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**STUDIES ON ECTOPARASITES OF BATS OF
RAJASTHAN AND GUJARAT (INDIA)**

by
RANJAN ADVANI
and
T. G. VAZIRANI

**Issued by The Director
Zoological Survey of India, Calcutta**

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Desert Regional Station, Zoological Survey of India, Jodhpur



सत्यमेव जयते

Edited by the Director, Zoological Survey of India

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STUDIES ON ECTOPARASITES OF BATS OF RAJASTHAN AND GUJARAT (INDIA)

by

RANJAN ADVANI⁽¹⁾ AND T. G. VAZIRANI

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INTRODUCTION

This paper incorporates the results of studies of little over two years studies on the ectoparasites of bats in Rajasthan and Gujarat, collected over the years by the authors and their colleagues at the Desert Regional Station of the Zoological Survey of India, Jodhpur. Most of the specimens are from Rajasthan and Gujarat, although a few others from neighbouring states are also examined. The presence of Shri Y. P. Sinha, a chiropterologist, in the Station is an added advantage especially in the identification of host species and for collection of the parasites.

There are several groups of Insects and Arachnids which are recorded as ectoparasites of bats in India. They are the insects belonging to the families Cimicidae, Polychtenidae (Hemiptera : Heteroptera) ; Streblidae, Nycteribiidae (Diptera : Pupipara) ; Ischnopsyllidae (Siphonoptera) and the arachnids belonging to the families Spinturnicidae, Macronyssidae, Myobiidae, Trombiculidae, Sarcoptidae, Argasidae and Ixodidae (Acarina). The present studies are confined to Cimicidae, Streblidae, Nycteribiidae, Spinturnicidae, Macronyssidae, Argasidae and Ixodidae.

It is a well established fact that there are a number of insects which are vectors of human diseases and that they transmit a number of pathogenetic organisms. The interest in such insect and arachnid vectors has been recently stimulated in India by the incidence of Kyasanur Forest Disease by KFD virus of man and monkey and discovery of an ixodid tick vector *Haemaphysalis spinigera* Neumann (Work, and Trapido, 1957). Recently the virus has also been isolated from the spleen of bats of *Rhinolophus rouxi*, parasitized by yet another

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species of argasid tick *Ornithodoros (Reticulinosus) chiropterophila* Dhanda & Rajagopalan (Rajagopalan *et al.*, 1969). Chatton (1909) recorded a new species of trypanosome *Crithidia nycteribiaeci* from nycteribiid parasite *Cyclopodia sykesii* (Westwood) from India. Elsewhere, also the trypanosomes have been reported from nycteribiid parasites. Anciaux (1965) discusses the possibility of transmission of bat malaria by nycteribiid and streblid flies in Katanga, Congo.

The groups under investigation are all haematophagus and since bats visit and roost human habitations, the investigation of their ectoparasites is considered important, least a considerably favourably tilt in the population of these ectoparasites may endanger human habitations in future.

The cimicid bugs after taking blood meal from the host bat, roost in hidden places (crevices, etc.), which may be in the vicinity of human habitations. Thus, through usual or occasional bites bugs can transmit several diseases as these are reported to be carriers of several pathogens of leprosy, oriental sore, kala azar fever, relapsing fever and brucellosis (Burton, 1963). Bed bugs have been also found infected in nature with *Wuchereria bancrofti* (agent of Filariasis), *Brugia malayi*, *Trypanosoma cruzi*, *Brucella melitensis*, *Coxiella burnetti* and rickettsiae, causing exanthematous typhus (Usinger, 1966). Some argasids, ixodids and trombiculid mites on bats which frequent the same habitat shared by man and bats can transmit bacterial and viral infections if their population increases, as already reported in case of KF disease. Likewise, puparian flies are also reported as carriers of bacteria, rickettsia, parasitic fungi, haemoflagellates, parasitic haemosporidia from some parts of the world (Anciaux, 1965 ; Chatton, 1909 ; Aschner, 1931 ; Speiser, 1901 ; Scott, 1914b).

The studies though confined to a small area have made significant contribution to the systematics and zoogeography of these parasites. In the course of studies, 1465 examples of parasites on 850 examples of bats were examined as under :

<i>Parasites</i>		<i>Host</i>	
Family	Number of ex. (total species collected)	Family	Number of ex. (total species collected)
Cimicidae	376 (5 species)	Pteropidae	57 (3 species)
Streblidae	460 (8 species)	Rhinopomatidae	266 (2 species)
Nycteribiidae	300 (5 species)	Emballonuridae	102 (4 species)
Spinturnicidae	86 (7 species)	Megadermatidae	78 (1 species)

<i>Parasites</i>		<i>Host</i>	
Family	Number of ex. (total species collected)	Family	Number of ex. (total species collected)
Macronyssidae	49 (4 species)	Rhinolophidae	51 (3 species)
Argasidae	152 (6 species)	Molossidae	22 (1 species)
Ixodidae	42 (1 species)	Vespertilionidae	274 (4 species)

The study of ectoparasites in general and of mammals in particular has been generally neglected in our country. We owe our knowledge of ectoparasites of bats to the monographic work of Hiregaudar and Bal (1956).

The review of literature dealing with ectoparasites on Indian bats of the above groups is given below :

FAMILY CIMICIDAE : Jordon & Rothschild (1912) were first to report a new cimicid species *Cacodmus indicus* on bats in India. Later Patton & Cragg (1913), Horwath (1925), Mathur (1953) and Hiregaudar & Bal (1956) reported some species of this family. In recent years, Bhat *et al.* (1973a) and Bhat (1974a) described 2 new species from India and later Bhat (1974b) also reviewed the Indian Cimicidae, reporting 10 species (including one doubtful species) from India, 8 of which being exclusive parasites on bats. Present studies added four more new species and one new record from India. Thus, there are now 14 species in India of which 12 are exclusively parasitic on bats. Usinger (1966) has monographed the 'world fauna' and discussed host-parasite relationships. Ueshima (1968) has revised the keys to species of genera *Cimex*, *Cacodmus*, *Stricticimex* and *Leptocimex* and has described several new species.

FAMILY STREBLIDAE : We owe our knowledge of Indian species to Jobling (1930, 1934, 1951). First record of the streblid *Raymondia lobulata* was made by Speiser (1900). Some new records for India were reported by Bal and Ahmad (1949a, b), Hiregaudar and Bal (1956). Maa (1962) proposed a new subgenus for the only species *Raymondia lobulata*. Maa (1965b and 1971) has provided an interim world list and annotated bibliography of bat flies respectively. Recently, Vazirani and Advani (1976) have described a new species and a new record from Rajasthan. Present studies have raised the number of species from 12 to 19 with addition of 1 new genus *Parascodipteron* and 5 new species. One subfamily Ascodipterinae and 2 species under genus *Ascodipteron* are reported for the first time from India. One species has been reported as a new record from Rajasthan and Gujarat.

FAMILY NYCTERIBIIDAE : Westwood (1835) was the first to describe *Cyclopodia sykesii* from India. Later Speiser (1903, 1907) described 3 new species and some new records from India. Scott (1908, 1914a, 1917, 1925) studied the Indian species of Nycteribiidae and gave the zoogeography, systematic notes, host-parasite relationships coupled with description of some new species and records from India. Bal and Ahmad (1949a, b) reported one species as new record from India. Hiregaudar and Bal (1955, 1956) studied extensively the nycteribiids of Bombay (Maharashtra) and redescribed and recorded 11 species including 2 new species and 1 new subspecies. Theodor (1956, 1963) has studied 7 species from India and described some new species and some new records. Maa (1962, 1968) reported some new records from India. Present studies revealed 5 species, all of which are reported for the first time from Rajasthan and Gujarat. Uptill now 24 species of this family are known to occur in India.

FAMILY SPINTURNICIDAE : First record of this family is by Hiregaudar and Bal (1956) who reported 7 species spread over 5 genera for the first time from India (Bombay), including one new species. Bhat (1973) added one new species. Rudnick (1960) has revised the entire family. Delfinado and Baker (1963), Baker and Delfinado (1964). Prasad (1969) have studied the family from south-east Asia. Allred (1969, 1975) has reported 2 species under genus *Spinturnix* from Pakistan. Vazirani and Advani (1976) have reported some species of bats found to be infested with spinturnicid and other mesostigmatid mites. Under present studies, one new genus *Parameristaspis* and 3 new species are being described thus raising the number of genera from 5 to 6 and species from 8 to 11, as reported from India.

FAMILY MACRONYSSIDAE : First record of this family from India was by Oudemans (1914) who reported *Steatonyssus javensis*. Since then, Hiregaudar and Bal (1955, 1956) have described 2 new species and one new record from India. Radovsky (1966) has revised and classified the entire family and later the same author (1967) has published a monograph on Macronyssidae and Laelapidae parasitic on bats of the world. Bhat (1973) has described one new species from India. Allred (1969, 1976) has reported four species of this family from Pakistan. Present studies have increased the number of species known from India from 5 to 9 with addition of 4 new species.

FAMILY ARGASIDAE : Only 3 species have so far been recorded on bats in India (*vide* Dhanda and Rajagopalan, 1971). These all belong to genus *Ornithodoros*. In the present collections, the genus *Argas* is represented by 5 new species and 1 new record from India. These

belong to subgenera *Carios* and *Chiropteragus*. This raises the number of species of this family to 9 on Indian bats. Soneshine *et al.* (1962, 1966) have provided keys to the larvae of genus *Argas* and also dealt with systematics of the subfamily Ornithodorinae of eastern hemisphere.

FAMILY IXODIDAE : This is the first record of the genus and species *Ixodes vespertilionis* Koch from India on bats.

Dichotomous keys to Indian genera and species, most of them provided for the first time, will facilitate easy determination of species.

Besides the contribution to the taxonomic studies as stated above and dealt with in part 1, an attempt has been in part 2 to analyse host parasite relationship *vis a vis*.

1. average number of parasites collected per bat.
2. average number of parasites collected per infested bat.
3. number of hosts infested.
4. percentage of infestation among the host bats.

The geographical distribution has also been discussed. A list of hitherto known and recorded ectoparasites on Indian bat species with a cross reference to the source of information is provided for the first time. A classified list of host species, with their ectoparasites in India has also been included to facilitate further studies.

Thus as a result of present studies, the number of species reported as ectoparasites of bats in India has gone up from 75 to 101, representing an increase of nearly 35%.

Nearly 850 bats belonging to 18 species were examined for collection of ectoparasites.

All types are deposited in the National Zoological Collections of the Zoological Survey of India, Calcutta. The measurements are given in mm.

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We are thankful to the Director, Zoological Survey of India for laboratory facilities etc. Thanks are also due to the senior colleagues—Shri Y. P. Sinha, Assistant Zoologist for the identification of bats; Dr. S. K. Bhattacharyya, Deputy Director and Dr. S. K. Gupta, Superintending Zoologist for their valuable suggestions; Dr. N. S. Rathore, Assistant Zoologist, Shri A. Basit, Photographer and Shri Avinash Mehta, Artist and Shri V. Muraleedharan, Stenographer, Shri Baijnath Kharwar, Taxidermist.

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PART I — SYSTEMATIC STUDIES HEMIPTERA : HETEROPTERA

Family — CIMICIDAE Latreille

Usinger (1966) records 74 species and states that there is a high degree of specificity in the host relations of Cimicidae. They hide themselves in crevices and cracks for a long time. Unlike the dipteran ectoparasites of bats, they do not generally remain attached to the host, and are not adapted for clinging to the host. They are thus ectoparasites for a temporary period, and suck the blood of the host. They are generally collected from the roosting places of bats or nests of birds or sleeping beds, etc., in the case of those species associated with man.

Of the 22 known genera, 12 are associated with bats, 9 with birds and the remaining genus *Cimex* infests bats, birds, man and domestic animals. Species of the genus *Cacodmus* have been recorded from bats as well as flying lemurs.

Man is infested by 3 species viz. *Cimex lectularius*, *C. hemipterus* and *Leptocimex boueti*. The first one is generally cosmopolitan, the second one is tropical and subtropical in distribution, while the third one is only known from West Africa. In India, *C. hemipterus* is more common than *C. lectularius*.

Bhat (1974) has reviewed Indian species and described 2 new species viz. *Cimex usingeri* and *C. himalayanus* and reported *Cimex insuetus* Ueshima and *Leptocimex inordinatus* Ueshima from India for the first time, thus bringing the number of species known from India to nine excluding the one doubtful species viz. *Cimex pipistrelli* Jenyns. With the addition of two species of *Cimex*, one each of *Cacodmus* and *Leptocimex* new to science now, and a new record of *Stricticimex namru* from India, the number rises to 14 species. Two of these species are associated with man, while the rest with bats.

Dichotomous keys to genera and species known from India have been given for the first time, thus filling the much needed lacunae.

Hiregaudar & Bal (1956) reported 2 known species on bats. Bhat (1974b) quoting from Usinger (1966) remarked that one of these species viz., *Cimex pipistrelli* has restricted geographical range in England and Ireland only. Material resembling *C. pipestrelli sensu* Hiregaudar & Bal is also available to the present authors and described here under as species new to science.

In the description of the species, the terminology used by Ueshima (1968) has been followed.

KEY TO THE SUBFAMILIES OF CIMICIDAE KNOWN FROM INDIA

- Bristles at the sides of pronotum minutely serrate on outer sides or, rarely, only at obliquely truncate tips. Female with paragenital sinus always ventral. Metasternum commonly forming a flat plate between coxae. Tibia simple (Worldwide. Bats, birds and man). *Cimicinae*
- Bristles at the sides of pronotum not minutely serrate on outer sides or at oblique tips, but may be minutely clefted at tips or acute. Females with paragenital sinus dorsal, rarely absent. Metasternum a rounded lobe more or less compressed between coxae. Tibiae bent subapically. (Worldwide. Bats, flying lemurs, birds and man). *Cacodminae*

Subfamily CIMICINAE Latreille

Cimicides Latreille, 1802 : 240 (Part).
Cimicinae Van Duzee, 1916 : 33 (Part) ; Usinger, 1966 : 301.

Diagnostic characters : Head wider than long or subequal, with numerous setae on clypeus, vertex, inner margin of eyes and juga. Bristles on pronotum curved and serrate or clefted at tips and usually serrate on outer sides. Metasternum forming a plate like lobe between middle coxae. Tibiae without mottling or pseudojoints. Tarsi without stiff bristles in apposition to claws at apices. Paragenital sinus ventral, opening between fifth and sixth or sixth and seventh segments.

Genus *Cimex* Linnaeus

Cimex Linnaeus, 1758 : 441 ; Usinger, 1966 : 310.

Acanthia Fabricius, 1775 : 693.

Clinocoris Fallen, 1829 : 141.

Klinophilos Kirkaldy, 1899a : 219.

Clinophilus Blanford, 1903 : 200.

Type species : *Cimex lectularius* Linnaeus, 1758, fixed by the International Commission on Zoological Nomenclature (1924).

Diagnostic characters : Second antennal segment subequal to interocular space. Pronotum less than twice as wide as head. Bristles at sides of pronotum more or less serrate on their convex sides. Body with short thick bristles. Metasternum a broad plate between the coxae. Female with the ectospermalege as a transverse thickening of anterior margin of sixth sternite with fifth sternite cleft or emarginate on right side. Fore and middle femora without a subapical row of short, stout spines. Tibiae with simple bristles on outer sides.

Distribution : Oriental and Ethiopian regions.

Host Bats and human beings.

Remarks : Usinger (1966) states that this genus occurs on bats in Holarctic Region and is cosmopolitan on man and domestic animals. He described one species on bats from Burma. Subsequently Ueshima (1968) has recorded this genus on bats in Thailand, Malaysia. Bhat *et al.* (1973a) has recorded *C. usingeri* from Karnataka (S. India) and in 1974, he added one more species *C. himalayanus* from Chamoli district, Uttar Pradesh. Bhat (1974b) adds *C. inseutus* Ueshima as occurring on Indian bats. Thus bringing the total number of species of this genus, known from India, to 6, including the doubtful one *C. pipistrelli*. As pointed out in introduction the records of this species refer to the new species *Cimex pattoni* described below. With the description of one more new species viz. *C. ueshimai*, now 7 species are known from India.

KEY TO THE SPECIES OF *CIMEX* KNOWN FROM INDIA

1. Area around paragenital sinus, with bristles, like those on other abdominal sternites. Hind margins of hemelytral pads broadly rounded on inner side. (*hemipterus* and *lectularius* groups) ... 2

Area around paragenital sinus naked. Hind margins of hemelytral pads usually only feebly rounded, their inner margins broadly contiguous. (*pipistrelli* group) ... 4
2. Pronotum less than 2.5 times as wide as long at middle. (*hemipterus* group) ... 3

Pronotum more than 2.5 times as wide as long at middle. *lectularius* group (Man, bats chicken-Cosmopolitan) ... *lectularius* Linnaeus
3. Pronotum distinctly less than twice as wide as long at middle. Head longer than wide. Second antennal segment longer than interocular space (Bats-Thailand & India) ... *insuetus* Ueshima

Pronotum distinctly more than twice as wide as long at middle. Head wider than long. Second antennal segment shorter than interocular space (Man, bats, chickens-Tropical) ... *hemipterus* (Fabricius)
4. Longest setae on pronotal margin 0.3 mm long. Antennae, hemelytral pads and abdominal tergites covered with proportionately longer setae (Host : *Myotis siligorensis*) ... *himalayanus* Bhat

Longest setae on pronotal margin less than 0.21 mm. Antennae, hemelytral pads and abdominal tergites without such longer setae ... 5
5. Head longer than wide, hind femur 2.47 times as long as broad (Host : *Pipistrellus dormeri*) ... *ueshimai* n. sp.

Head wider than long, hind femur ca. 2.7 times as long as broad ... 6
6. Anterior angles of pronotum truncate, interocular space about 5 times as wide as the eye (Host : *Rhinolophus rouxi*) ... *usingeri* Bhat et al.

Anterior angles of pronotum rounded, interocular space about 6.5 times as wide as the eye. (Host : *Scotophilus heathi heathi* and *Taphozous longimanus longimanus*) ... *pattoni* n. sp.

Cimex ueshimai n. sp.

(Fig. 1)

Host : *Pipistrellus dormeri dormeri* Dobson

Holotype : ♀, Z. S. I. Reg. No. 576/H16, Rajasthan : Dist. Jodhpur, Bijolai, 10 kms from Jodhpur, 12. viii. 1976 (*Rathore & Advani*). *Paratypes* : 2 ♂♂, 3 ♀♀, 2 NN, Z.S.I. DRS, Reg. No, Ent.

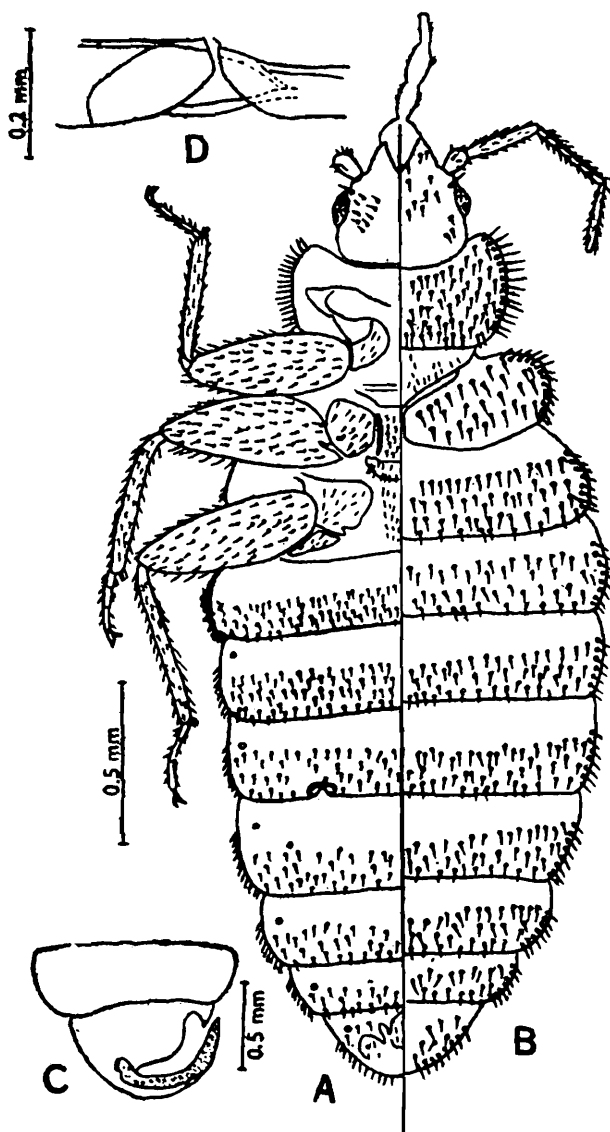


Fig. 1. — *Cimex ueshimai* n. sp. A. dorsal view of female B. ventral view of female C. male genital segment D. paragenital sinus of female.

1282/A, with same locality and date as of holotype ; 4 ♂♂, Z. S. I. DRS, Reg. No. Ent. 1418/A, Dist. Jodhpur, Bijolai, 10 kms from Jodhpur, 10. iv. 1977 (*Vazirani & Rathore*). Gujarat : 1 N, Z. S. I. DRS, Reg. No. 1419/A, Dist. Broach, Shukal tirth, 15 kms from Broach, 19. ix. 1976 (*Sinha & Advani*). Paratypes with same particulars as holotype in the National collections of Zoological Survey of India, Calcutta.

Distribution of parasite : INDIA : Rajasthan (Jodhpur) ; Gujarat (Broach).

Description : Female — *Head* 0.82 mm wide, 0.92 mm long, longer than wide 53 : 47 ; interocular space about 6 times as wide as an eye, 19 : 3. *Antennae* 1.36 mm long ; proportions of segments 6 : 12 : 13 : 11. *Rostrum* 0.81 mm long, proportions of segments 9 : 8 : 8. *Pronotum* 1.10 mm wide, more than twice as wide as long on median line 34 : 14 ; produced forward anterolaterally, sides slightly rounded ; lateral margins with numerous long bristles, longest bristle about 0.21 mm, longer than the greatest width of first antennal segment 5 : 3, discal bristles slightly longer than the distance between them with round bases.

Mesonotum — *Scutellum* with a row of 18 bristles along posterior margin and 2 medial longitudinal rows of 4 bristles each. Hemelytral pads feebly rounded, their inner margins broadly contiguous, about twice as wide as long 27 : 13 ; lateral bristles about equally as long as on pronotum, discal bristles longer than distance between bristles.

Legs short and stout ; hind femora about 2.47 times as long as wide, hind tibiae distinctly longer than femora 33 : 29.

Abdomen with tergites clothed with rather long bristles, longer than distance between bristles ; bristles on lateral margins slightly longer. Sterna covered with fine and short bristles arranged in regular rows. Paragenital sinus deeply cleft on the 5th sternum at posterior margin, slightly protuded forward in the antero-medial region.

Male — Like female. Paramere about 2/3 as long as width of genital segment at base.

Measurements of 5 ♂ ♂ and 5 ♀ ♀ selected at random, average is shown in brackets.

	♂	♀
Head width	0.81-0.82 (0.813)	0.82-0.825 (0.821)
Pronotum width	1.09-1.11 (1.10)	1.14-0.65 (0.161)
Length of antenna	1.34-1.35 (1.342)	1.35-1.375 (1.354)
Length of abdomen	2.7-3.10 (2.95)	3.40-3.62 (3.52)
Total length	5.10-5.44 (5.25)	5.60-6.01 (5.82)

Affinities : The species is close to *burmanus* Usinger of *pipistrellus* group in having (i) tout hind femora, (ii) the HW/3rd antennal, ratio being 1.81 very close to 1.84 of *burmanus*. But, it differs from it in having (i) the head being longer than wide as against wider than long in *burmanus* (as it does not differ from *usingeri* in this character which has head wider than long *vide* Bhat *et al.* 1973a), (ii) the pronotal bristles are longer (0.21 mm), (iii) the hind femora 2.47 times as long as wide as against 2.36 times.

Bio-ecology : In Jodhpur this cimicid species was collected on *Pipistrellus dormeri dormeri* along with an argasid, two macronyssid and spinturnicid mite species, on the host body. The cimicids were also found attached to the ribs of pan, hind legs and interfemoral membrane of bat.

The species is named after Dr. Norihiro Ueshima of Japan for his contributions towards the taxonomic and other aspects of the family and for his encouragement throughout the studies.

***Cimex pattoni* n. sp.**

(Fig. 2)

Type host species : *Scotophilus heathi heathi* Horsefield *C. pipis-*

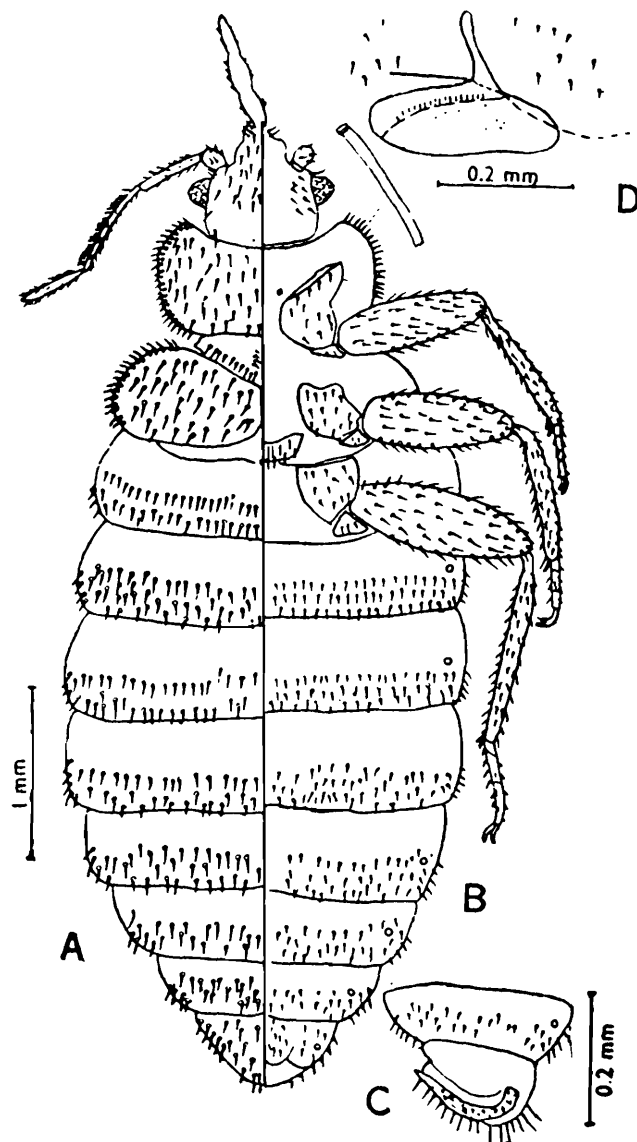


Fig. 2. — *Cimex pattoni* n. sp. A. dorsal view of female B. ventral view of female C. male genital segment D. paragenital sinus of female.

trelli Patton 1913 : nec Jenyns (1839 : 243). *C. pipistrelli sensu* Hiregaudar & Bal (1956 : 83) nec Jenyns (l.c.)

Holotype : ♀, Z.S.I., Reg. No. 577/H15, Gujarat : Dist. Broach, Rajpipla, 70 kms from Broach, 17. ix. 1976, (*Sinha & Advani*), (on bat *Scotophilus heathi heathi* Horsfield)—**Paratypes** : 13 ♂♂, 10 ♀♀, Z.S.I., DRS, Reg. No. Ent. 1269/A, of same particulars as of holotype. 1 ♂, 1 ♀ Z. S. I., DRS, Reg. No. Ent. 1281/A, Dadra & Nagar Haveli, Silvassa, 4. x. 1976, Rajasthan : 1 ♂, Z.S.I., DRS, Reg. No. Ent. 1278/A, Dist. Banswara, 28. xi. 1975 (*Sinha & Advani*) (on bat *Taphozous longimanus longimanus* Hardwicke)—Rajasthan : 1 ♂, Z.S.I., DRS, Reg. No. Ent. 1279/A Dist. Kota, Maharaja Bagh, 31.xii.1975 ; Gujarat : 7 ♂♂, 3 ♀♀, 2 NN, Z.S.I., DRS, Reg. No. Ent. 1219/A, Dist. Broach, 16. xi. 1976 (*Sinha & Advani*) in the National Collections of Zoological Survey of India, Calcutta.

Distribution of parasite : INDIA : Rajasthan (Kota), Gujarat (Broach), Dadra & Nagar Haveli.

Description : Female—Head quadrats 0.91 mm wide, 0.81 mm long ; wider than long 28 : 25 ; interocular space about 6.5 times as wide as eye—20 : 3. Antennae 1.70 mm long ; proportions of segments 6 : 15.5 : 16.5 : 15. Rostrum 0.71 mm long ; proportions of segments about 7 : 6 : 6.

Pronotum 1.25 mm wide ; twice as wide as long on median line 40 : 18 ; sides broadly rounded ; anterior angles broadly rounded, hind margin straight ; longest bristle at sides about 0.112 mm, equal to width of 1st antennal segment.

Mesonotum—Scutellum with about 25-26 small bristles, arranged along posterior margin and in the form of the medial longitudinal rows on each side. Hemeleytral pads feebly rounded and broadly contiguous at inner margins, $3/2$ times as wide as long 36 : 24, clothed with the bristles longer than the distance between them.

Legs short and stout, hind femora 2.7 times as long as wide, hind tibia distinctly longer than femur 40 : 31. Hind tibia shorter than width of pronotum 52 : 68.

Abdomen—tergites mostly with bristles equal or slightly longer than the distance between bristles. Paragenital sinus deeply cleft at the hind margin of sternite 5, saucer shaped with some small setae surrounding its lateral side.

Male—Similar to female. Paramere about $2/3$ as long as width of genital segment at base.

Measurements of 5 ♂♂ and 5 ♀♀ selected at random (average in brackets).

	♂	♀
Head width	0.88-0.90 (0.892)	0.885-0.914 (0.91)
Pronotum width	1.24-1.25 (1.243)	1.25-1.26 (1.251)
Length of antenna	1.67-1.70 (1.69)	1.67-1.71 (1.68)
Length of abdomen	3.8-4.16 (4.10)	3.41-3.90 (3.705)
Total length	6.10-6.35 (6.20)	6.00-6.25 (6.15)

Affinities : Following the revised key to species of genus *Cimex* by Ueshima (1968), the species falls close to *C. flavifusca* Wendt, of pipistrellus group in having (i) similar arrangement of setae on scutellum, (ii) hind tibiae shorter than width of pronotum. But, it differs from it in having (i) third antennal segment shorter than pronotal length as against third antennal segment longer than pronotal length, (ii) bristles of the abdominal tergites being equal or slightly longer than the distance between bristles in contrast to the bristles on abdominal tergites shorter than distance between them.

Remarks The specimens also agree with the figures of *Cimex pipistrelli* given by Hiregaudar and Bal (host species *Pipistrellus ceylonicus chrysothrix*). Bhat (1974) states 'the record of the tenth species *Cimex pipistrelli* Jenyns by Hiregaudar and Bal (1956) needs confirmation as Usinger (1966) restricts the geographic range of this species to England and Ireland' Our present studies confirm that *C. pipistrelli* does not occur in India and its records are referable to this new species.

Generally species of genus *Cimex* are found in association with vespertilionid bats ; but its collection twice on *Taphozous*, an emballonurid bat shows that there may be exceptions where the vespertilionid bats share their roosting place with emballonurid bats. In this case it has been observed by Mr. Y P. Sinha (private communication) that Indian *Scotophilus* and *Taphozous* bats do share the roosting places occasionally, though not in the case of present collection.

Bio-ecology : In Broach, the bugs were collected on *Scotophilus heathi*. They were found to be firmly attached over ribs of pan, legs and interfemoral membrane. The density of infestation was 2.79. All bats were infested and the sex ratio was 12 : 10 (♂ : ♀). From same district the species was collected on *Taphozous longimanus* roosting in hollows of trees. No bug was found firmly attached to the host, but some were fully fed. The density of infestation was 6 (12 bugs on 2 bats).

The species is named after Dr. Patton who has done pioneering work in the field of Medical Entomology, specially in the Indian region.

Subfamily CACODMINAE Kirkaldy

Cacodminae Kirkaldy, 1899b : 45 ; Usinger, 1966 : 389.

Diagnostic characters : Size usually less than 7.0 mm, in unexpanded specimens. Labrum short and broad. Bristles on pronotum not serrated laterally or at tips, but may be clefted at tips or acute. Metasternum a rounded lobe, more or less compressed (flat) between coxae. Tibiae bent subapically, not mottled ; tarsi without stout spines in apposition to claws. Middle and hind tibiae with fine bristles, which may be short or very long, but never with additional short, stout, spini-form bristles. Paragenital sinus dorsal and present in females only ; rarely lacking in some species.

Distribution : Oriental and Ethiopian regions.

Host : Bats, flying lemurs.

KEY TO GENERA OF CACODMINAE KNOWN FROM INDIA

1. Tibiae without apical tufts 2
- Tibiae with apical tufts 3
2. Third antennal segment longer than remain-
ing segments combined. Apical segment
of rostrum longer than second. Hemelytral
pads very short, 1/3 or 1/4 as long as wide
(Host bat families : Emballonuridae, Rhino-
pomatidae) *Leptocimex* Roubaud
- Third antennal segment shorter than remain-
ing segments. Third segment of rostrum
shorter than second. Hemelytral pads
longer, 2/3 as long as wide (Host bat
families : Vespertilionidae, Molossidae,
Rhinolophidae) *Stricticimex* Ferris & Usinger
3. Hind tibiae without subapical pseudo-
joints. Ectospermalege (paragenital sinus)
on left side and invaginating anteriorly,
as a tube from front margin of seventh
tergite (Host bat family : Vespertilionidae) *Cacodmus* Stål
- Hind tibiae usually with more or less distinct
subapical pseudojoints. No paragenital
sinus (Host bat families : Vespertilionidae,
Rhinolophidae, Pteropidae) *Aphrania* Jordon & Rothschild

Genus *Cacodmus* Stål

Cacodmus Stål, 1873 : 108, 104 ; Usinger, 1966 : 390.

Type species : *Cacodmus villosus* Stål, 1873 by original designation.

Diagnostic characters : All tibiae with apical tufts, but without subapical pseudojoints. ♀ ectospermalege of paragenital sinus dorsally situated on the left side and invaginating anteriorly, as a tube, from the front margin of seventh tergite.

Distribution : Oriental and Ethiopian regions.

Host : Bats and flying lemurs.

KEY TO THE SPECIES OF *CACODMUS* KNOWN FROM INDIA

Fourth antennal segment subequal to third ;

paramere sinuate, spermalege short ... *indicus*

Fourth antennal segment shorter than third ;

paramere not sinuate, spermalege elongate

and tubular *bhatti* n. sp.

Cacodmus bhatti n. sp.

(Fig. 3)

Host : *Pipistrellus dormeri dormeri* Dobson

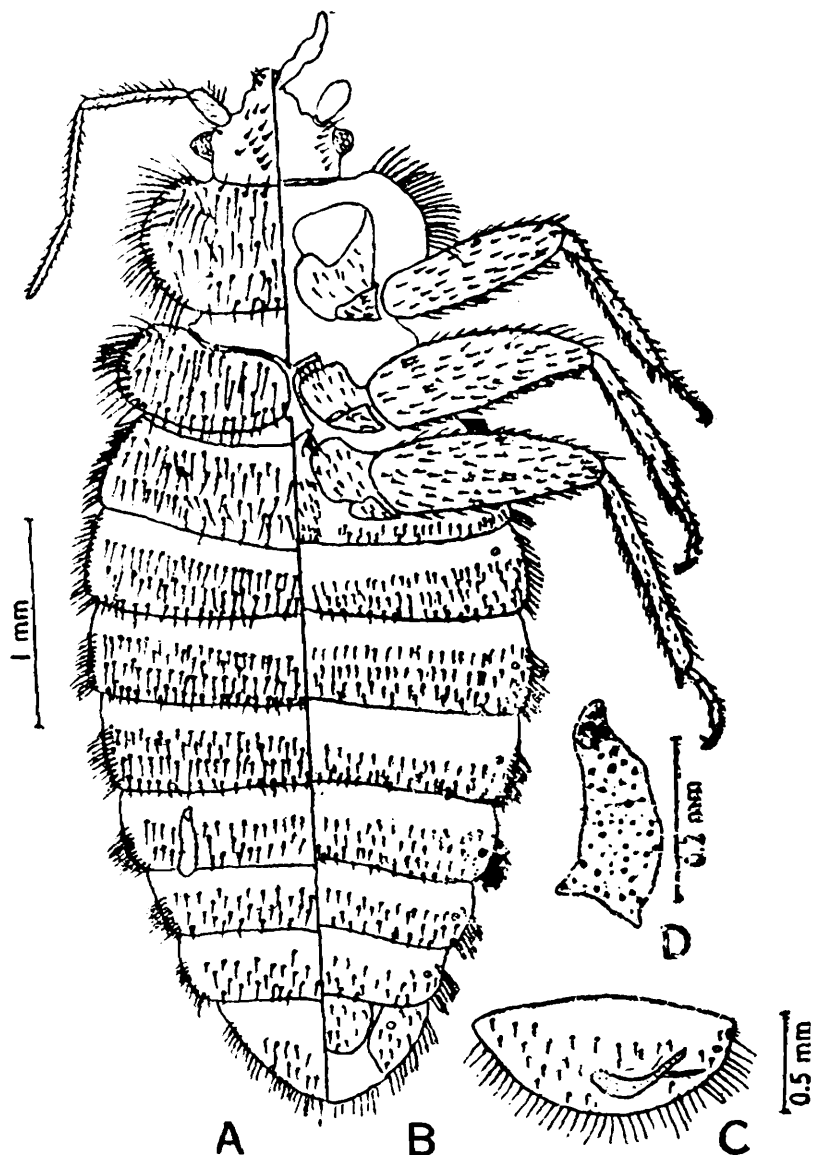


Fig. 3. — *Cacodmus bhatti* n. sp. A. dorsal view of female B. ventral of female C. male genital segment D. paragenital sinus of female.

Holotype : ♀, Z. S. I. Reg. No. 578/H15, Gujarat : Dist. Bulsar, Tithal village, 30. ix. 1976 (*Sinha & Advani*) **Paratypes :** 65 ♂ ♂ 45 ♀ ♀ Z. S. I., DRS. Reg. No. Ent. 1220/A & 1283/A, with same particulars of holotype : 1 N, Z. S. I., DRS, Reg. No. Ent. 1420/A, Dist. Dangs, Bansada, 27. ix. 1976 (*Sinha & Advani*). Also 99 nymphs from the type locality. In National Collections of Zoological Survey of India, Calcutta.

Distribution of parasite : INDIA: Gujarat (Bulsar, Dangs).

Description : *Female*—Head 0.76 mm wide, 0.53 mm long, distinctly wider than long, 23 : 16 ; interocular space about 5.6 times as wide as eye, 17 : 3. Antennae 1.62 mm long ; proportions of segments about 7.5 : 14.5 : 15 : 13. Rostrum 0.45 mm long ; proportions of segments about 5.5 : 6 : 4.

Pronotum 1.20 mm wide ; twice as wide as long on median line, 40 : 20 ; lateral sides broadly rounded ; anterior and posterior angles rounded ; hind margin slightly concave ; longest bristle at the lateral margin 0.23 mm long, slightly longer than first antennal segment.

Scutellum triangular with 4 pairs of small setae arranged medially. Hemelytral pads about 1.6 times as wide as long, 26 : 17, posterior margin convex, covered with longer bristles at margins and surface.

Legs short and stout ; hind femora about 3 times as long as its own greatest width, 50 : 17 ; slightly shorter than hind tibiae 50 : 51.

Abdomen densely bristled, bristles longest laterally and posteriorly. Spermalege elongate and tubular, as long as the tergite, tapering but not bent at apex, reaching up to the middle of pre-apical segment.

Male—Parameres bent at base, tapreing to apex but not sinuate.

Measurements of 5 ♂ ♂ and 5 ♀ ♀ selected at random (average in parentheses).

	♂	♀
Head width	0.72-0.74 (0.725)	0.75-0.78 (0.76)
Pronotum width	1.15-1.23 (1.18)	1.25-1.36 (1.33)
Length of antenna	1.48-1.55 (1.52)	1.60-1.62 (1.61)
Length of abdomen	2.40-2.49 (2.45)	2.45-2.61 (2.525)
Total length	5.10-5.35 (5.31)	5.40-5.77 (5.65)

Affinities : This species comes close to *indicus* in antennal segment 3 and 4 being subequal, but differs from it in having (i) spermalege being elongate and tubular as against short, (ii) paramere not sinuate as against sinuate. It also resembles *bambusicola* (from Java and

Malaysia) in having spermalege elongate, tubular and straight, but differs from it in having (i) hind tibiae shorter than pronotal width as against hind tibiae longer than pronotal width (ii) the fourth antennal segment being shorter, subequal to third as against fourth antennal segment longer than third. The species also resembles *burmanus* (from Burma) in having hind tibiae shorter than pronotal width, but differs from it in having straight spermalege at apex as against spermalege bent towards left, at apex.

Bio-ecology : The bats collected at Bulsar were highly infested with the parasites which were attached to body. The sex ratio was 65 : 46. (♂ : ♀). 91 nymphs of various stages were present out of total number of 202 examples.

The species is named after Dr. H. R. Bhat of Virus Research Institute, for his contribution towards the study of Indian Cimicidae.

Genus *Leptocimex* Roubaud

Leptocimex Roubaud, 1913 : 349 ; Usinger, 1956 : 441.

Klinophilos Kirkaldy, 1899a : 219.

Type species : *Cimex boueti* Brumpt, 1910 ; *vide* subsequent designation by Roubaud, 1913.

Diagnostic characters : Rostrum slender, longer than head, apical segment longer than second. Antenna with third segment longer than the remaining segments combined. Hemelytral pads, 1/3 or 1/4 as long as wide. Tibiae without apical tufts, middle and hind tibiae with only short bristles, scarcely longer than the thickness of tibia.

Distribution : Oriental and Ethiopian regions.

Hosts : Bats and human beings.

KEY TO THE SPECIES OF *LEPTOCIMEX* KNOWN FROM INDIA

Antenna with second segment about three times longer than first ; paramere moderately curved towards side of the genital segment, tapering and recurved at apex, not reaching the posterior margin of genital segment ... *inordinatus* Ueshima

Antenna with second segment about twice longer than first ; paramere strongly curved downwards reaching the posterior margin of genital segment, tapering to apex, but not recurved *hiregaudari* n. sp.

Leptocimex hiregaudari n. sp.

(Fig. 4)

Type host species : *Taphozous kachhensis kachhensis* Dobson

Holotype : ♀, Z.S.I. Reg. No. 575/H15, Rajasthan : Dist. Bundi, Taragarh Fort, 6.xii.1975 (Sinha & Advani) (on bat *Taphozous kachhensis kachhensis* Dobson)—Paratypes ; Rajasthan : 8 ♂♂, 9 ♀♀, Z.S.I., DRS, Reg. No. Ent. 1221/A, Dist. Bundi, Taragarh fort, 6.xii.1975 ; 2 ♂♂, 2 ♀♀ and 19 NN, Z.S.I., DRS, Reg. No. Ent. 1224/A, Dist. Jodhpur, Bhimbhark (12 kms west of Jodhpur), 24.vii.1975. Gujarat : 1 ♂, Z.S.I., DRS, Reg. No. Ent. 1222/A, Dist. Broach, Juna Masjid, Fort Parsiward, Broach, 15.ix.1976 (on host bat *Rhinopoma microphyllum microphyllum* (Brünnich)) —Rajasthan : 21 ♂♂, 9 ♀♀ and 14 NN, Z.S.I., DRS, Reg. No. Ent. 1223/A, Dist. Jhalawar, Jhalarpatan Ka Kila, 10 kms from Jhalawar, 1.xii.1975, 2 ♂♂, 2 ♀♀ and 2 NN, Z.S.I., DRS, Reg. No. Ent. 1284/A, Dist. Bundi, Taragarh Fort, 6.xii.1975

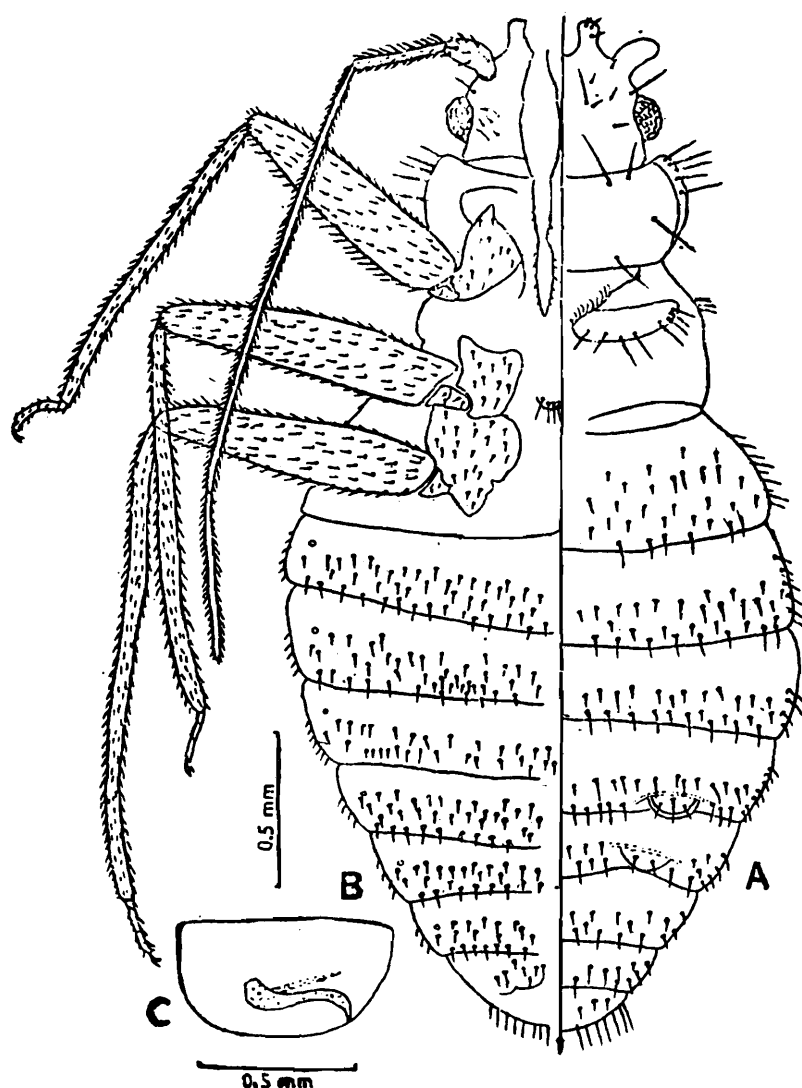


Fig. 4. — *Leptocimex hiregaudari* n. sp. A. dorsal view of female B. ventral view of female C. male genital segment.

(Sinha & Advani). In the National Collections of Zoological Survey of India, Calcutta.

Distribution of parasite : INDIA : Rajasthan : Bundi, Jodhpur, Jhalawar. Gujarat : Broach.

Description : Female—Head 0.56 mm wide, as wide as long 18 : 18 ; interocular space 4 times as wide as eye. Antennae about 2.85 mm long ; proportions of segments 7 : 12.5 : 59 : 22. Rostrum 1.1 mm long ; proportion of segments approximately 14 : 15 : 25.

Pronotum 0.72 mm wide ; twice as wide as long on median line, 20 : 10 ; evenly rounded laterally and narrowed near hind margin ; anterior margin round and posterior margin straight ; long bristles at sides 0.22 mm long, slightly longer than first antennal segment, 12 : 10.

Hemelytral pads about 3 times as wide as long 21 : 7, with 6-8 bristles on them.

Mesonotum and metanotum exposed, naked.

Legs long and cylindrical, hind femora nearly 6.5 times as long as wide 40 : 6, hind tibiae distinctly 1.5 times longer than hind femora 60 : 40.

Abdomen with tergites having prominent long bristles. Paragenital sinuses on 5th and 6th tergites on right side in form of 2 oval apertures.

Male—Paramere broadly curved downwards, reaching or even extending beyond posterior end, not recurved, tapering to a point. Fore femora of some male specimens with a row of stout and long setae posteriorly.

Measurements of 5 ♂♂, 2 ♀♀ selected at random (average shown in brackets).

	♂	♀
Head width	0.52-0.56 (0.55)	0.56-0.57 (0.563)
Pronotum width	0.61-0.66 (0.64)	0.64-0.67 (0.65)
Length of antenna	2.62-2.84 (2.72)	2.74-2.88 (2.80)
Length of abdomen	1.50-1.68 (1.61)	2.80-3.10 (2.85)
Total length	3.20-3.73 (3.61)	3.96-4.60 (4.38)

Affinities : The species is close to *L. inordinatus* Ueshima in the absence of a row of short and stiff bristles on inner posterior face of fore femora. But it differs from it (i) in the second segment of antenna being twice longer than first as against 3 times longer, (ii) paramere strongly curved downwards reaching the posterior margin of genital segment, not recurved as against paramere curved to the side, but not reaching posterior margin of genital segment, and recurved.

Bio-ecology : The parasites were collected not only from roosting places of both species of bats but also on them. The density of infesta-

tion of *L. hiregaudari* in Bundi was 3.11 (average parasite per infested bat) and 66% of bats were infested with a maximum of 6 bugs on a single host. In Jodhpur, the same data were 3.66, 50% and 5 respectively. This species is named after Dr. L. S. Hiregaudar in recognition of his pioneering work on ectoparasites of bats.

Genus *Stricticimex* Ferris & Usinger

Stricticimex Ferris and Usinger 1957 : 374 ; Usinger 1966 : 428.

Type species : *Stricticimex antennatus* Ferris & Usinger, 1957 by original designation.

Diagnostic characters : Rostrum slender, longer than head, third segment shorter than second. Antenna with third segment shorter than remaining segments combined together. Tibiae without apical tufts. Middle and hind tibiae with only short bristles, scarcely longer than the thickness of tibia.

Distribution : Oriental and Ethiopian regions.

Host : Bats.

KEY TO THE SPECIES OF *STRICTICIMEX* KNOWN FROM INDIA

Fore femora slightly longer than tibiae. Size
small, pronotum 0.6 mm wide ... *pattoni* Horvath

Fore femora slightly shorter than tibiae. Size
medium to large, pronotum 1 mm wide ... *namru* Usinger

Stricticimex namru Usinger

(Fig. 5)

Stricticimex namru Usinger 1966 : 433 ; Ueshima 1968 : 277 ; Vazirani and Advani, 1975 : 21.

Host : *Tadarida aegyptiaca thomasi* Wroughton

Material examined : Rajasthan : 2 ♂♂, Z.S.I., DRS, Reg. No. Ent. 1286/A, Dist. Kota, Bhitaria Kund, ca. 15 kms from Kota, 15.i.1975 ; 1 ♀ 1N, Z.S.I., DRS, Reg. No. Ent. 1275/A, Dist. Jodhpur, High Court, 27.x.1973 ; 1N, High Court, 15.vii.1976 (*Sinha*). 1 ♀ Z.S.I., DRS, Reg. No. Ent. 1277/A, Dist. Dungarpur Juna Mahal, 23.ii.1975 (*Sinha & Advani*).

Host range : *Tadarida aegyptiaca thomasi*, *T. aegyptiaca aegyptiaca*.

Distribution of parasite : INDIA : Rajasthan (Kota, Dungarpur, Jodhpur) ; EGYPT.

Female—Head 0.77 mm wide ; 0.61 mm long ; wider than long, 43 : 34 ; interocular space less than five times as wide as eye, 30 : 6.5 ;

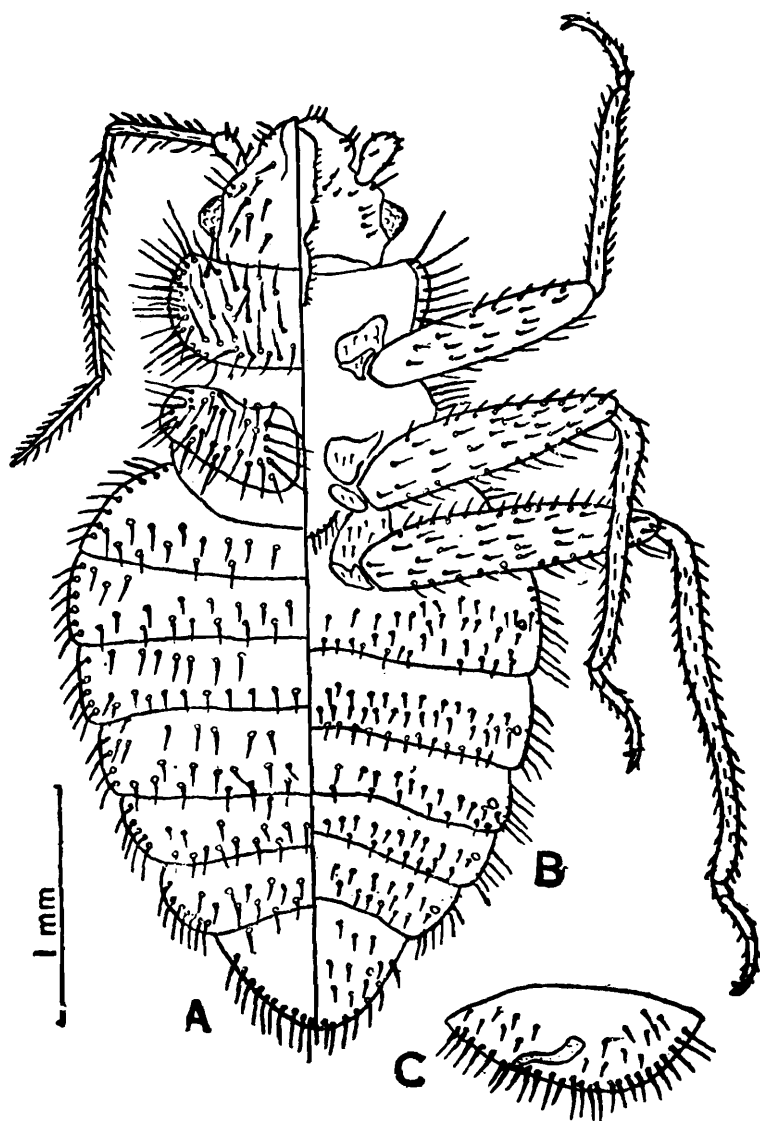


Fig. 5. — *Stricticimex namru* Usinger. A. dorsal view of female B. ventral view of female C. male genital segment.

labrum with 4-5 pairs of bristles ; 4-5 bristles along inner margin of each eye, vertex covered with small setae. Antennae about 2.27 mm long ; proportions of segments 11 : 25 : 56 : 32 ; second antennal segment much shorter than width of head 25 : 40. Rostrum 0.55 mm long ; proportions of segments 11 : 9 : 11.

Pronotum 0.92 mm wide ; twice as wide as long 51 : 25 ; longest bristles about 0.25 mm, lateral margins smoothly rounded, antero-lateral angles slightly produced ; side margin with 18-20 various sized stiff bristles on each side.

Mesonotum naked.

Legs long and slender ; hind femora about 4 times as long as greatest width, 57 : 14, tibiae about $3\frac{1}{2}$ times longer than femora 50:52.

Abdomen suboval ; terga covered with 2-4 irregular rows of robust setae ; sterna covered with finer bristles, sides of segments beset with longer bristles. Paragenital sinus sinuate broadly, situated on hind margin of third tergite. Ectospermalege broad at opening, directed inwards and bent.

Male—Paramere situated on left side and directed downwards, finger shaped, $1/2$ as long as width of genital segment at base.

Measurements of 2 ♂♂ and 1 ♀ are available. Average is in parentheses.

	♂	♀
Head width	0.58-0.59 (0.583)	0.77
Pronotum width	0.95-0.97 (0.96)	0.96
Length of antenna	2.24-2.26 (2.25)	2.27
Length of abdomen	2.74-2.76 (2.75)	2.78
Total length	3.75-3.87 (3.81)	3.89

Affinities : The species is close to *S. parvus* Ueshima, but differs from it in having second antennal segment shorter than length of pronotum ; interocular space wider than length of second antennal segment ; larger in size and width of pronotum.

Remarks : This species was first reported from India by Vazirani and Advani (1975) from Kota and is now being reported from other localities as indicated above.

Bio-ecology : Its infestation is found to be poor. In Kota only 2 specimens were found on 4 bats, in Jodhpur only 1 adult and 1 nymph was found on 4 host bats.

DIPTERA : PUPIPARA

Bat flies

Three small families, Nycteribiidae, Streblidae and Hippoboscidae are placed by several dipterologists in the group called PUPIPARA (suborder Cyclorrhapha). While the former two families are exclusively ectoparasites of bats, the Hippoboscidae are ectoparasites of birds and large mammals. Many consider the group to be polyphyletic in view of their obscure relationships. Theoder (1964) considers the similarity of proboscis and other characters in Streblidae and Nycteribiidae, as a result of convergence. This author opinions that Nycteribiidae are more ancient as a group than the other two families and that all the three families share a common ancestry. However, at present all show similar biological characteristics e. g., (a) vertebrate blood is the only

food taken by them, (b) they are closely attached to the body of the host and seldom leave it, (c) larviparous habit. The females do not lay eggs, which are retained in the uterus and are deposited as larvae. Only one larva matures at a time, thus reducing the rate of reproduction considerably ; only between 10-20 larvae per year in some species. The larva after being discharged from the vagina, hardly feeds any more, but forms a puparium thus the only food taken by the species throughout its life history is blood of the vertebrate host. It is interesting that the food factors which can not be supplied by vertebrate blood are compensated by the activity of the micro-organisms like mycetomes present in the pupipara.

These flies are fully adapted to parasitic life on mammals with, dorsoventrally flattened body, piercing and sucking mouth parts, legs with powerful claws for attachment to the host body, small eyes and antennae, wings present or with atrophied wing musculature or absent.

KEY TO THE FAMILIES OF PUPIPARA AS ECTOPARASITES ON BATS IN INDIA

Head rising apparently behind the front coxae
and capable of being folded back upon
the dorsum ; thorax greatly flattened and
expanded. Palpi longer than broad. Wings
always absent Nycteribiidae

Head not apparently rising from behind the
front coxae ; sometimes flattened, but never
with the thorax strongly flattened and ex-
panded. Palpi broader than long, projecting
leaf like in front of the head. Wings
absent, vestigial or fully developed, never
with the veins crowded towards the costal
margin Streblidae

Family STREBLIDAE Kolenati

General account : Though most of the species are ectoparasites of bats, some of them have however been reported from parrots, doves and opossum. They occur both in the old world as well new world, generally between 40°N and 40°S (Jobling, 1951). As pointed out by Askew (1971, p. 73) these parasites are usually host-specific. The range of hosts is governed by the habitat of bats. But if more than one species of bats roost at one place, they are likely to be infested by the same species of parasites except perhaps in the genus *Ascodipteron*.

The fully developed larvae are laid by the females, on surface of the roosting place, here again the larvae of *Ascodipteron* behave differently as they fall to the ground and pupate there. For these reasons

as well as the differences between two sexes, some authors consider that *Ascodiapteron* as a distinct family. The females of *Ascodiapteron* emerge as normal flies with well developed wings but on reaching the host bat, it makes a hole in the skin with its proboscis and then sheds its wings and legs. Abdomen swells slowly as the insect absorbs the host blood ; the female develops flask shaped fleshy tissues, with minute spines at its anterior end, posteriorly remaining exposed through the host tissue. The larvae are shed through this opening.

It is quite difficult to determine the true host for these flies, when there is mixed colony of host species. The flies do not remain attached to any part of the body of host. They immediately take to flight, when the colony of bats is disturbed. The flies can be collected loose/detached, from the jar, in which the bats have been placed for anaesthasiation. In contrast there is no such problem with the apterous nycteribiids which remain attached to the hairs of the host and do not leave the body during the process of anaesthasiation of host specimens.

KEY TO SUBFAMILIES OF STREBLIDAE KNOWN FROM INDIA

Sexes similar. Wings with 5 well sclerotised longitudinal veins and 2 cross veins. Anal vein short, forming an anal cell in one genus, much reduced or absent in the other 2 genera *Brachytarsinae*

Sexes markedly different. Male with small round head, free living. Female with head capsule much reduced, consisting of a few sclerites which are separated by wide membranous areas, and theca of labium very large, conical, strongly sclerotised, with 14 rows of strong teeth on eversible arcs on the labelum. Wings with 3 or 4 well sclerotised longitudinal veins. R2+3 reduced or well developed, M1+2 and anal vein indicated by weak folds. Cross veins absent or present. The female sheds legs and wings, burrows into the skin of bat and becomes flask shaped by growth of the first abdominal segment which encloses head and thorax *Ascodipterinae*

Subfamily BRACHYTARSINAE Maa

KEY TO GENERA OF SUBFAMILY BRACHYTARSINAE KNOWN FROM INDIA

Eyes single faceted. Head rounded or conical in profile, funnelshaped, without ventral depression for fore coxae. Postvertex extending between the laterovertrices *Brachytarsina* Macquart

Eyes absent. Head flattened, with ventral depressions for fore coxae. Postvertex not extending between latero vertices ... *Raymondia* Frauenfeld

Genus **Brachytarsina** Macquart

Brachytarsina Macquart, 1851 : 280 ; Theodor, 1968b : 315.

Nycteribosca Speiser, 1900 : 31.

Type species : *Brachytarsina flavipennis* Macquart, 1851, by original designation.

KEY TO THE SPECIES OF GENUS *BRACHYTARSINA* KNOWN FROM THE INDIAN REGION

- 1. Posterior part of thoracic squammae broadly rounded ... 2
Posterior part of thoracic squammae conical 4
- 2. Head very much darker than body ... 3
Head not darker than body ... *speiseri* Jobling
- 3. Post vertex small, elliptical ; size 3.0 mm ... *gigantea* Speiser
Post vertex large, deltoid ; size less than 2.0 mm ... *cucullata* Jobling
- 4. 3rd and 4th longitudinal veins divergent near wing margin ... 5
3rd and 4th longitudinal veins parallel near wing margin ... 8
- 5. Basal part of 3rd longitudinal vein as long as or shorter than anterior cross vein ... 6
Basal part of 3rd longitudinal vein longer than anterior cross vein ... 7
- 6. Thorax as long as or little longer than the width. Proctiger conical ... *amboinensis* Rondani
Thorax wider than long. Proctiger not conical ... *modesta* Jobling
- 7. Basal part of 3rd longitudinal vein much longer than anterior cross vein. Theca with sides slightly swollen. Postvertex with 6-8 short setae distributed on whole surface. Postgenae densely setosed. Cell IR more setosed ... *taji* Hiregaudar & Bal

Basal part of 3rd longitudinal vein slightly longer than anterior cross vein. Theca without swollen sides. Post vertex with 12 short setae peripherally. Post genae and IR cell of wing less setosed *theodori* n. sp.

8. Basal part of 3rd longitudinal vein as long as or shorter than the anterior cross vein. ... 9

Basal part of 3rd longitudinal vein longer than anterior cross vein 11

9. Post vertex triangular, with more than 4 setae 10

Post vertex ellipsoidal, with 2 setae on either sides *joblingi* n. sp.

10. Basal part of 3rd longitudinal vein much shorter than the anterior cross vein ; scutellum slightly triangular. Post vertex with 9 small setae. Body length 3.44 mm (♀) and wings 2.87 mm. *maai* n. p.

Basal part of 3rd longitudinal vein as long as the anterior cross vein ; scutellum crescent shaped ; post vertex with 4 small setae. Body length 2.2 mm (♀) and wings 2.5 mm. *caudata* Jobling

11. Theca conical, longer than broad ; 2 long setae in the middle of scutum ; alula and scutellum broadly rounded ; size 2.3 mm. ... *pygialis* Jobling

Theca pea shaped, as long as broad ; long setae in middle of scutum absent ; alula narrowly rounded, scutellum more or less triangular ; size 2.75-3.25 mm. ... *sinhai* Vazirani & Advani

***Brachytarsina maai* n. sp.**

(Figs. 6 & 7)

Hosts : A mixed colony of *Rhinopoma microphyllum microphyllum* (Brünnich) and *Rhinopoma hardwickei hardwickei* Gray.

Holotype : ♀, Z. S. I., Reg. No. 6495/H6 Rajasthan : Dist. Jodhpur, Surpura (10 kms east of Jodhpur), 28.vii.1976 (*Rathore & Advani*) ; in National Collections of Zoological Survey of India, Calcutta.

Distribution of parasite : INDIA : Rajasthan (Jodhpur Dist.).

Length : 3.44 mm.

Head : Cup-shaped, flattened laterally ; dorsal and ventral surfaces convex. Mediovertex membranous ; postvertex ellipsoidal with

nine short setae ; laterovertices covered with 12-13 setae at surface and 17-18 at sides. Eyes prominent, occupying the antero-lateral parts of the head. Post-genae studded with a row of short setae. Theca heart shaped, sides bulging, with setae at apex ; labella shorter than theca.

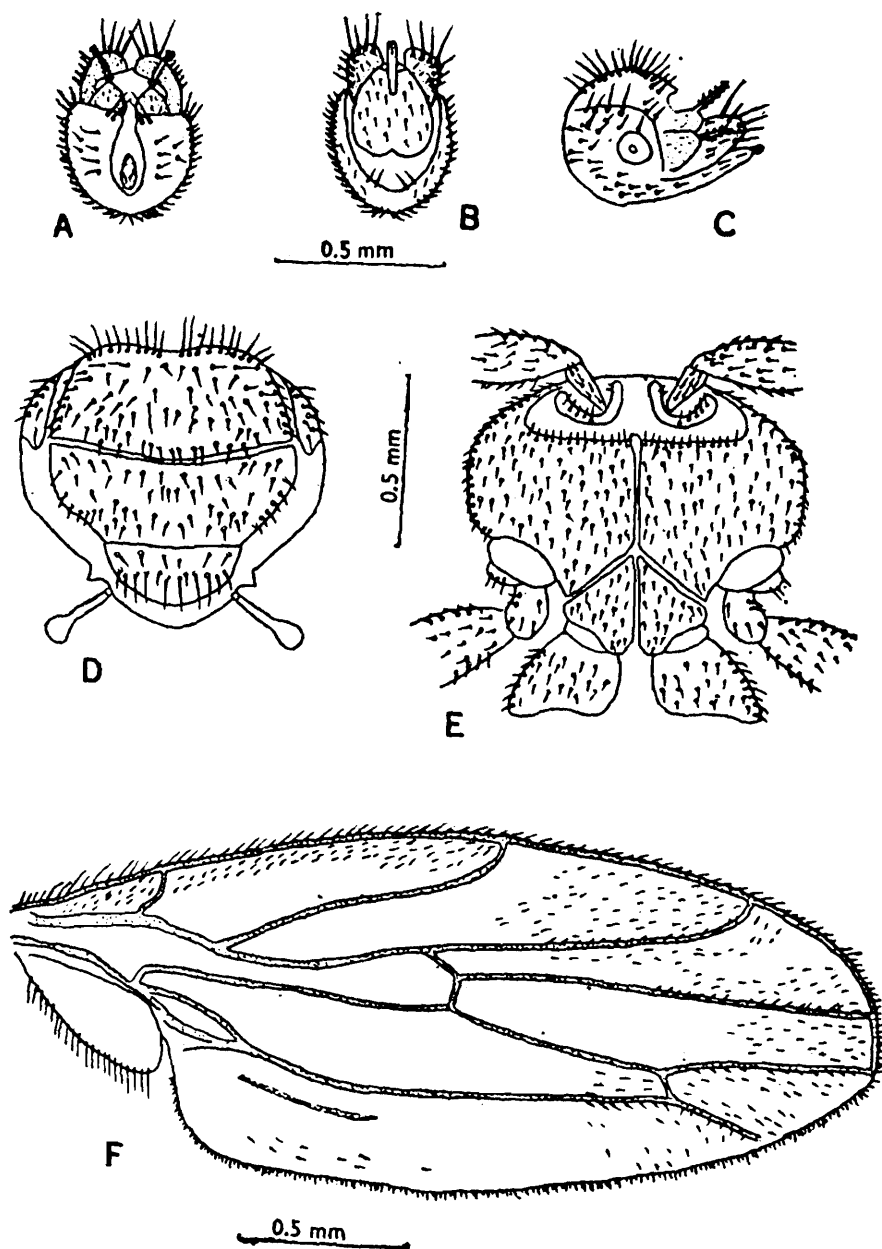


Fig. 6. — *Brachytarsina maai* n. sp. A. dorsal view of head B. ventral view of head C. dorsal view of thorax D. ventral view of thorax E. wing.

Thorax : convex on dorsal and flat on ventral surface, wider than long ; mesonotal suture complete ; prescutum longer than scutum, both covered with short and long setae ; setae on anterior margin of prescutum longer and thicker than on rest of the surface. Thoracic squamae conical. Mesopleurae narrow, covered with short and long setae. Halteres with a round knob and a long pedicel. Scutellum more or less triangular with about 16 short and 4 long setae ; sternopleurae completely separated from pleurotrochantines ; both covered with short setae. Legs strong ; the dorsal surface of femora with long setae and ventrally with very small setae ; tibiae beset with many small setae.

Wings : 2.87 mm ; costal vein thickly setose along its extension ; humeral vein narrow and faint ; cell enclosed by costal and humeral veins bearing smaller setae in three tiers. First longitudinal vein (R1) not parallel to costal vein, distal part of second longitudinal vein (R2+3) strongly bent towards costal margin. Basal part of the vein (R4+5) distinctly shorter than anterior cross vein (r-m). Alula (Al) slender, distal and rounded, posterior margin with 14 long, slender, thin setae. Calypter or wing squama small, with 5 setae.

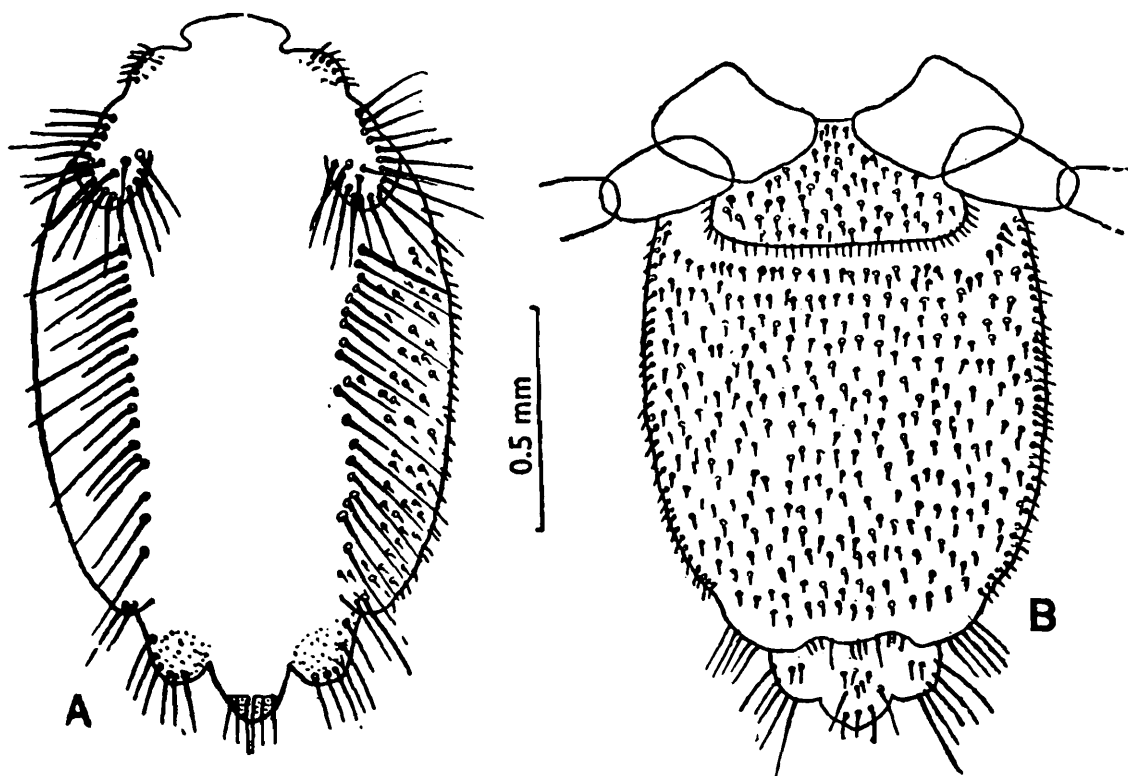


Fig. 7. — *Brachytarsina maai* n. sp. A. dorsal view of abdomen (♀) B. ventral view of abdomen (♀).

Abdomen : without any traces of segmentation. Tergite I with small setae ; tergite II composed of two broad rounded, plates, posteriorly bearing 19-20 long setae at surface. Tergites III-VI fused, membranous, with spine like 19-20 setae, bordering the median bare space. Sclerites of tergite VII with 6 strong setae across its surface. Sternite I-II fused, triangular, surface studded with short setae and a row of somewhat longer ones, along posterior border. Sternites III-VI fused ; sternite VII with long and short setae. Proctiger with 4 long and 5 short setae.

Affinities : In the key to the species *vide* Jobling (1934), it comes near to *allaudi* Falcoz & *caudata* Jobling. According to the key to the Indian species (*vide* Vazirani & Advani, 1976) it comes near to *pygialis*, *sinhai* and *caudata*. However, it very closely resembles *allaudi* in having (i) the basal part of third longitudinal vein much shorter than

anterior cross vein (ii) scutellum being slightly triangular, (iii) general wing venation and (iv) setation of dorsal and ventral surface of thorax. It differs from it (i) in having cell 1R₁, 5R, 2M₂ and basal cell comparatively more setose, (ii) alula with 14 slender setae as against 18 (iii) different shapes of pleurotrochantines and tergite 11 (iv) 5 short setae on ventral surface of proctiger as against 6, (v) different hosts — *Taphozous hildegardeae* Thomas for *B. allaudi* and *Rhinopoma hardwickei hardwickei* Gray and *R. microphyllum microphyllum* (Brünnich) (mixed colony) for this species.

It differs from other species known from India viz., *B. pygialis*, *B. sinhai* and *B. caudata* in relative lengths of basal part of 3rd longitudinal vein and shape of post vertex and other characters as shown in the key.

The single specimen of ♀, under description was collected along with 6 specimens of *B. sinhai* from a mixed colony of *R. microphyllum microphyllum* and *R. hardwickei hardwickei*. But as, *B. sinhai* has also been collected separately from *R. microphyllum*; it may therefore be presumed that this new species very likely infests *R. hardwickei*. The species is named after Dr. T. C. Maa in recognition of his pioneering work on pupiparous flies of the world.

***Brachytarsina joblingi* n. sp.**

(Figs. 8 & 9)

Host : *Taphozous perforatus perforatus* Geoffroy

Holotype : ♀ Z. S. I., Reg. No. 6496/H6, Rajasthan : Dist. Jodhpur, Mandore caves, 9 kms from Jodhpur, 27. ix. 1974 (*Sinha*) (from a jar containing bats in spirit), In National Collections of Zoological Survey of India, Calcutta.

Distribution of parasite : INDIA : Rajasthan (Jodhpur Dist.).

Length : 3.43 mm.

Head : Convex; yellowish brown, not darker than rest of the body; cup shaped in profile, mediovertex membranous: post vertex ellipsoidal with only 2 short setae on either sides; laterovertices with 6-7 setae, and a row of long and short setae on sides. Palps anteriorly rounded, with 4-5 long and rest short setae. Antennal arista long. Eyes prominent occupying antero-lateral positions of head. Post genae with a row of short setae at lateral borders and 4 slightly longer ones medially. Theca with minute setae on surface and swollen on lateral sides. Labella shorter than theca.

Thorax : Round, wider than long. Mesonotal suture complete. Prescutum longer than scutum. Setae on anterior margin of prescutum longer than setae on its surface as well as those on scutum. Scutellum triangular, having 6 long and 14 short setae on its surface. Thoracic squamulae conical. Mesopleurae prominent with medium sized setae assigned in a row. Halteres long with a long pedicel and knob shaped at apex. Flat sternopleurae completely separated from pleuro-trochantines, both uniformly covered with short, delicate setae. Legs strong and stout ; dorsal surface of femora with strong and long setae, ventral surface with very small tibiae beset with very minute setae.

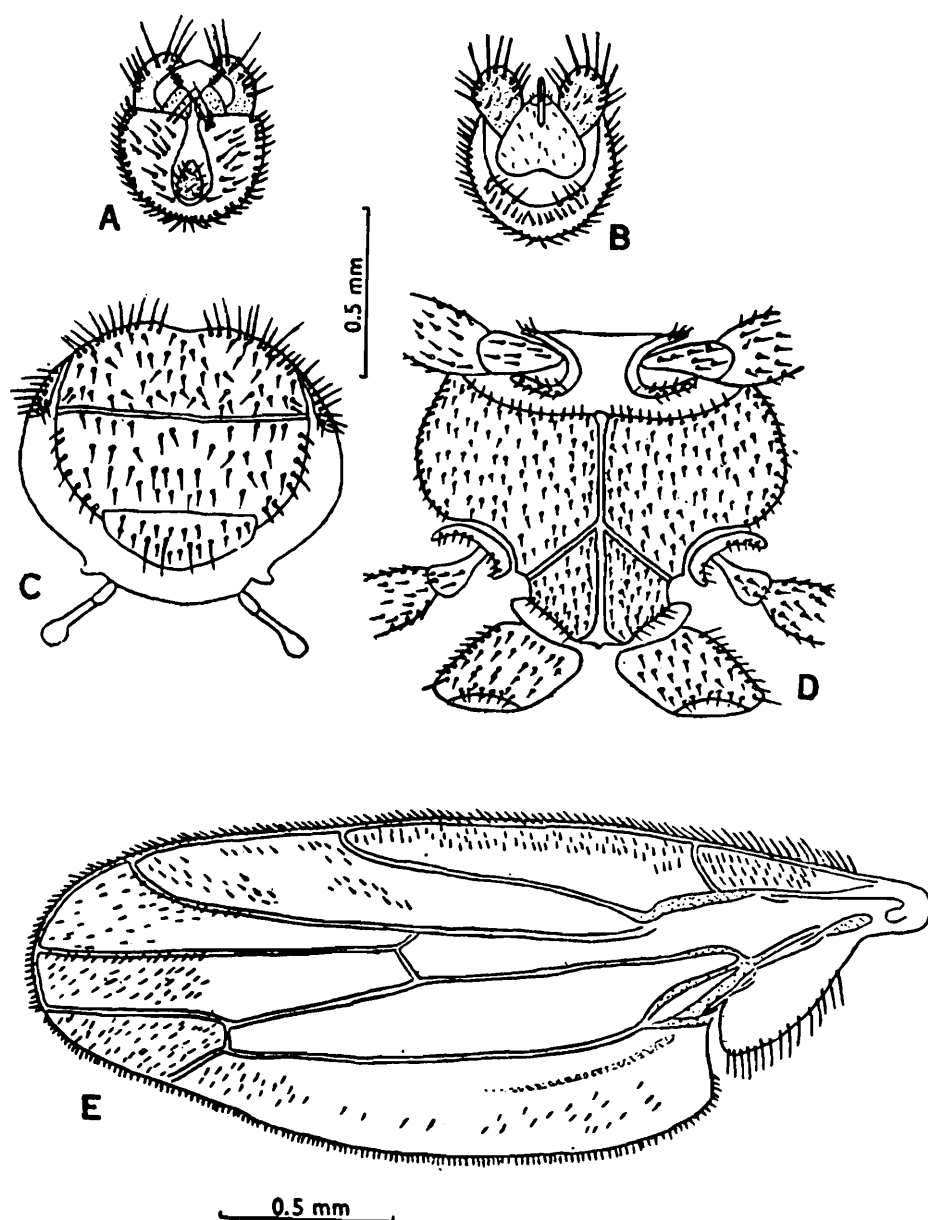


Fig. 8. — *Brachytarsina joblingi* n. sp. A. dorsal view of head B. ventral view of head C. lateral view of head D. dorsal view of thorax E. ventral view of thorax F. wing.

Wings : 2.90 mm long ; costal vein thickly setose, setae strong all along its anterior margin ; humeral vein narrow and feeble ; cell enclosed by costal and humeral vein having 3 rows of small setae. First longitudinal vein (R₁) not parallel to the costal vein ; distal

part of 2nd longitudinal vein ($R2+3$) strongly bent towards costal margin; third ($R4+5$) and fourth ($M1+2$) longitudinal veins parallel near wing margin (apex). Basal part of vein ($R4+5$)

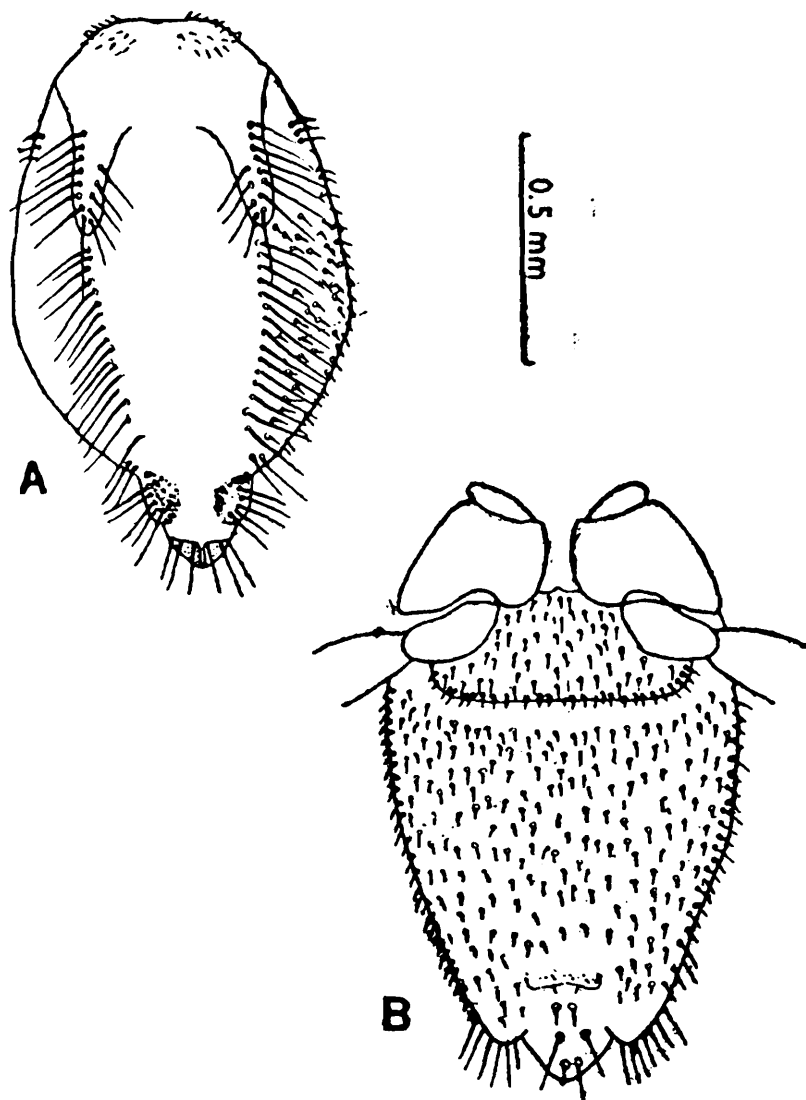


Fig. 9. — *Brachytarsina joblingi* n. sp. A. dorsal view of abdomen (♀) B. ventral view of abdomen (♀).

equal to the anterior cross vein ($r-m$). Alula rounded with about 21 setae. Posterior margin of the wing fringed with delicate setae of different sizes alternating with each other. Calypter with 5 long and 2 short setae.

Affinities : This species closely resembles *caudata* in having (i) the 3rd and the 4th longitudinal veins parallel (ii) basal part of $R3+4$ as long as the anterior cross vein $r-m$ (iii) shape of scutellum and the long setae on it (iv) general wing venation. It may be distinguished from the latter species (i) shape of postvertex which is elliptical and compressed laterally in this species and cordiform in *caudata* (ii) the number of setae on postvertex is 2 as against 4 (iii) the two species differ in size and arrangement of setae on proctiger (iv) body size 3.44 mm as against 2.20 mm (v) shape of theca much broader posteriorly (vi) presence of 6 long setae on scutellum as against 4.

The species is named after Dr. B. Jobling for his contribution towards the study of Oriental Streblidae.

***Brachytarsina theodori* n. sp.**

(Fig. 10)

Host : *Rhinopoma microphyllum microphyllum* (Brünnich)

Holotype : ♂, Z. S. I., Reg. No. 6497/46 Rajasthan : Dist. Nagaur, Maroth vill. (30 kms. from Nagaur), 2.viii.1973 (*Sinha*). In National Collections of Zoological Survey of India, Calcutta.

Distribution of parasite : INDIA : Rajasthan (Nagaur Dist.)

Length : 3.8 mm.

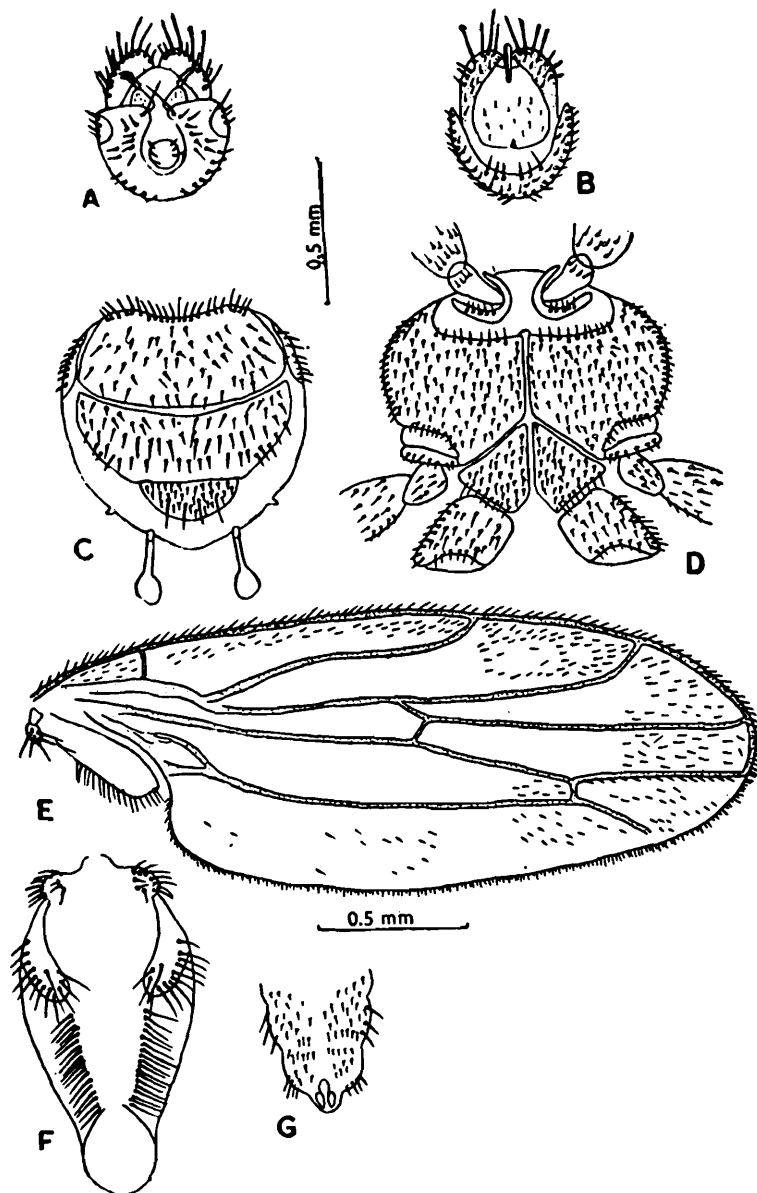


Fig. 10. — *Brachytarsina theodori* n. sp. A. dorsal view of head B. ventral view of head C. dorsal view of thorax D. ventral view of thorax E. wing F. dorsal view of abdomen (♂) G. ventral view of tip of abdomen (♂).

Head: Cup shaped, with rounded lateral margins ; dorsal and ventral surfaces convex. Eyes prominent on anterolateral side of head. Mediovertex membranous. Postvertex rounded, median area almost bare, with 6 setae of variable size, arranged in a group on each lateral side. Laterovertices covered with 7-8 setae on surface and 10 setae at sides. Ventral surface-post genae with a row of short setae on outer border and 6 slightly longer setae on middle of inner border. Theca, leaf shaped with few small setae, lateral sides gently curving. Labella shorter than theca.

Thorax: round, convex. Mesonotal suture complete. Prescutum covered with medium sized setae and a row of longer setae along anterior border. Scutum covered with short and medium sized setae on lateral and anterior sides, and with longer setae on the middle. Scutellum more or less triangular ; posterior margin rounded, with 31 small and 4 long setae arranged in a median longitudinal row. Thoracic squamae conical. Mesopleurae narrow with 8 long setae at lateral margin. Halteres with a round knob and a long cylindrical pedicel. Ventral surface flat, sternopleurae completely separated from pleurotrochantines ; both covered with short setae. A row of slightly longer setae, present at the round lateral margin of sternopleurae. Legs stout ; the dorsal surface of femora with long setae and ventral surface with small setae ; tibiae beset with many small setae.

Wings: 2.76 mm long ; costal vein thickly setose along its margin ; humeral vein faint ; cell enclosed by humeral and costal veins, with small setae ; first longitudinal vein (R1) not parallel to costal vein ; distal part of second longitudinal vein (R 2+3) strongly bent towards costal margin ; basal part of vein (R 4+5) slightly longer than anterior cross vein ; 3rd and 4th longitudinal veins viz. R 4+5 and M 1+2 diverging near wing margin. Alula slender, distally rounded ; posterior margin with 18 delicate setae arranged in a row. Calypterons with 5 strong setae.

Abdomen (♂) : Tergite I small ; tergite II composed of 2 broad plates, posteriorly round, bearing 12-13 long setae at surface and sides ; tergite III-VI fused, membranous, with spine like 20 setae bordering the median bare space. Sternite I+II triangular, surface uniformly covered with short setae. Sternite III-VI fused. Anal sternites composed of 2 oval plates, surrounded by an area of small setae.

Affinities : The new species closely resembles the species *Brachytarsina taji* Hiregaudar & Bal in having (i) 3rd and 4th longitudinal veins diverging near wing margin, (ii) the basal part of 3rd longitudinal vein parallel near wing margin. But this species can be easily distinguished

from *taji* in having (i) basal part of 3rd longitudinal vein slightly longer or equal to the anterior cross vein as against much longer (ii) the lateral sides of theca gently sloping as against swollen (iii) post vertex having 12 short setae as against 6-8, (iv) post genae and the cell IR of the wing less setose.

The species is named after Dr. O. Theodor for his pioneering work on bat flies of the world.

***Brachytarsina sinhai* Vazirani & Advani**

Brachytarsina sinhai, Vazirani & Advani, 1976 : 453-457 (T. L.—Rajasthan : Sawai Madhopur Dist. Malarana Dungar, Z. S. I.).

Host : *Rhinopoma microphyllum microphyllum* (Brünnich) for all specimens.

Material examined : Gujarat : 2 ♂♂, 5 ♀♀, Z.S.I., DRS, Reg. No. Ent. 1231/A ; Dist. Baroda, Bhadra Kachheri, Pani Gate, 13. ix. 1976 (*Sinha & Advani*), Rajasthan : 3 ♂♂ 9 ♀♀, Z.S.I. DRS, Reg. No. Ent. 1232/A ; Dist. Jhalawar, Gagron Ka Kila (15 kms from Jhalawar), 2. xii. 1975, 2 ♂♂ 6 ♀♀, Z. S. I., DRS, Reg. No. Ent. 1230/A ; Dist. Boondi, old fort, 6. xii. 1975 : 3 ♀♀, Z. S. I., DRS, Reg. No. Ent. 1235/A, Dist. Dungarpur, Ghati Ka Darwaza, 2. xii. 1975 ; 2 ♀♀, Dist. Jodhpur, Bhimbharak (15 kms. north of Jodhpur), 7. vi. 1975, (*Sinha & Advani*) ; 2 ♀♀, Z.S.I., DRS, Reg. No. Ent. 1229/A ; Mandore (10 kms from Jodhpur), 10. x. 1975 (*Anil Wason*) ; 2 ♂♂ 4 ♀♀, Z. S. I., DRS, Reg. No. Ent. 1226/A ; Surpura (10 kms from Jodhpur), 28. vii. 1976 (*Rathore & Advani*).

Distribution of parasite : INDIA : Rajasthan (Kota, Sawai Madhopur, Dungarpur, Bundi, Jhalawar, Jodhpur) ; Gujarat (Baroda).

Remarks : This species has been recently described by the authors (Vazirani and Advani, 1976) from Rajasthan. It now appears to be more widely distributed in Rajasthan and Gujarat.

Genus *Raymondia* Frauenfeld

Raymondia Frauenfeld, 1855 : 320 ; Jobling, 1930 : 283-301, 1951 ; 228 ; Theodor, 1968 : 326.

Type species : *Raymondia huberi* Frauenfeld, 1855, Logotype, *R. huberi* FrFld, designated by Speiser, 1900.

KEY TO SUBGENERA OF *RAYMONDIA* KNOWN FROM INDIA

Setae on sternal plate of thorax leaving two
longitudinal stripes bare *Brachyotheca* Maa

Setae on sternal plate of thorax uniformly distributed, except on the anterior triangular processes in some species, but not leaving any bare longitudinal stripes ... *s. str.*

Subgenus **Brachyotheca** Maa

Brachyotheca, Maa, 1962 : 436 ; Theodor, 1968b : 332.

Type species : *Raymondia lobulata* Speiser, 1900, by original designation.

Raymondia (Brachyotheca) lobulata Speiser

(Fig.11)

Raymondia lobulata Speiser, 1900 : 31-70 ; Jobling, 1930 : 288-290.

Raymondia kallari Schiner, 1869 *nec* Frauanfield 1855.

Host : *Megaderma lyra lyra* Geoffroy for all the specimens.

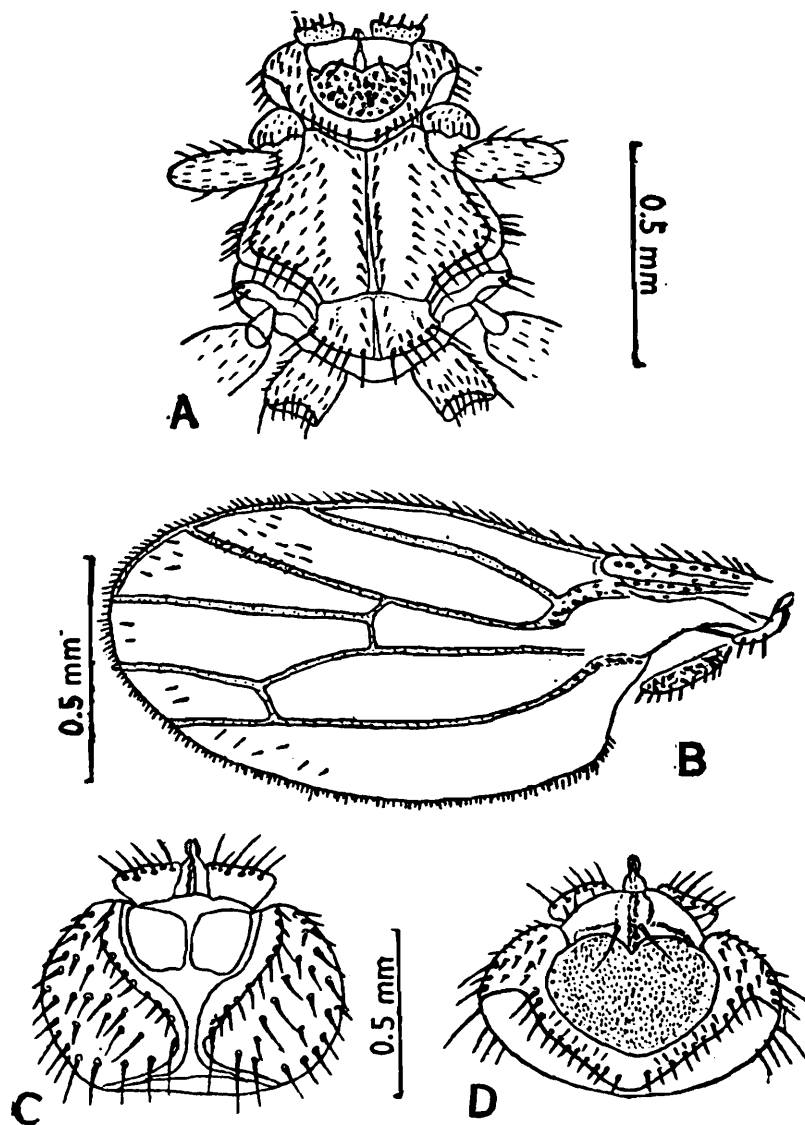


Fig. 11. — *Raymondia lobulata* Speiser A. ventral view of head and thorax B. wing C. dorsal view of head D. ventral view of head.

Material examined : Gujarat : 212 exs, Z.S.I., DRS, Reg. No. Ent. 1236/A ; Dist. Surat, Sultanabad (15 kms from Surat), 24. ix. 1976. Rajasthan : 22 exs, Z.S.I., DRS, Reg. No. Ent. 1234/A ; Dist. Dungarpur, old fort, 23. ix. 1975 ; 61 exs, Z.S.I., DRS, Reg. No. Ent. 1237/A ; Banswara, Shervilas, 27. xi. 1975 ; 11 exs, Z.S.I., DRS, Reg. No. Ent. 1238/A ; Dist. Jhalawar, Jhalarapatan Ka 'Kila (12 kms from Jhalawar), i.xii. 1975 (*Sinha & Advani*).

Distribution of parasite : INDIA : Tamil Nadu, Punjab, Rajasthan (Kota, Sawai Madhopur, Jhunjhunu, Jhalawar, Banswara, Dungarpur), Gujarat (Surat).

The following characters (measurements) may be added to the description given by Jobling (1930).

Female : Length 1.9-2.45 mm.

Wings : 1.62 mm long. Cell 3R with setae restricted at wing border, cell 5R with 2 setae at margin, cell 2 M₂ also with 2 setae, cell Cu₁ setosed with 7-8 or rarely 9 minutes setae at wing margin. Alula well developed with 9-11 setae. 5th longitudinal vein bent to its basal part.

Subfamily ASCODIPTERINAE Monticelli

Ascodipterinae Monticelli, 1898 : 255 ; Theodor, 1968b : 357.

In view of the addition of a new genus, described on the basis of a different pattern of wing venation, the subfamily is now redefined as under.

Sexes markedly different. Female (on emergence) — Sclerites of head markedly reduced, connected by wide membranous areas. Eyes and palps absent. Genae triangular. Laterovertices triangular. Small occipital and frontal sclerites present. Theca of labium very large, truncate conical, strongly sclerotised, with 14 rows of strong teeth on eversible arcs of the labellum. Only 3 pairs of abdominal spiracles concentrated on the apex of abdomen. Segmentation of abdomen obliterated. Legs long and slender, basitarsus elongate. Wings with 3 or 4 veins, R 2+3 reduced or absent or well developed. The female sheds legs and wings and then burrows in the skin of the bat. It becomes flask-shaped by growth of the first abdominal segment which envelopes head and thorax.

Male : With small rounded head and small, transversely elliptical theca of labium, free living, of ordinary streblid habitus. Eyes absent. Palps present, one segmented, tapering. Wings and legs as in female. Abdomen segmented, but with only 3 pairs of spiracles in last 2

abdominal segments. Genitalia : aedeagus long, with a connective membrane without spines and with a long apodeme ; parameres symmetrical, with a long apodeme ; flattened one-segmented claspers with several short hooks at apex.

KEY TO GENERA OF SUBFAMILY ASCODIPTERINAE

Wings with 3 well sclerotised longitudinal veins, R 2+3 absent or reduced, M 1+2 and anal vein indicated by weak folds, cross veins absent. ... *Ascodipteron* Adensamer

Wings with 4 well developed sclerotised longitudinal veins, R 2+3, M 1+2 well developed, anal vein indicated by weak folds but 2 cross veins present. ... *Paraascodipteron* n. gen.

Genus *Ascodipteron* Adensamer

Ascodipteron Adensamer, 1896 : 400 ; Theodor, 1968 : 357.

Type species : *Ascodipteron phyllorhinae* Adensamer 1896 by original designation.

KEY TO THE SPECIES OF *ASCODIPTERON* KNOWN FROM INDIA

(Encysted females)

Larger species (4.0-5.0 mm). Gena broad, broadly rounded anteriorly with 40-55 pigmented pegs. Theca in dorsal view markedly narrower anteriorly, truncate triangular, with straight sides, 0.47-0.55 mm long, 0.4-0.45 mm wide posteriorly. ... *namrui* Maa

Smaller species (3.5-4.0 mm). Gena narrow, triangular, with only 15-28 pigmented pegs. Theca broader anteriorly, sides slightly curved, 0.4-0.48 mm long, 0.3-0.32 mm wide posteriorly ... *rhinopomatos* Jobling

Ascodipteron namrui Maa

(Fig. 12)

Ascodipteron namrui Maa, 1965a ; 311 (T. L.-Egypt-host *R. microphyllum* in Field Museum of Natural History, Chicago). Theodor, 1968b : 360.

Host : *Rhinopoma microphyllum microphyllum* (Brünnich)

Material examined : Gujarat : 2 ex. encysted ♀ inserted in tissues of shoulder region of bat, Z. S. I., DRS, Reg. No. Ent. 1307/A ; Dist. Baroda : Bhadra Kachheri, Pani Gate, Baroda, 13. ix 1976 (*Sinha & Advani*). Rajasthan : 1 ♀, Z. S. I., DRS, Reg. No. Ent. 1308/A ; Dist.

Jodhpur, Jodhpur, 1 ♀, Z. S. I., DRS, Reg. No. Ent. 1309/A ; 28. vii. 1976, Surpura (10 kms east of Jodhpur) (*Rathore & Advani*).

Distribution of parasite : INDIA : Rajasthan (Jodhpur), Gujarat (Baroda) ; EGYPT ; ISRAEL.

Male and female as described by Maa (*l. c.*) and Theodor (*l. c.*). Some measurements etc. of the above encysted females, are given below for one example.

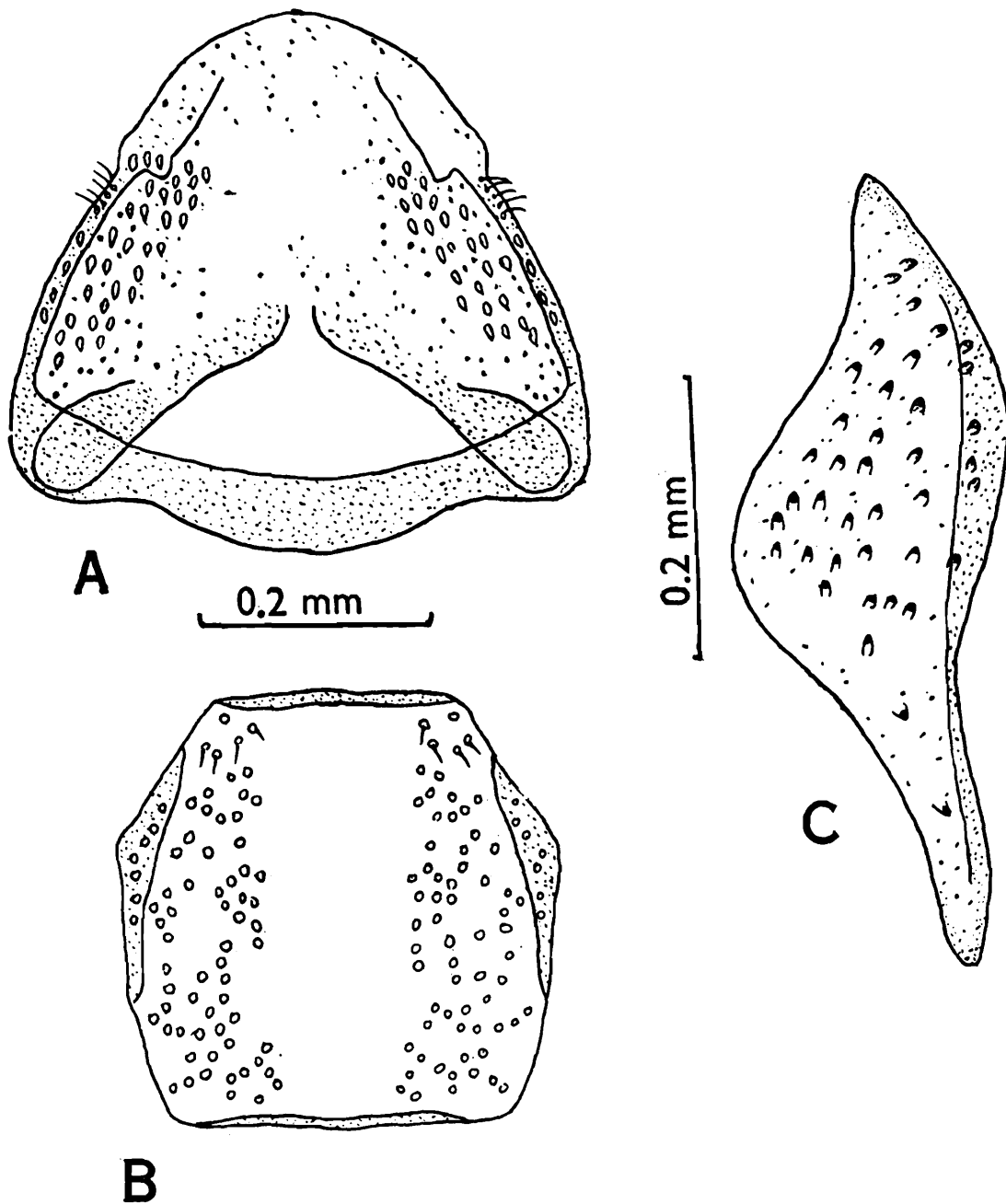


Fig. 12. — *Ascodipteron namrui* Maa Encysted ♀ A. dorsal view of theca B. mesonotum C. gena.

Length of encysted female, 4.30 mm. The encysted female capsule cream coloured, with 4 rows of fine brownish spines transversely but irregularly arranged at abdominal apex. Theca 0.445 mm long, 0.42 mm wide posteriorly. Gena broad, broadly rounded anteriorly with 39 pigmented pegs which extend to anterior portion of narrow ventral part and also to dorsal triangular corner.

Remarks : This is the first record of this species from India which is hitherto known from Egypt only. But in view of the wide range of the host species *R. microphyllum* it is not surprising, though interesting.

***Ascodipteron rhinopomatos* Jobling**

(Fig. 13)

Ascodipteron rhinopomatos Jobling, 1952 : 126 (T. L.—Egypt, Israel ; in Field Museum of Natural History, Chicago) ; Theodor, 1968b : 360.

Host : *Rhinopoma hardwickei hardwickei* Gray

Material examined : Rajasthan : Dist. Jodhpur, 1 ex ♀ encysted, deeply burried in tissues of lower fore arm region, Z. S. I., DRS, Reg. No. Ent. 1310/A, Surpura (10 kms east of Jodhpur) 28. vii. 1976, Jodhpur (*Rathore & Advani*).

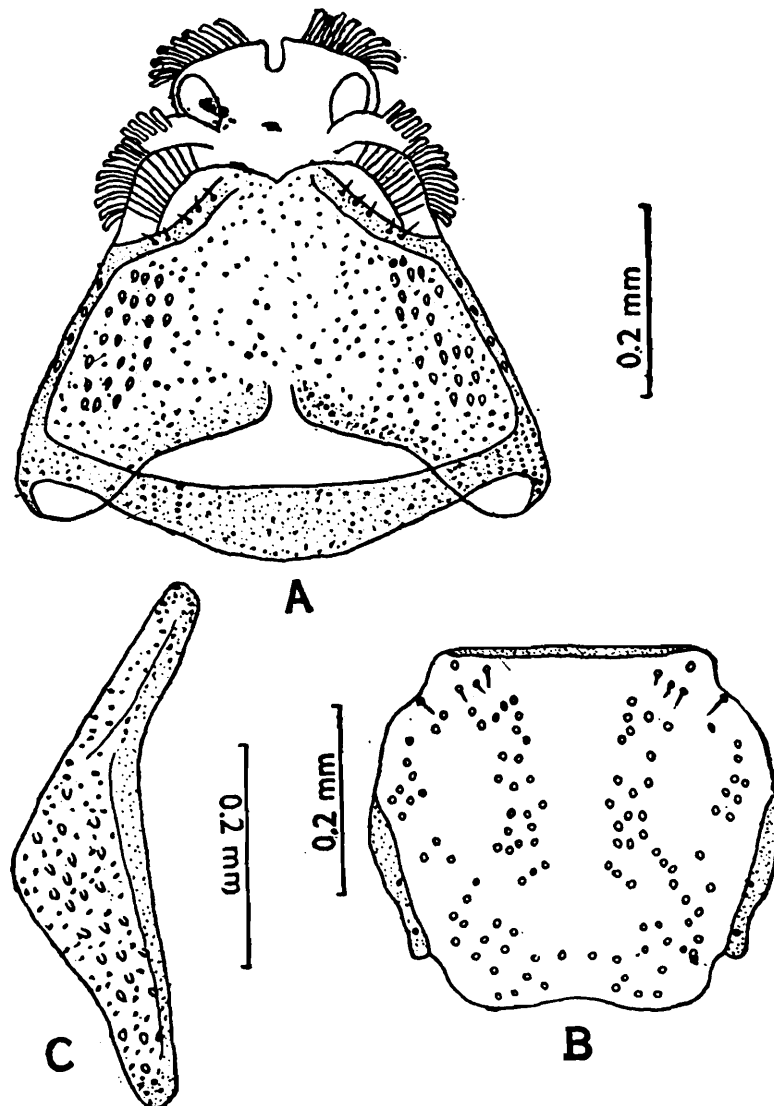


Fig. 13. — *Ascodipteron rhinopomatos* Jobling Encysted ♀ A. dorsal view of theca B. mesonotum C. gena.

Distribution of parasite : INDIA : Rajasthan (Jodhpur) ; AFGHANISTAN ; EGYPT ; ISRAEL ; SOMALI LAND.

Male and female as described by Jobling (*l.c.*) and Theodor (*l.c.*). Some measurements etc. for the above encysted female are given below.

Length : 4.10 mm, cream coloured, with 3 rows of fine brown spines, transversely, but irregularly arranged at abdominal apex. Theca 0.445 mm long, 0.50 mm wide posteriorly. Genae slightly triangular with 25 unpigmented small pegs, which extends to dorsal corner but not to the tubular narrow ventral part. Mesonotum as long as wide, with 4 delicate setae at each upper anterior corners and with about 60 circular depressions in each lateral half ; 5-6 rows of pegs on dorsal surface of theca present.

Remarks : This is the first record of the species from India, which is known only from Africa (Egypt) and Israel. Further additions to its occurrence are expected owing to wide distribution of the host species.

Bio-ecology : The host species *R. hardwickei* was roosting in a mixed colony along with *R. microphyllum*, which was also found infested with a closely related parasite species *namrui*. This indicates that there seems to be a very high degree of host specificity in this genus/subfamily.

Paraascodipteron n. gen.

Type species : *Paraascodipteron scotophilus* n. sp.

Diagnosis : Subfamily characters as above. Wing with 4 well sclerotized longitudinal veins. R2+3 well developed, M 1+2 indicated by moderate folds but anal vein weak ; 2 cross veins present, one of them rather weakly sclerotized.

Affinities : It is closely related to the only other genus *Ascodipteron* of the nominotypical subfamily but differs from it as shown in the key. Theodor (1968b) has indicated that Prof. Maa has several undescribed species, one of which perhaps needs a new genus. The authors are unaware of any publication of a genus similar to *Paraascodipteron* by Prof. Maa and hence described it as new to accomodate the new species, *P. scotophilus* described here under.

Paraascodipteron scotophilus n. sp.

(Figs. 14 & 15)

Host : *Scotophilus heathi heathi* Horsefield
(Captured in a mist net)

Holotype : ♂, Z.S.I., Reg. No. 6499/H6, Rajasthan : Jodhpur, Lal Maidan Paota, 2.xii.1973 (*Sinha*) in the National Collections of Zoological Survey of India, Calcutta.

Distribution of parasite : INDIA : Rajasthan (Jodhpur).

Length : 3.26 mm.

Head : Quadrangular dorsally, as broad as mesonotum. Eyes absent. Theca of labium very large, highly sclerotized with a row of setae distally. Antenna with an arista. Genae with 4 spines in posterior half, arranged in a row. Vertex rounded with a series of long setae, of which one is very long.

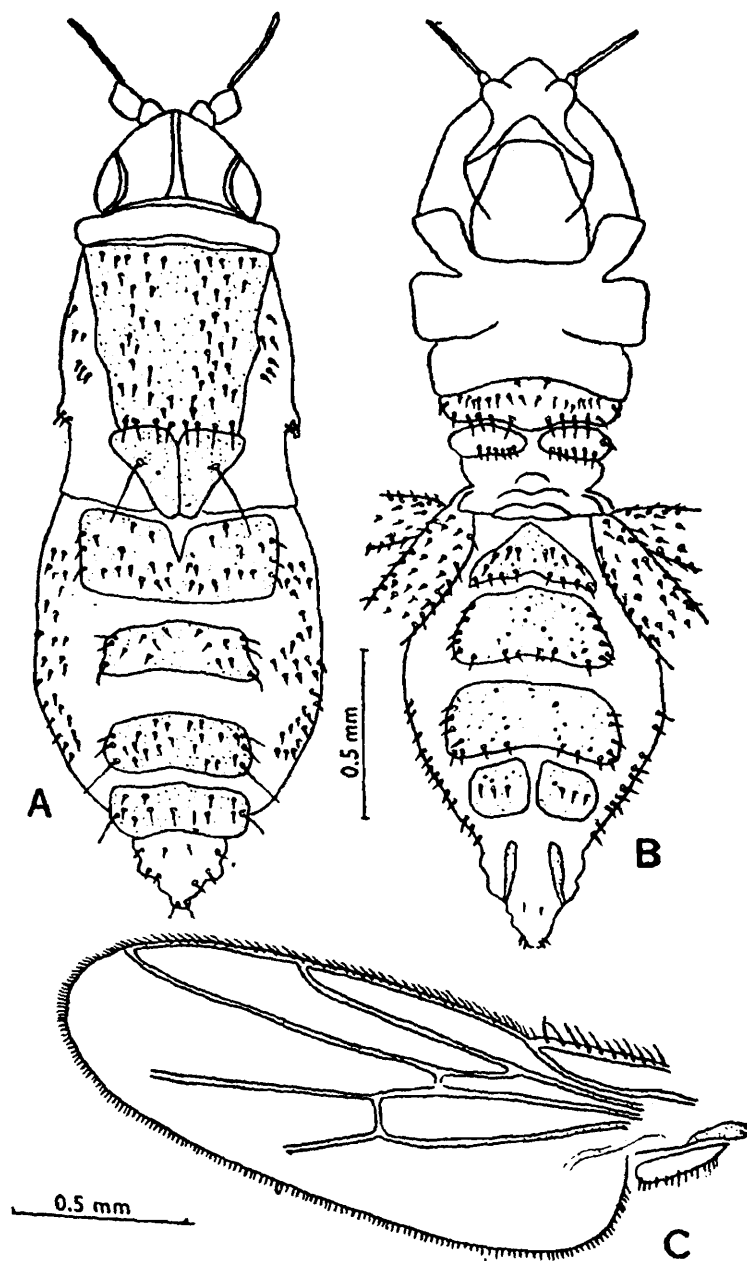


Fig. 14. — *Paraascodipteron scotophilus* n. gen. & n. sp. (♂) A. dorsal view B. ventral view C. wing.

Thorax : Longer than broad 34×24 . Prescutum narrow bare, separated from mesonotum by a suture. Mesonotum broader anteriorly, gradually narrowing posteriorly, covered with short setae, posterior fringe of 8 longer setae. Membranous area on both sides of mesonotum with small setae and a very long setae at the level of posterior margin

of mesonotum. Scutellum triangular, composed of two lateral sclerites fused medially ; with round posterior margin ; each sclerite with a long seta rising from anterior half.

Legs : Long and slender, covered with sharp spines, all femora of equal length, fore femora shorter than fore tibia. Basitarsus much longer than other tarsi.

Wings : With 4 longitudinal veins ; costal vein with setae longer than those on remaining anterior margin of wing ; humeral vein curved ; first longitudinal vein (R1) straight, meeting gently with wing margin ; second longitudinal vein (R 2+3) slightly curved ; 3rd and 4th longitudinal veins (M 1+2 and M 4+Cu1) not reaching wing margin. The cross veins present, the first cross vein weakly sclerotized, but second well developed ; anal vein indicated by weak fold.

Abdomen : Cylindrical, tapering to apex. Tergites clearly demarcated and interrupted by bare membranes ; lateral sides membranous, covered with short and medium setae. Tergite I excavated in the middle of anterior margin, the excavation extending to middle of the tergite, sparsely covered with small setae ; sides with slightly longer setae. Tergite II rectangular, with slightly convex anterior margin and slightly concave posterior margin ; sparsely covered with small setae ; lateral margins with 2 small and 1 long setae. Tergite III similar in shape to tergite I, slightly bigger, with small setae on surface ; lateral margins with 2 medium and one very long setae. Tergite IV somewhat broader than preceding tergites, with 5 setae on each lateral half. Anal or post abdominal tergite conical, with sinuate lateral margins ; sparsely covered with small setae.

Sternite I triangular, anterior margin convex sinuate ; and posterior margin concave, covered with small setae also bearing a row of setae at posterior margin. Sternite II and III broader, without any setae except on lateral and posterior margins. Sternite IV in the form of 2 square shaped sclerites ; each with 3 short setae in the middle ; anal sternite conical, with 2 small setae on each side. Pleural area membranous. At present this species is the lone member of the genus, and only related in broader terms to *Ascodipteron*, the other member of the subfamily.

Affinities : As discussed above for the genus.

Family NYCTERIBIIDAE Samouelle

General account—About 24 species of these flies are known from India. Theodor (1967) considers the family to be predominantly Old World and perhaps centred in the Malaysian subregion of the Oriental region. As stated above the same author considers the family to have

evolved earlier than Streblidae or Hippobosidae and its remarkably wide distribution of a number of its species, is considered as good evidence in support of such a hypothesis. Further the group is well adapted to the colder regions also e.g., it is collected at altitudes of 1000 to 2660 meters. The host specificity is only confined at the subfamily level. The parasites attack different hosts in different regions of the globe,

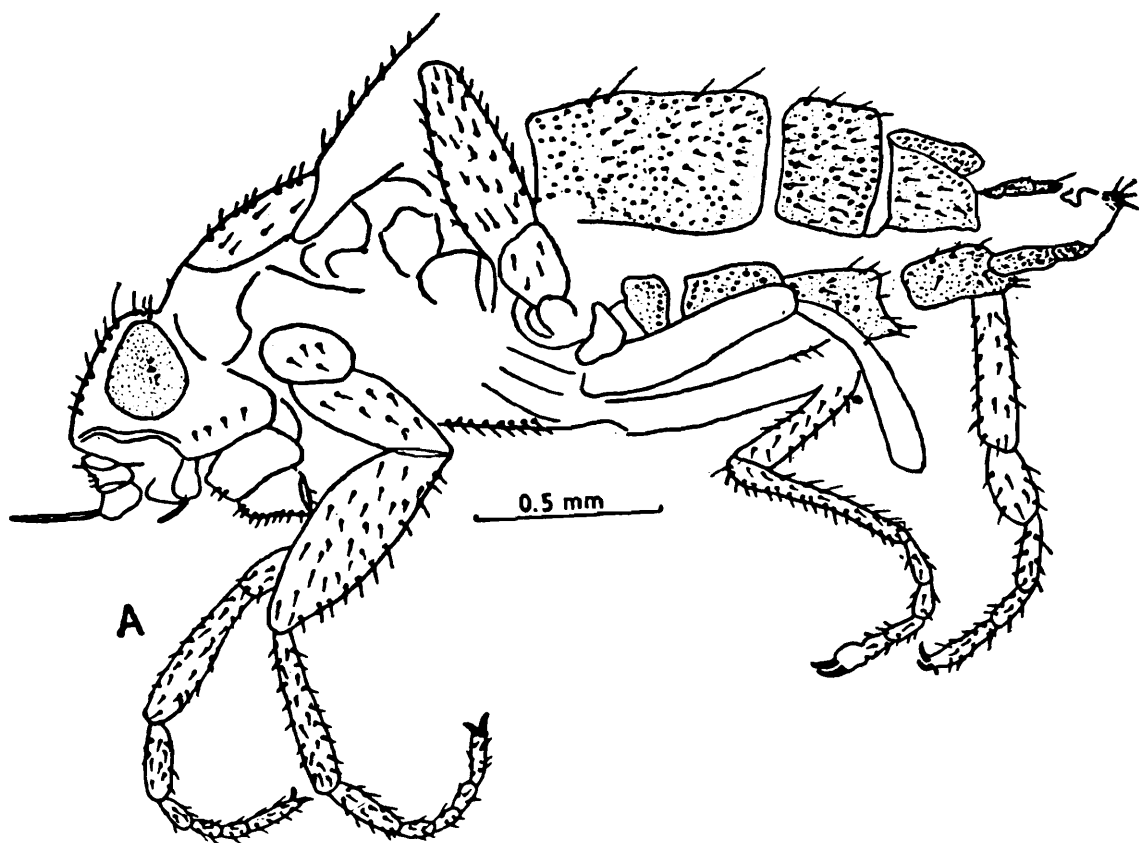


Fig. 15. — *Paraascodipteron scotophilus* n. gen. & n. sp. (♂) A. lateral view.

even though different subfamilies occur on different groups of bats — Nycteribiinae infest insectivorous bats (Microchiroptera) and Cyclopodinae occur on larger fruit-eating bats or flying foxes (Megachiroptera). A host species may be infested with more than one species of nycteribiid parasites and conversely one species of nycteribiid parasite may occur on more than one host species which are generally congeneric or at least belonging to the same family though there may be rare exceptions which need to be reinvestigated.

As pointed out by Askew (1971, p. 71), the parasites avoid the head region of the host and prefer to attach themselves to the neck or beneath the wings or both. The authors observed that in Megachiropteran bats, viz., *Pteropus giganteus giganteus* the flies are mainly found in abundance under the wings and thick fur of neck and thorax region, but in other fruit bats like *Cynopterus sphinx sphinx* and *Rousettus leschenaulti* which do not have similar thick fur on thorax and neck region, the flies are mainly found beneath the wings and abdomen. In the microchiroptean bats, the bat *Scotophilus heathi heathi* which is always found

to be heavily infested, there is no fixed region of body for infestation. The flies may be seen beneath and above the wings, dorsum and venter of the thorax, abdomen or neck region. *Taphozus longimanus longimanus*, is very poorly infested, and therefore the region of infestation could not be localised. The females leave the host only to deposit their larvae in some dry place in the roosting area while the males stagger from host to host in search of mates.

There are no observations on the life history of these flies in India, but elsewhere *Cyclopodia greeffi* is reported to lay the larva on a substratum, press it down with its own thorax to fix it properly. The rate of reproduction is higher in nycteribiids than in the other Pupipara, a single individual produces larvae at intervals of 2-6 days, probably through most of the year.

KEY TO SUBFAMILIES OF NYCTERIBIIDAE KNOWN FROM INDIA

Coxae 1 in profile at least 2.5 times as long as wide ; thoracic and abdominal ctenidia always well developed, with coarse blunt teeth. Parasitic on Megachiroptera. ... *Cyclopodinae*

Coxae 1 in profile at most 2 times as long as wide, thoracic and abdominal ctenidia occasionally absent, with slender pointed teeth. Parasitic on Microchiroptera. ... *Nycteribiinae*

Subfamily—CYCLOPODINAE Maa

Cyclopodinae—Maa, 1965b : 378.

KEY TO THE GENERA OF SUBFAMILY CYCLOPODINAE KNOWN FROM INDIA

1. Eyes single, unpigmented. ... *Eucampsipoda* Kolenati
 Eyes with two ocelli, pigmented. ... 2
2. Tibiae with 2 rings. Head moderately compressed laterally. Palps slender, tapering with a long terminal seta. Halteres' grooves open. Abdominal tergite V in male as long as or longer than tergite IV. No rows of specialized spines at the hind margin of sternite V in male. Anal sclerite present or absent in female. ... *Leptocyclopodia* Theodor
- Tibiae with 3 rings. Head flattened dorso-ventrally. Palps laterally compressed, broad with short terminal seta. Halteres' grooves either open or partly or completely closed by a covering flap. Abdominal tergites V and VI in male, always much shorter than preceeding tergites. Anal sclerite present in female. ... *Cyclopodia* Kolenati

Genus *Cyclopodia* Kolenati

Cyclopodia Kolenati, 1863 : 82 ; Theodor, 1959 : 242-308.

Type species : *Nycteribia sykesi* Westwood, 1834, designated by Musgrave (1925) as Logotype.

This genus is represented in India by a single species.

Cyclopodia sykesii (Westwood)

(Figs. 16 & 17)

Nycteribia sykesii Westwood, 1834 : 137 ; ♀ (type loc : 'India Orientali').

Eucampsipoda sykesii : Kolenati, 1857 : 62.

Cyclopodia sykesii : Kolenati, 1863 : 82 ; Hiregaudar & Bal, 1956 : 47 ; Maa, 1968 : 13.

Cyclopodia sykesi : Speiser, 1901 : 49 ; Mukerji & Das Gupta, 1954 : 1-25.

Cyclopodia (*Cyclopodia*) *sykesii* : Theodor, 1959 : 249, 300, 303 ; Maa, 1967b : 428 ; Theodor, 1967 : 438, 441, 444, map 4, fig. 12-17, 21, 57, 781, 784, 793, 795, 800.

Cyclopodia (*Cyclopodia*) *sykesi* : Scott, 1925 : 379.

Nycteribia hopei Westwood, 1834 : 137, ♂ (type loc : India Orientali) ; Walker, 1849 : 1148.

Cyclopodia hopei : Kolenati, 1863 : 83 ; Maxwell-Leofroy & Hewitt, 1909 : 657.

Cyclopodia kalyania Choudhuri & Mitra, 1965 : 63, figs. 1-8 ♂ ♀ (type loc : W. Bengal, India, Haringhata) ; Syn. vide Maa, 1968.

Host : *Pteropus giganteus giganteus* (Brünnich) for all specimens.

Material examined : Rajasthan : 1 ♂ 1 ♀, Z.S.I., DRS, Reg. No. Ent. 1242/A ; Dungarpur, Govt. School campus, 13.iii.1964 (*Bhargava*) ; 14 ♂ ♂ 5 ♀ ♀, Z.S.I., DRS, Reg. No. Ent. 1239/A ; Dungarpur, 25.xi.1975 ; 5 ♂ ♂ 4 ♀ ♀, Z.S.I., DRS, Reg. No. Ent. 1241/A ; Banswara, 29.xi.1975 ; 2 ♂ ♂ 1 ♀, Z.S.I., DRS, Reg. No. Ent. 1240/A ; Jhalawar, 5.xii.1975 (*Sinha & Advani*). Gujarat : 1 ♂ 1 ♀, Z.S.I., DRS, Reg. No. Ent. 1245/A ; Dist. Himmatnagar, Kankrol vill. (7 kms SE from Himmatnagar), 7.xi. 1964 (*Bhargava*), 16 ♂ ♂ 16 ♀ ♀, Z.S.I., DRS, Reg. No. Ent. 1247/A ; Baroda, 9.ix.1976 ; 1 ♂ 1 ♀, Z.S.I., DRS, Reg. No. Ent. 1246/A Dist. Surat, Sultanabad (15 kms east of Surat), 23.ix.1976 ; Dadra and Nagar Haveli : 2 ♂ ♂ 2 ♀ ♀, Z.S.I., DRS, Reg. No. Ent. 1243/A ; Silvassa, 6.x.1976 (*Sinha & Advani*). Maharashtra : 2 ♂ ♂, 1 ♀, Z.S.I., DRS, Reg. No. Ent. 1244/A ; Dist. Poona, Parvati temple, 9.vi.1975 (*Trivedi*).

Host range : **Pteropus giganteus*, **P. arial*, **P. intermedius* (the latter two may be considered as subspecies of *giganteus*), *Cynopterus sphinx*, *Pipistrellus ceylonicus*, *Tupaia* sp.

Distribution of parasite : INDIA : Kerala, Karnataka, Tamil Nadu, Maharashtra, Dadra & Nagar Haveli, Gujarat, Rajasthan, Uttar

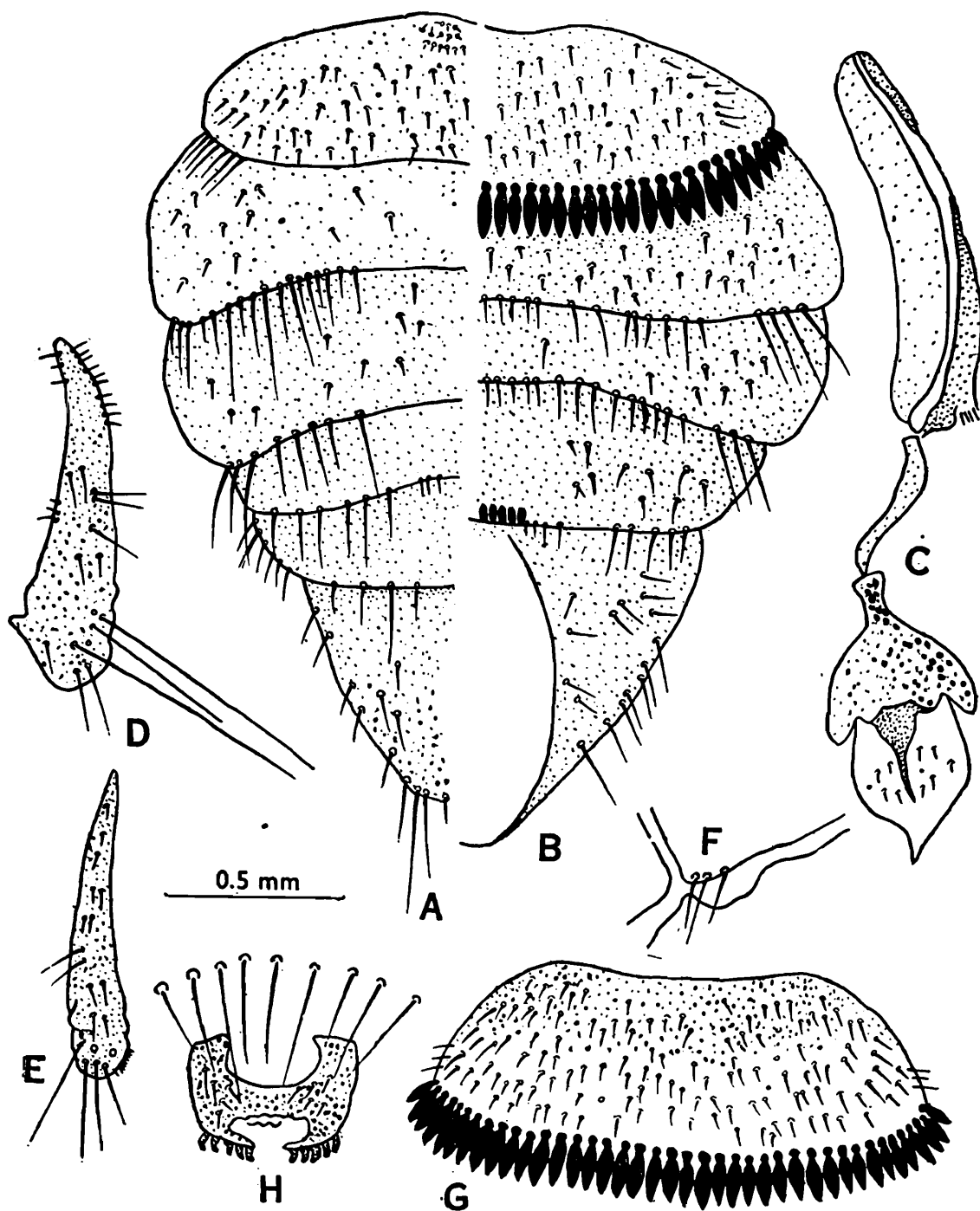


Fig. 16. — *Cyclopodia sykesii* (Westwood) ♂ A. dorsal view of abdomen B. ventral view of abdomen C. genitalia D-E. claspers F. notopleural plate G. sternite (I+II) H. genital plate.

Pradesh, Bihar, Assam, West Bengal, Orissa, Maldives ; PAKISTAN : Lahore ; SRI LANKA ; BURMA. The range is identical with that of *Pteropus giganteus*.

Remarks : This is a very well known species and the only species of the genus *Cyclopodia* occurring in India. It is confined to the

* True breeding hosts are marked with an asterik. Unpublished records which are underlined have been communicated by Prof. T C. Maa.

Oriental Region, and the bat *Pteropus giganteus* is its main host (Maa, 1965, 1968). Choudhuri and Mitra (1965) reported this parasite from Nadia (W. Bengal) as a new species *Cyclopodia kalyania* on *Pipistrellus ceylonicus* Kelaart, which was subsequently considered conspecific with the species under description by Maa (1968) who has shown that the new species has been based on variable characters. Further Maa (*l.c.*) states 'Even if *kalyania* could stand as a distinct species, it clearly belongs to the *sykesii* group which is confined to *Pteropus* bats. The only *Pteropus* in Peninsular India is *P. giganteus* (Brünnich) a proven host of *C. sykesii*. This almost certainly rules out the possibility of a second species of the *sykesii* group on *P. giganteus* in India. The occurrence of *Cyclopodia* and related flies on any Microchiroptera is so unlikely that the original host record of *kalyania* as ex *Pipistrellus* must be considered incorrect'

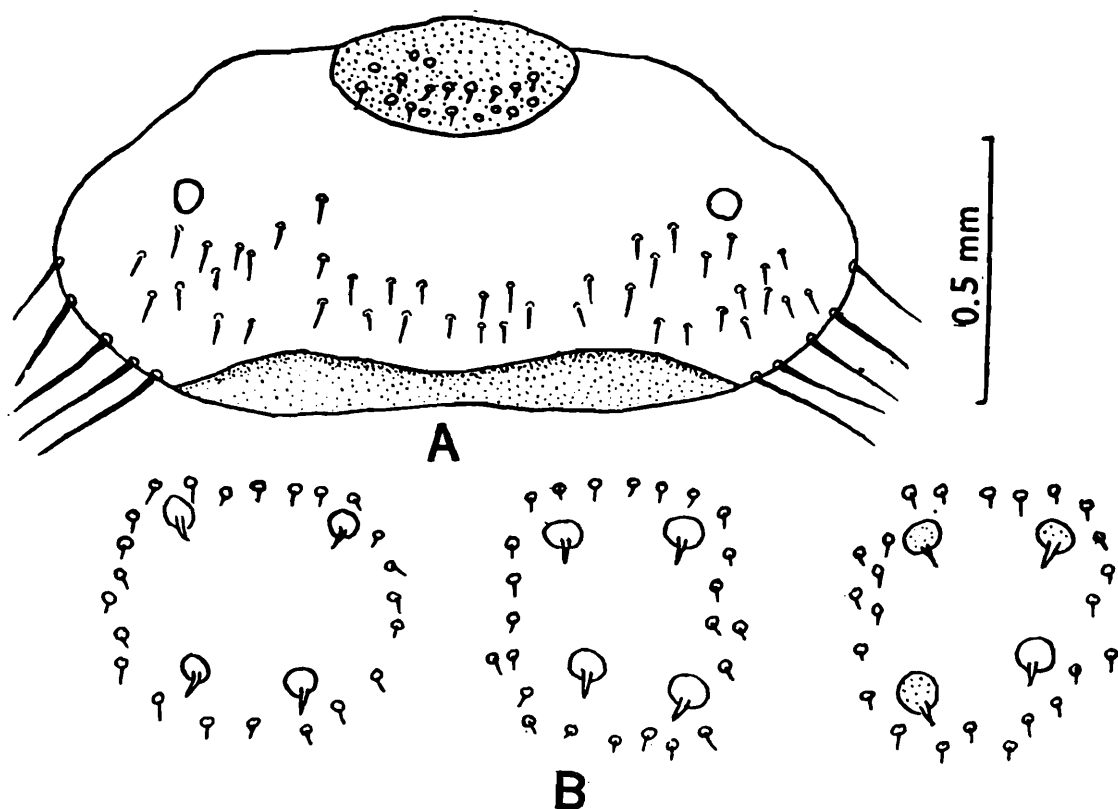


Fig. 17. — *Cyclopodia sykesii* (Westwood) ♀ A. tergite (I+II) B. abdominal tubercles showing variations in three examples.

Regarding the characters considered as variable by Maa (*l.c.*) our observations are compared as under :—

(a) Labella-Jobling (1928) states the number of prestomal and inner teeth to be 6 and 2 respectively, while Choudhuri *et al.* (*l.c.*) for *kalyania* state the number of prestomal teeth to be more than 6. In our specimens it is 6.

(b) Abdominal ctenidium — the number of teeth has been variably observed as under :

Theodor (1959)	32
Choudhuri <i>et. al.</i> (1965)	35
Hiregaudar & Bal (1956)	40
Present collection	37-42 (both sexes)

Bio-ecology : The parasite is always found abundant on the neck and ventral side of abdomen and wings of the host where thick fur is found.

Genus *Leptocyclopodia* Theodor

Cyclopodia (*Leptocyclopodia*) Theodor, 1959 : 284.

Leptocyclopodia : Maa, 1965b : 378 ; Theodor, 1968a : 247.

Type species : *Nycteribia ferrarii* Rondani, 1878, designated by Theodor (1959).

KEY TO THE SPECIES OF *LEPTOCYCLOPODIA* KNOWN FROM INDIA

- Lateral connexiva in female with a row of 2-4 outstandingly long setae at level of sternite V ; tergite IV in male entire ; anterior margin of sternite 1+2 deeply notched or incised at middle *ferrarii* (Rondani)
- Lateral connexiva in female without such outstandingly long setae ; tergite IV in male interrupted at middle ; anterior margin of sternite 1+2 either notched at middle or not *thaii* Maa

***Leptocyclopodia ferrarii ferrarii* (Rondani)**

(Fig. 18)

Nycteribia ferrarii Rondani, 1878 : 12 (150-169) (Type loc. Java 1 ♂).

Cyclopodia ferrarii : Speiser, 1901 : 55 ; Scott, 1914a : 222 ; *id.* 1917 : 607 ; Phillips, 1924 : 70 ; Scott, 1925 : 381 ; Hiregaudar & Bal, 1956 : 51.

Leptocyclopodia ferrarii : Maa, 1965b : 378 ; Maa, 1975 : 475.

Host : *Cynopterus sphinx sphinx* Vahl, for all specimens.

Material examined : Gujarat : 3 ♂ ♂ , Z. S. I., DRS, Reg. No. Ent. 1317/A, Dist. Surat, Old Kachheri Chowk, Surat, 23. ix. 1976 ; 2 ♂ ♂ , 5 ♀ ♀ , Z. S. I., DRS, Reg. No. Ent. 1248/A, Dist. Dadra & Nagar Haveli, Old Bus stand Silvassa, 4.x.1976 (*Sinha & Advani*)

Host range : *Cynopterus sphinx sphinx*, *C. marginatus*, *C. brachyotis ceylonicus*.

Distribution of parasite : INDIA : Maharashtra, West Bengal, Gujarat, MALAYSIA ; THAILAND ; INDONESIA (Java, Sumatra).

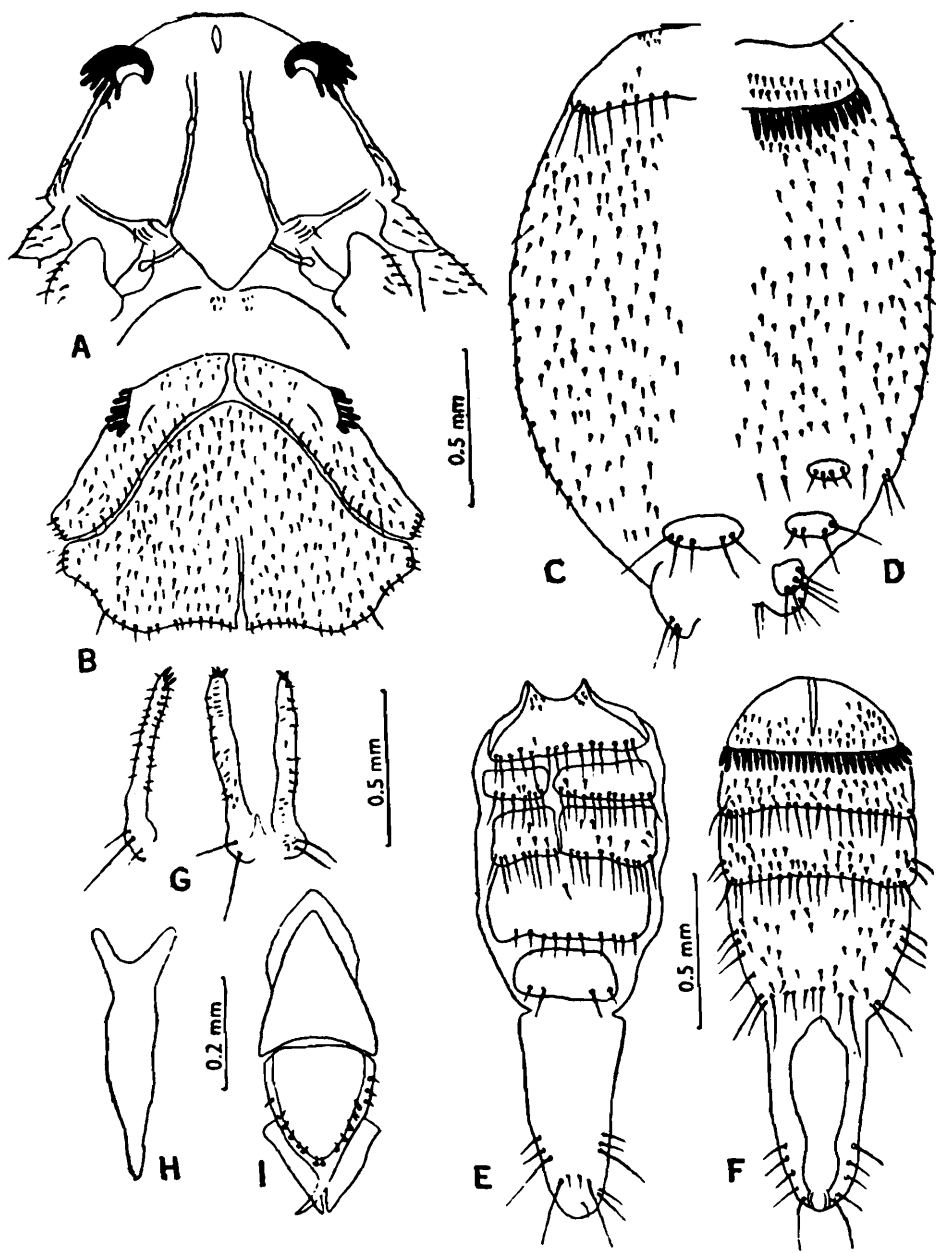


Fig. 18. — *Leptocyclopodia ferrarii ferrarii* (Rondani) A. dorsal view of thorax B. ventral view of thorax C. dorsal view of abdomen (♀) D. ventral view of abdomen (♀) E. dorsal view of abdomen (♂) F. ventral view of abdomen (♂) G. dorsal, ventral and lateral views of clasper H. genital deck plate of ♂ I. basal arch of ♂

Remarks : Maa (1975) has discussed and recognises 4 subspecies tabulated as under :—

Subspecies	Distribution	Host
1. <i>L. ferrarii ferrarii</i>	India (Maharashtra, W. Bengal) ; Thailand ; Malaysia.	<i>Cynopterus sphinx sphinx</i> <i>C. marginatus</i> <i>C. brachyotis ceylonicus</i>
2. <i>L. f. mabuhai</i>	Philippines (except Palawan)	<i>C. brachyotis luzoniensis</i>

<i>Subspecies</i>	<i>Distribution</i>	<i>Host</i>
3. <i>L. f. wallacei</i>	Sulawesi (Celebes)	<i>C. brachyotis</i> (no subspecies given)
4. <i>L. f. palawanensis</i>	Palawan	Host unknown

These subspecies have been based on differences in (i) number of setae on posterior margin of certain tergites, (ii) number of setae on sclerites of sternites, V-VII in female, (iii) length of hind femora and claspers in male. These data are given below in Table 1 for our specimens and compared under remarks with other subspecies as per data given by Maa (*l.c.*). They show some differences which are not considered very significant. While the nominotypical subspecies is predominant on *C. sphinx sphinx*, its other subspecies are predominant on the subspecies of *Cynopterus brachyotis* viz., *C. brachyotis ceylonicus*, *C. brachyotis luzoniensis* etc.

Bio-ecology : *Leptocyclopodia ferrarii ferrarii* is confined only to *Cynopterus* bats. The bats at Dadra Nagar Haveli were roosting in the central whorl of leaves at the top of *khajur* tree.

Genus *Eucampsipoda* Kolenati

Eucampsipoda Kolenati, 1857 : 62 ; Theodor, 1955 : 195-219.

Type species : *Nycteribia hyrtlil* Kolenati, 1856, by original designation.

KEY TO THE SPECIES OF *EUCAMPSIPODA* KNOWN FROM INDIA

Claspers narrow and tapering to a point ;
with peg like spines on the dorsal surface.

In female setae on the dorsum arranged in
a single posterior group *sundaicum* Theodor

Claspers broad throughout or in basal half ;
with only ordinary spines on the dorsal
surface. In female setae on the dorsum
arranged in two groups-one of shorter 8-10
fine setae close to tergite 1+2 and a group
of longer and thicker setae posteriorly *latisternum* Sch. Stekh. & Hardb.

Eucampsipoda latisternum Schuurmans, Stekhoven & Hardenberg (Fig. 19)

Eucampsipoda latisternum Schuurmans, Stekhoven & Hardenberg, 1938 : 1-37 ; Maa, 1965b : 379.

Eucampsipoda hyrtlil orientalis Hiregaudar & Bal, 1956 : 61 (host *Rousettus leschenaulti*) (Syn. vide Maa *l.c.*).

Host : *Rousettus leschenaulti leschenaulti* Desmarest for all the specimens under report.

Table 1. Showing comparison of *Leptocyclopodia ferrarii ferrarii* collected from India with *L. f. ferrarii* and *L. f. wallacei* of Southeast Asia as given in the tables 1, 2 & 3 by Maa (1975 : 475-76)

Material	Number of setae on the posterior margin of Tergites Range (Average)			Number of setae on Sternites V-VII Range (Average)			Length of hind femur Range (Average)		Length of claspers (♂) Range (Average)
	III (♂)	IV (♂)	VI (♀)	V ♀	VI ♀	VII ♀	♂	♀	
Authors' material (India) 5 ♂♂, 5 ♀♀	20-22 (20.6)	18-21 (19.0)	5-5 (5.0)	4-4 (4.0)	3-5 (3.6)	3-4 (3.8)	0.945-0.990 (0.972)	0.99-1.025 (1.003)	0.60-0.64 (0.618)
<i>L. f. ferrarii</i> (S. E. Asia)	29-36 (31.9)	20-32 (26.3)	2-6 (4.2)	4-4 (4.0)	3-5 (3.4)	4-6 (4.9)	1.00-1.08 (1.04)	0.98-1.08 (1.03)	0.52-0.68 (0.58)
<i>L. f. wallacei</i> (S. E. Asia)	16-23 (20.3)	16-21 (18.5)	3-5 (4.1)	4-5 (4.1)	5-6 (5.1)	4-6 (5.0)	0.90-0.96 (0.93)	0.92-0.96 (0.94)	0.56-0.50 (0.57)

Material examined : Rajasthan : 42 ♂♂, 30 ♀♀, Z. S. I., DRS, Reg. No. Ent. 1249/A, Dist. Jhalawar, Gagon Ka Kila (10 kms east of Jhalawar), 2.xii. 1975. Gujarat : 1 ♀, Z. S. I., DRS, Reg. No. Ent. 1250/A; Dist. Broach, Juna Masjid Parsiward, 15.ix.1976 (*Sinha & Advani*).

Host range : *Rousettus leschenaulti*, *R. seminudus*, *R. amplexicaudatus* (obviously misidentification for *R. leschenaulti*), *Cynopterus brachyotis*, *C. sphinx*, *Pteropus* sp., *Tylonycteris pachypus*.

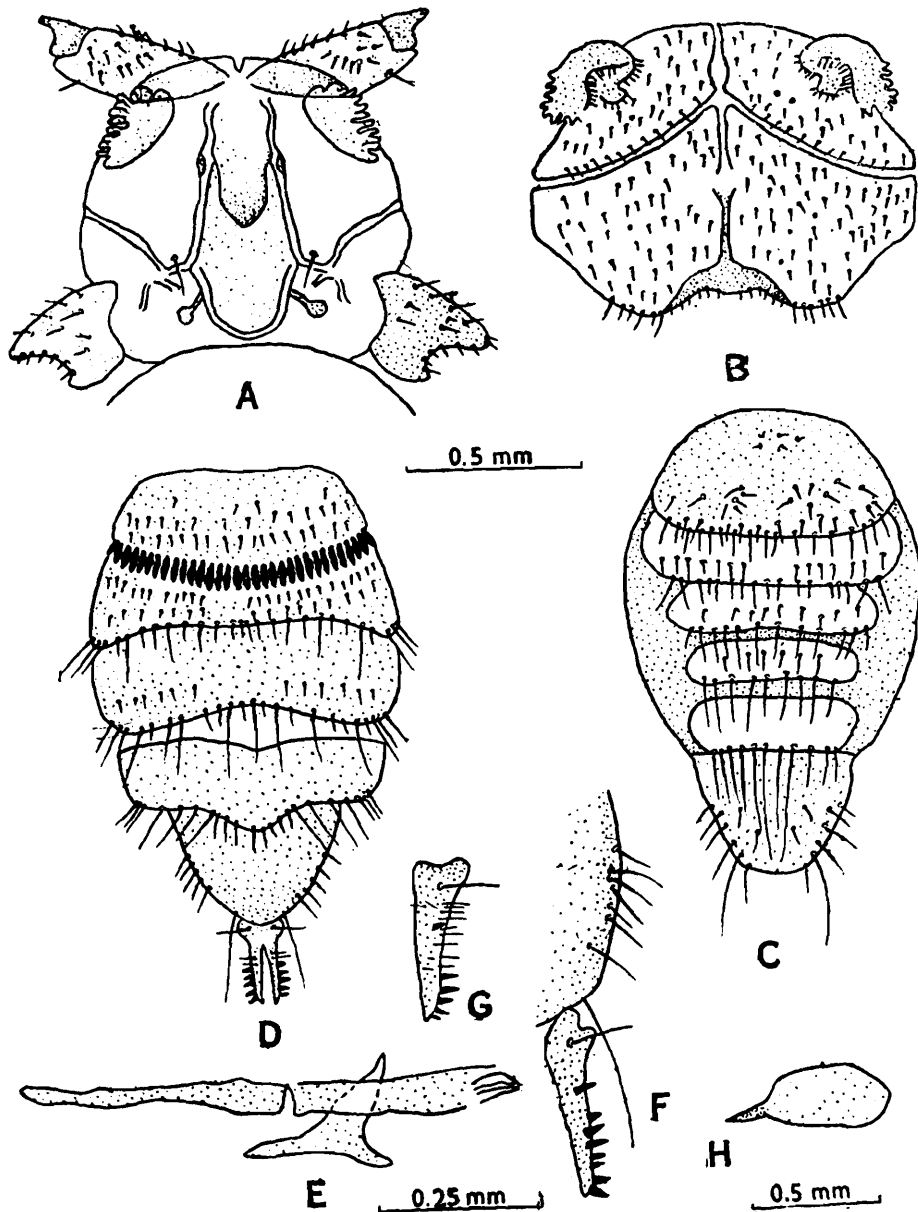


Fig. 19. — *Eucampsipoda latisternum* Sch. Stekh. & Hard. ♂ A. dorsal view of thorax B. ventral view of thorax C. dorsal view of abdomen D. ventral view of abdomen E. genitalia F-G. lateral views of claspers showing variation H. post spiracular sclerite.

Distribution of parasite : INDIA : Maharashtra, Orissa, Assam ; NEPAL ; BURMA ; SRI LANKA ; THAILAND ; LAOS ; VIETNAM ; S. CHINA ; INDONESIA ; JAVA. The range almost coincides with that of *Rousettus leschenaulti*.

Remarks : The species is being reported from Rajasthan and Gujarat for the first time. It comes close to *sundaicum* among the species known from India as shown in the key. However, as stated by Theodor (1955) it is more closer to *hyrtlui* (occurring in middle east) which has similar arrangement of two groups of setae on the dorsum in females, but has longer and more numerous setae in the anterior group.

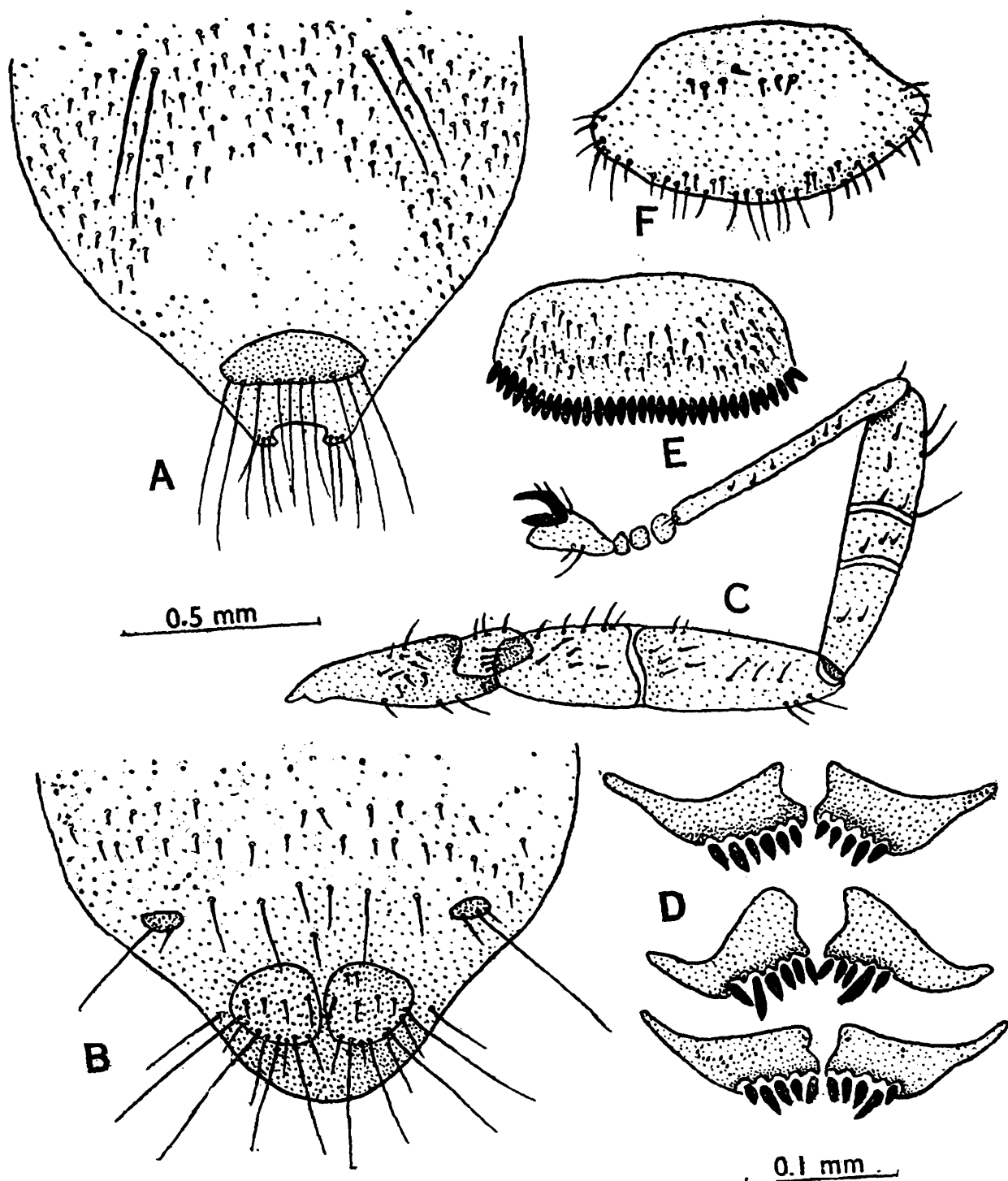


Fig. 20. — *Eucampsipoda latisternum* Sch. Stekh & Hard. ♀ A. dorsal view of abdomen B. ventral view of abdomen C. foreleg D. genital plates showing variation E. sternite (I+II) F. tergite (I+II).

Bio-ecology : The sex ratio was 40 : 30 (♂ : ♀) and about 16 females were gravid. The host bat *R. leschenaulti* (fruit bats) were

sharing their colony with the insectivorous bats *Rhinopoma microphyllum microphyllum* in a dark abandoned room surrounded by some prickly vegetation. The latter was infested with streblid flies and ticks.

Subfamily NYCTERIBIINAE

Nycteribiinae Samouelle, 1819 : 303 ; Maa, 1975 : 466.

KEY TO GENERA AND SUBGENERA OF NYCTERIBIINAE KNOWN FROM INDIA

1. Eyes absent ... 2
- Eyes present ... 3
2. Legs very long ; second abdominal tergite in female with posterior process bearing only setae or spines. ... *Basilina (Tripselia)* Scott
- Legs short ; second abdominal tergite in female without posterior process ; uniformly rounded or straight along posterior margin ... *Nycteribia* Latreille
3. Eyes with 1 ocellus, unpigmented ... *Penicillidia* Kolenati
- Eyes with 2 ocelli, pigmented ... 4
4. First abdominal tergite in female short. Abdominal tergites in male with small spines at the sides and surface ... *Basilina (s. str)* Miranda Ribeiro
- First abdominal tergite in female very long, covering 1/2 or 2/3 of the abdomen. Abdominal tergites in male almost without spines ... *Basilina (Paracyclopodia)* Scott

Genus *Basilina* Miranda Ribeiro

Basilina Miranda Ribeiro, 1905 : 177.

Type species : *Basilina ferruginea*, Miranda Ribeiro, 1905, by original designation.

Basilina (Paracyclopodia) royliei (Westwood)

(Figs. 21 & 22)

Nycteribia roylei Westwood, 1834 : 138.

Cyclopodia (Paracyclopodia) roylei : Scott, 1917 : 608 ; 1925 : 381.

Basilina (Paracyclopodia) royliei : Maa, 1965 : 380 ; Hurka & Povolny, 1968 : 293.

Host : *Scotophilus heathi heathi* Horsefield for all specimens.

Material examined: Rajasthan: 1 ♂, 1 ♀, Z.S.I., DRS, Reg. No. Ent. 1258/A, Dist. Jodhpur, Jodhpur, 9.iv.1973; 1 ♀, Z.S.I., DRS, Reg. No. Ent. 1252/A, Dist. Sawai Madhopur, Thingla Vill. (3 kms

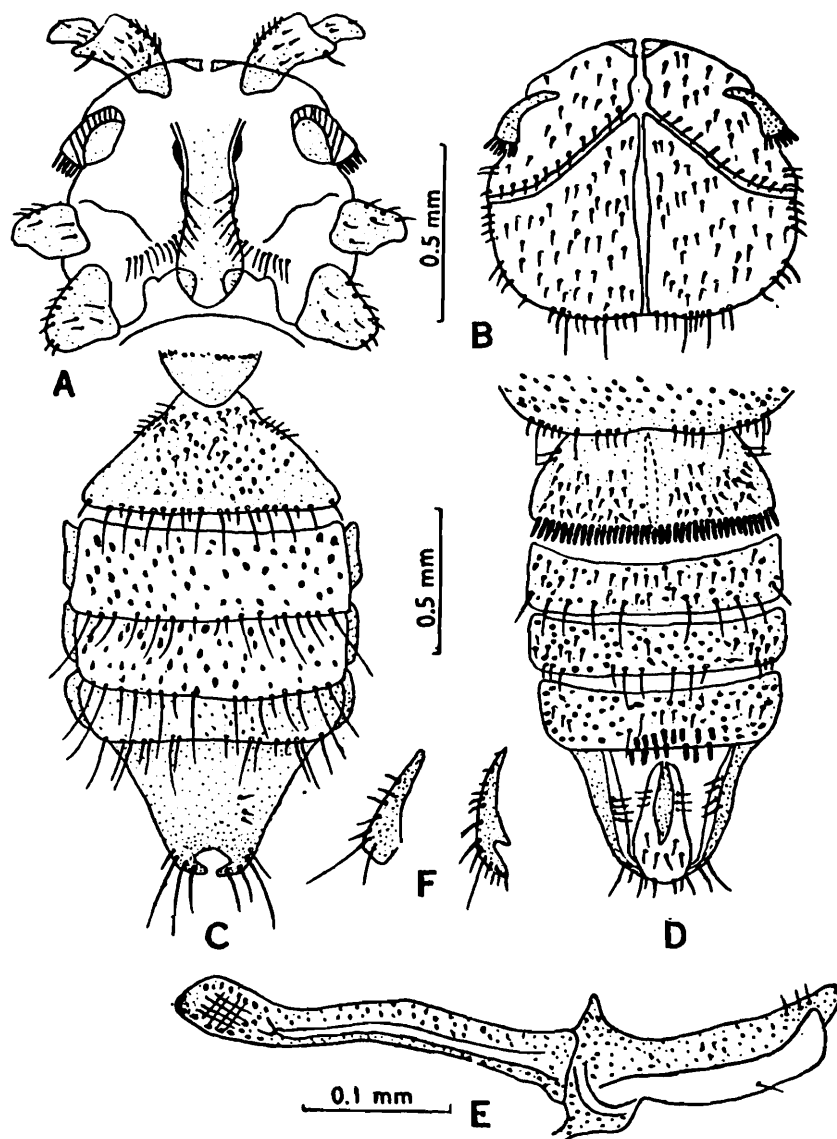


Fig. 21. — *Basilia roylii* (Westwood), ♂ A. dorsal view of thorax B. ventral view of thorax C. dorsal view of abdomen D. ventral view of abdomen E. genitalia F. claspers in different views.

south of Sawai Madhopur), 6.i.1975; 3 ♂♂, 5 ♀♀, Z.S.I., DRS, Reg. No. Ent. 1256/A, Dist. Ajmer, Rajgarh (12 kms from Nasirabad), 3.i.1975 (*Sinha*); 1 ♂, 1 ♀, Z.S.I., DRS, Reg. No. Ent. 1257/A, Dist. Dungarpur, Juna Mahal, 23.xi.1975; 4 ♂♂, 3 ♀♀, Z.S.I., DRS, Reg. No. Ent. 1255/A, Dist. Dungarpur, Surpur (3 kms from south of Dungarpur) 24.xi.1975; 2 ♀♀, Z.S.I., DRS, Reg. No. Ent. 1253/A, Dist. Dungarpur, a house near Dak Bungalow, Dungarpur, 25.xi.1975; 34 ♂♂, 57 ♀♀, Z.S.I., DRS, Reg. No. Ent. 1254/A, Dist. Banswara, Old Palace, 28.xi.1975; 2 ♂♂, 1 ♀, Z.S.I., DRS, Reg. No. Ent. 1251/A, Dist. Boondi, Shikarburj (11 kms Southeast of Bundi), 8.xii.1975. Gujarat: 8 ♂♂, 7 ♀♀, Z.S.I., DRS, Reg. No. Ent. 1260/A, Dist. Broach, Fatatalab, 16.ix.1976; 3 ♀♀, Z.S.I., DRS, Reg.

No. Ent. 1259/A, Dadra & Nagar Haveli, Silvassa and around 4.x.1976 (Sinha & Advani).

Host range : *Scotophilus heathi*, *S. temmincki wroughtoni*, *Pipistrellus coromandra*, *Myotis formosus*, *Tylonycteris pachypus*, *Megaderma lyra*.

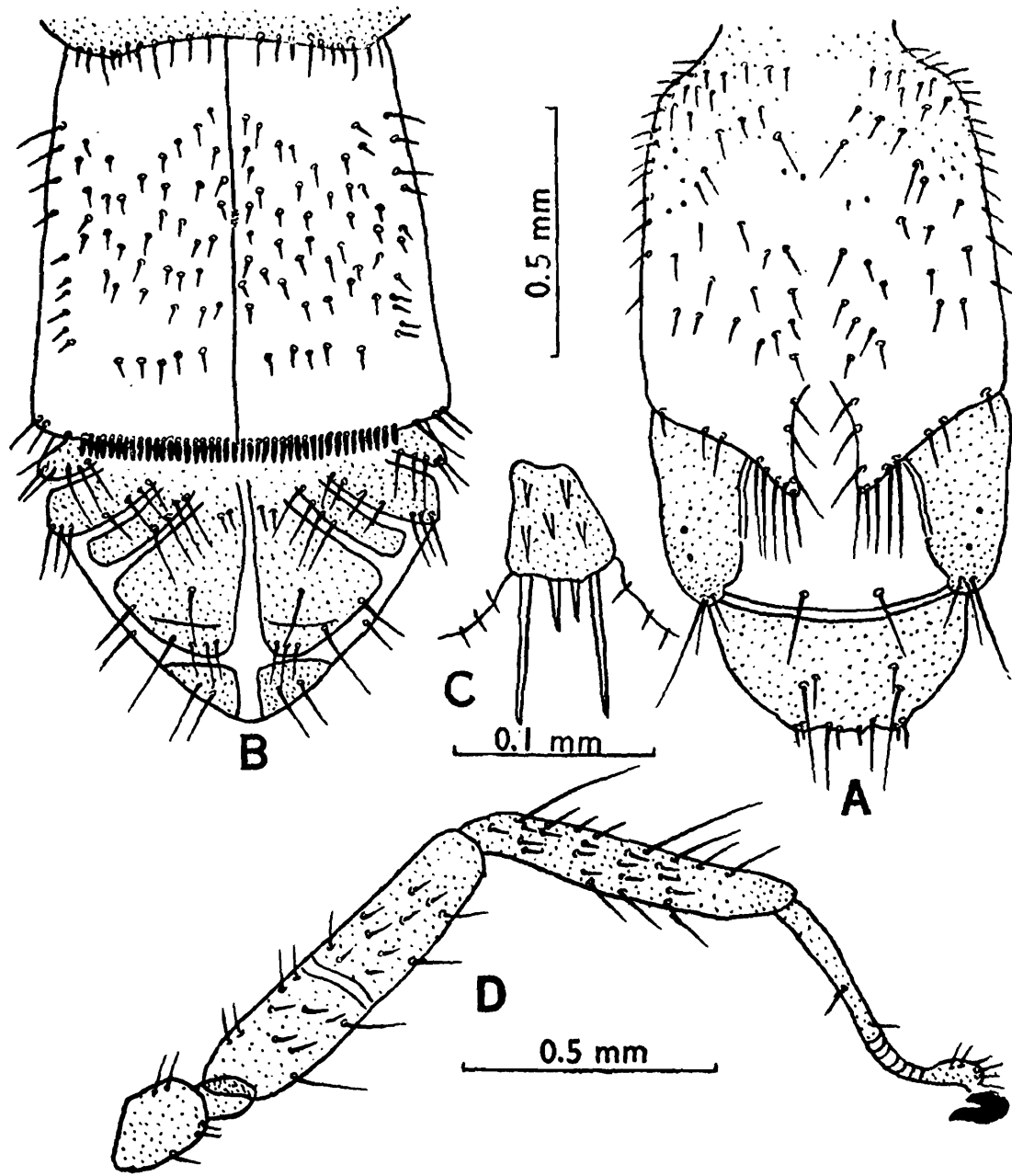


Fig. 22. — *Basilia roylii* (Westwood), ♀ A. dorsal view of abdomen B. ventral view of abdomen C. genital plate D. leg.

Distribution of parasite : INDIA : Uttar Pradesh, Bihar, Tamil Nadu, Rajasthan, Gujarat ; SRI LANKA ; AFGHANISTAN ; PAKISTAN. The range of this species probably parallels to that of *Scotophilus heathi*. Previous records of *roylii* from Japan etc., are considered unreliable by Maa (in a personal communication).

Remarks : This species has a wide range of intraspecific variations mainly in chaetotatic character.

At the valuable suggestion of Prof. Maa, number of setae on tergite II and sternites III-VI of female in this species have been submitted to statistical analysis as shown in Table 2. Application of 't' test to the material from various localities shows that while the variation in number of setae of tergite II is significant, it is insignificant in case of sternites V and VI and it is doubtful in the case of tergite III and IV. In short, these variations are considered infra-specific (inter population) and do not have subspecific importance.

Subgenus *Tripselia* Scott

Tripselia Scott, 1917 : 608.

Type species : *Cyclopodia amiculata* Speiser, 1907.

The only species belonging to the subgenus dealt below, occurs in India.

***Basilina* (*Tripselia*) *blainvillii amiculata* (Speiser)**

(Figs. 23 & 24)

Cyclopodia amiculata Speiser, 1907 : 296 (Host : *Taphozous longimanus*, locality : Calcutta).

Nycteribia (*Acrocholidia*) *fryeri* : Scott, 1914b : 163.

Tripselia fryeri : Scott, 1917 : 608.

Tripselia amiculata : Scott, 1925 : 283 ; Hiregaudar and Bal, 1956 : 56.

Basilina (*S. str.*) *amiculata* : Maa, 1965b : 380.

Host : *Taphozous longimanus longimanus* Hardwicke for all specimens.

Host range : *Taphozous longimanus*, *T. saccolaimus*, *Pipistrellus* sp.

Material examined : Rajasthan : 1 ♀, Z.S.I., DRS, Reg. No. Ent. 1263/A, Dist. Ajmer, Nandla Vill. (5 kms. North of Nasirabad), 31.xii.1974, 1 ♀, Z.S.I., DRS, Reg. No. Ent. 1262/A, Dist. Kota, Maharaja bagh Kota, 12.i.1975 (*Sinha*) ; Gujarat : 1 ♂, Z.S.I., DRS, Reg. No. Ent. 1261/A, Dist. Broach, Dak Bungalow Broach, 16.ix.1976 (*Sinha & Advani*).

Distribution of parasite : INDIA : West Bengal, Maharashtra ; SRI LANKA ; INDONESIA : Java, Sumatra.

Remarks : There are some infra specific variations as shown below. The characters/measurements shown in parentheses are *vide* Hiregaudar & Bal (1956).

- (i) Length of ♂ 2.13 mm, ♀ 2.44 mm (2.0-2.2 mm for both sexes),
- (ii) 10-11 notopleural setae present on thorax (8-12 notopleural setae

Table 2. Statistical studies of number of setae on tergite II and sternites III to VI of *B. roylli* (♀)

S. No.	Locality, Date	Tergite II	Sternite III	Sternite IV	Sternite V	Sternite VI
<u>RAJASTHAN</u>						
1.	Ajmer, 3.i.1975	Mean 157.33±3.169	15.666±2.80	17+1.915	8±0.6323	12.33±2.185
	6 exs.	S. D. 7.763	6.860	4.690	1.414	5.354
	Body length : 2.63 mm	C. V. 4.934	43.787	27.588	17.678	43.410
2.	Dungarpur, 23, 24, 25.xi.75	Mean 161.20±2.498	13.6±1.940	19.60±1.166	6.8±.4897	12.40±.678
	5 exs.	S. D. 5.586	4.336	2.608	1.095	1.5166
	Body length : 2.60 mm	C. V. 3.465	31.880	13.306	16.103	12.23
3.	Banswara, 28.xi.1975	Mean 189.105±4.738	24.158±.806	19.579±0.944	7.919±0.170	13.053±0.268
	38 exs.	S. D. 29.209	4.968	5.8199	1.0376	1.651
	Body length : 2.86 mm	C. V. 15.446	20.565	29.725	13.103	11.2285
<u>GUJARAT</u>						
4.	Broach & Dadra & Nagar Haveli	Mean 173.6±5.013	18±1.955	18.2±1.172	6.7±0.423	12.3±0.4955
	16.ix.1976 & 4.x.1976					
	10 exs.	S. D. 15.854	6.182	3.706	1.337	1.567
	Body length : 2.60 mm	C. V. 9.132	34.347	20.360	19.962	12.740
<u>'t' value of :</u>						
1.	Ajmer v/s Dungarpur	2.4(S)*	1.50 (IS)†	2.36(S)	0.57(IS)	0.65(IS)
2.	Banswara v/s Ajmer	22.6(S)	7.38(S)	2.85(S)	0.77(IS)	0.83(IS)
3.	Dungarpur v/s Banswara	30.0(S)	10.0(S)	0.35(IS)	0.25(IS)	1.12(IS)
4.	Banswara v/s Broach (Gujarat)	10.33(S)	3.8(S)	1.81 (IS)	0.17(IS)	1.75(IS)
5.	Ajmer v/s Broach	9.6(S)	1.76(IS)	1.44(IS)	0.36(IS)	0.03(IS)
6.	Dungarpur v/s Broach	7.3(S)	2.09(S)	0.45(IS)	0.57(IS)	0.16(IS)

* S=Significant (i.e., more than 1.96).

† IS=Insignificant (less than 1.96).

present), (iii) synsternite I+II composed of 46-49 long and pointed setae (40-45 long and pointed setae present), (iv) Tergite III in ♂ with 2 irregular rows of setae (with few scattered setae in the middle) (v) Tergite

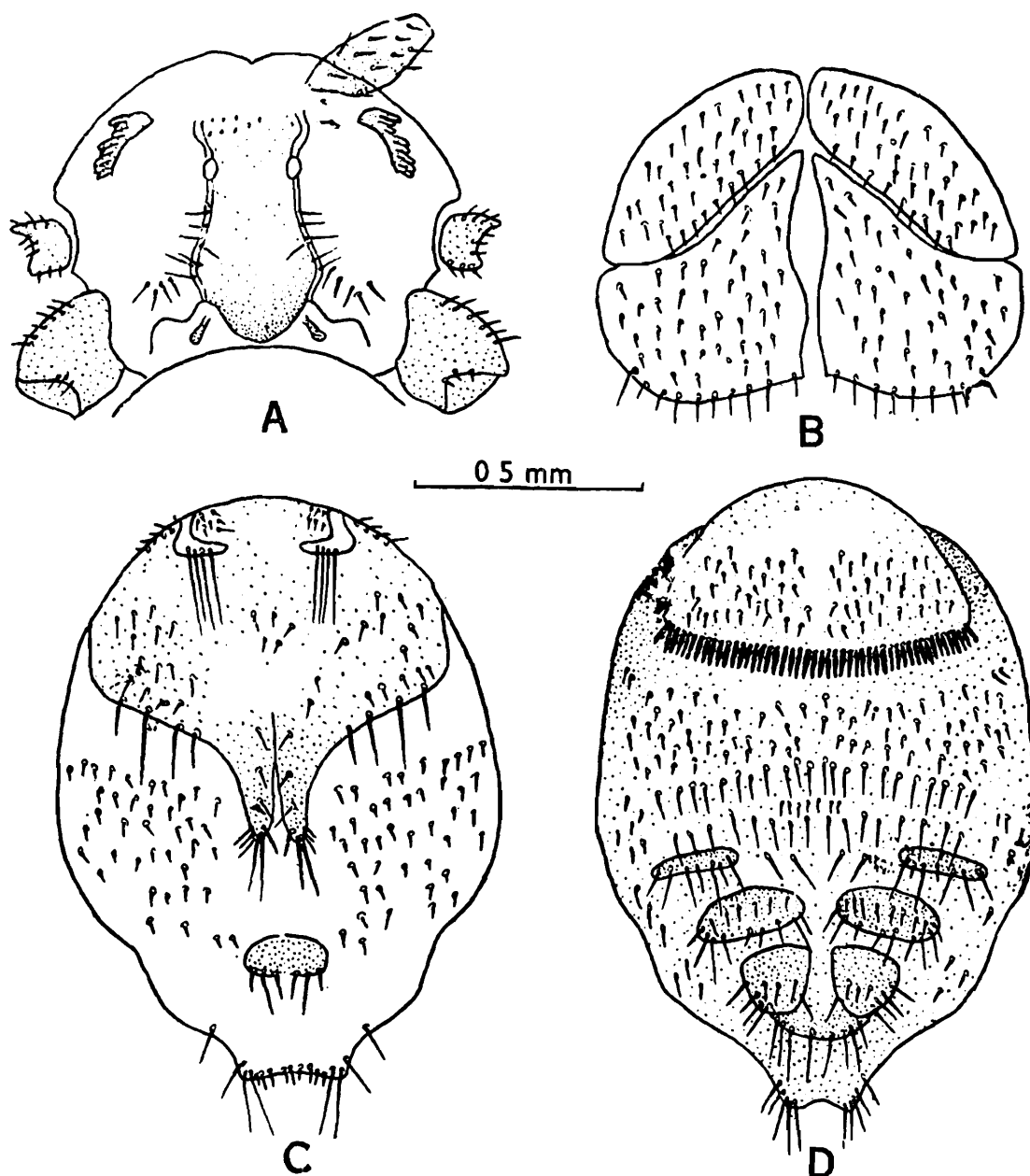


Fig. 23. — *Basilia amiculata* (Speiser), ♀ A. dorsal view of thorax B. ventral view of thorax C. dorsal view of abdomen D. ventral view of abdomen.

VI in ♂ with 1-6 short setae in the middle (with 1-2 setae at sides) (vi) In ♀, posterior processes of tergite I bearing 4 long and 5 short setae (with 4-5 long and 2-4 short setae) (vii) Dragger like processes of tergites II-V bear 4 short and 2 long setae, the longer setae not extending upto posterior end of the abdomen and merely reaching tergite VI (with 4-5 short and 2-3 long setae reaching upto posterior end of the abdomen) (viii) tergite VI bearing 6 setae of which 3 unequal, on either side (ix) Sternite 4 with a preapical row of short setae (no such setae present).

The range of this species is parallel to that of *Taphozous saccolaimus* but not that of *T. longimanus*, while present collections have been made on latter host species. The record of this species from Rajasthan and Gujarat is addition to its distribution.

ORDER ACARINA

Only two suborders MESOSTIGMATA and METASTIGMATA are represented in our collections.

ACARINA : MESOSTIGMATA

The suborder includes eleven superfamilies of which the superfamily Parasitoidea includes all the 3 families which are parasitic on bats and occur in India.

KEY TO FAMILIES OF PARASITOIDEA KNOWN FROM INDIA ON BATS

1. Coxae movable, not radially arranged ;
 legs simple 2
 Coxae immovable, readially arranged ; legs
 stout Spinturnicidae
2. Chelae reduced Macronyssidae
 Chelae not reduced Laelapidae

FAMILY : SPINTURNICIDAE Oudemans

Distribution : Cosmopolitan.

Hosts : Only bats.

General account :

The Spinturnicids are among the most specialized of the dermanyssoid mites, and there are no known intermediate forms to indicate their relationships. Spinturnicid morphology and biology are perhaps more consistent with a laelapine origin than any other families.

The family is highly modified for clinging to the body of host. Rudnick (1960) cites a number of observations in connection with the behaviour of Spinturnicids on their hosts. Vitzthum (1932) gave very interesting suggestions e.g., the mites spread out on the open wing and bring the legs under the body, as the wings close ; thus adjusting to rapid and frequent changes in wing position ; without changing the position of its own claws.

The spinturnicids provide a good example of the adaptation to permanent, or host dwelling, parasitism. These are viviparous and

the protonymph, deutonymph, female and male have similar adaptations for clinging to the host. According to Rudnick (*l.c.*), spinturnicid mites typically feed on blood, and it is not established that

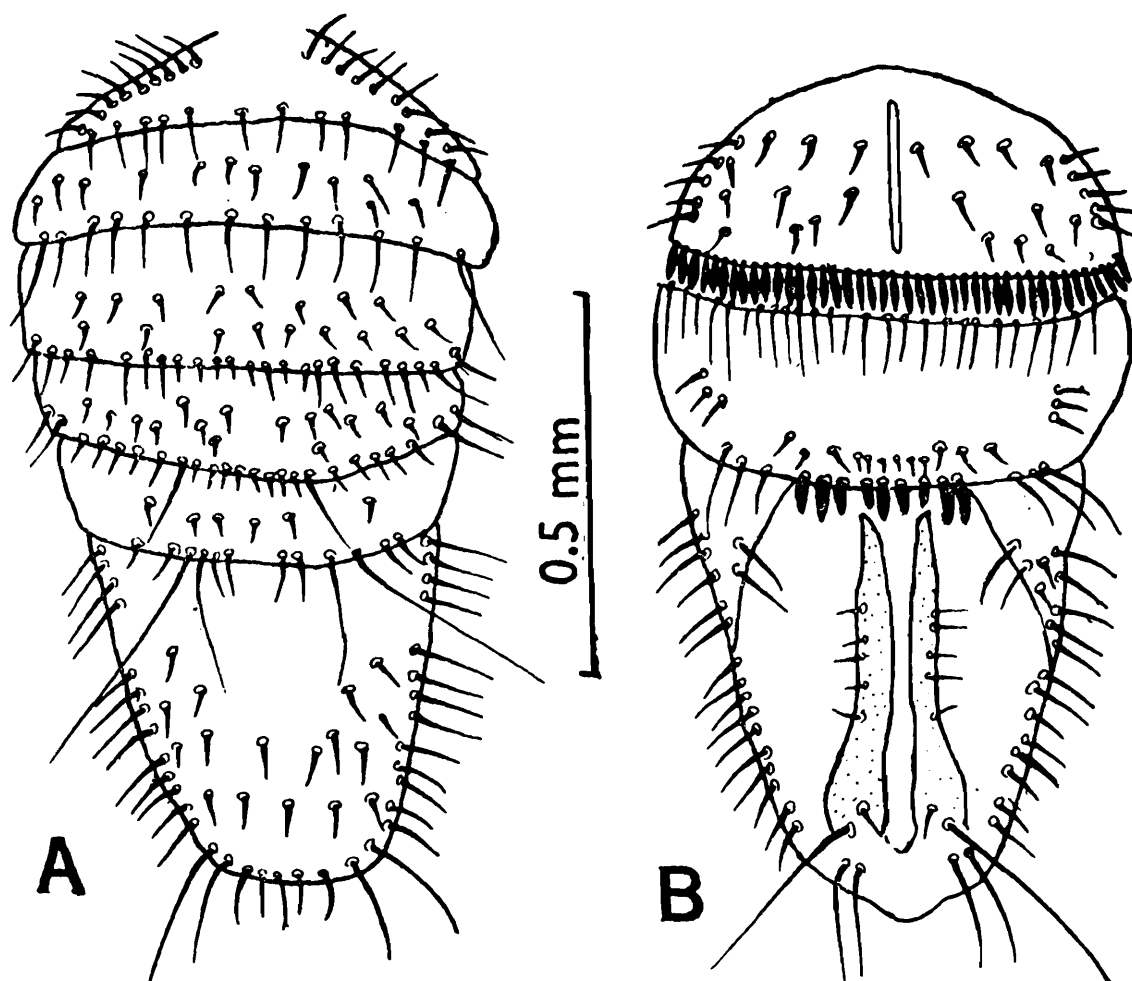


Fig. 24. — *Basilia amiculata* (Speiser), ♂ A. dorsal view of abdomen B. ventral view of abdomen.

they take any other food. In India, the family is so far represented by 8 species spread over 5 genera viz., *Spinturnix*, *Ancystropus*, *Meristaspis*, *Eyndhovia* and *Paraperiglischrus*. The present studies increase the number of genera known from India to 6 with inclusion of a new genus viz., *Parameristaspis* and raise the number of species to 11, after the addition of 3 species.

KEY TO THE GENERA OF SPINTURNICIDAE FROM INDIA*

- | | | |
|--|-----|------------------------------|
| 1. Peritreme completely dorsal | ... | 2 |
| Peritreme long, bending ventral between coxae II and III | ... | <i>Spinturnix</i> von Heyden |
| 2. Claws of leg I enlarged, caruncles I rudimentary | ... | <i>Ancystropus</i> Kolenati |
| Claws of leg I not enlarged ; caruncles I developed | ... | 3 |

*Modified from Baker and Delfinado (1964).

3. Without tritosternum between anterior
coxae *Paraperiglischrus* Rudnick
With tritosternum between anterior coxae ... 4
4. Five pairs of setae surrounding anterior
margin of dorsal shield *Eyndhovenia* Rudnick
Four pairs of setae surrounding anterior
margin of dorsal shield 5
5. Anterior tarsi with flattened terminal setae.
Tritosternum usually broader than long ... *Meristaspis* Kolenati
Anterior tarsi with normal, slender setae,
tritosternum square shaped, as long as
broad *Parameristaspis* n. gen.

Genus *Ancystropus* Kolenati

Ancystropus Kolenati, 1856 : 1-51 ; Rudnick, 1960 : 171.

Oncoscelus Delfinado and Baker, 1963 : 913 (Synon. by Domrow (1972) (Type of genus *A. kanheri*, T. L. — Bombay).

Type species : *Ancystropus zeleborii* Kolenati, 1856 (by monotypy).

Distribution : Ethiopian, Oriental and Palaearctic regions.

KEY TO THE SPECIES OF *ANCYSTROPUS* KNOWN FROM INDIA

1. Anterior tarsi with a large hook ; anterior
coxae with a small hook *kanheri* Hireg. & Bal
Anterior tarsi and coxae without any hooks 2
2. Anterior legs with peculiar curved, long,
spines ; sternal plate less sclerotized ... *taprobanius* Turk
Anterior legs without any curved, long,
spines ; sternal plate heavily sclerotized ... *zeleborii* Kolenati

Ancystropus taprobanius (Turk)

(Fig. 25)

Meristaspis taprobanius Turk, 1950 : 73 (T. L. — Ceylon).

Ancystropus taprobanius Domrow, 1972 : 571 ; Prasad, 1974 : 177.

Ancystropus indica Hiregaudar and Bal, 1955 : 221. (syn. *vide* Domrov *l.c.*).

Ancystropus indicus Hiregaudar & Bal ; 1956 : 92 ; Rudnick, 1960 : 176-177.

Ancystropus rudnicki Baker and Delfinado, 1964 : 577 ; Prasad, 1969 : 672 (syn. *vide* Domrow, 1972).

Host : *Rousettus leschenaulti leschenaulti* Desmarest.

Host range : *Rousettus leschenaulti*, *R. seminudus*.

Material examined : Rajasthan : 5 ♀ ♀, Z.S.I., DRS, Reg. No. Ent. 1292/A, Dist. Jhalawar, Gagrion Ka Kila, ca. 15 kms from Jhalawar, 2.xii.1975 (*Sinha & Advani*).

Distribution of parasite : INDIA : Maharashtra, Rajasthan, SRI LANKA.

Remarks : The following measurements are compared with those given by Hiregaudar and Bal (1956) being shown in parentheses.

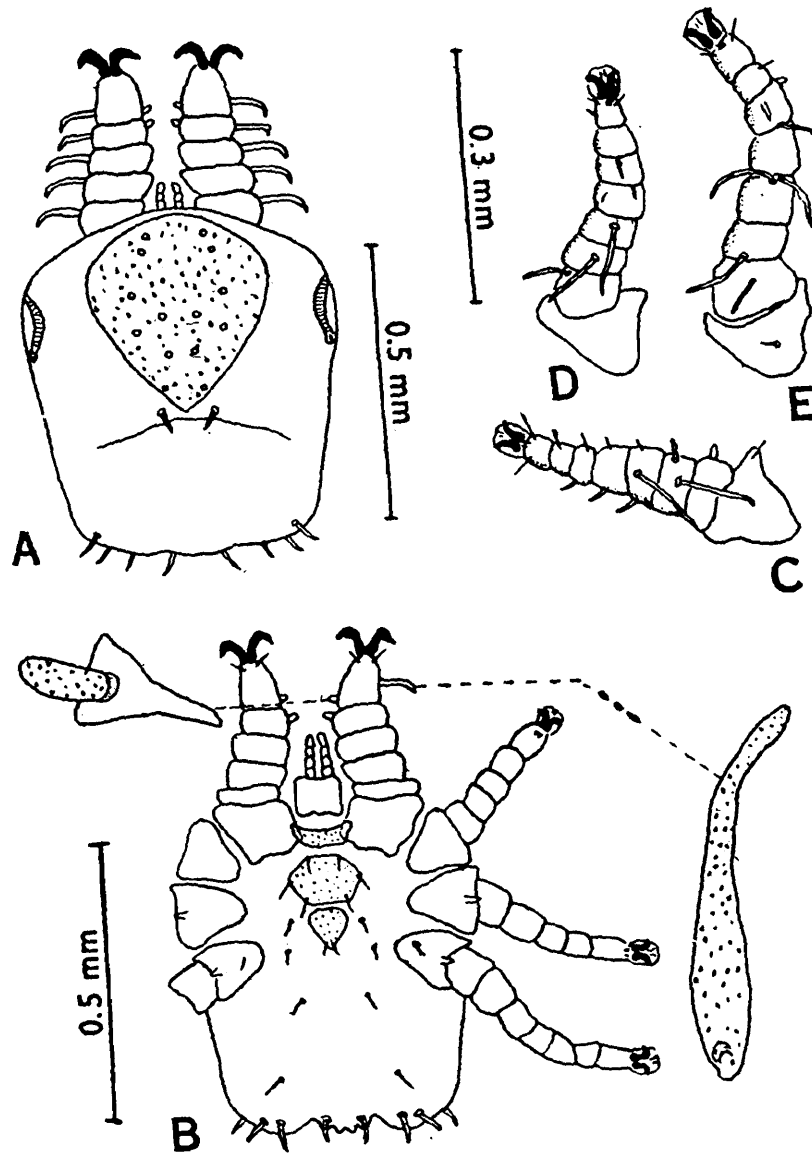


Fig. 25. — *Ancystropus taprobanus* (Turk), ♀ A. dorsal view B. ventral view C. leg II D. leg III E. leg IV.

Female : Length of idiosoma 0.741 (0.75-0.80). Width of idiosoma 0.37 (0.45-0.48). Dorsal shield with 8 pairs of pores (9 pairs).

The following characters may be added to the description given by Hiregaudar and Bal (1956). Gnathosoma—Chelicerae long, slender with dentate chelae. Leg—0.38 mm long ; trochanter and genu with a long wavy setae arising from its surface. Legs II-IV with some long wavy spines on genu and femora, and short spines on all other segments.

This species is closely related to *A. zeleborii* in the absence of caruncle of the anterior tarsi and strongly developed anterior pair of legs as also the shape of tritosternum (jugular plate) to some extent. But, it is at once separated by its peculiarly curved spines on the anterior legs and different shape of the sternal plate.

So far known from Maharashtra and Sri Lanka, it is now being recorded for the first time, from Rajasthan.

***Ancystropus zeleborii* Kolenati**

(Fig. 26)

Ancystropus zeleborii Kolenati, 1856 : 25 ; Rudnick, 1960 : 173-175 ; Prasad, 1974 : 178 (T. L. — Egypt ; Host : *Rousettus aegypticus*).

Ancystropus zelebori Hiregaudar & Bal, 1955 : 221 ; 1956 : 90.

Host : *Rousettus leschenaulti leschenaulti* Desmarest.

Host range : *Rousettus leschenaulti*, *R. aegypticus*.

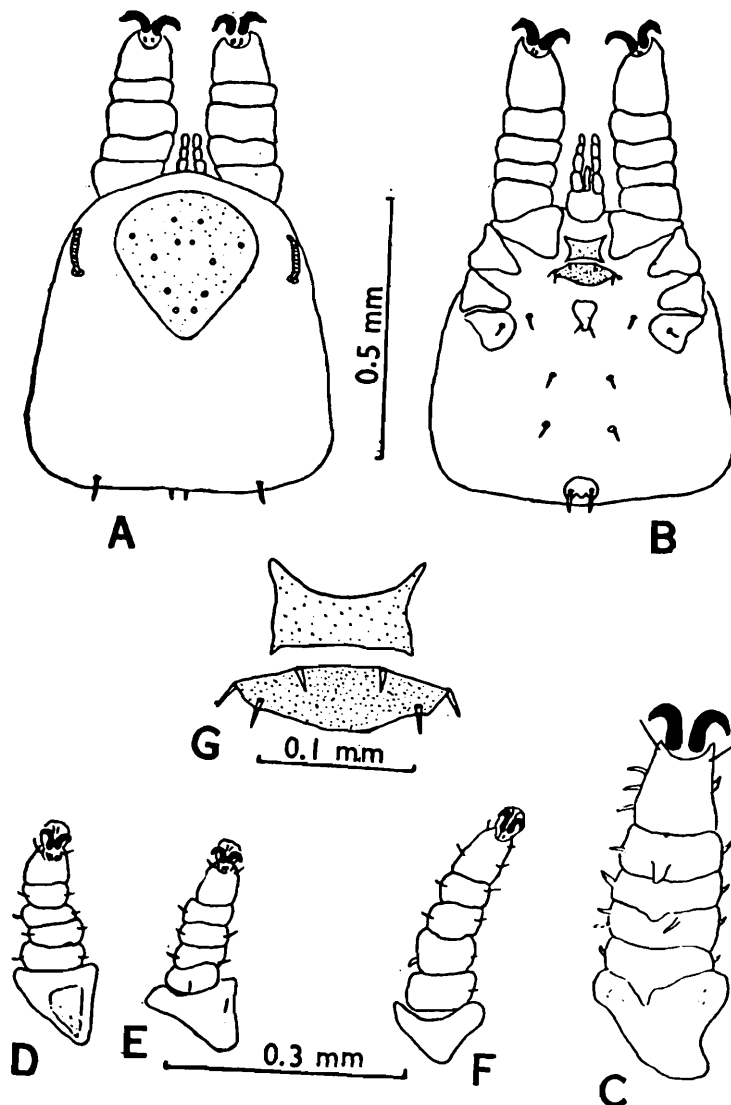


Fig. 26. — *Ancystropus zeleborii* (Kolenati), ♀ A. dorsal view B. ventral view C. leg I D. leg II E. leg III F. leg IV G. tritosternum and sternal shield.

Material examined : Rajasthan : 1 ♀, Z.S.I., DRS, Reg. No. Ent. 1295/A, Dist. Jhalawar, Gagron Ka Kila, ca. 15 kms. from Jhalawar, 2.xii.1975 (*Sinha & Advani*).

Distribution of parasite : INDIA : Maharashtra, Rajasthan ; CYPRUS ; EGYPT.

Remarks : The following measurements are compared with those cited by Hiregaudar & Bal (*l.c.*) as shown in parentheses.

Female : Body length 0.735 (0.85-0.95) mm. Body width : 0.425 (0.45-0.50) mm. Sternal plate is narrower than in the examples examined by Hiregaudar and Bal (*l.c.*).

Characters given below may be added to the description by Hiregaudar and Bal (*l.c.*).

Palps 0.11 mm long, integument around anal region finely striated. Gnathosoma-Chelicerae long, slender, with small toothed chelae ; tactum rounded. Leg I. 0.41 mm long, with large recurved projections on femur and genu. Legs II-IV subequal, 0.27 mm long, with short setae except one long setae present on anterolateral margin of trochanter IV.

This species is now being recorded, for the first time, from Rajasthan filling a gap between the Ethiopian and its earlier record from Maharashtra. It is closely related to the preceding species and can be distinguished as shown under it.

***Ancystropus kanheri* Hiregaudar and Bal**

(Figs. 27 & 28)

Ancystropus kanheri Hiregaudar and Bal, 1955 (no description) : 221 ; 1956 : 95 (T. L. — Maharashtra : Jogeshwaris, Kanheri and Elephanta caves) ; Rudnick, 1960 : 177 ; Domrow, 1972 : 570 ; Prasad, 1974 : 177.

Oncoscelus kanheri : Delfinado and Baker, 1963 : 914-915 ; Baker and Delfinado, 1964 : 579 ; Prasad, 1969 : 676.

Host : *Rousettus leschenaulti leschenaulti* Desmarest.

Host range : *Rousettus leschenaulti*, *R. amplexicaudatus*.

Material examined : Rajasthan : 1 ♀, Z. S. I., DRS, Reg. No. Ent. 1293/A, Dist. Jhalawar, Gagron ka Kila, ca. 15 kms from Jhalawar, 2.xii.1975. Gujarat : 1 ♀, Z. S. I., DRS, Reg. No. Ent. 1294/A, Dist. Broach, Juna Masjid fort Parsiward, Broach, 15. ix. 1976 (*Sinha & Advani*).

Distribution of parasite : INDIA : Maharashtra, Gujarat, Rajasthan ; PHILIPPINES ; NEW GUINEA ; MALAYSIA.

Remarks : This is the largest sized species of the family Spinturnicidae known from India. As pointed out by Delfinado and Baker (*l.c.*) the ♀ of this species differs from other known members of the family

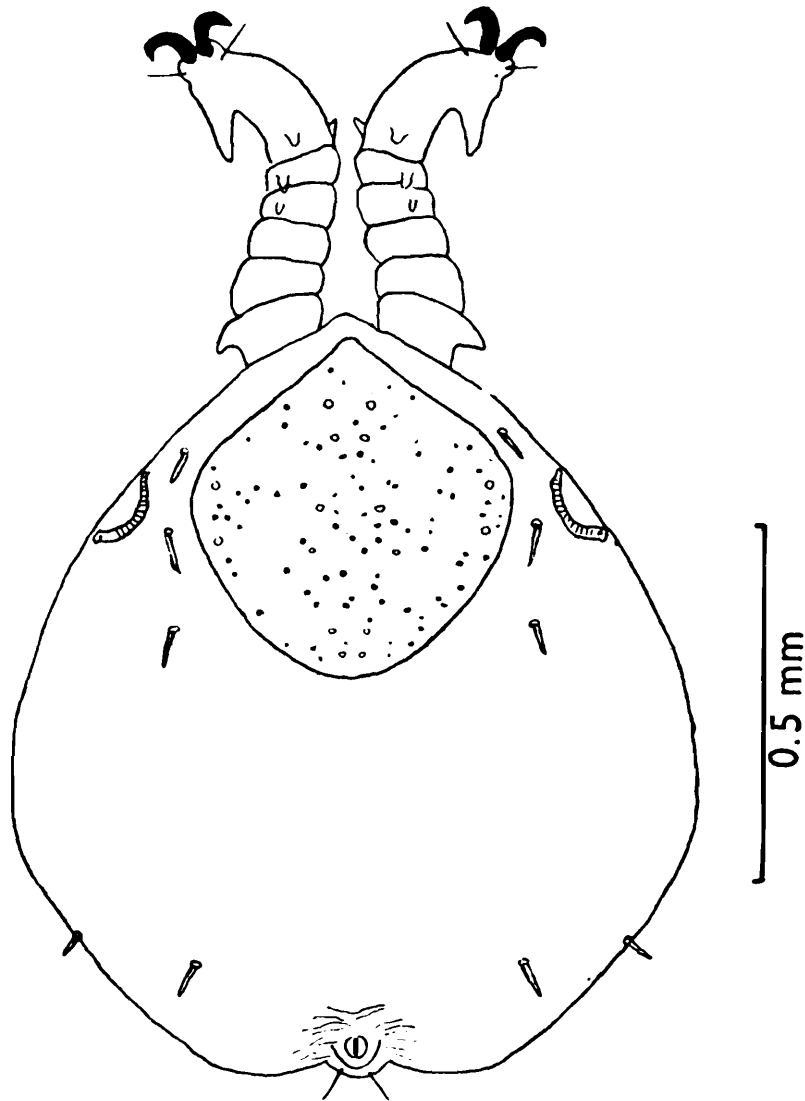


Fig. 27. — *Ancystropus kanheri* Hiregaudar & Bal, ♀ ventral view.

in having (i) characteristically modified anterior leg with large lateral hooks on tarsus I and coxa I (ii) gnathosoma small and tritosternum elongate, both tightly wedged between leg I (iii) venter of podosoma with internal sclerotic thickening (iv) idiosoma with a narrow podosomal region, pointed anteriorly.

Hiregaudar and Bal (1956) also pointed out the distinctive character of the anterior leg and suggested that this in itself is sufficient to place it in a separate genus. Delfinado and Baker (1963) did propose a separate genus *Oncoscelus*, but subsequently Domrow (1972) did not concur with them.

The records from Rajasthan and Gujarat extend the western limits of its range of distribution and indicate its chances of being present in

the middle east also in view of the occurrence of the host species in that region.

Bio-ecology : The species was collected along with two other species of same genus and one each of *Meristaspis* and *Parameristaspis*. In both instances of collection, only one female was collected.

Genus *Meristaspis* Kolenati

Meristaspis Kolenati, 1857 : 60 ; Rudnick, 1960 : 178 ; Delfinado and Baker, 1963 : 908.

Type species : *Pteropus lateralis* Kolenati 1856 ; by subsequent designation *vide* Vitzthum, 1932.

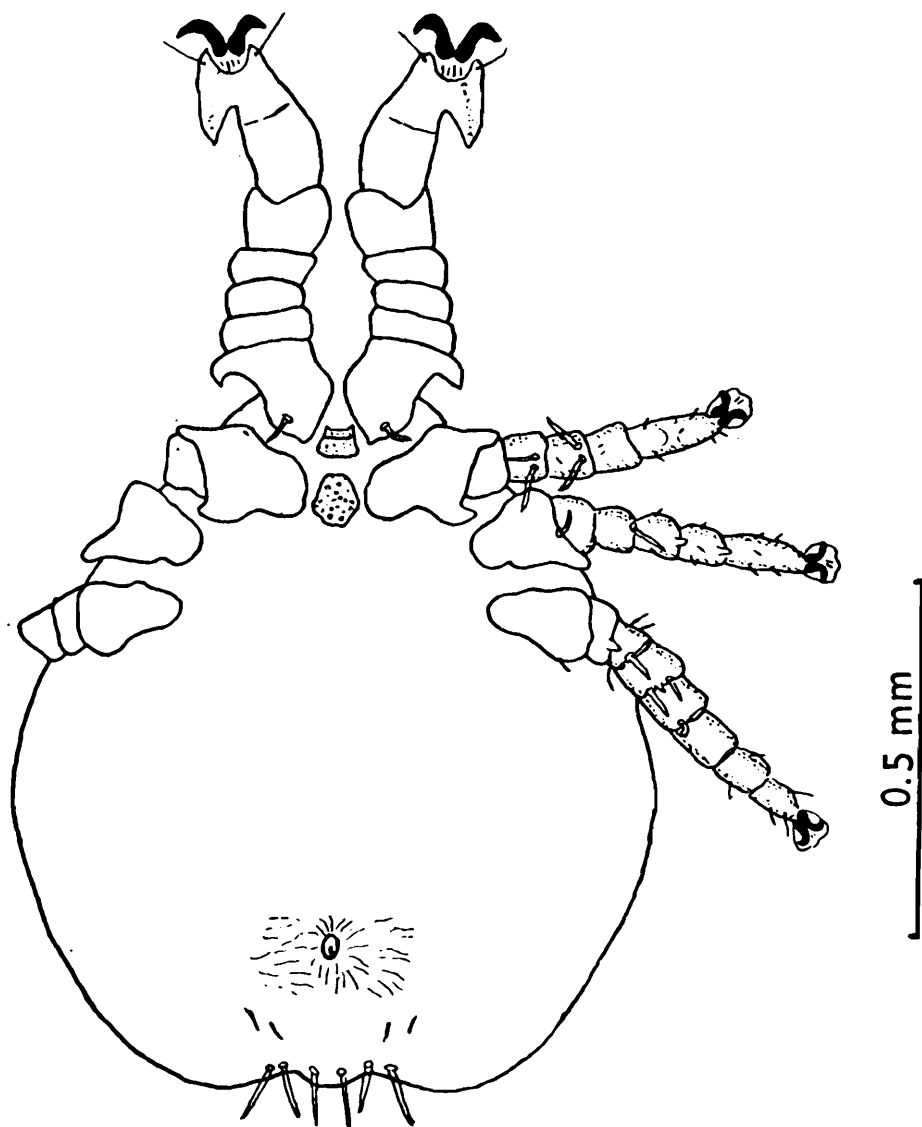


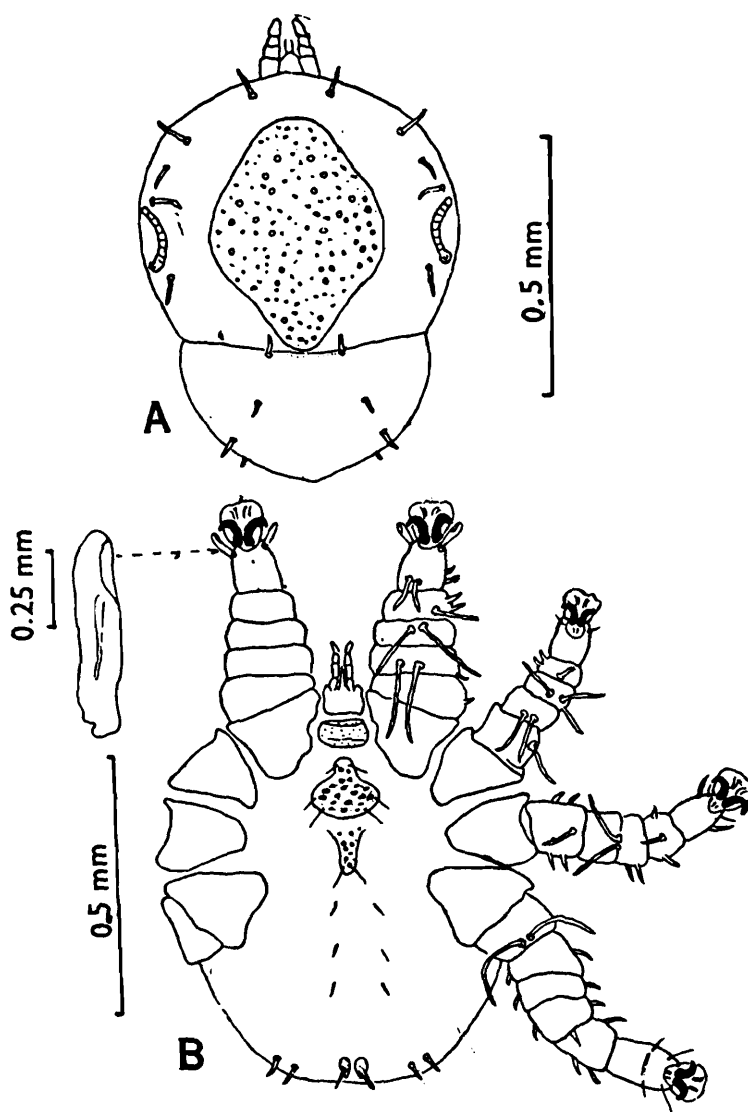
Fig. 28. — *Ancystropus kanheri* Hiregaudar & Bal, ♀ ventral view.

Distribution : Ethiopian, Oriental and Palaearctic Regions.

Remarks : In India, the genus is represented by only one species which is found in Ethiopian, Palaearctic and most of the Oriental Region.

Meristaspis lateralis Kolenati

(Figs. 29 & 30)

Pteropus lateralis Kolenati, 1856 : 29.*Pteropus punctolyra* Kolenati, 1856 : 28.*Meristaspis lateralis* Kolenati, 1857 : 60 ; Hiregaudar and Bal, 1955 : 221 , 1956 : 86 ; Rudnick, 1960 : 180-182 ; Delfinado and Baker, 1963 : 911-913 ; Prasad, 1974 : 69. (T. L. — Egypt ; Host—*Rousettus aegypticus*).*Meristaspis taprobanius* Turk, 1950 : 73.*Meristaspis lateralis ceylonicus* Turk, 1950 : 73.*Host* : *Rousettus leschenaulti leschenaulti* Desmarest.*Host range* : *Rousettus leschenaulti*, *R. aegypticus*, *R. amplexicaudatus*, *Eidolon sebaeum*, *Eonycteris robusta*, *Cynopterus brachyotis*, *Tupaia* sp.Fig. 29. — *Meristaspis lateralis* Kolenati ♀, A. dorsal view. B. ventral view.

Material examined : Rajasthan : 25 ♂♂ 20 ♀♀, Z.S.I., DRS, Reg. No. Ent. 1296/A, Dist. Jhalawar, Gagrion Ka Kila, ca. 15 kms. from Jhalawar, 2. xii. 1975. Gujarat : 1 ♂, 2 ♀♀, Z.S.I., DRS, Reg.

No. Ent. 1297/A, Dist. Broach, June Masjid, Fort Parsiward, Broach, 15. ix. 1976 (*Sinha & Advani*).

Distribution of parasite : INDIA : Maharashtra, Gujarat, Rajasthan ; EGYPT ; PALESTINE ; YEMEN ; PHILIPPINES ; NEW GUINEA ; INDONESIA : North Borneo, Timor.

Remarks : The species is widely distributed in Oriental and part of Palaearctic and Ethiopian regions and occurs on multiple hosts. The record from Gujarat and Rajasthan is an addition to its distribution and fills a gap between middle east and south east Asia. The species has been characterised by Hiregaudar and Bal (*l.c.*) as well as Delfinado and Baker (*l.c.*, Philippine example). The following variation is observed between the above two descriptions and our specimens.

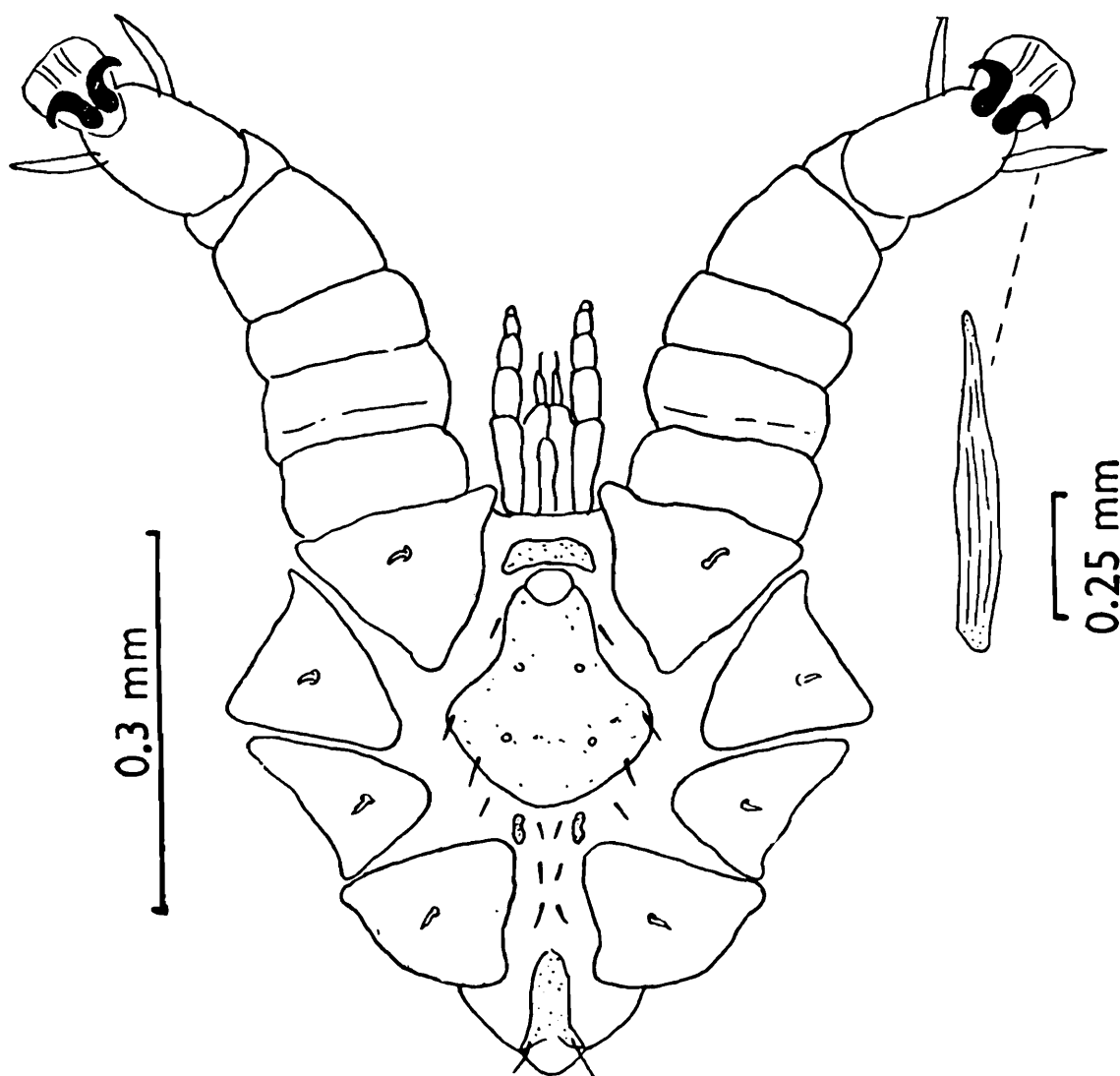


Fig. 30. — *Meristaspis lateralis* Kolenati ♂, A. ventral view.

Female :

(a) Size specimens on hand (in gravid) 0.75-0.81 mm long 0.54 mm wide — (non gravid) 0.55 mm long, 0.45 mm wide as against 0.68 mm long, 0.42 mm wide.

(b) Two minute chitinous rods behind the posterior end of sternal plate in ♀ present in Indian specimens, but absent in specimens from Philippines.

(c) Epigynial shield with a fan like anterior expansion is absent in Indian specimens but present in Philippine specimens.

The presence of 2 minute chitinous rods behind sternal plate in the Indian material, as reported by Hiregaudar and Bal (1956) from Bombay, and as also observed in present studies, distinguish the Indian specimens from specimens occurring in Philippines and Cyprus, Palestine.

Turk (1950) proposed the subspecies *ceylonicus* on the basis of differences in the length of dorsal setae and the shape of tritosternum. In the absence of material from different areas it is not possible to comment on subspecies. Delifinado & Baker (1963) have also ignored the subspecies *ceylonicus*. In view of the wide range of species, the subspecies *ceylonicus* is formally placed under synonymy now.

Genus *Parameristaspis* n. gen.

Type species : *Parameristaspis delfinadoi* n. sp.

Diagnostic characters : Anterior margin of dorsal shield surrounded by 4 pairs of setae. Peritreme restricted on dorsal surface. Leg I more stout than others. Claws of leg I not enlarged, similar to claws of legs II-IV, with well developed caruncles. Tarsus I with a pair of normal slender setae. Tritosternum distinct, well developed, as long as wide. Anal shield without postanal seta.

Distribution : Oriental region (India).

Affinities : The new genus *Parameristaspis* is found on fruit bats (Megachiroptera) like the species of genus *Meristaspis*, but differs from it in the setae of anterior tarsus I being slender as in *Eyndhovenia* Rudnick, it also differs from the latter in having 4 pairs of setae surrounding the anterior margin of dorsal shield as in *Meristaspis*, as against 5 pairs of setae. The genus *Eyndhovenia* is reported to be confined to insectivorous bats (Microchiroptera) of family Rhinolophidae (vide Radovsky, 1967). Radovsky (1967) states that there is correlation between spinturnicid genera and host bat families with few exceptions. In this case the *Parameristaspis* may be treated as exclusive on the bats of family Pteropidae.

***Parameristaspis delfinadoi* n. sp.**

(Figs. 31 & 32)

Host : *Rousettus leschenaulti leschenaulti* Desmarest.

Holotype : ♀ Regd. No. 3050/17 (on slide) : Gujarat : Dist. Broach, Juna Masjid, Parsiward, Broach, 15.ix.1976 ; *Paratypes* 3 ♀ ♀, Z.S.I. DRS, Reg. No. Ent. 1288/A same particular as holotype ; Rajasthan : 4 ♀ ♀, Z.S.I., DRS, Reg. No. Ent. 1289/A, Dist. Jhalawar, Gagron Ka Kila, ca. 15 kms from Jhalawar, 2.xii.1975. In National Collections of Zoological Survey of India, Calcutta.

Distribution of parasite : INDIA : Gujarat, Rajasthan.

Female : *Idiosoma* : Dorsal view-broadly ovate, opisthosoma not expanded, 0.530-0.541 (0.532 avg.) long and 0.370-0.373 (0.371 avg.)

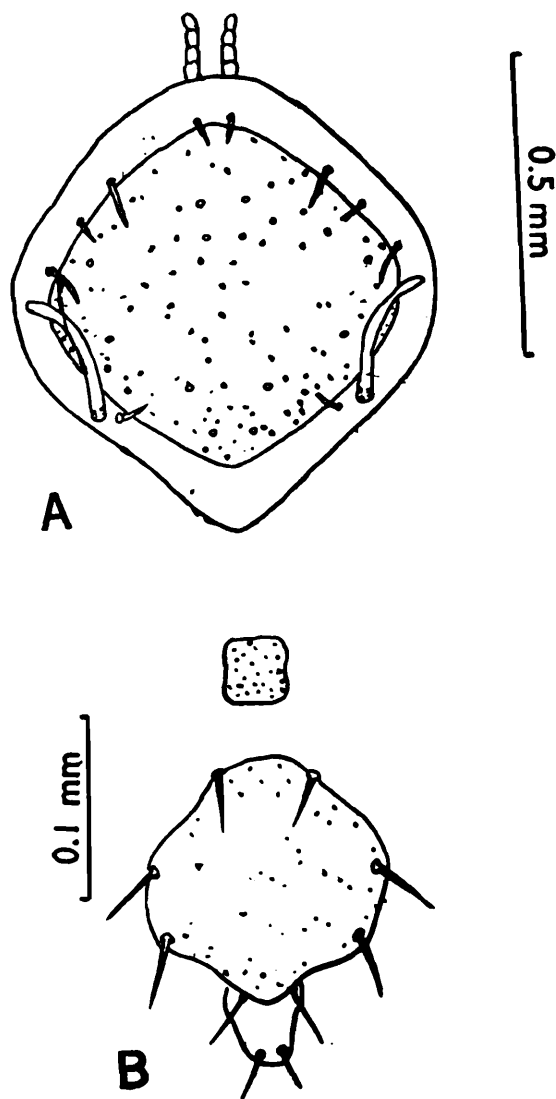


Fig. 31. — *Parameristaspis delfinadoi* n. sp. ♀, A. dorsal view B. tritosternum, sternal shield and epigynial plate.

wide. Dorsal shield as long as wide or slightly longer ; 4 pairs of setae surrounding dorsal shield, anterior to peritreme ; 10-11 pairs of pores present. Peritreme long, lying over entire length of coxa III.

Ventral view : Tritosternum in the form of a square (with side margins concave, in some paratype specimens), situated exactly in the middle of the space between first pair of coxae ; sternal shield flask shaped and slightly protuded posteriorly, with 3 pairs of setae. Epigynial shield triangular with rounded posterior lobe, bearing two setae. Anal shield small, without post anal seta.

Gnathosoma : Chelae large beset with teeth on lateral apical tip. Palps cylindrical, 4 segmented.

Legs : Leg I strongest, claws I not enlarged and caruncles well developed, tarsus I with slender normal pair of long setae. Legs II-IV, similar to leg I, except being less wide. Femur I with 2 very long,

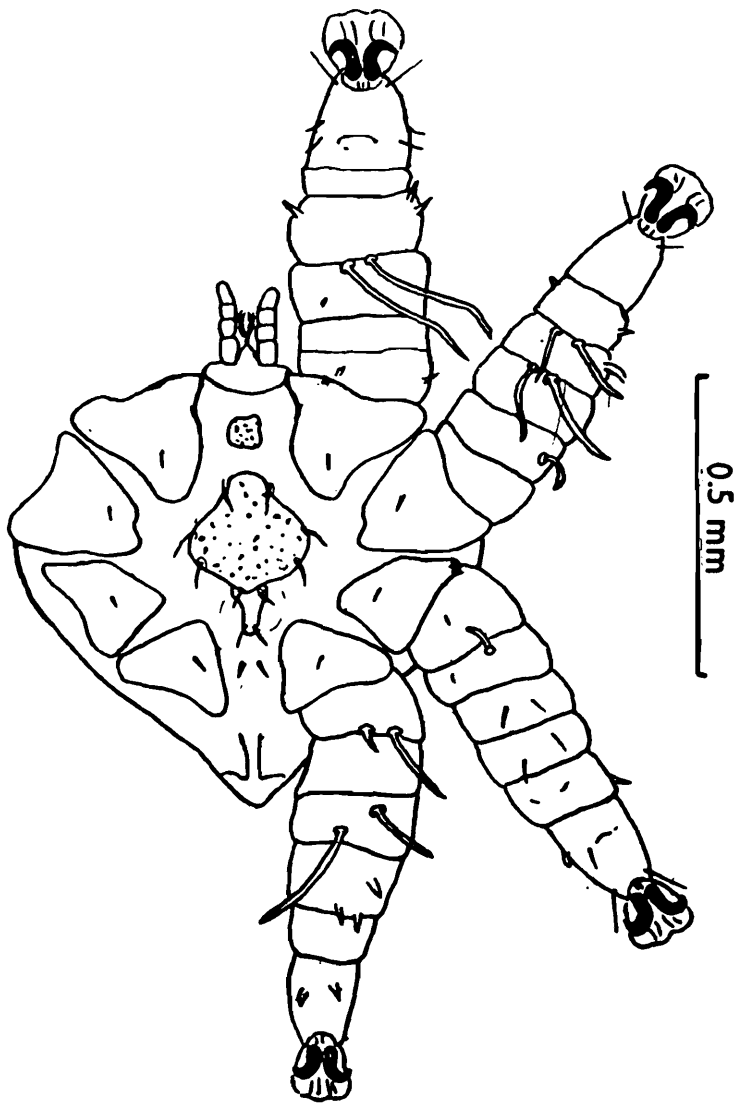


Fig. 32. — *Parameristaspis delfinadoi* n. sp. ♀, ventral view.

curved setae, serrated on inner margin. Femur II with 4 long setae. Some recurved small spines present on genu I and II. Ventrally, legs with small setae.

Affinities : This species appears to form a link between the genera *Meristaspis* and *Eyndhovia*. Like the former it was collected on a

species of fruit bats, but differs from it in the setae of the anterior tarsi being slender as in *Eyndhovia*. This species has 4 pairs of setae surrounding the anterior margin of dorsal shield as against five pairs in *Eyndhovia*.

The species is named after Dr. M. D. Delfinado for his contributions in systematic studies of parasitic mites.

Genus *Spinturnix* von Heyden

Spinturnix von Heyden, 1826 : 12 ; Rudnick, 1960 : 200 ; Delfinado and Baker, 1963 : 906.

Type species : *Pteropus myoti* Kolenati, 1856 : Designated by opinion 128 International Commission on Zoological Nomenclature, 1936.

Distribution : Throughout world.

Remarks : The genus is represented in India by only 2 species namely *Spinturnix psi* Kolenati (*vide* Hiregaudar and Bal) and *S. pindarensis* Bhat (1973). Allred (1969) reported two more species *S. nudatus* Allred and *S. plecotinus* (Koch) from Pakistan. The present studies with the addition of 2 new species raise the number of species to 4 within Indian limits.

KEY TO THE SPECIES OF *SPINTURNIX* KNOWN FROM INDIA & PAKISTAN

1. Terminus of dorsum without any setae ... *nudatus* Allred
 Terminus of dorsum with setae ... 2
2. Terminus of dorsum with 4-6 setae, usually
 4 ... 3
 Terminus of dorsum with more than 6
 setae. ... 4
3. Female sternal plate broader than long,
 with rounded anterior margin ; tritosternum
 absent ; terminus of dorsum with more
 than 4 setae, irregularly arranged. Male
 sternal plate flask shaped, posterior margin
 broadly rounded. ... *bakeri* n. sp.
 Female sternal plate differently shaped,
 longer than broad, conical ; tritosternum
 present ; terminus of dorsum with 4 setae
 arranged transversely. Male sternal plate
 differently shaped, narrowed at base. ... *rudnicki* n. sp.
4. Terminus of dorsum with 6-8 setae. ... *plecotinus* (Koch)
 Terminus of dorsum with numerous setae ... 5

5. *Opisthosoma* with long setae ; female sternal shield ovoid ; male sternal shield with 4 pairs of setae. *pindarensis* Bhat

Opisthosoma with short setae ; female sternal shield flask shaped, male sternal shield with 5 pairs of setae. *psi* Kolenati

***Spinturnix bakeri* n. sp.**

(Figs. 33 & 34)

Host : *Pipistrellus dormeri dormeri* Dobson

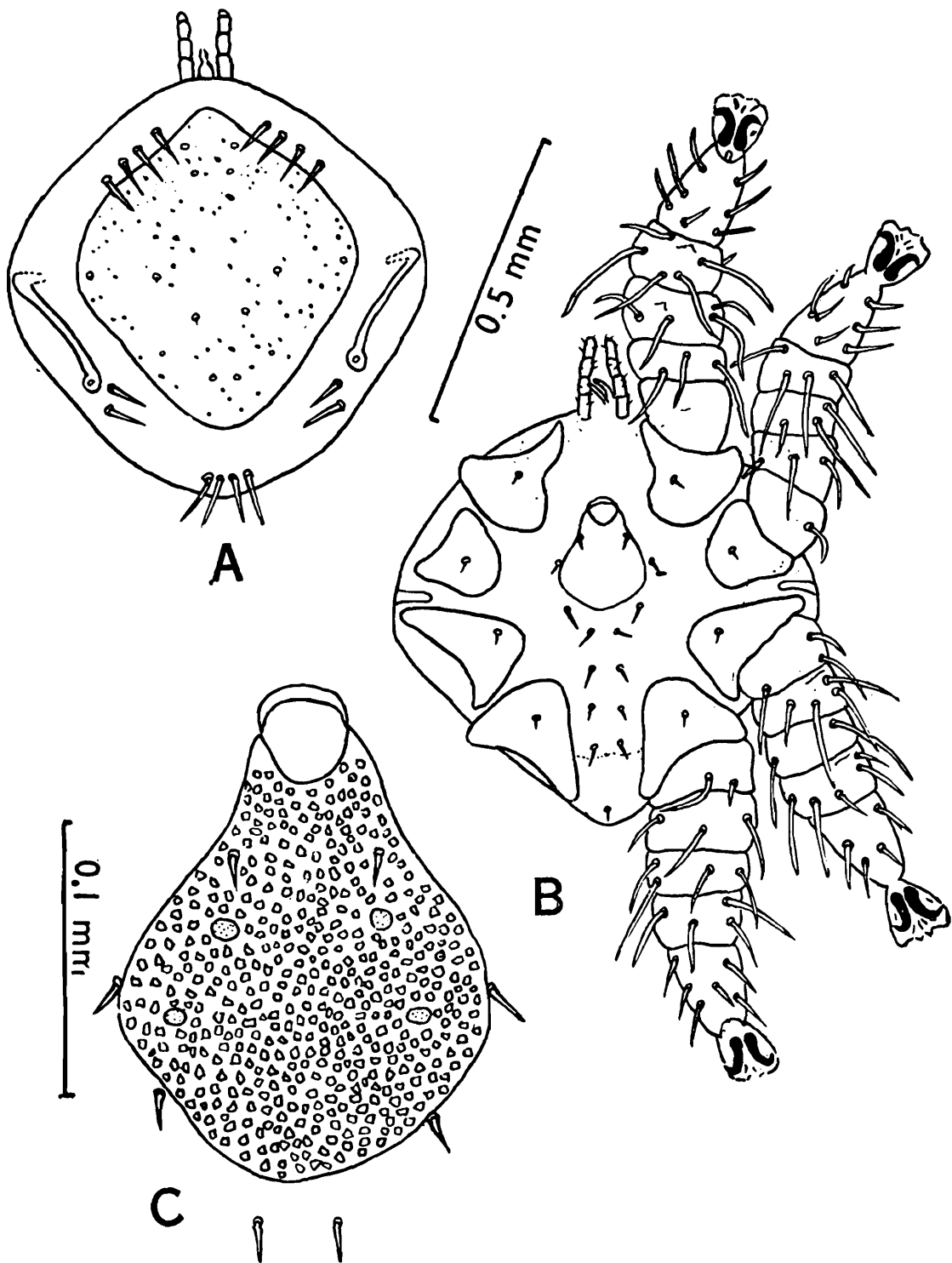


Fig. 33. — *Spinturnix bakeri* n. sp. ♂, A. dorsal view B. ventral view C. sternal shield.

Holotype : ♂ Regd. No. 3051/17 : Rajasthan : Dist. Jodhpur, Bajalai Palace (ca. 15 kms from Jodhpur) 12.vii.1976 (*Rathore & Advani*)
Paratypes : 8 ♂♂, 4 ♀♀, Z.S.I., DRS, Reg. No. Ent. 1291/A with same particulars as holotype in National Collections of Zoological Survey of India, Calcutta.

Distribution of parasite : INDIA : Rajasthan (Jodhpur).

Male : Dorsal surface : Idiosoma subspherical with small opisthosoma, measuring 0.69-0.72 mm in length, 0.52-0.54 mm in width. Dorsal shield elongate oval, with 10-12 pairs of pores ; 4 pairs of setae surrounding anterior margin of shield ; a row of 3-4 setae posterior to stigmata. Peritreme long, bending ventral between coxae II and III.

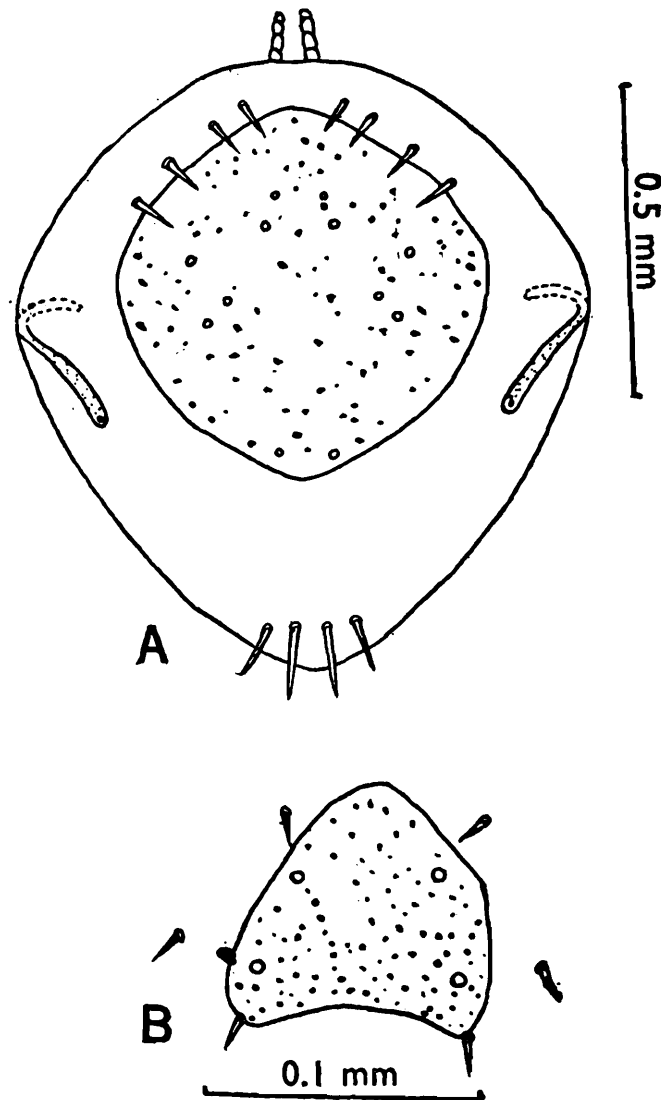


Fig. 34. — *Spinturnix bakeri* n. sp. ♀, A. dorsal view B. sternal shield.

Ventral surface : Chelicerae long, slender. Spermatophoretrager stout, curved towards apex. Tritosternum not visible. Sternal shield longer than broad (18×14), flask shaped with posterior margin broadly rounded ; with reticulated pattern as illustrated ; 3 pairs of sternal setae present, only 1st pair on sternal shield. Anal shield with terminal

opening, short postanal seta present. Legs : Stout, approximate, subequal in width and length, 35:32 : 30:34, covered with long and barbed setae on dorsal and ventral surfaces.

Female : Idiosoma 0.85-0.92 mm long, 0.72-0.74 mm broad. All other characters same as in male excepting sternal shield broader than long, flattened, rounded anteriorly and concave posteriorly, with 3 pairs of ventral setae and 2 pairs of pores.

Affinities : The species resembles *nudatus* Allred in having short and broad genital and sternal plates of ♂ and ♀ and 3 pairs of setae on or off these shields. It can be differentiated from *nudatus* in having (i) 4 setae on terminus of opisthosoma as against naked. (ii) the lateral expansions of sternal shield of male being absent, (iii) shape of sternal plate of female. It can also be distinguished from *Spinturnix rudnicki* (i) in lacking tritosternum (ii) shape of different sternal shields in male and female.

Bio-ecology : The host bats *P. dormeri* were collected from a hole in the wall. The bats were highly infested with a species of macro-nyssid mite, a cimicid bug and an argasid tick along with this species. The species is named after Dr. E. W Baker of USA in recognition of his contribution towards taxonomic studies of the family Spinturnicidae.

***Spinturnix rudnicki* n. sp.**

(Figs. 35 & 36)

Host : *Scotophilus heathi heathi* Horsefield

Holotype : ♂ Reg. No. 3052/17 : INDIA : Gujarat : Dist. Broach, Rajpipla ca. 70 kms from Broach, 17. ix. 1976 (*Sinha & Advani*). *Paratypes* : 4 ♂♂, 3 ♀♀, Z.S.I., DRS, Reg. No. Ent. 1290/A with same particulars as holotype in National Collections of Zoological Survey of India, Calcutta.

Distribution of parasite : INDIA : Gujarat (Broach Dist.). Male : Dorsal surface : Idiosoma : subspherical with narrow opisthosoma, measuring 0.93 to 0.96 mm in length and 0.71 to 0.72 mm in width. Dorsal shield elongate oval, 0.73×0.48 mm, with 10 pairs of pores ; 4 pairs of setae surrounding anterior margin of dorsal shield. A row of setae posterior to stigmata. Peritreme, long bending, ventrad between coxae II and III. Ventral surface : Tritosternum small, flat. Sternal shield asymmetrical, reticulate, longer than broad (0.26×0.135 mm), with posterior margin lobed, lateral margins sinuate ; with 3 pairs

of sternal setae, only 1st pair on the sternal shield. Anal shield with terminal opening, short postanal seta present.

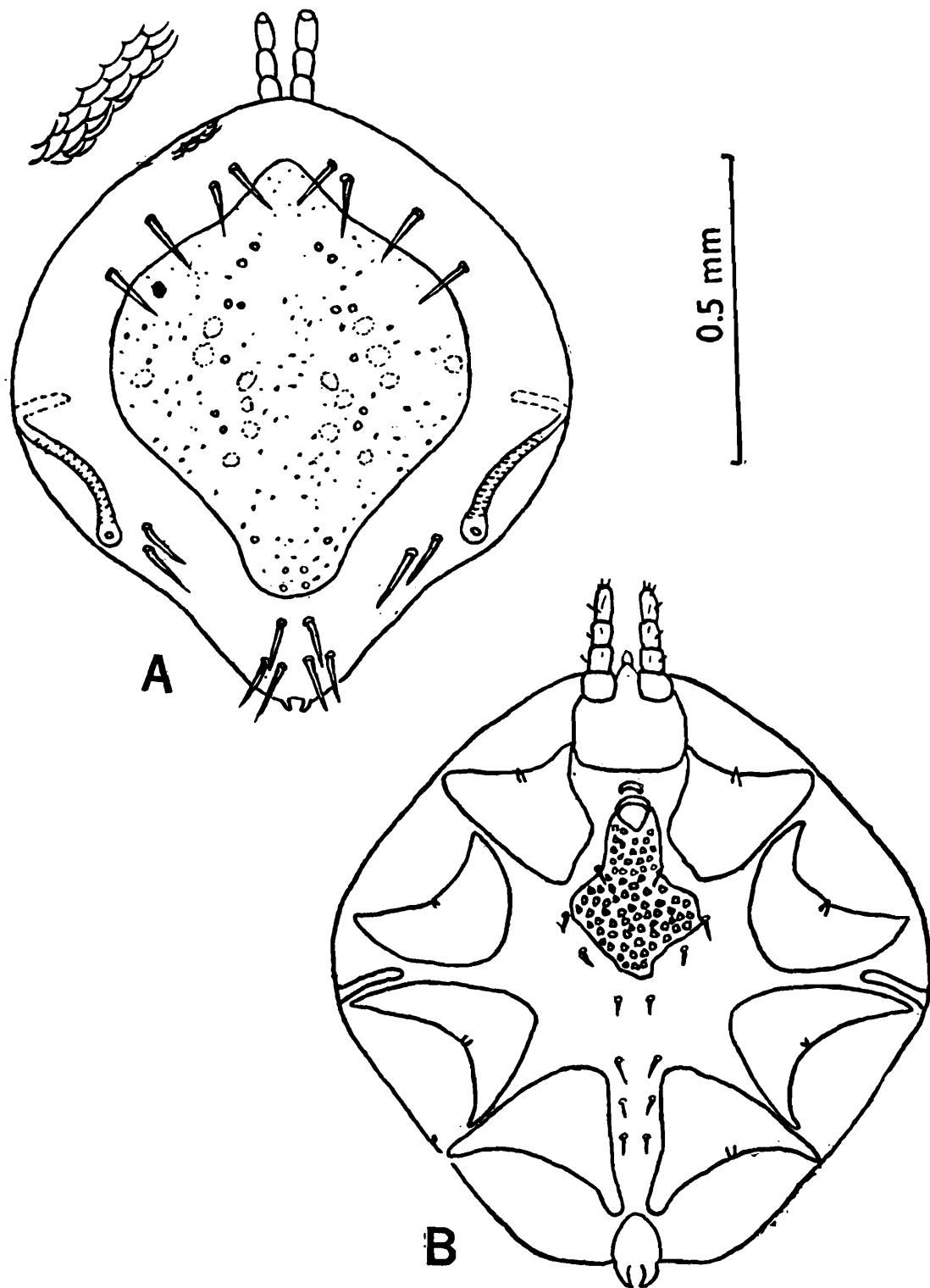


Fig. 35. — *Spinturnix rudnicki* n. sp. ♂ A. dorsal view B. ventral view.

Legs : Stout, proportions of lengths of legs I-IV 53 : 43 : 43 : 50, long and curved spines present on all legs on dorsal and lateral surfaces.

Female : Idiosoma 1.05-1.29 mm in length, 0.81-0.98 mm in width. Dorsal shield 0.59-0.61 mm long, 0.40-0.54 mm broad, opisthosoma with 4 setae in the form of a transverse row at terminus. Sternal shield longer than broad, with anterior margin produced anteriorly and pointed ; 3 pairs of setae on sternal plate.

Affinities : The species closely resembles *psi* (Kolenati) in general shape of sternal shield (longer than wide) in male but differs from it in having (i) 3 pairs of sternal setae as against 5 pairs. (ii) 1st pair of sternal setae placed laterally on the margin of the shield, while in *psi* it is off the shield, (iii) sternal shield of ♀ produced into a long pointed prolongation as against no such process in *psi*, (iv) the host being *Scotophilus heathi* as against *Miniopterus* spp. (*fuliginosus* in India).

The species is named after Dr. A. Rudnick for his contribution to the taxonomic studies of World Spinturnicidae.

FAMILY MACRONYSSIDAE Oudemans

Mites referable to this family are highly adapted for parasitic mode of life as evidenced by weak sclerotization, long and slender legs.

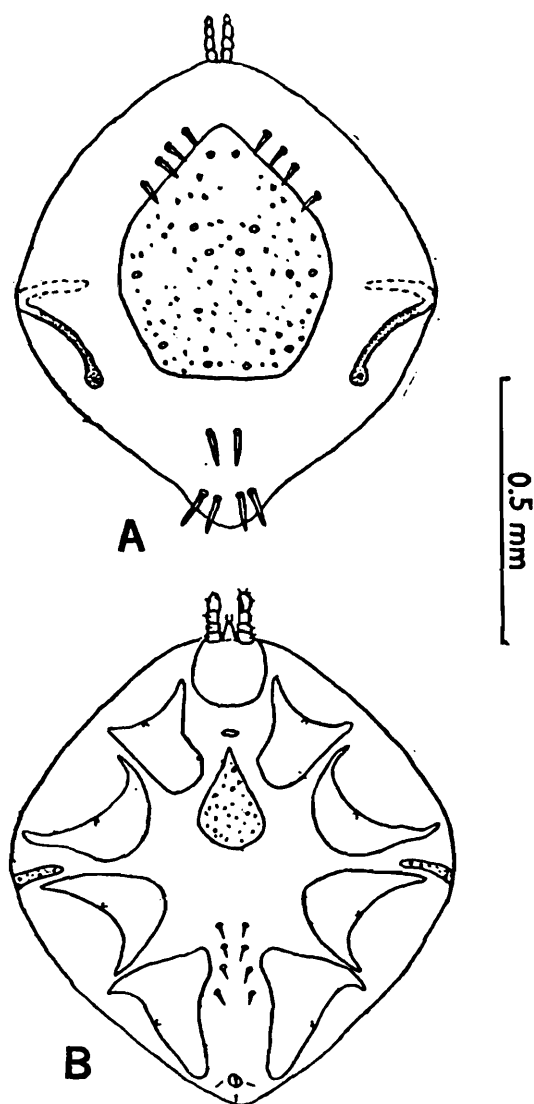


Fig. 36. — *Spinturnix rudnicki* n. sp., ♀ A. dorsal view B. ventral view.

In India, this family is represented by 5 genera and 10 species, of which 6 are restricted on bats and 4 on birds (*vide* Prasad, 1974). With the addition of 4 new species during these studies, the number of

species is raised to 10 on bats from India. Allred (1969, 1975) added 3 other species from Pakistan and thus, the total of 17 species of this family are known from India and Pakistan. The key to all the 13 species recorded on bats from India and Pakistan is provided. The terminology used has been adapted from Radovsky (1967).

KEY TO GENERA OF MACRONYSSIDAE KNOWN FROM INDIA ON BATS

FEMALES

1. Dorsal armature with 2 plates podosomal and opisthosomal, contiguous or separated by a narrow strip of striate integument. *Steatonyssus* Kolenati
 Dorsal armature comprising a single plate fused podosomal and opisthosomal plates. 2
2. Ventral process of palpal trochanter ridge like, arising along most of length of segment; sternal glands present; setae S8 present, but minute. *Macronyssus* Kolenati
 Ventral process of palpal trochanter blade like, arising on distal half of trochanter only; sternal glands absent; setae S8 generally absent, or not easily differentiated. *Parasteatonyssus* Radovsky

MALES

1. Palpal trochanter with well developed ridge like ventral process, setae S8 present. ... *Macronyssus* Kolenati
 Palpal trochanter rarely with ridge like ventral process; S8 present or absent, but if small process present on palpal trochanter then S8 absent. ... 2
2. Membranous process present on movable chela between dorsal arm and spermatodactyl, setae S8 present or absent; setae F1 normal. *Steatonyssus* Kolenati
 Membranous process absent on movable chela between dorsal arm and spermatodactyl; setae S8 absent; setae F1 sometimes 'T' shaped. *Parasteatonyssus* Radovsky

Genus *Steatonyssus* Kolenati

Steatonyssus Kolenati, 1858 : 8 ; Willmann, 1936 : 150-153 ; Radovsky, 1967 : 188-191.
Ceratonyssus Ewing, 1923 : 6.

Type species : *Steatonyssus periblepharus* Kolenati, 1858 (by subsequent designation *vide* Till & Evans, 1964 : 517-19).

Distribution : Worldwide.

The genus is divided into 2 subgenera only, the nominotypical subgenus occurs in India.

Subgenus *Steatonyssus*

*KEY TO THE SPECIES OF *STEATONYSSUS* KNOWN FROM INDIA AND PAKISTAN

1. Opisthosomal plate with 10 or more pairs of setae. ... 2
Opisthosomal plate with 4 to 7 pairs of setae. ... 3
2. Podosomal plate with 11 pairs of setae, opisthosomal plate with 11 pairs + 1 setae. *crassisetosus* Till & Evans**
Podosomal plate with 12 pairs of setae, opisthosomal plate with 10 pairs of setae. *decisetosus* n. sp.
3. Opisthosomal plate with 4 pairs of setae. ... *quadrisetosus* n. sp.
Opisthosomal plate with 5-7 pairs of setae. ... 4
4. Opisthosomal plate with 5 pairs of setae ; S8 absent. ... *allredi* n. sp.
Opisthosomal plate with 7 pairs of setae ; S8 present. ... 5
5. Peritreme not extending beyond anterior margin of coxa III. ... *heterovenralis*** Ah & Radovsky
Peritreme terminating over coxa II. ... 6
6. Sternal plate with St 1 markedly reduced, usually less than one-third, but rarely less than one half the length of St. 3. ... *periblepharis* Kolenati**
St 1 not much reduced, more than one-half length of St. 3. ... *javensis* Oudemans

Steatonyssus decisetosus n. sp.

(Figs. 37 & 38)

Host : *Scotophilus heathi heathi* Horsefield

Holotype : ♀, Reg. No. 3053/17. INDIA : Gujarat : Dist. Broach, Rajpipla, ca. 70 kms from Broach, 17. ix. 1976 (*Sinha & Advani*). *Paratypes* : 4 ♀ ♀, Z.S.I. DRS. No. Ent. 1266/A with same

**Steatonyssus hubli* is not included in the key due to inadequacy of description.

**Species reported from Pakistan *vide* Allred (1969, 1975).

particulars as holotype, in National Collections of Zoological Survey of India, Calcutta. 23 nymphs also present in the same collection.

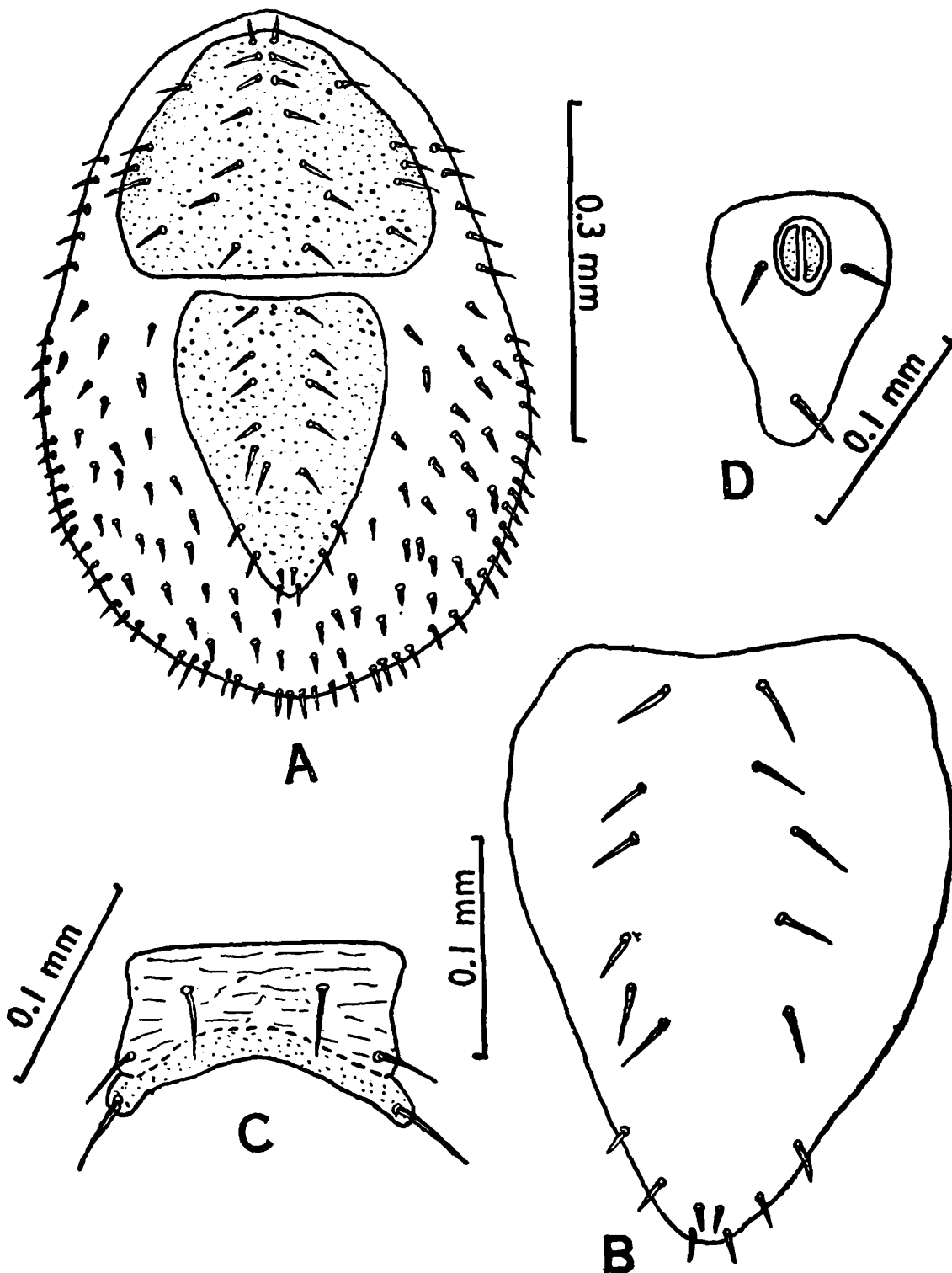


Fig. 37. — *Steatonyssus decisetosus* n. sp., ♀ A. dorsum B. opisthosomal plate C. sternal plate D. anal plate.

Distribution of parasite : INDIA : Gujarat (Broach).

Female : Dorsal surface : Idiosomal length 0.69-0.74 mm. Podosomal plate about as long as broad, 0.27×0.25 mm, with 12 pairs of setae, seta V not reduced, about subequal to the length of D1. Opisthosomal plate slightly narrower than podosomal plate, 0.33 mm long 0.23 mm broad in anterior half ; with 19 setae and S8 present ; M10 subequal to M11. Setae of unarmed dorsum, slightly long, sparse, tapering at

tip. Longest caudal setae .05 mm. Ventral surface : Sternal plate with posterior band sclerotized, St 1 smaller than St 3. Epigynial plate ovoid, slightly longer than broad 0.13 mm $\times$.09 mm, with slightly curved anterior margin and round posterior margin, anal ring large and elongated, adanal setae at the level of the ring. Metapodal plates inconspicuous. Peritreme narrow extending from posterior margin of coxa III to anterior margin of coxa I, setae on unarmed ventral opisthosoma slightly thinner than on dorsal surface.

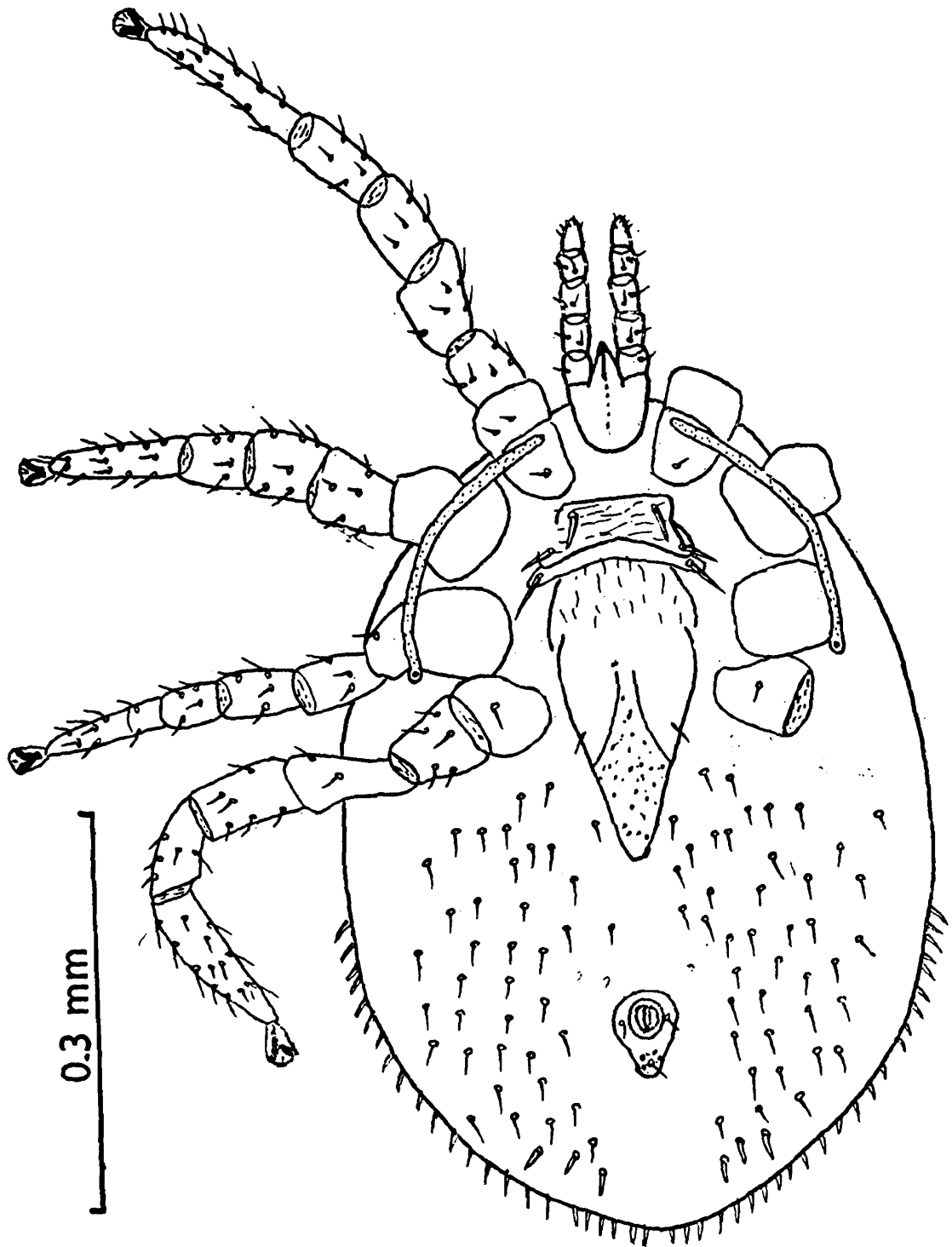


Fig. 38. — *Steatonyssus decisetosus* n. sp., ♀ A. venter.

Legs : Long and slender. Leg I not as stout as leg II, Coxa III without any spores. Leg I 0.61 mm long, tarsus I, 0.18 mm long.

Affinities : This species is very close to *faini* Delfinado, 1960 in having (i) 12 pairs of setae on podosomal plate, (ii) adanal setae at the level of anal ring and (iii) more than 7 pairs of setae on opisthosomal plate. However, it differs from it in having (i) 19 setae on opisthosomal plate as against 15 to 17, (ii) sternal plate with posterior band sclerotized as against without such band, (iii) the host of this species is *Scotophilus heathi heathi* as against *Scotophilus temmincki* Horsefield.

***Steatonyssus quadrisetosus* n. sp.**

(Figs. 39 & 40)

Host : *Pipistrellus dormeri dormeri* Dobson.

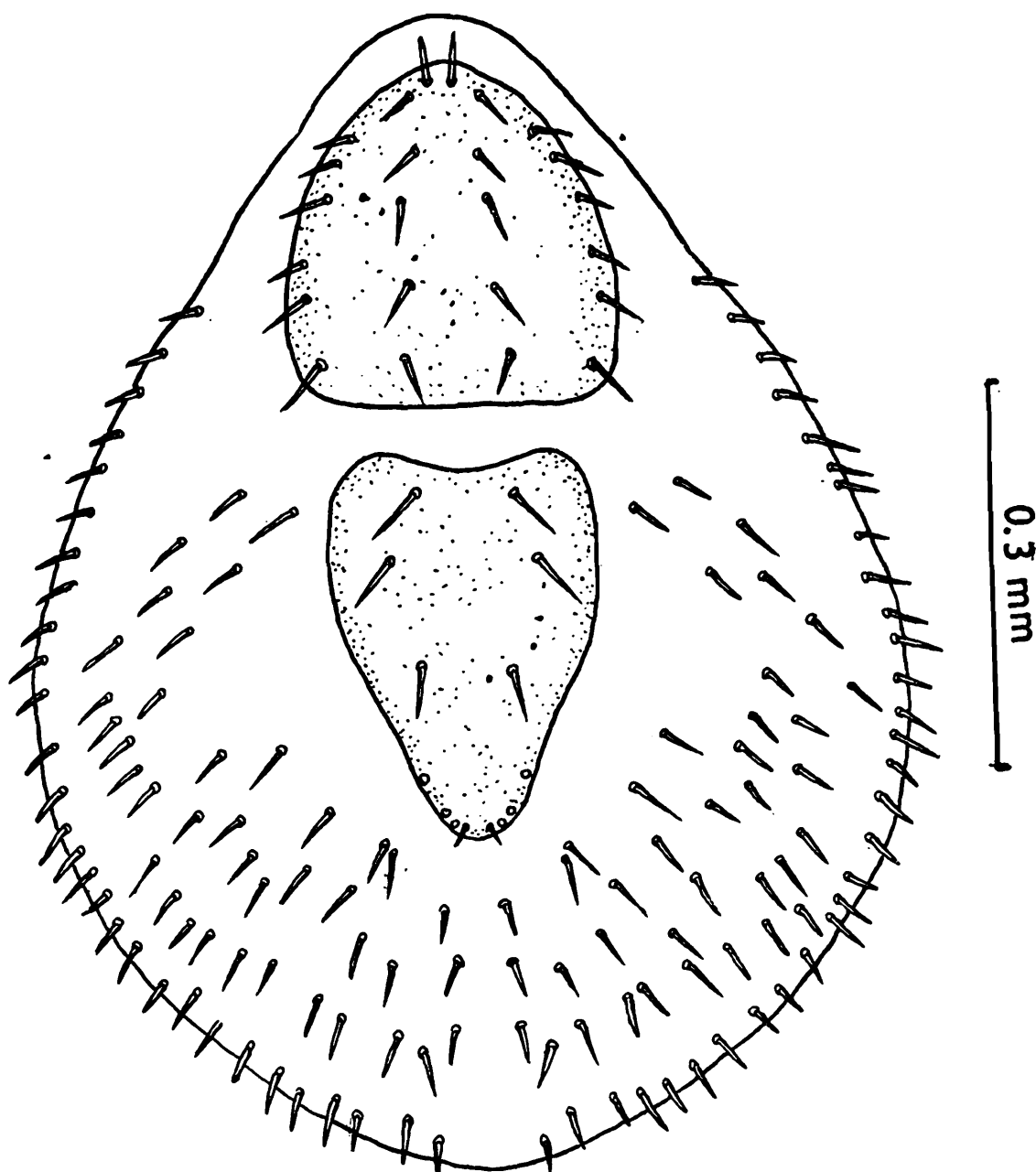


Fig. 39. — *Steatonyssus quadrisetosus* n. sp., ♀ A. dorsum.

Holotype : ♀, Reg. No. 3047/17, Gujarat : Dist. Broach, Fata-talab, Broach, 16.ix.1976 (*Sinha & Advani*). *Paratypes* : 4 ♀ ♀, Z.S.I.,

DRS, Reg. No. Ent., 1268/A, of same locality ; in the National Collections of Zoological Survey of India, Calcutta. 1 nymph also present in same collection.

Distribution of parasite : INDIA : Gujarat : Broach.

Female : Dorsal surface : Idiosomal length 0.75-1.11 mm, width 0.46-0.76 mm. Podosomal plate as long as wide, 0.30×0.30 mm separated from opisthosomal plate by a distinct band of striate integu-

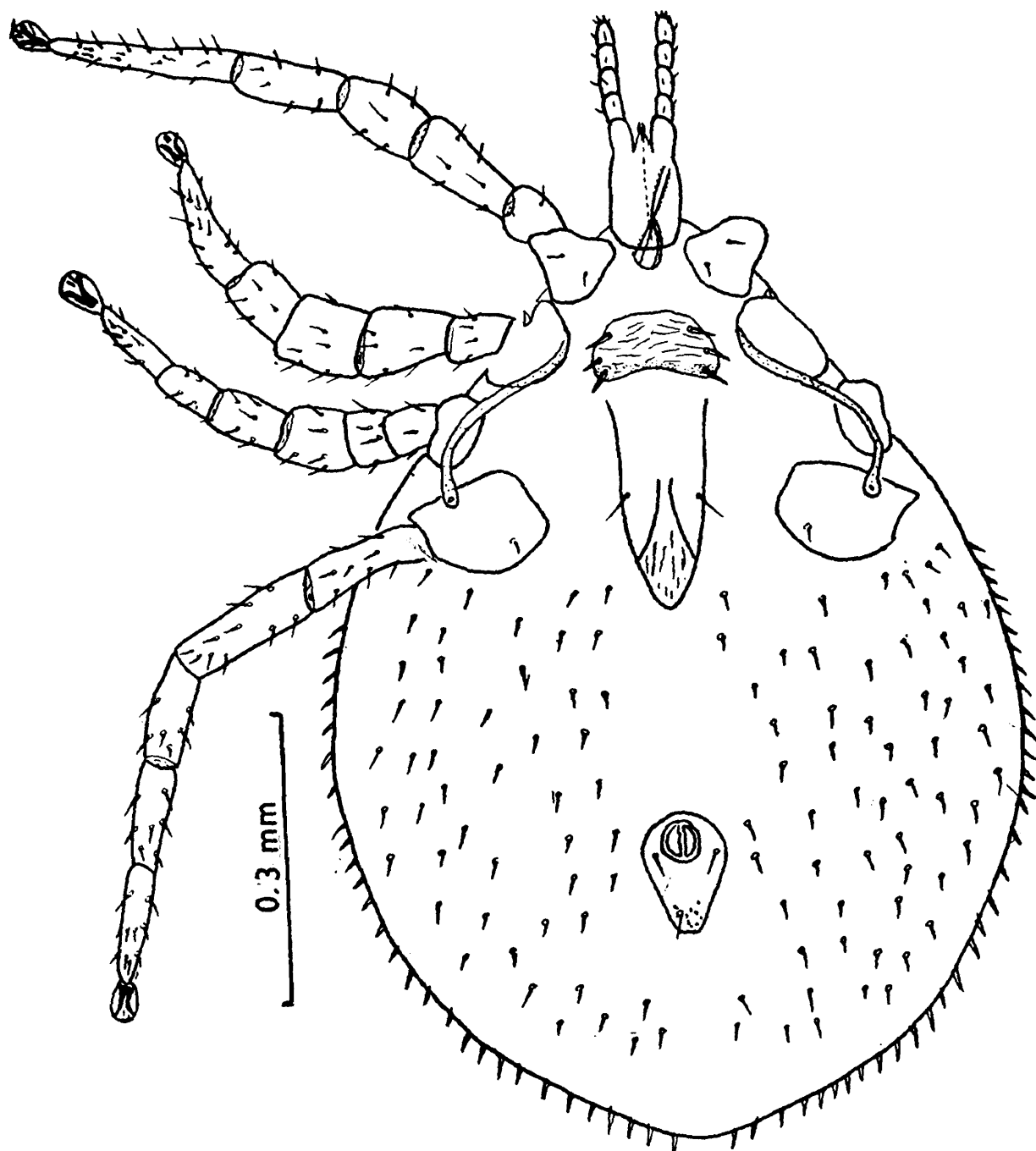


Fig. 40. — *Steatonyssus quadrisetosus* n. sp., ♀ A. venter.

ment, with 10 pairs of setae ; V being absent. Opisthosomal plate moderately broader in anterior half, gradually tapering in posterior half ; about 1.5 times as long as wide, 0.31×0.22 mm ; with 4 pairs of setae, first 3 pairs longer and more distinct than 4th pair (S8) minute,

situated at sides of posterior margin of plate. Setae on unarmed dorsum dense, cylindrical and tapering.

Ventral surface : Peritreme narrow, crossing over the coxa III but hardly reaching upto posterior margin of coxa II. Sternal plate broader than long, with posterior band sclerotized, St 1 slightly smaller than St 3. Epigynial plate 0.27×0.09 mm., tapering posteriorly with blunt tip. Anal plate 0.16×0.09 mm, oval with rounded anterior margin ; anal ring rounded ; adanal seta at the level of the ring. Venter of unarmed opisthosoma sparsely setosed in comparison to dorsum, longest caudal seta 0.08-0.09 mm.

Legs : Long and slender, Leg I thinner than leg II ; measures 0.68-0.72 mm long ; tarsus I 0.18-0.19 mm.

Affinities : The species comes near to the new species *allredi*, but differs from it in having (i) 4 pairs of setae on opisthosomal plate, the last one at the tip of plate being very minute as against 5 pairs of setae on the opisthosomal plate and the last moderately long, (ii) peritreme crossing the coxa III but hardly reaching upto the posterior margin of coxa II as against peritreme extending beyond the middle of coxa I, (iii) posteriorly epigynial plate more tapering, (iv) different shape of opisthosomal plate.

***Steatonyssus allredi* n. sp.**

(Figs. 41, 42, 43 & 44)

Host : *Taphozous longimanus longimanus* Hardwicke.

Holotype : ♀, Reg. No. 3048/17, Gujarat : Dist. Baroda, Karaili Bagh, Baroda, 11.ix.1976 (*Sinha & Advani*). **Paratypes :** 2 ♀ ♀, Z. S. I., DRS, Reg. No. Ent. 1267/A, with same particulars as holotype in National Collections of Zoological Survey of India, Calcutta. 6 nymphs also present in the above collections.

Distribution of parasite : INDIA : Gujarat (Baroda).

Female : Dorsal surface : Idiosomal length 1.08-1.11 mm, breadth 0.53-0.54 mm. Podosomal plate as long as wide, 0.27×0.27 mm ; with 10 pairs of setae, setae V being absent. Opisthosomal plate about twice as long as wide, 0.36×0.18 mm very narrow, posterior 1/3 with subparallel lateral margins ; with 5 pairs of moderate setae, S8, M10 and M11 absent. Setae on unarmed dorsum and margins long, stout, smooth, cylindrical and tapering to point.

Ventral surface : Peritremes narrow, terminating over coxa 1. Sternal plate broader than long, with posterior band sclerotized. St. 1

smaller than St. 3. Epigynial plate 0.29×0.05 mm, narrow, with blunt tip. Anal plate longer than broad, 0.12×0.07 mm, anterior

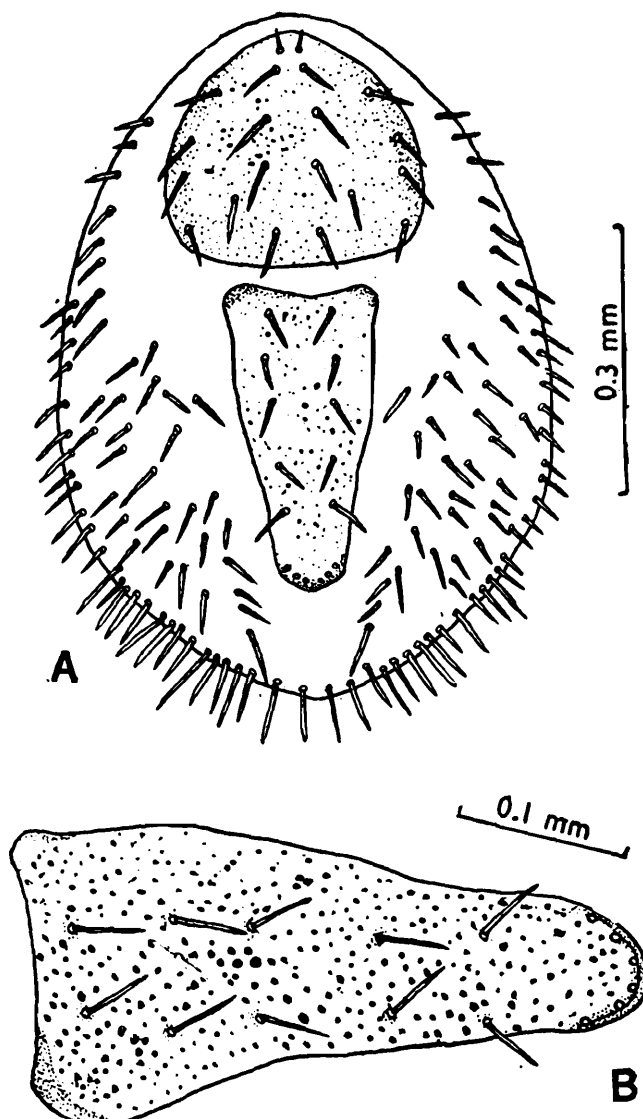


Fig. 41. — *Steatonyssus allredi* n. sp., ♀ (host *Taphozous longimanus*) A. dorsum B. opisthosomal plate.

margin rounded, posterior margin truncate, straight, anal ring large, elongate, adanal setae posterior to the ring. Metapodal plates inconspicuous. Venter of unarmed opisthosoma sparsely setosed, with shorter and less stouter setae than those on dorsum.

Legs : Long and slender. Leg I thinner than leg II, measuring 0.85-0.86 mm ; tarsus I 0.23 mm.

Affinities : The species runs to *S. benoiti* Till & Evans in the key to species (♀) (*vide* Radovsky, 1967), but differs from it in peritreme terminating over coxa I as against coxa II, and found on a different host viz., *Taphozous longimanus longimanus* Hardwicke (Emballonuridae) as against *Rhinolophus landeri lobarus* Blyth (Rhinolophidae).

Remarks : One more ♀ example collected on fruit bat *Rousettus leschenaulti* (Juna Masjid, Parsiward, Broach 15.ix.1976) very closely

resembles this species in the shape, number and arrangement of setae on podosomal and opisthosomal plates, but differs slightly in having (i)

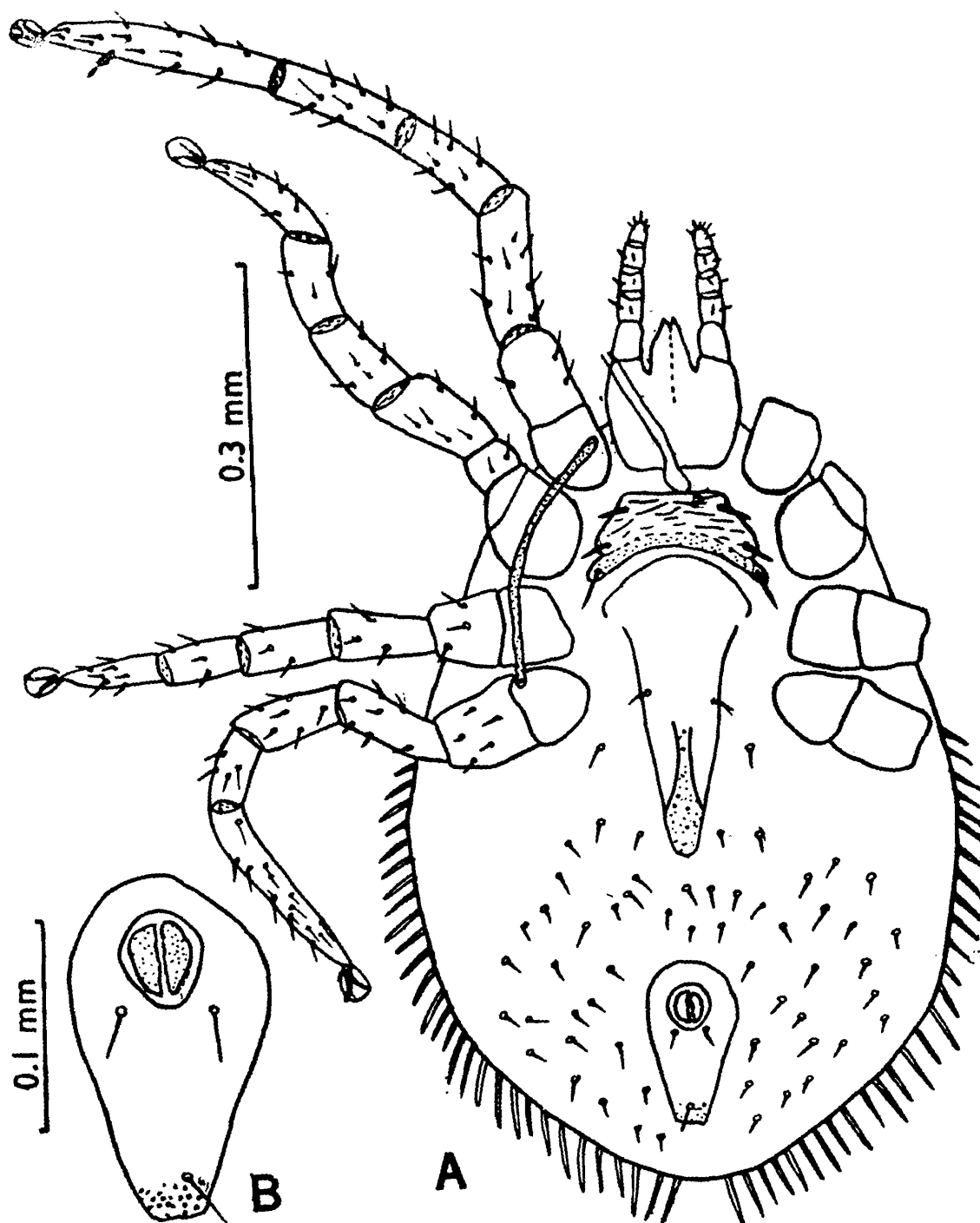


Fig. 42. — *Steatonyssus allredi* n. sp., ♀ (host *Taphozous longimanus*) A. venter B. anal plate.

body large, (ii) leg II longer, (iii) setation between epigynial and anal plate denser than that of *allredi*. (iv) peritreme extending upto middle of coxa I as against nearly reaching anterior margin of coxa I. This is not being described as a new species due to inadequacy of specimens and is provisionally referred to this species.

The species is named after Dr. D. M. Allred for his contribution towards studies of family Macronyssidae specially of Indian region.

Genus *Parasteatonyssus* Radovsky

Parasteatonyssus Radovsky, 1966 ; 98 ; 1967 : 185.

Type species : *Liponyssus nyctinomi* Zumpt and Patterson, 1951, by original designation.

Diagnostic characters : Some setae on idiosoma stout and lanceolate. Dorsal armature of both sexes undivided ; with about 20

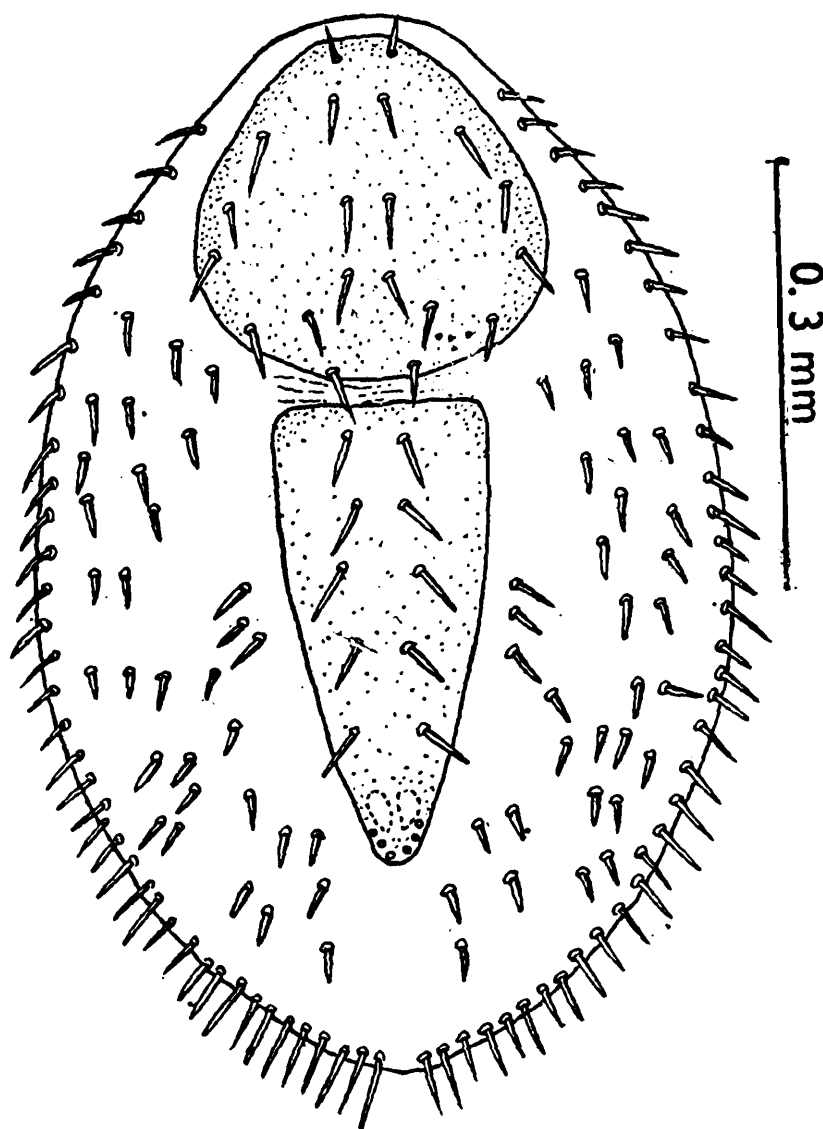


Fig. 43. *Steatonyssus allredi* n. sp., ♀ (host : *Rousettus leschenaulti*) A. dorsum.

to 25 pairs of setae ; S8 absent ; 2 or 3 setae present at the tip of dorsal plate. Sternal plate broad without a differentiating band along posterior margin. Female with a well developed ventral process on palpal trochanter.

The genus is represented by two species viz. *lingeraji* Hiregaudar and Bal and *jayanti* n. sp. in India. The former species was tentatively placed in this genus by Radovsky (1967) and this author did not include

former species in his key to World species due to inadequacy of original description. The host bat is *Tadarida aegyptiaca thomasi* in case of new species and *Taphozous longimanus* in case of *lingeraji*.

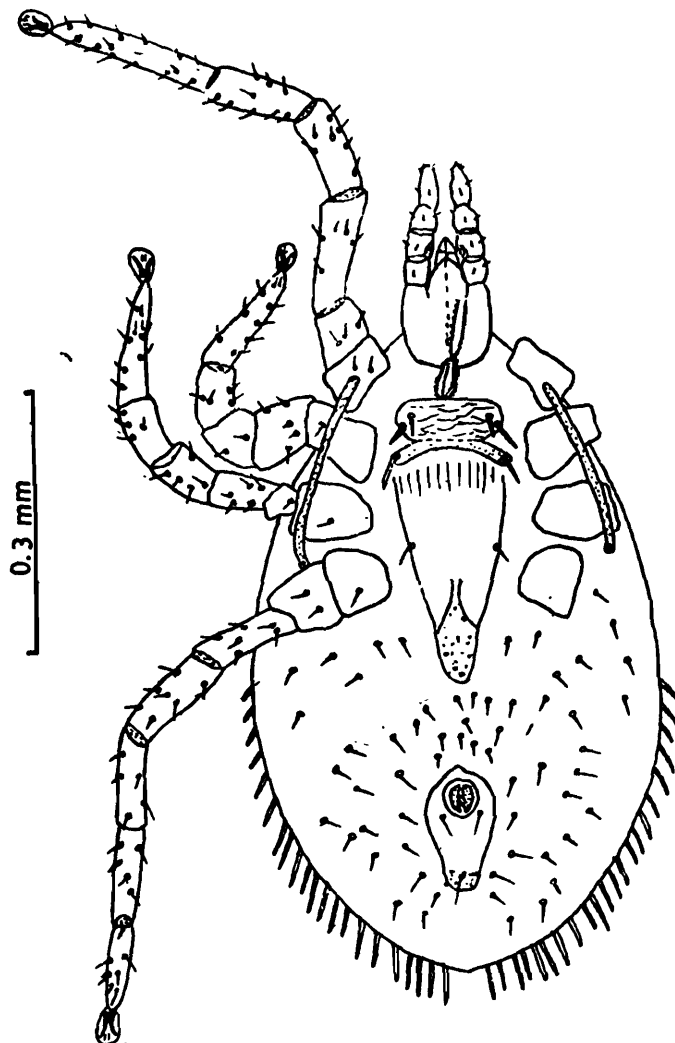


Fig. 44. *Steatonyssus allredi* n. sp., ♀ (Host : *Rousettus leschenaulti*) A. ventral view.

KEY TO THE SPECIES OF *PARASTEATONYSSUS* KNOWN FROM INDIA

Ventral armature of male narrowed in the posterior half, with 7 pairs of moderately long setae on lateral sides. ... *lingeraji* Hiregaudar & Bal

Ventral armature of male broadened in the posterior half, with 10 pairs of small setae on lateral sides. ... *jayanti* n. sp.

Parasteatonyssus jayanti n. sp.

(Figs. 45, 46 & 47)

Host : *Tadarida aegyptiaca thomasi* Wroughton

Holotype : ♀, Reg. No. 3049/17, Rajasthan : Jodhpur, 16.8.1976 (Advani). Paratypes 1 ♂, 3 ♀♀, Z.S.I., DRS, Reg. No. Ent. 1304/A, from same locality in the National Collections of Zoological Survey of India, Calcutta.

Distribution of parasite : INDIA : Rajasthan (Jodhpur)

Female : Idiosoma $0.72-0.73 \times 0.48-0.49$ mm. Dorsal plate 0.56 mm long and 0.28 mm wide, with 24 pairs of setae, tapering to a rounded tip covering major portion of dorsum lengthwise, unprotected dorsum

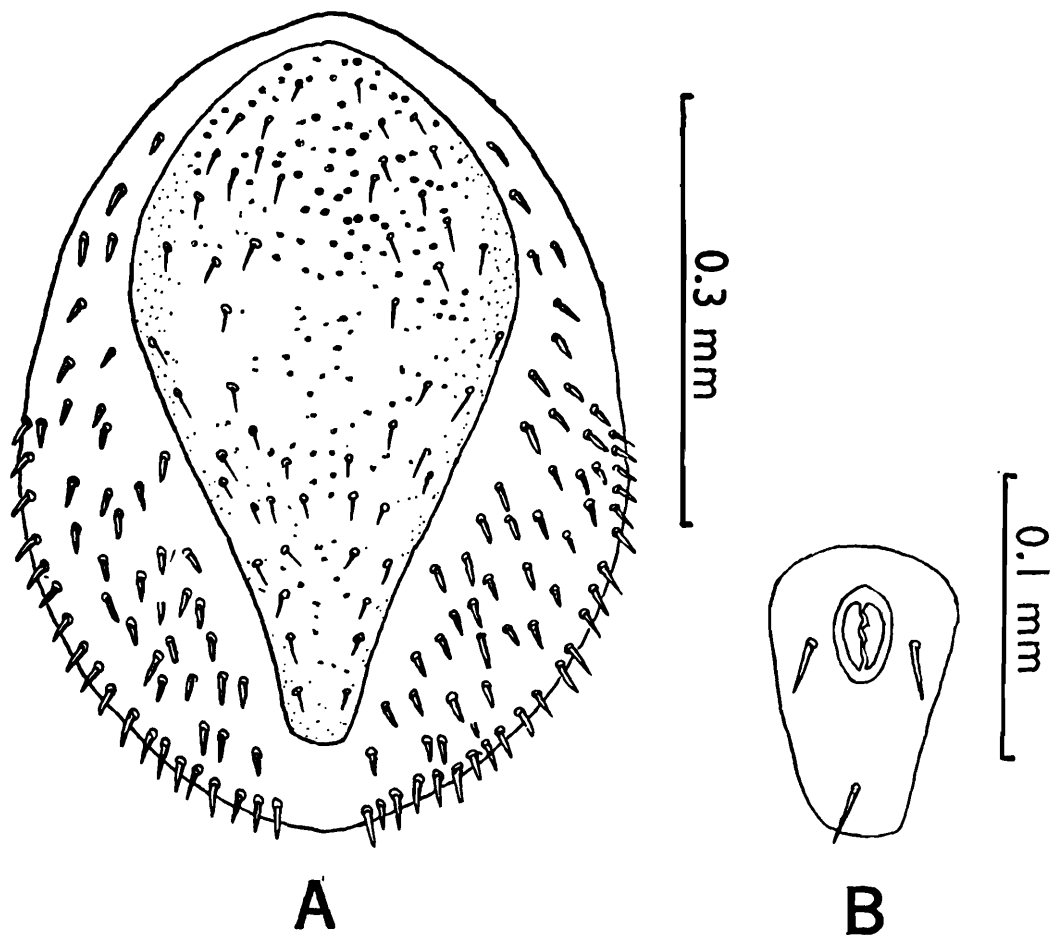


Fig. 45. *Parasteatonyssus jayanti* n. sp. ♀ A. dorsum B. anal plate.

with dense setae. Sternal plate broader than long without chitnised posterior margin. St 3 about equal in length to St 1. Caudal setae about 0.06 mm long. Peritreme ending over coxa I. Process on palpal trochanter distinct, flat relatively broad and blade-like. Epigynial plate 0.27 mm long, 0.06 mm broad, with side margins parallel, tapering in anterior $1/3$ into a broad rounded tip. Anal plate $.06 \times 0.35$ mm, with rounded anterior margin and straight posterior margin; adanal setae at the level of anal ring. Leg I 0.63 mm long, tarsus 0.18 mm long.

Male : Dorsal surface : Idiosoma 0.81×0.41 mm. Dorsal plate with 25 pairs of setae, covering most of the dorsum 0.81 mm long 0.37 mm broad; F1 slender not T-shaped; M11 well developed. Ventral armature entire. Holoventral (fused) plate broad posteriorly with about 10 pairs of setae on its lateral margins. Unarmed opisthosoma with 7 pairs of setae surrounding plate. Spermatodactyl long with

tapering tip. Dorsal arm not distinct. Adanal setae at level of the anal ring. Leg I 0.64 mm long, tarsus I 0.19 mm long.

Affinities: Following the key to the species by Radovsky (1967 : 186) of females, this species runs near to *nyctinomi* in having

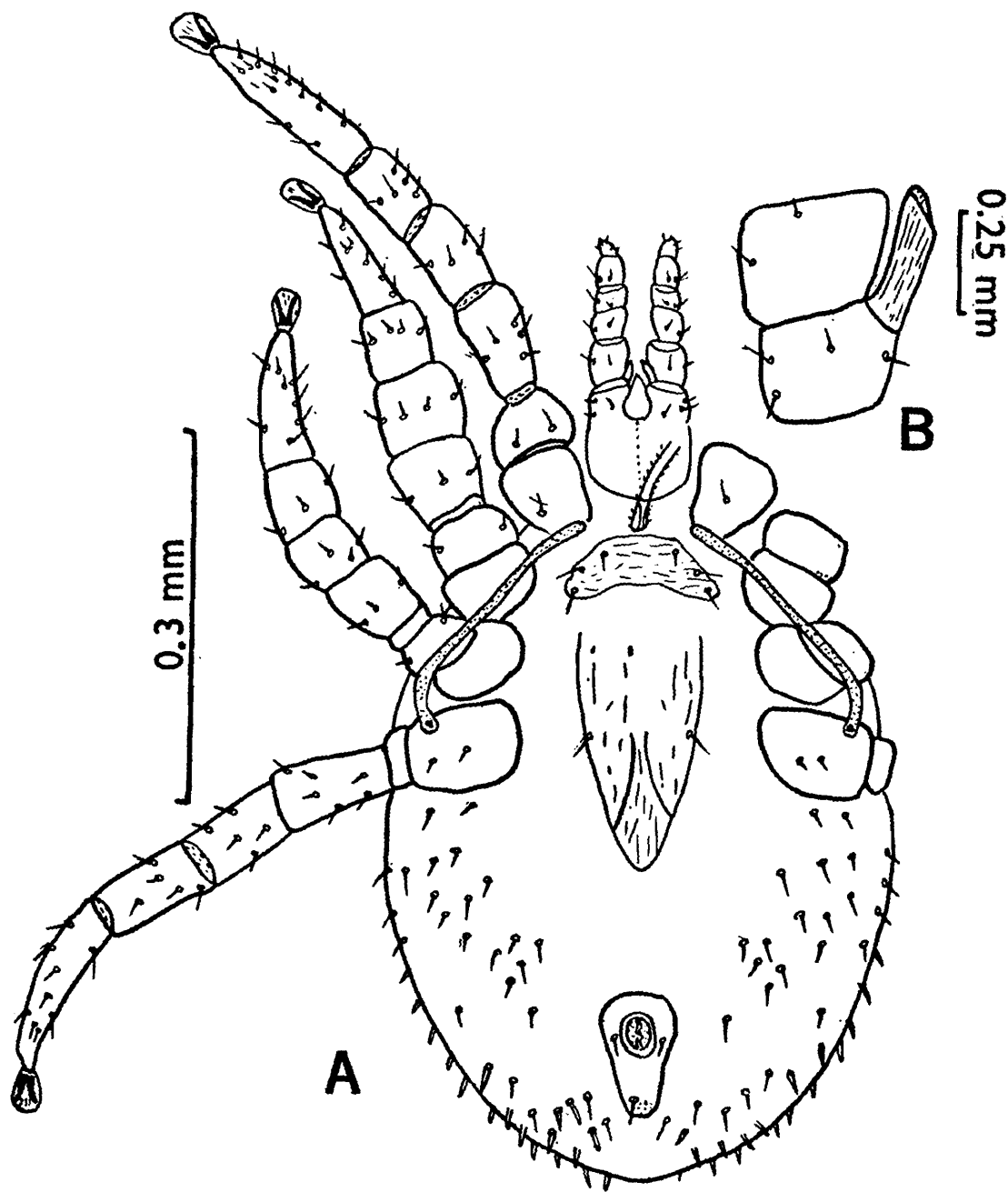


Fig. 46. *Parasteatonyssus jayanti* n. sp., ♀ A. venter B. palpal trochanter with modified process.

blade like ventral process on palpal trochanter though slightly differing in shape. It can be however, distinguished from it as under :

Female : (i) dorsal plate bearing 24 pairs of setae as against 20, (ii) epigynial plate broad and gently narrowing to a broad posterior margin as against abruptly narrowing to a conical base with pointed posterior margin, (iii) hind margin of anal plate broad and straight as against narrow and pointed.

Male : (i) dorsal plate with 24 pairs of setae as against 20, (ii) ventral armature of male broader in posterior half and ending into a broad rounded margin as against ventral armature narrow in posterior

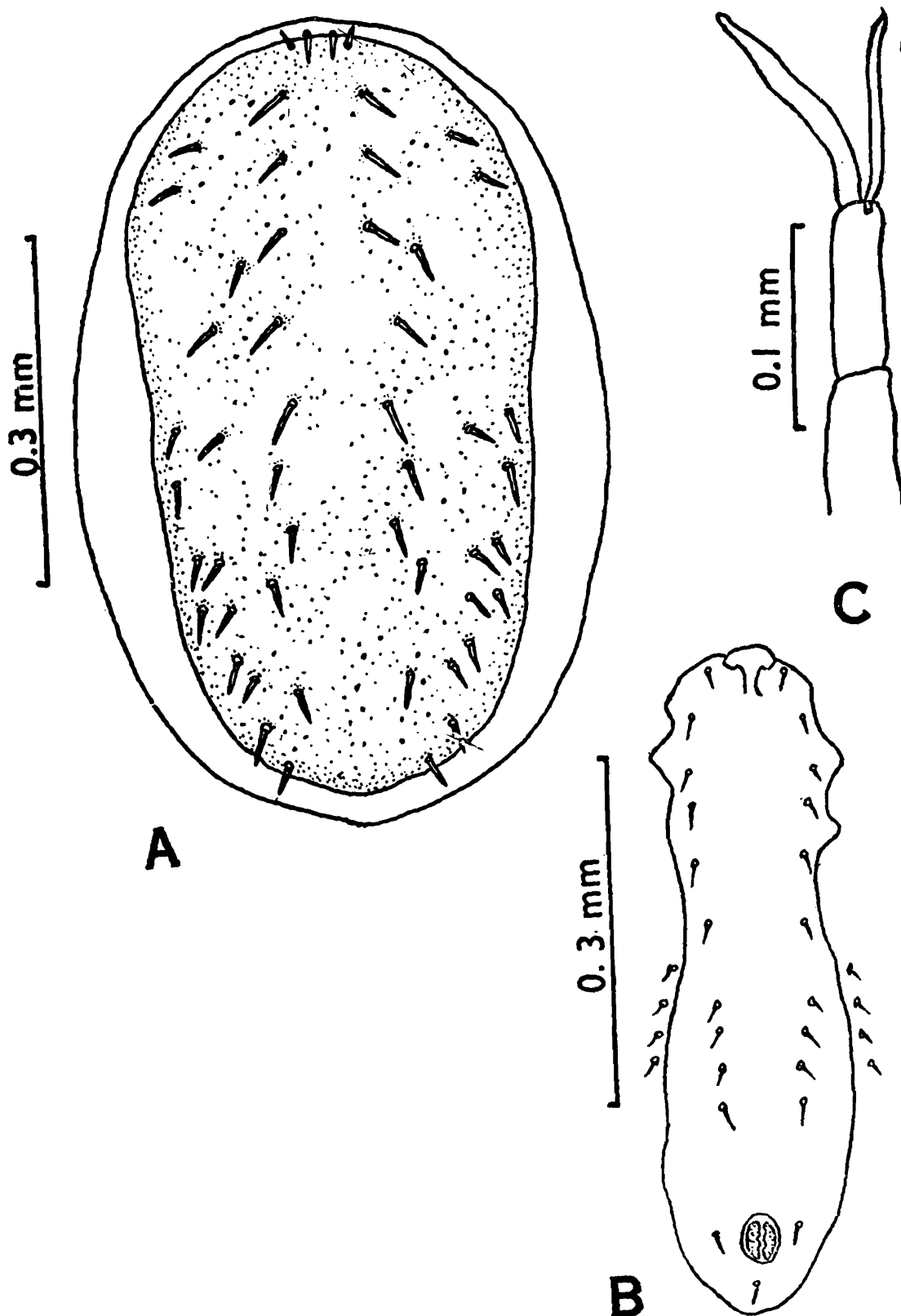


Fig. 47. *Parasteatonyssus jayanti* n. sp., ♂ A. dorsum B. holoventral plate C. chela.

half with a pointed tip, (iii) dorsal arm of the movable chela of the chelicerae as long as the spermatodactyl as against dorsal arm being about half the length of spermatodactyl, (iv) spermatodactyl arm of the chelicerae simple as against distinctive with expanded tip.

Bio-ecology : The host bats were roosting behind a notice board. The parasites were mainly collected on the back of the abdomen.

ACARINA : METASTIGMATA

KEY TO THE FAMILIES PARASITIC ON BATS IN INDIA

- Integument of body hardened into a scutum (shield) either covering the whole of the dorsal surface as in male, or anterior part behind the capitulum as in female, nymph and larva capitulum placed at the anterior end of the body and fully visible from above, except when fully fed and gravid, when it is directed downwards. Coxae often with one or more spurs ... Ixodidae
- Integument of body flexible, leathery and rough, lacking differentiation into a shield. Capitulum subterminal or ventrally placed, often hidden by the anterior edge of the body, except in larvae, rarely visible from above. Coxae always lacking spurs ... Argasidae

FAMILY ARGASIDAE Canestrini

General account : The family Argasidae is World wide in distribution. It parasitize a wide variety of hosts viz. about 8 orders of mammals (including Chiroptera), birds and some other lower vertebrates viz. turtles and snakes. The ticks feed intermittently like bed bugs. The adults frequent the burrows, crevices, nests of their hosts where they feed intermittently. Argasids are of considerable economic and medical importance as they transmit several types of micro-organisms. In India, the Kyasanur Forest Disease virus is supposed to be transmitted by the argasid *Ornithodoros chiropterophila* (as reported by Rajagopalan *et al.*, 1969). In Europe *Argas persicus* transmits a spirochaetal disease to fowls resulting in mass scale mortality. The spirochaets (*Borrelia* spp.) causing relapsing fever are transmitted to human beings by about 11 different species of the genus *Ornithodoros*. Few eggs are led at a time. The larvae after hatching, feed on the hosts for a long period and are attached to them with the help of recurved teeth present on the hypostome. After feeding, they leave the host and moult into the nymphal stage. Nymphs usually require only an hour or two for feeding, after which they leave the host and moult again into second nymphal stage. This follows another short period of meal and the nymphs transform into adult males or females. The sexes can be distinguished through slight differences in the genital openings

In India, the argasids, parasitic on bats are very poorly known. Only three species of genus *Ornithodoros* viz. *O. (Reticulinosus) faini* Hoogstraal, *O. (R.) piriformis* Warburton and *O. (R.) chiropterophila* Dhanda and Rajagopalan are recorded. But not a single species of other subgenera of *Argas* occurring exclusively on bats viz. *Carios* and *Chiropteragus* has been recorded. The present studies fill this lacunae : five species (4 new, and 1 new record) under subgenus *Carios* and one new species under subgenus *Chiropteragus* are described and reported.

There are 2 subfamilies under the family Argasidae, viz., Argasinae and Ornithodorinae. But, as Kohls *et al.* (1965) and Soneshine *et al.* (1966) state, not a single exclusive character has been yet found that will permit separation of larvae of Argasinae from those of the subfamily Ornithodorinae. So, the key to larvae of these subfamilies is impossible to be framed.

KEY TO GENERA OF FAMILY ARGASIDAE PARASITIC ON BATS IN INDIA (ADULTS)

Definite suture line, separating dorsal and ventral surfaces present	...	...	<i>Argas</i> Latreille
Definite suture line separating dorsal and ventral surfaces absent (except <i>O. capensis</i> parasitic on sea birds)	...	...	<i>Ornithodoros</i> Koch

The terminology has been adopted from Hoogstraal (1958).

Genus *Argas* Latreille

Argas Latreille, 1795 : 241 ; Soneshine, Clifford & Kohls, 1962 : 193-214.

Type species : *Acarus reflexus* Fabricius, 1874.

Out of the 3 subgenera reported on bats only 2 subgenera mentioned below, occur in India.

KEY TO THE SUBGENERA OF ARGAS PARASITIC ON BATS IN INDIA (FOR LARVAE)

Dorsal body setae arranged around lateral margins and in central region. Post hypos- tomal setae 1, short (less than 0.030 mm). Tarsus 1, short, within distal median setae. Body ventrally with posteromedian setae. Hypostome dentition 4/4 in anterior third	...	...	<i>Carios</i> Hoogstraal
Dorsal body setae arranged in anterior and posterior groups. Posthypostomal setae 1 long (greater than .050 mm). Tarsus 1 long; with distal median setae present. Body ventrally without posteromedian setae. Hypostome dentition 2/2 through entire length	...	...	<i>Chiropteragus</i> Hoogstraal

KEY TO SUBGENERA OF *ARGAS* PARASITIC ON BATS IN INDIA (ADULTS)

- Hood present. Periphery without cellular pattern. Tarsi with protuberances ... *Carios* Hoogstraal
- Hood absent. Periphery with cellular pattern. Tarsi without any protuberances ... *Chiropteragus* Hoogstraal

Subgenus *Carios* Hoogstraal

Carios—Hoogstraal, 1958 : 20.

Type species : *Carios vespertilionis* Latreille (by original designation).

Host : Exclusively bats.

KEY TO THE SPECIES OF SUBGENUS *CARIOS* KNOWN FROM INDIA (ADULTS)*

- Body longer than broad, size male 4.5×4.0 , tarsus I gradually tapering apically ... *vespertilionis* (Latreille)
- Body broader than long, size male 2.97×3.02 , tarsus I cleft apically ... *soneshinei* n. sp.

KEY TO THE SPECIES OF *ARGAS* (*CARIOS*) KNOWN FROM INDIA (LARVAE)

1. Relative distance between post palpal and post hypostomal setae 2.5-3.0 times ... *vespertilionis* (Latreille)
- Relative distance between post palpal and post hypostomal setae about 2 times ... 2
2. Body elongate, anteroexternal setae equal to posteroexternal setae in size ... *indicus* n. sp.
- Body subcircular ; anteroexternal setae about $1/2$ of posteroexternal setae in size ... 3
3. Posteroexternal setae not fringed, strongly tapering apically ... *gujaratensis* n. sp.
- Posteroexternal setae fringed, not tapering apically ... *hoogstraali* n. sp.

Argas (*Carios*) *soneshinei* n. sp.
(Figs.—48 & 49)

Host : *Pipistrellus dormeri dormeri* Dobson

Holotype : ♂, Z.S.I., Reg. No. 3043/17, Dadra and Nagar Haveli : Silvassa bus stand (host collected from a tree hole), 4.x.1976 (*Sinha & Advani*).

* The adult stages of *gujaratensis* and *hoogstraali* have not been collected so far.

Distribution of parasite : INDIA : Dadra and Nagar Haveli.

Male : 2.97 mm long, 3.02 mm wide. Colour (preserved) brownish yellow, translucent peripherally, slightly darker in middle portion. Body outline subcircular, anterior margin slightly bulging.

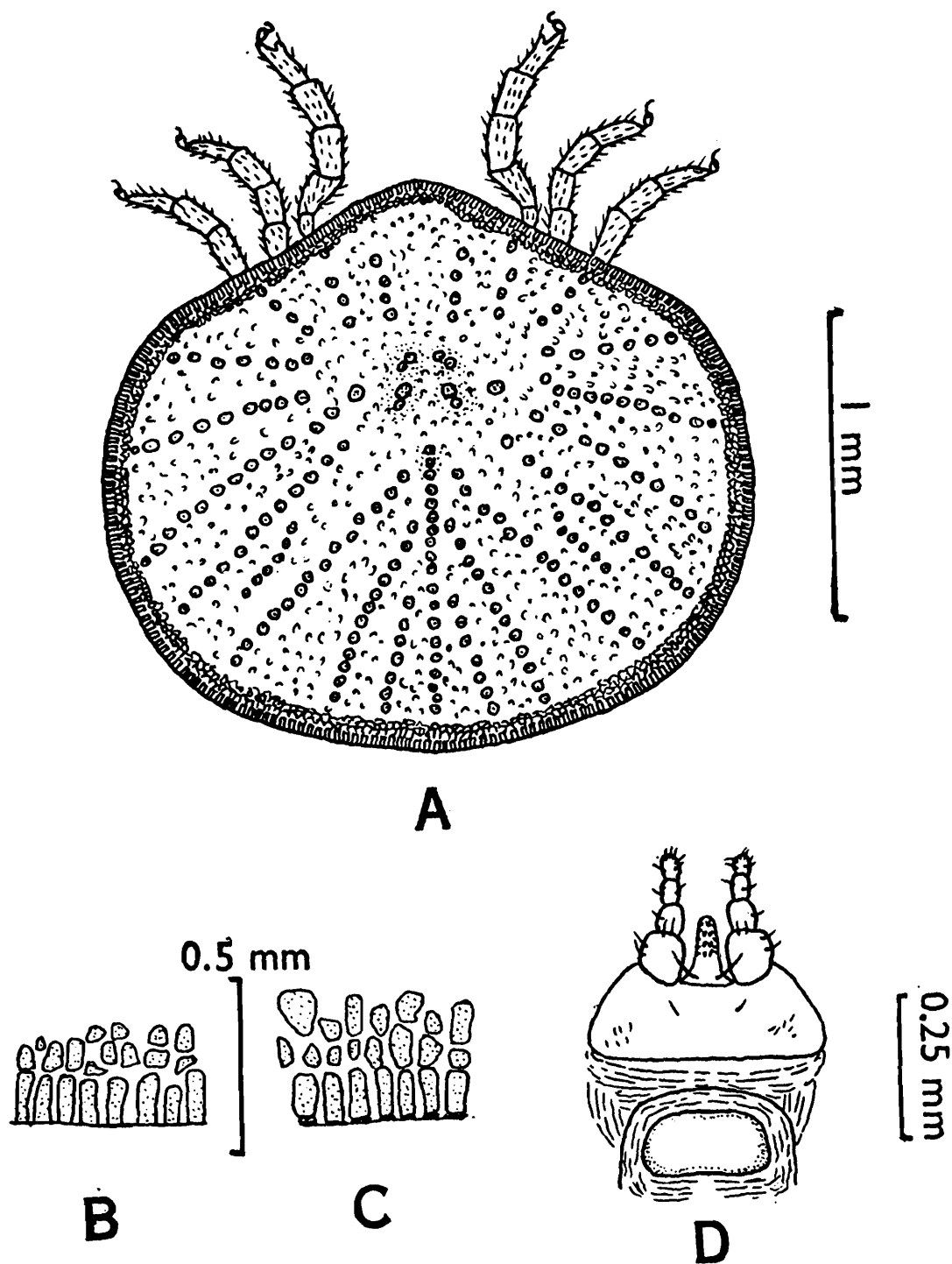


Fig. 48. *Argas (Carios) soneshinei* n. sp., ♂ A. dorsal view B. dorsal integumental pattern C. ventral integumental pattern D. capitulum and male genital area.

Dorsum : Body integument finely granulated. Discs circular, arranged in conspicuous radiating rows, closely spaced or contiguous, medial discs large. Peripheral cells elongate, the cells on the inner side of varied shapes. Lateral suture continuous.

Venter : integumental granulations, discs and peripheral cells same as on the dorsal side ; intercoxal area narrow, wrinkled. Genital area situated between coxae 1 and immediately posterior to camerostome ; operculum rectangular, anterior margin round, posterior margin straight ; integument thickly folded between aperture and camerostome, 2 thin folds laterad to aperture. Anus situated at the mid length of body ; each valve with 7 fine setae. Ventral paired organ, situated posterior to anus. Spiracular plates small, circular, laterad to coxa IV. Coxal and supracoxal folds present. Ventral grooves and eyes absent. *Capitulum* small, situated in a camerostome between anterior margins of coxae 1 surrounded laterally and posteriorly by thick integumental folds. *Basis capituli* broader than long, posterior margin convex,

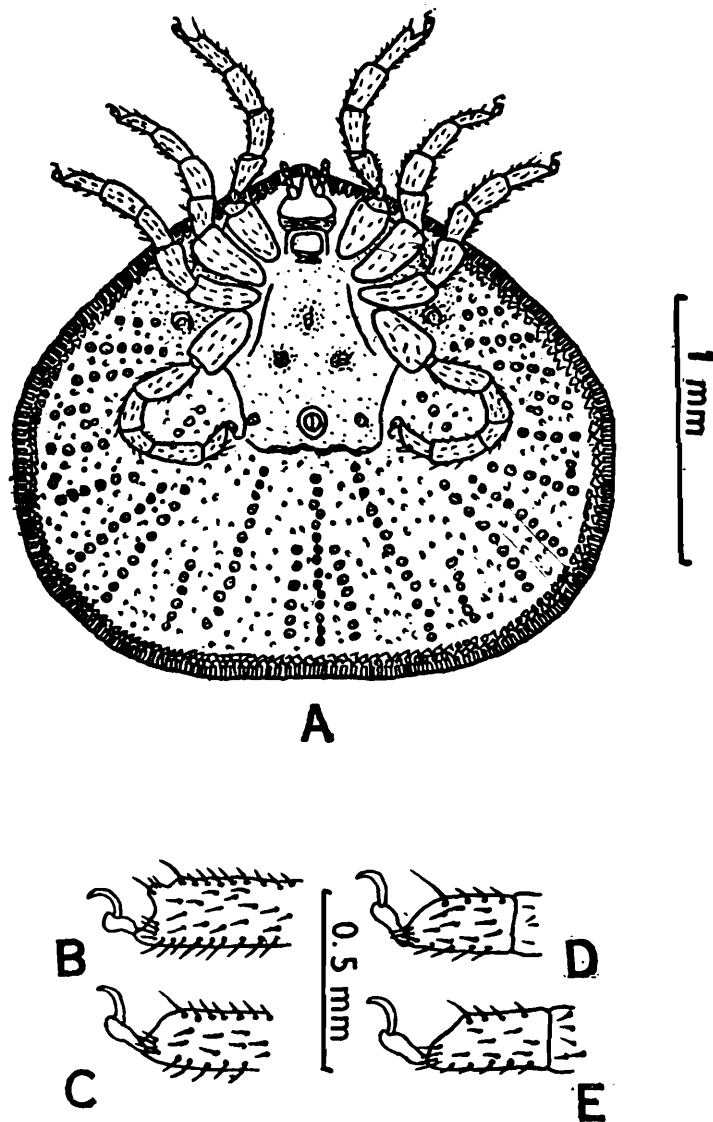


Fig. 49. *Argas (Carios) soneshinei* n. sp. ♂ Ventral view.

lateral margin diverging. Ventral setae 6 pairs antero-external, 2 pairs postero-lateral ; 1 pair post palpal arising posterior of postero-internal juncture of palpal segment 1 ; 1 pair posthypostomal arising near the base of hypostomal shaft, reaching at mid length of palpal segment 2. Palpi ca. 0.35 mm ; width successively decreasing from segment 1 to 4 ;

segment 1 bulbous, wider than long, about $3/2$ times as long as 2 ; segments 2 and 3 subequal, 4 shorter than 3. All segments with dorsal, ventral and external setae. Segment 4 with an apical tuft of 7 setae. Hypostome apex reaching at level of anterior margin of palpal segment 2, ca. 2.5 times as long as broad, apex pointed ; dental formula 2/2 ; 6 denticles in each file.

Legs short and stout, arising from anterior $1/3$ of body length ; segments visible from dorsal view as illustrated. Tarsi as illustrated ; tarsi I cleft apically, II-IV each with a small dorsoapical hump.

Affinities : The species comes close to *vespertilionis* in the dorsal and ventral body patterns, but it can be differentiated from it in having (i) body of male small, broader than long 2.97×3.2 as against body large, longer than broad 4.5×4.0 (ii) the tarsus I being cleft subapically as against gradually tapering to the apical tip.

The species is named after Dr. D. E. Soneshine of USA for his contribution towards systematics of Argasidae of the world.

Argas (Carios) vespertilionis (Latreille)

(Fig.—50)

Carios vespertilionis Latreille, 1802 ; pp. 67-68 (T.L.—France).

Argas (Carios) vespertilionis : Hoogstraal, 1958 : 20 ; Wilson, 1970 : 38.

Host : *Pipistrellus dormeri dormeri* Dobson.

Material examined : Rajasthan : Dist. Jodhpur, 2 NN, Z.S.I., DRS, Reg. No. Ent. 1272/A, Bijolai, ca. 15 kms from Jodhpur, 12.xii.1976 (*Rathore & Advani*).

Distribution of parasite : EUROPE ; INDIA : Rajasthan ; EGYPT ; BURMA ; CHINA ; KOREA ; TAIWAN ; INDONESIA ; AUSTRALIA.

Nymph : Size 1.95 to 2.86 mm in length and 1.39 to 2.70 mm in width.

This species has been redescribed by Hoogstraal (1958), the present specimens agree with this description.

Affinities : The adults of this species are closely related to the preceding new species *soneshinei*, but differs from it in (i) body broader than long as against body longer than broad, (ii) anterior tarsi cleft at apex as against gradually tapering towards apex.

Remarks : Hitherto known from Europe, Egypt, Burma, China, Taiwan, Korea, Philippines, Indonesia, Australia (*vide* Wilson, 1970),

it is now being reported for the first time from India, thus filling the wide gap in its known range of distribution. It has a wide range of host

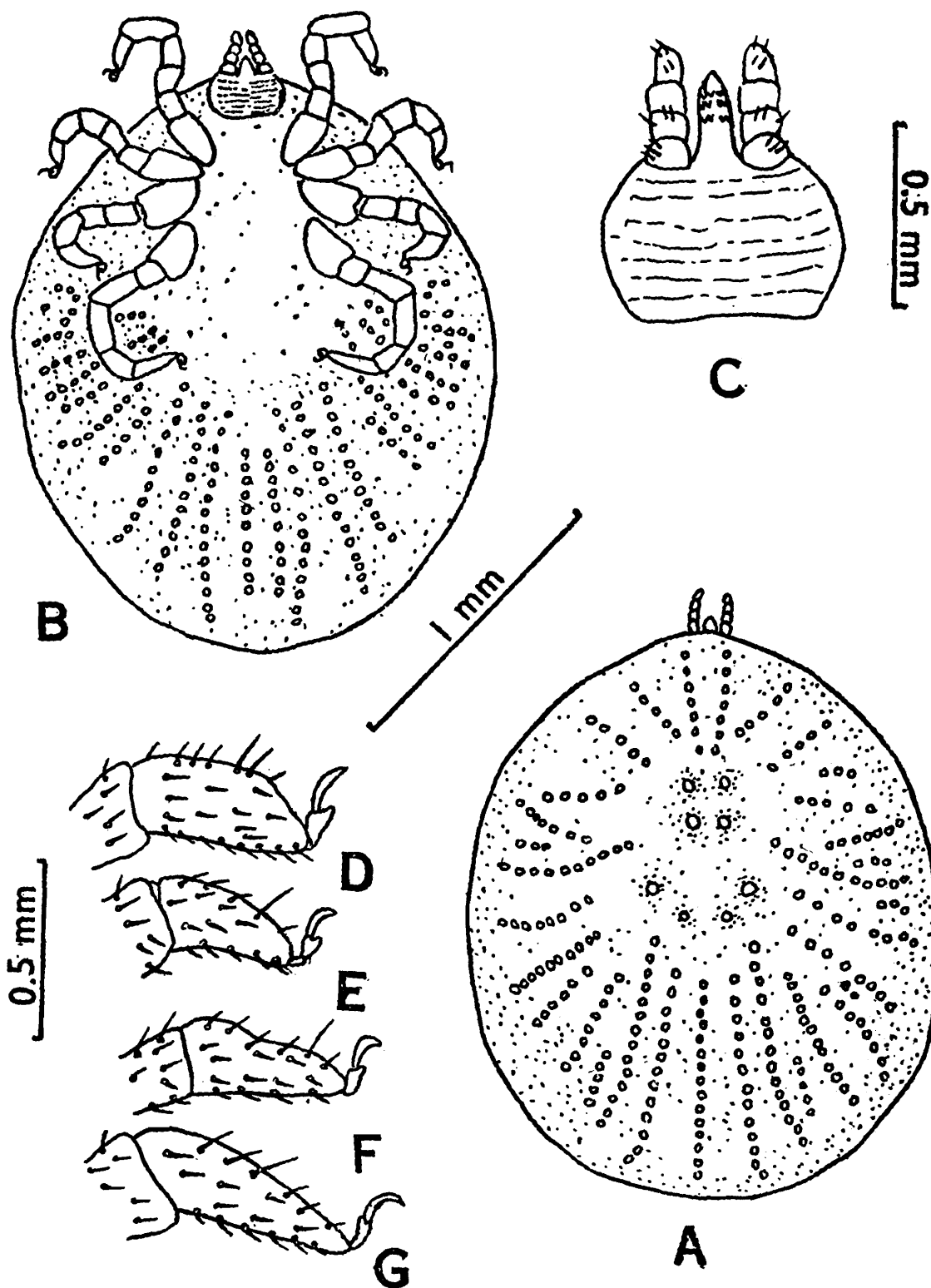


Fig. 50. *Argas (Carios) vespertilionis* (Latreille), Nymph ; A. dorsal view B. ventral view C. capitulum D-G. leg I-IV

species and the present host happens to be restricted in distribution in India only.

Bio-ecology : The 2 nymphs were collected from a colony of bats *P. dormeri* roosting in a hole of wall.

Argas (Carios) gujaratensis n. sp.

(Fig.—51)

Host : *Scotophilus heathi heathi* Horsefield

Holotype : larva, Z. S. I., Reg. No. 3045/17, Gujarat : Dist. Broach, Rajpipla and around, 17.ix. 1976. *Paratypes* : 30 LL, Z. S. I., DRS, Reg. No. Ent. 1298/A, with same particulars as holotype ; 1 ex larva, Fatatalab, Broach, 16.ix.1976 (*Sinha & Advani*). Dist. Baroda, 1 ex larva, Kirti Mandir, Baroda, 11.ix.1976, all specimens in the National Collections of Zoological Survey of India, Calcutta.

Distribution of parasite : INDIA : Gujarat (Broach, Baroda).

Larva : Body outline dorsally broadly oval, fed, size (unmounted, excluding capitulum) 0.825 to 1.60 mm (1.32 avg.) long, 0.82 to 1.55 mm. (1.30 avg.) broad ; mounted, 0.84 to 1.70 mm (1.32 avg.) long ; 0.83 to 1.61 mm (1.31 avg.) broad.

Dorsal plate : Size 0.209 to 0.239 mm (0.235 avg.) long, 0.115 to 0.125 mm. (0.121 avg.) broad ; anterior margins truncate or round ; lateral margins slightly convex in posterior half ; posterior margin straight in majority of specimens examined, rarely slightly concave. Cells mosaic, irregular, large ; not arranged anterolaterally in concentric formations.

Setae : On dorsal surface—length variable, shortest anteriorly, gradually increasing posteriorly in size ; number 14 or 15 pairs of which 11 or 12 dorsoexternal (5 or 6 anteroexternal and 6 postero-external) and 3 submedian pairs besides dorsal plate. Antero-external setae 0.035-0.045 mm (0.039 avg.) long. Postero-external setae 0.073-0.089 mm (0.076 avg.) long, strong, highly chitinized, tapering apically and almost in majority of specimens not fringed at all, rarely lightly fringed apically. On ventral surface—shorter than dorsal ones ; numbering 13 pairs in all out of which 3 pairs of intercoxal, 3 pairs circum anal, 1 pair on valves of anus, and one pair on each coxa, a single postanal.

Capitulum : *Basis capituli* widely subtriangular, ca. slightly more than 2 times as wide as long when measured up to insertion of posthypostomal setae. Hypostome — a narrowly elongate inverted 'V', apex sharply pointed, extending up to the level of apex of palpal segment 4 ; ca. 0.202 mm long (from insertion of post hypostomal setae to apex), dental length ca. 0.14 mm. Dental formula $2/2$, 6 denticles on each file ; apical fourth of shaft with minute denticles, basal portion of shaft expanded, lacking denticles. Post palpal setae small ; distance between these setae ca. 2.1 times than that between posthypostomal setae. Palpi

narrow, all segments subequal in width ; length from 1 to 4 (1) 0.04-0.0455 mm (0.0405 avg.) (2) 0.052-0.060 mm (0.056 avg.) (3) 0.048-0.051 mm (0.050 avg.) (4) 0.040-0.0405 mm (0.0401 avg.) ; palpal length formula 1.0 : 1.32 : 1.18 : 0.95. Setal counts on palps (1) 0 ; (2 and 3)

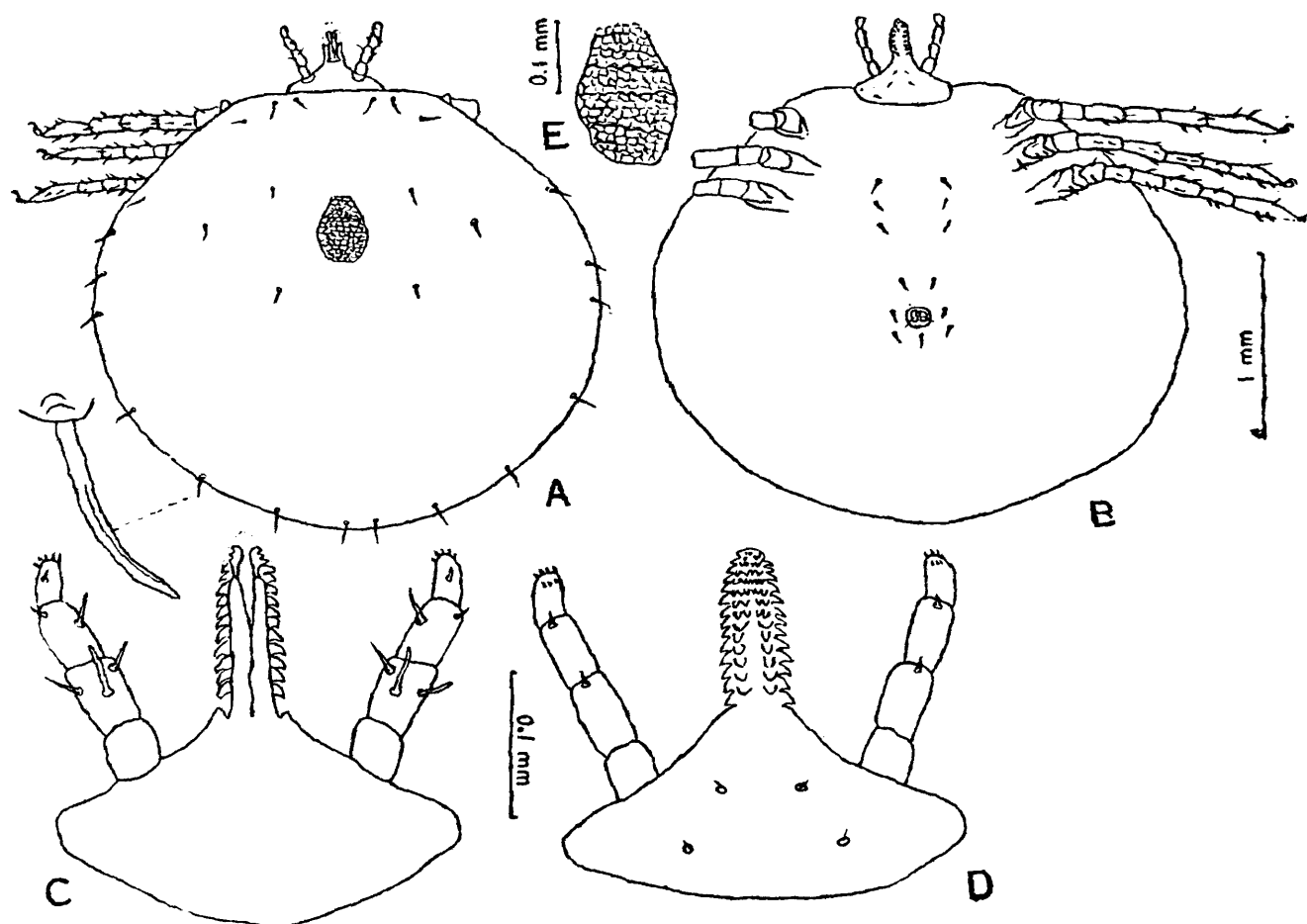


Fig. 51. *Argas (Carious) gujaratensis* n. sp., Larva A. dorsal view B. ventral view C. capitulum ; dorsal D. capitulum ; ventral E. dorsal plate.

each having 3 dorsal, 1 ventral ; (4) 1 dorsal, 1 ventral plus apical tuft of ca. 7. Legs : moderately short and stout. Haller's organ and setae as illustrated. Tarsi tapering to apex. Claws : distinct.

Affinities : The new species is close to *vespertilionis* in having (i) *basis capituli* twice as wide as long, (ii) dental formula anteriorly 4/4 and (iii) palpal segment 2 about 1.32 times as long as 1 ; but can be distinguished from it on the basis of (i) relative distance between post palpal and post hypostomal setae 2.0-2.1 as against 2.5-3.0 (ii) body shape being subcircular or globular as against elongate. (iii) the postero-external setae are not fringed as against fringed. (iv) the dorsal plate not oval with mosaic cells and posterior margin straight as against dorsal plate oval, scaly and posterior margin rounded.

Bio-ecology : The larvae were noticed infesting almost all parts of body, but mainly on digits of pans and lower half of the body.

***Argas (Carios) hoogstraali* n. sp.**

(Fig.—52)

Host : *Taphozus longimanus longimanus* Hardwicke.

Holotype : larva : Z. S. I., Reg. No. 3046/17 Gujarat : Dist. Baroda : Karaili Bagh, Baroda, 11.ix. 1976 (*Sinha & Advani*), *Paratypes* : 35 LL Z. S. I., DRS, Reg. No. Ent. 1299/A, with same particulars as holotype. In the National Collections of Zoological Survey of India, Calcutta.

Distribution of parasite : INDIA : Gujarat : Baroda. LARVA : Body outline dorsally broadly oval (fed). Size (unmounted, excluding capitulum) from 1.103 to 1.345 mm (1.201 avg.) long ; 1.081 to 1.345 mm (1.173 avg.) broad ; mounted, 1.120 to 1.371 mm (1.210 avg.) long ; 1.090 to 1.371 mm (1.190 avg.) broad.

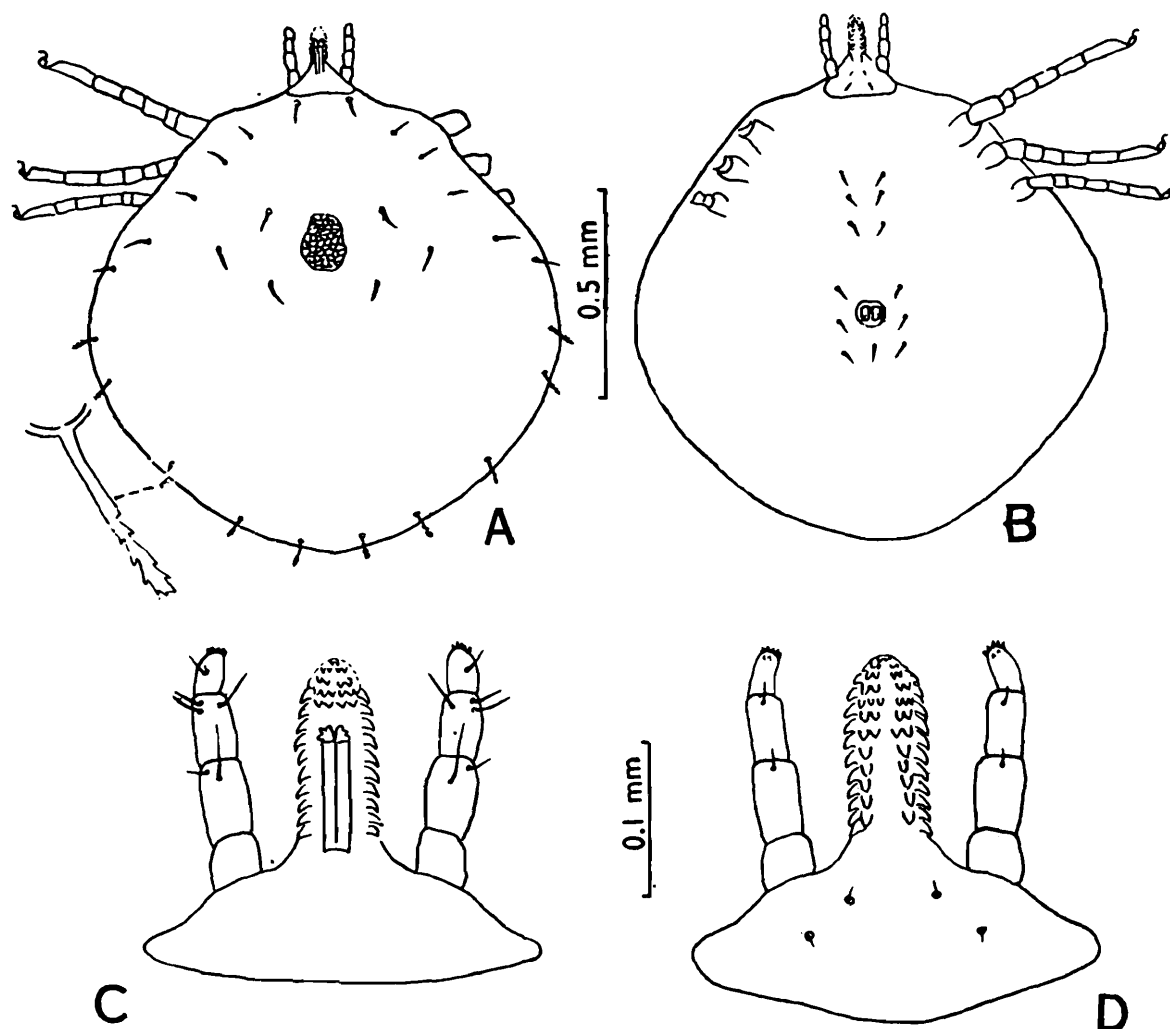


Fig. 52. *Argas (Carios) hoogstraali* n. sp. larva A. dorsal view B. ventral view C. capitulum ; dorsal D. capitulum ; ventral.

Dorsal plate : Size : 0.220 to 0.262 mm (0.233 avg.) long, 0.116 to 0.122 mm (0.120 avg.) broad ; anterior margins slightly convex, truncate ; lateral margins slightly bulging out in middle portion ;

posterior margin straight with round posterolateral corners. Cells irregular flat, hexagonal, not concentrated anterolaterally.

Setae : On dorsal surface—length variable, shortest anteriorly, gradually increasing posteriorly numbering 14, of which 11 external (5 antero-external and 6 postero-external) and 3 submedian pairs besides dorsal plate. Antero-external setae 0.031-0.040 mm (0.038 avg.) long. Postero-external setae 0.065-0.081 mm (0.069 avg.) long, tapering (50% specimens) not tapering (50% specimens), in majority of specimens fringed upto half length from apical tip. On ventral surface—shorter than dorsal ones, numbering 13 pairs in all, 3 pairs intercoxal, 1 pair on each coxa, 3 pairs circum anal, 1 pair on valves of anus and a single post anal seta.

Capitulum : *Basis capituli* wider, subtriangular, ca. 1.9 times as broad as long (when measured upto the insertion of posthypostomal setae). Hypostome as a narrow elongate inverted 'V', apex sharply pointed, extending up to the level of the apex of palpal segment 4 ; ca. 0.2 long mm long (from insertion of the post hypostomal setae to apex) ; dental length ca. 0.140 mm. Dental formula 2/2, 10-11 large denticles in each file ; denticles on apical fourth of the shaft minute, ranging from 4/4 anteriorly to 2/2 posteriorly ; basal portion of shaft expanded, without denticles. Post palpal setae slightly longer than posthypostomal setae ; distance between post palpal setae ca. 2.41 times than between post hypostomal setae. Palpi narrow, all segments subequal in width ; segmental length from 1 to 4 (1) 0.045-0.049 mm (0.046 avg.) ; (2) 0.059-0.065 mm (0.064 avg.) ; (3) 0.053-0.055 mm (0.053 avg.) ; (4) 0.040-0.043 mm (0.043 avg.) ; palpal length ratio 1.0 : 1.17 : 1.17 : 0.88. Setal counts on palpal segments (1) 0 ; (2 and 3) each 3 dorsal, 1 ventral ; (4) 1 dorsal, 1 ventral plus apical tuft of ca. 7. Legs : moderately short and stout. Haller's organ and setae as illustrated.

Affinities : The species resembles *vespertilionis* in having (i) *basis capituli* 2 times as broad as long (ii) dental formula ranging from 4/4 anteriorly to 2/2 posteriorly and (iii) palpal segment 2 about 1.17 times as long as 1. However, it differs from it in (i) relative distance between post palpal and post hypostomal setae 2.0—2.2 as against 2.5-3.0 (ii) body shape being subcircular as against elongate and oval (iii) the dorsal plate not oval with posterior margin round. It differs from *gujaratensis* in having postero-external setae fringed and not tapering as against setae not fringed but tapering.

Bio-ecology : The larvae of this species were found attached to the host on different parts of body. The species is named after Dr.

Harry Hoogstraal of NAMRU, Egypt for his remarkable contribution towards taxonomic studies of Argasidae and Ixodidae and who always encouraged us throughout the period of studies.

Argas (Carios) indicus n. sp.

(Fig.—53)

Host : *Tadarida aegyptiaca thomasi* Wroughton

Holotype : Larva, Z.S.I. Reg. No. 3044/17 Rajasthan : Dist. Jodhpur, High Court, Jodhpur, 5.v.1973 (*Sinha*) from jar containing the host specimen. In National Collections of Zoological Survey of India, Calcutta.

Distribution of parasite : INDIA : Rajasthan (Jodhpur) larva : Body elongate, oval, longer than broad, 73 : 49. Size (mounted) 1.34 mm long, 0.91 mm broad.

Dorsal plate : Size 0.241 mm long, 0.221 mm broad ; anterior margin slightly truncate, curved, lateral margins slightly bulging, in lower half ; posterior margin straight ; cells not distinct, irregular.

Setae : On dorsal surface length slightly, gradually increasing from anterior to posterior ; 13 pairs in all, of which 10 dorsoexternal (5 antero-external and 5 postero-external) and 3 submedian. Antero-external setae 0.165 mm in length ; postero-external setae slightly longer than antero-external setae 0.170 mm long, highly fringed in the apical 1/3rd portion. On ventral surface setae shorter than dorsal ones, 13 pairs in all viz. 3 pairs intercoxal, 1 pair on each coxa, 3 pairs circum-anal, 1 pair on valves of anus and a single post anal seta.

Capitulum : *basis capituli* subtriangular, ca. twice as wide as long (measured upto insertion of posthypostomal setae), Post palpal setae small and post hypostomal setae minute ; distance between post palpal setae approximately twice than that between post hypostomal setae. Hypostome as a narrow elongated 'V', apex sharply pointed, extending upto the level of apex of palp ; 0.19 mm long (from insertion of post-hypostomal setae to apex), denticles on apical shaft minute in 4/4 arrangement. Palpii narrow, palpal length formula : 1.0 : 1.53 : 1.29 : 1.0 ; all segments subequal in width ; length of segments 1 to 4 (1) 0.0335 mm, (2) 0.0581 mm. (3) 0.052 mm (4) 0.40 mm. Setal counts (1) 0, (2 and 3) each 3 dorsal, 1 ventral ; (4) 1 dorsal, 1 ventral plus an apical tuft of 7 small setae arranged in circle.

Legs : moderately short and stout ; tarsi tapering to apex, claws distinct.

Affinities : The species resembles *vespertilionis* in having body longer than broad and general shape. But, it differs from it in (i) relative distance between post palpal and post hypostomal setae being 2.0 as against 2.5-3.0, (ii) the dorsal plate not oval, elongate, with anterior and posterior margins straight as against dorsal plate oval, with anterior and posterior margins round.

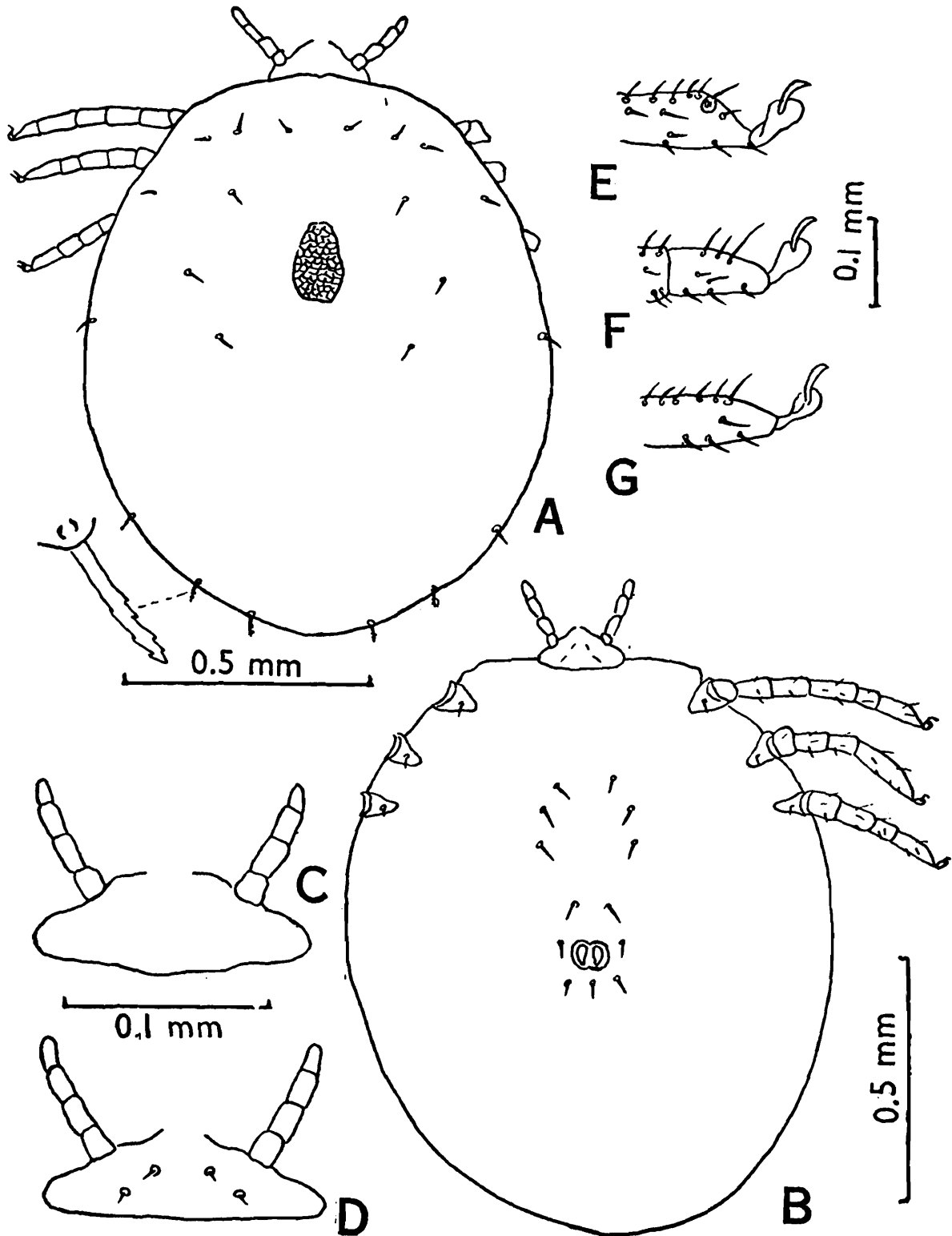


Fig. 53. *Argas (Carios) indicus* n. sp. larva A. dorsal view B. ventral view C. capitulum ; dorsal D. capitulum ; ventral E-G. legs I-III.

This new species also resembles the other two new species viz. *hoogstraali* and *gujaratensis*, in relative distance between post palpal

and post hypostomal setae but differs in (i) body oval, elongate as against globular, subcircular, (ii) the postero-external setae about equal to antero-external 9:8, as against postero-external setae. ca. 2 times as long as antero-external 18:9, (iii) legs are comparatively shorter.

Subgenus **Chiropteragus** Hoogstraal

Chiropteragus Hoogstraal, 1955 : 580 ; Soneshine *et al.*, 1962 : 209.

Type species : *Argas boueti* Roubaud & Colas-Belcour, 1933 by original designation.

Distribution : Ethiopian and Oriental Regions.

Host : Bats.

KEY TO THE KNOWN SPECIES OF SUBGENUS *CHIROPTERAGUS
(FOR ADULTS)

- | | |
|--|--|
| 1. Body cordiformis, hood depressed in body... | <i>cordiformis</i> Hoogstraal & Kohls |
| Body not cordiformis, hood protruding anteriorly, not depressed in the body ... | 2 |
| 2. Anteromedian elevation forming large anterior hood on ventral surface, body shape elliptical | <i>ceylonensis</i> Hoogstraal & Kaiser |
| Anteromedian elevation absent, body shape rounded | 3 |
| 3. <i>Basis capituli</i> longer than broad with lateral margins gently curved. ... | <i>boueti</i> Roubaud & Colas-Belcour |
| <i>Basis capituli</i> as long as broad or broader than long. | 4 |
| 4. <i>Basis capituli</i> broader than long with widely diverging lateral margins. ... | <i>confusus</i> Hoogstraal |
| <i>Basis capituli</i> as long as broad with lateral margins straight, subparallel, not divergent. | <i>wilsoni</i> n. sp. |

KEY TO THE KNOWN SPECIES OF THE SUBGENUS *CHIROPTERAGUS
(LARVAE)

- | | |
|---|----------------------------|
| 1. Tibia I with unusually long whip like seta which is as long as or longer than tibia itself. Body with 15-17 pairs of dorsal setae ; anterolateral setae longer than posterolateral setae. | 2 |
| Tibia I without unusually long whip like seta. Body with 13-15 pairs of dorsal setae (usually 13-14) ; anterolateral setae shorter than posterolateral setae (Egypt, Africa). ... | <i>confusus</i> Hoogstraal |

* The key includes all the known species.
* *A. (Ch.) ceylonensis* is not included in key since it is known only by adults, all other known species are included.

2. Dorsal plate elongate (Africa, USSR,
Malaya). *boueti* Raubaud & Colas-Belcour
- Dorsal plate rounded 3
3. 15 pairs of setae on dorsal surface (India). *wilsoni* n. sp.
- 17 pairs of setae on dorsal surface (S.
Africa). *cordiformis* Hoogstraal & Kohls

***Argas (Chiropteragus) wilsoni* n. sp.**

(Figs.—54, 55)

Host : *Rhinopoma microphyllum microphyllum* (Brünnich).

Holotype : ♀, Z. S. I., Reg. No. 3042/17, Rajasthan : Dist. Jhalawar, Jhalarpatan Ka Kila, 12 kms from Jhalawar, 1.xii.1975 (*Sinha & Advani*). In National Collections of Zoological Survey of India, Calcutta.

Distribution of parasite : INDIA : Rajasthan (Jhalawar)

Female : body pear-shaped, light brown, anterior margin with a large hood usually concealing all mouth parts when viewed dorsally, outline of hood converging anteriorly, anterior margin bluntly round, surface with circular striations. Size 7.45 mm long (excluding hood) and 6.80 mm broad, hood 0.46 mm long, 0.56 mm broad at junction with body.

Dorsal surface — integument finely granular, with close minute portuberances ; with short scattered setae ; discs distributed as shown in figure.

Lateral suture : absent.

Capitulum in deep camerostome ; *basis capituli* as long as wide 0.2 × 0.2 mm, with lateral margins parallel, straight, not curved. Hypostome about 1/4th as broad as long, with broad base, arising at the level of the base of 1st palpal segment ; with a single pair of files of 9 lateral denticles (1/1) which become gradually longer basally ; confined in anterior portion ; apex of hypostome pointed ; a pair of long post hypostomal setae, extending beyond the tip of hypostome. Palpi longer than hypostome ; segments becoming progressively shorter from base to apex ; segment 1 almost 3.2 times as long as broad ; segment 2, as long as broad, segments 3 and 4 slightly longer than broad. Ratio of segments 1 to 4 approximately 4:1:1.5:1. Eyes absent. Spiracular plates lateral to coxae IV Genital area transversely oval and surrounded by a fleshy fold ; genital aperture situated at the level of base of coxae I, slit like, bounded by rounded anterior lip and broad posterior lip, having

striated integument. Anus situated slightly posterior to middle of body (excluding hood), surrounded by a fleshy fold ; valves elongate each

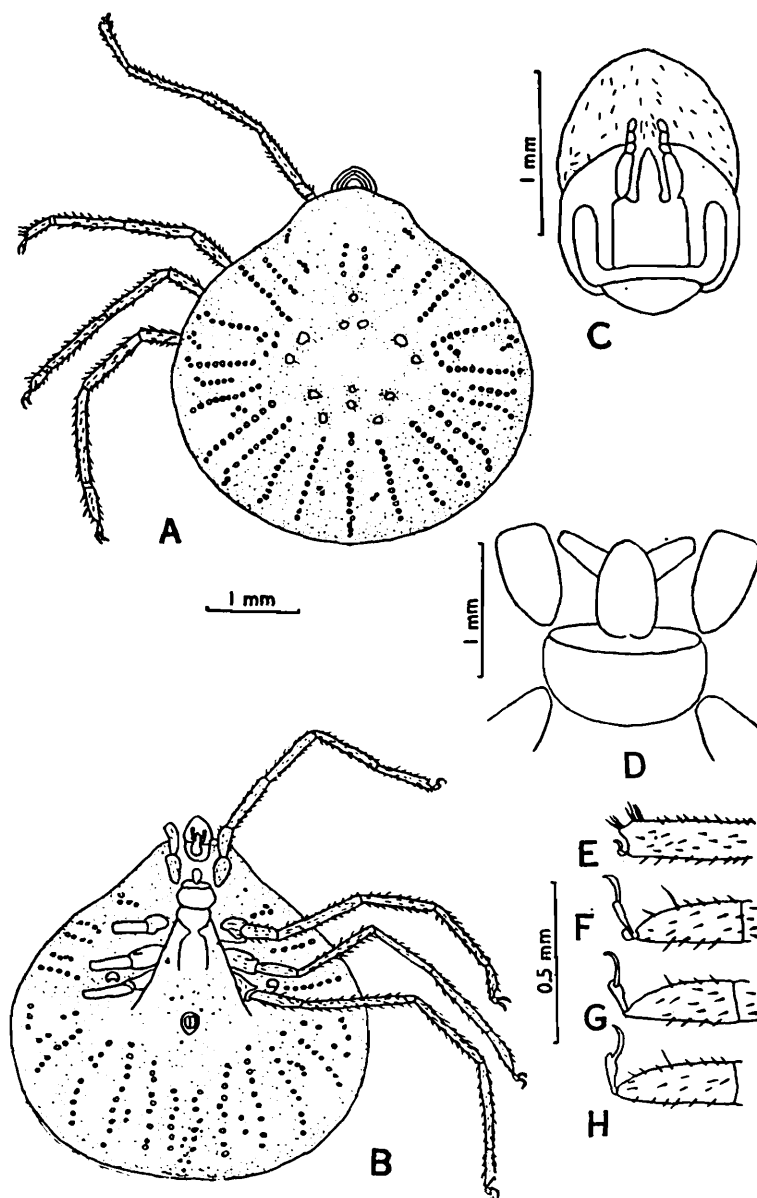


Fig. 54. *Argas (Chiropteragus) wilsoni* n. sp., adult, ♀ A. dorsal view B. ventral view C. capitulum ; dorsal D. capitulum ; ventral E-G. leg I-IV.

with 5-6 setae. Posterior paired organ situated slightly posterior to anus, as illustrated. Coxal folds present. Legs very long and slender ; coxae I widely separated from coxae II by integumental fold ; coxae II and III, and III and IV contiguous ; all coxae arising in anterior half region of body. Tarsi narrowly elongate ; tarsi I with dorsal and ventral surfaces parallel, apex notched ; tarsi II to IV gradually tapering ; claws II-IV long, slender. Pulvulli very small.

LARVA :

Host : *Rhinopoma microphyllum microphyllum* (Brünnich).

Material examined : Rajasthan : Dist. Jhalawar, 40 larvae, Z.S.I., DRS, Reg. No. Ent. 1273/A, Jhalarpatan Ka Kila, 12 kms from Jhalawar, 1.xii.1975, 38 exs. Gagrón Ka Kila, Jhalawar, 2.xii.1975 (Sinha & Advani).

Larva : Body circular or globular (depending on feeding). Capitulum anterior, length (exclusive of palpi and capitulum) approximately 1.23 mm, width 1.34 mm, posteroexternal margins broadly rounded ; antero-external margins converging ; mouth parts partially or completely concealed when body highly enlarged. Dorsal plate circular, small.

Setae : On dorsal surface—numbering 7 on each anterior quadrant and 8 in each posterior quadrant ; setal arrangement : 5 pairs of setae at anteroexternal margin ; 2 pairs on each side of anterior margin of dorsal plate ; 3 pairs submedially located ; 4 pairs below dorsal plate in

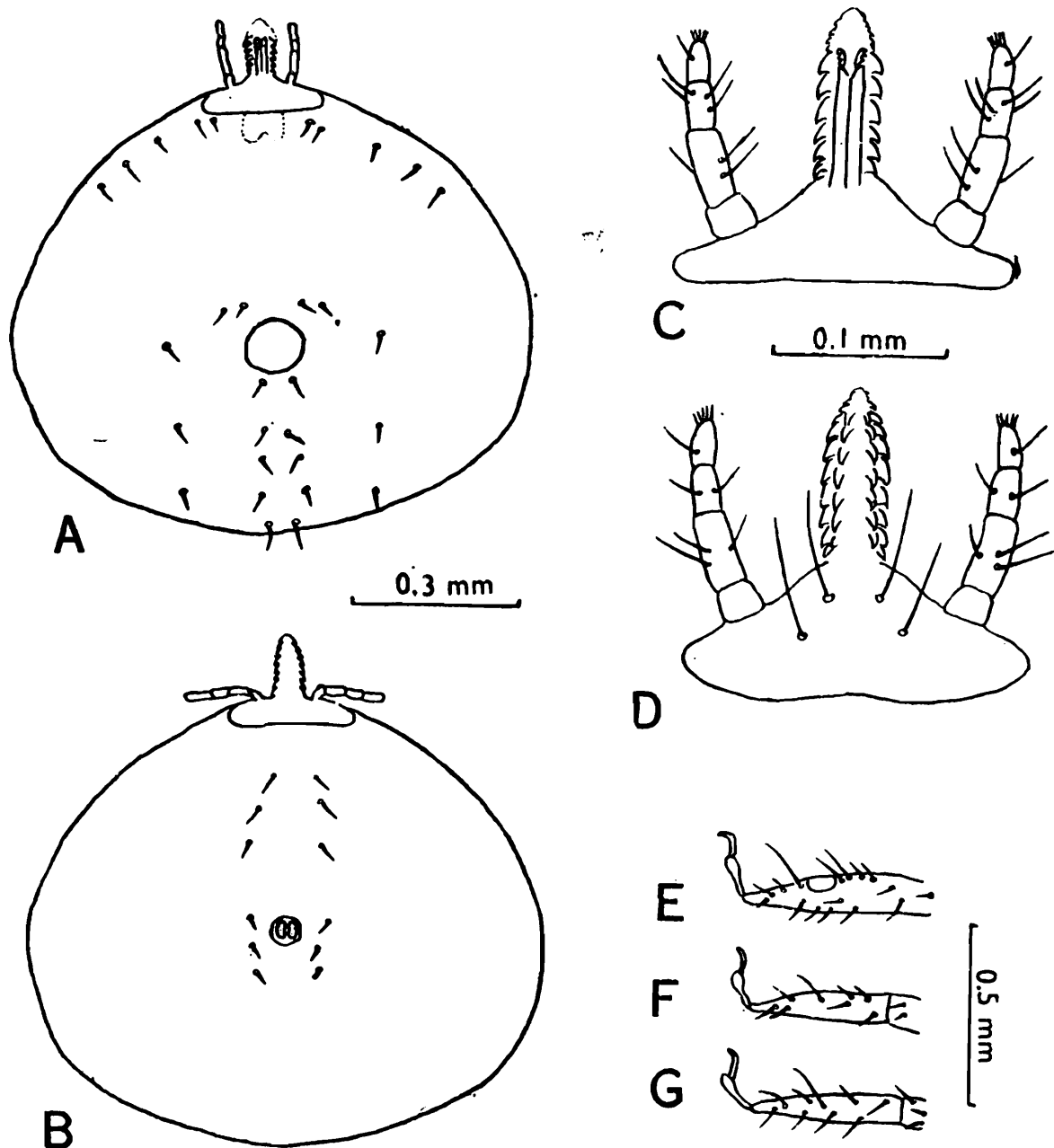


Fig. 55. *Argas (Chiropterargus) wilsoni* n. sp., larva, A. dorsal view B. ventral view C. capitulum ; dorsal D. capitulum ; ventral E-G. leg I-IV.

the form of a row and 1 postero-external pair (Dorsal setae number 15 pairs). Setae on ventral surface-total 12 pairs arranged as under-3

intercoxal pairs ; 1 pair anterior to and 2 pairs posterior to anus. Anus with a single long seta on each valve. Each coxa with 2 setae.

Capitulum : *Basis capituli* wide, medium sized, outline as illustrated ; posthypostomal setae about 0.71 mm long, arising at level of palpal insertions and not extending beyond mid length of hypostome ; postpalpal setae arising slightly posterior and lateral to posthypostomal setae. Palpi slender, about $4\frac{1}{2}$ times as long as wide ; subequal to hypostome ; the length ratios of palpal segments 1 to 4 8:11:9:9 ; segment 1 slightly wider than others, segment 2 almost equal in width to segment 3, apical half of segment 4 narrower. Setal counts of palpal segments (1) 0 ; (2) 2 dorsal, 1 external and 1 ventral ; (3) 3 dorsal, 1 external and 1 ventral, (4) 1 dorsal, 2 ventral plus apical tuft of ca 6-7 setae. Hypostome 0.12 mm long, shaft 3 times as long as broad, arising at the level of anterior margin of segment 1, apex pointed ; dental formula 2/2, denticles about 11-12 in each file, distal ones shorter than proximals, both files of denticles extending full length of shaft. *Legs* : long, slender ; setae as shown in figures. *Tarsi* : long, gradually tapering to apex. Claws prominent. Pulvulli obsolete.

Affinities : The adult specimens of this species come close to *A. boueti* and *A. confusus* in having body shape rounded as against heart shaped as in *cordiformis*. It can be differentiated from *A. boueti* in having (i) *basis capituli* as long as wide, as against *basis capituli* wider than long, (ii) lateral margin of *basis capituli* straight as against widely diverging posteriorly. It differs from *confusus* in having different body shape and *basis capituli* as long as wide as against wider than long. In the larval stage this specimen resembles the larva of *boueti* in having unusual long whip like seta on tibia I, but differs from it in having dorsal plate round as against elongate. It also resembles *cordiformis* in having round dorsal plate, but differs from it in having 15 pairs of setae on dorsal surface as against 17 pairs.

Bio-ecology : While the adult female specimen was collected on the wall of the roosting place, entangled in webs of spiders ; the larvae were found firmly attached to all parts of body of the host ; although the infestation was more in lower half of the body. The species is named after Dr. N. Wilson for his contribution towards Oriental Argasidae.

FAMILY IXODIDAE Mueray

Distribution : Cosmopolitan.

Hosts : Human beings, domestic and wild animals and bats.

General account : The members of this family are largest of the

all acarina. They are of considerable medical and veterinary importance in transmitting disease organisms. They may cause paralysis in human beings by regular bites and may also spread serious diseases like Rocky Mountain and Spotted fevers of USA, Tick bite fever and Typhus fever in Africa. Among domestic animals they cause Cattle fever and anaemia.

After taking a good amount of host blood meal and copulation, the female swells and deposits a large number of eggs in groups, on the ground. Eggs are hatched into larvae, under suitable conditions. They have 3 pairs of legs. The larvae then feed on the blood of the specific host and moult after a full meal, to the nymphal stage (4 pairs of legs). Again the nymphs are engorged by taking a blood meal and moult to respective adults.

KEY TO THE SUBFAMILIES OF IXODIDAE

1. Anal grooves surrounding anus anteriorly ;
 males with ventral surface covered by
 series of plates Ixodinae
 Anal grooves not surrounding anus an-
 teriorly ; ventral surface not completely
 covered by series of plates 2
2. Ventral surface of male without plates ;
 scutum ornamented. Amblyomminae
 Ventral surface of male with four posterior
 plates ; scutum usually plain. ... Rhipicephalinae

Subfamily IXODINAE Vitzthum, 1941

Ixodinae Vitzthum, 1941 : 891.

Genus *Ixodes* Latreille

Ixodes Latreille, 1795 : 125 ; Arthur, 1963 : 14.

Type species : *Acarus ricinus* Linnaeus

The genus *Ixodes* includes some species viz., *I. simplex simplex* and *I. vespertilionis* parasitic on bats. Our collection is represented by *I. vespertilionis*.

Ixodes vespertilionis Koch

(Fig. — 56)

Ixodes vespertilionis Koch, 1844 : 37 ; Arthur, 1963 : 135 ; Wilson, 1970 : 43.

Host : *Taphozous kachhensis kachhensis* Dobson.

Material examined : Rajasthan : 42 larvae, Z.S.I., DRS, Reg. No. Ent. 1270/A, Dist. Kota, Kota, 13. i. 1975 (*Sinha*).

Host range : *Rhinolophus osgoodi*, *R. rouxi sinicus*, *R. thomasi septentrionalis*, *R. affinis himalayanus*, *R. cornutus szechwanus*, *R. monoceros*; *Scotophilus* sp. *Miniopterus schreibersii*, *Myotis myotis*.

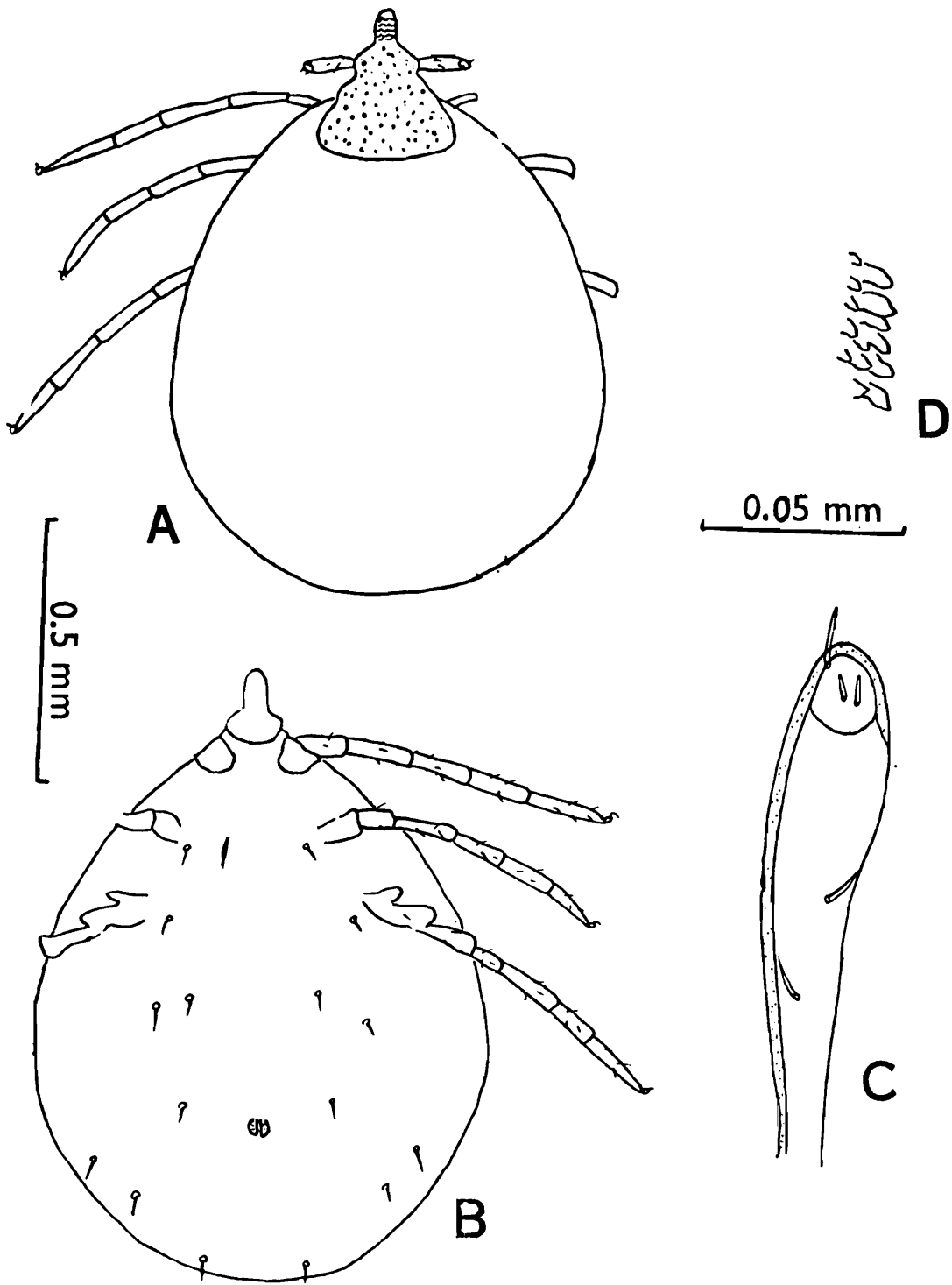


Fig. 56. *Ixodes vespertilionis* Koch, larva, A. dorsal view B. ventral view C. palp D. part of hypostome.

Distribution of parasite : INDIA : Rajasthan ; EUROPE ; AFRICA ; AND NORVEY EAST ; CHINA, JAPAN, AUSTRALIA.

Body length 1.0615-1.0918 mm, width 0.65-0.72 mm.

Remarks : The length and breadth of scutum of the specimen in our collection has been compared with the data given by Wilson (1970 : 44) for specimens from various localities.

Locality	Scutum		Tarsus I
	Length (mm)	Width	Length (mm)
China, Szechuwan Prov.	0.48	0.47	0.48
China, Yunnan Prov.	0.58	0.48	0.46
Japan	0.51	0.46	0.44
Switzerland	0.43	0.41	0.37
Taiwan	0.46	0.44	0.43
*India, Rajasthan	0.21-	0.285-	0.231-0.241
(Present collection)	0.23	0.301	(0.234 avg.)
	(0.215 avg.)	(0.298 avg.)	

* The measurements are given for 15 examples.

The above specimens are tentatively placed under this species. Wilson (*l.c.*) has given measurements of scutum and tarsus for specimens from countries in the Palaearctic zone only and none from the Ethiopian and Oriental Region. A comparison of measurements of these organs in the present specimens shows significant differences and may thus represent a different subspecies too. This should however await comparison of material from different places and hosts.

PART II — BIOGEOGRAPHY OF ECTOPARASITES

Order — HEMIPTERA

Family — CIMICIDAE

Askew (1971 : 17) states "there is a high degree of specificity in the host relations of Cimicidae". His statement is followed by a table showing host families *vis a vis* genera of cimicid parasites. His table indicates host specificity in bats at generic level with few exceptions as shown below :

Genus of cimicid parasites	Host families of bats
<i>Propicimex</i>	Vespertilionidae, Molossidae
<i>Cimex</i>	Vespertilionidae, Rhinolophidae, *Emballonuridae
<i>Aphrania</i>	Vespertilionidae, Pteropidae
<i>Stricticimex</i>	Vespertilionidae, Molossidae, Hipposideridae
<i>Loxaspis</i>	Molossidae, Emballonuridae
<i>Leptocimex</i>	Emballonuridae, *Rhinopomatidae

* It is observed by Askew (1971).

It is observed from Table 3 that *Cacodmus bhati* occurs in large numbers, the average number of parasites per infested bat being the maximum viz. 10.5 as against the lowest number of 1.25 in case of *Stricticimex namru*. The average number of parasites per bat examined

varies from 0.13-1.6. Among the bats *Tadarida aegyptiaca thomasi*, 18.2% of them were infested by the bugs closely followed by *Pipistrellus dormeri dormeri* (16.7%) and *Taphozous longimanus* (16.6%). The least infestation was found in *Rhinopoma microphyllum microphyllum* at 8.2%.

Analysing the occurrence of bugs on bats in Rajasthan and Gujarat we find 5 species (4 new to science) and 7 host species, involving 4 additional species of bats as their hosts. *Stricticimex namru* is known from Egypt and is reported by authors from India on *Tadarida aegyptiaca thomasi*, the host having 4 subspecies. The *Leptocimex hiregaudari* is being reported on two bat species viz., *Rhinopoma microphyllum microphyllum* and *Taphozous kachhensis kachhensis*.

As far as the distribution of parasites is considered *Stricticimex namru* is perhaps the extension of Ethiopian species upto Rajasthan. The genus *Cacodmus* with 2 species known from India both endemic has distribution between Oriental and Ethiopian regions. The genus appears to be quite old. *Leptocimex* has also similar distribution from Ethiopian to Oriental region, two species viz., *L. hiregaudari* and *L. inordinatus* occur in India and later extending to Sri Lanka. The genus *Cimex* is however widespread with seven species from India including 2 new species. Two of the species are associated with human beings, and are thus widely distributed. One species extends to Thailand leaving 4 endemic species, indicating that there is a dominant trend towards endemism.

Order — DIPTERA

Family — STREBLIDAE

It is apparent from the Table 4 that there is no parasite-host specificity and the number of hosts of some species of streblid parasite is perhaps determined by the habitat of the bats, when different species of bats share the same habitat same species of parasite infests them though all may not be the true breeding hosts. While this is true for the subfamily Brachytarsinae in which the sexes are similar; the host specificity is very much pronounced in the subfamily Ascodipterinae in which the females are very much modified i.e., they shed wings and legs and then bores into the skin of host by the proboscis (Muir, 1912). It is encysted by the enlargement of the first abdominal tergite and sternite, enclosing head and thorax. This encysted, flask shaped, structure develops minute circular rows of spines whose function is not yet known. It is felt that while initially the hole is made by the proboscis as stated by Muir (*l.c.*), this organ helps it to bore deeper till

only the apex of abdomen is visible from outside. The arrangement of these spines is of taxonomic value.

In Table 4 it is shown that the average number of parasites per infested bat varies from 1-5.3 specimens with the maximum number of specimens on an infested bat being 52. The maximum parasitism 97.7% is found in the bat *Megaderma lyra lyra* which is parasitised by *Raymondia lobulata*.

Among the 8 species of Streblidae, 5 species are endemic thus constituting nearly 62.5% endemism, other three species *Raymondia lobulata* Speiser, *Ascodipteron namrui* Maa and *Ascodipteron rhinopomatos* Jobling are a mixture of Ethiopian and Palaearctic elements extending to the western parts of India as known now. Among these two (66%) belong to the Ethiopian region and the remaining to the Central Asiatic subregion.

Regarding 5 species of hosts, 3 are widely distributed in Oriental, Ethiopian and part of Palaearctic region with subspecies in India viz. *Megaderma lyra lyra* (Geoffroy), *Rhinopoma hardwickei hardwickei* Gray and *Scotophilus heathi heathi* Horsfield. In case of *T. perforatus* and *R. microphyllum* distribution is between Ethiopian region and upto Indian subregion of the Oriental region thus indicating Ethiopian origin.

Family — NYCTERIBIIDAE

In this family the parasite-host specificity is confined to the subfamily level only. Three species viz. *Cyclopodia sykesii*, *Leptocyclopodia ferrarii ferrarii*, *Eucampsipoda latisternum* belonging to subfamily Cyclopodiinae, are restricted to fruit bats (suborder Megachiroptera), while 2 species viz. *Basilis roylui* and *Basilis blainvillii amiculata* belonging to subfamily Nycteribiinae, are restricted to the insectivorous bats (suborder Microchiroptera).

In Table 5 it is shown that the average parasite per infested bat varies from 1-6.9 specimens, with the maximum number of specimen on an infested bat being 21. The maximum parasitism was found in *Pteropus giganteus* being 100 percent followed by *Rousettus leschenaulti*.

In the subfamily Cyclopodiinae we find that all the three species of ectoparasites as well as their hosts are widely distributed in the Oriental Region including Pakistan. In the subfamily Nycteribiinae, it appears that both the hosts and parasites are confined to the Oriental Region, except one species of parasites and its host, which extend up to Afghanistan in Palaearctic Region. On the basis of present distribution it can be easily surmized that the parasitic genera have arisen in

the Oriental Region and subsequently extended into the Palaearctic Region — its Central Asiatic and Eastern subregions.

Out of 5 species none are endemic to India. One species viz. *Basilia roylli* Westwood extend westwards, while all others extend their range well into the eastern parts of the Oriental Region, though the host of *Cyclopodia sykesii* (Westwood) viz. *Pteropus giganteus giganteus* (Brünnich) is reported only between Pakistan, India, Sri Lanka and Burma. But, *C. sykesii* shows considerable intraspecific variations and this has not yet been correlated with the 2 subspecies of *P. giganteus* (as reported by Ellermann & Morrison-Scott, 1951). Perhaps the subspecies of *P. giganteus* may also not be valid.

Basilia roylli is the only species which extends from Palaearctic Region (Central Asiatic and Eastern Palaearctic subregions) to Malaysia, as its Eastern Border, with potentiality of its occurrence in Indonesia in view of the range of its host.

About 24 species of these flies are known from India. Theodor (1967) considers the family to be predominantly old world and perhaps centred in the Malaysian subregion of the Oriental Region.

Order — ACARINA

Family — SPINTURNICIDAE

Rudnick (1960) states that “Many species of Spinturnicidae seem to be restricted to a single species of bat or to species of bats that are very closely related...” At the generic level, he found a striking correlation between the spinturnicid genera and bat families with few exceptions. The genera *Ancystropus* and *Meristaspis* are almost exclusively found on bats of the family Pteropidae. The genera *Eyndhovenia* Rudnick and *Paraperiglischrus* Rudnick have been found almost exclusively on bats of family Phyllostomatidae. *Spinturnix* mites have been reported primarily on the bats of the family Vespertilionidae and Natalidae. Mites of genus *Paraspinturnix* have been found only on Vespertilionidae.

In our studies we find support for the above stipulation as :

Genus of Spintrnicidae	Bat Family/Families
<i>Spinturnix</i>	Vespertilionidae
<i>Ancystropus</i>	Pteropidae
<i>Meristaspis</i>	Pteropidae
<i>Parameristaspis</i> n. gen.	Pteropidae

It is observed from Table 6 that *Meristaspis lateralis* is the most common species of mites infesting *Rousettus leschenaulti* at 100 percent

level of infestation while *Ancystropus zeleborei* is quite rare, only 1 example being found on a single specimen of the same host species. The average number of parasites per bat varies from 0.03-1.33 and not more than 4 specimens have been collected from a single bat. The average number of parasites per infested bat also varies from 1-2 only. The percentage of infestation in hosts is also poor viz. 4-14% except in case of *R. leschenaulti* as shown above. It is further observed that the bat *Rousettus leschenaulti* harbours as many as 5 species of parasites of this family out of the total of 7 species indicating that there is no host specificity at specific level. Hiregaudar & Bal (1955, 1956) have reported 3 species of the genus *Ancystropus* from the same host *Rousettus leschenaulti*, but did not state any specific habitat or niches on the body. Our studies also confirm the occurrence of 3 species of the same genus on the same host and like the earlier authors, we have also failed to record the different specific niches on the body of the host. This is in view of the minute size of the parasites. Rudnick (1960 : 177) states that if all species occupy the same ecological niche, a most unusual biological situation exists. It is desirable to investigate this interesting phenomenon.

Regarding distribution the genera *Ancystropus*, *Meristaspis*, *Periglischrus*, *Endhovenia* are found in Ethiopian, Oriental and Palaearctic region, while *Spinturnix* is worldwide in distribution. There is considerable coevolution between parasitic species and particular genus of host in terms of their distribution as shown in taxonomic portion of study.

Out of 7 species under studies, the 3 species which are new to science and one *Ancystropus taprobanicus* occurs in India and Sri Lanka only, thus 57% species are endemic at present.

Out of remaining 3 species, one *Ancystropus zeleborei* occurs in Ethiopian Region and India only, it does not extend to south east Asia. But the 2 species viz. *Ancystropus kanheri* and *Meristaspis lateralis* are widely distributed, the former is found in India and extends upto southeast Asia and the latter is found from Ethiopian region (Egypt) upto south-east Asia (Philippines) through India and Sri Lanka.

Family—MACRONYSSIDAE

Both genera and species of Macronyssid mites on bats have a high level of host specificity. According to Radovsky (1967) 'there is sufficiently close correspondence between the independently derived phylogenies of Macronyssidae' The existing records show host specificity at least, at the generic level of parasites v/s family of the host bats.

The major family or super-family of bats associated with corresponding genera are as follows :—

Vespertilionidae	<i>Ichoronyssus</i> , <i>Macronyssus</i> , <i>Steatonyssus</i> , <i>Trichonyssus</i> , <i>Cryptonyssus</i> .
Molossidae	<i>Chiroptonyssus</i> , <i>Chelonyssus</i> , <i>Parasteatonyssus</i>
Rhinolophoidae	<i>Bewsilla</i> , <i>Megistonyssus</i> , <i>Macronyssus</i> *, <i>Steatonyssus</i> *
Emballonuridae	<i>Steatonyssus</i> , <i>Parasteatonyssus</i> *
Phyllostmatidae	<i>Parichoronyssus</i> , <i>Radfordiella</i> , <i>Macronyssoides</i>

In the Table 7 it will be seen that out of 4 species of parasites, 3 were collected on 3 different species of bats thus showing host specificity. Only remaining one species i.e. *Steatonyssus allredi* was found on 2 species of bats, but the single specimen collected on *Rousettus leschenaulti* was slightly different from those collected on *Taphozous longimanus*.

The maximum parasitism was found in the bat *Taphozous longimanus* by the macronyssid *Steatonyssus allredi*, closely followed by *Scotophilus heathi* v/s *S. decisetosus*.

The average number of parasites per infested bat varies between 1-3.5 specimens per host, with the maximum number of specimens on an infested bat being only 7. The average number of parasites per bat varies from 0.027-0.53 only. The percentage of infestation among the hosts varies from 1.7% to 22.2%.

All the species of parasites under report are so far endemic, being new to science. Out of the 5 host species except *S. heathi*, other species are either endemic or are represented by endemic subspecies.

Family—ARGASIDAE

The fauna of argasids on bats is comparatively little explored. Studies of Kohls *et al.* (1965) and Soneshine *et al.* (1966) indicate that there is no host specificity in the sub-family Ornithodorinae. We have however, not come across any species of this subfamily though there exist records of 3 species on Indian bats.

In the subfamily Argasinae, the genus *Argas* and its subgenera *Carios* and *Chiropteragus* to which our species belong, are found only on bats. The other subgenera of *Argas* limited host specificity i.e. between the subgenera of *Argas* and the major orders of *Mammalia*.

Table 8 shows that the average number of parasite per infested bat varies from 1-9 specimens, with the maximum number of specimens on an infested bat being 13. The average number of parasites per bat varies between 0.0005-0.0.

The maximum parasitism was found in *Taphozous longimanus* where 22.2 percent of bats were parasitised. This was followed by *S. heathi* v/s *A. (Ca) gujaratensis*.

* Genera reported from India.

Regarding distribution nothing much can be said now since out of six species, five are being reported as new to science and the sixth *A. (Ca) vespertilionis* is found in Palaearctic, Ethiopian and Oriental regions.

Family—Ixodidae

The only species, collected during these studies is *I. vespertilionis* which is not host specific and is found on the bats of family Vespertilionidae, Rhinolophidae and Emballonuridae. It is widely distributed and found in Ethiopian, Palaearctic and Oriental regions. In this case *I. vespertilionis*, in larval stages, were collected on bat *Taphozous kachhensis kachhensis*, an emballonurid bat. The percentage of infestation was 8.3, the average parasite per bat and per infested bat is 0.58 and 7 respectively (Table 8).

SUMMARY

This paper deals with 36 species of ectoparasitic insects, mites and ticks (1465 examples) spread over 7 families and 20 genera on 18 species of bats (850 examples) of Rajasthan and Gujarat. Dichotomous keys are provided to all the known Indian genera and species of the ectoparasites of bats under the respective families, subfamilies and complexes. Two new genera and twenty species, have been described as new to science. Four species are reported from India and remaining 12 species are recorded from Rajasthan and/or Gujarat for the first time. The following is the list of new taxa described : *Cimex ueshimai*, *C. pattoni*, *Cacodmus bhati*, *Leptocimex hireguadari* (HEMIPTERA : CIMICIDAE); *Brachytarsina maai*, *B. joblingi*, *B. theodori*, *Paraascodipteron scotophilus* (n. gen. & n. sp.) (DIPTERA : STREBLIDAE); *Parameristaspis delfinadoi* (n. gen. & n. sp.), *Spinturnix bakeri*, *S. rudnicki* (ACARINA : SPINTURNICIDAE); *Steatonyssus decisetosus*, *S. quadrisetosus*, *S. allredi*, *Parasteatonyssus jayanti* (ACARINA : MACRONYSSIDAE); *Argas (Carios) soneshinei*, *A. (Ca.) gujaratensis*, *A. (Ca.) hoogstraali*, *A. (Ca.) indicus* and *A. -(Chiropteraqus) wilsoni* (ACARINA : ARGASIDAE).

These studies have resulted in adding 26 parasite species to the hitherto known 75 species.

The literature has been reviewed under each family.

The zoogeographic distribution *vis-a-vis* the degree of infestation etc., has also been briefly discussed.

A list of hitherto known ectoparasites on Indian species of bats with a cross reference to the source of information is also provided for the use of the readers.

Table 3. Showing number of parasites and percentage of infestation in bats
HETEROPTERA : CIMICIDAE

Parasite	Number of examples	Average parasite per bat (Min.-Max.)	Average per infested bat	Host bat species	Number of host examined	Number of host infested	Percentage of infestation
<i>Cimex ueshimai</i>	32	0.27 (1-7)	1.7	<i>Pipistrellus dormeri dormeri</i>	119	18	15.1
<i>Cimex pattoni</i>	13	0.27 (1-7)	4.3	<i>Taphozous longimanus</i>	18	3	16.6
	24	0.45 (1-6)	4.0	<i>Scotophilus heathi heathi</i>	53	6	11.3
<i>Cacodmus bhati</i>	210	1.6 (1-16)	10.5	<i>Pipistrellus dormeri dormeri</i>	119	20	16.7
<i>Leptocimex hiregaudari</i>	39	0.54 (1-6)	4.3	<i>Taphozous kachhensis kachhensis</i>	72	9	12.5
	53	0.13 (1-3)	2.65	<i>Rhinopoma microphyllum microphyllum</i>	244	20	8.2
<i>Stricticimex namru</i>	5	0.23 (1-2)	1.25	<i>Tadarida aegyptiaca thomasi</i>	22	4	18.2

Table 4. Showing number of parasites and percentage of infestation in bats
DIPTERA : STREBLIDAE

Parasite	Number of examples	Average parasite per bat (Min.-Max.)	Average per infested bat	Host bat species	Number of hosts examined	Number of hosts infested	Percentage of infestation
<i>Brachytarsina maai</i>	1	.0037 (1-1)	1	<i>Rhinopoma microphyllum</i> & <i>R. hardwickei</i> (mixed colony)	272	1	0.4
<i>Brachytarsina joblingi</i>	1	.2 (1-1)	1	<i>Taphozous perforatus</i> <i>perforatus</i>	5	1	20.0
<i>Brachytarsina theodori</i>	1	.004 (1-1)	1	<i>Rhinopoma microphyllum</i> <i>microphyllum</i>	244	1	0.4
<i>Brachytarsina sinhai</i>	48	0.2 (1-2)	1.37	<i>Rhinopoma microphyllum</i> <i>microphyllum</i>	244	35	14.3
<i>Raymondia lobulata</i>	403	5.2 (2-52)	5.3	<i>Megaderma lyra</i> <i>lyra</i>	78	76	97.7
<i>Ascodipteron namrui</i>	3	.012 (1-1)	1	<i>Rhinopoma microphyllum</i> <i>microphyllum</i>	244	3	1.23
<i>Ascodipteron rhinopomatos</i>	1	.036 (1-1)	1	<i>Rhinopoma hardwickei</i> <i>hardwickei</i>	28	1	3.6
<i>Paraascodipteron scotophilus</i>	1	.019 (1-1)	1	<i>Scotophilus heathi</i> <i>heathi</i>	53	1	1.9

Table 5. Showing number of parasites and infestation in bats
DIPTERA : NYCTERIBIIDAE

Parasite	Number of examples	Average parasite per bat (Min.-Max.)	Average per infested bat	Host bat species	Number of hosts examined	Number of hosts infested	Percentage of infestation
<i>Cyclopodia sykesii</i>	76	6.9 (2-21)	6.9	<i>Pteropus giganteus giganteus</i>	11	11	100.0
<i>Leptocyclopodia ferrarii ferrarii</i>	10	1.0 (2-3)	2	<i>Cynopterus sphinx sphinx</i>	10	5	50.0
<i>Eucampsipoda latisternum</i>	73	2.03 (2-3)	2.7	<i>Rousettus leschenaulti leschenaulti</i>	36	27	76.1
<i>Basilina (Paracyclopodia) roylli</i>	130	2.4 (1-12)	4.2	<i>Scotophilus heathi heathi</i>	53	31	58.5
<i>Basilina blainvilli amiculata</i>	3	0.17 (1-1)	1	<i>Taphozous longimanus longimanus</i>	18	3	16.6

Table 6. Showing number of parasites and percentage of infestation in bats
ACARINA : SPINTURNICIDAE

Parasite	Number of examples	Average parasite per bat (Min.-Max.)	Average per infested bat	Host bat species	Number of hosts examined	Number of hosts infested	Percentage of infestation
<i>Ancystropus taprobanus</i>	5	0.14 (1-1)	1	<i>Rousettus leschenaulti leschenaulti</i>	36	5	14.0
<i>Ancystropus zeleborii</i>	1	.03 (1-1)	1	<i>Rousettus leschenaulti leschenaulti</i>	36	1	3.0
<i>Ancystropus kanheri</i>	2	.06 (1-1)	1	<i>Rousettus leschenaulti leschenaulti</i>	36	2	6.0
<i>Meristaspis lateralis</i>	48	1.33 (1-4)	1.33	<i>Rousettus leschenaulti leschenaulti</i>	36	36	100.0
<i>Parameristaspis delbinadoi</i>	9	0.25	?	<i>Rousettus leschenaulti leschenaulti</i>	36	7	?
<i>Spinturnix bakeri</i>	13	0.11 (1.2)	1.6	<i>Pipistrellus dormeri dormeri</i>	119	8	6.6
<i>Spinturnix rudnicki</i>	8	0.15 (1-3)	2	<i>Scotophilus heathi heathi</i>	53	4	4.0

Table 7. Showing number of parasites and percentage of infestation in bats
ACARINA : MACRONYSSIDAE

Parasite	Number of examples	Average parasite per bat (Min.-Max.)	Average per infested bat	Host bat species	Number of hosts examined	Number of hosts infested	Percentage of infestation
<i>Steatonyssus decisetosus</i>	28	0.53 (1—7)	3.5	<i>Scotophilus heathi heathi</i>	53	8	15.4
<i>Steatonyssus quadrisetosus</i>	6	0.05 (3—3)	3	<i>Pipistrellus dormeri dormeri</i>	119	2	1.7
<i>Steatonyssus allredi</i>	9	0.5 (1—3)	2.25	<i>Taphozous longimanus longimanus</i>	18	4	22.2
	1	0.027	1	<i>Rousettus leschenaulti leschenaulti</i>	36	1	2.7
<i>Parasteatonyssus iayanti</i>	5	0.23 (2—3)	2.5	<i>Tadarida aegyptiaca thomasi</i>	22	2	9.1

Table 8. Showing number of parasites and percentage of infestation in bats.
ACARINA : ARGASIDAE, IXODIDAE

Parasite	Number of example	Average parasite per bat (Min.-Max.)	Average per infested bat	Host bat species	Number of hosts examined	Number of hosts infested	Percentage of infestation
<i>ARGASIDAE</i>							
<i>Argas (Carios) soneshinei</i>	1	.005	7*	<i>Pipistrellus dormeri dormeri</i>	119	*	*
<i>Argas (Carios) vespertilionis</i>	2	.01	?*	<i>Pipistrellus dormeri dormeri</i>	119	*	*
<i>Argas (Carios) gujaratensis</i>	33	0.6 (1—9)	3.3	<i>Scotophilus heathi heathi</i>	53	10	19
<i>Argas (Carios) hoogstraali</i>	36	2 (1—13)	9	<i>Taphozous longimanus longimanus</i>	18	4	22.2
<i>Argas (Carios) indicus</i>	1	.05	1	<i>Tadarida aegyptiaca thomasi</i>	22	1	4.5
<i>Argas (Chiropteragus) wilsoni</i> (Adult)	1**	—	—)	<i>Rhinopoma microphyllum microphyllum</i>	244	—	
-do- (Larvae)	78	0.32 (1—5)	1.6	-do-			
<i>IXODIDAE</i>							
<i>Ixodes vespertilionis</i>	42	0.58 (1—10)	7	<i>Taphozous kachhensis kachhensis</i>	72	6	8.3

* Collected from roosting places of bats. ** Specimen collected in Spider's webs.

Table 9. Showing association between parasitic and host bat genera in India.

Group	Host genera/Parasitic Genera	MEGACHIROPTERA Pteropidae						Rhinopo- matidae	Emballo- nuridae	MICROCHIROPTERA Megader- matidae			Rhinolo- phidae	Molo- ssidae	Vespertilionidae					
		PTEROPUS	ROUSETTUS	CYNOPTERUS	SPHAERIAS	NYCTALUS	EONYCTERIS	RHINOPOMA	TAPHOZOUS	MEGADERMA	RHINOLOPHUS	HIPPOSIDEROS	TADARIDA	SCOTOPHILUS	PIPISTRELLUS	MYOTIS	MINIOPTERUS	TYLONYCTERIS	BARBASTELLA	LEUCONE
		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
HETEROPTERA	INSECTA	<i>Cimex</i>	×						×		×			×	×	×	×			
	HEMIPTERA	<i>Leptocimex</i>	×					×(2)*	×(2)			×(2)		×	×		×			
	Cimicidae	<i>Aphrania</i>		×																
		<i>Stricticimex</i>											×							
		<i>Cacodmus</i>													×(3)					
	Polychtenidae	<i>Eoctenes</i>							×(2)	×										
		<i>Polychtenes</i>								×										
(PUPIPARA)	SIPHONAPTERA																			
	Ischnopsyllidae	<i>Thaumpsylla</i>	×																	
	DIPTERA	<i>Brachytarsina</i>	×					×(2)	×(2)		×	×					×			
	Streblidae	<i>Raymondia</i>								×	×(2)	×								
		<i>Ascodiapteron</i>						×(2)												
		<i>Paraascodiapteron</i>												×						

* Record of parasitic genus on 2 or more species of bats of same genus is shown in parentheses.

Table 9 (continued).

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Nycteribiidae	<i>Cyclopodia</i>	×																		
	<i>Leptocyclopodia</i>			×(2)	×															
	<i>Eucampsipoda</i>		×(2)																	
	<i>Basilia</i>								×					×	×(2)		×			
	<i>Pthiridium</i>										×(3)	×(2)							×	
	<i>Nycteribia</i>															×	×			
	<i>Penicillidia</i>																×			×
ARACHINIDA	<i>Ancystropus</i>		×																	
ACARINA	<i>Meristaspis</i>		×																	
Spinturnicidae	<i>Parameristaspis</i>		×																	
	<i>Endhovenia</i>										×									
	<i>Paraperiglischrus</i>										×									
	<i>Spinturnix</i>													×	×	×		×		
														×	×	×		×		
Macronyssidae	<i>Steatonyssus</i>		×						×					×	×	×				
	<i>Macronyssus</i>					×	×											×		
	<i>Parasteatonyssus</i>								×				×							
Laelaptidae	<i>Neolaclaps</i>	×					×													
Trombiculidae	<i>Whartonia</i>		×								×	×								
	<i>Riedlinia</i>										×									
	<i>Trombicula</i>							×												
Sarcoptidae	<i>Nycteridocoptes</i>						×													
Myobiidae	<i>Foliomyobia</i>		×						×											
	<i>Neomyobia</i>										×					×				
Argasidae	<i>Argas</i>							×	×				×	×	×					
	<i>Ornithodoros</i>		×								×							×		
Ixodidae	<i>Ixodes</i>								×											

DISTRIBUTION OF PARASITE V/S HOST
Hemiptera — Heteroptera : Cimicidae

Name of species	O R I E N T A L														REMARKS
	Ceylonese subregion					Indo-chinese subregion					Malaysian subregion				
	ETHIOPIAN	PALAEARCTIC	Sri Lanka	India	S. of Karnataka	India Subreg.	N. F. India	Burma	Thailand	Indo-china	Malaysia	Indonesia	Phillipine	AUSTRALIAN	
	1	2	3	4		5	6	7	8	9	10	11	12	13	14
<i>Cimex ueshimai</i> n. sp.						+									
<i>Pipistrellus dormeri dormeri</i>					+	(+)	(+)								
<i>Cimex pattoni</i> n. sp.						+									
<i>Scotophilus heathi heathi</i>		+	(+)		(+)	(+)	(+)	+	+	+		+		+	
<i>Taphozous longimanus longimanus</i>			+		(+)	(+)		+			+	+			
<i>Cacodmus bhati</i> n. sp.						+									
<i>Pipistrellus dormeri dormeri</i>					+	(+)	(+)								
<i>Leptocimex hiregaudari</i> n. sp.						+									
<i>Taphozous kachhensis kachhensis</i>		+			(+)	(+)	(+)	+			+				
<i>Rhinopoma microphyllum microphyllum</i>	+	+				(+)									
<i>Stricticimex namru</i>	+														
<i>Tadarida aegyptiaca thomasi</i>	+				(+)	(+)									

DISTRIBUTION OF PARASITE V/S HOST

Diptera — Pupipara : Nycteribiidae

Name of species	O R I E N T A L													REMARKS	
	Ceylonese subregion			Indo-chinese subregion					Malaysian subregion			AUSTRALIAN			
	ETHIOPIAN	PALAEARCTIC	Sri Lanka	India	S. of Karnataka	India Subreg.	N. F. India	Burma	Thailand	Indo-china	Malaysia		Indonesia		Phillipine
	1	2	3	4		5	6	7	8	9	10	11	12	13	14
<i>Cyclopodia sykesii</i>		+	+		+	+	+	+							•Pakistan
<i>Pteropus giganteus giganteus</i>		+	(+)		(+)	(+)	(+)								•Pakistan
<i>Leptocyclopodia ferrarii ferrarii</i>			+		+	+	+								
<i>Cynopterus sphinx sphinx</i>			(+)		(+)	(+)	(+)	(+)	(+)	+		+			
<i>Eucampsipoda latisternum</i>			+		+	+	+	+	+	+		+			
<i>Rousettus leschenaulti leschenaulti</i>					(+)	(+)	(+)	(+)	(+)			(+)			
<i>Basilia (Paracyclopodia) roylii</i>		+	+		+	+					+				•Pakistan Afghanistan
<i>Scotophilus heathi heathi</i>		+	(+)		(+)	(+)	(+)	+	+	+		+		+	Sulawesi
<i>Basilia blainvilli amiculata</i>			+			+					+				
<i>Taphozous longimanus longimanus</i>			+		(+)	(+)	(+)	+				+			

(+) Distribution of the subspecies.

Distribution of Parasite V/S Host (continued) :

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Diptera			—	Pupipara	: Streblidae								
<i>Raymondia lobulata</i>		+			+									
<i>Megaderma lyra lyra</i>		+	+	(+)	(+)	(+)	+							upto Afghanistan
<i>Brachytarsina sinhai</i>					+									
<i>Rhinopoma microphyllum microphyllum</i>	+	+			(+)									
<i>Brachytarsina maai</i> n. sp.					+									
<i>Rhinopoma microphyllum microphyllum</i>	+	+			(+)									
<i>Rhinopoma hardwickei hardwickei</i>	+	(+)		(+)	(+)		(+)							
<i>Brachytarsina joblingi</i> n. sp.					+									
<i>Taphozous perforatus perforatus</i>	(+)	+			(+)									Arabia
<i>Brachytarsina theodori</i> n. sp.					+									
<i>Rhinopoma microphyllum microphyllum</i>	+	+			(+)									
<i>Ascodipteron namuri</i>	+	+			(+)									
<i>Rhinopoma microphyllum microphyllum</i>	+	+			(+)									
<i>Paraascodipteron scotophilus</i> n. sp.					+									
<i>Scotophilus heathi heathi</i>		+	(+)	(+)	(+)	(+)	+	+	+		+		+	
<i>Ascodipteron rhinopomatos</i>	+	+			+									
<i>Rhinopoma hardwickei hardwickei</i>	+	(+)		(+)	(+)		(+)							

(+) Distribution of subspecies

Distribution of Parasite V/S Host (continued) :

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Acarina : Mesostigmata : Spinturnicidae														
<i>Ancystropus taprobanus</i>			+	+	+									
<i>Rousettus leschenaulti leschenaulti</i>				+	+	+	+	+			+			
<i>Ancystropus zeledorii</i>	+	+			+									
<i>Rousettus leschenaulti leschenaulti</i>				+	+	+	+	+			+			
<i>Ancystropus kanheri</i>					+					+	+		+	
<i>Rousettus leschenaulti leschenaulti</i>				+	+	+	+	+		+				
<i>Meristaspis lateralis</i>	+	+			+					+	+	+		
<i>Rousettus leschenaulti leschenaulti</i>				+	+	+	+	+			+			
<i>Parameristaspis delfinadoi</i> n. sp.					+									
<i>Rousettus leschenaulti leschenaulti</i>				+	+	+	+	+			+			
<i>Spinturnix bakeri</i> n. sp.					+									
<i>Pipistrellus dormeri dormeri</i>				+	+	+								
Acarina : Mesostigmata : Macronyssidae														
<i>Steatonyssus decisetosus</i> n. sp.					+									
<i>Scotophilus heathi heathi</i>		+	+	+	+	+	+	+	+		+		+	
<i>Steatonyssus quadrisetosus</i> n. sp.					+									
<i>Pipistrellus dormeri dormeri</i>				+	+	+								
<i>Steatonyssus allredi</i> n. sp.					+									
<i>Taphozous longimanus longimanus</i>		+	+	+		+			+		+			
<i>Rousettus leschenaulti leschenaulti</i>			+	+	+	+	+				+			
<i>Parasteatonyssus jayanti</i> n. sp.				+										
<i>Tadarida aegyptiaca thomasi</i>	+		+	+										

(+) Distribution of subspecies

Distribution of Parasite V/S Host (continued) :

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Acarina : Ixodidae : Argasidae and Ixodidae													
<i>Argas (Carios) soneshinei</i> n. sp.					+									Dadra & Nagar Haveli
<i>Pipistrellus dormeri dormeri</i>				+	+	+								
<i>Argas (Carios) vespertilionis</i>		+			+		+		+		+		+	Nepal China & Korea Taiwan
<i>Pipistrellus dormeri dormeri</i>				+	+	+								
<i>Argas (Carios) gujaratensis</i> n. sp.					+									
<i>Scotophilus heathi heathi</i>		+	+	+	+	+	+	+			+		+	
<i>Argas (Carios) hoogstraali</i> n. sp.					+									
<i>Taphozous longimanus longimanus</i>			+	+	+		+			+	+			
<i>Argas (Carios) indicus</i> n. sp.						+								
<i>Tadarida aegyptiaca thomasi</i>	+			+	+									
<i>Argas (Chiropteragus) wilsoni</i> n. sp.					+									
<i>Rhinopoma microphyllum microphyllum</i>	+	+			+									
IXODIDAE														
<i>Ixodes vespertilionis</i>	+	+		+					+				+	China
<i>Taphozous kachhensis kachhensis</i>		+		+	+	+	+	+	+					

(+) Distribution of subspecies

LIST OF ECTOPARASITES V/S BAT HOSTS REPORTED FROM INDIA

S. No. 1	Species of ectoparasite 2	Host or Hosts 3	Record from India <i>vide</i> : 4
I. HEMIPTERA : CIMICIDAE			
1.	<i>Cimex insuetus</i> Ueshima	<i>Rousettus leschenaulti</i> and <i>Miniopterus schreibersi</i> inhabiting a common cave.	Bhat (1974a)
2.	<i>Cimex himalayanus</i> Bhat	<i>Myotis siligorensis</i>	Bhat (1974a)
3.	<i>Cimex usingeri</i> Bhat	<i>Rhinolophus rouxi</i>	Bhat <i>et al.</i> (1973a)
4.	<i>Cimex ueshmai</i> n. sp.	<i>Pipistrellus dormeri dormeri</i>	Present studies
5.	<i>Cimex pattoni</i> n. sp.	<i>Scotophilus heathi</i> , <i>Taphozous longimanus</i> from different localities of same district.	Present studies
6.	<i>Cacodmus indicus</i> Jordon & Rothschild	<i>Pipistrellus ceylonicus</i> , <i>P. pipistrellus</i>	Jordon & Rothschild
7.	<i>Cacodmus bhati</i> n. sp.	<i>Pipistrellus dormeri dormeri</i>	Present studies
8.	<i>Aphrania vishnou</i> (Mathur)	<i>Cynopterus sphinx</i>	Mathur (1953)
9.	<i>Stricticimex pattoni</i> Horvath	Unknown bat	Horvath (1925)
10.	<i>Stricticimex namru</i> Usinger	<i>Tadarida aegyptiaca thomasi</i>	Vazirani & Advani (1975)
11.	<i>Leptocimex inordinatus</i> Ueshima	<i>Taphozous melanopogon</i> (by original author), <i>Rousettus leschenaulti</i> , <i>Hipposideros bicolor</i> , <i>H. lankadiva</i> , <i>Taphozous kachhensis</i> , <i>Rhinopoma hardwickei</i> , <i>Miniopterus schreibersi</i>	Bhat (1974b)
12.	<i>Leptocimex hiregaudari</i> n. sp.	<i>Taphozous kachhensis kachhensis</i> & <i>Rhinopoma microphyllum</i> from different localities	Present studies
II. HEMIPTERA : POLYCTENIDAE			
1.	<i>Eoctenes maai</i> Bhat	<i>Taphozous kachhensis</i>	Bhat <i>et al.</i> (1973b)
2.	<i>Eoctenes spasmae</i> (Water house)	<i>Megaderma spasma</i>	Distant (1910)
3.	<i>Eoctenes intermedius</i> (Speiser)	<i>Taphozous melanopogon</i>	Maa (1964)
4.	<i>Polycctnes molossus</i> Giglioli	<i>Megaderma lyra</i>	Distant (1906)

List of ectoparasites v/s bat hosts (continued) :

S. No. 1	Species of ectoparasite 2	Host or Hosts 3	Record from India vide : 4
III. DIPTERA : STREBLIDAE			
1.	<i>Brachytarsina gigantea</i> Speiser	<i>Rousettus leschenaulti</i>	Bal & Ahmed (1949a)
2.	<i>Brachytarsina amboinensis</i> Speiser	<i>Miniopterus fuliginosus</i>	Hiregaudar & Bal (1956)
3.	<i>Brachytarsina modesta</i> Jobling	<i>Rhinolophus rouxi</i>	-do-
4.	<i>Brachytarsina taji</i> Hiregaudar & Bal	<i>Rhinopoma hardwickei</i>	-do-
5.	<i>Brachytarsina speiseri</i> Jobling	<i>Hipposideros lankadiva</i>	Jobling (1934)
6.	<i>Brachytarsina cucullata</i> Jobling	<i>Taphozous melanopogon</i>	-do-
7.	<i>Brachytarsina caudata</i> Jobling	<i>Taphozous melanopogon</i>	Jobling (1934)
8.	<i>Brachytarsina pygialis</i> Jobling	<i>Hipposideros lankadiva</i>	-do-
9.	<i>Brachytarsina sinhai</i> Vazirani & Advani	<i>Rhinopoma microphyllum</i>	Vazirani & Advani (1977)
10.	<i>Brachytarsina theodori</i> n. sp.	<i>Rhinopoma microphyllum</i>	Present studies
11.	<i>Brachytarsina joblingi</i> n. sp.	<i>Taphozous perforatus</i>	Present studies
12.	<i>Brachytarsina mazi</i> n. sp.	<i>whinopoma hardwickei</i> and <i>Rhinopoma microphyllum</i> (a mixed colony)	Present studies
13.	<i>Raymondia lobulata</i> Speiser	<i>Megaderma lyra lyra</i>	Speiser (1900)
14.	<i>Raymondia pagoderm</i> Speiser	<i>Hipposideros speoris speoris</i>	Kessel (1925)
15.	<i>Raymondia joblingi</i> Hiregaudar & Bal	<i>Rhinolophus rouxi</i>	Hiregaudar & Bal (1956)
16.	<i>Raymondia pseudopagoderm</i> Jobling	<i>Rhinolophus areuatus</i>	Jobling (1951)
17.	<i>Ascodipteron namrui</i> Maa	<i>Rhinopoma microphyllum microphyllum</i>	Present studies
18.	<i>Ascodipteron rhinopomatos</i> Jobling	<i>Rhinopoma hardwickei hardwickei</i>	Present studies
19.	<i>Paraascodipteron scotophilus</i> n. gen. & n. sp.	<i>Scotophillus heathi heathi</i>	Present studies

List of ectoparasites v/s ba thosts (continued) :

S. No. 1	Species of ectoparasite 2	Host or Hosts 3	Record from India vide : 4
IV. DIPTERA : NYCTERIBIIDAE			
1.	<i>Nycteribia allotopa</i> Speiser	<i>Miniopterus schreibersii</i>	Scott (1925)
2.	<i>Nycteribia dentata</i> Theodor	<i>Myotis longipes</i>	Theodor (1967)
3.	<i>Nycteribia parvula</i> Speiser	<i>Miniopterus schreibersii</i>	Scott (1925)
4.	<i>Phthiridium annandalei</i> (Scott)	<i>Rhinolophus lepidus</i>	Scott (1925)
5.	<i>Phthiridium burmense burmense</i> (Theodor)	<i>Rhinolophus subbadius</i> and <i>Hipposideros lankadiva</i>	Patton (1924)*
6.	<i>Phthiridium incisum</i> (Theodor)	<i>Hipposideros armiger</i>	Theodor (1967)
7.	<i>Phthiridium nuditerga</i> (Theodor)	<i>Barbastella leucomelas darjeelingensis</i>	Theodor (1967)
8.	<i>Phthiridium phillipsi</i> (Scott)	<i>Rhinolophus rouxi</i>	Scott (1925)
9.	<i>Basilia (s. str.) fletcheri</i> (Scott)	<i>Pipistrellus dormeri</i> , <i>P. ceylonicus</i>	Scott (1914)
10.	<i>Basilia majuscula</i> (Edw.) = <i>Scotti</i> Hiregaudar & Bal	<i>Pipistrellus ceylonicus chrysothrix</i>	Hiregaudar & Bal (1956)
11.	<i>Basilia (s. str.) pumila</i> (Scott) = <i>bombayensis</i> Hiregaudar & Bal	<i>Pipistrellus ceylonicus chrysothrix</i>	Scott (1925)
12.	<i>Basilia blainvilli amiculata</i> Speiser	<i>Taphozous longimanus</i>	Speiser (1907)
13.	<i>Basilia (s. str.) punctata</i> Theodor	<i>Pipistrellus ceylonicus</i>	Theodor (1956)
14.	<i>Basilia (s. str.) seminuda</i> Theodor	Host unknown	Theodor (1956)
15.	<i>Basilia royltii</i> Westwood	<i>Scotophilus heathi heathi</i>	Scott (1919)
16.	<i>Basilia peali</i> (Scott)	Host unknown	Scott (1925)
17.	<i>Basilia brevipes</i> (Theodor)	<i>Tylonycteris pachypus</i>	Theodor (1956)
18.	<i>Penicillidia indica</i> Scott	<i>Miniopterus schreibersii</i>	Scott (1925)
19.	<i>Penicillidia dufourii dufourii</i> (Westwood)	<i>Leuconoe longipes</i>	Scott (1925)
20.	<i>Eucampsipoda latisternum</i> Sch. Stkh & Hdbg.	<i>Rousettus leschenaulti</i>	Hiregaudar & Bal (1956)

* *P. burmense burmense* (Theodor) was recorded and misidentified by Patton (1924) as *Nycteribia (Acrocholidia) euxosta* from Assam.

List of ectoparasites v/s bat hosts (continued) :

S. No. 1	Species of ectoparasite 2	Host or Hosts 3	Record from India vide : 4
21.	<i>Eucampsipoda sundaicum</i> Theodor	<i>Rousettus aegypticus</i>	Bal & Ahmad (1949)
22.	<i>Leptocyclopodia ferrarii ferrarii</i> (Rondani)	<i>Cynopterus sphinx</i> , <i>C. marginatus</i>	Scott (1925)
23.	<i>Leptocyclopodia thaii</i> Maa	<i>Sphaerias blanfordi</i>	Maa (1968)
24.	<i>Cyclopodia sykesii</i> (Westwood)	<i>Pteropus giganteus</i>	Westwood (1935)
V. SIPHONAPTERA : ISCHNOPSYLLIDAE			
1.	<i>Thaumapsylla breviceps orientalis</i> Smit	<i>Rousettus leschenaulti</i>	Smit (1954)
VI. ACARINA : SPINTURNICIDAE			
1.	<i>Ancystropus kanheri</i> Hiregaudar & Bal	<i>Rousettus leschenaulti</i>	Hiregaudar & Bal (1956)
2.	<i>Ancystropus taprobanius</i> Turk	<i>Rousettus leschenaulti</i>	-do-
3.	<i>Ancystropus zeleborii</i> Kolenati	<i>Rousettus leschenaulti</i>	-do-
4.	<i>Meristaspis lateralis</i> Kolenati	<i>Rousettus leschenaulti</i>	-do-
5.	<i>Eyndhovenia euryalis</i> Canestrini	<i>Rhinolophus rouxi</i>	-do-
6.	<i>Paraperiglischrus rhinolophinus</i> Koch	<i>Rhinolophus rouxi</i>	-do-
7.	<i>Spinturnix psi</i> Kolenati	<i>Miniopterus schreibersi fuliginosus</i>	-do-
8.	<i>Spinturnix pindarensis</i> Bhat	<i>Myotis siligorensis</i>	Bhat (1973)
9.	<i>Spinturnix rudincki</i> n. sp.	<i>Scotophilus heathi</i>	Present studies
10.	<i>Spinturnix bakeri</i> n. sp.	<i>Pipistrellus dormeri</i>	Present studies
11.	<i>Parameristaspis delfinadoi</i> n. sp.	<i>Rousettus leschenaulti</i>	Present studies

List of ectoparasites v/s bat hosts (continued) :

S. No. 1	Species of ectoparasite 2	Host or Hosts 3	Record from India vide : 4
VII. ACARINA : MACRONYSSIDAE			
1.	<i>Macronyssus granulosus</i> Kolenati	<i>Miniopterus fuliginosus</i>	Hiregaudar & Bal (1956)
2.	<i>Macronyssus kumaonicus</i> Bhat	<i>Sphaerias blanfordi</i> , <i>Nyctalus leisleri</i>	Bhat (1973)
3.	<i>Steatonyssus hubli</i> Hiregaudar & Bal	<i>Pipistrellus ceylonicus chrysothrix</i>	Hiregaudar & Bal (1955)
4.	<i>Steatonyssus javensis</i> Oudemans	Bat (unknown species)	Oudemans (1914)
5.	<i>Steatonyssus decisetosus</i> n. sp.	<i>Scotophilus heathi heathi</i>	Present studies
6.	<i>Steatonyssus quadrisetosus</i> n. sp.	<i>Pipistrellus dormeri</i>	Present studies
7.	<i>Steatonyssus allredi</i> n. sp.	<i>Taphozous longimanus Rousettus leschenaulti</i>	Present studies
8.	<i>Parasteatonyssus jayanti</i> n. sp.	<i>Tadarida aegyptiaca thomasi</i>	Present studies
9.	<i>Parasteatonyssus lingarji</i> Hiregaudar & Bal	<i>Taphozous longimanus</i>	Hiregaudar & Bal (1956)
VIII. ACARINA : LAELAPIDAE			
1.	<i>Neolaelaps magnistigmatus</i> Vitzthum	<i>Pteropus giganteus</i>	Hiregaudar & Bal (1956)
2.	<i>Neolaelaps spinosa</i> Berlese	<i>Pteropus giganteus</i>	Berlese (1910)
IX. ACARINA : MYOBIIDAE			
1.	<i>Foliomyobia barenleyi</i> Radford	<i>Taphozous longimanus</i>	Hiregaudar & Bal (1956)
2.	<i>Foliomyobia jamesoni</i> Hiregaudar & Bal	<i>Rousettus leschenaulti</i>	-do-
3.	<i>Neomyobia luzonensis</i> Womersley	<i>Pipistrellus mimus</i>	Mitchell (1970)
4.	<i>Neomyobia tulsi</i> Hiregaudar & Bal	<i>Rhinolophus rouxi</i>	Hiregaudar & Bal (1956)

List of ectoparasites v/s bat hosts (continued) :

S. No. 1	Species of ectoparasite 2	Host or Hosts 3	Record from India vide : 4
X. ACARINA : TROMBICULIDAE			
1.	<i>Trombicula hampii</i> Hiregudar & Bal	<i>Rhinopoma hardwickei</i>	Hiregaudar & Bal (1956)
2.	<i>Whartonia indica</i> Hiregaudar & Bal	<i>Rhinolophus rouxi</i>	-do-
3.	<i>Whartonia brennani</i> Hiregaudar & Bal	<i>Hipposideros bicolor fulvus</i>	-do-
4.	<i>Whartonia kumaonensis</i> Bhat	<i>Eonycteris spelea</i> and <i>Rousettus leschenaulti</i>	Bhat (1971)
5.	<i>Riedlinia coeca</i> Oudemans	<i>Rhinolophus</i> sp.	Womersley & Audy (1957)
XI. ACARINA : SARCOPTIDAE			
1.	<i>Nycteridocoptes macrophallus</i> Fain	<i>Eonycteris spelaea</i>	Fain (1958)
2.	<i>Nycteridocoptes microphallus</i> Fain	<i>Eonycteris spelaea</i>	Fain (1959)
XII. ACARINA : ARGASIDAE			
1.	<i>Argas (Chiropteragus) wilsoni</i> n. sp.	<i>Rhinopoma microphyllum</i>	Present studies
2.	<i>Argas (Carios) vespertilionis</i> Latreille	<i>Pipistrellus dormeri</i>	Present studies
3.	<i>Argas (Carios) gujaratensis</i> n. sp.	<i>Scotophilus heathi</i>	Present studies
4.	<i>Argas (Carios) hoogstraali</i> n. sp.	<i>Taphozous longimanus</i>	Present studies
5.	<i>Argas (Carios) soneshinei</i> n. sp.	<i>Pipistrellus dormeri</i>	Present studies
6.	<i>Argas (Carios) indicus</i> n. sp.	<i>Tadarida aegyptiaca thomasi</i>	Present studies
7.	<i>Ornithodoros (Reticulinosus) chiropterphila</i> Dhana & Rajagopalan	<i>Rhinolophus rouxi</i>	Dhana & Rajagopalan (1971)
8.	<i>Ornithodoros (R.) piriformis</i> Warburton	<i>Miniopterus schreibersii</i>	Warburton (1918)
9.	<i>Ornithodoros (R.) faini</i> Hoogstraal	<i>Rousettus leschenaulti</i>	Soneshine <i>et al.</i> (1966)
XIII. ACARINA : IXODIDAE			
1.	<i>Ixodes vespertilionis</i> Koch	<i>Taphozous kachhensis kachhensis</i>	Present studies

**LIST OF BATS ON WHICH ECTOPARASITES HAVE BEEN REPORTED
FROM INDIA**

Abbreviations used for parasitic families

A = Argasidae
 C = Cimicidae
 IC = Ichnopsyllidae
 IX = Ixodidae
 L = Laelapidae
 Ma = Macronyssidae
 My = Myobiidae
 N = Nycteribiidae
 P = Polychenidae
 Sa = Sarcophagidae
 Sp = Spinturnicidae
 St = Streblidae
 T = Trombiculidae
 Order—CHIROPTERA
 Suborder—MEGACHIROPTERA
 Family—PTEROPIDAE
 Genus—Pteropus
 (1) *giganteus giganteus*
 N = *Cyclopodia sykesii*
 L = *Neolaelaps magnistigmatus*, *N. spinosa*
 Genus—Rousettus
 (2) *leschenaulti leschenaulti*
 C = *Cimex insuetus*, *Leptocimex inordinatus*
 St = *Brachytarsina gigantea*
 Ic = *Thaumpysylla brevipes orientalis*
 N = *Eucampsipoda latisternum*
 Sp = *Ancystropus zeleborii*, *A. taprobanus*,
A. kanheri, *Meristaspis lateralis*,
Parameristaspis delfinadoi n. sp.
 Ma = *Steatonyssus allredi* n. sp.
 My = *Foliomyobia jamesoni*
 T = *Whartonia kumaonensis*
 A = *Ornithodoros faini*
 (3) *aegypticus*
 N = *Eucampsipoda sundaicum*
 Genus—Cynopterus
 (4) *sphinx sphinx*
 C = *Aphrania vishnou*
 N = *Leptocyclopodia ferrarii ferrarii*
 (5) *marginatus*
 N = *Leptocyclopodia ferrarii ferrarii*
 Genus—SPHAERIAS
 (6) *blanfordi*
 N = *Leptocyclopodia thaili*
 Na = *Macronyssus kumaonicus*
 Genus—Nyctalus

(7) *leisleri*
 Ma = *Macronyssus kumaonicus*
 Genus—Eonycteris
 (8) *spelaea*
 T = *Whartonia kumaonensis*
 Sa = *Nycteridocoptes macrophallus*, *N. microphallus*
 Suborder—MICROCHIROPTERA
 Family—RHINOPOMATIDAE
 Genus—Rhinopoma
 (9) *microphyllum*
 C = *Leptocimex hiregaudari* n. sp., *L. inordinatus*
 St = *Brachytarsina sinhai*, *B. maai* n. sp.,
B. theodori n. sp. *Ascodipteron namrui*
 A = *Argas (Chiropteragus) wilsoni* n. sp.
 (10) *hardwickei*
 C = *Leptocimex inordinatus*
 St = *Brachytarsina taji* *B. maai* n. sp.,
Ascodipteron rhinopomatos
 T = *Trombicula hampii*
 Family = EMBALLONURIDAE
 Genus = Taphozous
 (11) *perforatus*
 St = *Brachytarsina joblingi* n. sp.,
 (12) *longimanus*
 C = *Cimex pattoni* n. sp.
 N = *Basilisa blainvilli amiculata*
 Ma = *Steatonyssus allredi* n. sp. *Parastea-*
tonyssus lingarji
 My = *Foliomyobia barnleyi*
 A = *Argas (Ca.) hoogstraali* n. sp.
 (13) *kachhensis*
 C = *Leptocimex hiregaudari* n. sp., *L. inordinatus*
 P = *Eothenes maai*
 Ix = *Ixodes vespertilionis*
 (14) *melanopogon*
 C = *Leptocimex inordinatus*
 P = *Eothenes intermedius*
 St = *Brachytarsina cucullata*, *B. caudata*
 Family = MEGADERMATIDAE
 Genus = Megaderma
 (15) *lyra lyra*
 P = *Polychenes molossus*
 St = *Raymondia lobulata*

(16) *spasma***P** = *Eoctenes spasmae***Family** = RHINOLOPHIDAE**Genus** = *Rhinolophus*(17) *rouxi***C** = *Cimex usingeri***St** = *Brachytarsina modesta*, *Raymondia joblingi***N** = *Phthiridium phillipsi***Sp** = *Endhovenia euryalis*, *Paraperiglis-chrus rhinolophinus***My** = *Neomyobia tulsi***T** = *Whartonia indica***A** = *Ornithodoros chiropterphila*(18) *arcuatus***St** = *Raymondia pseudopagoderma*(19) *lepidus***N** = *Phthiridium annandalei*(20) *Rhinolophus* sp. (?)**T** = *Riedlinia coeca***Genus** = *Hipposideros*(21) *bicolor***C** = *Leptocimex inordinatus***T** = *Whartonia brennani*(22) *lankadiva***C** = *Leptocimex inordinatus***St** = *Brachytarsina speiseri*, *B. pygialis*(23) *speoris speoris***St** = *Raymondia pagoderma***Family** = MOLOSSIDAE**Genus** = *Tadarida*(24) *aegyptiaca thomasi***C** = *Stricticimex namru***Ma** = *Parasteatonyssus jayanti* n. sp.**A** = *Argas (Carios) indicus* n. sp.**Family**—VESPRTLIONIDAE**Genus** = *Sctophilus*(25) *heathi heathi***C** = *Cimex pattoni* n. sp.**St** = *Paraascodipteron heathicus* n. sp.**N** = *Basilina roylli***Sp** = *Spinturnix rudnicki* n. sp.**Ma** = *Steatonyssus decisetosus* n. sp.**A** = *Argas (Ca.) gujaratensis* n. sp.(26) *temmnickei***C** = *Aphrania vishnou***Genus** = *Pipistrellus*(27) *dormeri dormeri***C** = *Cimex ueshmai* n. sp., *Cacodmus bhati* n. sp.**N** = *Basilina fletcheri***Ma** = *Steatonyssus quadrisetosus* n. sp.**A** = *Argas (Ca.) soneshinei* n. sp. *Argas (Ca.) vespertilionis*(28) *mimus mimus***My** = *Neomyobia luzonensis*(29) *ceylonicus chrysothrix***C** = *Cacodmus indicus***N** = *Basilina fletcheri*, *B. majuscula*, *B. pumila***Ma** = *Steatonyssus hubli*(30) *pipistrellus***C** = *Cacodmus indicus***Genus** = *Myotis*(31) *siligorensis***C** = *Cimex himalayauus***Sp** = *Spinturnix pindarensis***Genus** = *Miniopterus*(32) *fuliginosus***St** = *Brachytarsina amboinensis***N** = *Nycteribia allotopa*, *N. parvula*, *Penicillidia indica***Ma** = *Macronyssus granulosus*(33) *schreibersi***C** = *Cimex insuetus*, *Leptocimex inordinatus***Sp** = *Spinturnix psi***A** = *Ornithodoros piriformis***Genus** = *Leuconoe*(34) *longipes***N** = *Penicillidia dufourii dufourii***Genus** = *Barbastella*(35) *leucomelas darjeelingensis***N** = *Phthiridium nuditerga***Genus** = *Tylonycteris*(36) *pachypus***N** = *Basilina brevipes***UNKNOWN BAT SPECIES****C** = *Stricticimex pattoni***N** = *Basilina peali***Ma** = *Steatonyssus javensis*, *S. musculi*

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