venation to *Peloridinannus* is undescribed genitally. There is insufficient information on *Nesonannus, Schizopterops, Ptenidiophyes* and *Dictyonannus* to include them in the family tree at all.

INTER-FAMILIAL RELATIONSHIPS

The closeness of the association between the Schizopteridae and Cryptostemmatidae has been indirectly questioned by different taxonomists treating them as subfamilies or families, for there have been no previous analyses of the characters of either group.

The morphology of the Schizopteridae has been thoroughly discussed, but our knowledge of the Cryptostemmatidae is limited to those structures described or figured in the descriptions of new genera and species. As in the case of the Schizopteridae many of the earlier descriptions are poor.

There are currently eight really distinct genera of Cryptostemmatidae. *Crescentius* Distant, 1904 was poorly described from a unique type which has been subsequently lost (Hutchinson, 1944); *Teratocombus* Poppius, 1913 and *Seychellesannus* Distant, 1913 were also inadequately described but are still available for study; *Issodomimus* Poppius, 1910 has been usefully redescribed by Wygodzinsky (1950, 1953); *Ceratocombus* Signoret, 1852 (sensu lato) has numerous described subgenera and species, a few of which have been redescribed by Wygodzinsky (1951, 1953); *Cryptostemma* has also had some of its species fully described, and the four species of *Muatianvuaia* Wygodzinsky, 1953 are thoroughly described and figured and are most useful. *Hypsipteryx* Drake, 1961 was described only from characters that could be seen in dry-mounted specimens. Of

these genera only *Hypsipteryx, Seychellesanus* and *Ceratocombus* have been examined by the author but the first two have both revealed valuable characters. The relationship between these genera is suggested in figure 107.

The morphological similarities between the two families are considerable and include:—

1. **Tarsal formula.** Typically both families exhibit differential numbers of tarsi between the three pairs of legs of one sex and between the legs of the two sexes. The tarsal formula of the two families has been reviewed in Table 2 (p. 20) from which it can be seen that male Cryptostemmatidae may have a formula of 3.3.2, 3.3.3., or 2.2.2., but females have only a 2.2.2 formula. These combinations in both male and females definitely occur in the Schizopterid genera *Pinochius, Ceratocomboides, Dundonannus* and *Chinannus,* and may occur in *Silhouettanus.*
2. **Pre-tarsi.** The common schizopterid feature of an empodial vesicle between the claws of the first and second pair of legs of males also occurs in the Cryptostemmatid genera *Issodomimus, Muatianvuaia* and *Cryptostemma.*
3. **Abdominal spiracles.** Though both families have genera which are primitive, with spiracles present on abdominal segments II to VIII inclusive [e.g. *Hypselosoma, Hypsipteryx* and *Seychellesanus*], both also have specialised genera in which the spiracles are restricted to segments VI, VII and VIII [e.g., most Schizopteridae and *Ceratocombus* (sensu stricto)], and moreover the pair of spiracles on segment VIII are in both families carried on the tergites or paratergites.
4. **Male genitalia.** Both families have genera with
   (a) — a coiled vesica [all Schizopteridae and *Ceratocombus* (*Leptonannus* group)];
   (b) — conjunctival appendages (*Schizoptera, Issodomimus*);
   (c) — paraproctal appendages. Though the homology is not proven, these appendages lie either side of the anal tube in *Hypselosoma* and *Hypsipteryx* (figs. 75 and 76.)
   (d) — pregenital specialisations. Though the structures are perhaps neither analogous nor homologous, both

families show a tendency to specialise tergite VIII in association with the genitalia.

(e) — asymmetrical parameres. Though the parameres of *Seychellesanus* are nearly symmetrical, those of *Cryptostemma* and *Ceratocombus* are as asymmetrical as many species of Schizopteridae.

(f) — an asymmetrical genital capsule. That of *Cryptostemma* is as asymmetrical as many Schizopteridae.

(g) — the basal plates closely associated with the parameres. In fact all Schizopteridae and Cryptostemmatidae examined show this primitive feature.

5. **Female genitalia.**

(a) — the adults and larvae of both families have segment IX annular and encircling the anal tube.

(b) — the ovipositor of those Schizopteridae that have it well developed and that of the Cryptostemmatidae is similar in general and detailed structure.

6. **The spermatheca.** The spermatheca of the primitive Schizopterid *Glyptocombus* (fig. 87) is similar to that of *Ceratocombus* (fig. 84) and not dissimilar to those of *Hypsipteryx* (fig. 83), *Seychellesanus* (fig. 82), and *Cryptostemma* (fig. 85).

7. **The quadrilobate hindwing.** The primitive Schizopterid genera *Glyptocombus* and *Hypselosoma* have a quadrilobate hindwing which is similar to that of the Cryptostemmatid *Trichotonannus*.

8. **The structure of the egg.** The gross structure and chorionic sculpturing of the egg is similar (cf. figs. 104 and 105), and appears to be unlike that of other known Heteroptera.

9. **The proportions of the antennae.** The two families have the proximal pair of antennal segments short and the distal pair relatively long.

10. **The structure of the alimentary canal and associated organs.** The studies of Miyamoto (1961) have shown gross similarities between the two families.

The wing venation has been deliberately left out of this discussion because the venation of the Cryptostemmatidae has already been used to interpret the venation of the Schizopteridae. It is enough to

notice that the two groups have structural similarities in addition to easily comparable schemes of venation, for although the costal fracture is characteristic of the Cryptostemmatidae, *Guapinannus* also possesses a fracture which traverses the wing completely and many other Schizopterid genera have incipient fractures at the termination of the subcosta.

The points of distinction between the two families that have been given prominence in the past are principally specialisations of *Cryptostemma* and *Ceratocombus*, which, on account of their long taxonomic establishment and temperate distribution are the best known genera. McAtee and Malloch in their 1925 key mention such differences as the reduction of the pteropleura and the porrect attitude of the head in Cryptostemmatidae, but *Muatianvuaia* and *Issodomimus* have normally developed pteropleura and a head that is substantially deflexed. Conversely, the Schizopterid genus *Nannocoris* has a head which is quite as porrect as either *Ceratocombus* or *Cryptostemma*.

In the light of recent studies the only consistent differences that have been noticed are:—

1. The development of special structures of the pterosterna of Schizopteridae and the presence of metacoxal pads. Neither of these structures are represented in the Cryptostemmatidae.
2. It is the proepisternum that is developed anteriorly in Schizopteridae whereas in Cryptostemmatidae it is the proepimeron.
3. Macrochaetae are well developed and widely distributed over the head of Cryptostemmatidae, whereas in Schizopteridae they are less conspicuous and confined principally to the anteclypeus and rostrum.
4. The larvae of Cryptostemmatidae have three pairs of scent glands, one pair lying between each of the tergites of abdominal segments IV and V, V and VI, and VI and VII. Schizopterid larvae normally have only a single pair between tergites VI and VII (*Pinochius* may have none).
5. The specialisations of tergite VIII are, in Cryptostemmatidae, apical developments of the paratergites whereas in Schizopteridae tergite VIII usually carries a median or non-paired structure.
6. In Schizopteridae the basal segments of the antennae are subequal in length (fig. 1) whereas in Cryptostemmatidae the second joint is usually at least twice as long as the first (fig. 8).

The similarities are so diverse that in spite of the points of contrast they can hardly all be attributed to convergence. The Cryptostemmatidae either separated off from the Schizopteridae before the latter family acquired the metathoracic jumping organ, or, if it was already possessed then it has been subsequently lost. The uniformity of the thorax within diverse Cryptostemmatid genera suggest that the former view is more probably the correct one.

At their time of separation the mutual ancestors of both families would have possessed the primitive features of both groups. These features would have included, a substantially deflexed head, the characteristic antennae, a closely integrated head and prothorax, sclerotised forewings with a costal fracture and a bi-tuberculate wing coupling, membranous hindwings with a jugal lobe, a sexually dimorphic tarsal formula with differences between at least two pairs of legs, an empodial vesicle between the claws of the first and second pair of legs of males, an abdomen exhibiting at least six visible segments each with a pair of lateral spiracles, asymmetrical male genitalia with a pair of appendages associated with tergite IX, a pair of parameres mounted laterally within the genital capsule and joined by a basal plate, and an aedeagus differentiated into phallobase, conjunctive and vesica. The female genitalia would be well developed with two pairs of gonopophyses, as in some contemporary members of both families, and an almost spherical spermatheca. The nymphs would have three pairs of dorsal abdominal scent glands and a pair of spiracles on each of the thoracic segments.

It is not possible to say how many rostral segments there would have been for both three and four jointed rostra occur in each family.

INTRA-ORDINAL RELATIONSHIPS

Some contemporary hemipterists have suggested in discussion that the Schizopteridae and Cryptostemmatidae may have closer affinities with the Homoptera than with the Heteroptera. This view is based upon characters such as the deflection of the head capsule, the lack of contrast between the membrane and the corium, and the articulation of the parameres with the basal plate. However, there can be no doubt that the Schizopteridae are true Heteroptera on account of the typically heteropterous structure of the small but distinct gular region, the bi-tuberculate wing coupling, the constant

overlap of the membranal area of the forewings when in repose, the hindwing venation, the four jointed antenna, the metathoracic scent glands of adults (though known only in *Schizoptera*), the dorsal abdominal scent glands of the larvae and the dorsal opening of the genital capsule. The only features which can reasonably be used to cast doubt on the affinities of the family are the superficially Cercopid-like habit and the articulation of the parameres with the basal plate, which may be a more widespread feature in the Heteroptera than Singh Pruthi (1925) suggests.

The opinion of earlier authors on the systematic position of the Cryptostemmatidae within the Heteroptera must be viewed with discretion, for their judgments were based principally upon a knowledge of *Ceratocombus* and *Cryptostemma,* whose occurrence in the Holarctic realm has rendered them more available to north-temperate systematists. It is on these genera that the opinions of Douglas and Scott (1865), Lethierry (1874), Puton (1875), Ashmead (1888), Distant (1902), Kirkaldy (1907 and 1908) and Singh Pruthi (1925) are based. This matters less now that it is thought that the two families are closely related, but the two genera in question are far from typical.

The classifications of Schiödte (1869), Ashmead, (1888), Osborn (1895) and Distant (1902) are principally of historical interest, for the work of Reuter (1912a) is the first that considers the Schizopteridae. However, the work of the nineteenth century authors cannot be disregarded for the revival of Dufour's (1833) classification of the Heteroptera into Geocorisae, Amphibicorisae and Hydrocorisae has won general acceptance by contemporary hemipterists and it is within this framework that the affinities of the Cryptostemmatidae and Schizopteridae should be sought.

Reuter (1912a), followed by Oshanin (1916), divided the Heteroptera into seven series, one of which, the Trichotelocera, contained only the Cryptostemmatidae and Schizopteridae. Singh Pruthi (1925), on a study of the male genitalia of *Ceratocombus coleoptratus* and *Cryptostemma alienum*, both of which are atypical species in that the aedeagus is not differentiated into a vesica, was unable to place them satisfactorily and accepted Reuter's classification. He pointed out that the articulation of the parameres with the basal plate was an homopterous character, but he did not doubt that they were

true Heteroptera, and considered that the genitalia showed the greatest similarity to the Reduvioid pattern, but the agreement was not close.

Many of the earlier authors like Douglas and Scott (1865), Lethierry (1874), Kirkaldy (1908), and Bruner (1934) allied the Cryptostemmatidae to the Cimicidae or Anthocoridae, but this was upon the superficial resemblances of the then only known genera *Ceratocombus* and *Cryptostemma.* The resemblances include the general habit, the three segmented rostrum, the conspicuous costal fracture, the three pairs of nymphal scent glands and the investment of macrochaetae. Stichel (1955) still supports this view.

Southwood (1956) examined the structure of the eggs of the terrestrial Heteroptera and showed that it supported the division of the Geocorisae into Pentatomomorpha and Cimicomorpha. However, the Schizopteridae and Cryptostemmatidae appear to fall clearly into neither group for they have an operculum but no micropylar canals (?) and the first instar nymph has a median egg burster.

Pendergrast (1957) discussed the classification of the Heteroptera from an examination of the reproductive organs, but was unable to place the Cryptostemmatidae on account of the unique structure of the spermatheca. The male organs were unknown to him. From recent studies the homogeneous structure of the spermatheca throughout both families has been confirmed, and the presence of a bulbus ejaculatorius and mesodene accessory glands places the group near the Geocorisae. Judging only from Pendergrast's figures the male organs that most closely resemble those of the Schizopteridae are those of the Saldidae, though in Schizopteridae the testacular follicles were not distinguished. The median spermatheca is atypical of Cimicomorpha.

On the examination of the female genitalia of *Ceratocombus* and *Cryptostemma,* a structure in which these two genera are typical, Scudder (1959) also relates the Cryptostemmatidae to the Saldidae. He seems unaware however that some Schizopteridae also have a well developed ovipositor, and is of the opinion that the association of the two families is on superficial resemblances only.

Miyamoto (1961) compared the morphology of the alimentary organs of various Heteroptera and on the examination of *Kokeshia, Hypselosoma, Cryptostemma* and *Ceratocombus,* found that the histo-

logical structure of the salivary glands, together with those of the Enicocephalidae, differed from those of all the other Heteroptera studied. The alimentary canal was also unique in that it had affinity with both the Cimicomorpha (Geocorisae) and Amphibicorisae. The conclusion was the erection of the Dipsocorimorpha within the Geocorisae. The inconsistency of Miyamoto's illustrations makes evaluation of the characters very difficult, but it does seem than on the characters studied, as good a case could have been made for including the Dipsocorimorpha in the Amphibicorisae as in the Geocorisae.

Carayon (1962) reviewing the distribution and structure of scent glands in the Heteroptera points out that these are good systematic characters which unify the Geocorisae, but with the exception of the Saldidae, Dipsocoridae and their allies.

It would seem from these studies that the Cryptostemmatidae and Schizopteridae do not fall into any of Dufour's three divisions, and have affinities with both the Geocorisae and the Amphibicorisae. New characters like the duplicity of the salivary glands, the presence of an egg-burster, the structure of the egg and male reproductive organs, when added to the existing heterogeneity of structure, justify the re-adoption of Reuter's original proposal of a separate series to accommodate these two families.

Comparison with the Peloridiidae shows no closer affinity than would be expected in two primitive groups inhabiting similar habitats.

The potential interest of the evolutionary position of the Schizopteridae has been reinforced by the work of Wooton (1965) on the fossil Actinoscytinidae. Wooton demonstrates tracheal capture in this Permian family, and in particular the capture of the course of the cubitus by the first vannal vein, a condition which may be seen in both the Peloridiid genus *Peloridium* and Schizopteridae. The wing venation of *Microscytinella* (Wooton's fig. 5) is remarkably similar to that of recent *Hypselosoma.*

Before attempting further evaluation of the systematic position of the Schizopteridae a more comprehensive study is needed of the fossil groups and the Cryptostemmatidae, but it seems likely that both the Schizopteridae and the Cryptostemmatidae are conservative groups which have retained many primitive features that were characteristic of the Heteroptera shortly after their dichotomy with the Homoptera.

ANNOTATED CATALOGUE OF THE SCHIZOPTERIDAE

In the light of morphological studies it is now possible to suggest supra-generic groupings, and the following catalogue is arranged so as to present the family as an integrated unit. There are still genera without obvious affinities and these are placed last without attempting to infer their systematic position.

On account of their homogeneity the Schizopteridae cannot be given a higher status than that of family when viewed within the Heteroptera as a whole. But as both the Cryptostemmatidae and the Schizopteridae are of considerable importance to our understanding of the evolution of the Heteroptera, and will ultimately be shown to be very large and diverse groups, it is expedient to ensure family status now.

Hitherto the only suggested supra-generic groupings have been Hypsipteryxinae Drake, 1961, which was without indication of its affinities though it is here considered a Cryptostemmatid, and Hypselosomatini Esaki and Miyamoto 1959, which was a tribe of the Schizopteridae. To portray the relationships of the Schizopteridae properly it is necessary also to recognise the Schizopterinae which was suggested by Esaki and Miyamoto (1959), and to propose a new subfamily the Ogeriinae based on the genus *Ogeria*.

In the following catalogue all the known information is recorded both from published work and unpublished label data, and recommended taxonomic changes are based upon the examination of type or paratype material. In each genus the type-species is placed first with its generic name spelled in full.

ABBREVIATIONS

brachyp. — brachypterous, i.e. with the forewings reduced to heavily sclerotised elytra which may or may not exhibit venation. New term 'elytrous' would be better.

macrop. — macropterous, i.e. with the forewings fully developed.

sub-macrop. — sub-macropterous, i.e. with the forewing membrane and sometimes the corium reduced.

( ) — collected by

[ ] — in the collection of

AMNH — American Museum of Natural History, New York.

ANSP — Academy of Natural Sciences of Philadelphia.

BMNH — British Museum (Natural History), London.
CAS — California Academy of Sciences, Berkeley.
CUMZ — Cambridge University Museum of Zoology, England.
HMNH — Hungarian Museum of Natural History, Budapest.
IOC — Institute of Oswald Cruz, Brazil.
MD — Museum of Dundo, Angola.
NHMV — Natural History Museum of Vienna, Austria.
PMNH — Paris Museum of Natural History, France.
SAM — South Australia Museum, Sydney, Australia.
USNM — United States National Museum, Washington, D. C.
WBTRS — William Beebe Tropical Research Station, Arima Valley, Trinidad, West Indies.
ZILU — Zoological Institute of Lund University, Sweden.
ZMH — Zoology Museum of Helsinki, Finland.

Family SCHIZOPTERIDAE Reuter, 1891

as Schizopterina, Acta Soc. Sci. Fenn., **19**, (6):3
as Schizopterinae, Lethierry and Severin, 1896, Cat. Gen. Hemipt., 3:231-32.
McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):10.
China, 1946, Proc. R. ent. Soc. Lond., (B), **15**:148.
Wygodzinsky, 1947, Boln. Ent. venez., **6**, (1):26.
Wygodzinsky, 1948, Rev. bras., Biol., **8**, (1):143.
Wygodzinsky, 1950, Publ. cult. Cia Diamant. Angola, (7):9.
Wygodzinsky, 1951, Rev. bras., Biol., **11**, (3):263.
Gross, 1951, Rec. S. Aust. Mus., **9**:535.
Wygodzinsky, 1952, Acta zool. Lilloana, **10**:51-52.
Esaki & Miyamoto, 1959, Sieboldia, **2**, (2):119.
Wygodzinsky, 1959, Mém. Inst. sci. Madagascar, (E), **11**:509.
Miyamoto, 1960, Sieboldia, **2**, (3):163.
Schizopteridae, Reuter, 1910, Acta Soc. Sci. fenn., **37**, (3).
China & Miller, 1955, Ann. Mag. nat. Hist., Ser. 12, **8**:265.
Southwood, 1961, Entomologist's mon. Mag., **97**:89.

The Schizopteridae may be distinguished from Cryptostemmatidae by the anterior development of the pro-episternum which embraces the posterior part of the head capsule, the cuticular specializations of the pterosterna in association with the metacoxal pads, the trapezoidal cell on the corium at the apex of the vannus, the grossly asymmetrical male genitalia and genital capsule, the reduction of macrochaetae and the absence of paired paratergal appendages on the VIIIth segment of males.

Subfamily HYPSELOSOMATINAE Esaki and Miyamoto, 1959

as Hypselosomatini Esaki and Miyamoto, 1959, Sieboldia, **2**, (2):119.

Esaki and Miyamoto characterised the tribe Hypselosomatini by the exceedingly large eyes, a well developed ovipositor, and the male pro and meso tarsi being four-segmented, an artifact which may be observed in several other non-hypselosomatine genera. The size of the compound eye is subject to great variation within the family though the excessive size in this group may well be a diagnostic character. Of greater value, are the large number of longitudinal veins of the forewing, the presence of a jugal lobe and more complete venation on the hindwing, the large number of abdominal spiracles (six or seven pairs), and the nearly spherical spermatheca.

1. *Hypselosoma* Reuter, 1891, Acta Soc. Sci. fenn., **19**, (6):26-27, fig. 16. Redescribed: Wygodzinsky, 1959, Mém. Inst. sci. Madagascar, (E), **11**:511-513, figs. 2, 64. Type-species *H. oculata* by monotypy.
   (a) *Hypselosoma oculata* Reuter, 1891, Acta Soc. Sci. fenn., **19**, (6):27, fig. 16a and b. Poppius, 1910, öfvers. finska VetenskSoc. Förh., **57**, A, (1):13-14. Redescribed: Wygodzinsky, 1959, Mém. Inst. Sci. Madagascar, (E), **11**:516-519, figs. 2-26. Holotype brachyp. ♀ [Reuter], Mt. Kogui, New Caledonia (D. A. Fennel). Macrop. ♂, Mt. Kogui (probably lost). Macrop. ♂ with Vth instar larva [AMNH], 7 miles southeast of Foa, New Caledonia, under a stone, 22. iv. 1945 (C. E. Remington).
   (b) *H. boops* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13): 32, fig. 30. Holotype brachyp. ♀ [USNM 27611], Spirit Valley, Nanking, Kiangsu Province, China, 24.x.1919 (H. F. Loomis).
   (c) *H. hirashimai* Esaki & Miyamoto, 1959, Sieboldia, **2**, (2):110-116, pl. 14 A-1, pl. 15 A-C, pl. 16 A-F. Holotype and four macrop. ♂ paratypes, allotype and 29 brachyp. ♀ paratypes [Entomological Laboratory, Kyushu University], Yuwan Ukenson, Amani-Oshima, Japan, 21.vii.1954, on wet ground among grasses and rushes (*Cyperus melaccensis* Lam.) where submerged under seawater at high tide. Brachyp. ♀ on river bank not far from estuary, Nishinakamamure, 25.vii.1954. Brachyp. ♀ in moss Santaro-toge, Nishinakamamure, 26.vii.1954. Many specimens from type locality 9/10.iv.1954 [Miyamoto]. All specimens collected by S. Miyamoto and Y. Hirashima.
   (d) *H. lipovskyi* Wygodzinsky, 1959, Mém. Inst. sci. Madagascar, (E), **11**:537-538, figs. 150-160. Holotype brachyp. ♀ [USNM 64759], Guadalcanal, Solomon Islands, viii/ix.1944 (L. J. Lipovsky). Brachyp. ♀ paratype, data as above [AMNH]. Brachyp. ♂ & ♀,

Marine Creek, Guadalcanal, 19.xii.1944 (L. J. Lipovsky) [AMNH].

(e) *H. bakeri* Wygodzinsky, 1959, Mém. Inst. sci. Madagascar, (E), **11**: 535-536, figs. 140-149. Holotype brachyp. ♀ [USNM 64758], Mont Makiling, Luzon, Philippine Islands (Baker).

(f) *H. hickmani* Wygodzinsky, 1959, Mém. Inst. sci. Madagascar, (E), **11**:533-535, figs. 127-139. Holotype brachyp. ♀ [BMNH 1960, slide], Cascades, Tasmania, in moss, 9.vii.1943 (V. V. Hickman).

(g) *H. rossi* Wygodzinsky, 1959, Mém. Inst. sci. Madagascar, (E), **11**: 528-529, figs. 91-99. Holotype macrop. ♂ [CAS], and one macrop. ♂ paratype [AMNH], Baie Maffin, Dutch New Guinea, ix.1944 (E. S. Ross).

(h) *H. simile* Wygodzinsky, 1959, Mém. Inst. sci. Madagascar, (E), **11**: 529-530, figs. 100-106. Holotype macrop. ♂ [HMNH], Deslac Island, Solomon Islands, 1901 (Biró).

(i) *H. pauliana* Wygodzinsky, 1959, Mém. Inst. sci. Madagascar, (E), **11**:530-532, figs. 107-121. Holotype brachyp. ♀ [PMNH] and brachyp. ♀ paratype [BMNH 1957-244, slide], Ankazobe, forest of Ambohitantely, Madagascar, vii.1955 (R. Paulian). One brachyp. ♀ paratype [AMNH], Ankaratra, Manjakatompo, Madagascar, 1955, in forest litter (R. Paulian).

(j) *H. lituratum* Wygodzinsky, 1959, Mém. Inst. sci. Madagascar, (E), **11**:525-528, figs. 64-90. Holotype macrop. ♂ [HMNH], Friedrich-Wilhelmshafen, New Guinea, 1896 (Biró). Allotype brachyp. ♀ [HMNH], Seleo, Berlinhafen, New Guinea, 1896 (Biró). Two macrop. ♂♂ and six brachyp. ♀ paratypes [HMNH, AMNH], Erima, Astrolabe bay, New Guinea, 1896 (Biró). Nine brachyp. paratype ♀♀ [HMNH], New Guinea, 1896 (Biró).

(k) *H. rhodochroum* Wygodzinsky, 1959, Mém. Inst. sci. Madagascar, (E), **11**:522-525, figs. 44-63. Holotype macrop. ♂, allotype brachyp. ♀ [HMNH], Simbang, Gulf Huon, New Guinea, 1900 (Biró). One submacrop. ♂ [AMNH], Sattelberg, Gulf Huon, New Guinea, 1899 (Biró).

(l) *H. biroi* Wygodzinsky, 1959, Mém. Inst. sci. Madagascar, (E), **11**: 519-522, figs. 27-43. Holotype submacrop. ♂ [HMNH] and submacrop. ♂ paratype [AMNH], Lemien, Berlinhafen, New Guinea, 1896 (Biró). Brachyp. allotype and two brachyp. ♀ paratypes [HMNH], Seleo, Berlinhafen, New Guinea, 1896, (Biró). One brachyp. paratype ♀ [AMNH]; New Guinea, 1896 (Biró).

From a communication from the Curator of Insects at the Hungarian Museum of Natural History, Budapest, it is understood that the slide types deposited by P. Wygodzinsky are broken and the only specimen of Schizopteridae that can be located at present is the type of *Hypselosoma matsumurae* Horvath, 1905.

(m) *H. matsumurae* Horvath, 1905, Ann. Mus. Nat. Hung., 3:417. Redescribed: Esaki & Miyamoto, 1959, Sieboldia, 2 (2):117-118, figs. 17 A-E. Holotype macrop. ♂ [HMNH], Sendai, Japan (S. Matsumura). Macrop. ♂, Korasan, Chikugo, Kyushu, 3.viii.1954 (S. Miyamoto). Macrop. ♂ (appendages broken), Chikushiya-bakei, Chikuzen, 20.ix.1953 (I. Hiura). Brachyp. ♀, Jinryo, Awa, Shikoku, 21.vii.1952 (S. Miyamoto). All captured near streams among hills. It is likely the latter specimens are in either Miyamoto's collection or with the entomological laboratory of the Kyushu University.

2. *Glyptocombus* Heideman, 1906, Proc. ent. Soc. Wash. 7, (4):192-194, fig. 21a.
= *Hypselosoma*: Horvath, 1908, Ann. Mus. nat. Hung., 6:565. Type-species *G. saltator* by monotypy.

Horvath (1908) overstated the case when he maintained that *Glyptocombus* and *Hypselosoma* were congeneric, but as suggested by Esaki and Miyamoto (1959) they are certainly closely related. The discovery of a new undescribed macropterous species of *Glyptocombus* [AMNH] in Trinidad has confirmed the association of two genera within the Hypselosomatinae but the differences between their genital and rostral characters ensure generic distinction.

(a) *Glyptocombus saltator* Heideman, 1906, Proc. ent. Soc. Wash., 7, (4):192-194, fig. 21a. Holotype brachyp. ♂, 9.ix.1905 (D. H. Clemons). Brachyp. allotype, 4.x.1905 (E. A. Schwarz), and ♀ paratype, 8.x.1905 (O. Heideman) [USNM 7585, on card], Plummers Island, Maryland. One specimen on card [USNM], "det. Sailer" A.E.C. area (trap), 19.vi.1957, Oak Ridge, Tennessee. One slide, ♂, "Pergande, (coll.), sieved 26.i.1879". One specimen [ZMH], Plummers Island, Md., Oct. 1906, det. Heideman.

3. *Ommatides* Uhler, 1894, Proc. zool. Soc. Lond., p. 159. Type-species *O. insignis* by monotypy.
(a) *Ommatides insignis* Uhler, 1894, Proc. zool. Soc. Lond., p. 159. Holotype brachyp. ♂ [BMNH 95-206], St. Vincent, W. I. (H. H. Smith).

The unique type is well preserved but has not been thoroughly examined. The large eyes, inflated bucculae, and venation strongly suggest a close relationship with *Glyptocombus*.

Subfamily SCHIZOPTERINAE

Esaki and Miyamoto (1959) left the Schizopterini undefined, but it may now be tentatively characterised by the four veins ema-

nating from the trapezoidal cell, the three segmented rostrum, the normal tarsal formula of 2.2.3 in females and 3.3.3 in males with an empodial vesicle between the pro and meso thoracic claws of males, the hindwing lacking a jugal lobe, abdominal spiracles normally present only upon sternites VI and VII and tergite VIII, the venation of fore and hindwings reduced, the anal tube asymmetrically associated with the right side of the genital capsule, and the spermatheca longer than wide.

4. *Bironannus* Wygodzinsky, 1950, Rev. bras. Biol., **10**, (4):382-383. Type-species *B. huon* by original designation.

Bironannus and *Humpatanannus* are united by the possession of an anterodorsal appendage on the left anterior margin of the genital capsule, three macrochaetae on the salient anteclypeus, a similar tarsal and pretarsal formula in males (the female of *Bironannus* is unknown), and the absence of conjunctival and pregenital abdominal appendages, which separate them from the majority of Schizopterinae. They are also peculiar in that their larvae have a conspicuous bristle arising from on the compound eye.

(a) *Bironannus huon* Wygodzinsky, 1950, Rev. bras. Biol., **10**, (4):384-385, figs. 25-41. Holotype macrop. ♂ [HMNH, slide], Sattelberg, Huon-Golf, New Guinea, 1899 (Biró).

(b) *B. horvathi* Wygodzinsky, 1950, Rev. bras. Biol., **10**, (4):385, figs. 42-45. Holotype macrop. ♂, [HMNH, slide], Friederick-Wilhelmshafen, New Guinea, 1901 (Biró).

5. *Humpatanannus* Wygodzinsky, 1950, Publ. cult. Cia Diamant. Angola, (7):41-43. Type-species *H. additius* by monotypy.

(a) *Humpatanannus additius* Wygodzinsky, 1950, Publ. cult. Cia. Diamant. Angola, (7):43-45, figs. 184-208. Holotype macrop. ♂ and brachyp. allotype [BMNH 1952-471, slide], paratype macrop. ♂ and brachyp. ♀, and 3 larvae [MD], Boca de Humpta, near Sa da Bandeira Angola, under quartz stones, 24.ix.1949 (A. Barros Machado).

(b) *H. brincki* Wygodzinsky, 1958, S. Afr. Anim. Life, **5**:109-112, figs. 1-18. Holotype brachyp. ♂ and brachyp. allotype [ZILU], Quthing, Basutoland, 19.iii.1951, under stones on dry meadow, 5,600 ft. (Brinck & Rudebeck). One brachyp. paratype ♀ [ZILU], Makheke Mts. 10 mls. east-northeast Mokhotlong, 7.iv.1951 (Brinck & Rudebeck).

6. *Biturinannus* Wygodzinsky, 1947, Boln. Ent. venez., **6**, (1):26-27. Type-species *B. reuteri* by monotypy.

Biturinannus is related to both *Bironannus* and *Humpatanannus* on account of the salient anteclypeus with three macrochaetae, the tarsal and pretarsal formulae of the male (the female of *Biturinannus* is unknown), and the absence of pregenital abdominal appendages. In *Biturinannus* the M-Cu crossvein has been described as absent, but the venation is basically similar to that of *Pinochius*. This similarity is reinforced by the absence of an appendage on the genital capsule. The development of the paraproctal appendage is similar to that of *Nannocoris*, but the other differences are so considerable that no great importance is attached to it.

(a) *Biturinannus reuteri* Wygodzinsky, 1947, Boln. Ent. venez., **6**, (1):27-35, figs. 1-18. Holotype macrop. ♂ and three specimens [Nos. 875, 876, 877, Seção de Entomologia do Instituto de Ecologia e Experimentação Agricola, Rio de Janeiro], Biturana, Municipio Palmas, Parana, Brasil (Staviarski).

7. *Ceratocomboides* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):12, figs. 15, 44. Type-species *C. prima* by monotypy.

Ceratocomboides has a venation very similar to that of *Schizoptera* but has less specialized genitalia and wing couplings, and has a different tarsal formula which is closer to that of *Biturinannus* and *Pinochius*. The hindwing is uniquely specialised by the deep incisions and hairy margins.

(a) *Ceratocomboides prima* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):12, figs. 15, 44. Holotype macrop. ♂ [USNM 27577, on card), Porto Bello, Panama, 11.iii.1911 (E. A. Schwarz).

(b) *C. brasiliensis* Wygodzinsky, 1951, Rev. bras. Biol., **11**, (3):263-264, figs. 23-35. Holotype macrop. ♂ [IOC], Rio de Janeiro, Parque Nacional da Serra dos Orgaos, Teresopolis, Estado do Rio, Brasil, 1500-1700 m., 14/22-iv-1947 (P. Wygodzinsky).

8. *Pinochius* Carayon, 1949, Bull. Mus. Hist. nat., Paris, **21**, (2):239-241. Type-species *P. africanus* by monotypy.

= *Seabranannus* Wygodzinsky, 1950, Publ. cult. Cia Diamant. Angola, (7): 34-36. See Wygodzinsky, 1950, Rev. bras. Biol., **10**, (4):391.

(a) *Pinochius africanus* Carayon, 1949, Bull. Mus. Hist. nat., Paris, **21**, (2):241-242, figs. 1-4. Holotype submacrop. ♀ [PMNH], Doula, Cameroons, West Africa, 22.xii.1946, on plants at edge of stream.

(b) *P. anterii* (Wygodzinsky, 1950), Publ. cult. Cia Diamant. Angola, (7): 36-39, figs. 4, 5, 147-175. Holotype macrop. ♂, brachyp. allotype [BMNH 1952-471, slides], paratype macrop. ♂, two brachyp ♀, larvae, [MD], forest on left bank of River Chiumbe, 45 km. east of

Dundo, Angola, v.1949. Macrop. ♂ paratype, forest of river Tchikapa, 50 km. southwest of Dundo, 27.iii.1949. Macrop. ♂, 2 brachyp. ♀ paratypes and 7 larvae, forest of Tala Mungongo, 70 km. northwest of Nova Gaia, Dist. Malang, i/ii/iii/1949. One larva, bank of River Kassai, northeast Angola, 1.v.1949. All specimens taken from vegetable detritus by A. Barros Machado and with exception of holotype and allotype are in the AMNH or Dundo Museum. One ♀ [BMNH 1961-149, spirit], Bobiri forest, Ghana, viii.1957, Imp. Coll. Expdn., Det. T. R. E. Southwood.

(c) *P. similis* (Wygodzinsky, 1950), Publ. cult. Cia Diamant. Angola, (7): 40-41, figs. 179-191. Holotype macrop. ♂ [BMNH 1952-471, slide], forest on left bank of River Chiumbe, 45 km. east of Dundo, vegetable detritus, v.1949 (A. Barros Machado).

(d) *P. dunduno* (Wygodzinsky, 1950), Publ. cult. Cia Diamant. Angola, (7):39, figs. 176-178. Holotype macrop. ♂ [BMNH 1952-471, slide], forest of River Dunduno, tributary of River Luachimo, in vegetable detritus, vi.1949 (A. Barros Machado).

(e) *P. imitator* (Wygodzinsky, 1950), Publ. cult. Cia Diamant. Angola, (7):39, figs. 182-183. Holotype macrop. ♀ [BMNH 1952-471, slide], forest gallery of River Luachimo, near Dundo, sweeping bushes, v.1948 (A. Barros Machado).

9. *Silhouettanus* n. gen. — new name for the Schizopterid described by Distant 1913, Trans. Linn. Soc. Lond. (Zool.), **16**, (2):171, pl. 12, fig. 17. Type-species *S. alboclavatus* by monotypy.

Distant was uncertain of the generic allocation of *alboclavatus* and listed it as *Gen?*. Since it is now clear that it is not congeneric with any described Schizopterid the new name *Silhouettanus* is proposed. It does not seem closely related to any other known genera but the four veins emanating from the trapezoidal cell and other characters place it in the Schizopterinae.

(a) *Silhouettanus alboclavatus* (Distant, 1913) Trans. Linn. Soc. Lond. (Zool.), **16**, (2):171, pl. 12, fig. 17. Holotype macrop. ♂ [BMNH 1911-497-28, on card], Percy Sladen Trust Expdn., Mare aux Cochons, Silhouette, Seychelles, over 1,000 ft. 1908-09. Macrop. ♂ [CUMZ, slide], near Mont Pot-à-eau, about 1,500 ft., Silhouette. Macrop. ♂ [CUMZ, on card], Mahé, country above Port Glaud, 500-1,000 ft.

10. *Dundonannus* Wygodzinsky, 1950, Publ. cult. Cia Diamant. Angola, (7): 24-26. Type-species *D. chiumbiensis* by original designation.

Vilhenannus, Machadonannus and *Dundonannus* seem closely related on account of the similarities in the development of the pre-

genital abdominal appendages, the venation, and the wingcoupling apparatus which is continuous with a ridge along the posterior side of the vannal fold. *Dundonannus* has a dissimilar female tarsal formula, for both *Machadonannus* and *Vilhenannus* are similar to the bulk of the Schizopterinae and they also have a serrated margin to the proximal stem of R + M.

(a) *Dundonannus chiumbiensis* Wygodzinsky, 1950, Publ. cult. Cia Diamant. Angola, (7):26-29, figs. 2, 85-110. Holotype macrop. ♂ [BMNH 1952-471, slide], forest gallery of River Luachimo, xii.1948. Allotype brachyp. ♀ [MD? slide], forest gallery of River Mussungue, near Dundo, Angola, xi.1947. Macrop. ♂ paratype [MD? slide], forest on left bank of River Chiumbe, 45 km. east of Dundo, Angola, v.1949. All taken by A. Barros Machado from vegetable detritus in soil.

(b) *D. mussunguensis* Wygodzinsky, 1950, Publ. cult. Cia Diamant, Angola, (7):29, figs. 111-123. Holotype macrop. ♂ [BMNH 1952-471, slide], Dundo, Angola at light, iii.1948. Paratype macrop. ♂ [MD? slide], forest gallery of River Mussungue, near Dundo, vegetable detritus in soil. All taken by A. Barros Machado.

(c) *D. wygodzinskyi* Southwood, 1961, Entomologist's mon. Mag., 97: 91, figs. 1-5. Holotype macrop. ♂ (spirit), and paratype macrop. ♂ (slide), [BMNH 1961-149], Bobiri forest reserve, Ashanti, Ghana, viii.1947, Imperial College Expdn., extracted from wet litter from forest floor (J. Paterson).

11. *Vilhenannus* Wygodzinsky, 1950, Publ. cult. Cia Diamant. Angola, (7): 19-20. See note on *Dundonannus* for relationships. Type-species *V. angolensis* by monotypy.

(a) *Vilhenannus angolensis* Wygodzinsky, 1950, Publ. cult. Cia Diamant. Angola, (7):21-24, figs. 1, 36-74. Holotype macrop. ♂, brachyp. allotype [BMNH 1952-471, slides], macrop. ♂ paratype, 4th instar larvae, forest gallery of River Tchimana, tributary of River Tchikapa, vii.1948. Three macrop. ♀ paratypes, forest gallery of River Luachimo, near Dundo, v/vi.1948. Macrop. ♂ paratype, at light, ix.1948. Macrop. ♀ paratype, banks of River Tchitato, sweeping weeds, 3.x.1948. Sub-macrop. ♀ paratype, forest of Tala Mungongo, 70 km. northwest of Gaia, Malange District, i.1949. Sub-macrop. ♀ paratype (slide), forest of River Tchikapa, 50 km. southwest of Dundo, 27.iii.1949. Two macrop. ♀ paratypes, forest of River Dunduno, tributary of River Luachimo, vi.1949. All specimens except where stated otherwise taken from vegetable detritus by A. Barros Machado, and deposited in the Dundo Museum or the AMNH.

12. *Machadonannus* Wygodzinsky, 1950, Publ. cult. Cia Diamant. Angola, (7):14-16. See note on *Dundonannus* for relationships. Type-species *M. ocellatus* by monotypy.

(a) *Machadonannus ocellatus* Wygodzinsky, 1950, Publ. cult. Cia Diamant. Angola, (7):16-19, figs. 6-35. Holotype macrop. ♂ [BMNH 1952-471, slide], sub-brachyp. allotype [MD? slide], forest of River Tchikapa, 50 km. southwest of Dundo, 27.iii.1949. Three sub-brachyp. ♀ paratypes, Camissombo lowlands, 100 km. south of Dundo, iv.1949. Vth instar larva, forest of River Dunduno, iv.1949. One sub-brachyp. ♀ paratype, vii.1948. All specimens found in vegetable detritus by A. Barros Machado. Paratypes are deposited in the AMNH and Dundo Museum.

13. *Corixidea* Reuter, 1891, (as a subgenus of *Schizoptera*), Acta Soc. Sci. fenn. **19**, (6):17-18, fig. 14. Reuter, 1912, (as a genus), Ofvers. finska. VetenskSoc. Förh., **54**, nfd. A, (7):65. Type-species *C. lunigera* by monotypy.

Corixidea and *Voccoroda* share the absence of paraproctal appendages and the development of a very long process from the posterior margin of tergite VIII.

On account of the short truncately tipped rostrum, the absence of a pronotal collar, the similar venation and thickening of the anterior corial veins, the development of metathoracic hyperpleura, and the absence of conjunctival appendages there can be no doubt that *Corixidea, Voccoroda, Hoplonannus* and *Membracioides* are closely related. See note under *Hoplonannus.*

(a) *Corixidea lunigera* (Reuter, 1882), Rev. Ent., Caen, p. 164.
= *Schizoptera* (*Corixidea*) *lunigera* Reuter, 1891, Acta Soc. Sci. fenn. **19**, (6):24-25, fig. 14. Holotype and paratype macrop. ♂ ♂ [Reuter], Pernambuco, Brasil (D. Lethierry).

A number of specimens in the USNM have been previously determined as *C. lunigera.* They are: three specimens, from Trinidad, Rio Panama, 9.vi.1912 (A. Busck); four specimens, Ancon, Canal Zone, at arc light, 12.v.1911 (A. H. Jennings); two specimens, Barro Colorado Island, Panama, vi.1941 (J. Zeteck); one specimen, Guerro, Mexico, 28.ii.1946, on orchid; one specimen, Plane intercept, 31.xi.1945, Miami, Florida/LaGuira, via Trujillo, P. R.; and one specimen, Cocoa Trace Aguas, Alta Vera Paz, Guatemala, 13.viii.1911 (Schwarz and Barber).

(b) *C. bierigi* Bruner, 1934, Mem. Soc. Cubana Hist. nat., 8, (4):212, figs. 1, 3, 4. Holotype macrop. ♂ [Estación experimental Agronomica Cuba 10241], Sierra Range, Pinar del Rio, 14.i.1934 (A. Bierig).

(c) *C. crassa* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13): 25-26. Holotype macrop. ♂ (lost) and paratype macrop. ♂ [USNM

27603, on card], Ancon, Canal Zone, 12.v.1911, at arc light (A. H. Jennings).

The loss of holotype necessitates the paratype be designated the neotype.

(d) *C. major* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):26, figs. 19, 53. Holotype macrop. ♂ [USNM 27604 (S. E. Crumb, 137), on card], at light, 13 or 23.viii.1915, Clarksville, Tennessee (G. A. Runner).

(e) *C. scutellata* (Uhler, 1894), Proc. ent. Soc. Lond., pp. 156-160. Holotype macrop. ♂ [BMNH 95-206], St. Vincent, W.I. (H. H. Smith).

This is a new combination. The dried specimen of *Schizoptera scutellata* has been examined and on account of the large eyes, the venation and thickened veins on the corium and vannus, the elongate process from the VIIIth tergite, and the absence of a pronotal collar, this species should be assigned to *Corixidea*.

Corixidea crassa, the type of which has been lost, and *C. scutellata* are very closely related and with more material may be shown to be conspecific.

(f) *C. beebei* n. sp. Holotype macrop. ♂ [AMNH, in glycerine], at light, St. Augustine, Trinidad, W.I., 12.xi.1960 (M. G. Emsley). Two macrop. ♂ paratypes [USNM, AMNH, slides] same data.

(g) *C. julieae* n. sp. Holotype macrop. ♂ [AMNH, in glycerine], at light in Pangola pasture, University Field Station, St. Augustine, Trinidad, W.I., 26.iv.1962 (M. G. Emsley). Macropterous ♂ paratype [USNM, slide] same data.

(h) *C. underwoodi* n. sp. Holotype macrop. ♂ [AMNH, slide], at light, 1.xii.1960, St. Augustine, Trinidad, W.I. (M. G. Emsley).

(i) *C. doddsi* Van Duzee, 1924, Proc. Pacif. Cst. ent. Soc., 2:33-34. Holotype macrop. ♂ and 17 paratypes [CAS], Los Mochis, Sinaloa, Mexico, 20.vii.1922 (C. T. Dodds).

The holotype has not been seen, but though considered by both Van Duzee and McAtee & Malloch to be close to *Corixidea lunigera*, the illustration of the macropterous forewing is quite dissimilar to typical *Corixidea*. It seems unlikely to be even congeneric.

14. *Voccoroda* Wygodzinsky, 1950, Rev. bras. Biol., **10**, (4):377-378. See note under *Corixidea* for relationship. Type-species *V. carioca* by monotypy.

(a) *Voccoroda carioca* Wygodzinsky, 1950, Rev. bras. Biol., **10**, (4):378-382, figs. 1-24. Holotype macrop. ♂, and brachyp. allotype [IOC], paratype macrop. ♂ and brachyp. ♀ [AMNH], Represa do Cabeça, Corcovado, Rio de Janeiro, Brasil, 30.vi.1946, 7.vii.1946, 4.viii.1946, 21.ix.1947 (P. Wygodzinsky).

15. *Hoplonannus* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):30, fig. 26. Type-species *H. brunneus* by monotypy.

Hoplonannus and *Membracioides* differ from *Corixidea* and *Voccoroda* in the lack of thickened veins on the vannus, and in the possession of paraproctal appendages. *Membracioides* differs from *Hoplonannus* in the posterior elongation of the pronotum which then covers the mesoscutellum, but some undescribed specimens are known which present an intermediate condition.

(a) *H. brunneus* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):30, fig. 26. Holotype brachyp. ♀ [USNM 27610, on card], Cacao Trece Aguas, Guatemala, 26.iv.19?? (E. A. Schwarz and H. S. Barber).

(b) *H. paenebrunneus* n. sp. Holotype macrop. ♂ and brachyp. allotype [AMNH, in glycerine], in forest litter, Wm. Beebe Tropical Research Station, Arima Valley, Trinidad, W.I., 31.iii.1961 (M. G. Emsley). Twelve ♂ paratypes [USNM, ANSP], one in each month of 1962, at light (M. G. Emsley). Macrop. ♂ and brachyp. ♀ paratype [AMNH], in litter, Mason Hall, Tobago, W.I., March, 1962 (M. G. Emsley).

This species may be conspecific with *brunneus* but no reliable determination is possible because that species is represented only by an unique female.

(c) *H. craneae* n. sp. Holotype macrop. ♂ [AMNH, in glycerine], in forest litter, Mason Hall, Tobago, W.I., March, 1962 (M. G. Emsley). Allotype [AMNH, in glycerine] and macrop. male paratype [AMNH, slide], 2.iii.1962, Wm. Beebe Tropical Research Station, Arima Valley, Trinidad, W.I., in forest litter (M. G. Emsley).

16. *Membracioides* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):27, figs. 20, 55. See note under *Hoplonannus*. Type-species *M. parallela* by monotypy.

(a) *Membracioides parallela* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):27, fig. 85. Holotype macrop. ♂ [USNM 27605], Cordoba, Vera Cruz, Mexico, 27.iv.1908 (A. Fenyes).

(b) *M. zschokkei* Wygodzinsky, 1952, Acta zool. lilloana, **10**: 61-64, figs. 41-54. Holotype and eight macrop. ♂ paratypes [CAS], one paratype ♂ [Inst. Ent. de la Fundacion M. Lillo], two paratype ♂♂

[AMNH], Tres Rios Plantation, Gatun Lake, Panama, 1931 (T. O. Zschokke).

17. *Oncerodes* Uhler, 1894, Proc. zool. Soc. Lond., pp. 159-160. Type-species *O. robusta* by monotypy.

The unique female of *Oncerodes* has not been thoroughly examined as it is a unique type of card, but the absence of a pronotal collar and the presence of a truncate rostrum suggest affinity with *Hoplonannus* and *Corixidea.*

(a) *Oncerodes robusta* Uhler, 1894, Proc. zool. Soc. Lond., p. 160. Holotype brachyp. ♀ [BMNH], Leeward side, St. Vincent, Locality 202 (H. H. Smith).

18. *Nannocoris* Reuter, 1891, Acta. Soc. Sci. fenn., **19**, (6):18, as subgenus of *Schizoptera;* as a genus, McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):28, fig. 33. Type-species *N. nebulifera* by subsequent designation, Kirkaldy, 1906, Trans. Amer. ent. Soc., **32**, (2):148.

Though *Nannocoris* is specialised in the elongation of the head capsule and rostrum and in the association of the posterior pre-genital tergites with the genitalia, the texture of the hemelytra and sculpturing of the thorax are very similar to members of the *Schizoptera/Corixidea/Hoplonannus* group. The presence of paraproctal appendages allies *Nannocoris* more closely to *Hoplonannus* than to either of the other genera.

(a) *Nannocoris nebulifera* (Reuter, 1891), Acta. Soc. Sci. fenn., **19**, (6):23; as *Schizoptera* (*Nannocoris*) *nebulifera.* Macrop. holotype ?, [Reuter], Bolivia (D. Lethierry).

(b) *N. tuberculifera* (Reuter, 1891), Acta Soc. Sci. fenn., **19**, (6):23-24, figs. 13 a and b; as *Schizoptera* (*Nannocoris*) *tuberculifera*: McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):28, figs. 22, 23 and 56. Holotype macrop. ? [Reuter], Tovar estate, Venezuela (E. Simon).

(c) *N. arenaria* Blatchley, 1926, Heteropt. east north. Amer., p. 651. Holotype ? [?], several specimens Dunedin. Florida, 4.i. and 16.ii.19?? (?).

(d) *N. capitata* (Uhler, 1894), Proc. zool. Soc. Lond., pp. 156-170, as *Schizoptera capitata.* Holotype macrop. ♂ [BMNH 95-206], St. Vincent, W.I., locality 6 (H. H. Smith).

New combination. *Schizoptera capitata* is clearly a *Nannocoris* on account of the typical structure of the venation, rostrum, and meso and metasternum.

(e) *N. cavifrons* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):28-29. Holotype macrop. ♂ [USNM 27606], Cacao Trece Aguas, Guatemala, 25.iv.19?? (E. A. Schwarz and H. S. Barber).

(f) *N. descolei* Wygodzinsky, 1952, Acta zool. lilloana, **10**:58-61, figs. 22-40. Holotype macrop. ♂, and macrop. allotype [Inst. Ent. de la Fundacion M. Lillo], two paratype ♂♂ and four paratype ♀♀ [AMNH], Pie de la Sierra de San Javier, Tucuman, 30.viii.1948, 24.vi.1950. One paratype ♀ [BMNH 1951-141], Valle de San Javier, Tucuman, 800 m., 15.viii.1950 (P. Wygodzinsky), seven ♂ and nine ♀ paratypes [AMNH & J. Carayon].

(g) *N. flavomarginata* McAtee & Malloch, 1925, Proc. U.S. nat. Mus. **67**, (13):29, fig. 19. Holotype macrop. ♀ [USNM 27609], Paraiso, Canal Zone, Panama, 11.iv.1911 (E. A. Schwarz).

(h) *N. nasua* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13): 29, figs. 24-25, 42. Holotype and paratype macrop. ♀ [USNM 27607], Cacao Trece Aguas, Alta Vera paz, Guatemala, 19/18.iv.19?? (E. A. Schwarz and H. S. Barber).

(i) *N. schwarzi* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):29, fig. 32. Holotype macrop. ♂ [USNM 27608], Porto Bello, Panama, 12.iii.1911 (E. A. Schwarz).

(j) *N. arimensis* n. sp. Holotype macropterous ♂ [AMNH, glycerine], at light, WBTRS, Arima Valley, Trinidad, W.I., April 1963 (M. G. Emsley). Three paratype ♂♂ [AMNH, USNM glycerine], three paratype males [AMNH, USNM, slides], same data, July 1962.

(k) *N. wrightae* n. sp. Holotype macropterous ♂ [AMNH, in glycerine with genitalia on slide], at light, WBTRS, Arima Valley, Trinidad, W.I., March 1962 (M. G. Emsley). Paratype ♂ [USNM, on slide, genitalia missing], same data, June 1963.

(l) *N. pricei* n. sp. Holotype macropterous ♂ [AMNH, in glycerine, genitalia and one wing on slide], sieved from forest litter, Maracas Valley, Trinidad, W.I., 6.iii.1961 (M. G. Emsley); allotype [AMNH, in glycerine, wing and genital segments on slide], same data, 10.iii.1962, in forest litter (M. G. Emsley). Paratype ♀ [USNM, on slide] WBTRS, Arima Valley, Trinidad, W.I., at light, 6.i.1960 (M. G. Emsley).

19. *Schizoptera* Fieber, 1860, Wien. Ent. Monats., **4**, (9):268-269; Reuter, 1882, Rev. Ent., Caen, **1**:162; Reuter, 1891, Acta Soc. Sci. fenn., **19**, (6):16-17; McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13): 12-15; Wygodzinsky, 1952, Acta zool. Lilloana, **10**:64. Type-species *S. cicadina* by monotypy.

Schizoptera is a very large uniform genus, the species of which are always distinguishable on genital characters particularly the right conjunctival appendage, but which can be classified into species-

groups by conspicuous non-genital characters, for which subgeneric names have already been proposed.

I. Subgenus — *Schizoptera* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):12-14, fig. 37. Type-species *S. cicadina* by nomination.

The subgenus *Schizoptera* is distinguished by the lack of a process on the lateral margin of the propleurum and the absence of an elevated shiny area on the metepisternum, though the ventral edge, which terminates in the generically characteristic spine, may be narrowly smooth and polished. All the known specimens of both sexes are macropterous or rarely submacropterous.

(a) *Schizoptera cicadina* Fieber, 1860, Wien. Ent. Monats., **4**, (9):272; Reuter, 1882, Rev. Ent., Caen., **1**:162-163. Reuter, 1891, Acta Soc. Sci. fenn., **19**, (6):19. Holotype macrop. ♂ [NHMV (?)], Venezuela (D. Moritz).

Neither McAtee & Malloch nor the writer has seen the type species, so the allocation of the subgeneric name may be in error.

(b) *S.* (*S.*) *affinis* Poppius, 1910, Ofvers. finska VetenskSoc. Förh., **52**, (1):11-12; McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13): 22, fig. 73. Holotype macrop. ♂ [ZMH (?)], La Moka, Caracas, Venezuela, 6.x.1891 (Meinert).

(c) *S.* (*S.*) *apicalis* Reuter, 1882, Rev. Ent., Caen., **1**:163-164; Reuter, 1891, Acta Soc. Sci. fenn., **19**, (6):20-21, fig. 11 a and b; McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, 13:22-23, fig. 75. Holotype macrop. ? [Reuter (?)] Pernambuco, Brasil (D. Lethierry).

Three so-called *S. apicalis* from the Zoological Museum of Helsinki clearly do not belong to the subgenus *Schizoptera* but to *Cantharocoris* and are similar to *S. scymnus*, but as they are females it is not possible to determine them to species reliably.

(d) *S.* (*S.*) *apicipunctata* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):23; fig. 77. Holotype macrop. ♂ [USNM 27597], Trece Aguas, Alta Vera Paz, Guatemala, 5.iv.19?? (E. A. Schwarz).

(e) *S.* (*S.*) *caudata* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):21, fig. 70. Holotype macrop. ♂, paratype and macrop. allotype [USNM 27592], Tampico, Mexico, 15/18/14.xii.19?? (E. A. Schwarz).

(f) *S.* (*S.*) *flavipes* Reuter, 1882, Rev. Ent., Caen., **1**:163; Reuter, 1891, Acta Soc. Sci. fenn., **19**, (6):19, fig. 10; Poppius, 1910, Ofvers. finska VetenskSoc. Förh., **52**, (1):10-11. Holotype and paratype

[Reuter], Rio de Janeiro, Brasil, between 1875-1880 (F. Sahlberg). Brachyp. ♀ [ZMH?] Caracas, Venezuela, 17.vi.1891 (Meinert).

The brachypterous female described by Poppius (1910) as conspecific with *Schizoptera flavipes* has been examined and belongs to the subgenus *Lophopleurum*. One would not now expect a brachypterous female to be of the *Schizoptera* group. The type of *S. flavipes* was not examined by McAtee and Malloch, nor has the writer seen it, so the species itself may have to be transferred.

(g) *S.* (*S.*) *hirta* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):20-21, figs. 37, 47, 69, 83. Holotype macrop. ♂, and macrop. allotype (on same mount), and three macrop. ♂ paratypes [USNM 27591], Trece Aguas, Alta Vera Paz, Guatemala, 4/18.iv. and 28/30.iii.19??. One Macrop. ♂ paratype [USNM], Livingston, Guatemala, 4.v.19?? (E. A. Schwarz and H. S. Barber). The USNM also has some Panamanian specimens considered by McAtee & Malloch to be conspecific:— one macrop. ♀ Bohio, 7.ii.1911; two macrop. ♀♀, Paraiso, 30.iv.1911; and one specimen, Portobello, 21.ii.1911 (all E. A. Schwarz).

Schizoptera hirta and *S. reticulata* have the smooth shining ventral margin of the metepisternum much higher than in other species of the subgenus and present a condition intermediate between the *Schizoptera* and *Cantharocoris* subgenera.

(h) *S.* (*S.*) *mexicana* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):21, fig. 71. Holotype macrop. ♂ [USNM 27593], Tampico, Mexico, 26.xii.19?? (E. A. Schwarz).

(i) *S.* (*S.*) *monrosi* Wygodzinsky, 1952, Acta zool. lilloana, **10**:65-68, figs. 55-72. Holotype macrop. ♂ [Inst. Ent. de la Fundacion M. Lillo], macrop. allotype [AMNH], San Pedro de Colalao, Dep. Trancas, Tucuman 8.xi.1948 (P. Wygodzinsky). Two macrop. ♀ paratypes [AMNH], Valle de San Javier, Tucuman, 800 m., 15.viii. 1950.

(j) *S.* (*S.*) *paraguayana* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):21-22, fig. 72. Holotype macrop. ♂ [USNM 27594], San Bernardino, Paraguay (K. Fiebrig).

(k) *S.* (*S.*) *pilosa* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):22, fig. 74. Holotype macrop. ♂ [USNM 27595], Livingston, Guatemala, 6.v.19?? (E. A. Schwarz and H. S. Barber).

(l) *S.* (*S.*) *reticulata* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):20, fig. 68. Holotype macrop. ♂, and three paratype ♂♂ [USNM 27590], Livingston, Guatemala, 8/4/11.v.19??. One

paratype macrop. ♂ [USNM], Tampico, Mexico, 29.xii.19?? (E. A. Schwarz). See note, under *S.* (*S.*) *hirta.*

(m) *S.* (*S.*) *vitellius* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):24, figs. 38, 78. Holotype macrop. ♂ [USNM 27599], Livingston, Guatemala, 10.v.19?? (E. A. Schwarz).

(n) *S.* (*S.*) *maxima* n. sp. Holotype macropterous male [AMNH slide], WBTRS, Arima Valley, Trinidad, W.I., at light, 10.vi.1963 (M. G. Emsley).

(o) *S.* (*S.*) *rossi* n. sp. Holotype macropterous male [AMNH, genitalia on slide] and two macropterous male paratypes [USNM, AMNH, slides], WBTRS, Arima Valley, Trinidad, W.I., at light, June 1963 (M. G. Emsley).

(p) *S.* (*S.*) *kennyi* n. sp. Holotype macropterous male [AMNH, slide] and three macropterous male paratypes [AMNH, USNM, two glycerine, one slide]; WBTRS, Arima Valley, Trinidad, W.I., at light, 3.vi.1962 (type), paratypes various dates in June, August and September (M. G. Emsley). Two macropterous females [AMNH], indistinguishable from these males on non-genital structures and from the same locality have been provisionally allocated to this species on account of their size, but they could be *maxima* n. sp.

(q) *S.* (*S.*) *erythiza* n. sp. Holotype macropterous male [AMNH, slide], and four macropterous male paratypes [AMNH, USNM, two glycerine, two slides], WBTRS, Arima Valley, Trinidad, W.I., at light, 1.vi.1962 (type), paratypes various dates in July and August (M. G. Emsley). Two macropterous females [AMNH] with identical non-genital characters have been taken from the same locality and have been provisionally allocated to this species. One was taken at light, and the other sweeping lower canopy vegetation.

(r) *S.* (*S.*) *griffithi* n. sp. Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W.I., at light, 29.viii.1962 (M. G. Emsley).

(s) *S.* (*S.*) *susicauda* n. sp. Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W.I., at light, 30.xii.1961 (M. G. Emsley).

(t) *S.* (*S.*) *richardsi* n. sp. Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W.I., at light, 27.ix.1961 (M. G. Emsley).

(u) *S.* (*S.*) *caprona* n. sp. Holotype macropterous male [AMNH, slide] and ♂ paratype [AMNH, slide], WBTRS, Arima Valley, Trinidad, W.I., at light, 4.vi.1962 (M. G. Emsley). A macropterous female [AMNH] indistinguishable from the type on non-genital characters has been provisionally allocated to this species.

(v) *S.* (*S.*) *merleae* n. sp. Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W.I., at light, 6.vii.1963 (M. G. Emsley). Four male paratypes [AMNH, USNM two slides, two

glycerine] June 1962, at light, WBTRS, Trinidad, W.I., (M. G. Emsley).

(w) *S.* (*S.*) *brucei* n. sp. Holotype macropterous male [AMNH, glycerine] and fifteen paratype macropterous males [AMNH, BMNH, USNM, four slides, eleven glycerine], WBTRS, Arima Valley, Trinidad, W. I., at light, 31.i.1962 (type) and various dates in February, May, July and October (M. G. Emsley). A female with similar data has provisionally been allocated to this species [AMNH].

(x) *S.* (*S.*) *spiralis* n. sp. Holotype macropterous male [AMNH, glycerine] and two macropterous male paratypes [AMNH, USNM, slides], WBTRS, Arima Valley, Trinidad, W.I., at light, 6.ix.1961 (type), 19.ix.1961, 24.x.1961 (M. G. Emsley).

(y) *S.* (*S.*) *psalida* n. sp. Holotype macropterous male [AMNH, glycerine] and eight macropterous male paratypes [AMNH, ANSP, USNM, two glycerine, six slides], WBTRS, Arima Valley, Trinidad, W.I., at light, 8.ix.1961 (type), and various dates in April, July, August and November (M. G. Emsley). Allotype and two female paratypes [AMNH, slides] 10.x.1961, WBTRS, Trinidad, W.I., at light (M. G. Emsley).

(z) *S.* (*S.*) *anisota* n. sp. Holotype macropterous male [AMNH, glycerine] and thirteen macropterous male paratypes [AMNH, BMNH, USNM, two slides, eleven glycerine], WBTRS, Arima Valley, Trinidad, W.I., at light, 8.ix.1961 (type) and various dates in January, March, June and December (M. G. Emsley).

(aa) *S.* (*S.*) *chelifera* n. sp. Holotype macropterous male [AMNH, slide] and four macropterous male paratypes [AMNH, USNM, two glycerine, two slides], WBTRS, Arima Valley, Trinidad, W.I. at light, 16.ii.1962 (type) and 31.xii.1961, 20.x.1961 and 18.i.1961 (M. G. Emsley).

(bb) *S.* (*S.*) *falcicula* n. sp. Holotype macropterous male [AMNH, in glycerine], WBTRS, Arima Valley, Trinidad, W.I., at light, 2.ii.1962 (M. G. Emsley). Seven macropterous male paratypes [AMNH, USNM, six slides, one glycerine], at light, mile 2, Maracas Valley, Trinidad, 12.iv.1961 (J. L. Price). A female from the same locality has provisionally been assigned to this species [AMNH, slide].

(cc) *S.* (*S.*) *cleofan* n. sp. Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W.I., at light, 18.iv.1962 (M. G. Emsley).

(dd) *S.* (*S.*) *apatosulcata* n. sp. Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W.I., at light, 13.vii.1961 (M. G. Emsley). Three macropterous male paratypes [AMNH, USNM, two glycerine, one slide], same data but various dates in August and September. Numerous other specimens have been taken at the same locality in all the months of the year.

II. Subgenus — *Cantharocoris* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):13, fig. 36. Type-species *S. reuteri* by original designation.

The *Cantharocoris* group is distinguished by the elevated shining area on the metepisternum which extends halfway up the height of the pleurum. The reticulate pattern that occurs on the elevated episterna is particularly conspicuous in *Cantharocoris* and was noticed by McAtee & Malloch. Evidence so far suggests that only the females are brachypterous.

(a) *Schizoptera* (*Cantharocoris*) *reuteri* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):18-19. Holotype brachyp. ♀, Polochio River, Guatemala, 2.v.19?? (H. S. Barber); three paratype brachyp. ♀♀, Livingston, Guatemala, 8/10.v.19?? (E. A. Schwarz and H. S. Barber) [all USNM 27588].

(b) *S.* (*C.*) *licinius* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):23, as *S.* (*Schizoptera*) *licinius*. Holotype macrop. ♂ [USNM 27598], Frijoles, Canal Zone, 25.iii.1911 (E. A. Schwarz).

(c) *S.* (*C.*) *nigrita* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):23, fig. 76, as *S.* (*Schizoptera*) *nigrita*. Holotype macrop. ♂ [USNM 27596], Cordoba, Vera Cruz, Mexico, 15.iv.1908 (A. Fenyes).

(d) *S.* (*C.*) *scymnus* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):20, figs. 48, 66. Holotype macrop. ♂ [ZMH No. 3922 (?), coll. No. 5733] Colonia Tovar, Venezuela, 1.xi.1888 (E. Simon). Four other specimens in Helsinki Museum, previously determined as *S. apicalis*, are probably of this species, their data are as follows: brachyp. ♀, Tovar Estate, Venezuela, 1.ii.1888, E. Bergroth (E. Simon), [Montandon 1901-233]; brachyp. ♀, Tovar Estate, Caracas, Venezuela (D. Simon); brachyp. ♀, Pernambuco, Brasil (D. Lethierry); brachyp. ♀, Tovar Estate, taken with macropterous forms (D. Simon).

(e) *S.* (*C.*) *pseudosulcata* n. sp. Holotype macropterous male [AMNH, glycerine], WBTRS, Arima Valley, Trinidad, W.I., at light, 23.v.1962. Thirteen macropterous male paratypes [AMNH, USNM, three slides, ten glycerine], same data but various dates in March, June, September and November (M. G. Emsley).

(f) *S.* (*C.*) *hillae* n. sp. Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W.I., at light, 4.vi.1962. Eight paratype macropterous males [AMNH, USNM, one slide, seven glycerine], same data but 8.v.1962, 18.x.1961, and 20.x.1961 (M. G. Emsley).

III. Subgenus — *Lophopleurum* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):14, fig. 39. Type-species *S. sulcata* by original designation.

Lophopleurum shows the extreme condition of the metepisternum in which the elevated shining area reaches the costal margin of the forewing when in repose. The females are usually brachypterous and the males macropterous, but one undescribed brachypterous male is known from Brazil.

(a) *Schizoptera* (*Lophopleurum*) *sulcata* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):24, figs. 35, 39, 80. Holotype macrop. ♂ and two ♂ paratypes, windward side Balthazar, Grenada, W.I. (H. H. Smith); one macrop. ♂ paratype, Ancon, Canal Zone, 12.v.1911, at arc light (A. H. Jennings) [all USNM 27600]. Macrop. ♂ windward side Balthazar, locality 86, Grenada, W.I. (H. H. Smith); macrop. ♂ windward side locality 190 St. Vincent, W.I. (H. H. Smith); macrop. ♂, Grand Etang, Grenada, 1900 feet windward side locality 94, W.I., flying at sunset August and early September (H. H. Smith) [all BMNH 95-206]; 2 damaged macrop. ♂ ♂ [BMNH 1924-535], St. Augustine, Trinidad, W.I. 22.vii.1923 (C. L. Withycombe); numerous macrop. ♂ ♂, Wm. Beebe Tropical Research Station, Arima Valley, Trinidad, Secondary forest, April 1963, at light (M. G. Emsley); numerous macrop. ♂ ♂, University Farm, St. Augustine, Trinidad, March, 1963, at light in Pangola pasture (M. G. Emsley); macrop. ♂ ♂ and brachyp. ♀ ♀, WBTRS, sieved from forest litter, May 1963 (M. G. Emsley). Specimens have been deposited with the BMNH, USNM, and AMNH.

Uhler's statement in 1894 that *Schizoptera flavipes,* which was his mis-identification of *S. sulcata,* was known from Venezuela, the Antilles and Central and South America is curious, for no records of Schizopteridae from Central America were published until 1925 and then upon material collected in 1909-1910.

(b) *S.* (*L.*) *bispina* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):24, fig. 81. Holotype macrop. ♂ [USNM 27601], Cacao Trece Aguas, Alta Vera Paz, Guatemala, 1906 (E. A. Schwarz and H. S. Barber). A specimen which may be conspecific from Tampico, Mexico, 15.xii.19?? (E. A. Schwarz) is also in the USNM.

(c) *S.* (*L.*) *elegans* Poppius, 1910, Ofvers. finska. VetenskSoc. Förhs., **52**, (1):12-13. Redescribed: Wygodzinsky, 1951, Acta zool. lilloana, **10**:71-73, figs. 87-93. Two macrop. ♀ ♀ [HMNH], Guadeloupe, W.I. Poppius quotes three examples in Schouteden's collection, one

of which is distinguished as var *marginalis*, but the location of this specimen is unknown.

(d) *S.* (*L.*) *elmis* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):19, fig. 50, as *S.* (*Cantharocoris*) *elmis*. Holotype brachyp. ♀ [ZMH spec. and type No. 3997, coll. No. 5736], Caracas, 17.vi.1891 (Meinert).

(e) *S.* (*L.*) *reitteri* Reuter, 1891, Acta Soc. Sci. fenn., 19, (6):22, fig. 12 a and b; as *S.* (*Cantharocoris*) *reitteri*: McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):19. Holotype brachyp. ♀ [Reuter], Blumenau, Brazil. Brachyp. ♀ [ZMH, spec. and type No. 3924 or 3224 coll. No. 5734], det. McAtee & Malloch.

(f) *S.* (*L.*) *tenuispina* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):24-25, fig. 82. Holotype macrop. ♂ [USNM 27602], Gatun, Canal Zone, 7.iv.1911 (E. A. Schwarz). Many males, WBTRS, Arima Valley, Trinidad, W.I., at light, xi, x.1961 (M. G. Emsley).

(g) *S.* (*L.*) *uhleri* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):19, figs. 17, 36, 51; as *S.* (*Cantharocoris*) *uhleri*.

= *Ptenidiophyes mirabilis*: Uhler 1894. Holotype brachyp. ♀ and paratype ♀ [USNM 27589] windward side Chantilly Estate, August, in decaying weeds, Grenada (H. H. Smith). Paratype ♀ [BMNH 95-206], windward side Grand Etang, 1,900 ft., Grenada, August, decaying leaves (H. H. Smith).

An examination of the types and paratypes of *S. uhleri* in the USNM and BMNH shows that it lacks the prominence of the reticulate pattern typical of *Cantharocoris* and is a true *Lophopleurum*. It may be a female of *S. sulcata*. There is a third brachypterous female in the British Museum [BMNH], leeward side Grand Etang Road, Grenada (H. H. Smith S.214.125), but this is not conspecific with *uhleri*.

(h) *S.* (*L.*) *willinki* Wygodzinsky, 1951, Acta zool. lilloana, **10**:68-71, figs. 73-86. Holotype macrop. ♂, macrop. allotype, [Inst. de Ent. de la Fundacion M. Lillo]; two paratype macrop. ♀♀ [AMNH], all from Camino al Cerro de San Javier, Tucuman, Argentina, 30.viii.1948, and 24.vi.1950. Two macrop. ♂ paratypes and two macrop. ♀ paratypes [AMNH], Valle de San Javier, Tucuman, 800 m., 15.viii.1950 (All P. Wygodzinsky).

(i) *S.* (*L.*) *grandis* n. sp. Holotype macropterous male [AMNH, glycerine], WBTRS, Arima Valley, Trinidad, W.I., at light, 18.vi.1961. Ten macropterous male paratypes [AMNH, BMNH, USNM, one slide, nine glycerine], same data but dates in July and August. Five macropterous male paratypes [AMNH, BMNH, USNM, glycerine], Maracas Falls Trace, Maracas Valley, Trinidad, in litter, various

dates in July and August 1961. Numerous other specimens from each locality, (M. G. Emsley). Females [AMNH] provisionally assigned to this species were taken from the second locality.

(j) *S.* (*L.*) *torpedo* n. sp. Holotype macropterous male [AMNH, in glycerine], WBTRS, Arima Valley, Trinidad, W.I., at light fifty feet in forest canopy, 19.ix.1961. Two macropterous males [AMNH, USNM], same locality five feet from the ground, 29.ix.1961, 13.ii.1962, (M. G. Emsley).

(k) *S.* (*L.*) *wygodzinskyi* n. sp. Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W.I., at light, 10.x.1961 (M. G. Emsley).

IV. Subgenus — *Odontorhagus* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):13, fig. 16. Type-species *S. bipartita* by original designation.

= *Kophaegis* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13): 13, figs. 16, 41. New synonym.

McAtee & Malloch distinguished *Odontorhagus* from *Kophaegis* by the lack of ocelli and the lack of a subapical constriction to the mesoscutellum. Examination of some of the specimens assigned by McAtee & Malloch to *Odontorhagus*, for example the allotype of *repetita* shows ocelli present. The scutellar character is also of dubious value for it is the extreme form of a widespread condition throughout the whole genus. Of both males and females only macropterous forms are known.

(a) *Schizoptera* (*Odontorhagus*) *bipartita* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):15-16, fig. 60. Holotype macrop. ♂ and two paratypes ♂ ♂, Livingston, Guatemala, 12/11.v.19??. Macrop. allotype and ♀ paratype, Cacao Trece Aguas, Alta Vera Paz, Guatemala, 4/21.iv.19?? (E. A. Schwarz and H. S. Barber). [All USNM 27599].

(b) *S.* (*O.*) *clodius* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):16, fig. 62. Holotype macrop. ♂ [USNM 27581], Paraiso, Canal Zone, Panama, 2.iv.1911 (E. A. Schwarz).

(c) *S.* (*O.*) *commodus* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):17, fig. 64. Holotype macrop. ♂ [USNM 27583], Livingston, Guatemala, 9.v.19?? (E. A. Schwarz & H. S. Barber).

(d) *S.* (*O.*) *cubensis* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):17, figs. 41, 45; as *Schizoptera* (*Kophaegis*) *cubensis*. Bruner, 1934, Mem. Soc. Cubana Hist. nat., **8**, (4):210, figs. 2, 5, 6, 7. Holotype macrop. ♀ and macrop. ♀ paratype [USNM 27685], Cayamas, Santa Clara, Cuba, 20/11.v.19?? (E. A. Schwarz). Macrop. ♂ [?], Sierra Rangal, Pinar del Rio, 6.v.1934 (A. Bierig).

(e) *S.* (*O.*) *decius* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):17, fig. 63. Holotype macrop. ♂, Gatun, Canal Zone, Panama, 7.iv.1911 (E. A. Schwarz), paratype ♂, Cabima, Panama, 22.v.1911 (A. Busck) [both USNM 27582].

(f) *S.* (*O.*) *drusus* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):17, fig. 65. Holotype macrop. ♂ [USNM 27584], Cacao Trece Aguas, Alta Vera Paz, Guatemala, 30.iii.19?? (E. A. Schwarz and H. S. Barber).

(g) *S.* (*O.*) *repetita* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):16, figs. 34, 61. Holotype macrop. ♂, macrop. allotype, two paratype ♂♂ and one paratype ♀, Livingston, Guatemala 4/5/9.v.-19??; one macrop. ♂, Cacao Trece Aguas, Alta Vera Paz, Guatemala, 18.iv.19?? (E. A. Schwarz & H. S. Barber); two macrop. ♀♀, Tampico, Mexico, 14.xii.19?? (E. A. Schwarz) [all USNM 27580].

(h) *S.* (*O.*) *similis* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):18; as *Schizoptera* (*Kophaegis*) *similis*. Holotype macrop. ♀, and paratype ♀ [USNM 27586], Cayamas, Cuba, 5/6.iii.19?? (E. A. Schwarz).

(i) *S.* (*O.*) *stricklandi* China, 1946, Proc. R. ent. Soc. Lond., **15**:152-3, fig. 4 a-e. Holotype macrop. ♂, one paratype ♂ [BMNH], St. Augustine, Trinidad, W.I., xi.1943-ii.1944 (A. H. Strickland). Many specimens at light various localities in Trinidad, W.I., specimens deposited in BMNH, USNM, AMNH and ANSP.

(j) *S.* (*O.*) *southwoodi* n. sp. Holotype macropterous male [AMNH, glycerine] and four macropterous male paratypes [AMNH, USNM, glycerine], WBTRS, Arima Valley, Trinidad, W.I., at light, 21.vii.1961 (type), remainder various dates in January, March, May and August (M. G. Emsley). Numerous other specimens have been taken at light throughout the year at the University Field Station, and at mile 2, Maracas Valley, where they occur with *stricklandi*.

(k) *S.* (*O.*) *kirkpatricki* n. sp. Holotype macropterous male [AMNH, glycerine] and fourteen macropterous male paratypes [AMNH, BMNH, USNM, two slides, twelve glycerine] mile 12, Blanchisseuse road, 600 meters, at mercury-vapour light, 4.vii.1961 (M. G. Emsley).

(l) *S.* (*O.*) *trinitatis* n. sp. Holotype macropterous male [AMNH, glycerine], WBTRS, Arima Valley, Trinidad, W.I., at light, 12.ii.1962. Eleven macropterous male paratypes [AMNH, BMNH, USNM, three slides, eight glycerine], same data as above but various dates in February, May, July and October (M. G. Emsley). A female [AMNH, glycerine], same data, is provisionally allocated to this species.

V. Subgenus — *Zygophleps* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):13, fig. 46. Type-species *S. unica* by original designation.

The *Zygophleps* group is distinguished by the apical coalescence

of the anterior membranal veins. Only macropterous males are known.

(a) *Schizoptera* (*Zygophleps*) *unica* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):18, fig. 67. Holotype macrop. ♂ [USNM 27587], Livingston, Guatemala, 7.v.19?? (E. A. Schwarz and H. S. Barber). Two males WBTRS, Arima Valley, Trinidad, W.I., at light 28.viii.1961 (M. G. Emsley).

(b) *S.* (*Z.*) *simla* n. sp. Holotype macropterous male [AMNH, one wing, and terminal abdominal segments on slide, remainder in glycerine], and four macropterous male paratypes [AMNH, USNM, two slides, two glycerine], WBTRS, Arima Valley, Trinidad, W.I., at light 28.ix.1961 (type), 12.x.1961 and 12.i.1962 (M. G. Emsley).

(c) *S.* (*Z.*) *corallia* n. sp. Holotype macropterous male [AMNH, slide], WBTRS, Arima Valley, Trinidad, W.I., at light, 29.ix.1961 (M. G. Emsley).

(d) *S.* (*Z.*) *ultima* n. sp. Holotype macropterous male [AMNH, slide] and one macropterous male paratype [USNM, slide], WBTRS, Arima Valley, Trinidad, W.I., at light, 2.xi.1961 (type), 29.xii.1961 (M. G. Emsley).

VI. Subgenus — *Orthorhagus* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):13, fig. 46. Type-species *S. plana* by original designation.

Orthorhagus is unique within *Schizoptera* in the absence of a pronotal collar. Only macropterous males and brachypterous females are known. The beetle-like females have no trace of venation on the elytriform forewings.

(a) *Schizoptera* (*Orthorhagus*) *plana* McAtee & Malloch, 1925, Proc. U.S. nat. Mus., **67**, (13):15, figs. 49, 18, 59. Holotype macrop. ♂ [USNM 27578], Cacao Trece Aguas, Alta Vera Paz, Guatemala, 11.iv.19?? (E. A. Schwarz and H. S. Barber).

Incertae sedis

20. *Pachyplagioides* Gross, 1951, Rec. S. Aust. Mus., 9:540-541. Type-species *P. reginae* by monotypy.

(a) *Pachyplagioides reginae* Gross, 1951, Rec. S. Aust. Mus., 9:541, figs. 1C, 2C-J. Holotype macrop. ♂ [SAM], fallen leaves, Cairns district, Queensland (A. M. Lee).

21. *Itagunannus* Wygodzinsky, 1943, Rev. bras. Biol., 8:150-152. Type-species *I. itaguaiensis* by monotypy.

(a) *Itagunannus itaguaiensis* Wygodzinsky, 1948, Rev. bras. Biol., 8: 152-154, figs. 32-54. Holotype macrop. ♂ [Instituto de Ecologia e Experimentação Agricola], km. 47, de estrada Rio — Sao Paulo,

Municipio de Itaguai, estado do Rio de Janeiro, Brazil, 21.ii.1947, at light (P. Wygodzinsky).

Subfamily OGERIINAE n. subfam.

Schizopteridae with five veins emanating from the trapezoidal cell, a four-segmented rostrum, various tarsal formulae and pretarsal appendages, an elongate spermatheca, and only three pairs of abdominal spiracles.

22. *Ogeria* Distant, 1913, Trans. Linn. Soc. Lond., (Zool.), **16**, (2):173, fig. 16. Type-species *O. insularis* by monotypy.

Ogeria and *Pachyplagia* have a remarkably similar tuberculate sclerotisation of the abdomen.

(a) *Ogeria insularis* Distant, 1913, Trans. Linn. Soc. Lond., (Zool.), **16**, (2):173, fig. 16. Holotype macrop. ♂ [BMNH 1911-497], Percy Sladen Trust Expdn., about 1,000 ft. above Cascade, Mahé, Seychelles Islands, 1908 or 1909, found on the ground with *Seychellesanus typicus* and *Ceratocombus insularis* among damp leaves, mostly of *Stevensonia* palms.

(b) *O. taifunensis* Kellen, 1961, Proc. ent. Soc. Wash., **63**, (1):17-20, 9 figs. Holotype macrop. ♂, allotype and nine ♀ paratypes and one Vth instar larva [USNM slides 65848], Tufuna, Tutuila island, Samoa, 9.ix.1958, under bark (W. R. Kellen); paratype macrop. ♂ and ♀ [BMNH 1961-291, slides], same locality, 10.iv./15.vii/9.ix.1958; two paratypes, same data [AMNH].

23. *Pachyplagia* Gross, 1951, Rec. S. Aust. Mus., 9:539. Type-species *P. australia* by monotypy.

(a) *Pachyplagia australia* Gross, 1951, Rec. S. Aust. Mus., 9:539-540, fig. 1 A, B, fig. 2 A, B, C. Holotype macrop. ♂ and brachyp. allotype [SAM, Coll. No. 20,053-1 20,054], Sydney, N.S.W. (H. W. Cox). 41 paratypes from type locality and Port Lincoln, South Australia (H. W. Cox and A. M. Lea), presumably the 17 specimens [BMNH 1954-772], Sydney (A. M. Lea) are from this material.

24. *Luachimonannus* Wygodzinsky, 1950, Publ. cult. Cia Diamant, Angola, (7):31. Type-species *L. dundoensis* by monotypy.

(a) *Luachimonannus dundoensis* Wygodzinsky, 1950, Publ. cult. Cia Diamant. Angola, (7):31-34, fig. 3, 124-146. Holotype brachyp. ♂ (slide), brachyp. allotype (slide) [BMNH 1952-471], three brachyp. ♂ paratypes and one brachyp. ♀ paratype [MD], near Dundo, Angola, 30.ix.1946 (A. Barros Machado). Late instar larva, brachyp. ♂ and six brachyp. ♀ paratypes [MD or AMNH] in vegetable soil detritus, Angola, vii/ix.1948, (A. Barros Machado).

(b) *L. notius* Southwood, 1961, Entomologist's mon. Mag., **97**:91, figs. 6-16. Holotype brachyp. ♂, brachyp. allotype, macrop. ♀ paratype [BMNH 1961-149, spirit], brachyp. ♂ and three brachyp. ♀♀, [ANSP, spirit], Bobiri forest reserve, Ashanti, Ghana extracted from wet litter from forest floor, viii.1957 (J. Petersen).

25. *Kokeshia* Miyamoto, 1960, Sieboldia, **2**, (3):163, fig. 18 A & B. Type-species *K. esakii* by monotypy.

(a) *Kokeshia esakii* Miyamoto, 1960, Sieboldia, **2**, (3):163-169, pl. 18 A, B, pl. 19 A-F. Holotype macrop. ♂, paratype ♂ and brachyp. allotype [Entomological Laboratory, Kyushu University], Korasan, Chikugo, Kyushu, 25.ii.1955 (S. Miyamoto). Five macrop. ♂ paratypes, seven brachyp. ♀♀ from type locality 26/30.iv.1953, 6.iii and 21, ix.1955, (S. Miyamoto). One macrop. ♂ and ten brachyp. ♀♀, Amagi, Chikuzen, Kyushu, 4.v.1953 and 11.iv.1955 (S. Miyamoto). Brachyp. ♀, Kogoshima, Satsuma, Kyushu, 23.v.1953 (S. Miyamoto). One macrop. ♂, Santaro-Toge, Amami-Oshima, 26.vii.1954 (S. Miyamoto and Y. Hirashima). Some paratypes [Miyamoto]. In Kyushu found mainly in *Conocephalus-Mnium* moss associations.

26. *Chinannus* Wygodzinsky, 1948, Rev. bras. Biol., **8** (1):145-147. Type-species *C. bierigi* by monotypy.

(a) *Chinannus bierigi* Wygodzinsky, 1948, Rev. bras. Biol., **8** (1):147-150, figs. 1-27, 30-31. Holotype and paratype, macrop. ♂♂, and brachyp. allotype [Inst. de Ecol. e Exp. Agric. 889, 893, and 894], Chitaria, Costa Rica, 26.iii.1944, 7/11.iv.1944 (A. Bierig). Paratype macrop. ♂ and brachyp. ♀ [BMNH 1947-444, slides], Chitaria, Costa Rica. Five brachyp. ♀ paratypes [AMNH] from same locality as types.

(b) *C. trinitatis* (China, 1946) Proc. R. ent. Soc. Lond., **15**, (B):148-152, figs. 1 a-c, 2 a-e, 3; as *Ptenidiophyes trinitatis*. Holotype macrop. ♂ and paratype ♂ (missing) and brachyp. allotype [BMNH 1948-523, on card], Brigand Hill, Sangre Grande, Trinidad, W.I., 5.i.1944, ex. litter (A. H. Strickland). Two macrop. ♂ paratypes (slides) [BMNH 1948-523], Marper, Sangre Grande, Trinidad, W.I., 6.i.1944 (A. H. Strickland). Many macrop. ♂♂ and brachyp. ♀♀ (in spirit), from various localities in Trinidad [AMNH, ANSP, USNM] (M. G. Emsley).

Incertae sedis: The following genera have not been allocated to a subfamily.

27. *Tropistotrochus* Reuter, 1891, Acta Soc. Sci. fenn., **19**, (6):15-16. Type-species *T. ampliatipennis* by monotypy.

The unique specimen of this genus has been lost and its sex has not been recorded.

(a) *Tropistotrochus ampliatipennis* Reuter, 1891, Acta Soc. Sci. fenn., **19**, (6):16, fig. 9. Holotype macrop. (?), [ZMH, lost], Blumenau, Brazil (D. Reitteri).

28. *Peloridinannus* Wygodzinsky, 1951, Rev. bras. Biol., **11**, (3):264-265. Type-species *P. margaritatus* by monotypy.
(a) *Peloridinannus margaritatus* Wygodzinsky, 1951, Rev. bras. Biol., **11**, (3):265-268, figs. 36-53. Holotype macrop. ♀ and one badly preserved sub-macrop. ♀ paratype [AMNH], Chitaria, Costa Rica, 29/30.iv.1944 (A. Bierig).

29. *Guapinannus* Wygodzinsky, 1951, Rev. bras. Biol., **11**, (3):268-269. Type-species *G. bierigi* by monotypy.
(a) *Guapinannus bierigi* Wygodzinsky, 1951, Rev. bras. Biol., **11**, (3): 269-270, figs. 54-66. Holotype macrop. ♀ [AMNH], Guapiles, Costa Rica, 5/13.ii.1946 (A. Bierig).

30. *Schizopterops* Poppius, 1913, Ent. Tidskr., **34**:258-259. Type-species *S. pusillus* by monotypy.
(a) *Schizopterops pusillus* Poppius, 1913, Ent. Tidskr., **34**:259-260. Holotype brachyp. ♀ [ZMH coll. 5737], Anuradhapura, Ceylon, 19-21.xii.1910 (A. Luther).

31. *Dictyonannus* Gross, 1951, Rec. S. Aust. Mus., **9**:543. Type-species *D. flavus* by monotypy. This genus was inadequately described.
(a) *Dictyonannus flavus* Gross, 1951, Rec. S. Aust. Mus., **9**:543-544, fig. 1D. Holotype brachyp. ♀ [SAM coll. No. I 29,062, probably No. 20,062], Cairns district, Queensland, in fallen leaves (A. M. Lea).

32. *Ptenidiophyes* Reuter, 1891, Acta Soc. Sci. fenn., **19**, (6):25. Type-species *P. mirabilis* by monotypy.

The unique brachypterous female was inadequately described and is believed to be lost.

(a) *Ptenidiophyes mirabilis* Reuter, 1891, Acta Soc. Sci. fenn., **19**, (6): 26, fig. 15. Holotype brachyp. ♀ [Reuter], Blumenau, Brazil (D. Reitteri).

33. *Nesonannus* Usinger, 1946, Bull. Bishop Mus. No. 189:91. Type-species *N. saileri* by monotypy.

The location of the unique type has not been confirmed and the original description was inadequate and without figures.

(a) *Nesonannus saileri* Usinger, 1946, Bull. Bishop Mus., No. 189:91-92. Holotype macrop. ♂ [Bishop Museum], Barrigada, on hau, 22.vii. 1936 (O. H. Swezey).

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INDEX

Boldface page numbers where used indicate the main discussion or description and key to the name they follow.

ACTINOSCYTINIDAE, 80
additius, 86
affinis, 95
africanus, 87
alboclavatus, 88
alienius, 3
ambliatipennis, 106, 107
AMPHIBICORISAE, 78, 80
angolensis, 89
anisota, **50**, **56**, 98
anterii, 87
apatosulcata, **51**, **57**, 98
apicalis, 95
apicipunctata, 95
arenaria, 93
arimensis, **40**, 41, 42, 94
australia, 105
australiae, 35

bakeri, 84
beebei, **44**, 45, 91
bierigi [*Chinannus*], 106
bierigi [*Corixidea*], 90
bierigi [*Guapinannus*], 107
bipartita, 102
biroi, 84
Bironannus, 10, 11, 12, 25, 31, 32, 72, 86, 87
bispina, 100
Biturinannus, 10, 11, 12, 25, 28, 32, 72, 86, 87
boops, 83
brasiliensis, 87
brincki, 86
brucei, **50**, **55**, 98
brunneus, 92

Cantharocoris, **49**, **58**, 99
capitata, 93
caprona, **51**, **54**, 55, 97
carioca, 91, 92
caudata, 95
cavifrons, 94
CERATOCOMBIDAE, 2, 3, 4
Ceratocomboides, 15, 25, 27, 28, 38, 72, 74, 87
Ceratocombus, 2, 3, 5, 19, 24, 25, 30, 31, 35, 73, 74, 75, 76, 78, 79
chelifera, **50**, **56**, 57, 98
Chinannus, 10, 12, 14, 15, 17, 25, 26, 30, 32, 36, **39**, 73, 74, 106
chiumbiensis, 88, 89
cicadina, 1, 94, 95
CIMICOMORPHA, 79, 80
cleofan, **50**, **57**, 98
clodius, 102
coleoptratus, 3
commodus, 102
corallia, **66**, **67**, 104
Corixidea, 5, 10, 12, 14, 15, 17, 19, 25, 26, 28, 29, 32, 33, **39**, **43**, 46, 72, 90, 91, 92, 93
craneae, **46**, **48**, 92
crassa, 90, 91
Crescentius, 3, 73
CRYPTOSTEMMATIDAE, 3, 4, 10 *et seq.*, 73 *et seq.*, **82**
Cryptostemma, 2, 3, 4, 5, 7, 24, 25, 35, 73, 74, 75, 76, 78, 79
cubensis, 102

decius, 103
descolei, 32, 94
Dictyonannus, 10, 11, 12, 25, 73, 107
DIPSOCORIDAE, 3, 4, 80
DIPSOCORIMORPHA, 80
Dipsocoris, 3, 4
doddsi, 91
drusus, 103
dundoensis, 105
Dundonannus, 17, 18, 25, 28, 36, 72, 74, 88, 89

dunduno, 88
Dunstaniopsis, 22

elegans, 100
elmis, 101
erythiza, **51**, **53**, 97
esakii, 106

falcicula, **51**, **57**, 98
flavipes, 95, 96, 100
flavomarginata, 94
flavus, 107

GEOCORISAE, 78, 79, 80
Glyptocombus, 2, 8, 12, 14, 15, 19, 23, 25, 26, 27, 28, 29, 30, 31, 35, 38, 69, 70, 71, 75, 85
grandis, **60**, **61**, 62, 101
griffithi, **51**, **53**, 97
Guapinannus, 8, 10, 25, 26, 30, 31, 73, 76, 107

hickmani, 84
hillae, **58**, **59**, 99
hirashimai, 9, 12, 83
hirta, 96
Hoplonannus, 7, 10, 12, 16, 17, 21, 25, 26, 28, 29, 32, 33, 34, 36, **39**, **46**, 72, 90, 92, 93
horvathi, 86
Humpatanannus, 11, 12, 18, 25, 28, 31, 72, 86, 87
huon, 86
HYDROCORISAE, 78
Hypselosoma, 8, 10, 12, 14, 16, 18, 19, 23, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 36, 69, 70, 71, 74, 79, 80, 83, 85
HYPSELOSOMATINAE, **83**
HYPSELOSOMATINI, 83
Hypsipteryx, 3, 14, 16, 21, 26, 27, 31, 32, 35, 73, 74, 75

imitator, 88
insignis, 85
insularis [*Ceratocombus*], 105
insularis [*Ogeria*], 105
Issodomimus, 3, 16, 17, 25, 73, 74, 76
itaguaiensis, 104
Itagunannus, 10, 17, 18, 25, 26, 32, 72, 104

julieae, **44**, **45**, 91

kennyi, **51**, **52**, 97
kirkpatricki, **63**, **65**, 103
Kokeshia, 10, 12, 14, 16, 21, 25, 27, 33, 34, 35, 71, 73, 79, 106
Kophaegis, 102

Leptonannus, 74
licinius, 99
lipovskyi, 83
lituratum, 84
Lophopleurum, **49**, **59**, 100
Luachimonannus, 14, 16, 26, 30, 31, 36, 73, 105
lunigera, 90, 91

Machadonannus, 9, 12, 16, 25, 26, 28, 30, 32, 35, 72, 88, 89
major, 91
margaritatus, 107
matsumurae, 84, 85
maxima, **51**, 52, 53, 56, 97
Membracioides, 17, 25, 26, 32, 72, 90, 92
merleae, **50**, **54**, 97
mexicana, 96
Microscytinella, 80
mirabilis, 101, 107
monrosi, 96
Muatianvuaia, 3, 16, 17, 25, 73, 74, 76
mulsanti, 3
mussunguensis, 89

Nannocoris, 10, 11, 14, 16, 18, 25, 28, 29, 32, **39**, 72, 76, 87, 93
nasua, 94
nebulifera, 93

Nesonannus, 10, 25, 73, 107
nigrita, 99
notius, 106

ocellatus, 89, 90
oculata, 1, 83
Odontorhagus, **49**, **63**, 102
Ogeria, 14, 15, 16, 25, 26, 29, 32, 73, 81, 105
OGERIINAE, 71, 72, 73, **105**
Ommatides, 11, 12, 25, 26, 71, 85
Oncerodes, 72, 93
Orthorhagus, 48, **49**, 104
Orthotylus, 14

Pachyplagia, 7, 14, 22, 24, 25, 29, 32, 35, 73, 105
Pachyplagioides, 10, 22, 25, 72, 104
paenebrunneus, **46**, **47**, 48, 92
paraguayana, 96
parallela, 92
pauliana, 84
PELORIDIIDAE, 80
Peloridinannus, 8, 10, 26, 30, 73, 107
Peloridium, 80
PENTATOMORPHA, 79
pilosa, 96
Pinochius, 3, 16, 25, 28, 32, 35, 68, 72, 74, 76, 87
plana, 104
pricei, **40**, **42**, 94
prima, 87
psalida, **50**, **56**, 98
pseudosulcata, **58**, 59, 60, 99
Ptenidiophyes, 10, 15, 25, 39, 73, 107
pusillus, 107

reginae, 104
reitteri, 101
repetita, 102, 103
reticulata, 96
reuteri [*Biturinannus*], 86, 87
reuteri [*Schizoptera*], 99
rhodochroum, 84
richardsi, **51**, **54**, 97
robusta, 93
rossi [*Hypselosoma*], 84
rossi [*Schizoptera*], **51**, **52**, 53, 54, 97

saileri, 107
saltator, 85
Schizoptera [genus], 7, 11, 14, 15, 16, 17, 18, 19, 22, 25, 28, 30, 32, 33, 34, 36, 38, **39**, 43, **48**, 49, 68, 72, 74, 78, 87, 93, 94
Schizoptera [subgenus], 43, **49**, **50**, 65, 90, 93, **95**
SCHIZOPTERIDAE, 1, 3, 4, 10 *et seq.*, 73 *et seq.*, **82**
SCHIZOPTERINA, 2, 82
SCHIZOPTERINAE, 71, 72, 82, **85**
Schizopterops, 25, 73, 107
schwarzi, 94
scutellata, 91
scymnus, 95, 99
Seabranannus, 87
Seychellesanus, 3, 16, 17, 31, 73, 74, 75
Silhouettanus, 9, 14, 19, 24, 25, 26, 28, 72, 74, 88
simile, 84
similis [*Pinochius*], 88
similis [*Schizoptera*], 103
simla, **66**, 104
southwoodi, **63**, **64**, 103
spiralis, **50**, **55**, 98
stricklandi, 36, **63**, 64, 65, 103
sulcata, 36, 58, **59**, **60**, 61, 62, 100, 101
susicauda, **51**, **53**, 54, 56, 97

taifunensis, 105
tenuispina, **60**, **61**, 101
Teratocombus, 3, 73
torpedo, 59, **60**, **62**, 102
Triatoma, 23
TRICHOTELOCERA, 78
Trichotonannus, 7, 24, 25, 27, 35, 36, 75
trinitatis [*Chinannus*], 9, 36, 37, 39, 106
trinitatis [*Schizoptera*], **63**, **65**, 103

Tropistotrochus, 10, 26, 73, 106
tuberculifera, 11, 93
typicus, 105

uhleri, 101
ultima, **66**, **67**, 104
underwoodi, **44**, **45**, 91
unica, **66**, 67, 103, 104

VIANAIDIINAE, 21
Vilhenannus, 9, 12, 16, 18, 25, 26, 28, 30, 32, 36, 72, 88, 89
vitellius, 97
Voccoroda, 10, 17, 26, 72, 90, 91, 92

willinki, 101
wrightae, **40**, **41**, 42, 94
wygodzinskyi [*Dundonannus*], 89
wygodzinskyi [*Schizoptera*], **60**, **62**, 102

zschokkei, 92
Zygophleps, **49**, **65**, 103

Abbreviations Used in the Figures

A I — first antennal segment
A II — second antennal segment
A III — third antennal segment
A IV — fourth antennal segment
ac — anteclypeus
acc gl — accessory gland
af — anterior fold
ams — abdominal muscle scar
an — anus
anp — anterior notal process
app — appendage
app IX S — appendage of the ninth sternum
app VIII T — appendage of the eighth tergite
a sl g_1 — first accessory salivary gland
a sl g_2 — second accessory salivary gland
aux — auxilia
ax_1 — first axillary sclerite
ax_2 — second axillary sclerite
ax_3 — third axillary sclerite
ax co — axillary cord

b — buccula
blb ej — bulbus ejaculatorius
bp — basal plate

ca_1 — first coxal articulation
ca_2 — second coxal articulation
ca_3 — third coxal articulation
cf — clypeal fold
cg — cerebral ganglion
cl — claw
cms — cibarial muscle scar
cor — corium
con — concavity
c ov d — common oviduct
cpd e — compound eye
Cu — cubitus
cx_1 — procoxa
cx_3 — metacoxa
cx_3p — metacoxal pad

emp v — empodial vesicle
epm_1 — proepimeron
epm_2 — mesopimeron
epm_3 — metepimeron
eps_1 — proepisternum
eps_2 — mesoepisternum
eps_3 — metepisternum
evp — evaporating area

fb — frontal bristle
fe — femur

g cx_1 — first gonocoxa
g cx_2 — second gonocoxa
gl — gland orifice

gongl — gonangulum
$gonph_1$ — first gonopophysis
$gonph_2$ — second gonopophysis
gr — gular ridge

hpl — hyperpleural lobe

j — juga
jug l — jugal lobe
l — labrum

lca — left conjunctival appendage
lgs — larval scent gland scar
lpm — left paramere

M — media
m — membrane
M_1 — first branch of the media
M_2 — second branch of the media
M-Cu — media-to-cubitus crossvein
m_3e — metendosternite
m_2f — mesofurca
m_3f — metafurca
mlp t — malpighian tubule
mx pl — maxillary plate

o — ocellus
ob — ocular bristle
oes — oesophagus
ovd — oviduct
ovl — ovariole

pc — postclypeus
pf — profurca
pi — plural invagination
pnc — pronotal collar
pnms — pronotal muscle scar
pnp — posterior notal process
pns — pronotal suture
ppa — paraproctal appendage
pps — propleural suture
p sl g_1 — first principal salivary gland
p sl g_2 — second principal salivary gland

R I — first rostral segment
R II — second rostral segment
R III — third rostral segment
R IV — fourth rostral segment
R — radius
r — rectum
rca — right conjunctival appendage
rpm — right paramere

Sc — subcosta
Scl_2 — mesoscutellum
sp — spiracle
sp_2 — mesothoracic spiracle
sp_3 — metathoracic spiracle
sp b — spermathecal bulb
sp c — spermathecal capsule
sp d — spermathecal duct
s_2s — mesosternal spine
s_3s — metasternal spine
so g — suboesophageal ganglion

T_1 — first tarsal segment
T_2 — second tarsal segment
T_3 — third tarsal segment
t — testis
tc — trapezoidal cell
ten — tendon
t_1g — prothoracic ganglion
t_2g — mesothoracic ganglion
t_3g — metathoracic ganglion
tib — tibia
tr — trochanter
tub — tubercle

up — unguitractor plate

v — vannus
1V — first vannal vein
2V — second vannal vein
vb — vesicular bulb
vd — vas deferens
vf — vannal fold
vf_1 — anterior branch of vannal fold
vf_2 — posterior branch of vannal fold
vs — vesica

wc — wing coupling

I—X (T or S) — abdominal segments (Tergites or Sternites)

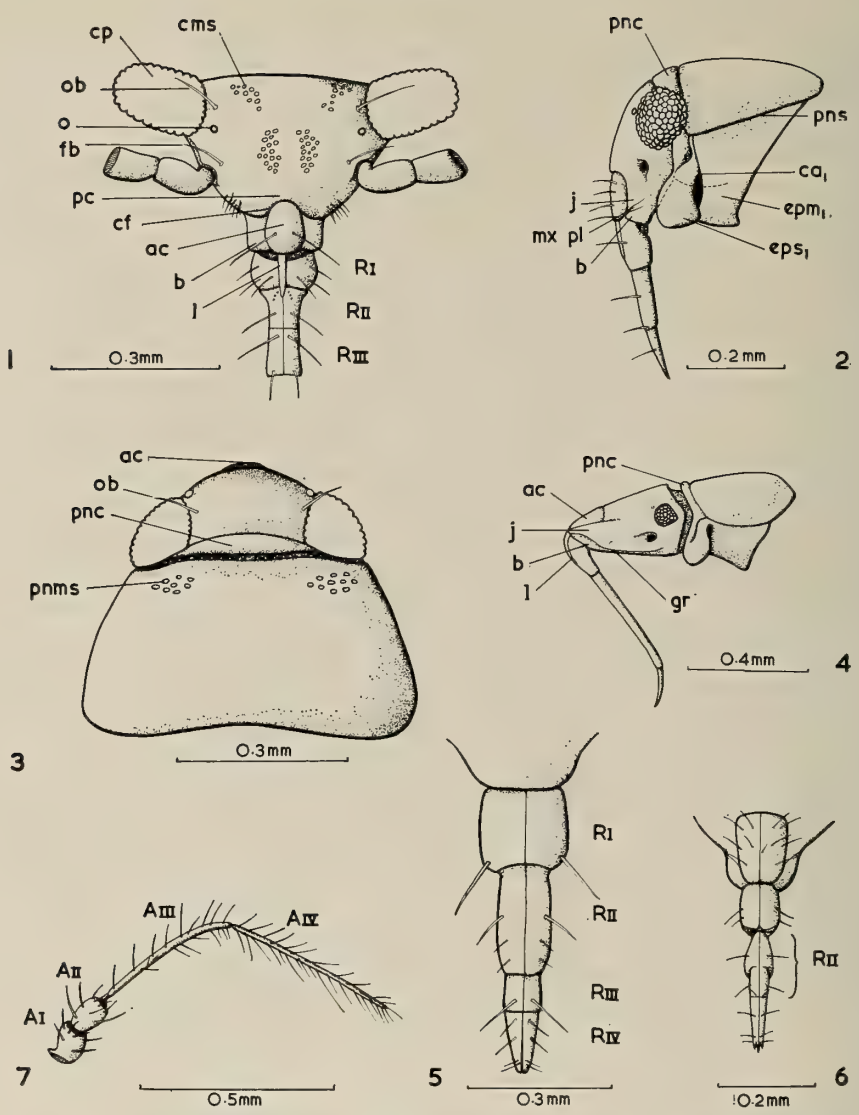


Fig. 1: anterior view of head of *Hoplonannus*. Fig. 2: left lateral view of head and prothorax of *Schizoptera*. Fig. 3: dorsal view of head and prothorax of *Schizoptera*. Fig. 4: left lateral view of head and prothorax of *Nannocoris pricei* n. sp. Fig. 5: dorsal view of rostrum of *Glyptocombus*. Fig. 6: dorsal view of rostrum of *Schizoptera brucei* n. sp. Fig. 7: typical Schizopterid right antenna.

Key to lettering used on this and subsequent figures on pages 118-119.

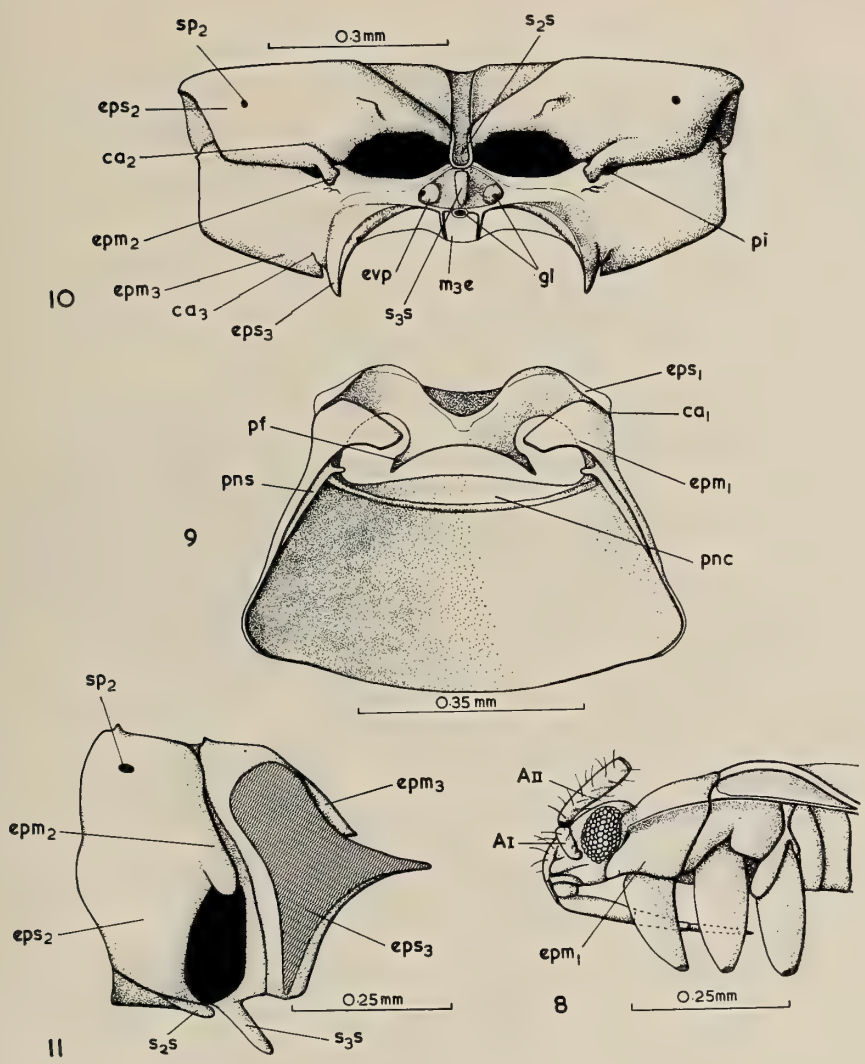


Fig. 8: left lateral view of head and thorax of *Seychellesanus typicus*. Fig. 9: ventral view of prothorax of *Schizoptera*. Fig. 10: ventral view of flattened pterothorax of *Schizoptera* (*Schizoptera*). Fig. 11: left lateral view of pterothorax of *Schizoptera* (*Lophopleurum*).

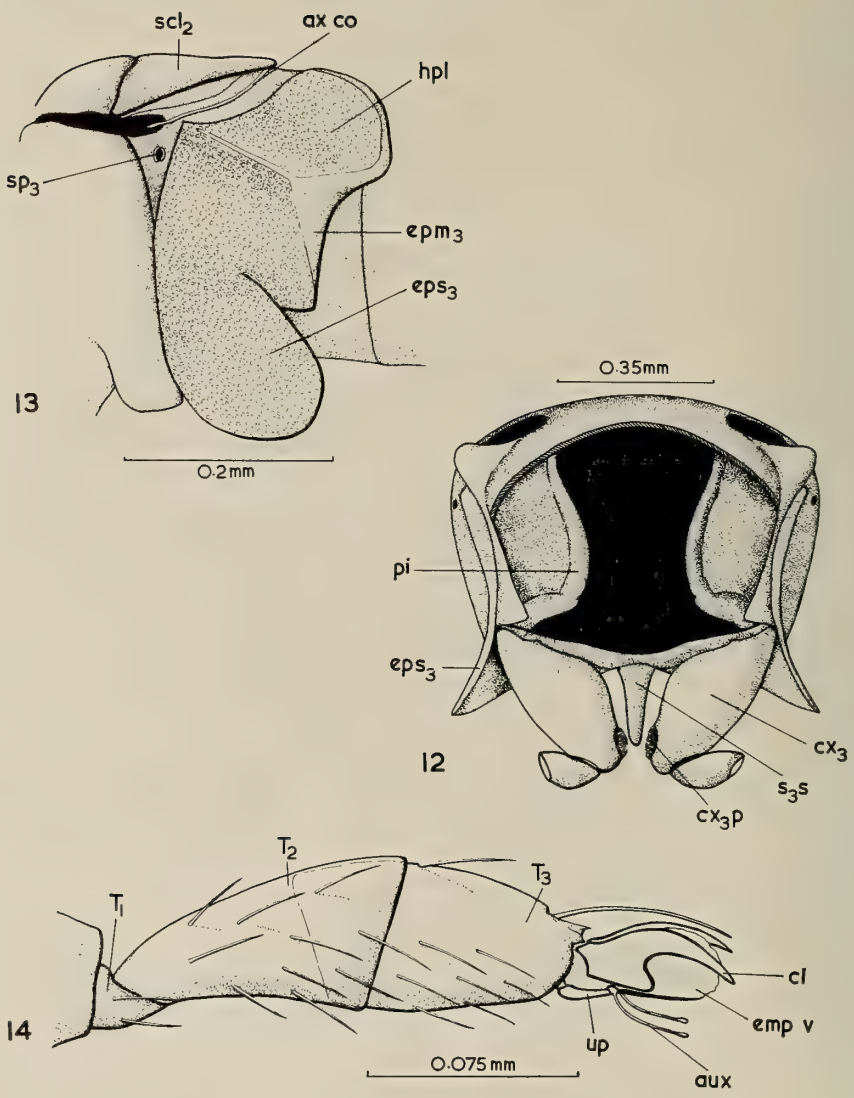
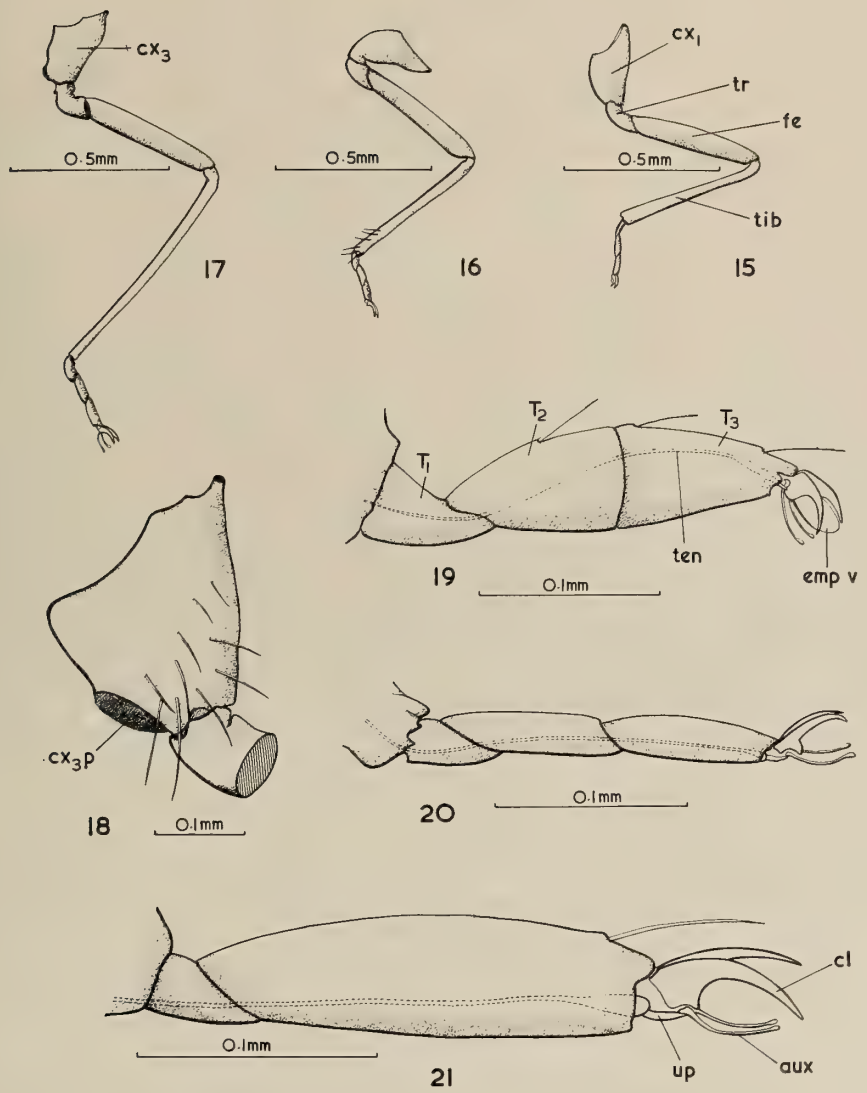
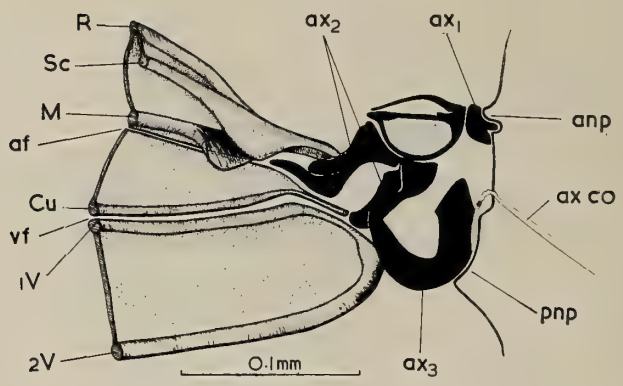


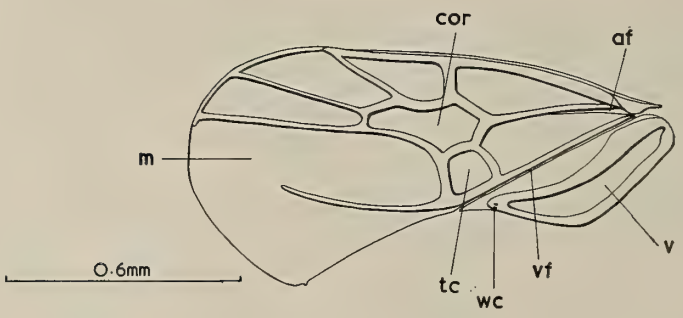
Fig. 12: posterior view of thorax and metacoxae of *Schizoptera.* Fig. 13: left lateral view of metathorax of *Corixidea.* Fig. 14: pseudo-four segmented tarsus of prothoracic leg of male *Silhouettanus alboclavatus.*



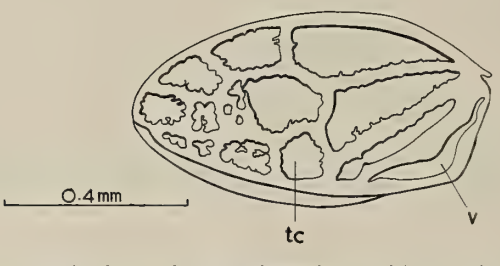
Figs. 15, 16 and 17: posterior view of right pro-, meso-, and metathoracic legs of typical male Schizopteridae. Fig. 18: similar view of metathoracic coxa. Figs. 19 and 20: pro-, and metathoracic tarsi of male *Schizoptera.* Fig. 21: prothoracic tarsus of female *Schizoptera.*



22



23



24

Fig. 22: ventral view of right forewing axillary sclerites of *Nannocoris*.
Fig. 23: ventral view of right forewing of macropterous male *Hoplonannus*.
Fig. 24: similar view of forewing of brachypterous female *Hoplonannus*.

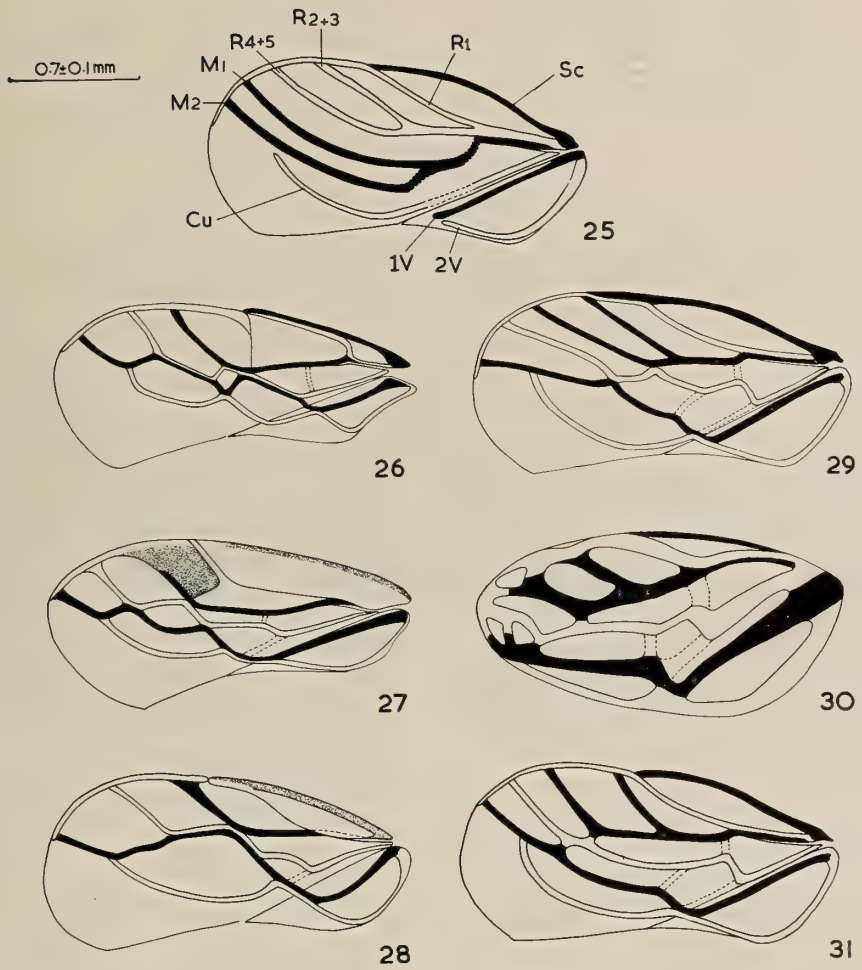
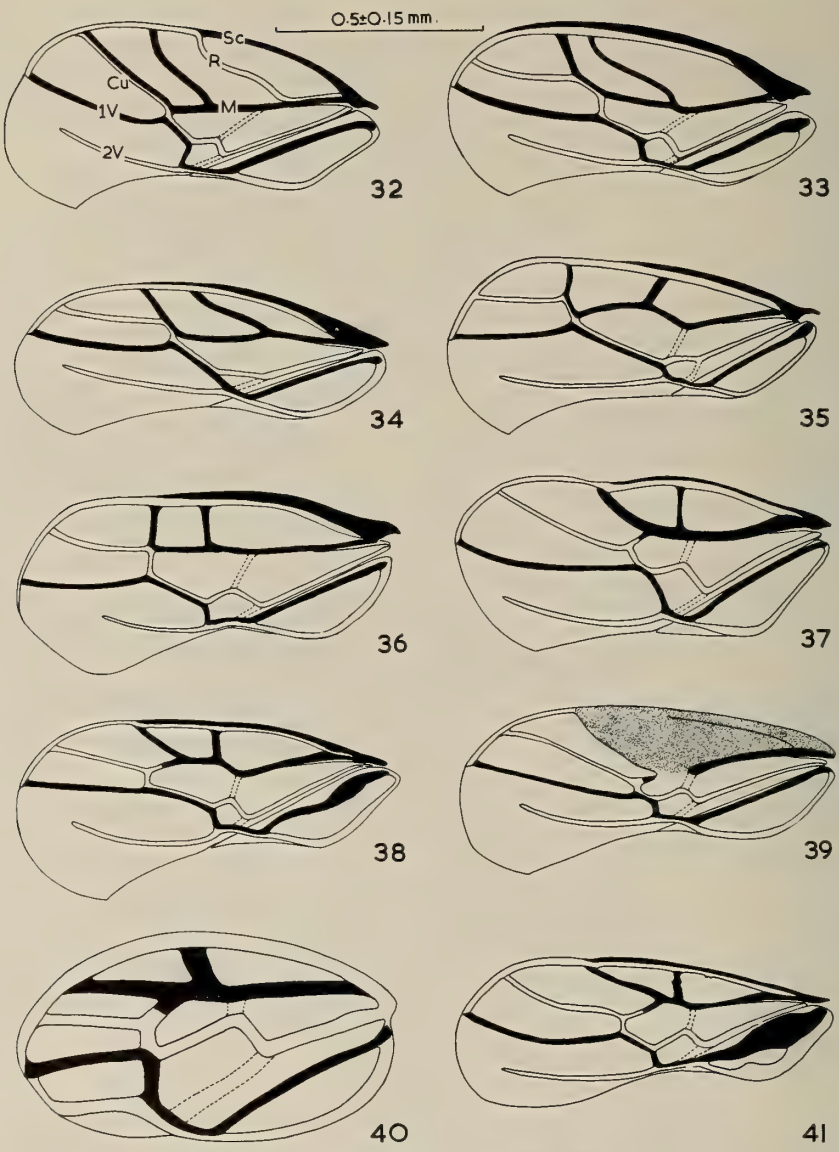
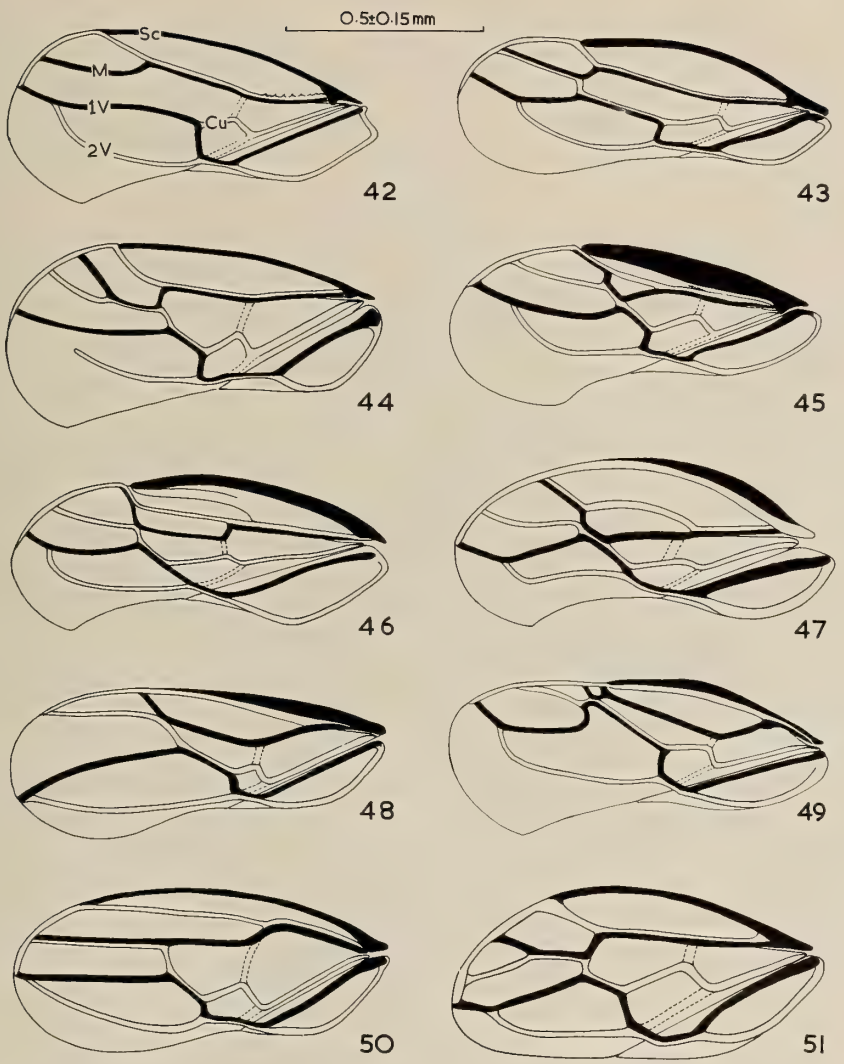


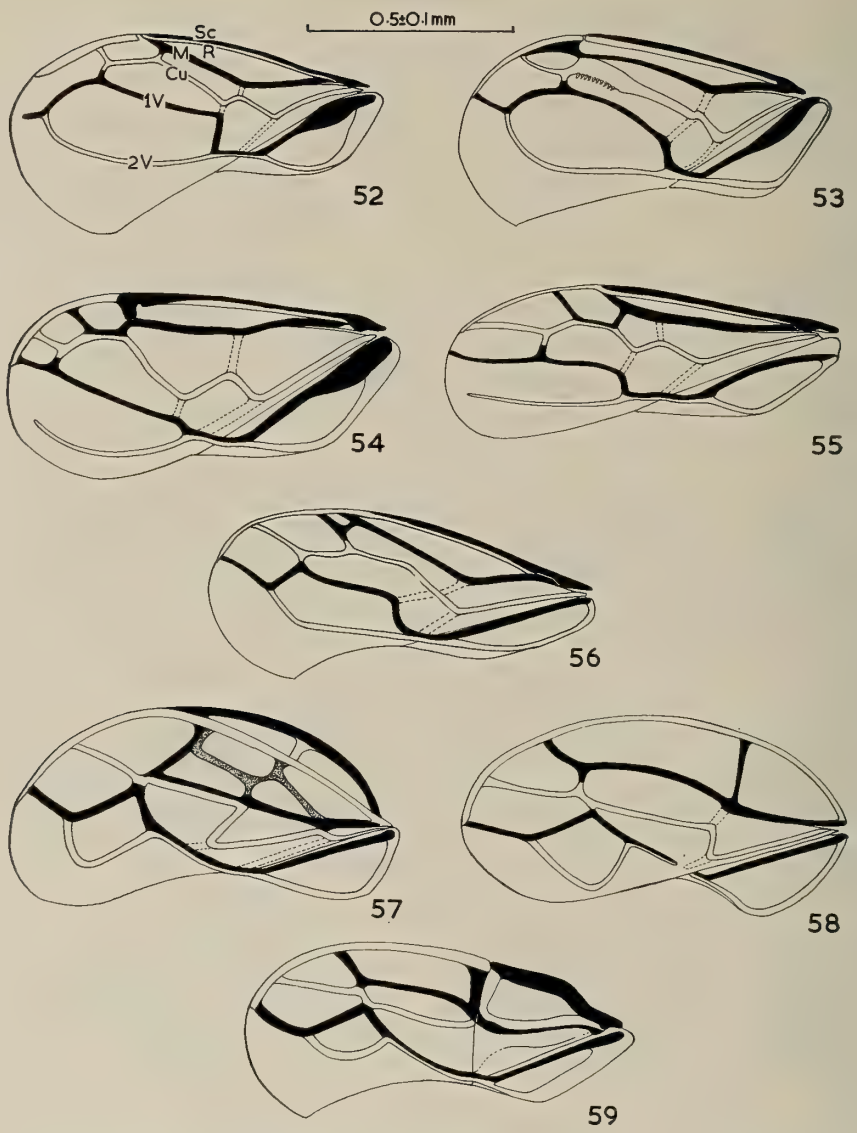
Fig. 25: hypothetical forewing venation of Schizopteridae. Figs. 26-31: venational interpretation of forewings of 26, *Cryptostemma;* 27, *Trichotonannus*; 28, *Ceratocombus*; 29, *Glyptocombus*; 30, *Ommatides*; 31, *Hypselosoma.*



Figs. 32-41: venational interpretation of forewings of 32, *Pinochius*; 33, *Nannocoris*; 34, *Biturinannus*; 35, *Ceratocomboides*; 36, *Schizoptera*; 37, *Membracioides* (adapted from McAtee and Malloch, 1925); 38, *Hoplonannus*; 39, *Voccoroda* (adapted from Wygodzinsky, 1950b); 40, *Oncerodes*; 41, *Corixidea*.



Figs. 42-51: venational interpretation of forewings of 42, *Machadonannus*; 43, *Vilhenannus*; 44, *Dundonannus*; 45, *Silhouettanus*; 46, *Humpatanannus* (adapted from Wygodzinsky, 1950a); 47, *Bironannus* (adapted from Wygodzinsky, 1950b); 48, *Pachyplagioides,* (adapted from Gross, 1951); 49, *Itagunannus* (adapted from Wygodzinsky, 1948b); 50, *Dictyonannus,* (deduced from brachypterous form of Gross, 1951); 51, *Schizopterops.*



Figs. 52-59: venational interpretation of forewings of 52, *Kokeshia* (adapted from Miyamoto, 1960); 53, *Chinannus*; 54, *Ogeria*; 55, *Pachyplagia*; 56, *Luachimonannus* (adapted from Southwood, 1961a); 57, *Peloridinannus* (adapted from Wygodzinsky, 1951); 58, *Tropistotrochus* (adapted from McAtee and Malloch, 1925); 59, *Guapinannus* (adapted from Wygodzinsky, 1951).

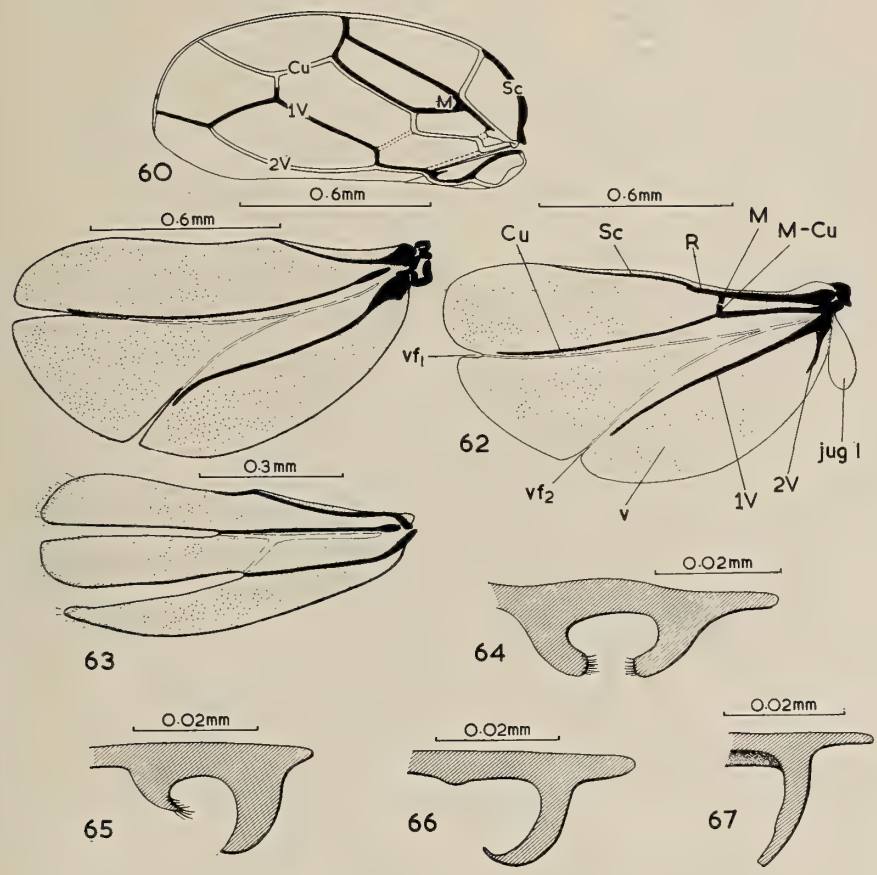
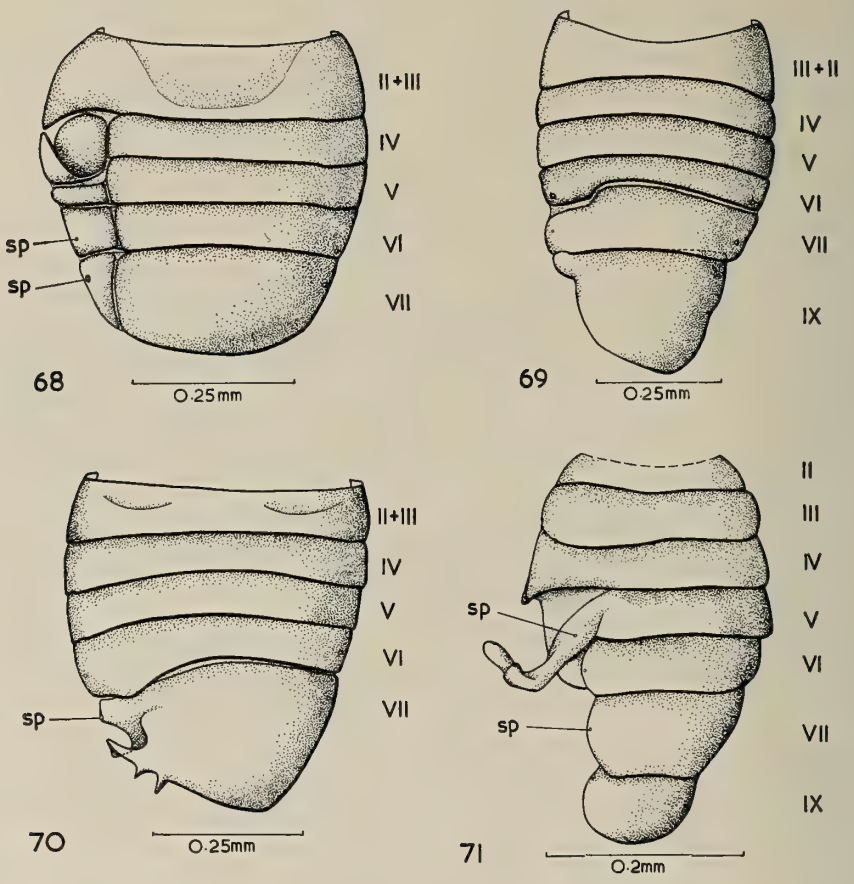
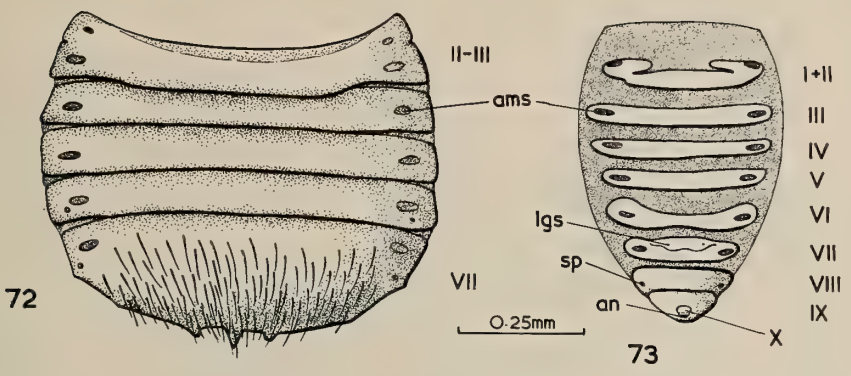


Fig. 60: venational interpretation of *Hypsipteryx* forewing. Figs. 61-63: hind wings of 61, *Schizoptera;* 62, *Glyptocombus;* 63, *Ceratocomboides.* Figs. 64-67: vertical sections through four types of wing coupling in Schizopteridae, the point at the extreme right of each section represents the posterior margin of the vannus.



Figs. 68-71: Ventral views of four types of male Schizopterid abdomen, 68, *Chinannus trinitatis*; 69, *Hoplonannus paenebrunneus* n. sp. 70, *Schizoptera tenuispina*; 71, *Vilhenannus angolensis* (from Wygodzinsky, 1950a).



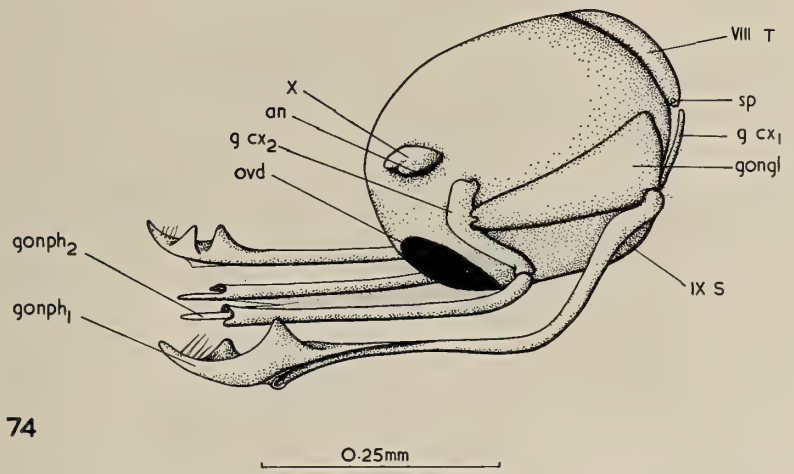


Fig. 72: ventral view of flattened abdomen of female *Hoplonannus paenebrunneus* n. sp. Fig. 73: dorsal view of same abdomen. Fig. 74: semi-diagrammatic right posterolateral view of Schizopterid ovipositor, based on *Glyptocombus*.

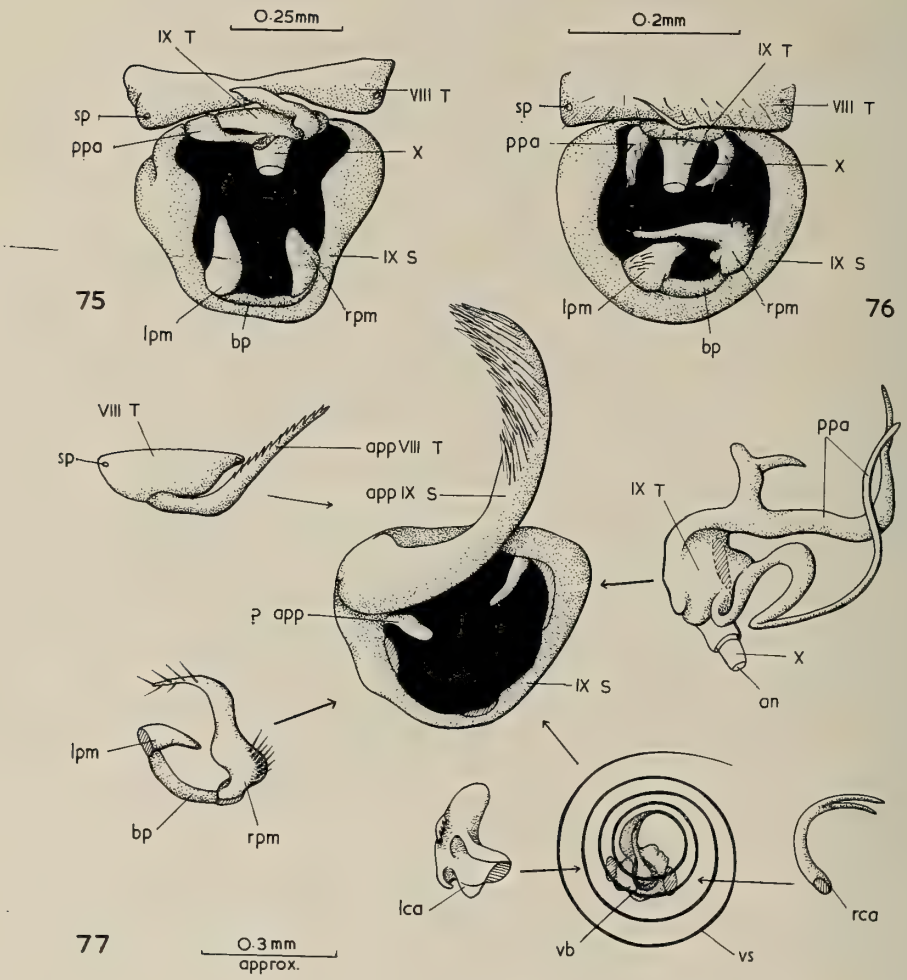


Fig. 75: dorsal view of genital capsule and eighth tergum of *Hypselosoma* (from Wygodzinsky, 1959). Fig. 76: similar structures in *Hypsipteryx*. Fig. 77: a composite drawing of all the genital structures known to occur in Schizopteridae as they would occur in one dissected specimen.

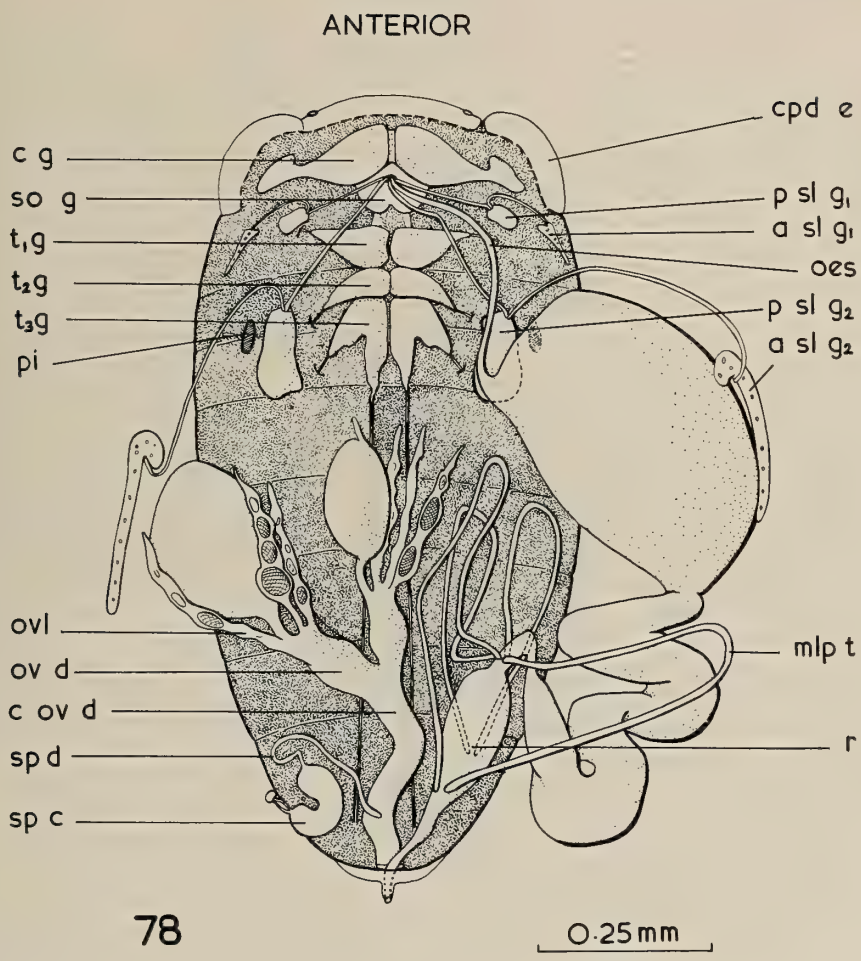
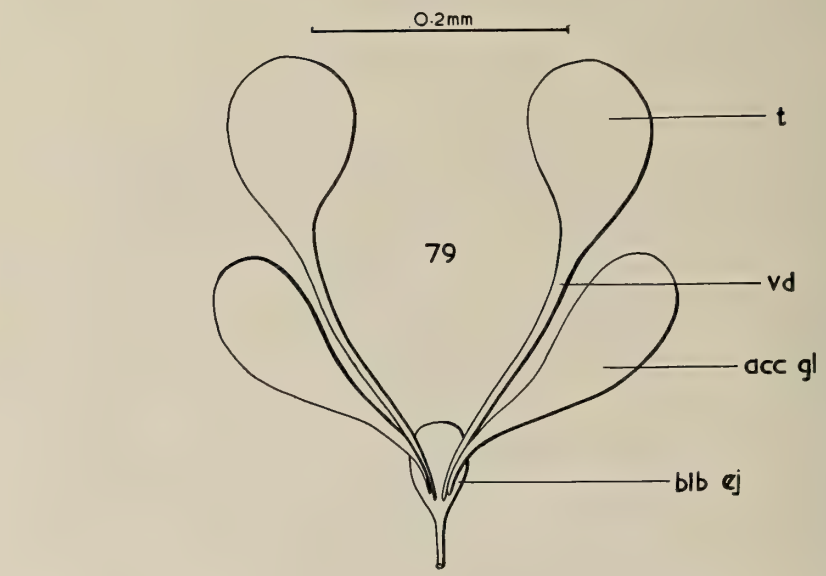
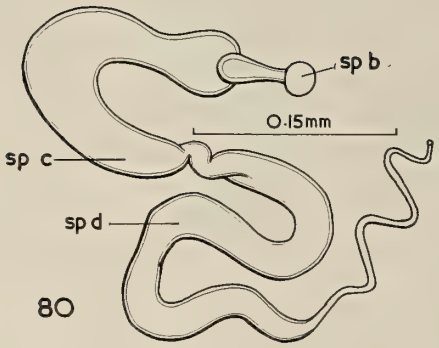


Fig. 78: dorsal view of a dissection of a female *Hoplonannus paenebrunneus* n. sp. to display the principal internal organ systems.





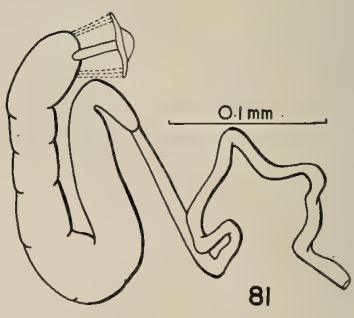
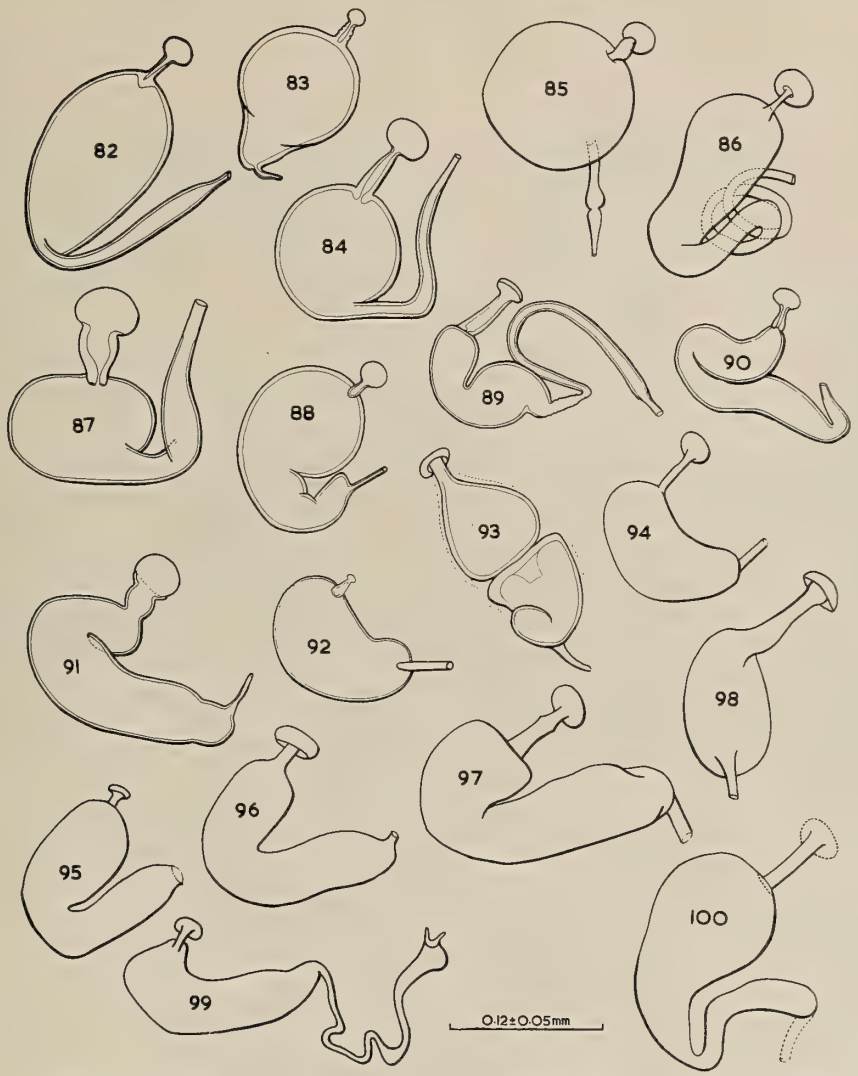
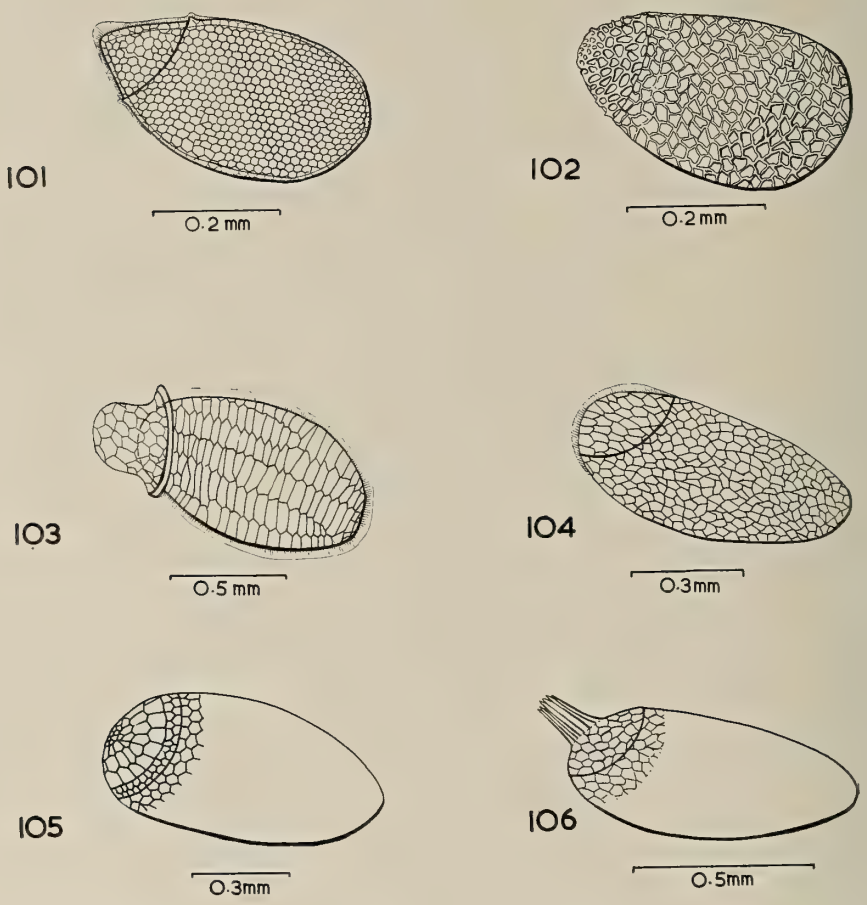


Fig. 79: dorsal view of male reproductive organs of *Schizoptera*. Fig. 80: spermatheca of *Pachyplagia*. Fig. 81: spermatheca of *Kokeshia* (from Miyamoto, 1960).



Figs. 82-90: *spermathecae* of, 82, *Seychellesanus typicus*; 83, *Hypsipteryx machadoi*; 84, *Ceratocombus* sp.; 85, *Cryptostemma usingeri* (from Wygodzinsky, 1955); 86, *Trichotonannus makilingensis;* 87, *Glyptocombus* sp.; 88, *Ceratocomboides* sp.; 89, *Hoplonannus paenebrunneus* n. sp.; 90, *Nannocoris pricei* n. sp.; 91, *Schizoptera erythiza* n. sp. 92, *Biturinannus* sp.; 93, *Machadonannus ocellatus*; 94, *Guapinannus bierigi*; 95, *Peloridinannus margaritatus*; 96, *Humpatanannus brincki*; 97, *Pinochius similis*; 98, *Vilhenannus angolensis*; 99, *P. imitator*; 100, *P. anterii*; (Figs. 93-100 are taken from Wygodzinsky 1950a, 1951 and 1958).



Figs. 101-106: eggs of Schizopteridae, 101, *Luachimonannus notius;* 102, *Hypselosoma hirashimai* (from Esaki and Miyamoto, 1959); 103, *Dundonannus chiumbensis;* 104, *Trichotonannus dundo;* 105, *Machadonannus ocellatus;* 106, *Vilhenannus angolensis.* (Figs. 103, 104, 105 and 106 from Wygodzinsky, 1950a, 1953).

Fig. 107: dendrogram illustrating the evolutionary relationships of the Schizopteridae.

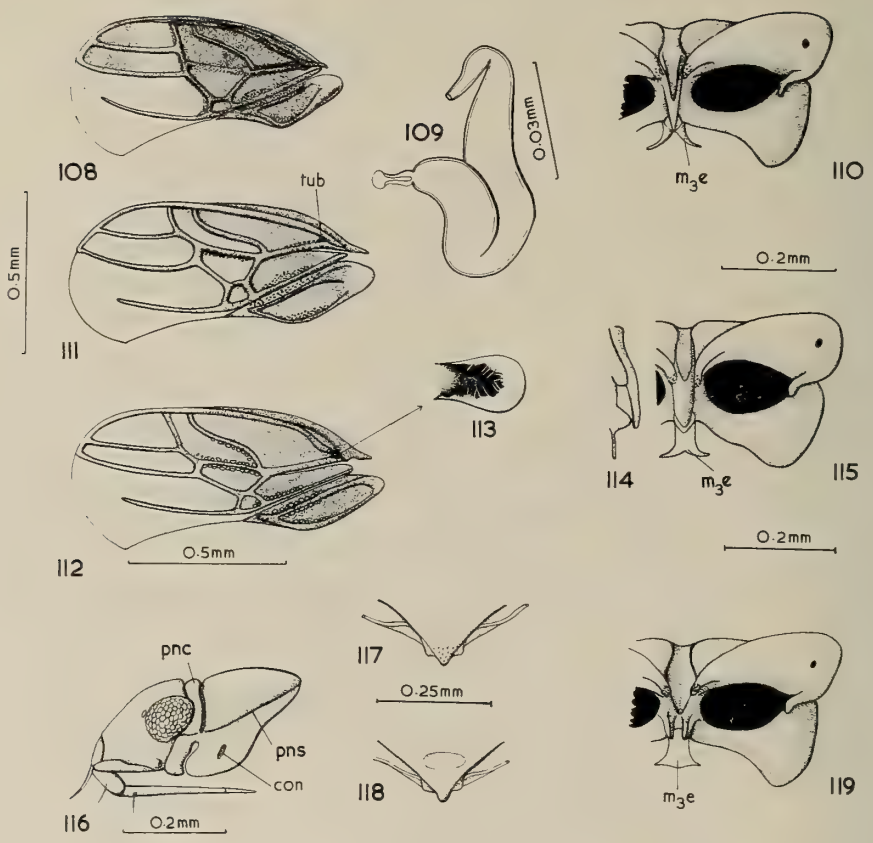
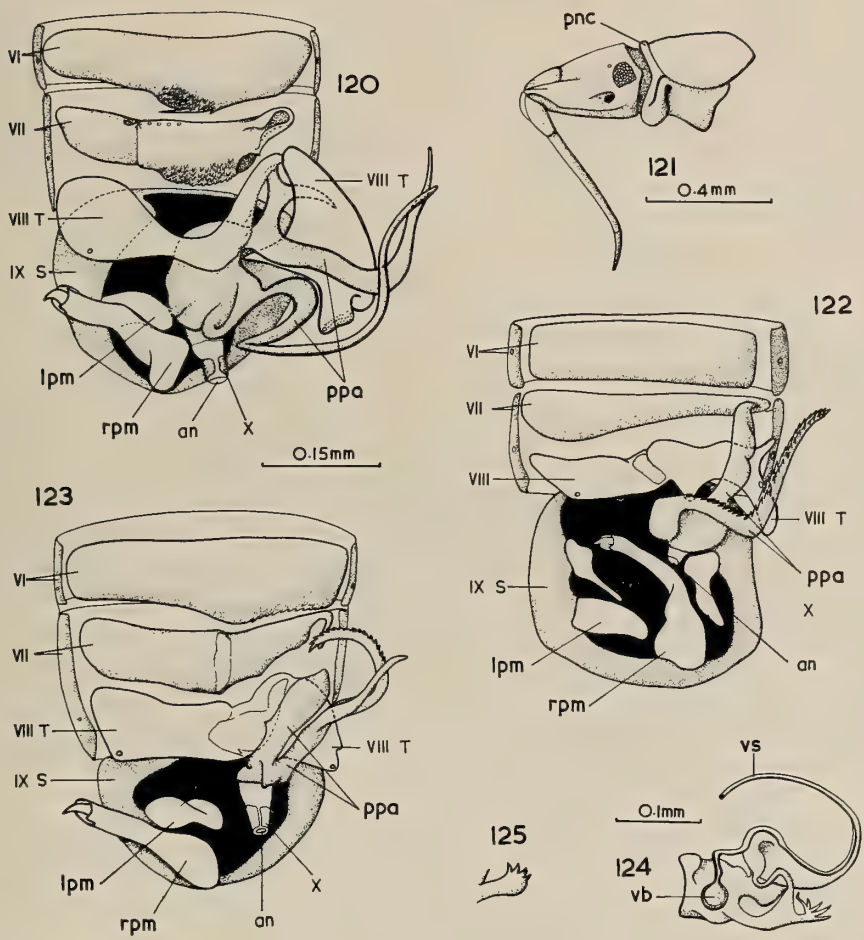


Fig. 108: ventral view of right forewing, Fig. 110: ventral view of pterothorax, Fig. 116: left lateral view of head and prothorax, Fig. 117: mesoscutellum of *Nannocoris arimensis* n. sp. Figs. 111 and 115: similar aspects of *Nannocoris wrightae* n. sp. Figs. 112, 119 and 118: similar aspects of *Nannocoris pricei* n. sp. Fig. 109: spermatheca of *Nannocoris pricei* n. sp. Fig. 113: detail of tubercle, *N. pricei*. Fig. 114: side elevation of pterosternum, *N. wrightae*.



Figs. 120, 122 and 123: dorsal views of the terminal tergites and genital capsules of *Nannocoris arimensis*, *N. wrightae* and *N. pricei* n. spp. Fig. 121: side view of head and prothorax of *Nannocoris pricei* n. sp. Fig. 124: detail of phallobase of *Nannocoris arimensis*. Fig. 125: "cockscomb" of *Nannocoris wrightae*.

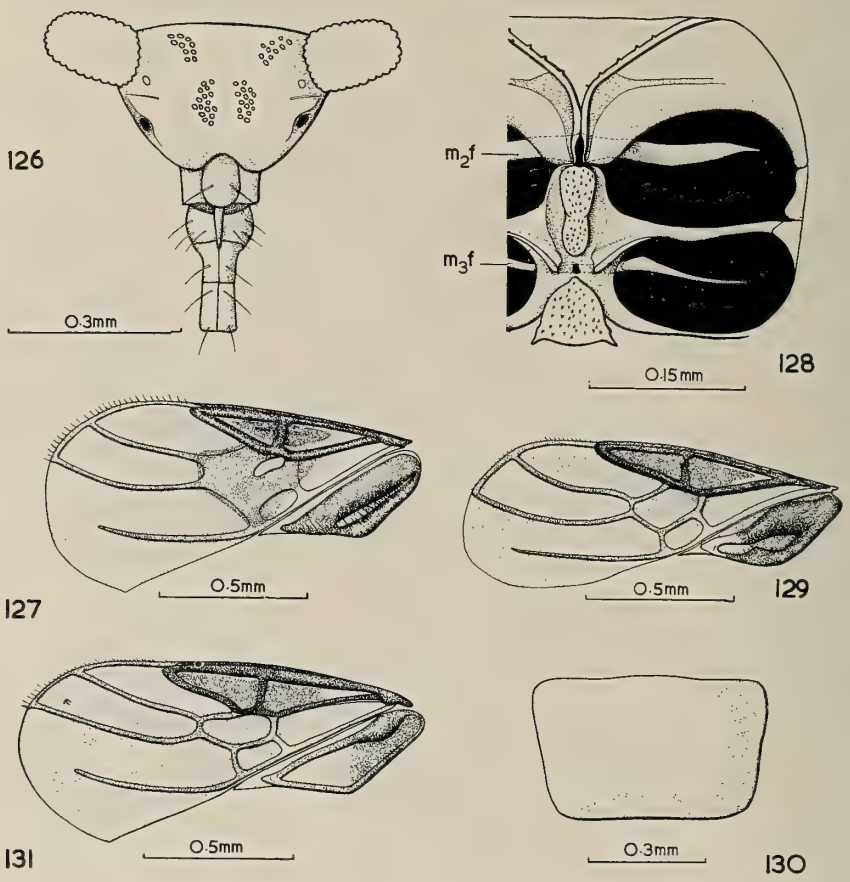
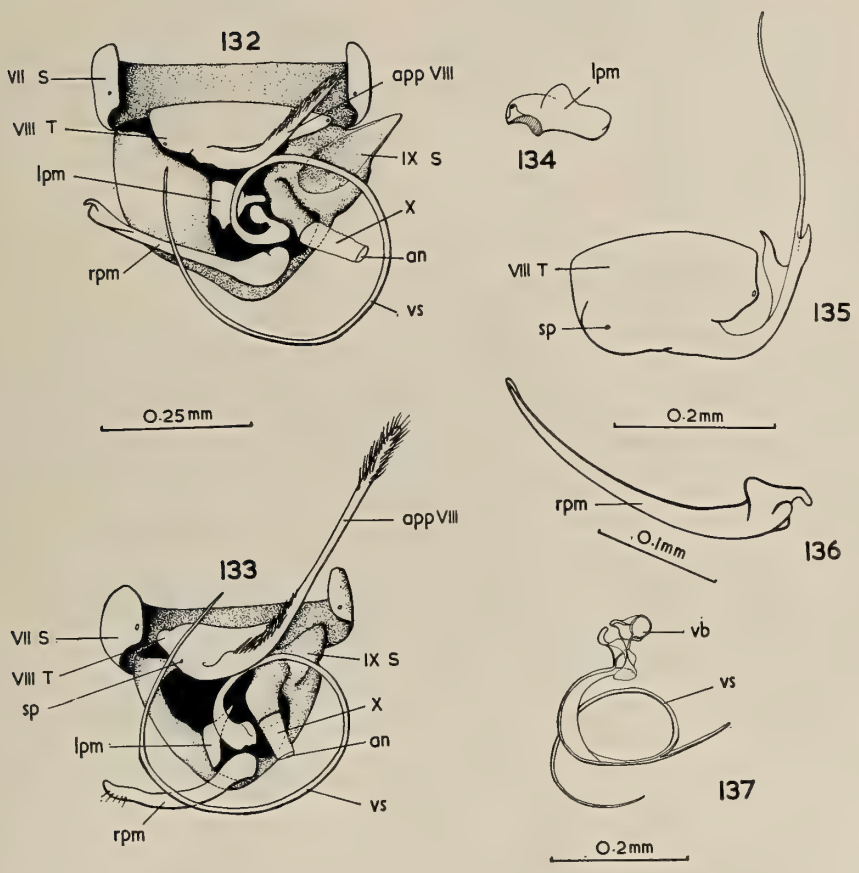
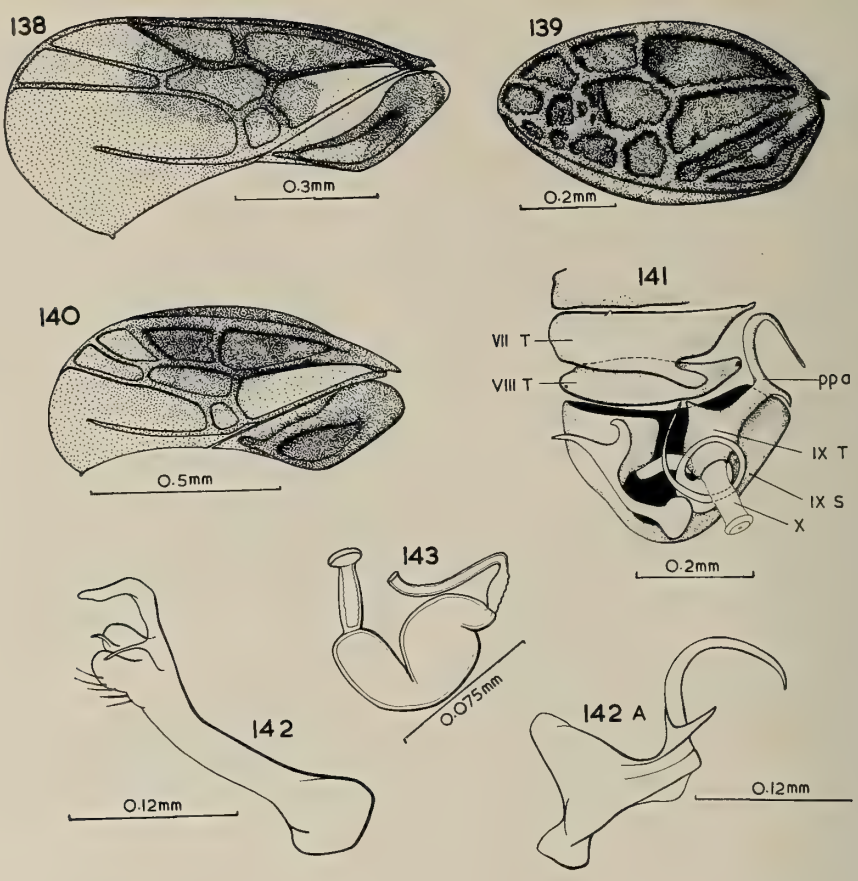


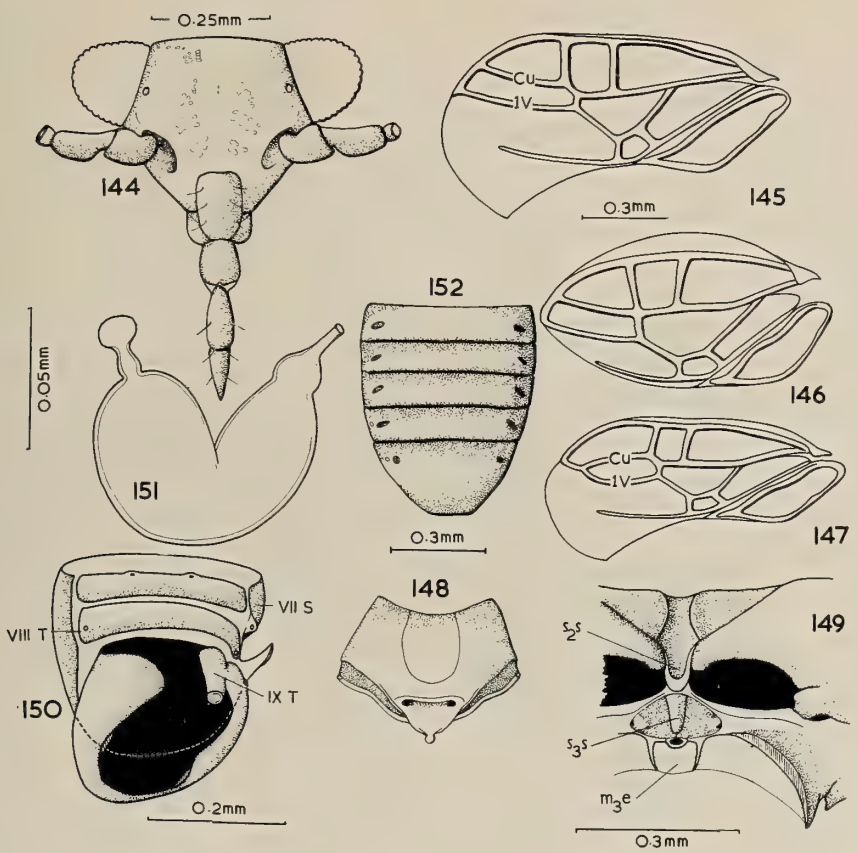
Fig. 126: anterior view of head of *Corixidea*. Fig. 128: ventral view of pterosterna of *Corixidea beebei* n. sp. Figs. 127, 131, 129: ventral view of right forewings of *Corixidea beebei, julieae* and *underwoodi* n. spp. Fig. 130: dorsal view of pronotum of *Corixidea*.



Figs. 132 and 133: dorsal view of terminal segments of male *Corixidea beebei* and *underwoodi* n. spp. Figs. 134, 135, 136 and 137: left paramere, tergite VIII, right paramere and aedeagus of *Corixidea julieae* n. sp.



Figs. 138 and 139: ventral view of right forewing of macropterous male and brachypterous female *Hoplonannus paenebrunneus* n. sp. Fig. 140: similar aspect of forewing of macropterous male *Hoplonannus craneae* n. sp. Fig. 141: dorsal view of terminal segments of male *Hoplonannus paenebrunneus* n. sp. Figs. 142 and 142A: right paramere and paraproctal appendage of *Hoplonannus craneae* n. sp. Fig. 143: spermatheca of *Hoplonannus paenebrunneus* n. sp.



Figs. 144: anterior view of the head of *Schizoptera*. Figs. 145 and 146: ventral view of right forewings of a macropterous male and a brachypterous female *Schizoptera*. Fig. 147: similar aspect of macropterous forewing of *Schizoptera* subgenus *Zygophleps*. Figs. 148-151: *Schizoptera*, 148, mesoscutellum; 149, ventral view of pterosterna; 150, dorsal view of terminal segments of the abdomen with appendages and aedeagus removed; 151, spermatheca; 152, ventral view of female abdomen.

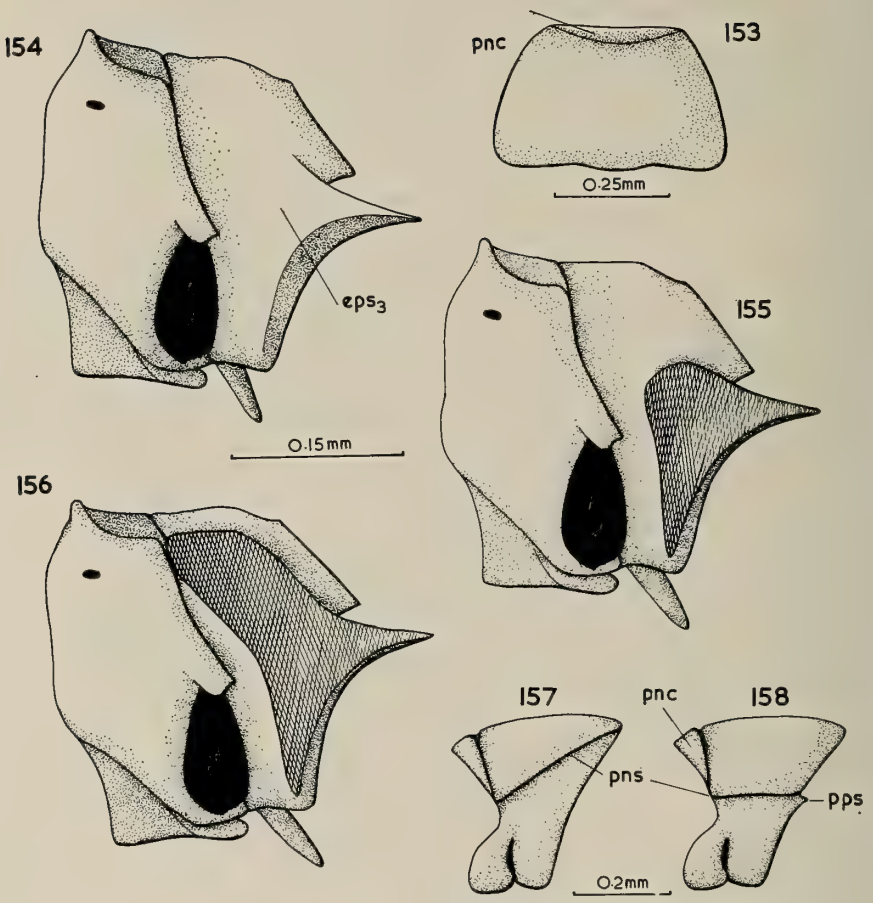
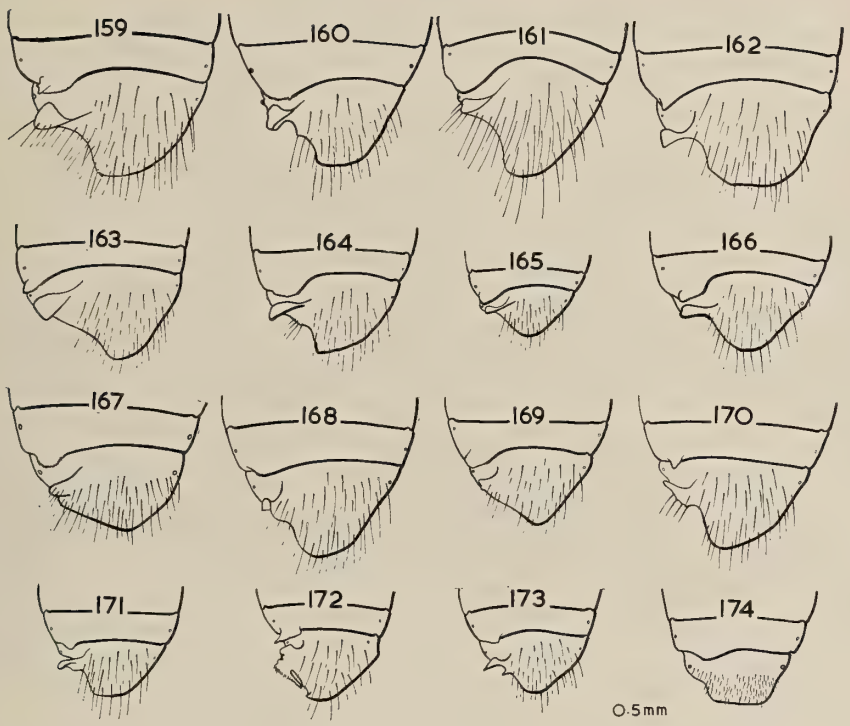
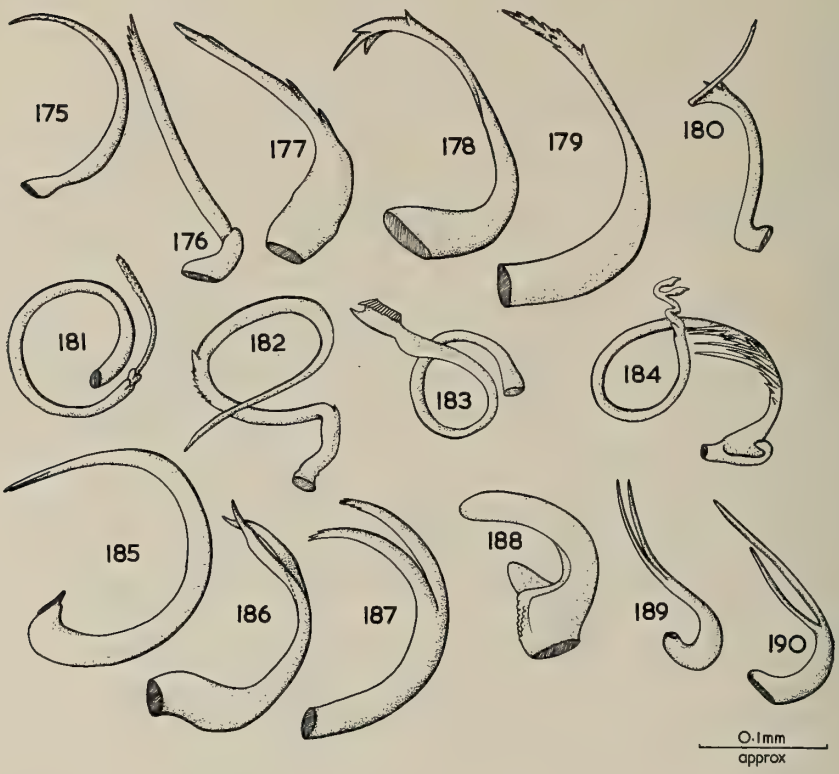


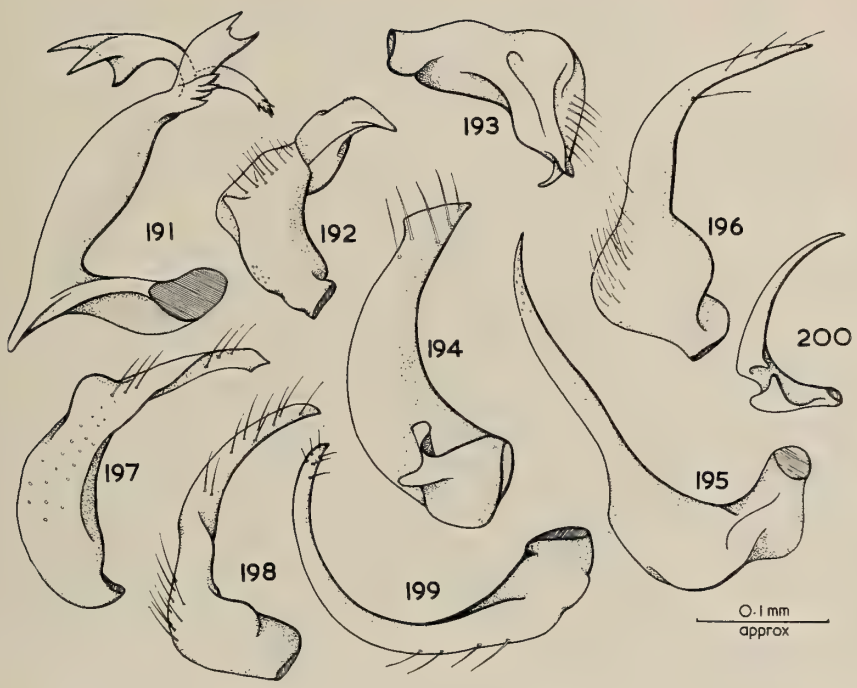
Fig. 153: dorsal view of prothorax of *Schizoptera* (not *Orthorhagus*). Figs. 154-156: left view of pteropleura of *Schizoptera*, 154 subgenus *Schizoptera*, 155 subgenus *Cantharocoris*, 156 subgenus *Lophopleurum*. Figs. 157 and 158: left lateral view of prothorax of *Schizoptera*, 157 subgenus *Schizoptera*, 158 subgenus *Odontorhagus*.



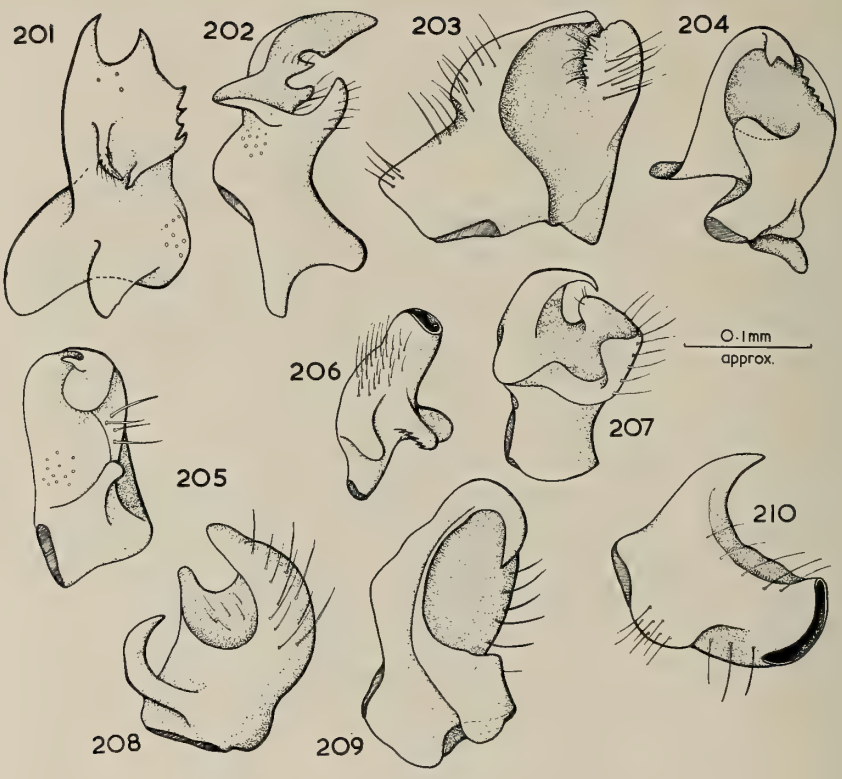
Figs. 159-174: ventral view of sternites VI and VII in male *Schizoptera* subgenus *Schizoptera*, 159 *maxima* n. sp.; 160 *rossi* n. sp.; 161 *kennyi* n. sp.; 162 *erythiza* n. sp.; 163 *griffithi* n. sp.; 164 *susicauda* n. sp.; 165 *richardsi* n. sp.; 166 *caprona* n. sp.; 167 *merleae* n. sp.; 168 *brucei* n. sp.; 169 *spiralis* n. sp.; 170 *psalida* n. sp.; 171 *anisota* n. sp.; 172 *chelifera* n. sp.; 173 *facicula* n. sp.; 174 *cleofan* n. sp.



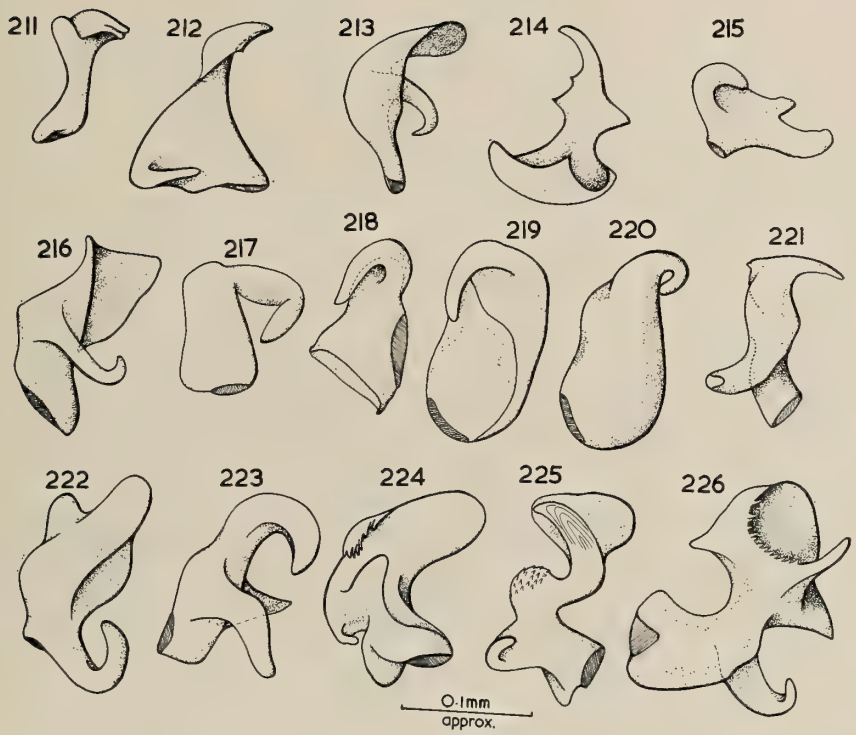
Figs. 175-190: right conjunctival appendages of *Schizoptera* subgenus *Schizoptera* (the morphologically anterior face is shown) 175 *falcicula* n. sp.; 176 *maxima* n. sp.; 177 *richardsi* n. sp.; 178 *griffithi* n. sp.; 179 *kennyi* n. sp.; 180 *merleae* n. sp.; 181 *spiralis* n. sp; 182 *susicauda* n. sp.; 183 *caprona* n. sp.; 184 *erythiza* n. sp.; 185 *rossi* n. sp.; 186 *psalida* n. sp.; 187 *brucei* n. sp.; 188 *chelifera* n. sp.; 189 *cleofan* n. sp.; 190 *anisota* n. sp.



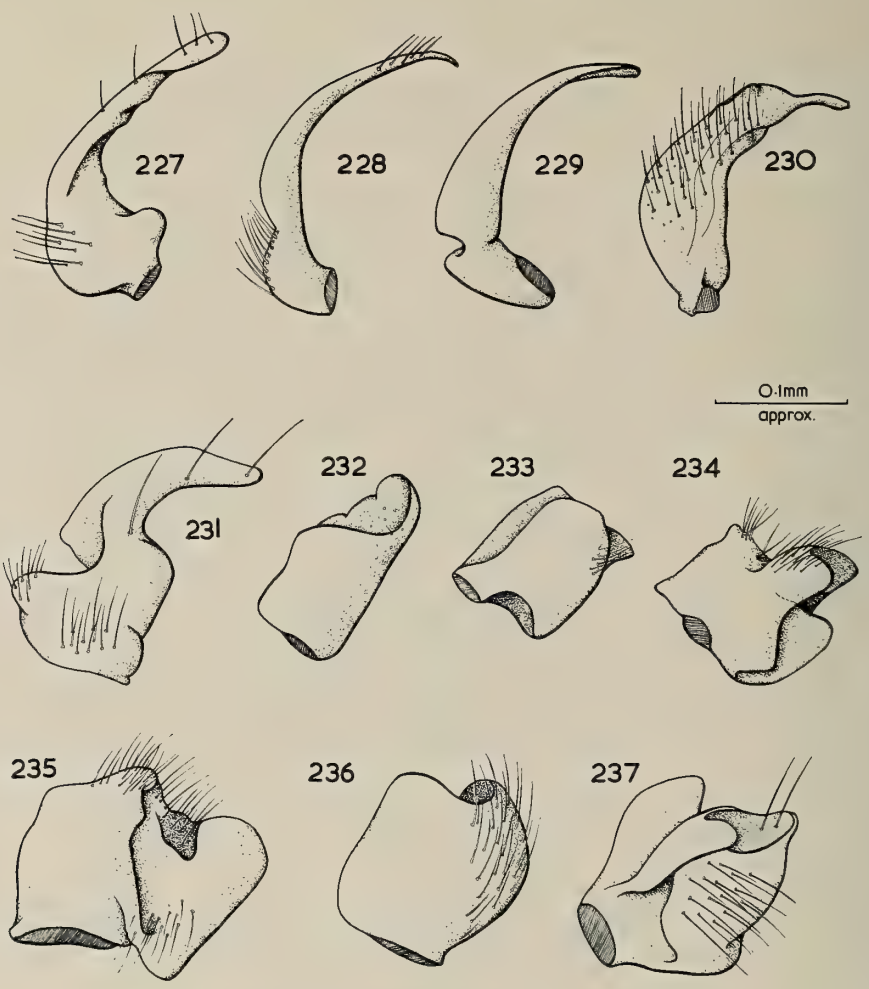
Figs. 191-200: right parameres of *Schizoptera* subgenus *Schizoptera* (the morphologically anterior face is shown) 191 *chelifera* n. sp.; 192 *rossi* n. sp.; 193 *brucei* n. sp.; 194 *erythiza* n. sp.; 195 *griffithi* n. sp.; 196 *psalida* n. sp.; 197 *maxima* n. sp.; 198 *merleae* n. sp.; 199 *spiralis* n. sp.; 200 *cleofan* n. sp.



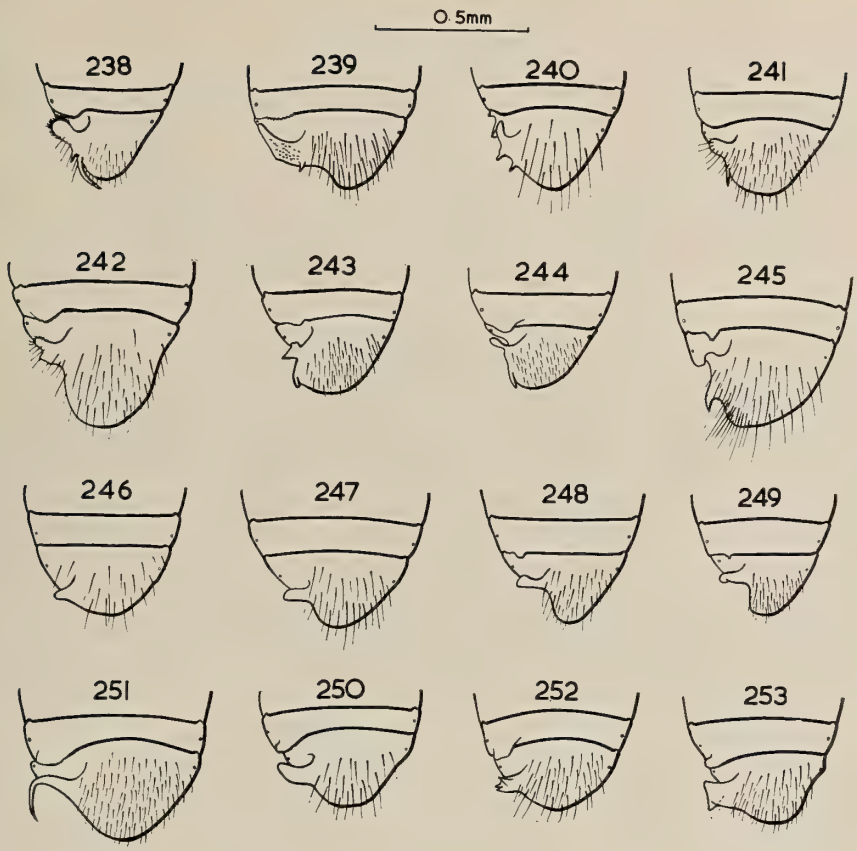
Figs. 201-210: left parameres of *Schizoptera* subgenus *Schizoptera* (various faces are presented) 201 *chelifera* n. sp.; 202 *griffithi* n. sp.; 203 *brucei* n. sp.; 204 *richardsi* n. sp.; 205 *spiralis* n. sp.; 206 *caprona* n. sp.; 207 *susicauda* n. sp.; 208 *merleae* n. sp.; 209 *erythiza* n. sp.; 210 *psalida* n. sp.



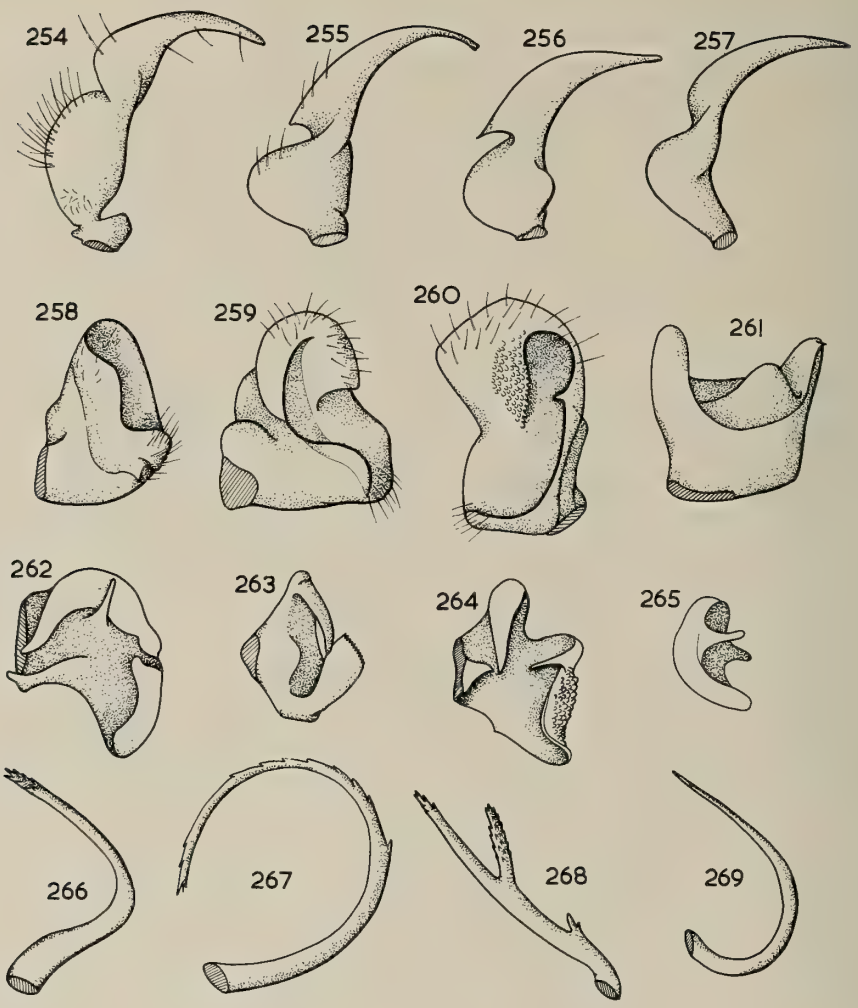
Figs. 211-226: left conjunctival appendages of *Schizoptera* subgenus *Schizoptera* (various faces are presented) 211 *cleofan* n. sp.; 212 *kennyi* n. sp.; 213 *erythiza* n. sp.; 214 *anisota* n. sp.; 215 *chelifera* n. sp.; 216 *griffithi* n. sp.; 217 *spiralis* n. sp.; 218 *merleae* n. sp.; 219 *maxima* n. sp.; 220 *caprona* n. sp.; 221 *susicauda* n. sp.; 222 *richardsi* n. sp.; 223 *falcicula* n. sp.; 224 *rossi* n. sp.; 225 *psalida* n. sp.; 226 *brucei* n. sp.



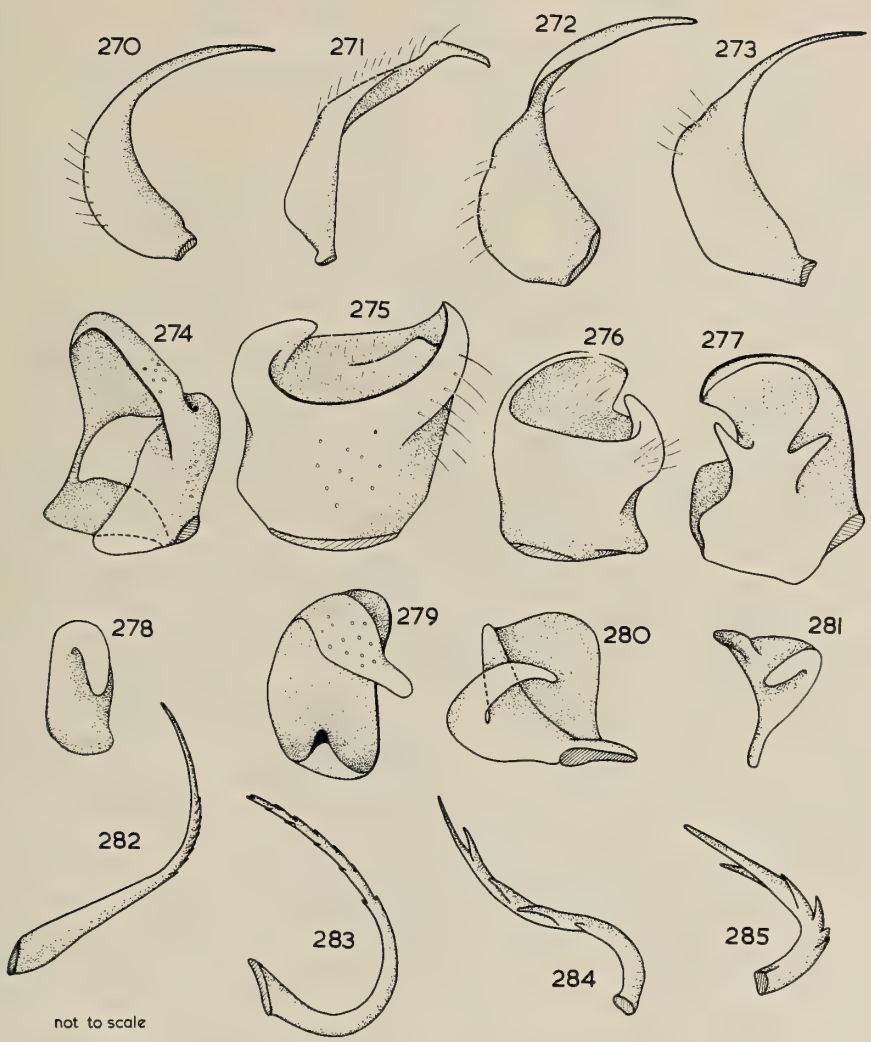
Figs. 227-231: right parameres of *Schizoptera* subgenus *Schizoptera* (the morphologically anterior face is presented) 227 *richardsi* n. sp.; 228 *caprona* n. sp.; 229 *anisota* n. sp.; 230 *kennyi* n. sp.; 231 *falcicula* n. sp. Figs. 232-237: left parameres of *Schizoptera* subgenus *Schizoptera* (various faces are presented) 232 *anisota* n. sp.; 233 *cleofan* n. sp.; 234 *rossi* n. sp.; 235 *kennyi* n. sp.; 236 *maxima* n. sp.; 237 *falcicula* n. sp.



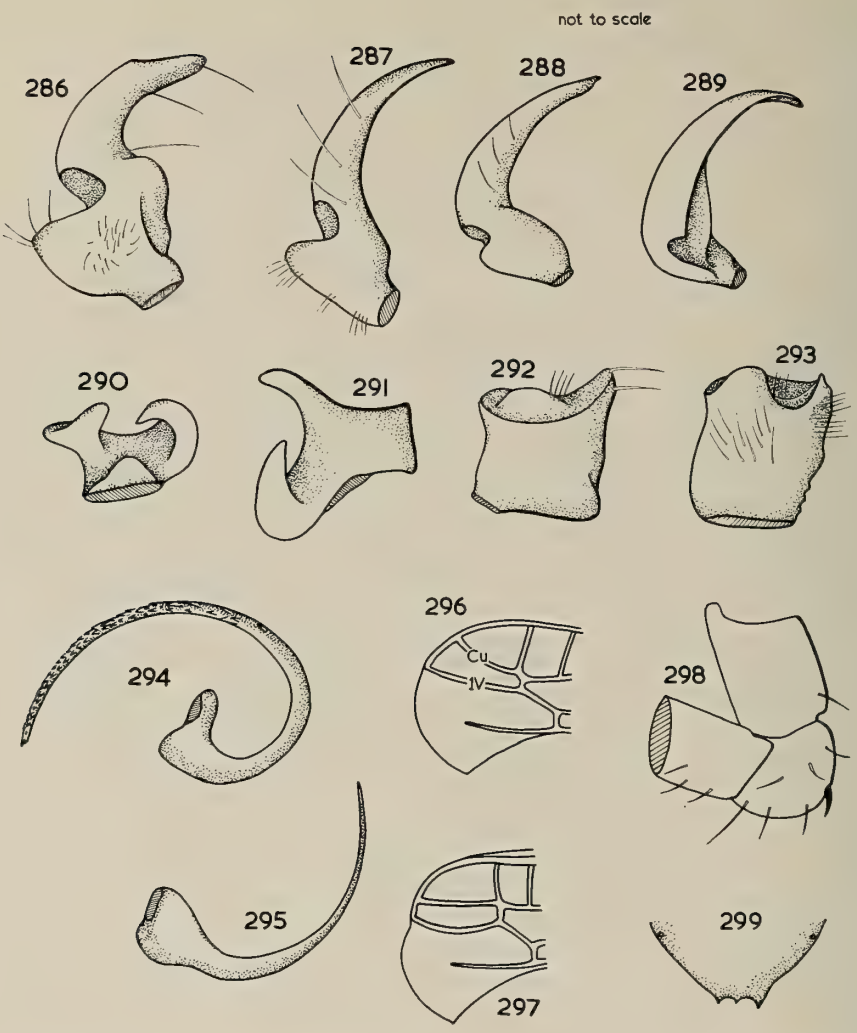
Figs. 238-253: ventral view of sternites VI and VII in male *Schizoptera,* subgenus *Lophopleurum,* 238 *torpedo* n. sp.; 239 *wygodzinskyi* n. sp.; 240 *tenuispina* McAtee and Malloch; 241 *sulcata* McAtee and Malloch; 242 *grandis* n. sp.; 243 *apatosulcata* n. sp. Subgenus *Cantharocoris,* 244 *pseudosulcata* n. sp.; 245 *hillae* n. sp. Subgenus *Odontorhagus,* 246 *stricklandi* China 1946; 247 *southwoodi* n. sp.; 248 *kirkpatricki* n. sp.; 249 *trinitatis* n. sp. Subgenus *Zygophleps,* 250 *simla* n. sp.; 251 *corallia* n. sp.; 252 *unica* McAtee and Malloch; 253 *ultima* n. sp.



Figs. 254-269: genital appendages of four species of *Schizoptera* subgenus *Zygophleps*, 254-257: right parameres of *simla* n. sp.; *ultima* n. sp.; *corallia* n. sp.; *unica* McAtee and Malloch. 258-261: left parameres of same series. 262-265: left conjunctival appendages of same series. 266-269: right conjunctival appendages of same series.



Figs. 270-285: genital appendages of four species of *Schizoptera* subgenus *Lophopleurum*, 270-273: right parameres of *torpedo* n. sp.; *grandis* n. sp.; *wygodzinskyi* n. sp.; *tenuispina* McAtee and Malloch. 274-277: left parameres of same series. 278-281: left conjunctival appendages of same series. 282-285: right conjunctival appendages of same series.



Figs. 286-299: right parameres of four species of *Schizoptera* subgenus *Odontorhagus,* 286 *stricklandi* China; 287 *southwoodi* n. sp.; 288 *kirkpatricki* n. sp.; 289 *trinitatis* n. sp. Figs. 290 and 291: left conjunctival appendages of *stricklandi* and *southwoodi* n. sp. Figs. 292 and 293: left parameres of *southwoodi* n. sp. and *stricklandi.* Figs. 294 and 295: right conjunctival appendages of *S.* (*Cantharocoris*) *pseudosulcata* n. sp. and *S.* (*Lophopleurum*) *sulcata.* Figs. 296 and 297: *Schizoptera* wing-tip shapes. Fig. 298: protrochantal spine. Fig. 299: VII sternite of female *S. kennyi* n. sp.

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