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RECORDS OF THE ZOOLOGICAL SURVEY OF INDIA

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Pages 1-108

CONTENTS

Pages

Sureshan, P. M. — First record of <i>Lyubana</i> Boucek from Indian subcontinent with the description of a new species from Sri Lanka (Hymenoptera : Chalcidoidea : Pteromlaidae)	1-5
Ushakumari, R. and Narendran, T. C. — A taxonomic revision of <i>Leptacis</i> Foerster (Hymenoptera : Pltygasteridae) of India	7-32
Talukdar, S. and Majumder, S. C. — Some aspects of web-building mechanism by an Araneid spider (<i>Argiope shillongensis</i> Sinha) from Bortibeel, North 24 Parganas, West Bengal	33-38
Talukdar, S. and Majumder, S. C. — Interesting observation on food and feeding behavior of a spider (<i>Neoscona mukerjei</i> Tikader) from Bortibeel, North 24 Parganas, West Bengal	39-44
Lahiri, A. R., Sandhu, S. and Walia, G. K. — <i>Gynacantha pallampurica</i> sp. nov. from Northern Himachal Pradesh, India (Odonata : Aeshnidae)	45-49
Mandal, G. P., Suman, K. K. and Hazra, A. K. — Role of soil pH on the Collembolan fauna of two uncultivated fields of North 24 Parganas, West Bengal	51-56
Mandal, G. P., Suman, K. K. and Hazra, A. K. — A study on the population of soil Arthropods fauna in tobacco leaf litter bags buried under soil, a preliminary report	57-62
Mandal, G. P., Suman, K. K. and Hazra, A. K. — Role of microbial flora on distribution of Collembola at waste disposal site, Dhapa, Kolkata	63-69
Nath, P., Dam, D., Bhutia, P. T., Dey, S. C. and Das, D. N. — A new fish species of the genus <i>Bhavana</i> (Homalopteridae : Homalopterinae) from river Noadhing drainage, Arunachal Pradesh, India	71-78

- Halder, K. R., Dhani, S. and Mandal, C. K. — On some earthworms present in unnamed collections of Zoological Survey of India 79-93
- Tessa Thomas and Jayachandran, K. V. — New locality record of *Caridina jalihali* Mariappan & Richard (outside the type locality) with notes on diagnostic characters and sexual dimorphism 95-99
- Short Communication*
- Rajmohana, K. and Narendran, T. C. — A systematic note on the genus *Trissolcus* Ashmead (Hymenoptera : Scelionidae) with a key to species from India 101-103
- Chandrasekhar, S. V. A. — The Rotifer fauna of Himayatsagar and Osmansagar alongwith other Rotifers known from Hyderabad and neighbourhood, Andhra Pradesh, India 105-108

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Dr. RAMAKRISHNA
Director-in-charge
Zoological Survey of India

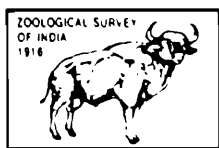
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Dr. RAMAKRISHNA
Director-in-charge
Zoological Survey of India



Rec. zool. Surv. India : 107(Part-3) : 1-5, 2007

**FIRST RECORD OF *LYUBANA* BOUCEK FROM INDIAN
SUBCONTINENT WITH THE DESCRIPTION OF A NEW
SPECIES FROM SRI LANKA (HYMENOPTERA :
CHALCIDOIDEA : PTEROMALIDAE)**

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INTRODUCTION

Lyubana was erected by Boucek in the subfamily Pteromalinae of Pteromalidae with type species *L. slavica* Boucek from Yugoslavia (Boucek & Rasplus, 1991). Later three species of *Lyubana* were described from Oriental China viz. *L. liaoi* Xiao and Huang, *L. longa* Xiao & Huang and *L. prolongata* Xiao & Huang (Xiao & Huang, 1997). Sureshan (2001) synonymised *Lyubana* under *Halticopterella* Girault & Dodd, but later invalidated his own synonymy thereby maintained the status of *Lyubana* valid (Status Rev.) (Sureshan, 2006). Currently *Lyubana* is known for four valid species from the world distributed in the Palearctic and Orietal regions. Here *Lyubana* is reported for the first time from the Indian subcontinent by describing a new species from the Central province of Sri Lanka. The occurrence of *Lyubana* in the extreme south is interesting, indicating the probable wider distribution of the genus in the Oriental region. A key to separate the species of *Lyubana* Boucek is also provided. The specimen belongs to the collections of Bohart Museum of Entomology, University of California which was kindly loaned by Dr. Steven L. Heydon for my study.

Following abbreviations are used in the text :

F1-F5 – Funicular segments 1 to 5,	OOL – Ocellocular distance;
POL – Postocellar distance;	SMV – Sub marginal vein;
MV – Marginal vein;	PMV – Post marginal vein;
STV – Stigmal vein;	T1-T2 – Gastral tergites 1 to 2.

*E-mail : samanyu2003@yahoo.com

Lyubana longigastra sp. nov.

(Figs. 1-3)

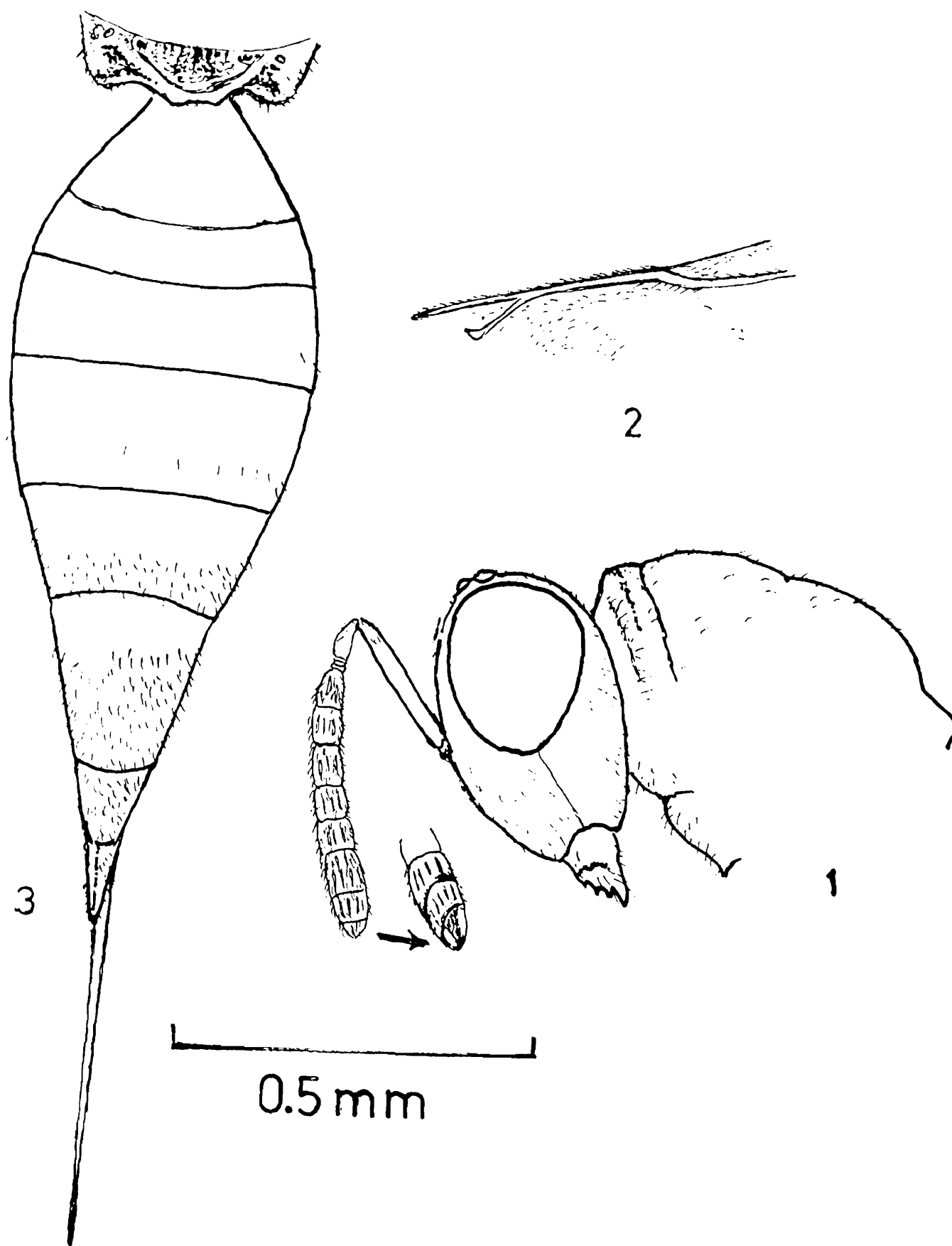
Holotype : Female : Length 2.4 mm. Head and thorax dark metallic blue; gaster blackish brown with metallic blue reflection on basal part, mainly on T1 dorsally; antennae yellowish brown, scape paler; eyes chocolate brown; mandibles brown; legs with coxae blackish brown, femora brown, tibiae and tarsi yellowish except on basal part infusate; tegulae brown; wings hyaline, veins brown; pubescence of body white.

Head : (Fig. 1) Head and thorax with extensive but short and subdecumbant pilosity, individual hairs curved, whitish. Head finely reticulate, in dorsal view width $2.1 \times$ length; POL : OOL 5.5 : 2.5; ocelli 2.5; temple length $0.23 \times$ eye length; eye length $1.22 \times$ width, length : width 14 : 11.5 (profile); malar space length $0.43 \times$ eye length. In front view head width $1.2 \times$ height; eyes separated $1.2 \times$ their height; clypeus anteriorly with two sharp teeth; both mandibles with 4 teeth. Antennae inserted below middle of face, almost level with lower margin of eyes, scape length $0.8 \times$ eye length, not reaching front ocellus, pedicel plus flagellum length $0.9 \times$ head width, pedicel little shorter than F1 (3 : 3.5), third anellus little wider, F1 slightly longer than F2 (3.5 : 3), F2-F4 equal, F5 little shorter, F1 with two rows of sensillae, club with sutures slightly oblique, little longer than two preceding segments combined (7 : 6), micropilosity strip down to base of third segment.

Thorax : Length $1.3 \times$ width, moderately reticulate punctuate; pronotum less wider than mesoscutum, moderately deep posteriorly, anteriorly with a very fine carina less distinct, hind margin with a broad smooth strip. Mesoscutum width $1.9 \times$ length, notauli incomplete. Scutellum medially slightly shorter than mesoscutum (11 : 12). Dorsellum narrow, almost fine. Propodeum medially almost half as long as scutellum, median carina slightly indicated in the anterior end which ends with some weak transversely striated reticulation in the nuchal area, few short rugae on either sides of median carina anteriorly; adpetiolar area less shiny; spiracles moderate, close to the metanotal border; callus with a convexity, covered with sparse white hairs. Mesopleuron reticulate; upper mesepimeron and sub alar area shiny. Prepectus finely reticulate except on margins, little shorter than tegula (3 : 4). Hind coxae bare dorsally, length $1.3 \times$ width, finely reticulate, ventrolaterally hairy; femora slender, length $4.1 \times$ width. Forewing (Fig.2) not densely pilose, length $2.2 \times$ width, speculum open below, basal hairline indicated, costal cell hairy towards tip, marginal fringe very small. Relative length : MV 11, PMV 8, STV 4

Gaster : (Fig. 3) in dorsal view length $2.7 \times$ width (excluding ovipositor), $1.42 \times$ as long as head plus thorax combined (in profile), hypopygium reaching little below middle of gaster (14/31), hind margin of T1 slightly and arcuately produced, T2 also slightly produced, epipygium medially $0.4 \times$ T6, ovipositor protruded out.

Holotype : Female : Sri Lanka : Central Province, Kandy dist., Vict. Randenigala. Rantembe Sanct. Mahawele R. N $07^{\circ}12'$ E $080^{\circ}57'$ 25–29.viii.1999. Malaise trap. M & J Wasbauer. (deposited in Bohart Museum of Entomology, University of California).



Figs. 1-3. : *Lyubana longigastra* sp. nov. (Female) : 1. Head and part of thorax in profile; 2. Forewing venation; 3. Gaster and propodeum in dorsal view.

Etymology : The species is named after its elongate gaster.

Remarks : This species differs from *L.slavica* Boucek and *L.prolongata* Xiao & Huang in having an elongated gaster which is distinctly longer than head plus thorax. (in *slavica* and *prolongata* the gaster is short only as long as head plus thorax combined). With *L.liaoi* Xiao & Huang and *L.longa* Xiao & Huang this species shares a long gaster, which is longer than head plus thorax, but it differs from *liaoi* in having propodeum with weaker reticulation in front of costula, basal cell of forewing not closed posteriorly and POL 2.2x OOL (in *liaoi* propodeum in front of costula with large punctures, POL slightly longer than OOL, basal cell of forewing closed posteriorly). It differs from *longa* in having antenna with F1 1.8x as long as broad with 2 rows of sensillae, basal cell of forewing not closed posteriorly and POL 2.2x OOL (in *longa* F1 2.6x as long as broad with 3 rows of sensillae, POL 1.3x OOL, and forewing with basal cell closed posteriorly).

Key to the species of *Lyubana* Boucek

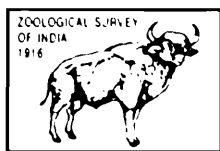
1. Gaster distinctly longer than head plus thorax combined 2
 - Gaster as long as head plus thorax combined 4
2. Antennae with F1 1.7–1.8x as long as broad with two rows of sensillae. Length. 2.2–2.4 mm 3
 - Antennae with F1 2.6x as long as broad with three rows of sensillae. Length. 4 mm *Lyubana longa* Xiao & Huai
3. POL 2.2x OOL; propodeum with only weaker reticulation in front of costula; basal cell of forewing not closed posteriorly. Length 2.4 mm. Sri Lanka *Lyubana longigastrea* sp. nov.
 - POL 1.1x OOL; propodeum with larger punctures in front of costula; basal cell of forewing closed posteriorly Length 2.2 mm. China. *Lyubana liaoi* Xiao & Huang
4. Antennae with F1 about 3x as long as broad with three rows of sensillae; POL 1.2x OOL; gaster about 3x as long as broad. Length 3.5–3.8 mm China *Lyubana prolongata* Xiao & Huang
 - Antennae with F1 less than 3x as long as broad with two rows of sensillae; POL as long as OOL; gaster about 2.4 x as long as broad. Length 3.2 mm. Yugoslavia *Lyubana slavica* Boucek

ACKNOWLEDGEMENTS

The author is grateful to the Director, Zoological Survey of India, Kolkatta and the Officer in charge, Zoological Survey of India, Estuarine Biological Station, Gopalpur-on-Sea, Orissa for providing facilities. He is also grateful to Dr. Steven L. Heydon, Bohart Museum, University of California, USA for kindly arranged the loan of the specimen.

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Rec. zool. Surv. India : **107**(Part-3) : 7-32, 2007

A TAXONOMIC REVISION OF *LEPTACIS* FOERSTER (HYMENOPTERA : PLTYGASTERIDAE) OF INDIA

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INTRODUCTION

Cecidomyiidae is one of the economically important families of Diptera. They are known as *gall midges* or *gall gnats*. The larvae of most gall midges feed within plant tissue, creating abnormal plant growths called galls. These are very fragile small insects usually only 2–3 mm in length and many are less than 1 mm long. Many are economically significant especially the important insect pests of agricultural importance. Many natural enemies prey upon them and the parasitic Hymenoptera genus *Leptacis* (most known species) is one among them. So far only ten species of *Leptacis* are known from India (Mukerjee 1978; Mani and Sharma 1982). In this paper we describe thirteen new species with a key to separate Indian species. The ten known species are also commented upon.

RESULTS AND DISCUSSION

Genus *Leptacis* Foerster

Leptacis Foerster, 1856b. *Hym. Stud.*, **2** : 107. Type species : *Ichneumon tipulae* Kirby, 1798.

Miramblyaspis Dodd, 1914. *Ent. News Philad.*, **25** : 455-456. Type species : *Miramblyaspis mirabilis* Dodd, 1914.

Xestonotidea Gahan, 1919. *Proc. U.S. Nat. Mus.*, **56** : 524; Kieffer, 1926, *Das Tierreich*. **48** : 625 (*Axestonotus* = *Xestonotus* Foerster). Type species : *Xestonotidae foersteri* Gahan, 1919. *Prosamblyaspis* Kieffer, 1926. *Daseich*, **48** : 1-885. Type species : *Amblyaspis flavosignata* Kieffer, 1912 by monotypy.

KEY WORDS : Hymenoptera, Platygasteridae, *Leptacis*, revision, India.

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Diagnostic characters : Body smooth and shiny; vertex with fine transverse carina behind; ocellocular space less than front ocellar space; antenna 10 segmented with four segmented club; notauli absent or present or with only faint traces; scutellum usually elongates gradually into sharp sublanceolate spine, which often extends beyond base of petiole. Petiole and base of second tergite hairy that do not form tuft like structure.

Distribution : Afro-tropical, Australian, Nearctic, Neotropical, Oriental and Palaearctic.

Biology : Parasites of Cecidomyiidae.

Remarks : 69 species reported over the world, out of this only 9 species are from India.

Key to the Indian Species of *Leptacis* Foerster (Based on females)

1. Scutellum with a long spine (Figs. 11, 13) 2
 - Scutellum with a short straight or upcurved spine (Figs. 3, 5) 10
2. Notauli absent, marginal fringe conspicuously longer (Fig. 13) 3
 - Notauli present, marginal fringe moderate to short and rarely long 5
3. Scutellar spine broad, brown, third and fourth funicular segments unequal 4
 - Scutellar spine slender, dark brown, third and fourth funicular segments subequal; body length : antennal length 100 : 53.5 *L. malabarensis* sp. nov.
4. Eyes bare; POL 4. 3x OOL; Scutellar spine black *L. keralensis* sp. nov.
 - Eyes pubescent, POL 9x OOL; scutellar spine yellowish brown *L. agastmuniae* Mukerjee
5. Marginal fringe long, third and fourth funicular segments unequal; scape 6x its width; fourth club segment elliptically ovate *L. yercaudensis* Mukerjee
 - Marginal fringe moderate or short; antennal character not as above 6
6. Marginal fringe moderate 7
 - Marginal fringe short 9
7. Third and fourth funicular segments subequal *L. brachyceras* Mukerjee
 - Third and fourth funicular segments unequal 8
8. Ovipositor well exerted *L. konkanensis* Mukerjee
 - Ovipositor not exerted *L. coorgensis* Mukerjee
9. Third and fourth funicular segments unequal; ovipositor slightly exerted
 - *L. thanensis* Mukerjee
 - Third and fourth funicular segments subequal; ovipositor not exerted
 - *L. bengalensis* Mukerjee

10. Scutellum with short straight spine (Figs. 7, 15) 11
 - Scutellum with short upcurved spine (Figs. 5, 3) 16
11. Scutellum semicircular 12
 - Scutellum triangular 15
12. Antennal length >60% of body length 13
 - Antennal length <60% of body length 14
13. Vertex deeply angled (Fig. 9); scutellum with nipple like black spine giving a median ridge like appearance for the scutellum (Fig. 9); length of insect 1.21 mm *L. diversus* sp. nov.
 - Vertex rounded; scutellum with a sharp black point like spine (Fig. 21) and not ridge like; length of insect 0.65 mm *L. nuperus* sp. nov.
14. Bluntly rounded black spine (Fig. 17); body length : antennal length 100 : 59; scape length 5.25x its width *L. mustus* sp. nov.
 - Pointed black spine (Fig. 1); body length : antennal length 100 : 50.95; scape length 3.6x its width *L. aeros* sp. nov.
15. Scutellum narrowly triangular (Fig. 7); scutellar spine triangular and with tuft of hairs at the tip; vertex rounded; body length : antennal length-100 : 55 *L. benazeer* sp. nov.
 - Scutellum broadly triangular (Fig. 15); scutellar spine pen nib like without tuft of hairs at the tip; body length : antennal length 100 : 76 *L. manii* sp. nov.
16. Second funicular segment longer than third funicular segment 17
 - Second funicular segment shorter than third funicular segment; third funicular segment larger in length and width than second funicular segment; antennal club forming segments more elongate; ovipositor exerted *L. asiaticus* sp. nov.
17. Antennal club forming segments elongate (Fig. 4); ovipositor not exerted; body length : antennal length 100 : 60.78 *L. alus* sp. nov.
 - Antennal club forming segments broad (Fig. 24); ovipositor exerted; body length : antennal length 100 : 52.2 *L. scaposus* sp. nov.

Key to the Indian species of *Leptacis* Foerster (Based on males)

1. Notauli present; marginal fringe short; scape length 7x its width *L. indicus* Mukerjee
 - Notauli absent; marginal fringe long; scape length <7x its width 2
2. Metasoma with anterior pits; marginal cilia on anterior and posterior margin, short and apical margin long 3
 - Metasoma without anterior pits; marginal cilia moderately long to much longer 4

3. Antennal segments more elongate; third funicular segment with a spiny process towards half the length *L. stom* sp. nov.
 – Antennal segments slightly broader; third funicular segment without a spiny process
 *L. thrissurensis* sp. nov.
4. First funicular segment subglobose; ocellocular space subequal to ocellar diameter : marginal cilia moderately long *L. atturensis* Mukerjee
 – First funicular segment 1.5x longer than thick; ocellocular space 0.50 of ocellar diameter; marginal cilia long *L. maldarensis* Mukerjee

1. *Leptacis aeros* Ushakumari and Narendran sp. nov.

(Figs. 1-2)

Female : Length 0.9 mm; black; antenna yellowish brown except the terminal club forming segments which is dark brown; eyes black; ocelli glassy white; mandible brown; legs with coxa and last tarsal segment dark brown and others yellowish brown; wings hyaline with pilosity dark brown; body pubescence white.

Head : Frons and vertex matt; eyes bare; antennal sockets close to clypeal border. Head viewed in front length to width 32 : 47; head width in dorsal view about 2.6x its median length; POL about 5x OOL; scrobe and interantennal projection indistinct; malar groove absent; hyper-occipital carina distinct; posterior margin of gena ecarinate; occipital carina distinct; head wider than mesosoma in dorsal view; maximum diameter of eye in lateral view about 3.25x malar space. Antenna (Fig. 2) 10 segmented; relative length of antenna : body length 49 : 100. Relative length : width of antennal segments : scape-33 : 9; pedicel-13 : 7; F₁-5 : 4; F₂-6 : 4; F₃-5 : 3; F₄-5 : 4; F₅-7 : 9; F₆-7 : 12; F₇-6 : 12; F₈-10 : 9.

Mesosoma : Finely reticulate; notauli absent; mesoscutum width slightly more than its length; scutellum slightly convex with few hairs, somewhat semicircular and ends in a short black spine; scutellum length up to the tip of spine as long as wide; propleuron partially reticulate; mesopleuron smooth and shiny; metapleuron with white hairs on its posterior margin. Forewing (Fig. 1) length 3x its maximum width, *sm* not distinct, marginal fringes much shorter; propodeum hairy on its lateral side; hind coxa as long as wide; hind femur 2x length of trochanter, about 3x its own maximum width and shorter than hind tibia; hind tibia dilated at its distal end and 2.5x length of hind metatarsus and as long as combined length of hind tarsal segments.

Metasoma : Petiole transverse, 1.8x as wide as its length, tuft of hairs present on its lateral side, with longitudinal grooves on petiole; second tergite smooth; posterior tergites finely punctate; metasoma length 2.5x its maximum width and tapering.

Male : Unknown.

Host : Unknown (probably paddy pests).

Etymology : The species name is an arbitrary combination of letters.

Material examined : Holotype : female, INDIA : Kerala, Attupuzha, 27-viii-1999, Coll. R. Ushakumari (DZCU).

Discussion : This species comes near *Leptacis thanensis* in the key to species of *Leptacis* by Mukerjee (1978). It resembles *L. thanensis* in having; second funicular segment much longer than the first; marginal fringes of forewing short and fourth funicular segment shorter than the third. However it differs from the species *L. thanensis* Mukerjee in having : notauli absent (notauli present in *L. thanensis*); scutellum with a short black spine (very long spine and apically with tuft of hairs in *L. thanensis*); length of insect 0.9 mm (*L. thanensis* 1.52 mm in length); scape length 4x its maximum width (in *L. thanensis* 5x longer than thick); scutellum with hairy tuft on propodeum and petiole (not like this in *L. thanensis*) and ovipositor not exerted (ovipositor exerted in *L. thanensis*).

2. *Leptacis alus* Ushakumari and Narendran sp. nov.

(Figs. 3-4)

Female : Length 0.85 mm; black; antenna with all segments except scape dark brown; scape brown; eyes black, ocelli glassy with black tint; mandible dark brown; tegula brown; legs with coxa dark brown to black; distal region of hind femur and tibia swollen and dark brown and its basal half yellowish brown; wings hyaline with pilosity dark brown; pubescence on body white.

Head : Frons and vertex finely reticulate; eyes bare; antennal sockets close to clypeal border. Head viewed in front length to width 33 : 42; head width in dorsal view 2.16x its median length; POL about 4.66x OOL; hyperoccipital carina distinct and vertex angled; malar groove absent; scrobe not distinct; interantennal projection slightly distinct; posterior margin of gena ecarinate; occipital carina distinct; head wider than mesosoma in dorsal view; maximum diameter of eye in lateral view about 8.5x malar space. Antenna (Fig. 4) 10 segmented; relative length of antenna : body length 60.78 : 100. Relative length : width of antennal segments : scape-50 : 12; pedicel-13 : 5; F₁-4 : 4; F₂-9 : 4; F₃-5 : 3.5; F₄-5 : 4; F₅-9 : 8; F₆-10 : 9; F₇-9 : 10; F₈-14 : 8.

Mesosoma : Finely reticulate; notauli absent; mesoscutum length as long as its width; sparsely hairy and somewhat humped. Scutellum hairy and with an up curved pointed short black spine; scutellar length including the spine as long as its maximum width; propodeum with tuft of white hairs on its lateral side and lateral ridges; propleuron partially and finely reticulate; mesopleuron smooth and shiny; metapleuron hairy on its distal end. Forewing (Fig. 3) length 2.5x its maximum width; *sm* short, straight, not reaching wing margin and without distal knob; marginal fringe short;

hind coxa length as long as wide; hind femur 1.9x length of trochanter, about 3.16x its own maximum width and shorter than hind tibia; hind tibia length about 1.95x length of metatarsus and shorter than combined length of hind tarsal segments.

Metasoma : Petiole transverse, its width about 2.5x its length, lateral margin with tuft of hairs; posterior end of second tergites and rest of the tergites finely punctured; metasoma longer than mesosoma but distinctly shorter than head and mesosoma combined, its length about 2.12x its maximum width in dorsal view.

Male : Unknown.

Host : Unknown (probably paddy pests).

Etymology : Species name is an arbitrary combination of words.

Material examined : Holotype : Female, INDIA : Kerala, Thrissur, 24-viii-1998, Coll. R. Ushakumari (DZCU).

Discussion : This species comes near *Leptacis konkanensis* Mukerjee in the key to species by Mukerjee (1978). It resembles *L. konkanensis* in having : second funicular segment much longer than the first; marginal fringes of forewing short and fourth funicular segment not shorter than the third. However it differs from *L. konkanensis* in the following characters : scutellum with an up curved pointed short black spine (long spine in *L. konkanensis*); notauli absent (in *L. konkanensis* is notauli present); body size 0.85 mm (*L. konkanensis* is 1.16 mm) : scape length 4.16x its maximum width (5.52x longer than thick in *L. konkanensis*); legs with coxa dark brown to black, hind femur and distal region of tibia dilated and dark brown and basal half yellowish brown (in *L. konkanensis* legs brown) and ovipositor not exserted (ovipositor exserted in *L. konkanensis*).

3. *Leptacis asiaticus* Ushakumari and Narendran sp. nov.

(Figs. 5-6)

Female : Length 1.24 mm; black; antenna except scape dark brown; scape brown; eyes dark brown; front and back ocelli glassy with yellow tint; mandible dark brown; legs with coxa and last tarsal segment dark brown; wings hyaline with pilosity dark brown : body pilosity white.

Head : Matt; eyes bare; antennal sockets close to clypeal border; head viewed in front (Fig. 5) length to width 32 : 50; head width in dorsal view about 2.69x its median length; POL about 5.66x OOL; scrobe and interantennal projection indistinct; malar groove absent : posterior margin of gena ecarinate; occipital carina distinct; head slightly wider than mesosoma in dorsal view; maximum diameter of eye in lateral view about 2.14x malar space. Antenna (Fig. 6) 10 segmented; relative length of antenna : body length 66 : 100. Relative length : width of antennal segments : scape-47 : 9; pedicel-11 : 5; F₁-6 : 4; F₂-7 : 4; F₃-13 : 7; F₄-7 : 6; F₅-11 : 8; F₆-12 : 9; F₇-11 : 10; F₈-18 : 9. Third funicular segment length 2x that of first funicular segment and 1.5x its width.

Mesosoma : Matt; notauli absent; scutellum somewhat conical with a short up curved spine; scutellum width about 1.27x its length including length of spine; propleuron finely reticulate; meso and metapleuron smooth, posterior margin of metapleuron hairy. Forewing (Fig. 5) length 2.66x its maximum width; *sm* short, not reaching wing margin and without distal knob; marginal fringe short; propodeum with a median ridge and lateral tuft of hairs giving a triangular appearance; hind coxa, distal end of hind femur, tibia and last tarsal segment dark brown; hind femur and tibia dilated at its distal end; first and second femora distally not dark brown; hind coxa only slightly longer than its width; hind femur 2.3x length of trochanter and about 3.5x its own maximum width and shorter than hind tibia; hind tibia 2.8x length of hind metatarsus and as long as combined length of hind tarsal segments.

Metasoma : Petiole transverse, 3x as wide as its length, hairy, which cover anterior margin of second tergite; second tergite smooth; posterior tergites punctate; metasoma more compressed, slightly longer than mesosoma but shorter than combined length of head and mesosoma, its length 1.6x its maximum width; ovipositor exerted.

Male : Unknown.

Host : Unknown.

Etymology : The species is named after Asia.

Material examined : Holotype : Female, INDIA : Kerala, Thrksur, 6-iii-1995, Coll. T.C. Narendran and party (DZCU).

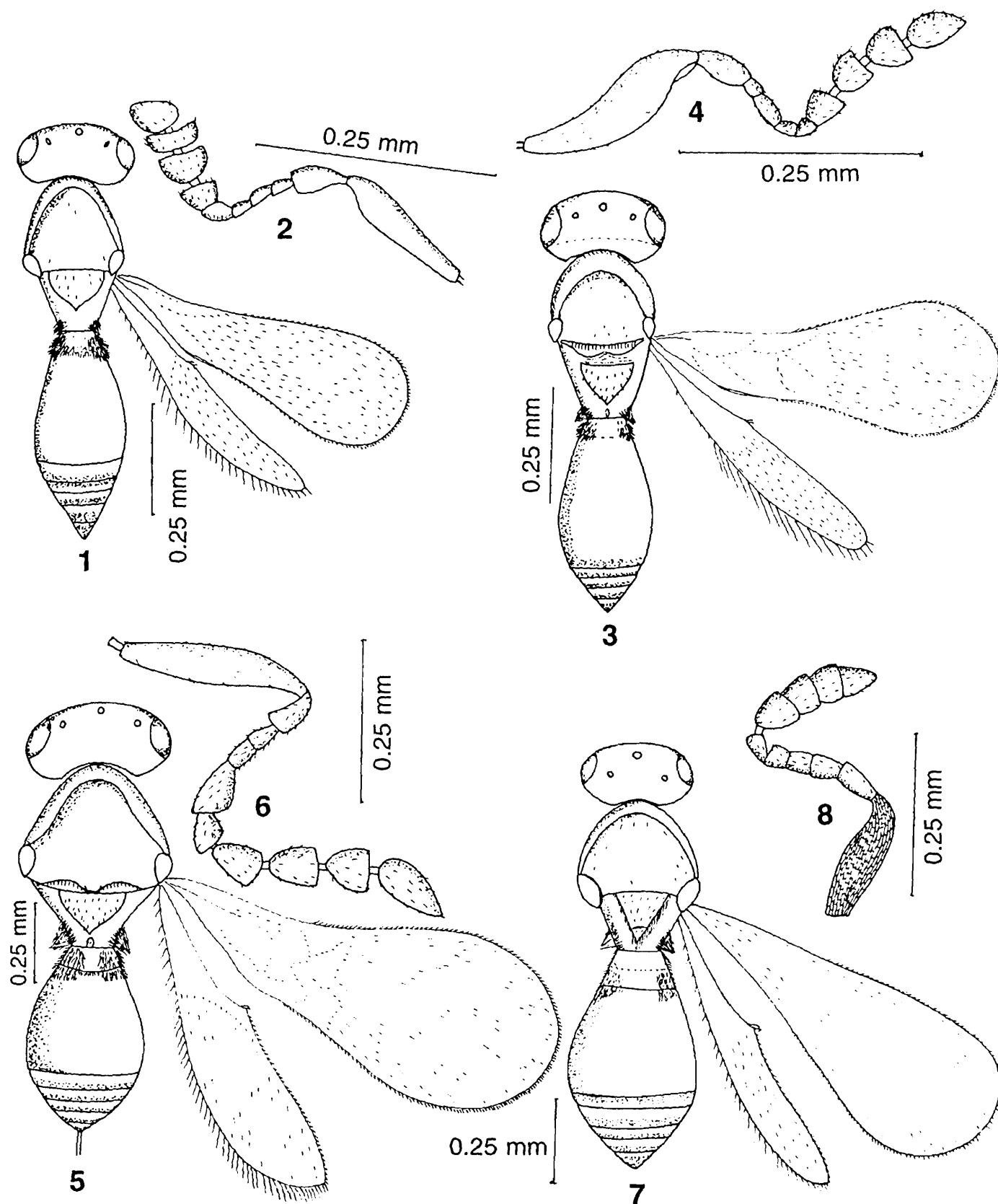
Discussion : This species comes near *L. brachycerus* Mukerjee in the key to species by Mukerjee (1978). It resembles *L. brachycerus* in having : second funicular segment much longer than first funicular segment and notauli absent. However it differs from *L. brachycerus* in having third funicular segment larger in length and width than the fourth funicular segment; (third funicular segment short in *L. brachycerus*) more elongate club forming segments; short up curved black spine for scutellum (long spine in *L. brachycerus*); compressed metasoma and dark brown colour for coxa, distal end of femur and tibia (in *L. brachycerus* legs brown except for the dark brown hind tibia apically).

4. *Leptacis benazeer* Ushakumari and Narendran sp. nov.

(Figs. 7-8)

Female : Length 1.17 mm; reddish brown; antenna dark brown except scape which is reddish brown; eyes glassy with a light red tint; ocelli glassy and brown; mandible reddish brown; tegula brown; all legs reddish brown; wings opaque with pilosity dark brown; body pubescence white.

Head : Frons and vertex reticulate; vertex rounded; eyes bare; antennal sockets close to elypeal border. Head viewed in front (Fig. 7) length to width 39 : 41; head width in dorsal view about 1.9x



Figs. 1-8. : 1-2. *Leptacis aeros* Ushakumari & Narendran sp. nov. (Female) Part of body : Dorsal view.

3-4. *Leptacis alus* Ushakumari & Narendran sp. nov. (Female) Part of body : Dorsal view;

5-6. *Leptacis asiaticus* Ushakumari & Narendran sp. nov. (Female) Part of body : Dorsal view;

7-8. *Leptacis benazeer* Ushakumari & Narendran sp. nov. (Female) Part of body : Dorsal view.

its median length; POL about 4.3x OOL; scrobe indistinct; interantennal projection distinct; malar groove absent; posterior margin of gena ecarinate; occipital carina distinct, head slightly narrower than mesosoma in dorsal view; maximum diameter of eye in lateral view about 6x malar space. Antenna (Fig. 8) 10 segmented; relative length of antenna : body length 55 : 100; relative length : width of antennal segments : scape-32 : 9; pedicel-11 : 5; F₁-6 : 5; F₂-6 : 5; F₃-5 : 5; F₄-7 : 4; F₅-9 : 8; F₆-6 : 10; F₇-6 : 8; F₈-9 : 7.

Mesosoma : Matt; notauli absent; scutellum somewhat triangular, with an apical small brown spine, hairy, hairs arranged like a beard at its tip; pro, meso and metapleuron finely reticulate, metapleuron with backwardly arranged hairs. Forewing (Fig. 7) length 2.64x its maximum width; marginal fringes rudimentary; wing lamina thickly hairy, *sm* indistinct; propodeum hairy, hairs arranged in such a way as to give a spine like appearance, a median ridge present; hind coxa as long as wide; femur 1.9x length of trochanter and its length about 3.8x its own maximum width and shorter than hind tibia; hind tibia about 2.7x of hind metatarsus and as long as combined length of hind tarsal segments.

Metasoma : Compressed; petiole transverse, its maximum width 1.8x its length, hairy : second tergite smooth and posterior tergites with minute punctures; metasoma slightly longer than mesosoma as long as combined length of mesosoma and head; its length about 1.8x its maximum width.

Female : Unknown.

Host : Unknown.

Etymology : The species name is taken from the Urdu word benazeer meaning 'beautiful'

Material examined : Holotype : Female, INDIA : Kerala, Kurarkutty, (6-v-1989, Coll. T.C. Narendran and party (DZCU).

Discussion : This species resembles *Leptacis brachycerus* Mukerjee in the key to *Leptacis* by Mukerjee (1978) in having : second funicular segment much longer than first funicular segment and in absence of notauli. However it differs from *L. brachycerus* in having : body colour reddish brown (in *L. brachycerus* black); vertex more rounded (vertex strongly margined in *L. brachycerus*); scutellum triangular with beard like hairs; (scutellum without tuft of hairs at its tip in *L. brachycerus*), and metasoma elongate, compressed and slightly curved upwards (metasoma more convex in *L. brachycerus*).

5. *Leptacis diversus* Ushakumari and Narendran sp. nov.

(Figs. 9-10)

Female : Length 1.21; black; antenna reddish brown with four segmented club; eyes dark brown to black; ocelli black glassy; tegula black; all legs reddish brown with coxa and last tarsal segment dark brown; distal one-fourth of tibia and femur dark brown; wings opaque with pilosity reddish brown; body pubescence white.

Head : Finely reticulate, sparsely pubescent; vertex deeply angled; hyper-occipital carina well distinct; eyes bare; antennal sockets close to clypeal border. Head viewed in front (Fig. 9) length : width 30 : 49; head width in dorsal view about 3x its median length; POL about 4.25x OOL; scrobe indistinct and inter antennal projection distinct; malar groove absent; posterior margin of gena ecarinate; occipital carina distinct; head wider than mesosoma in dorsal view; maximum diameter of eye in lateral view about 3.6x malar space. Antenna (Fig. 10) 10 segmented; relative length of antenna; body length 69 : 100. Relative length : width of antennal segments : scape-48 : 8; pedicel-13 : 5; F₁-4.5 : 4; F₂-11 : 5; F₃-5 : 3; F₄-5 : 3; F₅-9 : 7; F₆-8 : 9; F₇-8 : 8; F₈-13 : 8.

Mesosoma : Finely reticulate; notauli absent; scutellum somewhat semicircular with a short bluntly rounded nipple shaped dark brown process that extends to the proximal end as a median smooth ridge; except the ridge scutellum hairy; pro, meso and metapleura matt : metapleuron with hairs on its posterior end; scutellum length including tip of process 1.36x its maximum width; scutellar suture well distinct with bristle like hairs on its anterior margin. Forewing (Fig. 9) length 2.68x its maximum width; *sm* much shorter, not reaching the wing margin and without a knob; marginal fringe much shorter; propodeum with two median process; lateral side carry hairs arranged in a triangular pattern; hind coxa length 1.37x its maximum width; hind femur 2.75x length of trochanter and about 2.75x of its own maximum width and shorter than hind tibia; hind tibia 3.6x length of hind metatarsus and shorter than the combined length of hind metatarsus; distal end of femur and tibia dilated.

Metasoma : Petiole transverse, its width about 3.25x its length, hairy with longitudinal carina; second metasomal tergite matt and posterior segments with minute punctures : metasoma longer than mesosoma but shorter than combined length of head and mesosoma. Its length about 1.67x its own maximum width.

Male : Unknown.

Host : Unknown.

Etymology : The species name is taken from Latin meaning different.

Material examined : Holotype : female; INDIA : Kerala, Eravikulam, 28-xi-1993; Coll. T.C. Narendran and party (DZCU).

Discussion : This species comes near *L. coorgensis* in the key to species of Mukerjee (1978). It resembles *L. coorgensis* in having : second funicular segment much longer than first, and fourth funicular segment not shorter than third; second funicular segment 3x longer than thick; head and metasoma finely reticulate and hairy tuft on petiole. However it differs from *L. coorgensis* in having : notauli absent (notauli present in *L. coorgensis*); scutellum passing into a short nipple like spine which extends dorso-medially to the posterior end as a ridge (in *L. coorgensis* scutellar spine long); colour of antennae reddish brown, (antenna black except brownish scape in *L. coorgensis*) and marginal fringe of forewing much shorter (marginal fringe moderate in *L. coorgensis*).

6. *Leptacis keralensis* Ushakumari and Narendran sp. nov.

(Figs. 11-12)

Female : Length 0.73 mm; black; antenna brown except terminal four funicular segments which are dark brown; eyes black; ocelli glassy with a black tint; mandible dark brown; tegula brown; all legs brown; wings subhyaline with pilosity brown; pubescence on body white.

Head : Frons smooth and shiny; vertex weakly reticulate without pubescence; eyes bare; antennal sockets close to clypeal border. Head viewed in front (Fig. 11) length to width 32 : 40; head width in dorsal view about 1.38x its median length; POL about 4.3x OOL; malar groove absent; scrobe and interantennal projection indistinct; posterior margin of gena ecarinate; occipital carina distinct; head wider than mesosoma in dorsal view; maximum diameter of eye in lateral view about 3.2x malar space. Antenna (Fig. 12) 10 segmented; relative length of antenna : body length 72.7 : 100. Relative length : width of antennal segments : scape-40 : 8; pedicel-11 : 5; F₁-7 : 3; F₂-12 : 3.5; F₃-6 : 4; F₄-5 : 3; F₅-11 : 9; F₆-10 : 10; F₇-11 : 10; F₈-14 : 9.

Mesosoma : Finely reticulate, shiny; notauli absent; mesoscutum length 1.2x its maximum width; scutellum somewhat triangular, long and gradually passing into a long brown spine behind; scutellar length about 1.4x its maximum width, few hairs on its lateral margin; propodeum with tuft of white hairs on the lateral sides; pro and mesopleura partially punctate, shiny; inetapleuron smooth with tuft of white hairs on its posterior margin. Forewing (Fig. 11) length 3.25x its maximum width; *sm* short, straight, not touching wing margin and without distal knob; anterior and posterior marginal fringe shorter and apical fringe longer; wing lamina densely hairy. Hind coxa length as long as wide; hind femur 2.85x length of trochanter, about 4x its own maximum width and shorter than hind tibia; hind tibia 2.45x length of metatarsus and as long as combined length of hind tarsal segments; all femora and tibiae swollen apically.

Metasoma : Petiole transverse, 1.37x wide as its length, longitudinal carina on petiole, tuft of white silvery hairs present on ventral side; dorsolateral region of second metasomal tergite with anterior pits; metasoma little longer than mesosoma but shorter than combined length of head and mesosoma and about 1.78x its maximum width in dorsal view. Posterior metasomal tergites weakly punctuate.

Male : Unknown.

Host : Unknown.

Etymology : This species is named after Kerala state.

Material examined : Holotype : Female, INDIA : Kerala, Calicut University Campus, 18-vi-2000, Coll. T.C. Narendran and party (DZCU).

Discussion : In the key to Indian *Leptacis* by Mukerjee (1978) it comes closer to *L. yercaudensis* Mukerjee in having : the second funicular segment longer than first and third and fourth funicular

segments unequal; marginal fringes of forewing conspicuously long and forewing length to width 100 : 31. However it differs from this species in having : notauli absent (in *L. yercaudensis* notauli present) and second metasomal tergite with oval shaped anterior pits (without oval shaped anterior pits in *L. yercaudensis*).

7. *Leptacis malaburensis* Ushakumari and Narendran sp. nov.

(Figs. 13-14)

Female : Length 0.95 mm; black; antenna black except brown basal one fourth of scape; eyes black; ocelli white glassy; mandible yellowish brown; tegula dark brown; all legs with coxa brown, dilated portion of femur and tibia dark brown and basal narrow cylindrical portion light brown, tarsal segments light brown; wings subhyaline with pilosity dark brown; body pubescence silvery white.

Head : Frons, vertex and occiput punctate, shiny without pubescence; eyes bare; antennal sockets close clypeal border. Head viewed in front (Fig. 13) length to width 32 : 43; head width in dorsal view about 2.4x its median length; hyperoccipital carina not distinct; POL about 3.66x OOL; maximum diameter of eye in lateral view about 2.66x malar space. Antenna (Fig. 14) 10 segmented; relative length of antenna : body length 53.5 : 100. Relative length : maximum width of antennal segments : scape—42 : 9; pedicel—11 : 5; F₁—7 : 3.5; F₂—12 : 3; F₃—5 : 3; F₄—5 : 3; F₅—10 : 9; F₆—8 : 10; F₇—9 : 11; F₈—11 : 11.

Mesosoma : Weakly reticulate, shiny, sparsely hairy; notauli absent; mesoscutum length 1.1x its maximum width; scutellum somewhat triangular, flat, sparsely hairy and is produced into a slender long brown spine, length of scutellum with spine 1.3x its maximum width, lateral margin with few hairs; propodeum with white tuft of hairs almost converging to a point; propleuron smooth, shiny and upper part partially reticulate; mesopleuron shiny and upper part with weak transverse carina; metapleuron smooth, shiny, and distal end with white silvery tuft of hairs. Forewing (Fig. 13) length 2.9x its maximum width, *sm* short, straight, not touching wing margin and without distal knob; apical marginal fringe longer and anterior and anal marginal fringes much shorter; femur and tibia dilated apically, hind coxa length 2x its-maximum width; hind femur 2x length of trochanter and about 3.6x its own maximum width; hind tibial length 1.77x length of metatarsus and as long as combined length of hind tarsal segments.

Metasoma : Petiole as long as wide with white silvery hairs on its sides; second tergite smooth with line of hairs on its anterior margin; posterior metasomal tergites weakly punctate; metasoma little longer than mesosoma but shorter than combined length of head and mesosoma; its length about 1.79x its maximum width in dorsal view.

Male : Unknown.

Host : Unknown.

Etymology : The species named after Malabar, the region of collection.

Material examined : Holotype : Female, INDIA : Kerala, Muthanga, 6-v-2000, Coll. R. Ushakumari (DZCU).

Discussion : This species comes near *Leptacis yercaudensis* Mukerjee in the key to species by Mukerjee (1978). This species resembles *L. yercaudensis* in having : second funicular segment longer than the first and marginal fringes longer. However it differs from this species in having : notauli absent (in *L. yercaudensis* notauli present); third and fourth funicular segments subequal (unequal in *L. yercaudensis*); scutellum somewhat triangular which ends in a narrow, slender and brown scutellar spine (scutellum long gradually passing into a long spine in *L. yercaudensis*) and white silvery tuft of hairs on propodeum radiating to a point (this character not indicated in the available description by Mukerjee, 1978.)

8. *Leptacis manii* Ushakumari and Narendran sp. nov.

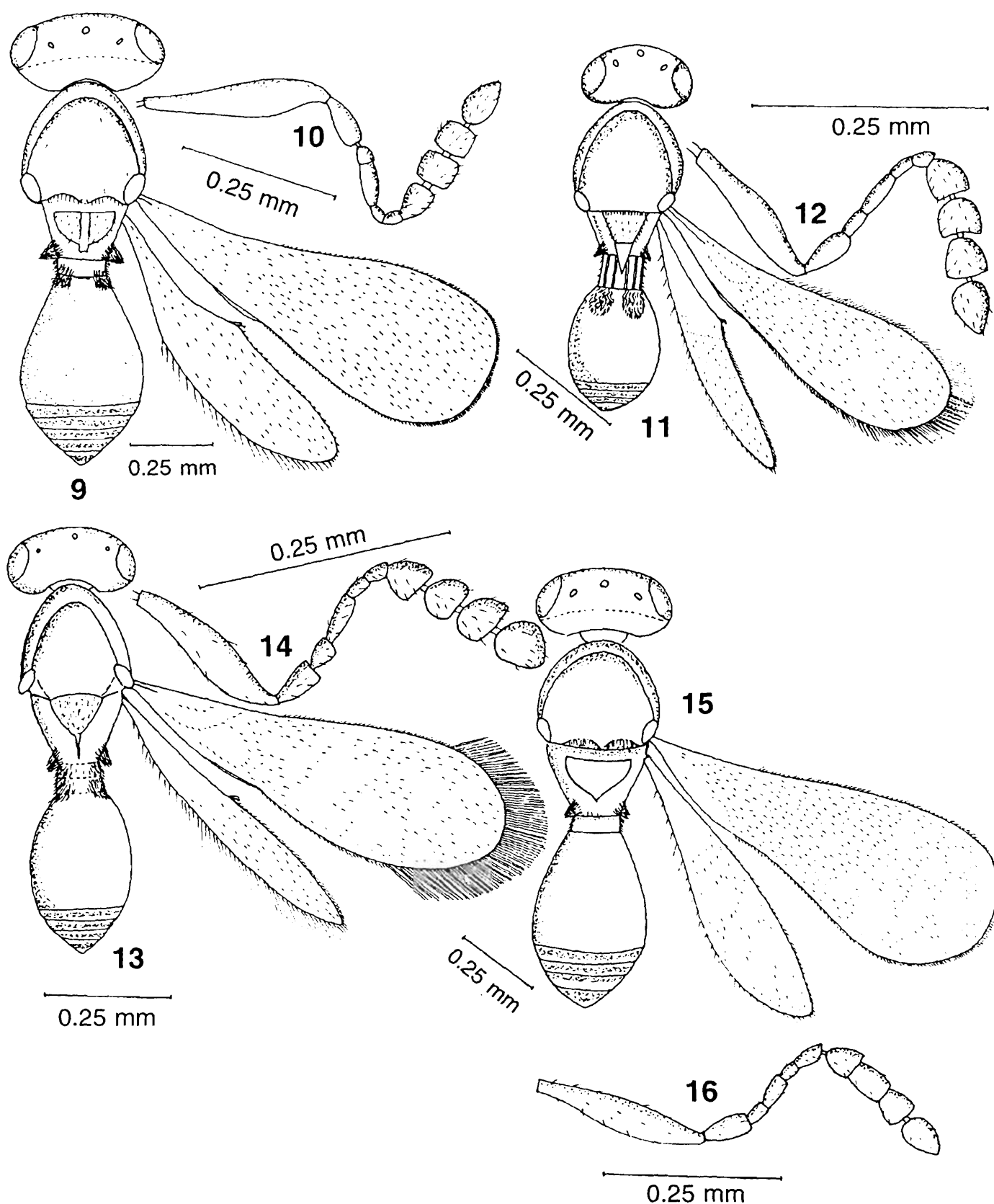
(Figs. 15-16)

Female : Length 1.24 mm; dark brown to black; antenna dark brown; eyes black; ocelli black; mandible brown; tegula black; legs with coxa, femur, tibia and last tarsal segment dark brown, other tarsal segments light brown; wings opaque with pilosity brown; body pubescence white.

Head : Frons and vertex finely reticulate and without pubescence; eyes bare; antennal sockets close to clypeal border; head viewed in front (Fig. 15) length to width 27 : 41; head width in dorsal view about 3.09x its median length; POL about 3.66x OOL; malar groove absent; malar space less; scrobe indistinct and interantennal projection distinct; posterior margin of gena ecarinate; hyper-occipital carina distinct; head wider than mesosoma in dorsal view. Antenna (Fig. 16) 10 segmented; relative length of antenna : body length 100 : 79 : relative length : width of antennal segments : scape-42 : 7; pedicel-11 : 5; F₁-4 : 3; F₂-8 : 4; F₃-4 : 3; F₄-7 : 4; F₅-8 : 7; F₆-9 : 7; F₇-7 : 8; F₈-10 : 7.

Mesosoma : Finely reticulate; notauli absent; mesoscutum as long as wide; scutellum broadly triangular, with a pen-nib like knob at apex and sparsely hairy; scutellar width including spine 1.5x its length; propodeum with hairs on its side and with a median ridge; propleuron finely reticulate; meso and metapleura smooth and metapleuron with few hairs at its posterior end. Forewing (Fig. 15) length 2.6x its maximum width; *sm* short, straight, not touching wing margin and without distal knob; marginal fringe short and wing lamina densely hairy; hind coxa length 1.5x its maximum width; hind femur length 2.2x length of trochanter and about 3.3x its own maximum width and shorter than hind tibia; hind tibia 2.75x length of metatarsus and longer than combined length of hind tarsal segments.

Metasoma : Petiole transverse, 2.5x as wide as its length, few hairs present; metasoma more compressed; metasoma little longer than mesosoma but shorter than combined length of head and



Figs. 9-16. : 9-10. *Leptacis diversus* Ushakumari & Narendran sp. nov. (Female) Part of body : Dorsal view.

11-12. *Leptacis keralensis* Ushakumari & Narendran sp. nov. (Female) Part of body : Dorsal view;

13-14. *Leptacis malabarensis* Ushakumari & Narendran sp. nov. (Female) Part of body : Dorsal view;

15-16. *Leptacis manii* Ushakumari & Narendran sp. nov. (Female) Part of body : Dorsal view.

mesosoma and its length about 1.74x its maximum width in dorsal view; second metasomal tergite smooth and shiny and rest of the segments finely punctate.

Male : Unknown.

Host : Unknown.

Etymology : The species named after Prof. M.S. Mani for his significant contribution to the study of parasitic hymenoptera.

Material examined : Holotype : Female, INDIA : Kerala, Ernakulam, 28-ii-1998, Coll. T.C. Narendran and party (DZCU).

Discussion : This species resembles *Leptacis konkanensis* Mukerjee in having : second funicular much longer than first and longest; marginal fringe of forewing short; fourth funicular segment not shorter than third and second funicular segment about 2x longer than thick. However it differs from *L. konkanensis* in having : notauli absent (notauli present in *L. konkanensis*); scape length 7x its maximum width (in *L. konkanensis* scape 5.52x longer than thick); scutellum with short pen nib like spine (scutellar spine long in *L. konkanensis*) and ovipositor not exerted (ovipositor exerted in *L. konkanensis*).

9. *Leptacis mustus* Ushakumari and Narendran sp. nov.

(Figs. 17-18)

Female : Length 1.19 mm; black; antenna with scape, pedicel and first to fourth funicular segments brown and four segmented club dark brown; eyes black; ocelli glassy and white; mandible dark brown; tegula dark brown to black; all legs with coxa dark brown; mid hind femur and distal end of hind tibia dark brown; all the other segments yellowish brown; wings subhyaline with pilosity brown; body pubescence white.

Head : Finely reticulate without pubescence; eyes bare; antennal sockets close to clypeal border; vertex angular. Head viewed in front (Fig. 17) length to width 42 : 51; head width in dorsal view about 3x its median length; POL about 6.5x OOL; malar groove absent; scrobe indistinct; interantennal projection slightly distinct; hyperoccipital carina distinct; posterior margin of gena ecarinate; mandible well developed; occipital carina distinct; head wider than mesosoma in dorsal view; maximum diameter of eye in lateral view about 4.6x malar space. Antenna (Fig. 18) 10 segmented; relative length of antenna : body length 59 : 100. Relative length : width of antennal segments : scape-42 : 8; pedicel-12 : 4; F₁-4 : 3; F₂-8 : 5; F₃-5 : 5; F₄-3 : 3; F₅-9 : 9; F₆-9 : 10; F₇-9 : 10; F₈-10 : 9.

Mesosoma : Finely reticulate and sparsely hairy; notauli absent; mesoscutum as long as wide; scutellum somewhat semicircular, finely punctate, hairy, and ends in a small spine like process; scutellar length to the tip of spine 1.6x shorter than its maximum width; scutellar groove deep with

hairs on its anterior margin; propodeum with, white hairs on its lateral side and a median ridge; propleuron finely reticulate; mesopleuron smooth and metapleuron hairy on its posterior margin. Forewing (Fig. 17) length 2.4x its maximum width; *sm* short, straight, not touching the wing margin and without a distal knob, marginal fringe much shorter and wing lamina moderately hairy; hind coxa length 1.5x its maximum width; hind femur 2.4x length of trochanter and 3.6x its own maximum width and shorter than hind tibia; hind tibia length 2.4x length of hind metatarsus and as long as combined length of hind tarsal segments.

Metasoma : Petiole transverse, hairy and not distinctly visible because of hairy tuft; second tergite smooth and posterior segments punctate; metasoma slightly shorter than mesosoma but longer than combined length of head and mesosoma.

Male : Unknown.

Host : Unknown.

Etymology : The species name is taken from Latin meaning new.

Material examined : Holotype : Female, INDIA : Kerala, Rravikulam, 25-ii-1995. Coll. T.C. Narendran and Party (DZCU).

Discussion : This species comes near *L. thanensis* Mukerjee in the key to species by Mukerjee (1978). It resembles *L. thanensis* in having : second funicular segment much longer than first; fourth funicular segment shorter than third; marginal fringe short; and antenna with four segmented club. However it differs from *L. thanensis* in having : notauli absent (notauli present in *thanensis*); scutellum semicircular ending in a small process (scutellum long gradually passing into a long spine in *thanensis*); body size small—1.19 mm (*L. thanensis* is 1.52 mm); petiole transverse and not distinctly visible because of the hairy tuft (petiole transverse with only few hairs in *thanensis*); ovipositor not exserted (ovipositor slightly exserted in *thanensis*).

10. *Leptacis stom* Ushakumari and Narendran sp. nov.

(Figs. 19-20)

Male : Length 0.98 mm; dark brown to black; antenna elongate; slender and brownish; eyes brown to black; ocelli glassy with an yellowish tint; mandible brown; tegula dark brown; all legs brownish and long; distal end of hind tibia reddish brown; wings hyaline with pilosity dark brown; body pubescence white.

Head : Frons and vertex finely reticulate without pubescence; somewhat globular; vertex rounded; eyes bare; antennal sockets close to clypeal border; head viewed in front (Fig. 19) length to width 32 : 46; head width in dorsal view about 3.36x its median length; POL about 6.3x OOL; malar groove absent; scrobe indistinct; interantennal projection distinct; posterior margin of gena ecarinate; mandible well developed; hyperoccipital carina not distinct; occipital carina distinct;

head wider than mesosoma in dorsal view; maximum diameter of eye in lateral view about 4.5x malar space. Antenna (Fig. 20) long, 10 segmented; second funicular segment elongate with a spiny appearance; relative length of antenna : body length 96.5 : 100. Relative length : width of antennal segments : scape-53 : 9; pedicel-10 : 7; F₁-7 : 5; F₂-22 : 4; F₃-11 : 5.5; F₄-20 : 4; F₅-15 : 5; F₆-20 : 6; F₇-17 : 6; F₈-26 : 6.

Mesosoma : Finely reticulate; notauli absent; mesoscutum as long as wide; scutellum somewhat triangular and gradually passing into a long and stout brown spine; scutellum length including spine 1.9x its maximum width; scutellum without spine as long as scutellar spine and sparsely hairy; propodeum with short hairs on its side and with a median ridge; propleuron finely reticulate; mesopleuron with a few transverse striations on upper region; metapleuron smooth, shiny and with tuft of white short silvery hairs at its posterior margin. Forewing (Fig. 19) length 3.09x its maximum width; *sm* short; marginal fringe long and wing lamina thinly hairy; hind coxa length 1.37x its maximum width; hind femur 3.12x length of trochanter, about 3.57x its own maximum width and shorter than hind tibia; hind tibia length 2.33x length of metatarsus and shorter than combined length of hind tarsal segments.

Metasoma : Petiole brown, transverse, 1.66x wide as its length and with short hairs. Metasoma more convex on its dorsal side; second metasomal tergite smooth, anterior pits present; metasoma as long as mesosoma but shorter than combined length of head and mesosoma; metasomal length 2x its maximum width; posterior metasomal segments weakly punctate.

Female : Unknown.

Host : Unknown.

Etymology : The species name is an arbitrary combination of letters.

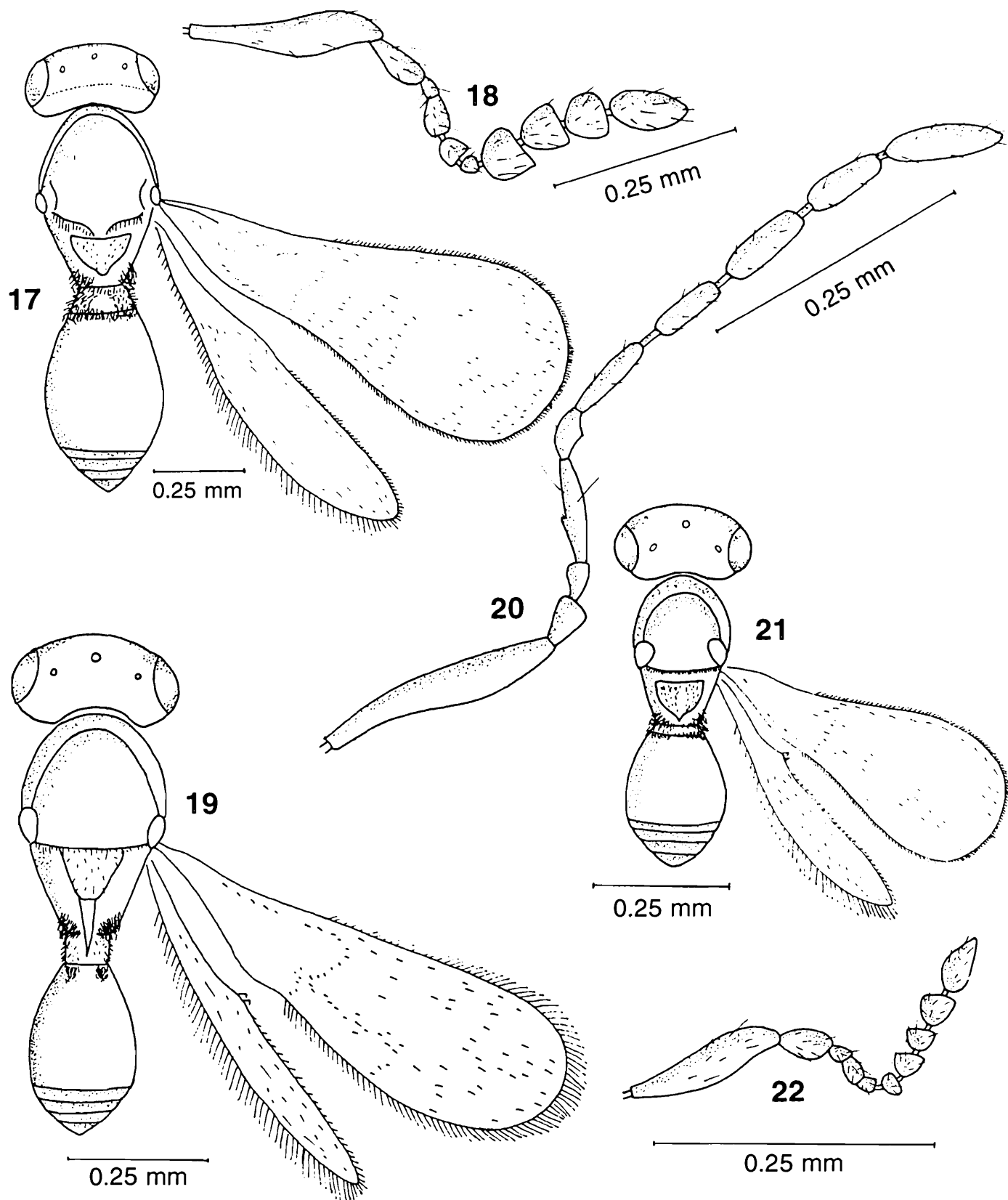
Material examined : Holotype : Female, INDIA : Kerala, Thiruvannur, 21-xi-1994. Coll. T.C. Narendran and party (DZCU).

Discussion : In the key to Indian *Leptacis* by Mukerjee (1978) this species resembles *L. maldarensis* in having : third and fourth funicular segments unequal and elongate; head finely reticulate and marginal fringe long; first funicular segment 1.6x longer than thick; long brown spine on scutellum; notauli absent and funicular segments with long hairs. However it differs from *L. maldarensis* in having : head more rounded (vertex angled in *L. maldarensis*); wing lamina thinly hairy and small anterior pits on second metasomal tergite (not indicated in *L. maldarensis*).

11. *Leptacis nuperus* Ushakumari and Narendran sp. nov.

(Figs. 21-22)

Female : Length 0.65 mm; dark brown to black; antenna with scape, pedicel and first four funicular segments yellowish brown and the four segmented club brown; eyes grey to black; ocelli



Figs. 17-22. : 17-18. *Leptacis mustus* Ushakumari & Narendran sp. nov. (Female) Part of body : Dorsal view.
 19-20. *Leptacis stom* Ushakumari & Narendran sp. nov. (Male) Part of body : Dorsal view;
 21-22. *Leptacis nuperus* Ushakumari & Narendran sp. nov. (Female) Part of body : Dorsal view.

black and glassy; tegula dark brown; coxa of all legs dark brown, first femur brown, second and third femora dark brown and distal end of hind tibia brown and others yellowish brown; wing subhyaline with pilosity dark brown; body pubescence white.

Head : Frons and vertex finely reticulate sparsely pubescent; eyes bare; antennal sockets close to clypeal border; vertex not distinctly angular; head viewed in front (Fig. 21) length to width 39 : 54; head width in dorsal view about 3x its median length; POL about 7x OOL; malar groove absent; scrobe indistinct; interantennal projection slightly distinct; hyperoccipital carina not distinct; occipital carina slightly distinct; head wider than mesosoma in dorsal view; maximum diameter of eye in lateral view about 4.3x malar space. Antenna (Fig. 22) 10 segmented; relative length of antenna : body length 62 : 100. Relative length : width of antennal segments : scape-35 : 8; pedicel-11 : 6; F₁-4 : 3; F₂-6 : 4; F₃-3 : 3; F₄-4 : 3; F₅-5 : 6; F₆-5 : 7; F₇-7 : 6; F₈-13 : 6.

Mesosoma : Finely reticulate, sparsely hairy; notauli absent; mesoscutum slightly wider than its length; scutellum somewhat semicircular, hairy; scutellum in its lateral view with a black sharp point; transcutal suture with hairs on its anterior margin; propleuron partially reticulate; mesopleuron smooth; metapleuron with transverse carina and posterior margin hairy; propodeum hairy on its lateral side, arranged in a triangular pattern and with a median ridge. Forewing (Fig. 21) length 2.4x its maximum width; *sm* not distinct; marginal fringe much shorter and wing lamina moderately hairy; hind coxa length 1.5x its maximum width; hind femur 1.6x length of trochanter, about 3x its own maximum width and shorter than hind tibia; hind tibia length 2.4x length of metatarsus and as long as combined length of hind tarsal segments.

Metasoma : Petiole not distinctly visible as it is hairy, hairs extends to the anterior margin of second tergite; metasoma as long as mesosoma but distinctly shorter than the combined length of head and mesosoma; second tergite smooth; posterior segments finely punctate.

Male : Unknown.

Host : Unknown.

Etymology : The species name is taken from Latin meaning new.

Material examined : Holotype : Female, INDIA : Kerala, Calicut University Campus. 3-xii-1994, Coll. T.C. Narendran and party (DZCU).

Discussion : This species comes near *L. konkanensis* Mukerjee in the key to *Leptacis* species by Mukerjee (1978). It resembles *L. konkanensis* in having : second funicular segment much longer than first; fourth funicular segment not shorter than third; second funicular segment about 2x longer than thick (1.5x longer than thick) and scape 5.6x longer than wide. However it differs from *L. konkanensis* in having : notauli absent (present in *L. konkanensis*); scutellum with a short black spine (in *L. konkanensis* long scutellar spine); body size small 0.65 mm (*L. konkanensis* is 1.16 mm); legs with coxa dark brown, first femur brown, second and third femora dark brown and

distal end of hind tibia brown and others yellowish brown, (in *L. konkanensis* all legs brown); antenna with scape, pedicel and first four funicular segments yellowish brown and the four segmented club brown. (Antenna dark brown except for the light brown scape in *L. konkanensis*); ovipositor not exerted (in *L. konkanensis* ovipositor exerted).

12. *Leptacis scaposus* Ushakumari and Narendran sp. nov.
(Figs. 23-24)

Female : Length 0.91 mm; black; antenna with four segmented dark brown club, rest of segments light brown; eyes black; ocelli glassy with a black tint; mandible brown; tegula brown; coxa of all legs, distal end of middle, hind femur, hind tibia and last tarsal segment dark brown; foreleg and second tibia light brown; wings hyaline with pilosity dark brown : body pubescence scarce and white.

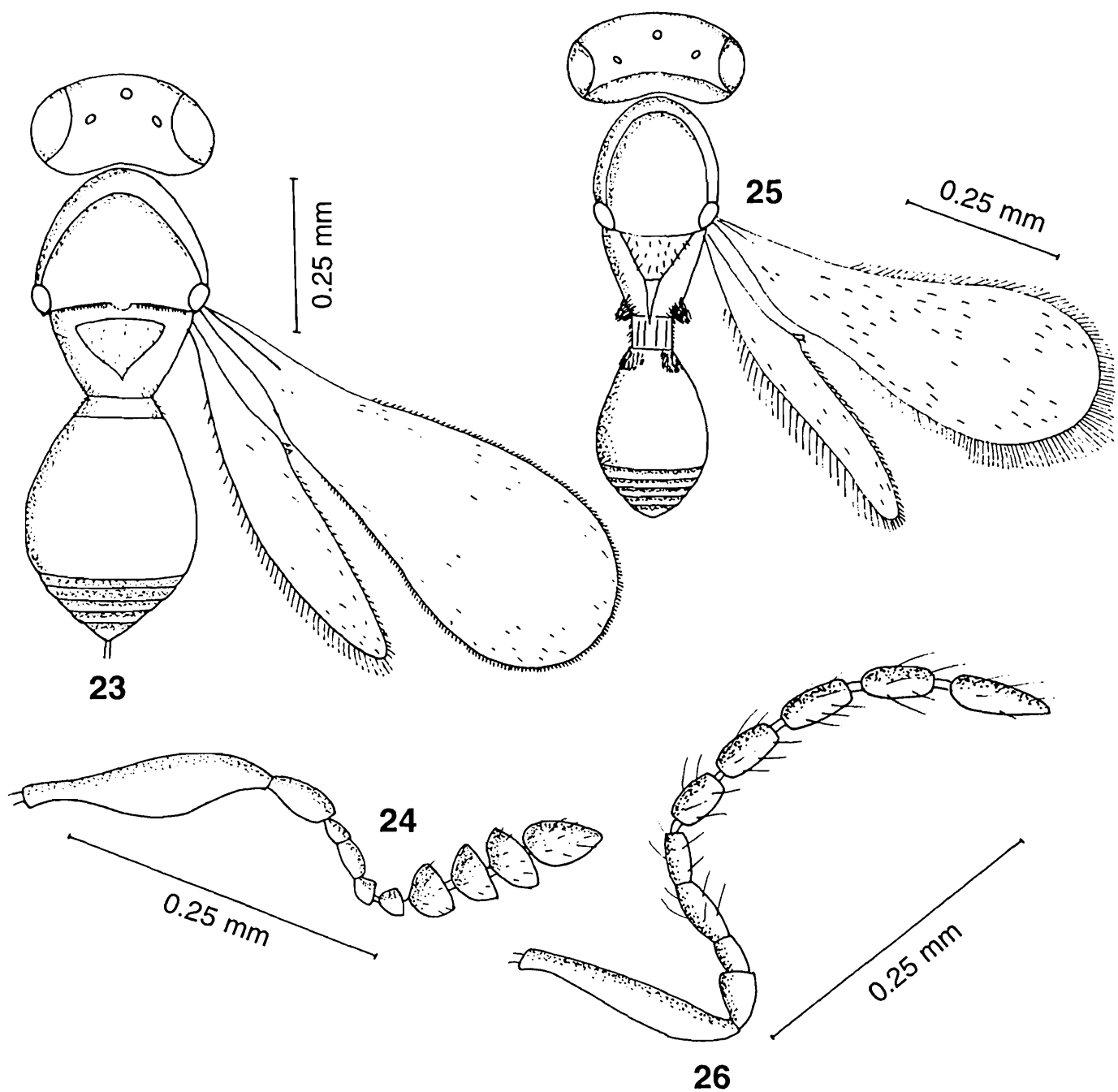
Head : Frons and vertex finely reticulate without pubescence; eyes bare; antennal sockets close to clypeal border; vertex angular. Head viewed in front (Fig. 23) length to width 51 : 65; head width in dorsal view about 2.5x its median length; POL about 4.8x OOL : malar groove absent; scrobe indistinct; interantennal projection slightly distinct, posterior margin of gena ecarinate; hyper-occipital carina distinct; occipital carina distinct; head wider than mesosoma in dorsal view; maximum diameter of eye in lateral view about 3.6x malar space. Antenna (Fig. 24) 10 segmented; relative length of antenna : body length 52.2 : 100. Relative length : width of antennal segments : scape-46 : 11; pedicel-12 : 6; F₁-5 : 4; F₂-7 : 3; F₃-4 : 4; F₄-5 : 4; F₅-8 : 8; F₆-6 : 10; F₇-7 : 12; F₈-12 : 9.

Mesosoma : Finely reticulate, sparsely hairy; notauli absent; mesoscutum slightly wider than its length; scutellum somewhat triangular, hairy with a small up curved spine : scutellum length to the tip of spine as long as its base; scutellar groove hairy on its margin : propodeum with a medium ridge like process; propleuron weakly reticulate, meso and metapleura smooth and shiny; mesopleuron with a few transverse carinae. Forewing (Fig. 23) length 2.8x its maximum width; *sm* short; straight, not touching the wing margin and without a distal knob; marginal fringe much shorter and wing lamina moderately hairy; hind coxa length 1.37x its maximum width; hind femur 2.3x length of trochanter, about 3x its own maximum width and shorter than hind tibia; hind tibia length 2.8x length of metatarsus and as long as combined length of hind tarsal segments.

Metasoma : Petiole short transverse, 4x wide as its length; second tergite larger : posterior tergites punctate; metasoma slightly longer than mesosoma but distinctly shorter than combined length of head and mesosoma; metasomal length 1.56x its own maximum width.

Male : Unknown.

Host : Unknown.



Figs. 23-26. : 23-24. *Leptacis scaposus* Ushakumari & Narendran sp. nov. (Female) Part of body : Dorsal view.

25-26. *Leptacis thrissurensis* Ushakumari & Narendran sp. nov. (Male) Part of body : Dorsal view.

Etymology : The species is named after relatively short antennal scape.

Material examined : Holotype : Female, INDIA : Kerala, Calicut University Campus, 3-xii-1994, Coll. T.C. Narendran and party (DZCU).

Discussion : This species comes near *L. konkanensis* Mukerjee in the key to species by Mukerjee (1978). It resembles *L. konkanensis* in having : second funicular segment much longer than first; fourth funicular segment not shorter than third; second funicular segment 2x longer than thick (2.6x longer than thick) and ovipositor exerted. However it differs from *L. konkanensis* in having : scape only 3.8x longer than thick (in *L. konkanensis* 5.52x longer than thick); notauli absent. (Notauli present in *L. konkanensis*) and scutellum somewhat triangular ending in a small up curved spine (in *L. konkanensis* scutellum long, gradually passing into a more or less long spine).

13. *Leptacis thrissurensis* Ushakumari and Narendran sp. nov.

(Figs. 25-26)

Male : Length 0.716 mm; dark brown to black; antenna dark brown except for the brownish scape; front and hind ocelli white glassy; mandible brown; all legs brown; tegula dark brown; wings hyaline with pilosity brown; body pubescence silvery white.

Head : Frons smooth; vertex weakly reticulate, shiny without pubescence; eyes bare; antennal sockets close to clypeal border. Head viewed in front (Fig. 25) length to width 31 : 46 : head width in dorsal view about 2x its median length; POL about 3.75x OOL; scrobe indistinct; interantennal projection distinct; hyperoccipital carina distinct; posterior margin of gena ecarinate; occipital carina distinct; head wider than mesosoma in dorsal view : maximum diameter of eye in lateral view about 6x malar space. Antenna (Fig. 26) 10 segmented, long hairs; relative length of antenna : body length 94.18 : 100. Relative length : width of antennal segments : scape—42 : 6; pedicel—10 : 6; F₁—7 : 4; F₂—14 : 5; F₃—9 : 5; F₄—11 : 6; F₅—12 : 6; F₆—14 : 5; F₇—12 : 6; F₈—19 : 5.

Mesosoma : Finely reticulate, shiny, sparsely hairy; notauli absent; mesoscutum length 1.14x its width; scutellum somewhat triangular, with a stout long dark brown spine; scutellum length up to tip of spine 2x its maximum width, hairy on its lateral and dorsal side; pro, meso and metapleura smooth and shiny; posterior end of metapleuron hairy. Forewing (Fig. 25) length 2.7x its maximum width; *sm* short, straight, not touching wing margin and without distal knob; wing lamina thinly hairy; forewing with moderately long fringes of hairs on upper and lower margin and with much longer fringes on apical lower margin. Propodeum laterally hairy, hairs arranged converging to a point and a median carina. Hind coxa length 1.28x its width; hind femur swollen and 3.2x length of trochanter, about 3.8x its own maximum width and shorter than hind tibia; hind tibia dilated at its distal end, its length 3x length of hind metatarsus and as long as combined length of hind tarsal segments.

Metasoma : Petiole transverse, 1.3x as wide as its length, few hairs on its lateral side and longitudinal carina; second tergite smooth, shiny with paired oval depression situated antero-laterally and with dense small hairs; ventral side with white silvery hairs; metasoma little shorter than mesosoma and distinctly shorter than combined length of head and mesosoma, a little less than 2x its width in dorsal view; metasoma more convex dorsally.

Male : Unknown.

Host : Unknown (probably paddy pests).

Etymology : The species is named after its locality.

Material examined : Holotype : Male, INDIA : Kerala, Thrissur, 15-x-1998, Coll. R. Ushakumari (DZCU).

Discussion : This species comes near *Leptacis maldarensis* Mukerjee in the key to species by Mukerjee (1978). It resembles *L. maldarensis* in having : long second funicular segment of antennae and presence of long hairs on the segments; absence of notauli and presence of long brown scutellar spine. However it differs from *L. maldarensis* in having : marginal fringes of wing being moderately long on the upper and lower margin and much long on the lower portion of apical margin (in *L. maldarensis* marginal hairs long); petiole with longitudinal carina (not indicated in *L. maldarensis*) and small oval shaped anterior pits on second metasomal tergite (not indicated in *L. maldarensis*).

14. *Leptacis coorgensis* Mukerjee

1981. *Leptacis coorgensis* Mukerjee, *Rec. zool. surv. India, Occ. Paper No.*, **27** : 65-67 (ZSI).

Diagnosis : Female : Length 1.00 mm. General body colour dark brown to black; antenna black except for the pale brown scape; scutellar spine light brown. Eyes bare. Antennal formula : 11044. Mesosoma with notauli distinct. Forewing about 2.9x as long as wide; marginal fringe longest seta as long as submarginal vein; metasoma with petiole transverse with a hairy tuft; second tergite longest.

Type locality : India : Karnataka, Coorg, Hudukeri.

Remarks : The above diagnosis is from the original description (Courtesy to Mukerjee, 1981).

15. *Leptacis maldarensis* Mukerjee

1981. *Leptacis maldarensis* Mukerjee, *Rec. zool. surv. India, Occ. Paper No.*, **27** : 67-68 (ZSI).

Diagnosis : Male : Length : 1.08 mm. Black; antenna dark brown with scape yellowish brown; legs pale brown with tip of hind tibiae dark brown. Eyes bare; OOL 0.50 of OD, antennal formula 11035. Metasoma with petiole short and with a few hairs on sides. Mesosoma with notauli absent.

Type locality : Karnataka, Malda (Courtesy : Mukerjee 1981).

16. *Leptacis agastmuniae* Mukerjee

1992. *Leptacis agastmuniae* Mukerjee : *Hexapoda*, 4(2) : 175-176, 180 (ZSI?).

Diagnosis : Female : length 0.80 mm. Brownish black to black; antenna pale yellow except for brown clava; scutellar spine yellowish brown; legs yellowish brown. Eyes sparsely pubescent; POL : OOL = 9 : 1; malar sulcus absent.

Type locality : India, Agastmuni (Chamoli) (Courtesy : Mukerjee 1992).

17. *Leptacis indicus* Mukerjee

1978. *Leptacis indicus* Mukerjee : *Mem. School. Ent.*, 5 : 82-84. (ZSI)

Diagnosis : Male : Length : 1.38mm. Black; fore and mid legs yellowish brown; hind leg yellowish brown except for the darker tip of femur, apical 0.45 of tibia and last tarsal segment; metasoma brownish black except for the brown petiole. Eyes bare; OOL about 0.60 of OD; POL about 4x OD; marginal fringe of forewing shorter than OD.

Type locality : India, Maharastra, Poona, Khandala Ghat (Courtesy : Mukerjee 1978).

18. *Leptacis konkanensis* Mukerjee

1978. *Leptacis konkanensis* Mukerjee : *Mem. School. Ent.*, 5 : 84-86. (ZSI)

Diagnosis : Female : Length 1.16 mm. Dark brown; scape light brown; legs brown. Eye bare; OOL about 2.25x OD, POL about 5x OD; antennal formula 11044; scape without laminar expansion; longest marginal fringe of forewing as long as submarginal vein; notauli present.

Type locality : India, Karnataka, Mahabaleshwar (Courtesy : Mukerjee 1978).

19. *Leptacis thanensis* Mukerjee

1978. *Leptacis thanensis* Mukerjee : *Mem. School. Ent.*, 5 : 86-88. (ZSI)

Diagnosis : Female : Length 1.52 mm. Black; antenna brown except for the brownish black clava; scutellar spine brown. Eyes bare; OOL about 60x of OD; POL about 4.30x OD. Forewing with marginal fringe about one-fourth as long as submarginal vein.

Type locality : India, Maharastra, Bombay, Thana Hills (Courtesy to Mukerjee 1978).

20. *Leptasis atturensis* Mukerjee

1981. *Leptasis atturensis* Mukerjee *Rec. zool. Surv. India. Occ. Paper No.*, 27 : 60-62. (ZSI).

Diagnosis : Male : Length 1.20 mm. Black except for the reddish brown petiole; eyes and ocelli brown; mandibles brown; antenna dark brown except for the yellowish brown scape and radicle; legs brown. Eyes finely and sparsely pubescent; POL 5x OD; antennal formula 11035.

Mesosoma with notauli absent. Metasoma with long dense pubescence on petiole laterally. (Courtesy Mukerjee 1981).

Type locality : India, Karnataka, Attur.

21. *Leptacis yercaudensis* Mukerjee

1981. *Leptacis yercaudensis* Mukerjee, *Rec. zool. Surv. India, Occ. Paper No.*, **27** : 69-71 (ZSI)

Diagnosis : Female : Length : 0.88 mm. Dark brown to black; antenna yellowish brown except for the dark brown clava; scutellar spine yellowish brown; legs brownish. Eyes bare, antennal formula 11044; mesosoma with notauli; metasoma with a hairy tuft on petiole.

Type locality : India, Yercaud (Courtesy Mukerjee 1981).

22. *Leptacis brachycerus* Mukerjee

1981. *Leptacis brachycerus* Mukerjee : *Rec. Zool. Surv. India, Occ. Paper No.*, **27** : 64 (ZSI)

Diagnosis : Female : Length 0.92mm. Black; antenna yellowish brown except for the dark club; scutellar spine brown; legs brown except for the dark brown apical part of hind tibia; metasomal petiole brown. Eyes conspicuously pubescent; antennal formula 11044. Mesosoma with notauli absent. Metasoma with petiole short and transverse.

Type locality : India, Karnataka, Appangala (Courtesy : Mukerjee 1981).

23. *Leptacis bengalensis* Mukerjee

1981. *Leptacis bengalensis* Mukerjee : *Rec. zool. Surv.. India, Occ. Paper No.*, **27** : 62-64 (ZSI)

Diagnosis : Male : Length 2.10 mm. Black; antenna brown except for brownish-yellow scape; scutellar spine brown; legs brown except for the black coxae. Eyes bare; antennal formula 11044; mesosoma with notauli present; metasoma smooth with very fine micro-sculpture. Metasoma with petiole short and transverse.

Type locality : India : West Bengal, Poro North (Courtesy Mukerjee 1981).

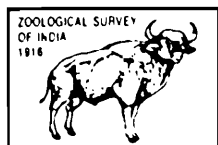
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SOME ASPECTS OF WEB-BUILDING MECHANISM BY AN ARANEID SPIDER *ARGIOPE SHILLONGENSIS* SINHA FROM BORTIBEEL, NORTH 24 PARGANAS, WEST BENGAL

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INTRODUCTION

In our regular life we often observe different types of spider webs in which only the diverse varieties of spiders perform their biological activities and do not wander. They build their webs restricting themselves around it and considered as weavers. Unlike different other spiders ~~they~~ do not build webs but wanders, ambushes, commensals and hunts as non-weavers. Among the web building spiders again there are great diversities in the physical outlooks, functional, structural and environmental conditions in their webs. According to the pattern of their webs web-building spiders are recognized as true orb-web weavers and non-weavers. *Argiope shillongensis*, the spider species of present context is a true orb-web weaver.

During last 5 years while carrying out the ecological investigation on wetland environment of Bortibeel, a 13 km stretched isolated Gangetic marsh land covering about 3,00,000 bighas of cultivated land and several agricultural and fishing villages situated between 88.29–88.38 degree East and 22.8–23.0 degree North of West Bengal the authors came across the experimental spider species *Argiope shillongensis* Sinha, belonging to the family Araneidae weaving it's orb web near the paddy field of the wetland and conducted an extensive behavioral observation.

The present paper deals with the details of the sites where the spider builds it's web, the net supports for anchoring web-threads, the type of alignment, the geometrical pattern of the orb-webs, the places it stays near the web while retract, the morphological structure and measurements of web, the mesh type, the thickness of the thread, the time span it needs to build the web and orb-weaving mechanism along with the biological significance.

Information on orb-weaving behavior of araneid spiders are lacking from Bortibeel wetland area of north 24 parganas District, west Bengal. Tikader (1961) made an observation on spider

web as a protective device of spider. Tikader (1987) recorded nest-building mechanism of spider from India, Tikader (1982) made an observation of nest building behavior of araneid spiders from India. Biswas *et al.* (1995) made an observation on rice field spiders from Bangladesh, Majumder (2001) recorded sum important notes on spider nest by which Odonates were caught. During last few years (since the pre-monsoon of 2001) the author while conducting the ecological studies on Bortibeel wetland have come across one araneid spider (*Argiope shillongensis* Sinha) the structural identity of it's web, the interesting orb-weaving behavior near the paddy fields of the wetland.

MATERIAL AND METHOD

Bortibeel : A 13 km stretch of marsh land crept up on several agricultural and fishing villages covering about 3,00,000 bighas of cultivated land situated between 22.8–23.0 degree Latitude and 88.29–88.38 degree Longitude in 5 assembly segment of Jagaddal, Khardah, Amdanga, Naihati and Barasat. The study area is situated between the 73/A bus root and Nilganj road in North-South and between NH34 and Kalyani high way in East-West. Several rail stations like Halisahar, Naihati, Kankinara, Jagaddal, Shyamnagar, Ichhapur, Palta, Barrackpur and Barasat connect the large wet area. Many villages like Ratanpur, Taraberia, Beharia, Boseganchia, Baraganchia, Kushdanga, Tapanpur and Tentulia are bordering the east while Dogachi Panpur, Mukundapur, Uchhegarh, Mahakaltala, Basudevpur, Kadamtala, UttarHansia, Dashgaria, Kaliaghata and Mathurapur, are bordering the West of the Wetland. The most important thing of this wetland is the network of several canals namely Ichhapur Khal, Pancha khal, Trimohini, khal, Koirapur khal, Basudevpur khal, Hanjana khal and Pakhimara Khal *etc.* are connecting Noai Khal (or Noai River) which was previously connecting the Vidyadhari River and also included with the riverine net work of GANGA which is now almost disconnected.

Climate : Monsoon prevails for about four months from mid of June to mid of October with high humidity. Annual range of humidity is between 85–95%. July-August are the heavy rainfall months with precipitations as high as 400 mm. Occasional rains are also encountered through out the year. Pre-monsoon is dry and warm with thunder storms. Post-monsoon is apparently cold with negligible rainfall. Maximum temperature reaches up to 45 degree Celcius in May while the mean maximum temperature is 30 degree Celcius. observed in June. On the other hand the minimum temperature drops up to 8 degree Celcius in January and the mean minimum temperature is 20 degree Celcius.

Agriculture : Several paddy-fields have grown in this wetland that are accessible only in the dry season up to early monsoon till the heavy rain stops and the stagnant water have dried up considerably. Rice of different varieties, Jute, Sugarcane and vegetable of almost all varieties possible to cultivate in this type of environment (on the comparatively uplands besides the fishery ponds) are grown in this wetland.

Aquaculture : Hundreds of reservoirs have been developed within the wetland area for the purpose of irrigation and aquaculture. Besides canal fisheries fishermen also developed the art of captive aquaculture with those man maid and natural reservoirs.

Instruments : Collections were made by an inverted umbrella, forceps with soft-tension, small brush and with a standard hand sweeping net (129 cm in diameter). Sunca electronic emergency lamp. Taxonomic studies have been made by a Olympus dissecting type binocular microscope with ocular micrometer while behavioral observations were performed by a Samsung's field binocular (B-10x25N), an electronic stop watch. Black velvet paper and tabulated data sheets were used.

Collections : Spiders were collected from the study areas directly from the webs by hand picking method, by the sweeping net and by dusting the nearby bushes in to an inverted umbrella. Web threads were collected in black velvet paper piece.

Preservation : Collected spider specimens were anaesthetized, killed in a killing jar and finally preserved in Oudman's preservative (90 parts 70% ethanol, 5 parts glycerol and 5 parts glacial acetic acid) in glass vials.

Identification : Well preserved spider specimens were sorted transferred in ethyle alcohol and studied under binocular microscope in a Petri dish. The specimens were identified up to species level.

OBSERVATIONS

Behavioral studies on araneid species were studied by random, repeated and extensive observations in different phases particularly in twilight dark as follows :

1. In Random observations, the specific behavior of the spiders were studied while came across any spider web under building process.
2. In Repeated observations, the same type of observations were noted from same and different study spots for same spider species.
3. To study the complete action of web-building, hours of continuous and extensive observation have been conducted when ever we got a chance from the beginning of the art.

In our initial observation during May, 2001 we first saw some *Argeope* spiders were busy in web-building process on the weed plants near the plaguing paddy fields. Later on September 2001 onwards we saw the same spider species was preparing its web on the paddy plants along with the folded leaf blades throughout the cultivated period. The observations were repeated continuously till the winter 2004. Every time the count of webs were increased simultaneously on the progress of flowering and reproduction of the paddy plants of the field. It is observed that they generally select their site both in dry and wet areas to build their web within the branches of low bushes or

on the small trees and in between shallow pump house and small vegetations to trap insects as their food. The highest number of orb-web of same type is observed during the early growth of paddy seeds when a particular odor, an aroma is thriving through out the field. The second highest count is observed during the flowering period. In maximum cases we saw the webs in fresh condition while watching in the morning. Even when we intentionally ruptured the snare in previous evening we saw the web is being repaired within the next very morning. The long paddy leaf blades, branches of low bushes and the walls of the pump houses in the field they took as their net support for anchoring the web vertically aligned to the ground. As we know that spider web has a particular shape and displays an engineering art of architecture in nature. It's technical morphology is totally build on the purpose of entangling insect preys for their nourishment. The web we observed made by *Argiope shillongensis* Sinha is an unique type having a circular disk-net entangled into an irregular pentagonal frame made by thick spider-silk-threads. The pentagonal frame is further entangled with the net support to hang the orb-web. The webs measured between 80.50 cm to 90.00 cm in radius for adults while 20 cm to 45 cm in case of young spiders which cover the larger population of our study materials.

The orb-web of *A. shillongensis* is commonly provided with stabilimentum, a zigzag ribbon like structure cross-mark across the hub. It consists of minute threads gather together to form a sticky band spun from the aciniform gland and aligned at the center of the web just after completion of the clockwise movement to build the web. In case of young spiders, the radial length of stabilimentum varies from 12 cm to 25 cm while in adult it is 30cm to 40cm. In two occasions near Uttar Hansia we noted the absence of such structure where in both cases the spiders were female and their measurements were 87.40 cm and 90.00 cm.

The mesh of the *A. shillongensis* is very irregular though in the outer side of the web the larger meshes are almost rectangular in shape and maximum of the meshes are quadrangles of different measuring ratios.

Unlike females, Male *A. shillongensis* perhaps does not prepare web or any nest near by their web but they watch for their prey and retreat when frightened. We saw the spider moving around the web leaving a comparatively thicker thread like dragline to be intimated by the entangled prey on it's web. It is also observed that in maximum cases the young *A. shillongensis* watching its prey by setting itself behind a small bush or leaf near by. Females after preparing their orb-web take rest and wait in the centre of the web camouflaging with it's stabilimentum. The threads we collected on velvet paper measure under microscope with ocular micrometer. The thickness found in the range between 0.009 mm to 0.015 mm and very occasionally up to 0.025 mm.

Generally we saw *A. shillongensis* to build its orb-web during our returning time from the field at evening and very occasionally in day time. To emphasize the studies on nest building habit of the spider we kept our evening observations in 5 nearby spots of little different habitats of

Basudevpur like (1) in the paddy field, (2) in between paddy field and nearby bushes, (3) in between two paddy fields, (4) in between two paddy fields separated by a small stream and (5) between the wall of pump house and leaf blades of paddy plants where we visited in short intervals of times. It is observed that adult spider took about 40–55 minutes to finish the web while the young one take only 30–40 minutes. In the other hand they could repair their webs very quickly. One major damaged web took only 10 minutes to repaire, which looks like a new one by an adult. Young one never observed in repairing job.

Orb weaving mechanism of *Argiope shillongensis*

Female spiders of this group spinned the weaves. The threads are first formed from the spinnerets and holds the threads by the claw of one of her hind legs and attaches it at the first anchoring point A at any net support item. From the initial point she drops herself with the threads until she reaches another point B of other net support then she moves further to two other points C, D, & E and finally she reaches to the point A thus a pentagonal outer frame work of the weave is formed. It took about 4–5 minutes. In the next step we observed her to move through the horizontal strand up to half of it's length and drops down to a point on the pentagonal frame to build a connecting thread line. She then again scroll up through the thread line up to it's middle, the ultimate centre of the web. From the centre the spider starts to construct the radial threads, thus the centre or hub of the web formed within another 10–15 minutes. From the centre she builds the circular less-viscid threads in anticlockwise direction up to the periphery. Later on she reverses its direction, rolls up the old threads and puts down the new thread which is finer and more closely intercepted sticky-silks. The clockwise spreaded threads ware comparatively more elastic and stickier. In both the movements took same time *i.e.*, about 20–35 minutes but not with uniform speeds. The speed in case of the clockwise movement is almost double to cover almost double the length of anticlockwise circled threads.

DISCUSSION WITH BIOLOGICAL SIGNIFICANCE

From our studies it is revealed that both young and adult *Argiope* build their orb-web within a day ranging an average time span from 30 to 55 minutes and at a stress or with considerable intervals in and around the paddy field. As we observed that population of the spider as well as their webs are higher in number during flowering and early seed bearing seasons like the pathogenic insects. Hence it is suggested that *Argiope* might have gathered in anticipation with the availability of sufficient prey for it's nourishment.

Whole the environmental condition along with the addicting aroma of mature paddy flower throughout the field together might have a key role on their gathering and web-building in a particular season. The number of smaller size web in larger count and larger size webs in lesser count may suggest the balance trophic level and size compatibility among the preys and predator.

In the measurement of threads unlike common threads we got some thicker threads measuring about 0.025 mm which might have been fused double, triple or tetrad thinner threads. In maximum occasions we observed the spider building its web in evening onwards. It might be due to their busy activities in daytime with capturing insect preys that are also diurnally active. We never saw a single young spider repairing its web might be due to their smaller webs which can easily be prepared instead of repairing it. The web building mechanism of *A. shillongensis* shows so sophistications and precisions that easily trap to capture prey for nourishment of spider thus demand immense biological significance towards the study of paddy pest population. The web-building habit by *A. shillongensis* near and in the paddy field traps different insects belonging to the orders Orthoptera, Lepidoptera, Coleoptera, Hemiptera Diptera, Hymenoptera etc. Lot of species from those insect families are hazardous to paddy plants and controlled naturally by the web building and feeding habits of the spider also have tremendous ecological impact and biologically significant. Thus the potential impact of *A. shillongensis* in insect pest management possesses great significance.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. J.R.B. Alfred Director and Dr. R.A. Khan, Additional Director, Zoological Survey of India for kind permission to carry out the work.

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PLATE I



Argiope shillongensis is reaching to a twig-end and approaching for crolling down as to build the first web-line

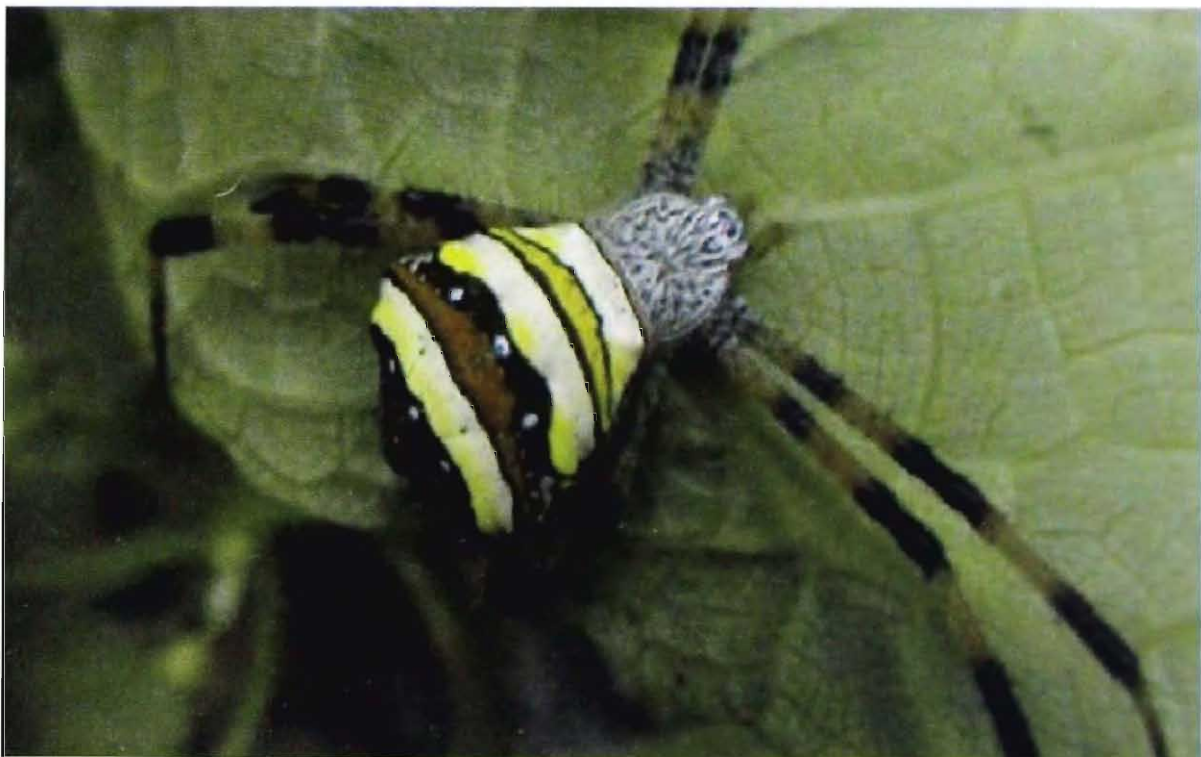


A. shillongensis is hanging down with an entangled web line from the end of the twig (starting point).

PLATE II

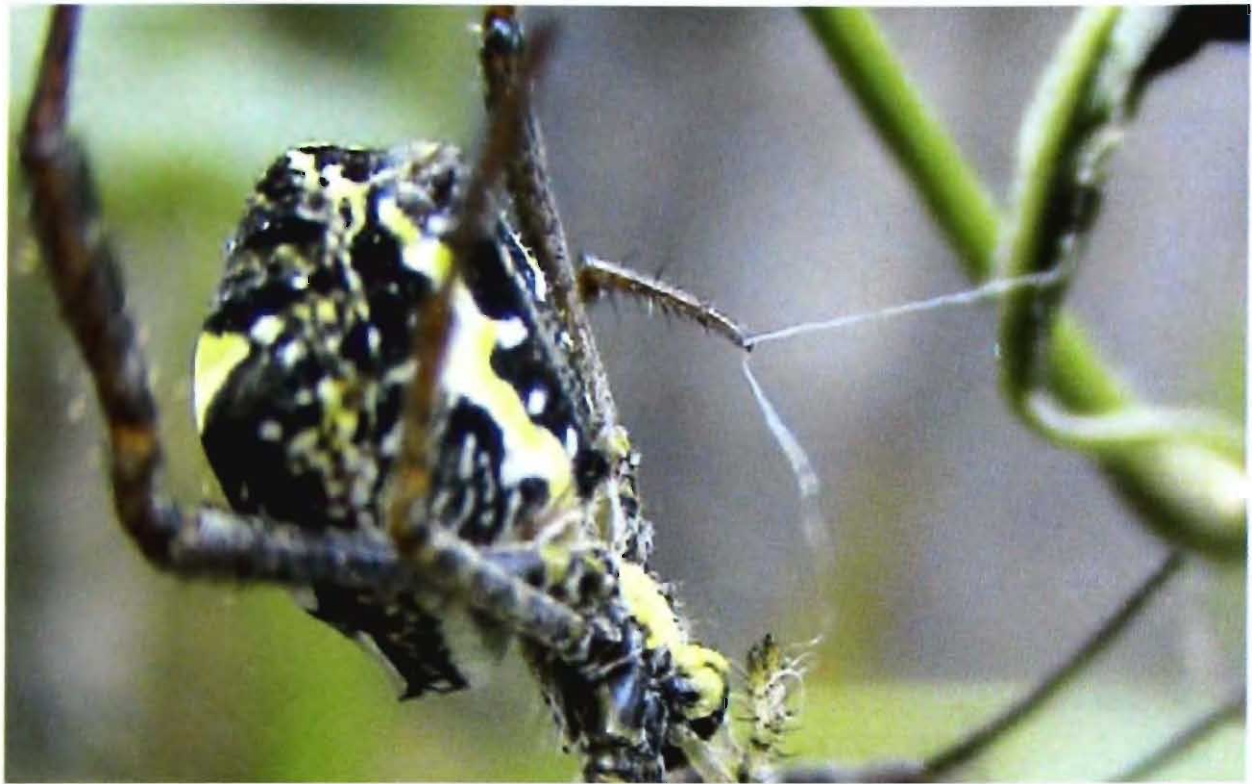


Ventral view of an *A. shillongensis* spider while initially approaching towards fixing it's web line.

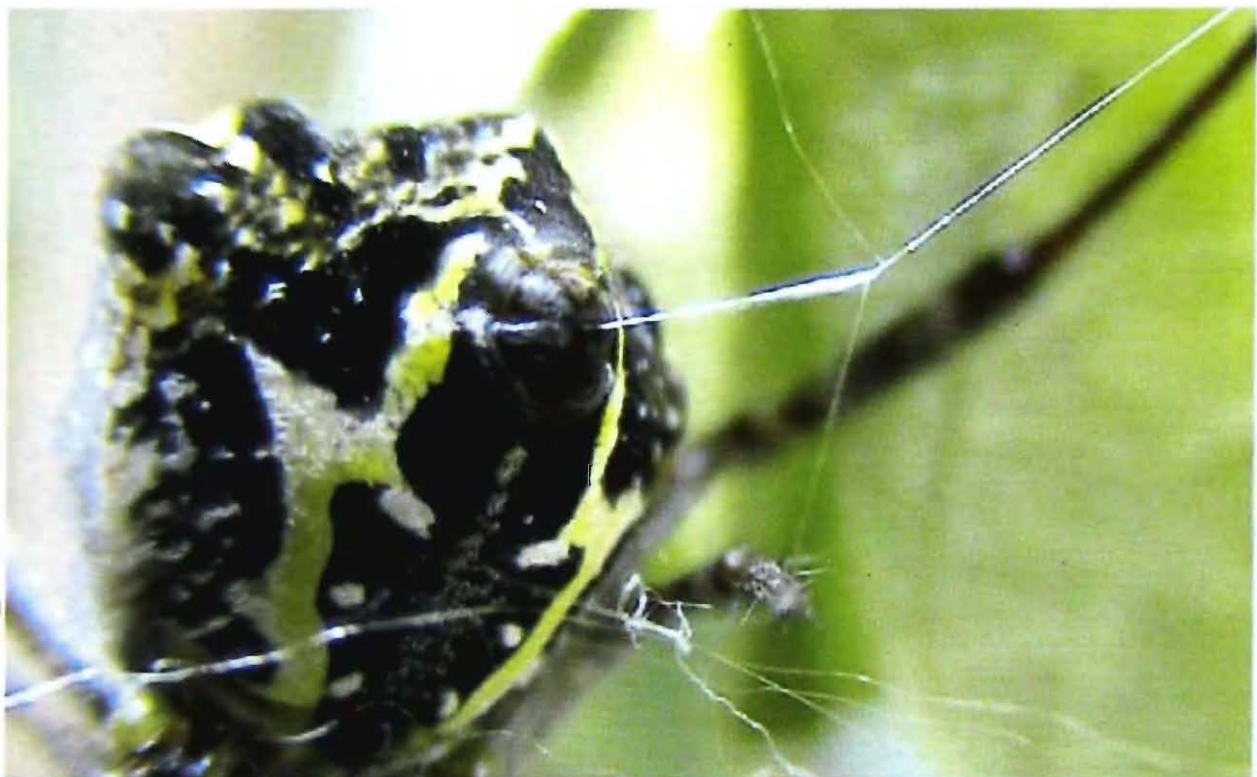


Dorsal view of an *A. shillongensis* while scrolling up through a big leaf blade to anchor the web line.

PLATE III



A. shillongensis is fixing the web-line with branch of a tree.

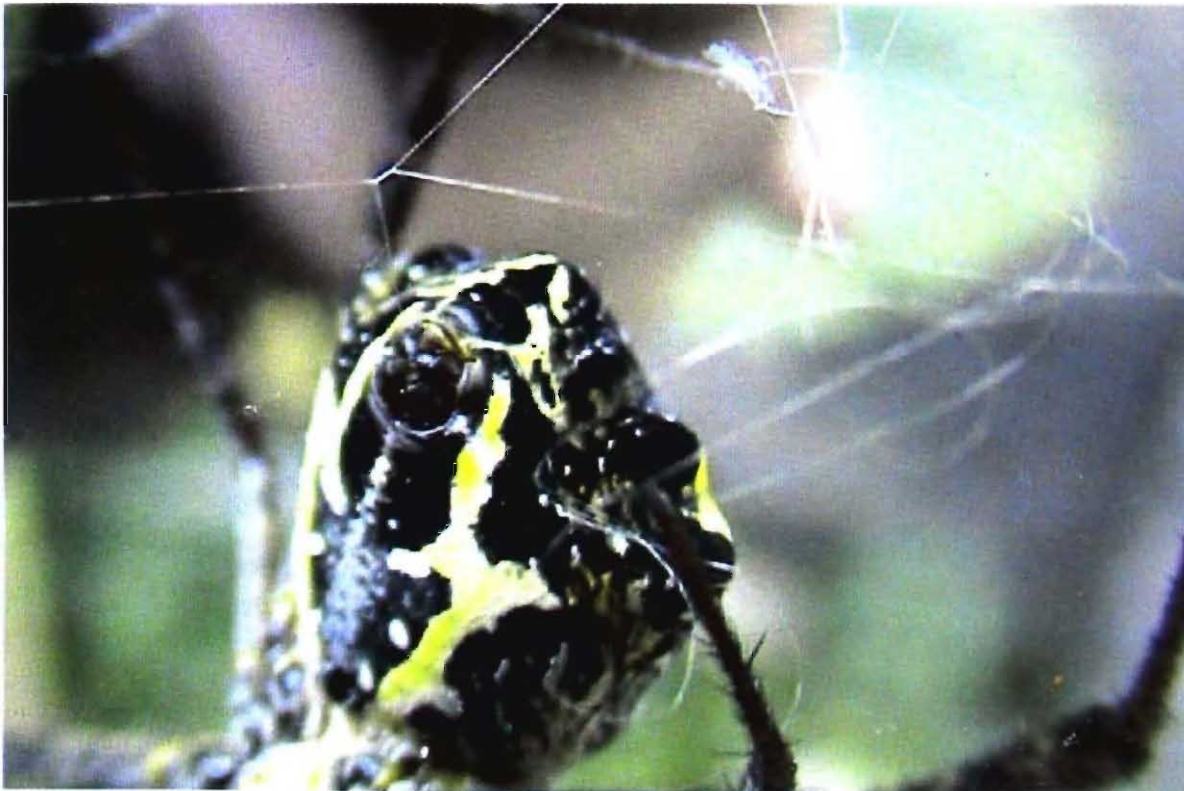


A. shillongensis is removing the silk thread from its spinnerets.

PLATE IV



An up side down view of *A. shillongensis* while trailing behind the thread for establishing the frame for it's orb web.



A. shillongensis is fixing the newly drawn silk thread with the previous one for building the orb web.

PLATE V



Tightening the web lines during the web building action by an *A. shillongensis* in Bortibeel.



Details of drawing and management of silk thread from spinneret organs by an *A. Shillongensis* with the help of its hind legs.

PLATE VI



A. shillongensis spider is estimating the positions of X-marked stabilimentum after weaving the orb web.

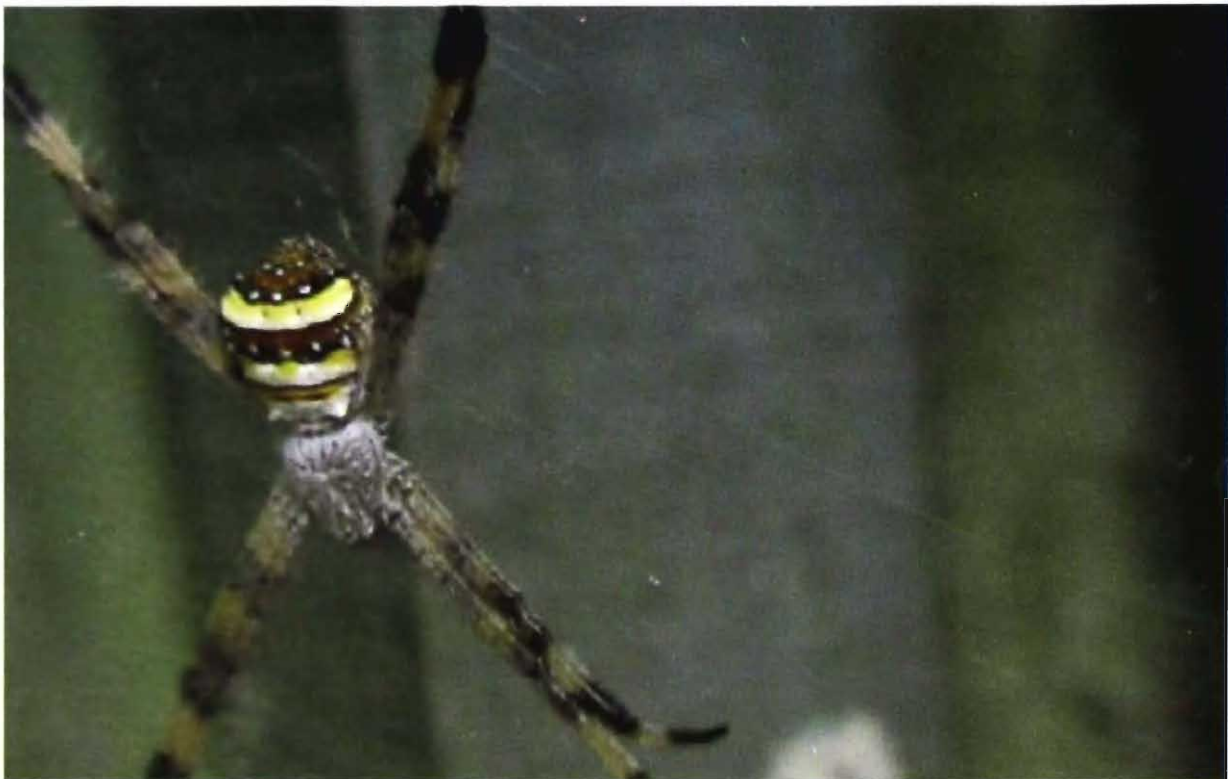


Ventral view of *A. shillongensis* while spreading the stabilimentum on the web.

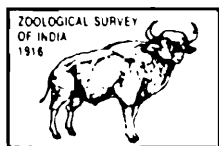
PLATE VII



A complete orb web of *A. shillongensis* in the border weeds of an agricultural field of Bortibeel.



A. shillongensis after completing the web building action waiting beside it near a shallow pump house.



Rec. zool. Surv. India : 107(Part-3) : 39-44, 2007

INTERESTING OBSERVATION ON FOOD AND FEEDING BEHAVIOR OF A SPIDER *NEOSCONA MUKERJEI* TIKADER FROM BORTIBEEL NORTH 24 PARGANAS, WEST BENGAL

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INTRODUCTION

All spiders are carnivorous in habit. Their preys consist chiefly of insects. *Neoscona muckerjei* is a true web-building spider of paddy field. Its web act as natural insect trap which catch many more preys than the spider can eat. Prey caught differ in size, from large grass hopper, beetle, moths butterflies to small insects such as leaf hopper, gall wasps, fruit flies and small moths.

During last 4 years while carrying out the ecological investigation on wetland environment of Bortibeel, a 13 km stretched isolated gangetic marsh land covering about 300000 bighas of cultivated land and several agricultural and fishing villages situated between 88.29–88.38 degree East and 22.8–23.0 degree North of West Bengal, the authors came across the experimental spider species *Neoscona muckerjei* Tikader, belonging to the family Araneidae predating it's prey near the paddy field of the wetland. In this field we conducted an extensive behavioural observation in light of potential biological control of various insect pests by *Neoscona*.

The present paper deals with the details of the sites where the spider builds it's web for trapping insects as their prey as well as the way of natural control of the paddy pest population, area of paddy infestation (through illustration) in the wet land. It is also included the food and feeding habits of *N. muckerjei*, the places it stays near the web while retreat, the morphological structure and measurements of the spider and its prey, the time span it needs to capture the prey, and digestive mechanism along with the biological significance. It is well established that all spiders are carnivorous and their preys consist chiefly of insects with very few exceptions. But studies on the feeding behavior of web-building spiders are lacking from Bortibeel wet land area of North 24 parganas, West Bengal. However, Tikader (1961) made an observation on prey capturing and food

of spiders. Kumar *et al.*, (1977) published a note on trapping insects by spider web, Ram *et al.*, (1978) and Majumder (2001) observed some odonate predation by spider. Kulkarni *et al.*, (1999) reported some predatory behavior of *Nephila maculata* (Fabr.) and Chatterjee *et al.*, (1979) made an observation on some predator spiders from India. While Chowdhury *et al.*, (1981) studied on the rice field spiders from Chittagong, Bangladesh. In the present context the authors while conducting the ecological studies on Bortibeel wetland have come across one araneid spider *Neoscona muckerjei* Tikader predating on several insect pests of paddy field as their prey by trapping them in to their orb-web.

The present paper also deals with the prey capturing behavior of *N. muckerjei* in Bortibeel, composition of captured insects observed from September 2001 to January 2005 in their orb-web, population pattern and diversity of entangled insect paddy pests along with area of paddy infestation (through illustration).

MATERIAL AND METHOD

Study Area : Bortibeel, a 13 km stretch of isolated-gangetic-marsh-land crept up on several agricultural and fishing villages covering about 3,00,000 bighas of cultivated land situated between 22.8–23.0 degree Latitude and 88.29–88.38 degree Longitude in 5 assembly segment of Jagaddal, Khardah, Amdanga, Naihati and Barasat. The study area is situated between the 73/A bus root and Nilganj road in North-South and between NH34 and Kalyani high way in East-West. The most important thing of this wetland is the network of several canals namely Ichhapur Khal, Pancha khal, Trimohini khal, Koirapur khal, Basudevpur khal, Hanjana khal and Pakhimara Khal *etc.* The spots from which places we performed our present observations are Dogachi, Panpur, Mukundapur, Uchhegarh, Mahakaltala, Basudevpur, Kadamtala, Uttar Hansia, Dashgaria, Kaliaghata and Mathurapur in the western margin and Ratanpur, Taraberia, Beharia, Boseganchia, Baraganchia, Kushdanga, Tapanpur and Tentulia are in the eastern margin of the wet land. The eastern part of the wet land is lacking canal system while western part is comparatively well irrigated.

Climate : Monsoon prevails for about four months from mid of June to mid of October with high humidity. Annual range of humidity is between 85–95%. July-August are the heavy rainfall months with precipitations as high as 400 mm. Occasional rains are also encountered through out the year. Pre-monsoon is dry and warm with thunder storms. Post-monsoon is apparently cold with negligible rainfall. Maximum temperature reaches up to 45 degree celcius in May while the mean maximum temperature is 30 degree celcius observed in June. In the other hand the minimum temperature drops up to 8 degree celcius in January and the mean minimum temperature is 20 degree celcius.

Collections : Spiders were collected from the study areas directly from the webs by hand picking method, by the sweeping net and by dusting the nearby bushes into an inverted umbrella.

Preservation : Collected spider specimens were anaesthetized, killed in a killing jar and finally preserved in Oudman's preservative (90 parts 70% ethanol, 5 parts glycerol and 5 parts glacial acetic acid) in glass vials.

Identification : Well-preserved spider specimens were transferred in ethyle alcohol and studied under binocular microscope in a petri dish. The specimens were identified upto species level following Tikader (1982).

OBSERVATION

In a post monsoon evening on 29th September, 2001 while returning from the field (Basudevpur), we came across a medium size paddy grass hopper (*Oxya velox*, Fabr.) entangled in a vertically aligned hexagonal spider web of *Neoscona muckerjei* Tikader and the spider measuring about 13 mm rushed at the hopper. The spider is then pierced the hopper with the fangs of its chelicerae and retreated back with fear due to vigorous jerking of the web by the entrapped hopper. Due to lack of light that day we collected both the prey and predator without observing them further in their habitat. In the next very day while consulting literature for taxonomic studies it is revealed that *O. velox* is a destructive pest generally active on leaves and ears of paddy plant. Later on extensive observations were conducted in 19 separate spots (8 in east and 11 in west) to incorporate the prey-predator relationship between food habit of *N. muckerjei* and insects infesting paddy crop. An illustration is incorporated with this context tabulating the information available from the observations throughout the whole study period (Post Monsoon 2001-02 to Post Monsoon 2004-05) on 10 insect preys belong to 6 families were predated by *Neoscona muckerjei*, their systematic position, the part of plant they destroy and their abundance in eastern and western part of the wet land.

From our observation it is revealed that *N. muckerjei* build its snare to trap the prey and wait for them near by out side the web. Drag-line threads of the orb webs are the connecting link. As soon as the prey insect entangled in the web the spider retreats at once without fear at first approach as their instinct behaviour. In this action it pierces the prey with the fang. In maximum cases the spider then took a position of little away from the victim for a short while and watches. In very few occasions we have seen that it retreats, pierces repeatedly when after receiving the first poisonous bite also the prey was very active.

Some times the victim took 30–40 minutes to be totally inactive. In no case we saw a prey fights a little. Condition appears very pathetic to the victim that they entrapped more and more so long they try to escape themselves from the web. Then the spider approaches the prey and pulling out a bunch of thread from it's spinnerets by one of its hind leg first then the other and thrusts the flat bunch against the insect. Spider is then rolls the insect over and over and completely wrapped.

Table 1. : Showing the list of insect pests, the area of plant they destruct and their abundance in the wetland.

ELLUSTRATION-1					
Sl. No.	Scientific Name Common Name	Systematic position	No. of insect observed in east-margin of the wet land	No. of insect observed in west-margin of the wet land	Area of Destruction
1.	<i>Oxya velox</i> Paddy grass hopper	Order : ORTHOPTERA Family : ACEIDIDAE	++	+++	Leaves and ear
2.	<i>Hierolyphus banion</i> Rice Grass hopper	Order : ORTHOPTERA Family ACRIDIDAE	+	++	Leaves and ear
3.	<i>Leptocorisa acuta</i> Rice bug	Order HEMIPTERA Family ATYDIDAE	++	+++	Milky grain and leaf sheath
4.	<i>Nilaparvata lugens</i> Brownplant hopper	Order HEMIPTERA Family : DELPHACIDAE	++	++	Chaffy ears
5.	<i>Nephotettix virescens</i> Greenleaf hopper	Order : HEMIPTERA Family CICADELLIDAE	+	+++	Suck sap from the leaf
6.	<i>Orseolia oryzae</i> Paddy gall fly	Order : DIPTERA Family CECIDOMYIIDAE	0	+	Seedling which fails to bear ears
7.	<i>Atherigona oryzae</i> Paddy stem fly	Order : DIPTERA Family : ANTHOMYIIDAE	++	+++	Seedling
8.	<i>Scirpophaga incertulus</i> Whiteleaf hopper	Order LEPIDOPTERA Family : PYRALIDAE	+	+++	Sucking the green tissues
9.	<i>Anomala dimidiata</i> Shining beetle	Order : COLEOPTERA Family RUTELIDAE	++	+++	Cut ear
10.	<i>Dicladispa armigera</i> Rice hispa	Order COLEOPTERA Family HISPIDAE	++	+++	Green matter of leaves

Maximum = +++; Optimum = ++; Minimum = +; Nil = 0.

After successful wrapping it sucks the fluid from victims body. Perhaps their venomous injecting fluid also contains some digestive enzymes to degrade the polymers of their body. A total action of feeding behavior of *N. mukerjei* requires 20–60 minutes in which juice sucking took only 10–15 minutes. We observed the body of dead prey remains totally intact.

In a pre-monsoon day on June, 2003 we observed some *Neoscona* sucking water from the narrow stream of the paddy field. In another occasion we saw few spider of same group sucking water from the droplets gathers due to shallow pump irrigation on April, 2004.

DISCUSSION AND SIGNIFICANCE

It is revealed from this study that prey of *Neoscona* are chiefly insects both in flying and jumping habit (Table-1). Some times we also saw them feeding other spider species. In one occasion on December 2003 we saw a *Neoscona* adult female measuring about 12.5 mm feeding one male *Neoscona* of 10.2 mm long Showing the habit of cannibalism. More over, *Neoscona* web is a natural insect trap which catch many more prey than spider can eat. It is observed that while retreating young spiders bite repeatedly but relatively large spiders (11–13 mm) bite once to inactivate the prey may be due to high amount of venom injected by the larger spiders. In the present study 10 insect species were found in the paddy fields of Bortibeel which are pest to the crop and naturally controlled by *Neoscona mukerjei* and highly significant as they are potentially biocontrolling natural agent in paddy fields of Bortibeel Wetland.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. J.R.B. Alfred Director and Dr. R.A. Khan, Additional Director, Zoological Survey of India for kind permission to carry out the work.

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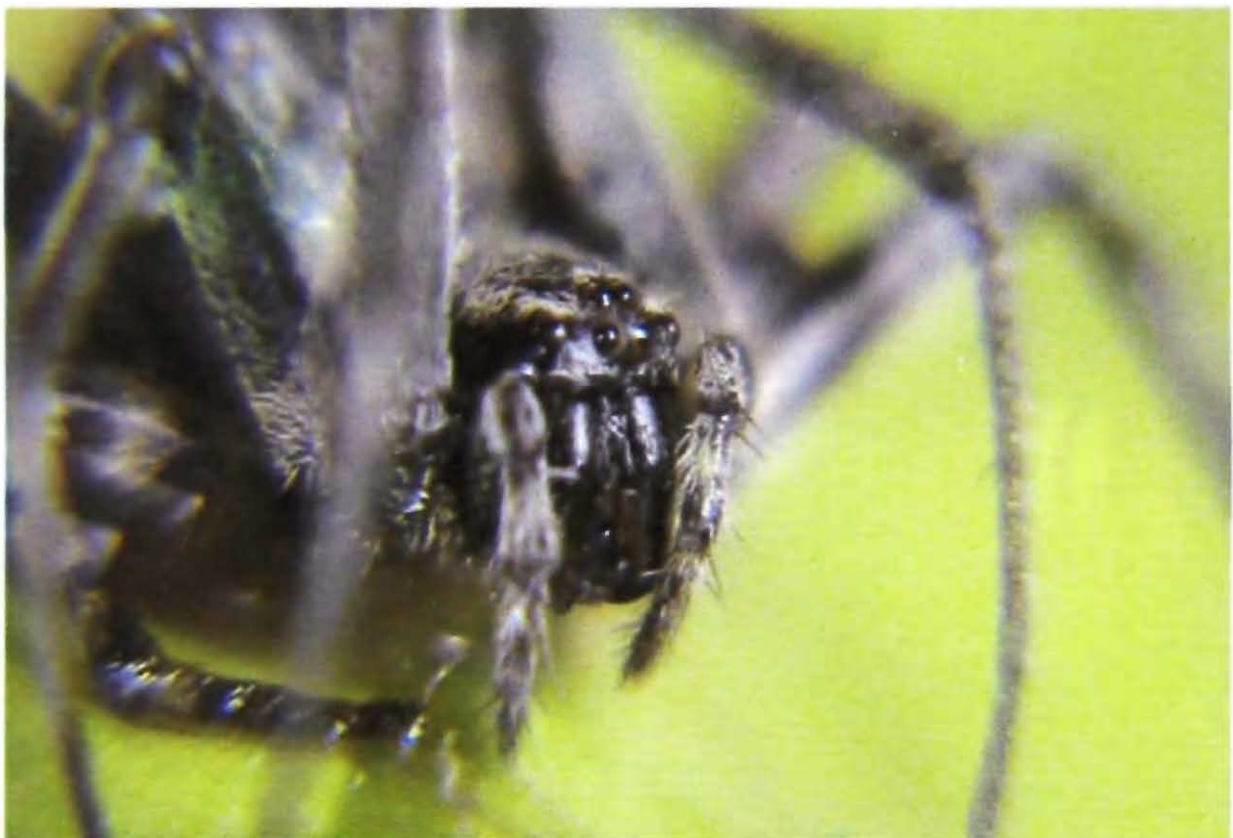
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PLATE I



Neoscona mukerjei is building its web for trapping prey.



N. mukerjei is watching its web from retreat.

PLATE II



N. mukerjei capturing prey in the hub of it's web.



N. mukerjei immobilizing its prey by injecting vemom.

PLATE III

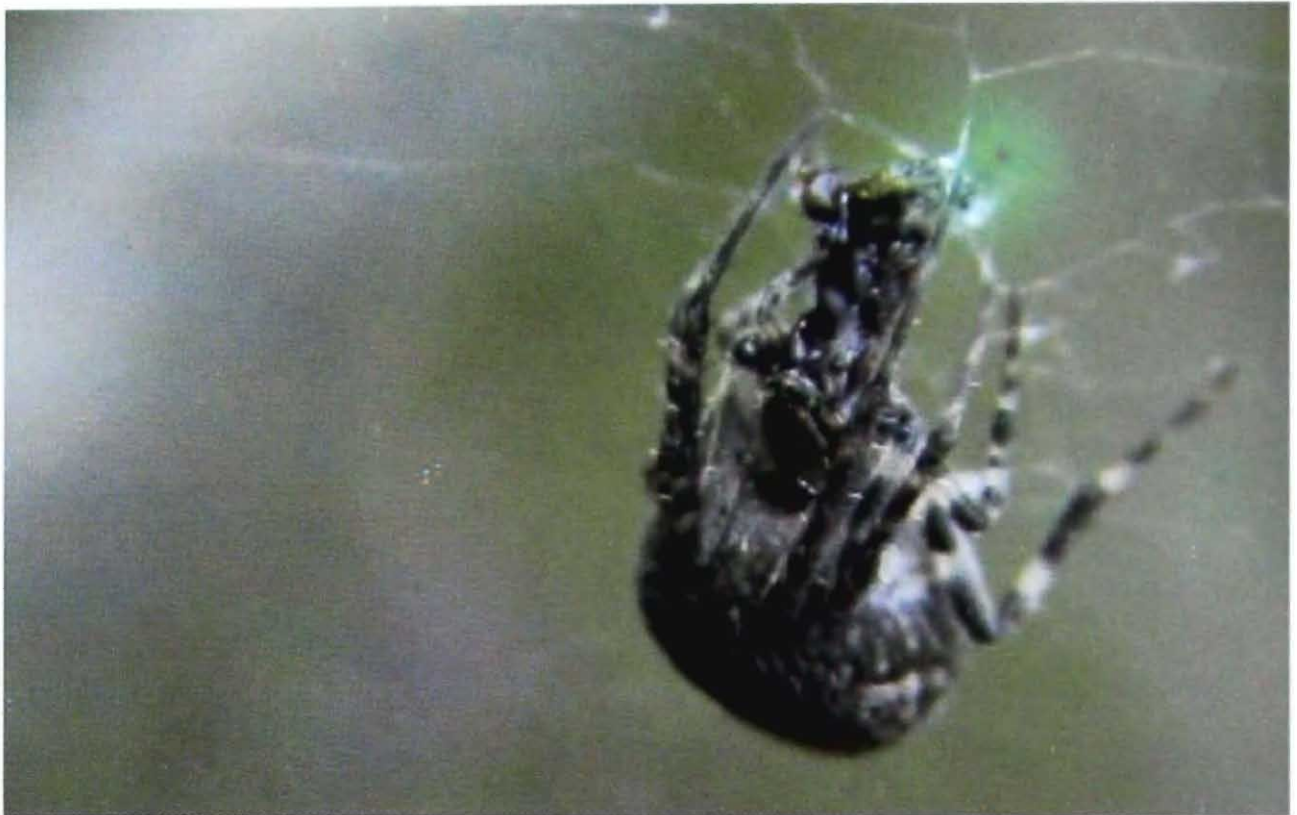


N. mukerjei sweth its captured prey with silk sheets keeping its body far from the victim.

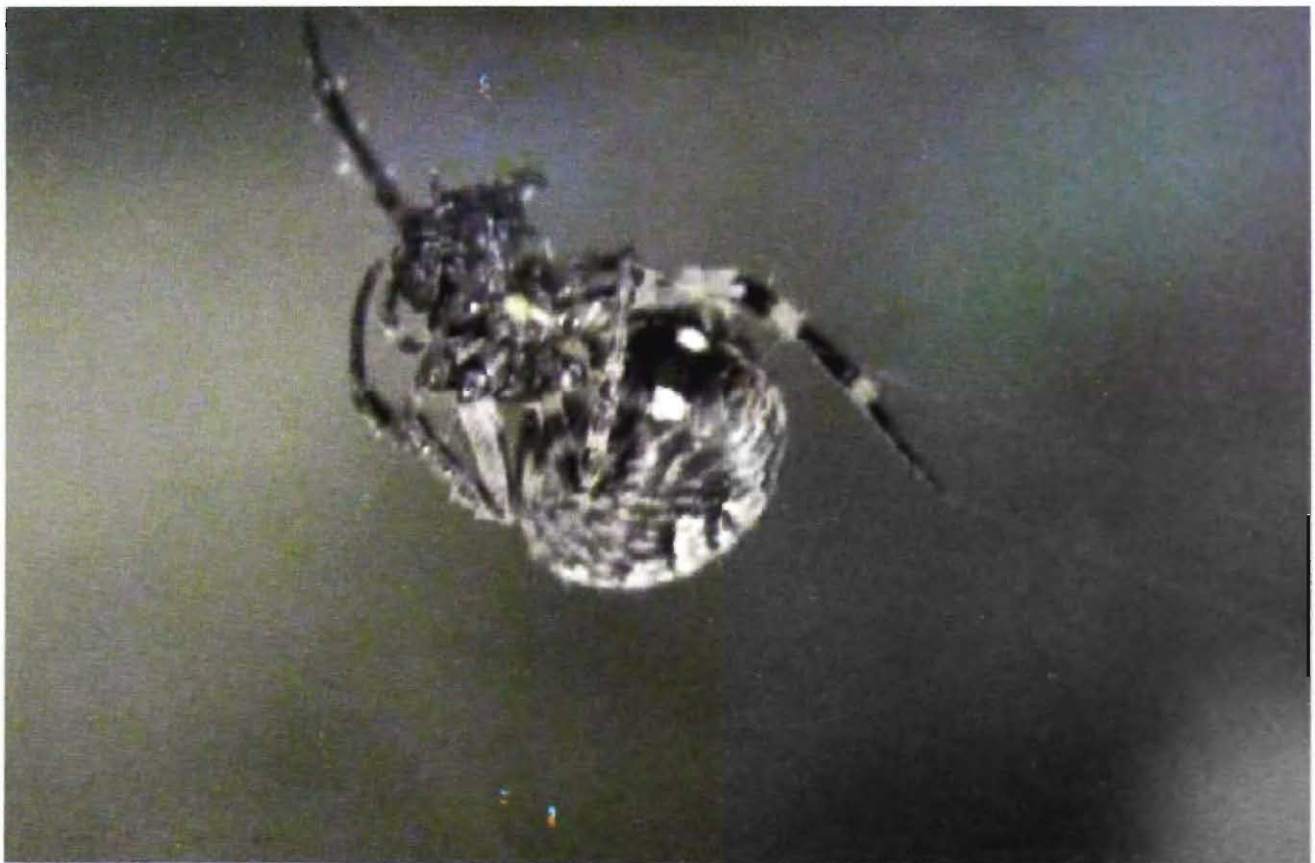


N. mukerjei is sucking juices from immobilized prey.

PLATE IV



N. mukerjei in advanced stage of sucking juices from it's prey.



N. mukerjei is finally sucking the nutritious juices.

PLATE V



N. mukerjei is discarding a small mass of undigestible material after final sucking.



N. mukerjei is approaching for repairing its torn web after feeding.

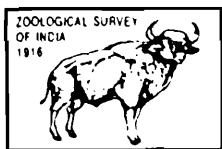
PLATE VI



N. mukerjei is repairing its web to entangle another prey.



N. mukerjei is finally entering into it's nest or resting.



Rec. zool. Surv. India : 107(Part-3) : 45-49, 2007

GYNACANTHA PALLAMPURICA SP. NOV. FROM NORTHERN HIMACHAL PRADESH, INDIA (ODONATA : AESHNIDAE)

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INTRODUCTION

Fraser (1936) provided a comprehensive account of *Gynacantha* species known from the then 'British India'. Navas (1930), Lieftinck (1960), Mitra and Lahiri (1975) and Asahina (1984) added a few more species to the genus. Hämäläinen et al. (1999), Lahiri (1987), Lahiri and Mitra (1993), Mitra (1995, 2006), Prasad (2002) and Prasad and Vershney (1995) among others also worked on the genus from different parts of India and as a result of contribution of all the above workers the genus *Gynacantha* Rambur turns out to be the most populated aeshnid genus of Indian dragonflies known from the main land and the Andaman and Nicobar islands. One more species, e.g., *G. pallampurica* sp. nov. has been added to Indian fauna in this communication together with collection data, illustration of relevant body parts and comparative notes in the text.

SYSTEMATIC ACCOUNT

Gynacantha pallampurica Lahiri and Walia sp. nov.

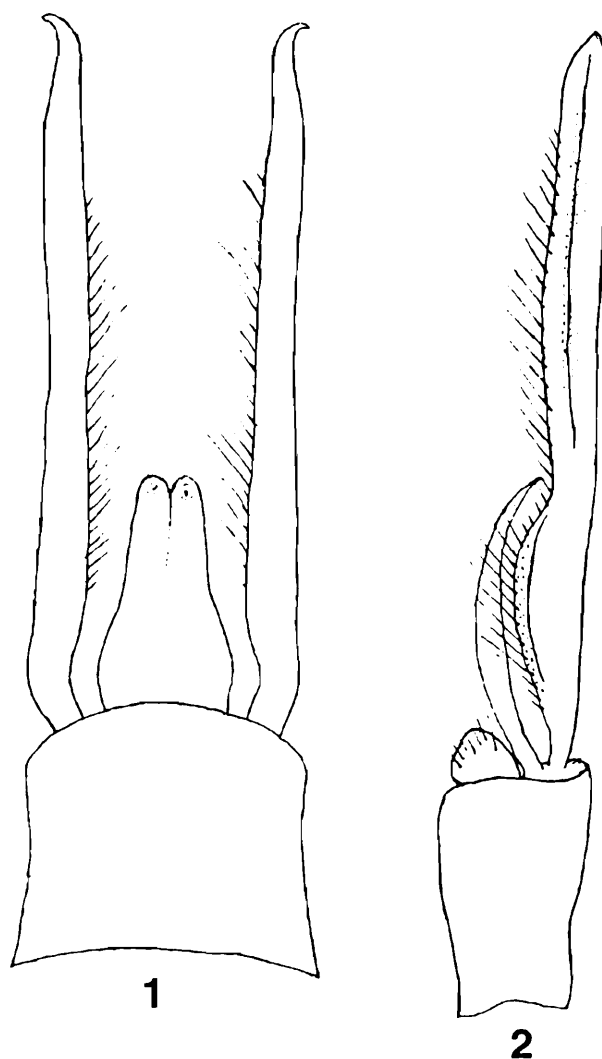
(Figs. 1-6)

Description : Male : Face and ventral side of body greenish yellow, dorsum of thorax and abdomen light blackish brown. Crest of frons marked by a black T shaped mark with subacute tips of its frontal arms extending half way to lateral edges of the frons; base of the black T narrowing at sulcus but then again expanding around ocelli. Front of thorax marked by a longitudinal triangular narrow greenish yellow streak on either side along the front part of humeral suture. Legs pale brown, flexor surface of femora blackish in apical half. Wings hyaline; primary antinodals the 1st

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and the 5th in forewing, the 1st and the 6th in the hindwing; Antenodals : forewing : 17-21, hindwing : 13-15; Postnodals : forewing : 15-18, hindwing : 16-18; anal triangle 3 celled; discoidal cell 5 celled; 8 cubitals in forewing, 7 in hindwing. Abdomen greenish yellow on lower parts of sides and beneath, black on dorsum with bluish markings as follows : segments 2 to 8 with narrow oblique transverse spots at jugal sutures and segments 3 to 8 with subapical triangular spots on either side, the subapical spots progressively growing larger in segments situated more apically; ventral greenish yellow expanded on 2nd segment to cover the oreillets and on segments 9 and 10 to reduce dorsal black on latter segments to mid-dorsal narrow stripes; apical margin of oreillets armed with a row of 6 to 8 minute teeth. 3rd segment markedly constricted – the point of constriction being about half the width of the segment at base : 2nd segment with an additional pair of greenish yellow spots on mid-dorsum; dorsum of segments 8 and 9 black from base to apex but the black constricted medially by expansion of ventral yellow; superior anal appendages black, about two and a half times as long as the segment 10 of abdomen, rather narrow organs extending straight backwards, slightly curved outwards on its long axis as seen from dorsum with bluntly pointed



Figs. 1-2. : *Gynacantha pallampurica* sp. nov., male;
1 & 2. anal appendages, 1. dorsal view, 2. lateral view.

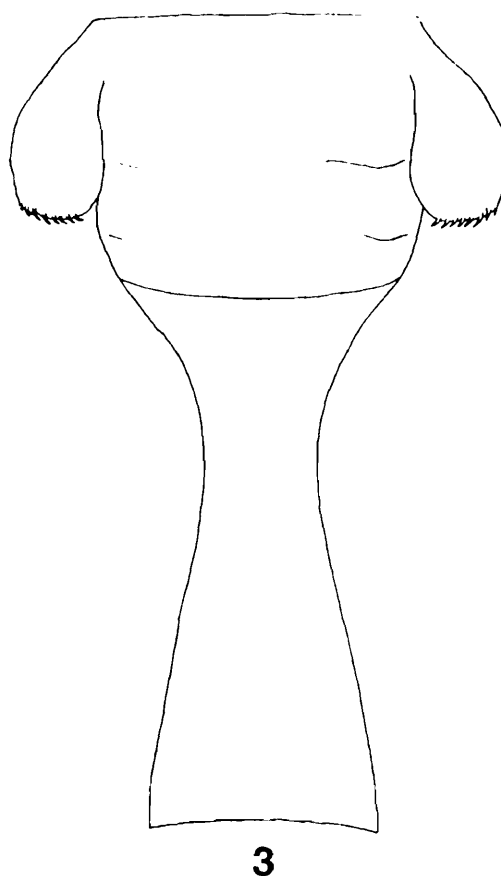


Fig. 3. : *Gynacantha pallampurica* sp. nov., male;
3. basal abdominal segments including oreillet, in dorsal view.

apex turned a little outwards; in lateral view the superiors again appear narrow organs with the pointed tip as well as the organs itself directed straight backwards, the apical half somewhat tubular and rather smooth, marked by a lateral ridge, the basal third marked by a bulging visible only in lateral view and somewhat rough in appearance; the inferior anal appendage is about one third the length of the superiors, yellow and broadly triangular as seen from dorsum, the apex deeply incised, each part ending in a fine black acute spine pointed upwards; in lateral view curved a little downwards medially to suitably extend beneath the ventral bulging of the superiors; fine, moderately long hairs extend inwards and ventrally from both the superiors and the inferior anal appendages.

Variations : Paratype males exhibit some variations in respect of markings from the Holotype. The black mark on frons may be very faint and obscure; apices of wings enfumed with brown; black on dorsum of second abdominal segment invading half way on to sides to include dorsal half of the oreillets; teeth along apical margin of the oreillet including minute ones may be upto ten; second abdominal segment without a pair of greenish yellow spots on mid-dorsum; subapical bluish spots on abdominal segments less prominent; subcostal and median space upto 1st antenodal cross vein brown and apices of wings narrowly enfumed; inferior anal appendage black along its margin.

Female : Similar to male but for sexual characters differing as follows : Frons marked as in Paratype male; wings palely enfumed between node and the pterostigma; Legs unmarked with black; segments three to five with mid-dorsal yellow stripe in basal half narrowing to apex; segment two pale greenish yellow at base upto jugal suture; the blue markings on abdomen evident only on segments 5th and 6th—obscure on other segments; segment one dirty black.

Measurements (in mm) : ♂ : length of abdomen : 41.00–45.00; length of anal appendage : 6.00; length of hindwing : 37.00–39.00; ♀ : length of abdomen : 46.00; length of hindwing : 41.00.

Material studied : Holotype ♂, Andretta (Pallampur, Himachal Pradesh), 29.ix.2004, coll. G. Walia “in the vicinity of a montane stream surrounded by a thick vegetation” (ZSI Regd. No. 3958/H13); Allotype ♀, same data as the Holotype (ZSI Regd. No. 3960/H13) (tip of right forewing lost); Paratype ♂, same data as the Holotype (ZSI Regd. No. 3959/H13); Paratype ♂, same data as the Holotype (ZSI Regd. No. 3961/H13); Paratype ♂, same data as the Holotype (ZSI Regd. No. 3962/H13) (tip of abdomen lost). The Types have been deposited in the National Zoological Collection.

Comparison : *G. pallampurica* sp. nov. comes close to *G. dravida* Leftinck in having frons marked with black T-shaped marking, in large built and on the shape of the male anal appendages – the inferior being about one third the length of the superiors. However, it differs from the same in having the inferior anal appendages comparatively a little shorter (the superiors about 2.6 times v.s. over 2.75 times as long as the inferior) and in having a unique ventral bulging in the basal third of superiors and in the absence of antemedian bulging of the latter. *G. pallampurica* sp. nov. further differs from *G. dravida* Lieftinck in being a smaller insect (♂ : abd. + ann. App. 47.00–51.00 mm vs 55.00–57.00 mm, hindwing : 37.00–39.00 v.s. 43.00–50.00 mm).

DISCUSSION

Most *Gynacantha* spp. Known from India are distributed in the southern and eastern parts of the union. In comparison, very few species of the genus are known from the northwestern region. Prasad (2002) in his detailed account of the odonate fauna of western Himalayas reported only *G. khasiaca* MacLachlan from western Himalayas (comprising the states of Kashmir, Uttar Pradesh and the Himachal Pradesh). Thus finding of *G. pallampurica* sp. nov. makes an important addition to the odonate fauna of the region.

SUMMARY

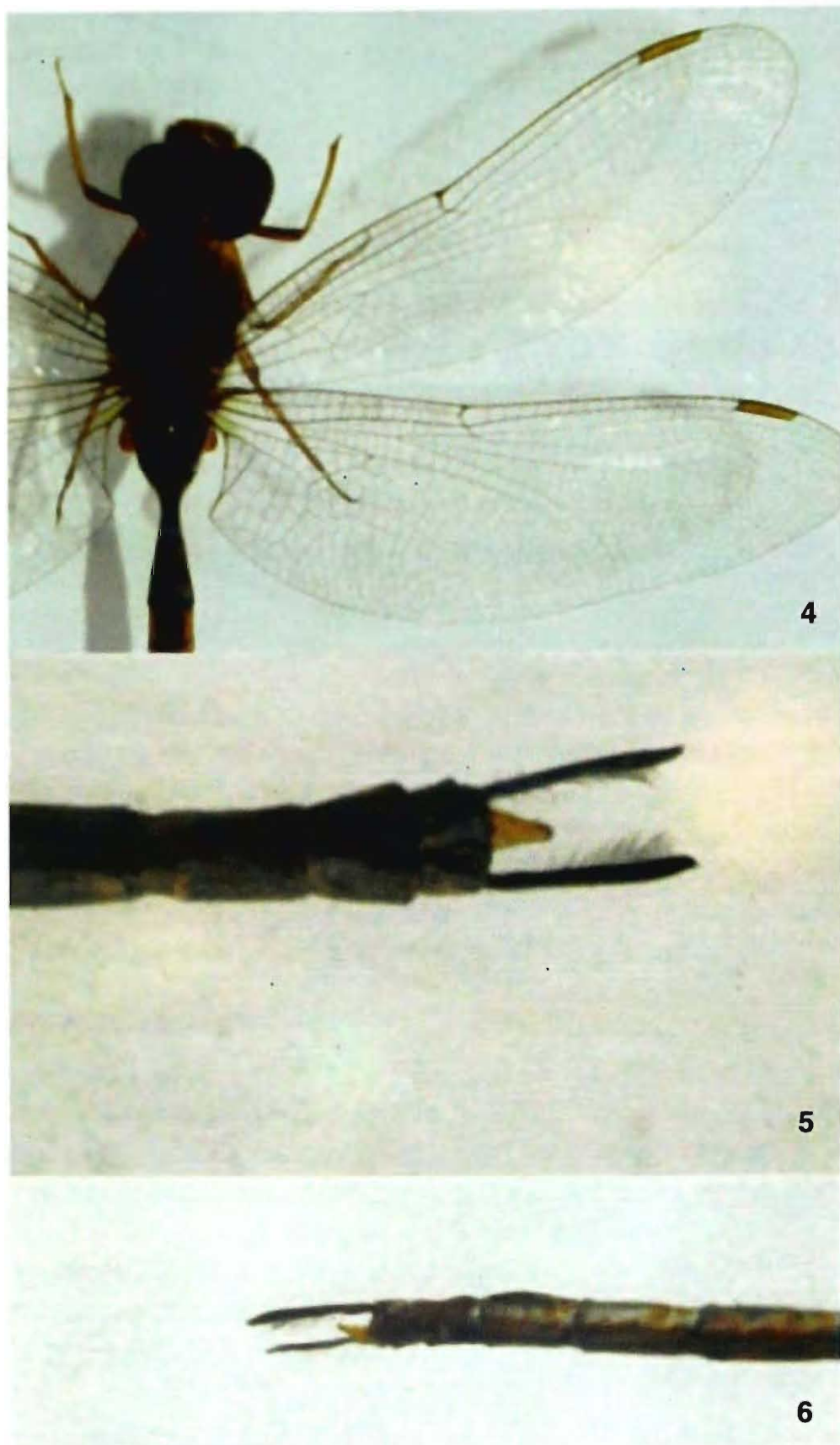
Gynacantha palolampurica sp. nov. is described from northern Himachal Pradesh together with illustration and comparative notes.

ACKNOWLEDGEMENTS

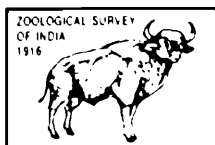
The authors are thankful to the department of Science and Technology for providing financial assistance to undertake the present work and to Dr. M. Prasad for some friendly suggestions.

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Figs. 4-6 : *Gynacantha pallampurica* sp. nov., male; 4. photograph of front part of body in dorsal view including head, thorax, right pair of wings and first three abdominal segments; 5 & 6. Photographs of anal appendages, 5. in dorsal view; 6. in semilateral view from right side.



Rec. zool. Surv. India : 107(Part-3) : 51-56, 2007

ROLE OF SOIL pH ON THE COLLEMBOLAN FAUNA OF TWO UNCULTIVATED FIELDS OF NORTH 24 PARGANAS, WEST BENGAL

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INTRODUCTION

Among the various factors in the soil the role of pH in limiting the distribution of collembolan fauna is still very poorly known. Workers like Agrell (1941), Bellinger (1954), Christiansen *et al.*, (1961), Dhillon and Gibson (1962), Davis (1963), Choudhari and Roy (1967), 1971, 1972) Hazra, *et al.*, (1976) made some sporadic attempts from time to time but failed to establish any decisive role played by soil pH on collembolan population. In view of this the present work made an extensive investigation for further evaluation of the factor and the influence exerted by it on collembolan fauna sampled from two uncultivated fields of 24 Parganas district (N), West Bengal.

Location and characteristics of sampling sites

Two uncultivated sites, 'A' (area : 40 m × 30 m) and 'B' (area 30 m × 25 m) in the village 'Badu' of 24 Parganas (N) district were selected for sampling. The village Badu is 10 kms. from Madhyamgram Railway station. These sites though about 2 km apart from each other were with almost equable ecological condition and experienced and average annual rainfall ranging between 150–160 cms. Both the site were uncultivated, undisturbed and covered with thickly-vegetated with herbs and shrubs of different plant families and soil surface was covered with debris of fallow leaves and dried twigs from trees such as *Casurina* sp. and *Mangifera indica*. Soils of the sampling sites were grayish or grayish black in color alluvial in nature, soil and fine sand with more or less equal proportion.

MATERIALS AND METHODS

Soil samples from each site were collected at random, 48 soil samples were collected from the sites 24 from each of the two site at monthly intervals for a period of two years (from

January' 2004 to December '2005). Samples were drawn by using a stainless steel corer (inner cross sectional diameter 8.5 sq cm) as employed by Dhillon and Gibson (1962). Separate sample units were taken from each site for the estimation of soil parameters. The soil samples thus collected were kept immediately in sterile polythene packet and stored in the laboratory. Soil pH value in each case was determined from soil suspension by an electric pH meter as described by Piper (1942). In these method 25 gms of soil was taken in a flask to which 100 ml of aerated distilled water was added and then stirred for one hour. The pH value was then determined within 60 seconds after the glass electrode was immersed in freshly shaken suspension.

Extraction of Collembola

Collembola were extracted from the soil using Tullgren funnels as modified by McFadden (1953). A 40 watt bulb was used for heat and light source. Soil samples were placed on wire screen (2 mm mesh) in the funnels approximately 15 cm below the bulbs. Collection jars (200 ml) with approximately 50 ml 70% ethanol plus 5% glycerin were attached below the funnels and the extraction period was 3 days. Specimens collected were identified as far as possible to species level and quantified to estimate the collembolan densities of the sites.

OBSERVATION

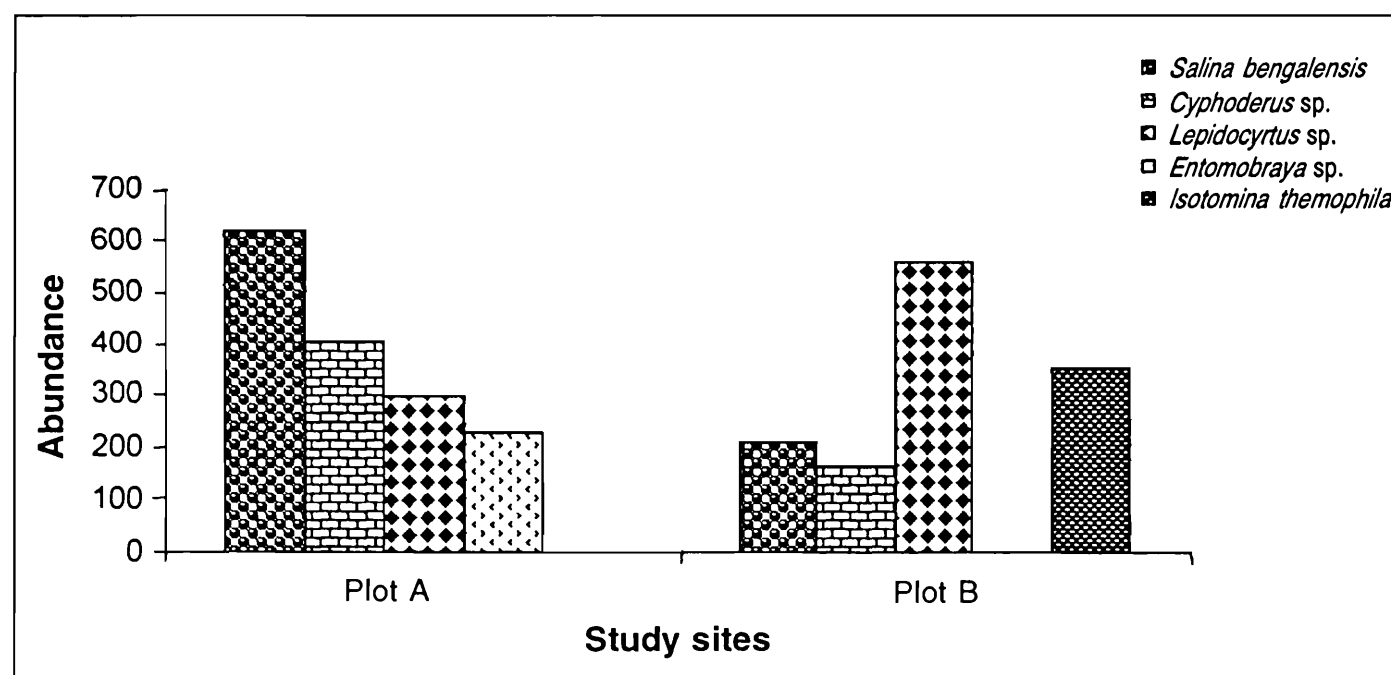
Collembolans fauna obtained from both the sites belonged to five genera (Table 1 and Fig. 1) of these five genera *Salina*, *Cyphoderus* and *Lepidocyrtus* were common in both the sites, while *Entomobrya* were found in site-A and *Isotomina* found in site-B. Of the 48 collections available for comparable standards 43 yielded less than 100 specimens, 5 yielded 100–200 specimens, 2 yielded more than 200 specimens, site-B was comparatively thickly populated than site-A. In degree of numerical dominance in site-A *Salina* came first followed by *Cyphoderus* and *Lepidocyrtus* while in site-B the predominant forms were *Lepidocyrtus* followed by *Isotomina* and *Salina*. The collembolan population through out the period of sampling in both the sites exhibited an irregular trend of fluctuation being maximum in July-August.

DISCUSSION

Altogether five species of Collembolan fauna were obtained during the present study. The pH values of the soil samples did not exhibit a wide range of variation and were between 7.0–7.5. The pH values were between 7.0–7.2 in 32 samples, 7.3 in 8 samples, 7.4 in 3 samples, 7.5 in 3 samples and 7.6 in 2 samples (Table 2 and Figs. 2, 3). In order to find out as to whether there was any significant correlation between soil pH and collembolan population, correlation coefficient (r) were worked out (Table 3). The population throughout the period of sampling in plot A exhibited a very weak positive correlation with soil pH while in plot B it was negative in the samples of 2004 and positive in those of 2005.

Table 1. : Collembolan fauna extracted from plot A and B at 'Badu' in two years.

	Genus	Total no. of each genus collected
Plot A	<i>Salina bengalensis</i>	617
	<i>Cyphoderus</i> sp	403
	<i>Lepidocyrtus</i> sp	297
	<i>Entomobraya</i> sp	227
	Total no. of collembolan fauna in plot A	1544
Plot B	<i>Lepidocyrtus</i> sp	558
	<i>Isotomina thermophila</i>	352
	<i>Salina bengalensis</i>	212
	<i>Cyphoderus</i> sp	164
	Total no. of collembolan fauna in plot B	1286

**Fig. 1.** : Abundance of Collembolan species in two plots.

The data clearly indicate (Table 2 and Figs. 2, 3) the neither the soil pH nor the collembolan fauna exhibited any regular trend of fluctuation. In the monsoon months in both sites the maximum population during which pH values were within the range between 7.2–7.4. Here nutrient conditions were favorable without being extreme and availability of certain salts was maximum. Besides, the values of pH in most cases were very near the natured point and were well within the tolerance range of most or rather all of the species (Choudhuri & Roy, 1972). The collembolan populations in most cases were either negatively correlated to soil pH or exhibited very weak positive correlation

Table 2. : No of collembolan and values of soil pH in samples of Badu, North 24 Pgs., West Bengal (From 48 samples in two years).

	YEAR 2004				YEAR 2005			
	SITE-A		SITE-B		SITE-A		SITE-B	
MONTHS	X	Y	X	Y	X	Y	X	Y
JANUARY	49	7.4	55	7.3	76	7.1	63	7.2
FEBRUARY	31	7.1	30	7	58	7	41	7.3
MARCH	25	7.2	33	7.2	44	7.4	37	7
APRIL	24	7.3	24	7.1	42	7.2	27	7.1
MAY	30	7.5	18	7.6	32	7.5	23	7.3
JUNE	27	7	21	7.3	33	7.1	20	7.1
JULY	132	7.4	117	7.2	326	7.2	278	7.2
AUGUST	52	7.3	53	7.6	178	7.1	159	7.1
SEPTEMBER	35	7.5	39	7.2	40	7.3	36	7.2
OCTOBER	24	7.1	22	7	40	7	37	7.2
NOVEMBER	20	7	15	7.2	51	7.2	41	7
DECEMBER	78	7.2	26	7.3	97	7.1	71	7.1

X = No. of collembolan per collection; Y = Value of Soil pH

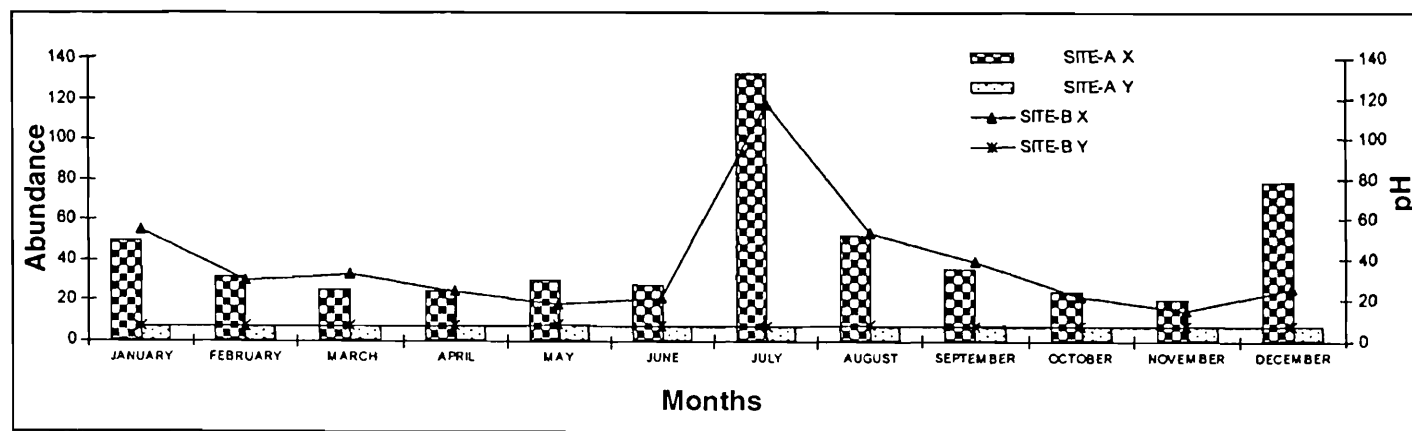


Fig. 2. : Monthly variation of Collembolan species in relation to soil pH at site-A and site-B in the year 2004.

(Table 3). It is therefore, clear from this study that pH has very little or no direct effect on collembolan population which is compatible with the findings of Agrell (1941), Bellinger (1954), Dhillon & Gibson (1962), Davis (1963) & Hazra *et al.*, (1976). Since the microorganisms and higher plants respond markedly to soil pH and since most of the collembolans are either Saprophagous or phytophagous it is assumed that soil pH may exert indirect influence on collembolan population by controlling the growth and activities of micro and macro flora.

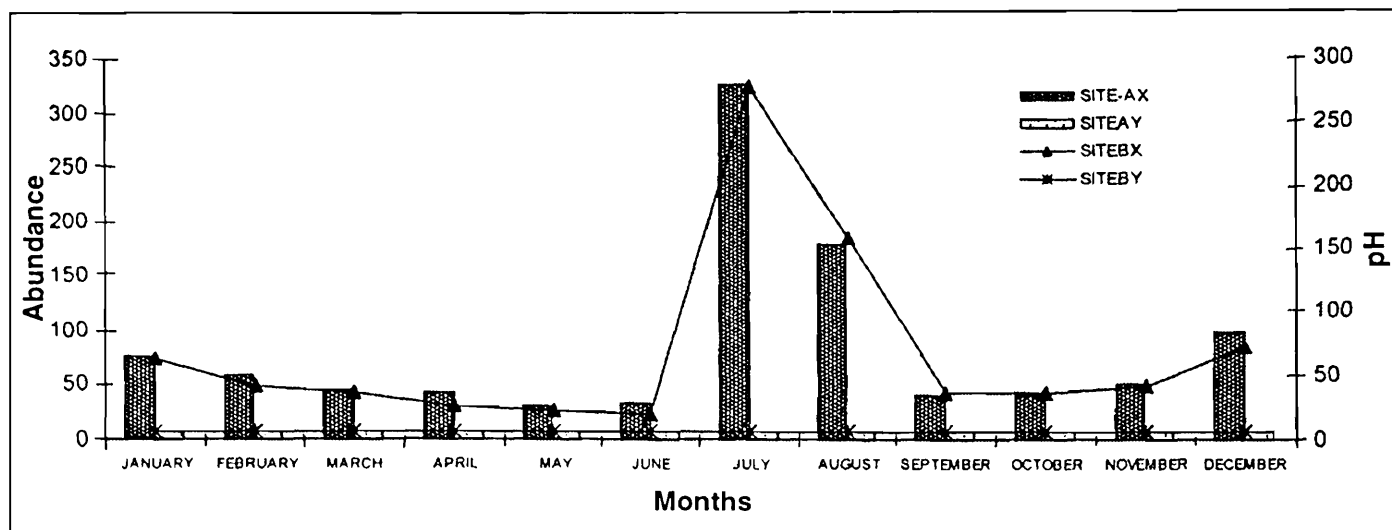


Fig. 3. : Monthly variation of Collembolan species in relation to soil pH at site-A and site-B in the year 2005.

Table 3. : Correlation coefficient (r) for soil pH and collembolan population (From 48 samples in two years).

PLOT	YEAR		VALUE OF 'r'
A	2004	Collembolan population : Soil pH	0.348 NS
	2005	Collembolan population : Soil pH	0.053 NS
B	2004	Collembolan population : Soil pH	-0.129 NS
	2005	Collembolan population : Soil pH	0.057 NS
			NS = Not significant

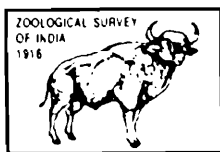
ACKNOWLEDGEMENT

Authors are thankful to Dr. Ramakrishna, Director-in-charge, Zoological Survey of India, Kolkata for providing the laboratory facilities.

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Rec. zool. Surv. India : 107(Part-3) : 57-62, 2007

A STUDY ON THE POPULATION OF SOIL ARTHROPODS FAUNA IN TOBACCO LEAF LITTER BAGS BURIED UNDER SOIL, A PRELIMINARY REPORT

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INTRODUCTION

The role of soil micro arthropods during decomposition of tobacco-ribs under the soil in litter bags has been conducted. A total of seven micro-arthropods groups were collected of which Collembola showed maximum population and this species *Lepidocyrtus medius* was most dominant. The arthropod population showed their maximum activities during first two months March-April. The interaction between the arthropod population and soil factors have been analyzed and discussed. Various author like Choudhuri and Roy (1971), Hazra (1976), Mitra (1977), Hazra and Choudhuri (1983) have studied the distribution of soil micro-arthropod particularly on Collembola in different ecosystem in India. But so far there is no record on the population structure on the soil micro-arthropods on tobacco leaf litter. Therefore, to fill up this lacuna the present investigation has been taken up.

MATERIAL AND METHODS

A total of twelve (12) nylon bags (mesh size-0.01 mm) were buried at the depth of 10 cm under the soil containing 200 gram of dry tobacco leaf ribs in the month of March, 2005. At the end of each month one litter bag was drawn up to the month of February 2006. The decomposed leaf litter was given on the Tullgren Funnel for extraction. The extraction was made by a modified Tullgren Funnel in the laboratory. A 40 watt bulb was used for heat and light source. Soil samples were placed on wire screen (2 mm mesh) in the funnels approximately 15 cm below the bulbs. Collection jars (200 ml) with approximately 50 ml 70% ethanol plus 5% glycerin were attached below the funnels and the extraction period was 3 days. Specimens collected were identified as far as possible to species level and quantified to estimate the collembolan densities of the sites.

The soil temperature was recorded by soil thermometer at the field. Soil moisture was determined by an Infra Red Moisture Balance (Model A). The pH of the soil was measured by glass electric pH meter. The organic carbon was estimated by titration method. (Walkley and Black, 1934). The particle size of soil sample was determined by mechanical analysis following the standard procedure.

LOCATION OF SAMPLING SITE

The site is located at Shyamnagar in North 24-Parganas, West Bengal. The site was covered with different types of grasses, herbs and shrubs. The soil was gangetic alluvium in nature, brownish black in colour and silty loom in texture.

OBSERVATION

1. *Faunal make-up* : The soil arthropod fauna obtain from this study belongs to seven different groups of soil micro-arthropods. Among the soil micro- arthropods, Collembolan fauna were most dominant (55.49%). The Collembola fauna were identified which belongs to five species under five genera. The *Lepidocyrtus medius* was dominant taxon comprising (18.45%) of the total Collembolan population followed by *Cryptopygus javanus* (13.89%), *Isotomina thermophila* (11.06%), *Sinella* sp. (6.92%) and *Willowsia* sp. (5.09%) respectively. The second dominant group was *Acarina* (21.45%), followed by *Diptera larvae* (9.68%), *Isopoda* (6.93%), *Diplura* (1.84%), *Chilopoda* (3.23%), and *Centipede* (1.38%) (Fig. 2).

2. *Soil factor* : The soil of this site was alluvium in nature, clay and silty in texture. The mechanical analysis of soil sample of this site shows maximum percentage of clay (38.66%), Silt (33.59%), Fine sand (22.45%) and coarse sand (4.08) respectively (Table 1).

Table 1. : Mechanical analysis of soil (%) at Shyamnagar, West Bengal.

Coarse sand	Fine sand	Silt	Clay
4.08	22.45	33.59	38.66

Among the edaphic factors, the percentage of organic carbon (%) was maximum (1.83) in the month of April when the number of soil arthropod also shows their highest density. The minimum and maximum soil temperature recorded was 18.5°C and 39.3°C. Soil moisture (%) recorded was minimum 23.5 and maximum 30.5 (Fig. 1).

3. *Monthly fluctuation of arthropods fauna* : It is evident from Fig. 2, maximum soil arthropods were present in the month of April (15.74%) of the total population collected during the present study and minimum population was recorded in the month of January (3.7%). The group-wise analysis was made and found that the population of Collembola was maximum (55.55%) followed by *Acarina* (26.38%), *Diptera larvae* (9.68%), *Isopoda* (6.93%), *Diplura* (1.84%), *Chilopoda* (3.23%) and *Centipede* (1.38).

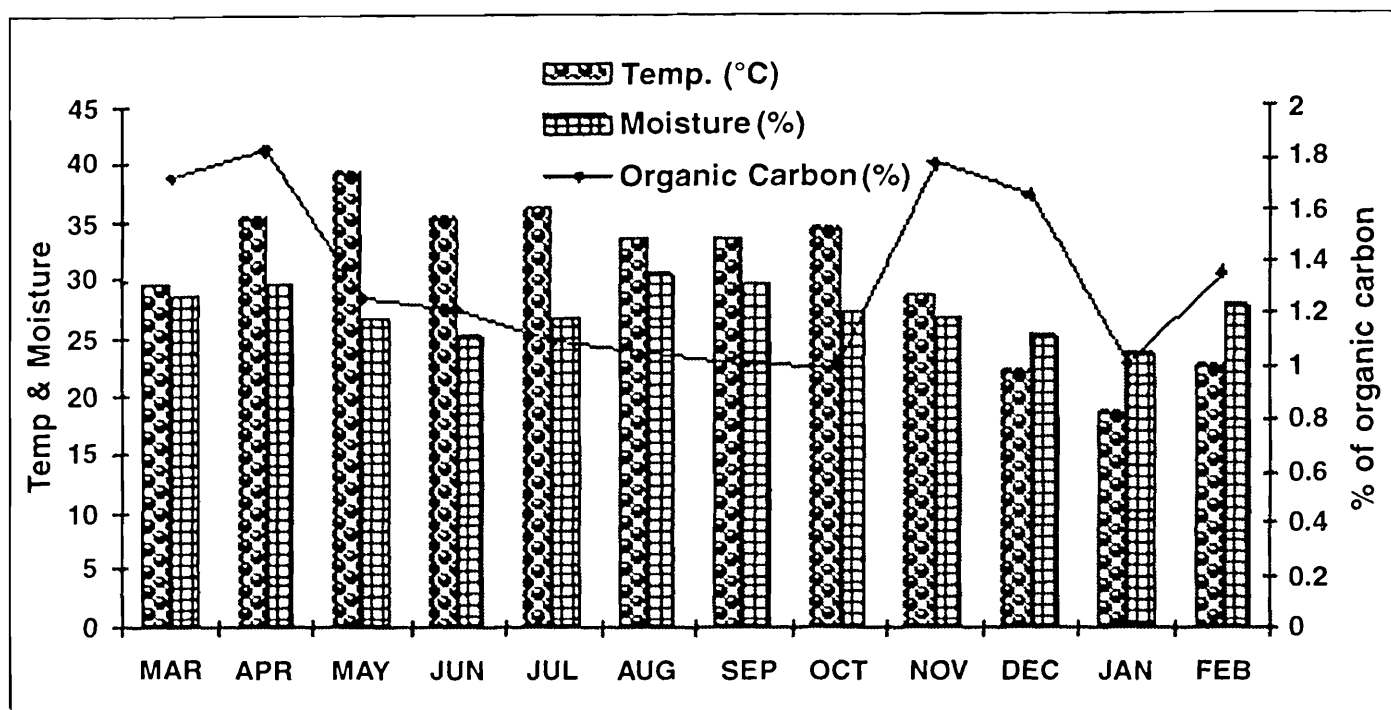


Fig. 1. : Monthly variation of edaphic factors (March, 05 to Feb., 06).

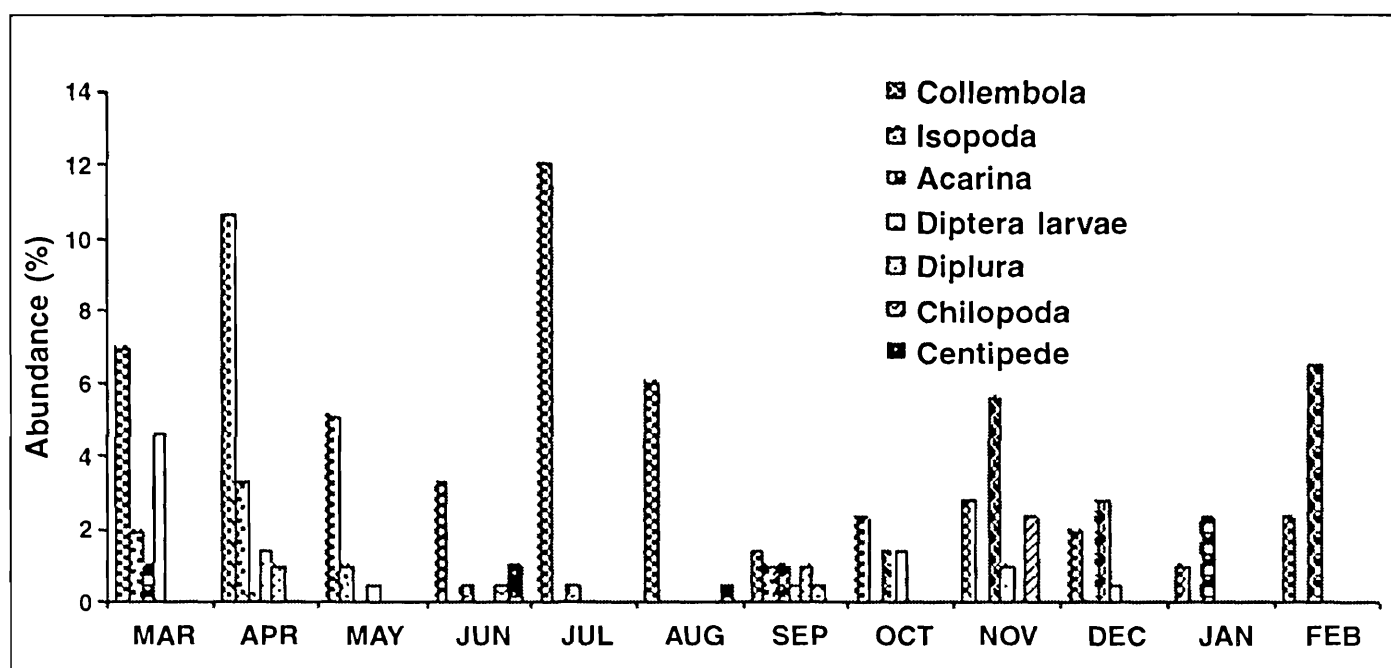


Fig. 2. : Monthly abundance of soil arthropods.

The population of soil micro-arthropod consisting of seven groups (Collembola, Diplura, Acarina, Isopoda, Dipterans larvae, Chilopoda and Centipede) and five species of Collembola showed changes with the change of month (Fig. 3) being maximum in the month of March and April and minimum in January. These observations were coincided with the observations of Sheals (1956), Haarlov (1960) in the temperate countries and Hazra *et al.*, (1999) in a garbage dumping area at Kolkata.

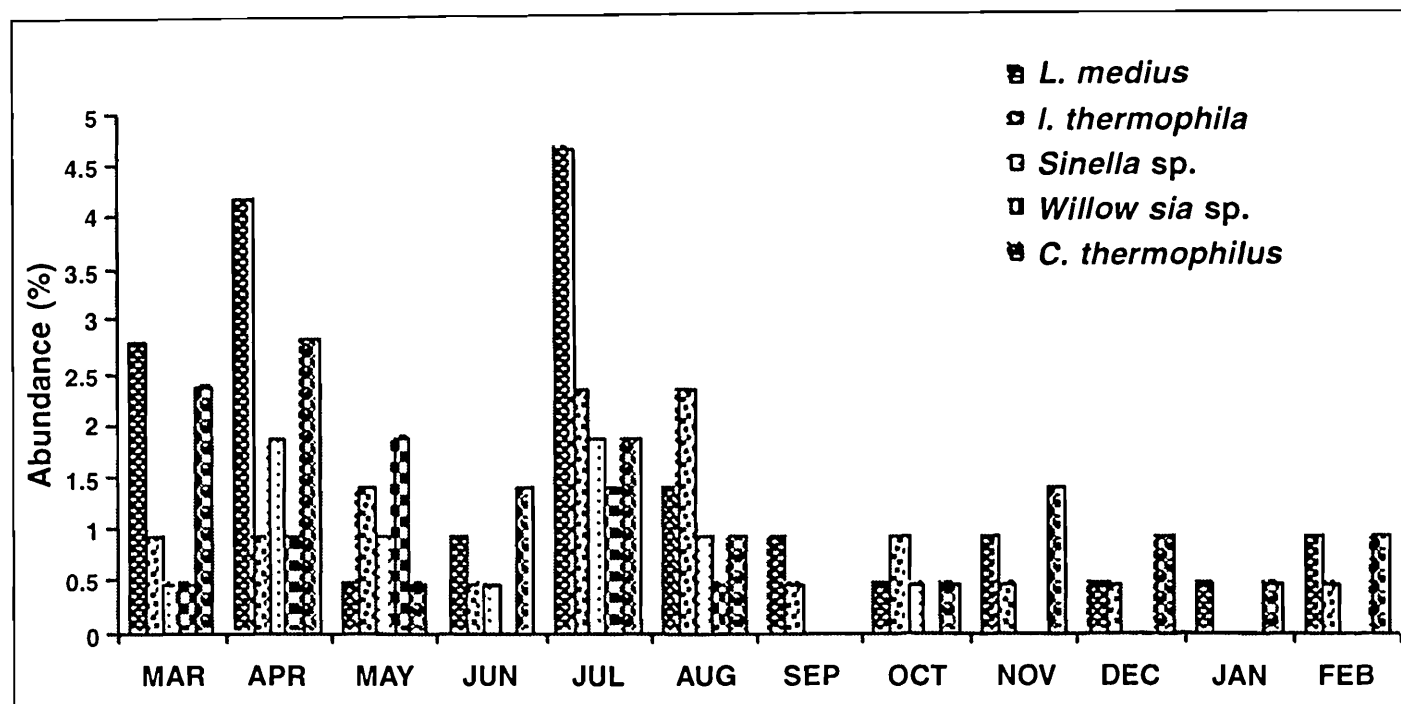


Fig. 3. : Monthly abundance of collembolan species.

Table 2. : Correlation coefficient (r) between edaphic factors and Collembola.

	C
C	1.00
T	0.544*
M	0.386 NS
OC	0.242 NS

Explanations : * = Significant at 1%, NS = Not Significant, C = Total collembolan population, T = Temperature, M = Moisture, OC = Organic carbon.

DISCUSSION

During 1st week of March the chopped Tobacco leaf ribs were buried under the soil it seems that the initial decomposition of leaves started and attracted the micro arthropod fauna as their nutrients and in the month of April population reached its peak. This might be due to the maximum organic carbon content (1.83%) in the surrounding soil (Fig. 1). Hazra (1978) showed the significant positive co-relation with the organic carbon and Collembolan population in West Bengal. Out of five species of Collembola, *Lepidocyrtus medius* showed maximum number (18.45%) followed by *Cryptopygus javanus* (13.89%). The maximum concentration of these two species was also in the month of April when organic carbon level of surrounding soil was high (Fig. 3). It could be inferred from this study that all these groups of soil arthropod and the five species of Collembola

played an important role in detoxification of nicotine of tobacco leaves after few week when these are buried under the soil.

In order to find out as to whether there was any significant correlation between soil micro-arthro pods particularly, collembolan population, correlation coefficient (r) were worked out (Table 2). The population of collembolan throughout the period of sampling exhibited positive correlation with soil temperature but weak positive correlation with soil moisture and organic carbon.

However, it could not be concluded specifically the role of buried tobacco leaves on the soil arthropod fauna unless the experimental studies conducted under laboratory condition with each groups and species of soil arthropod and Collembola respectively. But the organic carbon and moisture played a major role on the fluctuation of population of soil arthropod fauna (Figs. 1 & 2). This observation confirms the finding of Hazra & Choudhuri (1983).

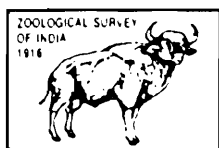
ACKNOWLEDGEMENT

Authors are thankful to Dr. Ramakrishna, Director-in-charge, Zoological Survey of India, Kolkata for providing laboratory facilities.

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Rec. zool. Surv. India : 107(Part-3) : 63-69, 2007

ROLE OF MICROBIAL FLORA ON DISTRIBUTION OF COLLEMBOLA AT WASTE DISPOSAL SITE, DHAPA, KOLKATA

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INTRODUCTION

The ecology of collembolan fauna as well as microbial communities in soil was studied earlier in India by several workers like Mitra *et al.*, (1977), Alfred *et al.*, (1991), Hazra and Choudhuri (1981, '83) and Hazra *et al.*, (1976, '99, 2003). But studies on the distribution of soil fauna in general and Collembola with association of microbial flora in particular in tropical countries have not been undertaken seriously, especially in India. The present study deals with the association of the predominant species of microbial flora and their role on distribution of Collembola at waste disposal site, Dhapa, Kolkata.

Location and Characteristic of sampling site

The site is a dumping ground of city wastes, located by the side of Eastern Metropolitan by pass, Kolkata. The area is demarcated by 'Organic Fertilizer Pvt. Ltd.' The main constituents of the dumped materials were household wastes, industrial effluents and the residues of vegetables. In this sampling site cultivation of different vegetables (Seasonal salad leaves, cauliflower maize *etc.*) is practiced mixing the decomposing materials in the soil.

MATERIALS AND METHODS

Methods of sampling : Soil samples were collected at random, at the rate of 3 samples every month during June, 2002 to November, 2003. Therefore, 54 soil samples were drawn by using a stainless steel corer (inner cross sectional diameter 8.5 sq. cm) from a depth of 5 cm. Separate sample units were taken for the soil microbes. The soil samples thus collected were kept immediately in sterile polythene packet and stored in 4°C in the laboratory.

Extraction of Collembola : Collembola were extracted from the soil using Tullgren funnels as modified by McFadden (1953). A 40 watt bulb was used for heat and light source. Soil samples

were placed on wire screen (2 mm mesh) in the funnels approximately 15 cm below the bulbs. Collection jars (200 ml) with approximately 50 ml 70% ethanol plus 5% glycerin were attached below the funnels and the extraction period was 3 days. Specimens collected were identified as far as possible to species level and quantified to estimate the collembolan densities of the sites.

Isolation of soil microbes : (Bacteria, Actinomycetes and Fungi) : Considering the variety of microorganisms harbored in soil, it is apparent that no single method can reveal the total microbial population. The techniques available to study the soil microorganisms the dilution plate method is most widely used. With wide acceptance and popularity there are many variations of this technique Johnson *et al.*, (1959) gave a good description of the detail procedure. Through the viable colony count from a plating of diluted soil suspension however, it must be recognized that a single medium and a prescribed condition of incubation will not support the growth of all species in any group of these microorganisms. In this present investigation, sterile de-ionized double distilled water was used to prepare the soil suspension for dilution series.

Nature of culture :

Isolation	Medium	Dilution grade	Temperature	Incubation
Bacteria	Luria agar	10-4	37°C	24 hrs.
Actinomycetes	Starch-casein	10-4	28°C	7 days
Fungi	Czapek-Dox	10-4	30°C	72 hrs.

OBSERVATION

A total number of 1,078 microbes and collembolan were obtained from this site. The specimens which were found to occur in all the sampling months were identified up to generic/specific level and those showing irregular distribution were kept as unidentified and mentioned here as others. Microbes were the dominant group obtained from all the samples and comprised of 53.70% of the total population. Among the microbes, the *Penicillium* was most dominant and comprised of 10.66% of the total population and occupied second position among the total fauna. *Rhizopus* and *Bacillus* (both 6.02%) *Mucor* (5.47%) and *E. coli* (4.35) occupied second third and fourth position respectively in order of dominance. Other unidentified microbes comprised of 21.15% of the total population. Among the collembolan population, *Lepidocyrtus cyaneus* was most dominant species among all the fauna obtained and comprised of 12.33% of the total population. *Xenylla obscura* (6.70%) *Cyphoderus javanus* (6.50%), *Seira indica* (5.10%), and *Cryptopygus thermophilus* (4.90%) occupied second, third, fourth and fifth position respectively in order of dominance and other collembolan comprised of 10.90% of the total population.

Percentage of total number of microbes and collembolan collected in each month showed maximum in the month of October and minimum in the month of June (Table 1 and Figs. 1-3).

Table 1. Abundance (%) of Collembola and Microbial flora extracted during June, 2002 to November, 2003.

SPECIES	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	Total
<i>L. cyaneus</i>	0.37	0.83	0.93	1.02	0.37	1.21	1.11	0.46	0.65	0.56	0.46	0.65	0.28	0.46	0.37	0.83	1.02	0.65	12.23
<i>X. obscura</i>	0.09	0.19	0.28	0.28	1.11	0.46	0.65	0.28	0.19	0.28	0.28	0.19	0.19	0.37	0.28	0.46	0.37	0.74	6.7
<i>C. javanus</i>	0.37	0.09	0.19	0.56	0.56	0.28	0.37	0.46	0.19	0.37	0.09	0.46	0.28	0.19	0.37	0.74	0.65	0.28	6.5
<i>Seira indica</i>	0.09	0.28	0.19	0.37	0.56	0.65	0.19	0.37	0.19	0.28	0.19	0.28	0.19	0.09	0.19	0.37	0.46	0.19	5.1
<i>C. thermophilus</i>	0.19	0.28	0.46	0.65	1.4	1.02	0.83	1.11	0.19	0.37	0.28	0.19	0.46	0.19	0.28	0.28	0.19	0.46	4.9
<i>Others</i>	0.19	0.28	0.46	0.65	1.4	1.02	0.83	1.11	0.19	0.37	0.28	0.19	0.46	0.37	0.56	0.65	0.83	1.02	10.9
	1.28	1.85	2.13	3.15	4.75	3.1	3.43	2.96	2.14	2.32	1.58	2.14	1.58	1.67	2.14	3.43	3.63	3.43	46.3
SPECIES	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	Total
<i>Penicillium</i>	0.37	0.65	0.74	0.65	0.93	0.74	0.65	0.46	0.46	0.56	0.28	0.37	0.09	0.46	0.56	0.65	1.11	0.74	10.66
<i>Mucor</i>	0.19	0.28	0.19	0.19	0.37	0.46	0.65	0.37	0.28	0.19	0.09	0.28	0.09	0.19	0.28	0.46	0.56	0.37	5.47
<i>Rhizopus</i>	0.19	0.28	0.56	0.46	0.74	0.65	0.56	0.28	0.19	0.28	0.19	0.37	0.19	0.09	0.19	0.37	0.37	0.19	6.02
<i>Bacillus</i>	0.09	0.19	0.46	0.37	0.46	0.56	0.37	0.37	0.46	0.28	0.46	0.09	0.19	0.28	0.09	0.28	0.46	0.56	6.02
<i>E. coli</i>	0.19	0.09	0.28	0.37	0.46	0.28	0.37	0.19	0.19	0.09	0.28	0.09	0.19	0.19	0.28	0.19	0.28	0.37	4.35
<i>Others</i>	0.83	1.02	0.65	1.3	1.95	1.76	1.21	1.58	1.02	0.74	0.56	0.74	0.83	1.02	1.3	1.58	1.48	1.58	21.15
	1.85	2.5	2.88	3.33	4.91	4.45	3.8	3.25	2.6	2.13	1.85	1.94	1.67	2.23	2.69	3.53	4.23	3.8	53.7

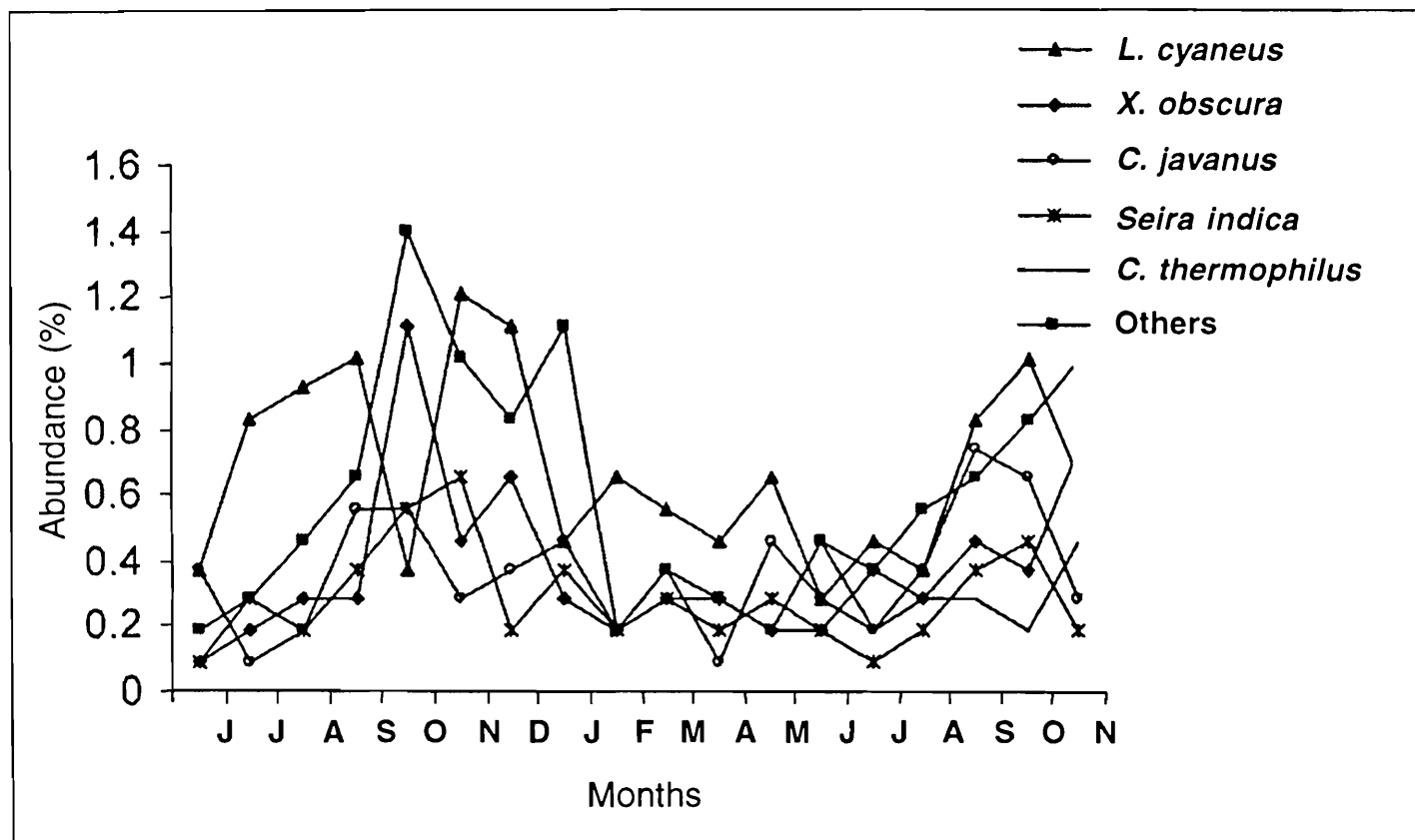


Fig. 1. : Monthly variation of collembola species.

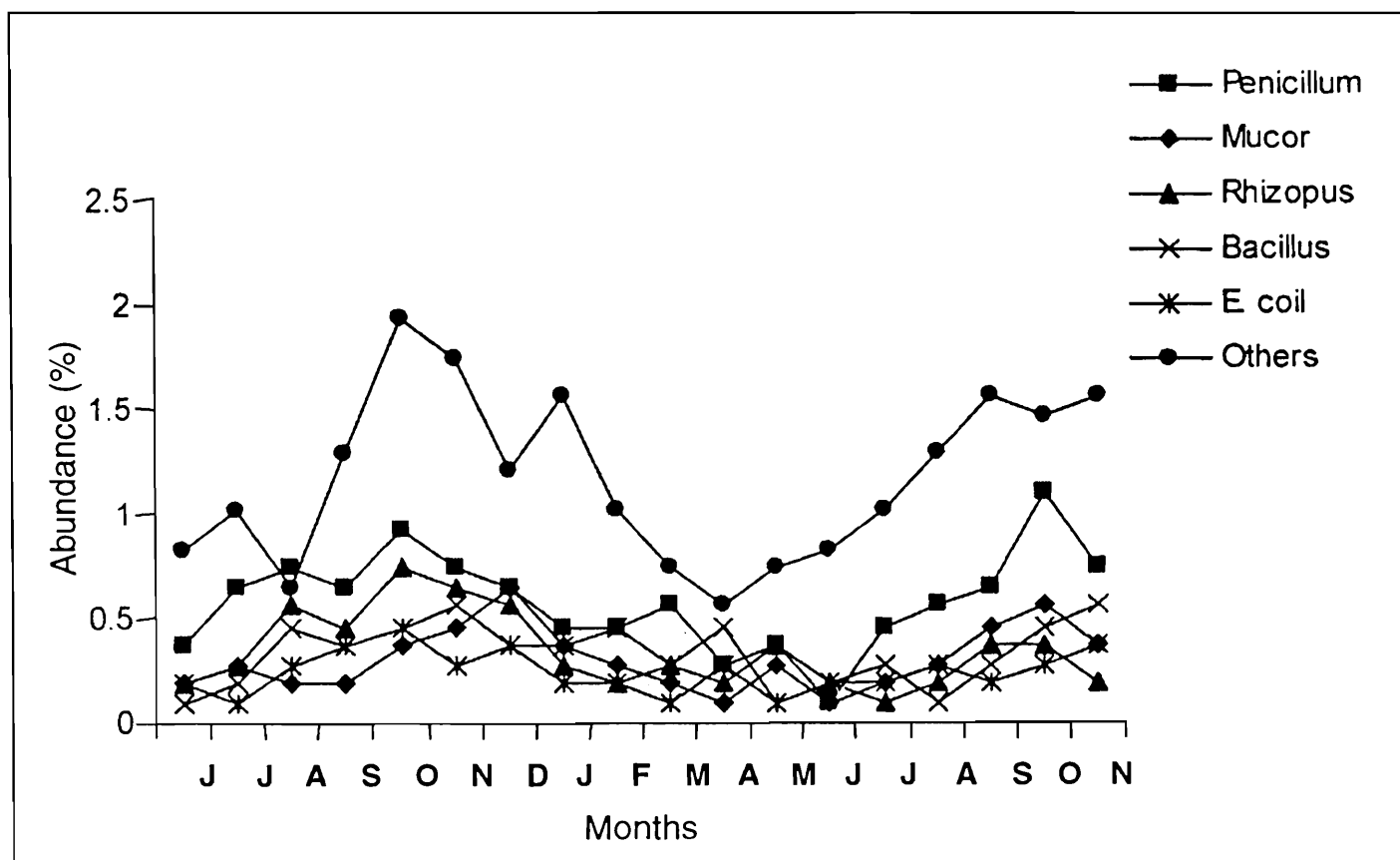


Fig. 2. : Monthly variation of microbial species.

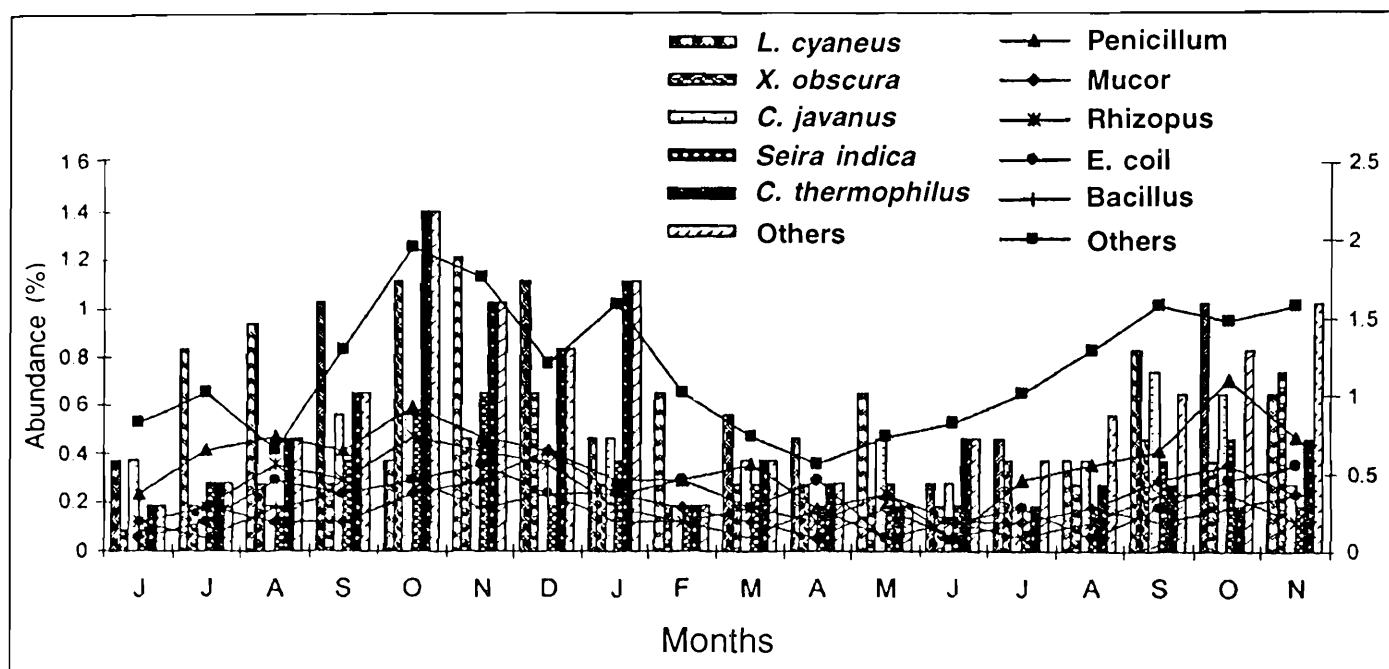


Fig. 3. : Monthly variation of Collembolan and Microbial species.

Predominant forms of microbes and collembolan showed and irregular trend of fluctuation during the sampling period. The population of different species of the groups showed peaks in different months but in general they showed maxima in post monsoon and minima in monsoon. The dumped wastes materials affects directly in shifting the population peaks of microbes and collembolan.

DISCUSSION

Altogether five genera of soil microbial flora (*Penicillium*, *Rhizopus*, *Bacillus*, *Mucor* and *E. coli*) and five genera of collembolan fauna (*Lepidocyrtus*, *Xenylla*, *Cyphoderus*, *Seira* and *Cryptopygus*) were obtained during the present study. In order to find out as to whether there was any significant correlation between soil microbes and collembolan population, correlation coefficient (r) were worked out (Table 2). The population of collembolan throughout the period of sampling exhibited positive correlation with soil microbes.

Table 2. : Correlation coefficient (r) for collembolan population and soil microbes.

PERIOD		VALUE OF 'r'
June, 2002 to November, 2003	Collembolan population : Soil microbes	0.929 (Significant at 5% level)

It is interesting to note that the microbial population showed an almost parallel pattern of fluctuation with that of Collembola. This coincided with the observations of Knight (1961), Mitchell and Parkinson (1976), Hazra and Choudhuri (1990), Pal *et al.*, (1992) and Hazra (1984).

This suggested a direct dependence of collembolan population of microbial flora. The maximum population peak of collembolans and microbes were found in the month of October (post-monsoon) in the site, it agreed with the observation of Hazra and Choudhuri (1990) and Pal *et al.*, (1992). According to them the significant increase in the moisture content of soil leading to a luxuriant growth of macro and micro flora during monsoon.

According to Knight (1961) as collembolan showed strong feeding preference for fungal hyphae and spores it might be suggested that distribution of these animals would partly be conditioned by the distribution of fungi species also indicated that the gut content of a single collembolan species taken from several habitats may show greater diversity than the gut content of several species taken from the same habitat, this suggests that collembolans are indiscriminate feeders.

The pattern of seasonal variation in population appeared to be different in different forms of microbes and collembolan which perhaps indicates the existence of different breeding periods. Again the existence of single population peak in some species of microbes and collembolan suggested the probability of only one generation per year.

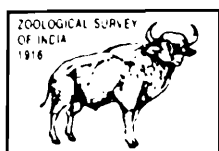
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A NEW FISH SPECIES OF THE GENUS *BHAVANIA* (HOMALOPTERIDAE : HOMALOPTERINAE) FROM RIVER NOADHING DRAINAGE, ARUNACHAL PRADESH, INDIA

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INTRODUCTION

Bhavana australis is the only species of genus *Bhavana* so far recorded from the southern states of India (Talwar and Jhingran, 1991). This fish species has a good number of synonymies, *Platycaura australis* (Jerdon, 1849), *Homaloptera maculata* (Day, 1877), *Homaloptera brucei* (Day, 1877), *Bhavana annandalei*, Hora (1920). Subsequently, Hora (1920) revised the genus *Bhavana* (Subfamily : Homalopterinae) on retrieval of the species *Bhavana australis* from the state of Kerela, Karnataka and other southern states of India. Even thereafter several Authors (Hora, 1941; Jayaram, 1981; Menon, 1987; Talwar & Jhingran, 1991) on redescription of the species *Bhavana australis* rather kept in the same genus *Bhavana*. Recently, on reassessment of the faunal wealth of Arunachal Pradesh, India, led to the record of one more species of *Bhavana* from the River Noadhing drainages, Lohit district. The new species has its own special characteristic features which could be readily differentiated from the species *Bhavana australis* on various scores : head dotted with pores and arranged in rows along the margin of orbit; thoracic region with a central pit; lateral line at the origin of ventral fin slightly curved; pectoral fin overlapping the ventral fin anteriorly; caudal emarginate, lower lobe longer than upper; longitudinal band from the base to the tip of lower caudal lobe, eight number of saddle-shaped blotches on the back. On the basis of these distinctive characters, the species has been described as a new species *Bhavana arunachalensis* along with a key to the identification of all the species of genus *Bhavana* in the text.

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Besides, another interesting features been described in the text is regarding the fish zoogeography confirming that the new fish belongs to genus *Bhavana*, a south Indian element. And its presence in the fish composition of Arunachal Himalaya appears to be of a rare phenomenon, which supports the '**Indobrahm hypothesis**' postulated by Pasco (1919) and Pilgrim (1919). Further the notable works on the fish geography on the Northeastern region of India are of Sen & Dey (1984) and Nath & Dey (2000).

Key to the species of genus *Bhavana* Jerdon

1. Head with pores-like outgrowths, rough and arranged in rows around orbit. Lateral line complete, slightly curved at the origin of ventral fin. Pectoral fin inserted opposite to orbit, extends beyond origin of ventral fin. Eight saddle-shaped blotches on the back; longitudinal band from base to the tip of lower caudal lobe. Caudal emarginate; lower lobe longer than upper *Bhavana arunachalensis* sp. nov
- Head with spine-like outgrowths. Lateral line complete, straight. Pectoral fin inserted behind orbit and set apart from ventral fin. Caudal fin forked. Body with black spots and fin with circular bands and bars *Bhavana australis* Hora

MATERIALS AND METHODS

Morphometric measurements and counts were made with dial calipers and recorded to the tenth of a millimeter following the method of Jayaram (1991). The measurement of head length and body parts has been presented as proportion of standard length (SL). The subunits of head are presented as proportion of head length (HL). Counts and measurements were made on the left side of the specimen whenever possible. The system of classification of fish followed is after Nelson (1995).

Type material : *Holotype* : Reg. No. APFS/ZSI/P-488 dt. 26th July 2005, 111.0 mm TL, O⁻ River Noadhing drainage near Namsai, about 30 km. from Tezu, the headquarter of Lohit district, Arunachal Pradesh, India.

Paratypes : Reg. No. APFS/ZSI/P-489 dated 26th July, 2005, 80.0–111.0 mm TL, 3 ex., O⁻, 4 ex., O⁺; other details as of holotype.

Bhavana arunachalensis sp. nov.

(PLATE-I, Figs. 1–3, and PLATE-II, Figs. 4–6)

Fin formula : Barbels vi, Dorsal ii. 7, Pectoral viii. 11, Ventral iii. 8, A.i.6

Body broad and flat anteriorly, tapering towards the tail, its depth 9.0–10.2 in SL. Head broad, flat, moderate in size, its length 4.3–4.8 in SL, its maximum width 1.1–1.3 times and inter-nostril distance 3.0–3.4 time both in HL; gill openings above base of pectoral fins. Eyes fairly small; its

diameter 36.0–43.0 in SL, 8.3–10.0 in HL, inter-orbital distance 2.0–2.6 times in HL. Snout smooth obtusely rounded. Mouth small, ventral, horseshoe shaped, sub equal. Lips thin, upper lip with tubercles longer than lower lip. Barbels six, two pairs rostral, one pair maxillary, all of equal length. Paired fins inserted horizontally, winged shaped and with adhesive apparatus. Pectoral fins overlapping the ventral fin at its origin. Dorsal fin smaller than paired fins, inserted almost opposite to ventral and nearer to snout tip than caudal fin base. Lateral line complete slightly curved at the base of ventral fin. Caudal fin emarginate, lower lobe longer than upper lobe; caudal peduncle 2.8–3.8 times longer than deep. Body scales small, cycloid covering the entire body, scale less at head and abdomen; lateral scale 70–75. Body color grayish with yellowish tinge above lateral line with eight saddle-shaped blotches on the back, longitudinal black band from the caudal base to the tip of lower caudal lobe, fins yellowish. Morphometric data as in Table 1.

From the comparative statement (Table 2) also could be stated that the specific characteristic features in respect of *Bhavana arunachalensis* strongly supports for the establishment as a new species. The comparative chart also revealed that the species *Bhavana arunachalensis* sp. nov. having closer affinity with *Bhavana australis* rather than *Balitora brucei*, commonly available in the hill streams of the North Eastern Regions of India PLATE-II, 6 and to some extent having close affinity with *Balitora burmanica*.

Interestingly, *Bhavana arunachalensis* is a south Indian form and its presence in the fish composition of Arunachal Himalaya however; justify the **Indobrahm Hypothesis** postulated by Pasco (1919) and Pilgrim (1919). According to them it infers that the Arunachal Himalaya was a part of peninsular shield separated by a broad strip of the Ganges-Brahmaputra alluvium (Krishnan, 1953; Sen & Dey, 1984; Nath & Dey, 2000).

DISTRIBUTION

The fish samples were collected from the river Noadhing drainages near Namsai Lohit district. The location is about 40 km. from Tezu, the district headquarter of Lohit district. The river flows out from Chaukan Pass (1440 m, **msl**) in Tirap district and after traversing c. 205 km. from its source joins the river Lohit, the main tributary of River Brahmaputra at Saikhoaghat (27°32' N and 95°24' E) in Assam. The river at the debouching point at Miao (150 m, **msl**) in Arunachal Himalaya bifurcates into branches, one flowing through Namsai (27°30' N and 96°24' E) in Lohit district as river Noadhing and the other as river Buridhing through Bordumsa (27°29' N and 96°10' E) in Changlang district.

ETYMOLOGY

The species *Bhavana arunachalensis* is named after the state of Arunachal Pradesh. Shri Kaling Borang, Office Assistant, Department of Fisheries, collected the fish specimens during his stay at Namsai during 2004.

Table 1. : Morphometric data for *Bhavana arunachalensis* sp. nov. ($n = 8$) from River Noadhing drainage, Namsai, Lohit District, Arunachal Pradesh.

Sl. No.	Measurement details (mm) in proportion to	Range	Mean $\pm$ SD
1.	Head length (HL)	4.3–4.8	4.6 $\pm$ 0.18
	Head width	1.1–1.3	1.3 $\pm$ 0.20
	Eye diameter	8.3–10.0	8.8 $\pm$ 0.62
	Inter-orbital distance	2.0–2.6	2.2 $\pm$ 0.24
	Interorbital width/ Eye diameter	3.8–4.1	–
	Post-orbital length	1.3–1.5	1.4 $\pm$ 0.07
	Inter-nostril distance	3.0–3.4	3.1 $\pm$ 0.15
	Snout length	1.5–1.8	1.7 $\pm$ 0.04
2.	Standard Length (SL)	65.0–87.0	76 $\pm$ 8.28
	Body depth	9.0–10.2	9.7 $\pm$ 0.43
	Head Length	4.3–4.8	4.6 $\pm$ 0.18
	Predorsal length	2.0–2.2	2.2 $\pm$ 0.09
	Postdorsal length	1.5–1.7	1.6 $\pm$ 0.14
	Prepectoral length	6.5–8.7	7.8 $\pm$ 0.78
	Preventral length	2.1–2.6	2.1 $\pm$ 0.20
	Preanal length	1.2–1.4	1.3 $\pm$ 0.08
	Caudal length	4.6–5.7	5.1 $\pm$ 0.32
	Anal-fin length	9.4–11.6	10.4 $\pm$ 0.42
	Ventral-fin length	4.0–5.8	4.7 $\pm$ 0.27
	Pectoral-fin length	2.8–3.6	2.0 $\pm$ 0.29
	Dorsal-fin height	5.0–6.3	5.5 $\pm$ 0.48
	Length of dorsal-fin base	6.1–6.7	6.4 $\pm$ 0.21
	Height of caudal peduncle (HCPD)	16.0–18.0	16.9 $\pm$ 0.72
	Length of caudal peduncle (LCPD)	4.4–5.7	5.1 $\pm$ 0.45
	LCPD/HCPD	2.8–3.8	3.3 $\pm$ 0.32
	Length of pectoral-fin base	5.3–6.5	5.8 $\pm$ 0.42
	Length of ventral-fin base	6.0–8.2	6.8 $\pm$ 0.95

Table 2. : Comparative morphological distinction between *Bhavana arunachalensis* and the allied genera/species of subfamily Homalopterinae.

Sl. No.	Characters	<i>Balitora burmanica</i>	<i>Balitora brucei</i>	<i>Balitora mysorensis</i>	<i>Homaloptera bilineata</i>	<i>Homaloptera modesta</i>	<i>Homaloptera montana</i>	<i>Homaloptera rupicola</i>	<i>Travancoria jonesi</i>	<i>Bhavana australis</i>	<i>Bhavana arunachalensis</i>
1.	Body depth (BD) in SL	7.8–10.0	8.0–10.0	7.9–8.4	7.5–8.0	8.00	6.4–8.2	5.7	–	–	9.8–10.2
2.	Head length in SL	4.4–5.2	5.0–5.4	4.0–4.3	5.0	3.7–4.5	3.8–5.0	3.2–3.8	–	–	4.3–4.8
3.	Head width in HL	1.2–1.4	0.9–1.2	1.2–1.3	– (Broad shorter than long)	– (Broad shorter than long)	– (Broad equal to long)	– (Broad shorter than long)	– (Broad shorter than long)	– (Broad as long)	1.1–1.3 (broad shorter than long)
4.	Gill opening	Extends to ventral surface	Extends to ventral surface	Extends to ventral surface	Extends to ventral surface	Extends to ventral surface	Extends to ventral surface	Extends to ventral surface	Extends to ventral surface	Above base of gill opening	Above base of gill opening
5.	Eye diameter	25.0–33.0 in SI	30.0–43.0 in SL	6.0–6.2 in HL	6.5–6.8 in HL	4.2 in HL	4.5 in HL	4.0 in HL	–	–	36.0–43.0 in SL; 8.3–10.0 in HL
6.	Pectoral fins	Separated from ventral I fin	Separated from ventral fin	Separated from ventral fin	Separated from ventral fin	Separated from ventral fin	Extends to ventral fin	Extends to ventral fin	Separated from ventral fin	Separated from ventral fin	Extends beyond ventral fin base
7.	Dorsal fin	Inserted behind ventral	Inserted behind ventral	Inserted behind ventral	Ahead of ventral	Inserted opposite to ventral	Inserted behind ventral	Inserted behind ventral	Inserted behind ventral	Inserted behind ventral	Inserted opposite to ventral
8.	Lateral line	Complete	Slightly curved at ventral	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete, slightly curved at the origin of ventral
9.	Lateral line scale	62–65	61–66	64–65	64	47	72	42–45	75–77	70–75	70–75

Table 2. : (Cont'd.).

Sl. No.	Characters	<i>Balitora burmanica</i>	<i>Balitora brucei</i>	<i>Balitora mysorensis</i>	<i>Homaloptera bilineata</i>	<i>Homaloptera modesta</i>	<i>Homaloptera montana</i>	<i>Homaloptera rupicola</i>	<i>Travancoria jonesi</i>	<i>Bhavana australis</i>	<i>Bhavana arunachalensis</i>
10.	Caudal fin	Forked	Emarginate (lower lobe longer)	Emarginate	Emarginate	—	Emarginate	Emarginate	Forked	Forked	Emarginate (lower lobe longer)
11.	Size range in SL (mm)	75	105	50	40	21	70	25	80	90	65.0–87
12.	Body coloration	6 blotches at back; dark mark at dorsal, anal, caudal	Body with several blotches; caudal with bands	7 blotches at back	Band from snout to dorsal fin base; dorsal with black spots	Body with spots; 3 black spots below eyes	10 bars at back	Body with spots; fins with bands	Body with spots; fins with bands	Body with spots; fins with bands	8 nos. of blotches along back
13.	Fin formula	D.iii.8, A.iii.5, P.viii–x. 10–12, V.ii.9.	D.iii.8, A.iii.5, P.ix–x. 10–12, V.ii.9–10	D.ii.iii.8–9, A.ii.5, P.viii–x. 10–11, V.ii.9.	D.ii.7, A.ii.5, P.iv.9–10, V.ii.7.	D.ii.7, A.ii.4–5, P.v–vi.8, V.ii.6.	D.ii.7, A.ii.5, P.iv.8, V.ii.6–7	D.ii.7, A.ii.5, P.v.11, V.ii.6	D.ii.7–8, A.i.4–5, P.vi.9–10, V.ii.6–7	D.ii.7–9, A.i.5–6, P.vi–iii. 9–11, V.ii.7–8	D.ii.7. A.i.6, P.viii.11, V.iii.8

DISCUSSION

The new fish species *Bhavana arunachalensis* has a close resemblance with the lone species *Bhavana australis* especially in the presence of wing shaped paired fins; gill opening above base of pectoral fin, lateral line scales 70–75; pectoral fin rays (viii.11); dorsal fin ray (ii.7); anal fin ray (i.6); head broad and body flat upto the origin of anal fin; size range recorded 65.0–87.0 mm SL in *arunachalensis* (versus 90.0 mm SL size in *australis* of Talwar & Jhingran, 1991). But *Bhavana arunachalensis* could be differentiated from the known species *Bhavana australis* on various scores : Head with pores-like outgrowths in *arunachalensis* (versus head with spine-like outgrowths in *australis*); mouth horse-shaped, lips thin in *arunachalensis* (versus mouth small, lips thick and fleshy in *australis*); lateral line decurved at the origin of ventral fin in *arunachalensis* (versus lateral line straight in *australis*); pectoral fins extending to the base of ventral fin in *arunachalensis* (versus pectoral and ventral fins set apart in *australis*); dorsal fin shorter than paired fins, inserted nearer to tip of snout than caudal fin base in *arunachalensis* (versus dorsal fin inserted almost midway between tip of snout and caudal fin base in *australis*); caudal fin emarginate in *arunachalensis* (versus caudal fin forked in *australis*); presence of eight saddle-shaped blotches at the back in *arunachalensis* with longitudinal band between nape and tip of lower caudal lobe (versus presence of black spots on the dorsal surface with bands and bars in the fins in *australis*).

Furthermore, *Bhavana arunachalensis* apparently appears to have close affinity with *Balitora* spp. on several characters, especially in the body depth (BD) 9.0–10.2 times in SL in *arunachalensis* (versus BD 8.0–10.0 in SL in *brucei*; 7.8–10.0 in SL in *burmanica*; 7.9–8.4 in SL in *mysorensis*); HL 4.3–4.8 in SL, HB 1.1–1.3 in HL in *arunachalensis* (versus HL 5.0–5.4 in SL, HB 0.95–1.2 in HL in *brucei*; HL 4.4–5.2 in SL, HB 1.2–1.4 in HL in *burmanica*; HL 4.0–4.3 in SL, HB 1.2–1.3 in HL in *mysorensis*). But also could be reasonably differentiated at various levels : Pectoral fins overlapping ventral fin in *arunachalensis* (versus pectoral and ventral fins set apart in *brucei*, *burmanica*, *mysorensis*); lateral line scales 70–75 in *arunachalensis* (versus lateral line scales 61–66 in *brucei*; 62–65 in *burmanica*, 64–65 in *mysorensis*); anus inserted far away from anal fin in *arunachalensis* (versus anus closer to anal fin in *brucei*, *burmanica*); thoracic region with a central pit in *arunachalensis* (versus central pit absent in *brucei*); body with eight blotches at the back and longitudinal band from the base to the tip of lower caudal lobe in *arunachalensis* (versus six blotches and caudal fin with vertical bands in *burmanica*; body with several blotches extending from back to lateral sides and caudal fin with bands in *brucei*; seven blotches at the back and a diffused band along lateral line in *mysorensis*).

The diagnostic features had vividly shown that the species under report, *Bhavana arunachalensis* could be readily separated as a new species from the only one known species of *Bhavana australis* as well as other related genera/species of subfamily Homalopterinae (of Jayaram, 1981; Menon, 1987; Talwar and Jhingran, 1991; Karmakar and Das, 2005). Besides the (Table 2) morphological distinction of a few important characters between *Bhavana arunachalensis* and the known species

Bhavania australis and the other allied genera/species of subfamily Homalopterinae may perhaps ventilate some more light on the establishment of *B. arunachalensis* as a new species.

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PLATE I



Fig. 1. : *Bhavana arunachalensis* sp. nov., dorsal view.



Fig. 2. : *Bhavana arunachalensis* sp. nov., dorsal view of Head region



Fig. 3. : *Bhavana arunachalensis* sp. nov., ventral view of Head region

PLATE II



Fig. 4. : *Bhavania arunachalensis* sp. nov., Ventral view.



Fig. 5. : *Bhavania arunachalensis* sp. nov., caudal fin.



Fig. 6. : Comparision of *Balitora brucei* and *Bhavania arunachalensis* sp. Nov.



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ON SOME EARTHWORMS PRESENT IN UNNAMED COLLECTIONS OF ZOOLOGICAL SURVEY OF INDIA

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INTRODUCTION

Aristotle described some terrestrial elongated worms as 'the intestine of earth'. These are the earthworms the megadrile oligochaetes of the phylum Annelida. They are bilaterally symmetrical coelomate invertebrates having external and internal segmentations throughout the body with setae as locomotary organs present on all segments excepting the first and last ones. Their respiration takes place by the gaseous exchanges through the moist skin. They are hermaphrodite and the fertilisation of their ova is external in the cocoons formed by the material secreted from the clitellum.

Earthworms are found in various types of soils where there is sufficient food and moisture. They occur in vegetable gardens, plant nurseries, cultivated fields, orchards, grasslands, forests, *etc.* They are also found under logs and stones, and even in the axils of leaves of some plants. Some are hydrophilous and occur near waterbodies.

Earthworms are popularly known as 'friends of farmers' because of their beneficial effects in increasing the fertility of soil, recycling various kinds of organic wastes, producing vermicompost and providing animal protein as poultry and fish feed. Out of about 3300 global species some 380 species of earthworms are so far known to occur in India. *Moniligaster perrieri*, the first new species of earthworms of the Indian mainland was described by Perrier in 1872 from Kerala. Subsequently our knowledge on the taxonomy of Indian earthworms was enriched by the contributions of Michaelsen (1907 and 1909), Stephenson (1914, 1921, 1923, 1924a & b, 1925, 1926 and 1931), Gates (1934, 1937a & b, 1938a & b, 1939a & b, 1940a & b, 1945a, b & c, 1947, 1951, 1956, 1962 and 1972), Halder (1989, 1999 and 2000), Halder & Julka (19670), Julka (1975, 1976a & b, 1977, 1978, 1981, 1983, 1988a & b), Julka & Halder (1975a & b, 1977), Julka & Rao (1982), Soota (1970), Soota & Halder (1977a & b, 1980a & b and 1981), Soota & Julka (1970 & 1972).

The present report is based on the study made during April, 1999 to May, 2003 on the unnamed National Zoological Collections of earthworms from different states of India, such as, Uttar Pradesh, Arunachal Pradesh, Meghalaya, Mizoram, Maharashtra, Gujarat, Bihar, West Bengal, Orissa, Kerala, Tamil Nadu and Lakshadweep. The paper deals with 27 species belonging to 18 genera and eight families out of which 10 species are recorded for the first time from six different states of India (one species from Meghalaya, two from Arunachal Pradesh, one from Mizoram, three from Bihar, one from Gujarat and two from West Bengal).

SYSTEMATIC ACCOUNT

Phylum ANNELIDA

Class OLIGOCHAETA

A. Order MONILIGASTRIDA

I. Family MONILIGASTRIDAE

1. Genus *Drawida* Michaelsen, 1900

1. *Drawida nepalensis* Michaelsen, 1907

B. Order HAPLOTAXIDA

II. Family ACANTHODRILIDAE

2. Genus *Pontodrilus* Beddard, 1874

2. *Pontodrilus bermudensis* Beddard, 1891

III. Family LUMBRICIDAE

3. Genus *Eisenia* Malm, 1877

3. *Eisenia foetida* (Savigny, 1826)

IV. Family GLOSSOSCOLECIDAE

4. Genus *Pontoscolex* Schmarda, 1861

4. *Pontoscolex corethrurus* (Muller, 1856)

V. Family MEGASCOLECIDAE

5. Genus *Amyntas* Kinberg, 1867

5. *Amyntas diffringenes* (Baird, 1869)

6. *Amyntas morrisi* (Beddard, 1892)

*7. *Amyntas robustus* (Perrier, 1872)

6. Genus *Lampito* Kinberg, 1866

8. *Lampito mauritii* Kinberg, 1866

7. Genus *Metaphire* Sims & Easton, 1972

9. *Metaphire pagnana* (Rosa, 1890)

10. *Metaphire posthuma* (Vaillant, 1868)

8. Genus *Perionyx* Perrier, 1872

- *11. *Perionyx excavatus* Perrier, 1872
- 12. *Perionyx kempi* Stephensen, 1914
- 13. *Perionyx sansibaricus* Michaelsen, 1891
- *14. *Perionyx turaensis* Stephensen, 1920
- *15. *Perionyx vanagatus* (Michaelsen, 1907)

9. Genus *Polypheretima* Michaelsen, 1934

- *16. *Polypheretima elongata* (Perrier, 1872)

10. Genus *Tonoscolex* Gates, 1933

- 17. *Tonoscolex rnichaelseni* Julka, 1976
- *18. *Tonoscolex striatus* (Stephenson, 1914)

VI Family OCTOCHAETIDAE

11. Genus *Harogaster* Gates, 1939

- 19. *Barogaster barodensis* (Stephenson, 1914)

12. Genus *Dichogaster* Beddard, 1888

- *20. *Dichogaster affinis* (Michaelsen, 1890)
- 21. *Dichogaster bolaui* (Michaelsen, 1891)

13. Genus *Eutyphoeus* Michaelsen, 1900

- *22. *Eutyphoeus gammiei* (Beddard, 1888)
- *23. *Eutyphoeus incomodus* (Beddard, 1901)
- 24. *Eutyphoeus orientalis* (Beddard, 1883)

14. Genus *Lennogaster* Gates, 1939

- *25. *Lennogaster chittagongensis* (Stephenson, 1917)

15. Genus *Octochaetona* Gates, 1962

- 26. *Octochaetona beatrix* (Beddard, 1902)

VII. Family ALMIDAE

16. Genus *Glyphidrilus* Horst, 1889

- *27. *Glyphidrilus tuberosus* Stephenson, 1916

VIII. Family OCNERODRILIDAE

17. Genus *Gordiodrilus* Beddard, 1892

- 28. *Gordiodrilus elegans morphaski* Stephenson, 1928

18. Genus *Ocnerodrilus* Eisen, 1878

- *29. *Ocnerodrilus occidentalis* Eisen, 1878

I. Family MONELIGASTRIDAE

1. Genus *Drawida* Michaelsen, 19001. *Drcnvida nepalensis* Michaelsen, 19071907. *Drawida nepalensis* Michaelsen, *Mitt. naturh. Mus. Hamb.*, **24** : 146.

Material examined : 3 exs., Reg. No. An 3140/1, 124 km on Miao Vijaynagar Road, Tirat District, Arunachal Pradesh, 11.i.1985; coll. S. Biswas.

Distribution : INDIA : Andaman & Nicobar Islands, Arunachal Pradesh, Assam, Bihar, Himachal Pradesh, Meghalaya, Sikkim, Tripura, Uttar Pradesh and West Bengal.

Elsewhere : Pakistan; Nepal; Bangladesh; Burma and Indonesia.

II. Family ACANTHODRILIDAE

2. Genus *Pontodrilus* Beddard, 18742. *Pontodrilus burmudensis* Beddard, 18911891. *Pontodrilus burmudensis* Beddard, *Ann. Mag. nat. Hist.*, (ser. 6), **7** : 96.

Material examined : 2 exs., Reg. No. An 3239/1, River Kistna, Wai, satara District, Maharashtra; 23.iii.1931; coll. H.S. Rao. 7 exs., Reg. No. An 3245/1; Kavaratti Island, Lakshadweep; 31.iii.1984; coll. B.P. Halder & D.R.K. Sastry.

Distribution : INDIA : Andaman & Nicobar Island, Andhra Pradesh, Goa, Kerala, Lakshadweep Islands, Maharashtra, Orissa, Tamil Nadu and West Bengal.

Elsewhere : Africa; Madagascar; Sri Lanka; Maldives; Burma; Vietnam; Indonesia; Australia; Some Islands in the Pacific Ocean; USA; West Indies and South America.

Remarks : This is a peregrine species inhabiting in mud with organic matter and salt on sea shore and margins of estuaries and brackish water lakes.

III. Family LUMBRICIDAE

3. Genus *Eisenia* Malm, 18773. *Eisenia foetida* (Savigny, 1826)1826. *Enterion foetidum* Savigny, *Mem. Acad. Sci. Inst. Fr.*, **5** : 182.

Material examined : 1 ex., Reg. No. An 3163/1; around Darjeeling town, Darjeeling District, West Bengal; 7.vi.1958; coll. H. Khajuna.

Distribution : INDIA : Delhi, Himachal Pradesh, Kerala, Nicobar Islands, Sikkim, Tamil Nadu and West Bengal.

Elsewhere : Europe; Lebanon; Turkey; Afganisthan; Korea; Japan; Australia; New Zealand; North America; West Indies; South America; Some Islands in the Atlantic Ocean.

IV. Family GLOSSOSCOLECIDAE

4. Genus *Pontoscolex* Schmarda, 18614. *Pontoscolex corethrurus* (Muller, 1856)

1856. *Lumbricus corethrurus* Muller, *Abhandl. Naturgesch. Ges. Halle*, **4** : 26.

Material examined : 1 ex., Reg. No. An 3224/1; Rabindra Sadan Compound, Kolkata, West Bengal; 21.viii.1999; coll. A. Aich. 7 exs., Reg. No. An 3246/1; Suranganar Reserve Forest, Alt. ca. 2500 ft. Tamil Nadu; 23.v.1969. coll. O.B. Chhotani.

Distribution : INDIA : Andaman & Nicobar Islands, Andhra Pradesh, Gujarat, Karnataka, Kerala, Maharashtra, Meghalaya, Tamil Nadu, Tripura and West Bengal.

Elsewhere : Africa; Madagascar; Mauritius; Komoro Islands; Iran; Pakistan; Sri Lanka; Burma; Thailand; Cambodia; Malay Peninsula; Indonesia; Philippines; Borneo; USA; Mexico; Central America and South America.

V. Family MEGASCOLECIDAE

5. Genus *Amyntas* Kinberg, 18675. *Amyntas diffrigenes* (Baird, 1869)

1869. *Megascolex diffrigenes* Baird, *Proc. zool. Soc. Lond.*, **1869** : 40.

Material examined : Near the Zoo Staff Quarters, Itanagar Zoo, Itanagar, 1 ex., 15.ix.1999, coll. P.T. Bhutia & party; Road to Doimukh from Yupia, Itanagar; 1 ex., 25.viii.2000, coll. D. Dam & party. Papu Nallah, Itanagar; 1 ex., 13.xii.2000, coll. D. Dam & party. Ganga Lake and around; 1 ex., 16.xii.2002, coll. D. Dam & party; 1 ex., Reg. No. An 3127/1; 77 miles base camp, Tirap District, Arunachal Pradesh; 31.i.1987; 2 exs., Reg. No. An 3128/1; Gandhigram, Namdapha, Arunachal Pradesh; 11.ii.1987; 5 exs., Reg. No. an 3129/1, Vijaynagar, Tirap District, Arunachal Pradesh; 14.i.1987; 1 ex., Reg. No. an 3131/1; Lower Jheel Camp, Namdapha, Arunachal Pradesh; 3.ii.1987; 9 exs., Reg. No. An 3135/1; on Miao Vijaynagar Road, Tirap District, Arunachal Pradesh; 5.i.1985; 15 exs., Reg. No. An 3135/1; 77 miles camp on Miao Vijaynagar Road, Tirap District, Arunachal Pradesh; 14.i.1985; 3 exs., Reg. No. An 3137/1; 124 km on Miao Vijaynagar Road, Titap District, Arunachal Pradesh; 14.i.1985; 2 exs., Reg. No. An 3144/1, Deban, 27 km east of Miao, Tirap District, Arunachal Pradesh, 5.xii.1983; 13 exs., Reg. No. An 3146/1. Hornbill, 27 km from Miao. Tirap District, Arunachal District; 2.xii.1983; coll. S. Biswas; 7 exs., Reg. No. 3161/1, around Darjeeling town, Darjeeling district, West Bengal; 7.vi.1958; coll. H. Khajuna.

Distribution : INDIA : Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Karnataka, Manipur, Meghalaya, Sikkim, Tamil Nadu, Uttar Pradesh and West Bengal.

Elsewhere : Africa; Madagascar & its adjacent Islands; Europe; China; Korea; Japan; Sri Lanka; Nepal; Bhutan; Bangla Desh; Burma; Indonesia; Philippines; Australia; New Zealand; Some Island in the Pacific Ocean; USA; Central America; West Indies and South America.

6. *Amyntas morrisi* (Beddard, 1892)

1892. *Perichaeta morrisi* Beddard, *Proc. zool. Soc. Lond.*, **1892** : 166.

Material examined : 9 exs., Reg. No. An 3075/1; Govt. Agricultural Garden, Mohaddipur, Gorakhpur District, Uttar Pradesh; 12.vi.1989; coll. H.C. Ghosh.

Distribution : INDIA : Delhi, Maharashtra, Meghalaya, Rajasthan, Uttar Pradesh and West Bengal.

Elsewhere : Europe; Pakistan; Chinna; Burma; Thailand; Malay Peninsula; Indonesia; Honk Kong; Taiwan; Hawaii; USA; Mexico and South America.

7. *Amyntas robustus* (Perrier, 1872)

1872. *Perichaeta robusta* Perrier, *Nouv. Arch. Mus. Hist. nat. Paris*, **8** : 112.

Material examined : 1 ex., Reg. No. An 3242/1; Shillong, Meghalaya; 10.i.1961; coll. S. N. Prasad.

Distribution : INDIA : Meghalaya (present record) and West Bengal.

Elsewhere : China; Korea; Japan; Burma; Hong Kong and Taiwan.

Remarks : This is a peregrine species so far known to occur in India from West Bengal only. It is now recorded here for the first time from Meghalaya also.

6. Genus *Lampito* Kinberg, 1866

8. *Lampito mauritii* Kinberg, 1866

1866. *Lampito mauritii* Kinberg, *Ofvers. K. Vetens. Akad. Forhandl. Stockholm*, **23** : 103.

Material examined : 1 ex., Reg. No. An 3078/1, Horticulture Garden, Bhujouli, Deona, Deoria District, Uttar Pradesh, 29.vi.1989; 12 exs., Reg. No. An 3079/1, P.W.D. Bungalow compound, Gorakhpur, Gorakhpur district, Uttar Pradesh, 10.vi.1989; 2 exs., Reg. No. An 3085/1, Gobrai village, Deona district, Uttar Pradesh, 25.vi.1989; 2 exs., Reg. No. An 3089/1, Govt Agriculture Garden, Basti, Basti district, Uttar Pradesh, 16.vi.1989; 4 exs., Reg. No. An 3092/1, Sonauli, Gorakhpur district, Uttar Pradesh, 13.vi.1989; 47 exs., Reg. No. An 3096/1, Kurnala, 2 km north of Deoria Rly. Stn., Deoria district, Uttar Pradesh, 29.vi.1989; 1 ex., Reg. No. An 3097/1, Dakhin Darwaza, Basti district, Uttar Pradesh, 22.vi.1989; 32 exs., Reg. No. An 3101/1, Rudrapur, Deoria district, Uttar Pradesh, 3.vii.1989; 6 exs., Reg. No. An 3114/1, Deoria town, Deoria district. Uttar Pradesh, 27.vi.1989; coll. H.C. Ghosh; 10 exs., Reg. No. An 3149/1, Kasubari village, 11 km from Junagarh on Rajkot Road, Gujarat, 24.viii.1982; 5 exs., Reg. No. An 3151/1, Chhatral village, on Mahasana-Ahmedabad Road, Gujarat, 18.viii.1982; 8 exs., Reg. No. An 3153/1, Apnalate, ca. 25 km from Baroda, Gujarat, 21.viii.1982; 2 exs., Reg. No. An 3154/1, Demrul village on Ahmedabad-Baroda Road, Gujarat, 20.viii.1982; 3 exs., Reg. No. An 3157/1, Surendra nagar, ca. 65 km from

Ahmedabad, Gujarat, 24.viii.1982, coll. T.D. Soota. 1 ex., 3164/1, Chandipur, Orissa, 8.iii.1939, coll. Unknown. 71 exs., Reg. No. An 3167/1, Varanasi Cantt., Uttar Pradesh, 21.x.1956, coll. U.P. Survey Party (1956). 1 ex., Reg. No. An 3225/1, Indian Museum compound, West Bengal, 2.viii.1999; coll. G.C. Ray. 4 exs., Reg. No. An 3238/1, Buldana, Berar, Maharashtra, 17.iii.1931, coll. M.N. Datta.

Distribution : INDIA : Widely distributed in India. Andaman & Nicobar Island, Andhra Pradesh, Bihar, Delhi, Gujarat, Karnataka, Kerala, Lakshadweep & Minocoy Island, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal.

Elsewhere : Zanzibar; Comoro Island; Madagascar; Seychellis Isl.; Mauritius; Pakistan; China; Maldives; Sri Lanka; Bangla Desh; Burma; Thailand; Malay Panninsula; Indonesia; Philippines; Hong Kong and New Caledonia.

7. Genus *Metaphire* Sims & Easton, 1972

9. *Metaphire peguana* (Rosa, 1890)

1890. *Perichaeta peguana* Rosa, *Ann. Mus. Civ. Nat. Genova*, **30** : 113.

Material examined : 7 exs., Reg. No. An 3230/1, Rabindra Sadan Compound, Kolkata, West Bengal, 21 & 28.vii.1999; 1 ex., Reg. No. An 3231/1, Eden Gardens, Kolkata, West Bengal, 4.viii.1999; coll. A. Aich.

Distribution : INDIA : Andaman Islands and West Bengal.

Elsewhere : Burma; Thailand; Vietnam; Malay Peninsula and Indonesia.

10. *Metaphire posthuma* (Vaillant, 1868)

1868. *Perichaeta posthuma* Vaillant, *Annl. Sci. Nat. (ser. 5)*, **10** : 228.

Material examined : 11 exs., Reg. No. An 3074/1, Govt. Agriculture Garden, Mohaddipur, Gorakhpur district, Uttar Pradesh, 12.vi.1989; 8 exs., Reg. No. An 3076/1, Rajghat, Gorakhpur district, Uttar Pradesh, 9.vi.1989; 1 ex., Reg. No. An 3077/1, Basti Town, Bast district, Uttar Pradesh, 18.vi.1989; 17 exs., Reg. No. An 3080/1, P.W.D. Bungalow compound, Gorakhpur district, Uttar Pradesh, 10.vi.1989; 3 exs., Reg. No. An 3081/1, P.W.D. Bungalow compound, Deoria, Deoria district, Uttar Pradesh, 4.vii.1989; 4 exs., Reg. No. An 3082/1, Govt. Horticulture Garden, Bhujouli, Deoria, Deoria district, Uttar Pradesh, 29.vii.1989; 11 exs., Reg. No. An 3090/1, Govt. Agriculture Garden, Basti, Basti district, Uttar Pradesh, 16.vi.1989; 1 ex., Reg. No. An 3098/1, Bokhira village, Basti district, Uttar Pradesh, 21.vi.1989; 17 exs., Reg. No. An 3112/1, Dakshin Darwaza, Basti district, Uttar Pradesh, 22.vi.1989; coll. H.C. Ghosh. 24. exs., Reg. No. An 3117/1, Barabanki, district, Uttar Pradesh, 10.v.1990, coll. L.K. Ghosh. 2 exs., Reg. No. An 3150/1, Gandhinagar, Ahmedabad, Gujarat, 19.viii.1982, coll. T.D. Soota. 1 ex., Reg. No. An 3227/1, Indian Museum compound, Kolkata West Bengal, 2.viii.1999, coll. A. Aich & G.C. Ray. 1 ex., Reg. No. An 3228/1, Eden Gardens, Kolkata, West Bengal; 2.viii.1999, coll. A. Aich & P.K. Ray.

1 ex., Reg. No. An 3229/1, Rabindra Sadan compound, Kolkata, West Bengal, 21.vii.1999, coll. A. Aich. 6 exs., Reg. No. An 3253/1, Noorabad, Gwalior, Gwalior district, Madhya Pradesh, 27.vii.1987; 3 exs., Reg. No. An 3254/1, Jaderuma Dam area near Gwalior town, Gwalior district, Madhya Pradesh, 27.vii.1987; coll. A.K. Sarkar.

Distribution : INDIA : Andaman Island, Bihar, Delhi, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh, Maharashtra, Meghalaya, Orissa, Punjab, Rajasthan, Uttar Pradesh and West Bengal.

Elsewhere : Pakistan; Bangla Desh; Burma; Thailand; Vietnam; Malay Peninsula; Indonesia; Philippines and USA.

8. Genus *Perionyx* Perrier, 1872

11. *Perionyx excavatus* Perrier, 1872

1872. *Perionyx excavatus* Perrier, *Notiv. Arch. Mus. Hist. nat. Paris*, **8** : 126.

Material examined : 60 exs., Reg. No. An 3099/1, Bokhira village, Basti district, Uttar Pradesh, 21.vi.1999; 6 exs., Reg. No. An 3113/1, Ramgarh Tal, Gorakhpur, Gorakhpur district, Uttar Pradesh, 11.vi.1989; coll. R.C. Ghosh. 1 ex., Reg. No. An 3132/1, Miao, Tirap district, Arunachal Pradesh, 4.xii.1982; 2 exs., Reg. No. 3133/1, Darlak, Arunachal Pradesh, 1.iii.1984; coll. S. Biswas. 1. ex., Reg. No. An 3160/1, around Darjeeling town, Darjeeling district, West Bengal, 17.vi.1958, coll. H. Khajuria. 11 exs., Reg. No. An 3240/1, Shillong, Meghalaya, 5.xii.1962, coll. A.K. Datta. 8 exs. Reg. No. An 3243/1, Madanpur, West Champaran district, Valmiki Tiger Project, Bihar, 10.vi.1993, coll. S. Chakraborty. 6 exs., Reg. No. An 3250/1, Santanatalapadu, Ongole, Andhra Pradesh, 9.iv.1998, coll. S.K. Mukhopadhyay.

Distribution : INDIA : Andaman Islands, Arunachal Pradesh, Assam, Bihar (present record), Himachal Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal.

Elsewhere : Madagascar and its adjacent Islands; Sri Lanka; Burma; Thailand; Vietnam; Malay Peninsula; Indonesia; Philippines; Taiwan and West Indies.

Remarks : This is a endemic species originated from the Himalays and is widely distributed throughout India. It is now recorded here for the first time from Bihar also.

12. *Peroinyx kempfi* Stephensen, 1914

1914. *Peroinyx kempt* Stephensen, *Rec. Indian Mus.*, **8** : 389.

Material examined : 4 exs., Reg. No. An 3145/1, Zero Camp, Narndapha, Tirup district, Arunachal Pradesh, 24.xii.1983, coll. S. Biswas.

Distribution : INDIA : Arunachal Pradesh.

Remarks : This is a very rare endemic species so far known to occur from Arunachal Pradesh only.

13. *Perionyx sansibaricus* Michaelsen, 1891

1891. *Perionyx sansibaricus* Michaelsen, *Mitt, naturh. Mus. Hamb.*, **9** : 4.

Material examined : 12 exs., Reg. No. An 3118/1, Panhala Port ca. 12 miles west of Kolhapur, Maharashtra, 9.ix.1964; 7 exs., Reg. No. An 3119/1, Satara, Maharashtra, 1.ix.1964; 20 exs., Reg. No. An 3120/1, Panchgani, Maharashtra, 20.viii.1964; 2 exs., Reg. No. An 3122/1, Khopoli, Maharashtra, 25.ix.1964; 20 exs., Reg. No. An 3123/1, Mahabaleswar, Maharashtra, 24.viii.1964; 76 exs., Reg. No. An 3237/1, Buldana Berar, Maharashtra, 17.iii.1931; coll. M.N. Datta. 6 exs., Reg. No. An 3252/1, Panchgoni-Mahabaleswar Road, Maharashtra, 21.viii.1964, coll. K.K. Tiwari. 43 exs., Reg. No. An 3155/1, Zaderuma Dam area, near Gwalior Town, Gwalior district, Madhya Pradesh, 27.vii.1987, coll. A.K. Sarkar.

Distribution : INDIA : Delhi, Gujarat, Kerala, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu and Uttar Pradesh.

Elsewhere : Zanzibar.

Remarks : This is a peregrine species successfully settled in the northern, central, western and southern part of India.

*14. *Perionyx turaensis* Stephensen, 1920

1920. *Perionyx turaensis* Stephensen, *Mew. Indian Mus.*, **7** : 216.

Material examined : 2 exs., Reg. No. An 3138/1, 79th mile Camp on Miao Vijoynagar Road, Tirup district, Arunachal Pradesh, 4.i.1985, coll. S. Biswas.

Distribution : INDIA : Arunachal Pradesh (present record) and Meghalaya.

Remarks : This is a rare endemic species so far known to occur from Meghalaya. It is now recorded here for the first time from Arunachal Pradesh.

*15. *Perionyx variegates* (Michaelsen, 1907)

1907. *Perionychella variegates* Michaelsen, *Mitt, naturh. Mus. Hamb.*, **24** : 158.

Material examined : Sinkie River, near police colony, Itanagar, 1 ex., 8.xi.2002, coll. P.T. Bhutia & party

Distribution : INDIA : Arunachal Pradesh, Sikkim and West Bengal.

Remarks : This rare endemic species is recorded here for the first time from Arunachal Pradesh.

9. Genus *Polypheretima* Michaelsen, 1934*16. *Polypheretima elongata* (Perrier, 1872)

1872. *Perichaeta elongata* Perrier, *Nouv. Arch. Mus. Hist. nat. Paris*, **8** : 124.

Material examined : 1 ex., Reg. No. An 3156/1, Ajwa Lake ca. 2 km from Baroda, Gujarat, 21.viii.1982. coll. T.D. Soota.

Distribution : INDIA : Andaman Nicobar Islands, Andhra Pradesh, Gujarat (present record), Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu, Tripura and West Bengal.

Elsewhere : Africa; Madagascar; Comoro Island; Pakistan; Sri Lanka; Bangladesh; Burma; Thailand; Malay Peninsula; Indonesia; Philippines; Taiwan; Australia; Papua New Guinea; New Britain; New Caledonia; Hawaii; Carolines Island; Ryuku Island; Tahiti; West Indies and South America.

Remarks : This is a peregrine species successfully settled in some parts of India, and is abundant in Sundarban areas of West Bengal. Now it is recorded from Gujarat also.

10. Genus *Tonoscolex* Gates, 1933

17. *Tonoscolex michaelsoni* Julka, 1976

1976. *Tonoscolex michaelsoni* Julka, *Rec. zool. Surv. India*, **69** : 233.

Material examined : 1 ex., Reg. No. An 3139/1, Hornbill, 27 km east of Miao, Tirup district, Arunachal Pradesh, 2.xii.1983; 2 exs., Reg. No. An 3147/1, Zero Camp, 28 km north-east of Miao, Tirap district, Arunachal Pradesh, 23 & 26.xii.1983; coll. S. Biswas.

Distribution : INDIA : Arunachal Pradesh.

Remarks : This is a very rare endemic species so far known to occur from Arunachal Pradesh only.

*18. *Tonoscolex striatus* (Stephenson, 1914)

1914. *Notoscolex striatus* Stephenson *Rec. India Mus.*, **8** : 380.

Material examined : Near the Zoostaff Quarters, Itanagar Zoo, Itanagar, 1 ex., 15.ix.1999, coll. P.T. Bhutia 7 party.

Distribution : INDIA : Arunachal Pradesh.

VI. Family OCTOCHAETIDAE

16. Genus *Barogaster* Gates, 1939

19. *Barogasler barodensis* (Stephenson, 1914)

1914. *Endichogaster barodensis* Stephenson, *Rec. Indian Mus.*, **10** : 358.

Material examined : 6 exs., Z.S.I. Reg. No. An 315z/1; Vithlapug nr. Viramgram, Gujarat; 25.viii.1982; 8 exs., Z.S.I. Reg. No. An 3155/1; Barwala village about 65 km from Virsdamgram on Ahmedabad Road, 22.viii.1982; coll. T.D. Soota.

Distribution : INDIA : Gujarat and Madhya Pradesh.

Remarks : This is rare endemic species so far known to occur from only two states of India.

17. Genus *Dichogaster* Beddard, 188820. *Dichogasterter affinis* (Michaelson, 1890)

1890. *Benhamia affinis* Michaelson, *Jb. hamb. wiss. Anst.*, **7** : 29.

Material examined : ex., Z.S.I. Reg. No. An 3226/1; Rabindra Sadan compound, Kolkata, West Bengal; 21.viii.1999; coll. A. Aick

Distribution : INDIA : Arunachal Pradesh, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya and West Bengal (present record).

Elsewhere : South west Africa; Madagascar; Zanzibar; Comoro Island; Sri Lanka; Burma; Thailand; Pacific Ocean Islands; Mexico; Central America; West Indies and Brazil.

Remarks : This is a peregrine species and is recorded for first time from West Bengal also.

21. *Dichogaster bolau* (Michaelson, 1891)

1891. *Benhamia bolau*, *Jb. hamb. wiss. Anst.*, **8** : 9.

Material examined : 2 exs., Z.S.I. Reg. No. An 3102/1, Darwaza, Basti, Basti Dist, Uttar Pradesh, 22.vi.1989, coll. K.C. Ghosh.

Distribution : INDIA : Andaman & Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Gujarat, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Orissa, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh and West Bengal.

Elsewhere : Africa; Madagascar and adjacent islands; Germany; Pakistan; Sri Lanka; Bangladesh; Burma; Malay Peninsula; Vietnam; China; Hainan Island; Indonesia; Philippines; Japan; Pacific Islands; Australia; North and central America; West Indies; South America.

Genus 18. *Eutyphoeus* Michaelson, 190022. *Eutyphoeus gammiei* (Beddard, 1888)

1888. *Typhoeus gammii* Beddard, *Q. Jl. microsc. Sci.*, **29** : 111.

Material examined : 1 ex., Z.S.I., Reg. No. An 1430/1; Kolanaga, Manipur; 16.iii.1926; coll. 22 exs., Z.S.I., Reg. No. An 3126/1; Hornbill, 27 km E of Miao, Tirap Dist; Arunachal Pradesh. 2.xii.1983 : 1 ex., Z.S.I. Reg. No. An 3141/1; Bulbulia; 32 Km NE of Miao, Tirap Dist; Arunachal Pradesh; 14.xii.1983; 1 ex., Z.S.I. Reg. No. An 3143/1; ZXero camp, Namdapha, Tirap Dist; Arunachal Pradesh; 24.xii.1983; coll. S. Biswas. 1 ex., Z.S.I. Reg. No. An 3248/1, Saipum, alt. 400 m, Aizol Dist; Mizoram, 2.i.1994; coll. S.S. Saha.

Distribution : INDIA : Mizoram (Present record), Arunachal Pradesh, Assam, Meghalaya, Tripura and West Bengal.

Elsewhere : Bangladesh.

Remarks : This is an endemic species recorded here for the first time from Mizoram also.

23. *Eutyphoeus incomodus* (Beddard)

1901. *Typhoeus incommodus* Beddard, *Proc. Zool. Soc. Lond.*, **1901** : 200.

Material examined : 1 ex., Z.S.I. Reg. No. An 1431/1; Near Tundi, Dhanbad, Bihar; 14.ix.1969; 1 ex., Z.S.I. Reg. No. An 1432/1; Jungle nr. Dholkota nalla at Topchanchi Lake, Dhanbad, Bihar; 19.ix.1969; Raj Tilak. 1 ex., Z.S.I. Reg. No. An 1433/1; Patna Bihar; 27.viii.1973; coll. T.D. Soota. 19 exs., Z.S.I. Reg. No. An 1434/1; Lahaardaga, Bihar; Date of colln. ?; coll. ? 1 ex., Z.S.I. Reg. No. An 3083/1; P.W.D. compound, Gorakhpur, Gorakhpur Dist., Uttar Pradesh; 10.vi.1989; 5 exs., Z.S.I. Reg. No. An 3084/1; Gobrai village, Deoria Dist., Uttar Pradesh; 25.vi.1989; 8 exs., Z.S.I. Reg. No. An 3088/1; Govt. Agriculture Garden, Basti, Basti Dist., Uttar Pradesh; 16.vi.1989; 2 exs., Z.S.I. Reg. No. An 3091/1; Sonauli, Gorakhpur Dist., Uttar Pradesh; 13.vi.1989; 9 exs., Z.S.I. Reg. No. An 3095/1; Irrigation Bungalow compound, Deoria, Deoria, Deoria Dist., Uttar Pradesh; 4.vii.1989; 6 exs., Z.S.I. Reg. No. An 3115/1; Deona, Deoria Dist., Uttar Pradesh; 27.vi.1989; coll. H.C. Ghosh. 2 exs., Z.S.I. Reg. No. An 3142/1; zero camp, Namdapha, Zirap Dist., Arunachal Pradesh; 24.xii.1983; coll. S. Biswas.

Distribution : INDIA : Arunachal Pradesh (present record), Bihar, Haryana, Himachal Pradesh, Orissa, Punjab, Rajasthan, Uttar Pradesh and West Bengal.

Elsewhere : Pakistan.

Remarks : This is an endemic species recorded here for the first time from Arunachal Pradesh also.

24. *Eutyphoeus orientalis* (Beddard, 1883)

1883. *Typhoeus orientalis* Beddard, *Ann. Mag. nat. Hist.*, (ser 5), **12** : 219.

Material examined : 1 ex., Z.S.I. Reg. No. An 1437/1; Hazaribagh, Bihar; 30.ix.1938; coll. ? 7 exs., Z.S.I. Reg. No. An 3093/1; P.W.D. Bungalow compound, Gorakhpur, Gorakhpur Dist., Uttar Pradesh; 10.vi.1989; 4 exs., An 3094/1, Irrigation Bungalow compound, Basti, Basti Dist., Uttar Pradesh; 18.vi.1989; 1 ex., Z.S.I. Reg. No. An 3116/1; Deona, Deoria Dist., Uttar Pradesh; 27.vi.1989; coll. H.C. Ghosh. 3 exs., Z.S.I. Reg. No. An 3233/1. Eden Gardens, Kolkata; 4.viii.1999; coll. A. Aich.

Distribution : INDIA : Bihar, Tripura, Uttar Pradesh and West Bengal.

25. *Lennogaster chittagongensis* (Stephenson)

1917. *Eudichogaster chittagongensis* Stephenson, *Rec. Indian Mus.*, **13** : 411.

Material examined : 5 exs., Z.S.I. Reg. No. An 3234/1; Eden Gardens, Kolkata, West Bengal; 4.viii.1999; 2 exs., Z.S.I. Reg. No. An 3236/1; Rabindra Sadan compound, Kolkata, West Bengal; 21d.vii.1999; coll. A. Aich. 2 exs., Z.S.I. Reg. No. An 3235/1; Z.S.I., F.P.S. Building lawn, Kolkata, West Bengal; 27.vi.1999; coll. A. Aich & G.C. Roy.

Distribution : INDIA : West Bengal : Kolkata (present record), Himachal Pradesh, Jammu & Kashmir.

Elsewhere : Bangla Desh and Burma.

Remarks : This species is recorded here for the first time from West Bengal also.

26. *Octochaetona beatrix* (Beddard, 1902)

1902. *Octochaetus beatrix* Beddard, *Ann. Mag. nat. Hist.* (ser. 7), **9** : 456.

Material examined : 1 ex., Z.S.I. Reg. No. An 1439/1; Jungle nr. canary Hill, Hazaribagh, Bihar; 2 25.ix.1938; coll. ? 7 exs., Z.S.I. Reg. No. An 1440/1; Rajgir, Bihar; 8.ix.1973; coll. T.D. Soota. 3 exs., Z.S.I. Reg. No. An 1441/1; Lohardaga, Bihar; Date of colln. ?; coll. ? 1 ex., Z.S.I. Reg. No. An 1567/1; Kaatra, Udhaupur Dist., Jammu & Kashmir; 12.vii.1965; coll. T.D. Soota. 2 exs., Z.S.I. Reg. No. An 1609/1; Banjaar village, Balaghat Dist., Madhya Pradesh; 6.ix.1957; coll. B. Biswas. 1 ex., Z.S.I. Reg. No. An 3086/1; P.W.D. Bungalow compound Gorakhpur, Gorakhpur Dist., Uttar Pradesh; j1d0.vi.1989; coll. H.C. Ghosh. 1 ex., Z.S.I. Reg. No. An 3232/1; Rabindra Sadan compound, Kolkata, West Bengal, 21.vii.1999; coll. A. Aick.

Distribution : INDIA : Assam, Gujarsat, Himachal Pradesh, Karnataka, Kashmir, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Uttar Pradesh and West Bengal.

Elsewhere : Pakistan; Nepal; Burma; Malay Peninsula; Philippines.

27. *Glyphidrilus tuberosus* Stephenson, 1916

1916. *Glyphidrilus tuberosus* Stephenson, *Rec. Indian Mus.*, **12** : 349.

Material examined : 56 exs., Z.S.I. Reg. No. An 3163/1; Chandipur, Orissa; 8.iii.1939; coll. ? 121 exs., Z.S.I. Reg. No. An 3166/1; Ramgarh, Hazaribagh Dist., Bihar; 26.xi.1968; coll. Raj Tilak.

Distribution : INDIA : Bihar : Ramgarh, Hazaribagh Dist; Orissa, Tamil Nadu, Tripura, West Bengal

Remarks : This is an endemic species and is recorded here for the first time from Bihar also.

28. *Gordiodrilus elegans morph paski* Stephenson 1928

1928. *Gordiodrilus paski* Stephenson, *Ann. Mag. nat. Hist.*, (ser, 10) : 1.

Material examined : 26 exs., Z.S.I. Reg. No. An 3165/1, Khirgam near Hazaribag Town, Hazaribag District, Bihar; 26.xi.1968; coll. Raj Tilak.

Distribution : INDIA : Andaman islands, Bihar-Khirgam, hazaribag District; Kamatak, West Bengal.

Elsewhere : Burma; West Indies.

18. genus *Ocnerodrilus* Eisen, 1878

29. *Ocnerodrilus occidentalis* 1878

1878. *Ocnerodrilus occidentalis* Eisen, *Nova Acta R Soc. Sci. Upsaliensis*, 3, 10(4) : 218.

Material examined : 4 exs., Z.S.I. Reg. No. An 3244/1; Madanpur, West Champaran District, Valmiki Tigre project, Bihar; 10.vi.1993; coll. S. Chakraborty.

Distribution : INDIA : Andaman Islands, Kerala, Maharashtra, Orissa, Rajasthan, Uttar Pradesh.

Elsewhere : Rhodesia; South-west Africa; Palestine; Lebanon; Central Asia; Denmark; Pakistan; Italy; Greece; Sri Lanka; Burma; Singapur; China; Japan; Phillipines; USA and Mexico.

Remarks : This is a peregrine species originated from Central America. It has settled in some states of India and is now recorded here for the first time Bihar also.

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NEW LOCALITY RECORD OF *CARIDINA JALIHALI* MARIAPPAN & RICHARD (OUTSIDE THE TYPE LOCALITY) WITH NOTES ON DIAGNOSTIC CHARACTERS AND SEXUAL DIMORPHISM

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INTRODUCTION

Studies on the shrimp resources of the genus *Caridina* H. Milne Edwards, 1837 of Kerala is limited (Natarajan, 1942; Pillai, 1964; Tiwari and Pillai, 1968; Thomas *et al.*, 1973; Jayachandran, 2005; 2006; Jayachandran *et al.*, 2006). Recently, Mariappan and Richard (2006) have described a new species, *Caridina jalihali*, from the River Arani at Periyapalayam and a lake at Thenneri and also from ponds situated at Maduranmangalam, Marimangalam, Redipalayam, Roshan Nagar and Singaperumalkoli of Thiruvalluvar district of Tamil Nadu. This species is small sized (grows up to 29 mm). During a recent survey, the authors have collected the species from Anchal (Kollam District, Kerala State). The present paper hence forms the first report of the species outside the type locality from Kerala state. The paper reveals important taxonomic data on the comparison of characters with original description and also discusses on sexual dimorphism and the possibilities of the species for utilization as a candidate species for aquarium.

MATERIALS AND METHODS

A total of 49 specimens (males : 25, 14.0–18.0 mm; females : 15 berried and 9 non-berried, 19.5–22.5 mm) were collected from paddy fields and adjoining channels at Anchal, Kollam District, 60 km from the town along Kollam-Punalur National High Way 208. The specimens were identified based on the literature (Jalihali *et al.*, 1984; Mariappan and Richard, 2006).

OBSERVATION AND DISCUSSION

The characters of the specimens of the present collection fully agree with that of Mariappan and Richard (2006). Table 1 shows a comparison of characters of the two collections. The rostral

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formula, spinules on the different segments of 3rd and 5th pereiopods come within the reported range already made for the species. Table 2 provides details of sexual dimorphism for the species and it reveals that it exhibits sexual dimorphism in characters like, total length, length of rostrum, relation between rostrum length and post-ocular carapace length, spinules on the ischium and merus of 5th pereiopods and appendix interna and appendix masculina of 1st and 2nd pleopods. With this report the distribution range of the species has been extended further south.

The species co-habits with *C. gurneyi* Jalihal *et al.*, 1984 at Dharwar, Karnataka State (Jalihal *et al.*, 1984) and *C. weberi* var. *sumatrensis* at Madras (Mariappan and Richard, 2006). In Kerala waters, it co-habits with *C. natarajani* Tiwari and Pillai, 1968. *C. jalihali* is more benthic in habitat and *C. natarajani* occupies preferably on the upper regions of the water bodies.

The species exhibits excellent colour pattern and is in general agreement with the colour described for the species by Mariappan and Richard (2006). The authors have maintained the species in aquarium along with fishes like guppy, gold fish, angel fish and gouramy and found quite suitable for community aquarium. Therefore, this is a new addition of shrimps in aquarium. Recently a few prawns and shrimps were introduced into the aquaria *Macrobrachium latimanus*, *M. gurudeve*, *M. ornatus*, *M. idella*, *C. natarajani* by Jayachandran *et al.* (2005) and Jayachandran (2006). The advantageous characters of the present species are—

1. Beautiful steel black colouration with off-white lines on the dorsal and lateral sides
2. Scavengers, feeds on detritus and faecal matter of fishes in a community tank.
3. Benthic forms hence avoid competition with fishes for food and space
4. Do not attack other organisms in the tank
5. Compatible with other aquarium fishes

Colour photographs of the species is given for easy identification of the species and for helping those breeders who would like to propagate the species for aquarium trade (Plate I, Figs. 1, 2).

Maximum size : 18.0 mm (male), 29.0 mm (female)

In the light of the above discussion, a revised diagnosis of the species is given as : small sized shrimps, with short rostrum extending between middle of 2nd segment to the middle of 3rd segment of antennular peduncle, tip of rostrum directed forwards, dorsal margin with 15–29 teeth (usually 17–22) of which 3–6 teeth (usually 4–5) post-orbital, ventral margin with 3–9 teeth placed more towards the distal part; ischium, merus, carpus and dactylus of third pereiopod with 1, 4–5, 1 and 6–7 spinules respectively on the inner side; ischium, merus, carpus and dactylus of fifth pereiopod with 0–1, 2–4, 1 and 30–60 spinules respectively on the inner side; telson broad with or without median terminal spine, dorsal surface with 5–6 pairs of spines and distal margin with 3–5 pairs of spinules; first pleopod of male with appendix interna and uropod with 17–20 spinules on the diaeresis. The animal is steel black in colour with distinct off-white bands on the dorsal and lateral sides of the abdomen.

Table 1 A comparison of characters of *C. jalihali* Mariappan & Richard from Madras and Kerala for analyzing the regional variations if any.

Characters	<i>C. jalihali</i> Mariappan & Richard	
	Madras, Tamil Nadu	Anchal, Kerala
Length of rostrum	Rostrum moderately long, extending up to middle of 3 rd segment of antennular peduncle	Rostrum extends in between the middle of 2 nd to 3 rd segments of antennular peduncle
Rostral formula	15–29/3–9 (3–6 post-orbital) (usually 17–22/5–7 (4–5))	18–24/5–8 (5–6 post-orbital) (usually 19–21/5–7 (6))
Proportion of rostrum to post-ocular carapace	0.40 to 0.58 times	0.47 to 0.55 times
Spinules on 3 rd pereopods		
– ischium	1	1
– merus	3–4	4–5
– carpus	1	1
– dactylus	8–10 (mostly 8–9)	6–7
Spinules on 5 th pereopods		
– ischium	0	0–1
– merus	2–3	2–4
– carpus	1	1
– dactylus	32–60	42–44
Telson		
– dorsal spines	5–6 pairs (mostly 5)	5–6 pairs (mostly 5)
– distal setae	3–5 pairs	3–4 pairs
– diaeresis	17–20	18–20
Eggs		
– colour	Brown in colour	Brown in colour
– size	0.60–0.67 x 0.88–1.07 mm	0.53–0.59 x 0.83–0.94 mm
Fecundity	50–100	54–112
Colouration	Steel black with distinct white bands mid-dorsally and cross bands in the abdomen and also with evenly distributed red chromatophores	Steel black with distinct off-white bands mid-dorsally and cross bands in the abdomen. No distinct red chromatophores.
Size (mm)		
– male	12.0–15.0	14.0–18.0
– non-berried	14.0–21.0	16.0–19.0
– berried	20.0–29.0	19.5–22.5

Table 2 : Sexual dimorphism in *C. jaliwali* Mariappan & Richard

Characters	Male	Female
Length of rostrum	Rostrum comparatively short	Rostrum comparatively longer
Rostral formula	17–23/5–7 (6 post-orbital)	18–24/5–8 (5–6 post-orbital)
Proportion of rostrum to post-ocular carapace	0.53–0.57	0.45–0.55
Spinules on 3 rd pereopod		
– ischium	1	1
– merus	4–5	4–5
– carpus	1	1
– dactylus	6	6–7
Spinules on 5 th pereopod		
– ischium	0–1	0
– merus	3–4	2–3
– carpus	1	1
Pleopods		
– 1 st pleopod	Endopod with appendix interna	Endopod lacks appendix interna
– 2 nd pleopod	Endopod with appendix masculina and interna	Endopod with appendix interna only
Size	14.0–18.0 mm	16.0–22.5 mm

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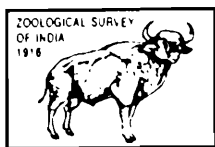
PLATE I



Fig. 1. : *Caridina jalihali* Mariappan & Richard, entire, lateral view showing colour pattern.



Fig. 2. : *Caridina jalihali* Mariappan & Richard, entire, dorsal view showing colour pattern.



Rec. zool. Surv. India : **107**(Part-3) : 101-103, 2007

Short Communication

A SYSTEMATIC NOTE ON THE GENUS *TRISSOLCUS* ASHMEAD (HYMENOPTERA : SCELIONIDAE) WITH A KEY TO SPECIES FROM INDIA

INTRODUCTION

Compared to the enormous diversity exhibited by Scelionidae in India, our taxonomic knowledge on the group is still naive. There has been no in-depth taxonomic studies on Indian Telenominae, the notable egg parasitoids of our agroecosystems. While more than 600 species of *Telenomus* Haliday and 175 species of *Trissolcus* Ashmead have been reported globally, we have only some scattered and superficial information on Indian species accounting to just about 19 of *Telenomus* and 7 of *Trissolcus* (Rajmohana, 2006).

During the course of our taxonomic studies on *Trissolcus* of India, three different species of *Trissolcus* were found bearing the same species name viz., '*indicus*' a certain case of taxonomic homonymy. They are *Trissolcus indicus* Mani (1936), *Trissolcus indicus* (Narayanan & Kaur, 1959) and *Trissolcus indicus* (Subba Rao and Chacko, 1961). At the time of publication all the three were placed in different genera, viz. *Dissolcus indicus* Mani, *Microphanurus indicus* Narayanan & Kaur and *Allophanurus indicus* Subba Rao and Chacko. Later through generic transfer by Johnson (1981, 1992) and Fergusson (1983) all the three species came under *Trissolcus* Ashmead, though no attempts were made to solve the problem of homonymy.

In the present study, the original descriptions of the three species were considered in detail, thus reconfirming the distinct species status of those species. Hence to solve the issue of homonymy, two new species names, based on their taxonomic characters, viz. *Trissolcus nigrus* (since body is black in colour) for *T. indicus* (Narayanan & Kaur) and *T. hyalinipennis* (since wings are transparent) for *T. indicus* (Subba Rao & Chacko) are hereby proposed. The original name has been retained for *T. indicus* (Mani).

Thus the seven species of *Trissolcus* in India are *T. barrowi* Dodd, *T. carinifrons* (Cameron), *T. orontes* (Nixon), *T. latisulcus* (Crawford), *T. indicus* (Mani), *T. hyalinipennis* Rajmohana & Narendran nomen. nov. and *T. nigrus* Rajmohana & Narendran nomen. nov.

Of these, *T. carinifrons* and *T. barrowi* were originally described from Dalhousie and Dehradun (India) respectively. *T. orontes*, was first recorded from Bombay, but later was also reported from Senegal by Risbec (1950). *T. latisulcus*, seen throughout the Oriental region (Johnson, 1992), was reported from South India by Ramakrishna Ayyar (1927). *T. hyalinipennis*, *T. nigrus* and *T. indicus* were originally described from Delhi.

The following dichotomous key distinguishes the seven species in India.

Key to the species *Trissolcus* Ashmead of India

1. Mesonotum posteriorly with notauli 2
 - Mesonotum posteriorly without notauli 3
2. Scutellum with coarsely rugulose sculpture; antenna predominantly yellow *T. latisulcus* (Crawford)
 - Scutellum with reticulate sculpture; antenna predominantly dark reddish brown *T. indicus* (Mani)
3. Radicle of antenna nearly half as long as scape *T. carinifrons* (Cameron)
 - Radicle of antenna distinctly less than half of scape 4
4. Frons with distinct bulges between orbital margin and antennal insertions 5
 - Frons without bulges between orbital margin and antennal insertions *T. orontes* (Nixon)
5. Scape darker and blackish, compared to radicle *T. barrowi* (Dodd)
 - Scape lighter and yellowish, compared to radicle 6
6. Metasomal T2 almost striated till tip medially *T. nigrus* Rajmohana & Narendran nomen. nov.
 - Metasomal T2 almost plain and smooth medially *T. hyalinipennis* Rajmohana & Narendran nomen. nov.

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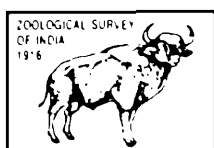
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Short Communication

THE ROTIFER FAUNA OF HIMAYATSAGAR AND OSMANSAGAR ALONGWITH OTHER ROTIFERS KNOWN FROM HYDERABAD AND NEIGHBOURHOOD, ANDHRA PRADESH, INDIA

INTRODUCTION

The rotifer fauna of India includes 325 species of which 91 are known from Andhra Pradesh (Sharma, 1996; Dhanapathi, 2000). Earlier studies on the rotifer fauna of the water bodies of Hyderabad (Andhra Pradesh) were given by Chandrasekhar (2002) and location, description of the water bodies concerned by Chandrasekhar and Kodarkar (1995). These are Hussainsagar (HS), Himayatsagar (HMS), Osmansagar (OS), Mir alam tank (MAT), Manjira lake (ML), Saroornagar lake (SN), Medchal tank (MT). Md. Arshaduddin and Khan (1991) reported some rotifers of four small ponds of the Osmania University campus (OU), which no more exist. Recently Chandrasekhar and Rajesh (2006) reported eight species from 3 ponds of 0.5 to 1 hectare of Kasu Brahmanda Reddy National Park (KBR). However there is no account of the rotifers of HMS and OS. The rotifers of these two water bodies have been studied recently during 2003, which consisted of 15 species including two species not known earlier from Hyderabad. These and earlier known rotifers of Hyderabad and neighborhood are summarized in the following table.

Species	Earlier Reports	Present Report
Class ROTIFERA Subclass MONOGONONTA Order PLOIMIDA Family BRACHIONIDAE		
1. <i>Anuraeopsis fissa</i> (Gosse)	OU	HMS
2. <i>Brachionus angularis</i> Gosse	MT, OU, SN	HMS
3. <i>B. bidentata</i> Anderson	HS, OU	–
4. <i>B. calyciflorus</i> Pallas	HS, KBR, MAT, ML, MT, OU, SN	
5. <i>B. caudatus</i> Bar. & Daday	HS, MAT, MT, OU, SN	

Species	Earlier Reports	Present Report
6. <i>B. diversicornis</i> Daday	KBR, OU	OS
7. <i>B. durgae</i> Dhanapathi	HS, MAT, ML, KBR, SN, OU	
8. <i>B. falcatus</i> Zacharias	HS, MAT, ML, MT, KBR, OU	OS
9. <i>B. forficula</i> Wierzejski	SN, OU	OS
10. <i>B. patulus</i> Müller	OU	–
11. <i>B. plicatilis</i> Müller	HS	–
12. <i>B. quadridentatus</i> Hermann	OU	HMS
13. <i>B. rubens</i> Ehrn.	HS, SN	
14. <i>Keratella cochlearis</i> Gosse	HS	HMS
15. <i>K. procurva</i> (Thorpe)	–	OS
16. <i>K. tropica</i> (Apstein)	HS, KBR, MAT, ML, MT, OU, SN	HMS
17. <i>K. volga</i> (Ehrn.)	HS	–
Family EUCHLANIDAE		
18. <i>Euchlanis dilatata</i> Ehrn.	OU	–
19. <i>Tripleuchlanis plicata</i> (Lav.)	OU	–
Family TRICHOTRIDAE		
20. <i>Trichotria tetractis</i> (Ehrn.)	OU	–
Family MYTILINIDAE		
21. <i>Mytilina ventralis</i> (Ehrn.)	HS, KBR, OU	–
Family COLURELLIDAE		
22. <i>Colurella obtuse</i> (Gosse)	OU	–
23. <i>Lepadella ehrenbergi</i> (Perty)	OU	–
24. <i>L. ovalis</i> (Müller)	OU	–
25. <i>L. rhomboides</i> (Gosse)	OU	–
Family LECANIDAE		
26. <i>Lecane (Lecane) curvicornis</i> Mur.	OU	–
27. <i>L. (L.) hastate</i> (Mur.)	OU	–
28. <i>L. (L.) ludgwigi</i> (Eck.)	OU	–
29. <i>L. (L.) luna</i> (Müller)	OU	–
30. <i>L. (L.) papuana</i> (Murray)	MAT, OU	HMS

Species	Earlier Reports	Present Report
31. <i>L. (L.) ploenensis</i> (Voigt)	OU	–
32. <i>Lecane (Monostyla) bulla</i> (Gosse)	HS, KBR, MAT, OU	HMS
33. <i>L. (M.) clostercerca</i> (Sch.)	OU	–
34. <i>L. (M.) lunaris</i> (Ehrn.)	OU	–
35. <i>L. (M.) obtuse</i> Murray	OU	–
Family NOTAMMATIDAE		
36. <i>Cephalodella gibba</i> (Ehrn.)	OU	HMS
37. <i>Scaridium longicaudum</i> (Müller)	OU	OS
Family TRICHOCERCIDAE		
38. <i>Trochocerca rattus</i> (Müller)	HS	–
Family ASPLANCHNIDAE		
39. <i>Asplanchna intermedia</i> (Hud.)	HS, MAT, OU, SN	
40. <i>A. sieboldi</i> (Sudzuku)	OU	–
Family SYNCHAETIDAE		
41. <i>Polyarthra vulgaris</i> Carliu	–	OS
Order GNESIOTROCHA		
Family FLOSCULARIDAE		
42. <i>Limnias melicerta</i> Weissa	OU	–
Family HEXARTHRIIDAE		
43. <i>Hexarthra intermedia</i> Wizneiski	HS	–
Family FILINIDAE		
44. <i>Filinia longiseta</i> (Ehrn.)	HS, MAT, OU, SN	OS, HMS
45. <i>F. opoliensis</i> Zacharias	HS, OU	–
46. <i>F. terminalis</i> (Plate)	HS, MAT, SN	
Family TESTUDINELLIDAE		
47. <i>Testudinella patina</i> (Hermann)	HMS, KBR, OU	–
Order BDELLOIDA		
Family PHILODINIDAE		
48. <i>Rotaria neptunea</i> (Ehrn.)	OU	–

The compilation reveals 48 species belonging to 20 genera from 15 families in three orders from the water bodies of Hyderabad and its neighborhood including *Brachionus durgae*, which appears to be endemic to Andhra Pradesh. Of these, 39 species were reported from OU of which 19 species were from the ponds, which no more exist and not reported from any of the water bodies mentioned herein. Of the 15 species from HMS and OS, eight are from HMS only, one from HMS and OS and two from OS only. The two species known only from OS, namely *Keratella procurva* (Thorpe) and *Polyarthra vulgaris* Carliu are newly reported from the Hyderabad water bodies.

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