

The Hoplopleurid Lice of the Indo-Malayan Subregion (Anoplura: Hoplopleuridae)

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ABSTRACT

The species of hoplopleurid sucking lice of the Indo-Malayan Subregion are discussed from the standpoint of their taxonomy and interrelationships with their mammal hosts. Including the 9 new species and 1 new genus described herein, 27 species and 6 genera of hoplopleurids are now known from this subregion. Keys to genera and species are included. The major part of the

material was collected in Malaya and British North Borneo by joint U. S. Army and British Colonial Office teams in the decade following World War II. Described as new are: *Hoplopleura dissicula*, *H. sicata*, *H. diaphora*, *Ancistroplax nasuta*, *Neohaematopinus pansus*, *N. robustus*, *N. pallidus*, *Sathrax durus*, and *Polyplax expressa*.

INTRODUCTION

This paper presents the available information on members of the anopluran family Hoplopleuridae Ferris of the Indo-Malayan Subregion of the Oriental Region. The Oriental Region is understood to include tropical Asia and the associated continental islands of Ceylon, Sumatra, Java, Borneo, Formosa, and the Philippines. The Indo-Malayan Subregion includes the Malay Peninsula, Java, Sumatra, Borneo, and the Philippines. The louse species involved are from Malaya, Borneo, the Philippines, and Indonesia.

The family Hoplopleuridae includes the typical anopluran parasites of rodents, insectivores, and lower primates. The genus *Pedicinus* Gervais from cercopithecoid primates is not included in the present discussions. In Ferris (1951) it is listed as the only included genus in the subfamily Pediciniinae Enderlein of the Hoplopleuridae. In my opinion the differences between *Pedicinus* and typical hoplopleurids are probably more important than the similarities. *Hamophthirus* Mjöberg from the dermopteran *Cynocephalus* also was included in Hoplopleuridae by Ferris (1951). The woefully inadequate original description and drawings of its only included species, *H. galcophitheci* Mjöberg, gave nothing which argued against its placement among the hoplopleurids. The types of *H. galcophitheci* were lost and the species was not re-collected. By happy chance Dr. R. E. Kuntz, NAMRC-2, Formosa (now at U. S. Naval Medical Center, Bethesda, Maryland), made a small collection of ectoparasites in British North Borneo in 1960. The collection included specimens of *H. galcophitheci*. *Hamophthirus* is far removed from any hoplopleurid. Its status and relationships will be discussed in a future paper.

The material given here is based in large part on specimens included in mammal-ectoparasite collections made in Malaya and British North Borneo during the 12 years following World War II by cooperating British and U. S. agencies. These agencies were the British Scrub Typhus Research Unit, Institute for Medical Research, Kuala Lumpur, Malaya, directed by Dr. Ralph Audy; and the U. S. Army Scrub Typhus Research Unit, a field team

from Walter Reed Army Medical Center, Washington, D. C., with operations directed by Col. Robert Traub, M. S. C., now retired.

Most of our knowledge of Indo-Malayan Anoplura has been gained through the efforts of the combined American and British teams mentioned. Including the Malayan-Bornean collections, 27 species of hoplopleurid lice are now known from this subregion, as opposed to 15 before. Seven of the 27 species were not included in the Malayan-Bornean surveys: with 3 of them described from the Philippines, 1 from Indonesia, and the remaining 3 from Malaya and Borneo. Nine species new to science were collected in Malaya and Borneo. Eight of these species are described here, one of them as the type of a new genus. The ninth (*Neohaematopinus knabalensis* Johnson 1959) was described in an earlier paper. One new species from the Philippines also is described here.

More important than the discovery of new anopluran species is the fact that with such large mammal-ectoparasite collections as these we can begin to elucidate the host relationships of Bornean and Malayan anopluran species and do preliminary studies of morphological variation within particular species, based on host and geographic differences. Although we now have more than a beginning knowledge of Indo-Malayan hoplopleurids, collections are sparse from areas other than North Borneo and Malaya. Indonesia is unknown territory and the Philippines are hardly touched.

Collections made by the British Scrub Typhus Research Unit have field numbers prefaced by an "R"; those of the U. S. Army team are prefaced by "RT-" or "RT B-." Skins of most of the "RT" series and some of the "R" series are deposited in the collections of the Division of Mammals, U. S. National Museum, Washington, D. C. Some of the mammal identifications were made in the field, but most were made by Dr. David H. Johnson, Curator of Mammals, U. S. National Museum.

Holotypes of the new species described in this paper are deposited in the collections of the Department of Entomology, U. S. National Museum. Wherever possible, paratypes and other material

have been deposited in the collections of the British Museum (Natural History) and in the Ferris collection of Anoplura, currently housed in the collections of the Department of Entomology, University of California, Berkeley.

If it is not stated in the host-parasite list and the species discussions that specimens were taken from a museum skin, it may be assumed that the host records are based on material from wild-caught hosts.

Like structures of two or more species illustrated on the same plate were drawn to the same scale.

I am grateful to Col. Traub and Dr. Audy for the opportunity to study their collections of Anoplura and for the privilege of depositing these collections in the U. S. National Museum. My thanks go also to Dr. D. H. Johnson, who kindly answered many questions on mammal relationships, distribution, and ecology.

TAXONOMY

KEY TO THE HOPOPLEURID GENERA FROM INDO-MALAYA

1. Anterior and middle legs of the same size and form, both small and slender, with slender claw; venter of abdomen with a pair of small widely separated sclerotized detached plates on segment 2; found only on sciurids ... **Enderleinellus**
Anterior legs the smallest of the three pairs, the second pair at least somewhat larger than the first and with stouter claw; venter of abdominal segment 2 without a pair of detached plates ... 2
- 2(1). Antenna four-segmented; posterior legs large, strongly compressed and flattened; on ground shrews ... **Ancistroplax**
Antenna five-segmented ... 3
- 3(2). Paratergal plates of segment 2 divided into two distinctly separate parts; sternal plate of segment 2 extended laterally to approximate or articulate with corresponding paratergal plates (fig. 19) ... **Hoplopleura**
Paratergal plates of segment 2 not so divided, though center may be only lightly sclerotized; sternal plate of this segment not extended laterally ... 4
- 4(3). Adults with many pointed tubercles on venter of head and first antennal segment (fig. 71); on *Tupia* ... **Sathrax**, n. gen.
Adult lacking such tubercles ... 5
- 5(4). No indication of division of paratergites of segment 2; tarsal claw of first leg apically bifid in all Indo-Malayan species; male with two stout setae dorsally on third antennal segment; second abdominal tergal plate of male posteriorly emarginate and bearing two groups of radially arranged setae at each end (fig. 48); on sciurids ... **Neohaematopinus**
Usually with an indication of division of the paratergal plates on segment 2; first tarsal claws not apically bifid; second tergal plate of segment 2 of male not modified; not on sciurids ... **Polyplax**

Genus *Enderleinellus* Fahrenholz

Enderleinellus Fahrenholz 1912, 56; Ferris 1920, 7; Werneck 1947, 281; Ferris 1951, 102 (sinks *Hoplophthirus*, *Cyclophthirus*, *Rhinothirus*, *Enderleinellus*); Johnson 1960, 7.
Hoplophthirus Ewing 1929, 194 (type: *Enderleinellus cuxeri* Ferris).
Cyclophthirus Ewing 1929, 195 (type: *Enderleinellus suturalis* Osborn).
Rhinothirus Ewing 1929, 196 (type: *Enderleinellus hcliosciuri* Ferris).
Enderleinellus Ewing 1929, 197 (Type: *Enderleinellus larisci* Ferris).

TYPE OF GENUS.—*Pediculus sphacrocephalus* Nitzsch (preocc.), original designation=*Enderleinellus nitzschi* Fahrenholz (n.n.).

KEY TO THE INDO-MALAYAN SPECIES OF *ENDERLEINELLUS*

1. Paratergal plates present on segment 2-4 ... 2
Paratergal plates present on segments 2-5 ... 3
- 2(1). Paratergal plate II (of second abdominal segment) with one apical seta, plates III-IV with two apical setae ... **kumadai**
Paratergal plates II and IV lacking apical setae, plate III with one such seta ... **larisci**
- 3(1). Paratergal plate II with one apical seta; thoracic sternal plate dumbbell shaped **malaysianus**
Each paratergal plate with two apical setae; thoracic sternal plate quadrate **nannosciuri**

DESCRIPTION.—First and second pairs of legs small, of similar size; third pair much larger, with a large flattened claw. Typical members of genus with pair of sclerites on venter of abdominal segment 2, these sclerites either joining paratergal plate II and lacking setae or occurring more medially, bearing flattened point which is apically free from body and bearing small posteroapical seta. All paratergal plates apically free from body wall, of two types: in the first type the median portion is raised into a median lobe and the plates are discrete and weakly sclerotized; in the second type the plates are weakly sclerotized and flat across the middle. Species possessing the second type of paratergites either have paired sclerotizations of the second abdominal sternum adjoining paratergal plates II, or these paired sclerites are missing. There is a tendency toward: coalescence of the sensoria of the fourth and fifth antennal segments; a bifid condition of the claws of the first and second pairs of legs; and reduction in the number of paratergal plates and abdominal spiracles. All known species except *nitzschi* Fahrenholz lack sclerotized abdominal plates. Female genitalia with "gonopods" of ninth segment bearing either a long, basally broad and apically acute spine or a shorter spine of about the same width throughout and apically somewhat blunt. Male genitalia of several types.

The genus has world-wide distribution and contains about 27 described species, all from sciurid rodents. These lice are so small and cling so tightly to the host hairs with their greatly modified and enlarged hind legs that they are often missed by

collectors, and probably are much more abundant than records suggest. Four species have been described from Indo-Malayan squirrels.

Enderleinellus kumadai Kaneko

Enderleinellus kumadai Kaneko 1954, 49, figs. 1, 2; Johnson 1959, 573, figs. 6-9.

Enderleinellus kumadai was based on the male holotype, female allotype, and a series of male and female paratypes collected from *Callosciurus erythraeus thaivanensis*, Oshima, Tokyo, Japan. The squirrels, which are native to Formosa, had escaped from a zoo. Johnson (1959) recorded this species from *Callosciurus fulvipes* and *Callosciurus* sp. from Nakhon Sawan and Chaiyaphum provinces, Thailand.

In the Malayan-Bornean survey, one female of *E. kumadai* was taken from *Callosciurus notatus* (B-19187, Ranau, North Borneo), a second female from *C. prevosti* (B-19164, Ranau), one male from *C. nigrocitatus* (B-19203, Mt. Kinabalu, North Borneo), one male and two nymphs from *Glyphotes* sp. (B-19430, Mt. Kinabalu), and two females from *C. notatus* (B-45256, Selangor, Malaya). The hosts all are tree squirrels. From the number of squirrel species found infested, it seems that the host spectrum of *E. kumadai* is a broad one. As with all *Enderleinellus* species *E. kumadai* is probably more common than records would indicate since these small lice are often overlooked.

E. kumadai may be separated from other Indo-Malayan *Enderleinellus* by one or more of the following characters: paratergal plates are present on segments 2-4, plate II has one apical seta, and plates III-IV have two apical setae; spiracles are present on segments 3-5.

Enderleinellus larisci Ferris

Enderleinellus larisci Ferris 1920 (dated 1919), 17, figs. 7, 8; Ferris 1951, 109.

Enderleinellus larisci: Ewing 1929, 197.

The type series (holotype, a male) is from the skin of a *Lariscus diversus* (*Lariscus insignis*), Lanchut, Southwest Borneo (U.S.N.M.). It has not been reported since the original description and was not collected during the present survey.

E. larisci is distinguished from other Indo-Malayan *Enderleinellus* species by a combination of having paratergal plates present only on abdominal segments 2-4; with plates II and IV lacking apical setae, while plate III has only one apical seta. Also, the head does not have postantennal angles.

Enderleinellus malaysianus Ferris

Enderleinellus malaysianus Ferris 1920 (dated 1919), 12, figs. 3, 4; Werneck 1947, 281, 392; Ferris 1951, 110; Johnson 1959, 574.

E. malaysianus was described from the holotype male, allotype female, and a large number of paratypes, all from skins in U.S.N.M. The holotype was taken from the skin of a *Sciurus lucas* (*Callosciurus*

caniceps), St. Lukes Island, Mergui Archipelago (west of lower Burma). A series of paratypes was taken also from *C. caniceps* from islands in the Mergui Archipelago. Original host names and localities are: Bentinck Island from *S. bentinckanus*; Domel Island from *S. domelensis*; Pulo Teratau (Pulau Teratau) from *S. lancanensis* (this island is west of southernmost Thailand and belongs to Malaya). Paratypes were taken also from *S. davisoni* (*C. caniceps*), Trong (Trang?), lower Thailand. Further paratypes were taken from *S. borneocensis* (*C. prevosti*), Pulo Kauchut, Borneo.

Johnson (1959) reported a single female from *C. caniceps*, from Nakhon Sawan Province, Thailand. *E. malaysianus* was not collected during the Malaya-Borneo surveys.

This species may be separated from other Indo-Malayan *Enderleinellus*, except *E. nanosciuri*, in that it has paratergal plates on abdominal segments 2-5, rather than 2-4, and from *E. nanosciuri* by having only one apical seta on paratergal plate II, and by the thoracic sternal plate being dumbbell-shaped, with rounded, heavily sclerotized lateral parts joined by a semimembranous median area.

Enderleinellus nanosciuri Ferris

Enderleinellus nanosciuri Ferris 1920 (dated 1919), 30, fig. 17; Ferris 1951, 110.

The holotype female was taken from the skin of a *Nannosciurus melanotis*, Batavia, Java (Djakarta, Indonesia) (U.S.N.M.). It has not been collected, and was not included in the present survey. The male is unknown.

Like *E. malaysianus*, this species has paratergal plates on segments 2-5, rather than 2-4 as in *larisci* and *kumadai*. It is distinguished from *malaysianus* in having two apical setae on each paratergal plate and in that the thoracic sternal plate is quadrate, not dumbbell shaped.

Genus *Hoplopleura* Enderlein

Hoplopleura Enderlein 1904, 221; Fahrenholz 1912, 44; Ferris 1921, 59; Ferris 1951, 125 (sinks *Ferrisiella*, *Ctenura*, *Euhoplopleura*, and *Ctenopleura*); Johnson 1960, 12.

Haematopinus (*Polyplax*): Neumann 1909, 531.

Ferrisiella Ewing 1929, 198 (type: *Hoplopleura ochotona* Ferris).

Ctenura Ewing 1929, 199 (type: *Hoplopleura pectinata* Cummings).

Euhoplopleura Ewing 1929, 199 (type: *Hoplopleura trispinosa* Kellogg and Ferris).

Ctenopleura Ewing 1929, 200 (type: *Hoplopleura cryptica* Ferris).

TYPE OF GENUS.—*Pediculus acanthopus* Burmeister, by original designation.

KEY TO THE INDO-MALAYAN SPECIES OF HOPOPLEURA

1. Sensoria of antennal segments 4 and 5 small and widely separated *erismata*
- Sensoria large and contiguous 2

- 2(1). First sternal plate of abdominal segment 3 not extended laterally to meet the corresponding paratergal plates; female lacking abdominal plates on segments 4-6 (fig. 29) *diaphora*

First sternal plate of segment 3 articulating with corresponding paratergal plates; females with plates on abdominal segments 4-6 (fig. 18) 3

- 3(2). First sternal plate of segment 3 with the paired lateral setae only slightly larger than other abdominal setae (fig. 25); apical lobes of paratergal plates III-VI narrow (fig. 35) *malaysiana*

Lateral paired setae of first sternal plate of segment 3 enlarged (fig. 18); apical lobes of paratergal plates III-VI not apically narrow, often emarginate (fig. 12) 4

- 4(3). Postantennal area of head extremely broad; paratergal plate VIII with two long apical lobes; apex of abdomen of female with eight stout setae set on prolongations of the exoskeleton *pectinata*

Not as above 5

- 5(4). Postantennal head margins strongly convex, postantennal angles marked (fig. 17); no sword-shaped setae on abdomen (fig. 18) *dissicula*

Postantennal head margins not convex (fig. 15); sword-shaped setae on abdomen (fig. 22) 6

- 6(5). Paratergal plate VII with a narrow dorsoapical lobe (fig. 13) *sicata*

Lacking apical lobe on paratergal plate VII *pacifica*

DESCRIPTION.—Antennae five-segmented, not strongly sexually dimorphic although the male may have enlarged dorsal setae on segment 3 and sometimes 4. Sensoria of segments 4-5 may be large and contiguous or small and separate. Thoracic sternal plate present. First pair of legs small with slender claw; second pair similar but larger; third pair much larger, usually flattened and with a very broad flattened claw, this pair of legs never with bladderlike membranous extensions. Paratergal plates usually well developed, those of segment 2 never produced into long bladlike extension, divided into small dorsal part and larger ventral seta-bearing part (the small dorsal part may actually be the paratergal plate of the first abdominal segment). Paratergal plates never showing tendency for partial division into two parts by reason of a longitudinal median area of lesser sclerotization. Functional spiracles present on segments 3-7. Always with indication of a small triangular plate ventrally on abdomen between posterior extremities of the hind coxae. Both sexes with second tergal row of segment 2 (if two rows on this segment) and first tergal row of segment 3 with setae arranged in lateral groups of two each on either side, so that median part between groups is bare; never with these setae sword shaped or otherwise modified in shape, usually with these setae longer and thinner than other setae on dorsum of abdomen. Sternal plate of seg-

ment 2 extended laterally to articulate with, or approximate, the corresponding paratergal plates. First sternal plate of segment 3 usually but not always articulating with paratergal plates III and bearing two groups of 2-4 enlarged stout setae. Usually, but not always, female with three rows of setae on each of typical abdominal segments both dorsally and ventrally; male with one row on each typical segment dorsally and two ventrally.

There are about 65 described members of *Hoplopleura*. A few species are found on sciuriform and hystricomorph rodents, but the majority occur on myomorph rodents from all parts of the world. Seven species, three of them new, are found in the Indo-Malayan subregion.

Hoplopleura pacifica Ewing

(Figs. 1, 5, 9, 10, 11, 15)

Hoplopleura ocnomydis Ferris 1921, 82 (*partim*); Ferris 1932, 121 (*partim*); Pritchard 1947, 374; Ferris 1951, 132 (*partim*).

Hoplopleura pacifica Ewing 1924, 9, figs. 1b-c; Hopkins 1949, 481; Johnson 1959, 577.

The type series of *H. pacifica* consists of five males and seven females collected from *Rattus exulans hawaiiensis*, Hawaiian Islands. The types are in the Bernice P. Bishop Museum, Honolulu.

H. pacifica is a typical parasite of *Rattus rattus* ssp. and the commonest anopluran taken from these animals in the Australian and Oriental regions. It was collected in large numbers from *Rattus rattus argentiventer* (5 collections), *R. r. diardi* (14 collections), *R. r. jalorensis* (15 collections), and *R. r. jarak* (4 collections) from Selangor and Palau Jarak, Malaya. Apparently it occurs naturally also on *Rattus exulans* (4 collections from Selangor), *R. exulans* is closely related to *R. rattus*. In Borneo *H. pacifica* was collected only twice, from *Rattus r. baluensis* and *Rattus* sp. Scattered single collections occur supposedly from other species of *Rattus*, never more than a single specimen to a collection and never from more than one or two of the total individuals of a particular species collected. Such occurrences were undoubtedly due to mechanical contamination during the collecting process.

For many years confusion has existed as to the identity of *H. pacifica*. The original description contains nothing that would serve to distinguish this species from *H. ocnomydis*. Until recently *H. ocnomydis* was known only from the type series, and small points of difference between true *H. ocnomydis* and *H. pacifica* simply could not be adequately investigated. As well, Ferris had before him at the time he described *H. ocnomydis* no fewer than three other species: *H. setzeri* Johnson from African *Grammomys*, *H. somereni* Waterston from African *Dusymys*, and *H. pacifica* from Philippine *Rattus*. The amount of difference between *H. ocnomydis* and specimens of *H. setzeri* and *H. somereni* is greater than the amount of difference found between true *H. ocnomydis* and Ferris' specimens of *H. pacifica*

from Philippine rats. Therefore it is not surprising that in 1932 Ferris felt justified in synonymizing *H. pacifica* under *H. oenomydis* on a morphological basis. In 1949 Hopkins indicated that because of host differences it was improbable that *H. pacifica* could be synonymized under *H. oenomydis*. In 1951 (with only his earlier specimens of *H. oenomydis* and forms he had referred to *H. oenomydis* available) Ferris reiterated that *H. pacifica* must fall as a synonym of *H. oenomydis*.

North American authors, beginning with Pritchard in 1947, have accepted Ferris' views of the synonymy of *H. oenomydis* and *H. pacifica* with the result that the *Hoplopleura* of *Rattus* in the South-eastern States is always referred to as *H. oenomydis*, not *H. pacifica*.

Fortunately, further specimens of *H. oenomydis* from the type host (*Oenonymus hypoxanthus* sp.) have been collected in the Republic of the Congo and in Uganda. I have seen the type series of *H. oenomydis* from *O. hypoxanthus* (3♂♂ 5♀♀), 1♂ 4♀♀ from *O. h. bacchante*, Uganda: North Bugishu, Buyobo, and a pair from *O. hypoxanthus*, Congo: Congo du Lemba. I have studied the specimens also from *Grammomys*, *Dasymys*, and *Rattus* which Ferris referred to *H. oenomydis* in the original description.

A study of the true *H. oenomydis* specimens and hundreds of *Hoplopleura* from *R. rattus* and some from *R. exulans* has proven the *Hoplopleura* of *Rattus rattus* and *R. exulans* from Madagascar, Southeast Asia, the Philippines, the Pacific Islands, the Caribbean Islands, and Southeastern United States to be, indeed, different from *H. oenomydis*. Morphological differences between the two *Hoplopleura* species are slight. Hopkins (1949) suggests convergence of form may have occurred, but it seems more likely that these two *Hoplopleura* species, both typical members of the genus in all ways, may merely not have diverged greatly in morphology. I suspect a wealth of species closely related to *H. pacifica* and *H. oenomydis* exists, particularly on Australasian *Rattus* and allies, as well as on other murid rodents in all parts of the world. Two such species are described in this paper.

DIAGNOSIS.—*H. pacifica* is a member of the *hesperomydis-affinis* group of *Hoplopleura*. It is closest morphologically to *H. oenomydis*. Like *H. oenomydis*, male and female *H. pacifica* have lateral abdominal setae off both the tergal and sternal plates, and the setae of typical abdominal rows are sword shaped, paratergal plates III-V have two truncate apical lobes, VI has the dorsal apical lobe truncate and the ventral lobe more-or-less acute, and plates VII-VIII lack free apical lobes. The normal setation of the paratergal plates is as follows: III, 2 apical setae reaching about to apex of lobes; IV-VI, 1 seta as long as apical lobes, other very short; and VII-VIII with usual pair of long apical setae. The male genitalia are similar in *H. oenomydis* and *H. pacifica* (compare figs. 5 and 6). Differences be-

tween *H. oenomydis* and *H. pacifica* are slight and not all are constant. *H. pacifica* has the dorsal apical angle of paratergal plate VI rugose and somewhat wrapped around the base of one of the two apical setae (fig. 11); however, one *H. oenomydis* specimen I examined had a tendency toward such a shape and rugosity. *H. pacifica* is a smaller species than *H. oenomydis*. Respective lengths are as follows:

- H. oenomydis* ♂ average 1.22 mm.
(1.1-1.34 mm., 2 specimens measured)
H. pacifica ♂ average 0.95 mm.
(0.8-1.1 mm., 41 specimens measured)
H. oenomydis ♀ average 1.49 mm.
(1.4-1.6 mm., 6 specimens measured)
H. pacifica ♀ average 1.27 mm.
(1.05-1.38 mm., 86 specimens measured)

Ferris (1921) gives the length of male *H. oenomydis* as 0.95 mm. One slight difference may be found in the heads of the two species (figs. 7 a-d and 10 a-d). *H. oenomydis* has the postantennal angles more broadly angled (fig. 8) than does *H. pacifica* (fig. 9). The most constant and easily recognized difference between *H. oenomydis* and *H. pacifica* is the shape of the thoracic sternal plate. In *H. pacifica* (fig. 1 a-j) the lateral angles are rather bulbous and the margins below are concave. In *H. oenomydis* (fig. 2 a-h) the lateral angles are less rounded, not bulbous, and the margins below are not, or only slightly, concave.

Hoplopleura dissicula, new species

(Figs. 3, 14, 17, 18-21)

TYPE DATA.—Female holotype, male allotype from *Rattus mulleri*, Malaya: Selangor, Pahang Road, 35 mi. north of Kuala Lumpur, 21 August 1948, RT-8334, Traub and Insoil collectors. A series of paratypes from *R. mulleri*, Malaya: Selangor, as follows: one male, Pahang Road, 16 mi. north of Kuala Lumpur, 4 Sept. 1948, RT-8387, BI-3326, Traub and Insoil collectors. Three females as above except 11 Nov. 1948, RT-8616, BI-4162. One female as above except 24 Nov. 1948, RT-8650. Four males, Ulu Gombak Forest Reserve, 8 Aug. 1956, RT B-45284. One female as above except 13 Sept. 1956, RT B-45466. From *Rattus mulleri*, North Borneo: Mt. Kinabalu, Tenompok, 13 August 1953, Traub collector, two female paratypes, RT B-19208 and RT B-19213.

Further specimens of this species were collected from various Bornean rats, all from Mt. Kinabalu: Ranau, Tenompok, and Bundu Tuhau as follows: from *R. rattus bahucensis* 1♂1♀; from *R. r. argenticenter* 2♀ from *R. sabanus* 1♀; from *R. infraluticus* (?) 1♀; from *R. cremoricenter* 1♀; from *R. whiteheadi* 1♀; and from *R. rattus* (?) 2♂♂ 3♀♀. Most of these records are undoubtedly due to straggling or mechanical contamination. However, the one group of two males and three females from *Rattus rattus* (?), RT B-20508, may represent a natural infestation. Note that the host determination is in doubt.

DIAGNOSIS.—*H. dissicula* is related to *H. pacifica*

and allies. It is immediately separated from *H. pacifica* and *H. sicata*, n.sp., by having the postantennal angles of the head very marked, produced anteriorly, and the posterolateral head margins convex (compare fig. 17 with figs. 15 and 16). Further, *H. dissicula* lacks sword-shaped setae on the abdomen and both sexes have a triangulate apically acute, dorsoapical lobe on paratergal plate VII (fig. 14).

DESCRIPTION.—FEMALE (fig. 18): *Head* (fig. 17). Anterodorsal head armature (transverse rodlike thickening anterior to antennae) heavy, straight. Postantennal angles marked, produced anteriorly; posterolateral head margins convex. Sensoria of antennal segments 4-5 contiguous, large. Dorsal head setation as in figure. *Thorax*. Sternal plate (fig. 3) longer than broad, narrowed posteriorly. *Abdomen*. All abdominal setae rather long, none of them sword shaped. Dorsally and ventrally with three narrow but not strongly reduced plates on typical segments, each plate bearing 7-9 posteromarginal setae. Several lateral setae off plates both dorsally and ventrally. Sternal plates of segments 2-3 articulating with respective paratergal plates, first sternal plate of segment 3 bearing 2 enlarged setae on either side. Paratergal plate II (fig. 14, plates III-VIII) with both apical angles acute; plate III bilobed apically, each lobe subdivided by abrupt concavity of posterior margin, with two apical setae extending about to apex of lobes; plates IV-VI bilobed apically, posterior margin of each lobe excised, with two apical setae, the dorsal one extending about as far as apex of lobes, ventral one usually minute, sometimes half length of longer seta (true of plate VI on both sides in holotype); plate VII with triangulate dorsoapical lobe which is apically acute; plate VIII lacking apical lobes. (Except in series from Bornean *Rattus rattus* (?), RT B-20508, and one of two females from Bornean *R. r. argenticenter*, RT B-20538. These specimens had a dorsoapical lobe on plate VIII which was up to one-third the length of the plate bearing it.) *Genitalia*. Not diagnostic.

MALE (fig. 19): *Head*. As in female except third antennal segment dorsally with slightly enlarged posteriorly directed seta. *Thorax*. As in female. *Abdomen*. Dorsally with one large plate on segments 4-7, ventrally with two narrow plates per segment. Tergal plates of segments 4-6 and second tergal plate of segment 3 with 15-21 long posteromarginal setae; no setae off plates. None of abdominal setae sword-shaped. Paratergal plates as in female. *Acceagus* (figs. 20, 21). With parameres convex laterally, usually strongly so, but differing as shown in figures.

LENGTH.—Female holotype: 1.35 mm.; paratypes: 1.3-1.45 mm. Male allotype: 1.1 mm.; paratypes: 1.15-1.2 mm.

Hoplopleura sicata, new species

(Figs. 4, 13, 16, 22-24)

TYPE DATA.—Female holotype, male allotype,

two male and seven female paratypes from *Rattus cremoricenter*, North Borneo: Mt. Kinabalu, Tenompok, 25 August 1953, RT B-20700, B. Walton collector. A series of paratypes, all from *Rattus cremoricenter*, North Borneo, as follows: One female, Ranau, 1 Aug. 1953, RT B-19172; one female, Ranau, 2 Aug. 1953, RT B-19179; two females, Trus Madi, Pampang, Ulu Kaingaran, 21 July 1953, RT B-19617; one female, Mt. Kinabalu, Bundu Tuhau, 14 June 1952, RT B-10480, R. 18999; two females, Ranau, 14 July 1953, RT B-19034; one male, three females, Ranau, 14 July 1953, RT B-19039; one male, one female, Ranau, 17 July 1953, RT B-20544.

DIAGNOSIS.—*H. sicata* is closely related to *H. pacifica* and *H. dissicula*. It is immediately separated from *H. pacifica* by having a narrow dorsoapical lobe on paratergal plate VII which, in the female, is about as long as the plate (fig. 13); and from *H. dissicula*, by having the abdominal setae sword shaped (compare figs. 22 and 18) and the postantennal angles of the head not extremely marked and projecting anteriorly (compare figs. 16 and 17).

DESCRIPTION.—FEMALE (fig. 22): *Head* (fig. 16). With its anterodorsal head armature (transverse rodlike thickening anterior to antennae) not heavy, its posterior margin somewhat convex. Sensoria of antennal segments 4-5 large and contiguous; dorsal head setation as in figure; postantennal angles rounded; lateral postantennal head margins straight, convergent posteriorly. *Thorax*. Sternal plate (fig. 4) longer than broad, rather narrowly rounded anteriorly, broadly expanded medially, then abruptly narrowed, with narrowly rounded posterior apex (not always as narrowly rounded anteriorly as in figure). *Abdomen*. Typical segments with three narrow but not much reduced plates dorsally and ventrally, their posteromarginal setae sword shaped; with lateral setae off plates both dorsally and ventrally; sternal plates of segments 2 and 3 articulating with respective paratergal plates, first sternal plate of segment 3 with two enlarged setae on either side. Paratergal plates (fig. 13) with plate II having both apical angles sharply pointed, plates III-VI with two truncate apical lobes, which may be slightly excised posteriorly, plate VII with narrow scaly dorsal lobe, which is narrowly rounded apically and almost same width throughout, plate VIII lacking apical lobes. Apical setae of plate III both extending beyond apical lobes, dorsal seta of plates IV-VI short, ventral one usually markedly longer than apical lobes. *Genitalia*. With the two dorsoapical spinelike processes of abdomen blunt in holotype, usually blunt in paratypes.

MALE (fig. 23): *Head*. As in female, third antennal segment lacking an obviously enlarged seta dorsally. *Thorax*. As in female. *Abdomen*. With one large tergal plate on each of segments 4-7; two narrow sternal plates on segments 4-6; posteromarginal setae sword shaped, particularly elongate dorsally; tergal plates of segments 4-7 with 7-9 posteromarginal setae. Paratergal plates as in

female. Usually with one lateral seta off tergal plates on segment 6 on each side, occasionally lacking these setae; ventrally one or more of segments 4-7 with one lateral seta off plates. *Aedeagus*. As in figure 24.

LENGTH.—Female holotype: 1.7 mm.; paratypes: 1.35-1.8 mm. Male allotype: 1.1 mm.; paratypes: 1.2-1.25 mm.

Hoplopleura pectinata (Cummings)

Polyplax pectinata Cummings 1913, 35; Ferris 1916, 174, 205; Ferris 1921, 99, figs. 61, 62; Ferris 1951, 142. *Ctenura pectinata*: Ewing 1929, 199 (designated type of *Ctenura* Ewing); Ferris 1921, 282.

The type series of *Hoplopleura pectinata* consists of two male and two female cotypes from *Mus surifer* (*Rattus surifer*), "rat no. 7," Biserat, Jalor, Malaya Peninsula. (I have not been able to trace this locality.) Ferris recorded this species from *Rattus surifer* (U.S.N.M. mammal No. 86750), Trong (Trang?), Lower Siam (Thailand).

The type host is a member of the *rajah* group of *Rattus*.

H. pectinata is a common parasite of *Rattus whiteheadi* (57♂♂♀♀ in 20 collections from Selangor and Trengganu, Malaya, and 47♂♂♀♀ in 27 collections from Ranau and Mt. Kinabalu, North Borneo). It occurred frequently on *Rattus alticola* (6♂♂♀♀ in 1 collection from Pahang, Malaya, and 22♂♂♀♀ in 13 collections from Mt. Kinabalu). It was taken also from *Rattus rajah* and *rajah*-group species (13♂♂♀♀ in 5 collections from Pahang, Trengganu, Kedah, Selangor, and Perak, Malaya, and 5♂♂♀♀ in 3 collections from Mt. Kinabalu and Ranau). Possibly *H. pectinata* occurs normally on *Rattus rapit* (14♂♂♀♀ in 2 collections, plus many alcoholic specimens from one of these, Mt. Kinabalu). It was taken from *Rattus niveiventer* (15♂♂♀♀ in 1 collection, Pahang, Malaya). Specimens of *H. pectinata* were found on *R. cremoricenter* (5♂♂♀♀ in 2 collections from Mt. Kinabalu and Ranau), but it is obviously not a common parasite of this rat. Scattered specimens from other *Rattus* species in the survey material were undoubtedly due to mechanical contamination.

Although *H. pectinata* is found on many individual hosts, seldom are more than two or three lice taken off a particular animal. Notable exceptions were the one *R. niveiventer*, with 15♂♂♀♀ of *H. pectinata* (this was the only louse-infested *niveiventer* collected in the survey), and one of the two louse-infested *R. rapit*, which also had a large number of *H. pectinata*.

Also of interest is the fact that almost three-fourths of the total adult *H. pectinata* collected were females (142 of 200).

According to D. H. Johnson, *R. whiteheadi* and *R. alticola* are related, but the *rajah* group is only remotely related, if at all, to *R. whiteheadi* and *R. alticola*. Possibly the wide host range of *H. pectinata* is partly primary in nature, but also owing to

successful secondary parasitism. With our present information it is impossible to say which may be its primary hosts.

H. pectinata is an oddly modified species but basically a typical member of its genus. It is not closely related to any particular group within *Hoplopleura*. It may be recognized by the very broad post-antennal region of the head; the large, overlapping paratergal plates; paratergal plate VIII having two long apical lobes; and the posterior end of the female with eight stout setae set on prolongations of the exoskeleton.

Hoplopleura erismata Ferris

Hoplopleura erismata Ferris 1921, 113, figs. 72B, E, F; Ferris 1951, 136; Johnson 1959, 580, figs. 20-21, 24, 26.

The holotype female of *H. erismata* was taken from the skin of a *Callosciurus ferrugineus*, Southeast Siam (Thailand). Paratypes were taken from *C. ferrugineus* and *C. caniceps*. Ferris recorded *H. erismata* also from *Tamias* sp., Tenasserim (Lower Burma). (All skins in U.S.N.M.). Johnson (1959) reported this species from *C. julysoni* and *C. caniceps* from various localities in Thailand. The male which Ferris recorded from *Tamias* is *H. erismata*, but the occurrence on *Tamias* may well be due to mechanical contamination of the skin after arrival in the museum.

From Selangor, Malaya, there is a single new record of one male and three females from *Callosciurus nigrovittatus* (B-45257).

Among many other differences, *H. erismata* is separable from *H. pacifica* and allies, *H. pectinata*, and *H. malabarica* Werneck, in having the sensoria of antennal segments 4 and 5 small and widely separated; and further separable from *H. pacifica* and allies and *H. pectinata* in that the paratergal plates lack apical lobes, the apical angles being produced into short points. Its closest relative is *H. thurmanae* Johnson, from Thai *Tamias macclerandi*. The two species differ in that *H. erismata* has the apical setae of paratergal plates IV-VI extending much beyond the apical points of these plates.

Hoplopleura malaysiana Ferris

(Figs. 25-28, 35, 36)

Hoplopleura malaysiana Ferris 1921, 79, figs. 44, 45; Ferris 1951, 138.

The type series (holotype, a female) was taken from *Rattus vociferans lancacensis* (*Rattus sabanus lancacensis*) (U.S.N.M. skin), Lankawi Island, Malay Straits. (Langkawi Island, Malacca Straits, Malaya).

The records given here are the first since the original description. Nine collections containing 4♂♂ 16♀♀, were included in the survey material. Eight collections were from *Rattus sabanus*, the ninth, of 2♀♀, was from *R. mulleri*. All the host animals were taken in various localities in Selangor, except one *R. sabanus* from the type locality of *H. malay-*

siana, Langkawi Island, Kedah, Malaya. For further discussion of the hosts see *Polyplax insulsa* Ferris.

Because of certain differences between the drawings of Ferris (1921) and some of the specimens at hand, figures are included of male and female *H. malaysiana*. The species may be differentiated from other *Hoplopleura* of the area by having the paired lateral setae of the first sternal plate of abdominal segment 3 scarcely larger than other setae on the abdomen (figs. 25, 26). It is further distinct in having the apical lobes of paratergal plates III-VI narrow and more-or-less rounded apically (figs. 35, 36).

The width of the head and conformation of its anterior apex depend on whether the specimen has been flattened during mounting. Ferris' specimens (1921, fig. 44) were flattened, and the anterior head margin is thus truncate rather than rounded. The parameres of the aedeagus (fig. 27) also vary according to flattening, and appear much broader basally than apically in flattened specimens such as the one illustrated by Ferris (1921, fig. 45C). The setation of the paratergal plates varies in the female. The female illustrated (fig. 35) has both apical setae of plates IV-VI extending beyond the apical lobes. Some females may have one seta on one or more of these plates small or minute. The male apparently always has one seta on each of plates IV-V minute, and sometimes one of the setae on plate VI is also very small.

Hoplopleura diaphora, new species

(Figs. 29-34)

TYPE DATA.—Female holotype, male allotype, nine male and seven female paratypes from *Rattus boversii*, Malaya: Selangor, Ulu Langat Forest Reserve, 10 Feb. 1956, R. 44621. A series of paratypes, all collected in Malaya from *R. boversii*, as follows: One male, data as holotype except 28 Sept. 1956, R. 46342. One female as above except 24 Mar. 1953, RT B-30034, Audy et al. collectors. One male, four females, Malaya: Fraser's Hill, January 1956, R-40030. One male as above except 12 Jan. 1956, R-44411. One male, two females, Pahang, the gap to Fraser's Hill, 12 Oct. 1956, RT B-45551. Three males, six females as above except 15 Feb. 1957, RT B-45917. One male, one female, Pahang, Pine Tree Hill, 13 Feb. 1957, RT B-45889. One male, one female as above except 29 Mar. 1957, RT B-46010. Five males, four females as above except RT B-46012. Four males, four females as above except RT B-46013. Two females, Perak, Mt. Brinchang, 27 Sept. 1957, RT B-46791. One male, one female as above except 28 Sept. 1957, RT B-46818. One female, Perak, Maxwell's Hill, 18 Mar. 1958, RT B-47598. One male as above except 19 Mar. 1958, RT B-47624.

DIAGNOSIS.—*H. diaphora* is not closely related to any group within the *Hoplopleura*. It is immediately separable from other *Hoplopleura* species of the

Indo-Malayan region by lacking paired enlarged setae on the first sternal plate of abdominal segment 3, and because this plate is not extended laterally to articulate with the corresponding paratergal plates (fig. 29). It is further separable by the paucity of abdominal plates; the male having but one plate per segment ventrally below segment 3, and the female lacking plates except the usual genital plates plus one plate on each of segments 2-3 ventrally, and 2-4 dorsally.

DESCRIPTION.—FEMALE (fig. 29): *Head*. Strongly sclerotized, about one and one-half times as long as broad; rounded anteriorly, extending well beyond antennal bases; head setation normal for genus. Sensoria of antennal segments 4-5 contiguous, not particularly large, occurring only on ventral surface. Postantennal angles present; occipital angles suppressed; posterolateral head margins slightly convergent posteriorly. *Thorax*. Broader than head, about as long as broad. Sternal plate as broad as long, roughly triangular. *Legs*. Third pair unlike that of most *Hoplopleura* in being of normal shape, not compressed. *Abdomen*. Cuticle leathery in appearance. With small sclerite typical of *Hoplopleura* present between posterior coxae. Dorsally with three irregular rows of heavy straight setae on each of segments 4-7. One thin reduced tergal plate present on segment 2; plates associated with each of first two rows of setae on segment 3; with first row on segment 4; and rarely with a very small sclerotization on first row of segment 5. Ventrally, typical segments with three rows of setae each. Sternal plates present only on segments 2-3 and genital segments. Sternal plate of segment 2 with postero-marginal setae all of same size, plate thin, articulating with corresponding paratergal plates; plate of segment 3 reduced, not reaching to paratergal plates nor bearing paired enlarged setae. Paratergal plates (fig. 33) reduced; plate II with dorsal detached portion, angles of larger ventral part produced into short points and with two apical setae, one of them very long; plate III triangulate, apices produced into points, the two apical setae longer than plate; plates IV-VI similar in appearance, apices produced into rounded points, each bearing but one long apical seta; plates VII-VIII much reduced, at times almost missing, each with usual two long apical setae. *Genitalia* (fig. 34). With plate reduced, lateral setigerous lobes of eighth segment incorporated into genital plate, each of these plates with three to five small slender setae. Spermatheca and uterus evident in most specimens; uterus bilobed apically.

MALE (fig. 30): *Head* as in female except third antennal segment dorsally with two slightly enlarged, posteriorly-directed setae. *Thorax* and *legs*. As in female. *Abdomen*. One thin tergal plate associated with row of setae on each of segments 3-7; segment 2 with two such plates. Ventrally with one narrow sternal plate on segment 2 which articulates with paratergal plates; two plates on segment 3, anterior not extending to paratergal plates nor bearing paired enlarged setae; segments 4-6 with two rows

of setae; a small slender plate associated with anterior row of each segment. Paratergal plates as in female, *Aedeagus* (fig. 31). Typical of *Hoplopleura*, not diagnostic.

LENGTH.—Female holotype: 1.8 mm.; paratypes: 1.6-1.95 mm. Male allotype: 1.35 mm.; paratypes: 1.2-1.4 mm.

Although *H. diaphora* is highly modified, its basic relationships are with the genus *Hoplopleura*. Typical of *Hoplopleura* are the head setation; the two slightly enlarged dorsal setae on the third antennal segment of the male; the presence of a small triangular sclerite between the coxae of the third pair of legs; the divided condition of paratergal plate II; the pair of posteromarginal setae found on either side on the first two tergal plates of the abdomen, with the central part of the respective plate margins lacking setae; the form of the aedeagus; and the number of rows of setae per segment on the abdomen in both sexes. *H. diaphora* departs from the typical condition in having lost most of its abdominal plates; in having only one apical seta on each of paratergal plates IV-VI; in having the third pair of legs normal, not compressed; in lacking paired enlarged setae on the sternal plate of segment 3, and not having this plate extending to paratergal plates III; and in reduction of paratergal plates VII-VIII. As well, the cuticle is leathery in appearance and the sclerotization of the head, legs, and thorax is much heavier than usual in *Hoplopleura*, suggesting the normal condition of the family Linognathidae.

Many of the departures from the norm exhibited by *H. diaphora* may be found to varying degree in other *Hoplopleura* species. For example, *H. disgrega* Ferris and *H. emarginata* Ferris do not have the first sternal plate of segment 3 articulating with the paratergal plates, *H. oxymycteri* Ferris has no apical setae on paratergal plates IV-VI, and *H. craticula* (Osborn) lacks abdominal plates in the female according to a pattern approaching that of *H. diaphora*. The form and setation of the sternal abdominal plates of segments 2-3 is similar in *H. emarginata*, *H. disgrega*, *H. malaysiana*, and *H. diaphora*, except that in *H. malaysiana* the plate of segment 3 extends to the paratergal plates and there are paired slightly enlarged setae present. Although the relationship may be remote, *H. diaphora* finds its closest relative among the Indo-malayan *Hoplopleura* in *H. malaysiana*. The hosts of *H. malaysiana* and *H. diaphora* (*Rattus sabanus* and *R. bowersi* respectively) are isolated forms of *Rattus*. According to D. H. Johnson, *Rattus bowersi* is superficially closer to *R. sabanus* than to the other *Rattus* species of the Indo-Malayan region.

Genus *Ancistroplax* Waterston

Ancistroplax Waterston 1929, 161; Ferris 1932, 308; Ferris 1951, 119.

TYPE OF GENUS.—*Ancistroplax crocidurae* Waterston, by monotypy.

DESCRIPTION.—Antennae four-segmented, sensoria of usual fourth and fifth segments coalesced into one. Anterior legs small, with slender claw, middle legs similar but larger, third legs large, heavily sclerotized and compressed, tarsal claw flattened. Thoracic sternal plate present. Spiracles on segments 3-8. Paratergal plates present on segments 2-8, those of segment 2 divided into small dorsal part and larger ventral seta-bearing part (the dorsal part may be the paratergal plate of segment 1); paratergal plates of segments 3-7 appear to be divided longitudinally into two parts by a median line of weak sclerotization. Sternal plate of abdominal segment 2 divided into two parts, other sternal and tergal plates well developed; female with three such plates dorsally and ventrally on segments 3-6; male with one plate on each segment, the plates on segments 4-6 with two rows of setae, suggesting fusion of two plates on each of these segments; tergal plate of segment 6 with lateroposterior angles produced into free process which is bent apically toward midline of body.

This genus now contains two species, including the one described in this paper. Both species infest ground shrews of the subfamily Crocidurinae. This genus is apparently most closely related to *Schizophthirus* from glirid rodents and *Haematopinoides* from moles.

Ancistroplax nasuta, new species

(Figs. 37-40)

TYPE DATA.—Female holotype and one female paratype from "ground shrew," North Borneo: Trus Madi, Pampang, Ulu Kainingan, 21 July 1953, Audy et al. collectors, RT B-19638. One female paratype from "shrew," Malaya: Pahang, Mt. Brinchang, 5,300 feet, 10 January 1958, RT B-47287. D. H. Johnson informs me that the host of the holotype is probably either *Suncus* sp. or *Crocidura* sp. Unfortunately, further host data are not obtainable at this time, but the discovery of a second species of this highly modified genus is of sufficient interest to warrant the description of the new form.

DIAGNOSIS.—Separable from the only other described member of the genus (*A. crocidurae* Waterston, from *Crocidura horsfieldi*, Ceylon) in that paratergal plates III-VII all have very short apical setae rather than with plates III and VII with setae at least as long as the plate bearing them. Female *A. nasuta* does not have the posterior margins of the abdominal plates concave between the setal bases, and the setae are much longer and thinner than in *A. crocidurae*.

DESCRIPTION.—FEMALE (fig. 37): Head (fig. 38, dorsum). Anterior to antennae narrowed into rounded projection which is as long as broad. Antennae four-segmented, with apparent third and fourth segments almost entirely coalesced (actual segments involved are 3-5); only one sensorium. Thorax. Broader than long, expanded dorsally at level of mesothoracic spiracles. Sternal plate (fig. 39) elongate, narrowly rounded posteriorly, anterior

apex more heavily sclerotized than other parts. Abdomen. Three dorsal plates each on segments 4-7 and three ventral plates each on segments 4-6. Posteroapical setae of these plates elongate sword shaped, each with its inclination from the margin of the plate bearing it fixed according to a pattern as shown in figure 37. Paratergal plates III-VII similar in shape (fig. 40), each with two large truncate apical lobes; median part surrounding spiracle semi-membranous; apical setae minute, set on semi-membranous median part; this part of margin never strongly convex; plate VIII lacking lobes, with long apical setae. Genitalia. With the pair of posteroapical processes at tip of abdomen long and pale, not heavily sclerotized nor spine-like in appearance. Posterior lip of vulva densely covered with small spicules; posterior margin of vulva fimbriate.

MALE: Unknown.

LENGTH.—Holotype and paratypes: 1.6 mm.

Genus *Neohaematopinus* Mjöberg

Neohaematopinus Mjöberg 1910, 160; Ferris 1923, 237 (sinks *Acanthopinus*, *Linognathoides* and *Luteus*); Ferris 1932, 283 (sinks *Ahaematopinus*); Ferris 1951, 185 (sinks *Petauristophthirus*); Johnson 1960, 43. *Acanthopinus* Mjöberg 1910, 160 (type: *Acanthopinus sciurinus* Mjöberg, n. n. for *Haematopinus antennatus* Osborn, procc.). *Linognathoides* Cummings 1914, 159 (type: *Linognathoides citelli* Cummings). *Luteus* Fahrenholz 1916, 31 (type: *Haematopinus* (*Polyplox*) *pectinifer* Neumann). *Ahaematopinus* Ewing 1929, 197 (type: *Neohaematopinus inornatus* Kellogg and Ferris). *Petauristophthirus* Eichler 1949, 12 (type: *Neohaematopinus petauristae* Ferris).

TYPE OF GENUS.—*Haematopinus sciuropteri* Osborn, by original designation.

KEY TO THE INDO-MALAYAN SPECIES OF *NEOHAEMATOPINUS*

1. Postantennal area of head very broad; postantennal head margins straight, parallel; postantennal angles distinct (fig. 44) 2
 - Head not especially broadened behind antennae; lateral margins somewhat convex; lacking distinct postantennal angles (fig. 47) 3
- 2(1). Basal antennal segment with heavy short spine dorsally near posterodistal angle (fig. 41A); female with short spine-like setae interspersed among normal setae on second tergal plate of abdominal segment 2 (fig. 44); male unknown **pansus**
- Basal antennal segment lacking heavy dorsal spine although an enlarged seta is present well in from apex (fig. 41B); no shortened and spine-like setae present on female abdomen **kinabalensis**
- 3(1). Plates associated with all ventral abdominal rows of setae 4
 - Such plates completely absent or only one plate present per segment, the posterior row lacking a plate 5

- 4(3). Abdominal plates well developed (fig. 47); thoracic sternal plate distinctly longer than broad, its posterior angles not produced into points (fig. 66) **robustus**
- Abdominal plates narrow, thoracic sternal plate about as broad as long, posterior angles produced into short points (fig. 65) **pallidus**
- 5(3). Paratergal plates much reduced; plates III-VI each having at least one of the two apical setae much shorter than the plate (fig. 61) **batuanae**
- Paratergal plates not reduced, apical setae on plates III-VI all as long as or longer than the plates bearing them 6
- 6(5). Abdomen lacking plates ventrally except for genital plates **elbeli**
- Abdomen with a ventral plate on each of abdominal segments 3-6 7
- 7(6). Posterodistal angles of basal antennal segment usually prolonged and always bearing an enlarged spine-like seta (fig. 43A-D) **callosiuri**
- Posterodistal angle of basal antennal segment never prolonged, spine not present on this angle but an enlarged seta present dorsally, proximal to the posterodistal angle **cognatus**

DESCRIPTION.—Antennae five-segmented, sexually dimorphic, male always with one or two stout setae dorsally on third segment (the African species have one stout seta, all others have two), sometimes third segment markedly prolonged apically. Sensoria of antennal segments 4-5 small and separate. Usually with distinct postantennal angles. Usually but not always with tarsal claw of first leg apically bifid (not true of the African species except *N. fovei* (Bedford), and of certain non-African species). First pair of legs small, second and third pairs subequal, at times third pair larger than second, but never flattened or expanded. All but one species with thoracic sternal plate present. Paratergal plates always present on segments 2-8, sometimes an anterior plate present (probably that of segment 1); spiracles on segments 3-8. There is a tendency to have three or more apical setae on paratergal plates, especially those of segments 7-8. Abdomen of male always with some development of tergal plates; female may lack these plates except on segment 2 or 2-3. Male almost always with second row of dorsal setae on segment 2 with at least a slightly developed tergal plate which, if not strongly reduced, is posteriorly emarginate and with the lateral setae at each end of the row different in size from the others and somewhat radially arranged. Male usually with one tergal row of setae on each segment (not segment 2, which has two rows) except the *petauristae*-group of species, which have two rows. All males have two rows of sternal setae on segments 2-6. Females usually with two rows of tergal setae on segments 2-7 and two rows of sternal setae on segments 3-6; the African species have three rows on these segments.

About 30 valid species have been described. The genus is worldwide in distribution and the species

occur almost exclusively on sciurids. Three of the eight Indo-Malayan species are described in this paper.

***Neohaematopinus callosciuri* Johnson**
(Fig. 43 A-E)

Neohaematopinus callosciuri Johnson 1959, 581, figs. 27, 28, 34b, 35c, 42, 43.

The male holotype and female allotype were taken from *Callosciurus fulaysoni*, Thailand; Loei, Dan Sai, Kok Sathon, Phu Lom Lo Mt., 26 Feb. 1955, RE-4800, R. E. Elbel collector. A long series of paratypes was taken from *C. fulaysoni*, *C. caniceps*, and *C. erythracus* from many Thai localities and from Formosan *C. erythracus*.

In Malaya *N. callosciuri* was collected from *Callosciurus caniceps* (7♂♂♀♀ in 5 collections from Selangor and Perak); *C. nigrovittatus* (1♀ from Selangor); *C. notatus* (16♂♂♀♀ in 5 collections from Selangor); and *C. tenuis* (3♀♀ in 3 collections from Selangor and Perak). There was one collection from *Lariscus insignis* (1♀, 1♀ nymph, and 1♂ nymph from Selangor). The normal occurrence of *N. callosciuri* on *Lariscus* remains to be verified. Bornean collections of a species which is probably *N. callosciuri* were as follows: from *C. nigrovittatus* (1♂ from Mt. Kinabalu); *C. notatus* (22♂♂♀♀ in 9 collections from Beaufort, Ranau, and Mt. Kinabalu); and *C. prevosti* (7♂♂♀♀ in 3 collections from Ranau and Mt. Kinabalu). Specimens which may belong to this species also occurred on Bornean pigmy squirrels, with the following records, all from Mt. Kinabalu: from *Glyphotes simus* (6♂♂♀♀ in 1 collection); *Glyphotes* sp. (5♂♂♀♀ in 2 collections); and "pigmy squirrel" (*Glyphotes?*) (11♂♂♀♀ in 1 collection).

N. callosciuri may be distinguished from other Indo-Malayan *Neohaematopinus*, except *N. cognatus* Johnson, by a combination of the following: head not strongly expanded posterior to antennae; basal antennal segment with ventral, flattened tubercle; male with one tergal plate on each of segments 3-6 and with only one sternal plate on segments 4-6, although two rows of setae are present on each of these segments; female with only one plate but two rows of setae on abdominal segments 3-7 dorsally and 3-6 ventrally. It differs from the closely allied *N. cognatus* in having an enlarged spinelike seta on the posterodistal angle of the basal antennal segment. This angle is usually prolonged. Like most other species of *Neohaematopinus*, the tarsal claw of the first leg is apically bifurcate.

The variation demonstrated in size of the posterodistal spine on the basal antennal segment of *N. callosciuri* is of considerable interest. Specimens from Formosan, Thai, and Malayan *Callosciurus* species always have the spine well developed and the posterodistal angle bearing it somewhat prolonged (fig. 43, A and C). Specimens from Bornean *Callosciurus* species always have this spine much smaller and the posterodistal prolongation slight or absent

(fig. 43 B and D). The size difference is not dependent upon the species of *Callosciurus* involved, and argues against the existence of a different louse species on Bornean *Callosciurus*. The variation appears to be geographical in type. Figure 43, A-D shows the difference in specimens from Malayan *C. notatus* and *C. nigrovittatus* as opposed to Bornean squirrels of the same two species. In each case, the spine of Malayan specimens is large, that of Bornean specimens small.

A different type of variation occurs between specimens from Bornean *Callosciurus* and those from Bornean *Glyphotes*. In this case the spine on the basal antennal segment of *Glyphotes* specimens (fig. 43E) is larger than that of Bornean *Callosciurus* specimens, but distinctly smaller than the spine in Malayan specimens. Further, specimens from *Glyphotes* are smaller than ordinary *N. callosciuri* (♀ 1.6-1.8 mm. from *Glyphotes*; ♀ 2.0-2.1 mm. from Malayan and Bornean *Callosciurus*). An intensive study of the species of *Neohaematopinus* from *Callosciurus* and *Glyphotes* from many different areas might shed light on the phenomenon of variation in the Anoplura. To date the study of infraspecific variation within the Anoplura, based on host or geographical differences, has been confined to study of variation in *Pediculus humanus* L., and equivocal conclusions have been drawn by the various investigators.

***Neohaematopinus cognatus* Johnson**

Neohaematopinus cognatus Johnson 1959, 583, figs. 35a, 35d, 39, 44.

N. cognatus was described from the male holotype and female allotype from *Menetes berdmorei*, Thailand; Loei, Dan Sai, Kok Sathon, Phu Lom Lo Mt., 8,000 ft., 22 Feb. 1955, RE-4765, R. E. Elbel collector. A long series of paratypes, all from *Menetes berdmorei*, was collected in Chaiyaphum, Kanchanaburi, Phet Buri, Nakhon Sawan, and Lop Buri provinces, Thailand.

During the present survey, specimens indistinguishable from *N. cognatus* were collected in North Borneo (none in Malaya). The majority came from *Dremomys everetti* and *Dremomys* sp. from Mt. Kinabalu and Trus Madi (27♂♂♀♀ in 11 collections from *D. everetti* and 15♂♂♀♀ in 7 collections from *Dremomys* sp.). Specimens which are probably this species were taken from *Callosciurus jentinki* (1♂1♀ in 2 collections, Mt. Kinabalu and Trus Madi) and *Nannosciurus whiteheadi* (2♂♂ in 1 collection from Mt. Kinabalu).

N. cognatus may be distinguished from other Indo-Malayan *Neohaematopinus* species except *N. callosciuri* by the characters given under *N. callosciuri*. It differs from *N. callosciuri* in lacking an enlarged spinelike seta at the posterodistal angle of the basal antennal segment although a slightly enlarged, but not spinelike, seta is present dorsally, proximal to the posterodistal angle; and because this angle is never prolonged.

The Bornean specimens from *Dremomys* pose a question. According to D. H. Johnson the type host of *N. cognatus*, *Menetes berdmorei*, is found only in Thailand or just without its borders, and *Menetes* is probably a monotypic genus. Species of *Dremomys*, on the other hand, are found in Thailand, Malaya, and Borneo. Malayan and Thai *Dremomys rufigenis* are infested by *N. elbeli* Johnson, a species not especially closely related to *cognatus*. *N. elbeli* or a related species does not occur on Bornean *Dremomys everetti*, as one might expect, but rather, we find *N. cognatus* or a species very similar to it. D. H. Johnson has told me that *Dremomys everetti* might be considered the closest ecological "replacement" for *Menetes* in Borneo. Thus, *N. cognatus* may be a secondarily acquired parasite of *Dremomys everetti*.

The specimens from *Nannosciurus whiteheadi* and *Callosciurus jentinki* have a tendency for the slightly enlarged dorsal seta of the basal antennal segment to be close to or actually upon the posterodistal angle. Available specimens are too few to decide whether this difference might be present in a significant number of specimens from *Nannosciurus* and *C. jentinki*.

***Neohaematopinus pansus*, new species**

(Figs. 41A, 42, 44-46)

TYPE DATA.—Female holotype from *Petaurillus hoscii*, North Borneo; Ranau, 13 July 1953, RT B-19016, R. Traub collector.

DIAGNOSIS.—This species is related to *N. capitaneus* Johnson from Thai *Hylopetes phayrei*, and *N. kinabalensis* Johnson from Bornean *Hylopetes sagitta harrisoni*. It is easily distinguished from both these species by having a very heavy short spine dorsally near the posterodistal angle of the basal antennal segment and, at least in the female, in having a short dorsal posteriorly directed spine on each of antennal segments 2 and 3 (compare figs. 41A and B). It differs further in the female in having the second tergal plate of abdominal segment 2 with short spinelike setae interspersed amongst the normal long thin posteromarginal setae.

DESCRIPTION.—FEMALE (fig. 44): Head (fig. 41A). Anteriorly broad and flattened; postantennal angles marked; postantennal area very broad, the lateral head margins extending about as far as apex of basal antennal segment. Basal antennal segment about as long as broad, with heavy spinelike seta dorsally at posterodistal angle; segments 2 and 3 each with dorsal posteriorly directed spinelike seta. Thorax. With sternal plate (fig. 46) longer than broad, posterodorsal margin concave, posterior angles rounded. Prothoracic pleural apophysis extremely long. Legs. Tarsal claw of first leg apparently apically bifurcate. Abdomen. Tergal and sternal plates well developed, two plates on each of segments 2-7 dorsally and ventrally; plates with long thin posteromarginal setae; second tergal plate of segment 2 with short spinelike setae interspersed amongst

long thin posteromarginal setae. One lateral seta off plates on each side of each typical segment both ventrally and dorsally. Paratergal plates (fig. 45) with II-VI having sharply pointed apical angles, pairs of apical setae about as long as plate bearing them, each seta flanked basally by sharp projections of posterior plate margin, and median third of plate (measured in a longitudinal direction) less heavily sclerotized than outer parts. Genitalia (fig. 42). With genital plate triangulate, about as long as broad, truncate posteriorly; lip of vulva delicately fimbriate; lateral stitigerous lobes of eighth segment elongate, set obliquely, bearing one medium-sized and two small thin setae.

MALE: Unknown.

LENGTH.—1.6 mm.

***Neohaematopinus kinabalensis* Johnson**

Neohaematopinus kinabalensis Johnson 1959, 589, figs. 48, 51, 55, 61-63.

This species was described from the male holotype and female allotype from *Hylopetes sagitta harrisoni*, North Borneo; Mt. Kinabalu, Tenompok, 5,000 ft., 31 June 1952, RT B-9089.

N. kinabalensis is distinguished from all oriental species of *Neohaematopinus* except those occurring on flying squirrels (*N. capitaneus* from Thailand and *N. pansus*) by having both the postantennal and occipital angles of the head strongly marked, and with the postantennal part of the head very broad. It may be distinguished from *N. pansus* in that antennal segments 2 and 3 do not bear a stout, short seta posterodorsally, and the stout, short, dorsal seta on the basal antennal segment is set closer to the base of the segment than to the apex. The two species differ also in the female genitalia, see fig. 43 (*N. pansus*), and Johnson (1959, fig. 48). It is easily separated from *N. capitaneus* in that the basal antennal segment is as broad as long, rather than considerably longer than broad. The two species also differ in the male and female genitalia, see Johnson (1959, figs. 47, 48, 55, and 56).

***Neohaematopinus elbeli* Johnson**

Neohaematopinus elbeli Johnson 1959, 592, figs. 64-68.

The male holotype, female allotype, and two paratypes, one male and one female, were taken from *Dremomys rufigenis*, Thailand; Loei, Dan Sai, Kok Sathon, Phak Khi Nak Mt., 19 March 1955, RE-4977, R. E. Elbel collector. Four male paratypes were taken from nearby localities, all from *Dremomys rufigenis*.

In the present survey there were 19♂♂ 23♀♀ in four collections, all from *Dremomys rufigenis*, Malaya; Pahang, Mt. Banchang.

The above-mentioned specimens are similar in all respects to the type series. It should be noted that in common with most species of *Neohaematopinus*, the tarsal claw of the first leg is bifurcate apically. In *N. elbeli* the bifurcation is shallow and may be

easily missed unless the claw is in a good position. Also, like all the known species of *Neohaematopinus* from Southeast Asian squirrels, except those from *Hypopetes* and *Petaurillus*, the basal antennal segment has a small ventral tuberosity which is flaplike along its posterior edge.

It is distinguished from the other species of *Neohaematopinus* from Indo-Malayan squirrels by a combination of having the postantennal area of the head normal, not especially broad; female lacking plates on abdominal segments 3 through 7 dorsally, and 2 through 6 ventrally; and the male lacking such plates ventrally on all but the genital segments.

Neohaematopinus robustus, new species

(Figs. 47, 48, 50, 56, 57, 66)

TYPE DATA.—Male holotype, female allotype, one male, and two female paratypes from *Petaurista elegans punctatus*, Malaya: Pahang, Mt. Brinchang, elev. 5,500 ft., 26 Sept. 1957, RTB-46779. One male and two female paratypes with data as above except: elev. 5,200 ft., 11 Jan. 1958, RT B-47345.

DIAGNOSIS.—*N. robustus* is a member of the group of *Neohaematopinus* species which infest Asian giant flying squirrels of the genus *Petaurista*. It may be separated from *N. petauristae* Ferris by a combination of the following characters: the abdominal tergal and sternal plates are not strongly reduced, the body form is slender, the thoracic sternal plate is obviously longer than broad (compare figs. 64 and 66), and in the male the lateral margins of the parameres are markedly convex and the pseudopenis extends well beyond the tips of the parameres (fig. 56). As well, there are fewer lateral setae off the tergal and sternal plates of the abdomen, especially in male *N. robustus* which does not have more than one seta, and often none, on each side opposite each sternal or tergal plate. *N. robustus* is distinct from *N. batuanac* Ferris and *N. pallidus*, n.sp., described in this paper, in having the tergal and sternal plates of the abdomen normal and a differently shaped thoracic sternal plate (compare figs. 62, 63 and 66). It further differs from *batuanac* in having large paratergal plates bearing apical setae, both of which are as long as the plate bearing them (compare figs. 57 and 61).

DESCRIPTION.—MALE (fig. 48): *Head*. Longer than broad, anteriorly flattened, lateral postantennal margins parallel, postantennal angles obsolete. Basal antennal segment with large, strong seta at postero-apical angle; third segment with two dorsoapical short, spine-like setae. *Thorax*. About as long as head, sternal plate (fig. 66, ♀) longer than broad, lateral and anterior margins angled, posterior margin not markedly concave. *Legs*. Tarsal claws of first pair apically bifurcate. *Abdomen*. Dorsally segments 2-6 with two narrow but not strongly reduced tergal plates. Posterior margin of second tergal plate of segment 2 slightly emarginate, with radial setae weakly developed but evident (fig. 50). Never with more than one lateral seta opposite each tergal plate.

Posteromarginal setae on both tergal and sternal plates long and thin. Ventrally with usual two sternal plates on each of segments 2-6, never more than one lateral seta off each plate. Paratergal plates (fig. 57, ♀) well developed, plates III-VI with apical angles produced into short points and with apical setae as long as plate bearing them. Plates VII-VIII each with three apical setae, the dorsal one captured from the dorsal integument. *Aedeagus* (fig. 56). Basal plate with narrow anterior apex, expanded basally; parameres with lateral margins markedly convex, about equal in length to pseudopenis.

FEMALE (fig. 47): *Head, Thorax, and Legs*. As in male except third antennal segment unmodified. *Abdomen*. Tergal and sternal plates narrow but not strongly reduced, one to three setae present laterally off each side of most plates both dorsally and ventrally. Paratergal plates (fig. 57) as in male. *Genitalia* not distinctive.

LENGTH.—Male holotype: 1.85 mm.; paratypes: 1.8-1.9 mm. Female allotype: 2.45 mm.; paratypes: 2.1-2.4 mm.

The *petauristae*-group of *Neohaematopinus* species from giant flying squirrels (genus *Petaurista*) are typical of the genus in shape of the head, the legs, and the male genitalia. However, unlike all other species of *Neohaematopinus*, the male has two tergal plates on abdominal segments 3-6, rather than only one plate on each of these segments.

According to D. H. Johnson, *P. petaurista* and *P. taylori* are closely related species, which probably accounts for the fact that one of the new species described herein (*N. pallidus*) occurs on both species of flying squirrels. The host spectra of the other three species of the *petauristae*-group are unknown.

Neohaematopinus pallidus, new species

(Figs. 49, 52, 53, 55, 59, 60, 62, 65)

Neohaematopinus petauristae, Johnson 1959, 594 (err. det.).

TYPE DATA.—Male holotype, female allotype, one male and one female paratypes from *Petaurista taylori*, Thailand: Prachuap Khiri Khan, Ban Khluu Klang, 14 Dec. 1958, RE-2032. (These specimens were reported as *N. petauristae* Ferris by Johnson 1959). Two male, three female paratypes from *Petaurista petaurista melanotus*, Malaya: Selangor, Pahang Road, 17th mile, 21 Aug. 1956, RT B-45316.

DIAGNOSIS.—Near *N. petauristae* and allies. *N. pallidus* is immediately separable from *N. robustus* in having the tergal and sternal plates of the abdomen much reduced and at times incomplete, and from *N. robustus* and *N. petauristae* in that the thoracic sternal plate is concave posteriorly (compare figs. 64, 65 and 66) and the paratergal plates are smaller and poorly sclerotized (compare figs. 57, 58 and 59). It differs further from *N. petauristae* in that both males and females never have more than eight marginal setae on any tergal or sternal

plate on abdominal segments 3-6. It may be distinguished from *N. batuanac* by its much larger size (*N. batuanac* ♂, 1.3 mm. and ♀, 1.8 mm.; *pallidus* ♂, 1.7 mm. and ♀ 2.15-2.4 mm.), by having reduced but definite sternal and tergal abdominal plates, in having both apical setae of paratergal plates III-VI as long as or longer than the plate bearing them (compare figs. 60 and 61), and in the male by the second tergal plate of segment 2 being much narrower (compare figs. 49 and 51), and the parameres of the aedeagus not at all convex laterally (compare figs. 54 and 55). (Note that the pseudopenis has been broken off in the allotype male of *N. batuanac*.)

DESCRIPTION.—MALE (fig. 53): *Head*. Broadly convex anteriorly, postantennal angles obsolete, lateral postantennal margins straight and parallel. Strong long seta at posteroapical angle of basal antennal segment, third segment with two short spine-like setae dorsoapically. *Thorax*. Broad, about as long as head. Sternal plate (fig. 62) concave posteriorly, lateral margins convex, anterior margin angled. *Legs*. Tarsal claws of first legs apically bifurcate. *Abdomen*. Stout. All setae long and slender. Radial setae of second tergal plate of segment 2 (fig. 49) evident but not marked. Terga 3-6 with two plates and rows of setae; plates narrow, at times incomplete; never with more than eight posteromarginal setae on a plate. Segments 3-6 with one or two setae on each side off tergal plates. Setation of venter similar to that of dorsum, plates normal, two per segment on segments 2-6. Paratergal plates (fig. 60) with apical angles only slightly pointed, plates small, weakly sclerotized, at least one of two apical setae longer than plate bearing it; plates VII-VIII each with three apical setae, the dorsal one captured from the dorsal integument. *Aedeagus* (fig. 55). With basal plate narrowed anteriorly; parameres long, with straight lateral margins, pseudopenis shorter than parameres.

FEMALE (fig. 52): *Head, Thorax, and Legs*. As in male except third antennal segment unmodified. *Abdomen*. Similar to male except for usual sexual differences. No more than eight posteromarginal setae on tergal and sternal plates of segments 3-8. *Genitalia*. Not distinctive.

LENGTH.—Male holotype and paratypes: 1.7 mm.; female allotype: 2.4 mm.; paratypes: 2.15-2.3 mm.

Neohaematopinus batuanac Ferris

(Figs. 51, 54, 61, 63)

Neohaematopinus batuanac Ferris 1923, 261, fig. 167B; Ferris 1951, 190.

The female holotype and male allotype were taken from the skin of a *Petaurista batuanac* (*P. petaurista batuanac*), Batu Islands, Malaysia.

P. batuanac may be distinguished from other Indo-Malayan *Neohaematopinus* species, except the *petauristae*-group, in having the abdominal plates much reduced and mainly absent and the male with two tergal rows on abdominal segments 3-6 rather than

one row on each of these segments. It can be separated from *N. robustus* and *N. pallidus* by the following: It has very small paratergal plates (fig. 61), with plates III-VI each having one apical seta shorter than the plate bearing it. It is further distinct in lacking abdominal plates (except for the usual genital plates) on all but terga 1, 2, and 9 of the female and terga 1 and 2 of the male.

Sathrax, new genus

DESCRIPTION.—Antennae five-segmented, sexually dimorphic, third segment of male antenna dorsally with two stout short posteriorly-directed setae. Post-antennal and occipital angles present. Head and antennae ventrally with raised, apically free, pointed tubercles. Thoracic sternal plate present. Prothoracic pleural ridge and apophysis present. First pair of legs small, second and third pairs larger, subequal. Paratergal plates present on abdominal segments 2-8; spiracles present on segments 3-8. Female dorsally with two rows of setae on abdominal segments 2-7, plates associated with the two rows on segment 2, remaining segments lacking plates; ventrally with two rows on segments 2-6, plates associated with both rows on segment 2 and first row of segments 3-6. Male dorsally with two rows of setae on segments 2-6, plates associated with two rows of segment 2, the second plate with posterior margin excised medially, this margin bearing a group of radially arranged setae laterally on either side; following segments lacking plates; ventrally setation and plate arrangement as in female. MONOTYPIC.—Type of genus: *Sathrax durus*, new species. *Sathrax*.—From the Greek, meaning "louse"; masculine.

Superficially *Sathrax* is most closely allied to *Docophthirus* Waterston, from *Anathana*, a tree shrew, approaching this genus in having thornlike tubercles on the venter of the head and antennae. It departs from *Docophthirus* in possessing a thoracic sternal plate, in that the male has radially arranged setae on the second plate of abdominal tergum 2, and two rows of setae on terga 3-6 rather than only one; and in both male and female, abdominal plates are present on typical segments ventrally, not dorsally. As well, the prothoracic pleural apophysis and pleural ridge are present in *Sathrax*, though weakly sclerotized in the only known species.

Affinities to *Neohaematopinus* Mjöberg are clearly shown in shape and dorsal setation of the head, size of the legs, and in the presence of radial setae on the second plate of abdominal tergum 2 in the male. More specifically, *Sathrax* approaches the *petauristae*-group of *Neohaematopinus* in having two rows of setae on abdominal terga 2-6 of the male, a condition unusual in *Neohaematopinus*-like forms.

Sathrax durus, new species

(Figs. 67-75)

TYPE DATA.—Male holotype, female allotype from *Tupaia glis*, Malaya: Selangor, Ulu Langat Forest Reserve, 25 Jan. 1957, R. 47287. A series of para-

types, all from *Tupaia glis*, Malaya, as follows: one male, one female, data as for holotype except R-47283. One female, Selangor, Bukit Lagong Forest Reserve, 22 Feb. 1958, RT B-47118. Eight males, eight females, Perak: Maxwell's Hill, elev. 4300 ft., 20 Mar. 1958, RT B-47648.

DESCRIPTION.—**MALE** (fig. 68): *Head*. Longer than broad, evenly rounded anteriorly, anterodorsal head armature broad, convex, heavily sclerotized. Post-antennal and occipital angles marked; postantennal head margins straight, slightly convergent posteriorly. Gular region of head venter (fig. 71, ♀) covered with pointed tubercles; basal and second antennal segments ventrally with such tubercles, venter of basal segment also with one squared flaplike lobe on proximoanterior part; third antennal segment with distal margin serrate in appearance ventrally, not especially prolonged anteroapically, the two enlarged spinelike setae close together, set on slight prominence of the dorsal surface (fig. 69). *Thorax*. Broader than head; with prominent longitudinal sclerotizations dorsolaterally; thoracic sternal plate (fig. 73, ♀) somewhat longer than broad, postero-apical angles slightly produced. *Legs*. First pair with specialized elongate broad seta subapically and laterally on thumblike process of tibia which opposes tarsal claw (fig. 70, ♀) (a tendency toward the same modification occurs in certain species of *Neohacmatopinus*). *Abdomen*. Radial setae of second plate on tergum 2 arranged in groups of three or four. Segments 3-6 dorsally with two to four heavy straight setae in each of two rows; these rows very close together; ventrally rows on segments 3-6 with four or five slightly thinner setae, and laterally one small seta on each side of segments 3-4 near corresponding paratergal plates. Paratergal plates II (fig. 74, ♀) wrapped around lateral margin of body, bearing one long and one short apical seta; plates III-VI similar to one another in shape, diminishing in size from anterior to posterior, posterior margin of plate concave between setal bases, apical points somewhat produced, rounded; pairs of apical setae all as long as plate bearing them; plates VII-VIII lacking posteroapical angles, apical setae long; plate VIII with three apical setae, the third being captured from the dorsal integument (a similar modification is common in *Neohacmatopinus*). *Aedeagus* (fig. 72). With long thin basal plate; parameres slightly convex, thin; pseudopenis broad basally, lacking serrate lateral margins, arrow-shaped apex extending beyond tips of parameres.

FEMALE (fig. 67): *Head* (fig. 71). As in male except third antennal segment not modified. The allotype has the antenna abnormal on one side, with only four segments. *Thorax* and *Legs*. As in male. *Abdomen*. Much as in male except no radial setae on tergum 2; rows on terga with highly variable number of setae (three to seven); sternal rows with four to five setae each. One paratype female is abnormal in having three apical setae on paratergal plate III on one side. *Genitalia* (fig. 75). With lateral setigerous lobes of segment 8 incorporated

into genital plate, bearing four or five medium-sized posteroapical setae.

LENGTH.—Male holotype: 1.25 mm.; paratypes: 1.1-1.35 mm. Female allotype: 1.4 mm.; paratypes: 1.4-1.6 mm.

Genus *Polyplax* Enderlein

Polyplax Enderlein 1904, 142, 223; Ferris 1923, 183 (sinks *Eremophthirus*); Ewing 1935, 201; Fahrenholz 1938, 239; Ferris 1951, 199; Johnson 1960, 48 (sinks *Synocia*).
Eremophthirus Glinkiewicz 1907, 381 (type: *Eremophthirus werneri* Glinkiewicz); Ewing 1935, 201; Fahrenholz 1938, 242.

Haematopinus (*Polyplax*): Neumann 1909, 529.
Synocia Fahrenholz 1938, 245 (type: *Polyplax brachyrrhynchus* Cummings); Ferris 1951, 220.

TYPE OF GENUS.—*Pediculus spinulosus* Burmeister, by original designation.

KEY TO THE INDU-MALAYAN SPECIES OF POLYPLAX

1. Abdominal plates reduced, occupying only the central third of any segment (fig. 76) 2
These plates not reduced, occupying nearly the entire area of each segment 4
- 2(1). One of apical setae on each of paratergal plates III-IV very long **insulsa**
Both apical setae on plates III-IV shorter than the plate 3
- 3(2). Head less than one and one half times as long as broad; paratergal plate VI never with both apical setae longer than plate **expressa**
Head almost twice as long as broad, plate VI with both setae much longer than the plate **bullimae**
- 4(1). Paratergal plates II-VI each with apical setae much shorter than the plate bearing them **spinulosa**
At least some of these plates with one or both setae as long as or longer than the plate bearing it 5
- 5(4). Plates III-V each with one short apical seta and one as long as the plate **tarsomydis**
Plates III-VI each with both apical setae as long as or longer than the corresponding plate **reclinata**

DESCRIPTION.—Antennae five-segmented, third segment in male may be modified and bearing a short stout dorsal apical seta; commonly basal antennal segment of male larger than that of female. Sensoria of antennal segments 4-5 large and contiguous or smaller and separate. Thorax usually but not always with distinct sternal plate. Anterior pair of legs small and weak with slender claw; middle pair larger with stouter claw; posterior pair still larger with stouter claw which may be somewhat flattened, but leg proper never strongly compressed. Abdomen with paratergal plates developed on segments 2-8 except in one aberrant species that may not belong in *Polyplax*, and always with spiracles present on segments 3-8. Abdominal tergal and sternal plates usually present, female always with two rows of

setae on terga 4-7 and sterna 3-7, male with one row of setae on each tergum; one or two rows on sterna 2-3; one row on remaining sterna. Ventral plates of abdominal segments 2-3 never produced laterally to articulate with or to approximate the paratergal plates of these segments.

There are about 46 valid described species of *Polyplax*. The distribution of this genus is worldwide, mainly on myomorph rodents, although one species occurs on shrews and another on a South American hystricomorph rodent. Six species are known to occur in the Indo-Malayan region. One of these species is described in this paper as new. Two of the species are cosmopolitan in distribution, *P. spinulosa* and *P. reclinata*.

Polyplax spinulosa (Burmeister)

Pediculus spinulosus Burmeister 1839, No. 8.
Polyplax spinulosa: Ferris 1923, 187, figs. 119, 120A, D, F, and H. Johnson 1959, 597, fig. 73.

This cosmopolitan species has as its normal hosts *Rattus rattus* and *Rattus norvegicus*. Johnson (1959) found it to be a relatively rare species on *Rattus rattus* in Thailand. It has been reported from *R. exulans* in the Philippines and from *R. stridens* (of the *sabanus-edwardsi* group) in Malaya by Ferris (1923).

In the Malaya-Borneo surveys, *P. spinulosa* was taken most commonly from *Rattus rattus diardi*: 19♀♀ in 11 collections, from Kuala Lumpur, Selangor, Malaya, and 5♀♀ in 1 collection from Mt. Kinabalu, North Borneo. One female was taken from *R. rattus jalorensis*, Elmira Rubber Estate, Selangor, Malaya. It also occurred on *Rattus exulans*: 5♂♂♀♀ in 2 collections from Mt. Kinabalu, and 1♀ from Bukit Lajan Forest Reserve, Selangor. Three collections containing 4♂♂♀♀ were taken from *Rattus edwardsi* in Perak, Pahang, and Selangor, Malaya. *P. spinulosa* was surprisingly common on *Rattus sabanus*, which is related to *edwardsi*, with 6♂♂18♀♀ in 5 collections from Selangor, and 1♂ from Mt. Kinabalu. The normal *Polyplax* of *R. sabanus* is usually *Polyplax insulsa* Ferris.

These host records are interesting in that only females, and these in very small numbers from individual animals, were taken from the most common host, *Rattus rattus diardi*. It appears that some ecological factor may operate to prevent successful parasitism by *P. spinulosa* of *Rattus rattus* subspecies other than *R. r. diardi*, since many other *R. rattus* subspecies were collected and only once, on *R. r. jalorensis*, was *P. spinulosa* collected from them.

P. spinulosa is easily distinguished from *P. insulsa*, *P. bullimae* Johnson, and *P. expressa*, n.sp., by having well-developed abdominal plates, and from *P. reclinata* (Nitzsch) and *P. tarsomydis* Ewing in that the setae of paratergal plates II-VI are very short, none being as long as the plate bearing it.

Polyplax reclinata (Nitzsch)

Pediculus reclinatus Nitzsch 1864, 23.
Polyplax reclinata leucodontis Jancke 1932, 525.
Polyplax deltoides Fahrenholz 1938, 256; Ferris 1951, 207.
Polyplax shimizu Kaneko 1957, 271.
Polyplax reclinata: Ferris 1951, 210 (sinks *leucodontis*); Johnson 1960, 55 (sinks *deltoides* and *shimizu*).

The type series of *reclinata* was from the European shrew, *Sorex araneus*. It has also been recorded from African and Japanese *Crocidura* and Asian *Suncus* under a variety of names. Johnson (1960) gives a complete synonymical listing of references to this species and a discussion of the morphological variation within the species.

During the present survey two females were collected from a *Suncus coccyzus* taken at Kuala Lumpur, Selangor, Malaya (RT B-9362).

Like most Southeast Asian specimens of *P. reclinata*, these females have very large spiracles. *P. reclinata* may be separated from *P. insulsa*, *P. bullimae* Johnson, and *P. expressa*, n.sp., by having well-developed tergal and sternal abdominal plates and from the above species plus *P. spinulosa* and *P. tarsomydis* in having both apical setae on paratergal plates IV-VI about as long as, or longer than, the plate bearing them.

Polyplax tarsomydis Ewing

Polyplax tarsomydis Ewing 1935, 206; Ferris 1951, 204, 214.
Eremophthirus tarsomydis: Fahrenholz 1938, 243.

The holotype male was taken from the skin of a *Tarsomys apocensis* (*Rattus (Tarsomys) apocensis*), Mindanao, Philippines (U.S.N.M.). Ferris (1951) recorded two females of *P. tarsomydis* from a skin of the type host species, U.S.N.M. mammal No. 144616, Summit of Mt. Bliss, Mindanao.

P. tarsomydis is related to *P. spinulosa* and allies. The single male has the aedeagus distorted and in a poor position, making its description impossible. The male does not have extremely small spiracles. As Ferris (1951, 204) says is true of the two females from U.S.N.M. 144616. I have seen these females and they are in such poor condition that a precise description of them is impossible.

A brief characterization of the male follows: Head broad anteriorly, with flattened anterior apex; definite postantennal angles; posterolateral head margins parallel and about as long as width of basal antennal segment. Basal antennal segment very broad, broader than long; third segment strongly modified, with anteroapical angle produced into dorsally-directed process bearing short heavy seta. Thoracic sternal plate six-sided, all sides of similar length, anterior and posterior apices acute, plate longer than broad. Abdominal tergal and sternal plates large. Paratergal plates more-or-less triangular; plates III-V with ventral apical angle rounded, dorsal apical angle produced into short point; each of these plates bearing one short ven-

troopical seta and one thinner dorsoapical seta which is as long as the plate bearing it. Plate VI with short ventral seta and very long dorsal seta.

This species may be differentiated from *P. spinulosa* by the six-sided thoracic sternal plate and by the fact that one of the two apical setae on each of paratergal plates III-V is as long as the plate bearing it. *P. tarsomydis* differs from *P. reclinata* in the shape of the thoracic sternal plate and because there are no apical setae on paratergal plates III-V longer than the plate bearing them. It is immediately separated from *P. insulsa*, *P. bullimae*, and *P. expressa*, in having the abdominal plates normal and not at all reduced.

Polyplax bullimae Johnson

Polyplax bullimae Johnson 1958, 76, figs. 5, 6, 8, 9.

This name was based on the male holotype, female allotype, and four male and two female paratypes from *Bullinus bagobus*, east slope of Mt. McKinley, Mindanao, Philippines, Chicago Natural History Museum mammal No. 56201 (holotype and three male paratypes), and C.N.H.M. mammal No. 56200 (allotype, and one male and two female paratypes).

This species is immediately separated from *P. reclinata*, *P. spinulosa*, and *P. tarsomydis* by having the abdominal plates much reduced. It differs from *P. insulsa* in not having the dorsal apical seta of paratergal plates II-III very long. It is separated from *P. expressa*, n.sp., by having the apical setae of paratergal plate VI both very long. Despite its superficial resemblance to *P. insulsa* and other *otomydis*-group species, *P. bullimae* is apparently more closely allied to the *spinulosa*-group.

Polyplax expressa, new species

(Figs. 76-81)

TYPE DATA.—Male holotype, female allotype, three female paratypes, from *Rattus* sp., Philippine Islands: Luzon; Mt. Santo Tomas, 6,500 feet, February 1950, Traub and Tipton collectors, RT B-6002. Further host information is not obtainable. The discovery of a second *spinulosa*-type species with reduced abdominal plates makes it worthy of description despite the limited host data.

DIAGNOSIS.—*P. expressa* is related to the *spinulosa* group of *Polyplax* and is most closely allied to *P. bullimae*. Like this species, *P. expressa* has the third segment of the male antenna strongly modified and in both sexes the abdominal plates are reduced, although not so markedly as in *P. bullimae*. It may be separated in both the male and the female from *P. bullimae* in that paratergal plate VI (fig. 81) has the apical setae shorter than the plate, not much longer. (One female paratype of *P. expressa* has one seta on one plate VI extremely long. This is presumably abnormal.) It is further separable in both sexes from *P. bullimae* in that the head is less than one and one-half times as long as broad, rather than almost twice as long as broad.

DESCRIPTION.—MALE (fig. 77): *Head*. Less than one and one-half times as long as broad; somewhat flattened anteriorly; with rounded postantennal angles; postantennal head margins converging slightly toward occiput. Gular region not raised. Basal antennal segment not especially enlarged, no larger than in female. Third antennal segment with short antero-apical prolongation dorsally, bearing short dorsally-directed spine. Sensoria of segments 4 and 5 not contiguous. *Thorax*. With its sternal plate (fig. 78, ♀) lightly sclerotized, more-or-less triangular, with semi-membranous margins which form a short anteriorly directed process. *Abdomen*. With narrow tergal and sternal plates which occupy median third of each segment. Each of segments 2-7 with one tergal plate. Ventrally with two sternal plates on segments 2 and 3; one such plate on segments 4-6. Setation of plates as in figure. Paratergal plates III-VII each flanked dorsally and ventrally by lateral seta. Paratergal plates II-VI with apical setae shorter than plates; plates III-VI triangular, with apical angles barely produced into very short points; the apical setae quite stout. *Aedeagus* (fig. 79). Pseudopenis joined to tips of parameres, broad basally, narrowing to acute posterior apex, lateral margins gently concave. Parameres almost entirely enclosed by distal arms of basal plate.

FEMALE (fig. 76): *Head* and *Thorax*. As in male except third antennal segment unmodified. *Abdomen*. Two narrow plates both dorsally and ventrally on each of segments 3-7, these plates occupying median third of corresponding segment and with setation as in figure. Paratergal plates (fig. 81) as in male except that one paratype has one of the apical setae very long on one plate VI. Each of plates III-VII flanked by one dorsal and one ventral lateral setae. *Genitalia* (fig. 80). With posterior lip of vulva fimbriate; lateral setigerous lobes of eighth segment present, each with three or four posteromarginal setae.

LENGTH.—Male holotype: 0.9 mm. Female allotype: 1.3 mm.; female paratypes: 1.2-1.35 mm.

Polyplax insulsa Ferris

Polyplax insulsa Ferris 1923, 231, figs. 151, 152A-C; Ferris 1951, 208; Johnson 1958, 77.
Ahaematopinus insulsus: Ewing 1929, 198.

The type series of *P. insulsa* (holotype, a female) was taken from the skin of an *Epimys sabanus* (*Rattus sabanus*), U.S.N.M. mammal No. 104765, Bangoran, Natuna Islands (west of Borneo).

The present specimens are the first reported since the original description. With one exception they were taken from the type host species, *Rattus sabanus*, from Malaya, as follows: 6♂♂6♀♀, Bukit Besi, Trengganu; 6♂♂5♀♀, Ulu Gombak Forest Reserve, Selangor; 5♂♂5♀♀, Ulu Gombak Forest Reserve; and 3♂♂5♀♀, Bukit Lagong Forest Reserve, Selangor. A single female taken from *R. mulleri*, Pahang Road, 16 mi. N. of Kuala Lumpur, Selangor, may have been a straggler. *P. insulsa* was once taken in the same collection with *Hoplopleura ma-*

laysiana, and both these species occur normally on *Rattus sabanus*. Specimens of *P. spinulosa* were taken in the same collection as the above two species.

The specificity of both *P. insulsa* and *H. malaysiana* for *Rattus sabanus* is probably quite rigid, although both species were taken once each from *R. mulleri* (not from the same host animal). According to D. H. Johnson, *R. sabanus* is an isolated form, not closely related to other *Rattus* species groups in Southeast Asia.

The specimens recorded above fit the original description. In the majority the position of the third pair of legs is such that the toothlike projection at the outer proximal angle of the tarsus is visible. The third antennal segment of the male is not modified in shape, but bears one stout short dorsal seta rather than one such seta on segments 3 and 4, as is common in other members of the *otomydis* group of *Polyplax*. *P. insulsa* may be distinguished from *P. spinulosa*, *P. tarsomydis*, and *P. reclinata* by having the abdominal plates reduced, occupying only the central third of any segment. It differs further from these species plus *P. bullimae* and *P. expressa* in having one of the apical setae on each of paratergal plates II and III very long, and the apical setae of plates IV-VI each shorter than the plate bearing them.

HOST-PARASITE LIST

Host classification at the generic level and above is according to Simpson (1945). Species are listed alphabetically under the appropriate genus.

	ORDER	Insectivora
	SUPERFAMILY	Soricoidae
	FAMILY	Soricidae
	SUBFAMILY	Crocilurinae

"ground shrew"

Ancistroplax nasuta TYPE HOST

Suncus coeruleus (ground shrew)

Polyplax reclinata

	ORDER	Primates
	SUBORDER	Prosimii
	SUPERFAMILY	Tupaioidea
	FAMILY	Tupaiaidae
	SUBFAMILY	Tupaiainae

Tupaia glis (tree shrew)

Sathrax durus TYPE HOST

	ORDER	Rodentia
	SUBORDER	Sciuroomorpha
	FAMILY	Sciuridae
	SUBFAMILY	Sciurinae
	TRIBE	Callosiurini

Callosciurus caniceps (oriental "tree" squirrels)

Enderleinellus malaysianus TYPE HOST (museum skin)

Hoplopleura erismata
Neohaematopinus callosciuri

C. erythraeus
Enderleinellus kumadai TYPE HOST
Neohaematopinus callosciuri

C. ferrugineus
Hoplopleura erismata TYPE HOST (museum skin)

C. finlaysoni
Enderleinellus kumadai
Hoplopleura erismata
Neohaematopinus callosciuri TYPE HOST

C. jentinki
Neohaematopinus cognatus, s. lat.

C. nigrocollatus
Enderleinellus kumadai
Hoplopleura erismata
Neohaematopinus callosciuri

C. notatus
Enderleinellus kumadai
Neohaematopinus callosciuri

C. precostii
Enderleinellus kumadai
Enderleinellus malaysianus (museum skin)
Neohaematopinus callosciuri, s. lat.

C. tenuis
Neohaematopinus callosciuri

Menetes berdmorei (tree squirrel)
Neohaematopinus cognatus TYPE HOST

Lariscus insignis (striped oriental ground squirrel)
Enderleinellus larisci TYPE HOST (museum skin)
Neohaematopinus callosciuri (normal host?)

Dremomys sp. (oriental ground squirrel)
Neohaematopinus cognatus

D. everetti
Neohaematopinus cognatus

D. rufipenis
Neohaematopinus elbeli TYPE HOST

Glyphotes sp. (pigmy squirrel)
Enderleinellus kumadai
Neohaematopinus callosciuri, s. lat.

Glyphotes simus
Neohaematopinus callosciuri, s. lat.

Nannosciurus melanotis (pigmy squirrel)
Enderleinellus nannosciuri TYPE HOST (museum skin)

N. whiteheadi
Neohaematopinus cognatus, s. lat.

SUBFAMILY Petauristinae
(Giant flying squirrels)

Petaurista elegans punctulatus
Neohaematopinus robustus TYPE HOST

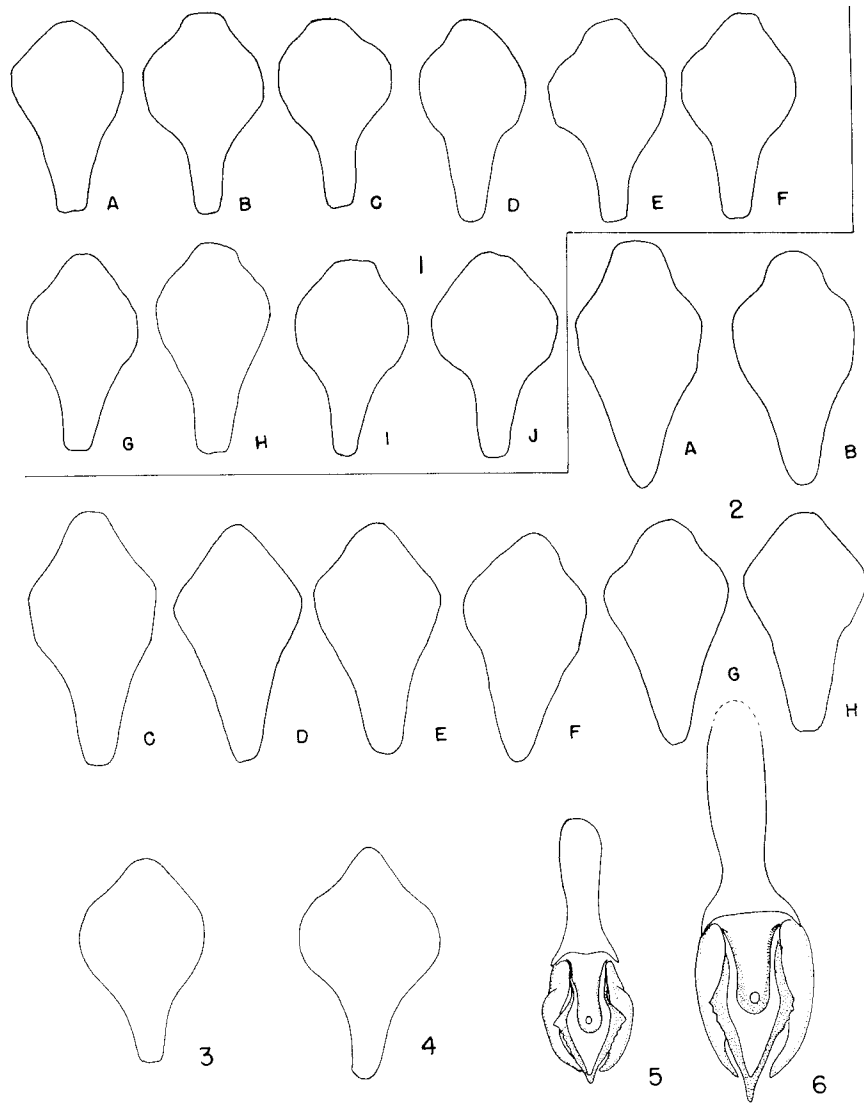
P. petaurista batuana
Neohaematopinus batuanae TYPE HOST (museum skin)

- P. petaurista melanotus*
Neohaematopinus pallidus
- P. taylora*
Neohaematopinus pallidus TYPE HOST
- Hyplopetes sagitta harrisoni*
Neohaematopinus kinabalensis TYPE HOST
- Petaurillus hosi*
Neohaematopinus pansus TYPE HOST
- ORDER Rodentia
SUBORDER Myomorpha
SUPERFAMILY Murioidea
FAMILY Muridae
SUBFAMILY Murinae
- Bullimus bayobus*
Polyplax bullimae TYPE HOST
- Rattus* sp.
Hoplopleura pacifica
Polyplax expressa TYPE HOST
- Rattus alticola*
Hoplopleura pectinata
- R. borcerisi*
Hoplopleura diaphora TYPE HOST
- R. cremoricenter*
Hoplopleura pectinata (not common)
Hoplopleura sicata TYPE HOST
- R. edwardsi*
Polyplax spinulosa
- R. exulans*
Hoplopleura pacifica TYPE HOST
Polyplax spinulosa
- R. mulleri*
Hoplopleura dissicula TYPE HOST
Hoplopleura malaysiana (not common, straggler?)
Polyplax insulsa (not common, straggler?)
- R. niveicenter*
Hoplopleura pectinata
- Rattus rajah*-group
Hoplopleura pectinata
- R. rajah*
Hoplopleura pectinata
- R. rapii*
Hoplopleura pectinata
- R. rattus* (?)
Hoplopleura dissicula, n.sp.
- R. rattus argenticenter*
Hoplopleura pacifica
- R. rattus baluensis*
Hoplopleura pacifica
- R. rattus diardi*
Hoplopleura pacifica
Polyplax spinulosa

- R. rattus jalorensis*
Hoplopleura pacifica
Polyplax spinulosa (not common)
- R. rattus jarak*
Hoplopleura pacifica
- R. sabanus*
Hoplopleura malaysiana
Polyplax insulsa TYPE HOST (museum skin)
Polyplax spinulosa
- R. sabanus luncavensis*
Hoplopleura malaysiana TYPE HOST (museum skin)
- R. stridens*
Polyplax spinulosa
- R. surifer*
Hoplopleura pectinata TYPE HOST
- R. whiteheadi*
Hoplopleura pectinata
- Rattus (Taromys) apoensis*
Polyplax taromydis TYPE HOST (museum skin)

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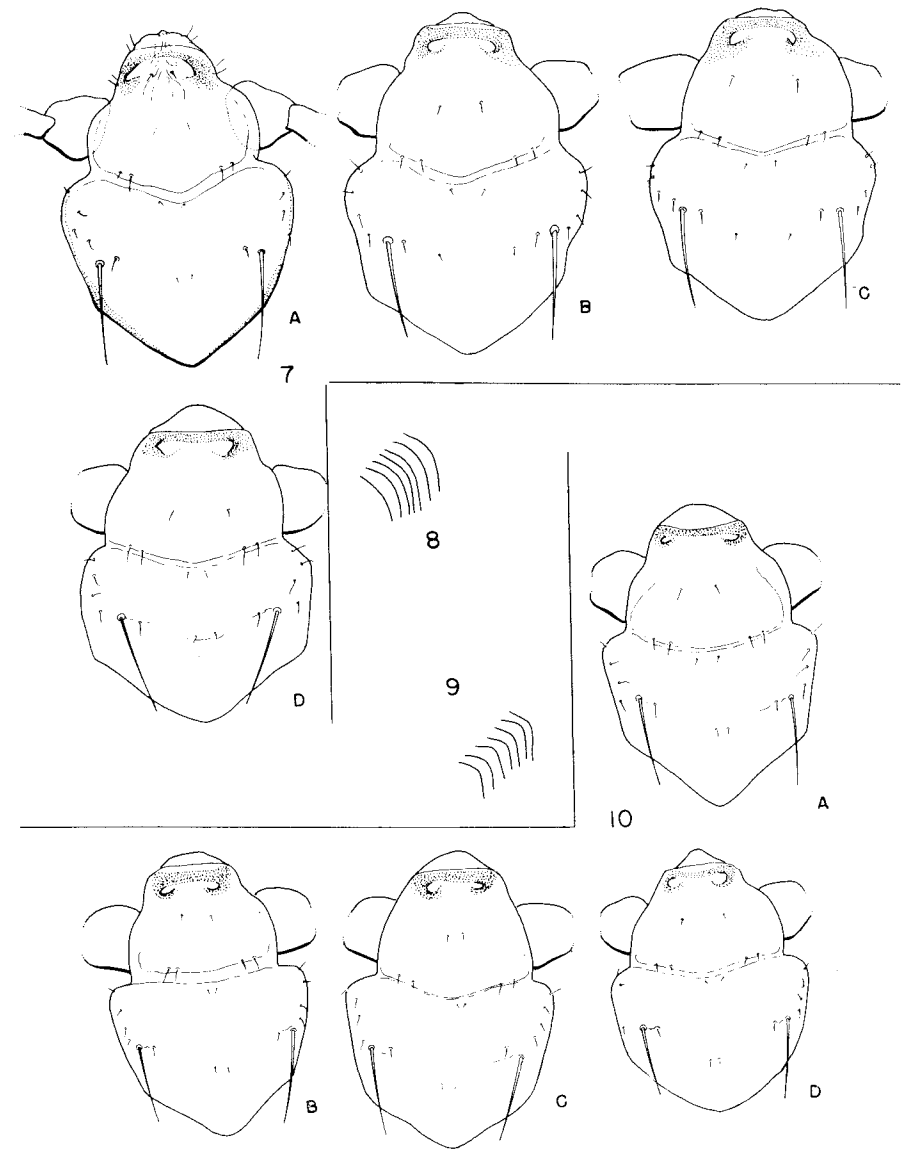
PLATE 1. *Hoplopleura* species

FIGS. 1, 5.—*H. pacifica* from *Rattus rattus* ssp. FIG. 1.—Thoracic sternal plates: a, Malaya; b, Thailand (*R. exulans*); c, Thailand; d, Laos; e, Madagascar; f, Formosa, g and h, Borneo; i and j, Malaya. FIG. 5.—Aedeagus (Malaya).

FIGS. 2, 6.—*H. oenomydis* from *Oenomys*. FIG. 2.—Thoracic sternal plates: a and b, Congo; c, paratype female; d-h, Uganda. FIG. 6.—Aedeagus, paratype.

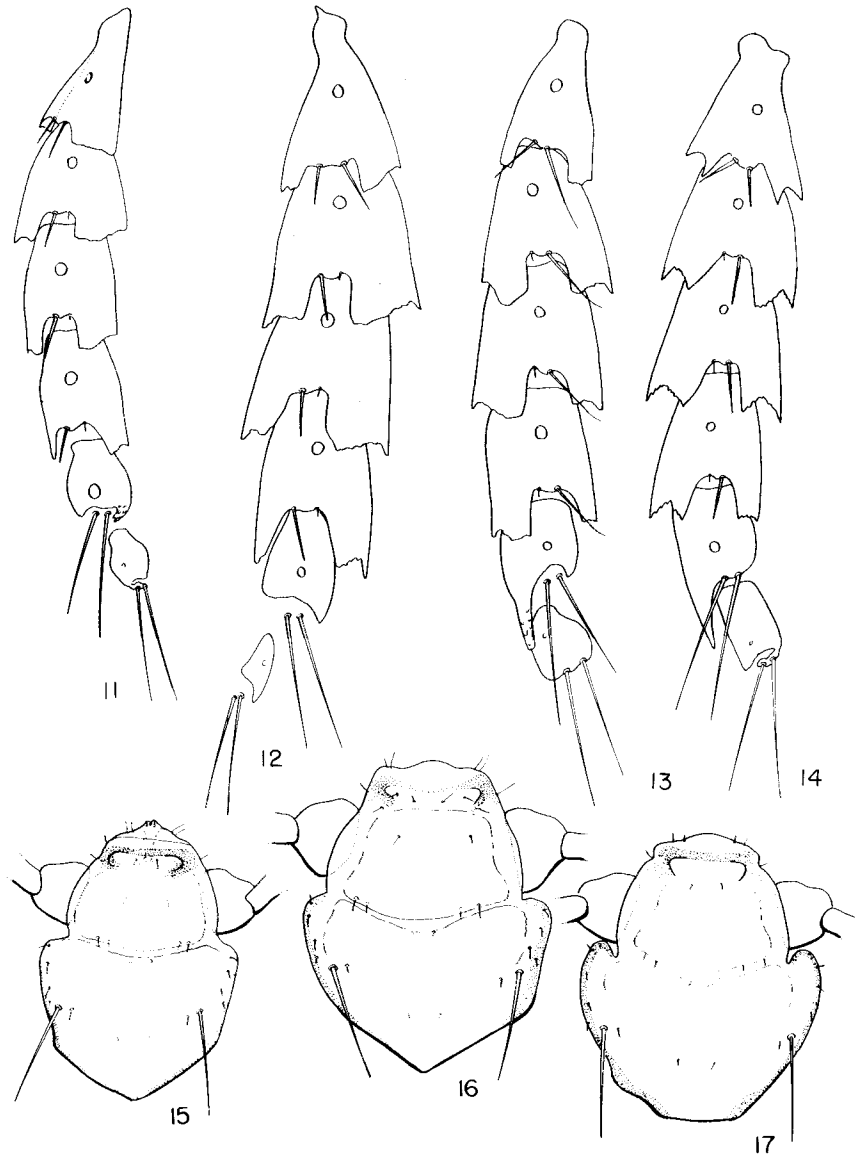
FIG. 3.—*H. dissicula*, thoracic sternal plate, female paratype (B-8616).

FIG. 4.—*H. sicuta*, thoracic sternal plate, female holotype.

PLATE 2. *Hoplopleura* species

FIGS. 7, 8.—*H. oenomydis*. FIG. 7.—Heads: a, paratype female; b and c, Congo; d, Uganda. FIG. 8.—Post-antennal angles, paratype, Congo, Uganda.

FIGS. 9, 10.—*H. pacifica* from *Rattus rattus* ssp. FIG. 9.—Postantennal angles, Borneo, Malaya, Thailand, Formosa, Madagascar. FIG. 10.—Heads: a, Borneo; b, Formosa; c, Madagascar; d, Thailand (*R. exulans*).

PLATE 3. *Hoplopleura* species

FIGS. 11, 15.—*H. pacifica* from *R. rattus*, Malaya. FIG. 11.—Paratergal plates III-VIII, female. FIG. 15.—Head, female.

FIG. 12.—*H. oenomydis*, female paratype, paratergal plates III-VIII.

FIGS. 13, 16.—*H. sicata* female paratype (RT B-19039). FIG. 13.—Paratergal plates III-VIII. FIG. 16.—Head.

FIGS. 14, 17.—*H. dissicula*, female paratype (B-8616). FIG. 14.—Paratergal plates III-VIII. FIG. 17.—Head.

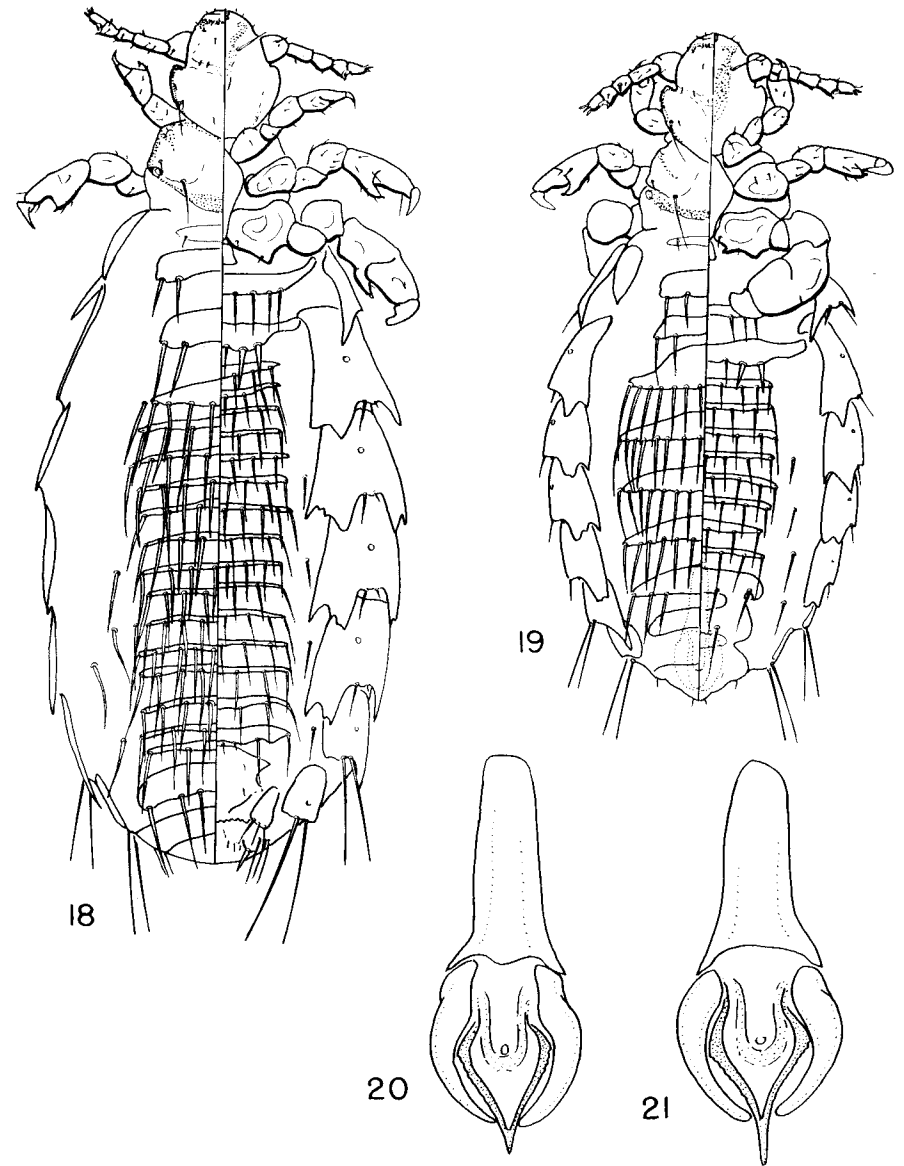
PLATE 4. *Hoplopleura dissicula*

FIG. 18.—Female paratype (RT B-8616). FIG. 19.—Male allotype. FIGS. 20, 21.—Aedeagus, two male paratypes (R. 45284).

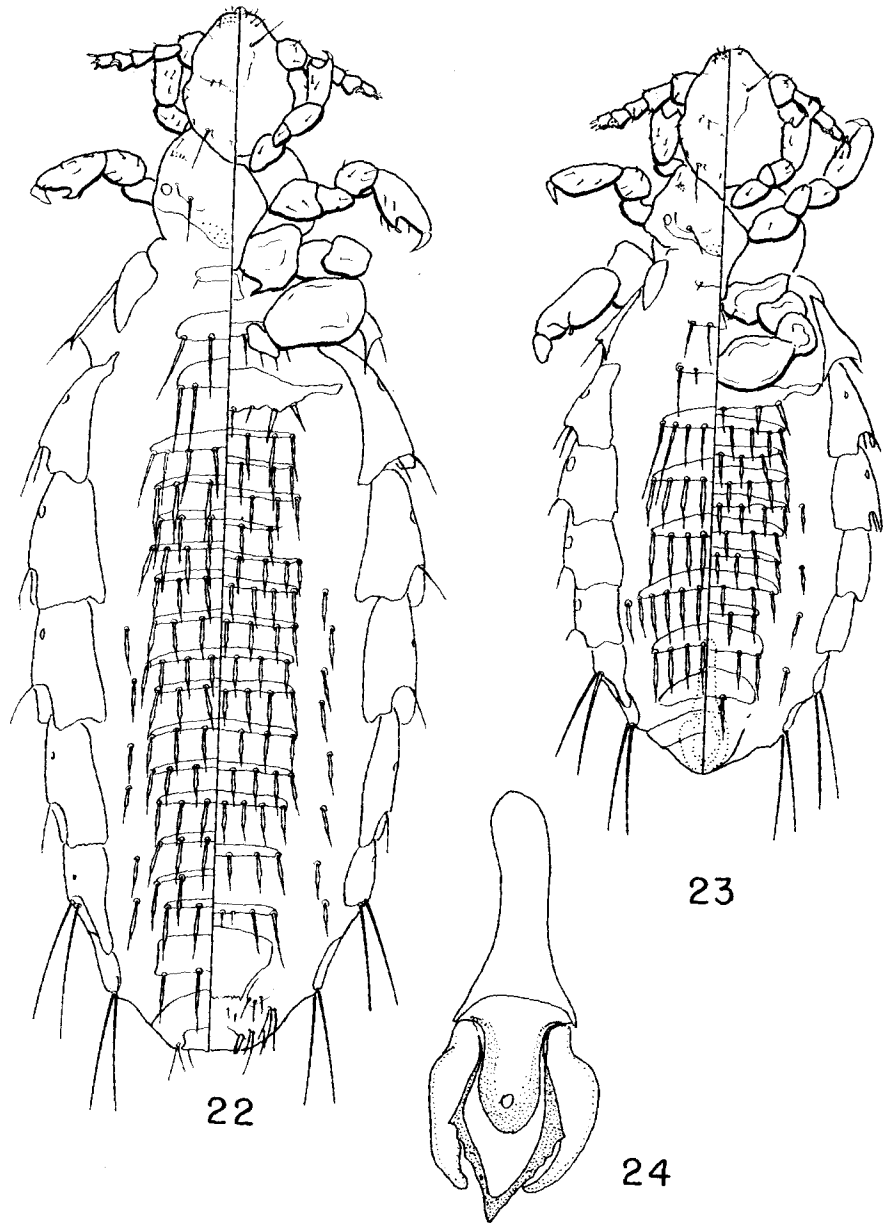
PLATE 5. *Hoplopleura sicata*

FIG. 22.—Female holotype. FIG. 23.—Male allotype. FIG. 24.—Aedeagus, paratype (RT B-19039).

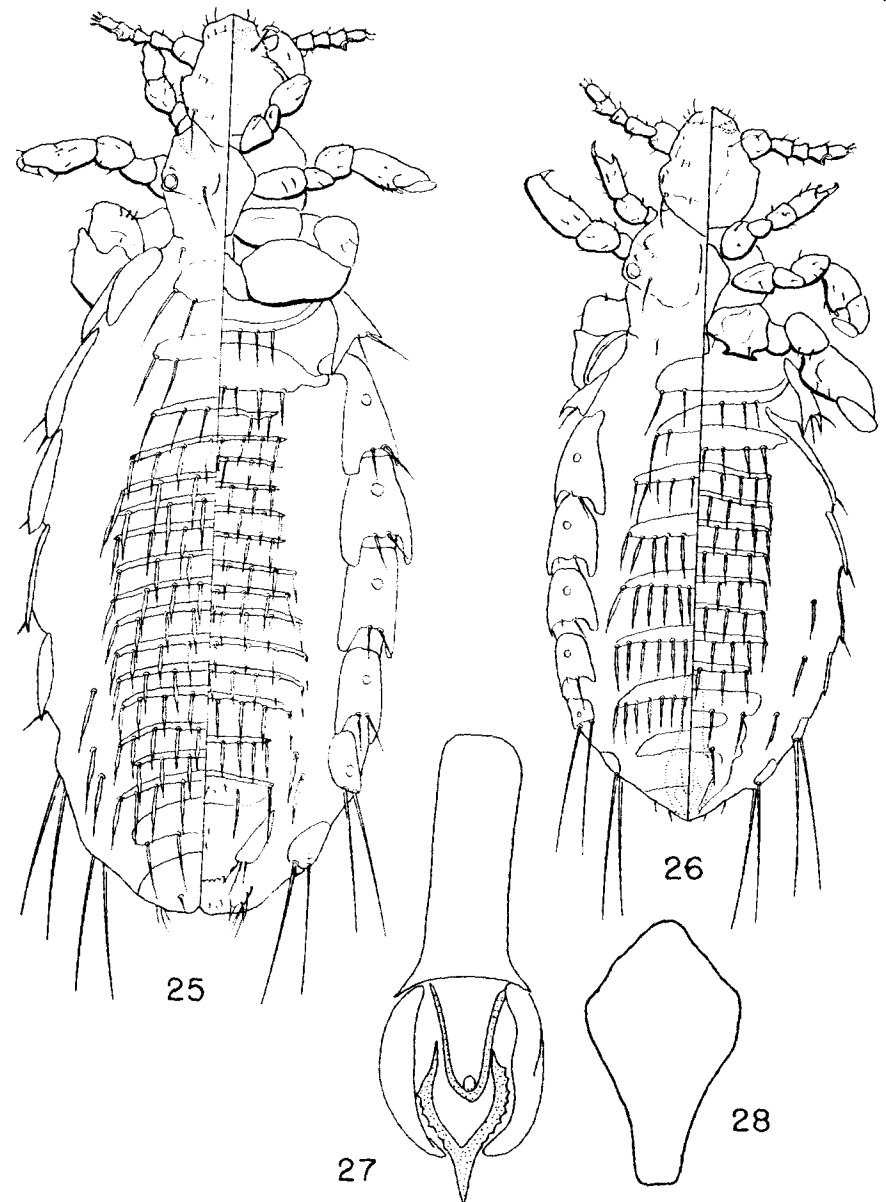
PLATE 6. *Hoplopleura malaysiana*, from *Rattus sabanus*, Malaya

FIG. 25.—Female. FIG. 26.—Male. FIG. 27.—Aedeagus. FIG. 28.—Thoracic sternal plate, female.

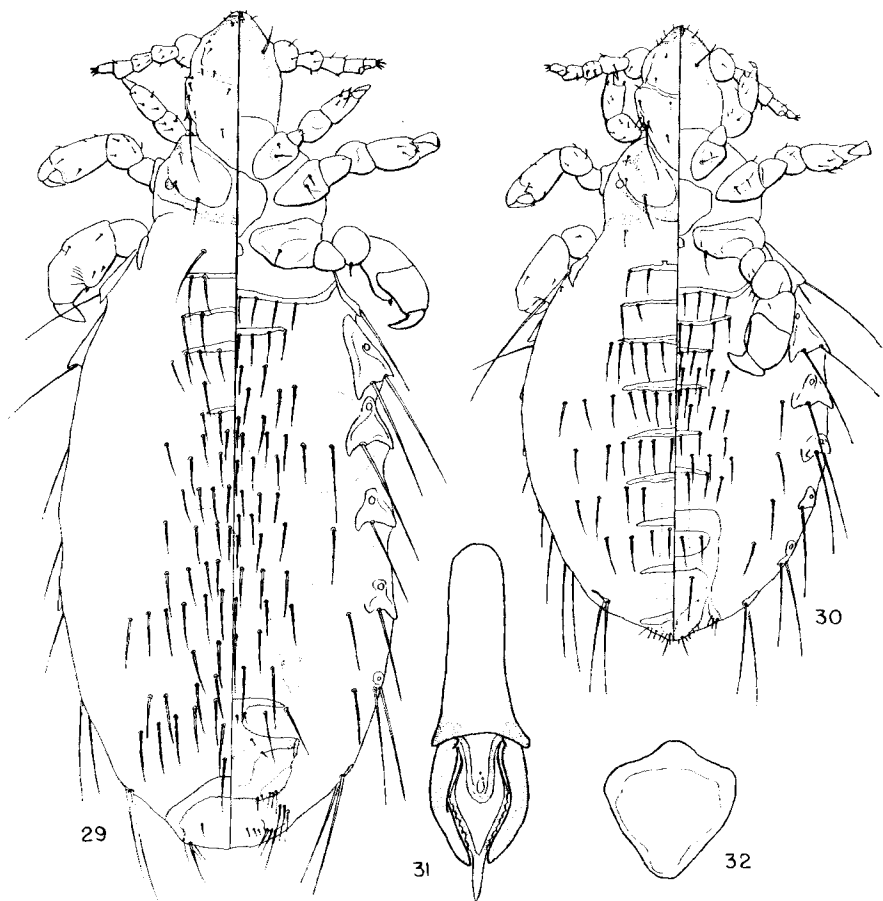


PLATE 7. *Hoplopleura diaphora*, female holotype, male allotype
 FIG. 29.—Female. FIG. 30.—Male. FIG. 31.—Aedeagus. FIG. 32.—Thoracic sternal plate, female.

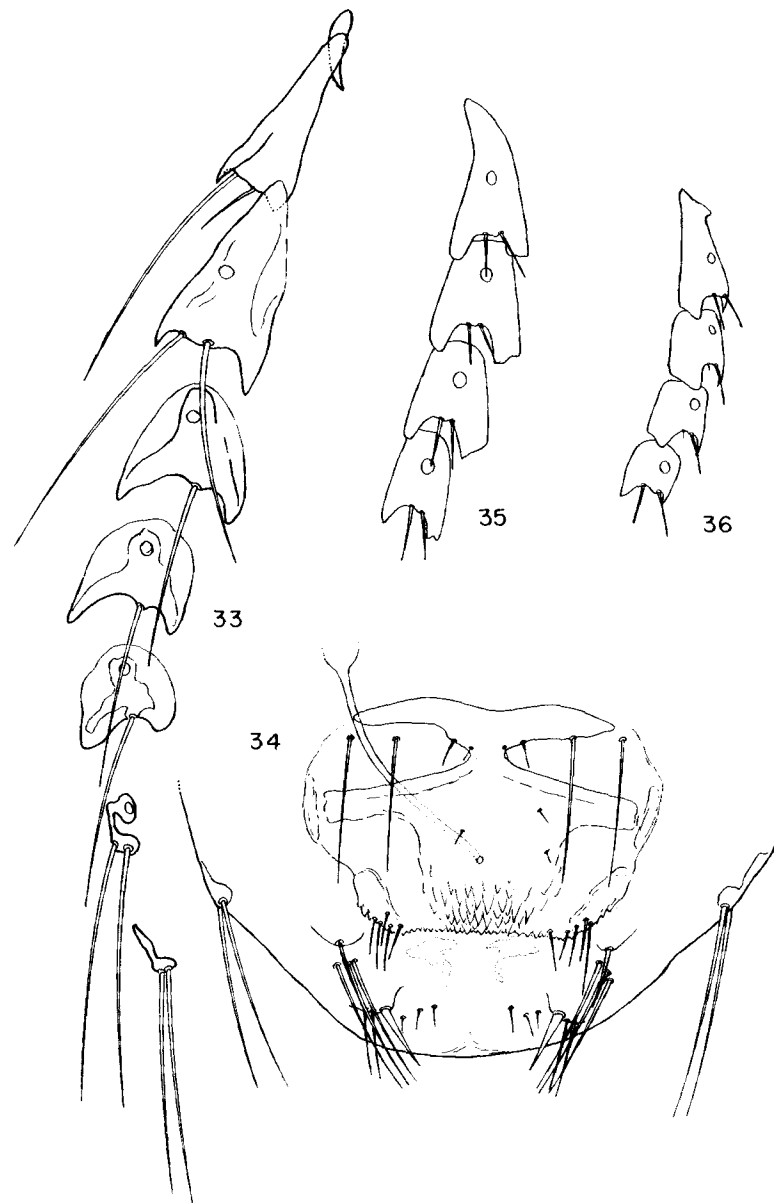


PLATE 8. *Hoplopleura* species
 FIGS. 33, 34.—*H. diaphora*, female holotype. FIG. 33.—Paratergal plates. FIG. 34.—Genital segments.
 FIGS. 35, 36.—*H. malaysiana* Ferris from *R. sabanus*, Malaya. FIG. 35.—Paratergal plates III-VI, female. FIG. 36.—Paratergal plates III-VI, male.

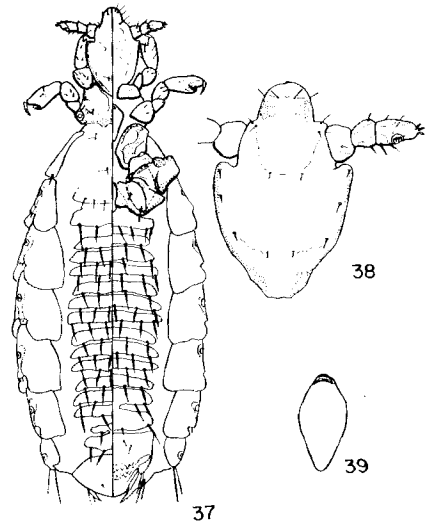


PLATE 9. *Ancistroplax nasuta*, holotype
 FIG. 37.—Female. FIG. 38.—Head, dorsal view. FIG. 39.—Thoracic sternal plate.

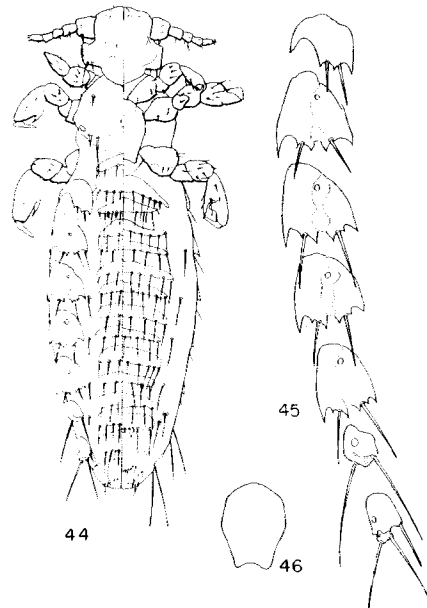


PLATE 11. *Neohaematopinus pansus*, holotype
 FIG. 44.—Female. FIG. 45.—Paratergal plates. FIG. 46.—Thoracic sternal plate.

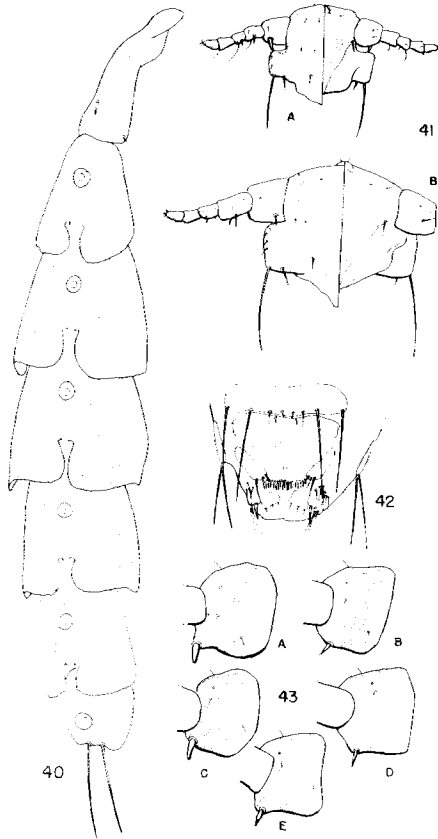


PLATE 10. *Ancistroplax* and *Neohaematopinus* species.
 FIG. 40.—*Ancistroplax nasuta*, paratergal plates, paratype, Malaya.
 FIGS. 41A, 42.—*Neohaematopinus pansus*, holotype.
 FIG. 41A.—Head. FIG. 42.—Genital segments, female.
 FIG. 41B.—*Neohaematopinus capitaneus*, head, female from type series.
 FIG. 43A-E.—*Neohaematopinus collosciuri*, dorsum of basal antennal segment: A, ♀ from *C. notatus*, Malaya; B, ♀ from *C. notatus*, Borneo; C, ♀ from *C. nigrovittatus*, Malaya; D, ♂ from *C. nigrovittatus*, Borneo; E, ♂ from *Glyphotes* sp., Borneo.

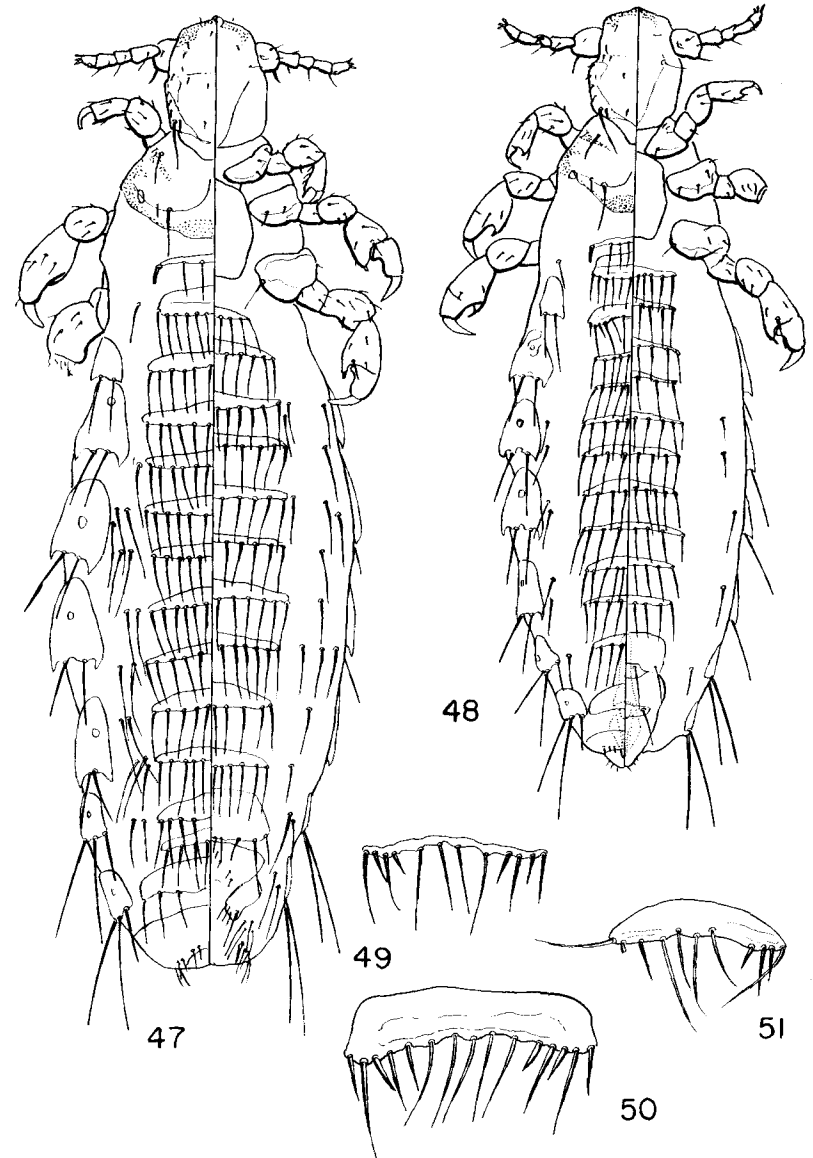
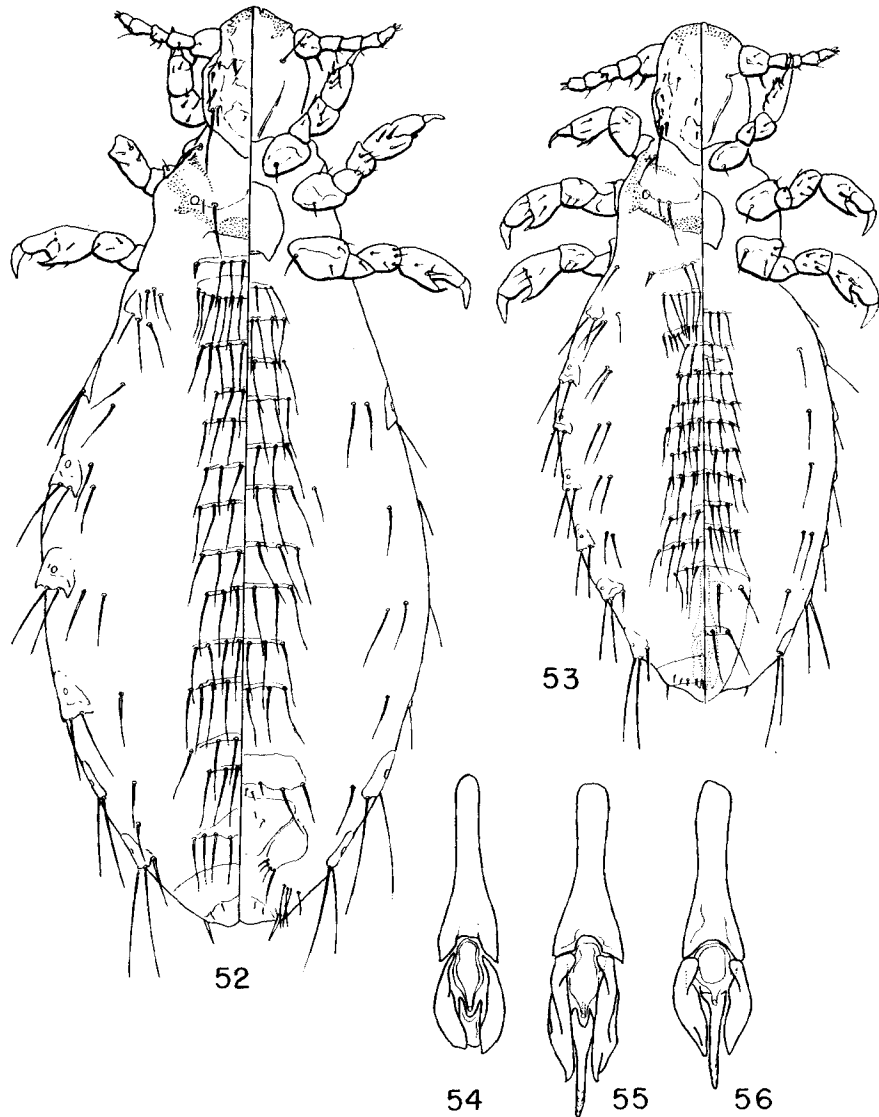
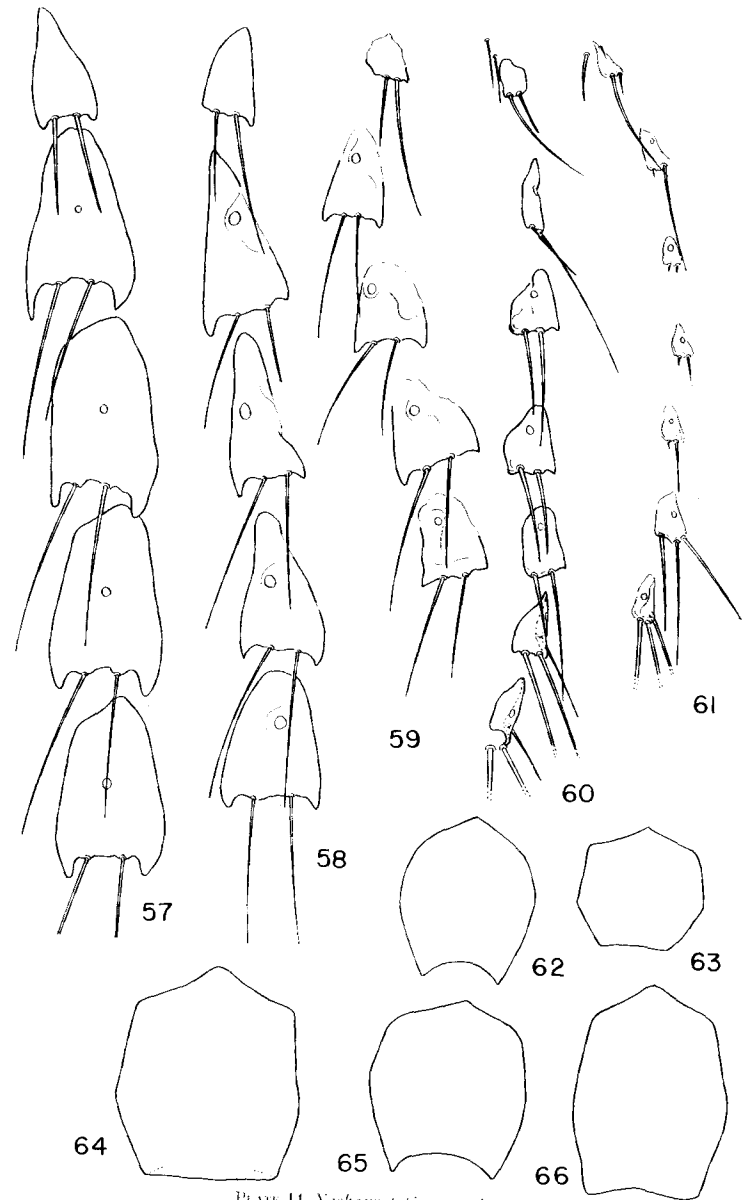


PLATE 12. *Neohaematopinus* species
 FIGS. 47, 48, 50.—*N. robustus*. FIG. 47.—Female allotype. FIG. 48.—Male holotype. FIG. 50.—Second tergal plate of abdominal segment 2, holotype.
 FIG. 49.—*N. pallidus*.—Second tergal plate of abdominal segment 2, male paratype from *P. petaurista*, Malaya (RT B-45316).
 FIG. 51.—*N. batuanac*, second tergal plate of abdominal segment 2, male allotype.

PLATE 13. *Neohaemaphysalis* species

Figs. 52, 53, 55.—*N. pallidus*. FIG. 52.—Female allotype. FIG. 53.—Male holotype. FIG. 55.—Aedeagus, holotype.
FIG. 54.—*N. batuanac*.—Aedeagus, allotype (pseudopenis broken off).
FIG. 56.—*N. robustus*.—Aedeagus, holotype.

PLATE 14. *Neohaemaphysalis* species

Figs. 57, 60.—*N. robustus*, female allotype. FIG. 57.—Paratergal plates II-VI. FIG. 60.—Thoracic sternal plate.
Figs. 58, 64.—*N. petauristae*, female paratype (from U.S.N.M. mammal No. 173374). FIG. 58.—Paratergal plates II-VI. FIG. 64.—Thoracic sternal plate.
Figs. 59, 60, 62, 65.—*N. pallidus*, male holotype, female allotype. FIG. 59.—Paratergal plates II-VI, female.
FIG. 60.—Paratergal plates II-VIII, male. FIG. 62.—Thoracic sternal plate, male. FIG. 65.—Thoracic sternal plate, female.
Figs. 61, 63.—*N. batuanac*, male allotype. FIG. 61.—Paratergal plates II-VIII. FIG. 63.—Thoracic sternal plate.

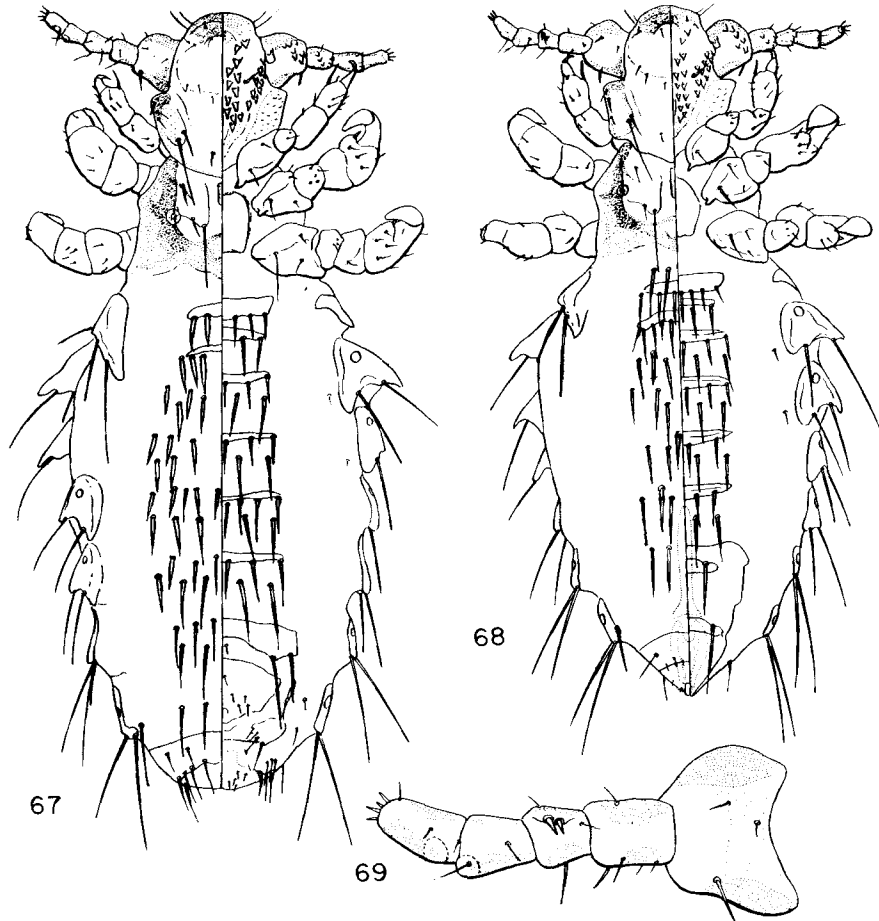


PLATE 15. *Sathrax durus*, male holotype, female allotype
 FIG. 67.—Female. FIG. 68.—Male. FIG. 69.—Dorsum of antenna, male.

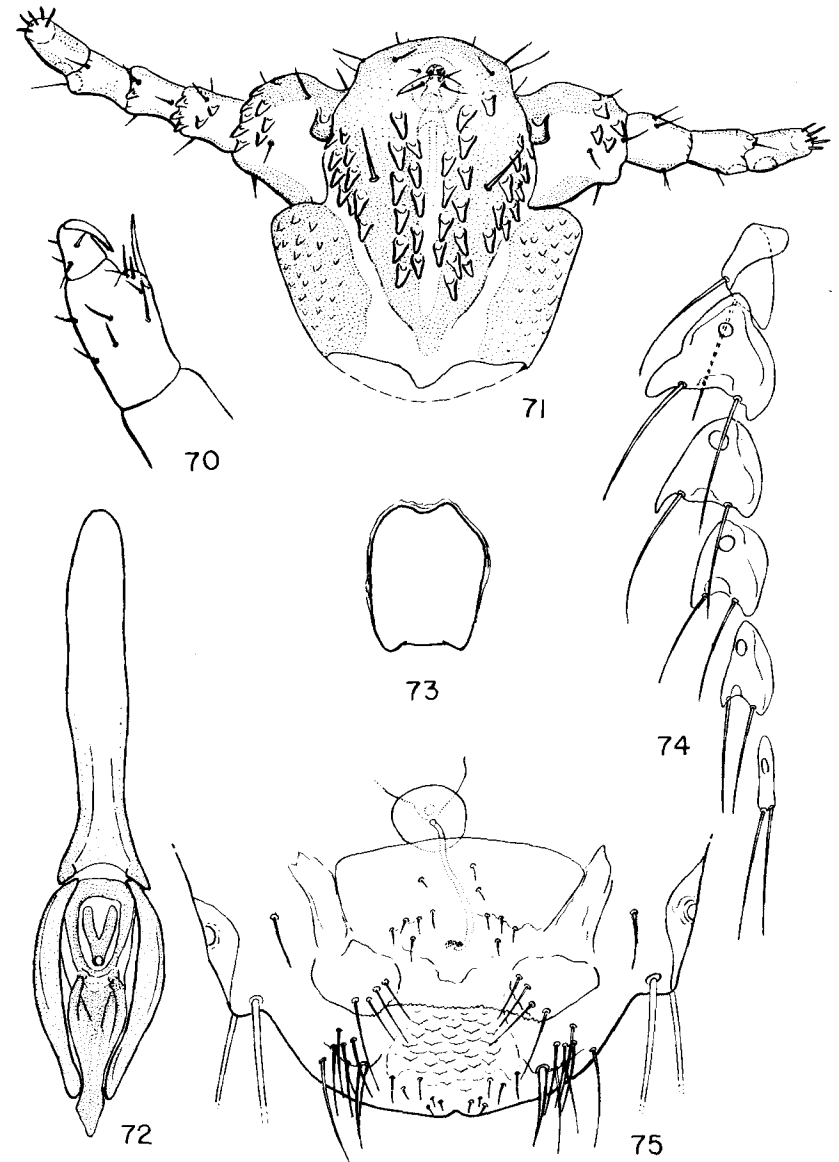


PLATE 16. *Sathrax durus*, male holotype, female allotype
 FIG. 70.—Tarsus of first leg, female. FIG. 71.—Venter of head, female. FIG. 72.—Aedeagus. FIG. 73.—Thoracic sternal plate, female. FIG. 74.—Paratergal plates II-VII, female. FIG. 75.—Genital segments, female.

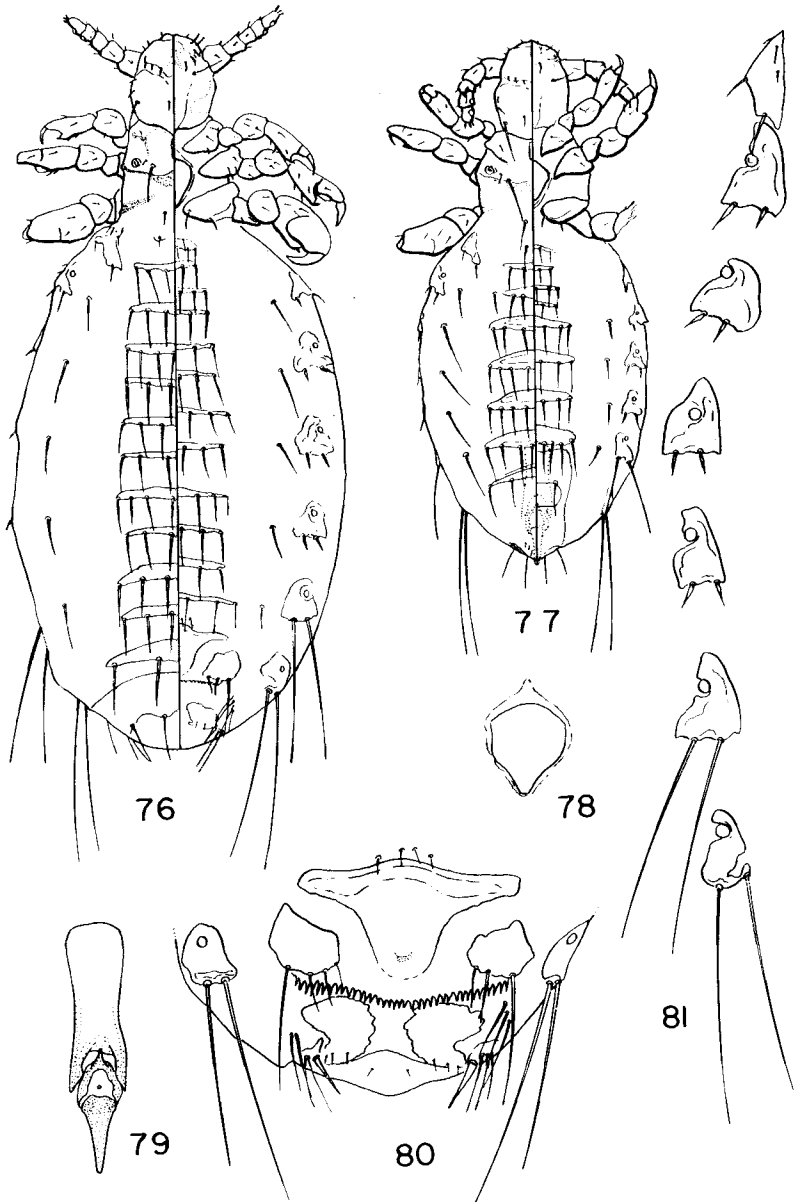


PLATE 17. *Polyplax expressa*, male holotype, female allotype

FIG. 76.—Female, (legs are a composite drawing from the paratypes). FIG. 77.—Male. FIG. 78.—Thoracic sternal plate, allotype. FIG. 79.—Genital segments, female paratype. FIG. 80.—Genital segments, female paratype. FIG. 81.—Paratergal plates, female paratype.