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THE HOPLOPLEURID LICE OF THE INDIAN SUBCONTINENT

(Anoplura : Hoplopleuridae)

by
A. C. MISHRA

Issued by The Director
Zoological Survey of India, Calcutta

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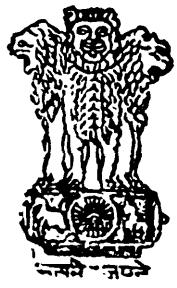

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CONTENTS

THE HOPLOPLEURID LICE OF THE INDIAN SUBCONTINENT

(ANOPLURA : HOPLOPLEURIDAE)[1]

By

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(Indian Council of Medical Research) Poona
(With 243 figures)

SUMMARY

This study deals with the Anoplura (sucking lice) belonging to the family Hoplopleuridae Ferris. This is the largest family under the order Anoplura and is commonly found on the hosts belonging to orders Insectivora, Lagomorpha, and Rodentia. A total of 39 species including 4 new species, belonging to 8 genera under 3 subfamilies have so far been recorded from this subcontinent. The systematics of all the species recorded is revised, furnished with necessary illustrations and presented in a consolidated form. Keys for the identification of the subfamilies, genera and species have been provided to facilitate identification. The host-parasite associations and the antiquity of hoplopleurid lice are discussed in the light of available information on evolutionary trends among the hosts.

INTRODUCTION

The Anoplura or the sucking lice stands out singularly amongst the external parasites of mammals. Though they have gained importance due to their suspected involvement in some

[1]Apart of the thesis approved for the Ph.D. Degree of the Poona University.
[2]Renamed as National Institute of Virology.

zoonotic diseases, what is more significant is their association with the hosts. They seem to be associated with mammals ever since their appearance in the evolutionary history. Apparently, the evolutionary divergence and resultant isolation of the mammalian hosts appears to have directed the speciation of their louse fauna. Detailed knowledge of Anoplura may thus provide some significant evidence for the study of evolution and phylogenetic relationship of their hosts.

Unfortunately, information available so far on the louse fauna and their ecogeographical distribution in the Indian subcontinent is meagre and sketchy. The present study deals with Hoplopleuridae, the largest family under the order Anoplura. The species recorded from this region are reviewed, furnished with necessary illustrations, and keys provided for their identification. In addition, phylogenetic interpretations on the basis of host-parasite associations are presented.

The area covered during the present study is bounded by Himalaya mountain range to the north, the Indus valley to the west, the Naga and Lushai hills to the east, and the Indian Ocean to the south. Politically, this area would comprise part of Pakistan, whole of India, Nepal, Bhutan, Bangladesh and Sri Lanka. Zoogeographically, it includes the Indian, Ceylonese and a part of Indochinese subregions of the Oriental region, and a narrow strip of Siberian subregion of the Palearctic region. Thus in delineating the study area, natural boundaries rather than purely zoogeographical or political, have been considered.

The huge collection at the Virus Research Centre, Poona accumulated as a result of several haematophagous arthropods surveys, undertaken in different parts of the country provided an opportunity to undertake an intensive study of the group. Important surveys under which the bulk of material was collected were in North East Frontier Agency (now Arunachal Pradesh), during 1964 by Dr. V Dhanda ; Himalaya regions of West Bengal, Sikkim, Uttar Pradesh, Himachal Pradesh and Jammu and Kashmir during 1967-70 by Drs. H. R. Bhat and S. M. Kulkarni ; Western Ghats of Poona district during 1970-71 by Dr. S. M. Kulkarni and the author ; Rajasthan during 1971 by Dr. H. N. Kaul ; Orissa during 1972 by Dr. H. N. Kaul and the

author. In addition, some specimens were obtained from other parts of the country particularly from Gujrat and Karnataka collected by Drs. H. Trapido and H. R. Bhat respectively. Besides, specimens were also obtained through the courtesy of specialists working in different parts of the world.

ACKNOWLEDGEMENTS

I am extremely grateful to Dr. N. P. Gupta, M.D., Dip. Bact., Director, Virus Research Centre, for providing the facilities, and for his kind permission to study the specimens available in the collection of the Centre. It is a pleasure to extend my sincere gratitude to Dr. Vijai Dhanda, Ph.D., D.A.P. & E., Assistant Director, Virus Research Centre, Poona, for his invaluable advice, constant encouragement and guidance throughout the course of this study. I am particularly beholden to Drs. H. R. Bhat, S. M. Kulkarni, and H. N. Kaul for their criticism and advice.

I am grateful to Dr. K. C. Emerson, 2704 North Kensington Street, Arlington, Va., U.S.A. ; Dr. K. C. Kim, The Frost Entomological Museum, The Pennsylvania State University, U.S.A. ; and Dr. K. Kaneko, Tokyo Medical and Dental University, Bunkyo-ku, Tokyo, Japan, for the supply of specimens and some invaluable literature. Help received for the confirmation from Dr. K. C. Kim for louse specimens and Dr. Joe Marshall for some rodents is also gratefully acknowledged.

The services of Mrs. A. Reethamma in typing the manuscript, Mr. S. R. Dogra in mounting the specimens, and Late Mr. B. B. Bhosale, Mr. M. A. Potnis and Mr. H. M. Shinde in photography is gratefully acknowledged.

COLLECTION AND PRESERVATION

Lice were collected as ectoparasites from domestic and wild mammals. The specimens from individual host were collected directly in a vial containing 70% alcohol with the help of a fine camel hair art brush. Only one animal was taken at a time for the search of ectoparasites to avoid contamination. A representative sample of each species of small mammals from a particular area was preserved for the confirmation of their identity.

MOUNTING AND IDENTIFICATION

During present study, both permanent and temporary slide mounts of lice were made by employing Canada balsam and Hoyer's medium respectively. Following procedures were adopted :

(i) *Mounting in Canada balsam :*

(a) The specimens were transferred from alcohol to water. A small puncture was made with the help of a fine needle in the abdominal region of each specimen, avoiding setae. The specimens were then soaked in 10% Potassium hydroxide (KOH) solution for about 15 hours at room temperature (28°C ± 2).

(b) Each specimen was then gently pressed with the help of a bent needle to remove the dissolved soft parts. They were then transferred into water and washed for 2 to 3 hours with frequent changes of water.

(c) The specimens were dehydrated by passing them through the ascending grades of alcohol (40%, 70%, 90% and 100%) Duration in each grade varied from 5 to 30 minutes depending upon the type of spceimens.

(d) These were then transferred in to clove oil for ½ an hour or until they became clear.

(e) The specimens from clove oil were directly mounted in Canada balsam on clean glass slides.

Unstained specimens were used in most of the cases for study. However, in some cases, where staining was necessary, a few drops of Carbol Fuschin were added to 40% alcohol and the specimens were passed rapidly through the subsequent grades of alcohol to avoid destaining.

(ii) *Mounting in Hoyer's Medium (Gum-chloral) :*

(a) and (b) These steps were same as for Canada balsam mounting.

(c) The washed specimens were mounted directly into Hoyer's Medium and were ready for study after 2 or 3 days.

This method was found quite satisfactory for the immature stages. It was also used when a long series of specimens was required to be examined.

Composition of the Hoyer's medium used is a slight variant of the following formula given by Baker and Wharton (1952).

Distilled water	50 ml
Gum arabic	30 gms
Chloral hydrate	200 gms
Glycerine	20 ml

During the present study Glycerine was replaced by sugar, due to which slides dried up faster.

The procedures described by Hopkins (1949) for processing dry specimens and for remounting the poorly mounted specimens, were followed. In case of specimens mounted in Canada balsam, the slides were placed in a petri-dish containing Xylene and were left for sufficient time to allow the balsam to dissolve completely. Specimens were gently removed from Xylene to absolute alcohol and remounted following the usual procedure. The dry specimens were kept in KOH solution overnight and mounted the next day by the usual procedure. Specimens in Hoyer's medium were kept in water for dissolving the mounting medium and then remounted as required.

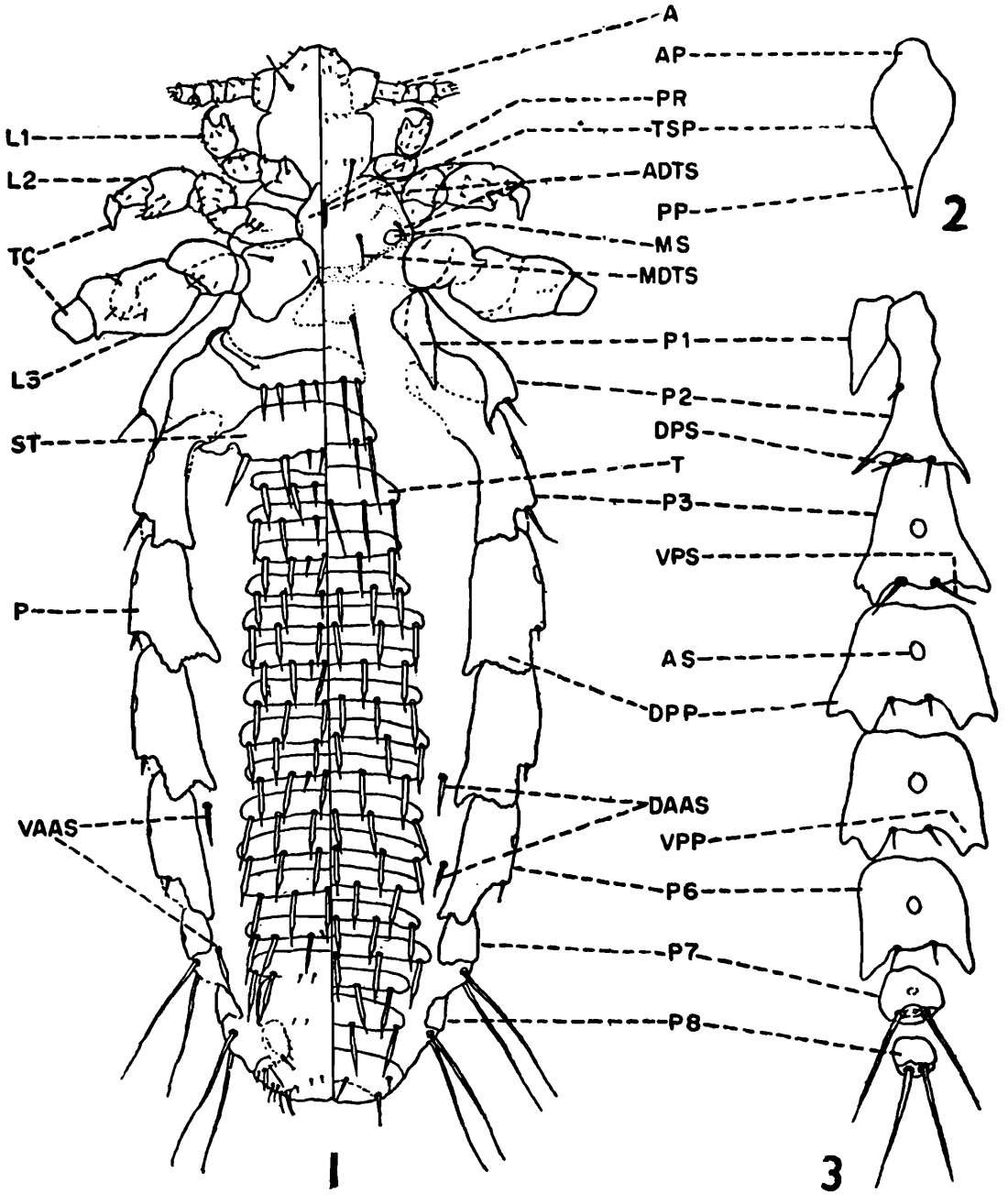
The small mammals were identified following Ellerman and Morrison-Scott (1951), Ellerman (1961),and Mishra and Dhanda (1975). Specimens belonging to *Mus platythrix* group were referred to Dr. Joe Marshal, SEATO Medical Research Laboratory, Bangkok, for identification.

The preliminary identification of the lice upto species group were done following Ferris (1951). The final identification of the species was done on the basis of subsequently published literature and also by comparing them with the authentically identified specimens. Some specimens were also referred to Dr. K. C. Kim, Frost Entomological Museum, Pennsylvania, U.S.A. for confirmation.

All the illustrations included here were prepared by the author with the help of Camera Lucida (Carl-Zeiss) from unstained mounted specimens. Mounted specimens of some species were also photographed on Leitz-Ortholux microscope, fitted with MIKAS microattachment with a Leica camera.

GENERAL MORPHOLOGW AND EXPLANATION OF THE TERMS USED

General morphology of adult stages of sucking lice have been discussed at length by Ferris (1951). A brief explanation of the terms is given by Johnson (1960a) and Kim (1965). Ter-



Figs. 1-3. Generalized drawing of a hoplopleurid lice 1, female (ventral and dorsal views); 2, thoracic sternal plate; 3, paratergites II-VIII.

minology for nymphal stages of *Hoplopleura* was suggested by Cook and Beer (1959) and latter standardized by Kim (1966a) after certain modification. Some of the important taxonomic characters used in this work are explained below.

I. *Adults*

In describing adults of a species, the following characters were considered to have taxonomic value.

Head (Figs. 1, 4).

1. Length of head in relation to its width. The length and the width were measured at the longest and the widest point.
2. Postantennal angles (PAA). The lateral angles just posterior to the base of the antenna on each side of the head.
3. Gular area (GU) The postero-median portion of the venter of the head.
4. Gular fold (GUF) Ventral folds which begin medially near the posterior end of the head, then diverge to run anterolaterally on each side to the base of antennae.
5. Occiput (O). The posterior most part of the head. It is often constricted and bounded on two sides by the occipital angles (OA).
6. Head setae. The setal arrangement on the head, position, length and thickness of individual seta. Names and abbreviations of head setae : Clypeal setae (CS), Oral setae (OS), Ventral Oral setae (VOS), Preantennal setae (PAS), Antennal setae (AS), Inner sutural head setae (ISHS), Outer sutural head setae (OSHS), Anterior central head setae (ACHS), Posterior central head setae (PCHS), Postantennal head setae (PoAS), Marginal head setae (MHS), Principal dorsal head setae (PDHS), Accessory dorsal head setae (ADHS).
7. Antennae (Figs. 5, 6, 7). Number of segments and condition of sensory areas (SA) found on 4th and 5th antennal segments.

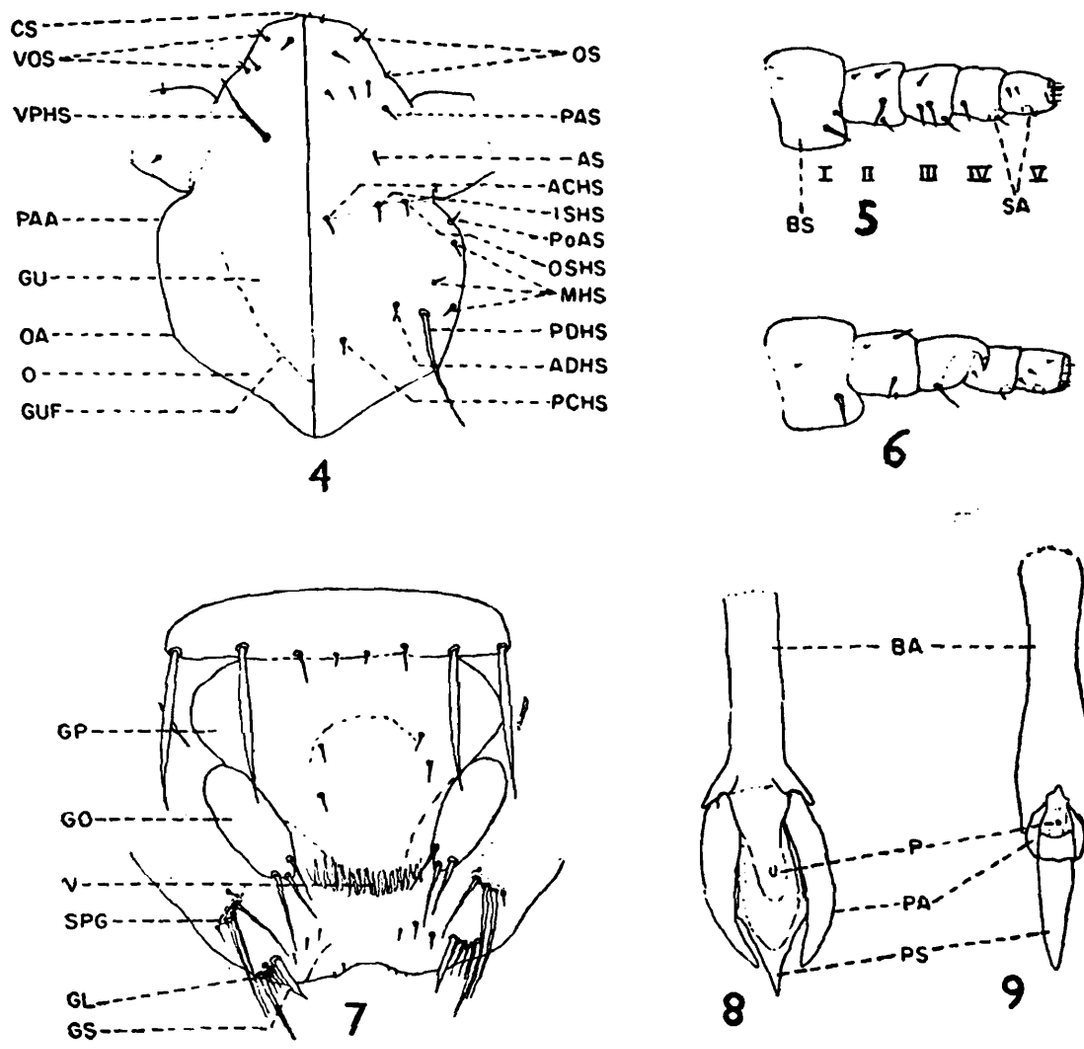
Thorax (Figs. 1, 2).

1. Thoracic sternal plate (TSP) (Fig. 2), its shape, the anterior process (AP) and the posterior process (PP).

2. Pronotum (PR) is a small, reduced narrow plate just posterior to the occiput.
3. The shape of the tarsal claw (TC).
4. Chaetotaxy on the dorsal side of thorax and shape and size of these setae. Names and abbreviations used for these setae : Median dorsal thoracic setae (MDTS), Accessory dorsal thoracic setae (ADTS).

Abdomen (Figs. 1, 3).

1. Sternal plates of abdomen or sternites (ST). Shape and number of sternal plate per segment, and associated setae.
2. Tergal plate of abdomen or tergites (T).
3. Paratergal plates or paratergites (P), their number, shape, and chaetotaxy. Terminology used for its parts : Dorsal Paratergal Process (DPP), Ventral Paratergal



Figs. 4-9. Generalized drawing of important parts of hoplopleurid lice. 4, head (ventral and dorsal views); 5, 6, antennae ♂, ♀; 7. terminal segments ♀; 8, 9, genitalia ♂.

Process (VPP), Dorsal paratergal setae (DPS), Ventral paratergal setae (VPS).

4. Dorsal accessory abdominal setae (DAAS) are setae between tergites and paratergites off the plates.
5. Ventral accessory abdominal setae (VAAS) are setae between sternites and paratergites off the plates.

Female genitalia (Fig. 7).

The main parts of the female genitalia are : Genital plate (GP), Gonopods (GO), Genital lobes (GL), Female genital opening or vulva (V), setae posterolateral to gonopods (SPG), Genital seta (GS)

Male genitalia (Figs. 8, 9).

The principal parts of male genitalia are : Basal apodeme (BA), Paramere (PA), Pseudopenis (SP), Penis (P)

II. *Nymphs*

The characters and abbreviations used for head and thorax are same as for adults. Abbreviations for different abdominal setae (Fig. 10) are as follows : Dorso-central abdominal setae (DCAS), Ventro-central abdominal setae (VCAS), Major abdominal setae (MAS), Anal setae (AnS), Accessory setae (AcS).

Family **Hoplopleuridae** Ferris

Hoplopleuridae Ferris, 1951, The sucking lice : 98.

———— Johnson, 1960, *U.S.D.A. Tech. Bull.* **1211** : 5 ; 1964, *Misc. Publ. Ent. Soc. America*, **4** : 68.

Characters : External evidence of eyes absent. Antennae 5 segmented, at times proximal two or three segments more or less fused together strongly sexually dimorphic in some species. Thoracic sternal plate present. Ventral prothoracic apophyseal pits lacking. Abdominal paratergites, sternites, and tergites usually present except in some species where it is partially or completely lacking. Gonopods in female usually short, never elongated and leaf like.

Note : The name Hoplopleuridae was chosen by Ferris (1951) from *Hoplopleura* which is the largest genus and in which characters of the family are well depicted. Ferris *(loc. cit.)* divided this family into 5 subfamilies : *viz.,* Enderleinellinae Ewing, Hoplopleurinae Ferris. Hybophthirinae Ferris, Polyplacinae Ferris and Pedicininae Enderlein. Johnson (1964) rejected the

inclusion of Pedicininae under Hoplopleuridae on the ground that the differences between Hoplopleurid lice and *Pedicinus* (the only genus under Pedicininae) are more important than their similarities. This concept has been followed during the present study.

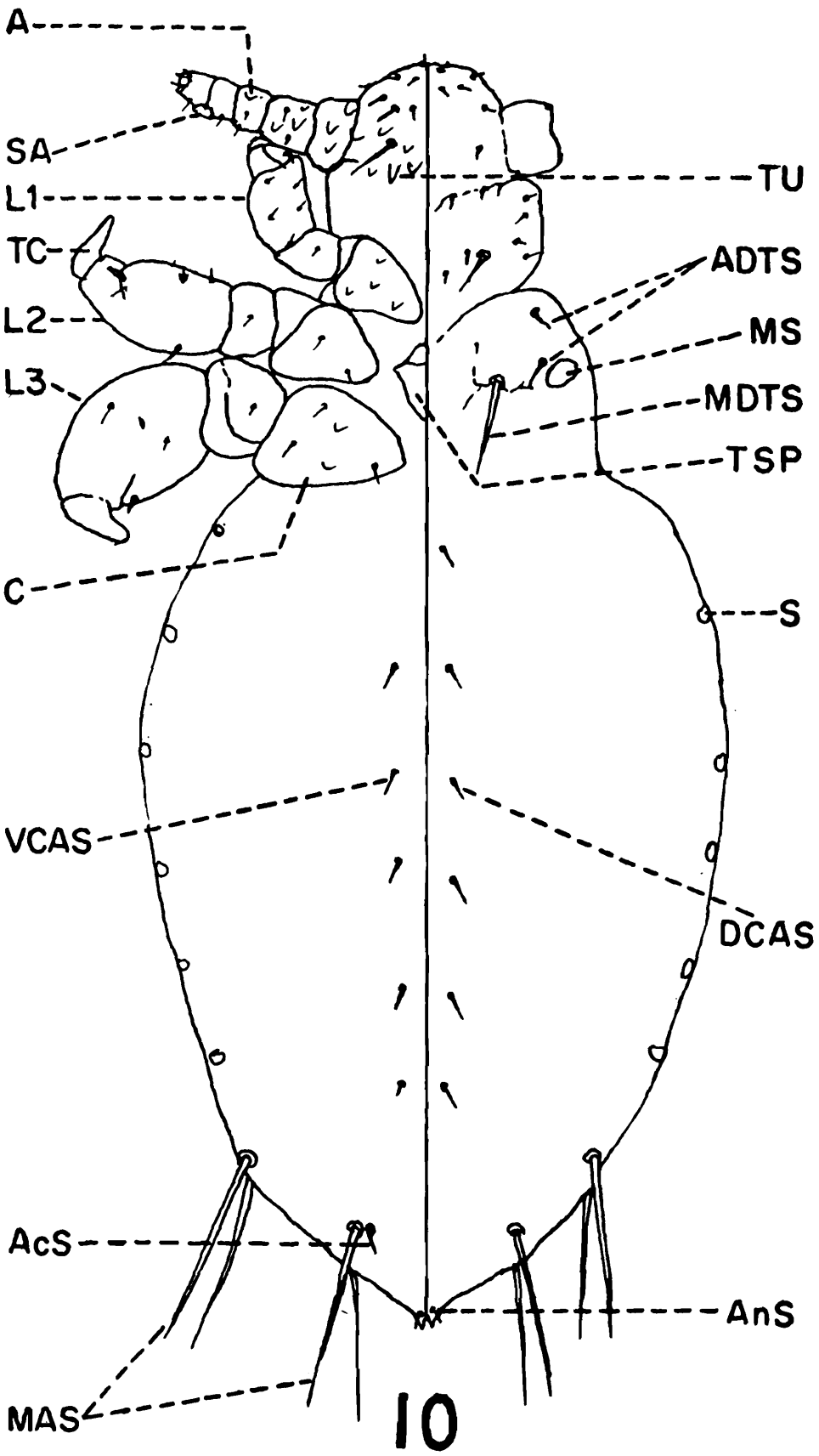


Fig. 10. Generalized drawing of a nymph.

Of these 4 subfamilies, members of the subfamily Hybophthirinae Ferris, are not recorded from India. They are known from members of the family Echimyidae of the order Rodentia ; and family Orycteropodidae of the order Tubulidentata.

KEY TO THE INDIAN SUBFAMILIES

1. First and second pair of legs similar in size and form, both small and slender, with slender claw. Ventral side of abdomen in most species with a pair of small, sclerotized, detached plates on abdominal segment II. Restricted to members of Sciuridae.....
.....Enderleinellinae

— First pair of legs smallest of the three pairs, the second pair somewhat larger than the first and with stouter claw. Ventral side of abdomen without such detached plates.....2

2. Sternal plate on abdominal segment II extended laterally on each side to articulate with the corresponding paratergal plate.....
.....Hoplopleurinae

— Sternal plate on abdominal segment II never thus extended laterally.....Polyplacinae

Subfamily **Enderleinellinae** Ewing

Enderleinellinae Ewing, 1929, Manual of external parasites : 132.
———Ferris, 1951, The sucking lice : 101.
———Johnson, 1960, *U.S.D.A. Tech. Bull.* **1211** : 6.

Characters : First and second pairs of legs small, slender, with slender claw ; third pair stout with large and flattened claw. All are small-sized species, restricted to the members of rodent family Sciuridae.

Note : Ferris (1951) proposed 3 genera, *viz., Enderleinellus* Fahrenholz, *Microphthirus* Ferris, and *Werneckia* Ferris to contain all the members of the subfamily. Kuhn and Ludwig (1965) added one more genus *Phthirunculus,* raising the total number of genera to 4.

All the species belonging to these genera are specific parasites of rodents belonging to the family Sciuridae. Family Sciuridae is divided into two subfamilies, namely Sciurinae (non flying

squirrels), and Petauristinae (flying squirrels). All the members of the subfamily Enderleinellinae parasitizing Sciurinae belong to genera *Enderleinellus* and *Werneckia ;* members parasitizing Petauristinae are represented by two monotypic genera, *viz., Microphthirus volans* ex *Glaucomys volans,* and *Phthirunculus sumatranus* ex *Petaurista petaurista.* Only exception is *Enderleinellus replicatus* ex *Sciuropterus volans,* a member of Petauristinae.

Of the 4 genera, *Enderleinellus* and *Phthirunculus* have been recorded in this subregion.

KEY TO THE INDIAN GENERA OF ENDERLEINELLINAE

Venter of abdominal segment II with a pair of detached sclerotized plates. Claws of anterior 2 pairs of legs not curved apically..... ....*Enderleinellus*

Venter of abdominal segment II devoid of detached sclerotized plate. Claws of anterior 2 pairs of legs curved apically ....*Phthirunculus*

Genus **Enderleinellus** Fahrenholz

Enderleinellus Fahrenholz, 1912, *Niedersachs. Zool. Ver. Hannover Jahresb. Abhandl.* **2-4**: 56.

Cyclophthirus Ewing, 1929, *Manual of external parasites,* p. 195 (Type : *Haematopinus saturalis* Osborn).

Hoplophthirus Ewing, 1929, *loc. cit.,* p. 194 (Type *Enderleinellus euxeri* Ferris).

Rhinophthirus Ewing, 1929, *loc. cit.,* p. 196 (Type: *Enderleinellus heliosciuri* Ferris).

Euenderleinellus Ewing, 1929, *loc. cit.,* p. 197 (Type: *Enderleinellus* larisci Ferris).

Type Species: *Pediculus sphaerocephalus* Nitzsch (preocc), orig, design. = *Enderleinellus nitzschi* Fahrenholz (nomina nuda).

Additional citations of references and synonymies may be found in Ferris (1951), Johnson (1960b, 1972b) and Kim (1966b).

Characters : First and second pair of legs small, similar in size ; third pair much larger with a large, flattened claw. Abdominal segment II with a pair of chitinized plate ventrally, bearing a flattened point, apically free from body.

Note : Ewing (1929) proposed to include segregates of this genus under 5 genera, namely *Enderleinellus, Cyclophthirus, Euenderleinellus, Hoplophthirus* and *Rhinophthirus*. Subse quently, these were rejected by Ewing himself and by Ferris (1951) on the ground that no useful purpose could be served by retaining all of them. Werneck (1947) attempted a grouping based mainly on male genitalia. Although this method appeared to be more natural, it could not satisfactorily dispose off all the species. Therefore, the most satisfactory classification accepted todate is by Ferris (*loc. cit.*).

The genus is now represented by approximately 43 species. All excepting one, *E. replicatus* Redikorzev, are restricted parasite to the members of subfamily Sciurinae. *E. replicatus* has been inadequately described from *Sciuropterus volans,* a member of Petauristinae. Its inclusion under the genus *Enderleinellus* is still tentative. Considering the extreme host specificity of the members of *Enderleinellus* to non-flying squirrels, this inclusion seems doubtful and needs further investigation.

Only two species, namely *E. nishimarui* Kaneko and *E. platyspicatus* Ferris have been recorded in this region.

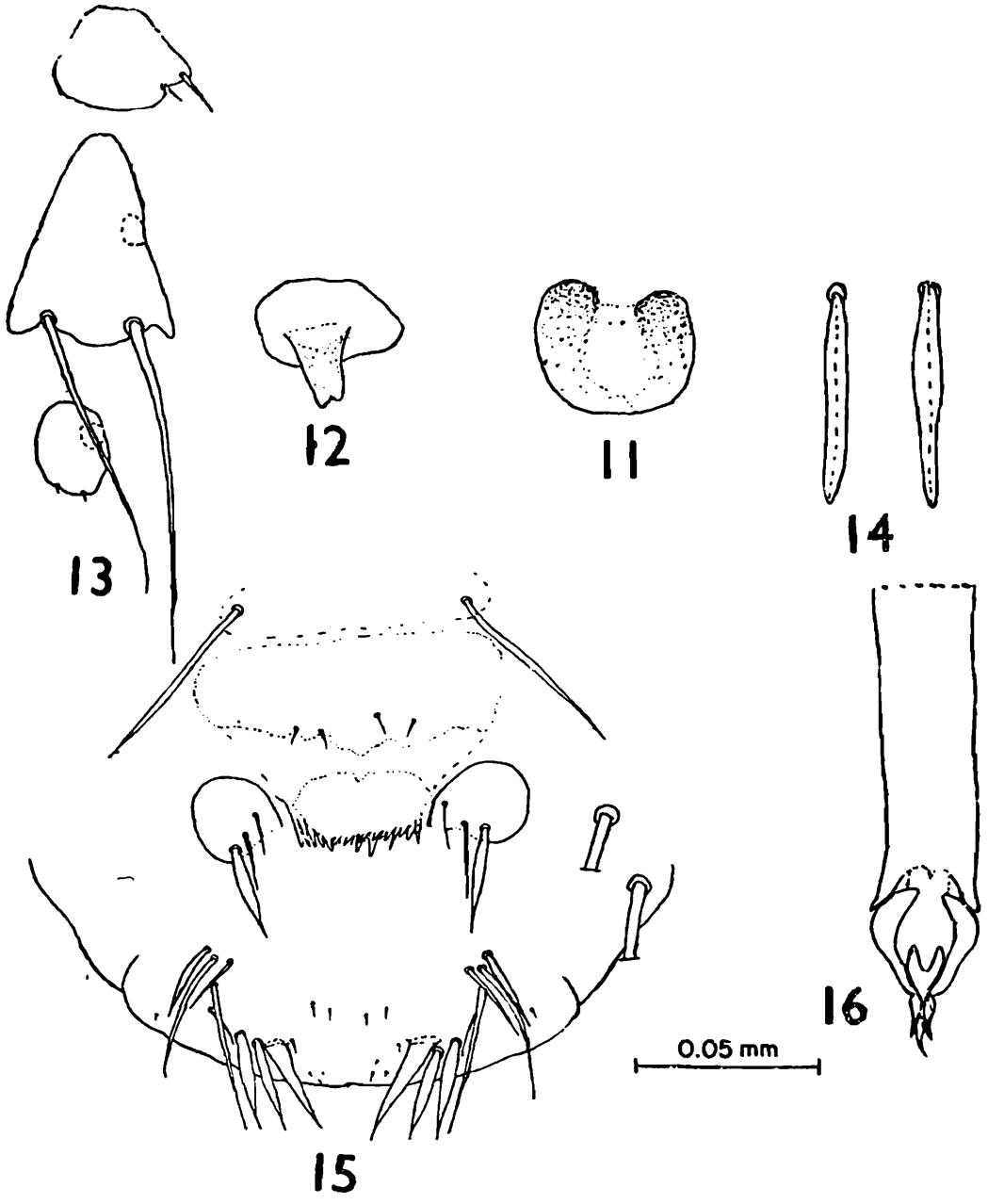
1. **Enderleinellus nishimarui** Kaneko (Figs. 11-16)

Enderleinellus nishimarui Kaneko, 1962, *Bull. Tokyo Med. Dent. Univ.*, **9**: 129-37, figs. III, IV.

According to Kaneko (1962) this species closely resembles *E. platyspicatus* Ferris and can be separated by more numerous tergites in the male and in having a pair of short setae on paratergites II and IV

Female : Total body length 0.63 to 0.66 mm. *Head* longer than wide. Anterior margin rounded, lateral margins almost straight and parallel. Antennae 5 segmented, sensoria on segments 4 and 5 separate. *Thorax.* Sternal plate (Fig. 11) consists of two posteriorly attached kidney-shaped pieces with lateral margins more heavily pigmented than the remainder. *Abdomen.* Tergites absent except one each on segments II and III ; these tergites are with a median pair of minute setae and an outer pair of slender setae. Sternites absent except usual pair of sclerotized plate (Fig. 12) on segment II, and sclerotization of genital region. Paratergites (Fig. 13) present on segments II to IV Paratergites

II and IV each with a pair of small setae ; III with a pair of long setae. Spiracles present on paratergites III and IV only. Typical



Figs. 11-16. *Enderleinellus nishimarui* Kaneko. II. thoracic sternal plate ♀; 12, sclerotized plate of abdominal segment II ♀; 13, paratergites II, III, IV ♀; 14, typical abdominal setae ♀; 15, terminal segments ♀; 16, genitalia ♂

abdominal setae between segments IV and VI are elongate and cuneiform (Fig. 14). *Genitalia* (Fig. 15) Genital plate bears two pairs of small setae, pigmentation gives an appearance of its being divided into two parts. Gonopods paired, rounded in shape, each with a broad, flattened, and two narrow setae. Genital lobe with genital setae thick and flat. Close to genital setae are another 2 thick flattened setae at the outer side and 3 minute setae towards inner side. Posterior to each gonopods is a group of

four medium to long, and two minute setae. Between the gonopods is the opening of vulva beset with numerous, small filamentous processes.

Male : Total body length 0.56 to 0.6 mm. *Head* and *Thorax* as in female. *Abdomen.* Each segment with a single narrow tergite. Sternites absent. Paratergites and typical abdominal setae as in female. *Genetalia* (Fig. 16) consists of a basal apodeme ; a pair of flattened curved parameres, having pointed caudal process projecting outside ; and a triangular pointed pseudopenis.

Nymphs : Unknown.

Hosts and distribution : Known from its type series which consists of *holotype* ♂ *allotype* ♀ *paratypes* 10 ♀ ex *Funambulus pennanti,* from India, Madhya Pradesh, Nalainpur.

2. **Enderleinellus platyspicatus** Ferris

Enderleinellus platyspicatus Ferris, 1919, *Stanford Univ. Publ., Uni. Ser.* 26, figs. 14, 15.—Ferris, 1951, *The sucking* lice, p. 113.

This species was described on the basis of specimens collected ex *Funambulus palmarum* from Colombo, Sri Lanka and is known from its type collection only.

Female and male have been described and illustrated by Ferris (*loc. cit.*). On the basis of available descriptions, the species appears to be similar to *E. nishimarui.* The distinguishing characters are given under *E. nishimarui.*

Genus **Phthirunculus** Kuhn and Ludwig

Phthirunculus Kuhn and Ludwig, 1965, *Senck. Biol.,* **46** : 245.

This is a monotypic genus, represented by *Phthirunculus sumatranus* Kuhn and Ludwig.

Characters : Genus *Phthirunculus* can be separated from all the species of *Enderleinellus* excepting *E. euxeri* by the absence of paired sclerotized plates on the venter of abdominal segment II. However, the inclusion of *E. euxeri* under the genus *Enderleinellus* is mainly based on the shape of paratergites and presence of bifid claws. *Phthirunculus sumatranus* is not related to *E. euxeri* because of the complete absence of paratergites and

in possessing claws which are not bifid. It also differs from the other two genera, namely, *Werneckia* and *Microphthirus* by its 4 segmented antennae, complete absence of paratergites, and in having a large number of characteristic setae.

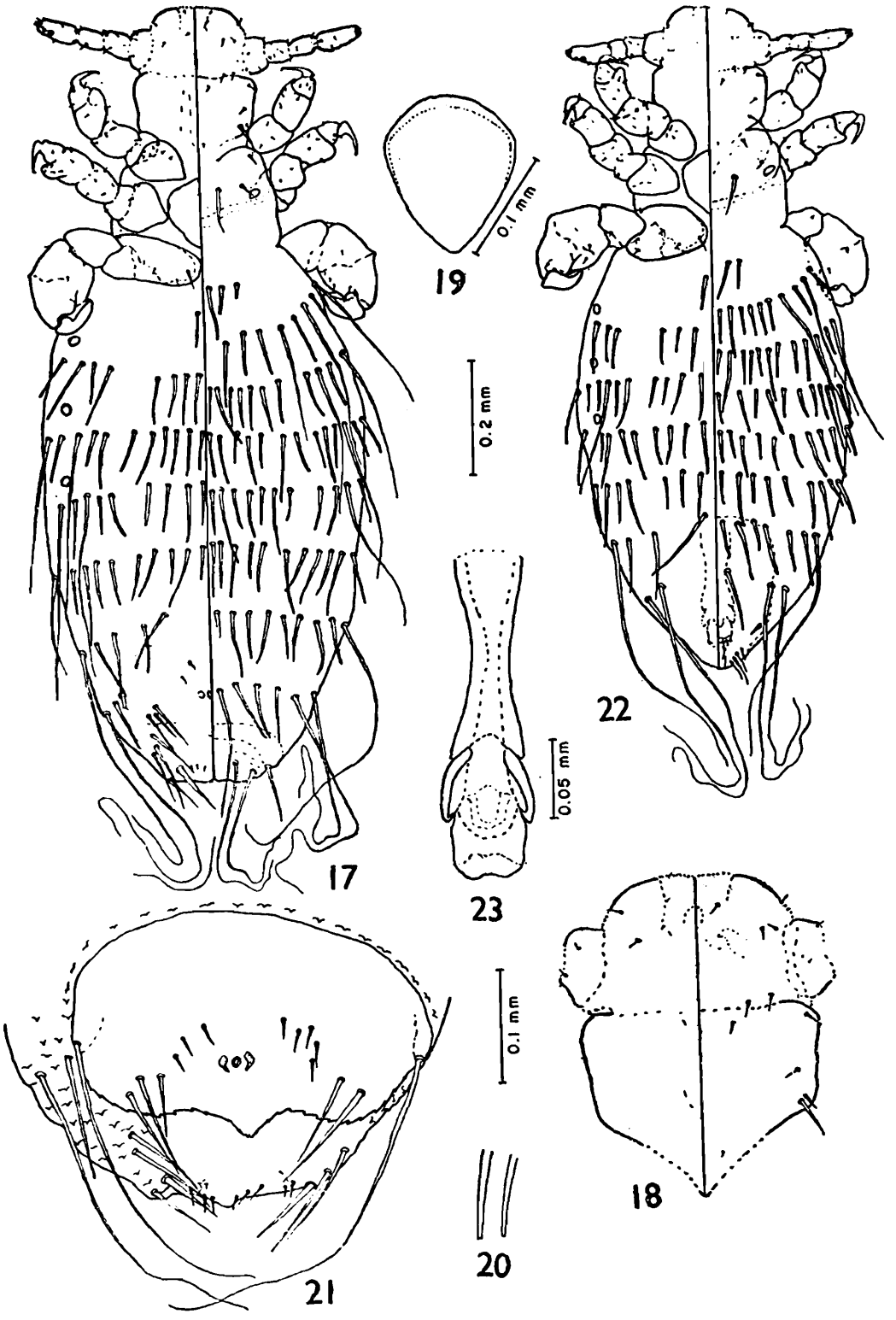
3. **Phthirunculus sumatranus** Kuhn and Ludwig (Figs. 17-24)

Phthirunculus sumatranus Kuhn and Ludwig, 1965, *Senck. Biol* **46**: 245-250, figs. 1-8.—Kim, 1971, *J. med. Ent.*, **8**: 49-51, figs. 1-5.

The species can be easily distinguished from other species of the subfamily Enderleinellinae by the characters given for the genus.

Female (Fig. 17) : Total body length 1.24 mm ($\bar{X}$, N=10) ; range 1.16 to 1.36 mm. *Head* (Fig. 18). Approximately 1.3 × as long as wide ; rounded anteriorly. Anterodorsal head armature broad, convex, heavily sclerotized. Postantennal and occipital angles rounded. Setae arranged as given in figure. ADHS and PoAS absent. AS shifted anteriorly, adjoining PAS. DPHS and VPHS small. Antennae 4 segmented, terminal segment compound having 2 sensoria. *Thorax*. Sternal plate (Fig. 19) 0.14 mm long, 0.11 mm wide ; more or less triangular with anterior margin rounded. Pronotum absent. MDTS one pair, medium sized ; ADTS two pairs, small-sized. *Legs*. Anterior 2 pairs small and slender, with slender claw ; claw apically curved, not bifid ; third pair stout with stout claw. *Abdomen*. Dorsal side with 9 transverse rows of setae : first row with 3 pairs, 2nd to 7th with 9 to 11 pairs, 8th with 5 or 6 pairs, and 9th with 2 pairs of setae. Tergites absent except on terminal segment. *Ventral* side with 6 rows of setae between segments II and VII : first with one pair, 2nd to 5th with 8 to 11 pairs, 6th with 5 or 6 pairs of setae. Segment VIII with 2 or 3 pairs of setae lateral to genital plate. Sternites absent except usual sclerotization of genital region. *Lateral*. Paratergites absent. Segments III to V each with a pair of spiracles. Majority of setae medium sized, with characteristic shape, giving appearance of being truncated at tip (Fig. 20) ; others extremely long, extend up to 3 or 4 segments, sometimes even longer, having sharp pointed tips. *Genitalia* (Fig. 21) Genital plate broad with 2 or 3 pairs of medium sized pointed setae, 3 to 5 pairs of small thin setae, and a pair of long pointed setae laterally. Opening of spermathecal duct

is guarded with a pair of small sclerotized plates. A group of 3 or 4 large and 2 or 3 minute setae on each side posterior to genital plate. Genital seta slightly enlarged.



Figs. 17-23. *Phthirunculus sumatranus* Kuhn and Ludwig. 17. female (ventral and dorsal views) ; 18, head (ventral and dorsal views) ♀ ; 19, thoracic, sternal plate ♀ ; 20, typical abdominal setae ♀ ; terminal segments ♀ ; 22, male (ventral and dorsal views) ; 23. genitalia ♂ .

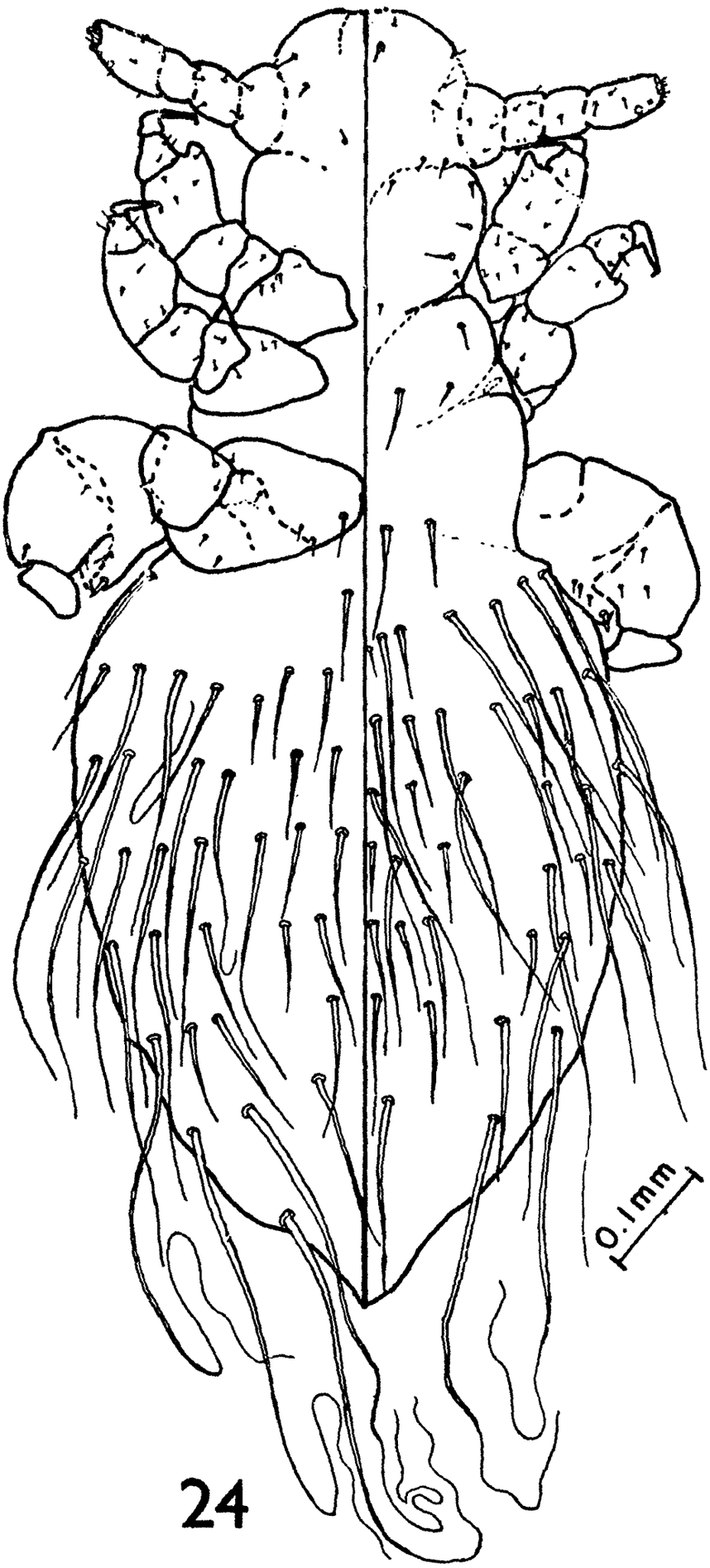


Fig. 24. *Phthirunculus sumatranus* Kuhn and Ludwig. Nymph 3.

Male (Fig. 22) : Total body length 1.14 mm ($\bar{X}$, N=9) ; range 1.01 to 1.19 mm. *Head* and *thorax* as in female. Thoracic sternal plate 0.11 mm long, 0.08 mm wide. *Abdomen* : Tergites and sternites absent except on terminal segment and genital region respectively. Dorsum with 8 rows of setae ; first row with 2 pairs, 2nd to 6th with 8 to 12 pairs, 7th with 7 or 8 pairs, and last with 3 pairs of setae ; terminal segment with several minute setae. Venter with 7 row of setae ; first with one pair, 2nd to 5th with 5 to 10 pairs, 6th with 4 pairs , and last row with 2 pairs of setae. Paratergites absent. Spiracles and setae as in female. Genitalia (Fig. 23). Pseudopenis thick, and blunt, parameres paired and small.

Nymph 1 : Unknown.

Nymph 2 : This has been described by Kim (1971). Specimens were not obtained during the present study.

Nymph 3 (Fig. 24) : Total body length 1.02 to 1.17 mm (N=2). *Head* longer than wide. Anterior, postantennal, and posterolateral margins rounded. Chaetotaxy essentially similar to adults. Antennae 4 segmented, terminal segment with one large and one small sensorium. *Thorax* : Mesothoracic spiracles distinct. MDTS one pair, ADTS two pairs, all small-sized. *Legs* as in adults. *Abdomen* : Tergites and sternites and segmentation absent. Spiracles 3 pairs. Dorsal and ventral sides each with 8 rows of several setae.

Subfamily **Hoplopleurinae** Ferris

Hoplopleurinae Ferris, 1951, The sucking lice, 119.

————————Johnson, 1960, *U.S.D.A. Tech. Bull.*, **1211** : 11.

Characters : First pair of legs small with slender claw ; second pair larger with stouter claw ; third pair largest, generally flattened, with broad claw. Abdominal segment II with its sternal plate laterally extended on each side to articulate with the corresponding paratergites.

Note : Eubfamily Hoplopleurinae was proposed by Ferris (1951) to contain *Pterophthirus* Ewing, *Schizophthirus* Ferris, *Haematopinoides* Osborn, *Ancistroplax* Waterston and *Hoplopleura* Enderlein. Johnson (1972b), after a comparison of the 4

species included under the genus *Pterophthirus* with those under *Hoplopleura* suggested suppression of the name *Pterophthirus* and to include all the species under *Hoplopleura*. These four valid genera of this subfamily contain approximately 120 species. Of these *Haematopinoides* is a monotypic genus ; *Schizophthirus* is represented by 5 species and *Ancistroplax* by 2 speciess.

Only two genera viz., *Ancistroplax* and *Hoplopleura* are recorded in the Indian subcontinent.

Key to the Indian genera of Hoplopleurinae

Antennae 4 segmented. Sternal plate of abdominal segment II divided longitudinally into two expanded plates..... ....*Ancistroplax*

Antennae 5 segmented. Sternal plate of abdominal segment II never so divided..... .....*Hoplopleura*

Genus **Ancistroplax** Waterston

Ancistroplax Waterston, 1929. *Parasitology*, **21** : 161. Ferris, 1951, *The sucking lice*, p. 119.—Johnson, 1964, *Misc. Publ. Ent Soc.* America, **4** : 76.

Type Species: *Ancistroplax crocidurae* Waterston

*Character** : Antennae 4 segmented, terminal segment with a large sensoria. First pair of legs small, with a slender claw ; second pair somewhat larger ; third pair largest, with flattened claw. Abdominal tergites and sternites well developed. Sternite of segment II divided into 2 parts. Female with 3 tergites and 3 sternites on each of the segments III to VI. Male with one tergite and one sternite on each segment, those of segments IV to VI with 2 rows of setae, suggesting fusion of 2 plates on these segments ; tergite of segment VI with posteriolateral angles produced into free process which is bent apically toward midline of body. Paratergites present on abdominal segments II to VIII ; paratergites III to VII gives the appearance of being divided longitudinally into two parts by a median line of weak sclerotization.

Note : The genus contains 2 species, *viz.*, *A. crocidurae* Waterston ex *Crocidura horsfieldi*, and *A. nasuta* Johnson ex *Suncus* or *Crocidura* sp. In the Indian subcontinent, this genus is represented by *A. crocidurae* from *Sri Lanka*.

*Based on Ferris (1951).

4. **Ancistroplax crocidurae** Waterston

Ancistroplax crocidurae Waterston, 1929, *Parasitology*, **21** : 161.—Ferris, 1932, *Contributions toward a monograph of the sucking lice*. pt. 5 : 308. figs. 188, 189.——Ferris, 1951. *The sucking lice*, p. 120, figs. 53, 54.

This species is known from a single collection ex *Crocidura* illustrated by Ferris *(loc. cit)*. Specimens could not be obtained during present study.

Genus **Hoplopleura** Enderlein

Hoplopleura Enderlein, 1904, *Zool. Anz*, **28** :221.

Ferrisella Ewing, 1929, *A manual of external parasites*, p. 198 (Type: *Hoplopleura ochotonae* Ferris).

Ctenura Ewing, 1929, *loc. cit.*, p. 199 (Type : *Hoplopleura pectinata* Cummings).

Euhoplopleura Ewing, 1929, *loc. cit.*, p. 199 (Type : *Hoplopleura trispinosa* Kellogg and Ferris).

Ctenopleura Ewing, 1929, *loc. cit.*, p. 200 (Type : *Hoplopleura cryptica* Ferris).

Type Species : *Pediculus acanthopus* Burmeister, by original designation.

Complete citations of references and synonymies may be found in Ferris (1951), Johnson (1960b, 1964 and 1972b).

Characters : Description of typical members of the genus is given below.

Female : Head with several small setae. Typical head-setae on dorsal side are : OS 2 rows, 2 to 4 pairs each ; PAS, AS, PoAS, ADHS, MDHS, ACHS, PCHS one pair each ; SHS 2 pairs ; MHS 3 pairs ; setae on ventral side are : CS 3 or 4 pairs, VOS 2 rows, 1 or 2 pairs each ; VPHS 1 pair. Antennae 5 segmented, never strongly sexually dimorphic ; sensoria on segments 4 and 5 may be contiguous or well separated. *Thorax* : Mesothoracic spiracles one pair. MDTS one pair, may be short or long ; ADTS normally two pairs, small-sized. There is an indication of small triangular chitinized plate on abdomen between the posterior extremity of hind coxae. *Legs* : First pair smallest, claw slender and pointed ; second pair similar but larger, claw strong but pointed ; third pair much larger and robust, claw broad and flattened. *Abdomen* : Dorsally, segment II with 2 tergites, anterior usually indistinct ; III to VII each with 3 tergites, anterior 2 tergites of segment III normally broad ; VIII and terminal segment each with one broad tergite. All the tergites with a single row of setae. Ventrally, segment II with a

single sternite, lateral extensions produced anterolaterally so as to articulate with the corresponding paratergite, with 3 or 4 thin setae ; III with 4 sternites, first broad with lateral extensions, posterior margin with a group of 2 enlarged setae present laterally on each side and 3 to 5 thin setae mesially ; IV to VI each with 3 sternites ; VII with 2 sternites. All the sternites with a single row of setae. Remaining sternites modified to form genitalia. None to several setae off the plates between the tergites and paratergites (DAAS), or sternites and paratergites (VAAS). *Paratergites* : Segment I is probably reprresented by a small, triangular chitinized plate, lying on the dorsal side, partially fused with paratergite of segment II. Paratergite II with posterior processes acute, one small seta along its dorsal side, and 2 setae of varying length in the cleft on posterior margin ; III to VIII usually well developed and overlapping, provided with 2 setae on the posterior margin. Spiracles present on segments III to VIII. *Genitalia* : Genital plate may be fused anteriorily with posterior sternite of segment VII or well separated ; beset with several small setae. Gonopods lobed and paired, each lobe with 2 to 4 setae. Genital opening sitiuated between the gonopods, beset with numerous small filamentous process. *Anal opening* terminal, several small setae present on anal lobes.

Male : Head and *thorax* as in female. *Abdomen* : Dorsally, segments II and III with 2 tergites, anterior most tergite usually indistinct ; IV to VI each with one or two tergites. Venrally, sternite of segment II and anterior sternite of segment III as in female ; segments IV to VI each with 2 sternites ; VII and VIII each with a single sternite, sometimes fused with one another. Each tergite or sternite provided with a single row of setae. DAAS and VAAS varies from none to several pairs. *Genitalia* : Parameres paired, usually enclosing part of pseudopenis.

Nymphs : Three nymphal instars present. Chaetotaxy of head and thorax almost same as in adults. Other morphological characters are discussed with individual species.

Key to the Indian Species of *Hoplopleura*

1. First sternal plate of abdominal segment III without enlarged setae [Found on *Ochotona* sp.] .....*ochotonae*
   First sternal plate of abdominal segment III with two (rarely three) enlarged setae on each side.....2
2. Paratergite VIII with both dorsal and ventral posterior processes well developed ; typical abdominal setae on tergites and sternites

spine-like, tapering gradually ..... *sinhgarh*
Paratergite VIII devoid of one or both the processes; typical abdominal setae on tergites and sternites swordshaped.....3

3. Paratergites VII with both dorsal and ventral posterior processes present.....4
Paratergites VII devoid of one or both the processes.....7

4. Setae on paratergite III small, almost half the length of the processes; MDTS minute; female with a single pair of VAAS..... *ramgarh*
Setae on paratergite III almost as long as or longer than processes; MDTS long; female with 5 to 7 pairs of VAAS.....5

5. Paratergites IV to VI with dorsal setae minute, ventral long, almost equal to processes; posterior process of thoracic sternal plate truncated at tip..... *silvula*
Paratergites IV to VI with dorsal and ventral setae almost of same size, much shorter than the processes; posterior process of thoracic sternal plate rounded at tip.....6

6. Dorsal posterior process of paratergite VII broad and truncated at tip ..... *sahyadri*
Dorsal posterior process of paratergite VII narrow and pointed ..... *captiosa*

7. Paratergite VII with dorsal posterior processes well developed, ventral absent 8
Paratergite VII devoid of both the processes.....9

8. Paratergite VI with ventral posterior process tapering to a blunt tip; MDTS minute ..... *himalayana*
Paratergite VI with ventral posterior process truncated; MDTS elongated ..... *sicata*

9. Paratergite VI devoid of both the posterior processes..... *phaiomydis*
Paratergite VI with atleast one posterior process present.....10

10. Anterodorsal and anteroventral angles of paratergites IV and V with a well developed process which projects towards the midline of the body..... *erismata*
Paratergites VI and V devoid of such processes.....11

11. Paratergite VI with both dorsal and ventral posterior processes narrow and tapering to a point.....12
Paratergite VI with atleast one of the posterior processes broad, usually truncated at tip.....15

12. Paratergites IV to VI with one seta minute, other long, usually longer than the processes..... *malabarica*
Paratergites IV to VI with both dorsal and ventral setae equal in length, may or may not extend beyond the processes.....13

13. Paratergites III to V with both dorsal and ventral posterior processes small and acute; paratergites IV and V with both setae extending well beyond the processes..... *maniculata*

Paratergites III to V with both the processes well developed; paratergites IV and V with both the setae shorter than the processes.....14

14. Paratergite VI with both setae almost equal to posterior processes; male with a prominent tooth-like projection laterally at the base of pseudopenis.....*acanthopus*
Paratergite VI with both setae extending beyond the posterior processes; male without tooth-like projection at the base of pseudopenis.....*alticola*

15. Paratergites IV to VI with dorsal seta minute, ventral elongated. In female, paratergite VI with dorsal posterior process broad, more or less truncated, ventral narrow and acute.....16
Paratergites IV to VI with both setae small, almost equal in size. In female, paratergite VI with both dorsal and ventral posterior processes broad, somewhat truncated.....18

16. Thoracic sternal plate acute at tip. Female genital plate rectangular. DAAS lacking, VAAS single pair.....*cutchicus*
Thoracic sternal plate blunt or rounded at tip. Female genital plate not rectangular. DAAS and VAAS several pairs.....17

17. Paratergites III to V with dorsal process comparatively much wider than ventral processes. Female with DAAS or VAAS 10 pairs or more. Third nymphal instar with 8 transverse rows of long setae. Specific to *Golunda ellioti*.....*khandala*
Paratergites III to V each with dorsal processes comparatively less wider than ventral processes. Female with DAAS or VAAS less than 10 pairs. Third nymphal instar devoid of transverse rows of setae. Specific to *Rattus* spp.....*pacifica*

18. Paratergites III to V each with dorsal and ventral processes further divided into two lobes of almost equal size; dorsal seta of paratergite III absent. Genital setae in female long and tapering.....*kondana*
Paratergites III to V each with dorsal and ventral lobes truncated and emarginate, but not divided into lobes; dorsal seta of paratergite III present. Genital setae in female short and spine-like.....*blanfordi*

5. **Hoplopleura acanthopus** (Burmeister) (Figs. 25-29, 33, 34).

Pediculus acanthopus Burmeister, 1839, *Genera Quaedam Insectorum*, **1**: no. 5, pl. 1, fig. 2.

Haematopinus acanthopus (Burm.) Denny, 1842, *Monographia Anoplurum Britanniae* p. 25, pl. 24, fig. 3.

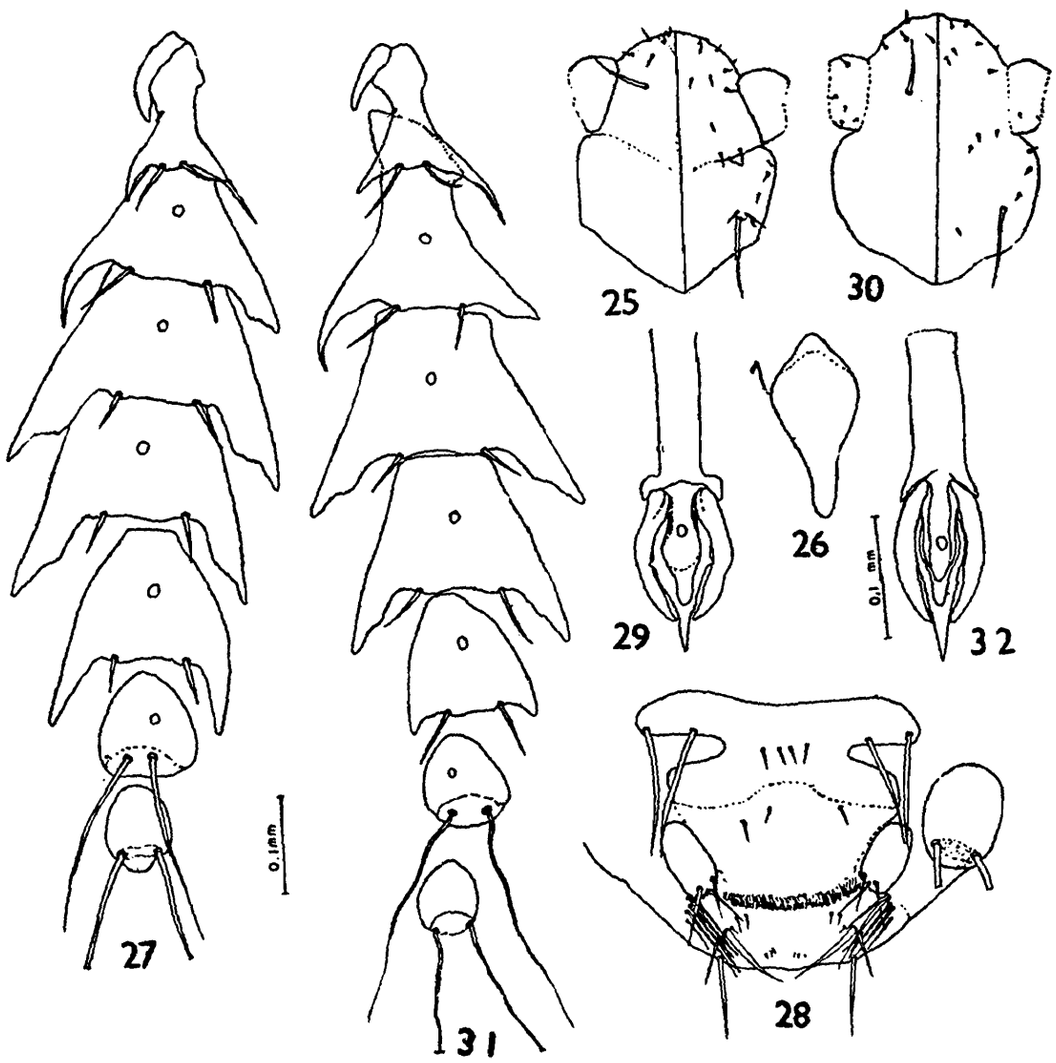
Polyplax acanthopus (Burm.) Enderlein, 1904, *Zool. Anz.*, **28**: 142.

Hoplopleura acanthopus (Burm.) Enderlein, 1904, *Zool. Anz.*, **28**: 221, figs. 1, 2.

Complete citation of references and synonymies is given by

Ferris (1951), Wegner (1966b), Beaucournu (1968) and Kim and Emerson (1971).

Close to *H. alticola* Mishra and Bhat but can be easily distinguished due to the prominent basal tooth-like lateral projections on the pseudopenis of male, and posterior process of paratergite VI of female which is longer than the corresponding setae.



Figs. 25-29. *Hoplopleura acanthopus* (Burm.). 25, head (ventral and dorsal views) ♀; 26, thoracic sternal plate ♀; 27, paratergites ♀; 28, terminal segment ♀; 29, genitalia ♂

Figs. 30-32. *Hoplopleura alticola* Mishra and Bhat. 30, head (ventral and dorsal views) ♀; 31, Paratergites ♀; 32, genitalia ♂

Female : Total body length 1.33 mm. *Head* (Fig. 25) longer than wide. All typical head setae present, ADHS close to PDHS. Antennae with separate sensoria. *Thorax* : Sternal plate (Fig. 26) with posterior process rounded at tip. MDTS one pair, long. *Abdomen* : Tergites and sternites narrow. Typical abdominal

setae sword-shaped. Paratergites (Fig. 27) : II with long posterior processes, both setae medium-sized ; III with dorsal posterior process long and tapering, ventral small and serrated, both setae medium-sized ; IV to VI each with posterior processes well developed and tapering at tip, both setae medium-sized, smaller than lobes ; VII and VIII devoid of processes, each with 2 long setae.

Genitalia (Fig. 28) : Genital setae long, tapering and slightly enlarged.

Male : Total body length 1.03 to 1.05 mm (N=2) *Abdomen* : Tergites and sternites narrow. Segments IV to VI each with 2 tergites. Paratergites as in female. *Genitalia* (Fig. 29) : Parameres almost uniform in thickness ; pseudopenis with prominent basal tooth-like projection and serrated sides.

Nymphs : All the 3 stages have been described and illustrated by Cook and Beer (1959). A careful comparison of 4 nymphs available during the present study reveals that one belongs to the first and 3 to the third nymphal instar.

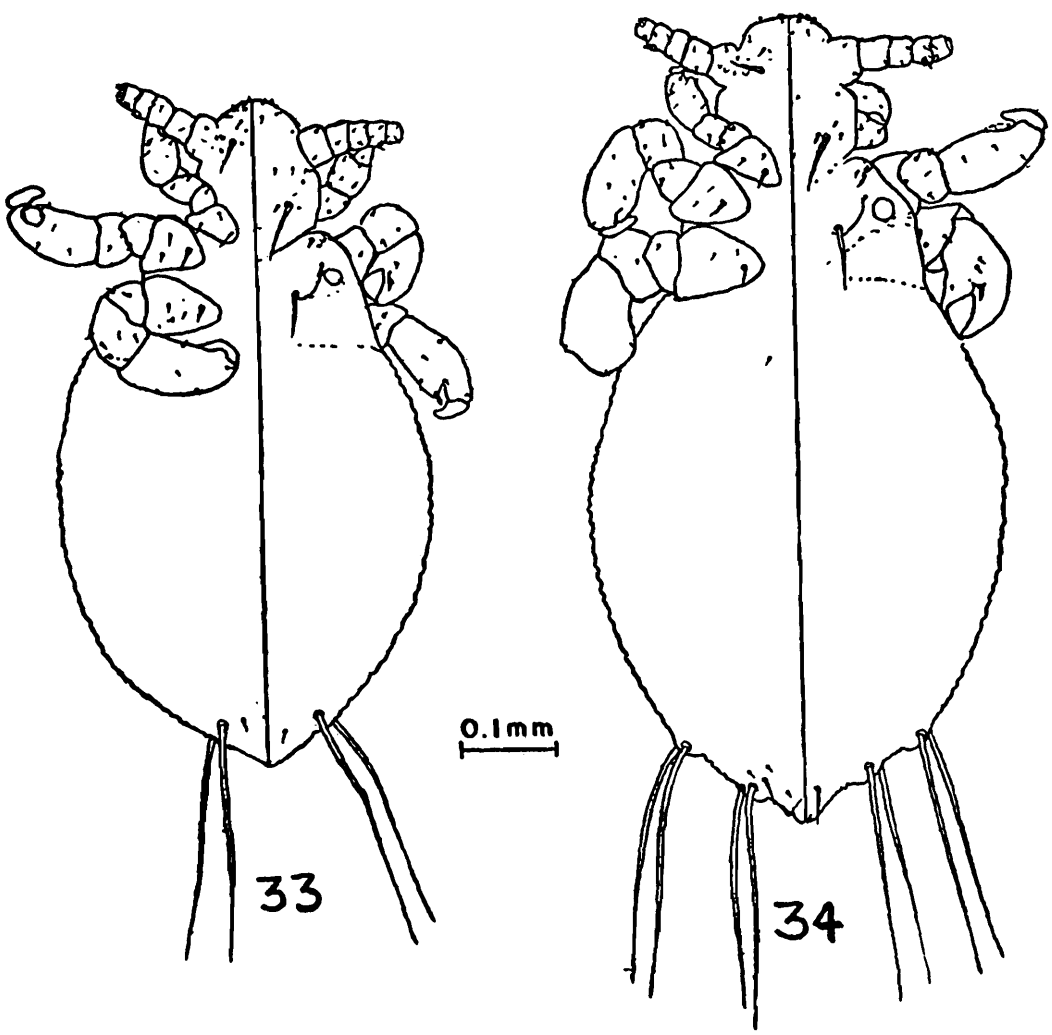
Nymph 1 (Fig. 33) : Total body length 0.67 mm. *Head* longer than wide. Postantennal and occipital angles feebly developed. All typical head setae present, MHS not in a straight line, ADHS small and close to the medium-sized PDHS. Antennal sensoria separate. Ventral surface of antennae and head with variously sized tubercles. *Thorax* : Mesothoracic spiracles distinct. MDTS one pair, medium-sized, ADTS two pairs, minute. Thoracic sternal plate absent. Coxae devoid of distinct tubercles. *Legs* : First pair smallest with slender claw ; second and third pairs similar in size and shape, with blunt claw. *Abdomen* with no evidence of segmentation. DCAS and VCAS absent. MAS one pair on each side. AcS, AnS each single pair.

Nymph 2 : Specimens of this stage were not obtained. According to Cook and Beer *(loc. cit.)* this is similar to nymph 3 but can be distinguished by its smaller size.

Nymph 3 (Fig. 34) : Total body length 0.89 mm ($\bar{X}$ N=3) ; range 0.84 to 0.89 mm. Similar to nymph 1 excepting as follows : *Thorax* with third pair of legs larger than second pair. *Abdomen* with VCAS one pair ; MAS 2 pairs on each side ; AcS 3 pairs.

Hosts and distribution : Regarded as a primary parasite of microtine rodents in both the old and new world but also seems to be established on Palearctic *Mus* (Johnson, 1960b).

In the Indian subcontinent, it has been recorded from *Rattus rattus* in Nainital, U.P. (Wattal *et al.*, 1967) ; and from *Pitymys sikkimensis* in Changu and Kyangnosla, Sikkim (Mishra *et al.*, 1974).



Figs. 33-34. *Hoplopleura acanthopus* (Burm.) 33, npmph 2 ; 34, nymph 3.

6. **Hoplopleura alticola** Mishra and Bhat (Figs. 30-32).

Hoplopleura alticola Mishra and Bhat, 1972, *Oriental Ins.*, **6**: 523-530, figs. 10-18. ——— Mishra *et al.*, 1974, *Indian J. med. Res.*, **62**: 1271.

Adult : Very similar to *H. acanthopus* (Burmeister), described above, but differs due to the shape of head (Fig. 31) ; absence of basal prominent tooth-like lateral projection of pseudopenis in male (Fig. 32) ; and posterior processes of paratergites VII, which are shorter than corresponding setae (Fig. 30).

Nymphs : Unknown.

Hosts and distribution : Known only from type series which consists of *holotype* ♀, *allotype* ♂ , and *paratypes* 10 ♂ 19 ♀, ex.

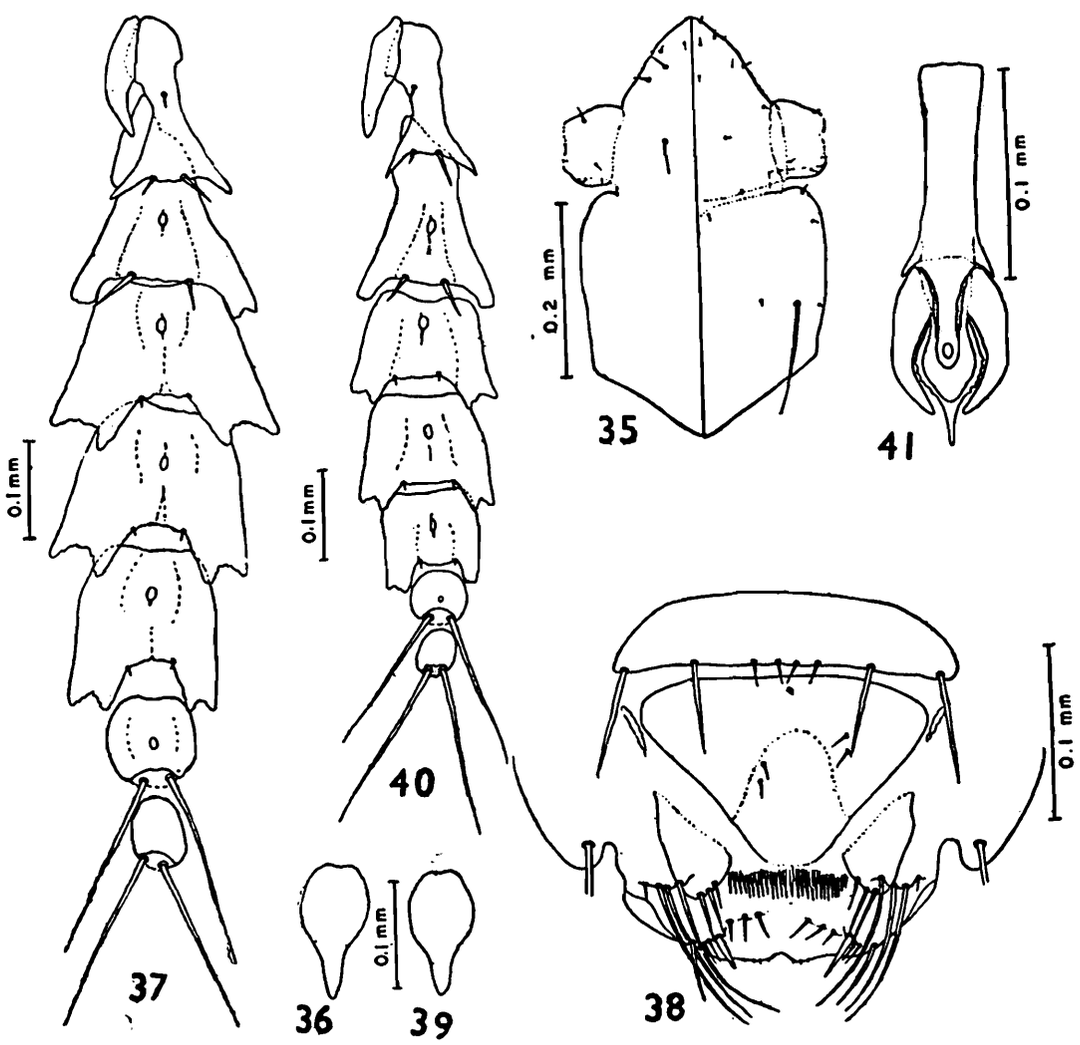
Alticola roylei from various localities in Uttar Pradesh and Himachal Pradesh states of India.

7 **Hoplopleura blanfordi** Mishra and Dhanda (Figs. 35-43).

Hoplopleura blanfordi Mishra and Dhanda, 1972, *J. Parasit.*, **58**: 393-396, figs. 1-9.

Resembles *H. patersoni* Johnson ex *Aethomys* sp. and *H. kondana* sp. nov. ex *Millardia* spp. It differs from former due to the truncated ventral process of paratergite VI, and absence of dorsal process of paratergite VII ; and from latter by the characters given in the key.

Female : Total body length 1.23 mm ($\bar{X}$, N=10) ; range 1.17 to 1.30. *Head* (Fig. 35) approx. 1.7 × as long as wide. Antennal sensoria contiguous. *Thorax* : Sternal plate (Fig. 36) clavate, anterior margin straight, posterior process narrow, gradually



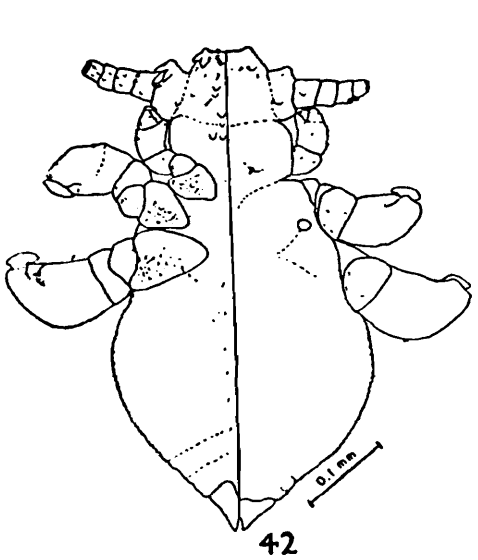
Figs. 35-41. *Hoplopleura blanfordi* Mishra and Dhanda. 35, head (ventral and dorsal views) ♀; 36, thoracic sternal plate ♀; 37, paratergites ♀; 38, terminal segments ♀; 39, thoracic sternal plate ♂, 40, paratergites ♂ ; 41, genitalia ♂.

tapering with rounded apex ; MDTS minute. *Abdomen* : Typical setae sword-shaped. DAAS one pair ; VAAS 4 pairs. Paratergites (Fig. 37). II typical, dorsal seta longer than ventral, both shorter than processes ; III with both processes broad and truncated, dorsal seta equal to and ventral smaller than lobes ; IV to VI each with posterior processes as for III, both setae minute ; VII and VIII devoid of processes both setae long. *Genitalia* (Fig. 38) : Genital seta short and slightly enlarged.

Male : Total body length 0.88 mm ($\bar{X}$, N = 10 ; range 0.83 to 0.94 mm. *Abdomen* : Segments IV to VII each with a single tergite. DAAS absent ; VAAS 2 pairs. Paratergites (Fig. 40) as in female. *Genitalia* (Fig. 41) : Parameres thickened near base ; pseudopenis pointed towards tip.

Nymph 1 : Unknown.

Nymph 2 (Fig. 42) : Total body length 0.52 mm. *Head* longer than wide. Anterolateral angles with strong hook-like protuberance, giving the anterior margin somewhat concave appearance ; postantennal angles rounded. Dorsal head-setae minute, or indistinct ; DPHS short, thorn-like ; ventral setae CS, VOS and VPHS distinct. Antennal sensoria small and separate.



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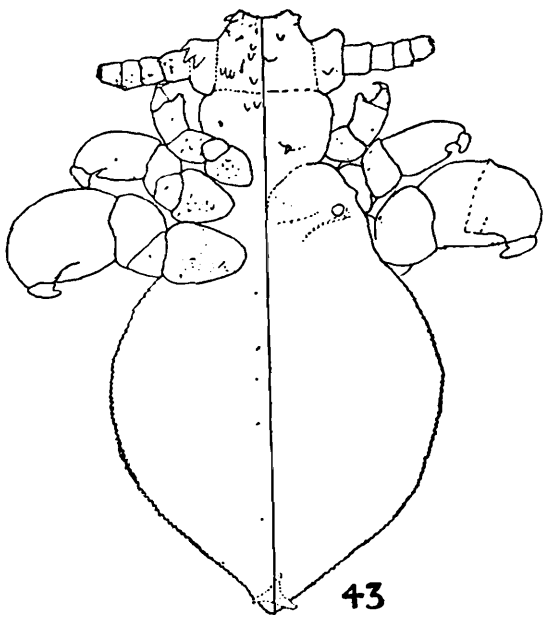

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Figs. 42-43. *Hoplopleura blanfordi* Mishra and Dhanda. 42, nymph 2 ; 43, nymph 3.

Ventral surface of head and antennae with well developed, sparsely scattered tubervles. *Thorax* : Mesothoracic spiracles distinct. Sternal plate absent. Setae minute, rarely delineable. *Legs* as in adults. *Abdomen* : Spiracles absent. VCAS 6 pairs.

DCAS, MAS, AcS and AnS indistinct. Terminal segment bifurcated and guarded by paired chitinized structure.

Nymph 3 (Fig. 43) : Total body length 0.69 mm ($\bar{X}$, N=12) ; range 0.65 to 0.78 mm. Similar to nymph 2.

Hosts and distribution : Known ex *Rattus blanfordi* from various localities in Maharashtra and Karnataka states (Mishra and Dhanda *loc. cit.*, Mishra *et al.* 1977) ; and by 1 ♂ , 1 ♀ from Orissa State, Matkhai forest, INDIA (V.R.C. unpublished date).

8. **Hoplopleura captiosa** Johnson (Figs. 44-50).

Hoplopleura captiosa Johnson 1960, *U.S.D.A. Tech. Bull.* **1211**: 23-28, figs. 23C, 24C, 25C, 26, 27, 37A, B. (Partim, not the records from *Mus cervicolor*, Thailand).

Hoplopleura musculi Wegner, 1961, *Bull. Inst. Mar. Med.* Gdansk, **12**: 155-164, figs. 1-3.

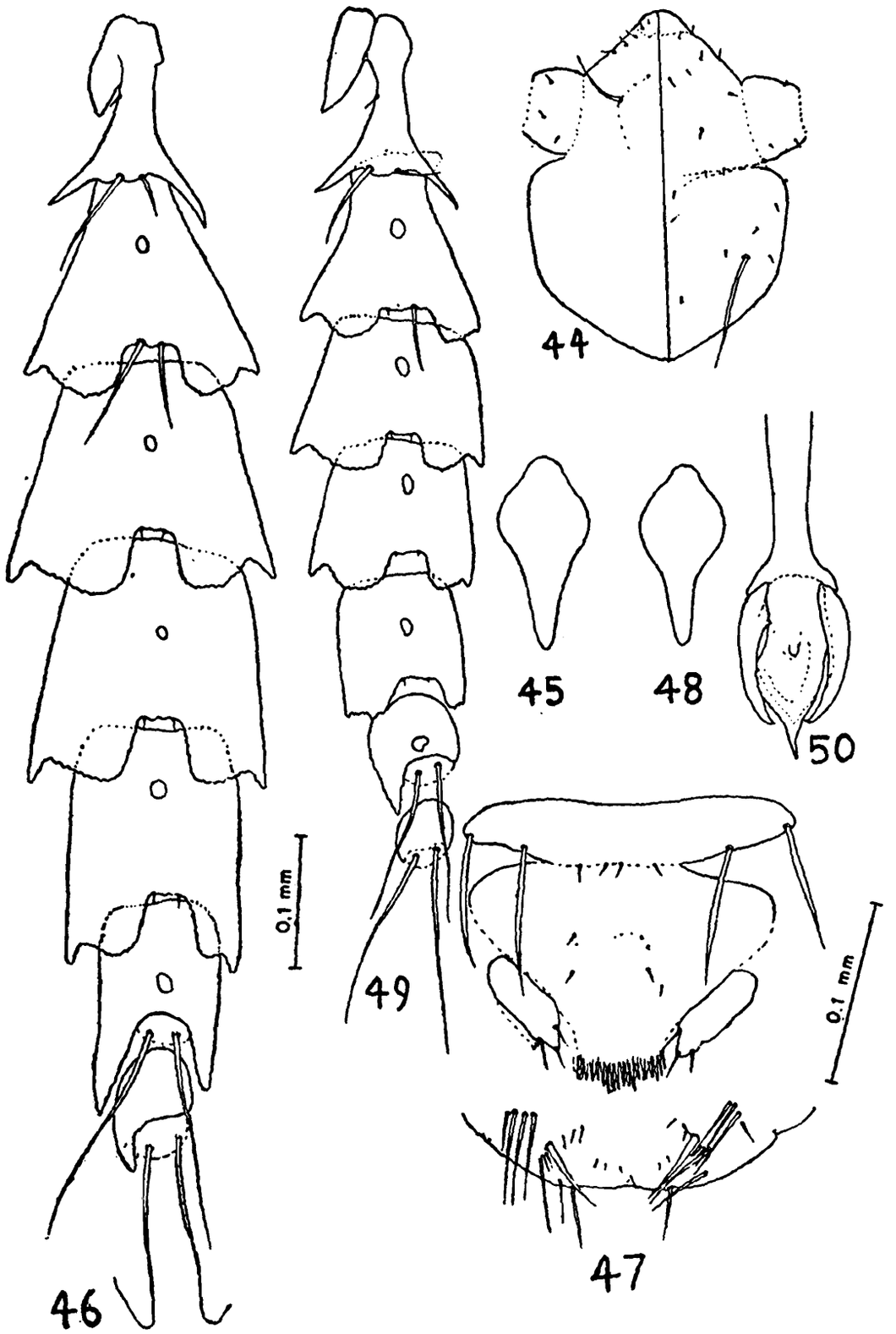
A complete citation of references and synonymies is found in Johnson (1960b), Kim (1965, 1966a) and Kim and Emerson (1971).

It is close to *H intermedia* and allies (Johnson, 1972c) of the *hesperomydis* group (*sensu* Kim, 1965) due to the presence of PDHS. However, it closely resembles *H johnsonae* Kim and *H. sahyadri* sp. nov. and can be differentiated due to its narrow and acute posterior processes of paratergite VII. *H. johnsonae* is best recognized in nymphal stages (Kim, 1966a).

According to Kim (1966a) setae on paratergite III in the males of *H. captiosa* are essentially similar to females ; and *H johnsonae* Kim ex *Mus cervicolor* has one minute and other long setae. During present study, all the male specimens of typical *H. captiosa* taken from *Mus musculus,* were found to have setae as described for *johnsonae* and none as described for *captiosa* by Kim (*loc. cit.*). Kim also gives this character as one of distinguishing character between *H. johnsonae* and *H. captiosa.*

Female : Total body length 1.34 mm ($\bar{X}$, N=5) ; range 1.26 to 1.42 mm. *Head* (Fig. 44) longer than wide. All the typical head setae present, MHS not in a straight line. Postantennal angles broad ; postantennal lateral margins almost straight. Antennal sensoria large and contiguous. *Thorax* : Sternal plate (Fig. 45) with a long posterior process, rounded at tip. MDTS long. *Abdomen* : Tergites and sternites well sclerotized. Typical abdo-

minal setae sword-shaped. DAAS absent. VAAS 4 to 6 pairs. Paratergites (Fig. 46) : II typical, dorsal paratergal seta longer and ventral shorter than processes of their sides ; III to VI each



Figs. 44-50. *Hoplopleura captiosa* Johnson. 44, head (ventral and dorsal views) ♀; 45, thoracic sternal plate ♀; 46 paratergites ♀; 47, terminal segments ♀; 48, thoracic sternal plate ♂; 49, paratergites ♂; 50, genitalia ♂

with posterior process lobed, lobes truncated, both setae short except on paratergite III, which extends beyond the apices of lobes ; VII with both processes acute, dorsal longer than ventral ; VIII with dorsal lobe long and acute, ventral lobe absent. *Genitalia* (Fig. 47) : Each genital lobe with 3 thin setae Genital setae long, tapering and a little enlarged.

Male : Total body length 0.95 mm ($\bar{X}$, N=6) ; range 0.92 to 1.02 mm. *Abdomen* : Tergites and sternites well developed. Segments IV to VI each with a single tergite. Paratergites (Fig. 49) : II, IV to VI as in female ; III with dorsal seta minute, ventral longer than process of its side ; VII wiih small and acute dorsal process, ventral process absent ; VIII devoid of posterior processes. *Genitalia* (Fig. 50) : Parameres almost uniform in thickness ; pseudopenis narrow and pointed apically, margins serrated.

Nymphs : All 3 nymphal stages have been described and illustrated by Kim (1966) and Wegner (1966a) During present study only nymph 2 and nymph 3 have been obtained. Brief description of these stages are given below.

Nymph 2 : Total body length 0.59 mm ($\bar{X}$, N=4) ; range 0.56 to 0.62 mm. *Head* : Typical setae present. Antennal sensoria large and contiguous. Venter of head and antennae with sparsely scattered blunt tubercles. *Thorax* : MDTS one pair, medium-sized ; ADTS 2 pairs, small. Sternal plate absent, coxae with small tubercles. Legs as in adults. *Abdomen* with 6 pairs of paratergites. Each paratergite with a spiracle. VCAS 1 or 2 pairs, DCAS absent. AnS 2 or 3 pairs. A single MAS present on each side.

Nymph 3 : Total body length 0.69 mm ($\bar{X}$, N=5) ; range 0.63 to 0.75 mm. Same as nymph 2.

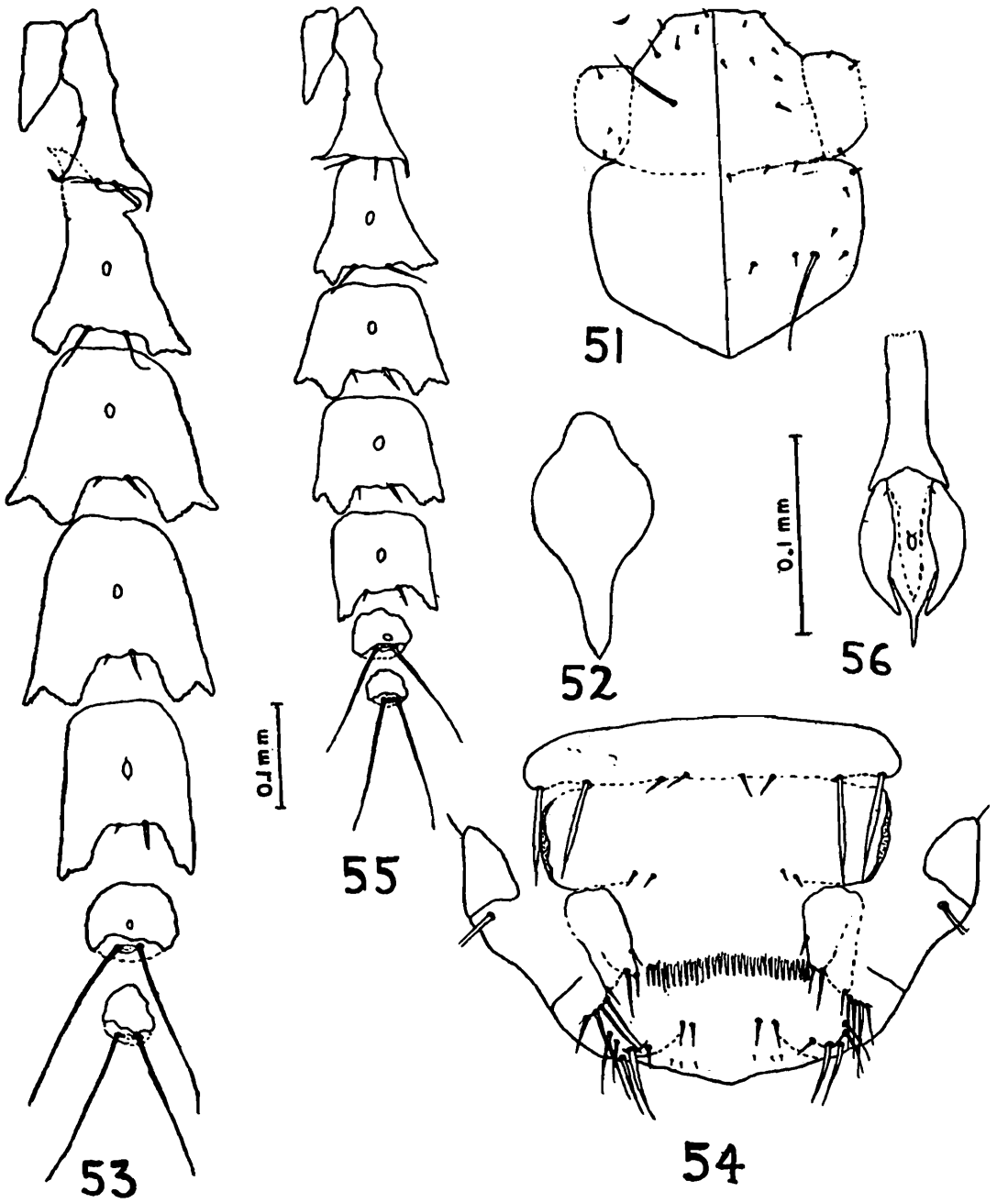
Hosts and distribution : This is regarded as a primary parasite of *Mus musculus* and is commonly recorded on it and several other *Mus* sp. in Palearctic and Oriental regions.

In the Indian subcontinent, it is recorded from *Mus booduga* in Madhya Pradesh (Mitchell *et al.* 1966), and from *Mus musculus* and some other hosts from number of localities in Jammu and Kashmir, Himachal Pradesh, and Uttar Pradesh states of INDIA (Mishra *et al.* 1974).

9. Hoplopleura cutchicus Mishra and Kaul (Fig. 51-56).

Hoplopleura cutchicus Mishra and Kaul, 1973. *J. Med. Ent.*, **10**: 43-44, figs. 1-9.

Closely resembles *H. blanfordi* Mishra and Dhanda and *H. pacifica* Ewing but can be easily separated due to the following characters : Thoracic sternal plate with posterior process acute at tip ; MDTS medium-sized ; and paratergites IV to VI with dorsal seta thin and minute, ventral stout but smaller than processes.



Figs. 51-56. *Hoplopleura cutchicub* Mishra and Kaul. 51, head (ventral and dorsal views) ♀; 52, thoracic sternal plate ♀; 53, paratergites ♀; 54, terminal segments ♀; 55, paratergites ♂; 56, genitalia ♂.

Female : Total body length 1.11 mm ($\bar{X}$; N=8) ; range 1.00 to 1.18 mm. *Head* (Fig. 51) approx. 1.1 x as long as wide. Antennal sensoria contiguous. *Thorax* : Sternal plate (Fig. 52) pear-shaped, with small rounded process anteriorly and long posterior process, acute at tip. MDTS small-sized. *Abdomen* : Typical setae sword-shaped. DAAS absent ; VAAS one pair. Paratergites (Fig. 53) : II typical, setae as long as lobes ; III with posterior process serrated and truncated, both setae extending beyond the lobes ; IV, V each with posterior process with outer angles pointed, posterior margins serrated and emarginate, dorsal seta minute, ventral stout but smaller than lobes ; VI as V except narrower processes ; VII and VIII devoid of lobes, both setae long. *Genitalia* (Fig. 54) : Genital seta slightly enlarged and modified.

Male : Total body length 0.78 and 0.88 mm (N=2). *Abdomen* : Segments IV to VI each with a single tergite. DAAS and VAAS absent. Paratergites (Fig. 55) as in female. *Genitalia* (Fig. 56) : Parameres thickened near base, pseudopenis pointed towards tip.

Nymphs : Unknown.

Hosts and distribution : Known only from type-series which consists of *holotype* ♀, *allotype* ♂ *paratypes* 2 ♂, 8 ♀, ex *Rattus (Cremnomys) cutchicus* from various localities in Rajasthan state INDIA.

10. **Hoplopleura erismata** Ferris

Hoplopeura erismata Ferris, 1921, *Contributions toward a monograph of the sucking lice*, pt. 2 : 113, figs. 72 B, E, F.

———Hopkins, 1949. *Zool. Soc. Proc.* (London), **119** : 459, 460. ———Ferris, 1951, *The sucking lice*, p. 136. ———Johnson, 1958, *Bull. Brook. Ent. Soc.*, **53** : 41.. ———Johnson, 1959. *Proc. U. S. Nat. Mus.*, **110** : 580, figs. 20, 21, 24, 26. ———Johnson, 1964, *Misc. Publ. Ent. Soc.* America. **4** : 74. ———Kim, 1966, *Parasitology*, **56** : 611. ———Blagoveshtchensky, 1972, *Rev. Ent.* USSR, **51** : 307.

Closely resembles *H. thurmanae* Johnson ex *Tamiops macclellandi* and *H maniculata* (Neumann) ex *Funambulus* spp. It can be separated from former due to apical setae of paratergites IV to VI which extends much beyond the produced angles of the plates ; and from latter due to the well developed anteroventral and anterodorsal angles of paratergites IV and V, which projects towards midline of the body.

Adults : Antennal sensoria small and widely separated. Thoracic sternal plate almost rectangular in shape. Paratergites with short, pointed posterior processes ; paratergites IV and V with anterior angles strongly produced towards middle of the body ; setae on paratergites IV to VI extend far beyond processes of their respective plates.

Nymphs : Unknown.

Hosts and distribution : Known ex *Callosciurus ferrugineus* from Southeast SIAM, ex *C. ferrugineus, C. caniceps* from THAILAND, ex *Tamiops* sp. from BURMA (Ferris, 1951) ; ex *C. f. tacherdi* from THAILAND (Johnson, 1959) ; *C. nigrovittatus* from Malaya (Johnson, 1964) ; *C. erythraceus, C. pygerythrus* from CHINA and VIETNAM regions (Blagoveshtchensky, 1972b) ; and *C. f ferrugineus, C. macclellandi* and *Funambulus palmarum* from INDIA (Ansari, 1951).

Johnson (1959) presumes that record from *Tamiops* sp. should actually be *H thurmanae* Johnson.

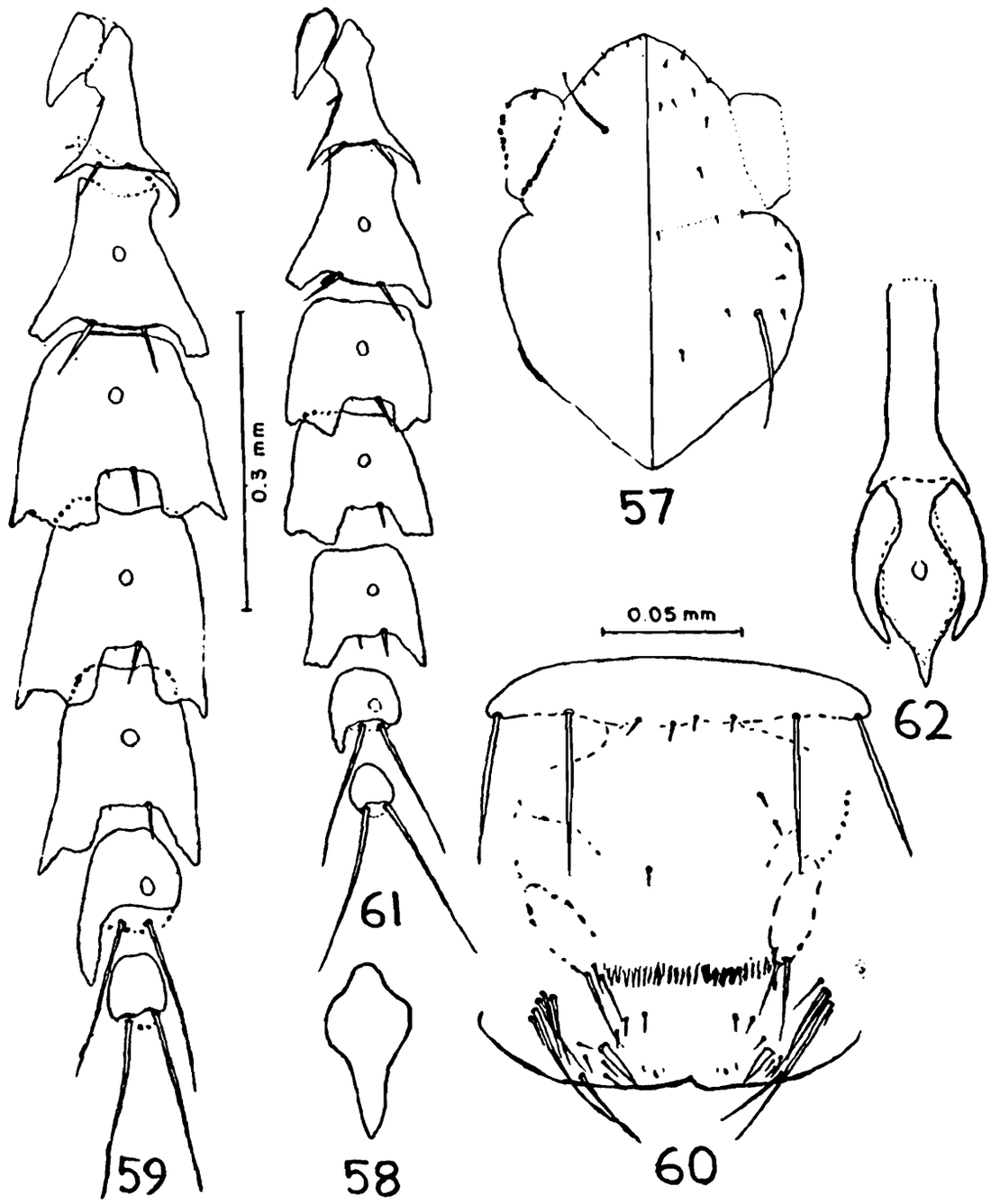
11. **Hoplopleura himalayana** Mishra, Kulkarni and Bhat (Figs. 57-65)

Hoplopleura himalayana Mishra *et al.*, 1973, *Oriental Ins.*, **7** : 501-06, figs. 1-10. ————Mishra *et al.*, 1974, *Indian J. med. Res.*, **62** : 1272.

On the basis of adult morphology, it is a member of *H. pacifica* group (sensu, Johnson 1972a) However, it closely resembles *H. akanezumi* Sasa, ex *Apodemus speciosus* : and *H. hmianezumi* Kaneko ex *Apodemus arenteus*. It can be separated from former due to short MDTS and from latter due to the shape of thoracic sternal plate and comparatively broader dorsal lobe of paratergite III.

Female : Total body length 1.28 mm ($\bar{X}$, N=10) ; range 1.17 to 1.46 mm. *Head* (Fig. 57) approx. 1.4 x as long as wide. Antennal sensoria contiguous. MHS not in a row. *Thorax* : Sternal plate (Fig. 58) pear shaped with a small process anteriorly and a long tapering process posteriorly, rounded at tip. MDTS minute. *Abdomen* : Typical setae sword-shaped. DAAS one or 2 pairs. VAAS 5 to 8 pairs. Paratergites (Fig. 59) : II typical, dorsal seta equal to and ventral shorter than processes of its side ; III with processes broad and truncated, both setae extends beyond the lobes ; IV to VI each with lobes truncated and slightly emarginate having pointed posteroouter angles ; dorsal seta minute, ventral almost as long as lobes ; VII with narrow dorsal process,

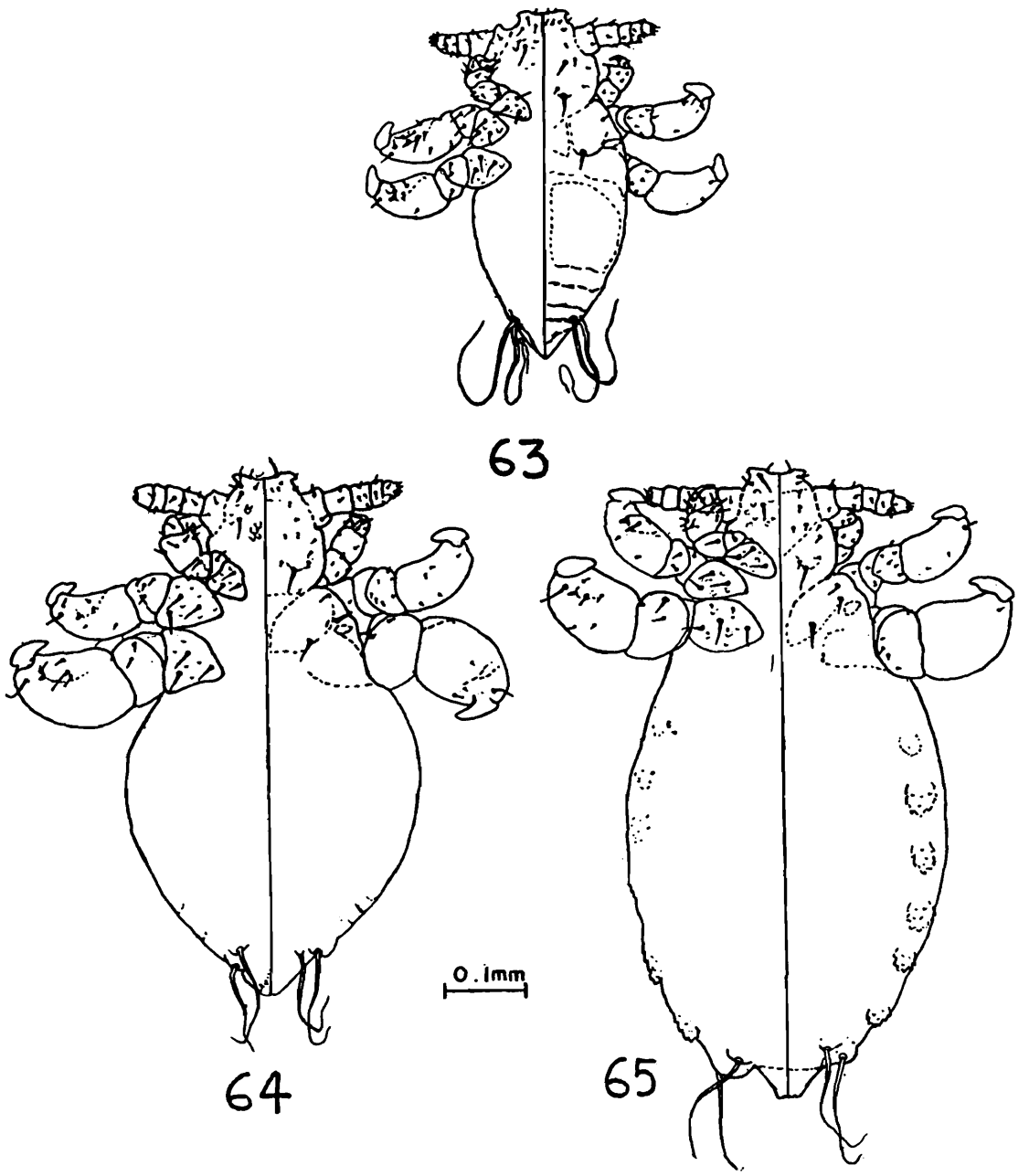
ventral lobe absent, both setae long ; VIII devoid of processes, both setae long. *Genitalia* (Fig. 60) : Genital setae enlarged and modified.



Figs. 57-62. *Hoplopleura himalayana* Mishra, Bhat and Kulkarni. 57, head (ventral and dorsal views) ♀ ; 58, thoracic sternal plate ♀; 59, paratergites ♀; 60, terminal segments ♀; 61, paratergites ♂ ; 62, genitalia ♂

Male : Total body length 0.97 mm ($\bar{X}$. N=10) ; range 0.92 to 1.08 mm. *Abdomen* : Segments IV to VII each with a single tergite. DAAS absent. VAAS 1 to 3 pairs. Paratergites (Fig. 61) as in female. *Genitala* (Fig. 62) : Parameres thickened near base, pseudopenis pointed towards tip.

Nymph 1 (Fig. 63) : Total body length 0.4 mm. *Head* longer than wide. Anterior margin straight, anterolateral angles with hook-shaped tubercles. Postantennal and posterolateral angles not prominent ; CS, OS, PAS, AS, VPHS distinct ; ISHS much longer than OSHS, MHS 2 pairs ; DPHS one pair, medium-sized ; ADHS one pair ; ACHS, PCHS, PoAS indistinct. Antennal sensoria contiguous. Ventral surface of head and antennae with sparsely scattered tubercles. *Thorax* : Mesothoracic spiracles distinct.



Figs. 63-65. *Hoplopleura himalayana* Mishra, Bhat and Kulkarni. 63, nymph 1 ; 64, nymph 2 ; 65, nymph 3.

Sternal plate absent. MDTS and ADTS one pair each. *Legs* : First pair smallest with slender claw ; second pair considerably larger with blunt claw ; third pair similar to second. *Abdomen* : Dorsal

side with distinct segmentation ; DCAS and VCAS absent ; a pair of long MAS present on each side ; AcS and AnS indistinct.

Nymph 2 (Fig. 64) : Total body length 0.73 mm ($\bar{X}$, N=5) ; range 0.58 to 0.84 mm. Similar to nymph 1 except as follows : *Head* : ISHS and OSHS similar in size. *Thorax* with 2 pairs of ADTS. Third pair of legs larger than second pair. *Abdomen* devoid of distinct segmentation ; 2 or 3 small leathery patches present distally at lateral extremities ; AnS 2 pairs.

Nymph 3 (Fig. 65) : Total body length 0.76 and 0.85 mm (N=2). Similar to nymph 2, except that abdomen with 7 pairs of distinct leathery patches laterally.

Hosts and distribution : Known from type series which consist of *holotype* ♀ ; *allotype* ♂ ; and *paratypes* 183 ♂ , 383 ♀, ex *Apodemus flavicollis,* 5 ♀ ex *Mus musculus,* 1 ♂ , 4 ♀ ex *Alticola roylei ;* and 11 nymphs ex. *A. flavicollis* from various localities in Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh (Mishra *et al.,* 1974).

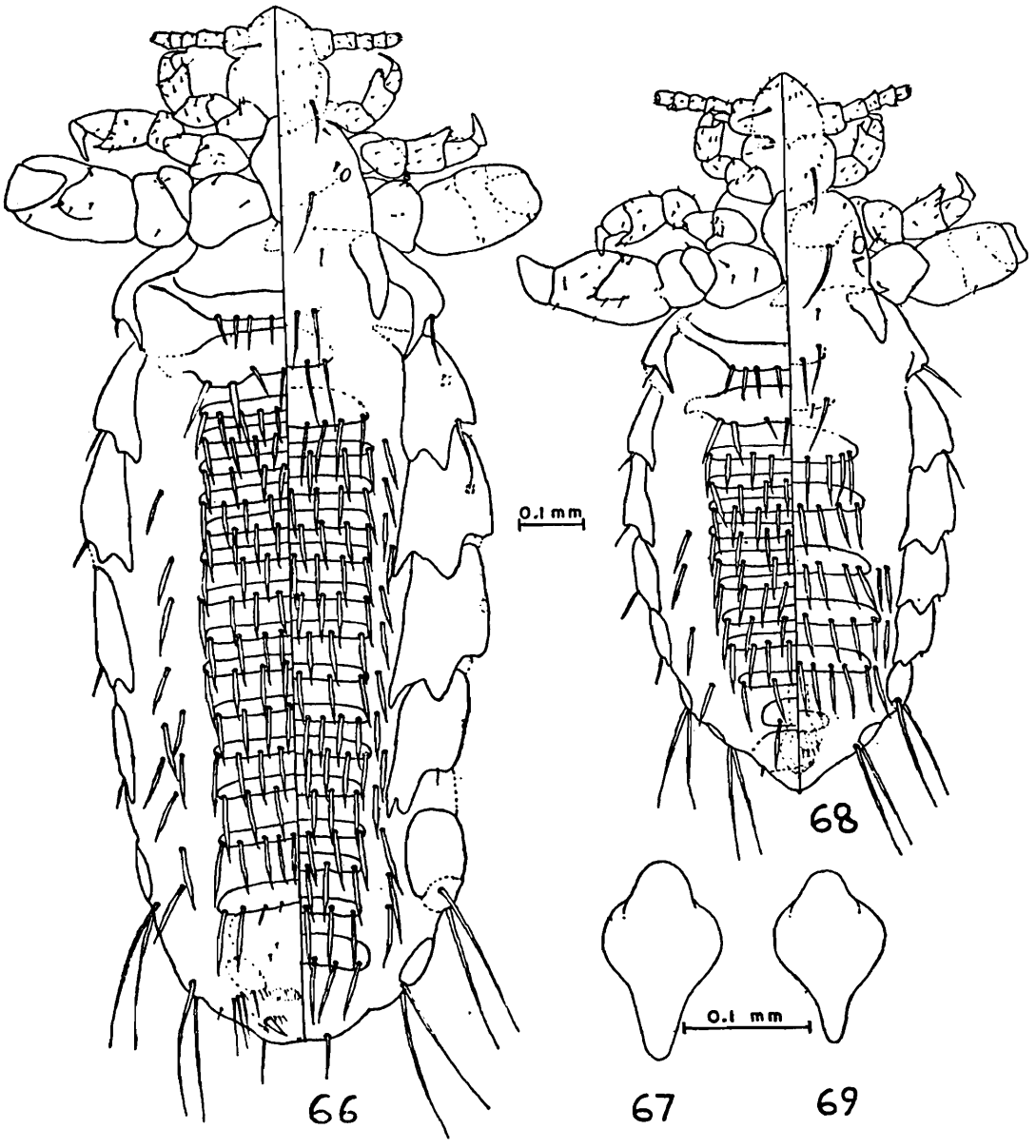
12. **Hoplopleura khandala** sp. nov (Fig. 66-77).

On the basis of adult morphology, this species closely resembles *H. pacifica,* and can be considered as a member of *H. pacifica* group (*sensu* Johnson, 1972a). However, it is separable from *H. pacifica* due to larger size, comparatively broader dorsal process than ventral of paratergite III to V ; and more than 10 DAAS in female.

Though separation of adult stages are difficult, the species is best recognised in its nymphal stage. Nymph 3 is unique due to the possession of 8 transverse rows of long abdominal setae.

Female (Fig. 66) : Total body length 1.51 mm ($\bar{X}$, N=10) ; range 1.32 to 1.64 mm. *Head* (Fig. 70 : Approximately 1.3 x as long as wide. Postantennal angles rounded. All typical head setae present, ADHS set well apart from MDHS, MHS not in a straight line. Antennal sensoria ccontiguous. *Thorax* : Thoracic sternal plate (Fig. 67) 0.16 mm long, 0.1 mm wide ; pear shaped, posterior process rounded at apex. MDTS long, one pair ; ADTS minute, two pairs. *Abdomen. Dorsal* : Segment II with a single tergite ; two rows of setae, anterior consists of 2 minute and posterior with 2 pairs of thin and elongate setae, posterior row associated with tergite. Segments III to VII each with 3 tergites, having 5 to 9 setae each, except first tergite of segment III which

bears only 4 setae ; VIII and terminal segments each with a single tergite, having 5 and 2 setae respectively. DAAS 11 to 13 pairs. *Ventral* : Segment II with a single typical sternite, having

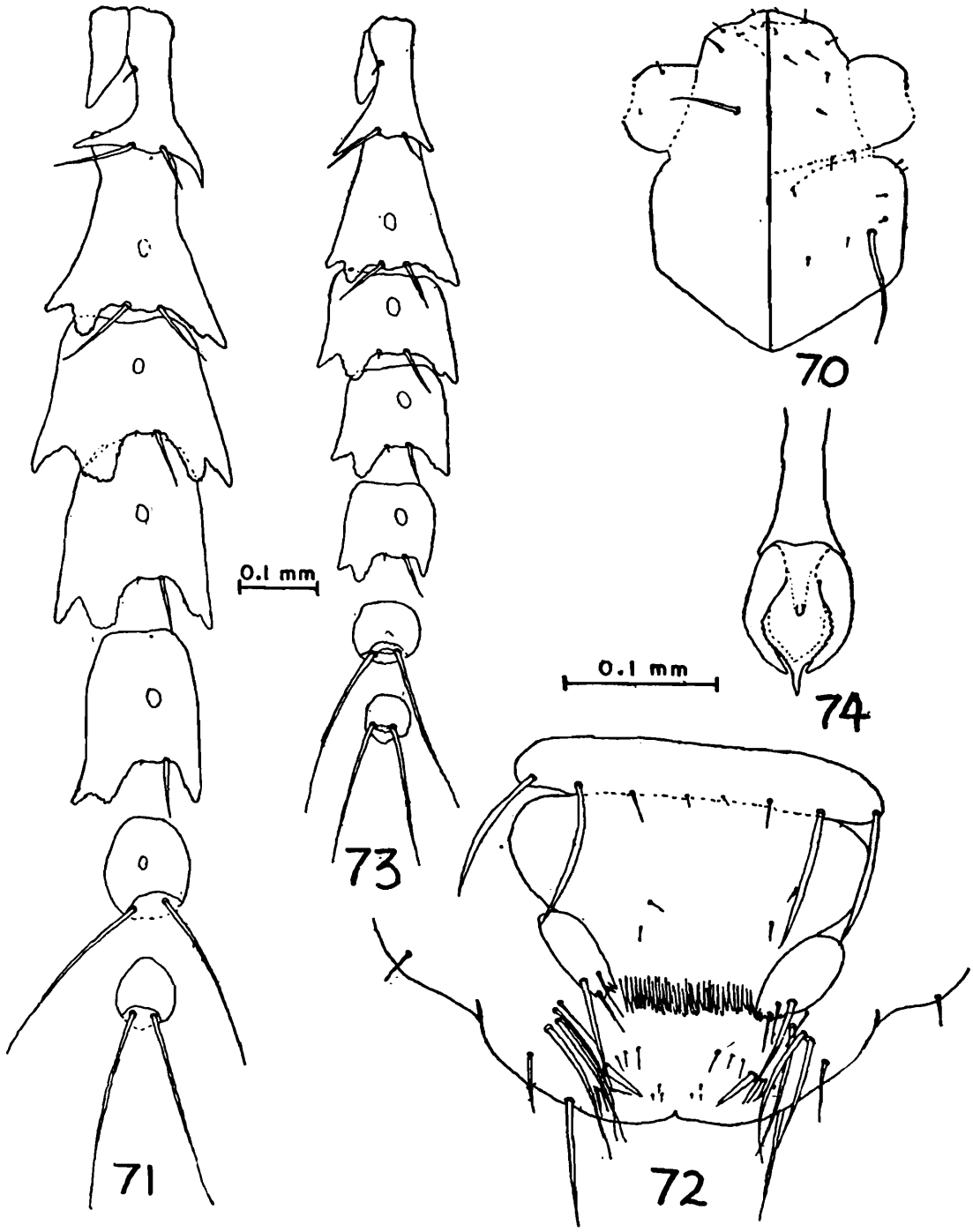


Figs. 66-69. *Hoplopleura khandala* sp. nov. 66, female (ventral and dorsal views) ; 67, thoracic sternal plate ♀ ; 68, male (ventral and dorsal views) ; 69, thoracic sternal plate ♂

8 setae ; III with 4 sternites, first one typical, 2 groups of 2 enlarged setae laterally and 3 narrow setae mesially remaining sternites narrow with 7 to 9 setae each ; IV to VI each with 3 narrow sternites, having 6 to 8 setae each ; VII with 2 sternites, anterior narrow with 9 setae, posterior broad with 2 pairs of long and 2 pairs of small setae. Remaining sternites modified to form genitalia. VAAS 10 to 12 pairs. *Lateral* : Paratergites (Fig. 71) : II typical ; III to V each bilobed, lobes emarginate and serrated, dorsal lobe broader than ventral ; VI with dorsal lobe broad and emarginate ventral lobe almost acute ; VII and VIII devoid of

lobes. Paratergite II with 2 setae, dorsal smaller and ventral longer than lobes of their sides ; III with both setae reaching beyond lobes ; IV to VI each with dorsal seta minute, ventral longer than lobe of its side ; VII and VIII each with a pair of long setae. *Genitalia* (Fig. 72) : Genital plate wide anteriorly, narrow posteriorly ; beset with 4 setae, inconsistent in possition. Gonopods lobed, paired, 3 setae on each. Genital setae enlarged, and tapering.

Male (Fig. 68) : Total body length 1.15 mm ($\bar{X}$, N=4) ; range 1.14 to 1.25 mm. *Head* and *thorax* as in female. Thoracic



Figs. 70-74. *Hoplopleura khandala* sp. nov. 70, head (ventral and dorsal views) ♀ ; 71, paratergites ♀ ; 72, terminal segments ♀ ; 73, paratergites ♂ ; 74, genitalia ♂ .

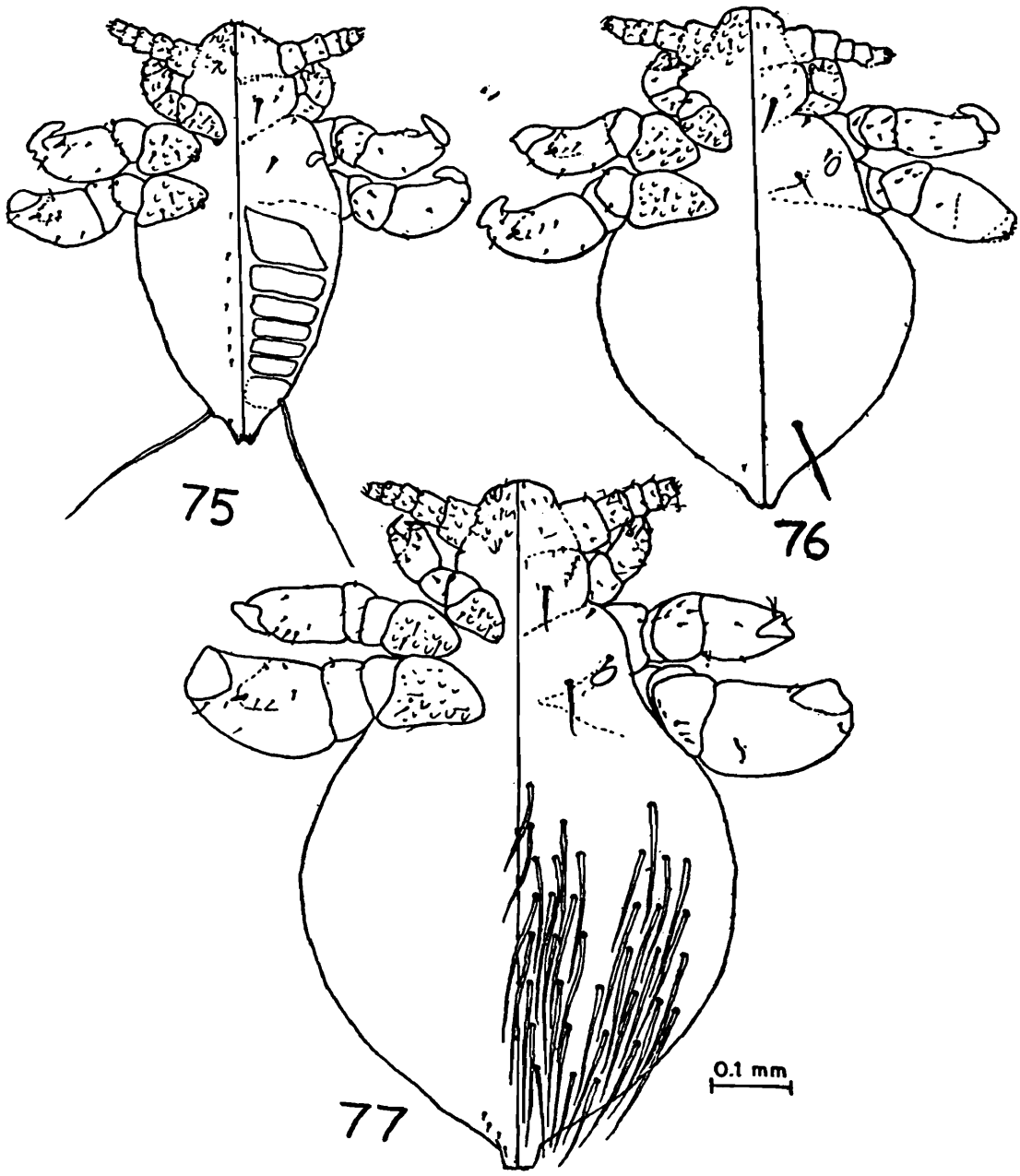
sternal plate (Fig. 69) 0.15 mm long, 0.09 mm wide. *Abdomen. Dorsal* : Segment II as in female ; III with 2 tergites, anterior with 4, posterior with 8 setae ; IV to VII each with a single tergite, having 7 to 9 setae on each ; VIII with a single tergite, devoid of setae ; terminal segment with several small setae. DAAS one to 4 pairs. *Ventral* : Segment II as in female ; III with 3 sternites, anterior one as in female, remaining with 7 or 8 setae each ; IV to VI each with 2 sternites, 5 to 7 setae each ; VII and VIII each with a single sternite, former with 4 and later with 2 setae ; terminal segment with several minute setae. VAAS 4 or 5 pairs. *Lateral* : Paratergites (Fig. 73) same as in except that ventral lobe of paratergite V more or less acute. *Genitalia* (Fig. 74) : Parameres thickened near base, pointed towards tip ; pseudopenis pointed with serrated sides.

Nymph 1 (Fig. 75) : Total body length 0.52 mm ($\bar{X}$, N=4) ; range 0.5 to 0.53 mm. *Head* approximately as long as wide. Postantennal and occipital angles rounded. All typical head setae present except PCHS and PoAS indistinct, MHS two pairs. Antennal sensoria contiguous. Venter of head and antennae with sparsely scattered tubercles. *Thorax* : Sternal plate absent. MDTS and ADTS one pair each. *Legs* : First pair smallest with slender claw ; second pair larger, with blunt claw ; third pair similar to second. Coxae with one well developed and several small tubercles. *Abdomen* : Dorsal side with 8 distinct segments, anterior 2 segments coalesced. Ventral side unsegmented, scaly, with numerous small trachae. DCAS absent. VCAS 7 pairs, minute. A single long MAS present on each side. AnS single pair.

Nymph 2 (Fig. 76) : Total body length 0.64 mm ($\bar{X}$, N=4) ; range 0.63 to 0.65 mm. Similar to nymph 1 except as follows : *Head* with 3 pairs of MHS. Thorax with 2 pairs of ADTS. Third pair of legs larger than second pair. *Abdomen* devoid of segmentation. DCAS, VCAS and MAS abent. AnS one pair, AcS 3 pairs. Of the 4 specimens, 2 possessed a single long seta on the dorsal side of the abdomen, which was absent in the other 2 specimens.

Nymph 3 (Fig. 77) : Total body length 0.84 mm ($\bar{X}$, N=3). Similar to nymph 2 except as follows : *Abdomen* dorsally with 8 transverse rows of long setae : 1st row with 2 setae ; 2nd to 8th each with 6 to 12 setae, arranged in 3 groups. This nymph is unique, because on other species under *Hoplopleura* is known to have such setae on dorsal side of the abdomen.

Hosts and distribution : *Holotype* ♀, *allotype* ♂ , *paratypes* 3 ♂ 11 ♀, 11 N ; ex *Golunda ellioti,* INDIA : Maharashtra, Poona, Khandala, 26.II.1975, Coll. A. C. Mishra. Type specimens are deposited in National Institute of Virology, Pune.



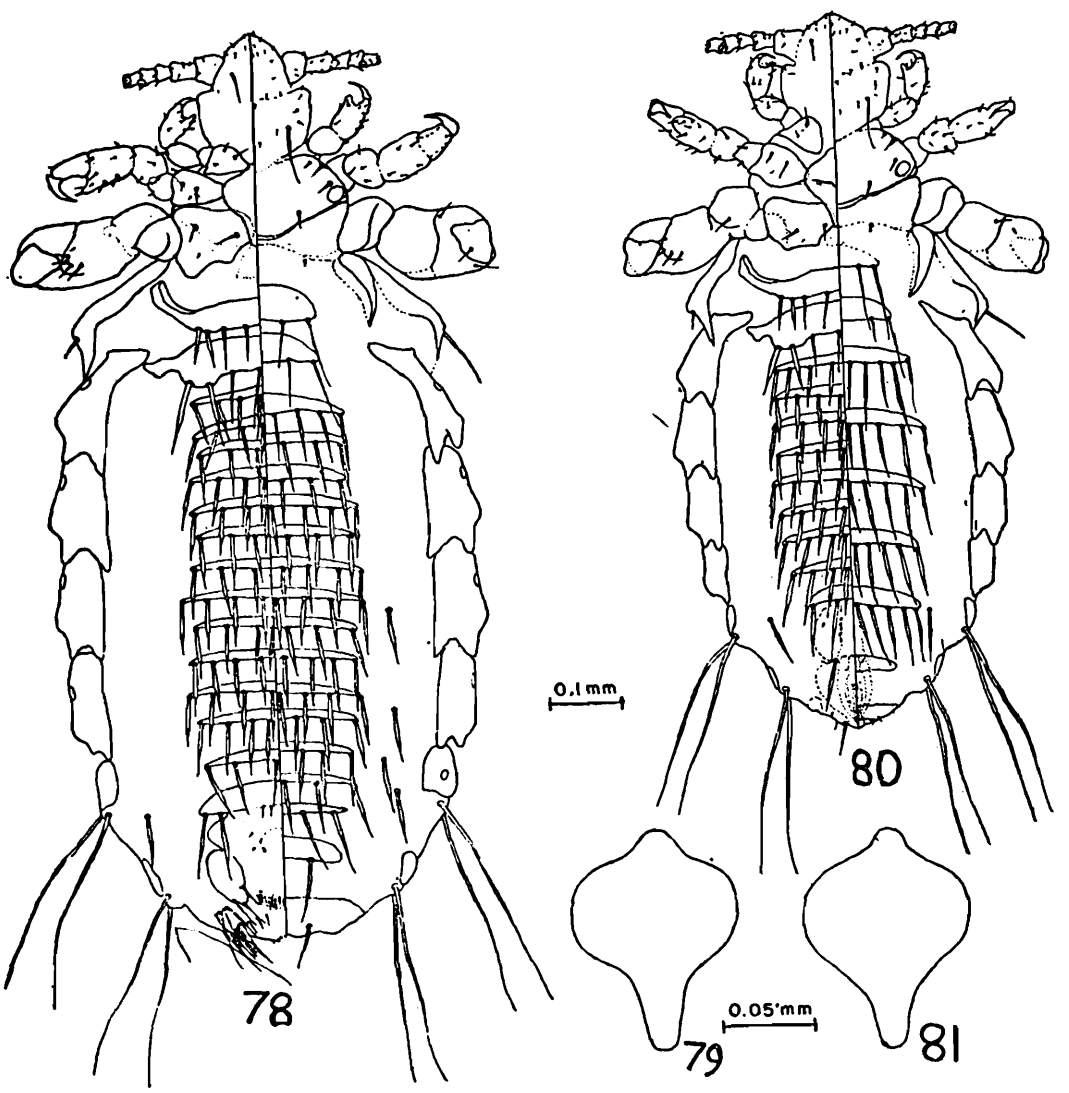
Figs. 75-77. *Hoplopleura khandala* sp. nov. 75, nymph 1 ; 76, nymph 2 ; 77, nymph 3.

13. **Hoplopleura kondana** sp. nov (Figs. 78-89).

Closely resembles *H mylomydis* and can be considered as a member of *H enormis* group (*sensu* Johnson, 1960b) The group includes *H enormis* Kellogg and Ferris, *H. pelomydis* Ferris, *H. spiculifer* (Gervais) and *H mylomydis* Ferris. *H. kondana* sp. nov. is separable from all these (except *H mylomydis*) due to the absence of lobe on paratergites VII and VIII. *H. mylomydis* differs from *H kondana* due to its posterodorsal process of para-

tergites being longer than the others, and emargination between all the lobes being almost equal.

Female (Fig. 78) : Total body length 1.25 mm ($\bar{X}$, N=8) ; range 1.21 to 1.31 mm. *Head* (Fig. 82) : Approximately 1.3 x longer than wide. Postantennal angles rounded. All typical head setae present, AS is more towards posterior side. Antennal sensoria contiguous. *Thorax* : Sternal plate (Fig. 79) 0.12 mm long, 0.09 mm wide ; pear-shaped, anterior process small and rounded, posterior process longer, rounded at apex. MDTS one pair, ADTS 2 pairs, all small in size. *Abdomen. Dorsal* : Segment II with a single tergite ; two rows of setae, anterior with 2 minute and



Figs. 78-81. *Hoplopleura kondana* sp. nov. 78, female (ventral and dorsal views) ; 79, thoracic sternal plate ♀; 80 male (ventral and dorsal view); 81, thoracic sternal plate ♂

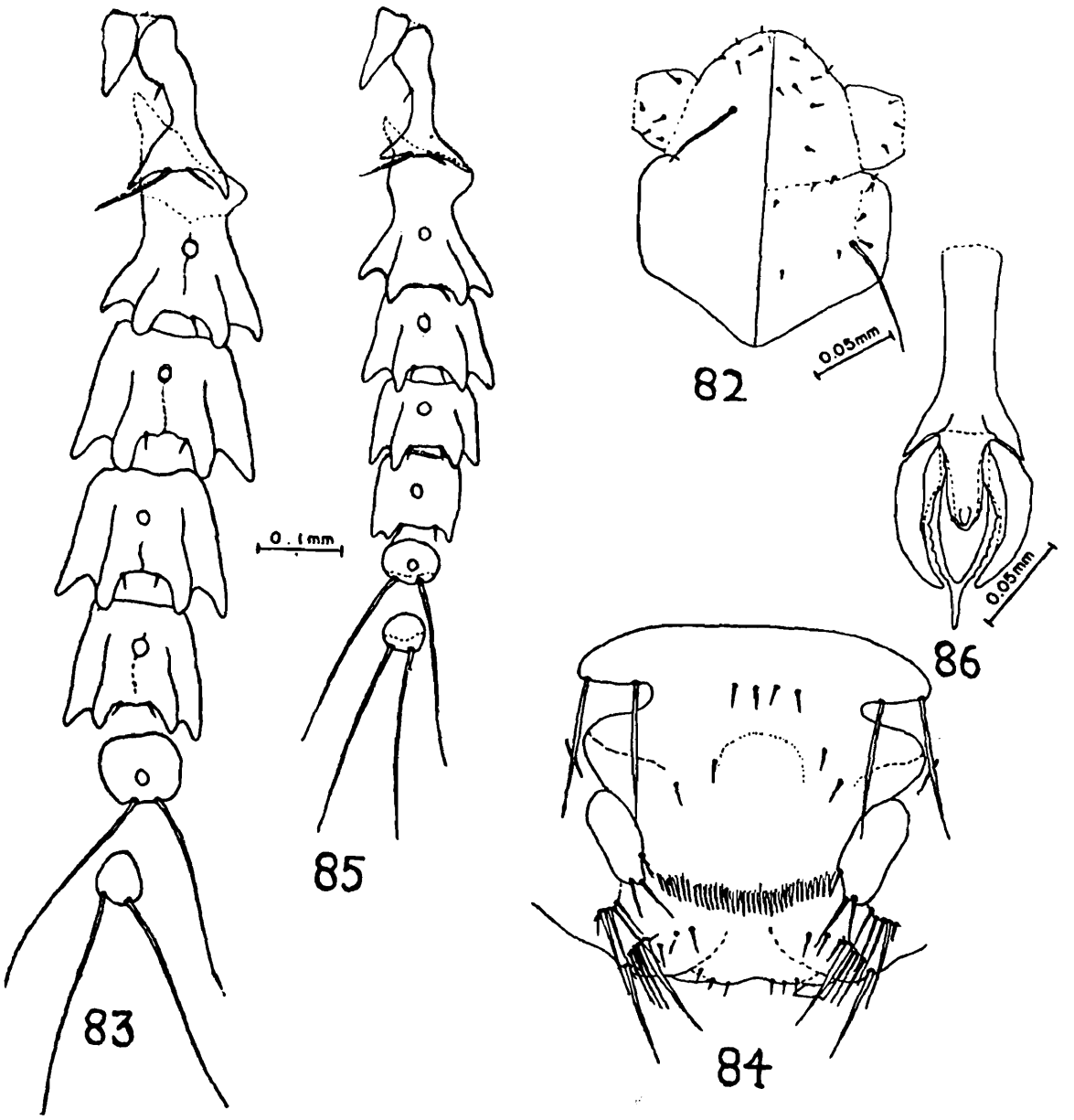
posterior with 2 pairs of thin and elongate setae, posterior row associated with the tergite. Segments III to VII each with 3 tergites, each tergite narrow with 5 to 9 sword-shaped setae except

first tergite of segment III which is broad and bears 4 thin setae; VIII and terminal segments each with a single tergite, 2 setae on each. DAAS 3 or 4 pairs. *Ventral* : Segment II with a typical sternite, 4 pairs of thin setae ; III with 4 sternites, first typical with 2 groups of 2 enlarged setae laterally and 3 narrow setae mesially, remaining narrow with 6 or 7 setae ; IV to VI each with 3 sternites, 5 to 8 setae each ; VII with 2 sternites, anterior narrow having 5 to 7 setae, posterior broad with 2 pairs of long and 2 pairs of small setae. VAAS none of one pair. *Lateral* : Paratergites (Fig. 83) : II typical, dorsal seta longer, ventral shorer than processes of their sides ; III with both the lobes further divided into 2 lobes of almost equal size with somewhat rounded apices, median emargination with a small ventral paratergal seta, dorsal paratergal seta absent ; IV to VI similar to III in shape, median emargination with 2 small setae ; VII and VIII devoid of lobes, both setae long. *Genitalia* (Fig. 84) : Genital plate fused anteriorly with posterior sternite of segment VII to form complete genital plate; 2 pairs of minute setae, inconsistent in position. Gonopods with 3 or 4 setae on each. A group of 5 or 6 setae on side, posterolateral to gonopods. Each genital lobe with 7 to 9 setae (one long, 5 to 7 small, thin setae, and one slightly enlarged and elongated genital seta).

Male (Fig. 80) : Total body length 0.93 mm ($\bar{X}$,N=5) ; range 0.87 to 0.97 mm. *Head* and *thorax* as in female. Thoracic sternal plate (Fig. 81) 0.11 mm long, 0.08 mm wide. *Abdomen. Dorsal.* Segment II as in female; III with 2 tergite, anterior with 4, posterior with 8 to 10 setae ; IV to VII each with a single tergite, 7 to 10 setae each ; VIII with a single tergite without setae ; terminal segment with several minute setae. DAAS, one pair. *Ventral.* Segment II as in female ; III with 3 sternites, anteriormost as in female, remaining 2 narrow, with 7 or 8 setae each ; IV to VI each with two sternites, with 7-9 setae each ; VII and VIII each with a single sternite, with 2 pairs and one pair of setae respectively ; terminal segment with several minute setae. VAAS one pair. *Lateral.* Paratergites (Fig. 85) same as in female except ventral lobe of paratergite VI is not subdivided. *Genitalia* (Fig. 86). Parameres thickened near base ; pseudopenis serrated, pointed towards tip.

Nymph 1 (Fig. 87) : Total body length 0.48 mm ($\bar{X}$,N=8) ; range 0.42 to 0.54 mm. *Head* almost as long as wide. Postantennal and posterolateral angles undeveloped. All typical head

setae present except PCHS which is indistinct. Antennal sensoria contiguous. Venter of head and antennae with sparsely scattered



Figs. 82-86. *Hoplopleura kondana* sp. nov. 82, head (ventral and dorsal views) ♀; 83, paratergites ♀; 84, terminal segments ♀; 85, paratergites ♂ ; 86, genitalia ♂ .

tubercles. *Thorax*. Sternal plate absent. MDTS and ADTS minute, one pair each. *Legs*. First pair smallest with slender claws, second pair larger with strong claw, third pair similar to second. Each coxa with a prominant and several small tubercles. *Abdomen*. Dorsal side with 8 distinct segments, first two segments coalesced, except for a faint separating line mesially ; ventral side unsegmented, scaly with numerous small trachae. DCAS and VCAS absent. A single long MAS present on each side. AcS and AnS indistinct.

Nymph 2 (Fig. 88) : Total body length 0.6 mm ($\bar{X}$, N=6) ; range 0.52 to 0.64 mm. Similar to nymph 1 except as follows : Head with PCHS distinct. *Thorax* with 2 pairs of ADTS. Third pair of legs larger than second pair. *Abdomen* devoid of any segmentation. Dorsal side leathery, ventral side scaly with numerous small trachae. VCAS 5 pairs. MAS absent.

Nymph 3 (Fig. 89) : Total body length 0.6 mm ($\bar{X}$, N=7) ; range 0.69 to 0.97 mm. Similar to nymph 2.

Hosts and distribution : Holotype ♀, allotype ♂ , ex *Millardia kondana,* Maharashtra, Poona, Sinhgarh, 9.vii.71, *Paratypes* 1 ♀ ex *M. meltada,* Jammu and Kashmir (referred as *Hoplopleura* sp. in Mishra *et al.,* 1974) ; 2 ♂ , 3 ♀, 6 N ex *M. meltada,* Poona, Dishli, 30.vi.71 ; 20 ♂ , 39 ♀, 84 N ex *M. kondana,* Sinhgarh, 9.vii.71 and 6.viii.71 ; and 2 ♂ , 1 ♀, 2 N ex *M. meltada,* Rajasthan state, Jalore Ahore, 11.xi.71. Type specimens are deposited in National Institute of Virology, Pune.

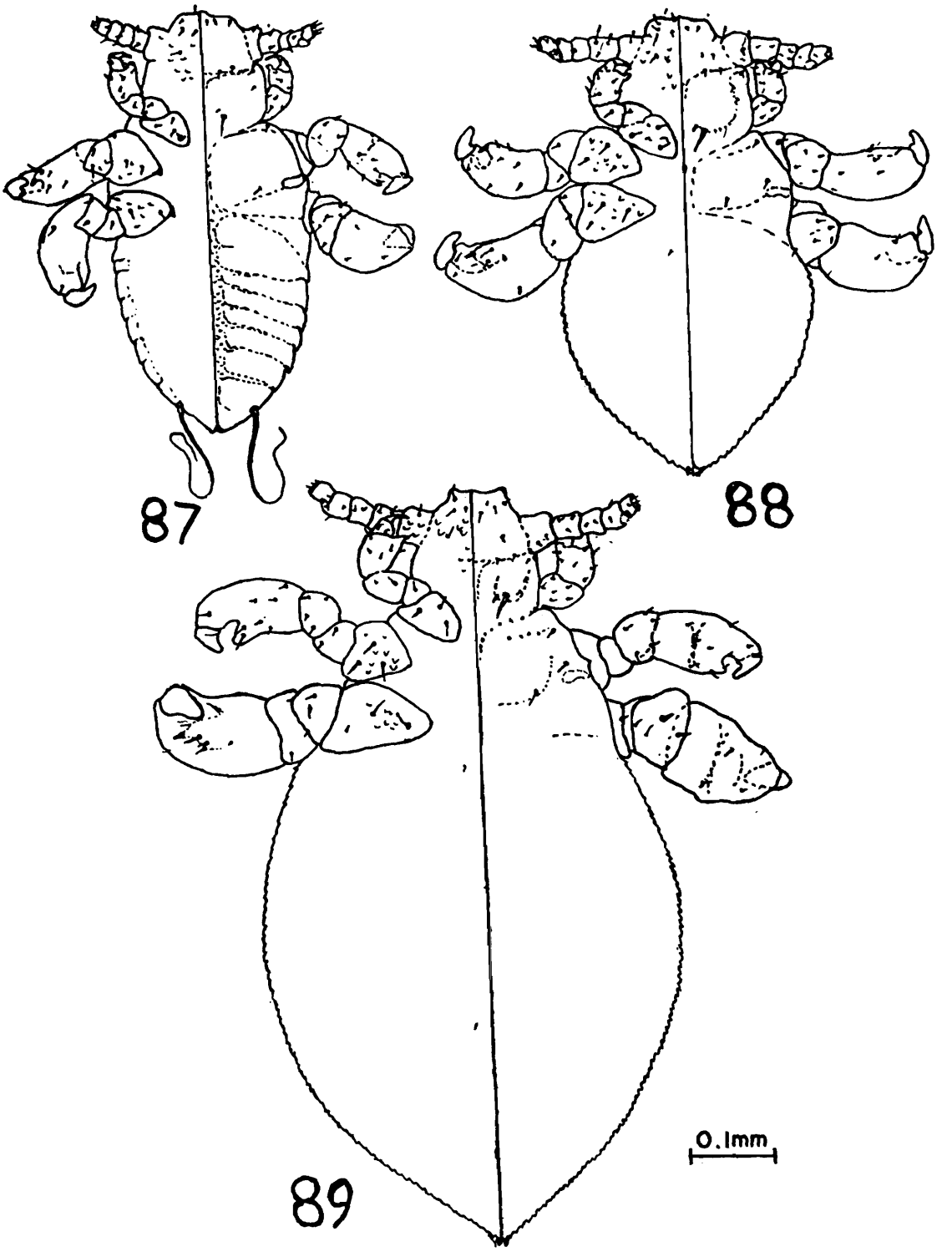
14. **Hoplopleura malabarica** Werneck

Hoplopleura malabarica Werneck, 1954, *Rev. Brazil Biol.*, **14**: 113-16, figs. 8-12. — Johnson, 1959. *Proc. U.S. Nat. Mus.*, **110**: 575, figs. 12, 14, 16. — Kim, 1966, *Parasitology*, **56** : 611.

Closely resembles *H. hirsuta* Ferris, a parasite of *Sigmodon* sp. in the new world. Comparative characters to differentiate these species have been discussed in detail by Johnson (1959) The species can be separated from other species of this region except *H. ochotonae* due to the absence of tergites and sternites in female and sternites in male. *H ochotonae* is easily separable due to the possession of short setae on paratergites III to V ; and absence of paired enlarged setae on first sternite of segment III.

Female : Total body length 1.32 mm ($\bar{X}$, N=4) ; range 1.3 to 1.36 mm. *Head* longer than wide. All typical head setae present. Antennal sensoria large and contiguous. *Thorax.* Sternal plate pear-shaped, posterior process rounded at apex. MDTS elongated. *Abdomen.* Tergites and sternites absent except a few on anterior and terminal segments. Paratergites : II typical, dorsal seta much longer than ventral ; III to V each with both posterior lobes small and acute, III with both setae long, remaining with one long and other short setae ; VI with dorsal lobe small and acute, ventral lobe absent, dorsal seta minute, ventral long ; VII and VIII devoid of lobes, both setae long. Spiracles large. *Genitalia.* Each gonopod with 3 setae. Genital seta broad and long.

Male : Total body length 1.05 mm ($\bar{X}$, N=4) ; range 1.02 to 1.08 mm. *Abdomen* with narrow tergites. Paratergites VI devoid of lobes. Genitalia with serrated pseudopenis.



Figs. 87-89. *Hoplopleura kondana* sp. nov. 87, nymph 1 ; 88, nymph 2 ; 89, nymph 3.

Nymphs : Unknown.

Hosts and distribution : Known ex *Bandicota malabarica* from Colombo, SRI LANKA ; ex *B. bengalensis, B. indica* and *B. malabarica* from various localities in THAILAND (Johnson, 1959 ; Kim, 1966).

15. **Hoplopleura maniculata** (Neumann) (Figs. 90-99).

Haematopinus (*Polyplax*) *maniculatus* Neumann, 1909. *Arch. Parasit.*, **13**: 521-23, figs. 21, 22.

Hoplopleura maniculata (Neumann) Ferris, 1921, *Contributions towards a monograph of the sucking lice*, pt 2 : 112-13, figs. 71, 72 ; 1951. *The sucking lice*, p. 138. — Pratt and Stojanovich, 1961, *J. Kansas Ent. Soc.*, **34**: 79-83. — Mishra *et al.* 1974, *Indian J. med. Res.*, **62**: 1273.

Hoplopleura mitsuii Kaneko, 1962, *Bull. Tokyo Med. Dent. Univ.*, **9** : 129-132, figs. I, II. (New synonymy)

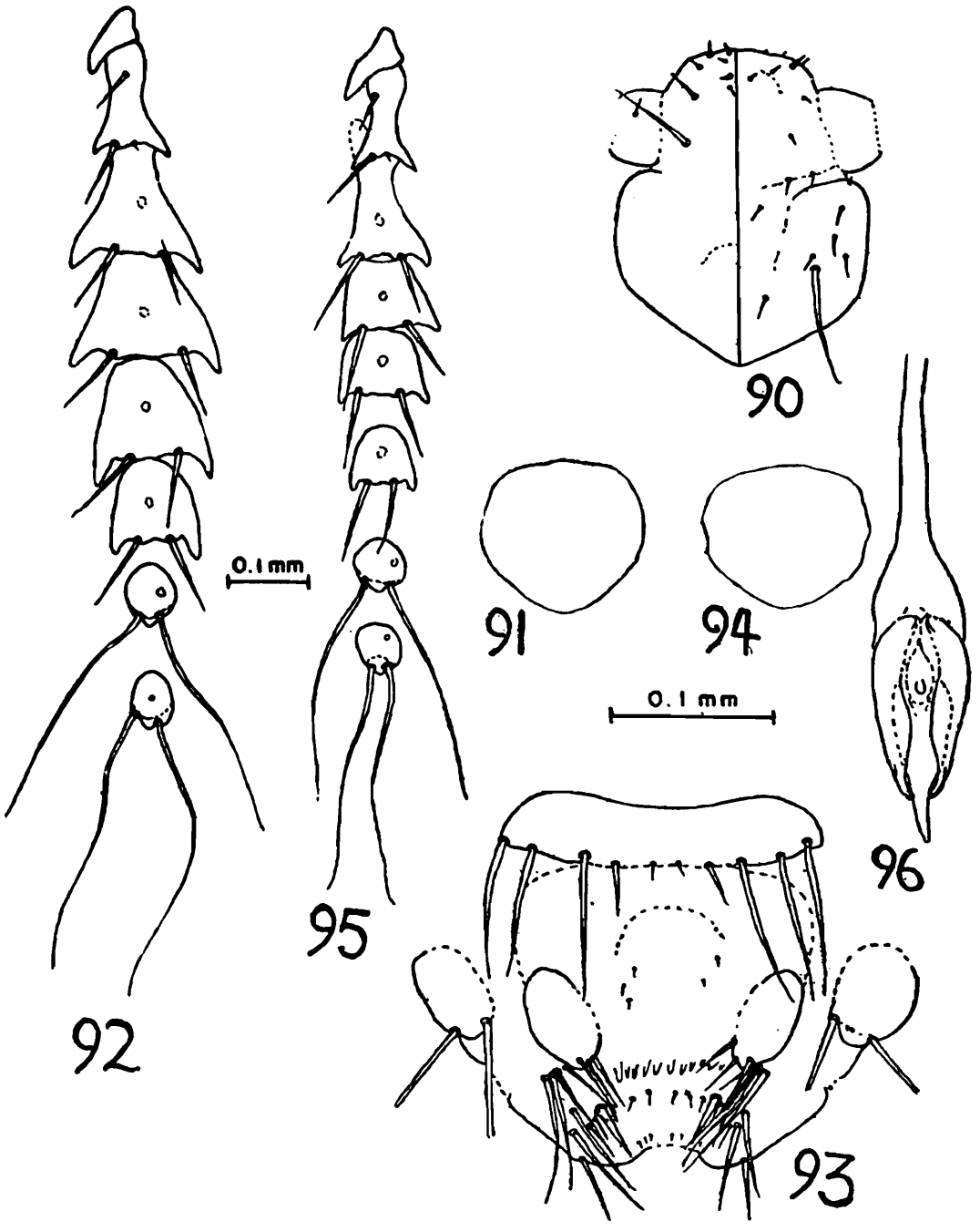
Closely resembles *H erratica* (Osborn) and *H. arboricola* Kellogg and Ferris due to the short thoracic sternal plate ; sternite of terminal abdominal segment with a pronounced lobe-like posterior extension on each side ; and a definite notch at the tip of each paramere. It differs from these in possessing well developed tergites and sternites, and a short seta at either end of the median sternites of abdominal segments V and VI.

Female : Total body length 1.36 mm ($\bar{X}$, N=10); range 1.23 to 1.42 mm. *Head* (Fig. 90). Approximately 1.3 × longer than wide. Postantennal angles rounded. All typical head setae present. Antennal sensoria separate. *Thorax*. Thoracic sternal plate (Fig. 91) 0.01 mm long, 0.09 mm wide ; devoid of anterior and posterior processes. MDTS long sized. *Abdomen*. Setae sword-shaped. DAAS 9 to 11 pairs. VAAS 8 or 9 pairs. Paratergites (Fig. 92). II typical, dorsal seta medium-sized, ventral minute ; III to VI each with small acute posterior processes, both setae longer than posterior processes ; VII and VIII devoid of processes, both seta elongated. *Genitalia* (Fig. 93). Genital seta enlarged and modified.

Male : Total body length 1.12 mm ($\bar{X}$, N=8) ; range 1.05 to 1.17 mm. Thoracic sternal plate (Fig. 94) 0.09 mm long, 0.1 mm wide. *Abdomen*. Segments IV to VII each with a single tergites. VAAS 3 pairs. Ventral terminal segment is provided with a pronounced lobe-like posterior extension on each side. Paratergites (Fig. 95) as in female. *Pseudopenis* (Fig. 96). Parameres with a definite notch at the tip.

Nymph 1 (Fig. 97) : Total body length 0.41 mm ($\bar{X}$, N=6) ; range 0.36 to 0.47 mm. *Head*. Approximately as long as wide. Postantennal angles not developed. Antennal sensoria small and separate. All typical head setae well developed and distinct. Ventral side of head and antennae with numerous sparsely

scattered tubercles. *Thorax*. MDTS and ADTS each one pair, small in size. *Legs*. First pair smallest with slender claw ; second

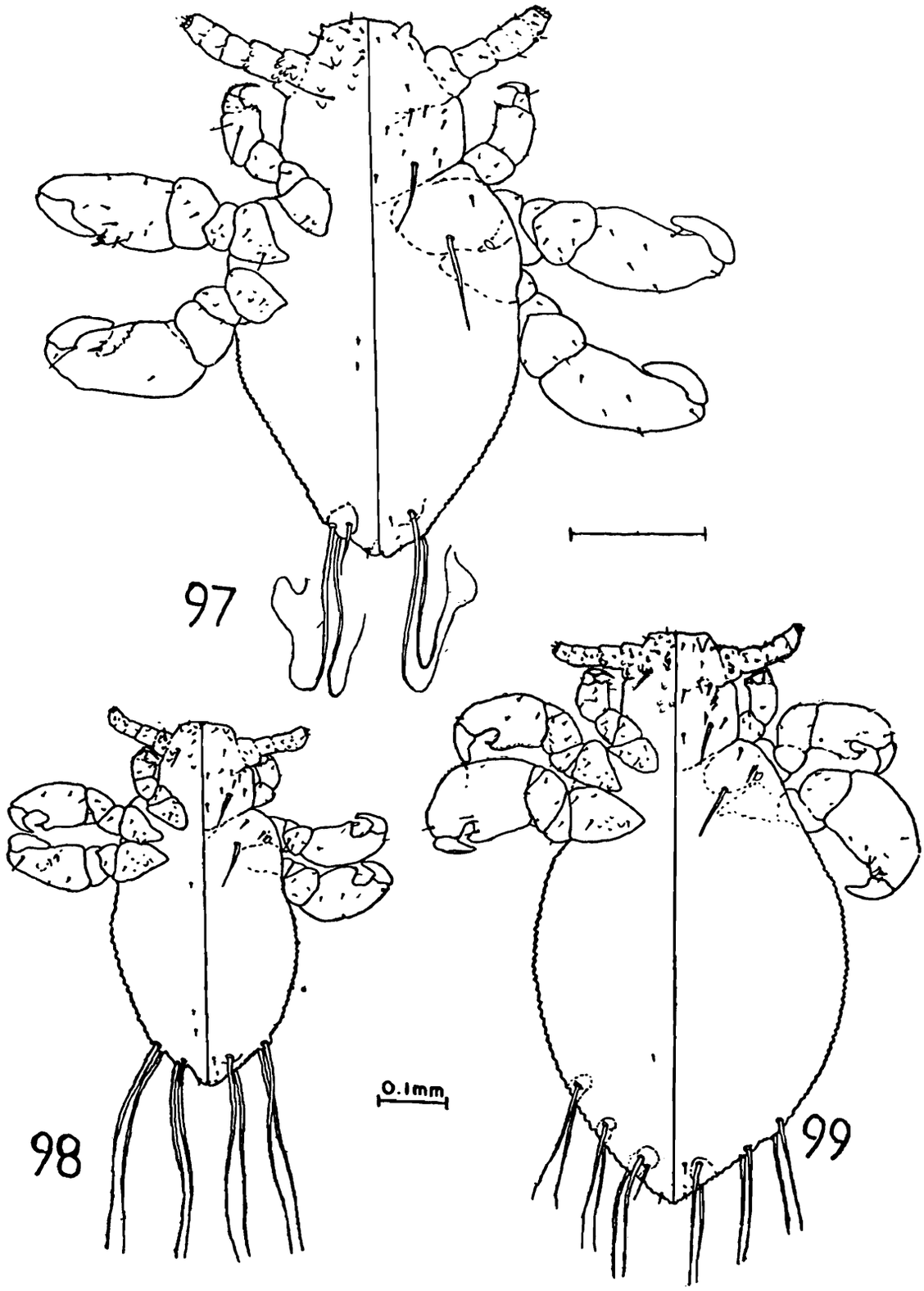


Figs. 90-96. *Hoplopleura maniculata* (Neumann). 90, head (ventral and dorsal views) ♀; 91, thoracic) sternal plate ♀; 92, paratergites ♀; 93, terminal segments ♀; 94, thoracic sternal plate ♂ ; 95, paratergites ♂ ; 96, genitalia ♂ .

pair considerably larger with blunt claw ; third pair similar to second. *Coxae* with numerous small tubercles. *Abdomen* devoid of segmentation. DCAS absent. VCAS 7 pairs. MAS one pair on each side. AcS one pair, AnS 2 pairs.

Nymph 2 (Fig. 98) : Total body length 0.53 mm ($\bar{X}$, N=4) ; range 0.48 to 0.56 mm. Same as nymph 1 except as follows :

Thorax with 2 pairs of ADTS. Third pair of legs larger than second pair. *Abdomen* with 2 pairs of MAS on each side.



Figs. 97-99. *Hoplopleura maniculata* (Neumann). 97, nymph 1; 98, nymph 2; 99, nymph 3.

Nymph 3 (Fig. 99) : Total body length 0.72 mm ($\bar{X}$, N=7) ; range 0.65 to 0.83 mm. Same as nymph 2 except that 3 pairs of MAS on each side of abdomen.

Hosts and distribution : Known ex *Funambulus palmarum* from Rajkote, INDIA and SRI LANKA (Ferris, 1951) ; ex *F palmarum* from Nalainpur, Madhya Pradesh (Kaneko, 1962) ; ex *F pennanti* from Himachal Pradesh and Uttar Pradesh states (Mishra *et al.*, 1974) ; ex *F tristriatus* from Maharashtra state (Mishra *et al.*, 1977).

16. **Hoplopleura ochotonae** Ferris

Hoplopleura ochotonae Ferris, 1922. *Contributions towards a monograph of the sucking lice*, pt 3 : 142, fig. 92.
— Hopkins, 1949, *Proc. zool. Soc. Lond.*, **119** : 453.
— Ferris, 1951, *The sucking lice*, p. 139.

This is an isolated species, and resembles *H. diaphora* Johnson, and *H kitti* Kim due to the absence of enlarged setae on the first sternite of abdominal segment III. *H. ochotonae* is separable from *H. kitti* due to the absence of sternites and tergites on abdominal segments IV to VI; and from *H. diaphora* due to both the setae on paratergites II, III, V, VI smaller than the posterior paratergal processes.

Female : Total body length 1.2 mm. *Head* longer than wide. *Thorax.* Sternal plate large and broad, with anterior margin rounded, lateral margins parallel, posterolateral margins converging to a blunt tip. *Abdomen.* Tergites absent except on terminal segment. Sternites absent except one on segment II, and two on segment III. First sternite of segment III devoid of typical enlarged paired setae. Number of setae in each row range from 10 to 14 in the typical segments both dorsally and ventrally. Paratergites II to VI each with posterior processes acute, both setae smaller than the processes, except setae on paratergite VI which extend much beyond; VII and VIII devoid of processes; each with 2 long setae. *Genitalia* : Genital setae not modified.

Male : Unknown.

Nymphs : Unknown.

Hosts and distribution : Known ex *Ochotona thibetana* (=*Ochotona cansus* from Taochao, CHINA; ex *O. roylei* from Braldu valley, BALLISTAN; ex *O. daurica* from Tabool, MANGOLIA (Ferris, 1951).

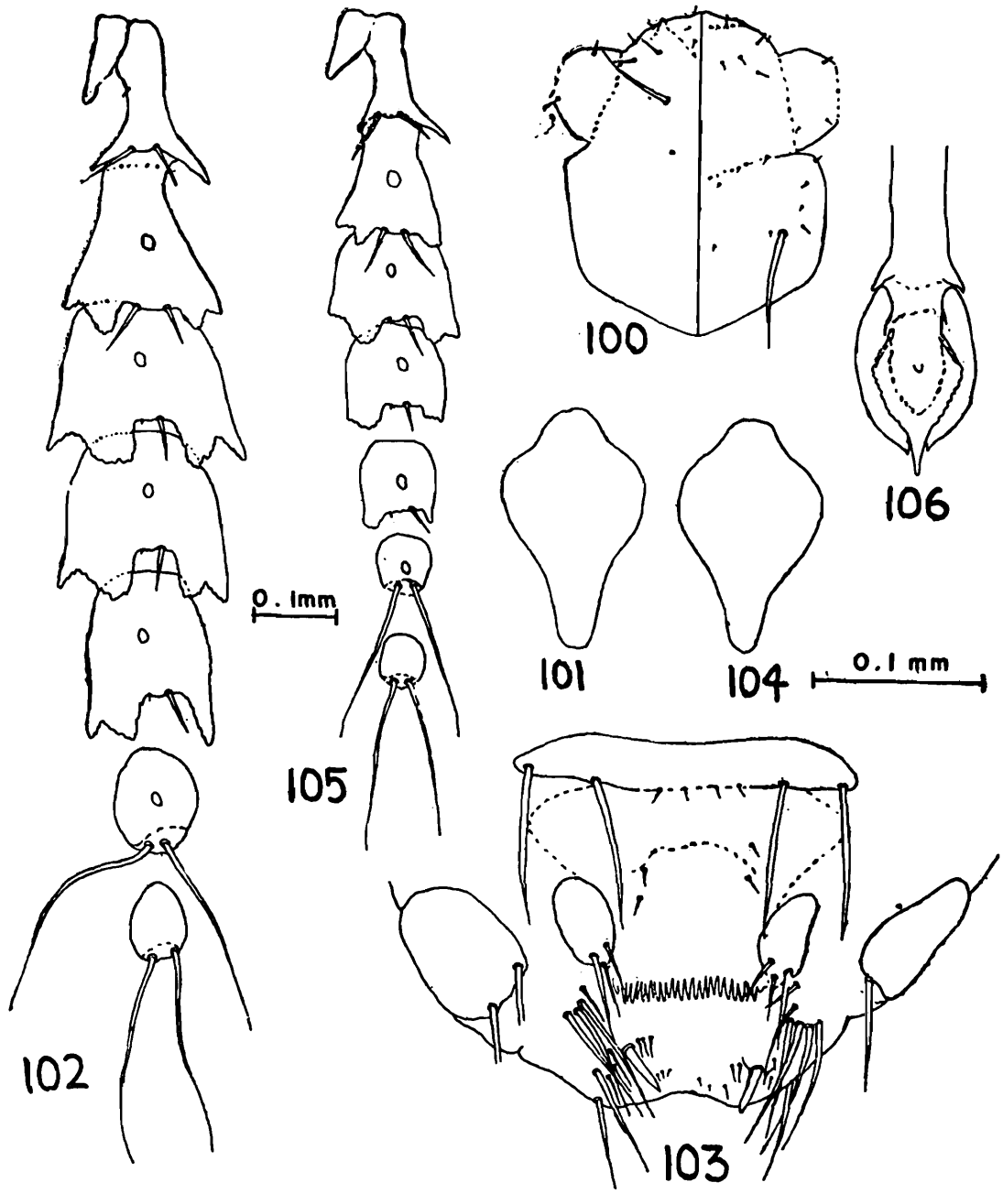
During present study 1 ♀ ex *Ochotona* sp., Mustang dist., Jamosan area, NEPAL, 9.ii.-970 was obtained through the courtesy of Dr. K. C. Emerson.

17 **Hoplopleura pacifica** Ewing (Fig. 100-108).

Hoplopleura pacifica Ewing, 1924, *Bull. Bishop Mus.* Honolulu, **14**: 9.

Citations of references and synonymies are given by Johnson (1972a) and Kim and Emerson (1974).

Closely resembles *H. oenomydis* Ferris and *H. khandala* sp.nov. *H oenomydis* is a typical parasite of *Oenomys* spp., an African genus of rodent. Detailed distinguishing characters of *H. pacifica* with *H. oenomydis* have been discussed by Johnson (1964 and 1972a). *H. khandala* adults can be distinguished from



Figs. 100-106. *Hoplopleura pacifica* Ewing. 100, head (ventral and dorsal views) ♀; 101, thoracic sternal plate ♀; 102, paratergites ♀; 103, terminal segments ♀; 104, thoracic sternal plate ♂; 105, paratergites ♂; 106, genitalia ♂.

H. pacifica by a combination of following characters : comparatively larger in size; female with 10 or more DAAS. Moreover, *H. khandala* is an unique species in as much as its nymph 3 bears 8 transverse rows of elongated setae.

Ferris (1932) synonymized *H. pacifica* under *H. oenomydis* on the basis of morphological characters. Subsequently, the same view was followed by several authors (Pritchard, 1947; and Ferris, 1951). However, Hopkins (1949) indicated that because of host differences, it was inprobable that *H. pacifica* could be synonymized under *H oenomydis*. Johnson (1964) carried out a detailed study of *H. pacifica* collected from *Rattus rattus* and *Rattus exulans hawaiiensis* with *H oenomydis,* colelcted from its type-host *Oenomydis hypocanthus* from Republic of Congo, and from Uganda. Voss (1966) designated and redescribed the lectotype of *pacifica*. Both Johnson and Voss asserted *H. pacifica* as a valid name for the typical louse parasite of *Rattus rattus* and regarded it as the commonest Anoplura taken from this animal in the Australian and Oriental regions.

Female : Total body length 1.29 mm ($\bar{X}$, N=10); range 1.20 to 1.39 mm. *Head* (Fig. 100) longer than wide. Postantennal and posterolateral angles rounded. All typical head setae present. Antennal sensoria contiguous. *Thorax.* Thoracic sternal plate (Fig. 101) with posterior process rounded at tip. MDTS one pair, long. *Abdomen.* Tergites and sternites well developed. Typical setae sword-shaped. DAAS, 5 or 6 and VAAS 7 or 8 pairs. Paratergites (Fig. 102) : II typica; III to V each with posterior processes truncated and emarginate; VI with dorsal process as in V, ventral process acute ; VII and VIII devoid of processes. Paratergite II with 2 setae, dorsal longer, ventral shorter than processes of its side; III with both setae long; IV to VI each with dorsal seta minute, ventral equal to processes; VII and VIII with usual long setae. *Genitalia* (Fig. 103) Each genital lobe with 3 setae ; genital setae short, slightly enlarged.

Male : Total body length 0.97 mm ($\bar{X}$, N=10); range 0.93 to 1.09 mm. *Abdomen.* Tergites and sternites well developed. Segments IV to VI each with a single tergite. DAAS 1 or 2 pairs, VAAS 3 or 4 pairs. Paratergites (Fig. 105) as in female. *Genitalia* (Fig. 106). Parameres almost uniform in thickness; pseudopenis with serrated lateral margins.

Nymphs : All the 3 nymphal stages have been described and

illustrated by Pratt and Karp (1953), Cook and Beer (1959), and Johnson (1972a) During the present study only nymph 2 and nymph 3 were obtained.

Nymph 2 (Fig. 107) : Total body length 0.58 mm ($\bar{X}$, N=3) ; range 0.56 to 0.6 mm. *Head* longer than wide. Postantennal and posterolateral angles rounded. All typical head setae present except PoAS which is not delineable. Antennal sensoria contiguous. Venter of head and antennae with sparsely scattered tubercles. *Thorax*. Sternal plate absent. MDTS one pair ; ADTS two pairs. *Legs* as in adults. Abdomen devoid of segmentation. Dorsal surface leathery; ventral scaly, with numerous small trachae. VCAS, 5 pairs; DCAS, MAS, AcS and AnS indistinct.

Nymph 3 (Fig. 108) : Total body length 0.85 mm ($\bar{X}$, N=10); range 0.74 to 0.9 mm. Similar to nymph 2.

Hosts and distribution : Common parasite of *Rattus rattus* known from Australian and Oriental regions. In INDIA, it is recorded as *H. oenomydis* ex *Rattus rattus* from Dharmsala, Himachal Pradesh (Srivastava and Wattal, 1970); as *H. pacifica* ex *R. narbadae* from Madhya Pradesh (Mitchell *et al.* 1966) ; ex *R. rattus* subspp., *R. rattoides, R. nitidus* (Mishra *et al.* 1974); ex *R. r. satarae* from Maharashtra (Mishra *et al.* 1977); ex *R. r. arboreus* (1 ♀ 1 nymph) from Orissa, and ex *R. r. brunneusculus* (10 ♀) from Arunachal Pradesh states of India (V.R.C. Unpublished data). Records from other hosts ex *Bandicota bengalensis* (Wattal *et al.* 1967), ex *Mus, Apodemus, Suncus* (Mishra *et al.* 1974) are attributed either to misidentification of the hosts or contaminations.

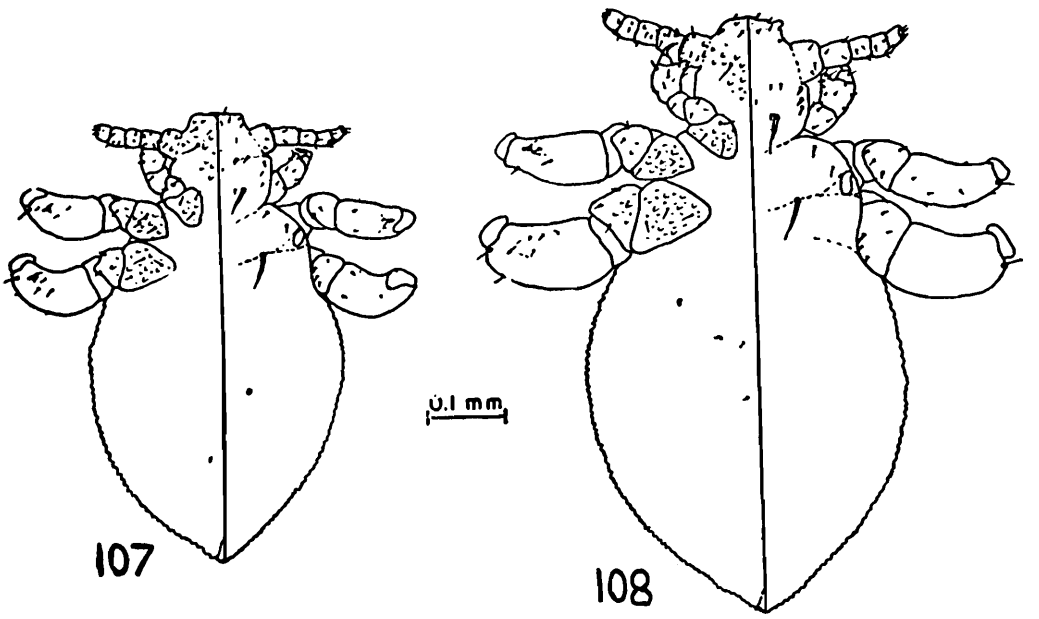
18. **Hoplopleura phaiomydis** Ferris

Hoplopleura phaiomydis Ferris, 1921, *Contributions towards a monograph of the sucking lice*, pt 2 : 120, figs. 77, 78.
— Hopkins, 1949, *Proc. zool. Soc. Lond.*, **119**: 476.
— Ferris, 1951, *The sucking lice*, p. 142.

Resembles *H. acanthopus* and *H alticola* due to the presence of 2 tergites on abdominal segments III to VI each of the male. It can be easily separated from these due to the absence of processes on paratergite VI in both sexes.

Female : Total body length 1.3 mm. *Head* with slight postantennal angles. *Thorax*. Sternal plate with sharp lateral angles, posterior process long, rounded at tip. *Abdomen*. Tergites and sternites narrow. Paratergite II with dorsal process short and

acute, ventral long and tapering; III to V with both posterior processes long and tapering; VI to VIII devoid of processes. Paratergites II to VI with a pair of small setae; VII and VIII with usual long setae.



Figs. 107, 108. *Hoplopleura pacifica* Ewing. 107, nymph 2; 108, nymph 3.

Male : Total body length 1 mm. *Abdomen* with narrow tergites and sternites. Segments III to VI each with 2 tergites. Paratergites as in female. *Genitalia* with parameres nearly straight, as long as basal plate; pseudopenis usually large, arms short and slender, shaft long and stout with its margins toothed.

Nymphs : Unknown.

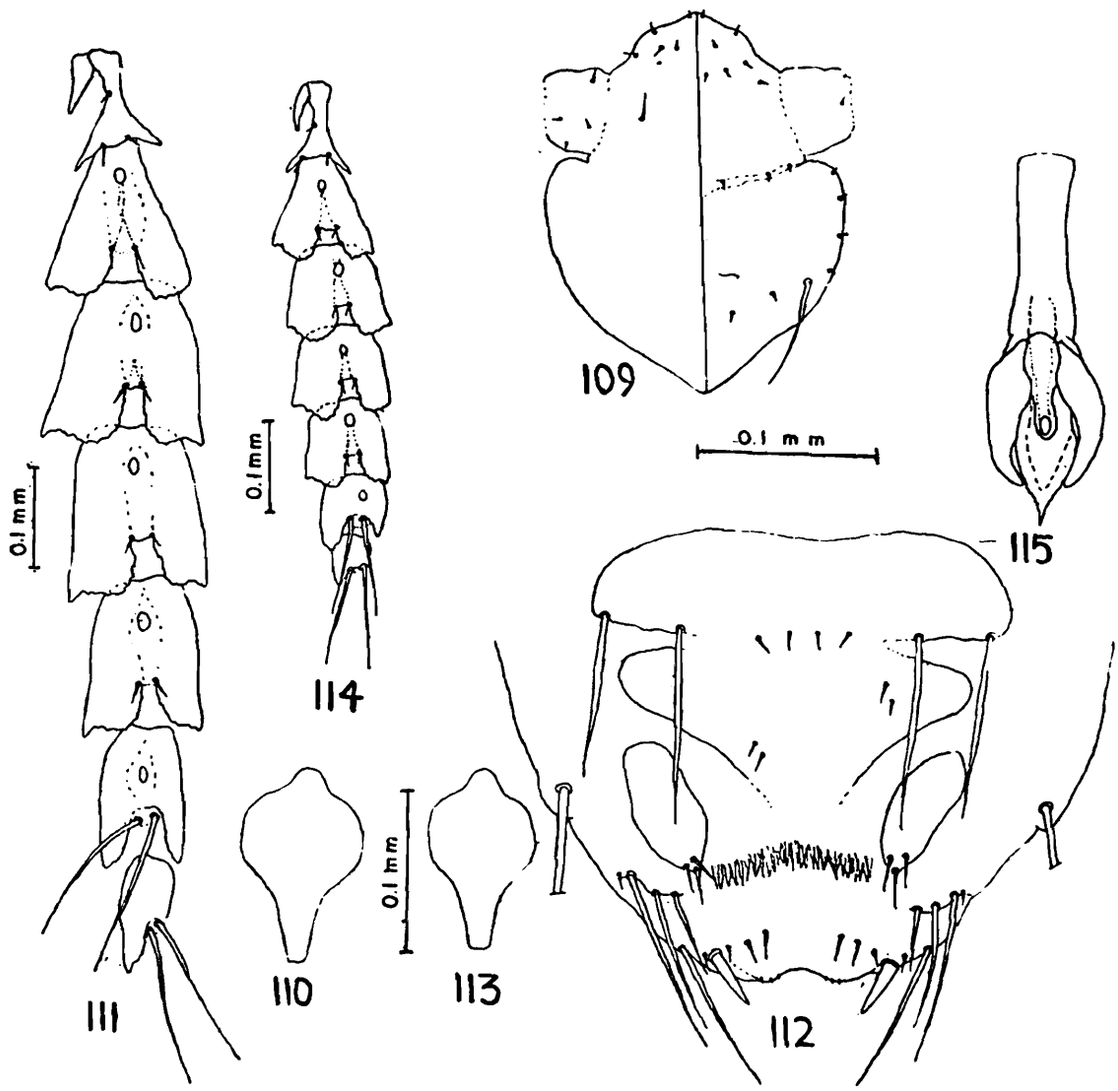
Hosts and distribution : Known ex *Phaiomys* sp. East Ladakh, Jammu & Kashmir state, INDIA. Hopkins (1949) ascertained host species as *Microtus (Phaiomys) blythi* [=*Pitymis* (*Phaiomys*) leucurus, sensu Ellerman, 1961].

19. **Hoplopleura ramgarh** Mishra, Bhat and Kulkarni (Figs. 109-115).

Hoplopleura ramgarh Mishra *et al.*, 1972, *Parasitology*, **65**: 11-21, figs. 1-9. — Mishra *et al.*, 1974, *Indian J. med. Res.*, **62**: 1275.

It is a member of *H. intermedia* group (*sensu* Johnson, 1972c). The group includes *H. inexpectans* Johnson, *H. zelotomydis* Johnson, *H. intermedia* Kellogg and Ferris and *H. ismailiae* Johnson. *H. ramgarh* can be separated from all these by a combination of following characters : MDTS medium-sized parater-

gite III with setae about half the length of processes and placed anterolaterally on the anterior edge of median emargination; VAAS only one pair, both setae of paratergite VII long.



Figs. 109-115. *Hoplopleura ramgarh* Mishra, Bhat and Kulkarni. 109, head (ventral and dorsal views) ♀; 110, thoracic sternal plate ♀; 111, paratergites ♀; 112, terminal segments ♀; 113, thoracic sternal plate ♂ ; 114, paratergites ♂ ; 115, genitalia ♂ .

Female : Total body length 1.43 mm ($\bar{X}$, N=10). range 1.28 to 1.52 mm. *Head* (Fig. 109). Approximately 1.3 × as long as wide. Antennal sensoria contiguous. *Thorax*. Thoracic sternal plate (Fig. 110) pear-shaped, posterior process long and tapering at tip. MDTS small-sized. *Abdomen*. Setae sword-shaped. Tergites and sternites well developed. DAAS absent. VAAS one pair. Paratergites (Fig. III) : II typical, both setae smaller than processes; III with processes lobed, margin serrated, postero-outer angles usually produced into points, setae about half the length of

lobes, situated laterally in the cleft ; VII with dorsal process wider, ventral narrower, both setae long ; VIII with well developed dorsal process, ventral process lacking, both setae long. *Genitalia* (Fig. 112). Genital setae flattened and spiniform.

Male : Total body length 1.01 mm ($\bar{X}$, N=5) ; range 0.92 to 1.07 mm. *Abdomen*. Segments IV to VII each with a single tergite. DAAS absent, VAAS, single pair. Paratergites (Fig. 114) essentially same as in female. *Genitalia* (Fig. 115) Parameres thickened near base ; pseudopenis pointed at tip.

Nymphs : Unknown.

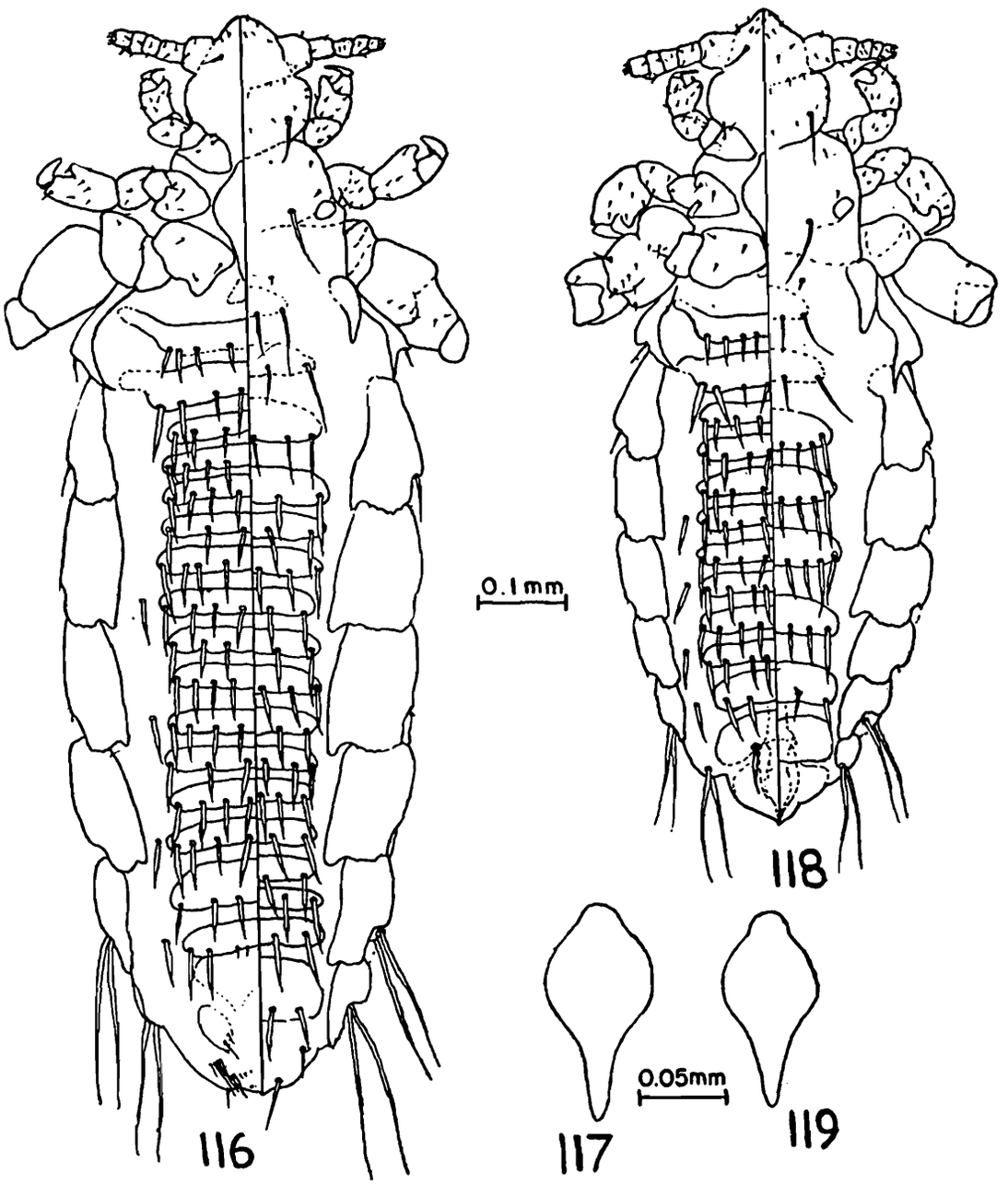
Hosts and distribution : Known from type series which consists of *holotype* ♀, *allotype* and *paratype* 5 ♂, 15 ♀ ex *Mus saxicola sadhu* (sensu, Dhanda *et al.*, 1973) ; 20 ♂ 32 ♀ ex type host, from Maharashtra state (Mishra *et al.*, 1977) ; and 1 ♂ 2 ♀ from Orissa state (VRC Unpublished data).

20. **Hoplopleura sahyadri** sp. nov (Figs. 116-124).

Closely resembles *H. captiosa* Johnson and *H. johnsonae* Kim. It can be separated from these by a combination of following characters : Dorsal lobe of paratergite VII broad and almost truncated at the tip, never tapering ; ventral lobe narrow, rounded at tip.

Female (Fig. 116) : Total body length 1.14 mm ($\bar{X}$, N=6) range 1.06 to 1.21 mm. *Head* (Fig. 120). Approximately 1.2 × longer than wide. Postantennal angles rounded, postantennal lateral margins slightly convex. All typical head setae present, ADHS set well apart from MDHS, MHS not in a straight line. Antennal sensoria contiguous. *Thorax*. Sternal plate (Fig. 117) 0.116 mm long, 0.063 mm wide ; posterior process narrowly elongated, pointed at apex. MDTS one pair, elongated ; ADTS two pairs, minute. *Abdomen. Dorsal.* Segment II with a single tergite ; 2 rows of setae, anterior row with 2 minute setae, posterior row with 2 pairs of thin and elongate setae, posterior row associated with tergite. Segments III to VII each with 3 tergites, having 3 to 5 setae each ; VIII and terminal segments each with a single tergite, having 4 or 5 setae. DAAS absent. *Ventral.* Segment II with a single typical sternite, having 8 setae ; III with 4 sternites, first one typical, with 2 groups of 2 enlarged setae on each side and 3 narrow thin setae mesially, remaining tergites narrow with 6 to 8 setae ; IV to VI each with

3 narrow sternites, 5 to 8 setae each ; VII with 2 sternites, anterior with 6 setae, posterior with 8 setae, outer 2 pairs long,



Figs. 116-119. *Hoplopleura sahyadri* sp. nov. 116, female (ventral and dorsal views) ; 117, thoracic sternal plate ♀; 118, male (ventral and dorsal views) ; 119, thoracic sternal plate ♂

inner 2 pairs small. VAAS 3 or 4 pairs. *Lateral.* Paratergites (Fig. 121) : II typical, dorsal paratergal seta longer than ventral, almost equal to process of its side ; III to VI each with posterior processes lobe-like, lobes broad and serrated, posterior outer angles somewhat pointed, setae small-sized, except with paratergite III in which dorsal seta smaller than ventral but both extend beyond the processes ; VII with dorsal process broad and almost truncated, ventral narrow and pointed, ventral process

absent, both setae long. *Genitalia* (Fig. 122). Genital plate wide anteriorly, narrow posteriorly ; beset with 3 or 4 thin small setae, inconsistent in position. Gonopods lobed, paired, with 2 or 3 setae each. Genital seta slightly enlarged and pointed.

Male (Fig. 118) : Total body length 0.85 mm ($\bar{X}$, N=5) ; range 0.81 to 0.9 mm. *Head* and *thorax* as in female. Thoracic sternal plate (Fig. 119) 0.115 mm long, 0.059 mm wide. *Abdomen. Dorsal.* Segment II as in female ; III with 2 tergites, anterior with 4, posterior with 8 setae ; IV to VII each with a single tergite, having 4 to 9 setae each ; VIII with a single tergite, devoid of setae ; terminal segment with several small setae. DAAS absent. *Ventral.* Segment II as in female ; III with 3 sternites, anterior one as in female, remaining with 7 or 8 setae ; IV to VI each with 2 sternites, having 4 to 8 setae ; sternites of VII and VIII fused with each other, a single row of 2 setae ; terminal segment with several minute setae. VAAS 3 or 4 pairs. Paratergites (Fig. 123) as in female except as follows : Paratergite III with minute dorsal seta ; VII with dorsal process broad and truncated, ventral absent ; VIII devoid of processes. *Genitalia* (Fig. 124). Parameres thickened near base, pointed towards tip. Pseudopenis long, pointed, with serrated sides.

Nymphs : Unknown.

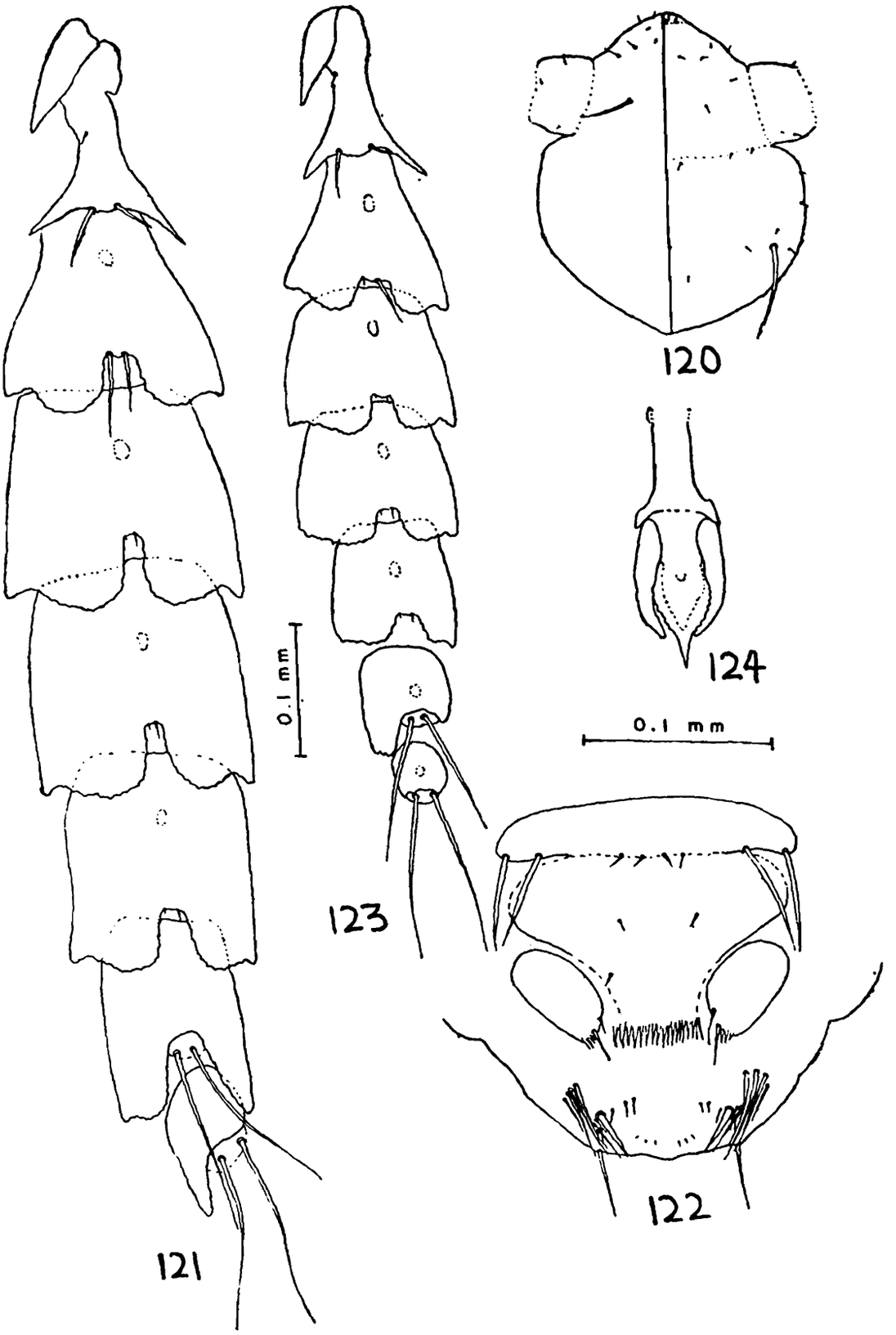
Hosts and distribution : *Holotype* ♀, *allotype* ♂, *paratypes* 8 ♂, 9 ♀, ex *Mus dunni,* INDIA : Maharashtra state, Poona, Sinhgarh, 9.ix.1971. Type specimens are deposited in National Institute of Virology, Pune.

21. **Hoplopleura sicata** Johnson (Figs. 125-132).

Hoplopleura sicata Johnson, 1964, *Misc. Publs. Ent. Soc. Am.*, **4**: 73, figs. 13, 16, 22-24. —Johnson, 1972, *J. Med. Ent.*, **9**: 221. —Mishra *et al.* 1974, *Indian J. med. Res.*, **62**: 1275.

It is a member of *Hoplopleura pacifica* group (*sensu* Johnson, 1972a) and is closely related to *H. pacifica* Ewing, *H. dissicula* Ferris and *H. himalayana* Mishra, Kulkarni and Bhat. It can be easily separated from *H. pacifica* by the presence of a well developed dorsal process of paratergite VII. It can be separated from *H. dissicula* by the sword-shaped abdominal setae ; and postantennal angles being less projected. *H himalayana* is separable by its short MDTS, and rounded tip of the ventral process of paratergite VI.

Female : Total body length 1.39 mm ($\bar{X}$, N=5); range 1.33 to 1.5 mm. *Head* (Fig. 125) longer than wide. All typical head setae present, MHS not in a straight line. Antennal sensoria large and contiguous. *Thorax*. Sternal plate (Fig. 126) with



Figs. 120-124. *Hoplopleura sahyadri* sp. nov. 120, female (ventral and dorsal views) ; 121, paratergites ♀; 122, terminal segments ♀; 123, paratergites ♂ ; 124, genitalia ♂

posterior process long, rounded at tip. MDTS medium-sized. *Abdomen*. Tergites and sternites well developed. Typical setae sword-shaped. Paratergites (Fig. 127) : II typical ; III to VI with posterior processes truncated and emarginate ; VII with dorsal process narrow, rounded at tip, ventral process lacking ; VIII devoid of processes. Paratergites II and III with dorsal seta longer, ventral equal or shorter than processes of their sides ; IV to VI with dorsal seta minute, ventral medium-sized but falls short of the process ; VII and VIII with usual long setae. *Genitalia* (Fig. 128). Genital setae short and thick.

Male : Total body length 1.14 mm ($\bar{X}$, N=3) ; range 1.1 to 1.2 mm. *Abdomen*. Tergites and sternites well developed. Segments IV to VI each with a single tergite. Paratergites as in female. *Genitalia* (Fig. 130). Parameres thickened near base, pseudopenis serrated at sides.

Nymphs : All 3 nymphal stages have been described and illustrated by Johnson (1972a) During present study, nymph 2 and nymph 3 were obtained.

Nymph 2 (Fig. 131) : Total body length 0.68 mm. Head slightly longer than wide. Postantennal and posterolateral angles narrowly rounded. All typical head setae present. Antennal sensoria contiguous. Venter of head and antennae with sparsely scattered tubercles. *Thorax*. Mesothoracic spiracles distinct. Sternal plate absent. MDTS one pair, medium-sized ; ADTS two pairs, minute. *Legs*. As in adults. *Abdomen* devoid of segmentation; DCAS absent; VCAS 5 pairs, minute; MAS absent; AnS 2 pairs.

Nymph 3 (Fig. 132) : Total body length 0.98 mm. Similar to nymph 2.

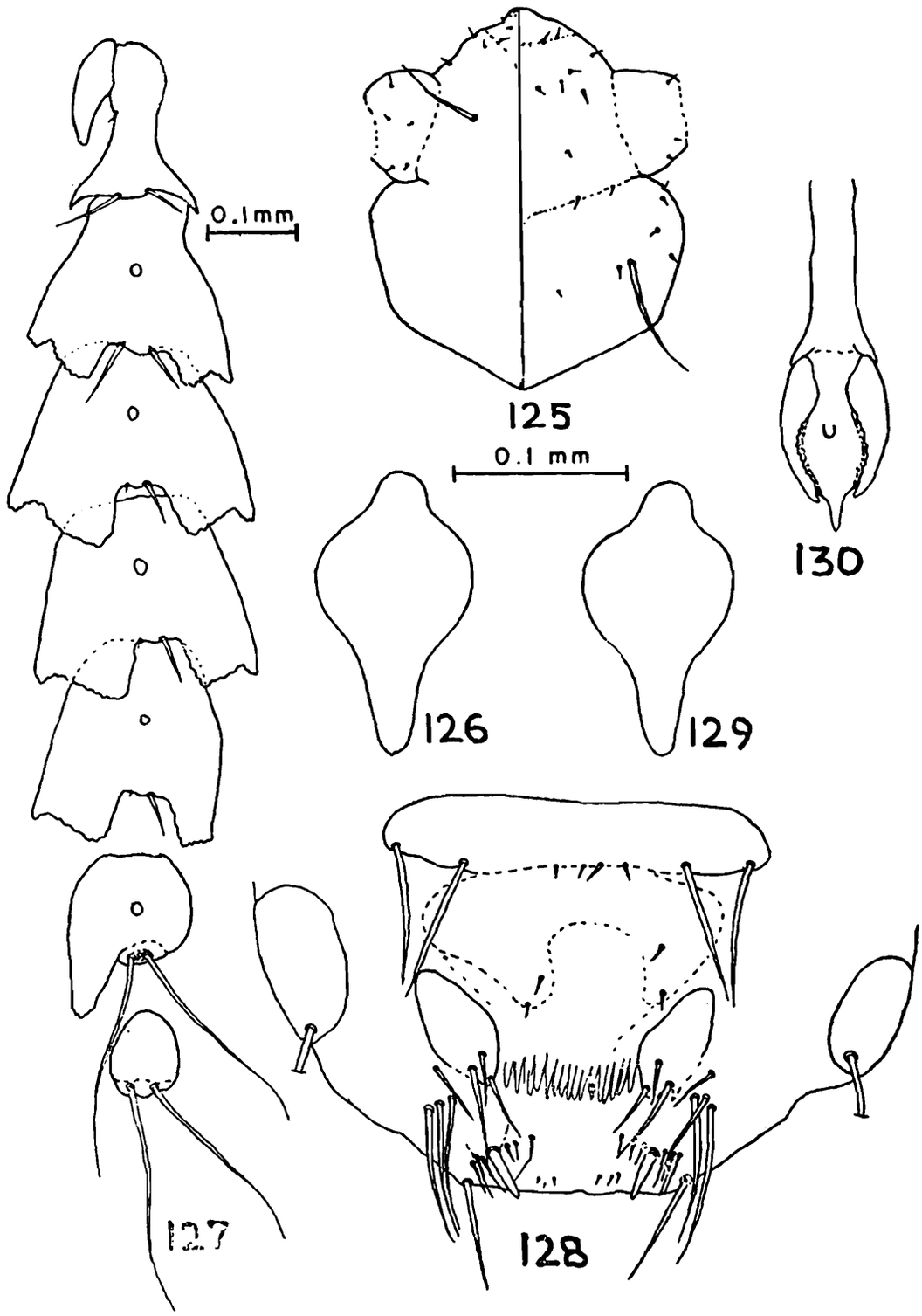
Hosts and distribution : Known ex *Rattus cremoriventer* from North BORNEO; *R. niviventer, R. fulvescens, R. arjentiventer, R. exiguus* and *R. cremoriventer* from Laos (Johnson, 1972a).

In India, it is recorded ex *R. fulvescens, R. niviventer, R. eha* and *R. rattoides* from Jammu and Kashmir, West Bengal and Sikkim states of INDIA (Mishra *et al.*, 1974)

22. **Hoplopleura silvula** Johnson (Figs. 133-141).

Hoplopleura silvula Johnson, 1972, *Pacific Ins.*, **14**: 607 611, figs. 8-10, 12.

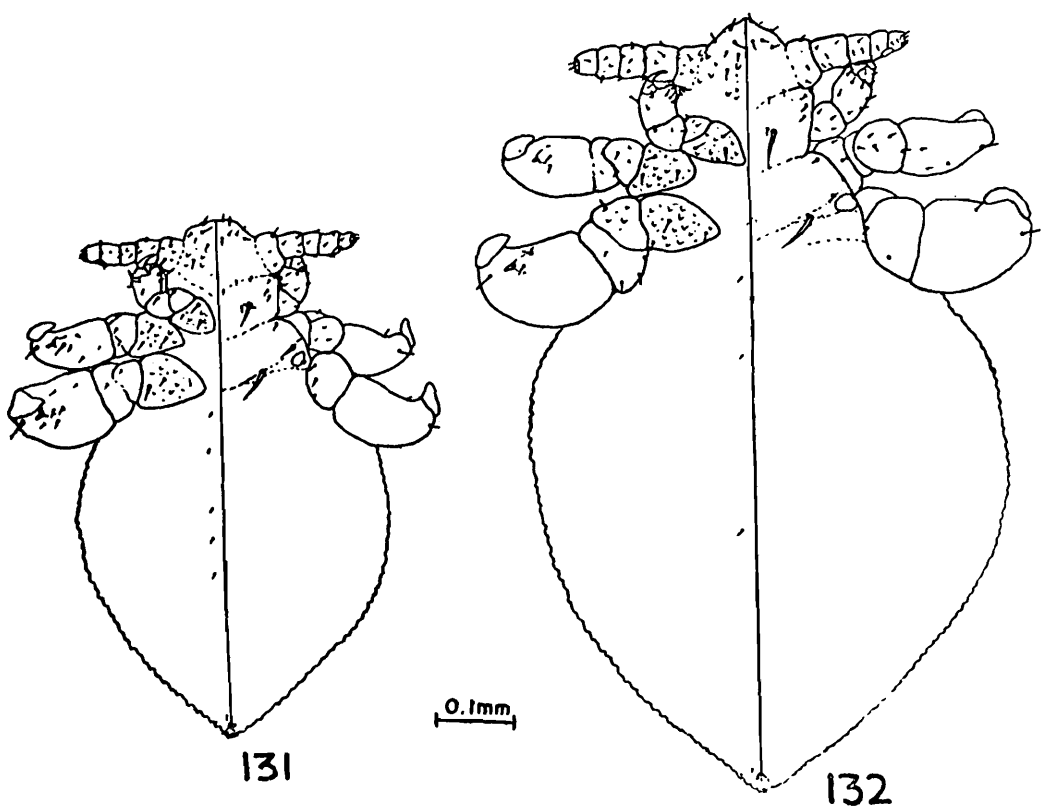
Hoplopleura vandeleuria Mishra and Bhat, 1972, *Oriental Ins.*, **6**: 521-530, figs. 1-9 (New Synonymy). — Mishra *et al.*, 1974, *Indian J. med. Res.*, **62**: 1276.



Figs. 125-130. *Hoplopleura sicata* Johnson. 125, head (ventral and dorsal views) ♀; 126, thoracic sternal plate ♀; paratergites ♀; 128, terminal segments ♀; 129, thoracic sternal plate ♂; 130, genitalia ♂.

It is a member of *H. hesperomydis* group (*sensu* Kim, 1965) and is close to *H. difficilis* Kim, *H. reithrodontomydis* Ferris, and *H. onychomydis* Cook and Beer. *H. silvula* can be separated

from these by a combination of following characters : Thoracic sternal plate with posterior process truncated at tip. Paratergites II and III with both setae well developed; IV to VI each with dorsal setae minute, ventral well developed; VAAS several pairs; genital setae modified and spiniform.



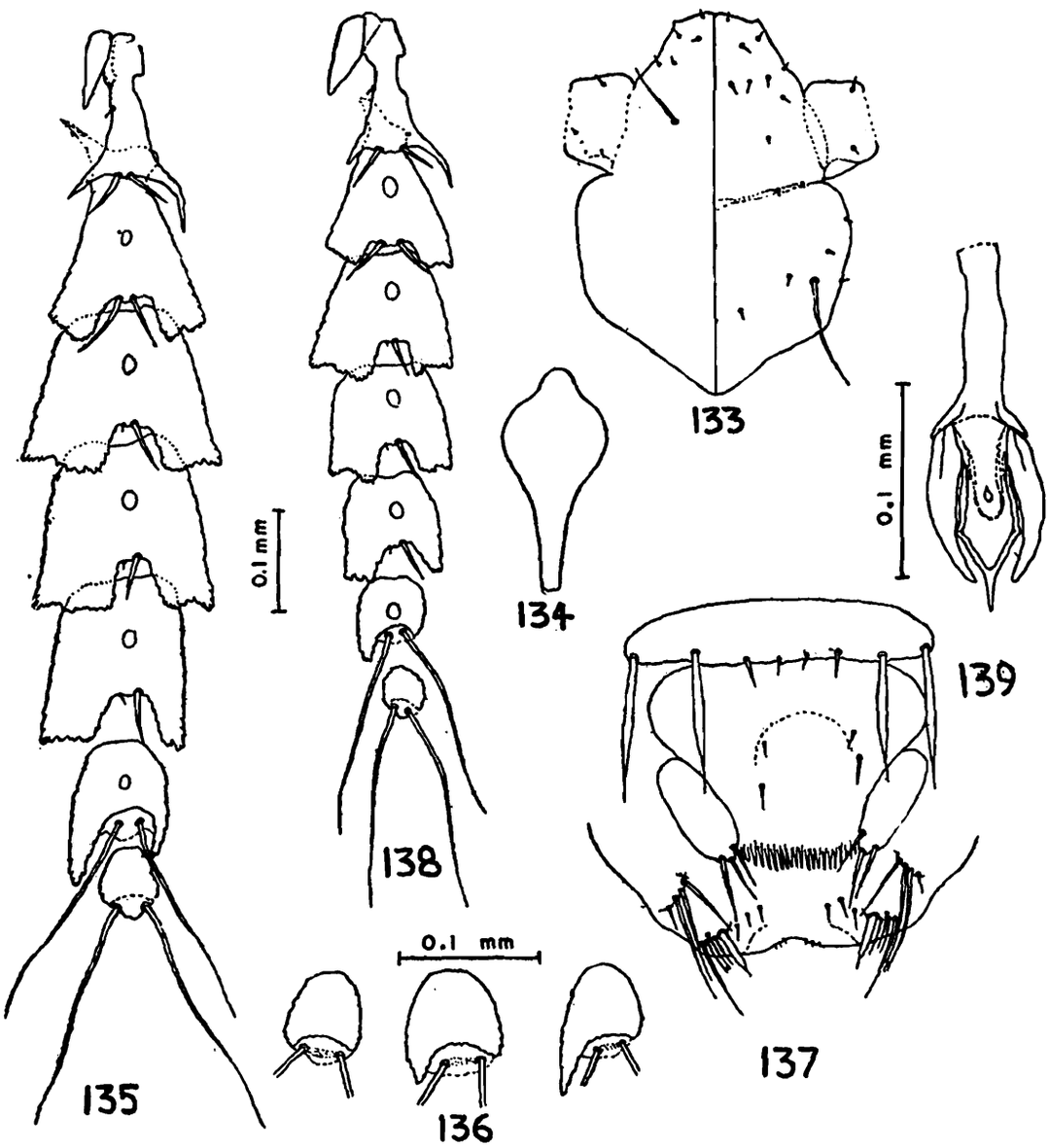
Figs. 131, 132. *Hoplopleura sicata* Johnson. 131, nymph 1 ; 132, nymph 2.

Johnson (1972d) described this species on the basis of female *holotype,* male *allotype,* and 2 male, 6 female *paratypes* ex *Vandeleuria oleracea* from Laos, and published it in November issue of Pacific insects. Mishra and Bhat (1972) described *H. vandeleuria* from the same host-species from India and published it in December issue of Oriental Insects. After careful comparison, it was found that both were synonym. On the basis of priority of publication, *H. vandeleuria* Mishra and Bhat is being considered as junior synonym of *H silvula* Johnson.

In Indian subcontinent, it is recorded from type hosts from Maharashtra, Karnataka and Himachal Pradesh states of India (Mishra *et al.,* 1974; 1977).

Female : Total body length 1.13 mm ($\bar{X}$, N=10); range 1.03 to 1.21 mm. *Head* (Fig. 133) Approximately 1.4 × as long as wide. Antennal sensoria contiguous. ACHS indistinct. *Thorax.* Sternal plate (Fig. 134), pear-shaped, posterior process long

tapering and truncated at tip. MDTS long-sized. *Abdomen.* Tergites and sternites well chitinized. DAAS absent. VAAS 7 pairs. Paratergites (Fig. 135) : II typical, dorsal seta as long as and ventral shorter than processes of their sides; III with processes lobed, serrated and emarginate, both setae extending beyond the lobes; IV and V same as III in shape, dorsal seta minute, ventral well developed, almost as long as processes; VI same as V except narrow ventral process; VII with both processes well developed and acute, setae long; VIII with ventral process absent, dorsal process variable, absent, feably developed or well developed but acute, both setae long. *Genitalia* (Fig. 137). Genital seta enlarged and flattened.



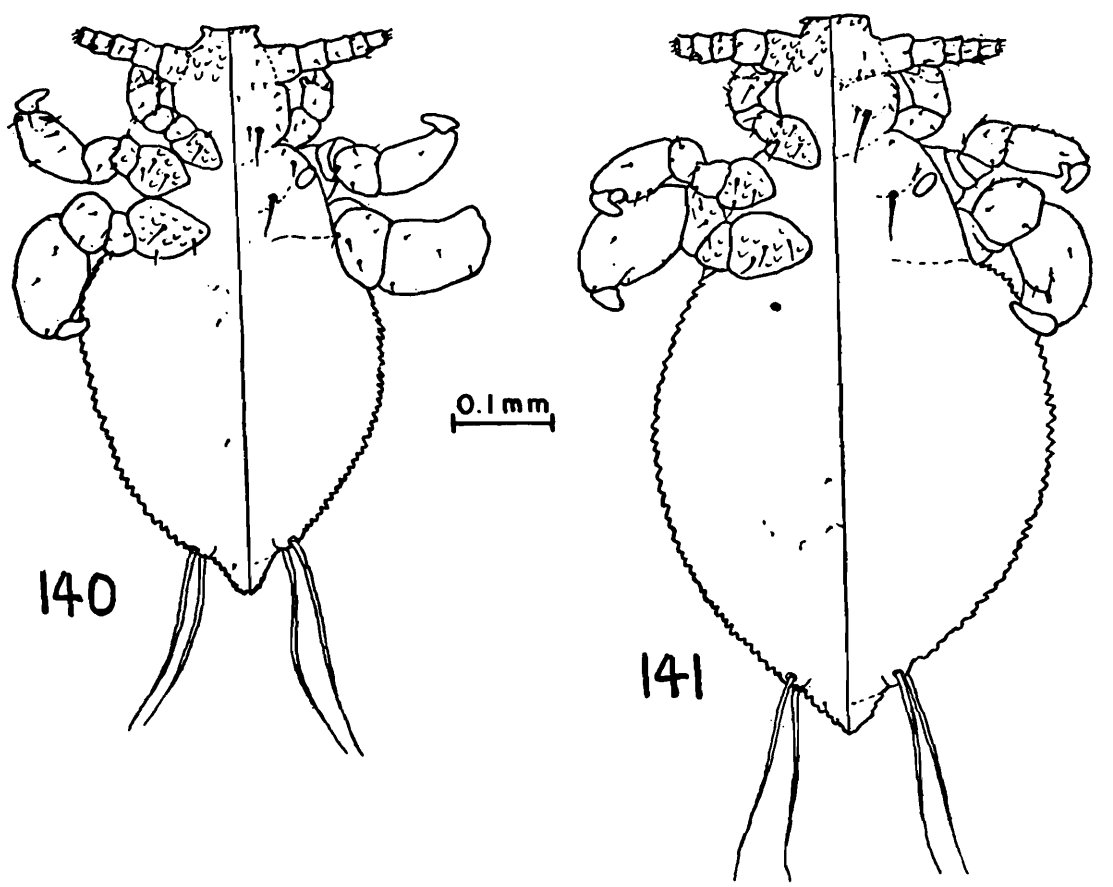
Figs. 133-139. *Hoplopleura silvula* Johnson. 133, head (ventral and dorsal views) ♀; 134, thoracic sternal plate ♀; 135, paratergites ♀; 136, variations in paratergites VIII; 137, terminal segments ♀; 138, paratergites ♂; 139, genitalia ♂

Male : Total body length 0.79 mm ($\bar{X}$, N=10); range 0.75 to 0.09 mm. *Abdomen.* Segments IV to VI each with a single tergite. DAAS absent. VAAS 4 pairs. Paratergites (Fig. 138) : II to VI same as in female; VII with well developed dorsal process, ventral process absent, both setae long; VIII devoid of both the processes, both setae long. *Genitalia* (Fig. 139). Parameres thickened near base, pseudopenis pointed at tip.

Nymph 1 : Unknown.

Nymph 2 (Fig. 140) : Total body length 0.57 mm. *Head* slightly longer than wide. Anterior margin straight with pointed angles; postantennal and posterolateral angles rounded. Typical head setae present except PCHS which is indistinct. Antennal sensoria contiguous. Venter of head and antennae provided with sparsely scattered tubercles. *Thorax.* Mesothoracic spiracles distinct. Sternal plate absent. MDTS small, one pair; ADTS minute, 2 pairs. *Legs* as in adults. Abdomen devoid of segmentation. DCAS absent. VCAS 5 pairs. MAS one pair on each side. AnS one pair.

Nymph 3 (Fig. 141) : Total body length 0.75 mm ($\bar{X}$, N=3). Similar to nymph 2.



Figs. 140, 141. *Hoplopleura silvula* Johnson. 140, nymph 2; 141, nymph 3

Hosts and distribution : Known ex *Vandeleuria oleracea* from various localities in INDIA (Mishra and Bhat, 1972) ; and Laos (Johnson, 1972d). 4 nymphs ex *V o.,* Maharashtra, Poona, 20.viii.1974, coll. *A. C. Mishra.*

23. **Hoplopleura sinhgarh** Mishra, Bhat and Kulkarni (Fig. 142-150).

Hoplopleura sinhgarh Mishra *et al.*, 1972, *Parasitology*, **65** : 11-21, figs. 10-18.

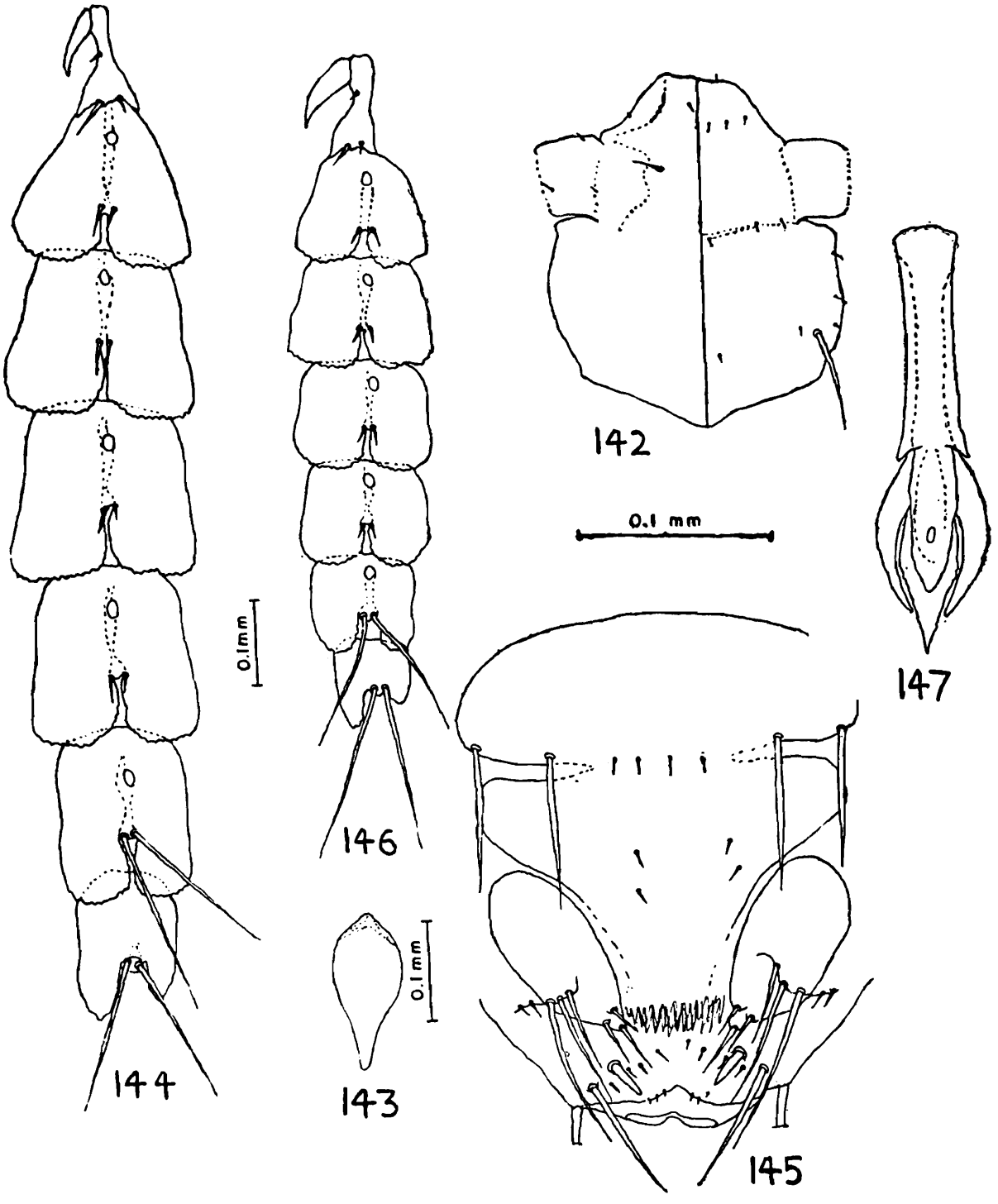
Closely resembles *H pectinata* (Cummings) and *H brasiliensis* (Werneck). It can be easily separated from *H. pectinata* due to the absence of finger-shaped prolongations on the tergite of terminal segment; and from *H. brasiliensis* due to the shape of thoracic sternal plate; less serrated margins of paratergites; and flattened modified genital seta.

Female : Total body length 1.77 mm ($\bar{X}$, N=10); range 1.65 to 1.89 mm. *Head* (Fig. 142) Approximately 1.3 × as long as wide; postantennal angles bluntly pointed; antennal sensoria contiguous. *Thorax.* Sternal plate (Fig. 143) narrowly rounded anteriorly, gradually tapering posteriorly with rounded apex. MDTS small-sized. *Abdomen.* Typical abdominal setae tapering, pointed at tip. Tergites and sternites well chitinized. DAAS and VAAS absent. Paratergites (Fig. 144) : II typical, dorsal seta extends beyond the process, ventral smaller than process of its side; III-VI with processes lobed and serrated, both setae small, dorsal slightly longer than ventral; VII same in shape as VI, both setae long; VIII with both process well developed, both setae long. *Genitalia* (Fig. 145). Genital setae short and spiniform.

Male : Total body length 1.13 mm ($\bar{X}$, N=10); range 1.08-1.2 mm. *Abdomen.* Segments IV to VII each with a single tergite. DAAS, VAAS absent. Paratergites (Fig. 146) same as in female. *Genitalia* (Fig. 147). Parameres thickened near base, gradually tapering towards tip.

Nymph 1 (Fig. 148) : Total body length 0.58 mm. *Head* slightly longer than wide. Postantennal and posterolateral angles rounded. Typical head setae present except AS and PCHS which are indistinct. A strong PoAS and anterior MHS present

on each postantennal angle. Antennal sensoria large and contiguous. Venter of head and antennae with sparsely scattered



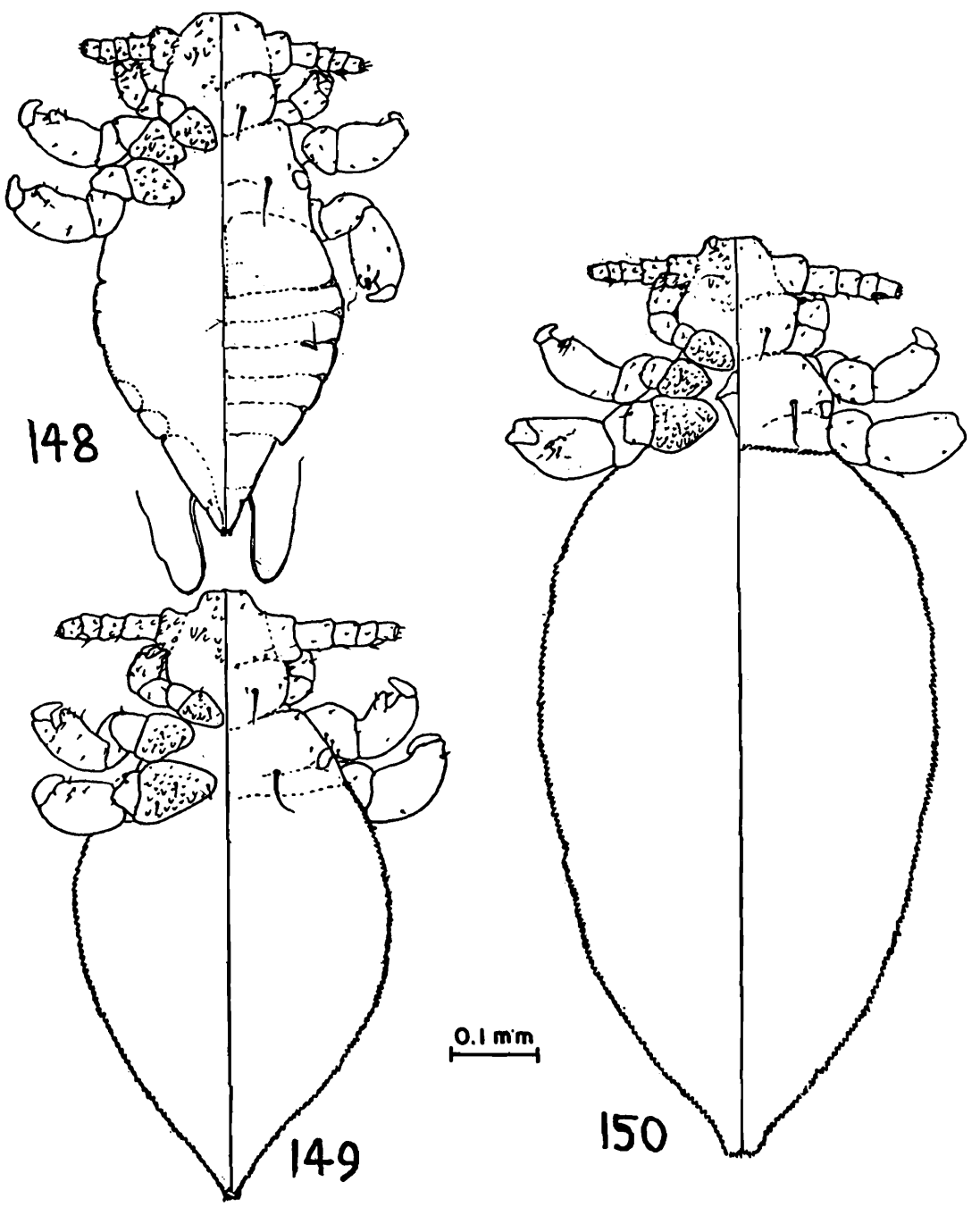
Figs. 142-147. *Hoplopleura sinhgarh* Mishra, Bhat and Kulkarni. 142, head (ventral and dorsal views) ♀; 143, thoracic sternal plate ♀; 144, paratergites ♀; 145, terminal segments ♀; 146, paratergites ♂; 147, genitalia ♂

tubercles. *Thorax*. Mesothoracic spiracles distinct. Sternal plate absent. MDTS small, one pair; ADTS, minute, two pairs. *Legs*. First pair smallest with slender claw, second pair larger with blunt claw, third pair similar to second. *Abdomen*. Dorsal side with 8 segments, first two only separated mesially; ventral side

unsegmented except on lateral sides. DCAS and VCAS absent. A single long MAS present on each side; AcS absent; AnS one pair.

Nymph 2 (Fig. 149) : Total body length 0.75 mm ($\bar{X}$, N=4); range 0.69 to 0.79 mm. Similar to nymph 1 except as follows : *Thorax*. Third pair of legs larger than second pair. Abdomen devoid of segmentation; dorsal side with several tergal plaques of irregular outline. MAS absent.

Nymph 3 (Fig. 150) : Total body length 1.05 mm ($\bar{X}$, N=4); range 0.9 to 1.2 mm. Similar to nymph 3 except the presence of a small thoracic sternal plate.



Figs. 148-150. *Hoplopleura sinhgarh* Mishra, Bhat and Kulkarni. 148, nymph 1; 149, nymph 2; 150, nymph 3.

Hosts and distribution : Known from its type series which consists of holotype ♀, allotype ♂, paratypes 19 ♂, 32 ♀, ex *Mus* platythirx (*sensu* Dhanda et al., 1973) from Maharashtra state; and 10 nymphs ex *M. platythrix,* from Maharashtra (Mishra *et al.* 1977).

Subfamily **Polyplacinae** Ferris

Polyplacinae Ferris, 1951, *The sucking lice,* p. 162. —Johnson, 1960, *U.S.D.A. Tech. Bull.,* **1211** : 142.

Characters : Antennae 5 segmented, sexual dimorphism common, male with the apical preaxial angle of antennal segment 3 prolonged, terminating in a sclerotized point, or it may bear 1 or 2 short, stout setae dorsally. First pair of legs small with slender claw; second pair larger with stout claw; third pair largest but not flattened, with stouter claw. Paratergites present but never overlapping. Sternite of segment II never extended laterally to articulate with corresponding paratergites.

Note : Ferris (1951) recognized 16 genera under the subfamily Polyplacinae. Johnson (1964) described a new genus *Sathrax* from *Tupaia glis* under this subfamily; but disregarded inclusion of the genus *Hamophthirus* Mjöberg, under the family Hoplopleuridae. To accommodate the only species of this genus, *H gaelopitheci* Mjöberg, she created a separate new family Hamophthiridae (Johnson, 1969). Chin (1975) proposed an additional new genus *Tupaiphthirus* raising the total number to 17 Of the 17 valid genera, only 4, namely *Haemodipsus* Enderlein, *Docophthirus* Waterston, *Neohaematopinus* Mjöberg, and *Polyplax* Enderlein have been recorded in this region.

KEY TO THE INDIAN GENERA OF POLYPLACINAE

1 Paratergites very small, consisting of a single point which projects from a slight base..... .....*Haemodipsus*
Paratergites otherwise..... 2

2. Antennae with both basal and distal anterior angles of the basal segment prolonged into a distant hook. Known from *Anathana* in India..... .....*Docophthirus*
Antennae not thus..... 3

3. Paratergite II with evidence of distinct longitudinal division into two plates.....*Polyplax*
Paratergite II with no evidence of longitudinal division. Occuring chiefly on the rodent family Sciuridae.....
....*Neohaematopinus*

Genus **Docophthirus** Waterston

Docophthirus Waterston, 1923, *Bull. Ent. Res.*, **14**: 101. —Ferris, 1932, *Contributions towards a monograph of the sucking lice*, pt. 5: 303. — Ferris, 1951, *The sucking lice*, 164-65.

This is a monotypic genus, represented by *Docophthirus acinetus* Waterston. No specimens of this genus were available during the present study.

*Characters** : "Polyplacinae with five-segmented antennae which are not sexually dimorphic; with the first segment having the anterior margin produced basally and ventrally into sclerotized hooks. Second and third legs both enlarged and practically equal in size. Paratergal plates of the abdomen present on at least segments 2-6, those of segment three not longitudinally divided, those of all the segments with each posterior angle produced into a distinct point. Abdomen of the female with two rows of tergal setae on segments 3-7, and one row on segments one and eight, with a small tergal plate present in connection with the anteriormost row of setae on segments 2-7; with two rows of setae on the sternites of segments 2-7; but with a distinct plate present only on segment two. Male with a single row of tergal setae on all tergites except segment two, which has two rows, with one row and one plate on segments one and 4-7 and two plates on segment two; ventrally with but one plate and one row of setae on segment two and with but one row of setae on any other segment and no plates except on segments seven and eight. Spiracles present on segments 2-8. Thoracic sternal plate no developed"

24. **Docophthirus acinetus** Waterston

Docophthirus acinetus Waterston, 1923, *Bull. Ent. Res.*, **14**: 101, figs. 21a, b. —Ferris, 1932, *Contributions toward a monograph of the sucking lice*, pt. 5: 304, figs. 185, 186. —Ferris, 1951, *The sucking lice*, p. 168, figs. 73, 74.

The species is known from its original record, ex *Anathana ellioti,* the tree shrew, belonging to the family Tupaiidae from INDIA. As the specimens were not available for study, no further comments are possible.

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*Based on Ferris (1951).

Genus **Haemodipsus** Enderlein

Haemodipsus Enderlein, 1904, *Zool. Anz.*, **28**: 139, 143. Haematopinus (*Polyplax*) Neumann, 1909, *Arch. Parasitol.*, **13**: 536.

Type Species: *Pediculus lyriocephalus* Burmeister.

*Characters** : "Antennae five-segmented, not sexually dimorphic. First pair of legs small and with slender claw; second and third legs moderately stout and with stout claw, about equal to each other. Type species with the abdomen membranous throughout and without trace of paratergal plates; in other species of the genus with small paratergal plates on segments 3-6, these being merely a slight, sclerotized point which projects from the body wall and is supported by a slight, expanded sclerotization at the base. Abdominal segments in both sexes with a single row of setae on each, both dorsally and ventrally. Thoracic sternal plate present, but very weakly developed and at no point free from the body. Spiracles present on abdominal segments 3-8.

The members of this genus occur on hares and rabbits of the family Leporidae of the Order Lagomorpha"

Note : Ferris (*loc. cit.*) included 4 species known from different parts of world, under this genus. Subsequently, Blagoveshtchensky (1965, 66) added 3 more species bringing total number of known species to 7 Of these, only *H. ventricosus* has been recorded from this region.

25. **Haemodipsus ventricosus** (Denny)

Haematopinus ventricosus Denny, 1842, *Monographia Anoplurorum Britanniae*, p. 30, pl. 25, fig. 6.

Haematopinus (*Polyplax*) *ventricosus* Denny. Neumann, 1909, *Arch. Parasitol.*, **13**: 527, fig. 27.

Polyplax ventricosus (Denny) Evans, 1913, *Proc. R. Phys. Soc. Edin.*, **19**: 94.

Haemodipsus ventricosus (Denny) Enderlein, 1904, *Zool. Anz.*, **28**: 143.

Complete citations of references and synonymies may be found in Ferris (1951) and Blagoveschensky (1960).

This species was originally described from an European rabbit, *Oryctolagus cuniculus,* from ENGLAND. Subsequently, it has been recorded from this host and from domestic rabbits in many parts of the world. In the Indian subcontinent, it was

recorded from the type host by Ansari (1951) from Punjab. Jancke (1932) described *H ventricosus* from wild rabbit. The form described by Jancke (*loc. cit.*) was subsequently proposed to belong to a new species *H. janckei* by Blagoveshtchensky (1966).

During the present study specimens of this species could not be procured.

Genus **Neohaematopinus** Mjöberg

Neohaematopinus Mjöberg, 1910, *Arch. Zool.* (Stockholm), **6**: 160.
Acanthopinus Mjöberg, 1910, *loc. cit.*, **6**: 13 (Type: *Acanthopinus sciurinus* Mjöberg, n.n. for *Haematopinus antennatus* Osborn, preocc.).

Linognathoides Cummings, 1914, *Bull. Ent. Res.*, **5**: 159 (Type: *Linognathoides citelli* Cummings).

Lutegus Fahrenholz, 1916, *Arch. f. Naturgesch.* [Berlin] 31 (Type: *Haematopinus* (*Polyplax*) *pectinifer* Neumann).

Ahaematopinus Ewing, 1929, *Manual of external parasites*, p. 197 (Type: *Neohaematopinus inornatus* Kellogg and Ferris)

Petauristophthirus Eichler, 1949, *Soc. Ent. Ital. Biol.*, **79**: 12 (Type: *Neohaematopinus petauristae* Ferris).

Type Species: *Haematopinus sciuropteri* Osborn, by original designation.

Complete citations of references and synonymy may be found in Ferris (1951), Johnson (1960b, 64) and Blagoveshtchensky, 1972).

Characters : Antennae 5 segmented, may or may not be sexually dimorphic, sensoria on segments 4 and 5 small and separate. First pair of legs small, with slender claw; second and third pair larger and equal, with stout claw, sometimes third pair may be largest but never flattened. Thoracic sternal plate well developed. Paratergites present on segments I to VIII; chitinization may be obscure to distinct.

Note : All the members of this genus are parasites on the rodent family Sciuridae except two North American species, found on *Neotoma* (Muridae). Of about 35 known species, 4 have been recorded in the Indian subcontinent.

KEY TO THE INDIAN SPECIES OF *Neohaematopinus*

1. Tergites and sternites absent, except the tergites on second and

*After Ferris (1951).

terminal segments in female, and some greatly reduced tergites in male..... ...*palearctus*
Tergites and sternites definitely developed and well chitinized in all segments in both the sexes..... ... 2

2. Thoracic sternal plate heptagonal, sides almost straight, posterior angles devoid of distinct points.....*petauristae*
Thoracic sternal plate otherwise, posterior angles produced into a distinct point..... ... 3

3. Paratergites IV to VI each with setae arranged in two groups, dorsal group with 4 and ventral with 3 setae.....*echinatus*
Paratergites IV to VI each with setae arranged in two groups, dorsal with 4 and ventral with a single seta.....*ceylonicus*

26. **Neohaematopinus ceylonicus** Ferris

Neohaematopinus ceylonicus Ferris, 1951, *The sucking lice*, p. 190.

Neohaematopinus echinatus (Neumann) Ferris, 1922, *Contributions toward a monograph of the sucking lice*, part 4: 250, fig. 161 (only male, misidentification).

Ferris (1922) illustrated a male obtained from *Funambulus palmarum*, Colombo, SRI LANKA as the male of *N. echinatus* (Neumann) and indicated that it did not agree entirely with the description given by Neumann. Later, Ferris (1951) after receiving more specimens from *F palmarum* from Kandesanturai, SRI LANKA, created this species considering the male earlier illustrated as the holotype and the material later received as allotype and paratypes.

Note : No specimens of this species could be obtained during the present study. The species is essentially similar to *N. echinatus* and can be differentiated by the characters discussed with the latter species.

27 **Neohaematopinus echinatus** (Neumann) (Figs. 151-161).

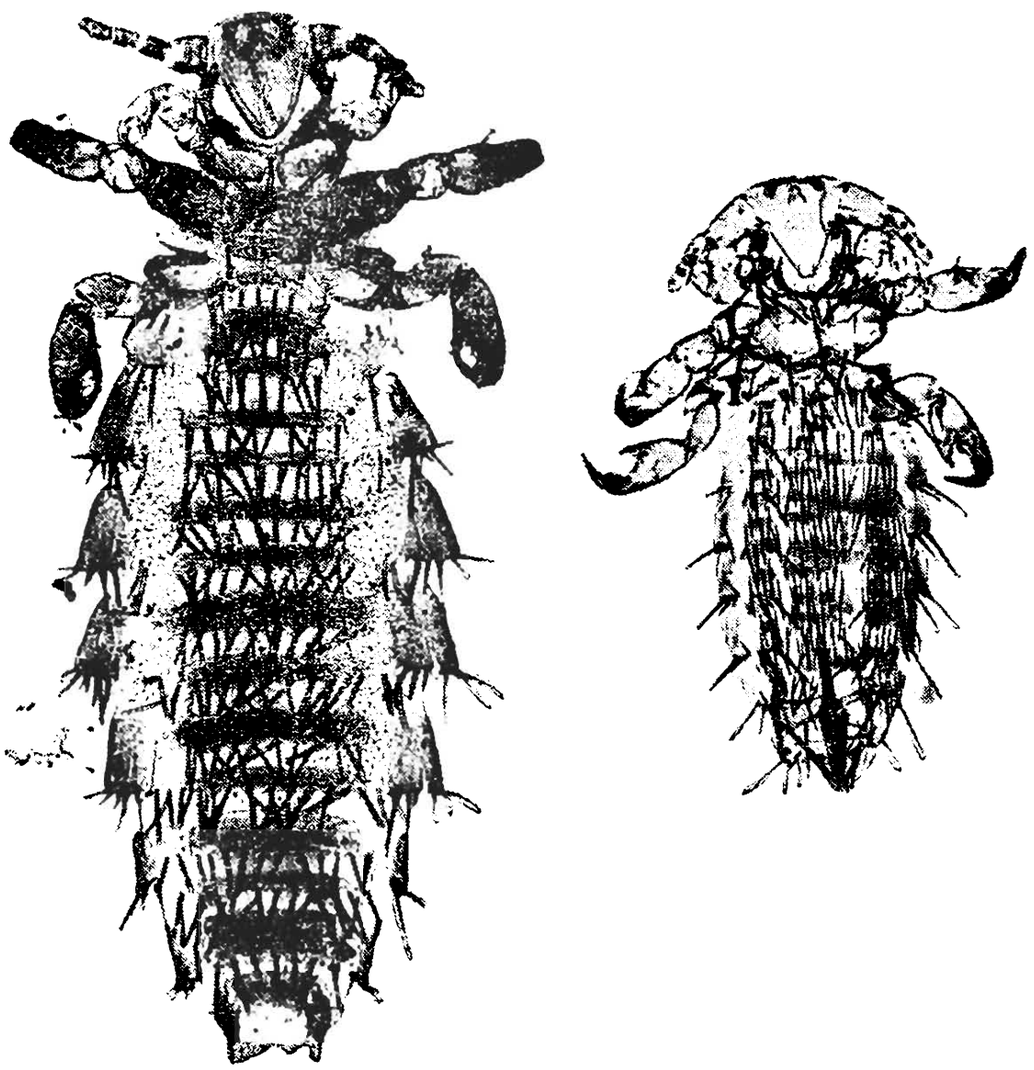
Haematopinus (*Polyplax*) *echinatus* Neumann, 1909, *Arch. Parasit*, **13**: 517, figs. 19, 20.

Neohaematopinus echinatus (Neumann), Cummings, 1912, *Bull. Ent. Res.*, **3**: 393,—Ferris, 1951, *The sucking lice*, p. 191. —Pratt and Stojanovitch, 1961, *J Kansas Ent. Soc.*, **34**: 79-81, fig. pl. II.—Kaneko, 1962, *Bull. Tokyo Med. Dent. Univ.*, **9**: 136. —Mishra *et al.* 1974, *Indian J. med. Res.*, **62**: 1276.

It is a member of *sciuropteri* group of *Neohaematopinus*, and is closely related to *N ceylonicus* Ferris. It differs from all other species of the genus in the shape of anterior sternite on segment II. It differs from *N. ceylonicus* in having 3 setae on

the posteroventral margin of paratergites IV to VI; in *ceylonicus* these are provided with a single seta.

Female (Fig. 151) : Total body length 2.02 mm ($\bar{X}$, N=7); range 1.92 to 2.19 mm. *Head* (Fig. 153*) longer than wide, postantennal angles prominent, occipital region feebly developed with a slight depression on posterior margin; setae arranged as shown in figure, ADHS short and thorn-like. Antennae (Fig. 154) with first segment enlarged, bearing a stout, short, thorn-like



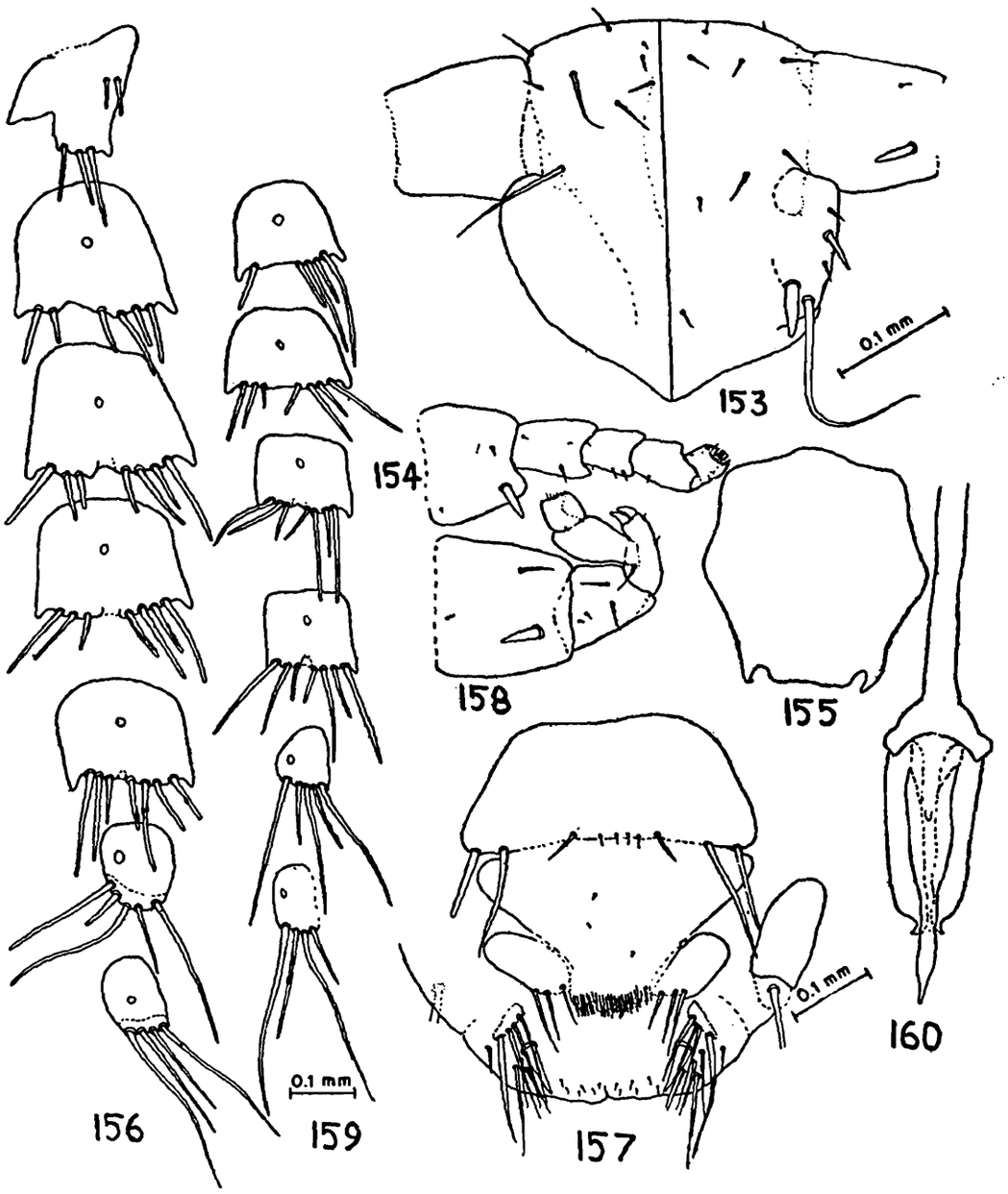
Figs. 151, 152. *Neohaematopinus echinatus* (Neumann). 151, female; 152, male.

seta on the dorsal side; remaining segments longer than wide with normal setae; sensoria on segments 4 and 5 well separated. *Thorax*. Sternal plate (Fig. 155*) 0.24 mm long, 0.21 mm wide ; anterior and lateral margins with a mesial convexity, posterior margin straight, each posterolateral angle produced into a dis-

tinct point. MDTS one pair, long and tapering; ADTS two pairs, small. *Abdomen* : *Dorsal.* Segment I with a single posteriorly concave tergite, having 5 or 6 setae, outer setae on each side stout and thorn-like; II to VII each with 2 tergite, having 7 to 11 setae each; VIII and terminal segment each with one broad tergite, having 7 or 8 setae. DAAS 5 to 7 pairs. *Ventral.* Segment II with 2 sternites; anterior broad, posteriorly concave mesially, convex posterolaterally, having 3 or 4 stout setae on each side on the lateral convexity, and 2 or 3 setae mesially; posterior sternite narrow with 6 setae. Segments III to VI each with 2 sternites, anterior broad, posterior narrow, each with 6 to 8 setae; VII with a single broad sternite with 10 setae, 2 outer pairs long, others small. Remaining sternites modified to form genitalia. VAAS 8 to 10 pairs, anterior 2 or 3 pairs thin and small, remaining long and slender. *Lateral.* Paratergites (Fig. 156) : I small, partially fused with II, having 2 setae; II with a wide dorsal process having 3 setae, and a narrow ventral process without setae; III to VI with posterolateral angles acute, posterodorsal margin with 4 setae, posteroventral margin with 3 setae, excepting III, which has 2 setae; VII and VIII with rounded posterolateral angles, former with 3 long and 2 short setae, and later with 2 long and 2 short setae. *Genitalia* (Fig. 157) Genital plate large, broad anteriorly and narrow posteriorly; beset with 5 or 6 thin setae, inconsistent in position. Gonopods paired, 3 setae on each. Genital setae stour and tapering at tip.

Male (Fig. 152) : Total body length 1.51 mm ($\bar{X}$, N=4); range 1.35 to 1.61 mm. *Head* and *thorax* as in female except antennal segment III apicodorsally prolonged into a hook-like process, bearing two short and stout setae (Fig. 158). *Abdomen* : *Dorsal.* Segment I with a single tergite, having 6 setae; II with 2 tergites, anterior with 8 setae, posterior with a group of 5 setae on a lobe on each side laterally, and 5 or 6 setae mesially; III to VII each with a single tergite, having 17 to 19 setae; VIII with a pair of triangular tergites, without setae; terminal segment triangular in shape with several small setae. DAAS 3 or 4 pairs. *Ventral.* Segments II to VI each with two tergites, anterior most as in female, remaining with 5 to 7 setae each; VII and VIII each with a single broad sternite, with 4 and 2 setae respectively; terminal segment triangular with several small setae. VAAS, 5 or 6 pairs. *Lateral.* Paratergites (Fig. 159)

as in female except as follows : III with a single seta on posteroventral margin; VIII fused with the triangular abdominal tergites of its sides. *Genitalia* (Fig. 160). Pseudopenis long, smooth, extending well beyond the apices of parameres. Parameres uniform in thickness, apically curved and pointed.



Figs. 153-160. *Neohaematopinus echinatus* (Neumann). 153, head (ventral and dorsal views) ♀; 154, antenna ♀; 155, thoracic sternal plate ♀; 156, paratergites ♀; 157, terminal segments ♀; 158, antenna ♂; 159, paratergites ♂; 160; genitalia ♂

Nymph 1 : Unknown.

Nymph 2 (Fig. 161) : Total body length 1.03 mm. *Head* about as long as wide, setae arranged as shown in fig; antennae

as in female. *Thorax*. Sternal plate absent; setae and legs as in adults. *Abdomen*. Dorsally with 9 rows, ventrally with 7 rows of 2 to 10 setae. Tergites and sternites completely absent. Paratergites I small, located dorsally, with a single seta; II large, 3 setae on posterodorsal margin, one on posteroventral margin; III to V well developed, posterior angles acute, posterodorsal and posteroventral margins with 2 setae each; VII and VIII small, with 2 setae each. Two long MAS on each side, posterior to paratergites. AnS indistinct.

Nymph 3 : Total body length 1.3 mm ($\bar{X}$, N=4); range 1.19 to 1.41 mm. Similar to nymph 2.

Hosts and distribution : Recorded ex *Funambulus palmarum* from Rajkote and Agra, India (Ferris, 1951); ex *F pennanti* from Nalainpur, India (Kaneko, 1962); ex *F tristriatus* from Sagar, Shimoga dist., Karnataka state, India (Pratt and Stojanovitch, 1961); ex *F pennanti* in several localities in Uttar Pradesh, and Himachal Pradesh states of INDIA (Mishra *et al.* 1974); and ex *Funambulus tristriatus* in Maharashtra state, India (Mishra *et al.* 1977)

28. **Neohaematopinus palearctus** Olsoufiev (Figs. 162-167).
Neohaematopinus palearctus Olsoufiev, 1938, *V.I.E.M. Ot. Med. Trudy* Moscow, **3**: 210-212, figs. 1-6. — Mishra *et al.*, 1974, *Indian J. med. Res.*, **62**: 1276.

This species is close to *N mormotae* Ferris and *N. laeviusculus* (Grube) but can be easily differentiated due to its longer head, roughly oblonged shape of thoracic sternal plate, large-sized thoracic spiracles, absence of sternites, and by the shape of male genitalia.

The original description was overlooked for a long time and there is no record of its occurrence even in the classical publications of Hopkins (1949) and Ferris (1951)

Female (Fig. 162) : Total body length 2.74 mm ($\bar{X}$, N=7), range 2.63 to 2.84 mm. *Head* longer than wide. Preantennal and postantennal regions with strong chitinous armature. Postantennal angles small and rounded, occipital angles with a slight depression on posterior margin. All typical head setae comparatively long and slender. Antennae devoid of any modified setae, sensoria on segments 4 and 5 well separated. *Thorax*. Spiracles large. Sternal plate (Fig. 164) 0.19 mm long, 0.17 mm wide; roughly oblong in shape. MDTS one pair, ADTS two pairs.

Abdomen. Tergites and sternites entirely absent with the exception of rudiments of tergites on second and terminal segments,

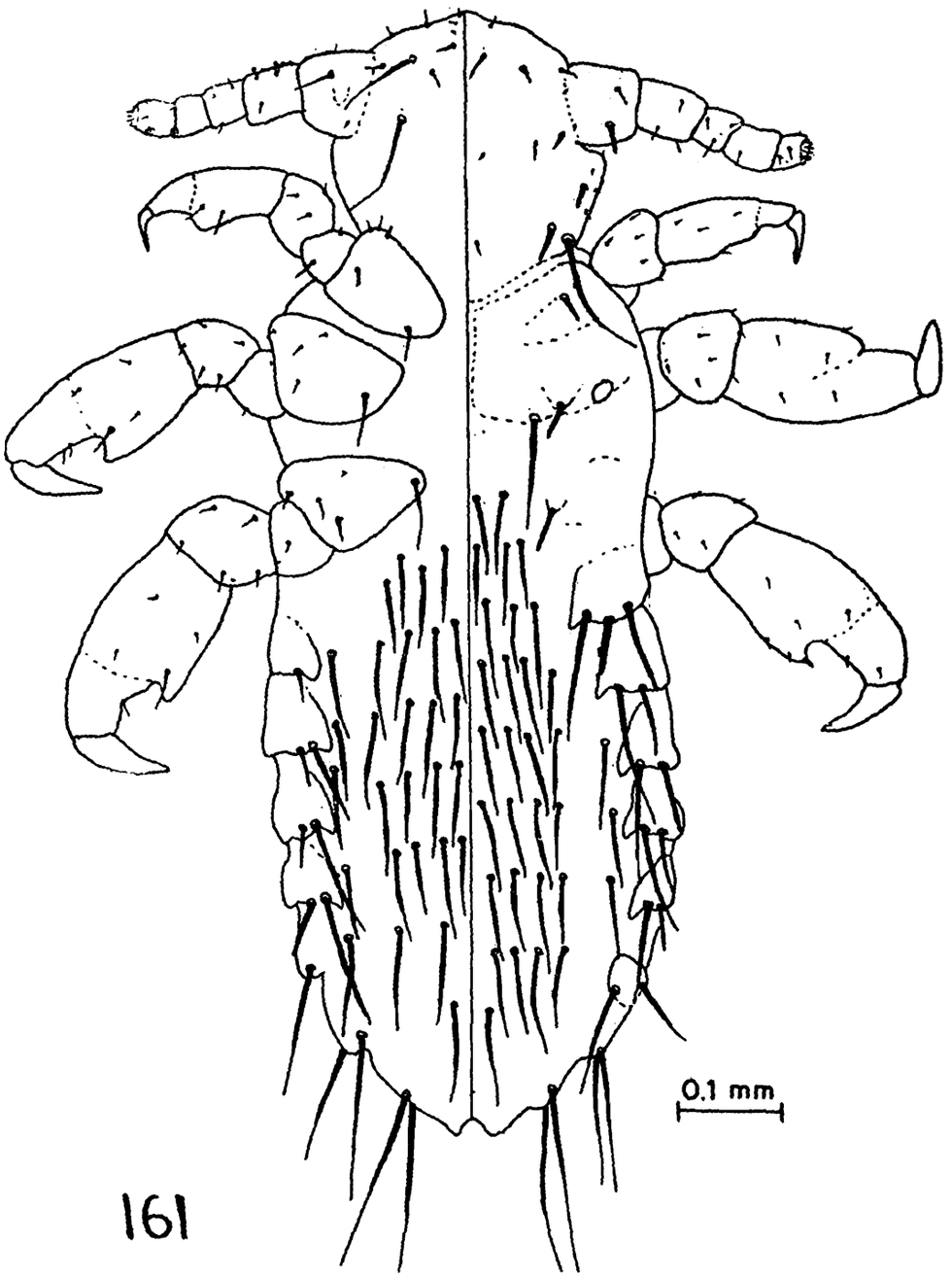
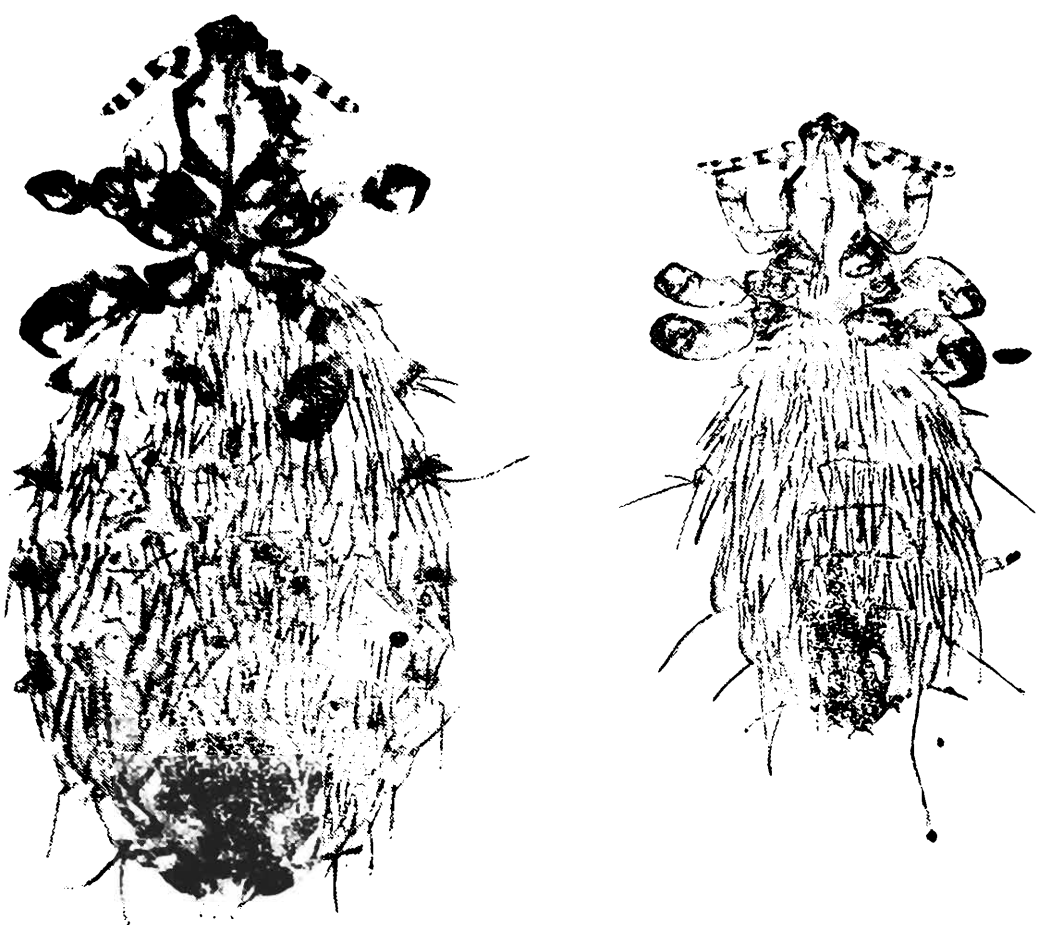


Fig. 161. *Neohaematopinus echinatus* (Neumann) nymph 3.

and usual sclerotization of the genital region. Dorsal side with 15 rows of thin, slender setae : first 14 rows with groups of 4 to 8 setae on each side laterally and 9 to 17 setae mesially; last row with 2 setae. Ventral side with 12 rows of setae : anterior 2 rows with 6 to 8 setae arranged medially, remaining rows with groups of 2 to 4 setae on each side laterally, and 7 to 15 setae mesially. *Lateral.* Spiracles present on segments II to VII. Para-

tergites chitinized on abdominal segments II to VI; only unchitinized protuberance present on segments I, VII and VIII. Paratergite I and II with one small and one long setae; III to VI each with 3 setae of varying length, at times only 2 setae present; VII and VIII each with 2 long setae. *Genitalia* (Fig. 165). Genital plate roughly pentagonal in shape, beset with several long and small setae. Gonopods paired, each with one long and two small setae. Genital setae enlarged and stout.

Male (Fig. 163) : Total body length 1.89 mm ($\bar{X}$ N=7); range 1.83 to 1.97 mm. *Head* and *thorax* as in female. *Abdomen.* Dorsal side with small, narrow tergites; 8 rows of 6 to 16 long, slender setae in middle, and 7 rows of 2 to 5 setae in lateral groups; terminal segment with several small setae. Ventral side devoid of any sclerotization except in genital region; 11 rows of 2 to 12 long, thin setae in the middle, 5 to 6 rows of 2 to 4 setae in lateral groups; terminal segment with several small setae. Paratergites as in female. *Genitalia* (Fig. 166) well developed. Parameres almost uniform in thickness with pointed and slightly curved apices; pseudopenis with distinct serration on sides.



Figs. 162, 163. *Neohaematopinus palearctus* Olsoufiev. 162, female ; 163, male.

Nymphs : Unknown.

Hosts and distribution : Known ex *Marmota caudata jacquem* from U.S.S.R.; and *Marmota caudata* from Jammu and Kashmir state of INDIA (Mishra *et al.* 1974).

29. **Neohaematopinus petauristae** Ferris

Neohaematopinus petauristae Ferris, 1923, *Contributions toward a monograph of the sucking lice*, part 4: 258, figs. 166, 167A, C, E. — Ferris, 1951, *The sucking lice*, p. 195. — Johnson, 1964, *Misc. Publs. Ent. Soc. Am.*, 4: 80, 81, figs. 58, 64.

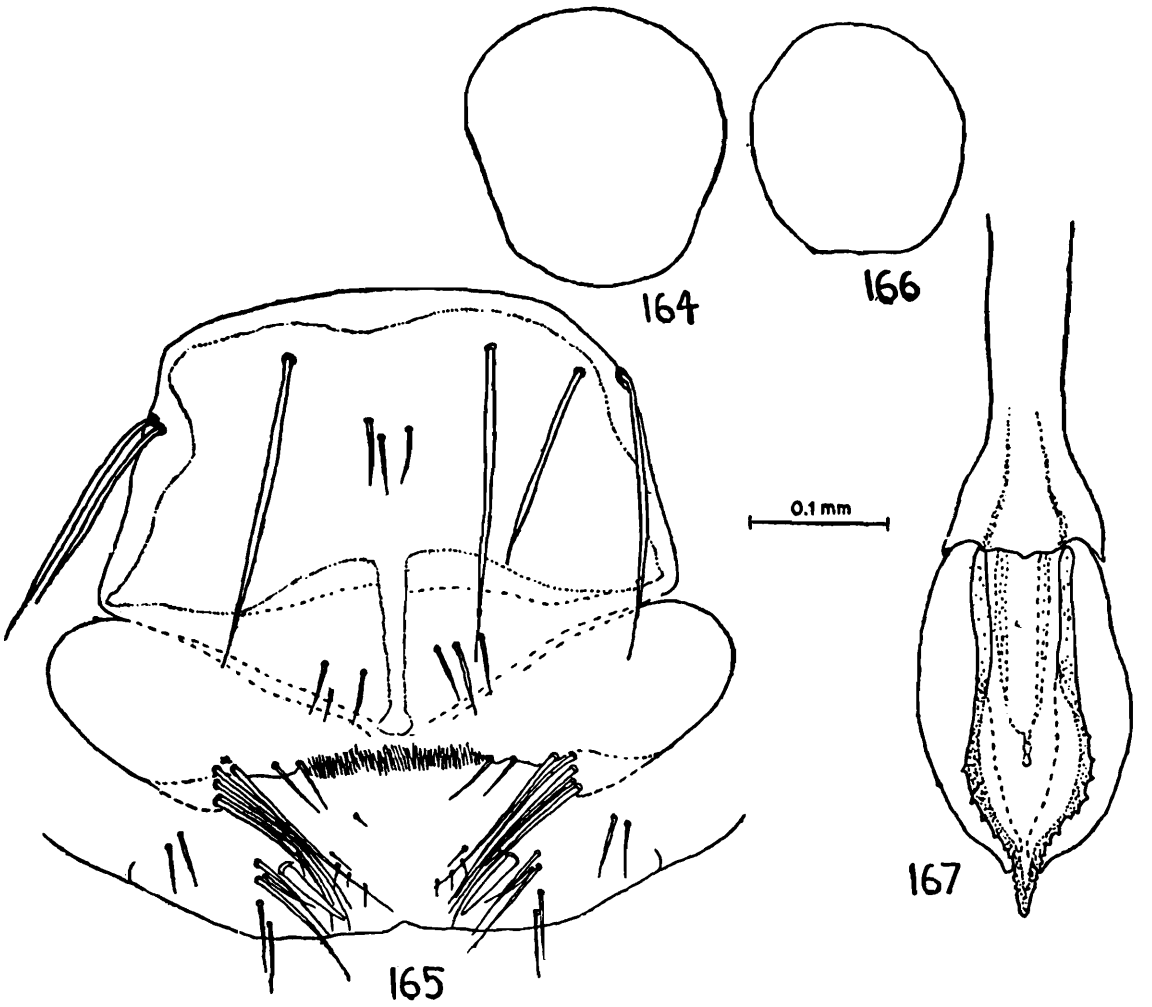
Petauristophthirus petauristae (Ferris) Eichler, 1949, *Soc. Entomol. Ital. Boll.*, 79: 12.

This is a representative of a group of *Neohaematopinus* species which infest Asian giant flying squirrels of the genus *Petaurista*. The group includes *N. batuanae* Ferris ex *P. batuana,* Batu Islands, Malaysia; *N. robustus* Johnson ex *P. elegans punetatus,* Pahang, Malaysia; and *N. pallidus* Johnson ex *P taylori* and *P. petaurista melanotus,* Selangor, Malaysia. *N. petauristae* can be differentiated from other species of the group by a combination of following characters : Thoracic sternal plate heptagonal, with straight posterior margin; abdominal tergites and sternites greatly reduced, but complete, more than 15 abdominal setae off the plates, and by the shape and chaetotaxy of paratergites.

Female : Total body length 2.3 mm. *Head* longer than broad. Postantennal angles practically obsolete, occipital regions constricted, lateral margins nearly straight and parallel. First antennal segment with a long, slender seta at distal postaxial angle. *Thorax*. Sternal plate irregularly seven-sided (heptagonal) *Abdomen*. Tergites and sternites narrow, usually with 7 to 10 slender setae. Each segment except the ventral side of first with 1 to 3 setae near the margin opposite the end of each row of setae. *Paratergites* : I obsolete, marked by 3 slender setae; II with a small and acute dorsal posterolateral angle, having 2 long setae; III to VI each with both dorsal and ventral posterolateral angles small and acute, having 2 setae, setae longer than plates; VII and VIII devoid of acute angles, having 2 long and slender setae.

Male : Total body length 1.8 mm. *Head* and *thorax* as in female, except third antennal segment which is modified and bears a pair of stout, recurved setae. *Abdomen*. Segments III to

VI each with 2 tergites. Paratergites as in female. *Genitalia.* Parameres more than half as long as basal plate, stout, some-



Figs. 164-167. *Neohaematopinus palearctus* Olsoufiev. 164, thoracic sternal plate ♀; 165, terminal segments ♀; 166, thoracic sternal plate ♂ 167, genitalia ♂

what curved but nearly paralled, enclosing part of pseudopenis; pseudopenis long and serrated.

Nymphs : Unknown.

Hosts and distribution : Known from its type series ex *Petaurista petaurista albiventer* (=*P inormata*) from Kashmir. Record from THAILAND ex *P. taylori* (Johnson, 1959) is later attributed to be *N. pallidus* by Johnson (1964).

Genus **Polyplax** Enderlein

Polyplax Enerlein, 1904, *Zool. Anz.*, **28**: 142, 223.

Eremophthirius Glinkiewicz, 1907, *S. B. Acad. Wiss. Wien.*, **116**: 381 (Type: *Eremophthirius werneri* Glinkiewicz).

Haematopinus (*Polyplax*) Neumann, 1909, *Arch. Parasit*, **13**: 529.

Symoca Fahrenholz, 1938, *Z. Parasit.*, **10**: 245 (Type: *Polyplax brachyrrhynchus* Cummings).

Type Species: *Pediculus spinulosus* Burmeister, by original designation.

Complete citations of references and synonymies may be found in Ferris (1951), Johnson (1960b, 64).

Characters : Description of typical members of the genus is given below :

Female : *Head.* Postantennal and occipital angles may or may not be developed. Gular area usually raised, gular folds present. Typical head setae on dorsal side are, OS (3 to 5 pairs); SHS (2 pairs); MHS (3 pairs); PAS, AB, PoAS, ADHS, PDHS, ACHS and PCHS one pair each; and on ventral side, CS (3 or 4 pairs); VOS (3 or 4 pairs); VPHS (1 pair). Antennae 5 segmented, sensoria on segments 4 and 5 may be contiguous or well separated. *Thorax.* Pronotum present in the form of a narrow, median longitudinal stripe. Thoracic sternal plate well developed. MDTS, one pair, usually long; ADTS one to several pairs, small. *Legs.* First pair of legs small and weak, with a slender claw; second pair large with stout claw; third pair largest with stouter claw, but not flattened or expanded. *Abdomen.* Segments I and II fused with each other and are considered as segment II only. Segments II to VII each usually with 2 tergites and sternites; VIII and terminal segment each with a single tergite dorsally, and with usual genital sclerotization ventrally. Tergite and sternite may be well developed, narrow or sometimes absent; each with a row of setae. DAAS and VAAS none to several pairs. Paratergite II characteristic in shape, having appearance of being divided into two plates, with a membranous area in between; several small setae on the membranous area, and a single seta on each plate. Paratergites III to VIII. *Genitalia* consists of genital plate, beset with several small setae; genital lobes, paired, each with 2 or 3 setae; a group of several small to long setae posterolateral to gonopods; and a group of setae on each genital lobe, genital seta may be normal or slightly enlarged.

Male : *Head* and *thorax* as in female. Antennae sometimes with preaxial angle of segment 3 prolonged and terminating in a sclerotized point, or with some modified setae, exhibiting sexual dimorphism. *Abdomen.* Segments II and III usually with 2 ter-

gites and 2 sternites; IV to VIII and terminal segment each with a single tergite and sternite. Tergites and sternites may be well developed, narrow, or absent, each with a row of setae. Paratergites as in female. Genitalia consists of a basal apodeme, a pair of parameres, and pseudopenis. Pseudopenis may be enclosed by the parameres or articulates at their tips.

Nymphs : Three nymphal instars are present. Chaetotaxy of head and thorax is almost same as in adults. Other morphological characters will be discussed with individual species.

KEY TO THE INDIAN SPECIES OF *Polyplax*

1. Thoracic sternal plate with distinct, well sclerotized, handle-like prolongation, about one fourth length of plate, extending anteriorly between the coxae of first pair of legs.....*stephensi*
   Thoracic sternal plate devoid of such a process..... 2
2. Setae of paratergite VI much longer than the plate; spiracles unusually large; specific parasites of shrews of family Crocidurae... .....*...reclinata*
   Setae of paratergite VI never longer than the plate..... 3
3. Setae of paratergites III to VI definitely shorter than the corresponding plate..... ... 4
   At least one seta on one of these paratergites as long as or longer than the plate..... ... 6
4. Dorsal setae of paratergites IV to VI small, ventral comparatively longer but shorter than the plates; VAAS absent.....*kondana*
   Both setae of paratergites IV to VI more or less equal in size; at least one pair of VAAS present..... ... 5
5. Both setae of paratergite VII smaller than the plate. VAAS, one pair.....*...cutchicus*
   Both setae of paratergite VII much longer than plates. VAAS more than one pairs.....*spinulosa*
6. Paratergites II and III with both setae smaller than the plate; dorsal seta of paratergite IV about as long as or longer than the plate..... 7
   Paratergites II and III with dorsal seta much longer than plate; both seta of paratergite IV smaller than plate..... 8
7. Paratergites III to VI with both posterolateral angles acute and pointed; both setae of paratergite VII long and equal..... .....*serrata*
   Paratergites III to VI with dorsal posterolateral angle pointed, ventral seta of paratergite VII about half the length of dorsal seta..... .....*...blanfordi*
8. Head less than 1.5 × longer than wide; antennae in male with 2 small hook-like setae showing sexual dimorphism; parameres slender and pointed at tip.....*hurrianicus*
   Head at least 1.5 × longer than wide; antennae do not show sexual

dimorphism; parameres strongly incurved, enclosing the pseudopenis..... 9

9. Female tergites and sternites absent except for a few small tergites on the anterior part of abdomen and sternites associated with genital region. Male tergites and sternites reduced and narrow..... .....*asiatica*
Tergites and sternites well chitinized, invaribly present on all the segments in both the sexes.....*indica*

30. **Polyplax asiatica** Ferris (Figs. 168-176).

Polyplax asiatica Ferris, 1923. *Contributions toward a monograph of the sucking lice*, part 4: 233, fig. 152 D.

Polyplax turkestanica turkestanica Blagoveshtchensky, 1950, *Parazitol. Sborn., Zool. Inst., Akad. Nauk S.S.S.R.* **12**: 81, figs. 1, 2.

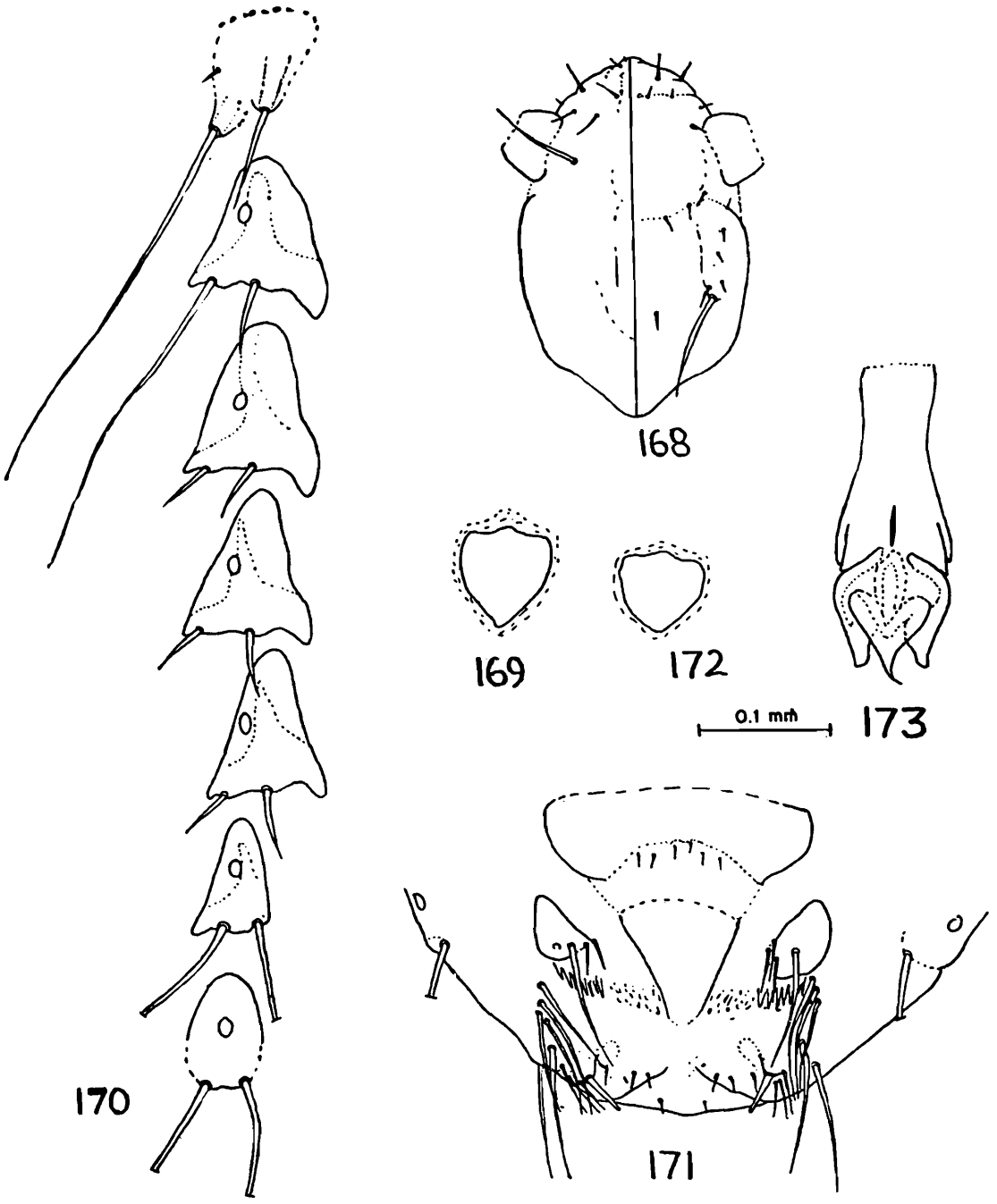
Polyplax turkestanica major Blagoveshtchensky, 1950, *loc. cit.*, **12**: 85, fig. 3.

Complete citation of references and synonymis may be found in Kim (1971) and Kaneko (1972).

Close to *P. insula* Ferris and *P indica* Mishra and Kulkarni. It can be separated from these due to the absence of well developed abdominal tergites and sternites. Further it is separable from *P. insula* due to the shape of head which is longer than wide, and by the well developed the posteroventral process of paratergites III to VI, which is not acute but rounded at tip.

Female : Total body length 1.58 mm ($\bar{X}$, N=10); range 1.35 to 1.72 mm. Head (Fig. 168). Approximately 1.5 × longer than wide. Postantennal and occipital angles not marked; gular area not raised. All typical head setae present, except AS which is indistinct; ADHS close to MDHS. Antennal sensoria large and contiguous. *Thorax.* Sternal plate (Fig. 169) irregularily triangular, enclosed in a semi-membranous rim, anterior margin slightly projected in middle. MDTS one pair, long; ADTS two pairs, small. *Abdomen.* Tergites and sternites absent except a few small tergites on anterior segments. Paratergites (Fig. 170) : II to VIII each irregularly pigmented; II typical, dorsal seta long, ventral small; III with posteroventral angle produced into a large, almost rounded process, posterodorsal angle small and acute; ventral seta smaller, dorsal longer than the plate; IV to VI similar in shape to III, both setae shorter than the plates; VII with a small, acute posterodorsal angle, both setae long;

VIII devoid of acute angles, setae long. *Genitalia* (Fig. 171). Genital setae slightly enlarged.

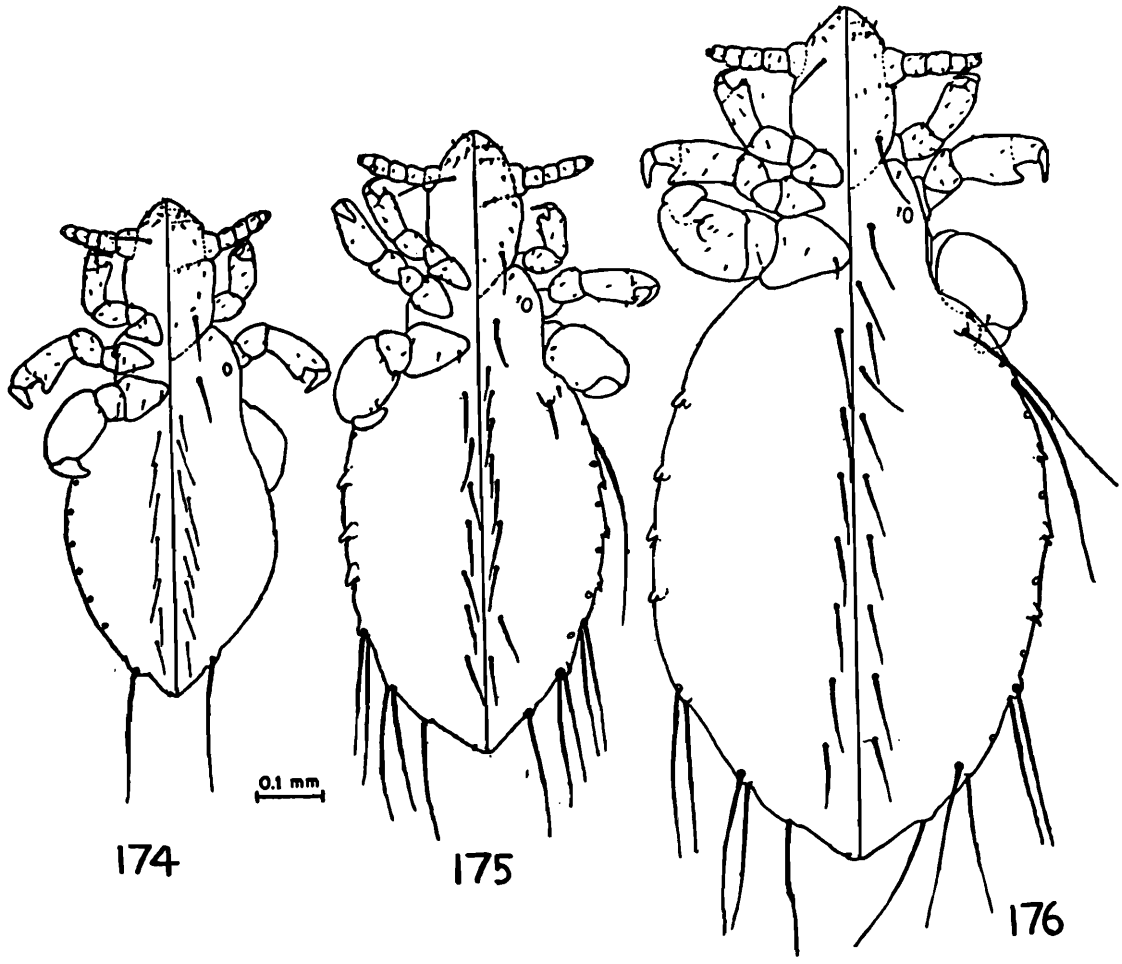


Figs. 168-173. *Polyplax asiatica* Ferris. 168, head (ventral and dorsal views) ♀; 169, thoracic sternal plate ♀; 170, paratergites ♀; 171, terminal segments ♀; 172, thoracic sternal plate ♂

Male : Total body length 1.01 mm ($\bar{X}$, N=5) ; range 0.93 to 1.05 mm. *Abdomen*. Tergites present, although much reduced. Sternites absent. Paratergites as in female. *Genitalia* (Fig. 173). Pseudopenis narrow and pointed, enclosed by recurved parameres.

Nymph 1 (Fig. 174) : Total body length 0.78 mm ($\bar{X}$, N=3); range 0.75 to 0.82 mm. *Head* longer than wide. Typical head

setae present. Postantennal and occipital angles undeveloped. *Thorax* with MDTS long, ADTS small, one pair each. Sternal plate absent. *Legs* as in adults. *Abdomen*. Spiracles 6 pairs. Paratergites absent. DCAS 9 pairs; VCAS 7 pairs; a single MAS present on each side; AnS minute, single pair.



Figs. 174-176. *Polyplax asiatica* Ferris. 174, nymph 1; 175, nymph 2; 176, nymph 3.

Nymph 2 (Fig. 175) : Total body length 0.91 mm ($\bar{X}$, N=8); range 0.85 to 0.94 mm. Similar to nymph 1 except as follows : *Thorax* with ADTS two pairs. *Abdomen* shows some development of paratergites. Paratergites II and III with one small and one long setae; IV to VI each with small protruded angles, 2 minute setae; VII and VIII each with 2 pairs of long and slender setae.

Nymph 3 (Fig. 176) : Total body length 1.14 mm ($\bar{X}$, N=8); range 1.04 to 1.29 mm. Similar to nymph 2 except that paratergites comparatively more chitinized.

Hosts and distribution : Originally described ex *Crocidura caerulea* from Rangoon, BURMA. However, it is now almost

established that the original host record is erroneous and it is a well established common parasite of *Nesokia* and *Bandicota* spp. in ASIA and AFRICA.

In INDIA, it is recorded ex *B. malabarica, B. bengalensis* and *N. indica,* from Punjab, Maharashtra, Uttar Pradesh, Himachal Pradesh states (Ansari, 1951; Wattal and Tondan, 1965 ; Mishra *et al.* 1974, 1977). Other records ex *Mus platythrix, Suncus murinus* etc. are attributed to contamination or misidentifications.

31. **Polyplax blanfordi** Mishra and Dhanda (Figs. 177-187).

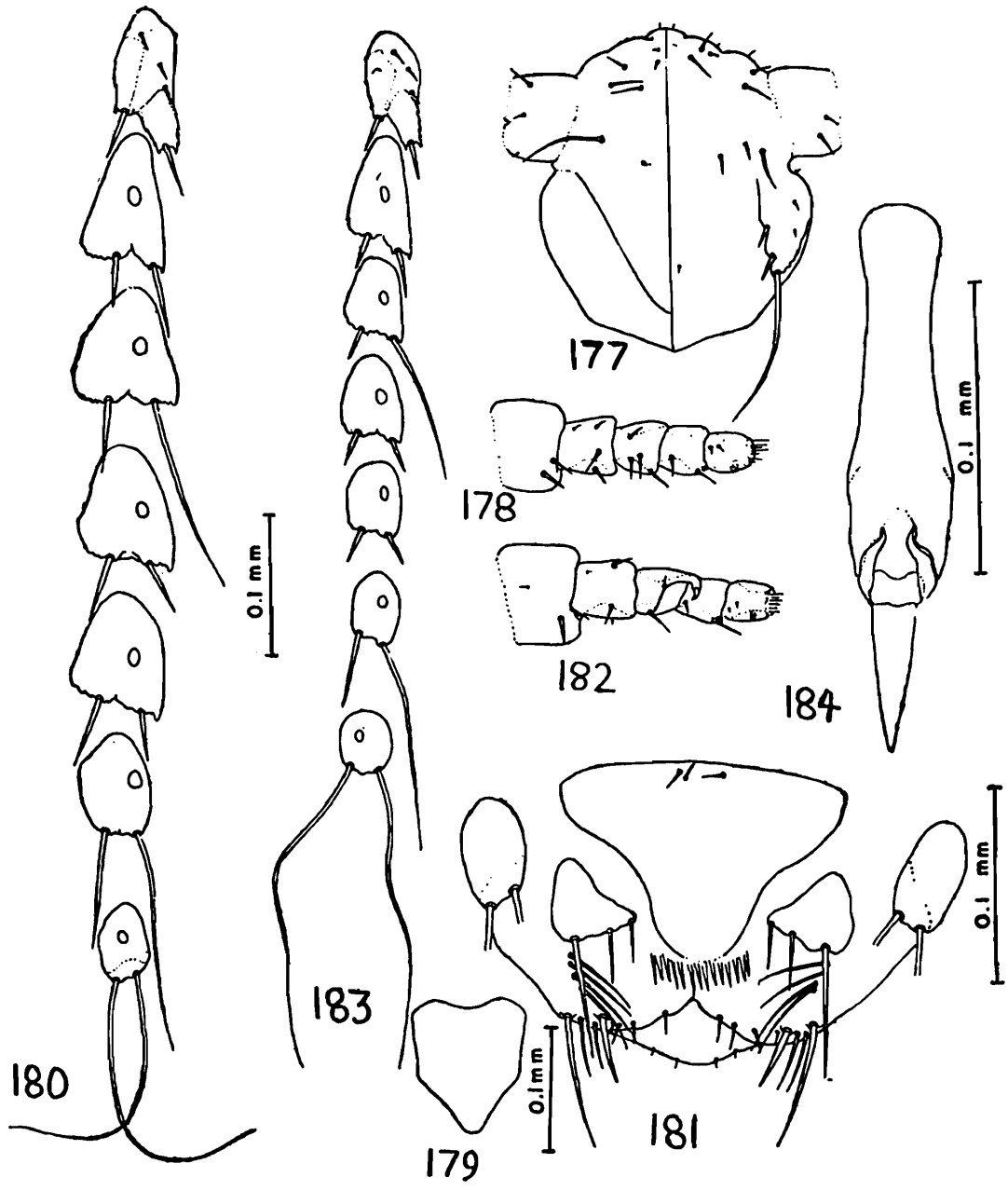
Polyplax blanfordi Mishra and Dhanda, 1972, *J. Parasit.*, **58**: 393-399, figs. 10-18.

Close to *P. serrata* Burmeister and *P. cutchicus* Mishra and Kaul. It can be separated from *P. serrata* due to rounded posteroventral angles of paratergites III-VI and ventral seta of paratergite VII being 0.5 × the length of dorsal seta; and from *P. cutchicus* due to long ventral seta of paratergite IV and long dorsal seta of paratergite VII.

Female : Total body length 1.05 mm ($\bar{X}$, N=10); range 1.01 to 1.08 mm. *Head* (Fig. 177). Approximately 1.2 × as long as wide. Antennal sensoria present on segment 4 and 5, well separated (Fig. 178). *Thorax.* Sternal plate (Fig. 179) with anterior margin concave medianly, posterior process rounded at tip. MDTS one pair, long. *Abdomen.* Tergites and sternites well sclerotized. DAAS 3 pairs, VAAS 5 pairs. Paratergites (Fig. 180) : II typical, paratergal setae smaller than plates; III to VI subtriangular, each with dorsoposterior angle produced into small tooth-like process, ventral posterior angles rounded, setae smaller than plates, except dorsal seta of paratergite IV, which is much longer; VII devoid of process, dorsal seta about 2 × of ventral seta; VIII small, devoid of processes, setae long. *Genitalia* (Fig. 181). Genital seta stout and modified.

Male : Total body length 0.73 mm ($\bar{X}$, N=10); range 0.65 to 0.78 mm. *Head* and *thorax* as in female except antennal segment III apicodorsally prolonged, bearing a short stout seta (Fig. 182). *Abdomen.* DAAS and VAAS absent. Paratergites (Fig. 183) as in female. *Genitalia* (Fig. 184). Parameres short, pseudopenis well developed, gradually tapering distally, articulating with apices of parameres.

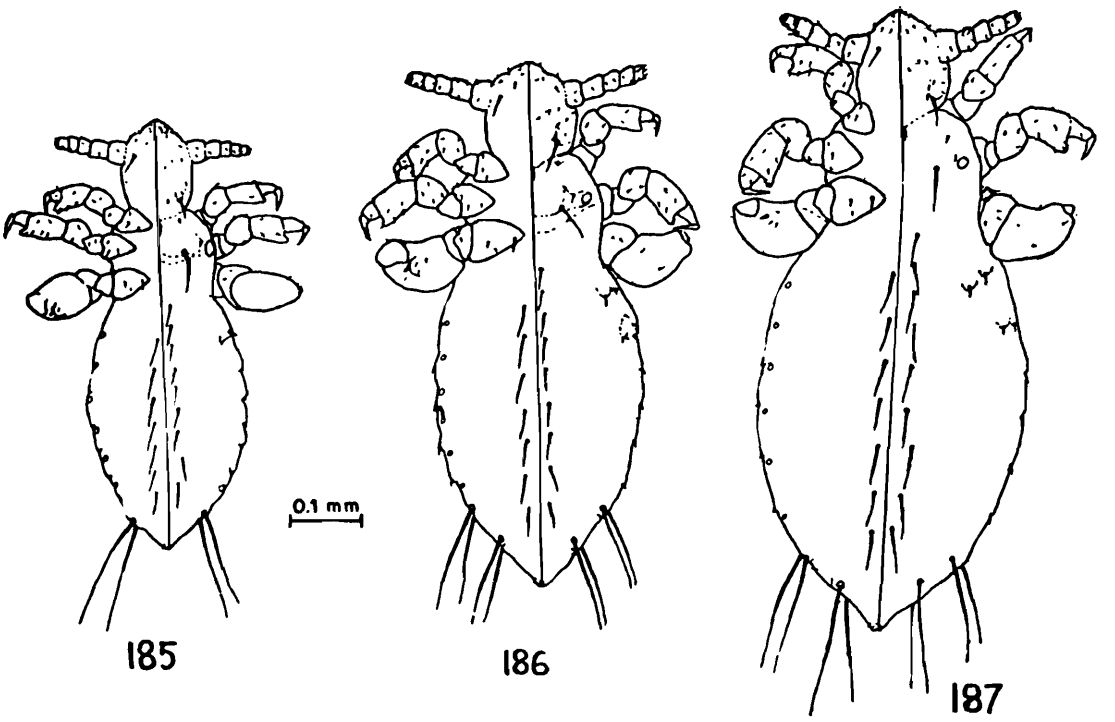
Nymph 1 (Fig. 185) : Total body length 0.59 mm ($\bar{X}$, N=6); range 0.56 to 0.61 mm. *Head* longer than wide. Postantennal



Figs. 177-184. *Polyplax blanfordi* Mishra and Dhanda. 177, head (ventral and dorsal views) ♀; 178, antenna ♀; 179, thoracic sternal plate ♀; 180, paratergites ♀; 181, terminal segments ♀; 182, antenna ♂; 183, paratergites ♂; 184, genitalia ♂

and occipital angles not marked. Typical head setae present, MHS only two pairs. Antennal sensoria separate. *Thorax*. Sternal plate absent. MDTS long, ADTS minute, one pair each. *Legs* typical, as in adults. *Abdomen*. DCAS 9 pairs, VCAS 7 pairs, MAS one pair on each side, AnS one pair, AcS indistinct. Some indication of segmentation laterally, all segments with a pair of minute setae.

Nymph 2 (Fig. 186) : Total body length 0.69 mm ($\bar{X}$, N=6); range 0.63 to 0.75 mm. Similar to nymph 1 except as follows :



Figs. 185-187. *Polyplax blanfordi* Mishra and Dhanda. 185, nymph 1; 186, nymph 2; 187, nymph 3.

Thorax with 2 pairs of ADTS. *Abdomen* with some development of paratergites. Paratergites II to VII each with a pair of small setae, VIII with a pair of long setae. MAS one pair on each side.

Nymph 3 (Fig. 187) : Total body length 0.84 mm to 0.85 mm. Similar to nymph 2 except that the paratergites are comparatively more chitinized.

Hosts and distribution : Known from its type series which consists of *holotype* ♀, *allotype* ♂, *paratypes* 90 ♂ 136 ♀, ex *Rattus blanfordi* from various localities in Maharashtra and Karnataka states; 14 ♂ 16 ♀, 137 nymphs ex *R. b.*, around Poona, Maharashtra state (Mishra *et al.* 1977); and 1 ♂ 4 ♀, ex *R. b.* from Orissa state (VRC Unpublished data).

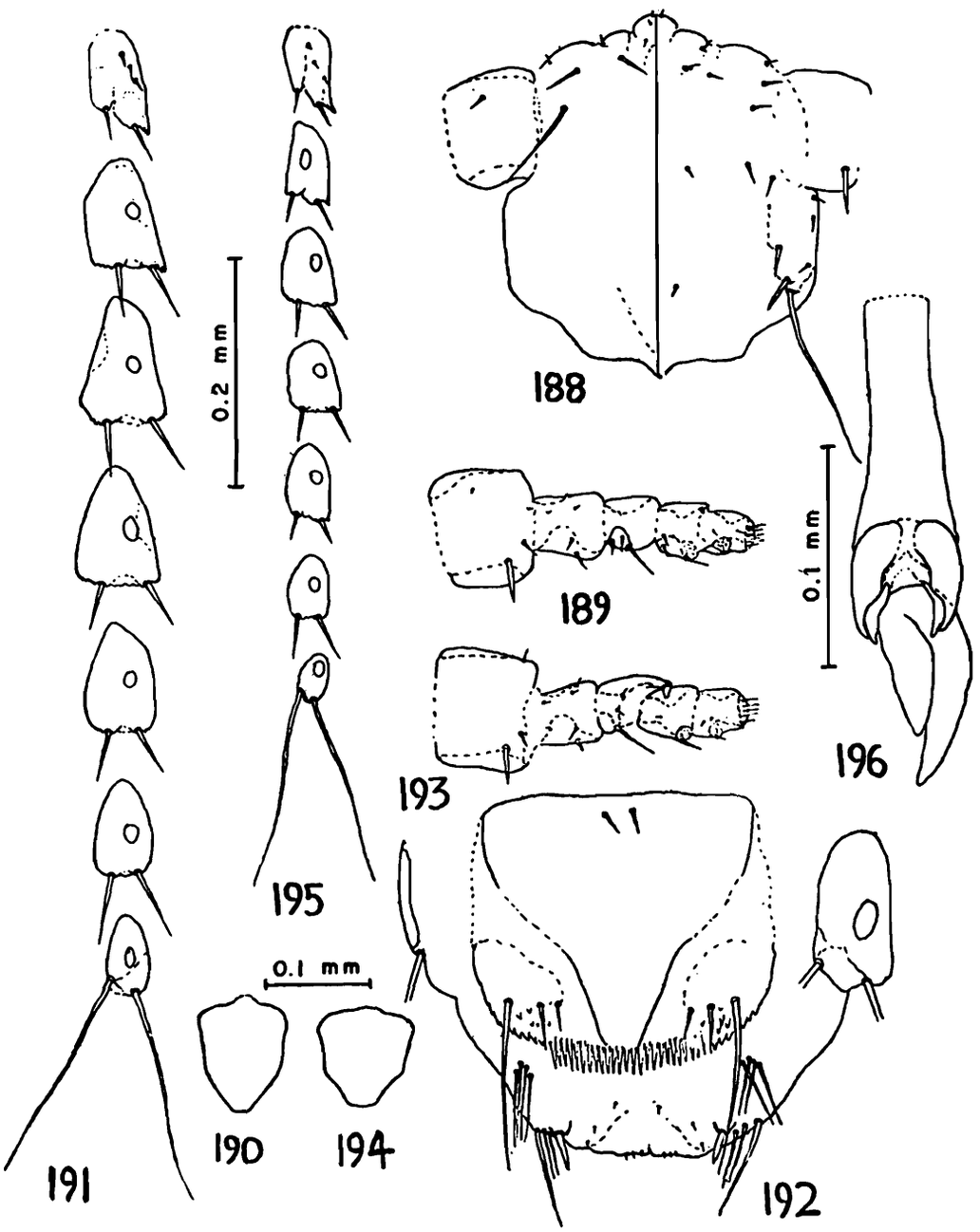
32. **Polyplax cutchicus** Mishra and Kaul (Figs. 188-196).

43-46, figs. 10-20.

Polyplax cutchicus Mishra and Kaul, 1973, *J. med. Ent.*, **10**:

Close to *P. blanfordi* Mishra and Dhanda, but can be easily separated due to both setae on paratergite IV small, and almost equal; and dorsal seta of paratergite VII which is almost equal to ventral seta, both smaller than setae on paratergite VIII.

Female : Total body length 1.23 mm ($\bar{X}$, N=8); range 1.2 to 1.4 mm. *Head* (Fig. 188). Approximately 1.2 × longer than wide. Antennal sensoria on segment 4 and 5 well separated (Fig. 189). *Thorax.* Sternal plate (Fig. 190) with a slight convexity on anterior margin, posterior process truncated at tip. MDTS one pair, medium-sized. *Abdomen.* Tergites and sternites well sclerotized. DAAS and VAAS each one pair. Paratergites (Fig. 191) : II typical, both setae short; III to VII each subtriangular, dorsal and ventral posterior angles with minute



Figs. 188-196. *Polyplax cutchicus* Mishra and Kaul. 188, head (ventral and dorsal views) ♀; 189, antenna ♀; 190, thoracic sternal plate ♀; 191, paratergites ♀; 192, terminal segments ♀; 193, antenna ♂ ; 194, thoracic sternal plate; ♂ 195, paratergites ♂ ; 196, genitalia ♂ .

serrations, setae smaller than plates; VIII small, both setae long. *Genitalia* (Fig. 192). Genital setae short and spiniform.

Male : Total body length 0.77 mm ($\bar{X}$ N=5); range 0.71 to 0.78 mm. *Head* and *thorax* as in female except antennal segment III which is apicodorsally prolonged, bearing a small hook like seta (Fig. 193) *Abdomen.* DAAS and VAAS absent. Paratergites (Fig. 195) as in female. *Genitalia* (Fig. 196) Parameres short; pseudopenis well developed, articulating with apices of parameres.

Nymphs : Unknown.

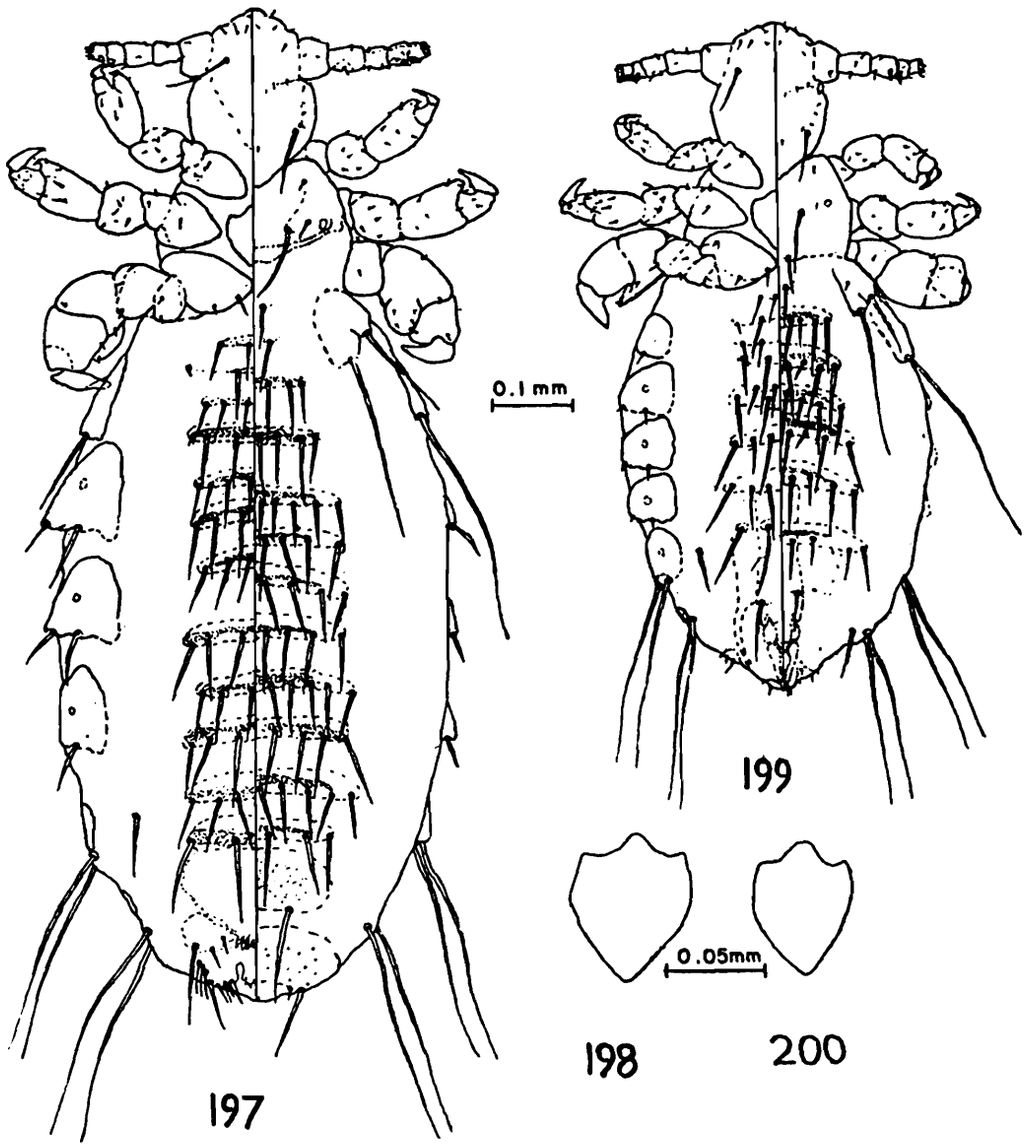
Hosts and distribution : Known from its type series which consists of *holotype* ♀, *allotype* ♂ *paratypes* 5 ♂ 16 ♀, ex *Rattus* (*Cremnomys*) *cutchicus* from various localities in Rajsthan state ; and 1 ♀ ex R. c, from Orissa state, INDIA (VRC Unpublished data).

33. **Polyplax hurrianicus** sp. nov (Figs. 197-205).

It is close to *P. paradoxa* Johnson, *P. indica* Mishra and Kulkarni and *P. asiatica* Ferris. It can be distinguished from *P. paradoxa*, a parasite of *Meriones* sp., due to the long dorsal seta of paratergite II. It is separable from other related species by a combination of following characters : Antennae sexually dimorphic ; tergites and sternites present but poorly chitinized in both the sexes ; abdominal spiracles poorly developed ; male genitalia with parameres slender, enclosing two third of the pseudopenis.

Female (Fig. 197) : Total body length 1.13 mm ($\bar{X}$, N=8) ; range 1.06 to 1.2 mm. *Head* (Fig. 201). Approximaely 1.5 x longer than wide. Postantennal and occipital angles not marked ; gular area not raised. Typical head setae present, ADHS set anterior to PDHS. Antennal sensoria small and well separated. *Thorax.* Sternal plate (Fig. 200) 0.07 mm long, 0.06 mm wide ; shield-shaped, anterior margin with a convexity in middle, posterior tip almost acute. MDTS one pair, long ; ADTS, two pairs, small. *Abdomen. Dorsal.* Segment II devoid of tergites, having 2 rows of 2 setae each ; III to VII each with 2 tergites, 5 to 15 setae on each ; VIII witih a single broad tergite, 3 or 4 setae ; terminal segment with a single tergite, 2 pairs of setae. DAAS absent. *Ventral.* Segment II with 2 sternites ; anterior with 3 or 4, posterior with 2 medium-sized setae mesially and one minute seta

on each side ; III to VII each with two sternites, 4 to 8 setae on each. Remaining sternites modified to form genitalia. VAAS, one pair, usually on segment VII. *Lateral.* Spiracles poorly developed. Paratergites (Fig. 202) : II typical, dorsal seta much longer than

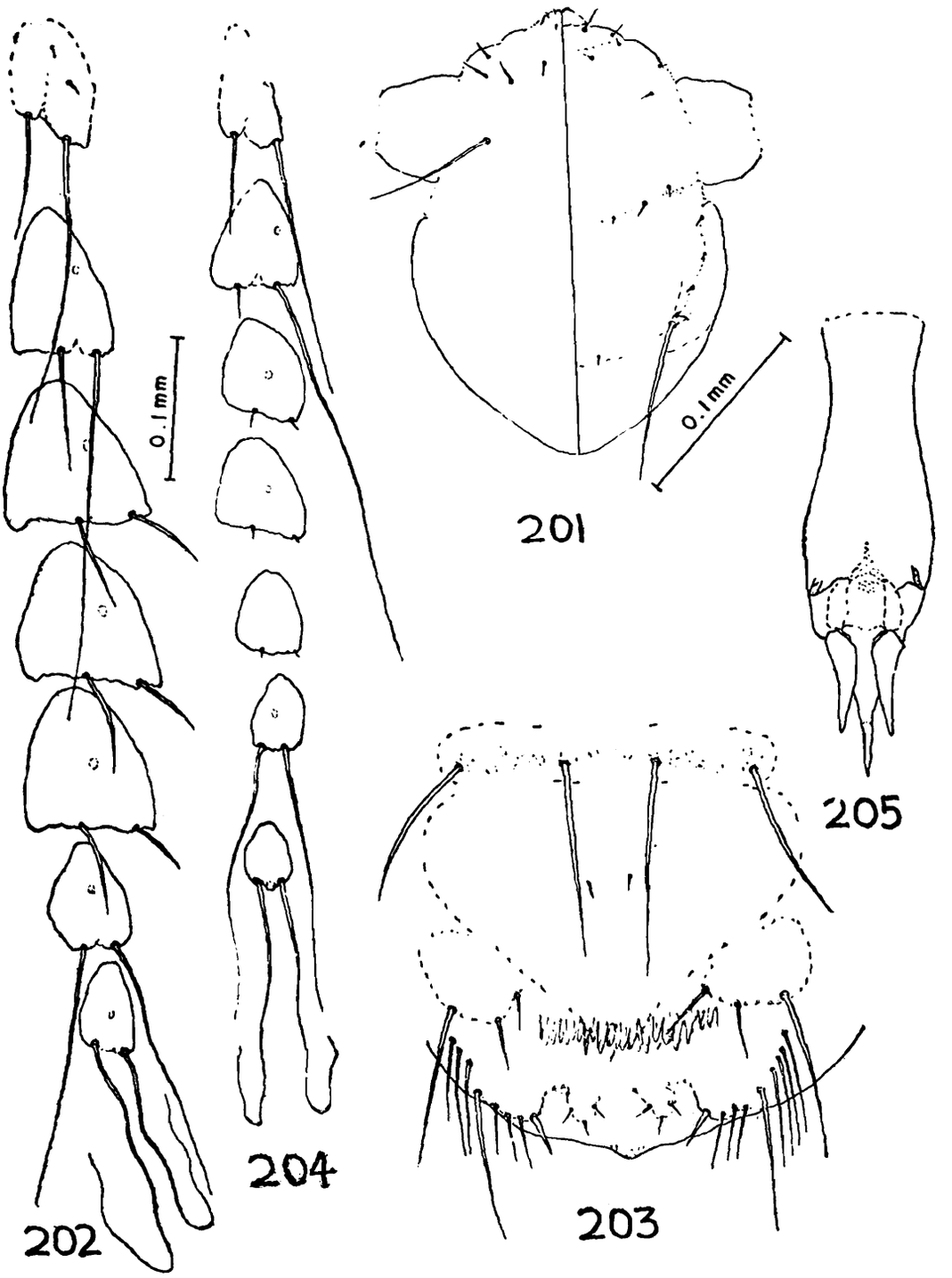


Figs. 197-200. *Polyplax hurrianicus* sp. nov. 197, female (ventral and dorsal views) ; 198, thoracic sternal plate ♀ ; 199, male (ventral and dorsal views) ; 200, thoracic sternal plate.

ventral ; III to VI each with posteroventral angle prolonged into a somewhat rounded lobe ; setae always smaller than the plates except dorsal setae of III which is much longer ; VII and VIII devoid of prolonged angles, both setae long. *Genitalia* (Fig. 203). Genital plate wide anteriorly, narrow posteriorly ; 2 or 3 setae, inconsistent in position. Genital setae enlarged and spiniform.

Male (Fig. 199) : Total body length 0.85 mm ($\bar{X}$, N=6) ; range 0.83 to 0.92 mm. *Head* and *thorax* as in female except antennal segments 3 and 4, each with one small stout seta.

Abdomen with poorly sclerotized plates. *Dorsal.* Segment II as in female ; III with 2 tergites, 6 setae on each ; IV to VII each with a single tergite, 8 to 10 setae ; VIII with 2 setae mesially and 1 seta close to paratergite on each side ; terminal segment with several minute setae. *Ventral.* Segments II and III each with



Figs. 201-205. *Polyplax hurrianicus* sp. nov. 201, head (ventral and dorsal views) ♀; 202, paratergites ♀; 203, terminal segments ♀; 204, paratergites ♂ ; 205, genitalia ♂

2 sternites, having 3 or 4 setae each ; IV to VII each with a single sternite, having 5 to 8 setae ; VIII with one sternite having 2

setae ; terminal segment with several minute setae. VAAS one pair, usually on segment VII. *Lateral.* Paratergites (Fig. 204) as in female except III to VI with ventral apical angles not much prolonged, setae minute except usual long dorsal seta of III. *Genitalia* (Fig. 205). Parameres slender, apically acute, enclosing two-third of pseudopenis ; pseudopenis narrow and apically pointed.

Nymphs : Unknown.

Hosts and distribution : *Holotype* ♀, *allotype* ♂ , *paratypes* 2 ♂, 5 ♀ (VRC A 33971) ; 1 ♂ , 2 ♀ (VRC A 33975) ex *Meriones hurrianae,* INDIA, Gujarat state, Banni Kutch, Wad Wali Wai, 21.iii.1960. Coll. *H. Trapido.* Type specimens are deposited in National Institute of Virology, Pune.

34. **Polyplax indica** Mishra and Kulkarni (Figs. 206-211).

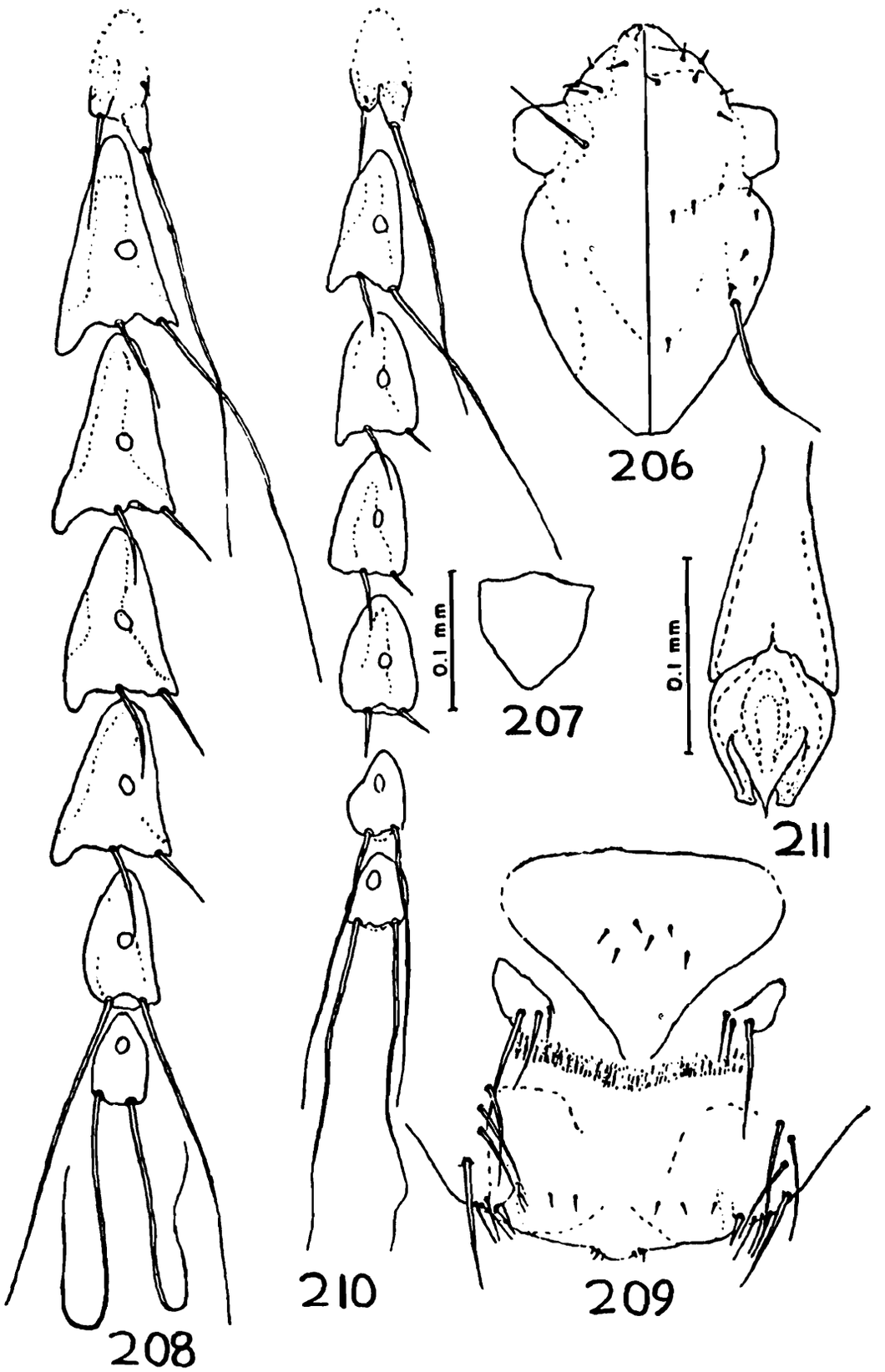
Polyplax indica Mishra and Kulkarni, 1974, *Oriental Ins.,* **8**: 89-94, figs. 1-9. — Mishra *et al.* 1974, *Indian J. med. Res.,* **62**: 1278.

It is close to *P. asiatica* Ferris and *P. insula* Ferris. It can be separated from *P. asiatica* due to the presence of well chitinized abdominal tergites and sternites, and from *P. insula* due to longer head, blunt posteroventral process of paratergites III to VI, and absence of tooth-like projection at the proximal angle of the tarsus of third leg.

Female : Total body length 1.51 mm ($\bar{X}$, N=4) ; range 1.34 to 1.69 mm. *Head* (Fig. 206). Approximately 1.6 x as long as wide. Antennal sensoria contiguous. *Thorax.* Sternal plate (Fig. 207) with anterior margin with a convexity, posterior process rounded at tip. MDTS one pair, long. *Abdomen.* Tergites and sternites small, well chitinized. DAAS and VAAS one pair. Paratergites (Fig. 208) : II typical, both setae long, dorsal much longer than ventral ; III to VI each with ventral posterior angles prolonged into bluntly pointed lobe, all setae smaller than plates except long dorsal seta of paratergite III ; VII and VIII without prolonged angles, both setae long. *Genitalia* (Fig. 209). Genital seta small and slightly enlarged.

Male : Abdomen. Paratergites (Fig. 210) as in female except that ventral posterior process of paratergites V, VI not prolonged. *Genitalia* (Fig. 211). Parameres incurved apically, shorter than

pseudopenis ; pseudopenis narrow and pointed apically, enclosed within parameres.



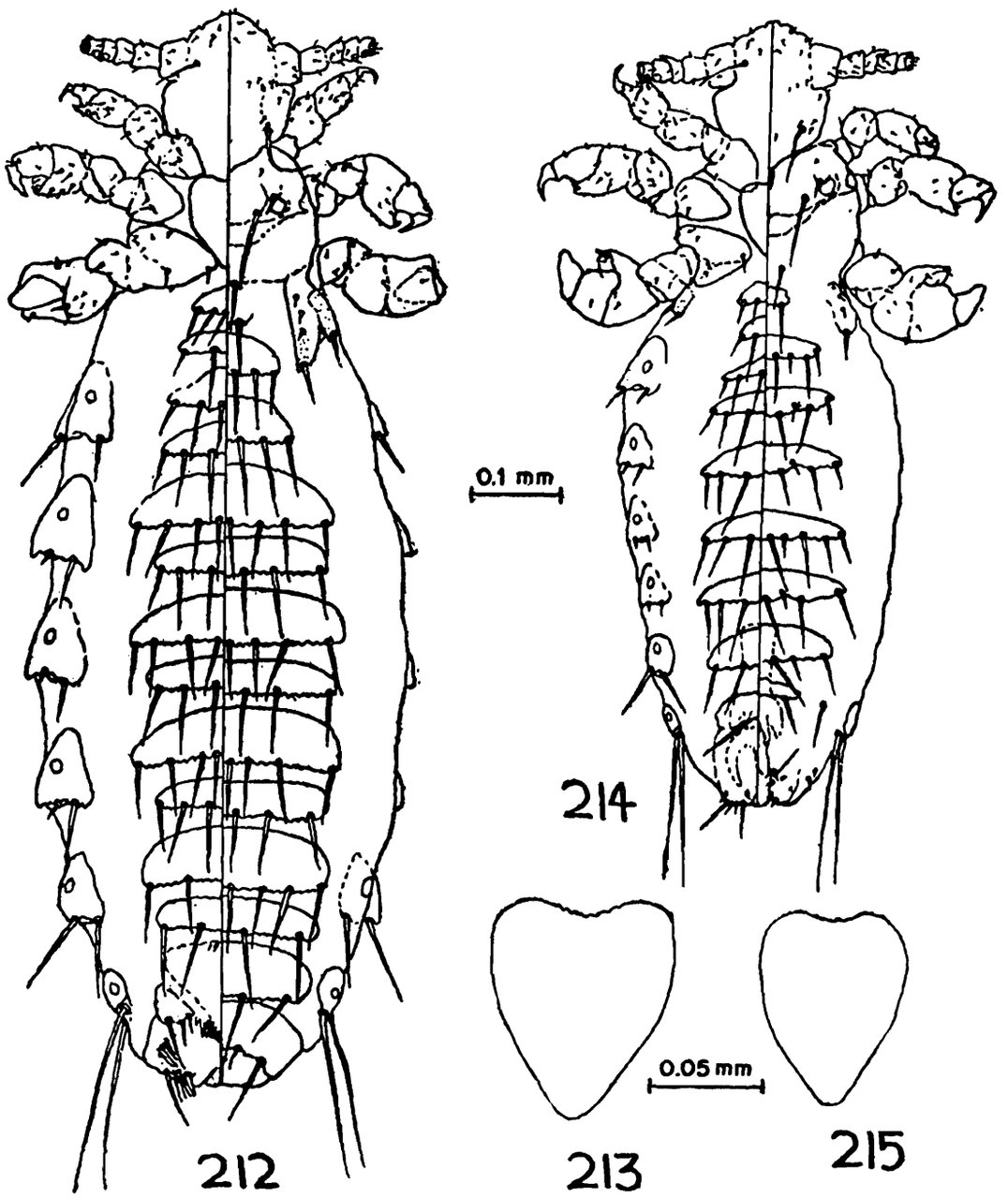
Figs. 206-211. *Polyplax indica* Mishra and Kulkarni. 206, head (ventral and dorsal views) ♀; 207, thoracic sternal plate ♀; 208, paratergites ♀; 209, terminal segments ♀; 210, paratergites ♂ ; 211, genitalia ♂

Nymphs : Unknown.

Hosts and distribution : Known from type series which consists of *holotype* ♀, *allotype* ♂ , *paratypes* 3 ♀, ex *Golunda ellioti* from various localities in INDIA ; and 3 ♂ , 4 ♀ ex *G. e.* Maharashtra, Poona, 26.II.1975.

35. **Polyplax kondana** sp. nov. (Figs. 212-222).

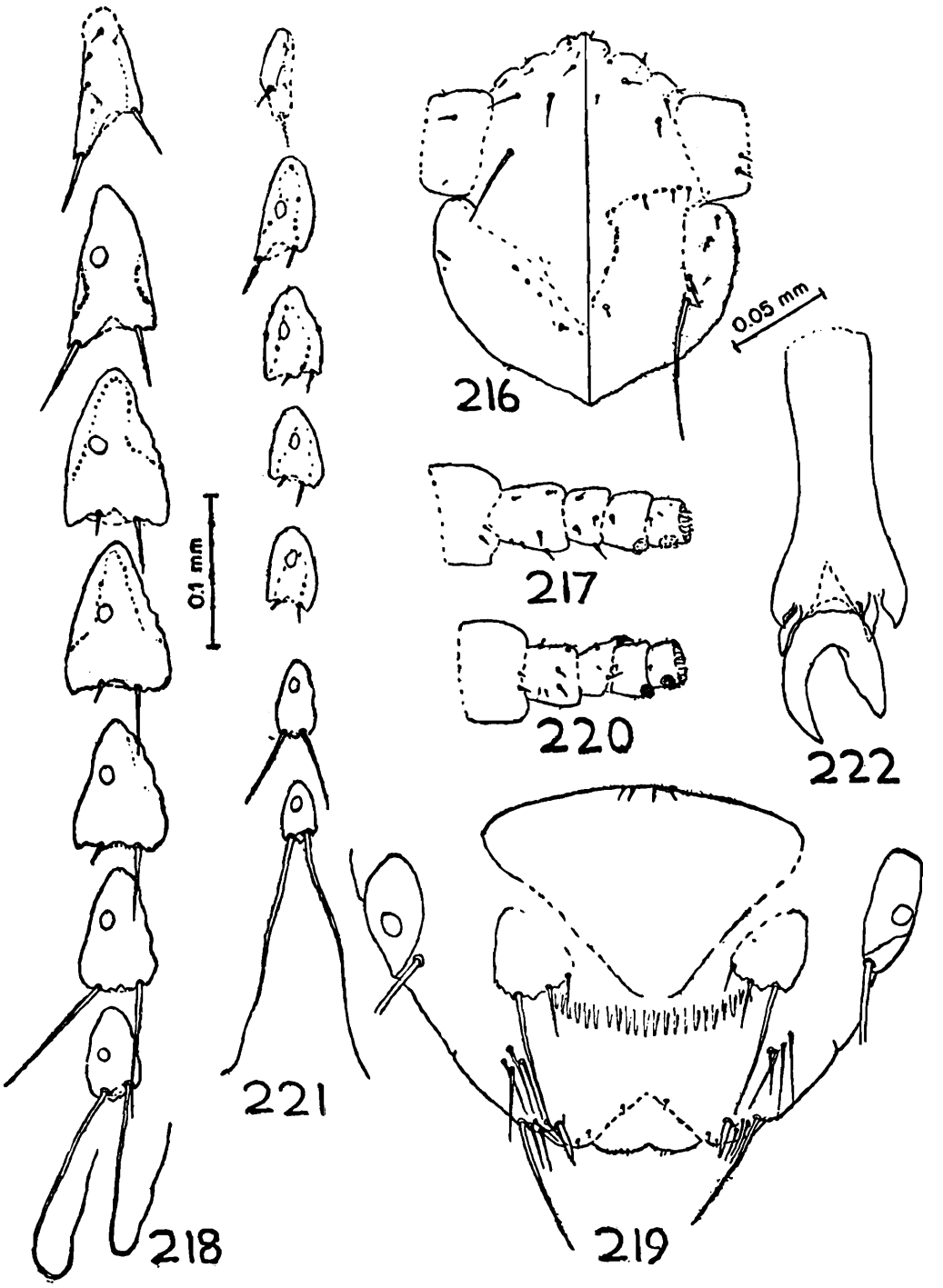
It resembles *P. spinulosa* (Burmeister), *P. blanfordi* Mishra and Dhanda, and *P cutchicus* Mishra and Kaul. It can be separated from *P. spinulosa* due to comparatively longer dorsal seta of paratergites IV to VI, and short setae on paratergite VII ;



Figs. 212-215. *Polyplax kondana* Mishra. 212, female (ventral and dorsal views) ; 215, thoracic sternal plate ♂ .

from *P. blanfordi* due to the absence of long dorsal seta on paratergite IV, and short setae on paratergite VII ; and from *P. cutchicus* due to the short dorsal setae of paratergites IV to VI.

Female (Fig. 212) : Total body length 1.17 mm ($\bar{X}$, N=5) ; range 1.07 to 1.23 mm. *Head* (Fig. 216) Approximately 1.2 x longer than wide. Preantennal and occipital angles not much developed, gular area raised. Typical head-setae present. Antennal



Figs. 216-222. *Polyplax kondana* sp. nov. 216, head (ventral and dorsal views) ♀; 217, antenna ♀; 218, paratergites ♀; 219, terminal segments ♀; 220, antenna ♂; 221, paratergites ♂ ; 222, genitalia ♂ .

sensoria well separated. *Thorax.* Sternal plate (Fig. 217) 0.09 mm wide ; roughly triangular, with a concavity on anterior margin. MDTS one pair, long ; ADTS two pairs, small. *Abdomen : Dorsal.* Segment II devoid of tergites, having 2 rows of 2 setae each ; III to VII each with 2 tergites, 4 to 8 setae each ; VIII and terminal segment each with a single tergite, 4 setae. DAAS absent. *Ventral.* Segments II to VII each with 2 sternites, 4 to 8 slender setae on each. Remaining modified to form genitalia. VAAS absent. *Lateral.* Paratergites (Fig. 218) : II typical, both setae small ; III with 2 setae, equal in length, smaller than plate ; IV to VI with 2 setae, ventral longer than dorsal, but both smaller than plates ; VII and VIII each with 2 long setae, setae on VII longer than plate but about half length of setae on VIII. *Genitalia* (Fig. 219). Genital plate triangular, usually with 4 setae. Gonopods paired, each with 2 small and a long setae. Genital seta slightly enlarged and spiniform.

Male (Fig. 214) : Total body length 0.87 mm. *Head* and *thorax* as in female except antennal segment 3 with one stout seta. Thoracic sternal plate (Fig. 215) 0.08 mm long, 0.07 mm wide. *Abdomen. Dorsal.* Segment II with a single tergite ; 2 rows of 2 setae each, posterior row on the tergite ; III with 2 tergites, 8 setae on each ; IV to VIII each with single tergite, 6 to 10 setae each, except VIII which has 2 setae ; terminal segment with several minute setae. DAAS one pair, usually on segment VIII. *Ventral.* Segments II and III each with 2 sternites, 4 to 6 setae each ; IV to VII each with one sternite, 4 to 7 setae each ; VIII with a single sternite, having 2 setae ; terminal segment with sternite less sclerotized and fused with sternite of segment VIII, having several minute setae. *Lateral.* Paratergites (Fig. 221) as in female. *Genitalia* (Fig. 222). Parameres short ; pseudopenis well developed, articulating with apices of parameres.

Nymphs : Unknown.

Hosts and distribution : *Holotype* ♀, *allotype* ♂ , *paratypes* 4 ♀, ex *Millardia kondana,* INDIA : Maharashtra, Poona, Sinhgarh, 13.x.71, Coll. *A. C. Mishra.* Type specimens are deposited in National Institute of Virology, Pune.

36. **Polyplax reclinata** (Nitzsch) (Figs. 223-225).

Pediculus reclinatus Nitzsch, 1864, *Zs. Gesam. Naturw.*, **23**: 23.
Polyplax reclinata (Nitzsch) Enderlein, 1904, *Zool. Anz.*, **28**: 142.

Haematopinus reclinatus Giebel, 1874, *Insecta Epizoa*, p. 37.
Haematopinus (Polyplax) reclinatus Neumann, 1909, *Arch. Parasitol*, 524, fig. 24.
Polyplax reclinata leucodontis Jancke, 1932, *Z. Parasitenk*, **4**: 525, fig. 2.
Polyplax reclinata reclinata Fahrenholz, 1938, *loc. cit.*, **10**: 257, figs. 9-11.
Polyplax deltoides Fahrenholz, 1938, *loc. cit.*, 256, figs. 12, 23d.
Polyplax shimizui Kaneko, 1957, *Tokyo Med. Dent. Univ. Bull.*, **4**: 271, figs. 2, 1-4.

A full citation of references and synonymies may be found in Kim and Emerson (1968). Morphological variation are discussed by Johnson (1960b, 64) and Beaucournu and Houin (1967). Additional records are by Kim (1971), Kim and Emerson (1973, 1974).

It is an isolated species and does not have close relative. It can be separated from *P serrata* due to the long setae of paratergite VI ; and from *P stephensi* due to the large spiracles, and absence of handle-like anterior prolongation of thoracic sternal plate.

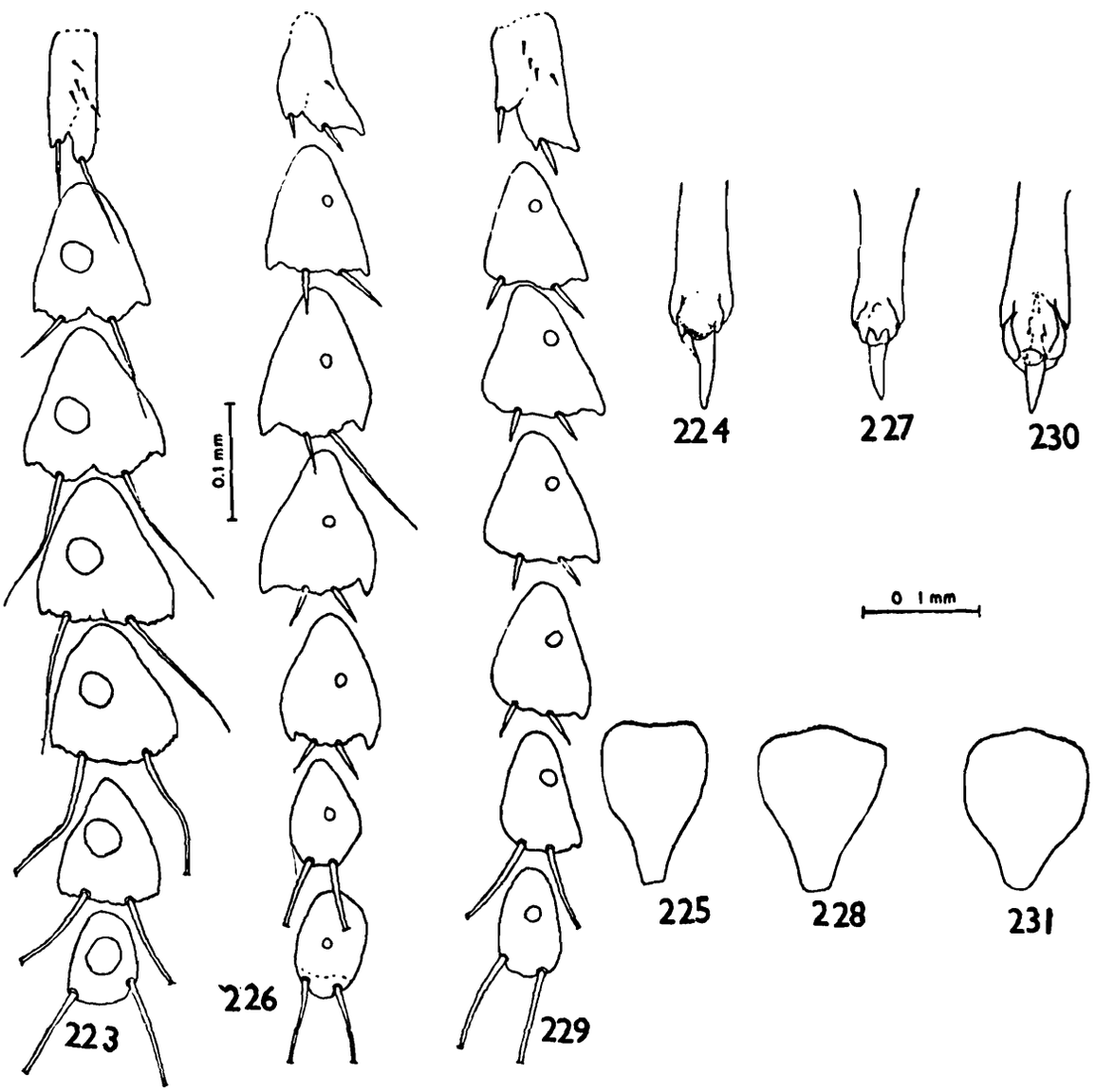
Female : Total body length 1.25 mm ($\bar{X}$, N=8) ; range 1.17 to 1.35 mm. *Head* longer than wide. Postantennal and occipital angles feebly developed, gular folds present. All typical head setae present, AS close to PAS, PCHS near posterior margin, PDHS unusually long. Antennal sensoria large and contiguous. *Thorax.* Sternal plate (Fig. 225) roughly triangular, anterior margin straight. posterior process truncated at tip. Spiracles unusually large. MDTS one pair, long ; ADTS two pairs, small. *Abdomen.* Tergites and sternites well chitinized. Paratergites (Fig. 223), II typical, setae usually shorter plan plates ; III to VIII roughly triangular, posterior angles usually rounded, sometimes slightly angular ; II to V each with setae variable in length ; VI to VIII always with both setae long. Spiracles unusually large. Genital setae short and spiniform, never flattened.

Male : Total body length 0.91 mm ($\bar{X}$, N=6) ; range 0.88 to 0.94 mm. *Abdomen.* Tergites and sternites well developed. Paratergites and spiracles as in female. *Genitalia* (Fig. 225). Pseudopenis long and tapering, articulating at the tips of parameres.

Nymphs : All 3 nymphal stages have been described and illustrated by Kim (1971).

Nymph 1 : Total body length 0.53 mm ($\bar{X}$, N=6); range 0.48 to 0.56 mm. *Head* about as long as wide; postantennal and occipital angles slightly developed. Antennal sensoria large and contiguous. *Thorax*. MDTS long, ADTS small, one pair each. Sternal plate absent. *Abdomen*. Spiracles 6 pairs. DCAS 9 pairs. VCAS 1 or 2 pairs. MAS one pair on each side. A single AcS present on each side at the base of MAS.

Nymph 2 : Total body length 0.69 mm, ($\bar{X}$, N=5) ; range 0.63 to 0.75 mm. Similar to nymph 1 except as follows : *Thorax*.



Figs. 223-231. *Polyplax reclinata* (Nitzsch), 223, paratergites ♀; 224, genitalia ♂ ; 225, thoracic sternal plate ♀. Figs. 226-228. *Polyplax serrata* (Burmeister). 226, paratergites ♀; 227, genitalia ; 228, thoracic sternal plate ♀. Figs. 229-231. *Polyplax spinulosa* (Burmeister). 229, paratergites ♀; 230, genitalia ♂ ; 231, thoracic sternal plate ♀.

ADTS 2 pairs; small sternal plate present. *Abdomen*. DCAS 9 pairs. VCAS 7 pairs. Seven pairs of developing paratergites present, II to VI each with a pair of small setae, VII with a long and other small setae, VIII with both setae long.

Nymph 3 : Total body length 0.86 mm ($\bar{X}$, N=6); range 0.83 to 0.93 mm. Similar to nymph 2 except as follows : *Thorax* with sternal plate elongated. *Abdomen* with paratergites well developed and sclerotized, II to V each with both setae small, remaining with long setae.

Hosts and distribution : It is an established parasite on members of Soricidae and has been recorded repeatedly from *Sorex, Crocidura,* and *Suncus* spp. in many parts of the old world. In Indian subcontinent, it has been recorded ex *Crocidura* sp. at Atchbel, Kashmir, and *Suncus* sp. in SRI LANKA (Werneck, 1953); *S. murinus* in Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh states (Mishra *et al.*, 1974), in Maharashtra (Mishra *et al.*, 1977), Rajsthan and Orissa states, INDIA (VRC Unpublished data)

37 **Polyplax serrata** (Burmeister) (Figs. 226-228, 232-234).

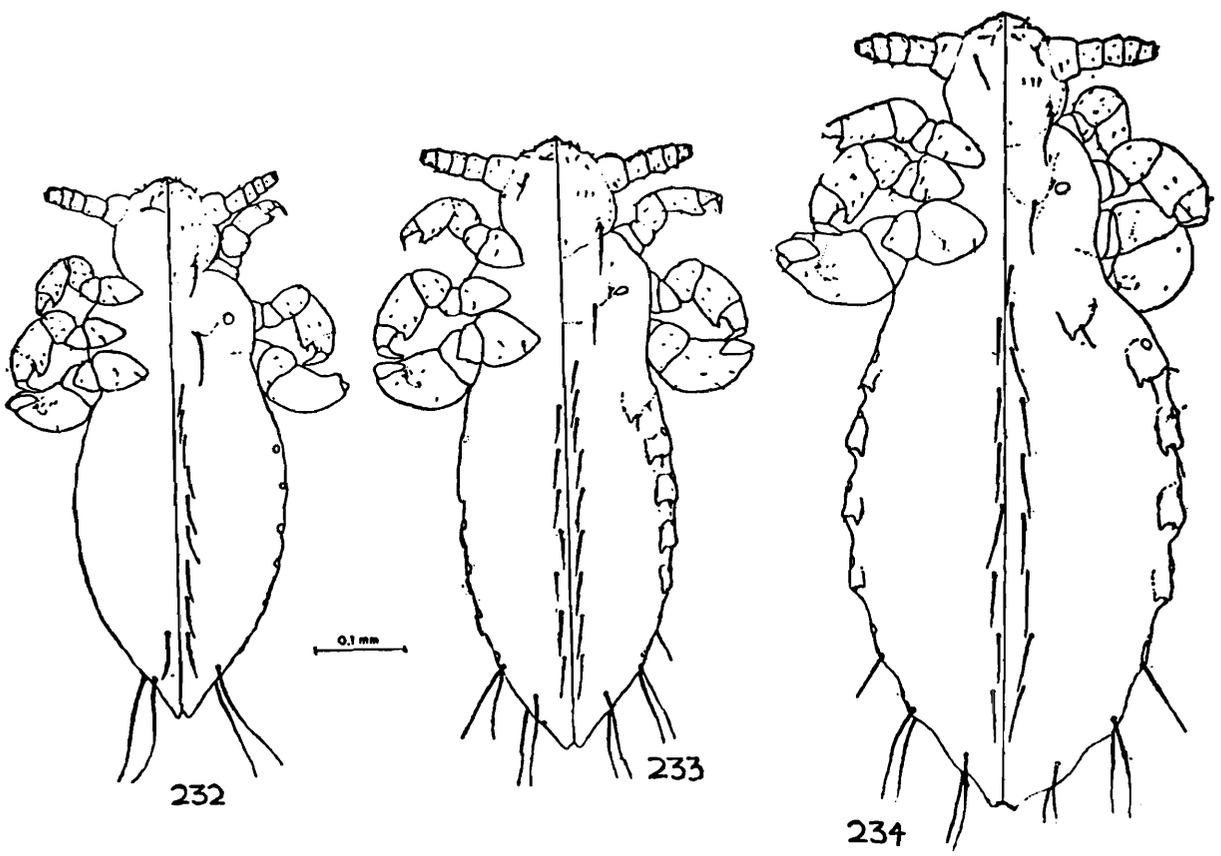
Pediculus serratus Burmeister, 1838, *Genera Insectorum, Rhynchota*, No. 6.

Polyplax serrata (Burm.) Enderlein, 1904, *Zool. Anz.*, **28**: 142.
Haematopinus serratus (Burm.) Denny, 1842, *Monographia Anoplurorum Britanniae*, p. 36.
Polyplax affinis (Burm.) Fahrenholz, 1912, *Abhandl. Niedersachs. Zool. Ver. Hannover, Jahresb.*, **2-4**: 39-42, figs. 13-15.
Polyplax serrata affinis Fahrenholz, 1938, *Zs. Parasitenk*, **10**: 261.
Polyplax serrata paxi Eichler, 1952, *Behandlungstechnik parasitarer Insecten* [Leipzig] p. 206, fig. 62.

A complete citation of references and synonymies may be found in Kim and Emerson (1971).

P. serrata is close to *P. spinulosa* (Burm.) and *P. blanfordi* Mishra and Dhanda. It can be separated from *P. spinulosa* due to presence of long dorsal seta on paratergite IV, and from *P. blanfordi* due to short ventral seta of paratergite VII; and from both due to acute posteroventral angles of paratergites III to VI.

Female : Total body length 1.4 mm ($\bar{X}$, N=10); range 1.24 to 1.48 mm. *Head* slightly longer than wide. Postantennal and



Figs. 232-234. *Polyplax serrata* (Burmeister). 232, nymph 1 ; 233, nymph 2 ; 234, nymph 3.

occipital angles well marked and rounded, gular folds present, gular area raised. All typical head setae present. Antennal sensoria large and contiguous. *Thorax*. Sternal plate (Fig. 228) roughly triangular, anterior margin with a small convexity in middle, posterior process rounded at tip. MDTS one pair, long; ADTS two pairs, small. *Abdomen*. Tergites and sternites well chitinized. DAAS absent. VAAS 4 or 5 pairs. Paratergites (Fig. 226) : II typical, both setae small; III to VI each triangular with both posterior angles acute, both setae shorter than plate except the ventral apical seta of IV which is much longer than others and is as long as or longer than the plate; VII and VIII devoid of acute angles, both setae long. *Genitalia*. Genital setae short and stout.

Male : Total body length 0.99 mm ($\bar{X}$, N=6); range 0.94 to 1.06 mm. *Abdomen* as given for female except that VAAS 2 or 3 pairs. *Genitalia* (Fig. 227). Parameres short; pseudopenis long, tapering and articulates at tips of parameres.

Nymph 1 (Fig. 232) : Total body length 0.63 mm. *Head* about as long as wide. Postantennal and occipital angles not pronounced. All the typical head setae present. Antennal sensoria separate. *Thorax*. Mesothoracic spiracles distinct. Sternal

plate absent. MDTS long, ADTS small, one pair each. *Legs* as in adults. *Abdomen*. Spiracles 6 pairs. DCAS 9 pairs. VCAS only one pair. MAS one pair on each side. AcS and AnS indistinct.

Nymph 2 (Fig. 233) : Total body length 0.71 mm ($\bar{X}$, N=3); range 0.7 to 0.72 mm. Similar to nymph 1 except as follows : *Thorax* with ADTS 2 pairs. *Abdomen* with paratergites feebly developed. Paratergites II to IV each with a pair of small setae except the dorsal seta of paratergite IV which is comparatively longer; VII with a pair of medium-sized setae; VIII with a pair of long setae. MAS one pair on each side behind paratergite VIII.

Nymph 3 (Fig. 234) : Total body length 0.85 mm ($\bar{X}$, N=6); range 0.79 to 0.93 mm. Similar to nymph 2.

Hosts and distribution : The species is world wide in distribution and is well established parasite of *Mus musculus* and *Apodemus* spp. In INDIA also it is recorded from both these species (Mishra *et al.*, 1974).

Note : According to Johnson (1960b) *P. serrata* is an original parasite of *Apodemus* spp., having secondarily adapted to *Mus musculus* in ASIA and EUROPE. Johnson showed that all other records from other regions, like Hawaii (Joyce, 1953) and Texas (Menzies, 1949) and other parts of New world, and from AFRICA are either from Laboratory mice or those associated with them. On the other hand Eichler (1960) suggested that *Mus musculus* is the specific host of the louse *P. serrata* (Burmeister) and only its subspecies are found on the various species of the genus *Apodemus,* namely, *P. s. affinis* Fahrenholz on *A. sylvaticus; P. s. paxi* Eichler on *A. agrarius,* and *P. serrata* subspecies (*aff affinis*) Eichler on *A. flavicollis.*

Subsequently, Wegner (1974) carried out a detailed morphological analysis of various characters in *P. serrata* specimens obtained from different sources and hosts. Wegner concluded that considerable variability was observed in lice parasitizing different host species and even in the specimens obtained from the same host individual and thus ruled out the occurrence of subspecies on different hosts.

38. **Polyplax spinulosa** (Burmeister) (Figs. 229-231).

Pediculus spinulosus Burmeister, 1839, *Genera Insectorum, Rhynchota,* no. 8.

Polyplax spinulosa Enderlein, 1904, *Zool. Anz.*, **28**: 142.

Haematopinus spinulosus (Burm.) Denny, 1842, *Monographia anoplurorum Britanniae*, p. 26, pl. 24, fig. 5.
Pediculus donticulatus Nitzsch, 1864, *Zs. Gesam. Naturw.*, **23**: 24.
Polyplax campylopteri Zavaleta, 1945, *Ann. Inst. Biol.*, **11**: 431.

Additional citations of references and synonymies may be found in Ferris (1951), Kim and Emerson (1968, 1973)

It is close to *P. cutchicus* Mishra and Kaul and *P. kondana* sp. nov. It can be separated from these by a combination of following characters : Paratergites III to VI each with both setae small and almost equal in length; Paratergite VII with both setae long, and almost equal to the setae of paratergite VIII.

Female : Total body length 1.35 mm ($\bar{X}$, N=10); 1.17 to 1.42 mm. *Head* slightly longer than wide. Postantennal and occipital angles well developed, gular folds present, gular area raised. All typical head setae present. Antennal sensoria separate. *Thorax*. Sternal plate (Fig. 231) with lateral margins almost parallel, posteriorly produced into a blunt point. MDTS one pair, long; ADTS two pairs, small. *Abdomen*. Tergites and sternites well developed. DAAS and VAAS 2 to 4 pairs. Paratergites (Fig. 229) : II typical, both setae short ; III to VI triangular. with acute posterodorsal and rounded posteroventral angles; each with 2 setae, shorter than plates; VII and VIII devoid of acute angles, both setae long. *Genitalia*. Genital setae small and enlarged.

Male : Total body length 0.96 mm ($\bar{X}$, N=8); range 0.88 to 1.05 mm. *Head* and *thorax* as in female except antennal segment III apicodorsally prolonged and bears a short stout seta. *Abdomen*. Tergites and sternites well chitinized. Paratergites as in female. Genitalia (Fig. 230) Parameres short and convex; pseudopenis almost equal to parameres in length, articulates at their tips.

Nymph 1 : Total body length 0.54 and 0.61 mm (N=2). Similar to the corresponding nymph of *P. serrata*.

Nymph 2 : Total body length 0.75 mm ($\bar{X}$, N=5); range 0.71 to 0.79 mm. Similar to corresponding nymph of *P. serrata* except that paratergites II to VII each with a single pair of small setae.

Nymph 3 : Total body length 0.97 mm ($\bar{X}$, N=6) ; range 0.89 to 1.05 mm. Similar to nymph 2.

Hosts and distribution : Commonly recorded from various species of genus *Rattus* throughout the world. Other host records are attributed to misidentification, or stragglers. In INDIA, it is recorded ex *Rattus rattus gangutrianus, R. r. satarae, R. r. rufescens, R. rattoides, R. niviventer*, from various parts (Mishra *et al.* 1974, 1977), and ex *R. r. arboreus* from Orissa state (VRC Unpublished data).

39. **Polyplax stephensi** (Christophers and Newstead) (Figs. 235-243).

Haematopinus stephensi Christophers and Newstead, 1906, *Thomps. Yates Lab. Rept.* (n.s.) **7**: 3, pl. 1.

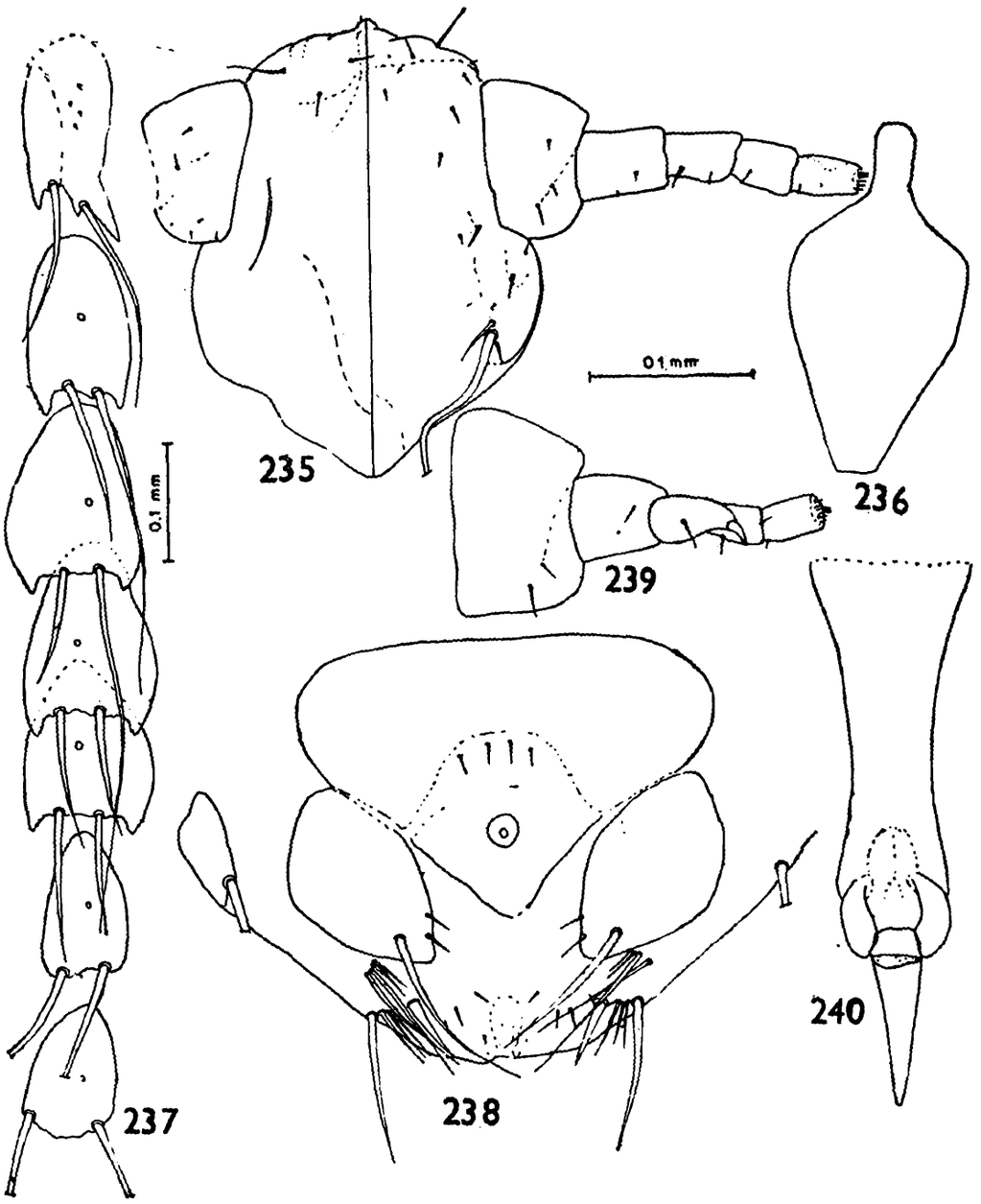
Polyplax stephensi (Christophers and Newstead) Ferris, 1923. *Contributions toward a monograph of the sucking lice*, part 4: 206. — Ansari, 1951, *Indian J. Ent.*, **13**: 127. — Ferris, 1951, *The sucking lice*, p. 214. — Kim and Emerson, 1971, *J. Med. Ent.*, **8**: 13. — Mishra *et al.*, 1974, *Indian J. med. Res.*, **62**: 1279.

Eremophthirus stephensi (Christophers and Newstead) Fahrenholz, 1938, *Z. Parasitenk.*, **10**: 243.

It is a member of *P. praecisa* group (*sensu* Ferris, 1923). The group includes 9 species, all of which are found on members of Gerbilinae (*Tatera, Gerbillus, Pachyuromys,* and *Meriones*). *P. stephensi* is closest to *P taterae* Ferris, and *P. biseriata* Ferris. *P taterae* can be easily separated due to the absence of long seta on paratergite IV, and less developed posterior angles of paratergites. *P. stephensi* can be separated from *P biseriata* due to the absence of stout and large seta on antennal segment one ; ADTS 5 or 6 pairs, and comparatively longer setae on paratergites II, V and VI.

Female : Total body length 1.77 mm ($\bar{X}$, N=8) ; range 1.61 to 1.93 mm. *Head* (Fig. 235) slightly longer than wide. Postantennal and occipital angles well developed and rounded. Gular area raised, gular folds present. All typical head setae present; MDHS very long. Antennal sensoria separate. *Thorax*. Thoracic sternal plate (Fig. 236) 0.2 mm long, 0.1 mm wide, anterior margin with a distinct, narrow, handle-like prolongation extending forward between the coxae. MDTS long, one pair; ADTS 6 or 7 pairs, small. *Abdomen*. Tergites and sternites narrow and poorly sclerotized. Dorsal side with 13 rows of elongated setae; 1st row with 2; 2nd with 6 to 8; 3rd to 12th with numerous; and 13th

row with 2 setae. Terminal segment with several minute setae. Ventral side with 12 rows of setae; 1st row with 13 to 15; 2nd to 11th with numerous; and 12th with 8 setae. Second sternite



Figs. 235-240. *Polyplax stephensi* (Christophers and Newstead). 235, head (ventral and dorsal views) ♀; 236, thoracic sternal plate ♀; 237, paratergites ♀; 238, terminal segments ♀; 239, antenna ♂; 240, genitalia ♂

of segment VII devoid of small setae. *Paratergites* (Fig. 237) : II typical, both setae long; III to VI each with posterior angles acute, both setae as long as or slightly longer than plates, except dorsal seta of III and IV which are very long; VII and VIII devoid of acute angles, both setae long. *Genitalia* (Fig. 238).

Genital plate roughly triangular, with a distinct spermathecal opening guarded by a small chitinized plate; usually with 4 setae. Gonopods paired, each with 2 small and one long seta. Genital seta enlarged and tapering.

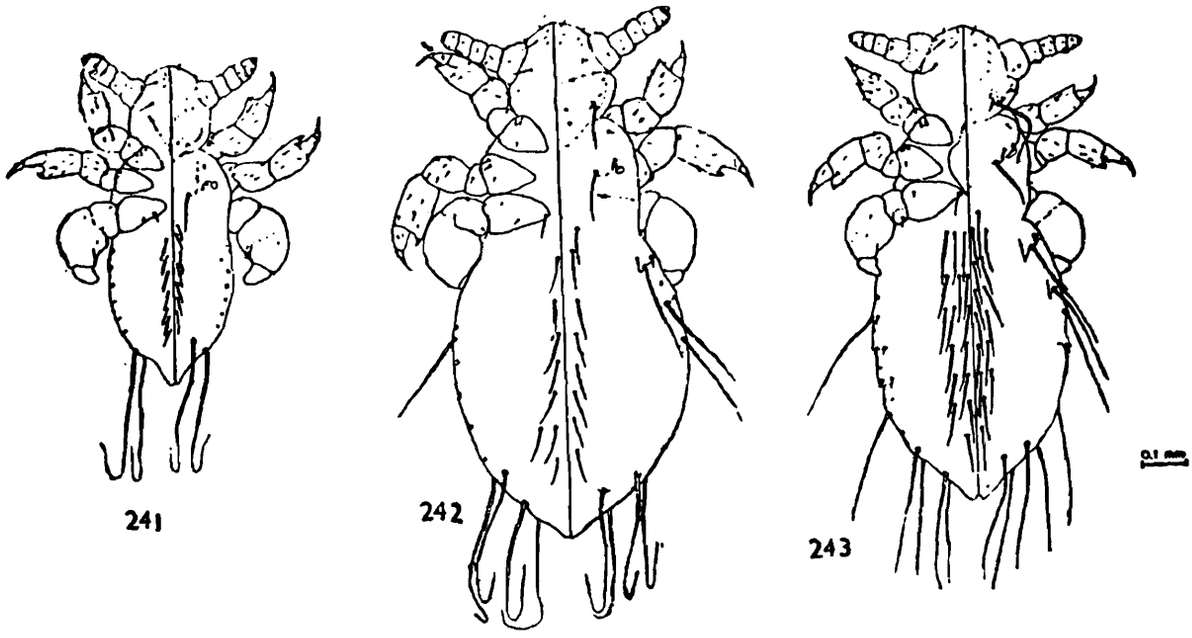
Male : Total body length 1.42 mm ($\bar{X}$, N=8); range 1.35 to 1.5 mm. *Head* and *thorax* as in female except antennal segment 3, which is apicodorsally prolonged into a small extension and bears a small thick-seta (Fig. 239). Thoracic sternal plate 0.21 mm long, 0.11 mm wide. *Abdomen. Dorsal* side with 9 rows of elongated setae : 1st row with 2; 2nd with 6 to 8; 3rd to 7th with numerous setae particularly laterally, where they form clusters; 8th also with large number but lateral clusters with lesser number of setae; 9th with 2 long setae mesially and 4 setae on each side. Terminal segment with 2 small tergites placed laterally, each with a single seta. *Ventral* side with 7 rows of setae; anterior 6 with numerous setae, seventh with only 2 setae. Terminal segment triangular with many small setae. Paratergites as in female. *Genitalia* (Fig. 240). Parameres small; pseudopenis long, stout, and articulates at the tips of parameres.

Nymph 1 (Fig. 241) : Total body length 0.51 to 0.56 mm ($\bar{X}$, N=2) *Head* slightly longer than wide. Postantennal and occipital angles undeveloped. All typical head setae present, MDHS minute. Antennal sensoria separate. *Thorax*. Sternal plate absent. MDTS long, ADTS small, one pair each. *Abdomen*. Spiracles 6 pairs. DCAS 8 pairs. VCAS 7 pairs. MAS one pair on each side. AcS and AnS indistinct.

Nymph 2 (Fig. 242) : Total body length 0.89 mm (N=10); range 0.78 to 0.93 mm. Similar to nymph 1 except as follows : *Head*. MDHS long. *Thorax*. ADTS two pairs. *Abdomen*. DAAS 9 pairs. VAAS 7 rows, each row with one pair of setae except 6th row which is having 2 pairs of setae. Paratergites feebly developed. Paratergites II and III each with one long and one small, IV with only one long seta, V to VII undeveloped and devoid of setae, VIII with a pair of long setae. AnS one or 2 pairs.

Nymph 3 (Fig. 243) : Total body length 1.16 mm ($\bar{X}$, N=10); range 1.06 to 1.29 mm. Similar to nymph 2 except as follows : *Thorax*. ADTS 3 pairs. Sternal plate distinct, with shape as in adults. *Abdomen*. DCAS 9 rows, anterior one and last two rows with 2 setae each, remaining 6 rows with 4 to 6 setae each.

VCAS 7 rows, first 5 with 4 to 6 setae each, last 2 with 2 setae each. Paratergites better developed than nymph 2. Paratergite



Figs. 241-243. *Polyplax stephensi* (Christophers and Newstead). 241, nymph 1; 242, nymph 2; 243, nymph 3.

IV with a small seta in addition to a long one; V and VI each with a pair of small setae; VII with a single long seta.

Hosts and distribution : Known ex *Tatera indica* in various localities in INDIA (Wattal and Tandon 1965; Wattal *et al.*, 1967, Srivastava and Wattal, 1970; Mishra *et al.*, 1974; VRC Ann. Rep. 1971, 1973); and in IRAN (Kim and Emerson, 1971). Other host records e.g. *Bandicota bengalensis, Rattus rattus* and *Mus musculus* (Srivastava and Wattal, 1970; Wattal *et al.*, 1967) are attributed to contaminations or misidentifications.

HOST-PARASITE LIST*

Order INSECTIVORA

Family SORICIDAE

Suncus murinus	:	*Polyplax reclinata*
Crocidura horsfieldi	:	*Ancistroplax crocidurae*
Anathana ellioti	:	*Docophthirus acinatus*

Order LAGOMORPHA

Family OCHOTONIDAE

Ochotona roylei	:	*Hoplopleura ochotonae*

Family LEPORIDAE

Oryctolagus cuniculus	:	*Haemodipsus ventricosus*

*To avoid ambiguity, records which are considered dubious are not included in the list.

Order RODENTIA
Family SCIURIDAE

Petaunista petaurista alboventer	:	*Neohaematopinus petauristae*
P. p. philippinensis	:	*Phthirunculus sumatranus*
Callosciurus finlaysoni ferrugineus	:	*Hoplopleura erismata*
C. maccelellandi		*Hoplopleura erismata*
Funambulus tristriatus tristriatus		*Hoplopleura maniculata* *Neohaematopinus echinatus*
F. pennanti	:	*Hoplopleura maniculata* *Neohaematopinus echinatus* *Enderleinellus nishimarui*
F. palmarum	:	*Hoplopleura maniculata* *Neohaematopinus ceylonicus* *Enderleinellus platyspicatus*
Marmota caudata caudata	:	*Neophaematopinus palearctus*

Family **Muridae**
Subfamily **Gerbillinae**

Tatera indica	:	*Polyplax stephensi*
Meriones hurrianae	:	*Polyplax hurrianicus*

Subfamily **Microtinae**

Alticola roylei	:	*Hoplopleura alticola*
Pitymys leucurus	:	*Hoplopleura phaiomydis*
P. sikkimensis	:	*Hoplopleura acanthopus*

Subfamily **Murinae**

Apodemus flavicolis	:	*Hoplopleura himalayana* *Polyplax serrata*
Vandeleuria oleracea	:	*Hoplopleura silvula*
Rattus (Rattus) rattus arboreus	:	*Hoplopleura pacifica* *Polyplax spinulosa*
R. (R.) r. brunneusculus	:	*Hoplopleura pacifica*
R. (R.) r. rufescens	:	*Hoplopleura pacifica* *Polyplax spinulosa*
R. (R.) r. narbadae	:	*Hoplopleura pacifica*
R. (R.) r. satarae	:	*Hoplopleura pacifica* *Polyplax spinulosa*
R. (R.) r. gangutrianus	:	*Hoplopleura pacifica* *Polyplax spinulosa*
R. (R.) rattoides	:	*Hoplopleura pacifica* *Polyplax spinulosa*

R. (R.) nitidus	:	*Hoplopleura pacifica*
R. (R.) exulens	:	*Hoplopleura pacifica*
R. (R.) norvegicus	:	*Hoplopleura pacifica*
R. (R.) blanfordi	:	*Hoplopleura blanfordi* *Polyplax blanfordi*
R. (Maxomys) niviventer	:	*Hoplopleura sicata*
R. (M.) fulvescens	:	*Hoplopleura sicata*
R. (M.) eha	:	*Hoplopleura sicata*
R. (M.) cremoriventer	:	*Hoplopleura sicata*
R. (Cremnomys) cutchicus	:	*Hoplopleura cutchicus* *Polyplax cutchicus*
Millardia meltada	:	*Hoplopleura kondana*
M. kondana	:	*Hoplopleura kondana* *Polyplax kondana*
Mus saxicola	:	*Hoplopleura ramgarh*
M. platythrix	:	*Hoplopleura sinhgarh*
M. booduga	:	*Hoplopleura sahyadri*
M. musculus	:	*Hoplopleura captiosa*
Golunda ellioti	:	*Hoplopleura khandala* *Polyplax indica*
Nesokia indica	:	*Polyplax asiatica*
Bandicota bengalensis	:	*Polyplax asiatica*
B. malabarica	:	*Hoplopleura malabarica*

Host Parasite Associations

All the stages of Anoplura are obligatory external parasites of mammals. The eggs are fastened to the hair and they need body temperature of the host for development and hatching. This type of life history provides an extreme degree of adaptation to one kind of host, and this extreme host specificity leads to the interesting evolutionary features in the study of order Anoplura. There is overwhelming evidence that the vast majority of lice got associated with the groups of hosts on which they now occur, ever since the period when these host groups got differentiated from their ancestral stocks. The speciation of Anoplura has evidently taken place concurrently with the evolution of their hosts. However, the rate of evolution has been slower in lice than their hosts and, therefore, the relationship between the former may be used to trace the phylogeny and interrelationship of the hosts. Present discussion pertains to the following two aspects :

I. Interrelationship among Hoplopleurid lice and phylogeny of their hosts.

II Antiquity of hoplopleurid lice.

I. Interrelationship among hoplopleurid lice and phylogeny of their hosts.

Family Hoplopleuridae is an aggregation of a large number of species and it will be beyond the scope of this study to discuss all the species. An attempt has been made here to discuss the interrelationship among the species of lice found in the Indian subcontinent and its significance in interpreting relationship among their hosts. It must, of course, be mentioned that due to the limited evidence at our disposal, the deductions drawn here should not be taken as final. They are likely to change when the conclusions are drawn on the basis of a study of the hoplopleurid fauna of the entire world.

Hoplopleuridae in this region is represented by 3 subfamilies *viz.*, (i) Enderleinellinae, (ii) Hoplopleurinae and (iii) Polyplacinae.

Enderleinellinae is represented by 2 genera, namely *Enderleinellus* Fahrenholz and *Phthirunculus* Kuhn and Ludwig. Genus *Enderleinellus* is represented by 2 species, both parasitizing squirrels of the genus *Funambulus* (subfamily Sciurinae). *Phthirunculus* is a monotypic genus, represented by *P sumatranus*. This is a specific parasite of the genus *Petaurista* (subfamily Petauristinae). Thus, all the members of Enderleinellinae are parasites of family Sciuridae (suborder Sciuromorpha, order Rodentia).

Hoplopleurinae is represented by 2 genera, *viz.*, *Ancistroplax* Waterston, and *Hoplopleura* Enderlein. In this region, *Ancistroplax* is represented by *A. crocidurae* Waterston ex *Crocidura horsfieldi* from Sri Lanka.

Members of the genus *Hoplopleura* recorded in this region parasitize hosts belonging to families Sciuridae, and Muridae (order Rodentia). On the basis of external morphology, the members of this genus can be divided into following 5 groups.

1. *H. pacifica* group
2. *H captiosa* group
3. *H. acanthopus* group
4. *H. maniculata* group
5. Ungrouped species

H. pacifica group

Adults of this group posses the following common characters : Paratergites well developed ; III to VI each with posterior processes broad and lobed ; VII and VIII devoid of posterior processes except for *H. sicata* and *H. himalayana,* in which paratergite VII is provided with a dorsal posterior process.

The following species can be included under this group :

H. pacifica	parasitizing	*Rattus (Rattus)* spp.
H blanfordi	,,	*R. (R.) blanfordi*
H cutchicus	,,	*R. (Cremnomys) cutchicus*
H sicata	,,	*R. (Maxomys)* spp.
H. kondana	,,	*Millardia* spp.
H. himalayana	,,	*Apodemus flavicollis*
H khandala	,,	*Golunda ellioti*

Of these seven species, first 5 are parasites of *Rattus* and the related genus *Millardia*. There has been a constant disagreement amongst Mammalogists regarding the taxonomic status of *Rattus, Millardia, Cremnomys* and *Maxomys.* Ellerman (1941) considered *Millardia* as an independent genus, members now included under *Cremnomys* as belonging to subgenus *Rattus,* and *Maxomys* as an independent subgenus. Subsequently, Ellerman (1961) regarded all these as subgenera of the genus *Rattus.* Misson (1969), on the basis of dental characters, recognized them as independent genera. Whatever might be their taxonomic status, it appars certain that these groups have radiated from a common ancestral stock. Nymphal study of the lice parasitizing these hosts also suggest kinship with one another and show great morphological similarity. *Hoplopleura sicata* parasitizing *Maxomys* spp. is morphologically an isolated species within this group, and probably reflects distant relationship of its host with the other host species.

Rattus blanfordi is supposed to be an aberrant species. It was placed under subgenus *Rattus* by Ellerman (1961) with the remark that "it stands rather well apart from typical *Rattus,* and is probably allied to *Cremnomys.*" Missone (1969) transferred *R. blanfordi* from *Rattus* to *Cremnomys* and elevated *Cremnomys* to generic level. He further suggests that *blanfordi* could also make a genus of its own. At the same time he noted the simila-

rity of dental characters between *R. blanfordi* and *Millardia*. Comming to their lice fauna, the adults of *H. blanfordi* closely resemble *H. kondana* suggesting a closer relationship of their hosts *R. blanfordi* and *Millardia* sp. On the other hand, all the species and subspecies of the subgenus *Rattus*, from which *Hoplopleura* is known, invariably harbour *H. pacifica*. This suggests that *R. blanfordi* should be given an independent status having the same rank as *Millardia*, *Cremnomys* and *Rattus*.

Two other species of the group, *H. himalayana* and *H. khandala*, though closely resemble other species *H pacifica* group in adult morphology, fall well apart when compared on the basis of nymphal morphology.

Adults of *H. sicata* closely resemble *H. himalayana*. However, the nymphal stages of these two species are quite distinct. Similarly, the adults of *H. pacifica* and *H. kondana* are quite similar, but their nymphs are distinct. The differences in the nymphs show phylogenetic distance between these species. The resemblance in adults of these species probably represents convergence of forms, rather than true relationship. As the nymphal stages of *H sicata* are close to nymphal stages of other four species parasitizing members of *Rattus* group is indicated.

Thus, it can be surmised that kinship amongst *H. pacifica*, *H. blanfordi*, *H kondana* and *H. cutchicus* is due to the divergence of their hosts from a recent common ancestral stock, whereas their relationship with *H. himalayana* and *H. khandala* is due to the convergence of forms rather than homology due to the recent common ancestry.

H captiosa group

This group possesses the following common characters : Abdominal tergites and sternites well developed. Paratergites well developed and overlapping. Paratergites VII and VIII with well developed posterior processes.

The following species can be grouped under this category :

H. captiosa	parasitizing	*Mus musculus*
H. sahyadri	,,	*M. dunni*
H ramgarh	,,	*M. saxicola*
H. sinhgarh	,,	*M. platythrix*
H. silvula	,,	*Vandeleuria oleracea*

H captiosa closely resembles *H sahyadri* which probably

suggests close relationship of their hosts, *Mus musculus* and *Mus booduga*.

H. sinhgarh is morphologically an aberrant species and is not close to *H. raingarh*. But their hosts, *M. platythrix* and *M. saxicola* are closely related species in their morphology and have sympatric distribution in Western Ghats of Maharashtra State. These species of mice have often been collected in the same trap line. Although there is a great morphological similarity between them, they have invariably been found harbouring their own species of lice. Occurrence of two distinct lice on these sibling species of mice suggests that their morphological resemblance may be due to the convergence of the forms rather than the homology due to the divergence from a recent ancestor. A study of karyotypes of these mice also suggests that they are distinct (Dhanda *et al.*, 1973). Ellerman (1961) regarded *M. saxicola* as a synonym of *M platythrix*. But it was the study of their louse fauna that gave indication of their being two distinct species (Mishra *et al.*, 1972).

H. sinhgarh resembles *H. pectinata* which parasitizes *Rattus* sp., in both nymphal and adult morphology. The evidence of lice suggests that either *M. platythrix,* may have got an early separating from the main *Mus* ancestros, close to the origin of the genus *Rattus,* or it may be a case of secondary infestation sometime during the course of its evolution.

H. silvula, another interesting species known from *Vandeleuria oleracea,* reserbles the *Hoplopleura* species found on the genus *Mus*. Genus *Vandeleuria* stands apart morphologically as well as ecologically from the genus *Mus*. However, the close resemblance of louse fauna may be due to some phylogenetic relationship of the hosts.

H. acanthopus group

The species of this group posses following common characters : Tergites and sternites narrow, having large number of setae. Paratergites III to VI each with posterior processes long and tapering, VII and VIII devoid of posterior processes. The following species can be included in this group :

H. acanthopus	parasitizing	*Pitymys* spp. and *Microtus* spp.
H. alticola	,,	*Alticola roylei*
H. phaiomydis	,,	*Phaiomys* sp.

All these rodent hosts belong to the subfamily Microtinae and kinship of lice species may be due to the common recent ancestry of their hosts.

H maniculated group

This group can be recognized by the following characters : Antennal sensoria on segments 4 and 5 well separated. Thoracic sternal plate devoid of long posterior process. Paratergites III-V each with posterior lobes small and acute, setae extend much beyond the lobes.

Two species can be included in this group :

H maniculata	parasitizing	*Eunambulus* spp.
H erismata	,,	*Callosciurus* spp.

These species of rodents belong to the family Sciruidae. The resemblance between their lice species suggests a common ancestry of these two host genera.

Ungrouped members

H malabarica	parasitizing	*Ochotona roylei*
H. ochotonae	,,	*Bandicota* spp.

H malabarica is not related to any other species of this region. *H. ochotonae* also is an aberrant species due to the absence of enlarged setae on sternite of abdominal segment II. The aberrance of these species probably reflects phylogenetic isolation of their hosts from other species.

Subfamily Polyplacinae is represented by following 4 genera :

Docophthirus Waterston, *Haemodipsus* Enderlein, *Neohaematopinus* Mjoberg, and *Polyplax* Enderlein.

Docophthirus is a monotypic genus, represented by *D. acinetus* Waterston ex *Anathana ellioti*. Members of *Haemodipsus* are specific parasites of family Leporidae (suborder Lagomorpha) In this region, it is represented by a single species, *H ventricosus* (Denny).

Members of the genus *Neohaematopinus* are specific parasites of Sciuromorpha except a few species which are found on Myomorpha (Microtinae) In this region, it is represented by 4 species :

N. ceylonicus	parasitizing	*Funambulus palmarum*
N. echinatus	,,	*F pennanti* and *F tristriatus*

N. palearctus	,,	*Marmota caudata*
N. petauristae	,,	*Petaurista inormata*

Of these, the first 2 species closely resemble one another suggesting close relationship of their hosts. The other two species are isolated in this region, hence, no comments are offered on the relationship of their hosts.

Genus *Polyplax* is represented by 10 species. These can be grouped under the following categories :

1. *P spinulosa* group 2. *P asiatica* group
3. Ungrouped species

P. spinulosa group

The species of this group possesses following common characters : Male genitalia with parameres short, pseudopenis articulates at the tips of parameres ; paratergite II and III devoid of long setae.

The following species can be placed in this group :

P. spinulosa	parasitizing	*Rattus* spp.
P blanfordi	,,	*Rattus blanfordi*
P cutchicus	,,	*R. cutchicus*
P kondana	,,	*Millardia kondana*
P. serrata	,,	*Mus musculus* and *Apodemus* sp.

Under as discussed earlier with *Hoplopleura pacifica* group of species, the first 4 host-species have probably diverged from a common ancestral stock in the recent past. The resemblance of the *Polyplax* spp. further strengthens this view. *Polyplax blanfordi* shows more resemblance with *P cutchicus* and *P kondana* than with *P spinulosa* which further strengthens the conclusion drawn from the study of *Hoplopleura* spp. and of their hosts.

Polyplax serrata resembles *Polyplax* spp. parasitizing *Rattus* group. Adults of *Hoplopleura* spp. from *Apodemus* spp. also resemble *Hoplopleura* parasitizing *Rattus* group. Thus, it gives some indication that the *P. serrata* may be an original parasite of *Apodemus* and might have got secondarily adapted to *Mus* spp.

P asiatica group

This group possesses the following characters : Paratergites II and III each with a very long seta ; male genitalia with long

parameres ; pseudopenis long, pointed and partly enclosed within the parameres. Following species can be included in this group :

P. asiatica	parasitizing	*Bandicota* and *Nesokia* spp.
P. hurrianicus	,,	*Meriones hurrianae*
P. indica	,,	*Golunda ellioti*

Of these, *P. asiatica* and *P indica* are closely related to one another showing some relationship of their hosts. *P. hurrianicus* is a distant relative due to the shape of its male genitalia.

Ungrouped species :

P. reclinata	parasitizing	*Suncus murinus*
P. stephensi	,,	*Tatera indica*

Except *P. reclinata* which parasitizes member of the family Soricidae (order Insectivora), all other *Polyplax* species are specific parasite of rodents belonging to family Muridae. On phylogenetic ground, it is almost certain that *P. reclinata* is an early isolation from the main stock of the genus. Morphologically also this species does not show close affinity with any particular species of *Polyplax* found on Muridae.

Polyplax stephensi is also an isolated species. It resembles other species recorded from *Tatera* in other parts of the world but does not show resemblance to *P. hurrianicus*, described here from *Meriones hurrianae,* though both these hosts belong to subfamily Gerbillinae.

On the basis of fore going discussion, some important derivations can be summarized as follows :

1. Host specificity differs at varying levels in different groups. In some instances, several species of the same genus of host harbour the same species of Anoplura. But this also does not go beyond the group level. As given under host-parasite list, 3 species of *Funambulus* are parasitized by *H maniculata*. Five subspecies of *Rattus rattus* and 3 other species of *Rattus* are parasitized by *H pacifica*. But all these are under the subgenus *Rattus* of genus *Rattus* (*sensu* Ellerman 1961). Four species under *Rattus, viz., R. niviventer, R. fulvescens, R. eha* and *R. cremoriventer* are parasitized by *H sicata*. All these species belong to subgenus *Maxomys* under genus *Rattus*. Two species under *Millardia* are parasitized by *H kondana*.

In certain instances, individual host species of a genus harbour different species of Anoplura, *viz.*, 4 species of *Mus* have their individual *Hoplopleura*. In other instances, two genera of rodents are parasitized by the same species of Anoplura e.g., *Bandicota* and *Nesokia*, both parasitized by *P. asiatica*.

With the limited data available, it can be surmized that the certain genera e.g., *Rattus, Millardia, Maxomys* and *Funambulus* probably diversified at a much faster rate, and their parasite could not cope up with the rate of speciation. Thus, a single Anoplura species have now come to parasitize several host species. Other genera *viz., Mus* and *Pitymys* probably diversified at a much slower rate and as a result, all the species of these hosts have their own lice species. Some other genera *viz., Nesokia* and *Bandicota* have the same species of Anoplura, which suggests recent separation of their hosts in phylogenetic history.

2. In some cases, Anoplura can be used as a criterion to differentiate closely related species of the hosts. It can also be used as a guide to know probable relationship of a host species in a particular group. In this connection, an interesting experience can be cited. During our studies, we came across an interesting rat-like species. The specimens of this particular species had some characters of the genus *Rattus* and other of *Millardia*. When the louse fauna from this host was examined, we realized that it was the same species of louse which was earlier found on *Millardia meltada*. This lead us to include the newly discovered rat under the genus *Millardia* even though the definition of this genus had to be revised (Mishra and Dhanda, 1975).

Recognition of *Mus saxicola* as valid species, distinct from *Mus platythrix* is yet another example where the louse fauna has led to correct the classification of its mammalian host.

II. *Antiquity of Hoplopleurid Lice*

It is generally inferred that lice have descended from Psocid-like ancestors (Hopkins, 1949) On the basis of evidence derived from the distribution of lice, Hopkins (*loc. cit.*) claims to have proved that Anoplura must have existed in the mid Cretaceous period and in any case not later than the divergence of main branches of the placental mammals. He maintains that genera akin to *Linognathus* and *Haematopinus* probably existed in the late Cretaceous period.

Practically, no attempt has so far made to find out the antiquity of the present day Hoplopleuridae.

Before going into details regarding the origin of Hoplopleuridae, it will be necessary to get a clear understanding of the terms, primary and secondary infestations. According to Hopkins (1949) those instances in which almost every member of a given group of mammals is infested with lice closely related to those found on other members of the group may be called primary infestations ; and those instances in which the occurrence on a given host or group of hosts of a particular species or group of lice can not be explained by the phylogeny of the hosts may be called as secondary infestations. In case of primary infestation, louse-infestation is considered at least from the period when the group of hosts diverged from their parent stock. In case of secondary infestation, the infestation must necessarily have originated after the divergence of the host-unit from the parent stock.

Members of the family Hoplopleuridae (restricted to present concept) are parasites on orders Insectivora and Primates under cohort Unguiculata; Lagomorpha and Rodentia under cohort Glires, phylogenetically closely related groups of mammals. The only exception is the genus *Ratemia,* which parasitizes zebras and donkeys (Perissodactyla), the distantly related group of mammal. Genus *Ratemia* probably represents a case of secondary infestation or needs to be assigned to some other group of lice, in order to make Hoplopleuridae a phylogenetically homogeneous group.

If the infestation of both the cohorts *viz.,* Unguiculata and Glires is considered as primary, then the hoplopleurids must have been in existance before the insectivores got separated from the rest of the placentals. If however, the genera infesting insectivores are the result of secondary infestations and have diverged from the main ancestral stock, which infests members of cohort Glires, then the hoplopleurids must have come into existance after insectivores got separated from the rest of the placentals.

According to Simpson (1945), Insectivora is of extremely ancient origin and differentiation. Fossils belonging to this order are found as early as the Cretaceous period and remains from the Oligocene rocks are referable to existing families and sometimes perhaps to living genera. They probably splitted off from the main stem of the earliest placental mammals before the

middle of the Cretaceous period. Other living orders of cohort Unguiculata, *viz.*, Dermoptera, Chiroptera, Primates, Edentata, and Pholidota have been derived from insectivore-like ancestors.

Lagomorphs and rodents (cohort-Glires) are known to be rareties in the late Paleocene and were in some abundance during the Eocene period. Sciuromorpha is supposed to be the most primitive rodent group and includes oldest known rodents discovered in the upper Paleocene. Myomorpha and Hystricomorpha were well established in the Oligocene and therefore must surely have made their first appearance not later than Eocene. Murids probably arose from the Cricetids at a relatively late date, most likely towards the end of Miocene and soon differentiated profusely becoming the dominant rodents.

The present day rodents belonging to suborder Sciuromorpha are parasitized by the 3 subfamilies of Hoplopleuridae, *viz.*, Enderleinellinae, Hoplopleurinae and Polyplacinae. It is therefore presumed that the ancestors of these three subfamilies must have been in existance at the time the Sciuromorphs separated, i.e., during the Paleocene period.

Thus let us presume that Hoplopleuridae was represented by at least 4 ancestors which form the present day subfamilies, before Sciuromorphs came into existance.

Subfamily *Enderleinellinae*

Among the ancestral stock, Enderleinellinae probably represents the most primitive form, which can be supported by the fact that some members developed strong host specificity at a much early stage, e.g. sometime in lower Paleocene or in any case not later than late Paleocene, probably corresponding with appearance of Sciuromorphs. This was earlier than the present day Myomorphs and Hystricomorphs came into existance. In the course of evolution, they differentiated into the present day genera of the subfamily Enderleinellinae along with the differentiation of Sciuromorphs.

Subfamily *Hybophthirinae*

A genus like *Scipio,* belonging to the subfamily Hybophthirinae, which parasitize Hystricomorph rodents probably also represent a primitive stock. Members of this genus have a short claw-like structure, besides the true claw on the first pair of legs. This character is also found in the genus *Hybophthirus* which parasitizes *Orycteropus afer,* the sole modern representative of

order Tubulidentata, cohort Ferungulata. Hopkins (1949) gives one clawed condition as an adaptation to life on mammals. In all groups of Mallophaga of birds and some of mammals such as Boopidae and Trimenoponidae, tarsi are 2-clawed, but in all other mammal infesting groups, there is a strong tendency for one of the claws to be lost. In *Haematomyzus,* the tarsi are provided with one large claw and another one of somewhat doubtful nature which is probably best regarded as a vestigial claw.

The genera *Scipio* and *Hybophthirus* are placed in the same subfamily because of this character, otherwise they have very few characters in common. According to Hopkins, these genera might have acquired this character either as a result of burrowing specialization of hosts or may be due to a retention of primitive character. However, his first argument does not seem convincing as no other Anoplura of burrowing hosts are known to prosses this character. It therefore appears reasonable to presume that it is a retention of the primitive character.

According to Simpson, fossil remains of Tubulidentata are extremely meagre, but the genus existed during Pliocene period and forms doubtfully referable to the order occur in much earlier rocks, including lower Eocene. It is probable that the primitive form existed in late Paleocene. Ancestors of Anoplura, which acutally parasitized Rodentia branch probably got secondarily adapted to Tubulidentata and could not diversify any further. The other branch which parasitized Rodentia were probably passed on to Hystricomorphs. Although there is no strong evidence to show that the Hybophtherin are from the ancestral stock of subfamily Enderleinellinae, but both together certainly represent the primitive phylogenetic group of Hoplopleuridae.

Subfamily *Hoplopleurinae*

Ancestors of subfamily Hoplopleurinae are presumed to have been in existance in Paleocene. The existance of this group can not be of later origin than the diversification of Sciuromorphs. This is supported by the fact that members of the genus *Hoplopleura* have successfully parasitized all the diverse branches of present day Sciuromorphs. Had the origin been later, secondary infestation could not have been so successfully established. Members of the genus *Schizophthirus* are specific parasites of the rodent family Gliridae. This genus appears to

have got separated from the main stock earlier or close to the origin of the genus *Hoplopleura*. Since *Schizophthirus* is not found on present day Sciuromorphs, its hosts, the Gliroids must have separated from the rest of the muroids, even earlier than, or close to the separation of primitive Sciuromorphs. This strengthens Simpson's views, who mentions that Gliroidae "is decidedly isolated group, it has been so since the early Tertiary. Gliroids are as old and quite as distinctive as muroids"

The other 2 genera of present day Hoplopleurinae, viz., *Ancistroplax* and *Haematopinoides* are known from ground shrews of the family Soricidae and moles of the family Talpidae. These two insectivore-infesting genera are close to *Schizophthirus* parasitizing Gliroids. It is therefore likely that these genera might have separated from the main stock sometimes in early Eocene or late Paleocene close to the separation of *Schizophthirus* and most likely got secondarily established on insectivores.

Subfamily *Polyplacinae*

It is presumed that ancestors of subfamily Polyplacinae were already present in Paleocene. The genus *Neohaematopinus* parasitizing Sciuromorphs are probably the most ancient in this subfamily. It might be an early separation from the main branch which later gave rise to the present day genera of the subfamily. Members of *Neohaematopinus* are specific to Sciuromorpha except a few on Cricetid rodents. Presence of *Neohaematopinus* on Cricetids strengthens the view that Cricetids are the most ancient among the Myomorphs and have arisen from a primitive Sciuromorph ancestory. The next genus in phylogenetic chronology may be a form like *Eulinognathus* which might have originated not later than the separation of Hystricomorphs and Myomorphs. This is evident from the fact that they have successfully parasitized Hystricomorphs and Myomorphs including Cricetids. Their origin could not have been earlier than the separation of Sciuromorphs as they are not found on them. There is also considerable morphological resemblance between *Euliognathus* and *Neohaematopinus*.

Origin of *Polyplax* must have been close to the origin of Cricetids, probably after the Hystricomorphs got separated from the rest of the muroids, sometimes in Eocene. This is evident due to the fact that they are restricted to Myomorphs only, except

P. reclinata, which parasitizes members of the family Soricidae, of order Insectivora. *Polyplax reclinata* probably represents a secondary infestation at a very early stage, close to the appearance of the genus *Polyplax*. The present day family Soricidae must have been in existance at that time but its generic separation was yet to take place. This is evident due to the fact that *Polyplax reclinata* has successfully parasitized several genera of the family Soricidae throughout the range of its distribution.

The other 2 genera of family Polyplacinae, *viz., Docophthirus* parasitizing *Anathana,* and *Sathrax* parasitizing *Tupaia* are known from the members of family Tupaiidae. Ellermann considers Tupaiidae as a family of order Insectivora, whereas Simpson gives it under primates. But it is certain that it represents an intermediate form with some characters of Primates and some of Insectivora.

The genera *Lemurphthirus* and *Phthirpediculus* are recorded from African and Madagascar lemurs respectively. According to Simpson the only unquestionable tupaid fossil is from early Oligocene period from Mongolia and in some respects it is even more lemur-like than the living forms. Lemuroidea are known from early Paleocene strata. According to Johnson (1964) *Docophthirus* and *Sathrax* are closely related genera and have closest affinity with *Petauristae* group of *Neohaematopinus*. According to Ferris *Docophthirus* is closely related to *Phthirpediculus* due to absence of prothoracic pleural apodeme and the prothoracic pleural ridge. *Lemurphthirus* is also closer to *Neohaematopinus* than to *Docophthirus* or *Phthirpediculus*. Thus, it appears that *Docophthirus, Lemurphthirus* and *Phthirpediculus* have secondarily adopted to Insectivora or Primates and have probably separated from the ancestors of subfamily Polyplacinae, close to the origin of *Neohaematopinus*. Probably *Sathrax* originated subsequently from *Docophthirus-like* forms or vice-versa, as these 2 genera are closely related to one another.

The genus *Neolinognathus,* under family Neolinognathidae, parasitizing members of family Macroscelidae of order Insectivora is obviously isolated and perhaps represent primary infestation.

Ewing (1923) considered *Phthirpediculus* to be close to the lice of Anthropoidea, but Ferris states that this belief is erroneous. According to Hopkins (1949) absence of eyes in all the known genera parasitizing Insectivora and Lemuroidea places

them off the direct line of the descent of the genera found on Anthropoidea, all of which have eyes.

It is here maintained that except *Neolinognathus,* all other lice known from Insectivora and Lemuroidea are secondary infestations and have descended from ancestors of the family Hoplopleuridae. Hoplopleurids are phyletically original lice of cohort Glires. Though *Neolinognathus* appears to be primary infestation on insectivores, this falls far off to show any relationship with the genera found on Anthropoidea.

It is now established that Primates are derived from Insectivora. If this view is accepted, then a form in someway related to modern genera of lice of Anthropoidea must have been in existance on Insectivores before Primates came into existance. Either this form became extinct from Insectivora in due course, or still remains to be discovered. The other view may be that Insectivora originally did not possess lice and genera infesting modern Anthropoidea may be as a result of secondary infestation, from a primitive form which had eyes.

Lagomorpha is infested by 2 genera of Hoplopleuridae, *viz.*, *Hoplopleura* which is known from Ochotonidae and *Haemodipsus* from Leporidae. *Hoplopleura ochotonae* the only known species, is very much isolated from other species of the genus and might have got separated soon after the genus came into existance. Lagomorpha from Eocene rocks were apparently already differentiated into the two existing families. As Hoplopleura is not found on both the subfamilies, this genus probably came into existance after separation of the families of Lagomorpha.

Haemodipsus probably represents primary infestation and might have been derived from ancestors of the subfamily Polyplacinae. This evidence as a whole favours common origin of Lagomorpha and Rodentia. The Lagomorphs got separated earlier than the Sciuromorphs and probably in lower Paleocene period.

From the above cited evidences, it can now be deduced that the main hoplopleurid stock came into the existance after Insectivora got splitted off from the main stem, probably in upper Cretaceous period. The main stock was represented by a minimum of 4 groups which represent the present day subfamilies. The major genera came into existance in Eocene and not later than Oligocene.

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