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2000**

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Dr. J. R. B. ALFRED
Director
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Dr. J. R. B. ALFRED
Director
Zoological Survey of India

RECORDS OF THE ZOOLOGICAL SURVEY OF INDIA

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SEVEN NEW SPECIES OF *ETHA* CAMERON FROM ORIENTAL REGION (HYMENOPTERA : ICHNEUMONIDAE)

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INTRODUCTION

The genus *Etha* Cameron belongs to the tribe Ischinini of the subfamily Mesosteninae, family Ichneumonidae. It contains medium to large species measuring 13-15 mm in length. This small genus occurs in Oriental region (Townes, 1970 : 166; Gupta, 1987 : 787).

In Oriental region this genus is represented by three species viz. *Etha striata* (Cameron) from Kalimantan, *Etha striatiformis* Cameron from Java and India, and *Etha tuberculata* (Uchida) from Taiwan. In addition seven new species are described here from India (Karnataka, Meghalaya and Uttar Pradesh), Myanmar, China and Philippines.

SYSTEMATIC ACCOUNT

Genus *Etha* Cameron

1903. *Etha* Cameron *Mem. & Proc. Manchester Lit. Phil. Soc.*, **47**(14) : 17. Type : *Etha striatiformis* Cameron. Designated by Viereck, 1914.

1970. *Etha* Cameron : Townes, *Mem. Amer. Ent. Inst.*, **12** : 166. Syn.

Body slender. Face with a median tubercle (Fig. 1c). Clypeus of moderate size, strongly convex with apical 0.3 flattened, apical margin weakly convex without median tooth or irregularly. Malarspace about 0.5 as long as basal width of mandible. Lower tooth of mandible slightly shorter than upper tooth. Mesoscutum polished or subpolished, with small to median sized punctures, punctures dense to rather sparse, usually also with some indistinct transverse wrinkles. Notaulus sharp, reaching beyond the middle of mesoscutum. Propodeal spiracle about 2.2x as long as wide, propodeum with irregular crests or apophyses, apical carina not well defined. Front edge of hind coxa with a short horizontal groove arising from lower edge of its articulations. First tergite (Fig. 1b) with a lateral triangular tooth at base, without longitudinal carinae, second tergite mat with small dense punctures. Wing venation variable : such as the position of nervulus and nervellus; and sometimes axillula vein weakly divergent from anal margin of hind wing (Fig. 1a). Ovipositor sheath about 0.7x as long as hind tibia (Fig. 1d).

Length : Female, 13-16 mm. Fore wing 12-13 mm. Ovipositor sheath 3.75-4 mm.

Type-species Etha striatifrons Cameron

This genus can be readily recognised by having a strong to weak median tubercle on face. Clypeus without a median tooth; areolet about 0.5x as high as the length of second recurrent vein. First abdominal tergite long, terete, without longitudinal carinae and its base with lateral tooth. It shows affinities with *Ischnus* Gravenhorst, *Caenocryptoides* Uchida and other related genera of tribe Ischnini, in having a weak or strong lateral tooth or projection at the base of first tergite, and clypeus without a median tooth or irregularities.

Key to the species of *Etha*

1. Epomia strongly tuberculate near the shoulder. Facial tubercle narrow at base, high and pointed. Axillus diverging from the anal margin, its tip straight. (Mesopleurum strongly rugose; nervellus intercepted at its lower 0.4. Face black, facial tubercle yellow). 1. *flavofaciata*, sp. nov.
- Epomia normal, not tuberculate. Facial tubercle broad at base, conical, weak to moderately strong. Axillus close to wing margin, its tip curved towards the anal margin. 2
2. Head and thorax largely black, variously marked with yellow. 3
- Head and thorax largely yellow to reddish-brown, with various markings. 7
3. First abdominal tergite long, about 4x as long as wide at apex, its postpetiole 2-3x as long as wide at base. (Face yellow, clypeal groove and facial tubercle black. Nervulus opposite, nervellus intercepted slightly above the middle, mesopleurum weakly rugose). 2. *longipetiolata*, sp. nov.
- First abdominal tergite about 3x (3-3.3x) as long as wide at apex, postpetiole about 2x as long as wide at base, except in *E. flavocoxata*, 2.6x and 1.5x respectively. 4
4. Facial tubercle weak, not well developed, face medially uniformly weakly convex. Mesopleurum largely finely puncto-reticulo-wrinkled type. 5
- Facial tubercle moderately high and conical. Mesopleurum without punctures, finely wrinkled or rugoso-wrinkled type. 6
5. All coxae yellow. Apices of all the abdominal tergites and apical half of propodeum, yellow. Wings yellowish hyaline. Mesopleurum finely rugoso-wrinkled, at some places puncto-reticulate. First abdominal tergite about 2.6x as long as wide at apex. Postpetiole 1.5x as long wide at apex. 3. *flavocoxata*, sp. nov.
- All coxae, propodeum and abdomen wholly black. Wings brownish, hyaline. Mesopleurum finely to coarsely transversely striatopunctate. First abdominal tergite about 3.2x as long as wide at apex; postpetiole about 2x as long as wide at base. 4. *nigra*, sp. nov.
6. Lateral carina of scutellum not marked, antennal scape, yellow. Face usually yellow, sometimes black along clypeal groove. Nervellus variable. 5. *striatifrons* Cameron

- Lateral carina of scutellum yellow marked, antennal scape black. Face yellow with a median inverted 'Y' shaped black mark. Nervellus intercepted at the middle. 6. *flaviorbita*, sp. nov.
- 7. Mesopleurum finely rugose-wrinkled. Propodeum between apical carina and apex striato-wrinkled, between apical and basal carinae finely striato-punctate. Mesoscutum, metascutellum and basal area of propodeum of same colour as of thorax (reddish-brown). 7. *burmensis*, sp. nov.
- Mesopleurum finely rugose. Propodeum between basal carina and apex strongly coarsely trans-striate. Mesoscutum, metascutellum, and basal area of propodeum dark brown to blackish. 8. *nigromaculata*, sp. nov.

(Note : *Etha striata* (Cameron) and *Etha tuberculata* (Uchida) could not be included in the key).

1. *Etha flavofaciata*, sp. nov.

This is a distinct species by having epomia strongly tuberculate near the shoulder. Facial tubercle narrow at base, high and pointed. Axillus diverging from the anal margin, its tip straight. Face black and facial tubercle yellow.

Female : Face subpolished, indistinctly punctate in the middle, longitudinally striate at sides. Clypeus shiny, shallowly and sparsely punctate. Malarspace granulose, 0.6x the basal width of mandible. Mandible shallowly punctate. Frons subpolished, irregularly longitudinally striate in the antennal scrobes, sublaterally with fine punctures, along the eye margin smooth and shiny. Vertex shiny with sparse and minute punctures. Temple shiny, sparsely and minutely punctate. Pronotum subpolished, coarsely trans-striate in the middle groove, finely obliquely striato-punctate above, lower margin closely punctate. Epomia strong reaching up to upper margin then turned mesad, forming a tubercle above. Mesoscutum along the margins of each lobe distinctly trans-striate, middle stripe of each lobe closely punctate, punctures running into striations. Scutellum shiny with moderately deep and coarse punctures; lateral carina extending to its basal 0.5. Metascutellum smooth and shiny. Mesopleurum subpolished, largely rugoso-wrinkled, speculum with deep and coarse punctures, area below sternalus with moderately deep and close punctures, punctures near the sternalus running into trans-striations, prepectal carina extending 0.75 the height of mesopleurum. Metapleurum transversely rugoso-punctate, juxtacoxal carina not well defined. Propodeum between basal carina and apex coarsely trans-striate, basal of basal carina closely punctate, with fine circular striations. First tergite smooth and shiny with a few scattered shallow punctures, following tergites mat and subpolished. Ovipositor long, its sheath about 0.8x as long as hind tibia, its tip long and pointed. Nervulus basal of basal vein by its own width. Nervellus intercepted at its basal 0.4.

Black. Antenna with apical half of fourth segment to twelfth segment above, pure white. The following are yellow : Oval mark on median tubercle on face, face narrowly along the eye margin, clypeus, malarspace, mandible, frons along the eye margin (Fig. 1e), pronotal collar largely above, lateral tubercles on upper margin of pronotum, tegula, subtegular ridge, scutellum, metascutellum, propodeum between apical carina and apex, this mark extending towards the base in the middle, first tergite broadly at base and apex, and apices of all the following tergites. Fore and middle

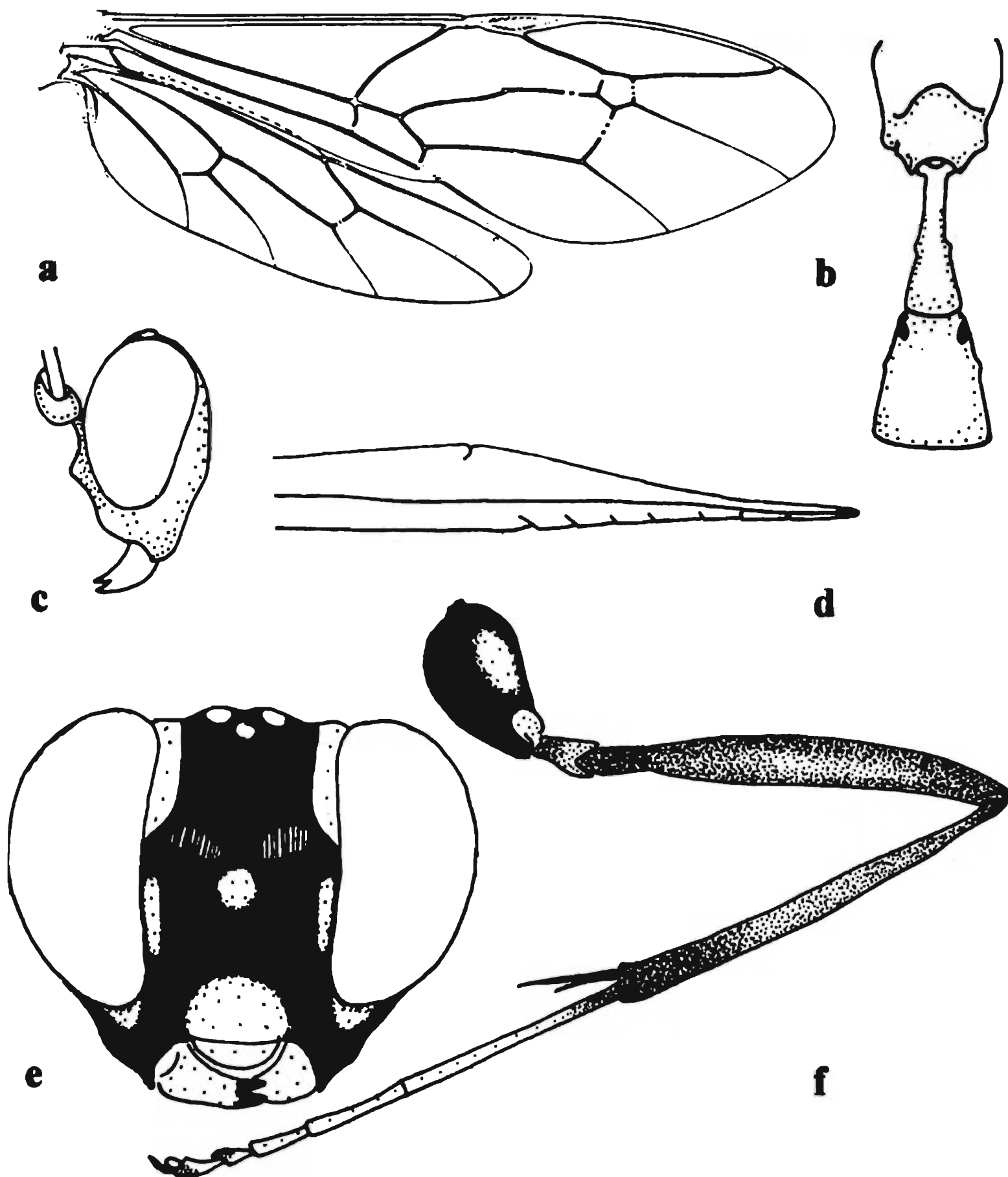


Fig. 1. *Etha* Cameron : a, fore and hind wings showing venation; b, head side view showing facial tubercle; c, dorsal view of first tergite; d, ovipositor tip. *Etha flavofaciata*, sp. nov. : colour pattern : e, front view of head; f, hind leg.

legs with their coxae and trochanters yellow, except the inner side of coxae sometimes with brown markings, rest of fore and middle legs brownish-yellow, with the apical segments of tarsi brown. Hind leg with coxa yellow except the apex irregularly black, first trochanteral segment brownish, second segment and femur almost black, tibia yellowish-brown, except its extreme base and apical 0.3 and spurs black; its tarsus white, except basal 0.2 of first and fourth, and fifth segment wholly brownish to black (Fig. 1f). Wings clear hyaline with a light yellow tinge.

Male : Essentially similar to female, except more polished and slender. Malar space 0.5x the basal width of mandible. Frons largely shiny with scattered shallow punctures in the middle and a few weak striae, rest at sides smooth and shiny. Vertex and temple shiny with a few punctures. Lateral carina of scutellum extending to its basal 0.3. Metapleurum strongly puncto-reticulate. first abdominal tergite mat and subpolished with a few punctures apico-laterally, following tergites mat and subpolished.

Black. The following are yellow : 7th - 19th flagellar segments, face almost wholly (except two sublateral stripes and along the clypeal groove dark brown), vertex along the eye margin, clypeus wholly, base of mandible, pronotal collar above and minutely below, pronotal tubercle, tegula, scutellum, subtegular ridge, metascutellum, arrow-shaped mark at the apex of propodeum, base and apex of first tergite, and apices of 2-6 tergites narrowly and seventh tergite with a median elongated mark. Legs similar to female, but colour of coxae variable, fore and middle coxae almost black to black with yellow in front, hind coxa largely black with an elongated yellow mark above.

Length : Female 13.5-16 mm; fore wing 12-13.5; ovipositor sheath 4 mm. Male, 13 mm; fore wing 9.5 mm.

Holotype Female, Philippines : Los Banos Leg., 25.x.1952, Townes family (A.E.I., Florida). **Allotype** male, Philippines : Los Banos Leg., 18.x.1953, H. & M. Townes (A.E.I., Florida). **Paratypes** 9 Females, 7 Males. Philippines : Los Banos Leg., 2 F, 1.ii.1953; 1 F, 30.i.1953; 1 M*, 1. viii. 1953 and 1 F, 25.x.1952, all Townes family; Alcate Mt victoria, Mindoro, 1 F, 9.iv.1954, H. M. & D. Townes; S. Luis Calapan, Mondoro, 1 M, 14.iv.1954, H. M. & D. Townes; Mt. Maquilling, Elev., 1 M, 10.x.1953, C. R. Baltazar. MYANMAR : Mt. Victoria, 1000m, 2 F*, 1 M, iii. 1938, Gerd Heinrich; Maymyo, 500m, 1 M, x.1937, Gerd Heinrich. W. JAVA Radjamandala, 350m, 1 M, xi.1939. All types in A. E. I., Florida, except 1 male and 1 female (*) in Z.S.I., Calcutta.

Distribution : Philippines and Myanmar.

2. *Etha longipetiolata*, sp. nov.

This species is recognised by having its first tergite about 4x as long as wide at apex, its postpetiole 2-3x as long as wide at base. Face yellow and clypeal groove and facial tubercle black.

Female : Median tubercle on face low (weak). Face subpolished largely rugulose, with fine aciculations in the middle. Clypeus dull, rugulose. Malarspace granulose, 0.8x the basal width of mandible. Mandible rugulose. Frons rugose in the middle, longitudinally striate at sides, smooth and shiny along the eye margin. Vertex mat and subpolished. Temple rugulose, subpolished; pronotum striato-wrinkled in the middle, above closely punctate, punctures running into fine striations, pronotal collar and extreme lower margin rugulose, epomia long reaching up to upper

margin but not forming tubercle. Mesoscutum subpolished, finely and densely punctate, punctures with fine transverse aciculations. Scutellum subpolished, coarsely and shallowly punctate, towards the apex smooth and shiny lateral carina extending to its basal 0.5. Metascutellum smooth and shiny. Mesopleurum subpolished, largely finely trans-rugose to striate, area just above and below sternaulus finely and closely puncto-striate, speculum shiny with moderately deep punctures and striate along the anterior margin, prepectal carina extending 0.85 the height of mesopleurum. Metapleurum largely finely transversely rugoso-punctate, juxtacoxal carina not defined. Propodeum subpolished, strongly trans-striate between basal carina and apex, basal of basal carina with moderately deep and dense punctures, punctures running into striations, at some places appears to be reticulate. First tergite 4x as long as wide at apex, post-petiole about 2-3x as long as wide at base, smooth and shiny; following tergites dull. Nervulus opposite to basal vein, nervulus intercepted slightly above the middle. Ovipositor sheath about 0.9x as long as hind tibia.

Black. Apical 0.33 of 5th to 9th antennal segments above, white. The following are yellow : Face (except median tubercle above and along clypeal groove, black), clypeus (except the apical margin), mandible (except the teeth), frons along the eye margin, malarspace and base of temple (Fig. 2a), pronotal collar, upper margin of pronotum, tegula subtegular ridge, a small quadrangular mark in the middle of scutellum. Abdomen largely yellowish-brown, except first to third tergites dorsally dark brown. Legs in general yellowish-brown. Fore and middle coxae and trochanters yellow with brown markings; hind coxa largely black except apico-ventrally brownish, femur along its upper margin, tibia at its extreme base and apex dark brown; tarsus whitish, except basal 0.6 of first segment black (Fig. 2b). Wings clear hyaline.

Male : Unknown

Length : Female, 14 mm. Fore wing 11 mm. Ovipositor sheath 5 mm.

Holotype Female and *Paratype* 1 Female, MYANMAR : Mt. Victoria, 2200 m, iv. 1938. Gerd Heinrich (A.E.I., Florida and Z.S.I., Calcutta).

Distribution : Myanmar.

3. *Etha flavocoxata*, sp. nov.

This species is close to *Etha longipetiolata*, sp. nov., but can be recognised by having first tergite short (3x) and postpetiole about 2x as long as wide at base.

Female : Face subpolished, closely and shallowly punctate, punctures running into striations, at sides rugulose. Clypeus largely smooth and subpolished, with a few scattered shallow punctures. Malarspace granulate, 0.8x the basal width of mandible. Frons moderately strongly rugoso-punctate in the middle, at sides rugulose. Vertex subpolished, weakly punctate. Temple sparsely and shallowly punctate, shiny. Pronotum largely trans-wrinkled, above densely and deeply punctate, punctures running into fine striations, epomia long, reaching up to upper margin. Mesoscutum densely punctate, along the margins of each lobe striate. Scutellum subpolished, sparsely punctate, lateral carina extending at its basal 0.2. Metascutellum smooth and polished. Mesopleurum finely rugoso-wrinkled, at some places appears to be puncto-reticulate, below subtegular ridge finely striate, speculum deeply punctate, punctures running into striations, area above sternaulus near

to prepectus with moderately deep and close punctures, prepectal carina extending 0.75 the height of mesopleurum. Metapleurum puncto-reticulate, juxtacoxal carina absent. Propodeum between apical carina and apex coarsely striate, between apical and basal carinae at sides coarsely striate and finely wrinkled in the middle, basad of basal carina with moderately deep and dense punctures, punctures running into striations. First and second tergites granulose, dull with a few scattered indistinct punctures. Nervulus opposite to basal vein, nervellus intercepted slightly below the middle. Ovipositor sheath about 0.8x as long as hind tibia.

Black. 4th to 10th flagellar segments white above. The following are yellow : Face (except a broad triangular black mark in the middle), clypeus except along the margins, frons and vertex along the eye margin, mandible except the teeth, malarspace, lower 0.5 of temple (Fig. 2c), pronotal collar, upper margin of pronotum, tegula, subtegular ridge, lateral carina of scutellum faintly, scutellum except at the apex, base of hind wing, propodeum broadly at apex, apices of 1st to 5th tergites narrowly in the middle and broadly at sides, 6th and 8th tergites broadly at sides, 7th broadly in the middle and sides and all the sternites almost wholly. Legs in general reddish-yellow, except fore and middle tarsi brown. Hind coxa at base with a small mark and apex of tibia, black, hind tarsus white, except basal 0.5 of first and fourth faintly, and fifth segment wholly black (Fig. 2d). Wings clear hyaline.

Male : Essentially similar to female, except more polished slender and weakly sculptured. Face weakly rugoso-punctate. Clypeus largely smooth and shiny. Frons rugoso-wrinkled. Vertex and temple distinctly punctate. Pronotum coarsely wrinkled, upper margin punctate with running striations. Propodeum in the middle coarsely trans-striate, towards the apex irregularly wrinkled, basad of basal carina with circular striae and with punctures in between the striae. Abdomen mat and subpolished. Nervulus slightly apicad of basal vein and nervellus intercepted slightly above the middle.

Black. 13th to 22nd flagellar segments white. Black mark on face small. Apices of all the tergites yellow. Hind leg with coxa broadly at base, apical 0.4 of tibia, basal 0.85 of first and apical 0.8 of fifth tarsal segment, black; rest of colour similar to female.

Length : Female 11.5 mm. Fore wing 8 mm. Ovipositor sheath 3.5 mm. Male, 12.5 mm. Fore wing 8.75 mm.

Holotype Female. KARNATAKA : Gunji, 573 m, 22.xi.1965, J.K. Jonathan, Coll. No. J100. *Allotype* Male, KARNATAKA : Mahabeleshwar, 1285 m, 14.xi.1965. D.T. Tikar, Coll. No. T110 (Z.S.I., Calcutta).

Distribution : India : Karnataka.

4. *Etha nigra*, sp. nov.

This species is close to *Etha flavocoxata*, sp. nov. in having nervulus opposite to basal vein, nervellus intercepted at its lower 0.45 and facial tubercle not so well developed. This species is distinguished by having first tergite 3.2x as long as wide at apex and lateral carina of scutellum, all coxae, propodeum and abdomen wholly, black.

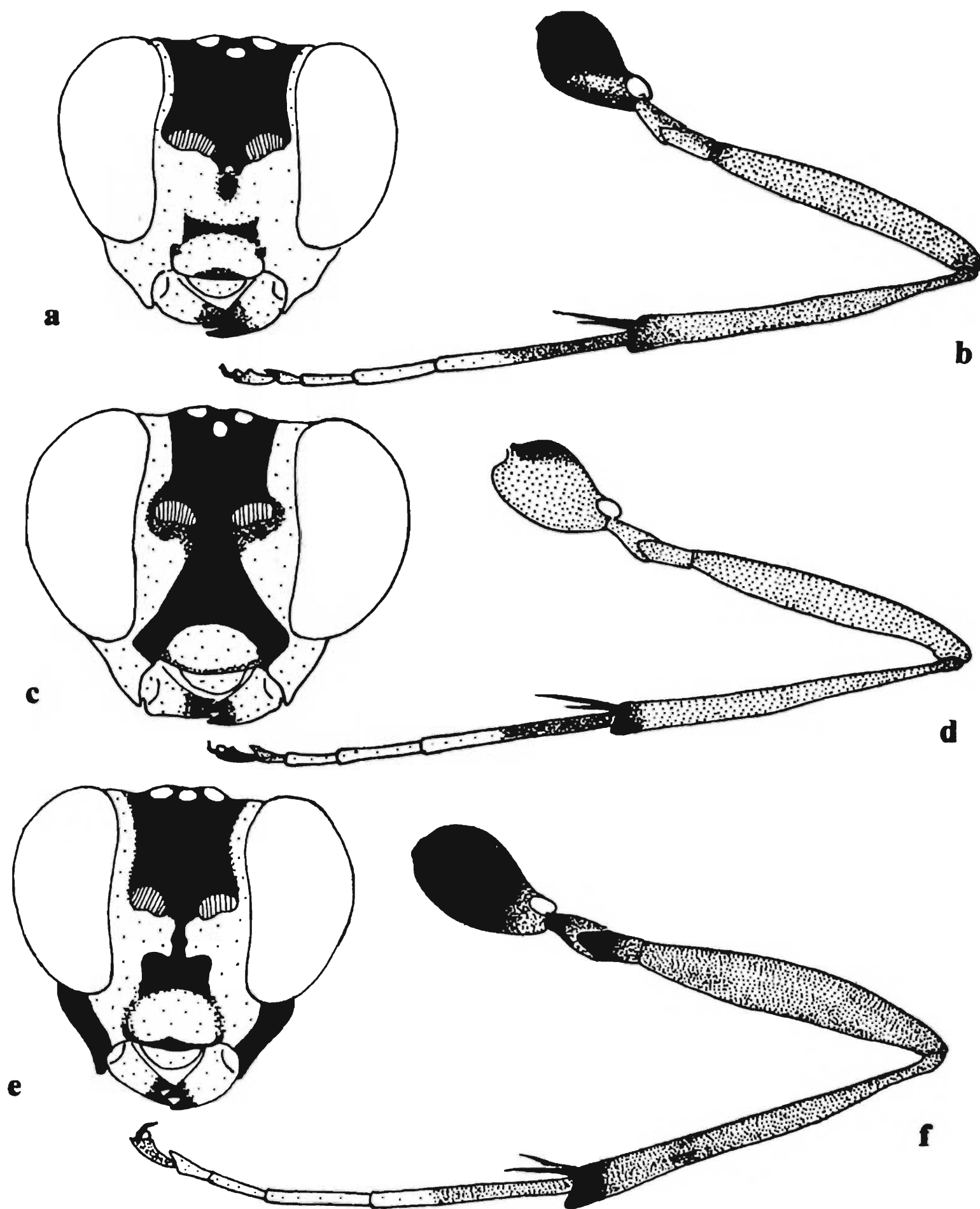


Fig. 2. *Etha longipetiolata*, sp. nov. : colour pattern : a, front view of head; b, hind leg. *Etha flavocoxata*, sp. nov. : colour pattern : c, front view of head; d, hind leg. *Etha nigra*, sp. nov. : colour pattern: e, front view of head; f, hind leg.

Female : Face subpolished, rugose-punctate in the middle, at side weakly rugose. Clypeus rugulose with a few shallow punctures in the middle. Malarspace granulose, 0.75x the basal width of mandible. Mandible shallowly punctate. Frons subpolished, finely to coarsely longitudinally striate, in between the striae in the middle with shallow punctures. Vertex shiny, somewhat shallowly punctate. Temple distinctly punctate, punctures towards the base of mandible running into striations. Pronotum subpolished, coarsely wrinkled in the scrobe, above deeply and densely punctate, punctures running into fine striations, pronotal collar also with large shallow punctures. Mesoscutum with dense, moderately large shallow punctures, punctures running into trans-striations. Mesopleurum in the middle finely to coarsely transversely striato-punctate, area below and above sternaulus closely punctate, speculum shiny with deep small punctures, striate along the anterior margin, prepectal carina extending 0.85 the height of mesopleurum. Metapleurum subpolished, finely trans-striate, punctate in between the striae, juxtacoxal carina not defined. Scutellum shiny, with coarse and shallow punctures, lateral carina extending at its basal 0.2. Propodeum between basal carina and apex coarsely trans-striate, at sides between transverse carinae deeply punctate, area basad of basal carina densely punctate, punctures small and running into circular striations. First tergite mat and subpolished, second and third tergites granulose with sparse undefined punctures, following tergites mat and subpolished. Nervulus more or less opposite to basal vein; nervellus intercepted slightly below the middle. Ovipositor long, its sheath about 0.9x as long as hind tibia.

Black. 5th to 9th flagellar segments whitish. The following are yellow : Face and clypeus (except face in the middle and along the clypeal groove and extreme apex of clypeus, dark brown to blackish), frons along the eye margin narrowly (Fig. 2e), pronotal collar above, upper margin of pronotum narrowly, tegula along the outer margin, scutellum with a squarish mark in the middle, subtegular ridge. Abdomen and legs in general black, except all the coxae at extreme apex, trochanters, femora, tibiae and tarsi, dark brown to blackish. hind tarsus whitish, except basal 0.9 of 1st and whole of 5th segment dark brown (Fig.2f). Wings clear hyaline.

Male : Unknown.

Length : Female, 14 mm. Fore wing 10.5 mm. Ovipositor sheath 4.5 mm.

Holotype Female, CHINA : Shawu Hsien, Fukein, 1200-1500 m, 6-10.v. 1943, Coll. T.C. Maa (A.E.I., Florida).

Distribution : China.

5. *Etha striatifrons* Cameron

1903. *Etha striatifrons* Cameron, *Mem. & Proc. Manchester Lit. Phil. Soc.*, **47**(14) : 18. Female, des. Type : Female, India : Khasi Hills in Meghalaya (formerly Assam) (type in Oxford museum).

1970. *Etha striatifrons* Cameron : Uchida, *Treubia*, **18** : 57. key.

1987. *Etha striatifrons* Cameron : Gupta, *Mem. Amer. Ent. Inst.*, **41**(2) : 784.

This species is close to *Etha flaviorbita*, sp. nov. in having nervulus distad of basal vein and facial tubercle moderately high and conical, but can be recognised by having lateral carina of scutellum black, face yellow. Nervellus consistently intercepted at its upper 0.4.

Female Face and clypeus subpolished. Face weakly rugose. Clypeus with moderately large and shallow punctures, interspaces about 0.5 their own diameter. Frons moderately strongly obliquely striate, with a few scattered punctures, and a median longitudinal carina extending from the base of median ocellus. Vertex mat and subpolished. Temple shiny, shallowly and closely punctate. Malarspace granulose, 0.66x the basal width of mandible. Pronotum subpolished strongly trans-striate in the middle, below striae fine and irregular, upper margin thickly punctate, and with fine striations. Mesoscutum densely punctate, punctures running into transverse striation, at some places tending to be rugose. Scutellum shiny, with deep, sparse punctures, lateral carina extending at its basal 0.75. Metascutellum smooth and shiny. Mesopleurum subpolished, finely rugoso-wrinkled, wrinkles transverse, speculum with deep punctures and trans-striation. Prepectal carina extending 0.8 the height of mesopleurum. Metapleurum finely transversely rugoso-wrinkled, at some places above appears to be reticulo-punctate, juxtacoxal carina absent. Prepodeum between apophyses and apex coarsely trans-striate, above between the basal carinae and apophyses strongly trans-wrinkled, reticulate in the middle region, basad of basal carina densely punctate, punctures running into fine circular striations. First tergite mat and dull, with a few scattered shallow punctures; following tergites mat and subpolished. Ovipositor long, its sheath about 0.8x as long as hind tibia, tip long and pointed. Nervulus slightly apicad of basal vein, nervellus intercepted little above the middle.

Black. The following are yellow Antenna with scape broadly in front, sixth to tenth flagellar segment above, face, clypeus, frons along the eye margin, temple at the basal half, mandible except the tip (Fig. 3a,c), pronotal collar above, sometimes narrowly below also, upper margin of pronotum, tegula, subtegular ridge, scutellum, metascutellum (sometimes largely blackish), metapleurum just above the middle coxa, propodeum between apophyses and at apex, this mark many be extended backward in the middle, all the abdominal segments ventrally and laterally, apices of all the tergites narrowly (Fig. 3b,d). Legs with fore and middle coxae and trochanters light yellow, their femora, tibiae and tarsi deep yellow to light brownish-yellow. Hind leg largely brownish-yellow, except coxa, trochanter and femur above with a line of dark brown; hind tibia along the upper margin and broadly at apex, dark brown, tarsus whitish-yellow, its fifth segment brown; colour of legs in general and hind leg in particular variable, sometimes becoming more darker. Wings clear hyaline, having yellowish tinge.

Variations : This species shows a high degree of variations in body structure and colour. The nervellus usually intercepted at the middle, but sometimes intercepted little below or above the middle. The face mostly yellow, but sometimes black in the middle and along the base of clypeus forming an inverted 'Y' shaped mark; middle lobe of mesoscutum at apex sometimes with an oval distinct or weak yellow mark; hind coxa reddish-brown with a black line above and apical abdominal segments becoming more reddish-brown.

Length Female, 13 mm. Fore wing 10.5 mm. Ovipositor sheath 3.75.

Specimens examined : 2 Females, INDIA : United Province, 1 F, 1949, coll. F. Bianchi, (Homotype *Etha striatifrons* Cameron, det. by H. Townes, 1958). W. JAVA : Tjibodas Godch, 1400 m, 1 F, 30.v.1937, M.A. Lieftinck, det. by H. Townes (A.E.I., Florida).

Additional specimens examined 50 Females, 25 Males. ASSAM : Rangapara : Charduar Forest, 1 M, 30.iv.1966, M.K. Kamath, No. K99. HIMACHAL PRADESH : Dalhousi, 2132m, 1 F,

27.iv.1971, M.K. Kamath, No. DH10; 1 F, 29.v.1971, J.K. Jonathan, No. JD8. Manali, 1828m, 2 M, 20-24.v.1970, M.K. Kamath, No. K222 & D. Ram, No. K235. Meghalaya (formerly Assam) : Khasi Hills : Shillong, Botanical Gardens, 1429m, 1 F, 14.v.1962, V.K. Gupta; 3 F, 27-31.iii.1966, Colls. D.T. Tikar, D. Ram & M.K. Kamath, Nos. T162, T163, K68. Cherrapunji, 1272m, 14 F, 2 M, 4-7.iv.1966, Colls. J.K. Jonathan, D. Ram, M.K. Kamath, D.T. Tikar, Nos. J122-125, T169, K77, K78 & T172-175. SIKKIM : Gangtok, 1871m, 1 F, 11.v.1966, V.K. Gupta, No. 176; 1 M, 6.v.1974, A. Ghorpade, A119. UTTAR PRADESH : Kumaon Hills : Bhowali, 1700m, 12 F, 5-10.iv.1968, V.K. Gupta, Nos. 315 & 316. Garhwal Hills : Dehra Dun, 1 F, 19.ix.1963, V.K. Gupta; 3 F, 6 M, 14-23.iii.1967, V.K. Gupta, No. 264, M.K. Kamath, no. K164. Kumaon Hills : Garjia, 2 F, 5-9.iv.1966, V.K. Gupta, No. 66, 79; 1 M, 9.iv.1968, D. Ram, No. 302; Jeolikote, 1142m, 1 F, 18.iv.1965, J.K. Jonathan, No. J20; Sat Tal, 1286m, 1 M, 6.v.1963, V.K. Gupta, No. 43; Chaubatia, nr. Ranikhet, 1942m, 1F, 16.vi.1968, V.K. Gupta, No. 321; Pawalgarh, 8 M, 11.iv.1965, Colls. D.T. Tikar, V.K. Gupta and J.K. Jonathan, Nos. T13 & 84, J13. Mohakampur, 1 M, 8.iv.1967, M.K. Kamath, No. K65. Haldwani, 1 M 14.iv.1977, P. Chand, No. P36. Mussorie, 2100m, 1 F, 22.x.1972, V. Khanna, no. V27. WEST BENGAL : Darjiling, Botanical Gardens, 1840-2142m, 3 F, 25.v.1962, V.K. Gupta; 3 F, 1 M, 4-6.iv.1966. Colls. V.K. Gupta, D.T. Tikar, Nos. 168 & 169, T234. Rangiroon nr. Darjiling, 1800m, 2 F, 25-26.v.1966, V.K. Gupta, Nos. 185 & 188.

Distribution : India : Assam, Himachal Pradesh, Meghalaya, Sikkim, Uttar Pradesh and West Bengal. Java.

6. *Etha flaviorbita*, sp. nov.

This species is distinguished from its closely related species viz., *Etha striatifrons* Cameron, by having lateral carina of scutellum marked yellow, nervellus intercepted at the middle and face with a black inverted 'Y' shaped mark (Fig. 3e).

Female : Median tubercle on face moderately high, finely punctate, face subpolished, weakly rugoso-punctate, at sides granulose. Clypeus subpolished, sparsely and shallowly punctate. Mandible transversely rugoso-punctate. Malarspace granulose 0.75x the basal width of mandible. Frons shiny, with a median longitudinal carina and on either side strong transverse ridges. Ocellar triangle densely punctate. Vertex subpolished, with coarse, close and shallow punctures. Temple shiny, indistinctly punctate. Pronotum subpolished, largely rough and trans-wrinkled, towards the upper margin distinctly punctate with obliquely running fine striations. Epomia strong reaching up to upper margin then turned mesad, forming weak lateral tubercles. Mesoscutum transversely rugoso-punctate, along the margins of each lobe distinctly striate. Scutellum shiny, sparsely and shallowly punctate, lateral carina more or less confined to its base. metascutellum smooth and shiny. Mesopleurum finely wrinkled, at some places wrinkles running transverse, speculum with moderately deep and close punctures, area below sternalus and just above it finely striato-punctate, prepectal carina extending 0.9 the height of mesopleurum. Metapleurum with moderately deep and large punctures, at some places appears to be reticulate, juxtacoxal carina not defined. Propodeum between apical carina and apex coarsely trans-striate, between the transverse carinae obliquely finely striato-wrinkled and with a few punctures, basad of basal carina with circular fine striations, and punctate in between the striae. First tergite largely smooth and shiny, with a few shallow punctures towards the apex, second tergite granulose, with dense, weak punctures, following tergites mat and subpolished. Nervulus distad of basal vein by 0.2-0.4 its length,

nervellus intercepted at the middle. Ovipositor long, its sheath about 1.0x as long as hind tibia, tip long.

Black. 5th-10th flagellar segments white above. The following are yellow : Face and clypeus (except face usually in middle with an inverted 'Y' shaped mark (Fig. 3e) and clypeus along the margin, black), mandible except the teeth, malarspace, basal half of temple, frons and temple along the eye margin, upper margin of pronotum, pronotal collar above, tegula, subtegular ridge, apical 0.5 of scutellum, lateral carina of scutellum, metascutellum, propodeum between apical carina and apex, first tergite at its basal 0.4 and narrowly at apex, apices and lateral margins of all the following tergites (Fig. 3f). Fore and middle legs in general brownish-yellow, except their coxae at extreme base blackish and their tarsi, brown. Hind leg with coxa, trochanter and femur reddish-brown, except coxa with a line above, trochanters broadly and femur with a narrow line above, black. Hind tibia brownish-yellow, with its extreme base and apex blackish, hind tarsus white, except its basal half of first segment, apical half of fourth and fifth segments wholly dark brown to blackish. Wings clear hyaline.

Male : Similar to female, except more slender and polished. Frons weakly striate. Mesoscutum densely punctate, punctures running into rugosities, along the margins of each lobe trans-striate. Propodeum between basal carina and apex irregularly wrinkled, in between the wrinkles punctate; basal of basal carina and first tergite smooth and shiny, following tergites mat and subpolished, rest as in female.

Black : 16th to 25th flagellar segments dirty white. The following are yellow Face and clypeus wholly, mandible, lower 0.6 of temple, frons and vertex along the eye margin, pronotum almost all along the margins, lateral carina of scutellum, basal 0.8 of scutellum, tegula, subtegular ridge, propodeum between apical carina and apex, apices of all the tergites and also first tergite at base, and fore and middle legs almost. Hind leg colour variable, its coxa almost black, except sometimes its apex yellow, trochanter and femur black or brownish with a broad black line above, tibia dark brown, lighter towards the base, tarsus white, except its first segment at base dark brown (most of the tarsi broken, except one tarsus with first and second segments). Wings clear hyaline.

Length : Female, 12.8 mm. Fore wing 10 mm. Ovipositor sheath 5 mm. Male, 10-12 mm. Fore wing 8-10 mm.

Holotype Female, UTTAR PRADESH : Jeolikote in Kumaon Hills, 1142 m, 18.iv.1965, D.T. Tikar, No. T21. **Allotype** Male, UTTAR PRADESH : Kumaon Hills : Garjia, Dibri Vill., 13.iv.1968, D. Ram, No. 305. **Paratypes** 2 Females, 2 Males. MEGHALAYA (formerly Assam) : Pynursla, 1257 m, in Jaintia Hills, 1 F, 11.iv.1966, J.K. Jonathan, No. J127; Kumaon Hills, 1 M, 5-20.iv.1965, no further data (Z.S.I., Calcutta). MYANMAR : MT. Victoria, 1000m, 1 F, 1 M, iii-iv.1938, Gerd Heinrich (A.E.I., Florida).

Distribution : India : Meghalaya, Uttar Pradesh. Myanmar.

7. *Etha burmensis*, sp. nov.

This species is close to *Etha nigromaculata*, sp. nov. in having head and thorax largely yellow to reddish-brown with various markings, but can be distinguished by its finely rugoso-wrinkled

mesopleurum; propodeum between the transverse carinae striato-punctate. Mesoscutum, metascutum and basal area of propodeum having same colour as that thorax (reddish-brown).

Female : Face rugulose dull. Clypeus subpolished, sparsely and shallowly punctate. Malarspace granulose, 0.6x the basal width of mandible. Frons subpolished, in the middle with circular and irregular striations, at sides sparsely and shallowly punctate. Vertex subpolished, in the ocellar triangle and behind that shallowly punctate, at side mat and subpolished. Temple shiny, with indistinct punctures. Pronotum largely trans-rugose, extreme upper margin with moderately deep and close punctures, epomia strong, reaching up to upper margin, but not forming a tubercle. Mesoscutum finely rugoso-punctate, finely striate along the margin of each lobe. Scutellum shiny, sparsely and shallowly punctate, lateral carina extending 0.6 the length of scutellum. Metascutellum smooth and polished. Mesopleurum largely weakly trans-rugose, speculum densely punctate, striate along the anterior margin, prepectal carina extending 0.75 the height of mesopleurum. Metapleurum with moderately deep and close punctures, towards metapleural fold rugoso-punctate, above near the pleural carina appears to be reticulate, juxtacoxal carina not defined. Propodeum between transverse carinae striato-punctate, between apical carina and apex striato-wrinkled, basad of basal carina in the middle densely punctate, punctures running into striation, laterally in spiracular area finely trans-striate. First tergite dull, subapically granulose with sparse and shallow punctures. Second and third tergites granulose, following tergites mat and subpolished. Nervulus opposite to basal vein, nervellus intercepted at the middle. Ovipositor long, its sheath about 0.8x as long as hind tibia.

Black. Apical 0.3 of 4th to 11th segment of antennal flagellum whitish above. The following are yellow : Scape in front, face, clypeus, mandible, malarspace, basal 0.5 of temple, frons along the eye margin, sometimes scutellum at apex, apices of second to fifth tergites narrowly and at sides broadly. Thorax largely reddish-brown (Fig. 3g). Fore and middle legs in general brownish-yellow, their coxae with a mark above and tarsi wholly dark brown. Hind leg with coxa yellowish-brown with a black broad and elongated mark above; trochanter, femur and tibia largely dark brown to blackish; tarsus white, except extreme base of its first and apex of fifth segment blackish. Wings clear hyaline, with yellowish tinge.

Male : Similar to female, except more slender and polished. Frons irregularly wrinkled. Vertex minutely punctate. Temple shiny, with indistinct sparse punctures. Mesoscutum largely densely punctate, striate along the margins of each lobe. Matapleurum reticulo-punctate. Propodeum largely moderately and strongly rugose, baso-laterally weakly rugose and punctate. First tergite subpolished and smooth, except for a few scattered punctures. Nervullus opposite or little apicad of basal vein, nervellus intercepted at or slightly above the middle.

Colour similar to female except 17th-25th antennal segments whitish; thorex largely reddish, with pronotum broadly in the middle, mesoscutum, metapleurum in the middle, propodeum largely, dark brown; sometimes hind coxa entirely dark brown to blackish.

Length : Female, 13 mm. fore wing 10 mm. Ovipositor sheath 3.75 mm. Male, 9.5-13 mm. Fore wing 7.5-9.5 mm.

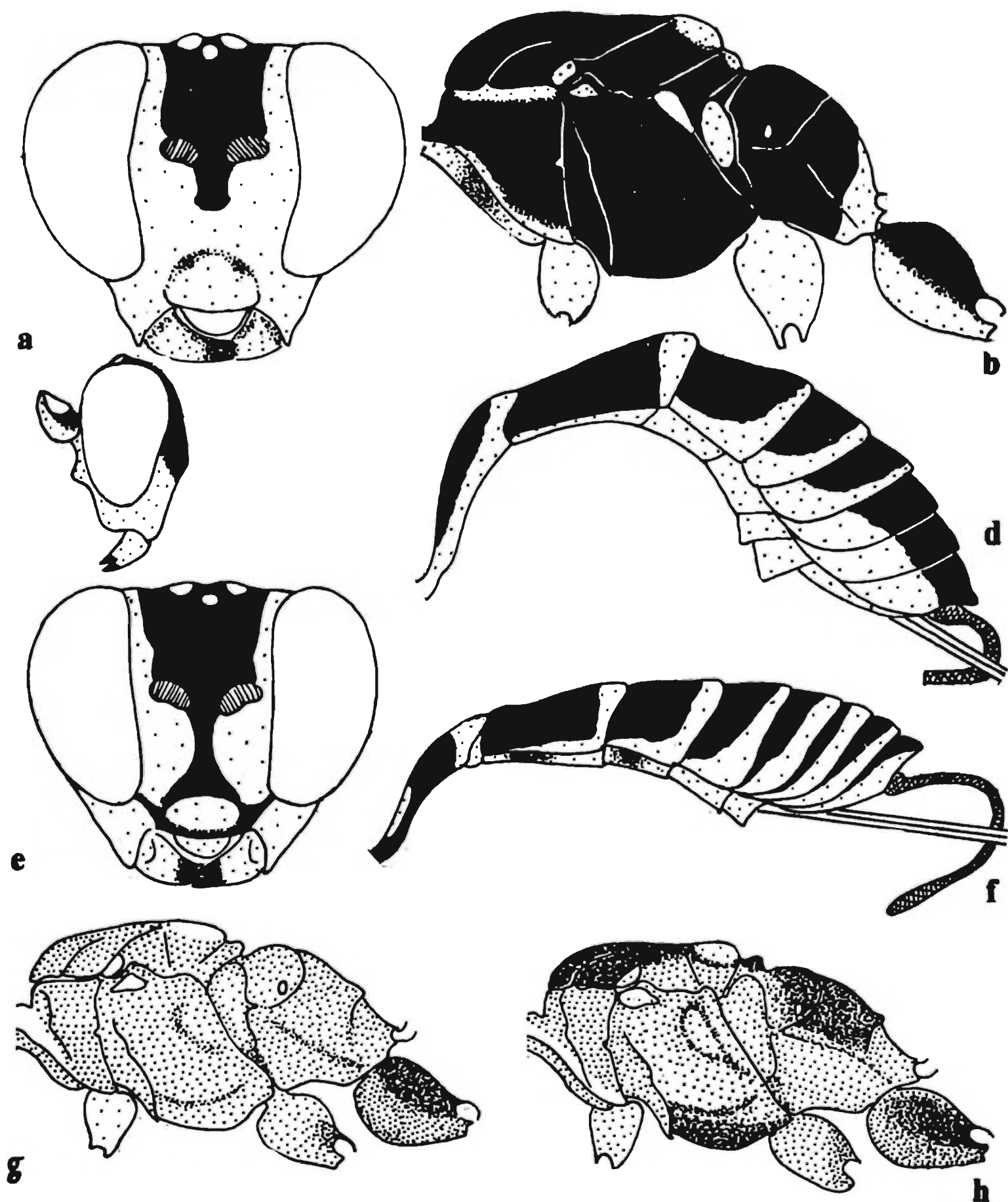


Fig. 3. *Etha striatifrons* Cameron : colour pattern; a, front view of head; b, side view of thorax; c, side of head; d, side view of abdomen. *Etha flaviorbita*, sp. nov. colour pattern : e, front view of head; f, side view of thorax. *Etha burmensis*, sp. nov. : g, side view of thorax showing colour pattern. *Etha nigromaculata*, sp. nov. : side view of thorax showing colour pattern.

Holotype Female and *Allotype* Male, MYANMAR : Mt. Popa, 600-1000m, xi.1937, Coll. Gerd Heinrich (A.E.I., Florida). *Paratypes* 3 Females, 4 Males. Same data as above, 2 F, 3 M (A.E.I., Florida); 1 F, 1 M, same data as above, x.1937 (Z.S.I., Calcutta).

Distribution : Myanmar.

8. *Etha nigromaculata*, sp. nov.

This species can be recognised from its allied species, viz., *Etha burmensis*, sp. nov. by having mesopleurum finely rugose. Propodeum largely trans-striate. Mesoscutum, metascutum and basal area of propodeum dark brown to blackish.

Female : Face subpolished, ruguloso-punctate, rugae radiating from median tubercle, at sides granulose with sparse shallow punctures. Clypeus subpolished, sparsely and shallowly punctate. Mandible subpolished, with sparse and shallow punctures. Malarspace granulose, 0.6x the basal width of mandible. Frons shiny with descending strong ridges from median ocellus, towards the antennal sockets trans-striate, a few punctures present in between the striae, at sides sparsely punctate. Ocellar triangle deeply punctate. Vertex behind ocellar triangle closely punctate. Temple shiny, distinctly punctate. Pronotum subpolished, in the scrobe finely wrinkled, upper 0.5 with deep and close punctures; pronotal collar rugoso-punctate, epomia strong, reaching upper margin then turned mesad. Mesoscutum densely punctate, punctures at some places coalescent with wrinkles, along the margins of each lobe finely striate. Scutellum sparsely and shallowly punctate, punctures, coarse, lateral carina extending to its basal more than 0.5. Metascutellum smooth and polished. Mesopleurum finely rugose in the middle, above with a few close punctures, area just above sternaulus near prepectal carina and below sternaulus finely and closely punctate, speculum shiny with small deep and close punctures, and striate along the anterior margin, prepectal carina extending 0.85 the height of mesopleurum. Metapleurum finely transversely rugoso-striate, with a few weak punctures above near pleural carina. Propodeum shiny, moderately strongly trans-striate between basal carina and apex, basad of basal carina deeply punctate. First tergite smooth and subpolished; second tergite granulose with sparse and shallow punctures, following tergites mat and subpolished. Nervulus slightly apicad of basal vein, nervellus intercepted near its 0.5. Ovipositor sheath about 0.8x as long as hind tibia.

Black : 5th to 10th flagellar segments white above. Scape, face, clypeus, mandible, malarspace, lower 0.5 of temple, frons and vertex along the eye margin, yellow. Thorax reddish-brown, except pronotal collar, upper margin of pronotum, subtegular ridge, tegula, basal 0.7 of scutellum, yellow. Mesoscutum almost wholly, apical 0.3 of scutellum, metascutellum, mesosternal area below sternaulus, propodeum at base and sublaterally black (Fig. 3h). Fore and middle legs brownish-yellow, their 5th tarsal segments dark brown. Hind leg reddish-brown, except coxa with an elongated line above, trochanters largely, femur above, tibia at extreme base and apex, blackish; its tarsus white except first segment at base black (4th & 5th segments broken). Abdomen with first tergite at base, all the tergites narrowly at apex and abdomen laterally narrowly on second and third tergites and more broadly towards the apex, yellow. Wings clear hyaline.

Male : Similar to female except more slender and polished. Face densely and shallowly punctate. Clypeus largely smooth. Frons with a few wrinkles and striations. Vertex and temple

shiny, sparsely and shallowly punctate. Pronotum trans-striate, upper area obliquely striato-punctate. Mesoscutum densely punctate, striate along the margins of each lobe. Scutellum sparsely punctate. Mesopleurum in the middle rugoso-punctate, striato-punctate above towards subtegular ridge and towards middle coxa, speculum shiny with deep coarse punctures, area below sternaulus distinctly punctate. Metapleurum with moderately large, deep and dense punctures. Propodeum between basal carina and apex coarsely trans-striate, basad of basal carina with fine circular striations, in between the striae punctate. First tergite smooth and shiny with a few (6-10) scattered punctures, following tergites mat and subpolished.

Length : Female 15.5 mm. Fore wing 13 mm. Ovipositor sheath 5 mm. Male, 12.25 mm. Fore wing 9.5 mm.

Holotype Female, and *allotype* Male, India : MEGHALAYA : Cherrapunji, 1272 m, in Khasi Hills (formerly Assam), 7.iv.1966. Colls. M.K. Kamath, Coll No. K 79 and J.K. Jonathan, Coll. No. J 125. (Z.S.I., Calcutta).

Distribution : India : Meghalaya.

9. *Etha striata* (Cameron)

1905. *Hadrocryptus striatus* Cameron *J. Straits. Branch Roy, Asiatic Soc.*, **44** : 150. Female, des. Lectotype (designated by Townes, Townes & Gupta, 1961). Female, Malaysia : Sarawak : Kuching (Type in B.M.N.H.).

1961. *Etha striata* : Townes, Townes & Gupta, *Mem. Amer. Ent. Inst.*, **1** : 167. Lectotype design., n. comb. Sarawak.

Diagnostic characters body 12mm, largely black. The following are white : clypeus, antennal joints 5-14, scutellum, postscutellum, apical slope of metanotum, 1-4 abdominal segments apically and basal 0.3 of first segment. Legs whitish, except all coxae, trochanters, hind femora, 5th joint of hind tarsi and 1-2 joints of fore and middle tarsi, black.

Facial tubercle longer than broad. Body largely striate to transversely striato-wrinkled; areolet large, squarish; wings clear hyaline.

Remarks : This species is known only from Kuching in Sarawak, Malaysia.

10. *Etha tuberculata* (Uchida)

1932. *Cryptus tuberculatus* Uchida *J. Fac. Agri. Hokkaido Imp. Univ.*, **33** : 168. Female, des. (Lectotype design. by Townes, Townes & Gupta, 1961) Female, Taiwan : Talin (= Taihorin) (type in Eberswalde museum).

1961. *Etha tuberculata* : Townes, Townes & Gupta, *Mem. Amer. Ent. Inst.*, **1** : 167. n. comb. Taiwan.

Distribution : Taiwan : Taihorin.

Remarks : Very little is known about this species, except the type specimen.

SUMMARY

This paper deals with ten species of *Etha* Cameron from Oriental Region. Of these, seven species viz., *E. flavofaciata*; *E. longipetiolata*; *E. flavocoxata*; *E. nigra*; *E. Flaviorbita*; *E. burmensis* and *E. nigromaculata* have been described as new to science.

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THREE NEW SPECIES OF *MYRMELEONOSTENUS* UCHIDA FROM INDIA (HYMENOPTERA : ICHNEUMONIDAE)

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INTRODUCTION

The genus *Myrmeleonostenus* Uchida belongs to the tribe Ischnini of the subfamily Mesosteninae, family Ichneumonidae. It contains small to medium sized species with moderately stout body, measuring 4.5 to 11 mm in length.

This genus is known to occur in Indo-papuan and southern part of Palaearctic Region. Townes (1970 : 196) referred to this genus 3 species viz., *Myrmeleonostenus babai* Uchida and *M. secundus* Momoi from Japan, and *Cryptus italicus* Gravenhorst from Europe and Siberia.

This genus is recorded here for the first time from India. Three new species are described here from India (Bihar, Himachal Pradesh, Jammu & Kashmir, Maharashtra and Uttar Pradesh).

SYSTEMATIC ACCOUNT

Genus *Myrmeleonostenus* Uchida

1936 *Myrmeleonostenus* Uchida *Insecta Matsumurana*, 10 : 116. Type species : *Myrmeleonostenus babai* Uchida. Original designation.

1970 *Myrmeleonostenus* Uchida : Townes, *Mem. Amer. Ent. Inst.*, 12 : 196. syn.

Body of moderate proportions, with stout thorax and first tergite moderately long and slender. Clypeus moderately small, about 2-4x as wide as long, with a subpyramidal convexity at centre, its apex convex or subtruncate, without a median tooth. Malarspace about 1.8x as long as basal width of mandible. Mandibles short and wide, its lower tooth a little shorter than upper tooth. Mesoscutum polished with small dense and deep punctures; notauli reaching up to the center of mesoscutum. Propodeal spiracle usually long and slit-like, atleast 2x as long as wide, apical carina of propodeum complete, moderately strong, sublaterally forming weak crests. Hind coxa without a groove at base on its basal or outer side. First tergite usually long and slender, sometimes short and stout, with or without a tooth at base, with 3 pairs of longitudinal carinae, these may be obsolete or obsolescent on postpetiole. First sternite opposite to spiracle or

extending more than 0.5 the distance between spiracle and apex. Second tergite mat to polished, its punctures small or fine, rather dense. Wing venation as figure (1a,b). Ovipositor sheath about 1.0x as long as hind tibia, ovipositor weakly compressed (Fig. 1c).

Length 6.5-11 mm. Fore wing 4.5-8.5 mm. Ovipositor sheath 3.5-4.5 mm.

Type species *Myrmeleonostenus babai* Uchida.

Host Myrmeleontidae.

The Indian species can be distinguished by the following key :

Key to the Species of *Myrmeleonostenus*

1. First tergite about 3.5x as long as wide at apex. Postpetiole 2x as long as wide at base. First tergite without lateral tooth at base. First sternite extending 0.5 the distance between spiracle and apex. (Two small elongate mark on mesoscutum, yellow; mesopleurum wholly black. Propodeum with an inverted V-shaped mark. First tergite and legs in general, red). 1. *longipetiolatus*, sp. nov.
- First tergite about 2.5x as long as wide at apex. Postpetiole 1.6x as long as wide at base. first tergite with or without a weak lateral tooth or angulation at base. First sternite extending less than 0.4 the distance between spiracle and apex..... 2
2. Face sublaterally rugoso-punctate. Malarspace about 1x the basal width of mandible. First tergite laterally smooth and shiny, except for a few weak punctures. Nervulus distad of basal vein. Face entirely yellow. Mesopleurum, metapleurum, propodeum and first segment largely red..... 2. *flavomaculatus*, sp. nov.
- Face uniformly densely punctate. Malarspace 0.75x the basal width of mandible. First tergite laterally with transverse ridges at base. Nervulus opposite to basal vein. Face black, marked with yellow. Mesoscutum with a median oval yellow mark. Mesopleurum, metapleurum, propodeum and first tergite largely, black. 3. *nigrimaculatus*, sp. nov.

1. *Myrmeleonostenus longipetiolatus*, sp. nov.

This is a distinct species having first tergite about 3.5x as long as wide at base, postpetiole 2x as long as wide at base, without lateral tooth at base. Mesopleurum wholly black and legs in general red.

Female : Face mat, with small dense punctures in the middle, at sides punctures weak and not well defined. Clypeus subpolished with closely placed punctures at its basal half, apical half smooth and shiny, except for a few scattered punctures. Mandible with minute dense punctures. Malarspace granulose about 0.75x the basal width of mandible. Frons subpolished, in the middle with small dense punctures, punctures running into rugosities, at sides along the eye margin largely smooth, a short shallow median groove present extending from the median ocellus. Vertex and temple subpolished with moderate sized and deep punctures, interspaces more than their our

diameter, punctures in ocellar triangle dense. Pronotum in the groove and below strongly transverse, its upper margin strongly and deeply punctate, pronotal collar with minute, sparse and weak punctures, epomia short, but strong. Scutellum shiny, with coarse shallow and moderately spaced punctures; lateral carina extending at its basal 0.2. Metascutellum smooth and polished. Mesopleurum largely ruguloso-wrinkled, area between subtegular ridge to speculum with deep, moderately large coalescent punctures, punctures running into striations. Mesosternum and area above sternaulus with small dense punctures, prepectal carina extending 0.7 the height of mesopleurum. Metapleurum rugoso-wrinkled, jutacoxal carina present. Propodeum apicad of apical carina moderately strongly wrinkled, between apical and basal carina with strong oblique ridges, basad of basal carina with small, deep and dense punctures. First tergite about 3.5x as long as wide at apex, tergite largely smooth and subpolished, except distinctly punctate at apex, tergite without lateral tooth, postpetiole about 2.0x as long as wide at base, sternum extending about 0.5 the distance between spiracle and base, second tergite mat, with fine dense punctures, following tergites mat and subpolished. fore wing with nervulus opposite to basal vein and strongly reclivous, areolet large, about as high as wide, nervellus in hind wing intercepted at its lower 0.2, axillul vein straight, prallel to wing margin.

Black. 5th-10th flagellar segments white above. The following are yellow : Face with an oval mark in the middle, orbital stripe all along the eye margin on face and frons (Fig. 1d), clypeus except the apical region, temple along the eye margin, pronotal collar, an oval mark at the upper margin, two small elongated mark in the middle of mesoscutum, scutellum, metapleurum, an inverted V-shaped mark on propodeum (Fig. 1e,f), apices of all the abdominal tergites. First tergite and legs in general red, except all the coxae with yellow marks, apex and base of hind tibia, middle and hind tarsus almost wholly brown to dark brown, wings clear hyaline.

Male : Essentially similar to female, except more slender and finely sculptured. Face, clypeus and frons with small, close to dense punctures, punctures on frons running into striations. Vertex and temple weakly punctate. Mesopleurum striato-wrinkled in the middle. Metascutellum shallowly punctate. Second tergite mat and dull with fine setiferous punctures (abdomen beyond 3rd tergite broken).

Black. Antennae without band. Face and clypeus wholly, frons and temple along the eye margin, yellow; rest of markings on thorax similar to female, except that the mark on metapleurum and propodeum much broad. First tergite black, fore and middle coxae and trochanters entirely yellow; all femora reddish; all tibiae and fore tarsus, yellowish-brown, except hind tibia broadly at apex and narrowly at base, dark brown; hind tarsus wholly and apical segment of fore and middle tarsus brown; abdominal tergites with usual apical yellow bands.

Length : Female, 6.5-10 mm. Fore wing 4.5-7.5 mm. Ovipositor sheath 3.5-4 mm. Male, about 8 mm. fore wing 6 mm.

Holotype Female and **Allotype** Male, INDIA : UTTAR PRADESH : Garjia, 610m, 26-29.iv.1969 and 22.iv.1967, V.K. Gupta, Nos. 268 & 335. **Paratypes** 9 Females, 1 Male. INDIA : ASSAM : Rangapara, Sonajuli Tea Estate, 1 M, 24.iv.1965. D. Ram, No. T198. UTTAR PRADESH : Gargia 610m, 2 F, 26-29.iv.1969, V.K. Gupta, No. 335; 1 F, 5.iv.1965, J.K. Jonathan, No. J1 (this female in A.E.I., Florida); Harbertpur, 1 F, 14.iv.1967, Tek Chand, No. J214; Dehra Dun, New Forest, 1 F,

15.vi.1962, V.K. Gupta, No. 13. HIMACHAL PRADESH Dharmshala, 1700 m (formerly in Punjab), 1 F, 12.vi.1963, V.K. Gupta. KARNATAKA Anmod, 600 m, 1 F, 27.xi.1965, M.K. Kamath, No. K50. BIHAR Namkum nr. Ranchi, 1 F, 3.i.1956, V.K. Gupta. MAHARASHTRA : Nechal, Satara dist. in Western Ghats, 1 F, 30.iv.1912, F.H. Gravely (Cameron in 1946, det. as *Etha rufopetiolata* Cameron) (Z.S.I., Calcutta).

Distribution India : Assam, Bihar, Himachal Pradesh, Karnataka, Maharashtra and Uttar Pradesh.

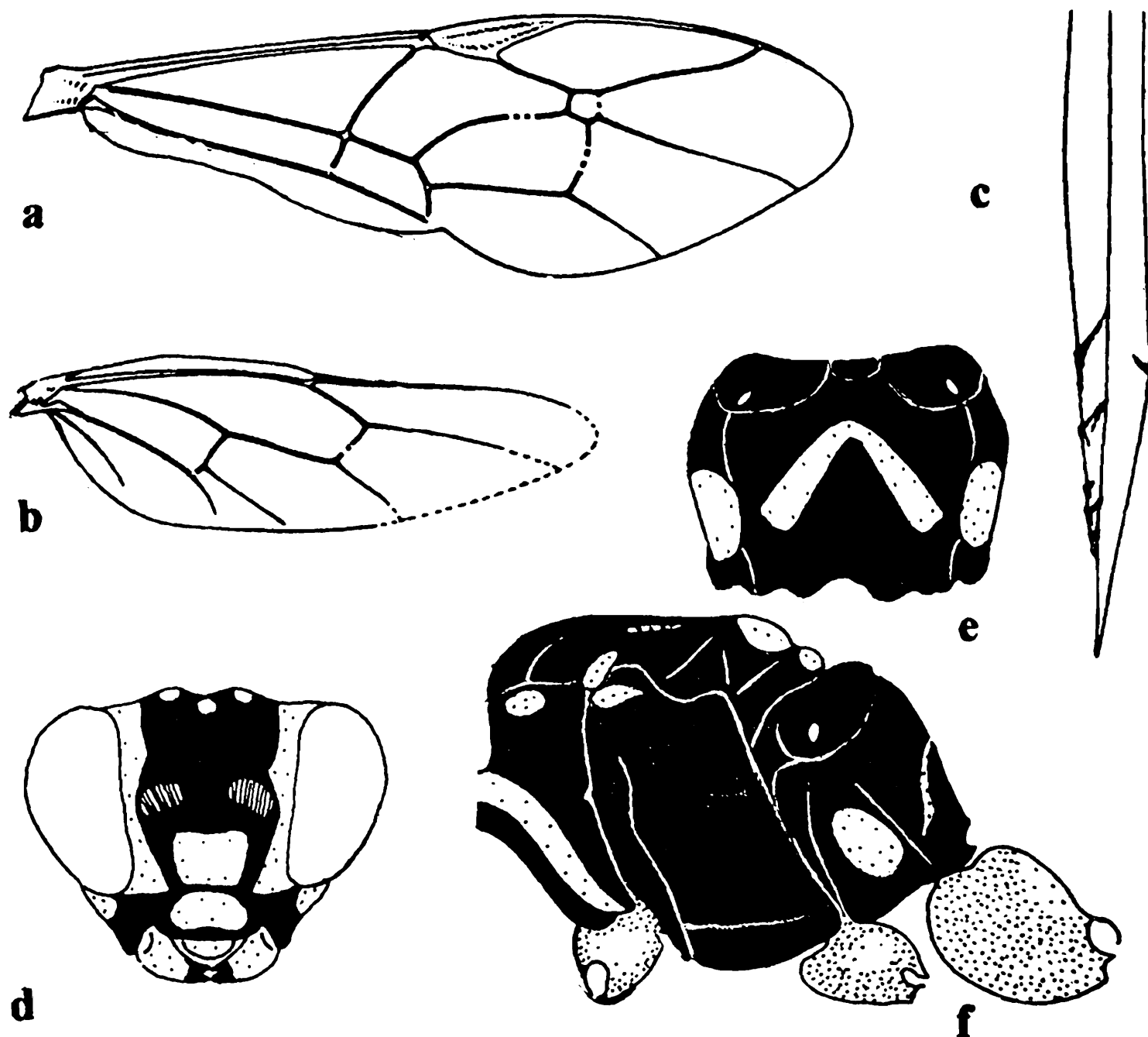


Fig. 1. *Myrmeleonostenus* Uchida a, b, fore and hind wings showing venation; c, ovipositor tip. *Myrmeleonostenus longipetiolatus*, sp. nov. : colour pattern d, front view of head; e, dorsal view of propodeum; f, side view of thorax.

2. *Myrmeleonostenus flavomaculatus*, sp. nov.

This species is close to *M. nigrimaculatus*, sp. nov. by having first abdominal tergite about 2.5x as long as wide at apex and first sternite extending less than 0.4x the distance between spiracle and apex. It is readily distinguished by having face rugoso-punctate, face entirely yellow; mesopleurum, metapleurum, propodeum and first abdominal segment largely, red.

Female : Face subpolished, with small sized, dense, shallow punctures. Clypeus subpolished, its basal half with small, close to sparse shallow punctures, at apex smooth and shiny. Malarspace granulate, about 1.0x the basal width of mandible. Base of mandible with indistinct punctures. Frons subpolished, having moderate sized, deep and closely placed punctures, punctures in the middle dense and running into wrinkles, median longitudinal groove short and shallow. Vertex and temple with moderate sized and closely spaced punctures. Pronotum subpolished, scrobe with strong trans-wrinkles, pronotum above with moderately large, deep and dense punctures, punctures running into wrinkles, pronotal collar weakly striato-punctate, epomia short and not defined due to wrinkles. Scutellum subpolished, coarsely and shallowly punctate, punctures close at apex, sparse at base, lateral carina extending about 0.5 its lengths. Metascutellum with a few shallow punctures. Mesopleurum along the oblique line drawn from the subtegular ridge to middle coxa finely rugose, subtegular ridge, and area below the ridge, specular area above sternaulus in front and sternum with small punctures, punctures dense and forming fine wrinkles, prepectal carina extending 0.75x the height of mesopleurum. Metapleurum rugose, juxtacoxal carina not defined. Propodeum subpolished, between basal carina and apex finely wrinkled, basal of basal carina with small deep punctures, punctures at sides near spiracles dense, basal carina sublaterally obsolescent. First tergite about 2.5x as long as wide at apex, at base with triangular lateral tooth, tergite shiny its postpetiolar area with closely spaced punctures, postpetiole about 1.6x as long as wide at base, sternite extending less than 0.4 the distance between spiracle and apex. Second and third tergites mat with small and close punctures, fourth tergite mat with setiferous punctures, following mat and sub polished. Fore wing with nervulus little apicad of basal vein, vertical. Nervellus intercepted at its lower 0.25, axilus parallel, its tip curved towards the margin.

Black. 2nd to 13th flagellar segments white above. The following are yellow : Scape, face, clypeus, mandible except the teeth, malarspace, frons, vertex, temple along the eye margin, pronotal collar and upper margin of pronotum broadly, two elongated lines on mesoscutum, scutellum, metascutellum, tegula, subtegular ridge, mesopleurum with a broad mark above sternaulus in front, a small mark just near the base of middle coxa, propodeum with two hemispherical marks sublaterally, apices of all the abdominal tergites (Fig. 2 a,b,c). Mesopleurum above including speculum, metapleurum largely, propodeum between apical carina and base laterally and first tergite, red. Legs in general also red. fore and middle coxae and trochanters yellow, except first segment of trochanters with a brown line above; hind tibia yellowish-brown, darker at apex and base, hind tarsus white except its fifth segment. Wings clear with brownish tinge.

Male : Unknown.

Length : Female, 8mm; fore wing 6.5 mm; ovipositor sheath 2.8mm.

Holotype Female, INDIA : UTTAR PRADESH : Barkot, 1143m, 23.v.1967, J.K. Jonathan, No. J224 (Z.S.I., Calcutta).

Distribution India : Uttar Pradesh.

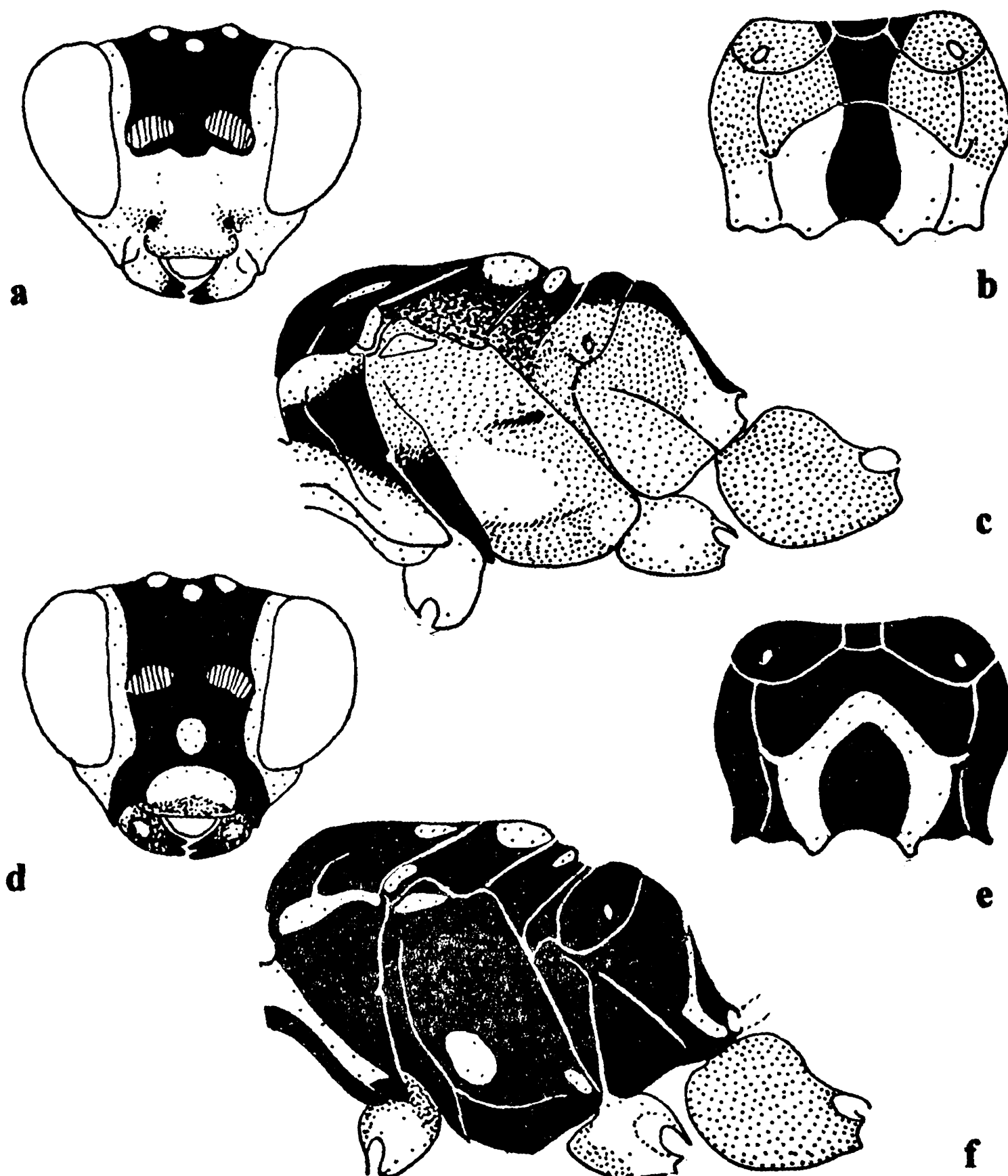


Fig. 2. *Myrmeleonostenus flavomaculatus*, sp. nov. colour pattern : a, front view of head; b, dorsal view of propodeum; c, side view of thorax. *Myrmeleonostenus nigrimaculatus*, sp. nov.: colour pattern : d, front view of head; e, dorsal view of propodeum; f, side view of thorax.

3. *Myrmeleonostenus nigrimaculatus*, sp. Nov.

This species is close to *M. flavomaculatus*, sp. nov. by having first tergite about 2.5x as long as wide at apex, postpetiole about 1.5x as long as wide at base and first sternite extending less than 0.4 the distance between spiracle and apex.

This species is distinguished by having face densely punctate, malarspace 0.75x the basal width of mandible; first tergite laterally with transverse ridges and base of tergite with or without basal lateral angulation or weak tooth.

Female : Face with small sized punctures, punctures in the middle closely placed, rugoso-punctate sublaterally, along the eye margin mat with sparse, shallow punctures. Clypeus subpolished, with small and sparsely placed punctures. Mandible sparsely and shallowly punctate, malarspace granulate, about 0.75x the basal width of mandible. Frons with moderate sized closely placed punctures, punctures in the middle dense and running into wrinkles, median groove not defined. Vertex and temple with moderately sized, deep and close punctures. Pronotum in its lower 0.6 strongly trans-wrinkled, its upper 0.4 densely punctate, epomia short but strong. Scutellum subpolished, coarsely and shallowly punctate, lateral carina more or less confined to its base. Metascutellum shiny with a few weak punctures. Mesopleurum moderately strongly rugose, speculum rugoso-punctate, meso-sternum and area above sternaulus with small dense punctures, subtegular ridge and area just below it finely punctate, Metapleurum rugoso-wrinkled, juxtacoxal carina present. Propodeum between basal carina and apex reticulo-wrinkled, basad of basal carina with moderately large, deep, closely placed punctures. First tergite about 2.5x as long as wide at apex, post-petiole about 1.5x as long as wide at base, tergite smooth and shiny at base, its postpetiolar area mat and densely punctate, punctures tending to be sparse towards the base, pleural area with strong transverse ridges, base of the tergite with or without weak tooth or angulation. Second tergite mat and subpolished with minute dense punctures, third tergite mat and with setiferous punctures, following tergites mat and subpolished. Fore wing with nervulus vertical, opposite to basal vein, nervellus intercepted at its basal .28, axillus vein parallel and its tip curved towards the margin.

Black. Apex of 3rd-10th flagellar segments white above. The following are yellow : a circular mark in the middle of face, clypeus, except apicomediaally, mandible at base, face, frons and temple all along the eye margin, pronotal collar, upper margin of pronotum, an oval mark at the center of mesoscutum, scutellum, metascutellum subtegular ridge, a large mark at the apex and a small mark at the base of sternaulus, propodeum with a 'ring-shaped' mark, apices of all the abdominal tergites, fore and middle coxae with irregular markings (Fig. 2 d,e,f). Legs in general red, except hind tarsus white with its first segment at base, fourth and fifth segment largely reddish. Wings clear hyaline.

Male : Essentially similar to female, except 11th-17th flagellar segments above white. Fore and middle coxae and trochanters yellow with black markings. Hind coxa and trochanter black.

Length : Female 8-11mm. Fore wing 6-9mm. Ovipositor sheath 3.5-4.5mm. Male, 8.5mm. Fore wing 6.5mm.

Holotype Female and **Allotype** Male, INDIA : UTTAR PRADESH : Bhyundar, 2286m, Garhwal

Hills, 26.v.1965, Colls. D.T. Tikar, V.K. Gupta, Nos. T28 & 101. *Paratypes* 12 Females, 4 Males. INDIA : UTTAR PRADESH : Bhyunder, 2286m, Garhwal Hills, 1 F, 26.v.1965, D. Ram, No. 100; Jangla, 2700m, 1 F, 21.vi.1977, V.K. Gupta. HIMACHAL PRADESH : Manali, 1828m, 4 F, 17-26.v.-2.vi.1970, Colls. M.L. Gupta, A.K. Gulati, D. Ram, Nos. M23, K211, K214, K223. Kasol, 1829m, 1 F, 23.vi.1970, D. Ram, No. K294. Dalhousi, 2132 m, 2 M, 23.iv.1971, M.K. Kamath, No. DH1. Ahla, 2286m, 1 M, 20.v.1971, M.K. Kamath, No. DH 55, Kulu, 2 F, vi.1964, colln. C.I.B.C., Nos. 20 & 21; 2 F, 22.ii.1967, Colln. C.I.B.C., Nos. 149 & 150. Jammu & Kashmir : Pahalgam, 2070m, 1 F, 30.vi.1966, J.K. Jonathan, No. J172 (Z.S.I., Calcutta). United Prov., 1 M 1949, F. Bianchi, no further data (A.E.I., Florida).

Distribution : India : Jammu & Kashmir, Himachal Pradesh and Uttar Pradesh.

SUMMARY

This paper deals with three new species of *Myrmeleonostenus* Uchida, viz., *M. longipetiolatus*, *M. flavomaculatus* and *M. nigrimaculatus* from India.

The genus *Myrmeleonostenus* has been recorded from Indo-papuan and southern part of the Palaearctic Region. This is the first record of this genus from India.

ACKNOWLEDGEMENTS

I am grateful to Prof. (Dr.) V.K. Gupta, Department of Entomology, University of florida, U.S.A., this study would not have been possible without his encouragement and guidance. I am thankful to Dr. J.R.B. alfred, Director, Zoological Survey of India, Calcutta for providing me all necessary facilities to carryout this research work.

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- Gupta, V.K. 1987. Catalogue of Indo-Australian Ichneumonidae, Part 2. *Mem. Amer. Ent. Inst.* **41**(2) : 598-12 10.

SHORT AND LONG-HORNED GRASSHOPPERS AND CRICKETS OF BASTAR DISTRICT, MADHYA PRADESH, INDIA

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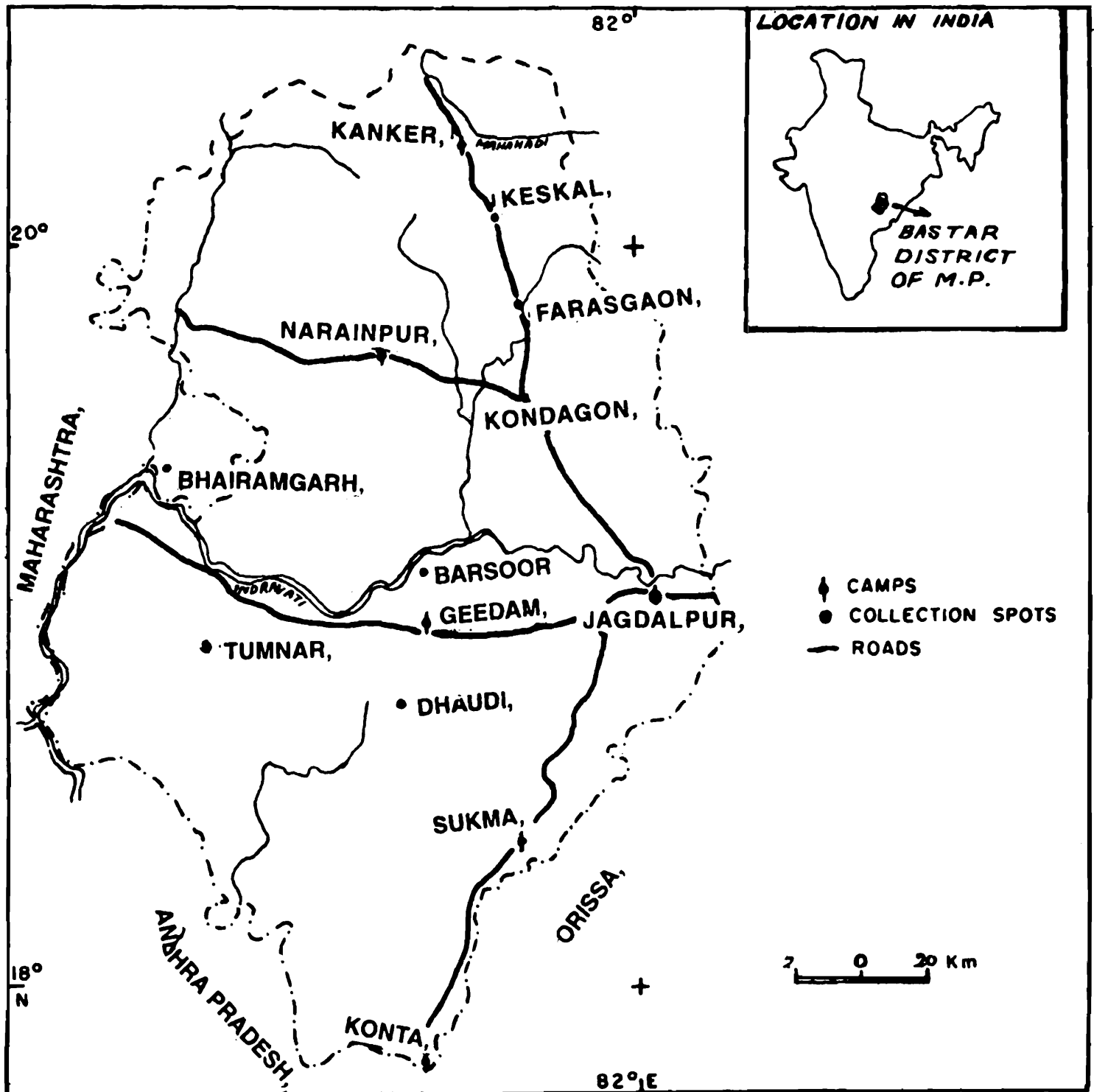
INTRODUCTION

Bastar is one of the biggest districts of Madhya Pradesh. In size it is larger than the State of Kerala in India and also some nations like Finland. The district is bounded by Maharashtra in the West, Andhra Pradesh in South and Orissa in East (Map 1). It is situated between 80°-15' to 82°-15' East Longitude and 17°-46' to 20°-34' North Latitudes. It has an area of 39,860 sq. kms. More than one-third area of Madhya Pradesh is covered with forest which is extensive and productive. Due to this thickness of forest, the fauna is very rich. the tract of Bastar is hilly and the altitude varies between 49 to 1,276 metres.

There are three seasons - winter, summer and monsoon. Winter season commences in the begining of November and lasts upto the end of February. It is mild throughout. The days are warmer and nights are colder at some places like Bailadila, Geedam, Kanker etc. Summer season extends from March to the middle of June. At that time it is extremely hot. However, in Konta Tehsil there is pleasant breeze at night from the Godavary valley. Monsoon season begins after the middle of June and lasts upto the month of October. The average rainfall is 1,521 mm. per year. The highest temperature may reach 19° C in the month of October and 31° C in the month of May.

Order Orthoptera includes both long and short-horned grasshoppers, crickets and grouse-locusts. These insects are moderate in size, but range in length from less than 5 mm. to 115 mm. The form of body and shape of head and thorax are diverse. The antennae are filiform but sometimes ensiform. Tarsi are 2-3 segmented, but 4 segmented are also found; hind femora large, slender and thick towards base and adapted for leaping. Wings either fully developed or reduced or absent; fore-wings, generally in the form of leathery tegmina; hind-wings are fan-like; male external genitalia complex (except in Tetrigidae), symmetrical and concealed when not in use. Female has external long or short ovipositor for depositing the eggs. Males of most species produce sound by different methods; females generally do not produce sound.

The number of known species of Orthoptera from the whole World is about 20,000. Out of these, 900 species are known from India. They are economically important insects, as some species do considerable damage to the crops, vegetable plants and forest plantations/ The well known locust belongs to this group. Majority of the species are tropical and well represented in temperate climates too. Vertically they are found from sea-level to high altitudes in the Himalayan region in India.



MAP 1 : District map of Bastar, Madhya Pradesh, showing places

Orthopteran insects have not been reported by any scientist from the Bastar District, except Chopard (1970) and Shishodia (1995). Chopard described *Arachnomimus subalatus* from Kutumswar cave, and Shishodia reported 15 species of Orthoptera from Indravati Tiger Reserve area, which is situated on the bank of river Indravati, in Bastar District. The present study deals with 77 species under 61 genera and 12 families. Sixty-one species are recorded for the first time from Bastar (*). All the materials reported in this study were collected by the author, unless otherwise stated.

Collecting Localities

Following is the list of localities from where the specimens were collected and studied for the present study :

- Jagdalpur : Dharampur road, P.W.D. Rest house, Kachauri village, Dongaghat, Bodghat, Sargipal forest, Jagdalpur, Atagura Kakapul.
- Geedam : Geedam, East to Geedam, P.W.D. Rest House, Haram, 2 kms. north to Geedam.
- Bhairamgarh : Bailadila; Narayanpur, Chitrakut, Bhanpuri; Kutumswar Cave; Tirathgarh.
- Tongpal : Malyawada; Tumnar; Nelasnar; Sonpur; Dhaudi; Narendrapur.
- Kondagaon : Hillock, east of Kondagaon; P.W.D. Rest House, Benur; Perambada; Keskal; Farasgaon; Bandapara.
- Kanker : Kanker north; Mankeshari, P.W.D. Rest House; Pandripani; Dumarpara.
- Sukma : Sukma; Forest Inspection Hut, Guḍiras.
- Barsoor : Barsoor; Forest Inspection Hut.
- Tumnar : Nelasnar; Sonpur; Dhaudi.
- Narayanpur : Chingrigarh; Narayanpur, Mahka.
- Govindpur : Bhanderpur.
- Konta : On way to Gollapalli.

SYSTEMATIC ACCOUNT

Order ORTHOPTERA

Key to superfamilies

1. Antennae about as long or longer than body, many segmented; tympanal organs, when present, on fore tibiae. 4
- Antennae shorter, with less than 30 segments; tympanum organs, when present, at base of abdomen. 2

2. Tarsi almost always 3-segmented; antennae usually longer. 3
 - Tarsi 1- or 2-segmented; antennae short, with 12 or fewer segments ... TRIDACTYLOIDEA
3. Pronotum extended backwards to cover abdomen; empodium absent; antennae longer than fore femur TETRIGOIDEA
 - Pronotum normal or if, rarely extended behind, then empodium present or antennae shorter than fore femur. ACRIDOIDEA
4. Tarsi 4-segmented, at least on middle and hind legs. TETTIGONIOIDEA
 - Tarsi 3-segmented. GRYLLOIDEA

Superfamily TRIDACTYLOIDEA

Antennae short; anterior tarsi 2-segmented; hind femora very large; hind tibiae, in addition to a number of subapical articulated spines, bears a pair of longer apical appendages between which lies vestigial unsegmented hind tarsi.

Family TRIDACTYLIDAE

Genus *Xya* Latreille, 1809

1. **Xya variegata* Latreille

1809. *Xya variegata* Latreille, Gen. Crust. Ins., 4 : 383.

1980. *Xya variegata* : Günther, *Dtsch. Ent. Z., N.F.* 27, Heft. I-III : 171.

Material examined : 1♂, Benur, 27.xii.1978.

Diagnosis : General colouration black to bronze, very shining almost completely glabrous; internal margin of eyes parallel, their inferior angle as much apart as the superior angle; outer posterior genicular lobe of hind femur more or less white; posterior tibiae provided with lamellae; posterior metatarsi tuberculiform; wings short.

Measurements (in mm.) : Body length 6.0; pronotum 1.5; tegmen 2.2; hind femur 4.0; hind tibia 2.9.

Distribution : India (Bihar, Kerala, Maharashtra, Meghalaya, West Bengal), South and Middle Africa, East to South-East Asia, China, and Europe.

Superfamily TETRIGOIDEA

Family TETRIGIDAE

Pronotum almost covers the whole abdomen and conceals the hind wings. The tegmina are reduced to small lateral scales, while the hind wings are well developed. The anterior and middle tarsi consist of two segments, while the posterior ones with three segments. The claws of tarsi are

not provided with an arolium or empodium. The structures of the phallic complex is entirely different. The epiphallus is absent.

Key to subfamilies

1. Posterior angles of lateral lobes of pronotum acutely produced outwards and generally spined; first segment of posterior tarsi usually longer than the third. SCELIMENINAE
- Posterior angles of lateral lobes of pronotum rarely acutely spined; first segment of posterior tarsi generally not longer than the third. 2
2. Posterior angles of lateral lobes of pronotum a little produced outwards, obliquely truncate behind, very rarely acutely spined; first and third posterior tarsi segments nearly equal in length. METRODORINAE
- Posterior angles of lateral lobes of pronotum turned downwards, more or less rounded; first and third posterior tarsal segments unequal in length, first rather longer than the third. TETRIGINAE

Subfamily SCELIMENINAE

Key to genera

1. Lateral margin of pronotum behind the shoulders produced. *Criotettix* Bolivar
- Lateral margin of pronotum behind the shoulders from the side view, distinctly angulated upwards and from top view bent inwards, wider between the shoulders; generally brachypterous with strong sculptures. *Thoradonta* Hancock

Genus *Criotettix* Boliver, 1887

2. **Criotettix bispinosus* (Dalman) (Figs. 1 & 2)

1818. *Acrydium bispinosum* Dalman, Kongl. Vet. Akad. Handl., 77.

1938. *Criotettix bispinosus* : Günther, stettin. ent. Ztg., 99 : 134.

Material examined : 1 ♂, Bhairamgarh, 21. xii. 1978.

Diagnosis : Head not extended above the pronotal surface; vertex broader than an eye, slightly narrowed in front; pronotum extended beyond the apices of posterior femora; posterior angles of lateral lobes of pronotum dilated and laminated, apex of anterior margin provided with a sharp pointed spine; directed backwards.

Measurements (in mm.) : Body length 6.0; pronotum length 11.5; hind femur missing.

Distribution : India (Arunachal Pradesh, Assam, Bihar, Madhya Pradesh, Manipur, Meghalaya,

Tripura, West Bengal), Borneo, Celebes, Hainan, Hongkong, Java, Luzon, Malaya, Myanmar, Sumatra, Taiwan and Thailand.

3. **Criotettix latifrons* Hebard

1929. *Criotettix latifrons* Hebard, *Revue suisse Zool.*, **36** : 578.

Material examined : 2 ♀, 2 ♂, Benur, 27. xii. 1978; 1 ♂, Perambada, Kondagaon, 28.xii.1978.

Diagnosis : Vertex broader than an eye; prozonal carinae convergent posteriorly; spine of the lateral lobes of pronotum directed transversely.

Measurements (in mm.) Body length 10.0; pronotum length 14.0; hind femur length 6.0; hind tibia 5.0.

Distribution : India (Andhra Pradesh, Maharashtra, Tamil Nadu). It is also studied from Basha ghat near Bargi, Madhya Pradesh (National Zoological Collection, Zoological Survey of India, Reg. No. 5427/H5).

Genus *Thoradonta* Hancock, 1908

4. *Thoradonta pruthii* Günther (Figs. 3 & 4)

1938. *Thoradonta pruthii* Günther, *Stettin. ent. Ztg.*, **99** : 129-130.

Material examined : 3 ♂, 1 ♀, Perambada and Bandapara, Kondagaon 2156m., 28,30.xii.1978; 1 ♂, Pandripani, Kanker, 3.i.1979; 1 ♂, Bhanpuri, 16.xii.1980; 1 ♀, Tumnar, 27.xii.1980; 1 ♀, Nelasnar, 29.xii.1980.

Diagnosis : Vertex wider than an eye; paired ocelli located below the middle of eyes; antennae situated below the eyes; lateral margin of pronotum below the shoulders less strongly folded upwards and inwards than the other Indian species; median carina of pronotum wavy and irregular but not buckled; lateral spine of pronotum narrow even at the base and almost directed transversely.

Measurements (in mm.) : Body length ♂6.5, ♀8.0; pronotum ♂8.0, ♀9.0; hind femur ♂4.0, ♀5.0; hind tibia ♂3.0, ♀4.0.

Distribution : India (Karnataka, Madhya Pradesh and West Bengal).

Subfamily METRODORINAE

Genus *Hyboella* Hancock, 1915

5. **Hyboella* sp.

Material examined : 1 (nymph), Geedam, 20.xii.1978.

Diagnosis : This species is very similar to *hyboella tentata* Hancock, but differs in having the middle of pronotum raised throughout its length.

PLATE 1

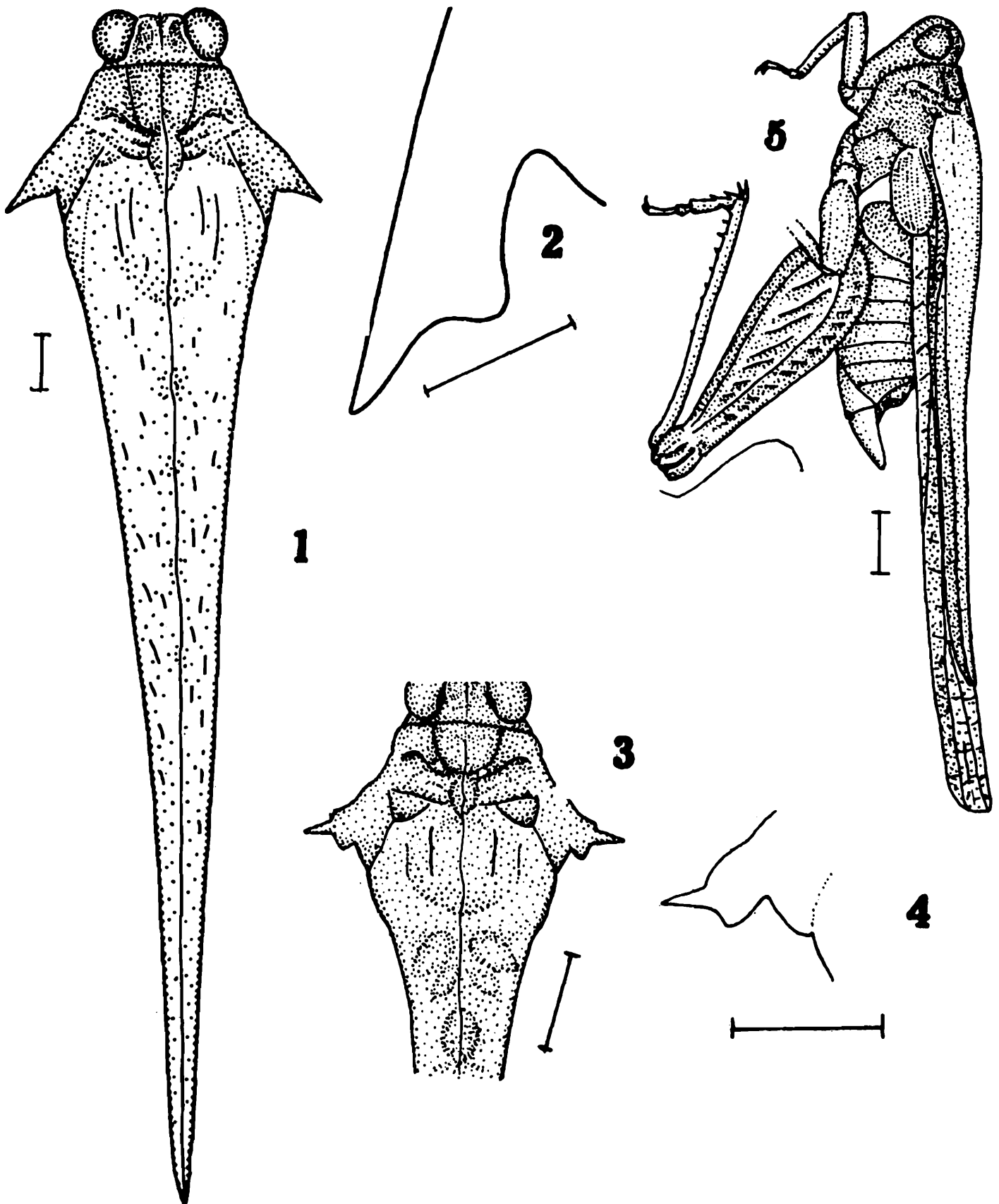


Fig. 1. Dorsal view of *Criotettix bispinosus* (Dalman); **Fig. 2.** Posterior angles of lateral lobes of pronotum of *Criotettix bispinosus* (Dalman); **Fig. 3.** Dorsal view of head and pronotum of *Thoradonta pruthii* Günther; **Fig. 4.** Posterior angles of lateral lobes of pronotum of *Thoradonta pruthii* Günther; **Fig. 5.** Dorso-lateral view of *Hedotettix gracilis* (De Haan).

Measurements (in mm.) : Interocular distance .75; body length 5.9; body length with pronotum 7.0; tegmen 4.3; shoulder width 2.1; hind femur missing.

Distribution : India, Java, Key Islands, Malaya, Myanmar, Sumatra, Thailand and Tibet.

Subfamily TETRIGINAE

Key to genera

1. Vertex and eyes obviously raised above the level of pronotum; antennae inserted between the lower border of eyes. 2
- Vertex and eyes very little or not at all raised above the level of pronotum; antennae scarcely placed below the middle of eyes. 3
2. Vertex narrower than an eye and truncate; frontal costa arcuately produced between the middle of the eyes; antennae inserted below the middle of eyes; median carina of pronotum not undulated; posterior femora with less conspicuous nodosities on the external medial surface. *Euparatettix* Hancock
- Vertex still narrower than an eye; antennae inserted distinctly below the inferior margin of eyes; median carina of pronotum a little or very well undulated; posterior femora with distinct nodosities on external medial surface. *Ergatettix* Kirby
3. Body generally smooth or a little granulose; vertex equal to or a little narrower than an eye, generally expanded, subtransverse or triangularly carinated in front; abbreviated carinae distinctly present; median carina of pronotum percurrent, not at all interrupted. *Hedotettix* Boliver
- Body generally granulose or tuberculose, vertex not expanded in front; abbreviated carinae indistinctly present; median carina of pronotum not percurrent. 4
4. Vertex narrower and more narrowed in front; frontal carinulae interrupted internally or recurved; dorsum of pronotum a little rugose, often bearing round or abbreviated lineate tubercles; median carina very fine and wavy or not. *Coptotettix* Bolivar
- Vertex narrower or equal or rarely wider than an eye, but not narrowed in front, with a concavity on either side; median carina a little raised but not wavy. *Paratettix* Bolivar

Genus *Euparatettix* Hancock, 1904

Key to species

1. Hind tibiae dense black with white annulations just behind the knee; frontal costa generally narrowly sulcate. *personatus* (Bolivar)
- Hind tibiae subunicoloured or obscurely marked but never dense black; frontal costa generally moderately sulcate. *histricus* (Stål)

6. **Euparatettix histricus* (Stål)

1860. *Tetrix histrica* Stål, Eugenes Resa Orth., : 347.

1991. *Euparatettix histricus* : Shishodia, *Rec. zool. Surv. India, Occ. Paper No. 140* : 135.

Material examined : 45♂, 19♀, Kachauri village, Jagdalpur, 11.xii.1978; 2♂, 2♀, Dongaghat, Jagdalpur, 12.xii.1978; 3♂, 2♀, Konta, 16.xii.1978; 11♂, 11♀, Benur, 27.xii.1978; 8♂, 5♀, Permbeda, Kondagaon, 28.xii.1978; 30♂, 11♀, Mankeshari, Kanker, 1.i.1979; 1♂, 1♀, Chitrakut, 14.xii.1980; 2♂, 2♀, Bhanpuri, 16.xii.1980; 1♀, Tumnar, 27.xii.1980; 3♂, 1♀, Narayanpur, 31.xii.1980; 1♂, Sonpur, 1.i.1981; 1♂, Dhaudi, Narayanpur, 2.i.1981; 1♀, Kutru, 26.i.1989, R.K. Ghosh coll.

Diagnosis : Head a little exerted; vertex narrower than an eye, front margin a little elevated, truncated, reflexed laterally; dorsum smooth or finely granulose, convex and wide between shoulders, with or without abbreviated markings. This species is always available in macropterous form.

Measurements (in mm.) : Body length ♂7-8, ♀10-11; body length with pronotum ♂10-10.5, ♀13-14; pronotum ♂9-9.5, ♀12-14; posterior femora ♂4.5-5.5, ♀5.4-7; shoulder width ♂2-2.1, ♀2.4-3.2.

Distribution : India (Throughout), N. Australia, Borneo, N. Caledonia, Celebes, S. China, Holland, Java, Malaya islands, Mindanao, Myanmar, Nepal, Pakistan, Philippines, Queensland, Sri Lanka, Sumatra and Taiwan.

7. *Euparatettix personatus* (Bolivar)

1887. *Paratettix personatus* Bolivar, *Annls. Soc. ent. Belg.*, : 31 : 188, 278.

1904. *Euparatettix personatus* : Hancock, *Spolia Zeylan.*, 2 : 146.

Material examined : 10♂, 9♀, Kachauri village, Jagdalpur, 11.xii.1978; 2♂, 1♀, Sargipal forest, Jagdalpur, 13.xii.1978; 4♂, 1♀, Geedam, 20.xii.1978; 4♂, 2♀, Benur, 27.xii.1978; 10♂, 9♀, Perambeda, Kondagaon, 28.xii.1978; 1♂, 1♀, Mankeshari, Kanker, 1.i.1979; 3♂, 1♀, Bhanpuri, 16.xii.1980; 5♂, 2♀, Kutru, 26.i.1989, R.K. Ghosh coll.

Diagnosis : Head exerted; vertex narrower than an eye; frontal costa narrowly sulcated; paired ocelli situated nearly between the middle of eyes; tegmina and wings well developed; hind tibiae dense black with white annulation just behind the knee.

Measurements (in mm.) : Body length ♂6-6.5, ♀8-9; body length with pronotum ♂9-10, ♀10.5-12; pronotum length ♂8-9, ♀10-11; posterior femora length ♂4.3-4.5, ♀4.7-5.4; shoulder width ♂2-2.2, ♀2.3-2.8.

Distribution : India (Throughout), Bangladesh, Bhutan, Indonesia (Java), Myanmar, Pakistan, Philippines, Sri Lanka and Taiwan.

Genus *Paratettix* Bolivar, 18878. **Paratettix cingalensis* (Walker)

(Plate 2, fig. 6)

1871. *Tettix cingalensis* Walker, *Cat. Derm. Salt. Brit. Mus.*, 5 : 827.1914. *Paratettix cingalensis* : Kirby, *Fauna Brit. India, Orth.* : 63.*Material examined* : 1 ♀, Benur, Kondagaon, 27.xii.1978.*Diagnosis* : Head a little or not at all exserted; frontal costa rarely sinuate; paired ocelli placed between the middle of eyes; tegmina and wings well developed; median carina of pronotum compressed, raised and generally arched in front.*Measurement* (in mm.) : Body length 8.0; pronotum length 6.0; hind femur 5.0; hind tibia 4.0.*Distribution* : India (Arunachal Pradesh, Assam, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Sikkim, Tamil Nadu), Borneo, Hainan, Malaya, Mindanao, Sri Lanka, Sumatra and Taiwan.Genus *Hedotettix* Bolivar, 1887

Key to species

1. Frontal costa widely sulcate, the rami more or less abruptly widened between antennae; median carina of pronotum more or less compressed-arcuate forwards before the shoulders, highest at the sulci; dorsum convex. *gracilis* (De Haan)
- Frontal costa not widely sulcate, rami not widened between the antennae; median carina of pronotum a little compressed, low arcuate forward. *attenuatus* Hancock

9. *Hedotettix gracilis* (De Haan)

(plate 1, fig. 5)

1842. *Acridium (Tetrix) gracile* De Haan, *Temminck, Verhandel.*, Orth. : 167, 169.1914. *Hedotettix gracilis* : Kirby, *Fauna Brit. India, Orth.* : 72.*Material examined* : ♂ 7, 3 ♀, Kachauri village, Jagdalpur, 11.xii.1978; 4 ♂, 4 ♀, Sabari river bed, Konta, 15.xii.1978; 1 ♀, near Kutumswar cave, 17.xii.1978; 5 ♂, 2 ♀, Geedam, 20.xii.1978; 10 ♂, 4 ♀, Perambada, Kondagaon, 28.xii.1978; 5 ♂, 5 ♀, Mankeshari, Kanker, 1.i.1979; 4 ♂, 7 ♀, Chitrakut, 14.xii.1980; 5 ♂, 2 ♀, Bhanpuri, 16.xii.1980; 1 ♂, 1 ♀, Tongpal, 21.xii.1980; 2 ♂, 3 ♀, Barsoor, 26.xii.1980; 5 ♂, 4 ♀, Tumnar, 27.xii.1980; 1 ♂, Narayanpur, 31.xii.1980; 1 ♂, 1 ♀, Sonpur, 1.i.1981; 1 ♂, 1 ♀, Bijapur, 6.ii.1990, R.K. Ghosh coll.*Diagnosis* : Both micro and macropterous forms are found in both sexes. The colour of dorsum vary from brown to brown-yellow or olive green or cinerous. Some specimens have

yellow longitudinal lines on either side of prozonal carinae which extend upto the posterior margin of shoulders, while in others this line runs in the middle of dorsum from prozonal area to posterior end of pronotum. Dark brown spots may or may not present on either side before and behind the shoulders.

Measurements (in mm.) : Body length ♂7.5-10, ♀9-10; body length with pronotum ♂7.5-13, ♀8.6-13.5; pronotum ♂7.5-12, ♀7.5-12.5; hind femora ♂5.4-6.4, ♀5.9-6.6; shoulder width ♂2.1-2.9, ♀2.1-3.

Distribution : India (Throughout), Celebes, Java, Myanmar, Sumatra, Sri Lanka, Taiwan, Thailand and Vietnam.

10. **Hedotettix attenuatus* Hancock

1904. *Hedotettix attenuatus* Hancock, *Spolia zeylan.*, 2 : 108.

Material examined : 4♂, Sargipal forest, Jagdalpur, 13.xii.1978.

Diagnosis : It is similar to the preceding species, except in the frontal costa which is narrowly sulcate and less strongly arcuate.

Measurements (in mm.) : Body length 8-10; body length with pronotum 8.6-14; pronotum 7.5-10.5; hind femora length 4.8-6; shoulder width 1.8-2.1.

Distribution : India (Arunachal Pradesh, Assam, Himachal Pradesh, Manipur, Meghalaya, Orissa, Tripura) and Sri Lanka.

Genus *Coptotettix* Bolivar, 1887

Key to species

1. Pronotum reaching upto the last abdominal segment or a little more but never beyond the hind femoral apices; dorsum not heavily granulose or tuberculose. *annandalei* Hancock
- Pronotum extended beyond the hind femoral apices; dorsum with scattered granules or tubercles. *conspersus* Hancock

11. **Coptotettix annandalei* Hancock

1915. *Coptotettix annandalei* Hancock, *Rec. Indian Mus.*, 11 : 119.

Material examined : 1♂, 7♀, near Kutumswar cave, 17.xii.1980.

Diagnosis : Pronotum acute at apex; dorsum flattened, finely granular or with scattered small tubercles or well developed rugosity; median carina undulated with depressions behind shoulders; wings extended upto or less than pronotal apex.

Measurements (in mm.) : Body length ♂7.8-8.8, ♀9.5-10.8; body length with pronotum ♂8.3-9.3, ♀9.2-10.5; pronotum ♂7.5-8.5, ♀7.5-8.5; hind femora length ♂5.4-5.9, ♀6.4-7; shoulder width ♂2.1-2.5, ♀2.5-3.7.

Distribution : India (Arunachal Pradesh, Assam, Karnataka, Manipur, Sikkim, Tripura, West Bengal), Myanmar, Nepal and Taiwan.

12. **Coptotettix conspersus* Hancock

1915. *Coptotettix conspersus* Hancock, *Rec. Indian Mus.*, 11 : 119.

Material examined : 1 ♀, Konta, 15.12.1978.

Diagnosis : Head not exserted above the surface of pronotum; vertex narrower towards front; middle carinula of vertex runs upto the half distance of fossulae; frontal costa arcuately produced, strongly divergent anteriorly; lateral lobe of pronotum narrow, roundly subtruncate; dorsum convex, finely granulose or rugose; median carina gently undulate behind the shoulders.

Measurements (in mm.) : Body length 9.0; body length with pronotum 13.5; pronotum length 12.0; hind femora length 5.0; shoulder width 2.9; hind tibia 4.0.

Distribution : India (Arunachal Pradesh, Assam, Maharashtra, Manipur, Meghalaya, Tripura, Uttar Pradesh, West Bengal) and Sri Lanka.

Genus *Ergatettix* Kirby, 1914

Key to species

1. Median carina of pronotum indistinctly undulate, lateral carinae without dilated lobes on the hind process of pronotum; middle femora less dilated, margins little lobate; hind femora with less protuberant tubercles on external surface..... *dorsifera* (Walker)
- Median carina of pronotum distinctly undulate, lateral carinae with small dilated lobes on the hind process of pronotum; middle femora sufficiently flattened, margins lobate; hind femora strongly tuberculate on external surface. *güntheri* Steinmann

13. *Ergatettix doraifera* (Walker)

1871. *Tettix dorsifera* Walker, *Cat. Derm. Salt. Brit. Mus.*, 5 Suppl. : 825.

1929. *Ergatettix dorsifera* : Hebard, *Revue suisse Zool.*, 36 : 588.

Material examined : 2♂, Kachauri village, Jagdalpur, 11.xii.1978; 3♀, Konta, 15.xii.1978; 1♂, On way to Gollapalli, Konta, 16.xii.1978; 2♂, Geedam, 20.xii.1978; 5♂, 7♀, Benur, 27.xii.1978; 5♂, 1♀, Bandapara, Kondagaon, 30.xii.1978; 5♂, 5♀, Manksehari, Kanker, 1.i.1979; 1♂, near Kutumswar cave, 17.xii.1980; 1♂, Tumnar, 27.xii.1980; 5♂, 2♀, Nelasnar, 29.xii.1980; 1♂, 5♀, Kutru, 26.i.1989, R.K. Ghosh coll.

Measurements (in mm.) : Body length ♂6-8, ♀8.2-9; body length with pronotum ♂9-10.5, ♀10.5-12.5; pronotum ♂8-9.5, ♀9.5-11.5; hind femora length ♂3.7-4, ♀4.8-5; shoulder width ♂1.7-2, ♀2.1-2.9.

Diagnosis : Dark-brown patches behind the shoulders may or may not developed, and these spots may or may not unite to form a band. This species is quite similar to *Ergatettix güntheri*, except the characters mentioned in the key.

Distribution : India (Arunachal Pradesh, Assam, Bihar, Delhi, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Sikkim, Tripura, Uttar Pradesh, West Bengal), Central Asia, Bangladesh, South China, Greater Sunda Islands, Java, Myanmar, Nepal, Sumatra, Sumba, Taiwan and Turkmenia.

14. **Ergatettix güntheri* Steinmann

1970. *Ergatettix güntheri* Steinmann, *Acta zool. hung.*, 16 : 234.

Material examined : 2♂, 3♀, Konta, 15.xii.1978; 2♂, 2♀, Geedam, 20-22.xii.1978; 4♂, 5♀, Benur, 27.xii.1978; 2♂, 2♀, Perambada, Kondagaon, 28.xii.1978; 3♂, 3♀, Mankeshari, Kanker, 1.i.1978; 2♂, 1♀, Chitrakut, 14.xii.1980; 1♀, Jagdalpur, 15.xii.1980; 3♂, 5♀, On way to Gollapalli, 20.xii.1980; 2♂, 1♀, Tongpal, 21.xii.1980; 2♀, Gudiras, 22.xii.1980; 3♂, 3♀, Nelasnar, 29.xii.1980; 5♂, 1♀, Narayanpur, 31.xii.1980.

Diagnosis : Colour variation is common in this species. Undulations in median carina of pronotum and nodosities on external surface of hind femora also vary from less to heavy. Female specimens have much undulations and nodosities on median carina of pronotum and external surface of hind femora respectively.

Measurements (in mm.) : Body length ♂6.8-8, ♀8.5-9; body length with pronotum ♂9.5-10.5, ♀11.5-12.5; pronotum ♂8.5-9.5, ♀11-11.5; hind femora length ♂3.5-4.5, ♀4.5-5.2; shoulder width ♂2-2.1, ♀2.5.

Distribution : India (Arunachal Pradesh, Assam, Bihar, Himachal Pradesh, Madhya Pradesh, Maharashtra, Meghalaya, Orissa, Tripura, Uttar Pradesh, West Bengal), Bangladesh and Sri Lanka.

Superfamily ACRIDOIDEA

Pronotum rarely cover a part of abdomen; tegmina, generally, well developed; tympanal organs, generally, present; all the tarsi three segmented; the claws always provided with an arolium; structure of phallic complex entirely different and epiphallus present.

Key to families

1. Foveolae of vertex contiguous, superior and forming the extremity of the fastigium; stridulatory mechanism absent. PYRGOMORPHIDAE

- Foveolae lateral or inferior, never forming the tip of fastigium; stridulatory mechanism present.
..... **ACRIDIDAE**

Family PYRGOMORPHIDAE

Key to genera

1. Anterior margin of prosternum strongly reflexed and dilated. ***Chrotogonus*** Serville
 - Anterior margin of prosternum neither reflexed nor dilated. 2
2. Antennae remote from the eyes, placed in front of the ocelli. ***Atractomorpha*** Saussure
 - Antennae near the eyes and inserted below the ocelli. 3
3. Posterior lobe of pronotum on the level of anterior lobe; abdomen without callosities; 4
 - Posterior lobe of pronotum convex, raised above the level of anterior lobe, with strong rugae; abdomen with dorsal callosities. ***Aularches*** Stål
4. Outer apical spine of posterior tibiae absent or difficult to detect; body small and slender.
..... ***Pyrgomorpha*** Serville
 - Outer apical spine of posterior tibiae very distinct; body large and robust.
..... ***Poecillocerus*** Serville

Genus ***Chrotogonus*** Serville, 1839

Key to species

1. Hind wings hyaline or occasionally faintly tinged yellowish brown but never infumated.
..... ***trachypterus*** (Blanchard)
 - Hind wings always infumated. ***oxypterus*** (Blanchard)

15. ****Chrotogonus (Chrotogonus) trachypterus trachypterus*** (Blanchard)

1836. *Ommesecha trachypterus* Blanchard, *Annie. Soc. ent. Fr.*, **5** : 618.

1959. *Chrotogonus (Chrotogonus) trachypterus trachypterus* : Kevan, *Publ. Soc. ent. Co. Diam. Angola*, No. 43 : 147.

Material examined : 1 ♂, 1 ♀, Perambada, Kondagaon, 28.xii.1978.

Diagnosis : Hind wings are clearly hyaline. It is available in both brachy and macropterous forms. This species is the pest of various types of crops of economic value, specially of short type of nature.

Measurements (in mm.) : Body length ♂ 14.0, ♀ 22.0; head length ♂ 3.0, ♀ 4.0; pronotum length ♂ 3.5, ♀ 5.0; tegmina length ♂ 9.0, ♀ 15.0; hind femur length ♂ 7.5, ♀ 10.0; hind tibia length ♂ 6.5, ♀ 8.0.

Distribution : India (Andhra Pradesh, Assam, Bihar, Delhi, Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Uttar Pradesh, West Bengal), Bangladesh, Nepal, E. Iran and Pakistan.

16. **Chrotogonus (Chrotogonus) oxypterus* Blanchard

1836. *Ommexecha oxypterus* Blanchard, *Annls. Soc. ent. Fr.*, 5 : 622.

1959. *Chrotogonus (Chrotogonus) oxypterus* : Kevan, *Publsöes cult. Co. Diam. Angola*, no. 43 : 48.

Material examined : 1♂, Dharampur, jagadalpur, 10.xii.1978; 1♀, Konta, 15.xii.1978; 4♂, 6♀, Geedam, 20-22.xii.1978; 1♀, Bhairamgarh, 21.xii.1978; 1♂, 6♀, Bailadila, 23.xii.1978; 5♂, 1♀, Kondagaon, 26.xii.1978; 1♀, Benur, 27.xii.1978; 1♀, Narayanpur, 27.xii.1978; 1♀, Farasgaon, 29.xii.1978; 2♂, 2♀, Kanker, 1.i.1979; 4♂, 1♀, Chitrakut, 14.xii.1980; 1♂, Tirathgarh, 17.xii.1980; Ahmad coll.; 3♂, 2♀, Sukma, 19.xii.1980; 1♀, Gudiras, 22.xii.1980; 3♂, 2♀, Nelasnar, 29.xii.1980; 1♂, 1♀, Dhaudi, Narayanpur, 2.i.1981.

Diagnosis : This species is fully alate to micropterous form. Hind wings infumated at basal part and extend nearly two-thirds as long as tegmina. It is a pest of various crops and vegetables and prefer the places where the amount of water is less in soil.

Measurements (in mm.) : Body length ♂ 13.5, ♀ 18-21; pronotum length ♂ 3.5, ♀ 4.5-5; tegmen length ♂ 7.5, ♀ 7.5-10; hind femur length ♂ 7.5, ♀ 9-10.5; hind tibia length ♂ 5.5, ♀ 7-9.

Distribution : India (Andhra Pradesh, Bihar, Goa, Karnataka, Kerala, South-east of Maharashtra, South of Madhya Pradesh, Orissa, Tamil Nadu, Uttar Pradesh, West Bengal) and Sri Lanka.

Genus *Poekilocerus* Serville, 1831

17. **Poekilocerus pictus* (Fabricius)

1775. *Gryllus pictus* Fabricius, *Sys. Ent.*, 289.

1914. *Poekilocerus pictus* : Kirby, *Fauna Brit. India*, Orth., : 172.

Material examined : 4♂, 6♀, Bailadila, 23.xii.1978.

Diagnosis : Body large in size; head and pronotum with faint median carina; antennae blue-black with yellow beyond the basal third of their length. Commonly known as ak grasshopper, and generally feed on ak plants (*Calotropis gigantea*), but also reported to feed on various crop, vegetable and fruit plants.

Measurements (in mm.) : Body length ♂ 50-52.0, ♀ 50-62; head length ♂ 5-5.5, ♀ 5-7; pronotum ♂ 11.5-13, ♀ 15-16; tegmen ♂ 34.5-37, ♀ 36-37.5; hind femur ♂ 20.5-23, ♀ 26.0; hind tibia ♂ 20.5-23, ♀ 24.5-26.0.

Distribution : India (Andhra Pradesh, Bihar, Delhi, Haryana, Jammu & Kashmir, Maharashtra, Orissa, Punjab, Rajasthan, Uttar Pradesh, West Bengal) and Pakistan. It is also studied somewhere else from Madhya Pradesh and Gujarat in India.

Genus *Pyrgomorpha* Serville, 183118. **Pyrgomorpha bispinosa bispinosa* (Walker)

1870. *Pyrgomorpha bispinosa* Walker, *Cat. Derm. Salt. Brit. Mus.*, **3** : 499.

1975. *Pyrgomorpha bispinosa bispinosa* : Kevan, *Acrida*, **4** : 58, 65.

Material examined : 1♂, On way to Gollapalli, Konta, 16.xii.1978; 4♂, 7♀, Kanker, 1, 2, 4.i.1979.

Diagnosis : Body moderately slender; postero-ventral point of lateral pronotal lobe generally short but distinct.

Measurements (in mm.) : Body length ♂13.0, ♀18.0; pronotum ♂3.0, ♀4.5; tegmen ♂10.0, ♀13.0; hind femur ♂7.0, ♀8.5; hind tibia ♂5.0, ♀7.0.

Distribution : Peninsular India.

Genus *Atractomorpha* Saussure, 186119. *Atractomorpha crenulata* (Fabricius)

1793. *T(ruxalis) crenulatus* Fabricius, *Ent. Syst.*, **2** : 28.

1861. *Atractomorpha crenulata* : Saussure, *Annls. Soc. ent. Fr.*, **4** : 475.

1969. *Atractomorpha crenulata* : Kevan & Chen, *Zool. J. Linn. Soc.*, **48** : 187.

Material examined : 3♂, 1♀, Dharampura, Jagdalpur, 10.xii.1978; 2♂, 5♀, Konta, 15.xii.1978; 5♂, 5♀, Geedam, 22.xii.1978; 2♂, 2♀, Bhairamgarh, 23.xii.1978; 7♂, 7♀, Perambada, Kondagaon, 28.xii.1978; 2♂, Farasgaon, 29.xii.1978; 2♂, 3♀, Mankeshari, Kankar, 1.i.1979; 2♂, Chitrakut, 14.xii.1980; 2♂, 2♀, Bhanpuri, 16.xii.1980; 1♂, near Kutumswar cave, 17. xii. 1980; 1♂, Sukma, 19.xii.1980; 1♂, Tongpal, 21.xii.1980; 2♀, Malyawada, 24.xii.1980; 3♂, 4♀, Barsoor, 26.xii.1980; 4♂, Tumnar, 27.xii.1980; 2♀, Nelasnar, 29.xii.1980; 3♂, 3♀, Dhaudi, Narayanpur, 2.i.1981.

Diagnosis : Body medium and slender; fastigium of vertex shorter; eyes convex and prominent; lateral pronotal lobes with distinct membranous area, specially in females; hind femora not clearly convex; tegmina pointed, extending for one-fourth of their length beyond the hind femora; hind wings normally tyrian pink to light mallow purple at base.

Measurements (in mm.) : Body length ♂15-15.5, ♀29.0; pronotum ♂4.0, ♀6-7; head with fastigium ♂3.0, ♀4-4.5; tegmen ♂14-14.5, ♀21.5-23; hind femur ♂8-8.5, ♀12-12.5; hind tibia ♂6-6.5, ♀10-10.5.

Distribution : India (Throughout), Bangladesh, Malaya, Myanmar, Pakistan, Sri Lanka, N.W. Sumatra, Thailand and S. Vietnam.

Family ACRIDIDAE

Key to subfamilies

1. Prosternal process or tubercle usually absent; if present, then antennae ensiform and body strongly elongate. 2
 - Prosternal process or tubercle present. 5
2. Sound producing mechanism represented by articulated or non-articulated stridulatory serrations or pegs on inner side of hind femur. 3
 - Sound producing mechanism not represented by such serration or pegs on inner side of hind femur. 4
3. Sound producing mechanism represented by unarticulated serration on inner side of hind femur. TRUXALINAE
 - Sound producing mechanism represented by row of articulated stridulatory pegs on inner side of hind femur. GOMPHOCERINAE
4. Head with acute in profile, and with acute angle of frons; tegmina without intercalary vein (if present, weak, irregular and not serrated even in male). ACRIDINAE
 - Head rounded in profile, face almost vertical, rarely oblique and tegmina always with an intercalary vein in median area (mostly well developed). OEDIPODINAE
5. Lower basal lobe of hind femur as long as upper one or only insignificantly longer or shorter.. ROMALEINAE
 - Lower basal lobe of hind femur distinctly shorter than upper one. 6
6. Radial area of tegmina with a series of regular, parallel stridulatory veinlets. HEMIACRIDINAE
 - Stridulatory veinlets of radial area of tegmina absent; if apterous, then tympanum (at least rudimentary) present. 7
7. Lower external lobe of hind knee with spine-like apex. OXYINAE
 - Lower external lobe of hind knee with apex rounded, angular or subacute but not spine-like. 8
8. Last abdominal tergite in male (in majority of genera) with well developed furcula; supra-anal plate mostly with attenuate or trilobate apex; subgenital plate with transverse fold. COPTACRIDINAE
 - Last abdominal tergite in male without well developed furcula; supra-anal plate variable; subgenital plate without transverse fold. 9
9. Mesosternal interspace closed. TROPIDOPOLINAE
 - Mesosternal interspace open. 10
10. Mesosternal lobes rounded or obtuse-angular or acute-angular, but not rectangular. 11

- Mesosternal lobes rectangular. CYRTACANTHACRIDINAE
- 11. Dorsum of pronotum flat or weakly tectiform, with median and lateral carinae linear (lateral carinae sometimes obliterated); male cercus with strongly compressed, lobiform or subacute, downcurved apex. EYPREPOCNEMIDINAE
- Dorsum of pronotum of variable shape; lateral carinae, if present, not linear; male cercus variable, but not with strongly compressed, lobiform or subacute, downcurved apex. CATANTOPINAE

Subfamily TRUXALINAE

Genus *Truxalis* Fabricus, 1775

20. **Truxalis indica* (Boliver)

1902. *Acrida (Acridella) unguiculate* Rambur, var. *indica* Bolivar, *Annls. Soc. ent. Fr.*, **70** : 589.

1951. *Truxalis indica* : Dirsh, *Eos. Madr.*, Tomo extraord (1950) : 178.

Material examined : 1 ♀, Mankeshari, Kanker, 1.i.1979; 1 ♂, Dumarpara, Kanker, 3.i.1979; 1 nymph, Narayanpur, 27.xii.1980.

Diagnosis : Fastigium of vertex broad, apex truncate; antennae lanceolate; hind femora with articulated pegs on internal surface; basal part of wing intensely bright pink.

Measurements (in mm.) : Body length ♂35.0, ♀63.0; head ♂9.0, ♀12.0; pronotum ♂5.0, ♀9.5; tegmen ♂28.0, ♀52.0; hind femur ♂22.5, ♀35.0; hind tibia ♂22.5, ♀35.0.

Distribution : India (Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu), Myanmar and Sri Lanka.

Subfamily GOMPHOCERINAE

Key to genera

1. Fastigium with acute apex; frontal ridge with obtuse lateral carinulae. *Leva* Bolivar
- Fastigium with truncate apex; frontal ridge without lateral carinulae. *Dnopherula* Karsch

Genus *Leva* Bolivar, 1909

Key to species

1. Lateral carinae of pronotum in prozona nearly parallel, divergent in metazona. *indica* (Bolivar)
- Lateral carinae of pronotum in front of medio-prozona excurved, divergent in metazona to make it X-shaped. *cruciata* Bolivar

21. **Leva cruciata* Bolivar

1914. *Leva cruciata* Bolivar, *Trab. Mus. Cienc. nat. Madr.*, **20** : 66.

Material examined : 1 ♂, Dongaghat, Jagdalpur, 12.xii.1978; 1 ♂, Konta, 15.xii.1978; 1 ♂, 1 ♀, On way to Gollapalli, 16.xii.1978; 5 ♂, 5 ♀, Geedam, 20.xii.1978; 2 ♂, 1 ♀, Narayanpur, 27.xii.1978; 1 ♂, 1 ♀, Benur, 27.xii.1978; 2 ♂, 1 ♀, Perambada, Kondagaon, 28.xii.1978; 1 ♀, Farasgaon, 29.xii.1978, 2 ♂, 1 ♀, Mankeshari, Kanker, 1.i.1979; 2 ♀, Malyawada, 24.xii.1980; 1 ♂, Tumnar, 27.xii.1980; 1 ♂, Nelasnar, 29.xii.1980; 1 ♀, Sonpur, 1.i.1981.

Diagnosis : Colour pale-yellowish or dull reddish brown; fastigium angularly produced; inferior foveolae indistinct; dorsum of pronotum constricted; median carina of pronotum distinct, lateral carinae excurved in prozona and metazona to form X-shaped marking.

Measurements (in mm.) : Body length ♂ 9.5, ♀ 11.5-12.5; pronotum ♂ 2.2, ♀ 3.0; tegmen ♂ 8.5-9, ♀ 11.0; hind femur ♂ 7.0, ♀ 9.0; hind tibia ♂ 5.0, ♀ 7.0

Distribution : India (Bihar, Karnataka, Orissa, Tamil Nadu, West Bengal) and Sri Lanka.

22. **Leva indica* (Bolivar)

1902. *Gymnobothrus indicus* Bolivar, *Annls. Soc. ent. Fr.*, **70** : 596.

1914. *Leva indica* : Bolivar, *Trab. Mus. nac. Cienc. nat. Madr.*, **20** : 64.

Material examined : 1 ♂, Sargipal forest, Jagdalpur, 13.xii.1978; 1 ♀, On way to Gollapalli, Konta, 16.xii.1978; 1 ♂, Geedam, 20.xii.1978; 1 ♀, Kondagaon, 26.xii.1978; 3 ♀, Narayanpur, 27.xii.1978; 1 ♀, Benur, 27.xii.1978; 1 ♀, Farasgaon, 29.xii.1978; 1 ♀, Mankeshari, Kanker, 1.i.1979; 1 ♀, Talkabad, 4.i.1979; 1 ♀, Malyawada, 24.xii.1980; 1 ♂, 1 ♀, Sonpur, 1.i.1981.

Diagnosis : Very similar to the preceding species, but the lateral carinae of pronotum parallel in prozona and divergent in metazona.

Measurements (in mm.) : Body length ♂ 8.5-10, ♀ 13-14; pronotum ♂ 2.5-3, ♀ 3.0; tegmen ♂ 8.5-9, ♀ 11-12; hind femur ♂ 7.0, ♀ 9-9.5; hind tibia ♂ 5.0, ♀ 7-7.5.

Distribution : India (Bihar, Delhi, Madhya Pradesh, Orissa, Tamil Nadu, Tripura, West Bengal); Sri Lanka.

Genus *Dnopherula* Karsch, 1896Subgenus *Aulacobothrus* Boliver, 190223. **Dnopherula (Aulacobothrus) luteipes* (Walker)

1871. *Stenobothrus luteipes* Walker, *Cat. Derm. Salt. Brit. Mus.*, **5** Suppl. : 82.

1971. *Dnopherula (Aulacobothrus) luteipes* : Jago, *Proc. Acad. Sci. nat. Philad.*, **123** (8) : 243.

Material examined : 1 ♂, Sukma, 19.xii.1980.

Diagnosis : Size small; antennae filiform; fastigium of vertex almost trapezoidal, with truncate apex; fastigial foveolae not visible from above; hind femora with three black bands on the dorsal surface and with a black one at distal end; pronotum with nearly parallel lateral carinae which are weakly concave in the middle.

Measurements (in mm.) : Body length ♂ 15.0; pronotum length 3.0; tegmen 11.0; hind femur 10.0; hind tibia 8.0.

Distribution : India (Assam, Bihar, Delhi, Himachal Pradesh, Jammu & Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu, West Bengal), N. America, China, Europe, Japan, Myanmar and Sri Lanka.

Subfamily ACRIDINAE

Key to genera

1. Head conically ascending; fastigium of vertex broad and laminate; lateral carinae of pronotum divergent posteriorly. ***Acrida* Linnaeus**
- Head not ascending; fastigium not so broad and laminate; lateral carinae of pronotum straight..
..... ***Phlaeoba* Stål**

Genus ***Acrida*** Linnaeus, 1758

24. ****Acrida exaltata*** (Walker)

1859. *Truxalis exaltata* Walker, *Ann. Mag. nat. Hist.*, (3) 4 : 222.

1954. *Acrida exaltata* : Dirsh, *Bull. Soc. Fouad Ent.*, 38 : 149.

Material examined : 4 ♂, Dharampur, Jagdalpur, 10.xii.1978; 1 ♂, On way to Gollapalli, Kōnta, 16.xii.1978; 9 ♂, 5 ♀, Geedam, 20.xii.1978; 1 ♂, 1 ♀, Bhairamgarh, 21.xii.1978; 1 ♂ (nymph), Bailadila, 23.xii.1978; 1 ♂, 2 ♀, Kondagaon, 26.xii.1978; 3 ♂, 2 ♀, Narayanpur, 27.xii.1978; 3 ♂, Benur, 27.xii.1978; 2 ♂, Farasgaon, 29.xii.1978; 5 ♂, 3 ♀, Mankeshari, Kanker, 1.i.1979; 1 ♀, Tirathgarh, 17.xii.1980; 2 ♀, Gudiras, 22.xii.1980; 4 ♂, 1 ♀, Malyawada, 24.xii.1980; 7 ♂, Barsoor, 26.xii.1980; 2 ♂, Tumnar, 27.xii.1980; Sonpur, 1.i.1981.

Diagnosis : Head conically ascending, basal part narrow, fastigium of vertex broad, laminate and truncate but less broad and laminate than the genus *Truxalis*; transverse sulcus of pronotum placed about the middle of disc; hind femora without any peg-like structure on internal surface.

Measurements (in mm.) : Body length ♂ 28.5, ♀ 40-50.0; head ♂ 5.0, ♀ 9-10; pronotum ♂ 5.0, ♀ 7-8.0; tegmen ♂ 23.0, ♀ 37-41.0; hind femur ♂ 16-17.0, ♀ 28-30.0; hind tibia ♂ 15.0, ♀ 25-28.0.

Distribution : India (Widely distributed), Afghanistan, Aden, Arabia, Bangladesh, S.E.Iran, Nepal, Pakistan, Sri Lanka, S.E.Tibet and Yemen.

Genus *Phlaeoba* Stål, 186025. **Phlaeoba infumata* Brunner

1893. *Phlaeoba infumata* Brunner, *Annali Mus. civ. Stor. nat. Giacomo Doria*, 33 : 124.

1914. *Phlaeoba infumata* : Kirby, *Fauna Brit, India*, Orthopt. : 103.

Material examined : 2♂, 2♀, Bhairamgarh, 21.xii.1978; 2♀, Geedam, 24.xii.1978; 1♀, Sonpur, 1.i.1981.

Diagnosis : Brownish testaceous in colour; tegmina and wings longer than abdomen; wings fusco-hyaline, infuscated towards extremity and subgenital plate of male acute at apex.

Measurements (in mm.) : Body length ♂20.0, ♀26.5-27.0; pronotum ♂5.0, ♀5.5-6.0; tegmen ♂17.0, ♀20-22.0; hind femur ♂13.0, ♀15-15.5; hind tibia ♂11.0, ♀12-13.

Distribution : India (Arunachal Pradesh, Bihar, Delhi, Haryana, Himachal Pradesh, Madhya Pradesh, Meghalaya, Orissa, Punjab, Sikkim, Tripura, Uttar Pradesh, West Bengal), S. China, Malacca, Myanmar, E. Nepal.

Subfamily OEDIPODINAE

Key to genera

1. Median carina of pronotum entire or slightly intersected by the transverse groove. (foveolae trapezoidal). *Aiolopus* Fieber
- Median carina of pronotum very distinctly interrupted by transverse groove. 2
2. Median carina of pronotum cut by one groove. 3
- Median carina of pronotum cut by two grooves. 6
3. Thorax rather short. 4
- Thorax long. 5
4. Wings without well-marked fascia. *Dittopternis* Saussure
- Wings with well-marked fascia. *Oedaleus* Fieber
5. Pronotum with strong crest or acutely tectiform, without rugae; wings without black at apex. *Gastrimargus* Saussure
- Pronotum with well-marked median carina, and with numerous longitudinal rugae. *Morphacris* Walker
-
6. Pronotum with well-marked crest, angulated behind; median carina of pronotum distinctly interrupted in the prozona by 2 transverse grooves and seems to be bidentate; occiput with a pair of tubercles between the eyes; wings without dark band. *Trilophidia* Stål

PLATE 2

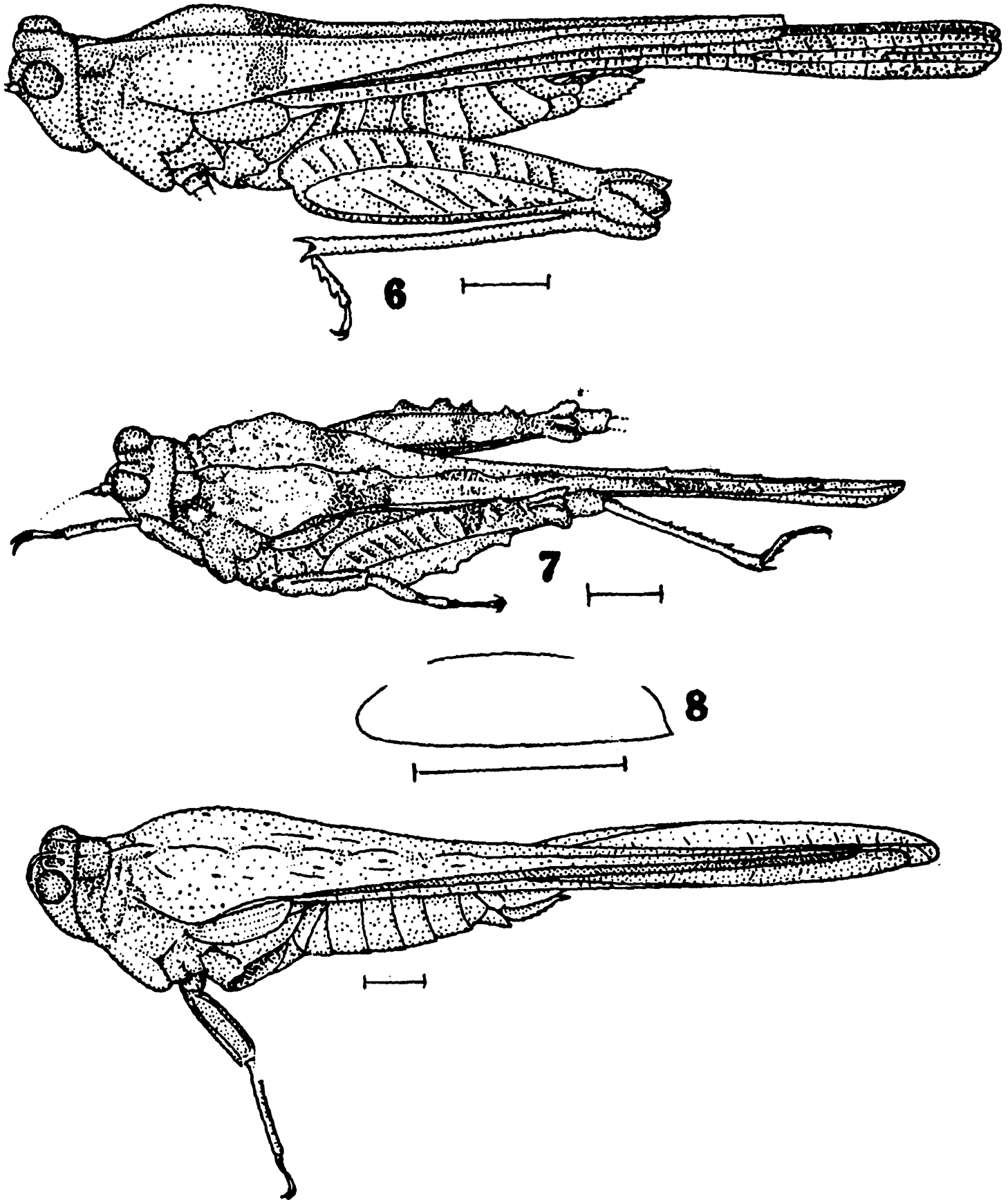


Fig. 6. Dorso-lateral view of *Paratettix cingalensis* (Walker); Fig. 7. Dorso-lateral view of *Ergatettix güntheri* Steinmann; Fig. 8. Tegmen of *Eragatettix güntheri* Steinmann; Fig. 9. Dorso-lateral view of *Coptotettix conspersus* Hancock.

- Pronotum without very distinct crest; median carina of pronotum indistinctly interrupted by the transverse grooves, not bidentate in the prozona; occiput without a pair of tubercles between the eyes; wings with dark band in the middle. *Acrotylus* Fieber

Genus *Aiolopus* Fieber, 1853

26. **Aiolopus thalassinus tamulus* (Fabricius)

1798. *Gryllus tamulus* Fabricius, *Ent. Sys., Suppl.* : 195.

1968. *Aiolopus thalassinus tamulus* : Hollis, *Bull. Br. Mus. nat. Hist. (Ent.)*, **22** (7) : 347.

Material examined : 1♂, 3♀, Kachauri village, Jagdalpur, 11.xii.1978; 1♀ Kanker, 1.i.1979; 2♀, Bhanpuri, 16.xii.1980; 1♀, Tumnar, 27.xii.1980; 1♂, 1♀, Dhaudi, 2.i.1981.

Diagnosis : Fastigium with front angle more acute; foveolae narrowly trapezoid, about twice as long as wide; frontal ridge gradually narrowing and almost angular towards fastigial end, sparsely punctured; pronotum somewhat saddle-shaped, posterior margin rounded; posterior tibiae usually with red colouration in apical fourth and broadly separated from black band by a wide bluish grey band.

Measurements (in mm.) : Body length ♂ 17.5-18.5, ♀ 23-25.0; pronotum length ♂ 3-3.5, ♀ 4.6-5; tegmen length ♂ 15.5-18.5, ♀ 21.5-23.0; hind femur length ♂ 10.5-11, ♀ 11.5-13; hind tibia ♂ missing, ♀ 9.5-10.5.

Distribution : India (Andaman & Nicobar Islands, Bihar, Delhi, Himachal Pradesh, Karnataka, Madhya Pradesh, Rajasthan, Tamil Nadu, West Bengal), Australia, Bangladesh, Borneo, Celebes, China, Hainan, Hong Kong, Japan, Java, Lombok, Malaya, Myanmar, New Guinea, Papua, Philippines, Singapore, Sri Lanka, Sumatra, Taiwan, Thailand and Timor.

Genus *Acrotylus* Fieber, 1853

27. **Acrotylus humbertianus* Saussure

1884. *Acrotylus humbertianus* Saussure, *Mem. Soc. Phys. Hist. nat. Geneva*, **28** (9) : 189.

1914. *Acrotylus humbertianus* : Kirby, *Fauna Brit. India*, Orthopt. : 153.

Material examined : 1♀, Dongaghat, Jagdalpur, 12.xii.1978; 1♂, 1 (nymph), 1♀, Geedam, 20.xii.1978; 3♂, 2♀, Perambada, Kondagaon, 28.xii.1978; 3♂, 2♀, Mankeshari, Kanker, 1.i.1979; 4♂, 5♀, Dumarpara, Kanker, 3.i.1979; 1♀, Gudiras, 22.xii.1980.

Measurements (in mm.) : Body length ♂ 14.5, ♀ 20-21.0; pronotum ♂ 2.0, ♀ 3.2; tegmen ♂ 14.0, ♀ 19.0; hind femur ♂ 8.5, ♀ 10.5; hind tibia ♂ 6.5, ♀ 8.5.

Diagnosis : Body pilose; antennae longer than head and pronotum together; the tip of vertex conical, concave, with a carina on each side; prozona with two fuscous fascia, lateral margin white below; tegmina with two oblique white spots or fascia; posterior intercalate space with a line of fuscous spots; wings hyaline, yellow at base; radial area with a semilunar fuscous fascia.

Distribution : India (Andhra Pradesh, Assam, Bihar, Delhi, Goa, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, West Bengal), Afghanistan, Bangladesh, Nepal, Pakistan and Sri Lanka.

Genus *Morphacris* Walker, 1870

28. **Morphacris fasciata sulcata* (Thunberg)

1815. *Gryllus fasciatus* Thunberg, *Mem. Acad. Sci. St.-Petersb.*, 5 : 230.

1929. *Morphacris fasciata sulcata* : Uvarov, *Revue suisse Zool.*, 36 : 546.

Material examined : 2♂, Dongaghat, Jagdalpur, 12.xii.1978; 1♂, 1♀, Way to Gollapalli, Konta, 16.xii.1978; 1♀, Farasgaon, 29.xii.1978; 4♂, 1♀, Pandripani, Kanker, 2.i.1979; 1♂, Chitrakut, 2.xi.1979, S. Ahmad coll.

Diagnosis : Antennae filiform, longer than head and pronotum together; pronotum tectiform, without lateral carinae; median carina of pronotum sharp and high; dorsum covered with parallel sharp longitudinal ridges; wings light yellow at base, and with dark transverse fascia.

Measurements (in mm.) : Body length ♂ 14.8-16.0, ♀ 22.5-23.5; pronotum ♂ 2.8-3.0, ♀ 4.5-5.0; tegmen ♂ 15-16.0, ♀ 21.5-22.8; hind femur ♂ 10-10.5, ♀ 13-13.5; hind tibia ♂ 8-8.5, ♀ 11-11.5.

Distribution : India (Andhra Pradesh, Bihar, Goa, Kerala, Madhya Pradesh, Maharashtra, Tamil Nadu), Africa, S. W. Asia and Sri Lanka.

Genus *Dittopternis* Saussure, 1884

29. **Dittopternis venusta* (Walker)

1870. *Oedipoda venusta* Walker, *Cat. Derm. Salt. Brit. Mus.*, 4 : 740.

1914. *Dittopternis venusta* : Kirby, *Fauna Brit. India. Orthopt.*, : 140.

Material examined : 2♂, 1♀, Way to Gollapalli, on, 16.xii.1978; 2♂, 3♀, Geedam, 22,24.xii.1978; 1♂, Perambada, Kondagaon, 28.xii.1978; 4♀, Farasgaon, 29.xii.1978; Dumarpara, Kanker, 3.i.1979.

Diagnosis : Pronotum rugose, granulated and strongly carinated, cut by the principal sulcus before the middle, obtusely angulated behind; tegmina with the basal half brown and with a large yellow blotch; wings yellow at base, with a broad suffused blackish band behind; hind tibiae black at base, followed by a light yellow band, then blue.

Measurements (in mm.) : Body length ♂ 17.0, ♀ 22-23; pronotum ♂ 3.5-4, ♀ 5.0; tegmen ♂ 17-17.5, ♀ 21-23; hind femur ♂ 11.0, ♀ 13-14; hind tibia ♂ 8.5-10, ♀ 11-12.

Distribution : India (Karnataka, Madhya Pradesh, Meghalaya, Orissa, Tamil Nadu, West Bengal), Sri Lanka.

Genus *Gastrimargus* Saussure, 188430. **Gastrimargus africanus africanus* (Saussure)

1888. *Oedaleus (Gastrimargus) marmoratus* var. *africana* Saussure, *Mem. Soc. Phys. Hist. nat. Geneve*, **30** (1) : 39.

1982. *Gastrimargus africanus africanus* : Ritchie, *Bull. Br. Mus. nat. Hist. (Ent.)*, **44** (4) : 248.

Material examined : 2♂, 1♀, Dongaghat, Jagdalpur, 12.xii.1978; 1♂, 4♀, Way to Gollapalli, Konta, 16.xii.1978; 4♂, 4♀, Geedam, 22,24.xii.1978; 2♂, 2♀, Perambada, Kondagaon, 28.xii.1978; 3♂, Keskai, 29.xii.1978; 1♂, 2♀, Mankeshari, Kanker, 1.i.1979; 2♂, Talkabad, 4.i.1979; 7♂, 2♀ Sukma, 19.xii.1980; 2♀, Nelasnar, 29.xii.1980; 4♂, 4♀, Sonpur, 1.i.1981.

Diagnosis : Pronotum tectiform with high sharp median carina; metazona of pronotum with X-marking usually effaced and without pale striae; tegmen surpassing hind knee by one-quarter to one-half of hind femur length, basal pale transverse band sometimes reduced or absent; wings with complete fascia, basal area usually bright yellow, apex variable infumate.

Measurements (in mm.) : Body length ♂22-24, ♀33-38; pronotum ♂5.5-6.0, ♀8.5-9.5; tegmen ♂24.0, ♀33-37.0; hind femur ♂13.5-15.0, ♀19-22.5; hind tibia ♂12-13, ♀17-20.

Distribution : India (Andhra Pradesh, Bihar, Delhi, Goa, Himachal Pradesh, Madhya Pradesh, Orissa, Sikkim, Uttar Pradesh, West Bengal), Nepal, Saudi Arabia, Sri Lanka, Thailand, Tibet and Yemen A. R.

Genus *Oedaleus* Fieber, 185331. **Oedaleus abruptus* (Thunberg)

1815. *Gryllus abruptus* Thunberg, *Mem. Acad. Sci. St.-Petersb.*, **5** : 233.

1981. *Oedaleus abruptus* : Ritchie, *Bull. Br. Mus. nat. Hist. (Ent.)*, **42** (3) : 104-107.

Material examined : 3♂, 2♀, Kachauri village, Jagdalpur, 11.xii.1978; 1♂, Way to Gollapalli, Konta, 16.xii.1978; 10♂, 5♀, Geedam, 20,22,24.xii.1978; 2♂, 2♀, Bhairamgarh, 21.xii.1978; 3♂, 3♀, Bailadila, 23.xii.1978; 2♂, 2♀, Perambada, Kondagaon, 28.xii.1978; 6♂, 3♀, Farasgaon, 29.xii.1978; 2♀, Mankeshari, Kanker, 1.i.1979; 1♀, Narayanpur, 24.x.1979, S. Ahmad coll.; 1♂, Bhanpuri, 16.xii.1980; 1♂, Tirathgarh, 17.xii.1980; 1♂, 4♀, Sukma, 19.xii.1980; 1♂, Tongpal, 21.xii.1980; 1♂, Gudiras, 22.xii.1980; 2♂, Malyawada, 24.xii.1980; 1♀, Barsoor, 26.xii.1980; 1♀, Nelasnar, 29.xii.1980.

Diagnosis : Pronotum low tectiform, median carina low arcuate, not intersected by posterior sulcus; hind margin obtusely angular; pronotal X-marking always with anterior and posterior arms separate; hind tibiae with 13 inner and 12 outer spines, straw or red coloured with dark basal ring and thicker subbasal pale ring.

Measurements (in mm.) : Body length ♂14-14.5, ♀21.0; pronotum ♂3.0, ♀4.0; tegmen ♂14-14.5, ♀20-21; hind femur ♂10.0, ♀12.0; hind tibia ♂8.0, ♀10.0.

Distribution : India (Andhra Pradesh, Bihar, Goa, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Meghalaya, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal). Afghanistan, Bangladesh, China, Indo-China, Myanmar, Nepal, Pakistan, Sri Lanka and Thailand.

Genus *Trilophidia* Stål, 1873

32. **Trilophidia annulata* (Thunberg)

1815. *Gryllus annulatus* Thunberg, *Mem. Acad. Sci. St.-Petersb.*, 5 : 234.

1965. *Trilophidia annulata* : Hollis, *Trans. R. ent. Soc. Lond.*, 117 (8) : 251.

Material examined : 2♂, 1♀, Dharampur, Jagdalpur, 10.xii.1978; 1♂, 1♀, Sabri river bed, Konta, 15.xii.1978; 5♂, 9♀, Geedam, 20,22,24.xii.1978 and 25.xii.1980; 1♂, 2♀, Bailadila, 23.xii.1978; 1♂, 1♀, Narayanpur, 27.xii.1978; 1♂, 1♀, Benur, 27.xii.1978; 1♂, Perambada, Kondagaon, 28.xii.1978; 3♂, 4♀, Kanker, 1.i.1978; 1♀, Chitrakut, 14.xii.1980; 1♂, Bhanpuri, 16.xii.1980; 2♀, Tirathgarh, 17.xii.1980; 1♂, 2♀, Tongpal, 21.xii.1980; 1♂, Malyawada, 24.xii.1980; 3♀, Barsoor, 26.xii.1980; 2♂, 2♀, Dhaudi, 2.i.1981.

Diagnosis : Brown or grey with black markings, pubescent beneath; pronotum rugose, with a high median carina, forming two teeth in front, and with lateral carinae; tegmina grey, some times with two indistinct brown bands; hind tibiae with a pale band towards the base and with a slight pale band beyond the middle.

Measurements (in mm.) : Body length ♂ 12.3-13.5, ♀ 15-16; pronotum ♂ 3.0, ♀ 3.5-4; tegmen ♂ 13.0, ♀ 14.5-15.5; hind femur ♂ 7.0, ♀ 8-9; hind tibia ♂ 5.0, ♀ 6.0.

Distribution : India (Widely distributed), Bangladesh, Borneo, Japan, Java, Korea, Malaya, Mongolia, Myanmar, Pakistan, Philippines, Sarawak, Singapore, Sri Lanka, Sumatra, Taiwan and Thailand.

Subfamily ROMALEINAE

Genus *Teratodes* Brullé, 1835

33. **Teratodes monticollis* (Gray)

1832. *Gryllus monticollis* Gray, *Griffith's Anim. Kingd.*, 5 : 215.

1914. *Teratodes monticollis* : Kirby, *Fauna Brit. India*, Orthopt., : 235.

Material examined : 3 nymphs, Kachauri village, Jagdalpur, 11.xii.1978; 6 nymphs, Bodhghat, Jagdalpur, 13.xii.1978; 1 nymph, Geedam, 22.xii.1978; 8 nymphs, Kondagaon, 26,30.xii.1978; 2 nymphs, Farasgaon, 29.xii.1978; 3 nymphs, Kanker, 1,3,4.i.1979.

Diagnosis : Body stout; head broad, rounded, face vertical; antennae short and filiform; pronotum raised, large, sublaminately compressed, the front arched above the head in a point, the middle forming a high crest, denticulated, specially behind, and covering half the length of abdomen; legs short, tegmina opaque.

All the specimens are in nymphal stage and are collected from the out skirt of forest. It appears that these nymphs were hatched either in the first week of December or the last week of November.

Measurements (in mm.) : Body length 38.0; pronotum length 20.0; tegman 8.0; hind femur 14.0; hind tibia 11.0.

Distribution : India (Andhra Pradesh, Madhya Pradesh and Maharashtra). It is also studied somewhere else from Bihar.

Subfamily HEMIACRIDINAE

Key to genera

1. Prosternal process conical; fastigium of vertex elongate, projecting far in front of eyes; pronotum not distinctly tricarinate. ***Gesonula*** Uvarov
- Prosternal tubercle or process spatulate; fastigium of vertex not much produced before the eyes, parabolic or obtusely angular; pronotum distinctly tricarinate. . ***Spathosternum*** Krauss

Genus ***Gesonula*** Uvarov, 1940

34. ****Gesonula punctifrons*** (Stål)

1860. *Acridium (Oxya) punctifrons* Stål, Kong. Sven. Fragattan Eug. Resa Omkring Jorden, 3 : 336.

1963. *Gesonula punctifrons* : Mishchenko, *Locusts and grasshoppers of U.S.S.R. and adjacent countries*, Catantopinae, Leningrad : 172.

Material examined : 1 ♀, Bhairamgarh, 21.xii.1978; 1 ♂, Sonpur, 1.i.1981; 1 ♀, Dhaudi, 2.i.1981.

Diagnosis : Eyes large; antennae longer than head and pronotum together; pronotum long, narrow and rugose; supra-anal plate spoon-shaped, wide basally, with wide longitudinal median groove; apical part of hind tibiae modified for swimming.

It is generally found adjacent to paddy fields, ponds etc. and damage water-hyacinth in India.

Measurements (in mm.) : Body length ♂ 19.0, ♀ 19.0; pronotum ♂ 4.0, ♀ 4.0; tegmen ♂ 18.5, ♀ 20.0; hind femur ♂ 10.5, ♀ 11.5; hind tibia ♂ 8.5, ♀ 9.0.

Distribution : India (Arunachal Pradesh, Assam, Delhi, Goa, Kerala, Maharashtra, Manipur, Meghalaya, Punjab, Tamil Nadu, West Bengal), Bangladesh, Borneo, China, Japan, Java, Malacca, Myanmar, Philippines, Sri Lanka, Taiwan, Thailand and Tonking.

Genus ***Spathosternum*** Krauss, 1877

35. ***Spathosternum prasiniferum prasiniferum*** (Walker)

1871. *Heteracris prasinifera* Walker, Cat. Derm. Salt. Brit. Mus., 5 Suppl. : 65.

1936. *Spathosternum prasiniferum prasiniferum* : Tinkham, Lingnan. Sci. Journ., Canton, 15 : 51.

Material examined : 2♂, 1♀, kachauri village, Jagdalpur, 11.xii.1978; 3♂, 6♀, Konta, 15.xii.1978; 5♂, 5♀, Geedam, 20,22.xii.1978; 2♂, 2♀, Bhairamgarh, 21.xii.1978; 2♂, 1♀, Bailadila, 23.xii.1978; 3♂, 3♀, Narayanpur, 27.xii.1978; 5♂, 4♀, Perambada, Kondagaon, 28.xii.1978; 4♂, 4♀, Farasgaon, 29.xii.1978; 4♂, 4♀, Mankeshari, Kanker, 1.i.1979; 1♀, Dharampur, 18.x.1979, S. Ahmed coll.; 1♀, Bhanpuri, 16.xii.1980; 1♀, Tirathgarh, 17.xii.1980; 1♀, Sukma, 19.xii.1980; 3♂, 5♀, Tongpal, 21.xii.1980; 2♂, Gudiras, 22.xii.1980, 3♂, 1♀, Barsoor, 26.xii.1980; 1♂, Tumnar, 27.xii.1980; 1♀, Nelasnar, 29.xii.1980; 1♂, Sonpur, 1.i.1981; 1♂, 4♀, Dhaudi, 2.i.1981.

Diagnosis : Broad blackish or dark-green stripe runs behind the lower part of the eyes and below the lateral carinae of the pronotum; central area of tegmen with a longitudinal black streak which is well marked in female and almost obsolete in male; tegmina and wings well developed.

Measurements (in mm.) : Body length ♂13.0, ♀18.0; pronotum ♂3.0, ♀4.0; tegmen ♂12.0, ♀14.0; hind femur ♂7.5-8, ♀10.0; hind tibia ♂6-6.5, ♀8.0.

Distribution : India (Widely distributed), Bangladesh, China, Indo-China, Myanmar, Sri Lanka, Thailand and Vietnam.

Subfamily OXYINAE

Genus *Oxya* Serville, 1831

Key to species (Male)

1. Supra-anal plate with a tubercle on each side of a median apical process. 2
- Supra-anal plate without lateral tubercle. *nitidula* (Walker)
2. Cercus laterally compressed, hardly narrowing towards apex, weakly bifurcate at apex.
- *fuscovittata* (Marschall)
- Cercus conical, narrowing towards apex and obtuse or truncate apically. *hyla* Serville

Key to species (Female)

1. Anterior margin of tegmen with a dense row of short bristles extending from costal bulge to apex; ovipositor valves with long teeth, the apical one curved. 2
- Anterior margin of tegmen weakly or not at all spined; valves of ovipositor with short teeth.
- *nitidula* (Walker)
2. Ventral surface of subgenital plate almost completely flat or weakly concave, appearing widen posteriorly. *fuscovittata* (Marschall)
- Ventral surface of subgenital plate flat or concave only in median posterior half, not widening posteriorly. *hyla* Serville

36. *Oxya hyla hyla* Serville

1831. *Oxya hyla* Serville, *Ann. Sci. nat. (Zool.)*, **22** : 287.

1971. *Oxya hyla hyla* : Hollis, *Bull. Br. Mus. nat. Hist. (Ent.)*, **26** (7) : 282.

Material examined : 1♂, 2♀, Kachauri village, Jagdalpur, 11.xii.1978; 6♂, 6♀, Geedam, 20,22.xii.1978 and 25.xii.1980; 1♂, Bhairamgarh, 21.xii.1978; 9♂, 9♀, Benur, 27.xii.1978; 5♂, Perambada, Kondagaon, 28.xii.1978; 1♂, Farasgaon, 29.xii.1978; 2♂, 2♀, Mankeshari, Kanker, 1.i.1979; 1♂, Chitrakut, 14.xii.1980; 1♂, 1♀, Tirathgarh, 17.xii.1980; 2♂, 1♀, Gudiras, 22.xii.1980; 2♂, 1♀, Tumnar, 27.xii.1980.

Diagnosis : Body finely rugose; supr-anal plate trapezoidal with triangular apical projection and a tubercle on each side of a median apical process; cercus with aubacuate apex; inner pair of lophi usually well-developed; subgenital plate of female with two longitudinal ridges extending forwards from posterior margin.

Measurements (in mm.) : Body length ♂ 17.0, ♀ 21-22; pronotum ♂ 4.0, ♀ 5.0; tegmen ♂ 16.0, ♀ 19-21; hind femur ♂ 10.0, ♀ 12-13; hind tibia ♂ 8.1, ♀ 10-11.

Distribution : India (Arunachal Pradesh, Assam, Goa, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Meghalaya, Orissa, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal), Afghanistan, Africa, Bangladesh, Iran, Madagascar, Maldives Island, Nepal, Pakistan.

37. **Oxya fuscovittata* (Marschall)

1836. *Gryllus fuscovittatus* Marschall, *Ann. Wien. Mus. Vienna*, **1** (2) : 211.

1971. *Oxya fuscovittata* : Hollis, *Bull. Br. Mus. nat. Hist. (Ent.)*, **26** (7) : 289.

Material examined : 1♂, Tirathgarh, 17.xii.1980; 2♂, Perambada, Kondagaon, 28.xii.1978.

Diagnosis : Integument finely pitted and shiny; cercus of male compressed and weakly bifurcate at apex; ventral surface of subgenital plate of female almost completely flat or weakly concave.

Measurements (in mm.) : Body length ♂ 18.5-21; pronotum length 4.0; tegmen length 15-18; hind femur length 12.0; hind tibia length 10.0.

Distribution : India (Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Goa, Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh, Maharashtra, Meghalaya, Orissa, Rajasthan, Uttar Pradesh, West Bengal), Afghanistan, Bangladesh, Pakistan and U.S.S.R. (South West).

Remarks : This species is associated with paddy and grasses adjoining cultivated fields.

38. **Oxya nitidula* (Walker)

1870. *Acridium nitidula* Walker, *Cat. Derm. Salt. Brit. Mus.*, **4** : 631.

1971. *Oxya nitidula* : Hollis, *Bull. Br. Mus. nat. Hist. (Ent.)*, **26** (7) : 315.

Material examined : 1 ♀, Kachauri village, Jagdalpur, 11.xii.1978; 1 ♀, Bhairamgarh, 21.xii.1978; 1 ♂, Haram, Geedam, 22.xii.1978; 1 ♂, 1 ♀, Bandapara, Kondagaon, 30.xii.1978; 1 ♂, 2 ♀, Pandripani, Kanker, 2.i.1979.

Measurements (in mm.) : Body length ♂ 17.5-18.3, ♀ 23-25; pronotum ♂ 4-4.5, ♀ 6.0; tegmen ♂ 13-14, ♀ 21-22; hind femur ♂ 10.0, ♀ 14-15; hind tibia ♂ 8.0, ♀ 11-12.0.

Diagnosis : Supra-anal plate roundly triangular; cercus conical, with acutely truncate apex; outer lophi relatively straight, inner lophi small and slender; ventral surface of subgenital plate of female, with a subapical tooth on each side of a median apical spine.

Distribution : India (Andhra Pradesh, Goa, Karnataka, Orissa, Rajasthan, Tamil Nadu, West Bengal) and Sri Lanka.

Subfamily COPTACRIDINAE

Key to genera

1. Frontal costa parallel-sided, not wider between antennae than vertex. *Coptacra* Stål
- Frontal costa distinctly widened between antennae and wider than vertex between eyes.
..... *Eucoptacra* Bolivar

Genus *Coptacra* Stål, 1873

39. **Coptacra punctaria* (Walker)

1870. *Acridium punctarium* Walker, Cat. Derm. Salt. Brit. Mus., 4 : 630.

1929. *Coptacra punctaria* : Uvarov, Revue suisse Zool., 36 : 561.

Material examined : 1 ♀, Geedam, 22.xii.1978; 1 ♂, Perambada, Kondagaon, 28.xii.1978; 1 ♀, Farasgaon, 29.xii.1978.

Diagnosis : Head rugosely punctate; antennae brown at base, dark at apex, basal segments flattened; interocular space narrower than the width of eyes; fastigium of vertex extend beyond the eyes (.75mm.), bounded by lateral carinulae, fossulate in the middle, open in front and ampliate behind; eyes oblong in profile; frontal costa between antennae equal to interocular space, punctate, parallel-sided throughout, sulcate between and below the median ocellus; pronotum rugosely punctate with raised granulate and crassate, subtransverse in front and sharply angulate behind; median carina tectiform, raised, cut by all the sulci, the hind sulcus placed behind the middle; prosternal tubercle stumpy and obtusely pointed at apex; mesosternal lobes transverse and separated from each other by their equal size distance; mesosternal lobes also distinctly separated; tegmen equal or longer than abdomen, expanded at costal area, obliquely truncate at apex; hind femur with a distinct or indistinct black spot on the superio-external face, just before the middle; hind tibiae red.

Measurements (in mm.) : Body length 16.5-18; pronotum 4.5-5; tegmen 17-19; hind femur 12; hind tibia 9-10.

Distribution : India (S. India).

Remarks : Walker (1870) recorded this species from S. India. Since then it has not been further reported. After nearly more than hundred years the author is recording it now from Bastar.

Genus *Eucoptacra* Bolivar, 1902

40. *Eucoptacra saturata* (Walker)

1870. *Acridium saturatum* Walker, *Cat. Derm. Salt, Brit. Mus.*, 4 : 628.

1921. *Eucoptacra saturata* : Uvarov, *Ann. Mag. nat. Hist.*, (9) 7 : 503.

Material examined : 1♂, Kachauri village, Jagdalpur, 11.xii.1978. 2♂, 3♀, Geedam, 20.12.1978; 4♀, Bailadila, 23.xii.1978; 5♂, 4♀, Kondagaon, 26.xii.1978; 3♂, 2♀, Farasgaon, 29.xii.1978; 3♀, Mankeshari, Kanker, 1.i.1979; 2♂, 1♀, Kutumswar, 17.xii.1980; 1♀, Gudiras, 22.xii.1980; 1♀, Nelasnar, 29.xii.1980; 1♀, Sonpur, 1.i.1981; 3♂, 2♀, Dhaudi, 2.i.1981.

Diagnosis : Ferruginous in colour; prosternal tubercle stout and slightly acute; hind femora black beneath, as long as the abdomen; hind tibiae red; tegmina with numerous small marks; hind wings hyaline or grey, tinged with blackish.

Measurements (in mm.) : Body length ♂ 15-15.5, ♀ 21-22; pronotum ♂ 3.5-4, ♀ 5; tegmen ♂ 16, ♀ 21-22; hind femur ♂ 10-11, ♀ 13; hind tibia ♂ 8-9, ♀ 11.0.

Distribution : India (S. India, Assam, Madhya Pradesh, Orissa, Uttar Pradesh and West Bengal).

Subfamily TROPIDOPOLINAE

Genus *Tristria* Stål, 1873

41. **Tristria* sp.

Material examined : 1 nymph, Geedam, 20.xii.1978.

Diagnosis : Fastigium of vertex parabolic; antennae filiform; prosternal tubercle curved backwards, almost square in cross section, strongly widened apically, with slightly concave apical surface.

Measurements (in mm.) : Body length 31.0; pronotum 6.0; tegmen 6.0; hind femur 14.5; hind tibia 11.0.

Distribution : C. Africa, China, Hong Kong, India, Java and Thailand.

Subfamily CYRTACANTHACRIDINAE

Key to genera

1. Prosternal tubercle strongly curved backward, touching or almost touching mesosternum, inflated in middle, with conical apex. *Cyrtacanthacris* (Walker)
- Prosternal tubercle straight or slightly incurved backward, far from reaching mesosternum, conical or compressed. 2
2. Tegmina with oblique venation in apical part; prosternal tubercle conical. *Pachyacris* Uvarov
- Tegmina with straight venation in apical part; prosternal tubercle almost cylindrical with rounded apex. *Patanga* Uvarov

Genus *Cyrtacanthacris* Walker, 187042. **Cyrtacanthacris tatarica* (Linnaeus)

1758. *Gryllus Locusta tataricus* Linnaeus, *Systema Naturae* (10th ed.). : 432.

1923. *Cyrtacanthacris tatarica* : Uvarov, *Bull. Ent. Res.*, 14 : 39.

Material examined : 1 ♂, 1 ♀, Kachauri village, Jagdalpur, 11.xii.1978; 2 ♂, Way to Gollapalli, Konta, 16.xii.1978; 1 ♂, Bhairamgarh, 21.xii.1978; 1 ♂, 2 ♀, Geedam, 22,24.xii.1978 and 25.xii.1980; 7 ♂, 8 ♀, Bailadila, 23.xii.1978; 1 ♂, Dumarpara, Kankar, 3.i.1979; 1 ♂, Narayanpur, 27.x.1979, S. Ahmad coll.

Diagnosis : Size large; pronotum on both sides above with a broad velvety blackish brown band; tegmina with dense and thick reticulation and transverse oblique fasciae or irregular spots; wings hyaline or sometimes yellowish at base; hind tibiae bluish or brown with yellow or brown spines, tips black.

Measurements (in mm.) : Body length ♂32.0, ♀40-42; pronotum ♂8.0, ♀11.0; tegmen ♂27-29, ♀38-39; hind femur ♂18.0, ♀24-25; hind tibia ♂16.0, ♀22-23.0.

Distribution : India (Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Delhi, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal), Africa (except N. Africa) and Sahara, Hainan, Madagascar, Philippines, Seychelles, Sri Lanka, Sumatra and Thailand.

Genus *Pachyacris* Uvarov, 192343. **Pachyacris vinosa* (Walker)

1870. *Acridium vinosum* Walker, *Cat. Derm. Salt, Brit. Mus.*, 3 : 588.

1923. *Pachyacris vinosa* : Uvarov, *Ann. Mag. nat. Hist.*, (9) 11 : 478.

Material examined : 1 ♂, Atagura, Narayanpur, 31.x.1979, S. Ahmad coll.

Diagnosis : No pale yellow mark behind the eyes and the lateral sides of the pronotum; antennae dark at base, reddish-brown beyond; tegmina with oblique venation in apical part; male cercus elongate, conical with acuminate apex.

Measurements (in mm.) : Body length 33.0; pronotum 9.0; tegmen 33.5; hind femur 20.0; hind tibia 17.0

Distribution : India (Assam, Bihar, Goa, Himachal Pradesh, Karnataka, Meghalaya, Mizoram, Orissa, Uttar Pradesh, West Bengal), China, Myanmar, Nepal, Thailand and Tongking.

Genus *Patanga* Uvarov, 1923

44. * *Patanga succincta* (Johansson)

1763. *Gryllus Locusta succinctus* Johansson, *Amoen. Acad.*, 4 : 398.

1923. *Patanga succincta* : Uvarov, *Ann. Mag. nat. Hist.*, (9) 12 : 364.

Material examined : 1 ♀, Dongaghat, Jagdalpur, 12.xii.1978; 1 ♀, Benur, 27.xii.1978.

Diagnosis : Tegmina with straight venation in apical part, transverse veins forming almost right angle with principal veins; wings base tinge with pink colour; male subgenital plate long, curved upwards, apex pointed.

Measurements (in mm.) : Body length 58-61; pronotum 12.0; tegmen 61-63; hind femur 34-35; hind tibia 30-31.

Distribution : India (Arunachal Pradesh, Assam, Bihar, Delhi, Goa, Himachal Pradesh, Jammu & Kashmir, Laccadive Island, Maharashtra, Meghalaya, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal), S. Arabia, Borneo, China, Hainan, Japan, Java, Malaya, Myanmar, Philippines, Sri Lanka, Sumatra, Taiwan and Tonkin.

Remarks : In the past, this species was a major pest of many crops in swarming phase but now it is found in solitary phase or non-swarming phase and is less harmful. Adults and nymphs feed on a very great variety of plants.

Subfamily EYPREPOCNEMIDINAE

Key to genera

1. Posterior femur moderately long, produced beyond abdomen, neither inflated basally nor strongly narrowing on apical half; prosternal tubercle with rounded or inflated apex..... *Eyprepocnemis* Fieber
- Posterior femur long, produced far beyond apex of abdomen, inflated basally and strongly narrowing at apical half; prosternal tubercle almost spatulate, with rounded, sometimes slightly inflated apex. *Tylotropidius* Stål

Genus *Eyprepocnemis* Fieber, 185345. **Eyprepocnemis alacris alacris* (Serville)

1839. *Acridum alacre* Serville, *Hist. nat. Ins. Orth.*, : 682.

1958. *Eyprepocnemis alacris alacris* : Dirsh, *Proc. R. Ent. Soc. Lond.*, (B) 27 (3-4) : 40.

Material examined : 1 ♂ (nymph), Geedam, 22.xii.1979; 1 ♀, Narayanpur, 27.xii.1978; 5 ♂, 2 ♀, Mankeshari, Kanker, 1.i.1979; 2 ♂, Pandripani, Kanker, 2.i.1979.

Diagnosis : Concavity of fastigium of vertex distinct, with a low apical carinula, separating it from frontal ridge; pronotum above with a characteristic narrow dark spot; lateral carinae converging forwards; hind tibiae bluish grey with two whitish ring at the base and reddish at apex; male cercus gradually narrowing towards apex, incurved and down curved.

Measurements (in mm.) Body length ♂ 22-22.5, ♀ 29.0; pronotum ♂ 4.0, ♀ 6.0; tegmen ♂ 18-22; ♀ 25.0; hind femur ♂ 13.0, ♀ 17.0; hind tibia ♂ 11.0, ♀ 15.0.

Distribution : India (Andhra Pradesh, Bihar, Delhi, Goa, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Orissa, Punjab, Rajasthan, Tamil Nadu, West Bengal), Afghanistan, Bangladesh, E. Iran, Pakistan and Sri Lanka.

Genus *Tylotropidius* Stål, 187346. **Tylotropidius varicornis* (Walker)

1870. *Heteracris varicornis* Walker, *Cat. Derm. Salt. Br. Mus.*, 4 : 667.

1914. *Tylotropidius varicornis* : Kirby, *Fauna. Brit. India. Orth.* : 265.

Material examined : 1 ♂, 3 ♀, Geedam, 25.xii.1980.

Diagnosis : Pronotum brown with lateral carinae of pale colour; prosternal tubercle compressed, bituberculate at apex; hind femora thickened at the base, very slender towards the tip; hind tibiae and tarsi dull blue; supra-anal plate of male elongato-triangular and sulcated; cerci straight, slightly compressed and acuminate.

Measurements (in mm.) : Body length ♂ 29.0, ♀ 40.0; pronotum ♂ 5.0, ♀ 7.5; tegmen ♂ 26.0, ♀ 32.5; hind femur ♂ 20.0, ♀ 26.0; hind tibia ♂ 17.0, ♀ 22.0.

Distribution : India (Andhra Pradesh, Goa, Himachal Pradesh, Maharashtra, Meghalaya, Orissa, Rajasthan, Tamil Nadu, West Bengal), Myanmar and Sri Lanka.

Subfamily CATANTOPINAE

Key to genera

1. Pronotum subcylindrical, slightly narrowing forwards; prosternal tubercle thick, cylindrical or slightly antero-posteriorly compressed with rounded apex. *Catantops* Schaum

- Pronotum not subcylindrical; prosternal tubercle not cylindrical and never with rounded apex...
.....2
- 2. Pronotum constricted in the middle; prosternal tubercle conical.
..... *Xenocatantops* Dirsh & Uvarov
- Pronotal disc not constricted; prosternal tubercle laterally compressed.
..... *Stenocatantops* Dirsh & Uvarov

Genus *Catantops* Schaum, 1853

Key to species

- 1. Male cercus simple, with rounded apex. *pulchellus* (Walker)
- Male cercus with widened, slightly hammer-shaped apex. *pinguis innotabilis* (Walker)

47. **Catantops pinguis innotabilis* (Walker)

1870. *Acridium innotabile* Walker, *Cat. Derm. Salt. Br. Mus.*, 4 : 629.

1953. *Catantops pinguis innotabilis* : Dirsh & Uvarov, *Tijdschr. Ent.*, 96(3) : 233.

Material examined : 1♂, Tirathgarh, 17.xii.1980; 1♂, Sukma, 18.xii.1980; 1♀, Nelasnar, 29.xii.1980.

Diagnosis : Lateral lobe of pronotum without coloured pattern; external disc of hind femur without the black median spot below the upper carinula; male cercus more upcurved, with more broadened apex and more projecting upper apical angle.

Measurements (in mm.) : Body length ♂23-24, ♀33-35; pronotum ♂5.0, ♀7-7.5; tegmen ♂21-22, ♀30.0; hind femur ♂12.5, ♀18-19; hind tibia ♂10-10.2, ♀15-16.0.

Distribution : India (Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Delhi, Goa and Laccadive Islands, Himachal Pradesh, Jammu & Kashmir, Kerala, Madhya Pradesh, Meghalaya, Orissa, Sikkim, Tamil Nadu, Uttar Pradesh, West Bengal), Afghanistan, Bangladesh, Borneo, China, Hong Kong, Indo-China, Japan, Java, Kambodia, Korea, Malaya, Maldive Islands, Myanmar, Nepal, New Guinea, Pakistan, Philippines, Sumatra, Thailand, Tibet and Yunnan.

Remarks : It is common in the plains of India and damage millet, cotton, maize, rice, tea, teak etc.

48. **Catantops pulchellus* (Walker)

1870 *Cyrtacanthacris pulchella* Walker, *Cat. Derm. Salt. Br. Mus.*, 3 : 574.

1943 *Catantops pulchellus* : Uvarov, *Ann. Mag. nat. Hist.*, (11) 10 (62) : 127.

Material examined : 2♀, Chingrigarh, Narayanpur, 25.x.1979. S. Ahmad coll.

Diagnosis : Prosternal tubercle subcylindrical, inclined backwards, with rounded and slightly broadened apex; external disc of hind femur buff with two longitudinal black stripes below the upper carinula, one in the middle, and another on the apical third.

Measurements (in mm.) : Body length ♀ 23.0; pronotum length 5.0; tegmen length 20.0; hind femur 12.0; hind tibia 10.0.

Distribution : India (Andaman Islands, Karnataka, Manipur, Sikkim), Bangladesh and Pakistan.

Genus *Xenocatantops* Dirsh & Uvarov, 1953

Key to species

1. Male cercus showing no clear apical bifurcation, but apically bilaterally compressed and slightly upcurved. *humilis humilis* (Serville)
- Male cercus clearly bifurcate apically. *karnyi* (Kirby)

49. **Xenocatantops humilis humilis* (Serville)

1839. *Acridium humile* Serville, *Ins. Orth.*, : 662.

1953. *Xenocatantops humilis humilis* : Dirsh & Uvarov, *Tijdschr. Ent.*, **96** : 237.

Material examined : 2♂, 1♀, Tirathgarh, 17.xii.1980.

Diagnosis : Pronotal and thoracic markings much lighter with proportionately broader light oblique band on episternum III. Ratio of length to depth of hind femur never less than 3.45. Dark markings of outer side of hind femur resemble with that of *Xenocatantops brachycerus*. Male cercus with rounded apex.

Measurements (in mm.) : Body length ♂20-21, ♀27.0; pronotum ♂4.5-5, ♀7.0; tegmen ♂18-19, ♀23.5; hind femur ♂12.0, ♀16.0; hind tibia ♂10.0, ♀13.0.

Distribution : India (Andaman Islands, Arunachal Pradesh, Assam, Bihar, Himachal Pradesh, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Tamil Nadu, Uttar Pradesh, West Bengal), Bangladesh, Borneo, Indo-China, Java, Lombok, Malaya, Myanmar, New Guinea, Philippines, Sri Lanka, Sumatra, Thailand, S. Tibet, Vietnam and Yunnan.

50. **Xenocatantops karnyi* (Kirby)

1910. *Catantops karnyi* Kirby, *Syn. Cat. Orthopt.*, **3** : 483.

1982. *Xenocatantops karnyi* : Jago, *Trans. Am. ent. Soc.*, **108** (3) : 455.

Material examined : 1♀, Haram, Geedam, 22.xii.1978; 1♀, Bailadila, 23.xii.1978; 1♀, Kondagaon, 26.xii.1978; 1♂, Farasgaon, 29.xii.1978; 2♂, 1♀, Dhaudi, 2.i.1981.

Diagnosis : Apical bifurcation of cercus bluntly pointed and subequal. This species closely resembles with *X. zernyi* (African species) though lateral pattern of head and thorax differ from the latter. Epiphallus distinctive with lophi almost square in plane view.

Measurements (in mm.) : Body length ♂ 15.5, ♀ 20-21.5; pronotum ♂ 4.0, ♀ 4.5-5; tegmen ♀ 13-15, ♀ 17-18; hind femur ♂ 9-9.5, ♀ 12-12.5; hind tibia ♂ 7.0, ♀ 10-10.5.

Distribution : India (Andhra Pradesh, Delhi, Himachal Pradesh, Tamil Nadu and Uttar Pradesh).

Genus *Stenocatantops* Dirsh & Uvarov, 1953

51. **Stenocatantops splendens* (Thunberg)

1815 *Gryllus splendens* Thunberg, *Mem. Acad. Sci. St.-Petersb.*, 5 : 236.

1953 *Stenocatantops splendens* : Dirsh & Uvarov, *Tijdschr. Ent.*, 96 (3) : 237.

Material examined : 1♂, 2♀, Kachauri village, Jagdalpur, 11.xii.1978; 2♂, 1♀, Geedam, 20,24.xii.1978; 1♀, Bhairamgarh, 21.xii.1978; 4♀, Chingrigarh, Narayanpur, 31.x.1979. S. Ahmad coll.; 2♂, 1♀, near Kutumswar cave, 17.xii.1980; 6♂, 1♀, Sonpur, 1.i.1981.

Diagnosis : Colour brown or brownish testaceous; body elongated; middle joints of antennae about twice or three times as long as broad; prosternal tubercle strongly curved and inclined backwards in profile.

Measurements (in mm.) : Body length ♂ 30.5-33, ♀ 37-38; pronotum ♂ 6-7, ♀ 8-9; tegmen ♂ 28-29, ♀ 35.0; hind femur ♂ 14.5-17, ♀ 19-20; hind tibia ♂ 12-14, ♀ 16-17.0.

Distribution : India (Andaman & Nicobar Islands, Arunachal Pradesh, Assam, Madhya Pradesh, Meghalaya, Orissa, Tamil Nadu, Uttar Pradesh, West Bengal), Borneo, Celebes, China, Hainan, Java, Korea, Malaya, Moluccas Island, Myanmar, Philippines, Sri Lanka, Sumatra and Thailand.

Remarks : It is found in open places on the outskirts of forest, grassland or fallow fields of crops, on road side vegetation and in gardens. This species is a minor pest.

Superfamily GRYLLOIDEA

The superfamily is characterized by long, slender antennae with numerous segments, by a large ovipositor, usually extending far beyond the abdominal extremity, by the auditory organs placed in the anterior tibiae, by a large part of the male tegmen transformed into a stridulatory organ, and by 3-segmented tarsi.

Key to families

1. Anterior legs short, presenting a special conformation for digging. GRYLLOTALPIDAE
- Anterior legs normally formed. 2
2. Second segment of tarsi compressed, minute. 3

- Second segment of tarsi depressed. TRIGONIDIIDAE
- 3. Posterior tibiae without denticles between the spines. GRYLLIDAE
- Posterior tibiae serrulated at base and between the spines. 4
- 4. Head lengthened, horizontal; slender insects with feebly swollen posterior femora; tegmina transparent. OECANTHIDAE
- Head short, vertical, more robust insects with usually long legs but posterior femora strongly swollen at base; tegmina, when present, coloured. PHALANGOPSIDAE

Family GRYLLOTALPIDAE

Genus *Gryllotalpa* Latreille, 1802

52. **Gryllotalpa africana* Beauvois

1905. *Gryllotalpa africana* Beauvois, *Ins. Afr. Amer.*, : 229.

1967. *Gryllotalpa africana* : Chopard, *Orthopt. Cat.*, Part 12 : 449.

Material examined : 1♂, Kutru, 1.ii.1990, R.K. Ghosh coll.

Diagnosis : Colour light brown; shape stout; mirror of male wider; anterior tibiae armed with four dactyls and pseudepiphallus is narrowly cordiform and the hooks rather short, acute.

It is reported to damage the crops.

Measurements (in mm.) : Body length 24-25; pronotum 8.0; tegmen 10.0; hind femur 7.0; hind tibia 4.5.

Distribution : India (Andaman Islands, Arunachal Pradesh, Assam, Bihar, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Meghalaya, Orissa, Tamil Nadu, Uttar Pradesh, West Bengal), Africa, Australia, Bhutan, Iran, Madagascar, Malaya, Myanmar, Nepal, Pakistan, Singapore, S.Spain and Sri Lanka.

Family GRYLLIDAE

Key to subfamilies

- 1. Spines of the posterior tibiae immovable, without hairs. GRYLLINAE
- Spines of posterior tibiae movable, pubescent. NEMOBIINE

Subfamily GRYLLINAE

Key to genera

- 1. Posterior femora long, usually as long as tibia and tarsus together; ocelli disposed in a straight line; body almost glabrous. *Gymnogryllus* Saussure

- Posterior femora no longer than tibia and metatarsus together; body usually more or less pubescent. 2
- 2. Head with narrow frontal rostrum. *Gryllodes* Saussure
- Head with wide frontal rostrum. 3
- 3. Head with a transverse yellow band between the ocelli; epiphallus deeply emarginate posteriorly forming H-shaped structure. *Modicogryllus* Chopard
- Head without a transverse yellow band between the ocelli; epiphallus of different structure. 4
- 4. Anterior projections of the ectoparamere approximately equal. *Gryllus* Linnaeus
- Internal anterior projection of the ectoparamere much longer than the external anterior projection. 5
- 5. Posterior femora short and thick; mesal lobes with their apices between the bases of the ectoparameres; endoparameres J-shaped. *Plebeigryllus* Chopard
- Posterior femora normal; mesal lobes with their apices between the apices of the ectoparameres; endoparameres C-shaped. *Teleogryllus* Chopard

Genus *Gymnogryllus* Saussure, 1877

1877. *Gymnogryllus* Saussure, *Mem. Soc. Geneva.*, **25** : 123.

1969. *Gymnogryllus* : Chopard, *Fauna of India*, Orthopt., **2** Grylloidea : 20-21.

53. **Gymnogryllus* sp.

Material examined : 1 ♀, Dharampur, Kanker, 10.x.1979, S. Ahmad coll.

Diagnosis : This species is nearer to *G. minor*, but differs from it in ovipositor, being smaller in size, and in colour of cerci which is yellow at base and black at apex. It also resembles with *G. fascipes* in genitalia.

Measurements (in mm.) : Body length 13.0; head length 2.0; head width 4.0; pronotum length 2.0, pronotum width 4.0; tegmen 8.0; hind femur length 7.0; hind tibia 4.5; body length with wings 22.0; ovipositor length 4.0.

Distribution : The genus is distributed in Tropical Asia, Africa south of the Sahara.

Genus *Gryllus* Linnaeus. 1758

54. **Gryllus bimaculatus* De Geer

1773. *Gryllus bimaculatus* De Geer, *Mem. Ins.*, **3** : 531.

1936. *Gryllus bimaculatus* : Chopard, *Ceylon J. Sci. (B)* **20** : 22.

Material examined : 1♂, 1♀, Narayanpur, 1.i.1981.

Diagnosis : Body and legs almost glabrous; body typically black with a yellow spot at base of each tegmen. It is known to damage potato plants.

Measurements (in mm.) : Body length 21-30; pronotum 4-4.5; hind femur 12-14.5; tegmen 13-20; ovipositor 18.0.

Distribution : India (Andaman Islands, Andhra Pradesh, Arunachal Pradesh, Bihar, Himachal Pradesh, Jammu & Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Meghalaya, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh, West Bengal), Africa, Malaya, Mediterranean region, Myanmar, Pakistan, Singapore and Sri Lanka.

Genus *Teleogryllus* Chopard, 1961

55. **Teleogryllus occipitalis* (Serville)

1838. *Gryllus occipitalis* Serville, *Handb. Ent.*, : 339.

1980. *Teleogryllus occipitalis* : Townsend, *J. nat. Hist.*, 14 : 154.

Material examined : 1♂, Narayanpur, 1.i.1981.

Diagnosis : Head with a yellow band along the internal margin of eyes; mirror broader than long, divided in the middle by a curved vein, 4 oblique veins; genitalia with large superior part, sinuated sides, and feebly acute at apex.

Measurements (in mm.) : Body length 20.0; pronotum 3.5; tegmen 14.0; hind femur 12.5.

Distribution : India (Andaman Islands, Arunachal Pradesh, Assam, Bihar, Himachal Pradesh, Karnataka, Madhya Pradesh, Manipur, Meghalaya, Orissa, Sikkim, Tamil Nadu, Uttar Pradesh, West Bengal), Bhutan, Japan, Laccadive Archipelagoes, Maldives, Sri Lanka, Philippines and Tibet.

Genus *Plebeiogryllus* Randell, 1954

56. *Plebeiogryllus guttiventris* (Walker)

1871. *Gryllus guttiventris* Walker, *Cat. Derm. Salt. Brit. Mus.*, Suppl. : 6.

1964. *Plebeiogryllus guttiventris* : Randell, *Can. Ent.*, 96(12) : 1598.

Material examined : 2♂, 1♀, Jagdalpur, 10.xii.1978; 1♂, Konta, 16.xii.1978; 2♂, 1♀, Geedam, 20.24.xii.1978; 1♀, Benur, 27.xii.1978; 1♂, Perambada, Kondagaon, 28.xii.1978; 1♂, 2♀, Kanker, 2.i.1979; 1♀, Barsoor, 25.xii.1980; 1♀, Kutru, 2.ii.1990, R. K. Ghosh coll.

Distribution : India (Bihar, Delhi, Goa, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Orissa, Pondicherry, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal), Myanmar and Sri Lanka.

Genus *Modicogryllus* Chopard, 196157. **Modicogryllus confirmatus* (Walker)

1859. *Acheta confirmata* Walker, *Ann. Mag. nat. Hist.*, (3) 4 : 221.

1964. *Modicogryllus confirmatus* : Randell, *Can. Ent.*, 96(12) : 1584.

Material examined : 1 ♂, Konta, 16.xii.1978 (at light); 1 ♂, Geedam, 27.xii.1980 (at light); 1 ♂, Pandripani, Kanker, 2.i.1979.

Diagnosis : Head brown with narrow yellow band connecting the lateral ocelli; occiput with 6 short yellowish lines; mirror longer than wide, divided by a curved vein; 2 oblique veins; lateral field transparent, two anterior veins strongly curved and separated from other posterior veins.

Measurements (in mm.) : Body length 10.5-11; tegmen 6.5-7.5; hind femur 7.5-8.

Distribution : India (Andaman Islands, Arunachal Pradesh, Assam, Bihar, Delhi, Haryana, Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal), Bangladesh, Indo-China, Israel, Malaya, Myanmar, Nepal, Sri Lanka and Thailand.

Genus *Gryllodes* Saussure, 187458. **Gryllodes sigillatus* (Walker)

1869. *Gryllus sigillatus* Walker, *Cat. Derm. Salt. Brit. Mus.*, 1 : 46.

1877. *Gryllodes sigillatus* : Saussure, *Mem. Soc. Phys. Geneva*, 25 : 216.

1969. *Gryllodes sigillatus* : Chopard, *Fauna of India*, Orthopot., 2 Grylloidea : 85.

Material examined : 1 ♀, Govindpur, Kanker, 21.x.1979, S. Ahmed coll.

Diagnosis : Head small, a little flattened; frontal rostrum much narrower; tegmina of female very short and widely separated; wings absent.

Measurements (in mm.) : Body length 17.5; tegmen 1.5; ovipositor 12.5.

Distribution : This species occurs in all tropical countries. In India it is reported from Andaman Islands, Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Delhi, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Punjab, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal.

Subfamily NEMOBIINAE

Key to genera

1. Tegmina of male provided with a distinct mirror; legs normal. *Pteronemobius* Jac. & Bian.

- Tegminal venation similar in both sexes; legs very long. *Paranemobius* Saussure

Genus *Pteronemobius* Jacobson & Bianchi, 1905

Key to species

1. Posterior femora adorned with blackish bands. 2
- Posterior femora unicolorous. 3
2. Maxillary palpi very dark at base, with 4th and 5th joints nearly white; lateral lobes of pronotum blackish. *fascipes* (Walker)
- Maxillary palpi testaceous, a little darkened at apex; lateral lobes of pronotum for the most part rufotestaceous. *csikii* (Bolivar)
3. Lateral lobes of pronotum and lateral field of tegmina blackish, contrasting with the upper part which is testaceous. *taprobanensis* (Walker)
- Lateral lobes of pronotum and lateral field of tegmina of the same colour as the upper part. 4
4. Posterior tibiae with 3 spines on each margin in the female sex. *rufipes* Chopard
- Posterior tibiae with 4 spines on each margin. *concolor* (Walker)

59. *Pteronemobius taprobanensis* (Walker)

1869. *Trigonidium taprobanensis* Walker, *Cat. Derm. Salt. Brit. Mus.*, 1 : 102.

1925. *Pteronemobius taprobanensis* : Chopard, *Ann. Mag. nat. Hist.*, (9) 15 : 507.

Material examined : 2♂, 2♀, Konta, 17.xii.1978; 1♂, Mankeshari, Kanker, 1.i.1979; 6♂, 7♀, Geedam, 24,27,29.xii.1980; 3♀, Kutru, 1.ii.1990, R.K. Ghosh coll.

Diagnosis : Colour greyish testaceous above, dark brown on the sides of the pronotum and the lateral field of the tegmina; tegmina extending to the apex of abdomen, spotted with brown above; posterior tibiae provided with 3 external and 4 internal spines in male, 3 on each margin in female.

Measurements (in mm.) : Body length 5-5.4; pronotum length 1.2; tegmen 3-3.5; hind femur 3.9; ovipositor 2.5-3.

Distribution : India (Andaman Islands, Arunachal Pradesh, Assam, Bihar, Karnataka, Madhya Pradesh, Maharashtra, Manipur, Orissa, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal), China, Malaya, Malacca, Myanmar, Sri Lanka and Vietnam.

60. *Pteronemobius fascipes* (Walker)

1869. *Eneoptera fascipes* Walker, *Cat. Derm. Salt. Brit. Mus.*, 1 : 67.

1931. *Pteronemobius fascipes* : Chopard, Bull. Raffles Mus., No. 6 : 134.

Material examined : 1 ♂, 1 ♀, Jagdalpur, 10.xii.1978 (at light); 6 ♂, 9 ♀, Konta, 15,16,17.xii.1978 (at light); 2 ♂, 1 ♀, Sabri River bed, Konta, 15.xii.1978; 3 ♂, 1 ♀, Geedam, 24,27,29.xii.1980; 1 ♂, 1 ♀, Kutru, 2.ii.1990. R.K. Ghosh coll.

Diagnosis : Head blackish with four pale lines on the occiput; palpi blackish at base, with 4th and 5th joints white; pronotum brownish above; posterior tibiae with 3 external and 4 internal spines in male.

Measurements (in mm.) : Body length 5.0; tegmen 3.5; hind femur 3-3.5; ovipositor 2.5.

Distribution : India (Andaman Islands, Arunachal Pradesh, Assam, Bihar, Delhi, Goa, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal), China, Malaya, Myanmar, Philippines, Sri Lanka and Taiwan.

61. **Pteronemobius csikii* (Bolivar)

1901. *Nemobius csikii* Bolivar, Zichy zool. Ergebn., 2 : 243.

1925. *Pteronemobius csikii* : Chopard, Ann. Mag. nat. Hist. (9) 15 : 507.

Material examined : 2 ♂, 1 ♀, Dongaghat, Jagdalpur, 12.xii.1978; 3 ♂, 1 ♀, Bandapara, Kondagaon, 30.xii.1978.

Diagnosis : Lateral lobes of pronotum dark brown in colour; 4th and 5th joints of maxillary palpi testaceous.

Measurements (in mm.) : Body length 6.5; tegmen 3.1; hind femur 4.5; ovipositor 4.0.

Distribution : India (Arunachal Pradesh, Assam, Bihar, Haryana, Karnataka, Madhya Pradesh, Orissa, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh), Bhutan, China, Myanmar, Siberia and Sri Lanka.

62. **Pteronemobius concolor* (Walker)

1871. *Eneoptera concolor* Walker, Cat. Derm. Salt. Brit. Mus., 5 Suppl. : 10.

1931. *Pteronemobius concolor* : Chopard, Bull. Raffles Mus., No. 6 : 134.

Material examined : 1 ♂, Geedam, 22.xii.1978, 1 ♂, 2 ♀, Malayawada, 24.xii.1978; 2 ♀, Kanker, 2.i.1979.

Diagnosis : General shape more elongated; last two joints of maxillary palpi concolorous; lateral lobes of pronotum and lateral field of tegmina of the same colour as the upper part; tegmina and wings well developed; ovipositor short and gently curved.

Measurements (in mm.) : Body length 6-7; tegmen 3.5-4; hind femur 4-4.5; hind tibia 3.4-4; ovipositor 2.5-2.7.

Distribution : India (Andaman & Nicobar Islands, Arunachal Pradesh, Assam, Goa, Karnataka, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Orissa, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal), Afghanistan, Malaya, Myanmar, Sri Lanka and Turkistan.

63. **Pteronemobius rufipes* Chopard

1969. *Pteronemobius rufipes* Chopard. *Fauna of India*, Orthopt., 2 Grylloidea : 163.

Material examined : 1 ♂, Mankeshari, Kanker, 1.i.1979.

Diagnosis : Body blackish-brown with light rufous legs; head blackish; 4th and 5th joints of maxillary palpi white; abdomen blackish; wings absent.

Measurements (in mm.) : Body length 5.0; tegmen 3.2; hind femur 3.5; hind tibia 2.8.

Distribution : India (Assam and West Bengal).

Genus *Paranemobius* Saussure, 1877

64. **Paranemobius pictus* (Saussure)

1877. *Pseudonemobius pictus* Saussure, *Mem. Soc. Phys. Geneva*, 25 : 67.

1925. *Paranemobius pictus* : Chopard, *Ann. Mag. nat. Hist.*, (9) 15 : 506.

Material examined : 1 ♀, Konta, 17.xii.1978 (at light).

Diagnosis : Tegmina over-lapping with each other on the median line of abdomen. The internal margin of left tegmen transparent, and its apical part a little truncated.

Measurements (in mm.) : Body length 10.0; pronotum length 2.0; tegmen 2.1; hind femur 8.0; ovipositor 11.5.

Distribution : India (Bihar, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu) and Sri Lanka.

Family PHALANGOPSIDAE

Genus *Arachnomimus* Saussure, 1876

65. *Arachnomimus subalatus* Chopard
(Figs. 10-14)

1970. *Arachnomimus subalatus* Chopard, *Bull. Soc. ent. Fr.* 75 : 122.

Material examined 3 ♀, Kutumswar cave, Jagdalpur, 17.xii.1980.

Diagnosis Size medium; colour testaceous; head small, with ornamentation; frontal rostrum a little narrower than the first antennal joint; antennae very long; palpi very long, 3rd & 4th joints more or less equal in length, 5th a little more longer and widened at apex.

Pronotum slightly wider at anterior margin; cerci very long; legs very long and slender; anterior tibiae with small tympanum, armed with two long, fine spurs; tarsi and metatarsi long; hind femora thick at base, slender apically; hind tibiae armed with three very fine spines (fig. 13) on either side; metatarsi very long; tegmina and wings absent; ovipositor very long and lanceolate.

Measurements (in mm.) : Body length 14.0; pronotum length 3.0; anterior femora 12.5; posterior femora 20.0; posterior tibiae 22.5; ovipositor 17.9.

Distribution : India (M.P.).

Remarks : This species was described by Chopard (1970) on a single male specimen collected from a place near to Jagdalpur (M.P.). Sinha & Agarwal (1973) described another species *Kempiella shankari* from Kutumswar cave, near to Jagdalpur. They have studied both male and female specimens. Female specimens of *Kempiella shankari* are apterous. The measurements of the present specimens and both *A. subalatus* and *K. shankari* are approximately equal. Therefore, it is possible that both species stated above are same. However, in absence of Type specimens of both species, it is not possible to synonymised *K. Shankari* with *A. subalatus* at present.

Family OECANTHIDAE

Genus *Oecanthus* Serville, 1831

66. * *Oecanthus indicus* Saussure

1878. *Oecanthus indicus* Saussure, *Mem. Soc. Phys. Genève*, **25** : 454.

1969. *Oecanthus indicus* : Chopard, *Fauna of India, Orthopt.*, **2** Grylloidea : 267.

Material examined : 1 ♀, On way to Gollapalli, Konta, 16.xii.1978.

Diagnosis : First two antennal joints without black markings; anterior tibiae more strongly dilated at base; tympanum not narrow; posterior tibiae serrulated and armed with spines.

Measurements (in mm.) : Body length 14.0; pronotum length 2.1; tegmen 11.5; hind femur 7.1; ovipositor 4.6.

Distribution : India (Andaman Islands, Arunachal Pradesh, Assam, Bihar, Karnataka, Madhya Pradesh, Maharashtra, Meghalaya, Orissa, Tamil Nadu, Tripura, West Bengal), China, Japan, Malaya, Philippines, Sri Lanka, Sumatra and Sumba.

Family TRIGONIDIIDAE

Key to genera

1. Tegmina glabrous or almost glabrous. 2
- Tegmina covered with an abundant fine pubescence. *Amusurgus* Brunner
2. Tegminal venation quite different in both sexes, showing always in male a very neat anal field and mirror. *Homoeoxipha* Saussure

PLATE 3

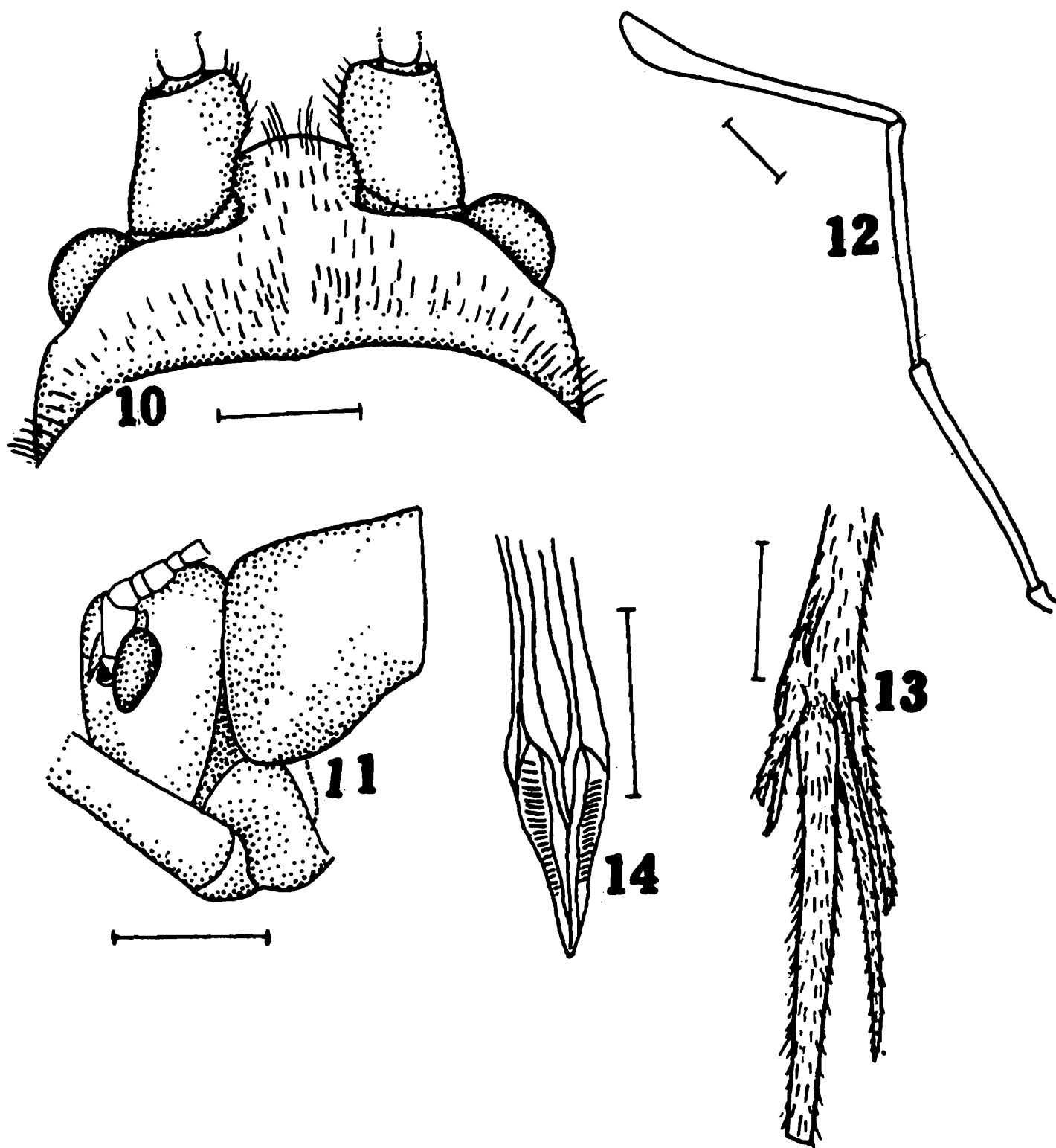


Fig. 10. Dorsal view of head of *Arachnomimus subalatus* Chopard; Fig. 11. Dorso-lateral view of head and pronotum of *Arachnomimus subalatus* Chopard; Fig. 12. Maxillary palpi of *A. subalatus* Chopard; Fig. 13. Hind tibia of *A. subalatus* Chopard; Fig. 14. Ovipositor valves of *A. subalatus* Chopard.

- Tegminal venation similar or almost similar in both sexes. 3
- 3. Tegmina presenting false veins between the principal veins which make them appear finely striated. *Trigonidium* Rambur
- Tegmina without false veins between the principal veins. *Metioche* Stål

Genus *Amusurgus* Brunner, 189367. **Amusurgus* sp.

Material examined : 1 ♀, Benur, 27.xii.1978.

Measurements (in mm.) : Body length 6.0; tegmen 5.0; hind femur 5.0; ovipositor 2.1.

Distribution : The genus is distributed in India, North Australia, Malaya, Myanmar, New Guinea and Sri Lanka.

Remarks : In absence of male the specimen could not be identified upto specific level.

Genus *Homoeoxipha* Saussure, 187468. **Homoeoxipha lycoides* (Walker)

1869. *Phyllopopus lycoides* Walker, *Cat. Derm. Salt. Brit. Mus.*, 1 : 71.

1925. *Homoeoxipha lycoides* : Chopard, *Ann. Mag. nat. Hist.*, (9) 15 : 532.

Material examined : 1 ♂, Geedam, 29.xii.1980.

Diagnosis : Pronotum narrowing and rounded in front; right anterior tibia without tympana and not swollen but the left anterior tibia has tympana and swollen; anterior and middle femora dark brown with yellowish ring at apex; posterior tibia and tarsi with a tinge of dark brown colour; tegmina with 4 indistinct black spots.

Measurements (in mm.) : Body length ♂ 4.0; pronotum 1.3; body length with wings 9.8; tegmen 4.5; posterior femora 3.7.

Distribution : India (Andaman Islands, Arunachal Pradesh, Assam, Bihar, Karnataka, Lakshadweep Island, Meghalaya, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal), Bangladesh, China, Malaya, Maldives Island, Myanmar, Queensland, Singapore, Sri Lanka and Taiwan.

Genus *Trigonidium* Rambur, 1839

Key to species

- 1. Tegmina strongly convex; wings short; anterior tibiae unperforated. ... *cicindeloides* Rambur
- Tegmina longer and less convex; wings usually caudate; anterior tibiae perforated.
..... *humbertianus* (Saussure)

69. **Trigonidium cicindeloides* Rambur

1839. *Trigonidium cicindeloides* Rambur, *Faune Andal.*, 2 : 39.

1969. *Trigonidium cicindeloides* : Chopard, *Fauna of India, Orthopt.* 2 Grylloidea : 304.

Material examined : 1 ♂, 1 ♀, Jagdalpur, 10.xii.1978; 1 ♂, Sabari river bed, Konta, 15.xii.1978; 1 ♂, 1 ♀, Perambada, Kondagaon, 28.xii.1978; 1 ♂, Mankeshari, Kanker, 1.i.1979; 2 ♂, Dumarpara, 3.i.1979.

Diagnosis : Colouration black, shining, with posterior legs light yellowish; subgenital plate of male conical, feebly notched at apex; ovipositor compressed, curved, acute at apex.

Measurements (in mm.) : Body length 4-5.5; tegmina 3-3.5; hind femur 4.0; ovipositor 2.1.

Distribution : India (Andaman Islands, Arunachal Pradesh, Assam, Bihar, Delhi, Goa, Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Orissa, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal), Africa, Madagascar, Malaya, Mauritius Island, Mediterranean region, Myanmar and Sri Lanka.

70. *Trigonidium humbertianum* (Saussure)

1878. *Homoeoxiphus humbertianus* Saussure, *Mém. Soc. Phys. Genève*, 25 : 468.

1925. *Trigonidium humbertianum* : Chopard, *Ann. Mag. nat. Hist.* (9) 15 : 525.

Material examined : 1 ♂, Kachauri village, Jagdalpur, 11.xii.1978; 2 ♂, 2 ♀, Sabari river bed, Konta, 15.xii.1978; 1 ♂, 2 ♀, Geedam, 24.xii.1978; 1 ♂, 1 ♀, Bandapara, Kondagaon, 30.xii.1978; 1 ♂, 3 ♀, Mankeshari, Kanker, 1.i.1979.

Diagnosis : This species is very similar to the preceding species, except the characters which are stated in the key given above.

Measurements (in mm.) : Body length 4.5-5; tegmen 3-3.5; hind femur 4-4.3; ovipositor 2.1.

Distribution : India (Arunachal Pradesh, Assam, Bihar, Delhi, Gujarat, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Tamil Nadu, Tripura, West Bengal), Malaya and Sri Lanka.

Genus *Metioche* Stål, 1877

71. **Metioche* sp.

Material examined : 1 ♀, Kachauri village, Jagdalpur, 11.xii.1978; 2 ♀, Dongaghat, Jagdalpur, 12.xii.1978; 2 ♀, Konta, 15,16.xii.1978; 1 ♀, Benur, 27.xii.1978.

Diagnosis : Tegmine without or very feebly pubescent; the veins somewhat irregular; transverse veinlets numerous.

Measurements (in mm.) : Body length 4-5.1; hind femur 4.3.

Distribution : The genus is distributed in Indo-Australian region and Philippines Islands.

Remarks : In absence of male specimens this material could not be identified upto specific level.

Superfamily TETTIGONIOIDEA

Key to families

1. Head subconical to strongly conical. CONOCEPHALIDAE
- Head usually short and rounded. 2
2. Prosternum lacks spine. (Auditory organ generally covered; 1st and 2nd tarsal segments not laterally grooved). PHANEROPTERIDAE
- Prosternum with a pair of spines. (Auditory organ developed in male only; prothoracic spiracles small, not hidden by pronotum). PSEUDOPHYLLIDAE

Family CONOCEPHALIDAE

Key to tribes

1. Small species with a short rounded rostrum; fore and middle femora unarmed; fastigium of vertex broad, obtuse, cephalic ventral portion not produced or forming a hook. CONOCEPHALINI
- Large species with more acute rostrum which is notched below at base; fore and middle femora armed, often the teeth quite large; fastigium of vertex conical, often forming an elongate cone with a tubercle at its base. COPIPHORINI

Tribe CONOCEPHALINI

Genus *Conocephalus* Thunberg, 1815

72. **Conocephalus maculatus* (Le Guillou)

1841. *Xiphidion maculatum* Le Guillou, *Revue suisse Zool.*, 4 : 294.

1980. *Conocephalus maculatus* : Pitkin, *Bull. Br. Mus. nat. Hist. (Ent.)*, 41 (5) : 344.

Material examined : 2♂, 1♀, East of Geedam, 20.xii.1978; 1♀, Bhairamgarh, 21.xii.1978; 1♀, East of Kondagaon, 26.xii.1978; 1♀, Benur, 27.xii.1978.

Diagnosis : Fastigium of vertex moderately wide, pronotum bispinose; tegmina pigmented with comparatively large dark spots; hind femora unarmed ventrally; ovipositor very short, relatively straight.

Measurements (in mm.) Body length ♂ 12-13, ♀ 14-15; tegmen ♂ 14-16, ♀ 15-17; hind femur ♂ 11-11.5, ♀ 11.5-12.8; hind tibia ♂ 10.5-11, ♀ 11-11.5; ovipositor 8.0.

Distribution : India (Throughout), Australia, Cameroon, Indonesia, Java, W.Malaysia, Philippines and Sierra Leone.

Tribe COIPHORINI

Genus *Euconocephalus* Karny, 1907

73. **Euconocephalus incertus* (Walker)

1869. *Conocephalus incertus* Walker, *Cat. Derm. Salt. Brit. Mus.*, 2 : 320.

1912. *Euconocephalus incertus* : Karny, *Gen. Insect.*, 2 (139) : 35.

Material examined : 1 nymph, Dongaghat, Jagdalpur, 12.xii.1978; 2 ♀, Geedam, 22.xii.1978.

Diagnosis : Fastigium of vertex produced conically in front; radius sector 2 arises much before the middle of wing; ovipositor subequal to the length of body.

Measurements (in mm.) Body length ♀ 25.0; head ♀ 3.0; pronotum 8.0; tegmen 41.0; hind femur 14.5; hind tibia 14.0; ovipositor 21.5.

Distribution : India (Andaman & Nicobar Islands, Madhya Pradesh, Meghalaya, Orissa, Sikkim, Tripura and West Bengal), Australia, Borneo, China, Java, Myanmar, Panang, Sri Lanka, Sumatra etc.

Family PHANEROPTERIDAE

Key to genera

1. Subgenital plate of male, divided almost from the base, bowed down in 45° to 90° angle; female subgenital plate obtuse-triangular; cerci long, curved to almost straight. *Letana* Walker
- Subgenital plate of male contiguous from base, not curved, female subgenital plate bilobed, cerci of male, acuminate, latero-internally sulcated. *Himertula* Uvarov

Genus *Himertula* Uvarov, 1940

74. **Himertula kinneari* (Uvarov)

1923. *Himerta kinneari* Uvarov, *J. Bombay nat. Hist. Soc.*, 29 : 651.

1990. *Himertula kinneari* : Ingrisich, *Spixiana*, 13 (2) : 157.

Material examined : 1 ♂, Bijapur, 8.ii.1990, R.K. Ghosh coll.

Diagnosis : Last tergite large, narrowly sulcate along the middle, with the hind margin almost

straight, very feebly and broadly sinuate, not obtusely excised; cerci with their apices compressed portion straight, forming an obtuse rounded angle with the base; subgenital plate with the lobes very long, strongly compressed and recurved, with the apices acute and turned outwards.

Measurements (in mm.) : Body length 12.0; tegmen 21.5; hind femur 18.0; hind tibia 16.0.

Distribution : India (Bihar-Palamau, Maharashtra-Surat) and Nepal.

Genus *Letana* Walker, 1869

75. **Letana megastridula* Ingrisch

1990. *Letana megastridula* Ingrisch, *Ent. Scand.*, 21 (3) : 258.

Material examined : 1 ♂, Haram, Geedam, 22.xii.1978.

Diagnosis : Body and legs with black or reddish dots; stridulatory field larger than broad; supra-anal plate with an almost circular, shallow depression in the middle; cerci with a weak baso-internal swelling; subgenital plate lateral lobes with apical part widening; subgenital plate of female long than broad; ovipositor short, curved in middle, apex turned upwards, finely serrulate from middle to apex.

Measurements (in mm.) : Body length 13.0; pronotum 4.5; tegmen 22.0; hind femur 14.5; hind tibia 14.5.

Distribution : India (S.India, Bihar and Maharashtra).

76. *Letana* sp.

Material examined : 1 ♀, Bijapur, 23.i.1990, R.K. Ghosh coll.

Diagnosis : Body with dark-brown or chocolate colour spots; antennae annulated with dark-brown rings; tegmina surpass the tip of hind femora, radial sector forked; ovipositor short, dorsal and ventral margins of apical part with big spines, space between two spines more, apex curved.

Measurements (in mm.) : Body length 13.0; pronotum 4.5; tegmen 25.0; hind femur 14.0; ovipositor 5.5.

Distribution : The genus *Letana* is Indian and Himalayan in origin, from where it spread over upto Indo-China.

Family PSEUDOPHYLLIDAE

Genus *Onomarchus* Stål, 1874

77. **Onomarchus* sp.

Material examined : 1 ♂, Bijapur, 23.i.1990, R.K. Ghosh coll.

Diagnosis : Head and fastigium of vertex small; fastigium medially grooved; pronotum granular, intersected by two grooves dorsally, median carina absent, anterior and posterior margin angularly rounded; anterior tibiae with tympanum mostly covered; middle femora with small spines on internal margin ventrally; hind tibiae with very small spines on both margins ventrally, and not compressed; hind femora with spines on both margins ventrally; anal field of tegmina not widened; 9th terga of abdomen concave; supra-anal plate triangular; subgenital plate broad basally, narrow beyond, bifurcated apically, the two lamina slightly curved towards apex, apex obtuse and with small spine.

Measurements (in mm.) Body length 24.0; pronotum 5.0; tegmen; 38.0; hind femur 12.0 and hind tibia 11.0.

Distribution : Tropical East Asia.

SUMMARY

Seventy-seven species and subspecies of grasshoppers and crickets have been reported from Bastar District of Madhya Pradesh, India. They belong to 61 genera and 12 families. Of these, 61 species and subspecies are new locality records. Keys to superfamilies, families, genera and species have been provided. Distribution of each species has also been shown.

ACKNOWLEDGEMENTS

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THREE NEW SPECIES OF THE GENUS *PROTOGAMASELLUS* KARG, 1962 (ACARINA : MESOSTIGMATA : ASCIDAE) FROM INDIA

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INTRODUCTION

Karg (1962) established the genus *Protogamasellus* to include *Protogamasellus primitivus* as type-species from Germany. Lindquist and Evans (1965) gave a detailed generic concept and included *Rhodacaropsis massula* Athias-Henriot, 1961 under the genus *Protogamasellus*. They also considered the possibility of inclusion of some other Athias-Henriot's (1961) species viz., *Rhodacarellus mica*, *Rhodacaropsis angustiventris* and *R. cognatus*. Later, Genis *et al.* (1967) described some new species and subspecies from the Ethiopian region. They also confirmed the nomenclatural status of *Rhodacarellus mica* as *Protogamasellus mica*. Through the works of various acarologists (Shcherbak, 1976; Shcherbak and Petrova, 1987; Karg, 1977 and Evans, 1982 etc.) around 19 species and subspecies of *Protogamasellus* are known all over the world.

The members of the genus *Protogamasellus* can be easily recognized by a combination of characters : continuous transverse line across surface at level of z6; 16 or 17 pairs of setae on podonotal shield and 15 pairs of setae on opisthonotal shield; paraverticilar setae z1 close to j1; setae z3 present; setae st4 off sternal shield; genu and tibia of leg IV with 8 and 9 setae respectively.

While studying the Indian soil mesostigmatid mites, several ascid mites were collected. In the present paper, three new species of the genus *Protogamasellus* are described as *Protogamasellus indica* sp. nov., *P. keralaensis* sp. nov. and *P. similiscuticulis* sp. nov.

The genus is being reported for the first time from India.

Setal chaetotaxy in the following description is after Lindquist and Evans (1965).

The type specimens are deposited in the National Zoological Collection, Zoological Survey of India, Calcutta.

Key to the Indian species of *Protogamasellus*

1. Anterior dorsal shield with 16 pairs of setae; setae j1 short; tritosternum short; sternal setae st1 on sternal shield; ventri-anal shield with 13 setae. *P. indica* sp. nov.

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- Anterior dorsal shield with 17 pairs of setae; setae j1 long; tritosternum long; sternal setae st1 not on sternal shield; ventri-anal shield with 7-9 setae. 2
- 2. Sternal setae st1 on desclerotized area; genital shield broad; metapodal shield oval; ventri-anal shield with 7 pairs of setae; teeth on fixed digit are of varying size.
..... *P. keralaensis* sp. nov.
- Sternal setae st1 on anterior projection; genital shield narrow; metapodal shield cigar-shaped; ventri-anal shield with 9 pairs of setae; teeth on fixed digit are of uniform size.
..... *P. similiscuticulis* sp. nov.

DESCRIPTION OF SPECIES

Protogamasellus indica sp. nov.

(Text-figs. 1-4)

Female : Dorsum covered by two shields, roughly equal in length and width; podonotal shield 129.85 μ m in length and 103.4 μ m in width; opisthonotal shield 122.2 μ m in length and 98.7 μ m in width; podonotal and opisthonotal shield with 16 and 15 pairs of setae respectively; eleven pairs of setae present on lateral membrane, all setae simple in nature; setae j1, j5, s5, and z5 are 18.7 μ m, 12.38 μ m, 21.24 μ m and 14.14 μ m in length respectively. Peritreme visible dorsally reaching posterior to setae s1 (Fig. 1).

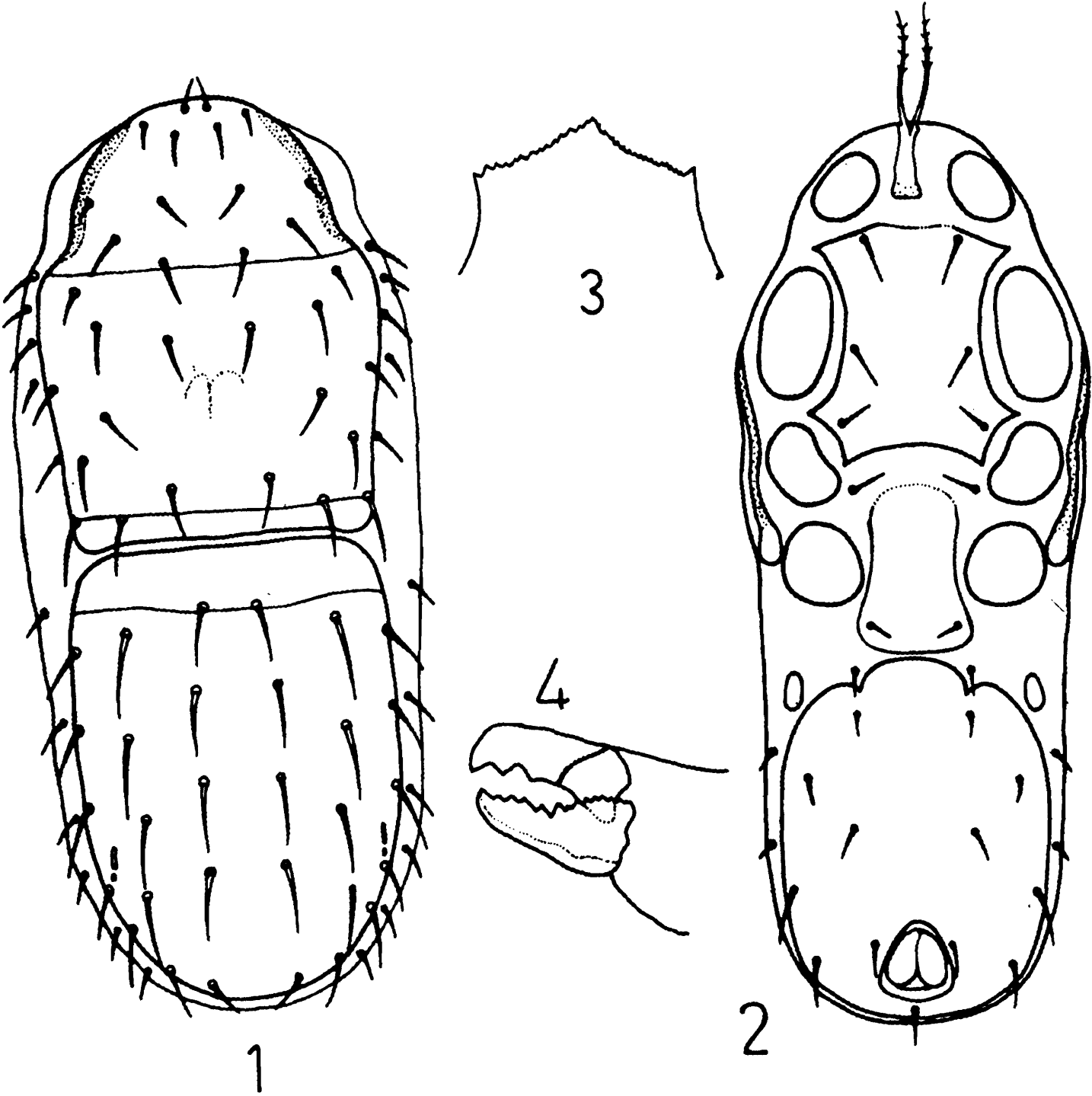
Tritosternum bipartite, serration of lacinae restricted to distal half only. Sternal shield (64.62 μ m long along midline, 31.72 μ m wide between coxae II and III) with three pairs of sternal setae, st1 being largest (Fig. 2); anteromedian margin of sternal shield slightly convex in nature and not clearly distinguishable; posterior margin strongly concave; fourth sternal setae placed on ventral membrane just below posterolateral corner of sternal shield. Genital shield with paired genital setae, anterior margin rounded, posterior margin truncate. Ventri-anal shield (103.4 μ m long, 37.69 μ m wide) with five pairs of setae excluding a pair of para-anal and a post-anal setae; V-shaped incision present on anterior margin immediately below base of setae Jv1; large prominent anal shield flanked by two para-anal setae; ventral membrane with three pairs of setae around ventri-anal shield, large stigmal opening placed beside coxae IV; peritreme extending upto posterior level of coxa II.

Margin of tectum denticulate (Fig. 3). Specialized seta of palpal tarsus two-tined. Chelicerae slender; movable digit bidentate and fixed digit multidentate (Fig. 4).

External mala horn-like; internal mala long; fringed marginally; capitular groove with seven rows of deutosternal denticles.

Legs I-IV with well-developed ambulacra, claws and rounded pulvilli. Length (excluding ambulacra) of legs I-IV are as follows : 176.25 μ m, 133.95 μ m, 110.45 μ m and 152.75 μ m. Chaetotactic formulae of femora, genua and tibiae of legs of I-IV are as follows : 12-11-6-6, 13-11-8-9 and 13-10-8-9.

Male : Unknown.



Figs. 1-4 : *Protogamasellus indica* sp. nov. Female : 1. Dorsum; 2. Venter; 3. Tectum; 4. Chelicera.

Material examined : *Holotype* : Female, 3 kms. away from Palghat Railway Station towards Shoranur along railway track, Palghat district, Kerala; ex. soil and litter below bush of *Arum* sp.; 26.iv.1997; Asit K. Bhattacharyya coll. *Paratypes* : 10 females, data same as for holotype; 1 female, Palanpur, Gujarat; ex. soil and litter; 19.ix.1997; Asit K. Bhattacharyya coll.; 1 female, Ahmedabad Zoological Garden, Ahmedabad, Gujarat; ex. soil and litter; 20.ix.1997; Asit K. Bhattacharyya coll.; 1 female, Crocodile Rearing Farm, Sasan Gir, Gujarat; ex. grass litter; 22.ix.1997; Asit K. Bhattacharyya coll.

Remarks : *Protogamasellus primitivus machadoi* described by Genis *et al.* (1967) from Angola, Ethiopia shows some affinities with new species *Protogamasellus indica* in the following aspect : length and nature of dorsal setae, shape of tritosternum, number and nature of setae on ventri-anal shield and dentition of chelicerae. However, *P. indica* can be easily distinguished in having 16 pairs of setae on anterior dorsal shield, length of sternal setae st1-st3 (which is subequal in *Protogamasellus primitivus machadoi*), oval-shaped metapodal shield, shape of tectum and shape of genital shield.

***Protogamasellus keralaensis* sp. nov.**

(Text-figs. 5-16).

Female : Dorsum divided completely to form two subequal shields; podonotal shield (185.65 μ m long, 112.8 μ m wide) with 17 pairs of simple setae (Fig. 5); apical setae j1 longest (13.5 μ m); opisthonotal shield (190.35 μ m long, 56.4 μ m wide) elongate in shape, with 15 pairs of simple setae; Z3 displaced towards median line; setae J5, S5 and Z5 are 11.75 μ m, 25.85 μ m and 42.30 μ m in length respectively; lateral membrane with 11 pairs of setae; remnants of peritrematal shield visible at level of setae z1.

Tritosternum long with paired lacinae, more than half of the distal length of lacinae serrated (Fig. 6). Sternal shield (141 μ m long, 96.35 μ m wide) with 3 pairs of subequal sternal setae; posterior margin of sternal shield highly concave, anterior region of sternal shield reduced to granular sclerotised area with a median groove; setae st1 arises from granular sclerotized area, first sternal pore situated on anterolateral margin of sternal shield. Metasternal setae borne on interscutal membrane. Genital shield boldly punctate, with paired genital setae; conspicuous dotted area behind genital shield notable; ventri-anal shield (136.9 μ m long, 79.9 μ m wide) fused posteriorly with body margin, lightly punctate over 3/4 of posterior region; two pairs of simple setae excluding a pair of para-anal and a post-anal setae present on ventri-anal shield; anal aperture moderately sized; para-anal setae placed wide apart; ventral membrane around ventri-anal shield bears 7 pairs of simple setae; para-anal setae and setae Jv5 subequal in length (47 μ m). Metapodal shield oval in shape along with its component present lateral to the anterior margin of ventri-anal shield. Peritreme extending halfway along breadth of coxae II.

Tectum with a median spine, evenly denticulate along its margin (Fig. 7). Movable chela bidentate; fixed chela with a set of teeth of irregular shape and size on its masticatory surface (fig. 8). Palp apotele two-tined, corniculi tapering gradually to rounded tip. Seven rows of hypognathal denticles present ventrally on gnathosoma.

Legs I-IV armed with claws and pulvilli. Length of legs (excluding ambulacrum) as follows : I-199.75 μ m, II-126.9 μ m, III-112.8 μ m and IV-197.4 μ m. Tarsus of leg I with macrosetae (fig. 9); apart from normal setae, leg IV provided with spinelike setae (Fig. 10). Numbers of setae on femora, genua and tibiae of legs I-IV, 12-11-6-6; 13-11-8-9 and 13-10-8-9 respectively.

Male : Anterior and posterior dorsal shield with 17 and 15 pairs of simple setae respectively (Fig. 11); some setae on both shields relatively longer in length than in female; unlike female, lateral membrane with 10 pairs of setae. Posterior region of opisthonotal shield behind z6 and region of podonotal shield anterior to Z1 and J1 lightly sclerotized, peritreme visible dorsally; anterolateral remnants of peritrematal shields present.

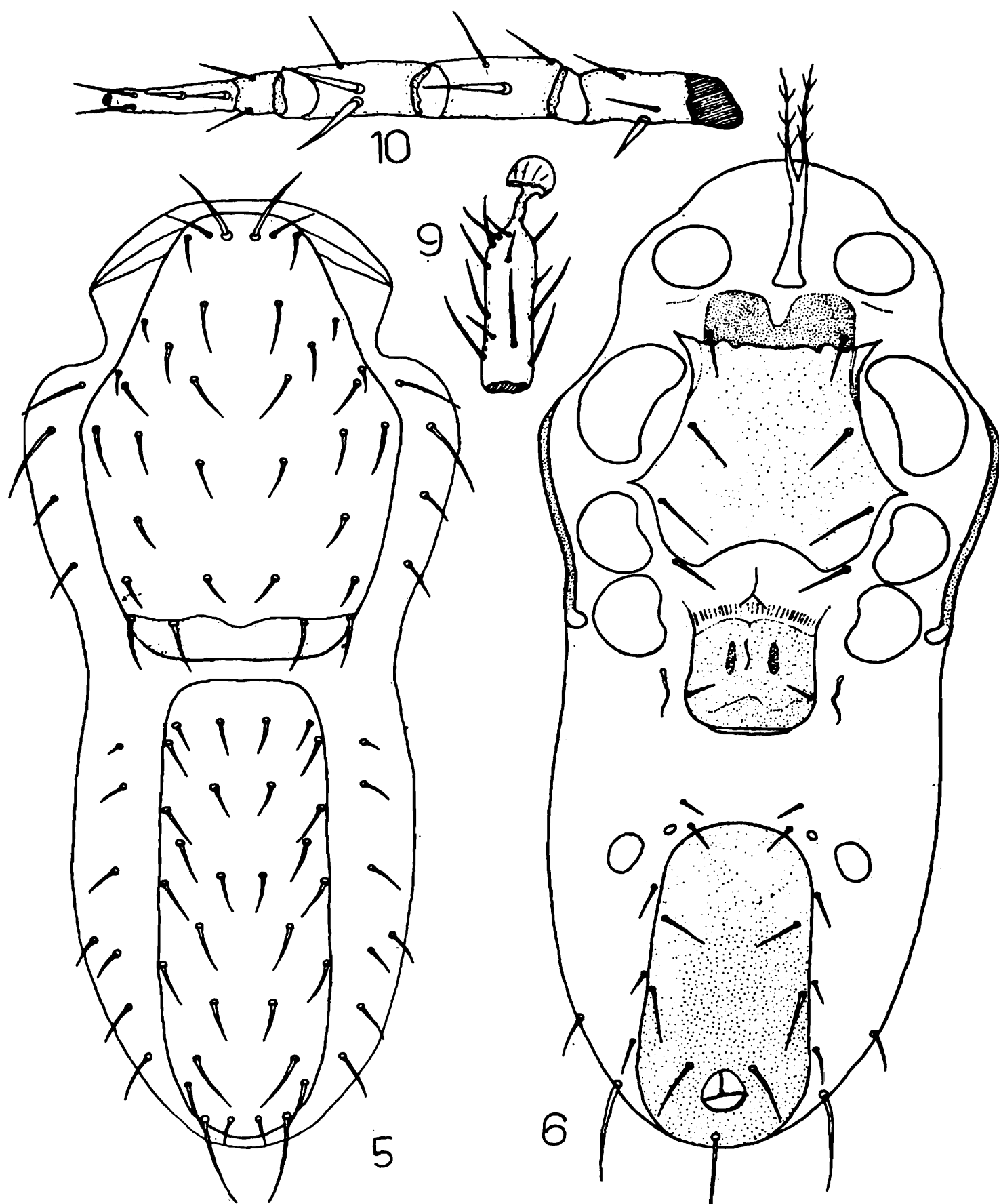
Tritosternum same as in female (Fig. 12). Sterniti-genital shield (145.7 μ m long, 98.77 μ m wide at level between coxae II and III) with 4 pairs of setae; more or less lightly sclerotized over the entire surface; first sternal setae arises from heavily sclerotized presternal area; stII-stIV subequal in length; posterior region of sterniti-genital shield lightly sclerotized; posterior region of shield with a transverse "slit-like" marking; genital orifice large, prominent, presternal in position, overlapping median groove. Ventri-anal shield (136.3 μ m long and 89.3 μ m wide) fused with body margin, with six paired and one unpaired setae. Anal aperture comparatively larger than that of female; para-anal setae lie closer to anterior margin of anal shield; paired minute setae on ventral membrane lie in close proximity with ventri-anal shield. Peritreme extending upto mid-level of coxa IV.

Tectum basically same as in female with a minor variation on one ridge (Fig. 13). Movable chela tridentate having one large and two small teeth, fixed chela with a set of six teeth, spermadactyl small (Fig. 14); pedipalp same as in female; no difference in gnathosoma between two sexes discernible.

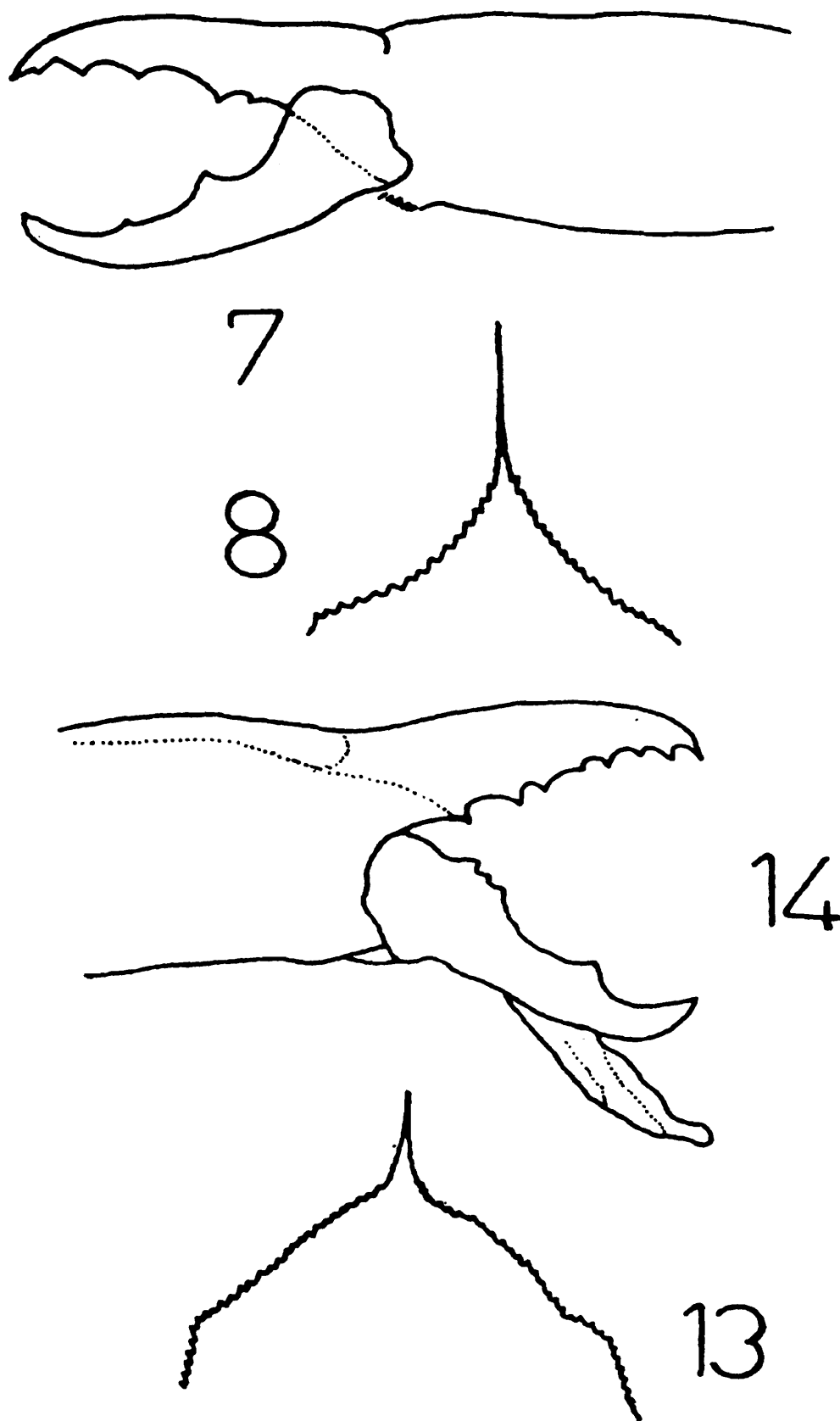
Length of legs I-IV (excluding ambulacrum) measure 277.5 μ m, 188.7 μ m, 170.2 μ m and 296 μ m respectively; tarsus of leg I provided with long setae (Fig. 15); ventrally leg IV bears two spine-like setae (Fig. 16); segments of legs I-IV devoid of any spur.

Material examined : *Holotype* : Female, 3 kms. away from Palghat Railway Station towards Shoranur along railway track, Palghat District, Kerala; ex. soil and litter below bush of *Arum* sp.; 26.iv.1997; Asit. K. Bhattacharyya coll. *Paratypes* : 2 males, data same as for holotype.

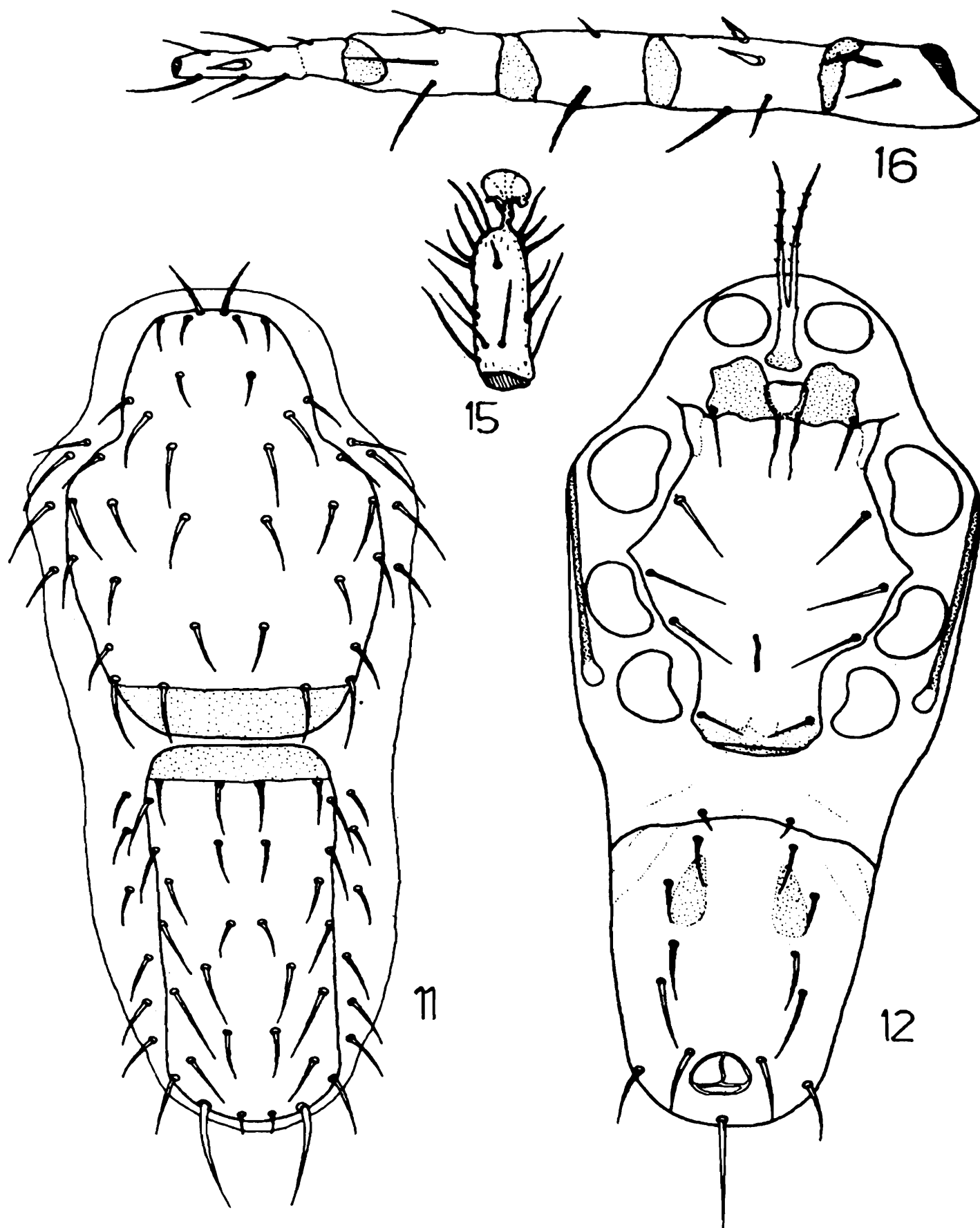
Remarks : The new species *Protogamasellus keralaensis* shows affinities with its allied species *P. dioscorus* Manson, 1972, intercepted at Auckland, New Zealand from yam in respect of nature of setae on dorsum, elongated opisthonotal and ventri-anal shield, similar shape of tectum, sternal shield and ventri-anal shield, but on closer examination it reveals a number of dissimilarities such as number of setae on anterior dorsal shield, length of setae j1, J5 and exceptionally long setae Z5, shape of tritosternum, components of metapodal shield, number of setae on ventri-anal shield and ventral membrane and presence of spine-like setae on leg IV. Male of *P. keralaensis* also shows differences with male of *P. dioscorus* in respect of shape of ventri-anal shield, shape of tritosternum, length of para-anal setae, presence and absence of spinelike setae and spurs respectively on any segment of leg IV.



Figs. 5, 6, 9, 10 : *Protogamasellus keralaensis* sp. nov. Female : 5. Dorsum; 6. Venter; 9. Tarsus of leg I; 10. Femur, genu, tibia and tarsus of leg I.



Figs. 7, 8, 13, 14 : *Protogamasellus keralaensis* sp. nov. *Female* : 7. Tectum; 8. Chelicera; 13. Tectum; 14. Chelicera.



Figs. 11, 12, 15, 16 : *Protogamasellus keralaensis* sp. nov. Male : 11. Dorsum; 12. Venter; 15. Tarsus of leg I; 16. Genu, tibia and tarsus of leg I.

Protogamasellus similiscuticalis sp. nov.

(Text-figs. 17-21)

Female : Complete division of dorsal shield forms two shields; podonotal shield longer than wide ($155.1\mu\text{m}$ long, $96.35\mu\text{m}$ wide), with 17 pairs of simple setae; opisthonotal shield ($141\mu\text{m}$ long, $68.15\mu\text{m}$ wide) with 15 pairs of simple setae; j2 and j4 almost equal in length; transverse line between bases of setae J1 absent; eight pairs of setae borne on lateral cuticle; j1, J5, S5 and Z5 are $21.15\mu\text{m}$, $7.05\mu\text{m}$, $14.1\mu\text{m}$ and $21.15\mu\text{m}$ in length respectively (Fig. 17).

Tritosternum with two proximally serrated lacinae (Fig. 18). Sternal shield ($63.45\mu\text{m}$ long along midline, $61.1\mu\text{m}$ wide) with concave posterior margin, bears two pairs of subequal setae; first sternal setae placed on anterior projection of sternal shield; region anterior to projected portion of sternal shield desclerotized; endopodal shield extended anterolaterally from sternal shield on both side; metasternal setae shorter than setae st1-st3, placed on ventral membrane at level posterior to coxa IV; metasternal plate absent. Genital shield truncate posteriorly, with one pair of setae; transverse small "slit-like" marking present in the middle of genital shield (Fig. 19); anterior region of genital shield with epigynial process; two minute setae, Jv1 and Jv2 situated on membrane anterior to ventri-anal shield. Ventri-anal shield longer than wide ($91.65\mu\text{m}$ long, $56.08\mu\text{m}$ wide), anterior margin convex, fused posteriorly, with 4 paired and one exceptionally long post-anal setae ($30.55\mu\text{m}$); anal aperture of moderate size; membrane around ventri-anal shield with two pairs of setae; paired metapodal shield lie close to body margin. Small posterior portion of peritrematal shield lie freely forming a free pointed end. Stigma small, placed at mid-level of coxa IV; interscutal membrane lineate.

Tectum triangular in shape with denticulate margin (Fig. 20). Palp apotele two-tined. Movable cheliceral digit with two teeth, one smaller than the other; fixed cheliceral digit multidentate, teeth of uniform size (Fig. 21). Corniculi slender but shorter; palps stout; seven rows of deutosternal denticles present.

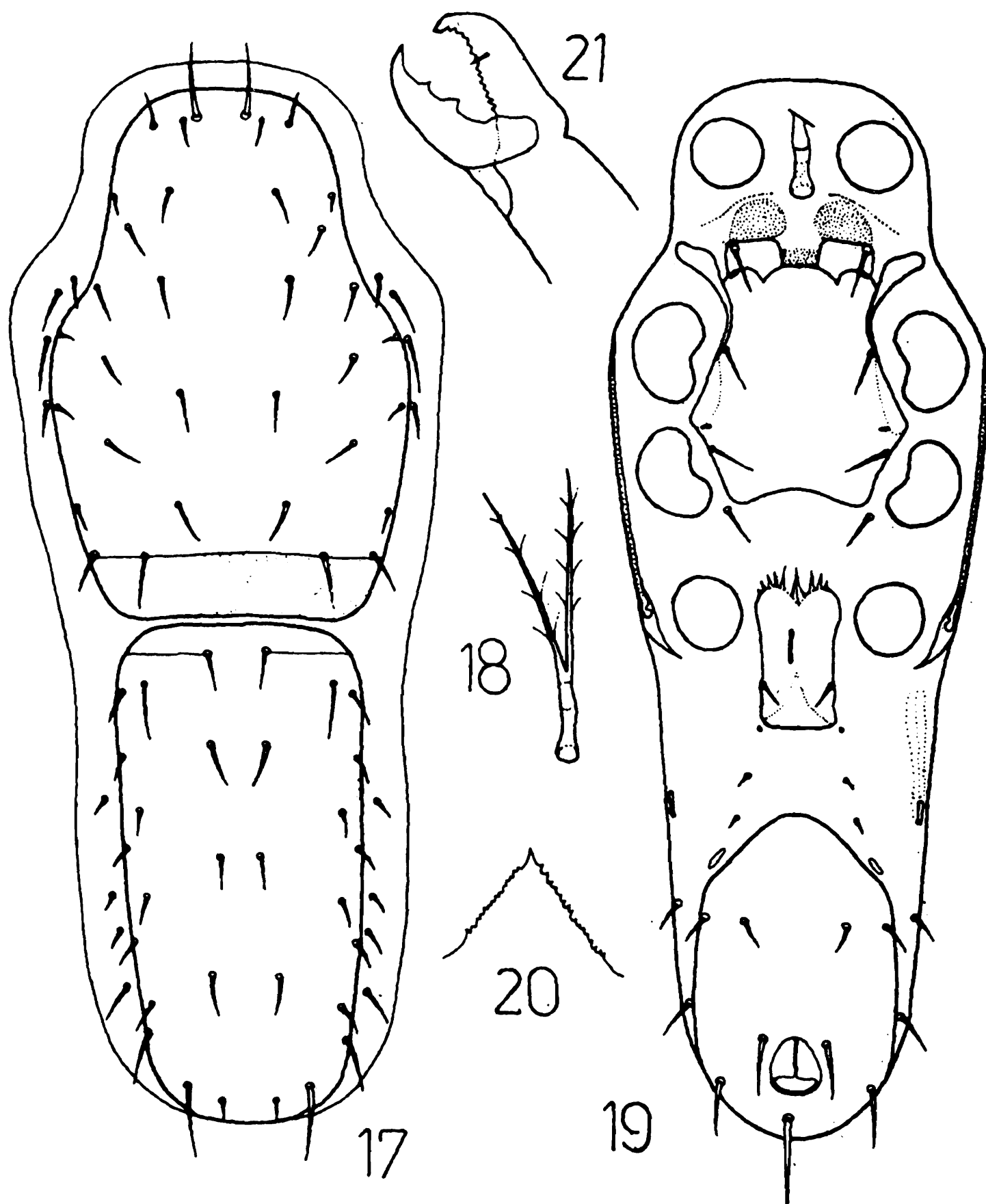
Legs bear claws and pulvilli; leg II and leg III of equal length ($159.8\mu\text{m}$); length of leg I and leg IV are $282\mu\text{m}$ and $216.2\mu\text{m}$ respectively; segmental chaetotaxy of legs I-IV as follows : femur, 12-11-6-6; genu, 13-11-8-9 and tibia, 13-10-8-9.

Male : Unknown.

Material examined : *Holotype* : Female, ISRO Compound, Bangalore, Karnataka; ex. soil and litter; 21.vi.1995; Asit K. Bhattacharyya coll. *Paratype* : 1 female, data same as for holotype.

Remarks : *Protogamasellus similiscuticalis* sp. nov. shows resemblances with *Protogamasellus scuticalis* Genis *et al.* (1967) in the following aspect : j1 longest of all podonotal setae; number of setae on podonotal and opisthonotal shield, shape of sternal shield and position of setae st1; shape of tectum and ventri-anal shield, position of setae Jv1 and Jv2.

However, *P. similiscuticalis* differs markedly from the known species in having the following characters : J1 and J4 not markedly longer than J2 and J3; discontinuous transverse line between bases of setae J1, shape of tritosternum, presence of peritrematal shield, minute Jv1 and Jv2 and shape of cheliceral digit.



Figs. 17-21 : *Protogamasellus similiscuticalis* sp. nov. Female : 17. Dorsum; 18. Tritosternum; 19. Venter; 20. Tectum; 21. Chelicera.

SUMMARY

Three new species, *Protogamasellus indica* sp. nov., *P. keralaensis* sp. nov. and *P. similiscuticalis* sp. nov. are described and illustrated alongwith their affinities. A key to all the three species are also provided. This is the first report of the genus from India.

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TWO NEW SPECIES OF THE GENUS *LASIOSEIUS* (MESOSTIGMATA : ASCIDAE) FROM INDIA

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INTRODUCTION

The mites of the genus *Lasioseius* Berlese, 1916 are very little known from Indian region. Prior to this study, only six species of *Lasioseius* were known from India. Chant (1960) described one new species of *Lasioseius* from citrus tree in Assam. Bhattacharyya (1968) described two new species from the soils of West Bengal. Ramdas and Ghai (1968) also described a new species from wheat plant in Delhi. Later, in 1992 one new species was described from bird's nest in West Bengal by Gupta and Paul. Recently Bhattacharyya *et al.* (1997) described one new species from squirrel nest in West Bengal.

Chaetotactic formulae are based on the review of Lindquist and Evans (1965). All measurements are given in microns(μ).

The type materials are deposited in the National Zoological Collection of Zoological Survey of India, Calcutta.

Key to The Indian Species of *Lasioseius*

1. Dorsal shield with 22 pairs of setae; ventri-anal shield with 6 pairs of pre-anal setae. 2
- Dorsal shield with more than 22 pairs of setae, ventri-anal shield with 3-4 pairs of pre-anal setae... 5
2. Lateral membrane of dorsum with 2 pairs of marginal setae. 3
- Lateral membrane of dorsum with more than 2 pairs of marginal setae. 4
3. Endopodal shield absent; one pair of ventral setae around ventri-anal shield.
..... *L. malaca* Gupta and Paul, 1992
- Endopodal shield present; two pairs of ventral setae around ventri-anal shield.
..... *L. parberlesel* Bhattacharyya, 1968
4. Lateral membrane of dorsum with 3 pairs of marginal setae; two pairs of ventral setae around ventri-anal shield. *L. terrestris* Ramdas and Ghai, 1968

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- Lateral membrane of dorsum with 4 pairs of marginal setae; one pair of ventral setae around ventri-anal shield. *L. indicus* sp. nov.
- 5. Dorsal shield with 31 pairs of setae; movable digit of chelicera unidentate.
..... *L. quadrisetosus* Chant, 1968
- Dorsal shield with more than 31 pairs of setae; movable digit of chelicera multidentate...6
- 6. Dorsal shield with 35 pairs of setae; one pair of metapodal shield; ventri-anal shield with 3 pairs of pre-anal setae. *L. sahai* sp. nov.
- Dorsal shield with 36 pairs of setae; two pairs of metapodal shield; ventri-anal shield with 4 pairs of pre-anal setae. *L. reticulatus* Bhattacharyya, 1968

DESCRIPTION OF SPECIES

Lasioseius indicus sp. nov.

(Text-figs. 1-8)

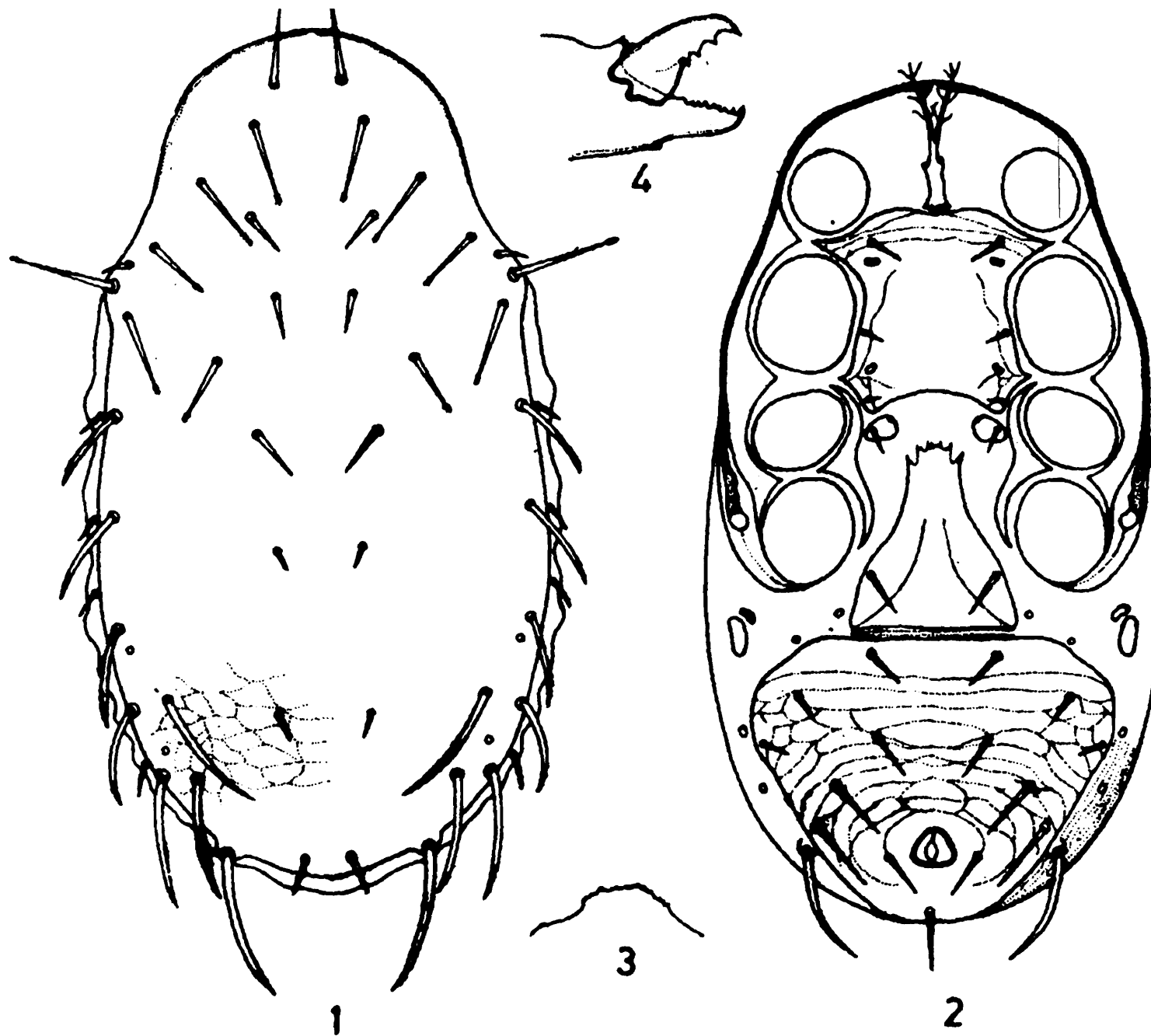
Female : Dorsal shield 340.4 long and 199.8 wide, entire, reticulated, bearing 22 pairs of setae, 12 pairs on anterior region; j2, j4, j5, j6 and r2 simple, seta s3 serrated, others pilose at tip only; humeral seta (r3) 48.1 long; posterior region with 10 pairs of setae; except J2, J4 and J5 all setae serrated; Z4 and Z5 five and six times longer than J5 (11.1); lateral membrane with 4 pairs of simple marginal setae (Fig. 1).

Bipartite tritosternum with narrow base, lacinae finely pilose distally; sternal shield (85.1 long, 11.1 wide) with 3 pairs of setae, anterior region lineated; metasternal shield with a seta; genital shield truncate posteriorly, with a pair of setae; endopodal plate well-developed; two pairs of conspicuous metapodal shields present. Ventri-anal shield (133.2 long, 162.8 wide) reticulated and with 6 pairs of setae (excluding a pair of para- and a post-anal setae). Stigma lying at level of coxa IV; peritreme extending beyond paravertical seta; post-stigmatal extension of peritrematal shield formed into a tubular shape, fused with exopodal shield curving inward to meet coxa IV; ventral interscutal membrane behind coxa IV striated irregularly, bearing scutellae and two setae (Fig. 2).

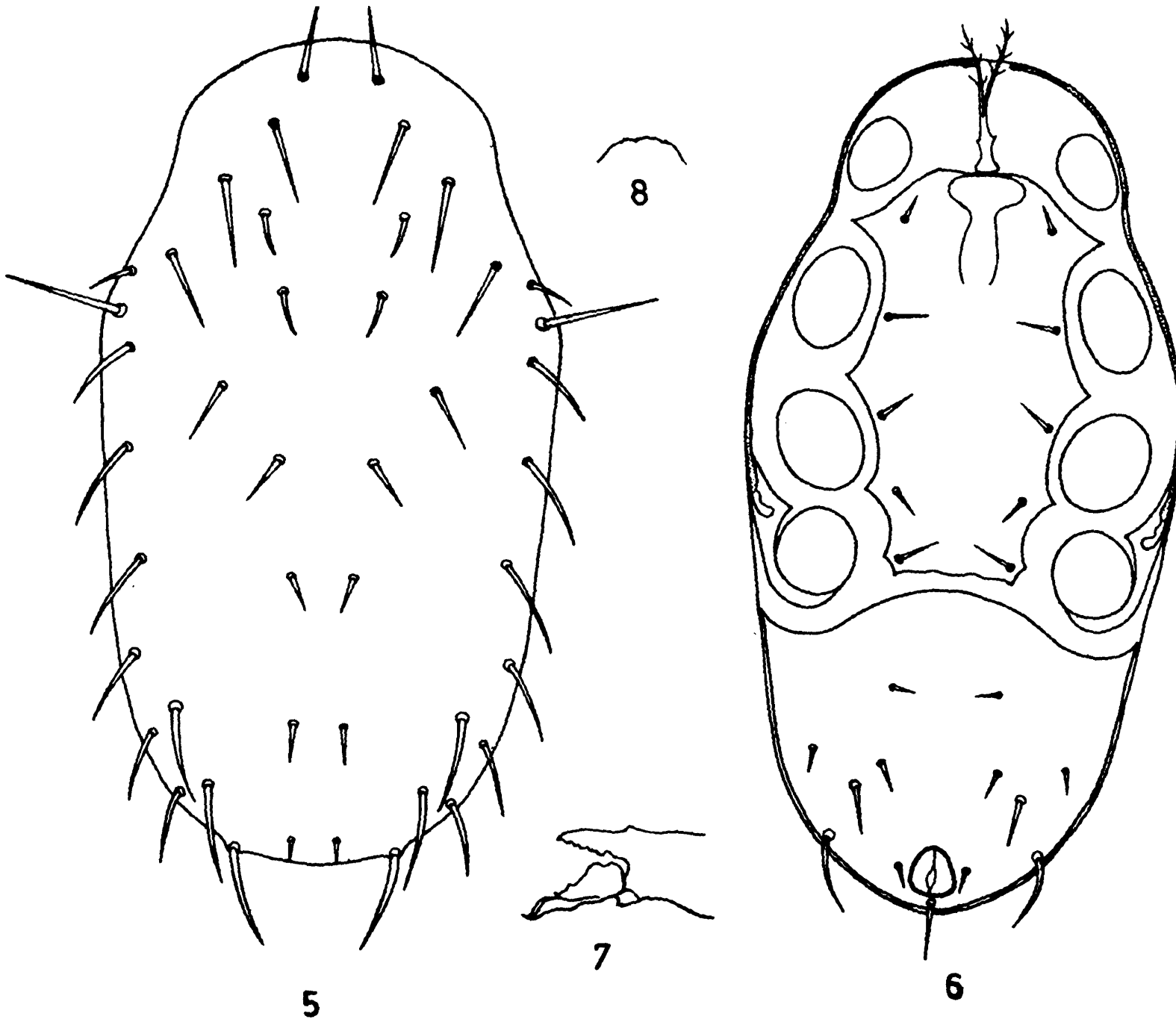
Tectum minutely denticulate (Fig. 3); pedipalp composed of five segments, all setae simple; specialized seta on palpal tarsus with two tines. Movable digit of chelicera provided with four teeth, fixed digit multidentate (Fig. 4). Hypostomal setae normal for genus. Ventral groove of gnathosoma with four rows of deutosternal denticles, with 11-15 denticles in each row.

Legs I-IV with well-developed claws and pulvilli.

Male : Dorsal shield 240.5 long and 466.2 wide, faintly reticulated with 22 pairs of simple to pilose setae; 12 pairs on anterior region, humeral setae (r3) 70.3 long; posterior region with 10 pairs of setae, Z5 and Z4 nearly five times longer than J5 (14.8); two pairs of simple marginal setae on lateral membrane (Fig. 5).



Figs. 1-4. *Lasioseius indicus* sp. nov. Female. 1. Dorsal view; 2. Ventral view; 3. Tectum; 4. Chelicera.



Figs. 5-8. *Lasioseius indicus* sp. nov. Male. 5. Dorsal view; 6. Ventral view; 7. Chelicera; 8. Tectum.

Tritosternum bipartite with sparsely pilose lacinae; sterniti-genital shield with genital aperture situated on anteromedian region and with 5 pairs of setae. Ventri-anal shield bearing 5 pairs of setae (excluding a pair of para- and a post-anal setae), para-anal setae at mid-level of anal aperture. Peritreme, peritrematal and exopodal shields same as in female.

Tectum denticulate (Fig. 7); apotele two-tined. Fixed digit of chelicera unidentate, movable digit multidentate, associated with spermadactyl process (Fig. 8).

All legs with ambulacra and claws.

Material examined : *Holotype* female, INDIA : Tamil Nadu : Chennai : Valasaravakkam; ex. grassland soil; 13.vi.1995; coll. T. Selvan. One paratype male and two paratype females, collection data same as for holotype.

Remarks : *Lasioseius indicus* sp. nov. superficially resembles with *L. lindquisti* Nasr and Abou-Awad, 1987, in having the same number of dorsal and ventral setae and similar pattern of reticulation of dorsal shield but the new species can be readily separated from *L. lindquisti* by following characteristics : shape of sternal, peritrematal and exopodal shields and tectum, very large endopodal plates, placement of sternal setae I in relation to anterior margin of sternal shield and number of teeth on fixed digit of chelicera.

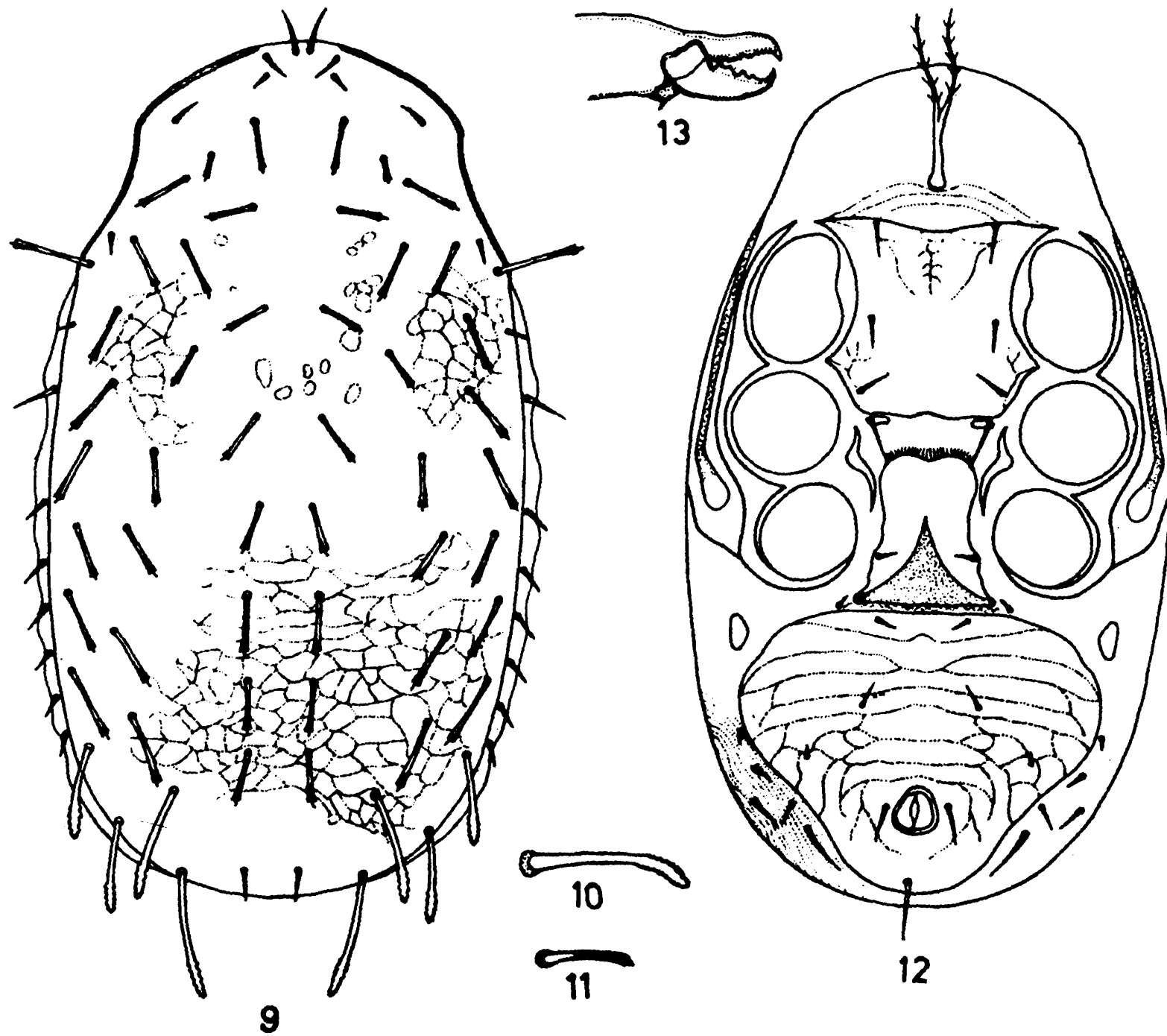
***Lasioseius sahai* sp. nov.**
(Text-figs. 9-13)

Female : Dorsal shield 455.1 long, 244.2 wide, entire, posterior region densely reticulated (Fig. 9), with 35 pairs of setae of which 20 on the anterior region, seta r3 largest (51.8) among them; setae j1, j2, z1, r2, r4 and J5 simple; Z4, Z5, S4 and S5 with distinctive shape; remaining setae lanceolate in shape; setae Z5, S4 and S5 five, four and five times longer than seta J5 (11.1); lateral membrane with 7 pairs of simple marginal setae, submarginal absent (Figs. 10 & 11).

Tritosternum with a long basal part and a pair of sparsely pilose lacinae. Pre-sternal area lineated. Sternal shield (129.5 long, 129.5 wide) well-developed, unique reticulation along anteromedian region and with fine granulation; first pair of sternal setae placed on anterior margin of sternal shield; metasternal shield bearing a seta; genital shield partly granulated, widened behind genital seta, posterior margin truncate. Ventri-anal shield 151.7 long and 188.7 at widest point, reticulated, bearing 3 pairs of setae (excluding a pair of para- and a post-anal setae); para-anal setae at mid-level of anal aperture; post-anal seta largest; six pairs of setae around ventri-anal shield behind coxa IV, posterior most largest. Large stigmatal opening between coxae III and IV; peritreme visible dorsally, reaching seta z1; peritrematal shield broadly connected to exopodal shield posteriorly, ventral region posterior to coxa IV striated irregularly (Fig. 12).

Apotele two-tined; pedipalp five-segmented. Fixed digit of chelicera with 12 small teeth arranged in a row along its cutting edge, movable digit with 5 teeth (Fig. 13). Gnathosoma with 4 pairs of setae of which *hyp2* largest. Ventral groove of gnathosoma with seven rows of deutosternal denticles.

Leg I-IV with ambulacra.



Figs. 9-13. *Lasioseius sahai* sp. nov. Male. 9. Dorsal view; 10-11. Dorsal setae; 12. Ventral view; 13. Chelicera.

Male : Unknown.

Material examined : Holotype female, INDIA : Mizoram : Lunglei : Sirap; ex. soil and leaf litter; 7.iv.1995; coll. S.S. Saha. Two paratype females, collection data same as for holotype.

Remarks : *Lasioseius sahai* sp. nov. is similar to *L. reticulatus* Bhattacharyya, 1968 in having lanceolate type of setae, similar reticulation of dorsal shield and by the shape of genital shield. However, the new species can be readily distinguished from the latter by the differences in number of setae on dorsal shield, ventri-anal shield and ventral interscutal membrane, shape and number of metapodal plates, shape of endopodal and peritrematal plates and number of teeth on fixed digit of chelicera.

The species is named after Shri S.S. Saha, collector of the species.

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AN ACCOUNT OF FISHES OF UTTAR PRADESH PLAINS

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INTRODUCTION

Information on fish fauna from Uttar Pradesh plain's is far from satisfactory, as it is fragmentary and haphazardly documented particularly pertaining to plain area, but for hilly districts a systematic and comprehensive account is available. Fishes from eastern U.P. have been reported by Srivastava (1958) who listed 87 fish species. Hora (1949) made a detailed study on river Rihand fish fauna and recorded 42 species. Motwani and David (1957) reported 95 fish species from river Sone and Srivastava et al. (1965), 55 species from river Ken, district Banda, U.P. Menon (1974) listed 141 species occurring in Ganga river system and Natarajan (1989) while studying environmental impact on fisheries of Ganga river system recorded 45 commercially important fishes at important landing centres situated along the bank of river Ganga. Joshi (1994) has given an account of the fish fauna of Kali river. Study on reservoir fish fauna is limited to only two reservoirs i.e. Sharda Sagar (district Pilibhit) and Rihand reservoir (district Sonbhadra), Motwani & Saigal (1974) and Anon (1981) reported 61 and 41 fish species respectively from the two reservoirs. Fish fauna pertaining to hilly area of the state has been studied by numerous workers but mention may be made of a few such as Hora (1937), Hora & Mukherjee (1936), Menon (1949, 1974), Pant (1970), Singh *et al.*, (1983) and Singh (1990).

The resource : Uttar Pradesh is the most populous province besides being the 3rd largest state based on the area among the Indian states. It's physiography is as diversified as its fish fauna which ranges from tiny fishes (< 3cm) to large fishes (> 2m in length), from clean water fishes (carps) to marshy inhabitants (live fishes) and from upland cold water denizen to warm plain water dwellers. Nature has bestowed to the state vast resources of water (1.165 mha) in the form of rivers, brooks, rivulets reservoirs, beels, tanks and ponds. However, the prime river of the state is the mighty Ganga, which is home of the fishes and mainstay of fishery. Talwar & Jhingran (1991) have reported 265 freshwater species from Ganga river system. The Ganga originates from Gaumukh glacier in the Garwal Himalayas (30° 55' N, 70° 7' E) at an altitude of 4100 m MSL. The river enters the plain at Rishikesh after covering a distance of 250 km in mountain and a general slope of 1 in 67. Upland reaches are characterised by steep slopes, cascades and water falls. The upper Ganga traverses the Ganga plain between Rishikesh and Allahabad in a stretch of 770 km and a slope of 1 in 4100. The middle Ganga extends from Allahabad to Farakka, 1035 km long and a slope of 1 in 13800 and the lower Ganga extends from Farakka to the Bay of Bengal, a stretch of 479 km. The total length of the main channel of the Ganga is 2525 km from source to mouth. The main tributaries are : Ramganga, Gomti, Ghagra, Yamuna, Gandak, Kosi and Damodar. These tributaries have a combined length of 12,500 km. The river breaks into a number of mazed channels

in the Ganga plain with extensive flood plains, meanders and oxbow lakes. These water bodies act as reservoir of fish stock.

List of the fishes from plain of Uttar Pradesh : In the present communication most of the data has been taken from the secondary records, but at certain places gap has been filled on the basis of author's own observations. Altogether, 129 fish species belonging to 27 families have been recorded from the area of study and the same is listed in table 1. In the list fishes have also been included which are though resident of hill streams but have adapted in rivers stretches adjoining to plain. The fish fauna of the state is a mixture of Central Asia, Sri Lanka, Peninsular India, eastern & western Himalayas and endemic fauna of river Ganga. Hora (1937), while comparing the fish fauna of the eastern western Himalayas stated that the probable origin of the two fauna's is described from the same source (Yunan, China). The Central Asiatic fauna comprising comparatively less specialised forms, was probably differentiated at an early date, when the parental stock was of a generalised nature, whereas the fauna of the southern face of the Himalayas was derived from a younger and vigorous stock which had already become specialized in southern-eastern Asia for life in torrential streams. Probably, the nature of water currents in the two regions is responsible for differentiation in species. Further, at some early stage Himalaya acted as effective barrier between the northern & southern forms. The southern Himalayas fauna was unable to adapt themselves to very turbulent waters and however, to this day remained confined to low valleys. The Himalayan element is represented in Ganga by *Nemacheilus* spp. *Amblyceps mangois*, *Glyptothorax* spp, *Gagata cenia*, *Crossocheilus latius* and *Eresthistes* sp. The Central Asian elements are member of families : schizothoracinae, sisoridae & cobitidae, the peninsular elements includes *Salmostoma boopis*, *Garra mullaya*, *Labeo boggut* (Sykes) *Nemacheilus dayi*, *N. Denisonni*. Sri Lankan and Peninsular fauna is represented by *Tor khudree* and *Puntius ambassius*. However, large river fishes eg., *Catla catla*, *C. mrigala*, *Wallago attu*, *Labeo* spp. and *Pangasius pangasius* are spread all over the India because due to subdivision of ancient 'Shivalik' river or 'Indobrahm' river (Pascoe, 1949) where these were residing into 3 rivers i.e., the Brahmaputra, the Ganga and the Indus. Further, Hora's Satpura hypothesis explains the reason of occurrence of peninsular fauna in the Ganga.

The above described fishes listed in Table 1 have been suitably adapted to habitat. For example, the hilly-fishes have developed streamlined body with reduced scales or without scales, a reduced respiratory system and small body size. While those living in pools, lakes, slow flowing rivers and marshes have suitably adapted to synchronize with the ecosystem i.e., their body is deep and large, well developed respiratory system to tide over low dissolved oxygen and euophagic feeding habits.

Causes of depletion of fish stock in the Ganga : The Ganga river system which supported a very lucrative fisheries in yesteryears, now is reeling under tremendous stress due to multifaceted anthropogenic activities. Developmental projects such as irrigation and hydroelectric, flood control measures, urbanization, changes in land use pattern and excessive use of pesticides in agricultural operation have resulted in wide changes in the river regime and in morphometry of the river's bed, floodplains and oxbow lakes causing deterioration in water quality. The ecological impact of these changes, coupled with sustained annihilation of broodstock, fry and fingerlings and unregulated fishing effort, has been adequately reflected in depletion of fishery with distinct changes in fish composition manifesting pauly's syndrome of ecosystem degradation. The description which

follows support the above view point.

At present, a downswing in fish population of river Ganga has been noticed from the past. The total fish yield ($\text{kg.ha}^{-1}.\text{yr}^{-1}$) in the middle stretch of the river has declined from 50 (1961-1970) to 22.45 (1988-1991) while that of major carps from 14.08 to 5.12 during the above period (CICFRI report). Similarly, the hilsa yield has come down from 159 kg km^{-1} during pre-Farakka period to 9.4 kg km^{-1} in post farakka period due to check of its migration on account of construction of a barrage at Farakka (Chandra, 1991). Natarajan (1989) stated that at Allahabad, the catch rate for major carps ($\text{kg.ha}^{-1} \text{ yr}^{-1}$) decreased from 4.19 to 2.02 for catfishes from 2.10 to 1.58 and for hilsa from 0.91 to 0.04 but the catch rate for miscellaneous fishes increased from 2.17 to 3.16 between the periods 1958-69 and 1973-84. By species, mrigal decreased in annual yield by 71.64% catla, 69.45% and L. rohita by 68.14% in the above period. More or less same conclusion was drawn by Jhingran (1989) during his study on impact of environmental perturbation on the fisheries ecology of river Ganga. On account of above described unplanned and unbridled developmental activities, a number of sensitive fish species are unable to adjust in existing ecosystem and their stock is gradually decreasing year after year. A list of endangered/threatened fishes in Ganga system has been prepared by Mohanta & Kapoor (1994), Pandey & Awasthy (1994) and for eastern U.P. by Singh *et al.*, (1994). Therefore, immediate attention should be paid for rehabilitation and conservation of these fishes. Remedial measures for eco-restoration for Ganga river have been prescribed by a host of workers (Natarajan, 1989, Jhingran, 1989 Khan *et al.*, 1996) but their implementation in letter & spirit is needed for revival of Ganga fisheries and for restoration of its past pristine glory.

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Table 1. Geographic area : UP, plain

Species	Local name	Distribution			Occurrence		Abundance		Max. Size cm		Ref. & Remarks
		End/ exo	Present	Past	Present	Past	Present	Past	Present	Past	
<i>Notopterus chitala</i> (Ham.)	Moh	End	1996 R	1957 I	1996 0-2	1993 0-3	1993 A-2	1996 A-3	100.0	122.0	Talwar & Jhingran 1991; Khan pers.ob. 1996
<i>N. Notopterus</i> (pallas)	Patra	End	1996 UA	1957 UA	1983 0-4	1957 0-4	1991 A-4	1983 A-4	45.0	61.0	Talwar & Jhingran 1991; Hora, 1949, Khan, 1983
<i>Xenentodon cancila</i> (Ham.)	Thona	End	1957 UA	1991 UA	1991 0-1	1957 0-1	1991 A-1	1967 A-1	33.50	40.0	Motwani & David 1957; Talwar & Jhingran, 1991
<i>Parlusiosma daniconius</i> (Ham.)	—	End	1974 UA	1991 UA	1991 0-3	1974 A-3	1991 A-3	1974	10.0	—	Motwani & Saigal 1974; Talwar & Jhingran, 1991
<i>Raiamas bola</i> (Ham.)	Gulabi Machli	End	1981	1949 R	1981 I	1949 0-2	1981 0-3	1949 A-2	28.4 A-3	30.4	Hora & Mokerji, 1936; Misra, 1959; Anon, 1981
<i>B. barila</i> (Ham.)	Bhareli	End	1981 UA	1957 UA	1981 0-2	1957 0-2	1981 A-3	1957 A-3	9.0	10.2	Anon, 1981; Misra, 1959; Motwani & David, 1957
<i>B. barna</i> (Ham.)	Darangni	End	1981 UA	1957 UA	1981 0-2	1957 0-2	1981 A-2	1957 A-2	—	—	Motwani & David, 1957; Anon, 1981
<i>B. bendelisis</i> var <i>chedra</i> (Ham.)	Daurah	End	1981 UA	1957 UA	1981 0-3	1957 0-3	1981 A-3	1957 A-3	7.5	8.0	Motwani & David, 1957; Misra, 1959

Species	Local name	Distribution			Occurrence		Abundance		Max. Size cm		Ref. & Remarks
		End/	Present	Past	Present	Past	Present	Past	Present	Past	
<i>B. vagra</i> (Ham.)	Chal	End	1991 UA	1981 UA	1991 0-2	1981 0-2	1981 A-2	1991 A-2	10.0	12.7	Anon, 1981; Talwar & Jhingran, 1991
<i>B. Shacra</i> (Ham.)	—	End	1957	—	—	—	—	—	—	—	Motwani & David, 1957
<i>Brachydanio rerio</i> (Ham.)	Salari	End	1981 UA	1957 UA	1981 0-4	1957 0-4	1981 A-4	1957 A-4	4.5	4.0	Motwani & David, 1957; Talwar & Jhingran, 1991 & Anon, 1981
<i>Esomus danricus</i> (Ham.)	Chiddulu	End	1991 UA	1949 UA	1991 0-4	1949 0-4	1991 A-4	1949 A-4	12.5	9.0	-do-, & Khan personnel obs. 1996
<i>Chela atpar</i> (Ham.)	Chilwa	End	1981 UA	1957 UA	1981 0-4	1957 0-4	1981 A-4	1957 A-4	9.0	10.2	Motwani & Saigal, 1957; Anon, 1981
<i>C. laubuca</i> (Ham.)	Dennahrah	End	1957 UA	1981 UA	1981 0-4	1974 0-4	1981 A-4	1974 A-4	5.5	8.9	Motwani & Saigal, 1974; Misra, 1959
<i>Salmostoma boopis</i> (Day)	Chiluwa	End	1981 UA	1974 UA	1981 0-4	1974 0-4	1981 A-4	1974 A-4	9.0	10.2	Motwani & Saigal, 1974; Anon, 1981
<i>S. clupeoides</i> (Bloch.)	Chilwa	End	1957 UA	1991 UA	1991 0-3	1957 0-3	1957 A-3	1991 A-3	—	15.0	Motwani & David, 1957; Talwar & Jhingran 1991
<i>S. bacaila</i> (Ham.)	Jellahri, Chilwa	End	1949 UA	1991 UA	1991 0-4	1949 0-4	1991 A-4	1949 A-4	14.8	18.0	Hora, 1949; Talwar & Jhingran, 1991
<i>Securicula gora</i> (Ham.)	Chilwa	End	1981 UA	1957 UA	1981 0-3	1957 0-3	1981 A-3	1957 A-3	20.0	23.0	Motwani & David, 1957 & Anon, 1981

Species	Local name	Distribution			Occurrence		Abundance		Max. Size cm		Ref. & Remarks
		End/ exo	Present	Past	Present	Past	Present	Past	Present	Past	
<i>Gadusia chapra</i> (Ham.)	Chapra	End	1957 UA	1989 UA	1989 0-4	1957 0-4	1989 A-4	1957 A-4	15.0	17.0	Motwani & David, 1957; Natarajan, 1989
<i>Hilsa ilisha</i> (Ham.)	Ilish	End	1989 R	1957 I	1989 0-1	1957 0-4	1989 A-1	1957 A-4	43.0	60.0	Motwani & David, 1957; Natarajan, 1989
<i>Setipinna phasa</i> (Ham.)	Phasia	End	1989 R	1968 I	1989 0-2	1968 0-4	1989 A-2	1968 A-4	26.0	30.0	Natarajan, 1989; Chandra, 1991
<i>Corica saborna</i> (Ham.)	—	End	1966 —	1979 —	—	—	—	—	—	—	Srivastava <i>et al.</i> 1966; Kamal & Ahsan, 1979
<i>Ilisha megaloptera</i> (Ham.)	—	End	1966 UA	1991 UA	1991 0-3	1966 0-3	1966 A-3	1991 A-3	10.2	27.5	Misra, 1959; Srivastava et al., 1966 and Talwar & Jhingran, 1991
<i>Gonialosa manmina</i> (Ham.)	Mackundi	End	1989 UA	1970 UA	1989 0-3	1970 0-3	1989 A-3	1970 A-3	10.0	14.0	Natarajan, 1989; Jhingran, 1970
<i>Danio devrio</i> (Ham.)	—	End	1957 UA	1991 UA	1991 0-3	1957 0-3	1991 A-3	1957 A-3	10.0	9.0	Motwani & David, 1957; Talwar & Jhingran, 1991
<i>Aspidopariya jaya</i> (Ham.)	Jaya	End	1957 R	1991 I	1991 0-3	1957 0-2	1991 A-3	1957 A-2	15.0	13.0	Motwani & David, 1957; Natarajan 1989

Species	Local name	Distribution			Occurrence		Abundance		Max. Size cm		Ref. & Remarks
		End/ exo	Present	Past	Present	Past	Present	Past	Present	Past	
<i>A. morar</i> (Ham.)	Pirohia	End	1989 UA	1957 UA	1989 0-4	1957 0-4	1989 A-4	1957 A-4	17.5	16.0	Motwani & David, 1957; Natarajan, 1989
<i>Amblypharyngodon mola</i> (Ham.)	Dhowri	End	1981 UA	1957 UA	1981 A-4	1957 0-4	1981 A-4	1957 A-4	18.0	20.0	Motwani & David, 1957; Anon, 1981
<i>Crossocheilus latius latius</i>	Petphorani	End	1981 UA	1957 UA	1981 0-3	1957 0-3	1981 A-3	1957 A-3	12.4	20.0	Motwani & David, 1957; Hora & Mukerji, 1936
<i>Garra gotyla gotyla</i> (Gray)	Siltokagotyl	End	1957 UA	1949 UA	1957 0-3	1949 0-3	1957 A-3	1949 A-3	17.0	15.2	Hora, 1949; Motwani & David, 1957
<i>G. mullya</i> (Sykes)	—	End	1957	1949 UA	1957 UA	1949 0-3	1957 0-3	1949 A-3	17.0 A-3	12.2	Hora, 1949; Motwani & David, 1957
<i>Aplocheilus panchax</i> (Ham.)	Lal Jhingra	End	1991 —	1822 —	—	—	—	—	9	—	Hamilton, 1822; Talwar & Jhingran, 1991
<i>Catla catla</i> (Ham.)	Bhakur	End	1963 I	1989 R	1989 0-2	1963 0-3	1989 A-2	1963 A-3	120.0	182.8	Natarajan & Jhingran, 1963, Talwar & Jhingran, 1991
<i>Cirrhinus mrigala mrigala</i> (Ham.)	Nain	End	1989 R	1957 UA	1989 0-2	1957 0-3	1989 A-2	1957 A-3	95.8	99	Motwani & David, 1957; Misra, 1959; Natarajan, 1989

Species	Local name	Distribution			Occurrence		Abundance		Max. Size cm		Ref. & Remarks
		End/ exo	Present	Past	Present	Past	Present	Past	Present	Past	
<i>C. Reba</i> (Ham.)	Rewah	End	1989 UA	1957 UA	1989 0-3	1957 0-3	1989 A-3	1957 A-3	17.5	16.0	Motwani & David, 1957; Misra, 1959; Natarajan, 1989
<i>Labeo rohita</i> (Ham.)	Rohu	End	1989 R	1957 I	1989 0-2	1957 0-3	1989 A-2	1957 A-3	91.4	96.0	Motwani & David, 1957; Natarajan, 1989; Misra, 1959
<i>L. bata</i> (Ham.)	Bata	End	1989 UA	1957 UA	1989 0-4	1957 0-4	1989 A-4	1957 A-4	61.0	60.9	Motwani & David, 1957; Natarajan, 1989
<i>L. boga</i> (Ham.)	Bhagan	End	1989 UA	1957 UA	1989 0-3	1957 0-3	1989 A-3	1957 A-3	30.0	30.4	Motwani & David, 1957; Misra, 1959; Natarajan, 1989
<i>L. boggut</i> (Sykes)	—	End	1989 UA	1957 UA	1989 0-3	1957 0-3	1989 A-3	1957 A-3	20.0	19.0	Natarajan, 1989; Talwar & Jhingran, 1991; Motwani & David, 1957
<i>L. calbasu</i> (Ham.)	Kalbose	End	1989 UA	1957 UA	1989 0-3	1957 0-3	1989 A-3	1957 A-4	90.0	91.4	Motwani & David, 1957; Misra, 1959; Natarajan, 1989
<i>L. dero</i> (Ham.)	Gid	End	1989 UA	1957 UA	1989 0-3	1957 0-3	1989 A-3	1957 A-3	75.0	65.4	Motwani & Saigal, 1957, Misra, 1959, Natarajan, 1989
<i>L. dyocheilus</i> (McClell.)	Boolia	End	1989 UA	1957 UA	1989 0-3	1957 0-3	1989 A-3	1957 A-3	60.0	90.0	Motwani & David, 1957; Misra, 1959; Natarajan, 1989

Species	Local name	Distribution			Occurrence		Abundance		Max. Size cm		Ref. & Remarks
		End/ exo	Present	Past	Present	Past	Present	Past	Present	Past	
<i>L. gonius</i> (Ham.)	—	End	1989 UA	1957 UA	1989 0-3	1957 0-3	1989 A-3	1949 A-3	40.0	45.0	Hora, 1949; Misra, 1959; Natarajan, 1989; Talwar and Jhingran, 1991
<i>L. fimbriatus</i> (Bloch)	—	End	1989 UA	1949 UA	1989 0-3	1949 0-3	1989 A-3	1949 A-3	91.0	95.7	Hora, 1949; Misra, 1959; Natarajan, 1989
<i>L. pangusia</i> (Ham.)	Rewa, Loane	End	1981 UA	1949 UA	1981 0-3	1949 0-3	1981 A-3	1949 A-3	48.0	60.0	Hora, 1949; Anon, 1981
<i>Osteobrama cotio cotio</i> (Ham.)	Goordah, Muchnee	End	1981 UA	1949 UA	1981 0-3	1957 0-3	1981 A-3	1957 A-3	15.0	15.2	Hora, 1949; Motwani & David, 1957; Anon, 1981; Talwar & Jhingran, 1991
<i>Puntius amphibius</i> (Valenc.)	Rotli	End	1957 UA	1949 UA	1957 0-3	1949 0-3	1957 A-3	1949 A-3	20.0	17.2	Hora, 1949; Motwani & David, 1957
<i>P. conchoniis</i> (Ham.)	Pothia	End	1991 UA	1957 UA	1957 0-4	1949 0-4	1957 A-4	1949 A-4	14.0	12.0	Motwani & David, 1957; Talwar & Jhingran, 1991
<i>P. sophore</i> (Ham.)	Pothia	End	1991 UA	1974 UA	1991 0-4	1974 0-4	1991 A-4	1974 A-4	13.0	10.0	Talwar & Jhingran, 1991; Motwani & Saigal, 1974
<i>P. ticto</i> (Ham.)	Pothia	End	1974 UA	1936 UA	1974 0-4	1936 0-4	1974 A-4	1936 A-4	10.0	8.0	Hora & Mukerji, 1936; Motwani & Saigal, 1974

Species	Local name	Distribution			Occurrence		Abundance		Max. Size cm		Ref. & Remarks
		End/ exo	Present	Past	Present	Past	Present	Past	Present	Past	
<i>P. sarana sarana</i> (Ham.)	Pothi	End	1949 UA	1989 UA	1989 0-3	1957 0-3	1989 A-3	1949 A-3	30.5	31.0	Hora, 1949; Misra 1959; Natarajan, 1989
<i>P. chola</i> (Ham.)	Siddhari	End	1991 UA	1957 UA	1991 0-3	1957 0-3	1991 0-3	1957 0-3	12.0	10.0	Talwar & Jhingran, 1991; Motwani & Saigal, 1974
<i>P. guganio</i> (Day)	Potti	End	1991 UA	1974 UA	1991 0-3	1974 0-3	191 A-3	1974 A-3	8.0	15.2	Talwar & Jhingran, 1991; Motwani & Saigal, 1974
<i>P. chagunio</i> (Ham.)	Musaina	End	1957 UA	1936 UA	1957 0-3	1936 0-3	1957 A-3	1936 A-3	25.0	46.0	Hora & Mukerji, 1936; Motwani & Saigal, 1974
<i>P. Gelius</i> (Ham.)	—	End	1991 UA	1974 UA	1991 0-4	1974 0-4	1991 A-4	1974 A-4	4.0	—	Hora & Mukerji, 1936; Motwani & Saigal, 1974
<i>Cyprinus carpio</i> (Lin.)	Common carp	Exo.	1996	—	—	—	—	—	30.0	—	Khan, 1996
<i>Tor khudree</i> (Sykes)	Mahseer	End	1981 R	1957 I	1981 0-3	1957 0-4	1981 A-3	1957 A-4	46.0	145.0	Talwari & Jhingran, 1991; Motwani & David, 1957
<i>Tor tor</i> (Ham.)	Mahseer	End	1989 R	1936 I	1989 0-2	1936 A-4	1989 A-4	1936 A-4	150	152	Hora & Mukerji, 1936; Motwani & David, 1957; Natarajan, 1989

Species	Local name	Distribution			Occurrence		Abundance		Max. Size cm		Ref. & Remarks
		End/ exo	Present	Past	Present	Past	Present	Past	Present	Past	
<i>Tor putitora</i> (Ham.)	Do	End	1989 R	1936 I	1989 0-2	1936 0-4	1989 A-2	1936 A-4	270.0	274.0	Hora & Mukerji, 1936; Misra, 1959; Natarajan, 1989
<i>Pangio pangia</i> (Ham.)	—	End	1991 UA	1957 UA	1991 0-3	1957 0-3	1991 A-3	1957 A-3	6.5	5.0	Motwani & David, 1957; Talwar & Jhingran, 1991
<i>Lepidocephalus guntea balgara</i> (Ham.)	Nauni	End	1981 UA	1936 UA	1981 0-3	1936 0-3	1981 A-3	1936 A-3	15.0	12.0	Hora, 1936; Anon, 1981; Talwar & Jhingran, 1991
<i>Nemacheilus moreh</i> (Skys)	Ghiwa	End	1957 UA	1936 UA	1957 0-3	1936 0-3	1957 A-3	1936 A-3	24	—	Hora, 1936; Anon, 1981; Talwar & Jhingran, 1991
<i>N. savona</i> (Ham.)	—	End	1981 UA	1936 UA	1981 0-3	1936 0-3	1981 A-3	1936 A-3	24	—	Hora, 1936; Anon, 1981; Talwar & Jhingran, 1991
<i>N. denisonii denisonii</i> (Day)	—	End	1981 UA	1949 UA	1981 0-3	1949 0-3	1981 A-3	1949 A-3	7.00	—	Hora, 1949; Anon, 1981; Talwar & Jhingran, 1991
<i>N. zonatus</i> (McClelland)	—	End	1957 UA	1981 UA	1981 0-3	1957 0-3	1981 A-3	1957 A-3	—	—	Motwani & David, 1957; Anon, 1981
<i>N. corica</i> (Ham.)	—	End	1991 UA	1974 UA	1991 0-3	1974 0-3	1991 0-3	1974 0-3	6.20	—	Motwani & Saigal, 1974; Talwar & Jhingran, 1991

Species	Local name	Distribution			Occurrence		Abundance		Max. Size cm		Ref. & Remarks
		End/ exo	Present	Past	Present	Past	Present	Past	Present	Past	
<i>N. doonensis</i> (Tilak & Hussain)	—	End	1991 UA	1977 UA	1991 0-3	1977 0-3	1991 0-3	1977 0-3	—	—	Tilak & Hussain, 1977; Talwar & Jhingran, 1991
<i>N. rupicola</i> (McClelland)	—	End	1936	1991	—	—	—	—	7.5	—	Hora & Mukerji, 1936; Talwar & Jhingran, 1991
<i>Botio dario</i> (Ham.)	—	End	1991 UA	1957 UA	1991 0-3	1957 0-3	1991 A-3	1957 A-3	9.0	8.9	Motwani & David, 1957; Talwar & Jhingran, 1991
<i>B. dayi</i> (Hora)	—	End	1991 UA	1981 UA	1991 A-3	1981 0-3	1991 A-3	1981 A-3	12.0	12.2	Misra, 1959; Anon, 1981; Talwar & Jhingran, 1991
<i>Somileptis gangota</i> (Ham.)	—	End	1991 UA	1974 UA	1991 0-3	1974 0-3	1991 A-3	1974 A-4	10.0	9.0	Motwani & Saigal, 1974; Talwar & Jhingran, 1991
<i>Ompok bimaculatus</i> (Bloch)	Pubta	End	1990 UA	1949 UA	1990 UA	1949 0-4	1990 0-4	1949 0-4	31.0	50.0	Hora, 1949; Misra, 1959; Khan, 1990, per. obs.
<i>Ompok papda</i> (Ham.)	Pallu	End	1990 UA	1957 UA	1990 0-3	1957 0-3	1990 A-3	1822 A-3	21	24	Hamilton, 1922; Khan, 1990; Motwani & David, 1957
<i>Wallago attu</i> (Sehneider)	Padhan	End	1990 R	1974 I	1990 0-3	1974 A-4	1990 A-3	1974 A-4	183.0	200.0	Motwani & Saigal, 1974; Khan, 1990 pers. obs.

Species	Local name	Distribution			Occurrence		Abundance		Max. Size cm		Ref. & Remarks
		End/ exo	Present	Past	Present	Past	Present	Past	Present	Past	
<i>Pinniwallago kanpurensis</i> (Gupta, Jayaram, Hajela)	—	End	1991	1981	—	—	—	—	50.0	—	Talwar & Jhingran, 1991; Gupta <i>et. al.</i> , 1981
<i>Ailia coila</i> (Ham.)	Bansputta	End	1989 UA	1957 UA	1989 0-3	1957 0-3	1989 A-3	1957 A-3	18.0	17.7	Motwani & David, 1957; Misra, 1959; Natarajan, 1989
<i>Clupisoma garua</i> (Ham.)	Bachua	End	1989 UA	1957 UA	1989 0-4	1957 0-4	1989 A-4	1957 A-4	60.0	100.0	Motwani & David, 1957; Misra, 1959; Natarajan, 1989; Talwar & Jhingran, 1991
<i>Clupisoma montana</i> (Hora)	—	End	1957	1937	—	—	—	—	18.0	29.0	Hora, 1937; Motwani & David, 1957
<i>Eutropiichthys murius</i> (Ham.)	—	End	1966 UA	1957 UA	1966 0-4	1957 0-4	1966 A-4	1957 A-4	28.0	—	Motwani & David, 1957; Srivastava <i>et al</i> 1966; Khalanski, <i>et al.</i> , 1990
<i>Eutropiichthys vacha</i> (Ham.)	Baikiri	End	1981 UA	1957 UA	1981 0-4	1974 0-4	1981 A-4	1974 A-4	35.0	31.0	Motwani & Saigal, 1974; Anon, 1981
<i>Silonia silondia</i> (Ham.)	Silond	End	1981 UA	1957 UA	1981 0-4	1957 0-4	1981 A-2	1957 A-3	100.0	182.0	Motwani & David, 1957; Misra 1959; Anon, 1981

Species	Local name	Distribution			Occurrence		Abundance		Max. Size cm		Ref. & Remarks
		End/ exo	Present	Past	Present	Past	Present	Past	Present	Past	
<i>Pangasius</i> <i>Pangasius</i> (Ham.)	Pangas	End	1989 R	1957 I	1989 0-2	1957 0-3	1989 A-2	1957 A-3	150.0	122.0	Motwani & David, 1957; Natarajan, 1989
<i>Pangasius</i> <i>Pangasius upienseis</i>	Pangas	End	1968	—	—	—	—	—	—	—	Srivastava, 1968
<i>Aorichthys aor</i> (Ham.)	Tengra	End	1989 R	1957 I	1989 0-3	1957 0-4	1989 A-3	1957 A-4	180.0	182.8	Motwani & David, 1957; Natarajan, 1989
<i>Aorichthys</i> <i>seenghala</i> (Sykes)	Seenghala	End	1989 R	1957 I	1989 0-3	1957 0-4	1989 A-3	1957 A-4	100.0	150	Motwani & David, 1957; Natarajan, 1989
<i>Mystus cavasius</i> (Ham.)	Tengra	End	1974 UA	1949 UA	1974 A-4	1949 0-4	1974 A-4	1949 A-4	40.0	45.7	Motwani & Saigal, 1974; Hora 1949
<i>Mystus vittatus</i> (Bloch)	Kala tengra	End	1966 UA	1974 UA	1966 A-4	1957 0-4	1966 A-4	1957 A-4	21.0	20.3	Motwani & Saigal, 1974; Srivastava, 1966
<i>Mystus bleckeri</i> (Day)	Tengra	End	1989	1966	—	—	—	—	13.5	8.90	Srivastava et al, 1966; Natarajan, 1989
<i>Rita rita</i> (Ham.)	Rita	End	1989 UA	1957 UA	1989 0-4	1957 0-4	1989 A-4	1957 A-4	129.0	150.0	Motwani & David, 1957; Natarajan, 1989
<i>Amblyceps</i> <i>mangois</i> (Ham.)	Billi	End	1981 UA	1957 UA	1981 0-3	1957 0-3	1981 A-3	1957 A-3	12.50	10.0	Motwani & David, 1957; Anon, 1981

Species	Local name	Distribution			Occurrence		Abundance		Max. Size cm		Ref. & Remarks
		End/ exo	Present	Past	Present	Past	Present	Past	Present	Past	
<i>Bagarius bagarius</i> (Ham.)	Gonch	End	1991 R	1989 I	1991 0-2	1989 0-3	1991 A-2	1989 A-3	19.0	—	Talwar & Jhingran, 1991; Natarajan, 1989
<i>Bagarius yarrellii</i> (Sykes)	Gonch	End	1989 R	1949 I	1989 0-2	1949 0-3	1989 A-2	1949 A-3	152.0	200.0	Hora, 1949; Natarajan, 1989
<i>Erethistoides mantana pipri</i> (Hora)	—	End	1957	1949	—	—	—	—	—	—	Hora, 1949; Motwani & David, 1957
<i>Gagata cenia</i> (Ham.)	Bhagi	End	1957 UA	1949 UA	1957 0-3	1949 0-3	1957 A-3	1949 A-3	15.0	—	Hora, 1949; Motwani & David, 1957
<i>Gagata gagata</i> (Ham.)	—	End	1991 UA	1957 UA	1991 0-3	1957 0-3	1991 A-3	1957 A-3	30.5	—	Motwani & David, 1957; Talwar & Jhingran, 1991
<i>Glyptothorax annandalei</i> (Hora)	—	End	1981 UA	1949 UA	1991 0-3	1981 0-3	1981 A-3	1949 A-3	11.5	—	Hora, 1949; Anon, 1981
<i>Glyptothorax horai</i> Shaw & shebbeare	—	End	1981 UA	1957 UA	1981 0-3	1957 0-3	1981 A-3	1957 A-3	—	—	Motwani & David, 1957; Anon, 1981
<i>Glyptothorax telchitta</i> (Hora)	—	End	1981 UA	1949 UA	1981 0-3	1949 0-3	1981 A-3	1949 A-3	10.0	9.0	Hora, 1949; Anon, 1981
<i>Glyptothorax Pectinopterus</i> (McClell)	—	End	—	1937	—	—	—	—	—	—	Hora, 1937

Species	Local name	Distribution			Occurrence		Abundance		Max. Size cm		Ref. & Remarks
		End/ exo	Present	Past	Present	Past	Present	Past	Present	Past	
<i>Glyptothorax cavia</i> (Ham.)	—	End	1991	1949	—	—	—	—	10.0	—	Hora, 1949; Talwar & Jhingran 1991
<i>Sisor rhapsophorus</i> (Ham.)	Kirla	End	1991	1957	—	—	—	—	18.0	—	Motwani & David, 1957; Talwar & Jhingran, 1991
<i>Nangra itchkeea</i> (Sykes)	—	End	1991	1981	—	—	—	—	7.6	—	Anon, 1981; Talwar Jhingran, 1991
<i>Laguvia kapuri</i>	—	End	1974	—	—	—	—	—	4.0	—	Tilak & Hussain, 1974
<i>Laguvia ribeiroi</i> (Hora)	—	End	1991	1949	—	—	—	—	10.0	—	Hora, 1949; Talwar & Jhingran, 1991
<i>Heteropneustes fossilis</i> (Bloch)	Singee	End	1989 UA	1957 UA	1989 0-4	1957 0-4	1989 A-4	1957 A-4	30.0	31.0	Motwani & David, 1957; Natarajan, 1989
<i>Heteropneustes microps</i> (Gunther)	Singhee	End	1991	1988	—	—	—	—	30.00	29.00	Datta Munshi & Srivastava, 1988; Talwar & Jhingran, 1991
<i>Clarias batrachus</i> (Linn.)	Mangur	End	1957 UA	1989 UA	1989 0-4	1957 0-4	1989 A-4	1957 UA	46.0	45.0	Motwani & David, 1957; Natarajan, 1989
<i>Rhinomugil corsulsa</i> (Ham.)	Answari	End	1991 UA	1957 UA	1991 0-3	1957 0-3	1991 A-3	1957 A-3	30.0	46	Motwani & David, 1957; Talwar & Jhingran 1991

Species	Local name	Distribution			Occurrence		Abundance		Max. Size cm		Ref. & Remarks
		End/ exo	Present	Past	Present	Past	Present	Past	Present	Past	
<i>Sicamugil cascasia</i> (Ham.)	—	End	1991 UA	1957 UA	1991 0-4	1957 0-4	1957 A-4	1991 A-4	9.0	10.2	Motwani & David, 1991; Talwar & Jhingran, 1991
<i>Chana orientalis</i> (Bloch & Sch.)	Girahi	End	1957 UA	1949 UA	1957 A-4	1949 0-4	1991 A-4	1957 A-4	9.0	10.2	Motwani & David, 1957; Hora, 1949
<i>Channa marulius</i> (Ham.)	Sowal	End	1957 UA	1949 UA	1957 0-4	1949 0-4	1957 A-4	1949 A-4	13.0	33.0	Hora, 1949; Motwani & David, 1957
<i>Channa punctatus</i> (Bloch)	Soal	End	1966 UA	1957 UA	1966 0-3	1957 0-3	1966 A-3	1957 A-3	122.0	121.9	Motwani & David, 1957; Srivastava, <i>et al.</i> , 1966
<i>Channa striatus</i> (Bloch)	Sowal	End	1991 UA	1957 UA	1991 0-3	1957 0-3	1991 A-3	1957 A-3	75.0	91	Motwani & David, 1957; Talwar & Jhingran, 1991
<i>Chanda nama</i> (Ham.)	Chanri	End	1966 UA	1957 UA	1966 0-4	1957 0-4	1966 A-4	1957 A-4	11.0	7.6	Motwani & David, 1957; Srivastava <i>et al.</i> , 1966
<i>Pseudambassis ranga</i> (Ham.)	Chanari	End	1966 UA	1957 UA	1966 0-4	1957 0-4	1966 A-4	1957 A-4	7.0	10.0	Srivastava, <i>et al.</i> , 1966; Motwani & David, 1957
<i>Johnius gangeticus</i> (Talwar)	Bola	End	1991 UA	1966 UA	1991 0-3	1966 0-3	1991 A-3	1966 A-3	12.0	10.0	Talwar & Jhingran, 1991; Srivastava <i>et al.</i> , 1966

Species	Local name	Distribution			Occurrence		Abundance		Max. Size cm		Ref. & Remarks
		End/ exo	Present	Past	Present	Past	Present	Past	Present	Past	
<i>Pama pama</i> (Ham.)	—	End	1991 UA	1966 UA	1991 0-4	1966 0-4	1991 A-4	1966 A-4	20.0	—	Talwar & Jhingran, 1991; Srivastava <i>et al.</i> , 1966
<i>Colisa fasciatus</i> (Schn.)	Kungee	End	1991 UA	1957 UA	1991 0-3	1957 0-3	1991 A-3	1957 A-3	12.0	10.0	Motwani & David, 1957; Talwar & Jhingran, 1991
<i>Nandus nandus</i> (Ham.)	—	End	1991 UA	1966 UA	1991 0-3	1966 0-3	1991 A-3	1966 A-3	19.00	17.7	Srivastava <i>et al.</i> , 1966; Talwar & Jhingran, 1991
<i>Badis badis</i> (Ham.)	—	End	1991 UA	1966 UA	1991 0-3	1966 A-3	1991 A-3	1966 A-3	8.0	7.5	Srivastava, <i>et al.</i> , 1966; Talwar & Jhingran, 1991
<i>Anabas testudineus</i> (Bloch)	Koi	End	1991 UA	1989 UA	1991 0-3	1989 0-3	1991 A-3	1989 A-3	25.0	20.3	Natarajan, 1989; Talwar & Jhingran, 1991
<i>Mastacembalus pancalus</i> (Ham.)	Bami	End	1989 UA	1957 UA	1989 0-3	1957 0-3	1989 A-3	1957 A-3	18.0	19.0	Motwani & David, 1957; Natarajan, 1989
<i>Macragnathus aral</i> (Bloch)	Bam	End	1989 UA	1957 UA	1989 0-3	1957 0-3	1989 A-3	1957 A-3	38.0	35.0	Motwani & David, 1957; Natarajan, 1989
<i>Mastacembalus armatus</i> (Leep)	Bam	End	1989 UA	1949 UA	1989 0-4	1949 0-4	1989 A-4	1949 A-4	61	60.9	Hora, 1949; Misra, 1959; Natarajan, 1989

Species	Local name	Distribution			Occurrence		Abundance		Max. Size cm		Ref. & Remarks
		End/ exo	Present	Past	Present	Past	Present	Past	Present	Past	
<i>Tetraodon cutcutia</i> (Ham.)	—	End	1966	1822	—	—	—	—	—	—	Hamilton, 1822; Talwar & Jhingran, 1991
<i>Anguilla bengalensis bengalensis</i> (Gray)	Bam	End	1981 UA	1957 UA	1981 0-2	1957 0-2	1981 A-2	1957 A-2	120.0	80.0	Anon, 1981; Motwani & David, 1957
<i>Glossogobius giuris</i> (Ham.)	Bulla	End	1989 UA	1957 UA	1989 0-3	1957 0-3	1989 A-3	1957 A-3	30.0	31.0	Motwani & Saigal, 1957; Natarajan, 1989; Misra, 1959
<i>Monopterus (Amphipnous) cuchia</i> (Ham.)	Anvayabaun	End	1991	1959	—	—	—	—	61.0	60.9	Talwar & Jhingran, 1991; Misra, 1959
<i>Pseudeutropius atherinoides</i> (Bloch)	Barusa	End	1991	1966	—	—	—	—	Small aquarium Fish	—	Srivastava, <i>et al.</i> , 1966; Talwar & Jhingran, 1991

Explanation of observations

Distribution :- UA = Unaltered; R = reduced, I = increased, from the past.

Occurrence :- is indicated in the scale of 0-1 to 0-4. 0-4 those commonly found and 0-1 for those species occurring sporadically in catches.

Abundance :- is indicated in the scale of A-1 to A-4. A-4 indicates abundance in large number and A-1 denotes only a few species.

ON AGE AND GROWTH DETERMINATION OF CERTAIN CATFISHES FROM RIHAND RESERVOIR

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INTRODUCTION

Ability for forecasting accurately age of the fishes by hard parts (scale, otolith, opercular bone, cleithrum, vertebrae, fish spine, fin-rays etc.), Petersen's method and tagging of fish provides a number of information on growth rate, age at maturity, number of spawning periods per life span, age at capture, abundance of year classes, longevity and mortality rates. These information are *sine qua non* for rational exploitation of fish stock.

A review of the literature revealed that considerable work has been done on ageing of the fishes throughout the world (Chugonova, 1926, Graham, 1929 Van Oostern, 1929, De Bont, 1967). Petersen suggested that age of the fish can be known through their length frequency distribution. Heincke (1904) established the validity of rings found on the concavities of the vertebral centra of certain fishes (gadoids & flatfishes) which was confirmed by latter workers (Aikawa, 1937; Yasuda, 1940). In India, study on ageing of fishes mainly by Petersen's method has been emphasized on marine fishes (Qasim, 1973). While in inland waters more attention has been paid on major carps age determination through their scales (Jhingran, 1959, Natarajan & Jhingran, 1963; Kamal, 1969) followed by other fishes i.e. *Gudusia chapra* (Jhingran, 1977) and *Notopterus notopterus* (Khan, 1983). Generally, ageing through hard parts is done in case of the non-scaly fishes. Thus, Saigal (1963), Saxena (1964), Ghosh et al. (1977) and Anwar & Siddiqui (1984) determined the age of *Mystus aor*, *Rita rita*, *Lates calcarifer* and *M. seenghala* respectively by counting rings on vertebral centra.

It is quite surprising that no attempt till date has been made to age these three important shilbeid fishes i.e. *Silonia silondia*, *Eutropiichthys vacha* and *Clupisoma garua* despite their commercial importance on account of their culinary value. Keeping this in view, an attempt has been made in the present communication to determine the age of these fishes from Rihand Reservoir, Uttar Pradesh, India.

Brief description of the locality : Rihand reservoir was constructed in 1962 by damming river Rihand or Rihand in district Son-Bhadra of U.P. It is having a catchment area of 13,344 km² with 3/4 area in Uttar Pradesh and rest in the Madhya Pradesh (24° 1' N and 83° E). Rihand reservoir basically is meant for electric generation and has an average water-spread area of 30,148 ha (FRL+DSL) with an annual water level fluctuation of about 15 m. It has an average depth of 24

m (FRL). The reservoir has a shore line of 561.35 km and a shore development index of 7.04; indicating an irregular shoreline. In early phase after initial filling, the reservoir was supporting a carp dominated fishery (>90%) but as the time lapsed, the catfishes gradually increased their share and at present form more than 85%. Generally, the catfish fisheries predominantly comprised these three species alongwith small quantity of *M. aor*, *M. seenghala* and *Wallago attu*. This points towards mismanagement of the reservoir and had set up an example to show how a carp dominated reservoir could be transformed into a catfish dominated one due to apathy of officials of the reservoir.

Material & methods : Fishes were procured from the experimental fishing conducted in Rihand Reservoir during 1989-90 with multimeshed gill nets. (20 mm - 400 mm mesh-bar) while studying the impact of hot water discharge on aquatic life of the Rihand reservoir. The fishes were weighed upto nearest gram and measured to the nearest millimeter. Freshly procured fishes were boiled for about half an hour to remove the flesh, then vertebrae were taken out. These were further cleaned with the help of a tough brush and put into a solution made up of 0.2% HCL and 0.2% pepsin for 6-8 hours. Later on samples were soaked in acetone for about 8 hours. The latter treatment successfully removed the adhering fat. A further treatment in absolute alcohol followed by glycerine (Saigal, 1963) rendered the rings present on centra of vertebrae clear and identifiable.

In this manner 28 vertebrae of each fish were cleaned for age study. The weight and length ranges of fishes from which vertebrae were collected were : 40 to 4,400 g and 180-835 mm; 50-330 g and 195-380 mm; and 90-300 g and 205-380 mm for silondia, vacha and garua respectively. Photographs of these vertebrae were also taken as described by Saxena (1964) for back calculation of age and length (Dahl-Lea, 1910, Sinha 1986). This was done after ascertaining that there exists a direct correlation between fish length and vertebral centrum size. The value of coefficient of correlation, was above 0.95 for these three species. The age of the fish was determined independently of its size by counting the narrow zones on the centra of the vertebrae.

Results and discussion : A careful examination of the vertebral centra by hand lens (10x) and photographs of the 3-species of fish undertaken for age determination revealed concentric circuli/rings around the centra of the vertebrae. These rings were of two types (1) a dark band comprising widely spaced circuli alternating with (2) closely packed rings giving an appearance of a translucent narrow band. A maximum number of 12 bands (wide and narrow) were observed in silondia of 835 mm (4,400 g) and 4 bands in a fish of 380 mm having a weight of 360 g (Fig. 1). Similarly, in vacha and garua also such types of bands were observed. In vacha, one narrow band was observed in a fish of 205 mm while, two narrow bands, were discernible in a fish of 320 mm (Fig 2 and 3). Similarly, garua of 205 mm showed one narrow band and of 260 mm indicated two narrow bands suggesting one and two years of age respectively. In general, larger the fish more the number of narrow zones, i.e. the vertebrae growth is directly related with the fish length. Narrow bands were observed in summer months and their representation go on decreasing in latter months. Similar observations were made by Aikawa (1937) and Saigal (1963) in *Scomber japonicus* and *M. aor* respectively.

A set of narrow and widely spaced band on hard parts of fish has been interpreted as annual increment or an "annulus" by numerous workers (Heinke, 1904; Aikawa, op. cit Saigal, op. cit

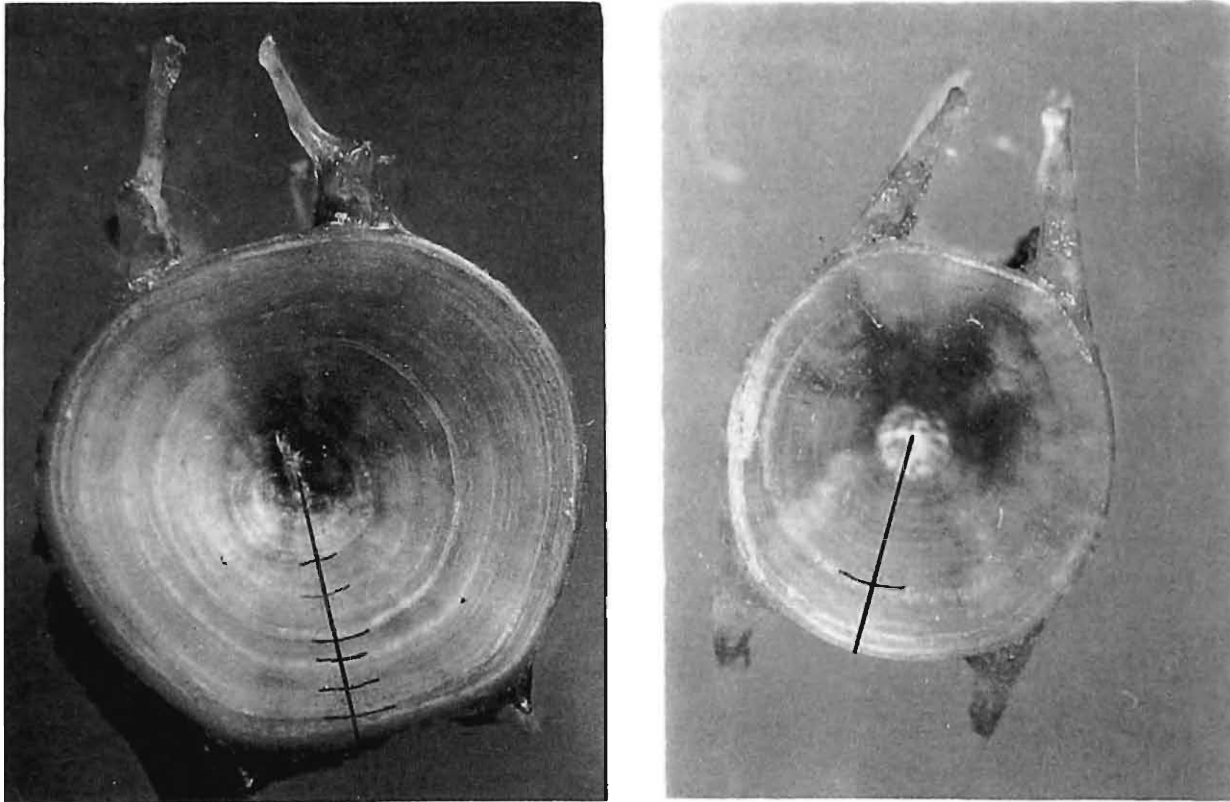


Fig. 1 a : Vertebra of *Silonia silondia* (TL = 835 mm, wt = 4400 g) shewing 6 annuli.

Fig. 1 b : (TL = 380 mm, wt = 360 g) indicating one annulus.

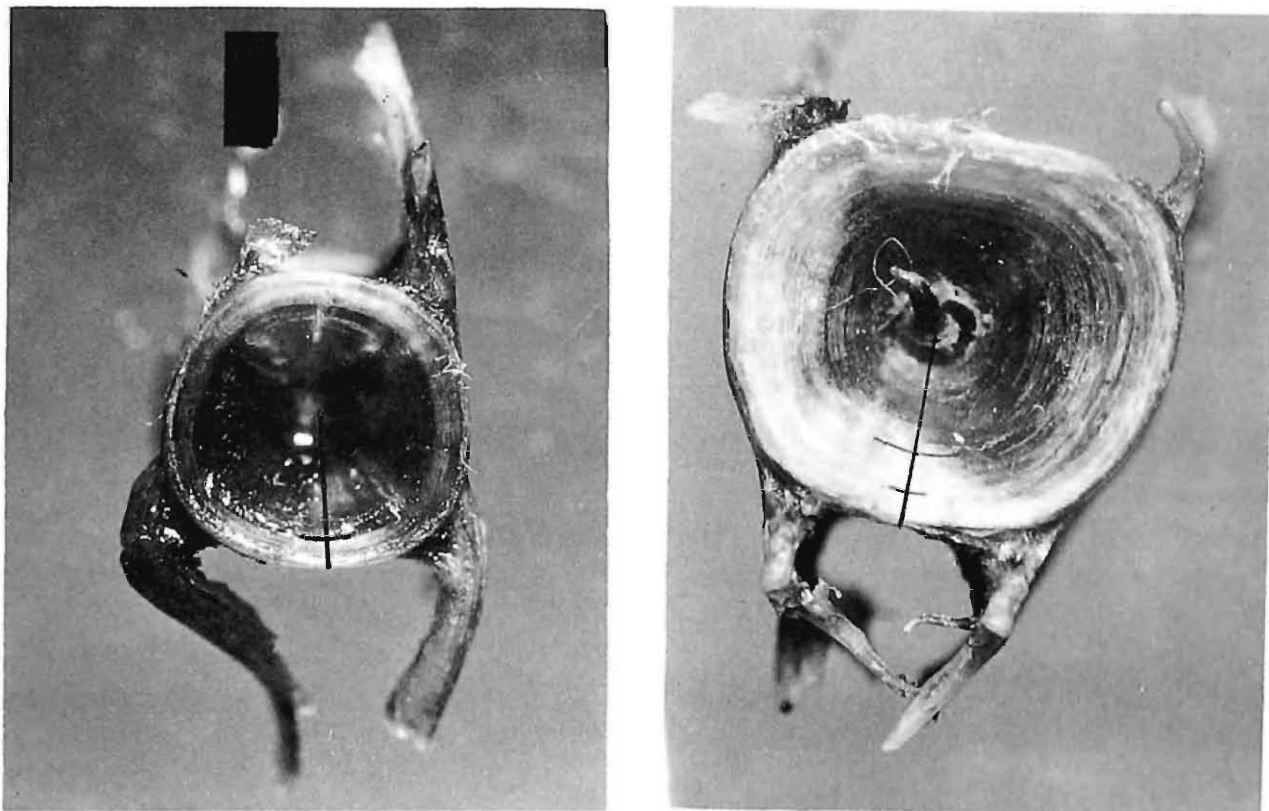


Fig. 2 a : *E. vacha* (TL = 205 mm, wt = 150 g) showing annulus on the vertebra.

Fig. 2 b : (TL = 320 mm, wt = 220 g) indicating two annuli.

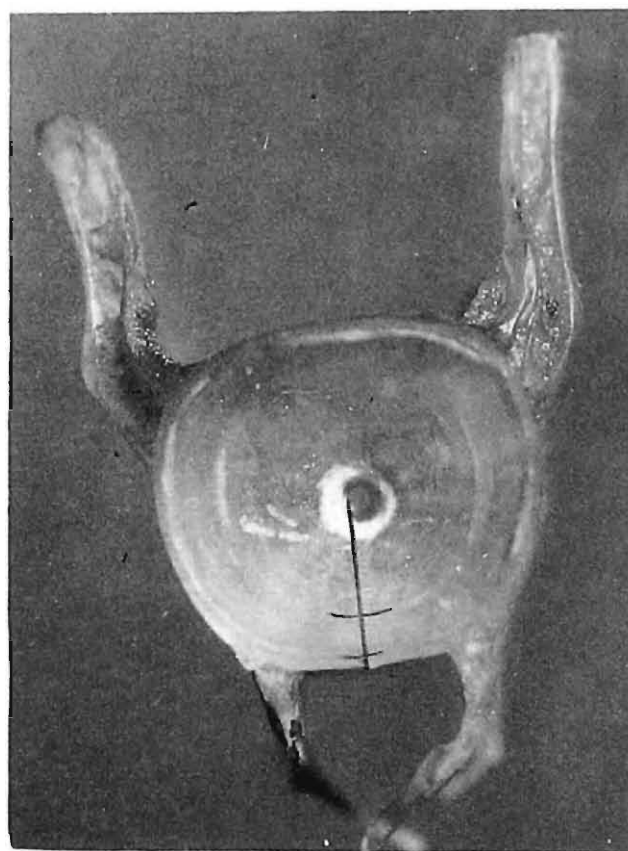
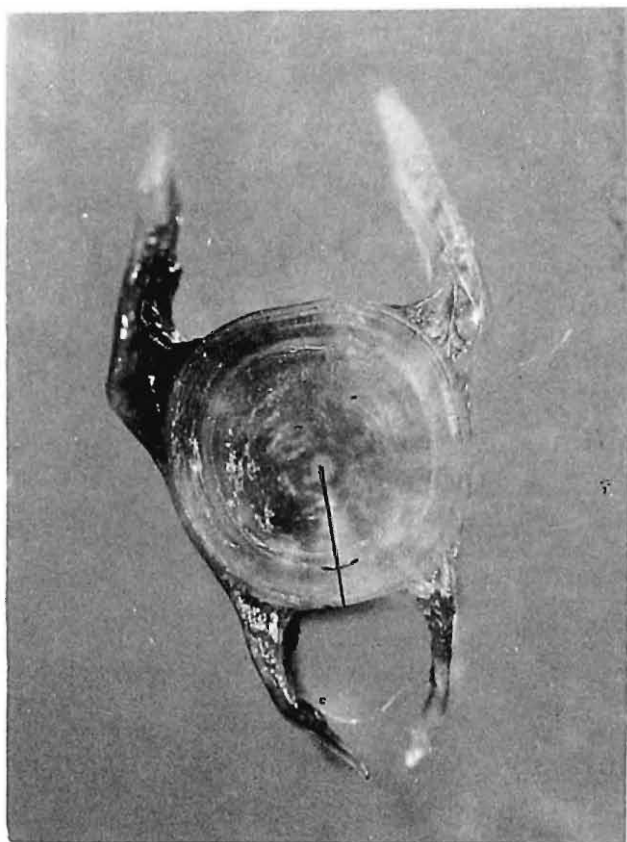


Fig. 3 a : Vertebrae of *C. garua* (TL = 205 mm, wt - 110 g) showing one annulus.
Fig. 3 b : (TL = 260 mm, wt = 130 g) indicating 2 annuli on vertebra.

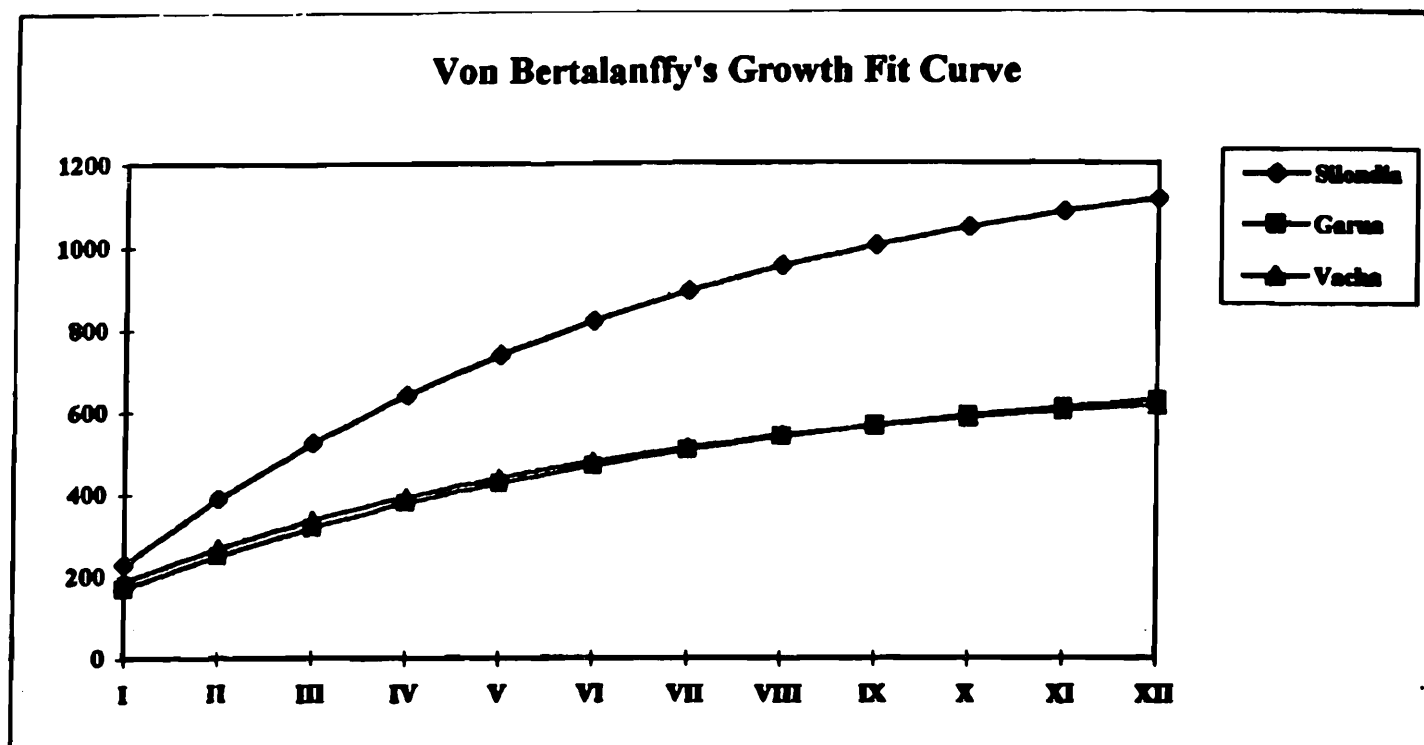
Ghosh *et al.*, 1977). These are supposed to be growth checks, indicating seizure of growth due to subdued feeding. A host of workers have given various causative factors for formation of growth checks but most of them are of the opinion that these are formed either due to extrinsic (temperature, dry season and paucity of food) or intrinsic (physiological rhythm such as maturity, spawning etc.). Beckman (1942) attributed annuli formation on the scales of certain game fishes to high water temperature. Kamal (1969) has reported that paucity of food in environment caused cessation of growth in mrigala thus causing annulus formation. Similar, view was offered by Seshappa and Bhimachar (1951) on the formation of rings on the scale of malabar soal. Chevey (1930, 1932) while studying age determination in fishes of Indo-China, Cochin, China and Cambodia observed concentrated rings on the scales of certain fishes and stated that a variation of water temperature of 4 to 5° C (23 to 27° C) seems to be sufficient enough to slow down the growth in fish, thus causing annulus formation on the scales. In the present study, a fluctuation of about 18° C was observed in water temperature i.e. from 19.8° C in winter to a high of 37° C in summer. This range of temperature is sufficient to cause growth checks on the hard parts (vertebrae) of the fish (Chevey, loc. cit).

Similarly, internal reasons (maturation of gonads, spawning and loss in Kn) as a cause for formation of annuli on hard parts of fishes have been observed by Holden, 1955; Garrod (1955), Natarajan and Jhingran (1963) and Jhingran (1977). Maturation of gonads due to advancement in maturity results in their elaboration, thus intestine is compressed under pressure of enlarging gonads which manifests in cessation of feeding activity causing slowing down of growth and resulting in formation of an annulus.

In the present study, the formation of annulus may be attributed to the above mentioned factors, because the high water temperature which prevailed in summer is synchronising with maturation of gonads causing strain on fish and resulting in the form of growth checks on the hard parts. This was corroborated by observing annuli in a number of fishes with empty stomachs or with less food. However, maximum food was observed in post-monsoon months (Vass *et al.*, 1997) which was coinciding with greater abundance of widely placed rings on vertebrae suggesting fast growth period. Reverse was the case in summer months, when narrow bands were observed on centra of the vertebrae of these fishes. These findings are in confirmation with the findings of Heincke, 1904 (gadoid fishes); Hiraki-Aikawa, 1937 (Japanese chub mackerel, Yasuda, 1940 (*Scombrops chilodipteroides*), Saigal, 1963, (*Mystus aor*). Saxena, 1964 (Rita rita) and Ghosh *et al.*, 1977 (*Lates calcarifer*).

False rings as described by many workers such as Natarajan and Jhingran, 1963 (*Catla catla*), Kamal, 1969 (*C. mrigala*) Jhingran, 1977 (*G. chapra*) and Khan, 1983 (*N. notoptasus*) were also observed on the scales of these fishes. These rings are probably formed due to temporary disturbance in the environment which caused slow growth in fish, resulting in formation of false annuli and when conducive conditions returned then normal growth takes place. Due to this reason false rings denote vague sculpture. False rings were observed on the vertebrae of these fishes too.

For further establishing validity of determination of age, other methods such as Petersen's method of length frequency distribution and von Bertalanffy's growth equation (von Bertalanffy, 1937; Beverton and Holt, 1957) were also tried (Table 1). These values have a very good agreement



with the values in length at different ages obtained by back calculation methods. In this equation length of fish at any time 't' is given by :

$$L_t = L_{\infty} (1 - e^{-K(t-t_0)}) \text{ where :}$$

L_{∞} is maximum size towards which the length of the fish is tending,

K = a measure of the rate of which length approximate L_{∞} or asymptotic length.

T_0 = a parameter indicating the (hypothetical) time at which the fish would have been zero size, if, it had always grown according to above equation. Values of different parameters in the above equation were calculated using standard methods. This equation was observed to hold good for these 3-species too (Fig. 4) and may be written as :

$$\text{for silondia - } L_t = 1290 \{ (1 - e^{-0.1632(t-0.1966)}) \}$$

$$\text{for garua - } L_t = 733.33 \{ (1 - e^{-0.1506(t-0.7603)}) \}$$

$$\text{for vacha - } L_t = 684.85 \{ (1 - e^{-0.17694(t-0.7944)}) \}$$

The largest fishes obtained in the samples were : 1000 mm for silondia and 380 each for garua and vacha. Desai (1993) has observed largest *S. silondia* in Rihand reservoir to the extent of 1130 mm in total length which is well inside asymptotic length (1290 mm) for this fish. While, Hora (1939) stated maximum length attained by garua to 2 feet and Day (1889) remarked that vacha is a medium size fish and could attain a length of upto 350 mm. These observations are within the range of L_{∞} of these two fishes estimated during the present study. Srivastava et al. (1992) could rear vacha and garua in a pond at Allahabad upto 301 days and recorded average growth of vacha

and garua as 264 and 179 mm respectively with an annual growth increment of 126 mm and 171 mm for the two fishes in the above order. The growth is a little more than estimated in the present study and this may be attributed to supply of supplementary feed as experiment was done under intensive culture condition.

Perhaps, this is the first report on age and growth of these three commercially important schilbeids fishes from open water and will be of utmost utility to the fisheries managers for augmenting fish production from such water bodies.

SUMMARY

Three species of schilbeid fishes viz., *Silonia silondia*, *Eutropiichthys vacha* and *Clupisoma garua* were studied for ageing through their veterbrae. It was revealed that in these fishes annuli were laid down in summer months. Spawning stress coupled with high temperature of water and low feeding intensity were found to be the main causative factors for the annuli formation. The lengths and ages derived from vertebrae method were checked against those derived by Petersen's method. von Bertalanaffy's growth equation was also derived which adequately explains growth pattern of these fishes.

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Table 1. Length at ages and growth (mm) of *S. silondia*, *C. garua* and *E. vacha* derived from different methods.

Age	<i>Silondia</i>			<i>Garua</i>			<i>Vacha</i>			Relative growth		
	Peterson method	Vertebra method	Von Bertalanffy's growth fit	Peterson method	Vertebra method	Von Bertalanffy's growth fit	Peterson method	Vertebra method	Von Bertalanffy's growth fit	Silondia	Garua	Vacha
I	240	230	228.84	180	170	170.77	190	188	186.30	159.79	78.65	80.85
II	410	385	388.63	250	255	249.42	260	262	267.15	135.72	67.64	67.76
III	530	524	524.35	320	310	317.06	330	340	334.89	115.29	58.21	56.75
IV	640	643	639.64	380	378	375.27	390	390	391.64	97.93	50.06	47.48
V	—	739	737.57	—	—	425.33	—	—	439.12	83.19	43.06	39.91
VI	—	819	820.76	—	—	468.39	—	—	479.03	70.65	37.15	33.37
VII	—	—	891.41	—	—	505.54	—	—	512.40	60.02	31.75	27.97
VIII	—	—	951.43	—	—	537.29	—	—	540.37	50.98	27.41	23.43
IX	—	—	1002.41	—	—	564.70	—	—	563.80	43.36	23.57	19.63
X	—	—	1045.72	—	—	588.27	—	—	583.43	36.78	20.28	16.44
XI	—	—	1082.50	—	—	608.55	—	—	599.87	31.20	17.45	13.78
XII	—	—	1113.70	—	—	626.00	—	—	613.65	—	—	—

SOME NEW RECORDS OF RODENTS FROM MIZORAM, INDIA

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INTRODUCTION

Faunistic surveys were conducted in Mizoram, specially for mammals during December, 1993 - January, 1994; March - May, 1995; and January, 1997 by scientists of the Zoological Survey of India. The collections thus obtained contain several species of rodents, of which, seven, namely, *Callosciurus erythraeus erythrogaster* (Blyth), *Callosciurus pygerythrus janetta* (Thomas), *Tamiops macclelandi macclellandi* (Horsfield), *Mus pahari* Thomas, *Niviventer niviventer mentosus* (Thomas), *Rattus nitidus obsoletus* Hinton, *Hystrix brachyura subcristata* Swinhoe were found to be unrecorded from Mizoram (Agrawal 1980, Corbet and Hill 1992, Das *et al.* 1995, Ellerman 1961, Roonwal 1950, Wilson and Reeder 1993). Since the finalisation of a detailed faunal account of mammals of Mizoram will take some more time, it was thought worthwhile to publish the new distributional records of these rodents hereunder.

External measurements have been taken in the field and the skull-measurements in the laboratory. All measurements are in millimetres and have been taken following standard methods.

Following is a list of abbreviations used for various measurements :

<i>apf</i>	=	anterior palatal foramina;
<i>b</i>	=	length of bulla;
<i>cb</i>	=	condylobasal length;
<i>d</i>	=	length of diastema;
<i>E</i>	=	length of ear;
<i>H&B</i>	=	length of head and body;
<i>Hf</i>	=	length of hindfoot;
<i>iw</i>	=	least interorbital width;
<i>ml</i>	=	mandibular length;
<i>mtr</i>	=	length of maxillary tooth-row;
<i>n</i>	=	length of nasal;
<i>on</i>	=	occipitonasal length;
<i>orb</i>	=	length of orbit;
<i>p</i>	=	palatal length;

Tl = length of tail;
zw = zygomatic width.

SYSTEMATIC ACCOUNT

Order : RODENTIA

Family : SCIURIDAE

Callosciurus erythraeus erythrogaster (Blyth, 1842)

Pallas's Squirrel

1842. *Sciurus erythrogaster* Blyth, *J. Asiat. Soc. Beng.*, 11 : 970 (Manipur).

Material examined : Mizoram : Lunglei district : 1 ♂, Sairep (c 1500 m), coll. T. P. Bhattacharyya, 20 April, 1995.

Measurements : External : 1 ♂ : H&B 247.0; Tl 225.0; Hf 53.0; E 18.0. Cranial : 1 ♂ : *on* 55.5; *cb* 50.1; *n* 17.2; *p* 26.4; *iw* 18.8; *mtr* 11.0; *b* 11.0; *orb* 16.9; *ml* 30.7.

Distribution : *Callosciurus erythraeus erythrogaster* is known within the Indian limits from Meghalaya, Assam, Nagaland and Manipur. The present specimen constitutes the first authentic record of this species from Mizoram.

Callosciurus pygerythrus janetta (Thomas, 1914)

Irrawaddy Squirrel

1914. *Sciurus pygerythrus janetta* Thomas, *J. Bombay nat. Hist. Soc.*, 23 : 203 (Mandalay, 200 ft., Myanmar).

Material examined : Mizoram : Lunglei district : 1 ♂, Sairep (c 1500 m), coll. T.P. Bhattacharyya, 22 April, 1995.

Measurements : External : 1 ♂ : H&B 140.0; Tl 113.0; Hf 43.0; E 17.5. Cranial : 1 ♂ : *on* 41.5; *cb* 35.7; *n* 11.5; *p* 20.0; *mtr* 8.2; *b* 7.9; *iw* 12.5; *orb* 13.2; *ml* 24.0.

Distribution : *Callosciurus pygerythrus janetta* is not known within the Indian limits. Hence, the present specimen constitutes the first record of this form from India. It is found in Myanmar.

Tamiops macclellandi macclellandi (Horsfield, 1839)

Himalayan Striped Squirrel

1839. *Sciurus macclellandi* Horsfield, *Proc. Zool. Soc. Lond.* : 152 (Assam, India).

Material examined : Mizoram : Lunglei district : 1 ♀, Sairep (c 1500 m), coll. T.P. Bhattacharyya, 20 April, 1995.

Measurements : External : 1 ♀ : H&B 121.0; Tl 99.0; Hf 25.5; E 12.0. Cranial : 1 ♀ : *on* 32.1; *cb* 28.4; *n* 9.5; *p* 14.5; *mtr* 5.5; *b* 5.9; *zw* 20.0; *iw* 11.7; *orb* 10.0; *ml* 17.7.

Distribution : *Tamiops macclellandi macclellandi* is known within the Indian limits from Sikkim, West Bengal, Assam, Arunachal Pradesh, Meghalaya, Nagaland, Manipur. The present specimen constitutes the first authentic record of this species from Mizoram.

Family : MURIDAE
Mus pahari Thomas, 1916
Sikkim Mouse

1916. *Mus pahari* Thomas, *J. Bombay nat. Hist. Soc.*, 24 : 415 (Batasia, Sikkim, 6000 ft., India).

Material examined : Mizoram : Aizawl district : 1 ♂, Tuikual Duty Post (c 850 m), c 10 km N of North Khawbung, coll. S.S. Saha, 17 December, 1993. Lunglei district : 1 ♂, 3 ♀, Sairep (c 1500 m), 15 & 16 January, 1997; 1 ♀, Lungsen (c 650 m), 22 January, 1997; coll. T.P. Bhattacharyya.

Measurements : External : 2 ♂ : H&B 102.0, 89.0; Tl 92.0, 88.0; Hf 20.0, 20.0; E 15.0, 15.0; 2 ♀ : H&B 93.0, 94.0; Tl 92.0, 101.0; Hf 19.0, 20.0; E 15.0, 15.5. Cranial : 2 ♂ : *on* 26.0, 25.4; *cb* 24.3, 24.1; *n* 10.0, 9.4; *p* 13.4, 12.9; *mtr* 4.1, 4.1; *b* 3.8, 4.0; *apf* 4.9, 4.7; *zw* 13.3, 11.9; *d* 7.5, 7.2; *ml* 14.6, 14.1. 2 ♀ : *on* 25.8, 25.9; *cb* 24.8, 24.5; *n* 10.0, 10.0; *p* 13.2, 12.5; *mtr* 4.4, 3.6; *b* 3.9, 4.0; *apf* 5.1, 4.9; *zw* 12.5, 12.3; *d* 7.2, 7.0; *ml* 14.3, 13.7.

Distribution : Within the Indian limits, *Mus pahari* is reported from Sikkim, West Bengal, Assam, Meghalaya, Nagaland. The present specimens, thus, constitute the first authentic record of this species from Mizoram.

Niviventer niviventer mentosus (Thomas, 1916)
White-bellied Rat

1916. *Rattus mentosus* Thomas, *J. Bombay nat. Hist. Soc.*, 24 : 643 (Hkamti, c 152 m, Upper Chindwin, Myanmar).

Material examined : Mizoram : Chintuipui district : 2 ♂, 1 ♀, Ngengpui (c 200m), coll. T.P. Bhattacharyya, 8-11 April, 1995.

Measurements : External : 1 ♂, 1 ♀ : H&B 155.0, 148.0; Tl 195.0, 169.0; Hf 32.0, 28.5; E 22.0, 21.5. Cranial : 1 ♂, 1 ♀ : *on* 40.5, 39.2; *cb* 37.7, 36.8; *n* 15.9, 15.5; *p* 19.9, 19.0; *mtr* 6.0, 5.8; *b* 5.0, 5.1; *apf* 7.0, 6.6; *zw* 17.3, 17.4; *d* 10.7, 10.2; *ml* 20.5, 17.7.

Distribution : *Niviventer niviventer mentosus* is known from Assam, Arunachal Pradesh, Meghalaya, Nagaland and Manipur in India. Hence, the present specimens constitute the first authentic record of this species from Mizoram.

Rattus nitidus obsoletus Hinton, 1919
Himalayan Rat

1919. *Rattus nitidus obsoletus* Hinton, *J. Bombay nat. Hist. Soc.*, 26 : 415 (50 miles W of kindat, c. 1524m, Chin Hills, Myanmar).

Material examined : Mizoram : Aizwal district : 2♂, Aizawl Circuit House, coll. Ajoy Kumar Mandal, 8 December, 1993. Chintuipui district : 1♂, Ngengpui (c 200m), coll. T.P. Bhattacharyya, 12 April, 1995. Lunglei district : 1♂, 3km SW of Zobawk, coll. T.P. Bhattacharyya, 20 January, 1997.

Measurements : External : 2♂ : H&B 150.0, 178.0; Tl 120.0, 165.0; Hf 31.5, 35.0; E 19.0, 19.0. Cranial : 2♂: *on* 39.2, 42.5; *cb* 36.4, 40.2; *n* 16.0, 17.0; *p* 21.1, 23.3; *mtr* 6.5, 6.8; *b* 5.8, 6.6; *apf* 6.5, 7.6; *zw* 18.0, 18.7; *d* 10.0, 12.0; *ml* 20.0, 21.4.

Distribution : *Rattus nitidus obsoletus* is known within Indian limits from Manipur (Roonwal 1950). Hence, the present specimens constitute the first authentic record of this species from Mizoram.

Family HYSTRICIDAE

Hystrix brachyura subcristata Swinhoe, 1870

Crestless Himalayan Porcupine

1870. *Hystrix subcristata* Swinhoe, *Proc. Zool. Soc. Lond.*, 638 (Foochow, Fukien, South-eastern China).

Material examined : Mizoram : Aizwal district : One skull (without lower jaw), 5 km N of Khawbung, coll. S.S. Saha, 17 December, 1993.

Measurements : External : Nil. Cranial : *on* 126.6; *cb* 123.7; *n* 68.0; *p* 65.0; *mtr* 25.8; *b* 17.3; *apf* 5.5; *zw* 66.8; *iw* 43.7; *d* 35.0.

Distribution : Within the Indian limits, *Hystrix brachyura subcristata* is reported from Nagaland, Manipur. The present specimen, thus, constitutes the first authentic record of this species from Mizoram.

SUMMARY

Callosciurus erythraeus erythrogaster, *Callosciurus pygerythrus janetta*, *Tamias maclellandi maclellandi*, *Mus pahari*, *Niviventer niviventer mentosus*, *Rattus nitidus obsoletus*, *Hystrix brachyura subcristata* have been recorded for the first time from Mizoram, India. Their collection locality, measurements, distribution in India have been appended.

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QUALITATIVE AND QUANTITATIVE STUDIES OF PLANT AND SOIL INHABITING NEMATODES ASSOCIATED WITH RICE CROP IN SIKKIM, INDIA

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INTRODUCTION

Rice is the main cereal crop in Sikkim State of India. The state is divided into four districts, i.e., North, South, East and West. During November, 1984, a random survey was conducted to collect the rice root and soil samples from East, West and South districts in order to study the qualitative and quantitative distribution of nematodes associated with the rice crop in Sikkim. In all, 100 root and soil samples were collected from 36 localities of three districts.

Material and Methods : Permanent slides were made in anhydrous glycerin for species identification. For quantitative estimation of nematodes, the methodology described by Baqri *et al.* (1983) was followed, except that the nematode population was counted per 200 ml of soil and 10 gm of roots from sample.

A. QUALITATIVE STUDY

Upon identification, the samples yielded 19 species of stylet bearing nematodes (mostly parasitic) belonging to 13 genera of the Orders Tylenchida and Aphelenchida (17 and 2 respectively); 20 species of Order Dorylaimida, of which three are ecto-parasitic while others are predaceous or free living; and 7 predaceous species belonging to the Order Mononchida. The species are listed below :

Order TYLENCHIDA Thorne, 1949

1. *Aglenchus fragariae* Szczygiel, 1969
2. *Tylenchorhynchus mashhoodi* Siddiqi & Basir, 1959
3. *Tylenchorhynchus nudus* Allen, 1955

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4. *Quinisulcius capitatus* (Allen, 1955) Siddiqi, 1971
5. *Hoplolaimus indicus* Sher, 1963
6. *Scutellonema brachyurum* (Steiner, 1939) Andrassy, 1958
7. *Helicotylenchus erythrinae* (Zimmermann, 1904) Golden, 1956
8. *Helicotylenchus dihystra* (Cobb, 1893) Sher, 1961
9. *Helicotylenchus egyptiensis* Tarjan, 1964
10. *Meloidogyne graminicola* Golden & Birchfield, 1965
11. *Pratylenchus scribneri* Steiner, 1943
12. *Pratylenchus thornei* Sher & Allen, 1953
13. *Pratylenchus loosi* Loof, 1960
14. *Hirschmanniella gracilis* (de Man, 1880) Luc & Goodey, 1963
15. *Macroposthonia ornata* (Raski, 1958) de Grisse & Loof, 1965
16. *Hemicriconemoides cocophyllus* (Loos, 1949) Chitwood & Birchfield, 1957
17. *Hemicriconemoides brachyurus* (Loos, 1949) Chitwood & Birchfield, 1957

Order APHELENCHIDA Siddiqi, 1980

1. *Aphelenchus avenae* Bastian, 1865
2. *Aphelenchoides* sp.

Order DORYLAIMIDA Pearse, 1942

1. *Laimydorous finalis* Thorne, 1975
2. *Laimydorous coomansi* Baqri, 1991
3. *Labronemella hemicaudata* Baqri, 1991
4. *Eudorylaimus chauhani* (Baqri & Khera, 1975) Andrassy, 1986
5. *Labronema* sp.
6. *Oriverutus sundarus* (Williams, 1964) Siddiqi, 1971
7. *Oriverutus lobatus* Siddiqi, 1971
8. *Opisthodorylaimus cavalcantii* (Lordello, 1955) Carbonell & Coomans, 1985
9. *Aporcelaimellus* spp.
10. *Xiphinema insigne* Loos, 1949*
11. *Xiphinema brevicolle* Lordello & Costa, 1961*
12. *Belondira neortha* Siddiqi, 1964
13. *Dorylaimellus indicus* Siddiqi, 1964
14. *Tylencholaimus pakistanensis* Timm, 1964
15. *Tylencholaimus obscurus* Jairajpuri, 1965
16. *Proleptonchus clarus* Timm, 1964
17. *Tyleptus variabilis* Jairajpuri & Loof, 1966
18. *Dorylaimoides micoletzkyi* (de Man, 1921) Thorne & Swanger, 1936
19. *Dorylaimoides longiurus* Siddiqi, 1965
20. *Paratrichodorus (Atlantodorus) porosus* (Allen, 1957) Siddiqi, 1974*

* Ectoparasites and virus vectors

Order MONONCHIDA Jairajpuri, 1969

1. *Clarkus elongatus* Jairajpuri & Khan, 1977
2. *Mylonchulus hawaiiensis* (Cassidy, 1931) Andrassy, 1958
3. *Paramylonchulus mulveyi* (Jairajpuri, 1970) Jairajpuri & Khan, 1982
4. *Parahadronchus shakili* (Jairajpuri, 1969) Mulvey, 1978
5. *Iotonchus indicus* Jairajpuri, 1969
6. *Iotonchus longicaudatus* Baqri, Baqri & Jairajpuri, 1978
7. *Iotonchus nayari* Mohandas & Prabhoo, 1979

B. QUANTITATIVE STUDY

The results of the quantitative estimation of different parasitic nematode genera and other nematodes from East, West and South districts have been furnished in Table nos. I, II and III respectively.

Table IV provides the comparative information from three districts regarding average percent frequency of occurrence and dominance of important pests in soil and only occurrence from rice roots.

District East Sikkim

The amalgamated results of the quantitative estimation of 41 soil samples collected from 16 localities have been analysed in Table I. The study reveals that the species of the genera *Tylenchorhynchus* and *Helicotylenchus* are most abundant. The results also confirm that *Helicotylenchus* are most abundant. The results also confirm that *Helicotylenchus* spp. (*H. dihystra*, *H. erythrinae*) and *Tylenchorhynchus* spp. (*T. mashhoodi* & *T. nudus*) are the key pests of paddy in East Sikkim because of their high degree of occurrence and dominance. *Meloidogyne graminicola* should also be considered as serious nematode pest because of its presence in almost all the localities, except Samsing, and high degree of dominance in a few samples. *Scutellonema brachyurum* was also recorded. Surprisingly, the *Hirschmanniella* species (rice root nematode) was not recorded.

District. West Sikkim

In all, 42 soil and root samples were collected from 14 localities of district West Sikkim. Table - II provides the frequency of occurrence and dominance of the important pests of the district. The results reveal that *Helicotylenchus* spp. and *Tylenchorhynchus nudus* are the key pest and the potential pest of paddy, respectively, in West Sikkim. The analysis of the soil populations shows that the *Helicotylenchus* spp. and the *Tylenchorhynchus* sp. occur in 81% and 74% samples and dominate over other parasitic species in 64% and 28.5% samples respectively. *Hirschmanniella gracilis*, *Macroposthonia ornata*, *Scutellonema brachyurum* and *Meloidogyne graminicola* have also been estimated but their frequency of occurrence or dominance has been found very low.

District South Sikkim

Only 17 soil and root samples could be collected from six localities of South Sikkim. The results of quantitative estimation of soil samples have been provided in Table - III. The results in this table reveal that the species of the genus *Helicotylenchus* are present in 100% samples with high degree of dominance. Hence, *Helicotylenchus* spp. are the key pest in South Sikkim also. *Tylenchorhynchus nudus* is a potential pest of paddy because of its dominance and occurrence has been calculated 82.3% and 17.3% respectively. The *Meloidogyne graminicola*, *Pratylenchus* spp. and *Macroposthonia ornata* have been found only from a few localities and in a limited number.

Table - IV provides the comparative information regarding occurrence and dominance of important nematode pests of rice in soil as well as roots in East, West and South districts of Sikkim State. This may easily be concluded from the degree of dominance and occurrence that the species of *Helicotylenchus* and *Tylenchorhynchus* are serious and important nematode pests of rice in three surveyed districts.

SUMMARY

During November, 1984, a random survey was conducted so as to know the qualitative and quantitative distribution of plant and soil nematodes associated with rice crop at 36 localities of the following three districts : East Sikkim, West Sikkim and South Sikkim. In all, 100 soil and root samples were collected and processed for the study. The study concludes that species of *Tylenchorhynchus* (*T. mashhoodi* and *T. nudus*) and *Helicotylenchus* (*H. dihystrera*, *H. erythrinae* and *H. egyptiensis*) are most abundant and dominant pests of rice crops in the area. The other important pests are : *Scutellonema-brachyurum*, *Hirschmanniella gracilis*, *Meloidogyne graminicola*, *Pratylenchus* spp. and *Macroposthonia ornata*. However, their frequency of occurrence and degree of dominance was not found alarming, except at few localities. The paper also reports 48 species of the Orders Tylenchida (19 spp.), Aphelenchida (2 spp.), Dorylaimida (20 spp.) and Mononchida (7 spp.).

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TABLE - I

Results of the survey of Rice crop in East district, Sikkim State.
Range of nematode number with its average per 200 ml of soil.
Figures in parenthesis indicate percent frequency of occurrence.

	LOCALITY/VILLAGE				
	Chota Singtham	Aahoo	Namchapong	Samsing	Chalamthang
No. of samples collected	3	2	5	1	3
Nematodes					
1. <i>Tylenchorhynchus</i>	10 : 10 (33.33)	20-20 : 20 (100)	30-120 : 60 (80)	—	90 : 90 (100)
2. <i>Helicotylenchus</i>	20-240 : 90 (100)	40-40 : 40 (100)	20-200 : 96 (100)	20 : 20 (100)	170-270 : 193 (100)
3. <i>Pratylenchus</i>	—	—	—	—	40 : 40 (33.33)
4. <i>Macroposthonia</i>	—	—	150 : 150 (20)	—	40 : 40 (100)
5. <i>Meloidogyne</i>	20-120 : 23 (100)	20 : 20 (100)	20-100 : 53 (60)	—	20-40 : 33 (100)
6. Other dorylaids	100-430 : 220 (100)	100-160 : 130 (100)	210-1280 : 580 (100)	40 : 40 (100)	230-400 : 290 (100)
7. Saprophagous	180-360 : 243 (100)	40-40 : 40 (100)	70-560 : 274 (100)	260 : 260 (100)	120-230 : 183 (100)

Table - I contd.

Results of the survey of Rice crop in East district, Sikkim State.

	LOCALITY/VILLAGE					
	Diling Pachakhani	Pachakhani	Pakyong	Dikling	Mamzoy	Magitar
No. of samples collected	1	3	3	1	2	2
Nematodes						
1. <i>Tylenchorhynchus</i>	—	10-20 : 17 (100)	40 : 40 (33.33)	—	120 : 120 (50)	20-30 : 25 (100)
2. <i>Helicotylenchus</i>	310 : 310 (100)	80-290 : 193 (100)	60-400 : 193 (100)	90 : 90 (100)	40-90 : 65 (100)	100-200 : 150 (100)
3. <i>Meloidogyne</i>	50 : 50 (100)	40-70 : 55 (66.6)	120 : 120 (33.3)	20 : 20 (100)	40 40 (50)	120 120 (50)
4. Other dorylaims	320 : 320 (100)	60-240 : 120 (100)	80-740 : 347 (100)	110 : 110 (100)	170-260 : 215 (100)	40-150 : 95 (100)
5. Saprophagous	330 : 330 (100)	160-500 : 277 (100)	60-540 : 313 (100)	90 : 90 (100)	110-510 : 310 (100)	20-90 : 55 (100)

Table - I contd.

Results of the survey of Rice crop in East district, Sikkim State.

	LOCALITY/VILLAGE				
	Sirwani	Ralap	Singbel	Makha	Bardan
No. of samples collected	5	4	1	4	1
Nematodes					
1. <i>Tylenchorhynchus</i>	140-340 : 230 (80)	40-400 : 167 (75)	180 : 180 (100)	10-60 : 35 (50)	30 : 30 (100)
2. <i>Helicotylenchus</i>	220-980 : 560 (100)	120-820 : 370 (100)	320 : 320 (100)	50-830 : 509 (100)	20 : 20 (100)
3. <i>Macroposthonia</i>	20-80 : 47 (60)	100-500 : 300 (50)	60 : 60 (100)	10 : 10 (25)	10 : 10 (100)
4. <i>Meloidogyne</i>	20-40 : 30 (100)	20 : 20 (25)	260 : 260 (100)	20-80 : 50 (75)	70 : 70 (100)
5. Other tylenchids	20 : 20 (60)	20 : 20 (25)	-	60 : 60 (25)	-
6. Other dorylaims	40-740 : 260 (100)	40-740 : 350 (100)	60 : 60 (100)	180-580 : 312 (100)	590 : 590 (100)
7. Saprophagous	80-880 : 288	100-820 : 295	260 : 260	260-770 : 455	260 : 260

TABLE - II

Results of the survey of Rice crop in West district, Sikkim State.
Range of nematode number with its average per 200 ml of soil.
Figures in parenthesis indicate percent frequency of occurrence.

	LOCALITY/VILLAGE				
	Geyalsing	Gurthang	Kyongsha	Lower Geyalsing	Omchung
No. of samples collected	3	2	3	5	6
Nematodes					
1. <i>Tylenchorhynchus</i>	20-350 : 185 (66.67)	100 : 100 (50)	10-160 63 (100)	20 : 20 (20)	30-1060 : 280 (83)
2. <i>Helicotylenchus</i>	80-140 : 110 (66.67)	100-170 : 135 (100)	70-260 165 (66.67)	20-70 : 38 (80)	100-390 273 (50)
3. <i>Hirschmanniella</i>	—	—	—	—	20-60 40 (50)
4. <i>Macroposthonia</i>	—	—	20 : 20 (33.33)	—	10-20 : 13 (50)
5. <i>Meloidogyne</i>	20 20	—	30 : 30 (33.3)	—	30 30 (16.6)
6. Other tylenchids	—	30 : 30 (50)	—	20 : 20 (20)	—
7. Other dorylaims	40-140 : 86 (100)	170-200 : 185 (100)	150-250 207 (100)	60-320 : 166 (100)	20-280 : 178 (100)
8. Saprophagous	50-690 : 293 (100)	140-200 : 170 (100)	30-260 : 137 (100)	30-360 : 158 (100)	110-280 : 156 (100)

Table - II contd.

Results of the survey of Rice crop in West district, Sikkim State.

	LOCALITY/VILLAGE				
	Legship	Sikip	Ghumoni	Baigunia	Budang
No. of samples collected	1	2	1	2	5
Nematodes					
1. <i>Tylenchorhynchus</i>	40 : 40 (100)	60 : 60 (50)	—	30 : 30 (50)	10-330 : 106 (100)
2. <i>Helicotylenchus</i>	320 : 320 (100)	900-2220 : 1560 (100)	80 : 80 (100)	20-30 : 15 (100)	10-790 : 248 (100)
3. <i>Hirschmanniella</i>	20 : 20 (100)	80 : 80 (50)	—	—	30 : 30 (20)
4. <i>Macroposthonia</i>	20 : 20	—	—	—	—
7. Other dorylaims	120 : 120 (100)	60-280 : 170 (100)	120 : 120 (100)	100-170 : 135 (100)	30-280 : 136 (100)
8. Saprophagous	60 : 60 (100)	280-600 : 440 (100)	260 : 260 (100)	30-60 : 45 (100)	40-330 : 114 (100)

Table - II contd.

Results of the survey of Rice crop in West district, Sikkim State.

	LOCALITY/VILLAGE			
	Upper Budang	Mansari	Daramdim	Tharpu
No. of samples collected	4	1	4	3
Nematodes				
1. <i>Tylenchorhynchus</i>	30-890 232 (100)	10 : 10 (100)	20-50 : 35 (50)	100-220 117 (100)
2. <i>Helicotylenchus</i>	20-80 70 (100)	60 60 (100)	60-190 125 (50)	160-580 : 370 (66.67)
3. <i>Macroposthonia</i>	20 : 20 (25)	10 10 (100)	—	—
4. Other tylenchids	—	—	—	20 : 20 (33.33)
5. Other dorylaims	20-210 : 120 (100)	130 : 130 (100)	80-520 : 282 (100)	180-240 : 200 (100)
6. Saprohagous	10-420 : 215 (100)	140 : 140 (100)	70-1440 : 755 (50)	200-600 : 360 (100)

TABLE - III

Results of the survey of Rice crop in South district, Sikkim State.
 Range of nematode number with its average per 200 ml of soil.
 Figures in parenthesis indicate percent frequency of occurrence.

	LOCALITY/VILLAGE					
	Mamring	Bermoik	Namphing	Raship	Tarku	Tanak Tarku
No. of samples collected	2	3	2	1	6	3
Nematodes						
1. <i>Tylenchorhynchus</i>	140-260 : 200 (100)	40-720 : 447 (100)	30-90 : 60 (100)	120 : 120 (100)	10-60 : 38 (66.67)	20-90 : 55 (66.67)
2. <i>Helicotylenchus</i>	640-800 : 720 (100)	180-940 : 440 (100)	750-860 : 805 (100)	200 : 200 (100)	110-460 : 280 (100)	90-700 : 363 (100)
3. <i>Pratylenchus</i>	90 : 90 (50)	—	—	—	10 : 10 (16.67)	—
4. <i>Macroposthonia</i>	—	10 : 10 (33.33)	—	—	40 : 40 (16.67)	10 : 10 (33.33)
5. Other dorylaims	220-360 : 280 (100)	200-480 : 307 (100)	150-240 : 195 (100)	160 : 160 (100)	120-570 : 270 (100)	60-460 : 213 (100)
6. Saprophagous	180-320 : 250 (100)	80-420 : 353 (100)	120-180 : 150 (100)	360 : 360 (100)	120-500 : 250 (100)	240-840 : 453 (100)

TABLE - IV

Comparative results of the 1984 survey of rice crop in East Sikkim, West Sikkim and South Sikkim.

Range of nematode number (important parasites) with its average per 200 ml and 10 gm roots.

Figures in parenthesis indicate percent frequency of occurrence with dominance in soil/only occurrence in roots.

Name of the district	<u>West Sikkim</u>		<u>South Sikkim</u>		<u>East Sikkim</u>	
	Soil Population	Root Population	Soil Population	Root Population	Soil Population	Root Population
Important Nematodes						
1. <i>Hirschmanniella</i>	20-80 : 42 (14.2 : 0)	—	—	—	—	—
2. <i>Tylenchorhynchus</i>	10-1060 : 147 (74 : 28.5)	40 : 40 (4.7)	10-720 : 160 (82.3 17.3)	40-120 : 80 (23.5)	10-400 90 (63.4 10)	40-120 70 (10)
3. <i>Helicotylenchus</i>	10-2220 : 239 (81.64.2)	40 : 40 (4.7)	90-940 432 (100 83)	40-360 152 (29.4)	20-980 : 207 (100 83)	40-200 96 (20)

REVIEW OF GENUS *METALLOPEUS* MALAISE (HYMENOPTERA : SYMPHYTA : TENTHREDINIDAE) FROM INDIA WITH AN ADDITION OF TWO NEW SPECIES

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INTRODUCTION

Genus *Metallopeus* was erected by Malaise (1934) taking *Tenthredo clypeata* Cameron as its type. Later on, in 1945 while reviewing this genus from South East Asia, Malaise added two new species to it from India. He also shifted two other species to it already described by Wood (1874) and Konow (1907) under different genera. Five new species were added to this genus by Saini and Singh (1990), thus raising the total to ten. In the present text, in addition to the first record of *M. inermis* Malaise, two new species are added. Now this genus is represented by 13 species from India. The types of new species are presently lying with the authors, but will be submitted to IARI, Pusa, National Collections, New Delhi, after this work is published.

REMARKS

This genus takes an intermediate position between *Tenthredo* and *Peus*. However, it can easily be distinguished by the following combination of characters : Body with strong metallic lustre, clypeus very large and flat; circum-inter- and postocellar furrows sharp, lateral furrows deep and sunken; hind orbit bulged and head strongly carinate behind eyes; mesoscutellum acutely pyramidal; posttergite strongly carinate; mesepisternum with strong curved carina anteriorly and below; subapical tooth of claw longer and stronger than apical one; propodeum divided along middle; head embossedly sculptured; mesepisternum rugose; mesosternum strongly microsculptured.

ABBREVIATIONS

AST = Anterior subbasal tooth, Cl = Clypeus, GP = Gonostipes, H = Harpe, IATS = Inner apical tibial spur, ICD = Intercenchri distance, IDMO = Interocular distance at the level of median ocellus, ITD = Intertegular distance, LB = Labrum, LID = Lower interocular distance, MB = Metabasitarsus, OATS = outer apical tibial spur, OCL = Ocello-occipital line, PNS = Parapenis, POL = Postocellar line, PST = Posterior subbasal tooth, VC = Valviceps, VV = Valvura,

Key to the Indian Species of *Metallopeus*

1. Hind orbital carina with trigonal, acutely pyramidal thorn somewhat below half of eye and almost as long as mesosternal thorn. *M. trigon* Malaise
- Hind orbital carina without any thorn. 2
2. Forewing clear. *M. intermis* Malaise
- Forewing entirely infuscated or with an infumated base. 3
3. Postocellar area with shallow middle furrow, punctures on mesonotum similar to those on head. *M. splendidus* (Konow)
- Postocellar area without middle furrow, punctures on mesonotum denser than those on head. 4
4. Anterior margin of clypeus truncate or rounded, not emarginate, median fovea with deep pit in front of median ocellus. 5
- Anterior margin of clypeus slightly roundly emarginate; median fovea without any pit. 6
5. Postocellar area wider than it is long; general colour of head and thorax coppery green with a reddish tinge above, dark blue below; frontal area distinct. *M. kashmiricus* Malaise
- Postocellar area as long as broad; general colour of head and thorax blue; frontal area indistinct. *M. balbiri* sp. nov.
6. Conspicuous tubercle almost as large as median ocellus present in front of median ocellus; head with strong cuperous lustre. *M. tuberculatus* Saini and Singh
- Tubercle in front of median ocellus absent; head without cuperous lustre. 7
7. Postocellar area without distinct longitudinal median carina; mesoscutellum with distinct punctures. 8
- Postocellar area with distinct longitudinal median carina; mesoscutellum with large, shallow and almost confluent punctures. 10
8. Clypeus with broad longitudinal furrow in basal half; postocellar area longer than broad. ..
..... *M. shimlaensis* Saini and Singh
- Clypeus without furrow and postocellar area as long as broad. 9
9. Median fovea with a flat bottom, head shining with distinct punctures; appendage minutely striated; LID : IDMO : EL = 2.0 : 2.8 : 2.3; OOL : POL : OCL = 5.5 : 1.0 : 4.4.
..... *M. mandalicus* Saini and Singh
- Median fovea broad and shallow with a blunt carina in the frontal region; appendage with some large and shallow punctures; LID : IDMO : EL = 2.0 : 2.1 : 1.7; OOL : POL : OCL = 3.5 : 1.0 : 1.5. *M. religiosus* sp. nov.
10. Median fovea distinctly carinate in its anterior 1/3; bulge of the hind orbits not pronounced.
..... *M. malaisei* Saini and Singh

- Bottom of median fovea flat without carina; bulge of the hind orbits strongly pronounced.
..... 11
- 11. Scape of equal width throughout; postocellar area broader than long; body with strong greenish lustre. *M. coccinocerus* (Wood)
- Scape gradually decreasing in width towards base; postocellar area as long as broad; body dull blue without greenish lustre. 12
- 12. Antenna 1.7x head width, frontal ridges indistinct; abdomen without microstriations.
..... *M. clypeatus* (Cameron)
- Antenna 2.1x head width; frontal ridges distinct; abdomen very finely microstriated;
..... *M. kalatopensis* Saini and Singh

***Metallopeus inermis* Malaise**

(Fig. 4)

Female : Length, 16 mm. Body metallic blue except following with strong cuperous lustre; head except labrum and antenna; thorax except mesoscutellum and metanotum. Wings clear, stigma and venation dark brown to black.

Antenna feebly compressed, 1.2x head width; segment 3 and 4 in ratio 3.2; anterior margin of clypeus slightly roundly emarginate in the middle; malar space 1.2x diameter of median ocellus; LID : IDMO : EL = 2.0 : 3.5 : 2.5; OOL : POL : OCL = 5.0 : 1.0 : 3.5; supraantennal tubercles strongly elevated and abruptly cut off from frontal ridges; median fovea deep with an uneven bottom, in front of median ocellus an acutely pointed thorn like tubercle as large as median ocellus; postocellar area flat, slightly broader than long with wide and shallow longitudinal furrow; ITD : ICD = 4. 1: mesosternum with distinct flattened thorns; metabasitarsus shorter than following 3 joints combined; IATS : MB : OATS = 2.0 : 1.7 : 4.5; metafemur shorter than tibia.

Head covered with irregular dense, but shallow punctures mixed with some wrinkles; hind orbit more densely punctured; mesonotum finely and densely punctured with surface smooth and shining; mesoscutellum with punctures more prominent on the posterior slope; appendage with large punctures; propodeum shining, rest of the abdominal terga microstriated.

Female lancet as in fig. 4, with 19 serrulae.

Male : Not known.

Specimen Examined : Female, Hemkunt Sahib, 4400m, 23.7.1992, U.P. Coll. PL-480 team.

Discussion : This species was reported by Malaise (1945) from Tibet, now it represents first record from India. The species can be easily distinguished from all other known species of this genus by having forewing clear.

***Metallopeus balbiri*, sp. nov.**

(Figs. 1, 2, 3)

Female : Length 13 mm. Body metallic blue except for dirty yellowish white labrum. Clypeus, supraclypeal area and head on and around the frontal area give a cuperous shine when seen from an angle. Fore wing distinctly infuscated more towards base, hind wing clear, stigma and venation dark brown to black.

Antenna 1.9x head width; segment 3 and 4 in ratio 4.3; clypeus almost truncate; malar space 1.5x diameter of median ocellus; LID : IDMO : EL = 2.0 : 2.8 : 2.0; OOL : POL : OCL = 3.5 : 1.0 : 2.5; Supraantennal tubercles abruptly cut off from the low lying frontal ridges; median fovea deep with a carina in the anterior half and indistinct in the posterior half; postocellar area flat, as long as broad; ITD : ICD = 3.0 : 1.0; mesosternum with distinct flattened thorns; metabasitarsus shorter than following 3 joints combined; IATS OATS : MB = 2.0 1.0 : 5.0; metafemur shorter than tibia.

Head almost impunctate on and around the frontal area, however, densely, minutely but shallowly punctured on the hind orbit; mesonotum minutely and densely punctured; mesoscutellum distinctly punctured, its appendage with few large punctures; metanotum and scutellum almost impunctate; propodeum with few punctures on its lateral aspects; remaining terga with very fine microsculpture.

Female lancet as in Fig. 3, with 20 serrulae

Male : Length 12 mm. Similar to female except forewing more strongly infuscated, labrum black. Shining character of female (when seen from an angle) missing.

Penis valvae - Fig. 1.

Gonoforceps - Fig. 2.

Holotype : Female, Valley of flowers, 3300m, 23.07.1992, U.P. Coll. PI-480 team.

Paratype 3 females and 3 males with same data as that of holotype.

Discussion This new species can be easily separated from its closely related species *M. kashmiricus* Malaise, on the basis of following combination of characters : frontal area indistinct (distinct in *M. kashmiricus*); colour of head and thorax blue (coppery green with a redish tinge above in *M. kashmiricus*); antennal joints 3 and 4 in ratio 4 : 3 (3 : 2 in *M. kashmiricus*); postocellar area as long as wide (wider than long in *M. kashmiricus*).

Etymology : The species is named after Dr. Balbir Singh, Lecturer, Govt. College Hoshiarpur (Pb.) a Sawfly taxonomist.

***Metallopeus religiosus*, sp. nov.**

Female Length, 10.5 mm. Body blue with metallic lustre except for lustrous green head and thorax. Labrum, yellowish brown. Forewing infuscated towards base, gradually fading towards stigma; hind wing clear; stigma and venation light to dark brown.

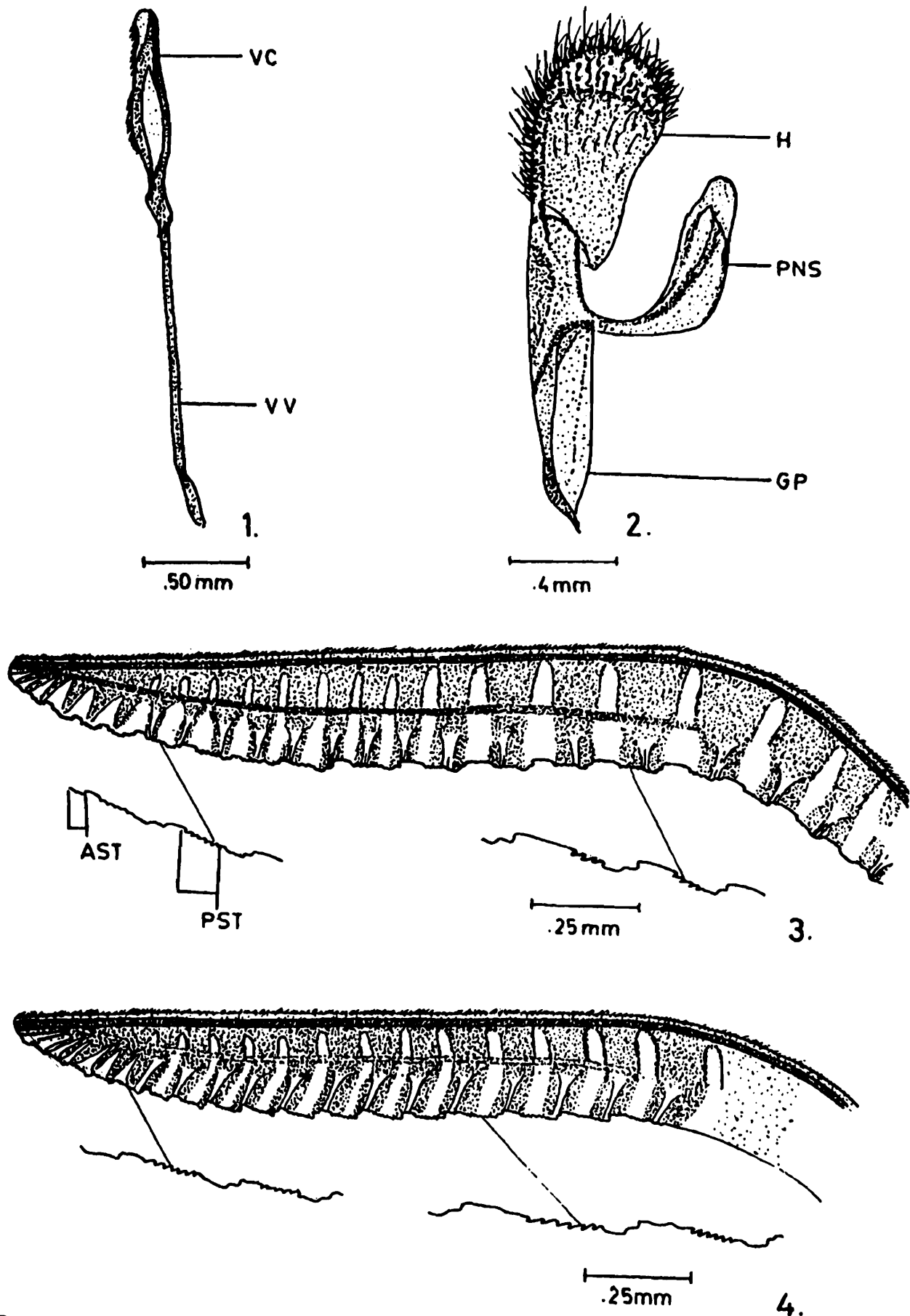


Fig. 1. . Penis valve - *M. balbiri*, **Fig. 2.** Gonoforceps - *M. balbiri*, **Fig. 3.** Lancet - *M. balbiri*, **Fig. 4.** Lancet - *M. internis*.

Antenna 2.0x head width, segment 3 and 4 in ratio 8 : 5; anterior margin of clypeus slightly roundly emarginate; malar space 1.7x diameter of median ocellus; LID : IDMO : EL = 2.0 : 2.2 : 1.7; OOL : POL : OCL = 3.5 : 1.0 : 1.5; frontal area below the level of eyes; supraantennal tubercles raised, sloping backwards and merging with similar frontal ridges; median fovea broad and shallow with blunt carina present in the anterior half and slightly sunken in front of median ocellus; postocellar area subconvex, broader than long in ratio 4 : 5; ITD : ICD = 2.7 : 1.0; mesosternum with long flattened thorns; metabasitarsus shorter than following 3 joints combined; IATS : OATS : MB = 2.0 : 1.7 : 5.0; metafemur shorter than tibia.

Head covered with minute, shallow, indistinct punctures; puncturation on hind orbit more distinct; punctures on mesonotum denser than those on head; mesoscutellum distinctly punctured, its appendage with some large and shallow punctures; metanotum almost impunctate; propodeum shining, remaining terga faintly microstriated.

Note : Unfortunately its female lancet was damaged to such extent that its structure could not be studied.

Male : Unknown.

Holotype : Female, Hemkunt Sahib, 4400m, 23.07.1992, U.P. Coll. PL-480 team.

Discussion : This new species can be separated from its closely related species *M. mandalicus* Saini and Singh 1990, on the basis of following characters : head and thorax with greenish lustre (blue in *M. mandalicus*); median-fovea with a blunt carina in its anterior half (flat in *M. mandalicus*); head covered with minute and shallow punctures (distinctly punctured in *M. mandalicus*).

Etymology : The species is named after its type locality Hemkunt Sahib a religious place.

SUMMARY

Two new species of genus *Metallopeus* Malaise, i.e. *M. balbiri* and *M. religiosus*, from Valley of flowers (330m.) U.P. and Hemkunt Sahib (440m.) U.P. respectively alongwith first record of *M. incermis* Malaise are described and illustrated from India. This genus is now represented by 13 species from India. A revised key is provided for the known Indian species.

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ODONATA (INSECTA) OF PARAMBIKULAM WILDLIFE SANCTUARY, KERALA, INDIA

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INTRODUCTION

The Odonata (Insecta) fauna of India is known by 3 suborders, 17 families, 139 genera and 499 species and subspecies (Prasad and Varshney, 1995). A perusal of literature (Fraser, 1933, 1934, 1936; Peters, 1981; Rao and Lahiri, 1983 and Mathavan and Miller, 1989) reveals that 112 species of Odonata occur in Kerala. Of these, however, only one species viz. : *Epithemis mariae* (Laidlaw) (synonym : *Amphithemis mariae* Laidlaw) is known so far in literature from the Parambikulam wildlife sanctuary (Fraser, 1936). The present study deals with 25 species and subspecies of Odonata belonging to 18 genera and 5 families collected from this sanctuary.

Occupying 285 sq. km. area of the Parambikulam valley between Anaimalai and Nelliampathy hill ranges, the sanctuary lies in the Palakkad district of Kerala between 10°21'-10°32' N lat. and 76°35'-76°51' E long. The types of vegetation found in the sanctuary belong to tropical evergreen and semievergreen forests, moist teak-bearing forests, south Indian moist deciduous forests and riparian fringing forests. The rivers, Karappara, Parambikulam, Thekkadiyar and their tributaries form the drainage system in this sanctuary. The altitudes range from 459m to 1439m above msl.

The material studied forms part of a general faunal collection procured during faunistic surveys conducted in the sanctuary area during 1995, 1996 and 1997. The specimens are deposited in the faunal depository of the Western Ghats Field Research Station, Zoological Survey of India, Calicut.

SYSTEMATIC LIST

- Order : ODONATA
- 1. Suborder : ZYGOPTERA
- 1. Superfamily : COENAGRIONOIDEA
- 1. Family : COENAGRIONIDAE
- 1. *Agriocnemis pygmaea* (Rambur)
- 2. Family : PLATYCNEMIDIDAE
- 2. *Copera vittata deccanensis* Laidlaw

2. Superfamily : CALOPTERYGOIDEA
3. Family : CALOPTERYGIDAE
3. *Neurobasis chinensis chinensis* (Linnaeus)
4. *Vestalis apicalis apicalis* Selys
5. *Vestalis gracilis gracilis* (Rambur)
6. *Vestalis gracilis montana* (Fraser)
4. Family : CHLOROCYPHIDAE
7. *Rhinocypha (Heliocypha) bisignata* (Selys)
2. Suborder : ANISOPTERA
1. Superfamily : LIBELLULOIDEA
1. Family : LIBELLULIDAE
8. *Cratilla lineata calverti* Foerster
9. *Diplacodes trivialis* (Rambur)
10. *Epithemis mariae* (Laidlaw)
11. *Orthetrum pruinatum neglectum* (Rambur)
12. *Orthetrum sabina sabina* (Drury)
13. *Potamarcha congener* (Rambur)
14. *Crocothemis servilia servilia* (Drury)
15. *Neurothemis fulvia* (Drury)
16. *Neurothemis intermedia intermedia* (Rambur)
17. *Neurothemis tullia tullia* (Drury)
18. *Trithemis aurora* (Burmeister)
19. *Trithemis festiva* (Rambur)
20. *Trithemis kirbyi kirbyi* Selys
21. *Palpopleura sexmaculata sexmaculata* (Fabricius)
22. *Rhyothemis variegata variegata* (Linnaeus)
23. *Pantala flavescens* (Fabricius)
24. *Tholymis tillarga* (Fabricius)
25. *Zygonyx iris malabaricus* Fraser

Key to the Odonata of Parambikulam Wildlife Sanctuary, Kerala

Key to the Suborders of Odonata

1. Wings petiolate, sub-petiolate or non-petiolate; discoidal cell in both wings simple, entire or traversed by nervures, closely similar in fore and hind wings. Zygoptera

- Wings never petiolate; discoidal cell in both wings subdivided into a triangle plus supratriangle.
..... Anisoptera

Key to the Superfamilies of Zygoptera

1. Only 2 antenodal nervures present; postnodals in strict alignment with the veins below; IR_{iii} and R_{iv+v} beginning much nearer to the nodus than to arculus. Coenagrionoidea
- Never less than 5 antenodals present; postnodals not in line with the veins below them. ..
..... Calopterygoidea

Key to the families of Coenagrionoidea

1. Discoidal cell short, anterior side considerably shorter than posterior; anal vein separating from wing border at various levels either proximal to, at or distal to the vein Ac; veins MA and IR_{iii} markedly zigzagged for the greater part of their length. Coenagrionidae
- Discoidal cell elongate, anterior and posterior sides subequal, apex rather obtuse; anal vein separating from wing border proximal to Ac; veins MA and IR_{iii} running straight for a greater part of their length, only zigzagged apically or not at all. Platycnemididae

Key to the genus and species of Coenagrionidae

1. Arc situated distal to the level of the distal antenodal nervure; the junction of ab and 1A (medio-anal link) markedly angulated; labrum metallic blue; superior anal appendages longer than inferior. Genus : *Agriocnemis* Selys species : *A. pygmaea* (Rambur)

Key to the genus and species of Platycnemididae

1. Costal and posterior sides of discoidal cell equal or nearly so; second segment of antennae as long as the third; legs bright citron-yellow; the two hind pairs of tibiae slightly dilated; superior anal appendages at least half the length of inferiors; posterior lobe of prothorax of female with a pair of divergent, slender, forwardly directed spines.
..... Genus : *Copera* Kirby species : *C. vittata deccanensis* Laidlaw

Key to the families of Calopterygoidea

1. The primary antenodals indistinguishable from the secondaries; basal antenodals present; vein R_{ii+iii} fused with R_i near its origin; discoidal cell long and traversed by many veins; 1st lateral thoracic suture complete. Calopterygidae
- The primary antenodals easily distinguishable from the secondaries; basal antenodals absent; clypeus produced in the form of a prominent uptilted snout; tibiae of males often dilated or brightly coloured. Chlorocyphidae

Key to the genera of Calopterygidae

1. Arc angulated; basal space traversed; sectors of arc separated at origin; main sectors not forked; Pterostigma absent in male, false or absent in female; fore-wings of both sexes hyaline; hind-wings opaque or hyaline. *Neurobasis* Selys
- Arc oblique, not angulated; basal space entire; sectors of arc arising from a single point; most main sectors forked; Pterostigma absent. *Vestalis* Selys.

Key to the species of *Neurobasis* Selys

1. Thorax brilliant metallic green; humeral and antero-lateral stripes blackish-brown in male; humeral and lateral sutures finely white with black borders in female; all wings of female with an opaque creamy yellow patch at node which usually covers one cell distal to node.
..... *N. chinensis chinensis* (Linnaeus)

Key to the species of *Vestalis* Selys

1. Tips of wings black; labrum yellow, marked with black. *V. apicalis apicalis* Selys
- Tips of wings hyaline; wings tinted variably, not uniformly with greenish yellow. 2
2. Two rows of cells between origins of Cu₁ and 1A; 3-4 rows of cells between 1A and the posterior margin of the wing. *V. gracilis gracilis* (Rambur)
- Only a single row of cells separating 1A and Cu₁; 3-4 rows of cells between 1A and the posterior margin of wings as in *V. g. gracilis*. *V. gracilis montana* (Fraser)

Key to the genus and species of Chlorocyphidae

1. Sectors of arc separated at origin; pterostigma present in fore-wings of both sexes; hind-wing nearly of equal width as fore-wing and not broader; in male, nearly apical third of fore and hindwings opaque; a single row of vitreous spots; in female, wings entirely hyaline tinted palely with yellow and apices narrowly enfumed; mesothoracic triangle extending from one-third to half-way up dorsum.
..... Genus : *Rhinocypha* subgenus : *Heliocypha* species : *R. (H.) bisignata* (Selys)

Key to the Superfamily of Anisoptera

1. Discoidal cell differing in size and shape in fore and hind-wings, that of fore-wing situated far distal of the arc; costal and subcostal antenodal nrvure coinciding; the robust primary antenodals absent; middle lobe of labium very small, not fissured, broadly overlapped by the lateral lobes. *Libelluloidea*

Key to the family of Libelluloidea

1. Tibiae of male without keels; bases of hind-wing rounded in both sexes; body usually coloured non-metallic; sectors of arculus fused at their origin and arising from a common stalk; primary antenodals absent. Libellulidae

Key to the genera of Libellulidae

1. Claw hooks equal in length to claws, which thus appear bifid; thorax metallic. *Zygonyx* Selys
- Claw hooks shorter than claws and arising from about middle of latter; thorax rarely metallic. 2
2. Borders of anal loop running on to meet posterior border of wing, apex of loop open; abdomen broad at base, then tapering gradually to the end; male with an opalescent white spot in centre of hindwing which is absent in female. *Tholymis* Hagen
- Borders of anal loop converging and meeting before posterior border of wing, apex of loop closed. 3
3. Distal antenodal nervure in fore-wing complete. 4
- Distal antenodal nervure in fore-wing incomplete. 6
4. Lobe of prothorax large and fringed with long hairs; frons non-metallic above, never less than 12 antenodal nervures in fore-wing. *Orthetrum* Newman
- Lobe of prothorax small, inconspicuous and usually naked. 5
5. Only 1 cubital nervure in all wings, anal loop very long and overlapping distal end of discoidal cell. *Cratilla* Kirby
- More than 1 cubital nervure in hind-wing, anal loop very short, of not more than 6 cells; discoidal cell in fore-wing entire. *Epithemis* Laidlaw
6. Lobe of prothorax large and fringed with long hairs; Cuii arising from posterior angle of discoidal cell in hind-wing; borders of discoidal field in fore-wing diverging widely at wing border. 7
- Lobe of prothorax small, usually naked. 8
7. Discoidal cell in hind-wing entire; costal border of fore-wing straight; frons non-metallic above; discoidal field in fore-wing beginning with a row of 2 cells. *Diplacodes* Kirby
- Discoidal cell in hind-wing traversed; costal border of fore-wing sinuous near base; frons metallic above; discoidal field beginning with at least 3 rows of cells. *Palpopleura* Rambur

8. Sectors of arc in fore-wing separated and diverging at origin; body very dark metallic; frons metallic above; discoidal field in fore-wing with borders parallel or strongly converging at wing border; wings generally broadly coloured black or black and golden amber. *Rhyothemis* Hagen
- Sectors of arc in fore-wing arising from a common and rather long stalk. 9
9. Discoidal field with borders converging strongly at wing margin. 10
- Discoidal field with borders parallel or widely divergent at wing margin. 11
10. Discoidal cell in fore-wing very narrow, its costal side only about one-fourth to one-third the length of basal; a conspicuous supplementary nervure, IR_{II} present between R_{II} and R_{III} *Pantala* Hagen
- Discoidal cell in fore-wing broader, its costal side about one-half the length of basal; no supplementary nervure IR_{II} present between R_{II} and R_{III} *Trithemis* Brauer
11. Wings coloured amber-yellow at base or more broadly dark reddish-brown, and often with a development of close secondary reticulation, especially proximal to node; more than 1 cubital nervure in all wings. *Neurothemis* Brauer
- Wings usually uncoloured or with but a small basal yellow marking in hind-wing; no secondary reticulation in the wings; only 1 cubital nervure in all wings. 12
12. Red or ochreous species; face and frons red; wings with yellow markings at extreme base. *Crocothemis* Brauer
- Variably coloured and darker species; never or only partly red or ochreous; arc situated between the first and second antenodal nervures; 2 rows of cells between IR_{III} and $R_{spl.}$ *Potamarcha* Karsch

Key to the species of *Cratilla* Kirby

1. Wings hyaline, apices sometimes tipped with brown but never with black; thorax non-metallic. *C. lineata calverti* Foerster

Key to the species of *Diplacodes* Kirby

1. Adults black, marked with yellow or pruinosed dark-blue throughout; wings uncoloured except at base with a minute yellow point in cubital space of hindwing. *D. trivialis* (Rambur)

Key to the species of *Epithemis* Laidlaw

1. Abdomen ruby-red at base; discoidal field beginning with only a single row of cells. *E. mariae* (Laidlaw)

Key to the species of *Orthetrum* Newman

1. Coloured violaceous-red, reddish brown or dull ochreous; discoidal cell in hind-wing 2 celled.
..... *O. pruinatum neglectum* (Rambur)
- Coloured brown or black with yellow markings; abdomen enormously swollen at base and then abruptly slimmed and compressed laterally to the end. *O. sabina sabina* (Drury)

Key to the species of *Potamarcha* Karsch

1. Wings hyaline with extreme apices tipped with brown in adults, but the costal area of both wings tinted with pale yellow in sub-adults; distal antenodal nervure of fore-wing incomplete.
..... *P. congener* (Rambur)

Key to the species of *Crocothemis* Brauer

1. Eyes but shortly contiguous; usually 9 1/2 to 10 1/2 antenodal nervures in fore-wing; bases of wings with amber-yellow marking in male, paler in female. *C. servilia servilia* (Drury)

Key to the species of *Neurothemis* Brauer

1. Wings dark reddish-brown from base to about middle of pterostigma; apex of wings also narrowly opaque brown to partly enclose a clear window in each wing at apex.
..... *N. fulvia* (Drury)
- Wings golden-yellow at base, not very sharply defined and rather pale in colour; costal border of wings pale yellow to as far as pterostigma; a pale brown humeral stripe on thorax.
..... *N. intermedia intermedia* (Rambur)
- Base of wings of male broadly black and the black basal area edged outwardly with an opalescent white band; base of wings of female, to as far as two or three cells distal to node bright amber-yellow and subcostal space from base of wing to node blackish-brown broadening at node into a very large blackish brown spot which traverses wings nearly to posterior border.
..... *N. tullia tullia* (Drury)

Key to the species of *Trithemis* Brauer

1. Thorax and abdomen bright vermilion - red; base of hind-wing bright orange; neuration yellow.
..... *T. kirbyi kirbyi* Selys
- Thorax and abdomen violaceous-black; base of hind-wing with a small dark brown spot; neuration black. *T. festiva* (Rambur)
- Thorax and abdomen violaceous-crimson; base of hind-wing with a small reddish-brown spot; neuration crimson. *T. aurora* (Burmeister)

Key to the species of *Palpopleura* Rambur

1. Wings hyaline, marked with black or blackish-brown; fore-wing with a black spot at node covering from 1/2 to 1 1/2 cells proximal to node.
..... *P. sexmaculata sexmaculata* (Fabricius)

Key to the species of *Rhyothemis* Hagen

1. Wings marked with black only or with black and brown with metallic reflex; wings widely different in the sexes; male with whole of wings tinted yellow; fore-wings with spots at node, discoidal cell, apex and at middle of Riii; hind-wing with similar dark spots and two broad longitudinal basal bands; female with broader, shorter wing; fore-wing hyaline from node to apex, basal half with broad black markings, hind-wings with broad irregular markings to as far distal as pterostigma, apex hyaline. *R. variegata variegata* (Linnaeus)

Key to the species of *Pantala* Hagen

1. Wings hyaline with base of hind-wing in male pale golden-yellow as far distal as anal loop and with a narrow apical brown spot limited to posterior border of wing; wings in female often evenly more or less deeply enfumed and without the apical brown spot.
..... *P. flavescens* (Fabricius)

Key to the species of *Tholymis* Hagen

1. Wings hyaline, with a broad fan-shaped smoky, golden-brown fascia extending from node to base of hind-wing bordered distally by a broad oval opalescent white spot about 4 cells deep in male; in female, the golden brown fascia very pale, obscure and the opalescent white spot wanting. *T. tillarga* (Fabricius)

Key to the species of *Zygonyx* Selys

1. Thorax with only a small round yellow spot at lower part of humeral region; mid-dorsal spot on segment 7 scutellate, broadening apically. *Z. iris malabaricus* Fraser

DISTRIBUTION OF ODONATA IN PARAMBIKULAM WILDLIFE SANCTUARY

Based on the specimens examined, the collection data depicting the distribution of each species in different localities of Parambikulam wildlife sanctuary is presented in Table. 1.

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Names of species & Dates of collection	Localities														
	A						B	C			D				
	i	ii	iii	iv	v	vi	vii	viii	ix	x	xi	xii	xiii	xiv	xv
14. <i>Crocothemis s. servilia</i> 27.x.1995								1M							
15. <i>Neurothemis fulvia</i> 29.i.1997, 23.i.1997, 24.iii.1997 3.xi.1995, 20.iii.1996, 5.xi.1995						1F		1M		1F	2M,2F	1F			
16. <i>Neurothemis i. intermedia</i> 23.i.1997								1F							
17. <i>Neurothemis t. tullia</i> 14.iii.1996			1M,1F												
18. <i>Trithemis aurora</i> 2.xi.1995, 3.x.1995, 3.xi.1995 5.xi.1995, 6.xi.1995					1M				1M		2M,1F	2M			1M,1F
19. <i>Trithemis festiva</i> 30.iii.1997														3M	
20. <i>Trithemis k. kirbyi</i> 23.i.1997								1F							
21. <i>Palpopleura s. sexmaculata</i> 22.iii.1997, 3.xi.1995					3F						1F				
22. <i>Rhyothemis v. variegata</i> 29.x.1995, 20.iii.1996		2F									1M,1F				
23. <i>Pantala flavescens</i> 17.iii.1996, 30.iii.1997							1M							1M	
24. <i>Tholymis tillarga</i> 29.x.1995		1F													
25. <i>Zygonyx iris malabaricus</i> 31.x.1995	1M														

A-D : Forest Ranges

i-xv : Collection sites

M : Male

F : Female

A - Sungam,

i - Kamathalachi,

vi - Thellickal,

xi - Orukomban,

B - Karimala,

ii - Sirkarpathy,

vii - Karimala,

xii - Muthuvarachal,

C - Parambikulam,

iii - Cheechali,

viii - Venkoli,

xiii - Pezhakunnu,

D - Orukomban.

iv - Peruvaripallam,

ix - Anchupoola,

xiv - Pulickal,

v - Thunakadavu

x - Parambikulam

xv - Muthalakayam

LIMNOLOGICAL INVESTIGATION AND DISTRIBUTION OF MICRO AND MACRO INVERTEBRATES AND VERTEBRATES OF FOX SAGAR LAKE, HYDERABAD

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INTRODUCTION

The demand for the proper management of inland water resources has increased with the increase of population and industrialisation. India abounds in confined water bodies but majority of these remain neglected, or if cultivated, not effectively managed and exploited. Effective management of the impounded water requires continuous monitoring and limnological surveillance to predict ecological alterations for the efficient water utilisation for agriculture and aquaculture.

In India, pioneering efforts on limnology of impounded water were initiated by Ganapati (1940) and by Madras State Fisheries Department (Raj, 1941). Later on a number of publication on the limnology of freshwater of India have appeared. Rao and Govind (1964), Hussainy (1967), Vasist (1968) and others investigated different limnological aspects of impounded water in India. Sreenivasan (1964, 65, 66) made an extensive study on the limnology of freshwater impoundments in Tamilnadu in relation to productivity. Notable contributions towards the limnology of freshwater around Hyderabad are those of Zafar (1966, 1986), Venkateswarulu (1969), Senayya (1971), Reddy et.al. (1986) and others. Most of these contributions are confined to the ponds, rivers, streams or manmade lakes covering different dimensions.

Hyderabad district of Andhra Pradesh is located at the centre of the Deccan plateau of the subcontinent, and lies approximately between 18°30' and 18°20' North latitude and between 77°30' 79°30' East longitude. The district is largely hilly and sparsely wooded. The Ananthagiri hill range straddles the district from Mahaboob Nagar border in the south to Darur area in Vicarabad taluk in the north. The hill range, mainly of high-grade laterite and in addition isolated hillocks and massive boulders are the characteristic of the district.

The chief river of the district is Musi, which rises from the hills of the adjacent Medak district and flows from west to east in the city limits. Two reservoirs namely Osman sagar across river Musi and Himayat sagar across river Esi (a tributary of river Musi) are situated close to the city. These two reservoirs are the main drinking water source of the city. In addition, a vast water body, namely, Husain sagar is located between the twin cities of Hyderabad and Secunderabad. Apart from these, quite a large number of tanks and smaller water bodies are located in the district of which several are maintained by the State Fisheries Department as nursery and stocking ponds.

In view of the expansion of the city limits forming industrial belts and residential localities, the size of many smaller water bodies have become non existent in recent years.

GEOLOGY

Hyderabad district is generally surrounded by rocky hills made mostly of granites of relatively fresh rock and the rocks are exposed all over the district (518 – 628 m above msl). Patches of low lying flood plains formed by the river Musi and Husain sagar streams are located in the city limits. Granites form the archean crystalline complex consisting of porphyritic, equigranular massive banded and streaky with erratic distribution of pegmatite veins. These granites contain Quartz, Felspar frequently giving rise to sandy plains with poor soil but rich in alkalies. In addition to granites, banded gneisses, megmatites, pegmatites, quartz veins and dolerite dykes are common in the district. A little alluvial land fit for cultivation with only wide expanse of undulating granite country and rocky knoll are present in many parts of the district.

Major soil groups of the district is the red earth comprising of loamy sands (Dhaba), sandy loams (Chalk) and sandy clay loams. The thickness of the soil cover range down to 1.5 m in the case of laterite and sandy clay loams and to 5 m in the case of alluvial black soil. The analysis of soil suitability of the district reveals that the soil is highly permeable and excessively drained, the application of the organic manures, tank silt, compost is recommended to improve its water holding as well as productive capacity.

CLIMATE

Data on solar radiation compiled by the Smithsonian Institute of USA indicates that Hyderabad is located in a region, whose radiation gain is to the tune of 3.9 g/cm/m in the months following August. From February onwards, the radiation gain gradually decreases till it completely balances against the radiation loss, in July. If biological function is taken as a function of radiation gain, Hyderabad could be regarded as continuously productive throughout the year (Zafar 1968). The study area falls in the semi arid region of the Deccan plateau and enjoys a tropical climate, being warm and dry in most part of the year.

Atmospheric temperature at Hyderabad is consistently high and varies slightly in the annual cycle. From about the mid February, the maximum and minimum temperature begins to increase steadily, May is the hottest month, with a mean daily temperature of 39.6° Celsius. During April and May, before the onset of monsoon, the day temperature often raches 40° Celsius and above. With the onset of southwest monsoon in mid June, a gradual drop in the temperature is noticed. December is the coldest month in the area with a mean daily maximum of 28.6° Celsius and mean daily minimum temperature of 13.6° Celsius. The diurnal range of temperature becomes narrower in the rainy season of June to September.

Hyderabad district is situated at a distance of about 265 km from the eastern seacoast, as a result, the marine climate becomes gradually peninsular, and the air becomes drier and the amount of rainfall decreases. The district is further situated in the interior rainfall region of the Indian peninsula and experiences a single south-west monsoon setting in the month of June, reaches its peak during August – September. Long term averages of rainfall in the district varies from 672

to 800 mm/year of which 70% is received from the south-west monsoon, with an average of 48 rainy days/year. Variation from the long term averages are also not uncommon i.e., high values (1380 mm), or scanty rainfall leading to drought (600 mm/year), thus making it an atypical rainfall year.

Like most other meteorological parameters, wind direction and velocity show a regular seasonal pattern. It is generally light to moderate with some increase in velocity during southwest monsoon. During post monsoon months and winter, wind is generally light and variable in direction in the morning hours and mostly north-easterly to easterly in the afternoon, however, during the months of January to March the direction being easterly to south eastern. Land breezes, local winds and squalls in the vicinity of thunderstorms with a speed of 50 – 75 km/hour and wind speed covering a large area controlled by prevalent synoptic situation with a speed over 40 km/hour are absent in the area.

The annual mean relative humidity at Hyderabad is 55.5 percent; one of the reasons for such a low percentage is due to the semi-arid condition prevailing in the area. The maximum and minimum relative humidity at Hyderabad is respectively 86% in the month of September and 19% in the month of April. The summer is the driest part of the year, the humidity generally between 30 – 35% in the afternoon hours.

The rate of evaporation is dependent on both temperature and humidity of the atmosphere as well as wind stress on the water surface. It has been estimated that the present rate of evaporation at Hyderabad is around 2172 mm/year, which gives a daily average of 6 mm.

FOX SAGAR LAKE

Fox Sagar Lake commonly known as Jeedimetla tank is an impoundment specially constructed for the purpose of irrigation in the year 1897 by the then rules of Hyderabad. It is situated one kilometer west of Hyderabad – Nizamabad road at a distance of 15 km from the Hyderabad City. The lake is mainly rainfed with a total catchment area of 47 sq. km. The gross capacity of the lake is ten million cubic meters when full, the details of the lake is in the Table-1. The lake holds water throughout the year but the level decreases from the month of October due to letting out of water for irrigation. Lake is open on all three sides; littoral region is shallow and retains water throughout. The catchment area has vegetable fields, grape gardens and some agricultural lands cultivating dry crops like Jowar, maize etc. Jeedimetla Industrial Estate, one of the fast growing industrial belts is coming up with in a kilometer radius and therefore, the suburban growth depends for its water requirement on the lake in future. Furthermore, the lake is used for fishery purpose by the local fisheries department and all major carps; *Tilapia* and *Channa* species are stocked for breeding and culturing. In recent years, the lake margin is utilised as dumping ground for the city garbage, and brick making industry, as a result of this anthropogenic activity in the lake vicinity, water quality deterioration is noticed affecting the biota of the lake ecosystem.

Table-1. Technical details of Fox sagar lake, Hyderabad.

1. Volume	: 10 million m ³
2. Full tank level	: 568.8 m msl
3. Maximum water level	: 569.8 m msl
4. Tank bund level	: 570.0 m msl
5. Sill level	: 558.5 m msl
6. Top bund width	: 3.6 m
7. Free catchment area	: 6.5 sq. km
8. Integrated catchment	: 40.0 sq. km
9. Total catchment area	: 46.5 sq. km
10. Maximum flood discharge	: 194.6 m ³ /sec.
11. Settled ayacut	: 128.7 Ha
12. Length of the canal	: 1.5 km

MATERIAL AND METHODS

Water samples were collected from three sampling stations on the littoral regions of the lake as in Figure-1. Monthly samples were collected for a period of two years at regular intervals between 9 am to 12 noon. Air and water temperature was recorded by using Elico Water Analysis Kit, pH by portable pH meter (Systronics, pH ep make) in the field and in the laboratory. Analysis of dissolved oxygen (Modified Winkler's method), carbondioxide, carbonate, bicarbonate, chloride, calcium, magnesium hardness, total dissolved solids, specific conductance, nutrients such as phosphate, nitrate, sulphate were estimated as per methods in Standard Methods for Examination of Water and Waste Water, A P H A 17th edition, (1985) and results are expressed in mg/l unless otherwise mentioned. Seasonal observation on the transparency using Secchi disc and productivity of the lake using dark and Light Method were undertaken during the investigation.

Plankton samples were collected from three sampling stations of the lake with the help of plankton nets of suitable mesh size. 40 litres of water was filtered through these nets at the sampling stations to obtain individual representatives. Suitable preservative was added and for phytoplankton a drop of Lugol's Iodine was used for better preservation of plankton material. Qualitative analysis of the plankton was made by sweeping the plankton net back and forth covering a maximum part of the sampling station. Estimation of absolute planktonic densities were made by using "Sedgewick Rafter Cell" under Stereo binocular microscope (Carl-Seiz, Technival – II) after preservation. Enumeration of phytoplankton was made by employing drop method under binocular microscope of 40X objective and 10X eyepiece. An average of three counts was taken for each sample and the mean was calculated for both zooplankton and phytoplankton. With the mean value of the concentration, the total count per litre was calculated and annual percentage was taken. The bottom macrofauna were collected with the help of dredges

and brought to the laboratory, washed in enamel trays, in order to get benthic samples and finally sorted and preserved. Periphyton communities were collected directly from the macrophytic vegetation by scraping and by handpicking.

WATER QUALITY PARAMETERS

Monthly variation in the surface water temperature at three sampling stations of Fox sagar presented in the table agrees with the general temperature pattern of other water bodies of similar meteorological conditions (Munawar 1970; Seenayya 1971). The water was clear generally during summer and winter months and muddy during monsoon, due to surface run-off from the adjacent agricultural land and brick industry. Transparency of the water recorded with Secchi disc indicated minimum during monsoon (Zsd – 62 cm) and maximum during winter (Zsd 1.65 m) with an annual average of 1.02 m.

The hydrogen ion concentration (pH) of the surface water at all sampling stations of the lake throughout the period of investigation was found to be in the alkaline range and the value varied between 7.2 to 9.8. The difference between surface and bottom layers of the lake was comparatively low varying between 0.3 – 0.5 unit. Carbon dioxide content was found to vary between nil to 58 mg/l indicating the presence of carbonate and bicarbonate in varying proportions. In vertical profile of water, carbon-dioxide was found to increase with the depth indicating the biogenic activity of the lake ecosystem. Relationship of pH, carbondioxide and bicarbonate in general was in agreement with the findings of Gonsalves and Joshi (1946), Rao (1953), Lakshminarayana (1965), Sreenivasan (1968), Seenayya (1971). Of all the chemical substances in natural water, oxygen is one of the most significant parameter, as it is essential for the existence of all forms of life, and also an important indicator of lake ecosystem. Dissolved oxygen varied between 1.5 – 8.6 mg/l during the period of study in surface layers, bottom layer exhibiting varying amount during different seasons. Peaks of dissolved oxygen were different in different years and fluctuation thus noticed was due to photosynthetic activity of phytoplankton and macrophytes.

Based on the work of Brown, Skongstad and Fishman (1970), the lake water in general are moderately hard to hard and in the present study the total hardness varied from 84 – 384 mg/l at different sampling stations. Variation in vertical and horizontal profiles of water was not much appreciable in quantity. Chloride content of the lake water, which is indicative of the extent of pollution entering into it from animal and plant refuse from the catchment area, varied between 38 – 132 mg/l with no appreciable variation in surface and sub surface layers. Specific conductance of the surface water indicates the ionic composition and the values obtained from different sampling stations are presented in the figure. The highest recorded was in the range of 1282 Uho/cm² in the month of January and minimum (400 Umho/cm²) was in the month of May. The key chemical nutrient promoting the growth of plants and animals are in different soluble forms of phosphorous and nitrogen, the values so obtained was in the range of 0.8752 – 1.0876 mg/l and 0.8764 – 2.162 mg/l respectively indicating the productivity of the lake, which can sustain a rich growth of algal population.

SEASONAL AND DIURNAL VARIATIONS

Seasonwise data of the various parameters according to the depth of the lake clearly indicates that the thermal stratification was not much significant, however, during summer months the thermal difference was in the range of 1.5 – 1.8 degree Celsius in the samples collected during midday indicating that the lake is not homothermal but a thermal gradient does exist in Fox sagar. Transparency varied again with the season, the lowest during the month of monsoon and highest during winter. Free carbondioxide was limited to morning and late night hours and further increase in carbondioxide content from surface to bottom layer was well marked. Presence of carbondioxide during summer months, according to Singh (1983) is related to the surplus release during rapid decomposition of the organic matter in the sediments owing to the low depth, greater intensity and longer duration of sunlight and ultimately more heat budget in the system. Changes in the alkalinity over 24 hours showed an increase normally in the early hours (07 am) in the bottom samples and 11 am in the surface and gradual decrease in the late afternoon. The water was mainly bicarbonate type, with a limited presence of carbonate, pH in the range of 7.5 – 8.6, a gradual increase in the bicarbonate and carbondioxide in deeper layers are indicative of higher values for the lake during to summer months. According to Welch (1975), increase in bicarbonate in summer months is due to the decomposition of organic matter in the sediments.

Dissolved oxygen concentration showed a definite trend with a peak at 15 hours and minimum before sunrise. Percentage saturation varied between 22.16 – 114 percent in surface and 19 – 71 percent in deeper layers. Lower values in the early hours and during night could be attributed to the respiration and higher values during the day to the photosynthetic activity. Furthermore, utilisation of oxygen in deeper layers for the formation of bicarbonate may also be the reason for their limited availability as described by Hutchinson (1957). Calcium and magnesium ion of the lake water remained almost uniform throughout the day and the hardness ranged from 75 – 320 mg/l, the surface water exhibiting more than that of deeper layers. Chloride content was in the range of 40 – 108 mg/l again deeper layers exhibiting lower values. Dissolved nutrients, Nitrate-nitrogen was in the range of 0.8764 – 2.162 mg/l and soluble phosphorous from 0.8752 to 1.0876 mg/l. Values of nutrients may not indicate the low productivity, but perhaps a high productivity due to the rapid assimilation of available nutrients by the luxuriant growth of macrophytes in the lake. The inconsistency in the ionic composition of the lake investigated show that they are subjected to the maximum anthropogenic activity. On the basis of available cations and anions, the lake water was clearly in the hardwater range and judging from the availability of calcium, nitrate-nitrogen, phosphate and humus formed by the senescent macrophytic vegetation, Fox sagar fits into the eutrophic category.

ANNUAL HEAT BUDGET OF THE LAKE

Annual heat budget of the lake is the measure of heat energy input from the lowest heat content during the winter to the greatest heat content during summer, thus it is the annual heat gain in the system. Heat budget of the lake is calculated by using the formula (Lind, 1975).

$$Q_{ba} = z (T_s - T_w)$$

Wherein z = mean depth, T_s and T_w are the maximum summer mean and the minimum

winter mean temperature and the values of the heat budget are expressed in $C/Cm^2/Year$. On the basis of the above formula, the heat budget of Fox sagar have been $1125/C/Cm^2/year$.

BIOLOGICAL PARAMETERS

Lakes of south India resemble some of the tropical counterpart in sustaining rather dense population of phytoplanktons all the year round and the seasonality of the phytoplankton is more obviously and intimately related to temperature changes (Zafar 1986). Ecological details of various orders of phytoplankters and factors affecting their distribution in the lakes of Hyderabad under different trophic status has been studied by Seenayya and Zafar (1979), Rao (1979), Zafar (1986) and others. Seasonality of freshwater phytoplankton is presented in the figures.

Myxophyceae : *Anabaena*, *Oscillatoria*, *Lyngbya*, *Spirulina*, *Microcystis* are the most important myxophycean members of the lake. *Oscillatoria* and *Microcystis* recorded throughout the year and their abundance increased from the month of December to March. *Spirulina* and *Lyngbya* species appear in larger percentage during summer months of February to March, thus indicating their distribution is related to temperature, this is in conformity with the observation made already by Zafar (1986).

Chlorophyceae : In comparison to other groups of phytoplanktons, chlorophycean members exhibit greater diversity but with a limited abundance. Seasonality also varies to that of myxophycean members, their number show relative abundance during pre-monsoon and monsoon periods and the highest concentration was noticed during the months of September and October. The filamentous forms such as *Spirogyra* and *Hydrodictyon* are distributed during the months of January to May in patches of water columns but the desmids such as *Staurostrum*, *Selenastrum*, *Closterium*, *Cosmarium*, *Scenedesmus* dominated during the pre monsoon, monsoon and post monsoon months. *Chara* species found to flourish well throughout the year except for the month of March to May. *Volvox globator*, is the only species among the chlorophycean members dominating the summer months.

Bacillariophyceae : Diatoms dominated the winter months of December to February. In comparison to Chlorophycean members, diatoms are represented by five genera, however, the percentage composition of the group on the higher side.

MACROPHYTES

Aquatic macrophytes provide extreme simple, cheap and efficient way of treating waste water to decrease the nutrient content and in this regard many of the macrophytes can remove a number of pollutants and heavy metals (William, 1983). Macrophytes also constitute a significant biotype of the aquatic ecosystem and the trophic level of the food chain from aquatic to terrestrial life. It was also found that the macrophytic vegetation of the lake harbors a considerable number of cladocera, copepoda, rotifera, insect and Insect larvae, crustaceans, molluscs and fishes offering food, shelter or other benefits to these groups directly or indirectly. One of the striking feature of the lake is the total absence of floating plants belonging to the family Nymphaeaceae (*Nymphaea*, *Nymphoides*) and *Nelumbo* species; family : Araceae (*Pistia* sp.); family : Pontederiaceae (*Eichhornia crassipes*), the last mentioned has invaded all other major ponds, lakes and tanks of

Hyderabad. From the list of macrophytic vegetation harbouring the lake, *Jussiea* was found in patches during summer months and submerged vegetation of *Ceratophyllum*, *Chara* and *Hydrilla* found throughout the year at all places. The marginal amphibious species of *Polygonum*, *Cyperus*, and *Paspalidium* were found occasionally submerged during monsoon months.

Table-2. Macrophytic vegetation of Fox sagar, Hyderabad.

Submerged species :

1. <i>Ceratophyllum demusrssum</i> (L.)	Ceratophyllaceae
2. <i>Hydrilla verticillata</i> (L.)	Hydrocharitaceae
3. <i>Blyxa octandra</i> (Roxb.)	Hydrocharitaceae
4. <i>Potamogeton crispus</i> (L.)	Potamogetanaceae
5. <i>Chara</i> sp	Characeae (Algae)

Marginal Amphibious species :

6. <i>Jussiea repens</i> L.	Onagraceae
7. <i>Polygonum glabrum</i> L.	Polygonaceae
8. <i>Cyperus platystylis</i>	Cyperaceae
9. <i>Paspalidium germinatum</i> (Forsk)	Poaceae
10. <i>Marselia quadrifolia</i> L.	Marseliaceae

Marginal Terrestrial Species :

11. <i>Amarantahus spinosus</i> L.	Amaranthaceae
12. <i>Tridax procumbens</i> L.	Poaceae
13. <i>Croton bonplandianum</i> Baill	Euphorbiaceae
14. <i>Argemone maxicana</i> L.	Argemonaceae
15. <i>Cassia fistula</i> L.	Caesalpeniaceae
16. <i>Acanthospermum</i> sp	Acanthaceae

Table-3. Phytoplankton composition of Fox sagar, Hyderabad**MYXOPHYCEAE**

1. *Lyngbya gracilis* (Menegh) Raben
2. *Anabaena sphaerica* Bornet et. Flahault
3. *Spirulina major* Zanard et. Gomant
4. *Microcystis aeruginosa* Kurtz.
5. *Oscillatorca* sp.

CHLOROPHYCEAE

6. *Vovox globator*
7. *Hydrodictyon reticulatum* (L.) Lagerh
8. *Senedesmus quadricauda* var *longispina* (Chodat) Smith
9. *Senedesmus quadricauda* var *bicaudatus* Hansgirg
10. *Selenastrum acuminatum*
11. *Cosmarium striatum*
12. *Cosmarium auriculatum* Reinsch
13. *Closterium monoliferum* (Borg.) Ehren
14. *Closterium acutum* Ehrenberg
15. *Zygnaema* sp
16. *Euglena acus* Ehrenberg
17. *Euglena* sp
18. *Spirogyra hyalina* Cleve
19. *Spirogyra paludosa* Czurda

BACILLARIOPHYCEAE

20. *Melosira* sp
21. *Cyclotella* sp
22. *Navicula* sp
23. *Cymbella* sp
24. *Fragilaria* sp

ZOOPLANKTON

Qualitative and quantitative analysis of zooplankton population reveals the presence of protozoa, rotifera, cladocera, and arachnida distributed throughout the period, the details of which is summarised below :

Protozoa : Protozoa are represented by members belonging to class mastigophora, ciliata and rhizopoda. Ciliates are generally present in small Patches among the senescent and putrefying

vegetation while rhizopoda are distributed in open water. The species distribution together with the taxonomic status is as under:

Sub kingdom	:	PROTOZOA
Phylum	:	SARCOMASTIGOPHORA
Sub phylum	:	MASTIGOPHORA
Class	:	PHYTOMASTIGOPHORA
Order	:	EUGLENIDA
Suborder	:	EUGLENINA
Family	:	EUGLENIDAE
		<i>Euglena acus</i> Ehrenberg
		<i>Euglena viridis</i> Ehrenberg
Subclass	:	TESTACEALOBOSA
Order	:	ARCELLINIDA
Family	:	ARCELLIDAE
		<i>Arcella gibbosa</i> Penard
Family	:	DIFLUGIDAE
		<i>Difflugia elegans</i> Penarad
		<i>Difflugia globosa</i> Dujardin
Class	:	OLIGOHYMENOPHOREA
Subclass	:	HYMENOSTOMATIA
Order	:	HYMENOSTOMATIDEA
Suborder	:	PENICULINAE
Family	:	PARAMECIIDAE
		<i>Paramecium caudatum</i> Ehrenberg
Subclass	:	PERITRICA
Order	:	PERITRICHIDA
Suborder	:	SESSILINAE
Family	:	VORTICELLIDAE
		<i>Vorticella companula</i> Ehrenberg
		<i>Carchesium</i> sp
Family	:	EPISTYLIDAE
		<i>Epistylis</i> sp

Rotifera : Six species of rotifera are recorded from the lake of which *Keratella tropica* and *Brachyonus calcyflorus* dominated, forming nearly 64% of the total rotifer population. The species represented and their taxonomic positions are as under :

Phylum	:	ROTIFERA
Class	:	MONOGONATA
Order	:	FLOSCULARIDAE
Family	:	TESTUDINELLIDAE <i>Filinea longiseta</i> (Ehrenberg)
Order	:	PLOIMA
Family	:	BRACHIONIDAE <i>Anuraeopsis fissa</i> Gossae <i>Brachyonus calcyflorus</i> Pallas <i>Brachyonus quadricaudatus</i> Hermann <i>Keratella tropica</i> (Apstein)
Family	:	PHILODINIDAE <i>Rotaria</i> sp.

Cladocera : Members of the cladocera distributed in the lake are the tropical representatives and are present during summer months. Abundance of cladocera increases from February till the onset of monsoon. However, *Chydorus* and *Diaphanosoma* found throughout the year, but the abundance decreases during the monsoon period of July to September. The species representation and their taxonomic position are as under :

Class	:	CRUSTACEA
Order	:	CLADOCERA
Family	:	SIDIDAE
Genus	:	<i>Diaphanasoma</i> Fischer 1850 <i>Diaphanasoma sarsi</i> Richard 1894
Family	:	MOINIDAE
Genus	:	<i>Moina</i> Baird 1850 <i>Moina micrura</i> Kurz 1874
Family	:	DAPHNIDAE
Genus	:	<i>Ceriodaphnia</i> Dana 1853 <i>Ceriodaphnia cornuta</i> Sars 1855
Genus	:	<i>Simocephalus</i> Schoedler 1858 <i>Simocephalus vetulus</i> O. F. Mueller
Family	:	CHYDORIDAE
Genus	:	<i>Chydorus</i> Leach 1816 <i>Chydorus sphaericus</i> (O. F. Mueller)
Genus	:	<i>Alona</i> Baird 1852 <i>Alona pulchella</i> Sars 1862.

Copepoda : Copepoda fauna are represented by two species viz. *Heliodyptomus* and *Mesocyclops*. Diversity of this group in the lake though low, abundance among zooplankton population is quite high specially during summer months. The adults occur during post monsoon months till the end of summer, however, their nauplii occur during the months of August to September. Species representation and their status are as under :

Class	:	CRUSTÁCEA
Order	:	CALANOIDEA
		<i>Heliodyptomus viduus</i> (Gurney 1916)
Order	:	CYCLOPOIDEA
		<i>Mesocyclops cf. Leucaartii</i> (Claus)

Miscellaneous zooplankton : Ostracoda are represented by two species of microbenthic forms whose dominance is noted during the different periods of the year. Species representation in the lake are 1. *Cypris globosa* and 2. *Hemicypris* species. The members of the shrimp (Decapoda : Attyidae) viz. *Macrobrachium rosenberghii*, *Cardenia* species found in abundance among the macrophytic vegetation of *Chara* and *Hydrilla* species. The other microbenthic invertebrate encountered during summer months is red mite belonging to *Hydrachna* species.

MACRO INVERTEBRATES

Diptera : Dipterans are represented by several aquatic and semi aquatic forms in freshwater ecosystems, however, in Fox sagar only three main genera viz. *Chironomus*, *Aedes* and *Culex* species are encountered. *Chironomus* species are distributed during the months of October to November in the shallow areas of the lake. The abundance of these species is indicative of the pollution status of the lake, as these are known to be indicator organisms in freshwater ecosystem. Mosquito larvae belonging to *Culex* and *Aedes* species are abundant in the months of November and June i.e., post monsoon months and in summer months. In comparison to *Chironomus* species, mosquito larvae are limited in their abundance and this may be related to the abundance of macrophytic vegetation especially *Chara* species in the lake, as mosquito repellent property of *Chara* species is already established to the limited extent by Kachroo (1983).

Odonata : Biological examination of net samples of Fox sagar reveals the presence of odonate larvae throughout the period of investigation, maximum during the months of March to May and second peak being September and October, the minimum being November to January. However, the distribution pattern of the larvae in the second year of investigation decreased.

Larval growth of aquatic insects are affected significantly by physical factors like temperature and sunshine hours. Temperature can affect growth directly by its influence on the rate of feeding, assimilation, respiration food conversion etc. (Sweeney 1978). Corbet (1957) proposed a model to describe how odonate could use seasonal changes in temperature and photoperiod during the larval development. The interpretation concerning these results is that the increased day length at a given temperature increases overall feeding period of odonate species especially since, most of them are visual predators (Sweeney & Vancote, 1981). In the present study, the lake in particular is situated in the semi-arid region with atmospheric temperature varying from 25 – 45° Celcius

and average sunshine hours of exceeding 10 hours/day, the larval dominance was maximum during the months of March to May. Post monsoon months of September and October were also ideal as the availability of food, light and temperature were in the favourable range.

Distribution of odonate larvae is largely governed by the larval adaptation to the physico-chemical characters of the water body and ability to withstand the adverse breeding condition is a measure of distributional potentiality of the species (Werger, 1978). According to Arthington and Watson (1982), faunistic studies on dragonflies based on the larval condition pose several taxonomic problems. According to these authors, the occurrence of sexually mature odonata found at the freshwater site is a strong evidence to show that they breed there. The adult specimens collected from the lake environs and their taxonomic position are as under :

Class	:	INSECTA
Order	:	ODONATA
Suborder	:	ZYGOPTERA
Family	:	COENAGRIIDAE
Subfamily	:	COENAGRIINAE
		<i>Ischnura elegans</i> (Vander Linden)
Suborder	:	ANISOPTERA
Family	:	GOMPHIDAE
Subfamily	:	GOMPHINAE
		<i>Ichtnogomphus rapax</i> (Rambur)
Family	:	LIBELLULIDAE
Subfamily	:	LIBELLULINAE
		<i>Brachythemis contaminata</i> (Fabricius)
		<i>Crocothemis servelia servelia</i> (Drury)
		<i>Pantala flavescens</i> (Fabricius)
		<i>Trithemis pallidinervis</i> (Kirby)

Members of Odonata are believed to be excellent indicators of water quality. Based on the Helsenhoff's tolerance score (Lehmull 1979) the biotic index falls between 0–5; members with zero tolerance score (Agrionidae, Gomphidae 0.5) are highly sensitive and taxa with the score of 3 are moderate in tolerance (Lestidae and Coenagrionidae – 3). Hence, natural, undisturbed aquatic ecosystem will have greater diversity of the species and such water bodies include many sensitive species. Present investigation confirms the above facts with the presence of *Ichtnus rapax* (Gomphidae) widely distributed in many oligotrophic lakes of Hyderabad. *Pantala* and *Brachythemis* being eurytypic in the environs of Hyderabad are also present in Fox sagar.

Hemiptera : Literature pertaining to the seasonal distribution and role of aquatic hemiptera in freshwater ecosystem is meagre. However, taxonomic account of Indian hemiptera are studied by Distant (1903), Pruthi (1929), Pradhan (1947), Hafiz and Pradhan (1947), Tonapi (1959), Venkateshan and Raghunatha Rao (1980). Stray instances of taxo-ecological studies on the group are attempted by Julka (1977), Goel (1978), Bist and Das (1983), Rupavathi and Radhakrishna (1983), Tirumalai (1988) and others.

List of Hemiptera and taxonomic position is presented in the Table-4. Faunal analysis reveals the presence of 19 species of heteroptera (Hemiptera) belonging to 9 genera. Family nepidae represented by 5 species, notonectidae, corixidae and belostomidae represented by 3 species; pleidae by two species; naucoridae, validae and gerridae with one species each. It is interesting to note that the studies on the aquatic hemiptera of Fox sagar establishes the existence of seasonal variation and periodicity of several members. From the point of view of abundance and diversity, post monsoon months represent an ideal period. *Anisops*, *Micronecta*, *Laccotrephes*, *Ranatra* and *Diplonychus* showed predominance during monsoon months. Furthermore, the latter three species showed abundance among the macrophytic vegetation of *Chara* and *Hydrilla* species. However, *Notonecta glauca* showed predominance during summer months. Species belonging to valide (*Microvelia*); naucoridae (*Heliochoris*) and gerridae (*Gerris*) exhibited discontinuous occurrence. Among the members of the pleidae, *Plea pallescens* exhibited limited abundance in comparison to *Plea frontalis*.

Abundance and composition of the aquatic hemiptera are related to the change in the physico-chemical conditions by various workers. Goel (1978) observed that the abundance of hemiptera in general is related to temperature and humidity rather than rainfall. However, Tonapi (1959), Julka (1977), are of the opinion that temperature and rainfall appeared to be important and have augmentative effect on the fluctuation in the population of the aquatic hemiptera. Carter (1960) opines that in tropics, amount of rainfall plays a significant role in regulating various biological rhythms. Differences in the temperature requirement have been considered by many workers to account for most of the distributional pattern (Macan, 1958; Hynes 1970). In tropics, as in the present case, temperature changes are usually minimum in limited areas of single habitat and hence this factor may have a very little bearing on the micro-distribution of hemiptera, since the thermal regimes of the lake exceeded 20° Celcius at all seasons.

During the present study, rainfall appeared to play a significant role as it controls the water level fluctuation in the lakes of Hyderabad, Andhra Pradesh, India. Rainfall affects the concentration of chemical constituents by dilution effect which in turn influences the quantity of plankton and primary production of the lake. Apart from dilution effect, rainfall has direct role in drying and reflooding of the water body. According to Bridges and Mahler (1985), drying and reflooding enhances the nutrient release which stimulates the macrophytic productivity. It is also evident from the present study, the rainfall deviated from the long term averages during the second year of investigation (nearly 480 mm instead of average of nearly 800 mm/year). This is further aggravated by the gross evaporation from the lake surface (5.91 mm/day during the first year and 6.01 mm/year during the second year of investigation), resulted in the water level reduction. This affected the water quality parameters, phyto-zooplankton population, macrophytic productivity which in turn affected the distribution of hemipteran population. A near bloom condition of the lake due to the abundance of *Microcystis aeruginosa* and *Oscillatoria* species of algae affected the hemipteran population, as the alga formed a continuous mat on the surface of water inhabiting distribution of other species.

It is therefore, reasonable to assume that changes in some water quality parameters due to the reduction in the water level, abundance of phytoplankton blooms, excessive predation by birds in the lake margin, changes in the food-web composition due to the reduction in the macrophytic productivity are the factors responsible for the species distribution and abundance. The ability of

hemipterans to migrate appear to be another factor causing fluctuation in the population as suggested by Julka (1977).

Table-4. Systematic list of Aquatic Hemiptera of Fox sagar, Hyderabad.

Class	:	INSECTA
Order	:	HEMIPTERA
Suborder	:	HETEROPTERA
Family	:	CORIXIDAE
Genus	:	<i>Corixa</i> Mueller <i>Corixa heiroglyphica</i> Dufont
Subfamily	:	MICRONECTIDAE
Genus	:	<i>Micronecta</i> Kirkaldy <i>Micronecta (Sigmonecta) quadristrigata</i> Bred <i>Micronecta (Sigmonecta) striata</i> Fieb.
Family	:	PLEIDAE
Genus	:	<i>Plea</i> Leach <i>Plea frontalis</i> (Fieber) <i>Plea pallescens</i> Distant
Family	:	NOTONECTIDAE
Subfamily	:	NOTONECTINAE
Genus	:	<i>Notonecta</i> <i>Notonecta glauca</i>
Subfamily	:	ANISOPSINAE
Genus	:	ANISOPS SPINOLAE <i>Anisops breddini</i> Kirkaldi <i>Anisops exigera</i> Howarth
Family	:	NEPIDAE
Subfamily	:	RANATRINAE
Genus	:	<i>Ranatra</i> Fabricius <i>Ranatra filiformes</i> Fabricius <i>Ranatra gracilis</i> Montondon <i>Ranatra sordidula</i> Dohrn
Subfamily	:	NEPINAE
Genus	:	<i>Laccotrephes</i> Stal <i>Laccotrephes elongatus</i> Montondon <i>Laccotrephes griseus</i> (Guerin)
Family	:	BELOSTOMIDE
Subfamily	:	BELOSTOMINAE
Genus	:	<i>Diplonychus</i> Amyot & Serville <i>Diplonychus rusticus</i> (Fabricius) <i>Diplonychus annulatum</i> (Fabricius) <i>Diplonychus molestum</i> (Dufont)

Family	:	NAUCORIDAE
Subfamily	:	LACCOCORINAE
Genus	:	<i>Heliotrophis</i> Stal
		<i>Heliochoris breviceps</i> Montondon
Family	:	GERRIDAE
Subfamily	:	GERRINAE
Genus	:	<i>Gerris</i>
		<i>Gerris spinolae</i> Lethierry & Severin
Family	:	VELIIDAE
Subfamily	:	MICROVELINAE
Genus	:	<i>Microvelia</i> Westwood
		<i>Microvelia senhglensis</i> Kirkaldy

Coleoptera : Free moving predacious pond insects are best exemplified by diving insects. These gradually range in number and frequency in inverse proportion to their size, smaller the species more often numerous the medium sized animals. Coleoptera, though a largest group among insects, represented by three species viz. *Hydatic fabricii* Macleay, *Cybister* sp. and *Rhantaticus* species.

Crustacea : Crustaceans are represented by *Macrobrachium rosenberghii* and *Cardenia* species. These two species exhibited abundance during the peak macrophytic productivity. *Macrobrachium* showed discontinuous distribution, as they are not cultured in the lake, however, *Cardenia* were more abundant and the size varied from 2 – 3.5 cm and hence, not much of commercial value except that it forms the link in the food chain for many aquatic animals.

Mollusca : Compared with the deeper zone, shallow water habitats usually and structurally more complex and are characterised by greater "Substratum heterogeneity" (Wetzel, 1975). This warrants for the abundance and diversity of macrobenthic forms especially molluscs. The shallow water region of the lake Fox sagar harbours seven species of gastropods with an interesting feature being the absence of bivalves. Of the seven species, *Bellamya bengalensis* and *Indoplanorbis exustus* are the dominant species, the former preferring the rocky bed while the later prefers an extensive growth of macrophytic vegetation. The distribution of *Bellamya* species on the rocky and hard substratum can be explained by it clinging ability to the surface with the help of adhesive foot and feeding on the organic matter formed by the epiphytic algae and plankton from the incoming water by wave action. Presence of cladocera, copepoda and epiphytic algae on the vegetation are the reasons for their abundance of the later species.

According to Boycot (1966), 50% of the molluscan species are hardly ever found in water with less than 20 mg/l of calcium ions and he treats this as the lower limits. It is also evident from the work of Furtado and Mori (1982), species of mollusca are absent in Tasek Bera lake in Malayasia due to its soft water with calcium deficiency. Fox sagar lake being eutrophic lake, calcium ion is not a limiting factor as these always occur in abundance (> 150 mg/l), the reason being, the area is full of laterite soil having greater percentage of calcium, magnesium, sodium and potassium.

Table-5. Molluscan Fauna of Fox sagar and its sysematic status

Class	:	GASTROPODA
Order	:	MESOGASTROPODA
Family	:	VIVIPARIDE
Subfamily	:	BELLAMYINAE
Genus	:	<i>Bellamya</i> Joussaeume 1886 <i>Bellamya bengalensis</i> (Lamarck, 1882) <i>Bellamya crassa</i> (Benson 1836) <i>Bellamya dissimilis</i> (Muelleer 1774)
Family	:	BITHYNIIDAE
Subfamily	:	BITHYNINAE (BULININAE)
Genus	:	<i>Gabbia</i> Tyron 1865 <i>Gabbia orcula var producta</i> (Neville 1884)
Subclass	:	PULMONATA
Order	:	BASSAMATOPHORA
Family	:	LYMNAEIDAE
Genus	:	<i>Lymnaea</i> Lamarck 1799 <i>Lymnaea (Pseudosuccenia) acuminata</i> Lamarck <i>Lymnaea (Pseudosuccenia) luteola</i> Lamarck
Family	:	PLANORBIDAE
Subfamily	:	BULININAE
Genus,	:	<i>Indoplanorbis</i> Annandale & Pershad 1929 <i>Indoplanorbis exustus</i> Deshayes 1834

Ichthyofauna : In recent years, State Fisheries Department utilised Fox sagar as the centre for stocking and culture site for fishes, as a result, the species composition of the natural population altered considerably. This was further aggravated by the introduction of *Tilapia* species in the lakes of Hyderabad. Species composition has also altered due to the change in the drainage pattern, due to the development of industrial area around the lake ecosystem, utilising the lake margin for the brick making as well as dumping site for the city garbage. These anthropogenic activities resulted in the alteration of species composition, sensitive species being replaced by the hardy ones. This is in confirmity with the findings of Baburao (1984) in the lakes of Hyderabad of similar status. Carnivorous and detrivorous species are more prominent (*Mystus*, *Chela*, *Channa*, *Wallago*, *Notopterus*, *Clarias*, *Tilapia* etc.) than the sensitive species.

Recordings of the abundance and frequency of the individual species was not available, as the lake was mainly used as stocking and nursery site, however, the systematic account of the ichthyofauna of Fox sagar, Hyderabad revealed the presence of 17 species belonging to 14 genera under 10 families. The species representation was similar to that of other freshwater lakes of Hyderabad of similar status. During the present investigation, due to the decrease in the general lake waterlevel, a large area of the lake bed was exposed, offered an excellent site for aquatic and semi aquatic birds, which was hitherto not recorded in our earlier investigation, feeding mainly on fishes.

Table-6. Fish Fauna of Fox sagar, Hyderabad and its Taxonomic status

Sl.No.	Order	Family	Species
1.	Cypriniformes	Clupeidae Cyprinidae	<i>Notopterus notopterus</i> (Hamilton) <i>Chela labuca</i> (Hamilton) <i>Puntius ticto</i> (Hamilton-Buchnan) <i>Puntius chola</i> (Hamilton- Buchanan) <i>Puntius sophore</i> (Hamilton-Buchnan) <i>Rasbora daniconius</i> (Hamilton) <i>Amblypaharyngodon mola</i> (Hamilton) <i>Garra malya</i> (Sykes)
2.	Siluridae	Cobitidae Bagridae Heteropneustidae Siluridae	<i>Lepidocephalichthyes guntea</i> (Hamilton) <i>Mystus vittatus</i> (Bloch) <i>Heteropneustes fossilis</i> (Bloch) <i>Wallago attu</i> (Bloch)
3.	Ophicephaliformes	Ophicephalidae	<i>Channa punctatus</i> (Bloch) <i>Channa gachua</i> (Hamilton)
4.	Perciformes	Gobidae Claridae Cichlidae	<i>Glossogobius giuris</i> (Hamilton) <i>Clarias batrachus</i> (Linnaeus) <i>Sarcotherodon mosambicus</i> (Peters)

Amphibia : Annandale and Rao (1918) and Parker (1934) have recorded amphibian from different parts of India, however, the information on the amphibian fauna of Hyderabad district is very scanty. During the present investigation only three species of amphibians were recorded from the lake the systematic position of these are as below :

Class	:	AMPHIBIA
Order	:	ANURA
Family	:	BUFONIDAE
Genus	:	<i>Bufo Laurenti</i> 1768 <i>Bufo melanogaster</i> Schneider
Family	:	RANIDAE
Genus	:	<i>Rana</i> Linnaeus, 1758 <i>Rana limnocharis</i> Boie <i>Rana cyanophlyctis</i> Schneider

Of the three species found in the lake, *Bufo melanosticus* is the big sized toad, nocturnal in habit and found in abundant number during the monsoon and post monsoon months. *Rana limnocharis* and *Rana cyanophlyctis* are the two smaller species found inside the lake margin and among the macrophytic vegetation. *Rana tigrina*, the bull frog not recorded in the lake, though common in many other lakes of Hyderabad.

Avifauna : Information on the avifauna of the lakes and other water bodies of Hyderabad

district is very scanty and therefore, a faunal inventory of the lake was undertaken in addition to their seasonal abundance and distribution. The list prepared is based on the observation for a period of two years. During the field trip, assistance of Dr. M. Vasanth, an eminent field ornithologist was taken, the list presented is complete or near complete. The present study also revealed that the majority of the birds are resident type and only about 12 species visited during winter (22% of the total are winter visitors). It was also observed for the first time that the Acacia trees in the lake margin formed an excellent site for the painted storks to nest and breed in the area. *Ardea alba* (large egret) was the only species found to be rare, as it was sighted twice in the entire period of two years.

Table-7. Avifauna of Fox Sagar, Hyderabad.

Family	Scientific and Common Name	Status
PODICIPIDIDAE	<i>Podiceps rufficollis</i> (Pallas) (Dab Chick)	Winter visitor, visits in small groups of 5 – 8
PHALACROCORACIDAE	<i>Phalacrocorax niger</i> (Viellot) (Little cormorant)	Winter visitor, visits in small groups of 4 – 6
ARDEIDAE	<i>Ardeola grayeii</i> (Sykes) (Pond Heron)	Common in summer
	<i>Ardea cinera</i> (Linnaeus) (Grey Heron)	Common throughout the year
	<i>Ardea alba</i> (Linnaeus) (Large egret)	Rare
	<i>Egretta garzetta</i> (Linnaeus) (Little egret)	Common and abundant
	<i>Egretta intermedia</i> (Wagner) (Common egret)	Abundant
	<i>Bubulcus ibis</i> (Linnaeus) (Cattle egret)	Common
CICONIDAE	<i>Nycterrenia leucocephala</i> (Penmant) (Painted stork)	Found in large number, Nests on Acacia trees in large nos.
ACCIPETRIDAE	<i>Nephron perenopterus</i> (Linnaeus) (Scavenger vulture)	Present in large nos. Common throughout the year due to the presence of garbage
	<i>Milvus migrans</i> (Boddaert) (Pariah kite)	Common in the lake margin throughout the year in large numbers & in catchment area

Family	Scientific and Common Name	Status
JACANIDAE	<i>Hydrophasianus chirugris</i> (Scopoli) (Pheasant Tailed Jacana)	Winter visitor, small number present on macrophytes
CHARADRIDAE	<i>Vanellus indicus</i> (Boddaert) (Redwattled lapwig)	Common throughout the year
	<i>Charadrius dubius</i> Scopoli (Little ringed plover)	Common in winter
RECURVIROSTRIDAE	<i>Himantopus himantopus</i> (Linnaeus) (Blackwinged stilt)	Common in winter
COLUMBIDAE	<i>Streptopelia chinensis</i> (Scopoli) (Indian Spotted dove)	Common in summer in marginal vegetation
	<i>Streptopelia decaocto</i> (Frivaidzky) (Ring dove)	Common in summer in lake margin
PSITTACIDAE	<i>Psittacula krameri</i> (Scopoli) (Roseringed parakeet)	Common in fruit gardens of the catchment area
CUCULIDAE	<i>Eudynamys scolopacea</i> (Linnaeus) (Koel)	Common throughout in the bushes & trees of lake margin
	<i>Centropus sinensis</i> (Stephens) (Coucal or Crow Pheasant)	Common throughout in the marginal vegetation
	<i>Clamator jacobinus</i> (Boddaert)	Common throughout (Pied crested cuckoo)
CAPRIMULGIDAE	<i>Caprimulgus asiaticus</i> Lanathum (Indian Nightjar)	Present during post monsoon and winter months
STRIGIDAE	<i>Athene brama</i> (Temminck) (Spotted owlet)	Common throughout in the lake margin and catchment
APODIDAE	<i>Cypsiurus paravus</i> (Lichtenstein) (Palm swift)	Common throughout the year
HIRUNDINIDAE	<i>Hirundo rustica</i> Linnaeus (Common swallow)	Common throughout the year
UPUPIDAE	<i>Upupa epos</i> Linnaeus (Hoopoe)	Common in winter
COERACIDAE	<i>Coracias benghalensis</i> (Linnaeus) (Blue Jay)	Common throughout the year
MEROPIDAE	<i>Merops orientalis</i> Latham (Green bee eater)	Winter visitor

Family	Scientific and Common Name	Status
ALCEDINIDAE	<i>Alcedo atthis</i> (Linnaeus) (Blue Kingfisher)	Common throughout the year
	<i>Halcyon smirnensis</i> (Linnaeus) (white breasted Kingfisher)	Common throughout the year
PICIDAE	<i>Dinopium bengalenis</i> (Linnaeus) (Golden backed woodpecker)	Post monsoon & Winter
MOTACILLIDAE	<i>Motacilla flava</i> (Linnaeus) (Yellow wagtail)	Common in winter and summer
	<i>Motacilla maderaspatensis</i> Gmelin (Large pied wagtail)	Common in summer
ALAUDIDAE	<i>Eremopterix grisea</i> (Scopoli) (Ashy crowned Finch lark)	Common in winter and winter
	<i>Alauda gulgula</i> Franklin	Common in summer
	<i>Galerida cristata</i> Linnaeus (Indian small Skylark)	Winter visitor
DICRURIDAE	<i>Dicrurus adsimilis</i> (Bechstein) (Black drongo)	Common throughout the year
STURNIDAE	<i>Acridotherus tristis</i> (Linnaeus) (Indian common myna)	Common throughout the year
CORVIDAE	<i>Corvus macrorhynchos</i> Wagler (Jungle crow)	Common throughout the year
	<i>Corvus splendens</i> Vieillot (Indian House crow)	Common throughout the year
	<i>Dendrocitta vagabunda</i> (Latham) (Tree Pie)	Common in the bushes, trees in lake margin & catchment
PYCNONOTIDAE	<i>Chloropsis aurifrons</i> (Temminck) (Goldfronted Chloropsis)	Winter visitor
	<i>Pycnonotus cafer</i> (Linnaeus) (Redwiskered Bulbul)	Common throughout the year
TIMALINAE	<i>Turdoides caudatus</i> (Dumont) (Common Babler)	Common throughout the year
	<i>Turdoides affinis</i> (Jerdon) (Whiteheaded Babler)	Common throughout the year
SILVINAE	<i>Prinia socialis</i> Sykes (Ashy wren Warbler)	Common throughout the year

Family	Scientific and Common Name	Status
TURNIDAE	<i>Saxicoloides fulicata</i> (Linneus) (Indian Robin)	Common throughout the year
NECTARINIDAE	<i>Nectarinia asiatica</i> (Latham) (Purpled Sunbird)	Common throughout the year
PLOCEIDAE	<i>Lonchura malbarica</i> (Linnaeus) (White throated Munia)	Common throughout the year
	<i>Passer domesticus</i> Linnaeus (House sparrow)	Common throughout the year

SUMMARY

Fox sagar, a perennial freshwater lake situated in the sub-urban environs of Hyderabad city, mainly constructed to irrigate the agricultural lands in the lower catchment area. The lake margin, in recent years has been employed to dump city garbage thereby causing deterioration in the water quality, affecting the fauna, flora and human health. It was also observed, that a large number of Pariah kites (*Milvus migrans* Boddaert) are hovering over the lake area, because of the abundant supply of food from the city garbage piled up in the area, in turn may cause serious damage to the air crafts (Airport is at an aerial distance of 3 – 4 km).

Suburban growth, development of Jeedimetla Industrial Estate, release of effluents from the industries are the subject matter of discussion in recent years. This is true in case of Fox sagar lake also. Enough precautions are to be taken before the release of untreated effluents in the lake catchment area. A minor industry viz. Brick making industry is directly operating in the lake margin. The impact of these are to be looked into before developing the same in the area.

The water quality is found to be conducive for the developemnt of fisheries in the state. However, in recent years the introduction of *Tilapia mosambica* in the lake, the fishermen operating in the area often complain that many carps which were once flourished in the lake have dwindled.

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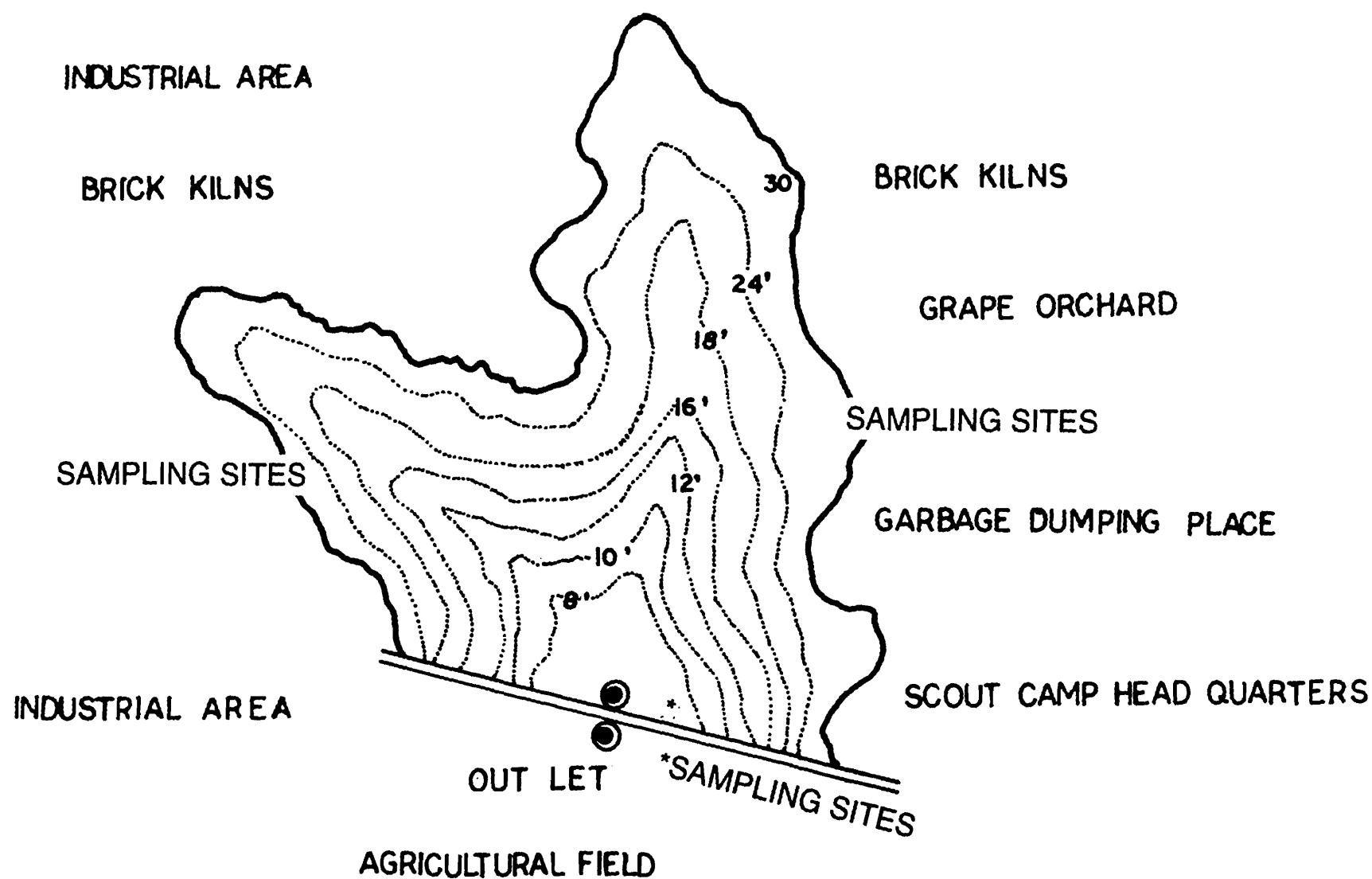
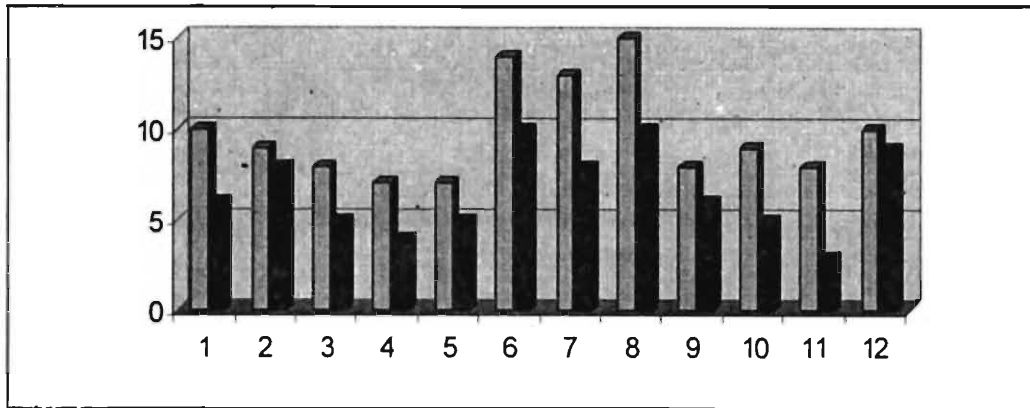
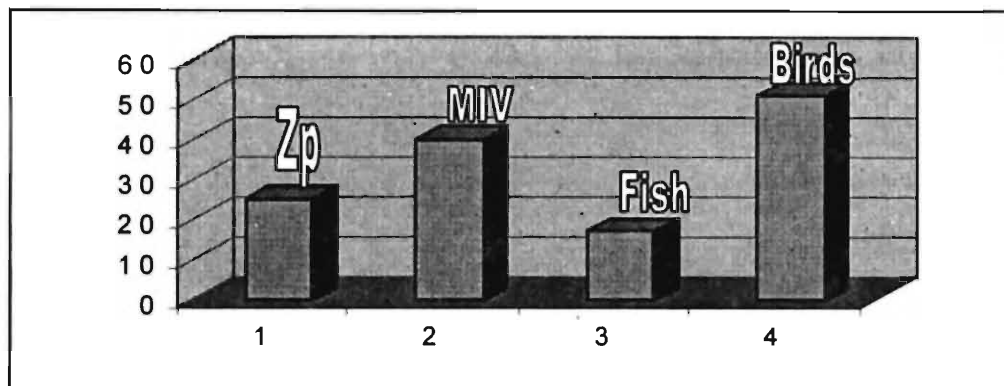


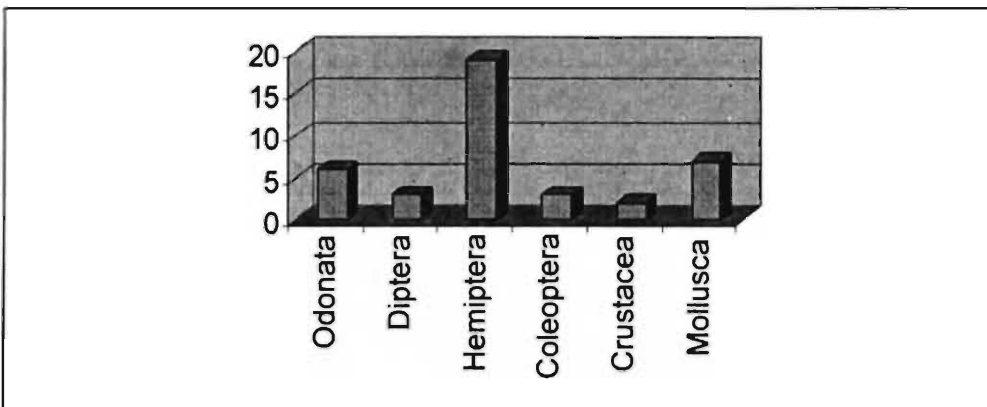
FIGURE 1 CONTOUR MAP OF FOX SAGAR, JEEDIMETLA, HYDERABAD.



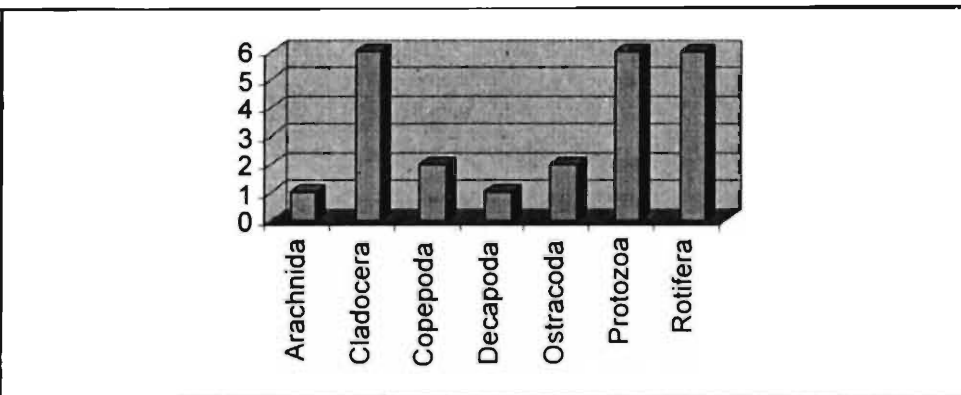
Species Composition of Aquatic Hemiptera in Fox Sagar Lake



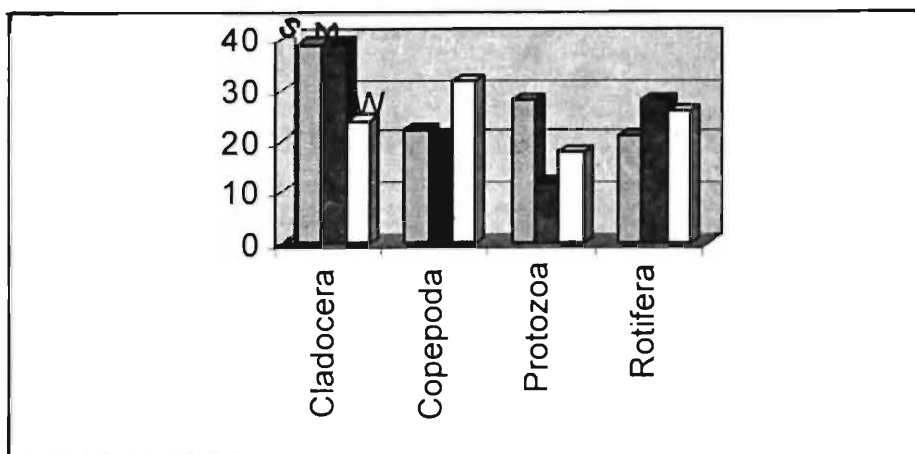
Species Composition of Micro-Macro Invertebrates & Vertebrates



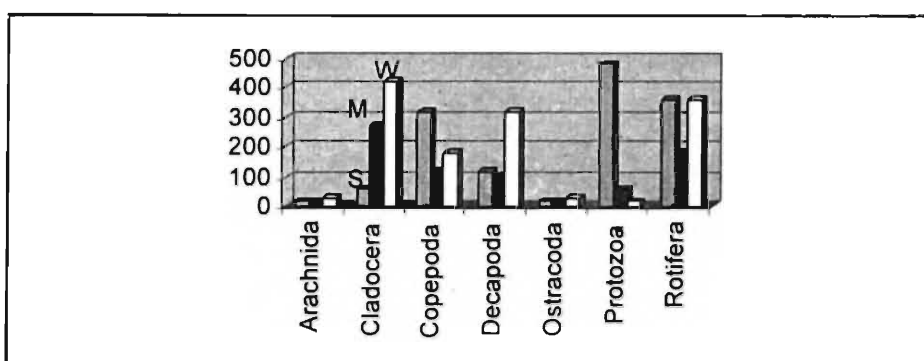
Species Composition of Macro-Invertebrates in Fox Sagar



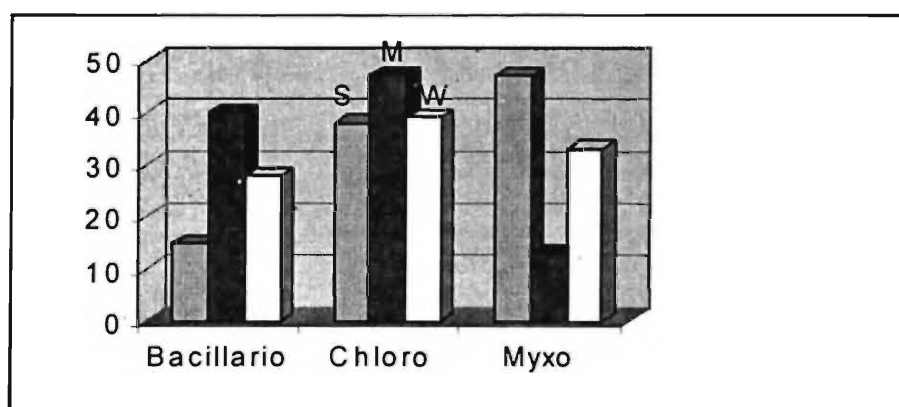
Species Composition of Zooplankton in Fox Sagar



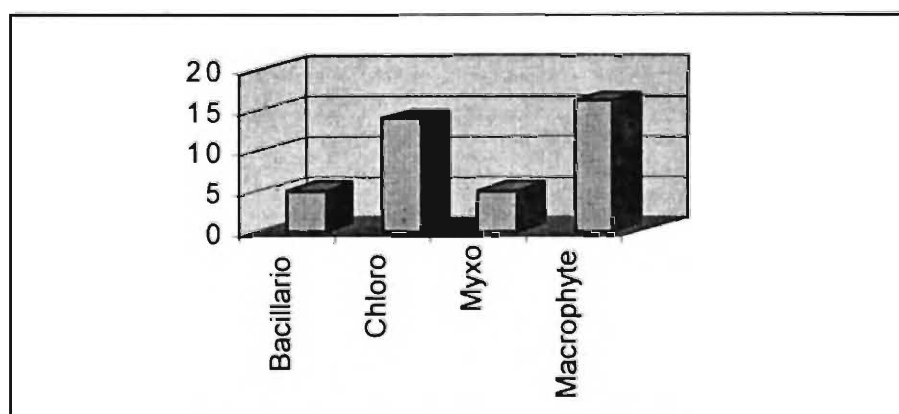
Seasonal Variation of Zooplankton (Percentage Composition)



Seasonal Variation of Zooplankton (number)



Seasonal Variation of Phytoplankton (Percentage Composition)



Species composition of phytoplankton & Macrophytes of Fox sagar

Short Communication

ON THE OCCURRENCE OF RABBIT FISH : *SIGANUS VERMICULATUS* (CUVIER AND VALENCIENNES), (FAMILY : SIGANIDAE) FROM DIGHA COAST, WEST BENGAL

INTRODUCTION

The marine ichthyofauna of West Bengal has been described by Talwar *et al.* (1994). In this account there is no mention of rabbit fish, *Siganus vermiculatus* (Cuvier and Valenciennes) belonging to the family Siganidae from West Bengal. Although the rabbit fish is common along both coasts of India, no report of this fish from West Bengal is available in literature.

Recently, in the course of investigation on faunal diversity, the authors came across one specimen of *Siganus vermiculatus* of 26.5 cm in total length, caught by drag net from Digha coast on 16.07.97. A brief description of the specimen is given below.

***Siganus vermiculatus* (Cuvier and Valenciennes)**

Amphacanthus vermiculatus (Kuhl and V. Hasselt) : Cuvier and Valenciennes, 1835, *Hist. Nat. Poiss.*, 10 : 126.

Material examined : 1 ex., loc. : Digha Hospital Ghat; dt. 16.7.97. Coll. : J. Sarkar and S. Talukdar; MARC. Regd. No. 1918.

Description : D. XIII 10, P. 16, A. VII 9, C. 24, Ll. 192, Ltr. 24. Body oval and compressed; profile of head slightly concave above eye, slightly convex in front of mid region of eyes, ventral surface of head flat and slightly convex. Maxilla reaches about half way to below the front edge of orbit. Dorsal fin spine strong and occupying about 5-7th of the length of the base of entire fin, rayed portion of the fin high and angular. Length of first dorsal fin spine 1.5 cm. Shape of anal fin angular. Caudal slightly emarginate. Scales minute but distinct.

Colour : Light brown, running into bluish-green with yellow blitter on the back, and nearly white on the abdomen. the whole of the body, head and lips are lineated with undulating bluish lines. Caudal fin with brown lines.

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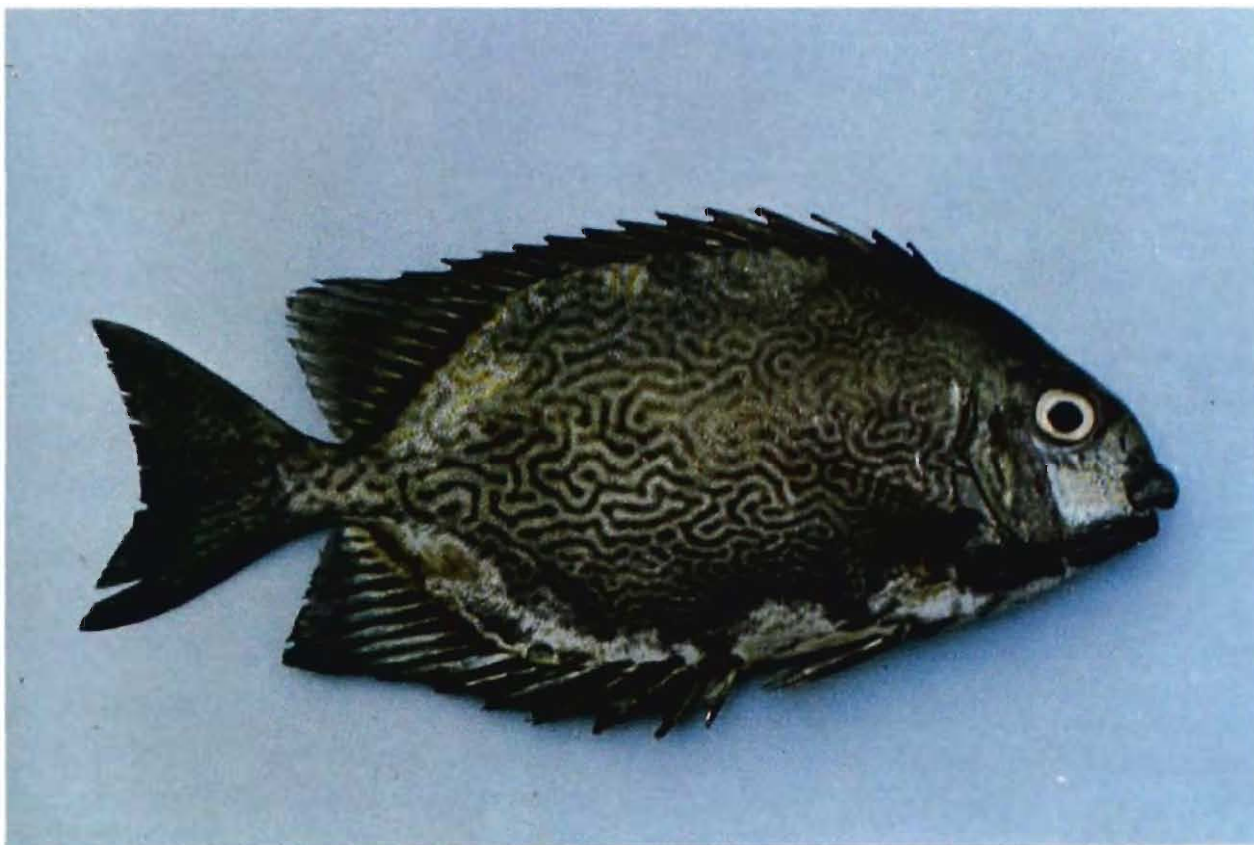


Fig. 1 : Rabbit fish : *Siganus vermiculatus* (Cuvier and Valenciennes).

Short Communication

SHELL-SIZE VARIABILITY OF THE SEA MUSSEL, *MODIOLUS STRIATULUS* (HANLEY)

INTRODUCTION

Modiolus striatulus Hanley, a bivalve mollusc belonging to the family Mytilidae, is a highly variable species (Subba Rao *et al.*, 1992). It occurs in the maritime States of West Bengal, Orissa, Tamil Nadu, Kerala, Maharashtra and Andaman in India and outside India from Sri Lanka, Singapore, Myanmar, Gulf of Thailand, China and Japan. Shells are usually attached to rocks, stones, wooden jetties in submerged waters and also on algal growths on stone. It was reported as a major nuisance causing mollusca in Palta Water Works, Calcutta (Krishnamurti and Rajagopalan, 1968).

Annandale and Kemp (1916) Studied the variation of this species and clarified its identity. However, its shell-size variability, if any, is ascertained herein using standard statistical tests and analysing morphometric relationship between shell length and shell width of different size groups.

Materials and Methods : A total of 200 specimens of *Modiolus striatulus* were collected at random from Matla river bed, Canning occurring as thick mussel mat of honey-comb-like appearance. The collected samples were measured for morphometric study to find out the shell length (SL) and shell width (SW) relationship. Furthermore, 35 examples of higher size groups from the same locality were also measured from the National Zoological Collection present in the Mollusca Section of this Department to complete this study. The strength of this length-width relationship is reflected following coefficient of correlation, regression equation, scatter diagram as well as log curve.

Result : In all 235 specimens of *Modiolus striatulus* have been measured for various statistical analysis based on shell length, a standard and widely used parameter. Frequency distribution of various size groups, average length, average width and length-width ratio of respective size groups are calculated and presented in Table - 1. The mean value is calculated as 13.34. From the Table - 1 it is clear that the length-width ratio bears more or less uniform relationship which decreases slightly (0.57 to 0.40) with the increase in size. The modal class represents 12-15 mm size group showing maximum frequency of 66.38%. Raw data also reveal that maximum individual frequency of *M. striatulus* corresponds to the shell length of 14 mm. The standard error, which represents the standard deviation of means, is calculated as 0.462. So, $\bar{X} \pm SE = 13.34 \pm 0.462$ [$\bar{X}$ = Mean, SE = Standard Error].

The correlation coefficient value (r) is calculated between the shell length and shell width as follows :

$$r = \text{cov}(x,y) / \delta x \delta y$$

Where, $\bar{x}$ = Shell length; y = Shell width; $\text{cov}(x,y)$ = covariance of x and y ; δx = Standard deviation of x ; δy = Standard deviation of y .

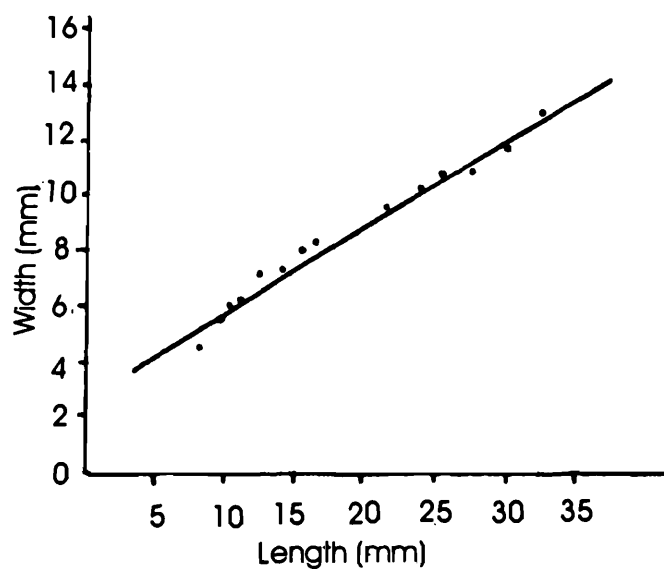


Fig. 1. Regression line with scatter diagram of shell width against shell length of *Modiolus striatulus*

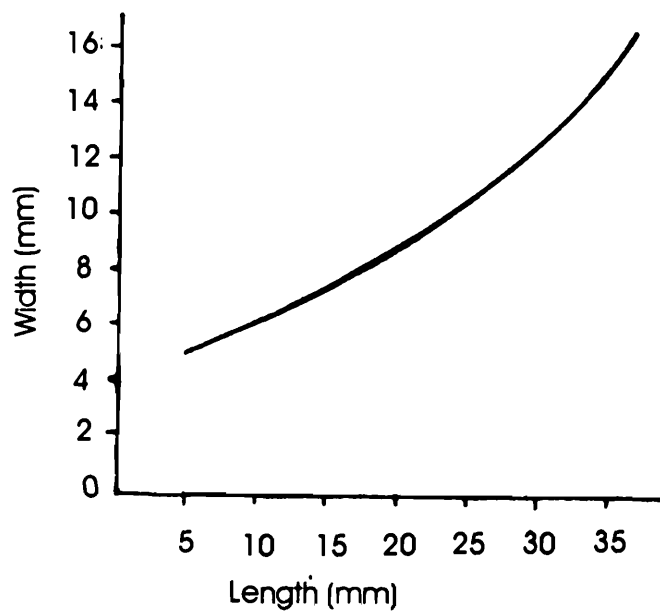


Fig. 2. Log-curve between shell width and shell length of *Modiolus striatulus*

The r value is calculated as 0.98 which clearly indicates a strong relationship between the two variables. The regression equation between SL and SW is calculated as

$$y = 0.313 x + 2.783 \text{ [where } x = \text{shell length in mm and } y = \text{shell width in mm].}$$

To check out the scattering of the value of SW against SL, the scatter diagram is drawn along with regression line equation and shown in Fig. 1. Both regression line and scatter diagram indicate a high degree of association between the variables as the regression line forms an angle approximately 45° and the scattering of the values are more or less very close to the regression line. Further, for final confirmation, the values of SW are plotted against the SL in log-curve (Fig. 2). The log equation yields the result as follows :

$$\log y = 0.618 + 0.016 x \text{ [where, } x = \text{shell length in mm and } y = \text{shell width in mm].}$$

So, the log equation for the fitted curve gives the value, $y = 4.154 (1.038)^x$ [Where, x = shell length in mm and y = shell width in mm].

Log-curve shows the tendency of increasing in shell width with shell length, more or less uniformly, indicating insignificant variation with respect to length-width relationship.

Table 1. Frequency distribution and length-width ratio of various size-groups in *Modiolus striatulus*.

SIZE GROUP (length in mm)	Frequency	Frequency %	Average length of the group (in mm)	Average width of the group (in mm)	Length-width ratio
8-11	38	16.17	10.80	6.17	0.57
12-15	156	66.38	13.65	7.06	0.52
16-19	13	5.53	16.52	8.19	0.48
20-23	5	2.13	22.50	10.18	0.45
24-27	10	4.26	25.31	10.67	0.42
28-31	8	3.40	29.25	11.72	0.40
32-35	5	2.13	32.40	12.96	0.40

DISCUSSION

Shell dimensions and their inter-relations in bivalve molluscs have been reported by several workers in India. (Rao, 1951; Nair & Nair, 1985, 1986; George *et al.*, 1986). The present study indicates strong inter-relation in the length-width ratio as well as in the correlation co-efficient between the shell length and shell width of *Modiolus striatulus* ($r = 0.98$) as also observed in

case of marine mussel, *Perna viridis* ($r = 0.94$) by George *et al* (1986). As such, morphometrically the variability between the two variables viz., shell length and shell width bears a highly proportional statistical inter-relationship characterising the specific identity of the species.

SUMMARY

Increase in shell length and shell width of *Modiolus striatulus* is strongly correlated.

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Short Communication

***ICHNEUMONOPSIS BURMENSIS* HARDY (TEPHRITIDAE : DIPTERA : INSECTA), A NEW RECORD FROM INDIA**

INTRODUCTION

The monotypic genus *Ichneumonopsis* (Tephritidae : Diptera : Insecta) was erected by Hardy (1973) based on two specimens (1 ♂, 1 ♀) collected by G. Heinrich in 1938 from Mt. Victoria, Chin Hills, Myanmar (Burma).

The genus is characterised by reduced chaetotaxy in the absence of ocellars, postocellars, inferior fronto-orbitals, humeral, dorsocentral, sternopleural and presutural bristles and also in the pleuroterga being bare. Possessing an elongate body, the species is *Ichneumon* (Hymenoptera) - like in general appearance.

TAXONOMIC REVIEW

Hardy (1973) placed the genus in the tribe Adramini of the subfamily Trypetinae because of the reduction of head and thoracic bristles. Hardy (1986) considers Adramini as composing of a somewhat heterogeneous group of genera which borderline the Dacinae and the Trypetinae and prefers to treat adramini in the Trypetinae.

According to Hancock (1986), the Oriental genus *Ichneumonopsis* Hardy appears not to belong to the subfamily Trypetinae as it exhibits relationship to Dacinae on the following considerations. The genus differs from typical members of Adramini in the absence of long hairs on the pleuroterga and in the presence of only two spermathecae, besides the anal cell extension of the wing being narrow. These characters, together with the wing pattern and general reduction of head bristles suggest a relationship to Dacinae. However, *Ichneumonopsis* differs from other Dacinae in the narrower second basal cell, normal positioning of the radial veins, short r-m cross vein, plumose arista, two lateral scutellar bristles and rounded spermathecae.

Hence, Hancock (1986) considered *Ichneumonopsis* the most primitive genus of subfamily Dacinae. He erected the tribe Ichneumonopsidini with *Ichneumonopsis* its type genus.

MATERIAL EXAMINED

Ichneumonopsis burmensis Hardy, 1 ex. ♀ (Fig. 1) Locality : Umtasor, Nongkhylllem Forest, Khasi Hills, Ri-Bhoi district, Meghalaya, India, 19.v.1982, Coll. C. Radhakrishnan.

The specimen agrees entirely with the description of the genus and species.

DISCUSSION

This is the first record of *Ichneumonopsis burmensis* Hardy from India and the first time it is being reported after it was originally described from Myanmar in 1973. The occurrence of this species both in Myanmar and India further establishes the fact that the eastern Indian borderlands must be described biogeographically a transitional area representing a 'gateway' through which the older Indian Peninsular and relatively younger Asiatic faunas meet and transgress (Mani, 1974).

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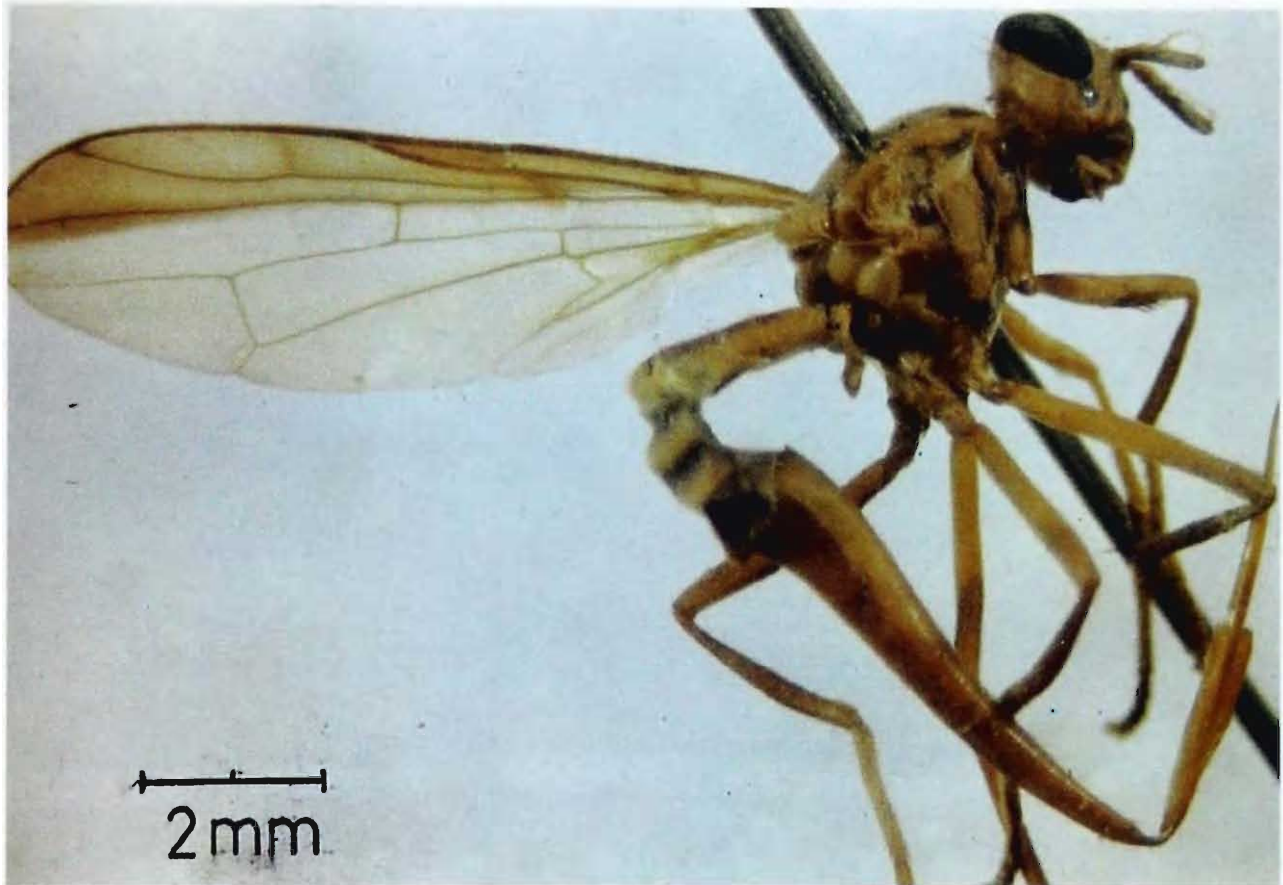


Fig. 1 *Ichneumonopsis burmensis* Hardy (Tephritidae : Diptera : Insecta) - ♀ lateral view.