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

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Frequency of Publication : Quarterly – 4 parts in one volume.

Publication time : Within 3 months after final acceptance.

Categories of published material : Full paper, Interesting Case Reports, Field Reports, Taxonomic description and distributions, Description of new taxa, Short Communications, Checklists.

Instruction of submission : The article to be organized as :—1. Title; 2. Author/Authors along with address clearly mentioning the corresponding author and Affiliation, e-mail address; 3. Introduction; 4. Materials and Methods; 5. Systematic accounts; 6. Results; 7. Discussion; 8. Summary; 9. Acknowledgement, 10. References; 11. Tables and Figures with appropriate title and legends on separate sheets.

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Introduction section should clearly describe the objectives of the study and provide enough background information to make it clear why the study was undertaken. Lengthy literature review is discouraged. Some earlier references of work may be cited.

Materials and Methods should provide the reader with all the information necessary to repeat the work. For modification of published methodology, only modification needs to be described with reference to the original source.

Under material examined the following format should be followed strictly for *e.g.* :

Material Examined : Holotype : Female : India, Kerala, Calicut University campus, 3-xii-1994, coll. T.C. Narendran and Party (Reg. No.)

Results to be presented by referring to tables and figures (if any) and without discussion.

Discussion should include a concise statement of the findings, a discussion of the variety of the observations, a discussion of the findings in the light of other published works dealing with the same or allied subjects.

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Entries under "Reference" should not include any reference which is not cited in the text.

Examples :

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Silas, E.G. 1961. Occurrence of the Sea-cow *Halicore dugong* (Erxl) off Saurashtra coast. *J. Bombay nat. Hist. Soc.*, **58**(1) : 263-266.

State Fauna/Conservation Areas : Mukhopadhyay, S.K. 1999. Fresh water Oligochaetes. *Fauna of West Bengal, State Fauna Series*, **3**(Part-10) : 95-123. Published by Zool. Surv. India.

Radhakrishna, C. 2007. Amphibia. In : *Fauna of Kudermukh National Park, Karnataka, Conservation Area Series*, **32** : 20-25, Published by Zool. Surv. India.

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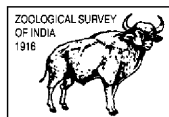
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TWO NEW SPECIES OF *MEGASTIGMUS* DALMAN (HYMENOPTERA : TORYMIDAE) FROM INDIA, WITH A REVISED KEY TO INDIAN SPECIES

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INTRODUCTION

The genus *Megastigmus* was described by Dalman in 1820 with *Pteromalus bipunctatus* Swederus as its type species. This genus belongs to the subfamily Megastigminae of the family Torymidae. This genus consists of 133 species worldwide of which 20 species were reported from the Oriental Region and 8 species from India (Noyes, 2003; Sureshan, 2009). Most species are phytophagous but some are parasitic in gall-forming insects (Narendran, 1994; Noyes, 2003). In this paper, two new species viz., *Megastigmus sonneratae* Narendran and Girish Kumar sp. nov. emerged from the leaf galls of the mangrove plant *Sonneratia apetala* Buch. Ham and *Megastigmus dharwadicus* Narendran and Vastrad sp. nov. emerged from the galls of *Eucalyptus*, are described. The new species *M. dharwadicus* is an important parasitoid of *Leptocybe invasa* Fisher and LaSalle which is a serious invasive pest (Narendran, 2007; Mendel *et al.*, 2004) of *Eucalyptus* in India and adjacent countries. A revised key to separate Indian species of *Megastigmus* is also provided.

The type specimens are deposited at the 'National Zoological Collections' of the Zoological Survey of India, Kolkata (NZSI).

MATERIALS AND METHODS

The leaf galls of the plant *Sonneratia apetala* and *Eucalyptus* were collected and reared in the laboratory from which the parasites emerged out. The specimens

were card mounted and studied under a stereozoom microscope (Wild Heerbrugg made in Switzerland) and drawings were made using the drawing tube of the microscope.

The following abbreviations are used in the text: F1-F2 = Funicular segments 1 and 2; MV = Marginal vein; NZSI = 'National Zoological Collections' of the Zoological Survey of India, Kolkata; OOL = Ocellocular distance; PMV = Postmarginal vein; POL = Postocellar distance; SMV = Submarginal vein; STV = Stigmal vein; T1- T2 = Gastral tergites 1 and 2.

RESULTS

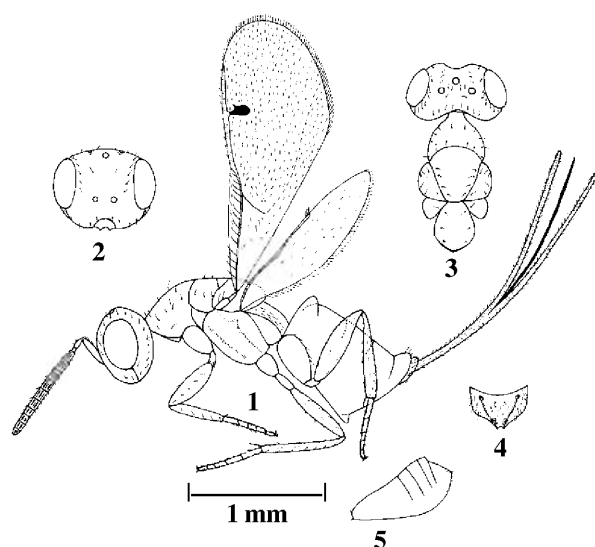
1. *Megastigmus sonneratae* Narendran and Girish Kumar sp. nov. (Figs. 1- 5)

Female : Holotype : Length 2.51 mm (excluding exerted ovipositor, 2.06 mm). General body colour yellow with gaster a little darker; antenna yellowish brown with scape and pedicel brownish yellow; eye brownish red; ocelli reflecting yellow; tegula concolorous with thorax; wings hyaline, veins pale brown; ovipositor sheath black. Pubescence in general pale brownish yellow with stouter setae on head, thorax and legs darker.

Head : Width in dorsal view (Fig. 3) 2.44x length, 1.76x as long as pronotal width; head width in anterior view (Fig. 2) 1.26x its median length; vertex convex, cross striate, with bristles black; POL 2.5x OOL; occiput moderately emarginate; vertex with six large brown setae

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Figs. 1-5 : *Megastigmus sonneratae* Narendran and Girish Kumar sp. nov.

Female : Fig. 1. Body profile. Fig. 2. Head front view. Fig. 3. Pronotum, mesoscutum and scutellum. Fig. 4. Propodeum.

Male : Fig. 5. Gaster.

on occipital margin submedially; an oblique line of strong setae on each parascrobal space (Fig. 2); clypeus demarcated with lower margin incised. Antenna inserted a little above level of ventral margin of eye; antennal formula 11173; scape not reaching front ocellus, pedicel as long as F1; ring segment shorter than half of pedicel; F1 shorter than F2; length of clava longer than preceding two segments.

Thorax : Pronotum 1.66x as broad as long, very finely transversely striated; mesoscutum with anterior one third smooth and shiny, remaining part striate reticulate, striae stronger than those of pronotum; scapulae transversely striated; mesoscutum with 5 pairs of setae, each scapulae with 7 setae on outer margin (arranged in two rows; 3 pairs outer; 4 pairs towards middle), 2 setae near inner margin. Scutellum as long as broad, transversely reticulate, with a median shallow sulcus extending upto middle; scutellum with 3 pairs of setae (one pair at the frenal area); frenal furrow indistinct, frenum longitudinally rugose. Dorsellum smooth. Propodeum (Fig. 4) 0.55x length of scutellum, with submedian grooves and few median shallow short grooves; surface of propodeum transversely and irregularly reticulate. Forewing (Fig. 1) length 2.54x its maximum width; costal cell narrow with pubescence in distal half, proximal half bare; basal cell with some

pubescence (about 8 setae in number), open basally; speculum very narrow, almost absent, closed below; MV a little shorter than half length of costal cell, subequal to PMV; 2.3x as long as STV; STV 1.64x as long as broad. Legs with minute pubescence with the following parts having thick setae: fore femur, fore tibia, mid tibia, hind coxa and hind tibia.

Gaster : As long as thorax; first tergite deeply emarginate on posterior margin; ovipositor sheath as long as combined length of thorax and gaster, 2x as long as thorax, 2x as long as gaster.

Male : Length 1.74-2.04 mm. Resembles female but differs in having: slightly dull in colour, propodeum and gaster darker; median sulcus of scutellum very shallow; clava flattened; gaster as in figure 5.

Host : Emerged from the leaf galls of *Sonneratia apetala* Buch. Ham (Family : Lithraceae), a mangrove plant commonly known as 'Mangrove Apple', which is one of the most common plants in Sunderbans mangrove forests.

Biology : Unknown.

Distribution : India : West Bengal; Sunderbans Biosphere Reserve.

Etymology : The species name is derived from the generic name of the host plant, *Sonneratia*.

Material examined : Holotype. Female, India : West Bengal, S- 24 Parganas dist., Sunderbans Biosphere Reserve, Netidhopani, 31.iii.2008, Coll. Girish Kumar, P. (NZSI Reg. No. 11813/H3). Paratypes. 1 Female and 2 Males, same collection data of the holotype. (NZSI Reg. Nos. 11814/H3 to 11816/H3).

Discussion : This new species comes close to *Megastigmus karnatakensis* Narendran, 2002 but distinctly differs from it in having: (1). Scapulae with 2 setae near inner margin (in *M. karnatakensis* scapulae with 3 or 4 setae near inner margin); (2). Ovipositor sheath 2x as long as thorax (in *M. karnatakensis* ovipositor sheath 2.7x as long as thorax); (3). Basal cell of forewing with some pubescence (about 8 setae in number) (in *M. karnatakensis* basal cell bare); (4). Speculum of forewing absent, setose (in *M. karnatakensis* speculum present); (5). Forewing length 2.54x its maximum width (in *M. karnatakensis* forewing length 3.17x its maximum width); (6). Gaster as long as thorax (in *M. karnatakensis* gaster distinctly longer (1.22x) than thorax).

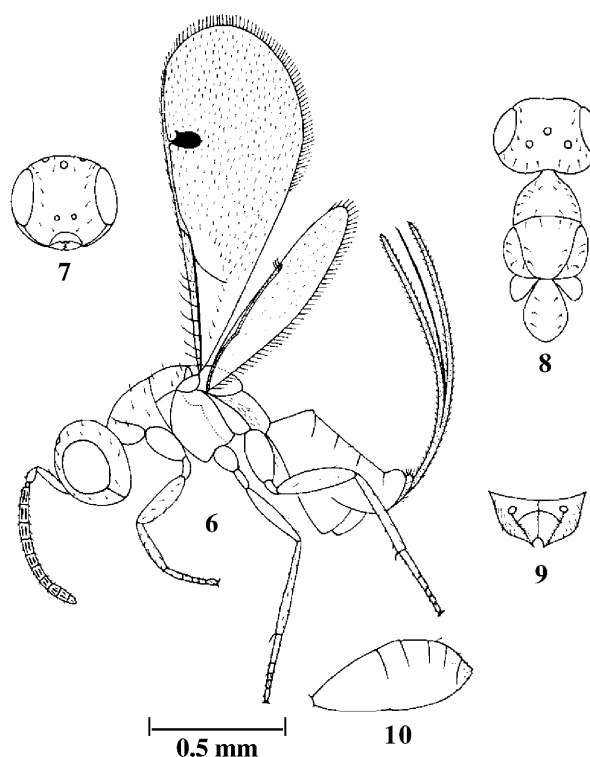
This new species also comes close to *Megastigmus viggianii* Narendran and Sureshan, 1988 but distinctly differs from it in having: (1). Frenum longitudinally rugose (in *M. viggianii* frenum nearly smooth); (2). Lower clypeal margin incised in the middle (in *M. viggianii* lower clypeal margin not distinctly bilobed or incised in the middle); (3). F1 shorter than F2 (in *M. viggianii* F1 longer than F2); (4). POL 2.5x OOL (in *M. viggianii* POL nearly twice OOL).

2. *Megastigmus dharwadicus* Narendran and Vastrad
sp. nov. (Figs. 6-10)

Female : Holotype : Length 1.67 mm (excluding exerted ovipositor, 1.15 mm). General body colour yellowish brown with small brownish black patches scattered on head and thorax; gaster mostly black with pale yellow on sides of T1 and T2, tegula concolorous with thorax; ovipositor sheath brownish black. Antenna brown with scape and pedicel yellowish beneath. Eye pale reddish brown; ocelli reflecting yellow. Wings hyaline with veins and pubescence brown, stigma dark brown, uncus transparent. Legs concolorous with the body.

Head : In dorsal view, head (Fig. 8) width 1.44x length, about 1.62x as long as pronotal width, moderately long and sparse bristles on vertex and face; vertex, frons and face below antenna finely striate reticulate; occipital carina distinct; POL 2.5x OOL. In front view, head (Fig. 7) 1.19x as broad as high; gena smooth and shiny; malar space 0.32x as long as eye; malar groove distinct; eye moderately protruded, length 1.16x width; scrobe deep and shiny, not reaching front ocellus. Antenna inserted above level of ventral margin of eye; antennal formula 11173; scape not reaching front ocellus, pedicellus plus flagellum 3.8x as long as scape, F1 shorter than pedicel and ring segment combined; ring segment distinctly shorter than half of pedicel; anellus elongated, terminal funicular segments a little shorter, others are of equal length, with a single row of long sensillae, clava 2.6x as long as preceding segment, 3x or a little more than 3x as long as wide.

Thorax : With rather weak cross striations except on pronotal collar and midlobe of mesoscutum a little coarser, with brown bristles. Pronotal collar 1.5x as broad as its median length and distinctly shorter than midlobe of mesoscutum. Mesoscutum 1.13x as broad as long,



Figs. 6-10 : *Megastigmus dharwadicus* Narendran and Vastrad sp. nov.

Female : Fig. 6. Body profile. Fig. 7. Head front view. Fig. 8. Pronotum, mesoscutum and scutellum. Fig. 9. Propodeum.

Male : Fig. 10. Gaster.

notauli complete. Scutellum as long as mesoscutum medially, 1.25x as long as broad, frenal furrow vaguely indicated. Dorsellum smooth. Propodeum (Fig. 9) medially 0.6x as long as scutellum; median area irregularly and finely reticulate; median carina present; cross carina present as in figure 9; callus with dense white hairs, base of each hair with reddish brown spot; spiracle oval, separated by its own diameter from hind margin of metanotum; postspiracular sulcus distinct. Prepectus broad, triangular, finely reticulate. Mesopleuron and metapleuron finely striate reticulate. Forewing (Fig. 6) 2.41x as long as broad; basal vein distinct, running obliquely to SMV, almost half as long as MV; MV 0.54x as long as costal cell; basal cell partly closed; cubital hair line complete; costal cell hairy in distal area; speculum present, closed below; stigma conspicuous with uncus distinct, stigmal lobe oval shaped, stigma 1.9x as long as broad (excluding uncus). Relative lengths of veins: SMV 17.5, MV 9.5, STV 3.8, PMV 8.5. SMV 1.92x as long as MV; STV 0.44x as long

- F1 shorter than (or at the most equal to) combined length of pedicel and ring segment 4
 - 3. Length of ovipositor 1.25x combined length of thorax and gaster; body yellow. Philippines (extralimital) .
..... *M. immaculatus* Ashmead*
 - Length of ovipositor 1.09x combined length of thorax and gaster; body yellow with dark tinge or patches on some parts of thorax and gaster. Host: fruits of *Dalbergia sericea*. Indonesia : Java (extralimital) ..
..... *M. leeuweni* Ferriere*
 - 4. Thorax dorsally metallic green; F1 equal to pedicel and ring segment combined. Host: parasitic on Cynipidae on *Quercus*. Europe; India: Uttar Pradesh
..... *M. dorsalis* (Fabricius)
 - Thorax dorsally yellowish brown; F1 shorter than pedicel and ring segment combined 5
 - 5. Ovipositor one fifth of metasoma; scutellum with a median groove; F1 equal to pedicel; general colour orange with base of propodeum black medially and with four black cross stripes on gaster; in habits on twigs of swellings on wild lemon Australia; India...
..... *M. brevivalvus* (Girault)*
 - Characters not as above, partly or completely different 6
 - 6. Ring segment of antenna about half as long as pedicel; forewing with stigmal lobe narrow and elongate, basal vein weakly distinct. Host: seeds of *Cupressus torulosa*. India: Himachal Pradesh, Punjab
..... *M. cupressi* Mathur*
 - Ring segment distinctly shorter than half of pedicel; forewing with stigmal lobe not as above, mostly oval or semicircular; basal vein clearly distinct ... 7
 - 7. Ovipositor 2x or more than 2x as long as gaster 8
 - Ovipositor less than 2x as long as gaster 10
 - 8. Frenum nearly smooth; lower clypeal margin not distinctly bilobed or incised in the middle; F1 longer than F2; POL nearly twice OOL. Host: bud galls of *Calycopterys floribunda*. India: Kerala.....
..... *M. viggianii* Narendran and Sureshan
 - Frenum longitudinally rugose; lower clypeal margin incised in the middle; F1 as long as or shorter than F2; POL 2.3- 2.5x OOL 9
 - 9. Scapulae with 2 setae near inner margin; ovipositor sheath 2x as long as thorax; basal cell of forewing with some pubescence (about 8 setae in number); speculum of forewing absent, setose; forewing length 2.54x its maximum width; gaster as long as thorax. Host: leaf galls of *Sonneratia apetala*. India: West Bengal *M. sonneratiae* Narendran and Girish Kumar sp. nov.
 - Scapulae with 3 or 4 setae near inner margin; ovipositor sheath 2.7x as long as thorax; basal cell bare; speculum present; forewing length 3.17x its maximum width; gaster distinctly longer (1.22x) than thorax. Hosts: Psychid (*Pteroma* sp.) from *Rhizopora mucronata* and parasitic on borers of *Sonneratia* seeds. India: Karnataka
..... *M. karnatakensis* Narendran
 - 10. POL as long as OOL; SMV about 7x as long as MV; STV about as long as MV; antennal club about 1.7x as long as preceding segment; scape 3.75x as long as pedicel. Host: pods of *Albizia*. India: Delhi, Tamil Nadu *M. albizziae* Mukerji
 - POL 2.3- 2.5x OOL; SMV 1.92- 2.33x as long as MV; STV 0.44-0.52x as long as MV; club 2.3- 2.6x as long as preceding segment; scape 2.17- 2.6x as long as pedicel 11
 - 11. Propodeum (Fig. 9) with cross carina; scape not reaching front ocellus; propodeal spiracle separated by its own diameter from hind margin of metanotum; malar space 0.32x as long as eye; mesoscutum 1.13x as long as broad; forewing with cubital hairline complete, speculum present; ovipositor sheath 1.78x as long as gaster, 3.23x as long as hind tibia. Host: tender leaf and stem galls of *Eucalyptus*. India: Karnataka *M. dharwadicus* Narendran and Vastrad sp. nov.
 - Propodeum without such a cross carina; scape exceeds level of vertex; spiracle separated by 1.5x its own diameter from hind margin of metanotum; malar space half as long as eye; mesoscutum 1.5x as long as broad; cubital hairline incomplete, speculum very narrow, almost absent; ovipositor sheath 1.5x as long as gaster, 2.3x as long as hind tibia. Host: Associated with wild rose *Rosa webbiana*. India: Jammu & Kashmir
..... *M. kashmiricus* Sureshan
- * Names with an asterisks indicate no material of the species was examined and the differential features

provided are from the previous descriptions and publications.

SUMMARY

Two new species of *Megastigmus* Dalman viz., *M. sonneratae* Narendran and Girish Kumar sp. nov. and *M. dharwadicus* Narendran and Vastrad sp. nov. are described from India and their affinities to the closest relatives are discussed. A revised key to the Indian species of *Megastigmus* is also provided.

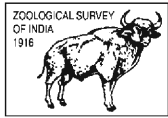
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eucalypti Girault in spite of the poor condition of these types. He also thanks Dr. Zerova M.D. and Dr. Victor Fursov of Shmalhausen Institute of Zoology, Ukraine for supplying and translating the key to *Megastigmus* of Palaearctic Region. Second author (P. G. K.) is grateful to Dr. Ramakrishna, Director, Zoological Survey of India, Kolkata, Dr. T. K. Pal, Additional Director & Officer-in-Charge of Entomology Division (A), Zoological Survey of India, Kolkata and Dr. S. I. Kazmi, Officer-in-Charge of Hymenoptera Section, Zoological Survey of India, Kolkata for giving an opportunity to participate in the Sunderbans expedition and providing necessary facilities and encouragements. Third author (A. S. V.) is grateful to the authorities of the University of Agricultural Sciences, Dharwad, Karnataka, for providing necessary research facilities.

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AMPHIBIANS OF KARLAPAT AND KONARAK-BALUKHAND WILDLIFE SANCTUARIES, ORISSA

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27, Jawaharlal Nehru Road, Kolkata-700016*

INTRODUCTION

Orissa with its varied topography is a storehouse of biological reserves. The State has a diversified topography that consists of hills, valleys, deciduous, evergreen and scrub forests, and estuarine as well as man-made forests. The forest area of Orissa is about 38% of its geographical area and the whole of the State abounds in natural reserves and wildlife sanctuaries. Whether it be the verdant plains or the hilly terrain, wildlife in Orissa is present everywhere. The diversified ecological niches and environmental settings of Orissa provide an excellent home for a rich and diversified amphibian fauna.

Karlapat Wildlife Sanctuary (19°41' N, 83°09' E) is a small but beautiful sanctuary located about 35 km from Bhawanipatna town in Kalahandi district of south-western Orissa, on the Bhawanipatna-Thuamula-Rampur road. The nearest railhead is the Kesinga Railway Station. This dense patch of lush green dry deciduous forest, covering an area of 147.66 sq km was upgraded to a sanctuary in 1992. The undulating topography of this sanctuary with low hills and vegetated valleys that form part of the Eastern Ghats of Peninsular India, as well as perennial streams and deep-water pools gives it a unique charm. The main vegetation consists of dry deciduous forests and lush green scrub jungles. This supports the wildlife population of this sanctuary which consists of Sambhar, Gaur, Nilgai, Barking deer, Mouse deer, Wild boar, Black-naped Hare, Porcupine, Indian Pangolin, Common Mongoose, Small Indian Mongoose, Leopard, Jungle Cat, Civets, Jackal, Hyena, Indian Wolf, Ratel and Sloth Bear. Besides, this

sanctuary also houses a rich variety of avian fauna and a wide variety of reptiles and amphibians.

There are several villages in or around the sanctuary, viz., Jaccum, Karlapat, Bedkot, Mundguda, Mendiabiri and Jugsahi-patana with small, slow-flowing but beautiful hill-streams cascading down beside them. The Khanduala waterfall situated at the foot of a hill adds to the charm of this sanctuary. The top of this hill is referred to as the abode of Goddess Khandula. The rippling flow of the Patalganga river gives rise to a beautiful waterfall named Phuljharan or Phurlijharan. This is a perennial source of water quenching thirst of many a wild denizen of this forest when the scorching overhead sun parches the landscape.

METHODOLOGY

One survey was conducted from 22nd to 31st August, 2008 by a three-member team from Zoological Survey of India, Kolkata. Due to naxalite problems in the forest area, the team had to stay at the nearest town (Bhawanipatna) and visit the Sanctuary everyday. Due to restrictions by the Orissa Forest Department, collections of specimens were not allowed.

Surveys were conducted daily both during the day and in the evening till late hours by hiring a jeep consecutively for seven days from 23-29 August, 2008. During the daytime all big and small water bodies inside the sanctuary, especially those near the several villages inside the sanctuary were surveyed. Many hill-streams flowing down from the low hills inside the sanctuary were also surveyed.

During the evenings these water bodies and hill-streams were again visited and the amphibians in or

near them were observed using powerful flashlights. The calls of the different species were recorded with an AIWA JS-195 audio cassette recorder and those species which could not be directly observed were identified from their distinct species-specific calls.

OBSERVATIONS

The following amphibians were observed or located in the sanctuary during this short survey:

Family BUFONIDAE

1. *Bufo stomaticus* Lutken, 1862

1862. *Bufo stomaticus* Lutken, *Vidensk. Meddr. Dansk. Naturh. Foren.*, **14** : 305.

Common Name : Marbled Toad (English).

Specimens Examined : 3 ex (1 male and 2 females) from Jaccum and 5 ex (2 males, 1 female and 2 juveniles) from Karlapat.

Size : 28-86 mm (Snout-vent length).

Diagnostic features : Medium-sized toads. Head broader than long, without any bony ridges. Snout rounded, nostril nearer to the tip of snout than the eye. Tympanum distinct, circular or oval and nearly two-third the diameter of the eye. Parotoid glands large, flat and elliptical but not bean-shaped.

Fingers without webs, the first finger is longer than the second. Tips of fingers and toes are swollen. Toes are two-third webbed with two phalanges of the fourth toe free. Both inner and outer metatarsal tubercles present, which are oval with sharp edges. Hind limbs are short, the tibio-tarsal articulation reaches between the tympanum and the eye, when the hind leg is held parallel to the body.

There are several irregular flat warts on the dorsum. Ventrums coarsely granular except the chin and throat.

Colour : Dorsum brownish or olive-gray, sometimes marbled. Ventrums white, belly and lower lip dull whitish. Juveniles are light brown with dark marblings.

Habitat : Drier and semi-arid regions of the Sanctuary, mostly in the plains. Dry deciduous forest areas also preferred but are seen near water bodies during the breeding season. Often found in association with Common Indian toads in the same habitat.

Remarks : The species is not uncommon. Usually solitary, terrestrial and nocturnal but also active during

daytime. Burrows in sandy soil and found under stones and crevices of tree-trunks.

2. *Duttaphrynus melanostictus* (Schneider, 1799)

1799. *Bufo melanostictus* Schneider. *Hist. Amph.*, **1** : 216.

Common Name : Common Indian Toad (English).

Specimens Examined : 6 ex (3 males, 1 female and 2 juveniles) from Jaccum, 9 ex (7 males and 2 females) from Karlapat, 4 ex (1 male and 3 females) from Bedkot, 3 ex (2 males and 1 female) from Mundguda, 5 ex (2 males, 1 female and 2 juveniles) from Mendiabiri.

Size : 35-109 mm (Snout-vent length).

Diagnostic features : Large-sized toads. Head is broader than long with cornified bony ridges. Snout is rounded. Nostril is nearer to the tip of the snout than the eye. Tympanum is distinct, circular or oval, nearly two-third the diameter of the eye. Parotoid glands are large and bean-shaped.

Fingers are without webs, the first finger is equal to or little longer than the second. Tips of fingers and toes are swollen. Toes are partly webbed with more than three phalanges of the fourth toe free. Both inner and outer metatarsal tubercle present. The tibio-tarsal articulation reaches in between the tympanum and the eye when the hind leg is held parallel to the body.

Skin is rough with several black-tipped spiny warts on the dorsum. Ventrums also rough in texture.

Colour : Uniformly grayish or dark brownish with a few yellow or pink coloured spots on the dorsum. Ventrums dull white with a yellowish tinge. Juveniles are black or dark gray on the dorsum but the ventrum is uniform white or speckled with black.

Habitat : Found inside forest areas among leaf-litter, beside rain-water pools and ponds and also along the roadsides. Also hide under logs, stones, in moist holes and huddle together in crevices of tree-trunks.

Remarks : Very common throughout the Sanctuary. Terrestrial and nocturnal, they seem to be well-acquainted with their habitat and return to the same site again and again. Usually solitary but congregate during the breeding season near water-bodies. Highly territorial during this time of the year. Juveniles wander on land during mornings and afternoons, if the air-temperature is sufficiently low. Adults are seen

throughout the year, even in winter months if the temperature does not fall severely. They do not seem to hibernate.

Family MICROHYLIDAE

3. *Microhyla ornata* (Dumeril and Bibron, 1841)

1841. *Engystoma ornatum* Dumeril & Bibron, *Erp. Gen.*, **8** : 745.

Common Name : Ornate narrow-mouthed frog, Ornate Microhylid frog (English).

Specimens Examined : 5 ex (4 males and 1 female) from Jaccum, 3 ex (all males) from Karlapat, 6 ex (4 males and 2 females) from Bedkot, 2 ex (both males) from Mundguda, 1 ex (male) from Mendiabiri and 2 ex (1 male and 1 female) from Jugsahi-patana.

Size : 18-26 mm (Snout-vent length).

Diagnostic features : Small-sized, stout, active and agile frogs with small arrow-shaped head and bulging eyes. Head broader than long, snout somewhat pointed and projects beyond the narrow mouth. Tongue elliptical. Nostril is nearer to the tip of the snout than the eye. Pupil circular. Tympanum indistinct.

Fingers rather slender and do not bear webs. The first finger is shorter than the second. Tips of fingers are dilated into small discs. Toes are minutely webbed at the base and the tips are dilated into small discs, devoid of grooves. Metatarsal tubercles are distinct, the inner being more well-developed. Hind limbs are moderately long and the tibio-tarsal articulation reaches the eye, when the hind limb is held parallel to the body.

Skin is smooth with a distinct supratympanic fold.

Colour : The body colour matches that of the soil. The dorsum is grayish-brown or reddish-brown with a distinct dark brown diamond-shaped marking on the back, beginning between the eyes, extending to both the upper eyelids, narrowing behind the head and widening above the shoulder, then narrowing again and finally broadening out and sending a stripe to the groin and the thigh. A dark streak extends along the sides from behind the eye to the shoulder. Limbs with dark brown cross bars. Ventrums dull whitish, with throat and chest stippled with brown.

Habitat : Found among moist leaf-litter in both deciduous and evergreen forests all over the Sanctuary.

Remarks : Very common. Can call very loudly and jump a long distance when compared to its small size.

4. *Ramanella variegata* (Stoliczka, 1872)

1872. *Callula variegata* Stoliczka, *Proc. Asiat. Soc. Beng.*, : 111.

Common Name : Variegated Ramanella (English).

Specimens Examined : 2 ex (both males) from Jaccum, 5 ex (4 males and 1 female) from Karlapat, 1 ex (male) from Bedkot, 2 ex (1 male and 1 female) from Mundguda and 1 ex (male) from Mendiabiri.

Size : 22-41 mm (Snout-vent length).

Diagnostic features : Head is broader than long. Snout is rounded, longer than the diameter of the eye and projects beyond the mouth. Nostril is nearer to the tip of the snout than the eye. Inter-orbital space is flat and much broader than the upper eyelid. Tympanum is hidden.

Fingers are rather long with enlarged triangular terminal discs, first finger is shorter than the second but only slightly shorter than the fourth. Toes with rudimentary web and dilated tips. Outer metatarsal tubercle very small and conical but the inner metatarsal tubercle is large and oval.

Skin is smooth but granular near the vent.

Colour : Dorsum brown with yellow marblings or spots, upper surface of the limbs are also with marblings. Ventrums white with no stable pattern. Males have brownish-black throat.

Habitat : All kinds of small temporary rain-water pools inside the forest especially the ones with grasses and emergent weeds.

Remarks : Quite common in the Sanctuary. They can also climb up tree-trunks.

5. *Kaloula taprobanica* Parker, 1934

1934. *Kaloula pulchra taprobanica* Parker, *Trust. Brit. Mus. London* : 86-87.

Common Name : Painted Frog, Indian Painted Frog, Painted Kaloula (English).

Specimens Examined : 2 ex (both females) from Karlapat, 2 ex (male and female) from Mundguda and 1 ex (male) from Mendiabiri.

Size : 25-58 mm (Snout-vent length).

Diagnostic features : Medium-sized, toad-like, colourful burrowing frog. Head is broader than long. Snout is rounded. Nostril is nearer to the tip of the snout than the eye. Tympanum is hidden. Tongue is elliptical.

Fingers are without webs. The first finger is shorter than the second. Tips of the fingers bear short well-developed truncate discs. Subarticular tubercles of the fingers and toes are prominent. Toes are about one-third webbed and bear dilated triangular discs. Inner metatarsal tubercle is well-developed, large and shovel-shaped. Outer metatarsal tubercle is small.

Dorsum is rough with scattered warts. Skin is wrinkled on the belly but granular on the throat and underside of the thighs.

Colour : Dorsum is blackish-brown or grayish-brown with brown or deep red spots and patches margined with black. A dark reddish lateral band runs on each side from the eyes to the groin of the hind feet. The belly is light brownish or white, spotted with grey. Males have black throat during breeding season.

Habitat : Open forests at the edge of the Sanctuary. Breeds in dirty ponds and pools.

Remarks : Not uncommon, the species is very colourful. They are terrestrial, burrowing and nocturnal, emerging from their burrows during the monsoon, sometimes even during the day and are often seen to climb up trees, where they are found in holes in tree-trunks, infested with termites, about one and a half meters above the ground.

6. *Uperodon globulosus* (Gunther, 1864)

1864. *Cacopus globulosum* Gunther, *Rept. Brit. India* : 416.

Common Name : Balloon Frog, Greater Balloon Frog (English).

Specimens Examined : 1 ex (male) from Karlapat, 1 ex (male) from Bedkot and 1 ex (female) from Mundguda.

Size : 40-66 mm (male), 60-84 mm (female).

Diagnostic features : Medium-sized, rotund, toad-like burrowing frogs with small beady eyes. The head is small relative to the body and is broader than long. Snout is rounded. Nostril is equidistant between the tip of the snout and the eye. Inter-orbital width is two to three times the width of the upper eyelid. Tympanum is indistinct. Tongue is oval.

Fingers are without webs, the first finger is shorter than the second. Tips of the fingers are rounded but without any disks. Subarticular tubercles are not so prominent. The hind limbs are short. Toes are with a rudiment of web. Two well-developed, large and shovel-shaped inner and outer metatarsal tubercles are present. The tibio-tarsal articulation does not reach the shoulder, when the hind leg is held parallel to the body.

Skin is smooth, soft and soggy on the dorsum but the wrinkled on the ventrum. Anal region is granular. Supratympanic fold is present.

Colour : Reddish-brown or grey on the dorsum but dirty white on the ventrum with tinges of yellow during the breeding season. Throat is black in the breeding male.

Habitat : Open mixed forest with loose sand and soft gravel, littered with piles of decaying logs infested with termites. Also found on stream-beds having damp soil.

Remarks : Not uncommon but emerges from the under ground only during the breeding season in early monsoon.

7. *Uperodon systoma* (Schneider, 1799)

1799. *Rana systoma* Schneider, *Hist. Amph.*, : 144.

Common Name : Marbled Balloon Frog, Lesser Balloon Frog (English).

Specimens Examined : 1 ex (male) from Bedkot, 3 ex (1 male and 2 females) from Mundguda and 2 ex (both males) from Mendiabiri.

Size : 55-65 mm (Snout-vent length).

Diagnostic features : Toad-like medium-sized burrowing frog with plump body and soft soggy skin. The eyes are relatively bigger than the Greater Balloon frog but the distance between the eyes is less than twice the width of the upper eyelid. Head is wedge-shaped and broader than long. Snout is rounded and equal to the diameter of the eye. Nostril is equidistant between the tip of the snout than the eye. Tympanum is hidden.

Fingers are free of webbing. First finger is shorter than the second. Tips of the fingers do not bear discs. Toes are rather short and webbed at the base. Inner metatarsal tubercle is twice as large as the outer

metatarsal tubercle but smaller than that of the Greater Balloon frog. Hind limbs are short and the tibio-tarsal articulation reaches the shoulder.

Skin smooth but soggy, granular at the anal region and on the underside of the thighs.

Colour : Olive, greenish-yellow or pinkish on the dorsum, marbled or spotted with dark brown resembling a leopard's coat to some extent. Ventrums whitish but throat and belly creamy yellow, mottled with brown. Throat is blackish in breeding males. In older males, the black vocal sac hangs down the chin in the form of a flap. No median line.

Habitat : Scrub and deciduous forests, often found under stones and logs.

Remarks : Not uncommon but emerges only during the breeding season. Calls like the bleating of a goat. Adults feed mainly on termites.

Family DICROGLOSSIDAE

8. *Euphlyctis cyanophlyctis* (Schneider, 1799)

1799. *Rana cyanophlyctis* Schneider, *Hist. Amph.*, 1 : 137.

Common Name : Skittering Frog, Skipping Frog, Skipper Frog, Water frog (English).

Specimens Examined : 5 ex (2 males and 3 females) from Jaccum, 7 ex (5 males and 2 females) from Karlapat, 2 ex (both females) from Bedkot, 3 ex (3 females) from Mundguda.

Size : 30-69 mm (Snout-vent length).

Diagnostic features : Medium-sized pond frogs. Head is broader than long. Snout is rounded. Nostril is equidistant between tip of snout and eye. Tympanum is distinct, nearly equal to diameter of eye.

Fingers are without webs, the first finger is equal to the second. Tips of the fingers are pointed. Subarticular tubercles are less prominent. Toes are fully webbed. Tips of the toes are swollen and rounded. A pointed toe-like inner metatarsal tubercle is present. Outer metatarsal tubercle is absent. Tibio-tarsal articulation reaches between the tympanum and nostril, when the hind leg is held parallel to the body.

Small warts are present on the dorsum. Ventrums are smooth with a single row of porous warts on each flank.

Colour : Dorsum grey, grayish-brown or grayish-black with darker rounded spots and stripes on the

limbs. Ventrums white with black spots. There is a dark-edged white band on the hinder under part of the thighs.

Habitat : Commonest frog found in all types of water-bodies inside the forest especially the permanent ones with standing water. Active throughout the year. They spend most of their time in the water or in the vicinity of water-bodies but may migrate onto land in the summer months when the temporary pools of water dry up.

Remarks : They float passively in water with only the nostrils projecting above the surface but when disturbed, can skip smoothly over the water for some distance and then float above the surface with the hind legs held parallelly.

9. *Fejervarya orissaensis* (Dutta, 1997)

1997. *Limnonectes orissaensis* Dutta, *Hamadryad.*, 22(1) : 1-8.

Common Name : Orissa Cricket Frog (English).

Specimens Examined : 3 ex (males) from Jaccum, 5 ex (2 males and 3 females) from Karlapat, 2 ex (both females) from Bedkot, 4 ex (3 males and 1 female) from Mundguda and 1 ex (male) from Mendiabiri.

Size : Snout-vent length : males (36.2-47.2 mm), females (34.2-53.8 mm).

Diagnostic features : Medium-sized frog with interrupted longitudinal folds on dorsum, smooth ventrum, wider and longer inner metatarsal tubercle and relatively pointed snout. Shorter hind limbs, more rounded finger and toe tips and a greater degree of webbing on the toes.

Head longer than wide, depressed. Snout pointed, extending beyond the mouth, internarial distance broader than the interorbital width. Narial openings dorsolateral. Tympanum distinct, rounded, diameter less than eye diameter with supratympanic fold extending from posterior corner of eye to forelimbs. Vomerine teeth distinct.

Finger and toe tips rounded, slightly swollen. First finger longer than second, third equal to or slightly longer than first. Subarticular tubercles rounded. Fingers not webbed. Hind limbs moderately long, with two metatarsal tubercles. Inner metatarsal tubercle oval and larger than outer metatarsal tubercle. Longitudinal ridge

extending from anterior border of outer metatarsal tubercle to tip of fifth toe. Subarticular tubercles rounded, similar to those on fingers. Webbing of fourth extends less than half way between distal and penultimate subarticular tubercles, that on fifth toe extends beyond distal subarticular tubercle.

Skin on dorsum of head smooth but body covered with interrupted, longitudinal ridges with small rounded ridges towards posterior border of body. Skin on flanks and chin smooth. Skin on belly and proximal ventral surfaces of thigh smooth.

Colour : Dorsum brown, grey or brick red. A V-shaped marking between eyes which is interrupted by a vertebral band, with or without yellowish narrow or wide vertebral band extending from tip of snout to vent. A X-shaped black patch on middle of body, limbs with complete or incomplete dark cross bars. Sides of thigh yellowish white with black speckles, jaw margins with black vertical bars.

Habitat : Found during monsoon on grassy lands near water pools.

Remarks : The species is very common. When disturbed jump into water but immediately returns to the edges. Active at night but hides in grass, below rocks or in small holes near water during the day. Eggs are laid in open temporary rain-water pools, the larvae are free-swimming.

10. *Fejervarya syhadrensis* (Annandale, 1919)
1919. *Rana syhadrensis* Annandale, *Rec. Ind. Mus.*, **6** : 121-125.

Common Name : Syhadra Cricket Frog (English).

Specimens Examined : 5 ex (2 males and 3 females) from Jaccum, 3 ex (2 males and 1 female) from Karlapat, 2 ex (both females) from Bedkot, 4 ex (2 males, 1 female and 1 juvenile) from Mundguda and 2 ex (both females) from Mendiabiri.

Size : 27-32 mm (males) and 29-40 mm (females).

Diagnostic features : The body is spindle-shaped. The head is pointed with the snout very distinctly jutting over the lower jaw. Inter-orbital distance is equal to the inter-narial space. The nostrils are lateral and distinctly closer to the tip of the snout than the eyes. Tympanum is round and hidden, half that of the eye

diameter. Pineal organ is distinctive as a white dot between the eyes.

Finger tips are rounded. The first finger is equal to the second, while the fourth finger is slightly longer than the second. Subarticular tubercles are globular with an oblong oval inner metacarpal tubercle and two additional rounded palmer tubercles.

Toes are webbed with rounded tips. Subarticular tubercles are distinctly smaller than those of the fingers and are rather oval with an oblong inner metatarsal tubercle that is laterally flattened and a very small point-like outer metatarsal tubercle in line with the tarsal fold. A narrow ridge is formed by a series of very small tubercles between the outer metatarsal tubercle and the proximal subarticular tubercle of the fifth toe. The tibio-tarsal articulation reaches between the eye and tip of the snout.

Dorsum is smooth with a few round or slightly oblong tubercles. Glandular folds are shorter with tiny light tubercles in the cloacal and loreal regions, the dorsal part of the lower leg and on the sides of the heel (tarsus). Venter is uniformly smooth.

Colour : Dorsum is grayish to brownish-olive with black irregular spots particularly fused into transverse bands. There are also dark, ring-shaped spots with a paler center and the sides of the body are faintly marbled. A very narrow yellowish-white mid-dorsal line, often interrupted. An inter-orbital band is present.

Fore-limbs are darkly banded and the hind-limbs are dotted on the thighs and striped on the lower leg. Venter of the hand and foot are dark with contrasting pale metacarpal or metatarsal tubercles. Toe webbing is faintly marbled.

Venter is uniformly white with narrow dark bars along the margin of the lower jaw. Males have a blackish-grey and crescent-shaped mark on the throat.

Habitat : Prefers vicinity of water without being really aquatic. They can be encountered far away from water-bodies between trees in Sal forests, near brooks, in open grassland, ools and ditches.

Remarks : Very common. Partly diurnal but only calls nocturnally. During the dry winter months hides in leaf-litter of woods or between buttresses of trees. Males call in the evening and night and are easy to locate.

11. *Hoplobatrachus crassus* (Jerdon, 1853)

1853. *Rana crassa* Jerdon, *J. Asiat. Soc. Beng.*, **22** : 531.

Common Name : Jerdon's Bull Frog (English).

Specimens Examined : 2 ex (both males) from Jaccum, 3 ex (1 male and 2 females) from Karlapat, 1 ex (female) from Mundguda, 2 ex (1 male and 1 female) from Mendiabiri.

Size : 40-86 mm (Snout-vent length).

Diagnostic features : Moderately large-sized flabby-shaped frogs. Head is little broader than long. Snout is generally pointed and projects beyond the mouth. Nostril is equidistant between the tip of the snout and the eye. Tympanum is distinct, nearly equal to the diameter of the eye.

Fingers are without webs, the first finger is longer than the second. Subarticular tubercles are not very prominent. Hind limbs are comparatively shorter, the tibio-tarsal articulation reaches in between the tympanum and the eye, when the hind limb is held parallel to the body. Toes are entirely webbed but deeply notched, with two phalanges of the fourth toe free. Tips of the toes are not pointed. A strongly compressed, shovel-shaped inner metatarsal tubercle is present. Outer metatarsal tubercle is absent.

Skin on the back and limbs is highly granular with some interrupted warts. 6-14 glandular longitudinal folds are present on the back. Ventrums smooth.

Colour : Greyish or greenish-brown with darker stripes or patches on the back. Ventrums whitish with black spots or deep brown stripes on the throat.

Habitat : Spend the day hiding inside crevices on elevated banks of ponds and ditches. They are found during breeding season in temporary rain-water pools.

Remarks : The species is quite common, found along with the Indian Bull frogs. They are terrestrial, nocturnal and also burrow in the ground.

12. *Hoplobatrachus tigerinus* (Daudin, 1803)

1803. *Rana tigerina* Daudin, *Hist. Nat.*, **1** : 42.

Common Name : Bull Frog, Indian Bull Frog (English).

Specimens Examined : 4 ex (3 males and 1 female) from Jaccum, 2 ex (both males) from Karlapat, 1 ex (female) from Bedkot, 2 ex (1 male and 1 female) from

Mundguda and 3 ex (2 males and 1 female) from Mendiabiri.

Size : 40-154 mm (Snout-vent length).

Diagnostic features : Large-sized frogs with smooth skin and longitudinal glandular folds on the back. Head is longer than broad. The snout is somewhat pointed and projects beyond the mouth. The nostril is equidistant between the tip of the snout and the eye. Tympanum is distinct, nearly equal to the diameter of the eye.

Fingers are without webs, the first finger is longer than the second. Tips of fingers and toes are not sharply pointed. Toes are fully webbed but the web does not reach the tip of the fourth toe. The fifth toe is with an outer fringe of web. Subarticular tubercles of the fingers and toes are not very prominent. Inner metatarsal tubercle is short and blunt. Outer metatarsal tubercle is absent. Hind limbs are comparatively long, with the tibio-tarsal articulation reaching the nostril, when the hind limb is held parallel to the body.

Dorsum smooth with longitudinal glandular folds. Ventrums smooth with no porous warts on the flanks. Supratympanic fold present.

Colour : Dorsum yellowish or olive-green with darker leopard-like spots. A yellowish median stripe runs from the tip of the snout to the vent. Ventrums whitish. Limbs are black-barred or spotted.

Habitat : Found among grasses, bushes and on the leaf-litter of the forest floor. Hide inside hollows at the edge of ponds and ditches. Aestivate inside burrows or under heaps of leaves. Seen frequently on the edges of ponds during breeding season into which they leap headlong at the least sign of danger.

Remarks : Very common species. Solitary creatures, which aggregate only during the breeding season. In the non-breeding season, they are difficult to locate but with the appearance of the rainy season their highly resonant call can be heard throughout the night.

13. *Sphaerotheca breviceps* (Schneider, 1799)

1799. *Rana breviceps* Schneider, *Hist. Amph.*, **1** : 140.

Common Name : Indian Burrowing Frog (English).

Specimens Examined : 2 ex (both females) from Jaccum, 1 ex (male) from Karlapat, 1 ex (male) from Bedkot, 2 ex (1 male and 1 female) from Mundguda.

Size : 28-52 mm (Snout-vent length).

Diagnostic features : Stout medium-sized toad-like burrowing frogs. Head is broader than long. Snout is short and rounded, not projecting beyond the mouth. Nostril is equidistant between the tip of the snout and the eye. Tympanum is distinct, more or less half the diameter of the eye.

Fingers are without web. The first finger is longer than the second but equal to the third. Tips of the fingers are swollen but not disc-like. Hind limbs are very short. The tibio-tarsal articulation only reaches upto the shoulder when the hind-limb is held parallel to the body. Subarticular tubercles are well-developed. Toes are slightly webbed with more than three segments of the fourth toe free. A highly developed, large, shovel-shaped inner metatarsal tubercle is present. Outer metatarsal tubercle is small.

Skin is smooth on the dorsum but granular on the belly and underside of the thighs. Sometimes there are small glandular skin folds on the back.

Colour : Dorsum is yellowish-brown or grayish with dark spots or markings. The ventrum is pinkish white and the throat is brownish. Limbs are with irregular dark cross-bars. The underside of the thighs are dark brown with yellowish spots. A yellow median streak is often present.

Habitat : Terrestrial, nocturnal and subterranean, found near water-bodies only during the rainy season for short periods of time, often in association with the Balloon frogs (*Uperodon sp.*).

Remarks : Although the species is not very uncommon, they are seen only at the onset of the monsoon when they come out of their burrows and the males croak near temporary pools of water, usually after a heavy shower.

14. *Sphaerotheca rolandae* (Dubois, 1983)

1983. *Tomopterna rolandae* Dubois, *Alytes.*, **2**(4) : 163-170.

Common Name : Roland's Burrowing Frog (English).

Specimens Examined : 2 ex (both males) from Bedkot, 1 ex (female) from Mundguda and 1 ex (male) from Mendiabiri.

Size : 28-45 mm (Snout-vent length).

Diagnostic features : Small-sized, stout and sluggish burrowing frog. The snout is short and blunt and the

tympanum is distinct. The inner metatarsal tubercle is large and shovel-shaped helping it to dislodge the soil and burrow into the ground. There is a small spur-like extension on the heel. Males have a single external vocal sac.

Colour : Generally pale brown to grayish-yellow, the back is marked with broad and symmetric brownish-black patches. A thin white vertebral stripe is frequently present.

Habitat : Wet stream beds where it buries itself in the sandy bank. Calling males stay close to the water.

Remarks: Uncommon and secretive species, spending most of its time underground. Mostly seen during the nights, especially after the rains. Prefer ants and beetles as food.

Family RANIDAE

15. *Hylarana malabarica* (Tschudi, 1838)

1838. *Rana malabarica* Tschudi, *Classif. Batrachia.*, **3** : 80.

Common Name : Fungoid Frog (English).

Specimens Examined : 1 ex (male) from Mundguda and 1 ex (male) from Mendiabiri.

Size : 55-71 mm (Snout-vent length).

Diagnostic features : Medium-sized terrestrial frog. Snout is obtuse, projecting slightly beyond the mouth. Tympanum is large, equal to the diameter of the eye.

First finger is longer than the second. Tips of the fingers and toes are swollen but not enlarged into discs. Toes feebly webbed with two or three phalanges of the fourth toe free. Subarticular tubercles on fingers and toes are prominent. Inner and outer metatarsal tubercles are distinct. Tibio-tarsal articulation reaches the eye when the hind limb is held parallel to the body.

Dorsal skin smooth or granular with a distinct dorsolateral glandular skin fold from above the tympanum to the groin, along the flanks. A shorter skin fold terminating in a rectal gland below the tympanum or continued as a line of glands along the flanks. Ventrum granular on belly and the underside of the thighs.

Colour : Dorsum bright orange-red or yellowish-red from the tip of the snout to the vent, distinctly separated from the black of the flanks along the side of the snout, upper eyelid and dorso-lateral fold. Upper

lid white and this colour may extend along the line of the glands on the side. Ventrally uniform white or spotted or marbled with black. Throat and chest often brownish black or black. Legs brown or black barred or marbled with yellowish white.

Habitat : Found in Sal forests where it hides under leaf-litter but to some extent semi-arboreal.

Remarks : Species is uncommon. The crimson colour on the back resembles red bark fungus hence the name fungoid frog. Obliterative pattern of the rest of the body breaks the outline, merging the frog into the background. A powerful fungoid odour is also given out under excitement, which smells like burnt rubber.

Family RHACOPHORIDAE

16. *Polypedates maculatus* (Gray, 1834)

1834. *Hyla maculata* Gray, *Indian Zoology*, **1** : 82.

Common Name : Common Tree Frog, Common Indian Tree frog (English).

Specimens Examined : 3 ex (2 males and 1 female) from Jaccum, 2 ex (1 male and 1 female) from Karlapat, 1 ex (male) from Bedkot, 2 ex (both females) from Mundguda and 1 ex (male) from Mendiabiri.

Size: Snout-vent length: 35-65 mm (male), 50-85 mm (female).

Diagnostic features : A medium-sized narrow-waisted tree frog with slender elongated limbs and goggling eyes. Head broader than long, skin on head free with a bony arch. Snout obtusely pointed and projects a little beyond the mouth. Nostril nearer to the tip of the snout than the eye. Inter-orbital space broader than the upper eyelid. Tympanum distinct almost equal to the diameter of the eye. Supratympanic fold present.

Fingers with rudimentary web, the first finger is equal to the second. Subarticular tubercles distinct. Tips of fingers and toes dilated into flattened, spherical and horse-shoe shaped adhesive disks. Toes nearly fully webbed, with two segments of the fourth toe free. Inner metatarsal tubercle present. Tarso-metatarsal articulation reaches between the nostrils and eye when the hind leg is held parallel to the body.

Skin smooth above but granular on the belly and underside of thighs. Sacral vertebrae form a pair of distinct elevations on the back, when the frog is at rest.

Colour : Colouration is highly variable and sometimes depends on the colour of the habitat. Colour varies from brownish, yellowish, grayish or whitish on the dorsum, sometimes with darker spots or patches. Venter white, a dark brown marking extends from the nostril on both sides of the head, covering the eye, down the flanks right upto the middle of the belly. The limbs are cross-barred and the lower side of the thighs marbled with round yellow or brown spots or a purplish network.

Habitat : Moist deciduous forest in trees, bushes, shrubs and in the breeding season sometimes on the ground beside ponds, ditches etc.

Remarks : A very common tree-frog seen on trees and bushes about 1-6 meters above the ground level in all areas of the Sanctuary. Lays eggs in hanging foam-nests near water in which the tadpoles fall and develop.

17. *Philautus* sp

Common Name : Bush Frog (English).

Specimens Examined : 1 ex (male) from Mendiabiri (SVL : 24.7 mm), 1 ex (female) from Munguda (SVL : 28.4 mm) and 1 ex (female) from Jugsahi-patna (SVL : 29.6 mm).

Size : Snout-vent length : 24.7 (male), 28.4-29.6 mm (female).

Diagnostic features : A small-sized slender bush frog with a narrow waist. Head wider than long and obtusely pointed, projecting beyond mandible. Mouth extending upto eye. Vomerine teeth absent. Tongue large, elongate, smooth, bifid and free posteriorly. Nostril nearer to the tip of the snout. Inter-orbital distance about twice the width of the upper eyelid. Tympanum concealed. A very distinct supratympanic fold present.

Finger tips dilated into small, rounded and flattened disks. Largest digital disk is on finger III. Fingers unwebbed. Tips of toes dilated into flattened disks which are wider than on the fingers. Webbing on toe IV less, not upto subarticular tubercle on inner side.

Dorsum of body and upper eyelids with minute scattered conical tubercles. Throat and pectoral region smooth, below pectoral region to inguinal area slightly tubercular. Undersurface of thighs smooth. Cloacal opening postero-ventral, slightly below upper level of thighs.

Colour : Dorsum pale brownish with two dark brown lines from the posterior border of the eye to the mid-body. Upper eyelids and supratympanic fold deep brown. Hind limbs with dark brown and yellow cross bands. Venter dull white, belly with minute black dots.

Habitat : Found on bushes about 1-1.5 meters above the ground.

Remarks : A rare bush frog inhabiting the hilly regions of the Sanctuary beside hill-streams, where they are found on bushes. Call is typical of other *Philautus* sp consisting of several tik-tik-tik sounds emitted at regular intervals.

DISCUSSION

Karlapat Wildlife Sanctuary in Kalahandi district of south-western Orissa consists of low hills which are part of the Eastern Ghats. The topography is undulating, covered with dry deciduous and scrub jungles in between which are lush green vegetated valleys through which flow perennial streams. The soil is red lateritic. This protected area supports a wide diversity of wildlife, a rich variety of avifauna and numerous reptiles as well as amphibians.

The amphibians consist of toads (Family Bufonidae with 2 genera and 2 species), burrowing Frogs (Family Microhylidae with 4 genera and 5 species), semi-aquatic frogs (Family Dicroglossidae with 4 genera and 7 species), terrestrial Frogs (Family Ranidae with 1 genus and 1 species) and tree and bush Frogs (Family Rhacophoridae with 2 genera and 2 species). The semi-aquatic and burrowing frogs are the most numerous while the toads and tree frogs are common. The terrestrial and bush frogs are rare. We observed a total number of 172 examples of amphibians belonging to 17 species under 13 genera and 5 families.

AMPHIBIANS OF KONARAK-BALUKHAND WILDLIFE SANCTUARY

INTRODUCTION

Konarak-Balukhand Wildlife Sanctuary is situated in Puri district of Orissa. It is a coastal sanctuary, starting about 14 km from Puri, near the town of Beleswar & stretching for about 25 km along the coast upto Chandraprabha.

It consists of two Ranges: Konarak Wildlife Range and Balukhand Wildlife Range. The two Ranges are

separated by the Kushabhadra river, which almost separates the Sanctuary into two equal halves.

The Range Office of Konarak Wildlife Range is at Konarak. Other important places in this Range are Chandraprabha, Ramchandi, Bali-Kapileshwar, Tikuna etc. There is a watch-tower in this range near Chandraprabha.

The Range Office of Balukhand Wildlife Range is at Beleswar. Other important places in this Range are Balighai etc.

The total area of the Sanctuary is 71.72 sq km which was established in 1984. The vegetation consists mainly of Casuarina, Anacardium, Neem, Tamarind, Cashew and Karanja etc.

The major Wildlife reported from the Sanctuary are: Blackbuck, Spotted Deer, Wild Boar, monkey, squirrel, Jungle Cat, Jackal, Hyena, Black-naped Hare and mongoose besides a variety of birds and reptiles.

METHODOLOGY

One survey was conducted from 28th March to 5th April, 2008 by a three-member team from Zoological Survey of India. As there are no forest lodges inside the Sanctuary, the team had to stay at the nearest town (Konarak) and visit the sanctuary everyday. Due to restrictions by the Orissa Forest Department, collection of specimens was not allowed.

OBSERVATIONS

The following amphibians were nevertheless observed in the Sanctuary during this short survey:

Family BUFONIDAE

1. *Duttaphrynus melanostictus* (Schneider, 1799)
1799. *Bufo melanostictus* Schneider. *Hist. Amph.*, **1** : 216.

Common Name : Common Indian Toad (English).

Specimens Examined : 7 ex, one each from Konarak, Chandraprabha, Ramchandi, Bali-Kapileshwar, Tikuna, Beleswar and Balighai.

Size : 35-109 mm (Snout-vent length).

Diagnostic features : Large-sized toads. Head is broader than long with cornified bony ridges. Snout is rounded. Nostril is nearer to the tip of the snout than the eye. Tympanum is distinct, circular or oval, nearly two-third the diameter of the eye. Parotoid glands are large and bean-shaped.

Fingers are without webs, the first finger is equal to or little longer than the second. Tips of fingers and toes are swollen. Toes are partly webbed with more than three phalanges of the fourth toe free. Both inner and outer metatarsal tubercle present. The tibio-tarsal articulation reaches in between the tympanum and the eye when the hind leg is held parallel to the body.

Skin is rough with several black-tipped spiny warts on the dorsum. Ventrums also rough in texture.

Colour : Uniformly grayish or dark brownish with a few yellow or pink coloured spots on the dorsum. Ventrums dull white with a yellowish tinge. Juveniles are black or dark gray on the dorsum but the ventrum is uniform white or speckled with black.

Habitat : Found inside forest areas among leaf-litter, beside rain-water pools and ponds and also along the roadsides. Also hide under logs, stones, in moist holes and huddle together in crevices of tree-trunks.

Remarks : Very common throughout the Sanctuary. They are terrestrial and nocturnal. Usually solitary but congregate during the breeding season near water-bodies. Juveniles wander on land during mornings and afternoons, if the air-temperature is sufficiently low. Adults are seen throughout the year. They do not seem to hibernate.

Family MICROHYLIDAE

2. *Microhyla ornata* (Dumeril and Bibron, 1841)

1841. *Engystoma ornatum* Dumeril & Bibron, *Erp. Gen.*, 8 : 745.

Common Name : Ornate narrow-mouthed frog, Ornate Microhylid frog (English).

Specimens Examined : 4 ex, one each from Ramchandi, Tikuna, Beleswar and Balighai.

Size : 18-26 mm (Snout-vent length).

Diagnostic features : Small-sized, stout, active and agile frogs with small arrow-shaped head and bulging eyes. Head broader than long, snout somewhat pointed and projects beyond the narrow mouth. Tongue elliptical. Nostril is nearer to the tip of the snout than the eye. Pupil circular. Tympanum indistinct.

Fingers rather slender and do not bear webs. The first finger is shorter than the second. Tips of fingers are dilated into small discs. Toes are minutely webbed at the base and the tips are dilated into small discs.,

devoid of grooves. Metatarsal tubercles are distinct, the inner being more well-developed. Hind limbs are moderately long and the tibio-tarsal articulation reaches the eye, when the hind limb is held parallel to the body.

Skin is smooth with a distinct supratympanic fold.

Colour : The body colour matches that of the soil. The dorsum is grayish-brown or reddish-brown with a distinct dark brown diamond-shaped marking on the back, beginning between the eyes, extending to both the upper eyelids, narrowing behind the head and widening above the shoulder, then narrowing again and finally broadening out and sending a stripe to the groin and the thigh. A dark streak extends along the sides from behind the eye to the shoulder. Limbs with dark brown cross bars. Ventrums dull whitish, with throat and chest stippled with brown.

Habitat : Found among leaf-litter all over the Sanctuary.

Remarks : Very common. Can call very loudly and jump very much when compared to its small size.

3. *Kaloula taprobanica* Parker, 1934

1934. *Kaloula pulchra taprobanica* Parker, *Trust. Brit. Mus. London* : 86-87.

Common Name : Painted Frog, Indian Painted Frog, Painted Kaloula (English).

Specimens Examined : 2 ex from Beleswar and Balighai.

Size : 25-58 mm (Snout-vent length).

Diagnostic features : Medium-sized, toad-like, colourful burrowing frog. Head is broader than long. Snout is rounded. Nostril is nearer to the tip of the snout than the eye. Tympanum is hidden. Tongue is elliptical.

Fingers are without webs. The first finger is shorter than the second. Tips of the fingers bear short well-developed truncate discs. Subarticular tubercles of the fingers and toes are prominent. Toes are about one-third webbed and bear dilated triangular discs. Inner metatarsal tubercle is well-developed, large and shovel-shaped. Outer metatarsal tubercle is small.

Dorsum is rough with scattered warts. Skin is wrinkled on the belly but granular on the throat and underside of the thighs.

Colour : Dorsum is blackish-brown or grayish-brown with brown or deep red spots and patches margined with black. A dark reddish lateral band runs on each side from the eyes to the groin of the hind feet. The belly is light brownish or white, spotted with grey. Males have black throat during breeding season.

Habitat : Open scrub forests of the Sanctuary. Breeds in dirty pools.

Remarks : Not uncommon, the species is very colourful. They are terrestrial, burrowing and nocturnal, emerging from their burrows during the monsoon, sometimes even during the day and are often seen to climb up trees, where they are found in holes in tree-trunks.

4. *Uperodon systoma* (Schneider, 1799)

1799. *Rana systoma* Schneider, *Hist. Amph.*, : 144.

Common Name : Marbled Balloon Frog, Lesser Balloon Frog (English).

Specimens Examined : 3 ex, one each from Chandraprabha, Ramchandi and Balighai.

Size : 55-65 mm (Snout-vent length).

Diagnostic features : Toad-like medium-sized burrowing frog with plump body and soft soggy skin. The eyes are relatively bigger than the Greater Balloon frog but the distance between the eyes is less than twice the width of the upper eyelid. Head is wedge-shaped and broader than long. Snout is rounded and equal to the diameter of the eye. Nostril is equidistant between the tip of the snout than the eye. Tympanum is hidden.

Fingers are free of webbing. First finger is shorter than the second. Tips of the fingers do not bear discs. Toes are rather short and webbed at the base. Inner metatarsal tubercle is twice as large as the outer metatarsal tubercle but smaller than that of the Greater Balloon frog. Hind limbs are short and the tibio-tarsal articulation reaches the shoulder.

Skin smooth but soggy, granular at the anal region and on the underside of the thighs.

Colour : Olive, greenish-yellow or pinkish on the dorsum, marbled or spotted with dark brown resembling a leopard's coat to some extent. Ventrums whitish but throat and belly creamy yellow, mottled with brown.

Throat is blackish in breeding males. In older males, the black vocal sac hangs down the chin in the form of a flap. No median line.

Habitat : Scrub forests, often found under stones and logs.

Remarks : Not uncommon but emerges only during the breeding season. Calls like the bleating of a goat.

Family DICROGLOSSIDAE

5. *Euphlyctis cyanophlyctis* (Schneider, 1799)

1799. *Rana cyanophlyctis* Schneider, *Hist. Amph.*, 1 : 137.

Common Name : Skittering Frog, Skipping Frog, Skipper Frog, Water frog (English).

Specimens Examined : 6 ex, one each from Konarak, Ramchandi, Bali-Kapileswar, Tikuna, Beleswar and Balighai.

Size : 30-69 mm (Snout-vent length).

Diagnostic features : Medium-sized pond frogs. Head is broader than long. Snout is rounded. Nostril is equidistant between tip of snout and eye. Tympanum is distinct, nearly equal to diameter of eye.

Fingers are without webs, the first finger is equal to the second. Tips of the fingers are pointed. Subarticular tubercles are less prominent. Toes are fully webbed. Tips of the toes are swollen and rounded. A pointed toe-like inner metatarsal tubercle is present. Outer metatarsal tubercle is absent. Tibio-tarsal articulation reaches between the tympanum and nostril, when the hind leg is held parallel to the body.

Small warts are present on the dorsum. Ventrums smooth with a single row of porous warts on each flank.

Colour : Dorsum grey, grayish-brown or grayish-black with darker rounded spots and stripes on the limbs. Ventrums white with black spots. There is a dark-edged white band on the hinder under part of the thighs.

Habitat : Commonest frog found in all types of water-bodies inside the Sanctuary. They are active throughout the year. They spend most of their time in the water or in the vicinity of water-bodies but may migrate onto land in the summer months when the temporary pools of water dry up.

Remarks : They float passively in water with only the nostrils projecting above the surface but when

disturbed, can skip smoothly over the water for some distance and then float above the surface with the hind legs held parallel.

6. *Euphlyctis hexadactylus* (Lesson, 1834)

1834. *Rana hexadactyla* Lesson, *Balang. Voy. Indian* : 331.

Common Name : Green Pond Frog (English).

Specimens Examined : 1 ex (male) from Tikuna.

Size : 84 mm.

Diagnostic Features : A large-sized dark-green aquatic frog. Head is almost as long as broad. Snout is flat and rounded or very slightly pointed, hardly projecting beyond the mouth. Nostril is nearer to the tip of the snout than the eye. Tympanum is distinct, nearly equal to the diameter of the eye.

Fingers are without webs, the first finger is equal to or longer than the second. Subarticular tubercles are feebly prominent. Tips of the fingers and toes are pointed. Toes are fully webbed. There is a strong dermal fringe on the outer toes. An elongated and digit-like, pointed inner metatarsal tubercle present. Outer metatarsal tubercle absent. Skin is smooth above, longitudinal glandular folds absent on dorsum. A supratympanic fold is present.

Granules and warts are present on the back, throat, belly and under the thighs. Two rows of large porous warts along the flanks.

Colour : Dark-green or bright grass-green on the dorsum, with a yellow median streak. Ventrums and flanks are white or yellowish white. Throat yellow.

Habitat : Found floating in an old village-pond with dense green floating vegetation.

Remarks : Very uncommon. The colour of the body merges with the vegetation so that they can easily camouflage and protect themselves from aerial and aquatic predators.

7. *Fejervarya orissaensis* (Dutta, 1997)

1997. *Limnonectes orissaensis* Dutta, *Hamadryad.*, **22**(1) : 1-8.

Common Name : Orissa Cricket Frog (English).

Specimens Examined : 5 ex, one each from Konarak, Ramchandi, Tikuna, Beleswar and Balighai.

Size : Snout-vent length : males (36.2-47.2 mm), females (34.2-53.8 mm).

Diagnostic features : Medium-sized Ranid frog with interrupted longitudinal folds on dorsum, smooth ventrum, wider & longer inner metatarsal tubercle and relatively pointed snout. Shorter hind limbs, more rounded finger and toe tips and a greater degree of webbing on the toes.

Head longer than wide, depressed. Snout pointed, extending beyond the mouth, internarial distance broader than the interorbital width. Narial openings dorsolateral. Tympanum distinct, rounded, diameter less than eye diameter with supratympanic fold extending from posterior corner of eye to forelimbs. Vomerine teeth distinct.

Finger and toe tips rounded, slightly swollen. First finger longer than second, third equal to or slightly longer than first. Subarticular tubercles rounded. Fingers not webbed. Hind limbs moderately long, with two metatarsal tubercles. Inner metatarsal tubercle oval and larger than outer metatarsal tubercle. Longitudinal ridge extending from anterior border of outer metatarsal tubercle to tip of fifth toe. Subarticular tubercles rounded, similar to those on fingers. Webbing of fourth extends less than half way between distal and penultimate subarticular tubercles, that on fifth toe extends beyond distal subarticular tubercle.

Skin on dorsum of head smooth but body covered with interrupted, longitudinal ridges with small rounded ridges towards posterior border of body. Skin on flanks and chin smooth. Skin on belly and proximal ventral surfaces of thigh smooth.

Colour : Dorsum brown, grey or brick red. A V-shaped marking between eyes which is interrupted by a vertebral band, with or without yellowish narrow or wide vertebral band extending from tip of snout to vent. A X-shaped black patch on middle of body, limbs with complete or incomplete dark cross bars. Sides of thigh yellowish white with black speckles, jaw margins with black vertical bars.

Habitat : Found during monsoon on grassy lands near water pools.

Remarks : The species is very common. When disturbed jumped into water but immediately returned to the edges. Active at night and hides in grass, below rocks or in small holes near water during the day.

8. *Fejervarya syhadrensis* (Annandale, 1919)

1919. *Rana syhadrensis* Annandale, *Rec. Ind. Mus.*, **6** : 121-125.

Common Name : Syhadra Cricket Frog (English).

Specimens Examined : 6 ex, one each from Konarak, Chandraprabha, Ramchandi, Tikuna, Beleswar and Balighai.

Size : 27-32 mm (males) and 29-40 mm (females).

Diagnostic features : The body is spindle-shaped. The head is pointed with the snout very distinctly jutting over the lower jaw. Inter-orbital distance is equal to the inter-narial space. The nostrils are lateral and distinctly closer to the tip of the snout than the eyes. Tympanum is round and hidden, half that of the eye diameter. Pineal organ is distinctive as a white dot between the eyes.

Finger tips are rounded. The first finger is equal to the second, while the fourth finger is slightly longer than the second. Subarticular tubercles are globular with an oblong oval inner metacarpal tubercle and two additional rounded palmer tubercles.

Toes are webbed with rounded tips. Subarticular tubercles are distinctly smaller than those of the fingers and are rather oval with an oblong inner metatarsal tubercle that is laterally flattened and a very small point-like outer metatarsal tubercle in line with the tarsal fold. A narrow ridge is formed by a series of very small tubercles between the outer metatarsal tubercle and the proximal subarticular tubercle of the fifth toe. The tibio-tarsal articulation reaches between the eye and tip of the snout.

Dorsum is smooth with a few round or slightly oblong tubercles. Glandular folds are shorter with tiny light tubercles in the cloacal and loreal regions, the dorsal part of the lower leg and on the sides of the heel (tarsus). Venter is uniformly smooth.

Colour : Dorsum is grayish to brownish-olive with black irregular spots particularly fused into transverse bands. There are also dark, ring-shaped spots with a paler center and the sides of the body are faintly marbled. A very narrow yellowish-white mid-dorsal line, often interrupted. An inter-orbital band is present.

Fore-limbs are darkly banded and the hind-limbs are dotted on the thighs and striped on the lower leg.

Venter of the hand and foot are dark with contrasting pale metacarpal or metatarsal tubercles. Toe webbing is faintly marbled.

Venter is uniformly white with narrow dark bars along the margin of the lower jaw. Males have a blackish-grey and crescent-shaped mark on the throat.

Habitat : Prefers vicinity of water without being really aquatic. They can be encountered far away from water-bodies between trees, in open grassland, pools and ditches.

Remarks : Very common. Partly diurnal but only calls nocturnally. During the dry winter months hides in leaf-litter of woods or between buttresses of trees. Males call in the evening and night and are easy to locate.

9. *Hoplobatrachus tigerinus* (Daudin, 1803)

1803. *Rana tigerina* Daudin, *Hist. Nat.*, **1** : 42.

Common Name : Bull Frog, Indian Bull Frog (English).

Specimens Examined : 3 ex, one each from Ramchandi, Tikuna and Balighai.

Size : 40-154 mm (Snout-vent length).

Diagnostic features : Large-sized frogs with smooth skin and longitudinal glandular folds on the back. Head is longer than broad. The snout is somewhat pointed and projects beyond the mouth. The nostril is equidistant between the tip of the snout and the eye. Tympanum is distinct, nearly equal to the diameter of the eye.

Fingers are without webs, the first finger is longer than the second. Tips of fingers and toes are not sharply pointed. Toes are fully webbed but the web does not reach the tip of the fourth toe. The fifth toe is with an outer fringe of web. Subarticular tubercles of the fingers and toes are not very prominent. Inner metatarsal tubercle is short and blunt. Outer metatarsal tubercle is absent. Hind limbs are comparatively long, with the tibio-tarsal articulation reaching the nostril, when the hind limb is held parallel to the body.

Dorsum smooth with longitudinal glandular folds. Ventrums smooth with no porous warts on the flanks. Supratympanic fold present.

Colour : Dorsum yellowish or olive-green with darker leopard-like spots. A yellowish median stripe runs

from the tip of the snout to the vent. Ventrums are whitish. Limbs are black-barred or spotted.

Habitat : Found among grasses, bushes and on the leaf-litter. Hide inside hollows at the edge of ponds and ditches. Aestivate inside burrows or under heaps of leaves. Seen frequently on the edges of ponds during breeding season into which they leap headlong at the least sign of danger.

Remarks : Very common species. Solitary creatures, which aggregate only during the breeding season. In the non-breeding season, they are difficult to locate but with the appearance of the rainy season their highly resonant call can be heard throughout the night.

10. *Sphaerotheca breviceps* (Schneider, 1799)
1799. *Rana breviceps* Schneider, *Hist. Amph.*, **1** : 140.

Common Name : Indian Burrowing Frog (English).

Specimens Examined : 2 ex from Ramchandi and Balighai.

Size : 28-52 mm (Snout-vent length).

Diagnostic features : Stout medium-sized toad-like burrowing frogs. Head is broader than long. Snout is short and rounded, not projecting beyond the mouth. Nostril is equidistant between the tip of the snout and the eye. Tympanum is distinct, more or less half the diameter of the eye.

Fingers are without web. The first finger is longer than the second but equal to the third. Tips of the fingers are swollen but not disc-like. Hind limbs are very short. The tibio-tarsal articulation only reaches up to the shoulder when the hind-limb is held parallel to the body. Subarticular tubercles are well-developed. Toes are slightly webbed with more than three segments of the fourth toe free. A highly developed, large, shovel-shaped inner metatarsal tubercle is present. Outer metatarsal tubercle is small.

Skin is smooth on the dorsum but granular on the belly and underside of the thighs. Sometimes there are small glandular skin folds on the back.

Colour : Dorsum is yellowish-brown or grayish with dark spots or markings. The ventrum is pinkish white and the throat is brownish. Limbs are with irregular dark cross-bars. The underside of the thighs are dark brown with yellowish spots. A yellow median streak is often present.

Habitat : Terrestrial, nocturnal and subterranean, found near water-bodies only during the rainy season for short periods of time.

Remarks : Very uncommon, they are seen only at the onset of the monsoon when they come out of their burrows and the males croak near temporary pools of water, usually after a heavy shower.

Family RHACOPHORIDAE

11. *Polypedates maculatus* (Gray, 1834)

1834. *Hyla maculata* Gray, *Indian Zoology*, **1** : 82.

Common Name : Common Tree Frog, Common Indian Tree frog (English).

Specimens Examined : 6 ex, one each from Konarak, Chandraprabha, Ramchandi, Tikuna, Beleswar and Balighai.

Size : Snout-vent length: 35-65 mm (male), 50-85 mm (female).

Diagnostic features : A medium-sized narrow-waisted tree frog with slender elongated limbs and goggling eyes. Head broader than long, skin on head free with a bony arch. Snout obtusely pointed and projects a little beyond the mouth. Nostril nearer to the tip of the snout than the eye. Inter-orbital space broader than the upper eyelid. Tympanum distinct almost equal to the diameter of the eye. Supratympanic fold present.

Fingers with rudimentary web, the first finger is equal to the second. Subarticular tubercles distinct. Tips of fingers and toes dilated into flattened, spherical and horse-shoe shaped adhesive disks. Toes nearly fully webbed, with two segments of the fourth toe free. Inner metatarsal tubercle present. Tarso-metatarsal articulation reaches between the nostrils and eye when the hind leg is held parallel to the body.

Skin smooth above but granular on the belly and underside of thighs. Sacral vertebrae form a pair of distinct elevations on the back, when the frog is at rest.

Colour : Colouration is highly variable and sometimes depends on the colour of the habitat. Colour varies from brownish, yellowish, grayish or whitish on the dorsum, sometimes with darker spots or patches. Venter white, a dark brown marking extends from the nostril on both sides of the head, covering the eye, down the flanks right up to the middle of the belly. The

limbs are cross-barred and the lower side of the thighs marbled with round yellow or brown spots or a purplish network.

Habitat : In trees, bushes, shrubs and in the breeding season sometimes on the ground beside ponds, ditches etc.

Remarks : A very common tree-frog seen on trees and bushes about 1-6 meters above the ground level in all areas of the Sanctuary. Lays eggs in hanging foam-nests near water in which the tadpoles fall and develop.

DISCUSSION

Konarak-Balukhand Wildlife Sanctuary is a coastal strip in Puri district of Orissa with vegetation like Casuarina, Anacardium, Cashew and Karanja. The soil is dry and sandy which supports few wildlife, some avifauna and reptiles. Amphibian species are sparse and are mainly those that breed in small temporary rain-water pools that form with the monsoon rains.

Amphibians consist of toads (Family Bufonidae with 1 genus and 1 species), burrowing Frogs (Family Microhylidae with 3 genera and 3 species), semi-

aquatic frogs (Family Dicroglossidae with 4 genera and 6 species) and 1 genus and 1 species of tree frog (Family Rhacophoridae). The burrowing and semi-aquatic frogs are the most diverse. A total of 45 examples of amphibians belonging to 11 species under 9 genera and 4 families were observed or located in Konarak-Balukhand Wildlife Sanctuary.

ACKNOWLEDGEMENTS

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1. Board proclaiming Sanctuary



2. A motorable road thru Balukhand WLS



3. Wild cashew trees in Balukhand WLS



4. Cashew undergrowth habitat for Sitana lizards



5. Keya trees in Balukhand WLS



6. Road to watch-tower



7. Watch tower



8. A pool in Balukhand WLS



9. Searching for frogs in Balukhand WLS

10. Narrow-mouthed Frog (*Microhyla ornata*)11. Burrowing Frog (*Sphaerotheca breviceps*)

12. Pond at Ramchandi (habitat of many frogs)

13. Green Pond Frog (*Euphlyctis hexadactylus*)



1. Low hills of Karlapat WLS



2. Scrub forests of Karlapat WLS



3. Hill-stream of Karlapat WLS



4. Forested stream inside Karlapat WLS

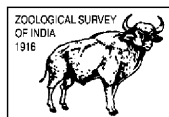


5. Skittering Frog (*Euphlyctis cyanophlyctis*)



6. Tree-frog (*Polypedates maculatus*)

7. Bull Frog, (*Hoplobatrachus tigerinus*)8. Bush frog (*Philautus* sp)9. Jerdon's Bull Frog (*Hoplobatrachus crassus*)10. Painted Frog (*Kaloula taprobanica*)11. Variegated Frog (*Ramanella variegata*)12. Burrowing Frog (*Sphaerotheca rolandae*)13. Balloon Frog (*Uperodon globulosus*)14. Marbled Balloon Frog (*Uperodon systema*)



Rec. zool. Surv. India : **110**(Part-2) : 27-30, 2010

INDIGENOUS TECHNIQUE OF CONVERTING SELECTED MARINE FISHES TO FRESH WATER CONDITIONS FOR ORNAMENTAL PURPOSE

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INTRODUCTION

Aquarium keeping is amongst the most popular of hobbies with millions of enthusiasts worldwide. This has resulted into attraction to uncommon colour varieties of ornamental aquarium fishes among aquarists. Although some marine aquarium fish and invertebrates are cultured by the industry and hobbyists, most of the marine ornamentals over 90% are from wild-caught fisheries and generally command higher prices than freshwater fish (Chapman, 2000; Cato and Brown, 2003). With the high demand and pricing of many beautiful species, ornamental fish are being harvested at greater volumes and higher rates, threatening the viability or sustainability of the fishery (Chao *et al.*, 2001; Vagelli and Erdmann, 2002; Cato and Brown, 2003; Lunn and Moreau, 2004). Responsible aquaculture practices rely on sustainable production systems, to minimize impacts on the natural environment, and support resource conservation. In other words, the harvest of fish from the wild or their domestic culture, if performed with sound foundations in ecological and economic principles, can be sustainable and self-reliant commercial industries. Although exact figures on the value and trade of the ornamental fish industry do not exist, the value of ornamental fish and invertebrates imported into different countries worldwide is approximately \$278 million US dollars (FAO, 1996-2005). Although most fish kept in aquariums are from freshwater, the acquisition of marine ornamental fish has greatly increased, popularized by

various media showing charismatic colourful fishes and other creatures.

Usual demand is of new varieties. To cater this rapidly increasing demand of new varieties and to conserve the wild stock, the new technique is practiced to convert the sea dwelling marine fishes of brilliant colour to freshwater tolerant forms. While maintaining Aquarium at MARC, we came across the demand to cater new varieties of fishes every time. But it is not possible to fulfill this demand throughout the year in all the season due to unavailability of different species in different seasons. We came across success stories of conversion of fresh water fishes to marine in various parts of world for ornamental purposes (Bringolf *et al.*, 2005; Kefford *et al.*, 2004; Ostrand and Wilde, 2001; Matern, 2001). But considering much diversity of colourful varieties of fishes in marine habitat we started the vice-versa practice with some coastal fish varieties. Later, it was developed technically to serve the need of our aquarium and used to other species and are being practiced for trade purpose by the fish suppliers. During conversion, the seasonal trend in environmental parameters was also taken into consideration. The salinity of the seawater around Digha coast found to be 33.5‰ in the post-monsoon and pre-monsoon months (Chatterjee *et al.*, 2008). During experiment this salinity of seawater was considered as 100% and it was lowered periodically.

Around fourteen common coastal ornamental varieties were used for this conversion experiment. The

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fishes used were Eel (*Gymnothorax meleagris* Shaw & Nodder), Pearl Spot (*Etroplus suratensis*), Tiger Perch (*Terapon jarbua*), Spotted Butterfish (*Scatophagus argus*), Common Shark (*Scoliodon laticaudus*), Sting ray (*Dasyatis zugei* Miller & Henle), Guitar fish (*Rhinobatus* sp.), Grouper (*Epinephelus* sp.), Spade fishes (*Sillago* sp.), *Megalaspis* sp., *Acanthurus* sp., *Platax* sp., *Ephippus* sp. and Puffer fish (*Tetraodon* sp.). The earlier studies from the area shows that these species were abundantly available in the study area i.e. West Bengal & adjoining Orissa coast (Manna & Goswami, 1985; Talwar, 1984; Talwar *et al.*, 1994; Chatterjee *et al.*, 2000).

MATERIALS AND METHODS

The fishes brought to aquarium were first acclimatized for 48 hrs. in same salinity from where they were brought (i.e. normal sea water). This salinity is considered as 100% salinity and then it was gradually lowered by 10% at every 24 hrs. by diluting with filtered de-ionised water. The environmental parameters were regularly monitored during the experiment i.e., temperature, pH, salinity, dissolved oxygen and nutrients. Feed was not given for initial 24 hrs. The chopped fish, shrimp and molluscs meat of 0.5% of body weight were provided every day. Overfeeding was avoided and any uneaten food siphoned out from the tank to avoid contamination. The cemented tanks of size 10' × 5' × 5' with epoxy paint were used for the

experiment purpose. Observations for survival were made every day.

RESULTS & DISCUSSION

Out of 14 species tried under this experiment, only 6 species could be successfully converted into freshwater fishes. These fishes are Eel (*Gymnothorax* sp.), Pearl Spot (*Etroplus* sp.), Tiger Perch (*Terapon* sp.), Spotted Butterfish (*Scatophagus* sp.) and Puffer fish (*Tetraodon* sp.). The impact of lowering salinity on the survival rate of various fishes is shown in the figure 1.

It was found that all the successful species converted to freshwater conditions attained approximately 90% survival rate. The species which could not attain more than 50% survival rate during initial decrease of salinity were considered at unsuitable for this technique. The species unsuccessful under this conservation technique are the fishes used were Sting ray (*Dasyatis zugei* Muller & Henle), Guitar fish (*Rhinobatus* sp.), Grouper (*Epinephelus* sp.), Spade fishes (*Sillago* sp.), *Megalaspis* sp., *Acanthurus* sp., *Platax* sp. and *Ephippus* sp.

Lot of the work undertaken to determine whether fish could survive the transition from freshwater to brackish water and then back to freshwater for ornamental practices and the impact on their eco-physiological aspects. In some species efforts were also done for low salinity tolerance tests (Allen and Avault, 1971; Kendall and Schwartz, 1968; Chen and Chen,

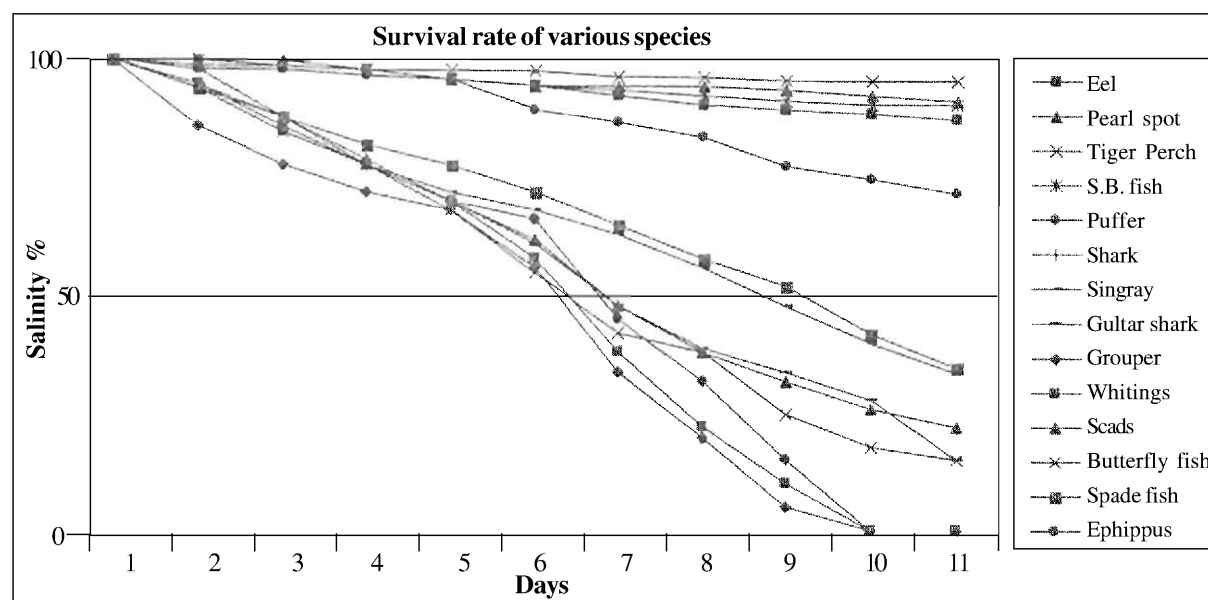


Fig. 1 : Survival rate of experimental species on various days of experiment after salinity changes.

2000). Fish in an estuarine environment would most likely be exposed to gradual changes in salinity, rather than abrupt changes. Some fishes are able to acclimate to higher salinities with gradual increases in salinity than with direct transfer into brackish waters (Eddy, 1981; Chervinski, 1984; Anyanwu, 1991). In the study of salinity tolerance of flathead catfish, it was found that more gradual rate of increase may result in every greater salinity tolerance and fishes can tolerate direct transfer to brackish waters but also can survive the converse transition from brackish water to freshwater (Bringolf *et al.*, 2005). In nature, high freshwater input events in estuaries and nearby coastal waters would certainly broaden the spatial limits that salinity would impose on dispersal of introduced fishes.

Knowledge of salinity tolerance could open doors to housing new combinations of species, and knowledge of salinity preference could bring an aquarist one step closer to providing ideal husbandry. Cichlids have long been known to be euryhaline and some occur in salty water. The Indian chromides (*Etroplus* sp.), have been observed in Negombo Lagoon, Sri Lanka at salinities ranging from 24-29 ppt (parts per thousand) (Ward and Wyman 1977). Although most aquatic organisms have physiological systems adapted to either freshwater or saltwater habitats, some species living in tidal marshes and streams experience daily fluctuations in salinity. Therefore, they must be able to rapidly to changes in their osmotic environment. These adjustments may be very similar to the thermal acclimation seen in many animals that occurs seasonally (Ricklefs, 2001).

CONCLUSION

It was observed that the best season for conversion experiment is monsoon and post-monsoon as the salinity in nature also decreased remarkable in this season and fishes won't face much stress. The

conversion took approximately 9-10 days. After conversion, it was found that about 90% fishes survived successfully in the new salinity. So far, five species are converted successfully under this experiment. These fishes are Eel (*Gymnothorax* sp.), Pearl Spot (*Etroplus* sp.), Tiger Perch (*Terapon* sp.), Spotted Butterfish (*Scatophagus* sp.) and Puffer fish (*Tetraodon* sp.). This is one of the most economic techniques for achieving various colored varieties of ornamental fishes. It is also expected that adoption of this technique will open a new avenue to the unemployed youth for earning. The technique also useful for arresting the over exploitation of particular fish varieties and depletion of bio-resources.

SUMMARY

The present study aims to establish indigenous technique of conversion of selected marine fishes to freshwater conditions for ornamental purpose. Trials were done with about 14 marine fish species and it was observed that at least five species out of them successfully survived after conversion to freshwater. These species are Eel (*Gymnothorax* sp.), Pearl spots (*Etroplus* sp.), Tiger Perch (*Terapon* sp.), Spotted butter fish (*Scatophagus* sp.) and Puffer (*Tetraodon* sp.). During the process, the salinity of water was gradually reduced every day. Entire process took 9 to 10 days and the survival rate is quite satisfactory (about 90%). Hence, the technique will be very useful to the small-scale aquarists, fish suppliers as well as public aquariums to cater the need of new varieties.

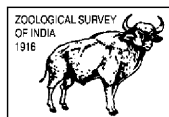
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We are also thankful to Dr. Ramakrishna, Director, Zoological Survey of India, for his support during the study. We are also thankful to Dr. C. Radhakrishnan, Additional Director, Western Ghat Regional Centre, Zoological Survey of India, Calicut for his encouragement for this work.

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INDIGENOUS TECHNIQUE TO ACHIEVE MAXIMUM SURVIVAL AND MATING BEHAVIOR OF STINGRAYS UNDER CAPTIVITY

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INTRODUCTION

The pale-edged stingray *Dasyatis zugei* (Muller and Henle) of family Dasyatidae is abundantly distributed along West Bengal coastal area (Manna & Goswami, 1985; Goswami, 1992; Chatterjee *et al.*, 2000). Being one of the major attractions for the visitors, it is displayed regularly in the aquarium at Marine Aquarium & Regional Centre, Zoological Survey of India, Digha. But, the survival success of this species under captivity was very poor. They could survive at the most for 8-10 days and sometimes overnight mortality was also recorded. Very little is known about the biology of most skates and rays—including stingrays—because they have been largely overshadowed by their more infamous relatives, the sharks. There are at least 96 species of stingrays worldwide (families Dasyatidae and Urolophidae combined), of which around 30 species from 8 genera are common in the Indian coasts (Talwar, 1984; Jhingran, 1997; Talwar *et al.*, 1994).

Some information about the mating behavior of elasmobranchs comes from captive individuals which has revealed that in several species of elasmobranchs, males are always aggressive and often bite females during the courtship and mating period (Springer, 1967). Male sharks, for example, bite the pectoral fins of females during the breeding period (Dempster & Herald, 1961; Clark, 1963; Taylor, 1971; Klimley, 1980; Castro *et al.*, 1988). Skates (Libby & Gilbert, 1960; Price, 1967) and rays (McCourt & Kerstitch, 1980; Tricas, 1980; Reed & Gilmore, 1981) display similar type of behavior during mating.

MATERIALS AND METHODS

The commonly available sting ray species in the locality *Dasyatis zugei* (Muller and Henle) was used

in the experiment (Fig. 1). The overall experiment was divided into two groups. First, the experimental group of sting rays after carefully removing sting immediately after collection and second, control group consisting of moderately sized (30-45 cm disc size) 10 individuals. The stings were removed immediately after collection on location itself. One tank of 10' × 5' × 5' exclusively allotted for the experiment and two groups of experiments were conducted separately. Normal rate of feeding i.e. 0.5% of total body weight were provided on alternate days throughout the experiment with chopped meat of clam, prawns and fishes. Any unspent feed remains in tank were siphoned out after few hours of feeding. The environs of tanks viz., temperature, pH, dissolved oxygen and salinity were routinely monitored and kept constant to avoid any other physiological impact while experimenting. The experiment was conducted separately in different batches of three replicates each in post-monsoon season when the stingrays were reproductively active. The experiment was conducted during September-December of 2006.

RESULTS AND DISCUSSION

Comparison of survival rate of experimental stingrays with control ones shows that at the end of experiment (i.e. 30 days) 63% stingrays survived. However, the control set stingrays could survive up to 8th day of experiment. On the 22nd day of experiment, a pair of female gave birth to 6 juveniles which were kept separately to avoid mortality. The comparison of survival rate of the test set with the control set of stingray is shown in Fig. 2.

During breeding season, female stingrays were chased and copulated by males (Oldfield, 2005a; 2005b). The first ever mating behavior of stingrays was explained in southern stingrays *Dasyatis americana* by Chapman *et al.*, (2003). In stingrays, fertilization occurred at 43 months, and birth at 46 months of age. Size at maturity for males was estimated 20-35 cm disc with and for females 24-32 cm disc. width. Gestation was thought to be a little over 3 months. Males would mate with more than one female (Chapman *et al.*, 2003). In the present paper, the cause of low survival rate was studied in the form of onen simple experiment through critically observing them in captivity. No specific observation could be made during day time and normally, mortality has recorded the next morning. This created some doubt about what happens in the night particularly to this species? During night, the species were observed quite aggressive, chasing each other and copulating. And the same pair was observed dead next morning. The dead specimen when carefully observed was found to have some wounds on the body which might have been caused due to sting and bites. It was observed during the collection that many fishermen remove the stings as soon as they collect the fish as the sting is very poisonous and fetal. This could have happened with these fishes. After removing the sting the fishes were survived for more than a month and the cause of death was due to other reasons. Study on freshwater ray shows that males

frequently bite females during the mating period but most male biting do not result in copulation. In bites that do not lead to copulation, males bite the posterior (or occasionally the medial) portion of the females' disc but females often free themselves from these bites. In bites that precede copulation, males bite the anterior portion of the females' disc and females do not struggle to free themselves. Thus, females may exert some form of choice when they are bitten (Brockman, 1975; Capape & Zauli, 1995; Capape, 1993; Young, 1993). During experiment, few baby rays which were delivered in aquarium tanks could be able observed (Fig. 3). In captivity, conception occurred generally at low temperature i.e. in winter. The captive born juveniles' disc measured up to 10 cm.

CONCLUSION

During the present study, it was also observed that the stingrays often chase each other during their active reproductive phase. They often bite each other and operates sting while copulating which leads to serious wounds on their body. Sometimes, these injuries lead to mortality. This type of mating behavior is also observed in other stingray species. When the sting was removed during the experiment, the fishes bite each other but this does not lead to death as sting has been removed. Hence, this technique may prove ideal for further breeding practices and behavioral studies under captivity.

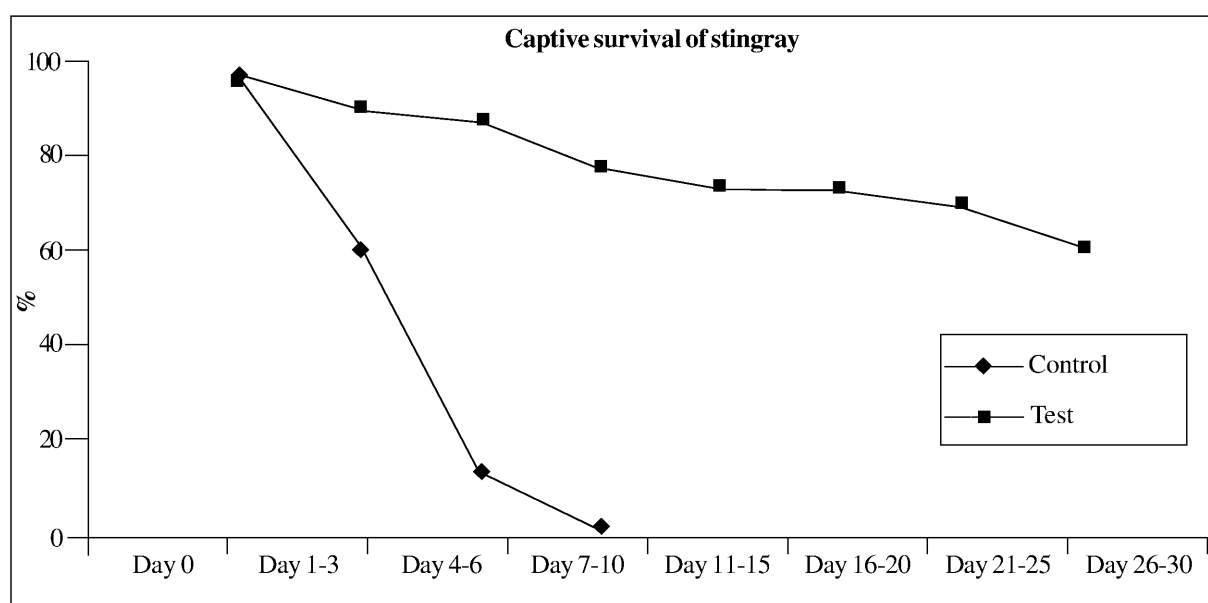


Fig. 2 : Survival rate of stingray under captivity.

SUMMARY

Keeping of sharks and rays under captivity as an exhibit is quite common in public aquaria in India and elsewhere. But, maintenance of such species under captivity is a big problem due to its mating behavior and possession of poisonous sting. The fishes were often found either severely injured or dead on the subsequent days of their stocking. The condition becomes worst when they operate their poisonous spine also during mating. The paper deals with the study of the mating behavior of pale-edged stingray *Dasyatis zugei* (Muller and Henle) using an indigenous technique to achieve maximum survival under captivity. After carefully removing the sting, the fishes survived for longer period with a survival rate (> 60%) at the end of 30th day of experiment, whereas, the control fishes with sting could be survive not more than 8 days. It was also observed that in some cases they gave birth to juveniles in the experimental period. Hence, removal of sting technique can be adopted for obtaining prolonged survival of stingrays under captivity as well as while breeding them.

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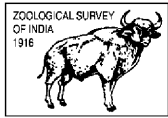


Fig. 1 : *Dasyatis zugei* (Muller & Henle)



Fig. 3 : Newly born pups of stingray.

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Rec. zool. Surv. India : **110**(Part-2) : 35-38, 2010

ON THE IDENTITY OF TWO *POLYNEMUS* SP. (PISCES : PERCIFORMES : POLYNEMIDAE) REPORTED FROM INDIA

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INTRODUCTION

The threadfin genus *Polynemus* Linnaeus (Perciformes: Polynemidae) is known to be represented by three species, viz. *P. longipectoralis* Weber and de Beaufort, *P. melanochir* Valenciennes and *P. paradiseus* Linnaeus from Indian waters (Talwar and Jhingran, 1991; Rao *et al.*, 2000). *P. longipectoralis* is regarded as a junior synonym of *Polynemus dubius* Bleeker that is known only from Malaysia and Indonesia (Motomura, 2003, 2004). Similarly *P. melanochir* is known to occur in Viet Nam, Malaysia and Kalimantan, Indonesia (Motomura and Sabaj, 2002). Although, Hamilton (1822) described three species, viz., *Polynemus aureus*, *P. risua* and *P. toposui*, from India, all these are relegated to junior synonymy of *P. paradiseus* Linnaeus (Motomura *et al.*, 2002). Except for *P. paradiseus*, occurrence of other *Polynemus* species from India seems to be doubtful (Froese and Pauly, 2009) and that required ascertaining by examination of the reported specimens.

Identity of *Polynemus longipectoralis*

While recording the polynemid fishes of India, Talwar and Kacker (1984) did mention the occurrence of *P. longipectoralis* in the Hooghly estuary in the “key to species” based on an unpublished paper (Talwar and Mukherjee, in press). Talwar and Jhingran (1991) provided the description of that species. *P. longipectoralis* is now considered as a junior synonym of *P. dubius* Bleeker (Motomura, 2003). Distribution of *P. dubius* is currently known from Malay Peninsula, Sumatra and Kalimantan, Indonesia (Motomura, 2004). Hence, its occurrence from India seems doubtful. The specimens in the National Zoological Collections, Z.S.I., Kolkata have been sorted out and examined for proper identity.

Materials : 2 samples, 118-124 mm standard length, Reg. No. F 7860/2, collected from Bakkhali, Hooghly River, West Bengal on 30-01-1981 by P. Mukherjee and T. K. Chatterjee; 15 samples, 82 to 120 mm in standard length, collected from Hooghly estuary (unregistered), all labeled as *Polynemus longipectoralis* Weber and de Beaufort, found among the National Zoological Collections, Z. S. I., Kolkata.

Diagnosis : Body depth at first dorsal fin origin 3.7 to 4.5, head length 3.7 to 4.0, and upper jaw length 6.6 to 7.7 in standard length. Lip on lower jaw well developed. Teeth on vomer and palatine, in broad bands. Eyes small, its diameter more than 1.3 in snout length. Posterior margin of preopercle serrated. First dorsal fin with VII spines, second dorsal fin with I spine and 14 or 15 soft rays. Anal fin with II spines and 12 rays. Pectoral fin with 15 to 18 unbranched rays and 7 free filaments, the longest extending beyond tip of caudal fin. Pectoral fin insertion near midline of body. Lateral line with 68 to 70 pored scales. Gill rakers 31 to 33 on first arch. Body grayish black dorsally and yellow ventrally; paired fins yellow; pectoral filaments yellowish.

Remarks : All the specimens examined belong to the genus *Polynemus* Linnaeus, characterized in having pectoral fin inserted near midline of body; small eyes, its diameter more than 1.3 in snout length; and preopercle with a serrated posterior margin.

Weber and de Beaufort (1922) considered both *P. longipectoralis* and *P. dubius* as valid distinguishing them by number of lateral line scales, i.e. 84 vs 67. Motomura (2003) regarded *P. longipectoralis* as a junior synonym of *P. dubius* after examining the holotype of

the former. It is stated that the diagnostic characters (7 pectoral filaments, 8 spines in the first dorsal fin, 79 pored lateral line scales, 13 scale rows below lateral line, vomer with villiform teeth and posterior portion of maxilla less than orbit diameter) found in the holotype of *P. longipectoralis* are consistent with those of specimens of *P. dubius* Bleeker (Motomura, 2004).

The Indian record of *P. longipectoralis* (= *P. dubius*) is based on its distinction from *P. paradiseus* by the number of pectoral filaments (first two or three) extending beyond tip of caudal fin (Talwar and Kacker, 1984) following Fischer and Whitehead (1974). The fragile filaments may be broken before determination process started and so, that single character can not be considered as the only identifying feature. Moreover, the authors examined several specimens in the fish markets of Kolkata those are having only two filaments extending beyond caudal fin tip, but are having only 7 spines in first dorsal fin, 2 spines in anal fin and about 70 lateral line scales. Hence, Indian specimens of the genus *Polynemus* having 7 spines in first dorsal fin do possess 7 free pectoral filaments, of which upper two filaments certainly longer than body length and the third may or may not extend beyond caudal fin tip.

P. dubius is distinguished in having 8 spines in first dorsal fin, 3 spines in anal fin and about 75 pored lateral line scales (Motomura, 2004). Although Talwar and Jhingran (1991) mentioned 8 spines in first dorsal fin, has not given importance to this character, but simply followed Weber and de Beaufort (1922) while giving the description. All the specimens examined by us were having 7 spines in first dorsal fin; 2 spines in anal fin and about 70 pored lateral line scales.

Based on the above cited observations, the specimens identified as *P. longipectoralis* from Indian coast are no way similar to *P. dubius* and these are now being determined as *Polynemus paradiseus* Linnaeus, 1758.

Identity of *Polynemus melanochir*

Rao *et al.*, (2000) reported *Polynemus melanochir* Valenciennes from Andaman and Nicobar Islands, India. In current parlance of nomenclature it may be considered as *Polynemus melanochir melanochir* Valenciennes, while a second sub-species, *Polynemus melanochir dulis* has been reported only recently

(Motomura and Sabaj, 2002) from freshwaters of Cambodia.

Materials : Two specimens collected from Kamorta, Nicobar group of Islands by H. S. Mehta and Kamla Devi on 12-11-1989, which were labeled as *Polynemus melanochir* Valenciennes bearing Reg. No. 1546 and having a standard length of 73 and 99 mm, were examined for confirmation.

Diagnosis : Body depth at first dorsal fin origin 32.3 to 33.0% and head length 32.9 to 33.7% of standard length. Lips on lower jaw well developed, villiform teeth restricted to upper surface. Teeth in narrow bands on jaws, palatine and ectopterygoids. The space between the premaxillary bands and between palatine and ectopterygoids about twice or more than its width. Vomerine tooth patch inconspicuous. Posterior margin of preopercle serrated. First dorsal fin with 8 spines, first one minute, second spine stronger than others. Second dorsal fin with 1 spine and 11 soft rays. Anal fin with 3 spine and 15 soft rays, its base shorter than head length but longer than second dorsal fin base. Pectoral fin inserted in lower third of body. Pectoral fin with 13 or 14 unbranched rays and 7 free filaments, the third and fourth filaments longest, extending beyond the base of caudal fin. Lateral line with 50 pored scales; lateral transverse scales 6/10. Gill rakers about 50. Body yellow in colour; pectoral filaments brown.

Remarks : Both the specimens were having pectoral fins inserted on lower third of body, but not close to midline of body. In *Polynemus* sp., pectoral fin insertion is supposed to be near midline of body. Hence, the generic allocation is certainly wrong and so, this is a misidentification of some other species belonging to family Polynemidae.

Further examination of the specimens reveal a combination of characters such as lower jaw teeth not fully exposed but covered partly by lips; first dorsal fin with 8 spines, the first one minute; anal fin with 3 spine and 15 rays, its base shorter than head length; base of pectoral fin shorter than upper jaw length; caudal fin lobes not produced or filamentous; lateral line extending to lower caudal fin lobe; premaxilla and palatine teeth bands narrow, space separating these bands twice or more width of each band. This led the authors to consider assigning it to the genus *Filimanus* Myers, 1936.



The misidentified specimens : *P. longipectoralis* from Hooghly River (top) and *P. melanochir* from Nicobar (bottom)

The specimens have 7 free pectoral filaments, the longest extending beyond base of caudal fin; anal fin with 15 soft rays and body depth at first dorsal fin origin contained 32.3 to 33.0% of standard length. Lateral line with 50 pored scales, with 6 and 10 scale rows above and below lateral line. Gill rakers about 50. Body yellow in colour and pectoral filaments are brown. This leads to determine it to be *Filimanus perplexa* Feltes, 1991.

Feltes (1991) recognized that the polynemid species commonly identified as *P. melanochir* was not true *P. melanochir*, but in fact represented a separate undescribed species, i.e. *Filimanus perplexa* Feltes. This Indian report discussed above is another example to support his view.

As observed by Feltes (1991), Myers (1936) described *Filimanus* as a new genus on the basis of a single specimen (USNM 72742, 14 mm SL), but had misidentified the species as *Polynemus melanochir* (non Valenciennes, 1831). Bleeker (1849) erroneously

referred to this species as *P. melanochir* and this name has been used by subsequent authors including Weber and de Beaufort (1922). While recognizing only two genera, *Eleutheronema* Bleeker and *Polynemus* Linnaeus in the family, Weber and de Beaufort (1922) separated the genus *Polynemus* into four groups based on number of free pectoral fin filaments leading to such misidentification.

The distinction at generic level using teeth band structure following Feltes (1991) and Motomura (2004) gives this an identity other than *Polynemus* and ascertain the occurrence of *F. perplexa* in coastal waters of India. *F. perplexa* has been reported from the Great Nicobar Island, only recently as a new distributional record from India (Mishra and Barman, 2009).

CONCLUSION

Apart from *Polynemus paradiseus* Linnaeus, two other species of the genus *Polynemus* Linnaeus, viz., *P. longipectoralis* Weber and de Beaufort (= *P. dubius*

* Not seen in original

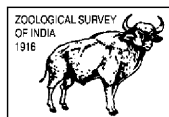
Bleeker) and *P. melanochir* Valenciennes, are recorded from India. Close examination of the representative specimens of these two species revealed that their report actually based on misidentification of *Polynemus paradiseus* Linnaeus and *Filimanus perplexa* Feltes. This establishes the fact that among the species under genus *Polynemus*, only *P. paradiseus* is distributed along Indian coast.

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TAXONOMIC NOTES ON SOME INTERESTING CLADOCERANS (CRUSTACEA : BRANCHIOPODA : CLADOCERA) FROM ASSAM (N.E. INDIA)

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INTRODUCTION

Taxonomic studies on the Indian Freshwater Cladocera began nearly one and a half century ago and since then these entomostraceous crustaceans have been documented from scattered localities from distant parts of this country (Sharma and Michael, 1987; Michael and Sharma, 1988; Sharma, 1991). The faunal investigations on cladocerans from different states of Northeastern India in general and that of Assam, in particular, are relatively fewer save for the studies by Patil (1976), Biswas (1980), Sharma and Sharma (1999, 2008) and Sharma (2008) while Michael and Sharma, 1988 referred to limited collections from N.E. region.

While working on zooplankton samples collected from the floodplain lakes (beels) of Assam, the authors came across nine interesting species of Cladocera, including four new records from North-Eastern India and five new records from Assam. All the recorded taxa are briefly diagnosed and illustrated, and remarks are made on their distribution.

MATERIALS AND METHODS

The present observations are based on plankton samples collected, during July, 2007-August, 2008, from floodplain lakes of Assam. All the samples were collected with nylobolt plankton net (No. 25) and preserved in 5% formalin. Individual collections were screened with a Wild-stereoscope binocular microscope. Various cladocerans and their disarticulated

appendages were mounted in Polyvinyl alcohol-lectophenol mixture. The details of head pores and their arrangements in the Chydorids were studied following Megard (1965).

Various taxa are identified following the works of Smirnov (1971, 1996), Michael and Sharma (1988), Korovchinsky (1992) and Sharma and Sharma (1999). The drawings are made with Leitz-Dialux phase contrast microscope using a drawing-tube attachment and the measurements are indicated in millimeters (mm). The reference materials are deposited in the holdings of the Department of Zoology, North-Eastern Hill University, Shillong.

LIST OF THE EXAMINED TAXA

Superclass	CRUSTACEA
Class	BRANCHIOPODA
Superorder	CLADOCERA (s. str.)
Order	CTENOPODA
Family	SIDIDAE

Diaphanosoma tropicum Korochinsky, 1998*

Sarsilatona serricauda (Sars, 1901)*

Order	ANOMOPODA
Family	MACROTHRICIDAE

Streblocerus serricaudatus (Fischer, 1849)**

Family	CHYDORIDAE
Subfamily	CHYDORINAE

Alonella clathratula Sars, 1886**

Chydorus ventricosus Daday, 1898*

Subfamily ALONINAE Frey, 1966

Alona guttata tuberculata (Kurz, 1875)**

A. monocantha tridentata (Stingelin, 1905)**

A. pulchella King, 1853**

A. verrucosa Sars, 1901*

TAXONOMIC NOTES

Diaphanosoma tropicum Korovchinsky, 1998
(Figs. 1-3)

1998. *Diaphanosoma tropicum* Korovchinsky, *Hydrobiologia*, **361**, p. 114-22, Figs. 1-35.

1981. *Diaphanosoma modigliani* Richard : Idris and Fernando, *Hydrobiologia*, **77**, p. 235-235, Figs. 2-4; Rajapaksa and Fernando, 1982, *Hydrobiologia*, **94**, Figs. 12-16.

Material examined : 4 exs., Anwa beel, Cachar district, Assam 26.02.2008, coll. B.K. Sharma.

Characters : Head large and cone-shaped, anterior part of head with a rounded bulge under the eye ventrally; eye located closer to ventral side of head. Antennae reaching posterior margin of valves. Antennal setae : 4-8/0-1-4; distal segment with prominent hook-like curved spine. Valves oblong, ventral margin with large inflexion and bearing 7-10 long feathered setae, posterior margin with 15-58 denticles, no dorsal spine at posterior margin of valves. Postabdomen prominent dorsally and, with groups of spinules laterally and distally; setae natatoria long. Claws large, with three basal spines, distal edge with a row of spines.

Differential diagnosis : *D. tropicum* differs from *D. modigliani* by its larger cone-like head, curved apical spine of upper antennal branch, longer swimming antennae and setae natatoria as well as fewer number of denticles along its ventro-posterior valve margins. In addition, it differs from *D. dubium* by its more massive head, longer swimming antennae, longer spine at the end of proximal segment of upper antennal branch and, by different form of posterior part of valves with prominent dorso-posterior angle and less numerous, smaller and sparsely distributed marginal denticles.

Distribution : India-Tamil Nadu. Elsewhere : Sri Lanka, Malayasia, Thailand, Indonesia, Philippines, Central-East China (Hubei province).

Remarks : Represents a new record from N.E. India.

Sarsilatona serricauda (Sars, 1901)

(Figs. 4-6)

1901. *Latonopsis serricauda* Sars, *Arch. Math. Naturvidensk. Christinia*, **23**, p. 6-19, Pl. 1, Figs. 1-6.

1905. *Latonopsis fasciculata* Daday, *Zoologica* **18**(44), p. 215-218, taf. 14, Figs. 13-17.

1985. *Sarsilatona serricauda* (Sars) Korovchinsky, *Int. Revue ges. Hydrobiol.* **70**, p. 406-418, Pl. III-VIII.

1990. *Latonopsis fernandoi* Rane : Sharma and Sharma, *Rev. Hydrobiol. trop.* **23**, 106, Figs. 1-5.

Material examined : 5 exs., Hilara beel, Cachar district, Assam, 20.10.2007, coll. B.K. Sharma.

Characters : Head high and separated from trunk by a small dorsal depression. Eye small and situated closer to dorsal side of head. Antennules relatively long, with large cylindrical base. Antennae massive with strong basipodite; thin sharp curved spine on dorsal side of antennal basipodite end. Thinner terminal spine of first segment of upper 2-segmented antennal branch much longer. Antennal setae : (8-9 – (10-12)/0-1-4. Ventral margin of valves with small sharp denticles, ventro-posterior corner with 11-12 long feathered setae and posterior margin with 4-5 dense clusters of minute spinules. Dorsal margin of postabdomen with 4-5 characteristic prominences; lateral sides with rows of 10-12 clusters of thin lanceolate anal teeth, with 2-4 teeth in each cluster. Claws thin and bearing three long basal spines; with thin setules on outer side and row of minute denticles along their dorsal side, inner basal side of claws with row of thin denticles.

Distribution : India : Madhya Pradesh. Elsewhere : Brazil, Paraguay, North America, Venezuela, Peru, Nicaragua, southern states of USA.

Remarks : Represents a new record from N.E. India.

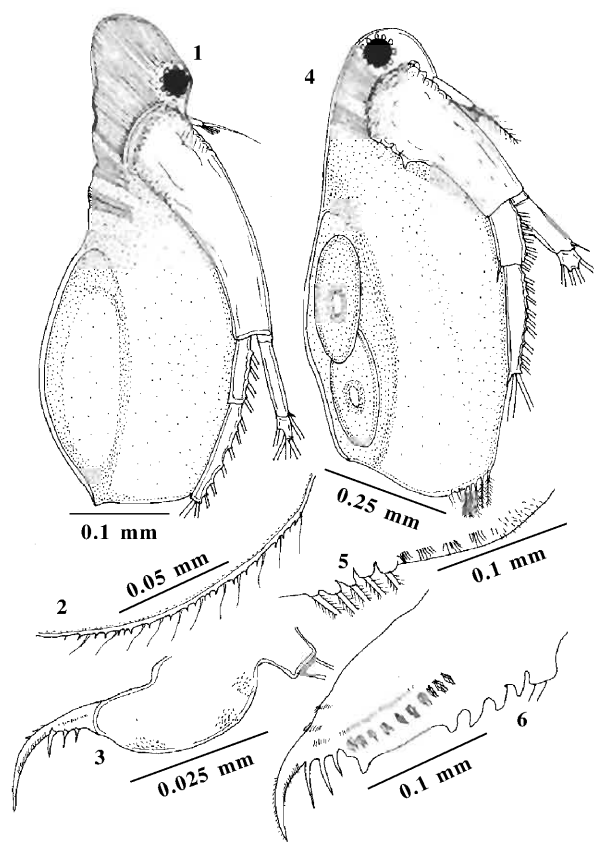
Streblocerus serricaudatus (Fischer, 1849)

(Figs. 7-8)

1849. *Daphnia serricaudata* Fischer, *Bull. Soc. Imp. Nat. Moscow*, **22**, p. 45, tab. IV, Figs. II-III.

* New record from North-eastern India

** New record from Assam



Diaphanosoma tropicum Korovchinsky : **Fig. 1.** parthenogenetic female, **Fig. 2.** posterior ventral valve margin, **Fig. 3.** postabdomen; *Sarsilatona serricauda* (Sars) : **Fig. 4.** parthenogenetic female, **Fig. 5.** posterior valve margin, **Fig. 6.** postabdomen.

1862. *Streblocerus minutus* Sars, *Forhandl. Vidensk. Selesk. Christinia* (1861), p. 284-285.

1876. *Streblocerus serricaudatus* (Fischer) : Hundendroff, *Bull. Soc. Nat. Moscow*, **50**, p. 41, Tab. II. Fig. 2, a-c.

Material examined : 3 exs., Deepor beel, Kamrup district, Assam, 19.07.2008, coll. B.K. Sharma; 2 exs., Samuajan beel, Dhemaji district, Assam, 09.08.2007, coll. B.K. Sharma.

Characters : Body rounded-oval, dorsal surface evenly arched, ventral surface produced in middle region and posterior end with a small protuberance. Valves reticulate, dorsal margin smooth and ventral margin with setae. Antennules curved distally, each with a lateral seta near its base and several hairs on inner edge; olfactory setae unequal. Postabdomen bilobed; anal part rounded and with spines, pre-anal part serrate and with rows of fine hairs. Claw small, curved and with setae on its concave margin.

Distribution : India : Meghalaya, Manipur and Rajasthan. Elsewhere : Europe and North America.

Remarks : Represents a new record from Assam.

Alonella clathratula Sars, 1896

(Figs. 9-10)

1896. *Alonella clathratula* Sars, *Arch. Math. Naturvidensk. Christinia*, **18**, p. 43-45, figs. 7-8.

Material examined : 4 exs., Salchapra beel, Cachar district, Assam, 20.10.2007, coll. B.K. Sharma.

Characters : Body elongated; length : height ratio 1.8. Valves with polygons with longitudinal striations and with blunt indentation at posterior-ventral corner. Antennules not reaching the tip of rostrum. Labral plate cuneiform and with blunt apex. Postabdomen elongated and with small irregular anal teeth. Claw with two basal spines, the proximal spine smallest.

Differential diagnosis : *A. clathratula* differs from the closely related *A. excisa* in its relatively elongated body, valves with polygons with longitudinal striations, nearly straight posterior margin of valves and shape of postabdomen.

Distribution : India : Meghalaya and Bihar. Elsewhere : Australian, Ethiopian and Neotropical regions and, Java.

Remarks : Represents a new record from Assam.

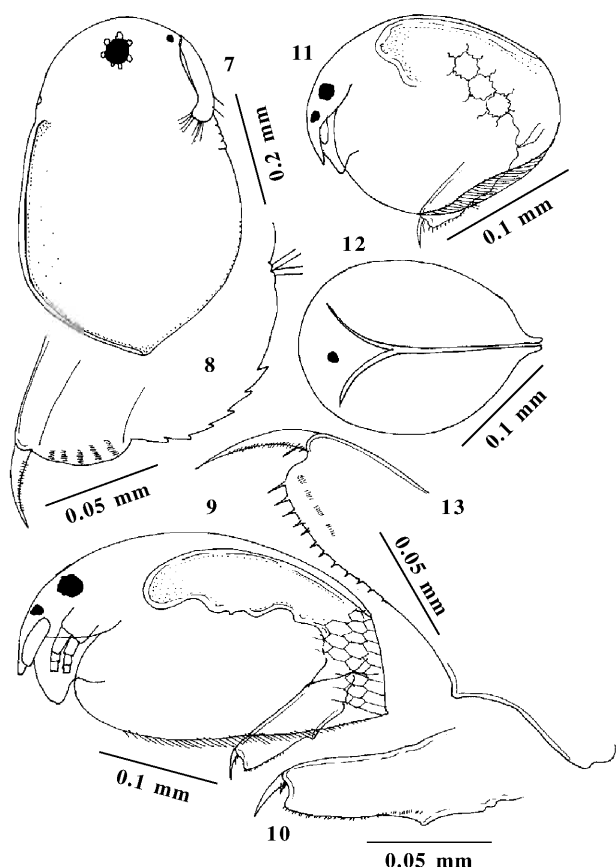
Chydorus ventricosus Daday, 1898

(Figs. 11-13)

1898. *Chydorus ventricosus* Daday, *Termes Füzetek*, **21**, p. 28-29, Figs. 10, a-d; Smirnov, 1971. *The World Chydorid Fauna*. USSR Acad. Sci. Zool. Inst. Nova ser. **101**, p. 298, Fig. 323; Michael and Sharma, 1988, *Indian Cladocera. Fauna of India series*, p. 151-152, Text-fig. 50, a-d; Smirnov, 1996. *Cladocera : The Chydorinae and Sayciinae (Chydoridae) of the World*. In : *Guides to identification of the Microinvertebrates of the Continental waters of the world*, **11**, p. 122, Figs. 500-507.

1966. *Chydorus brehmi* Biswas, *Crustaceana*, **11**, p. 113-114, Fig. 1, a-c; Brehm, 1971, *Rec. zool. Surv. India*, **63**, p. 136.

Material examined : 4 exs., Chatla beel, Cachar district, Assam, 20.10.2007, coll. B.K. Sharma; 3 exs., Salchapra beel, Cachar district, Assam, 20.10.2007, coll. B.K. Sharma.



Streblocerus serricaudatus (Fischer) : **Fig. 7.** parthenogenetic female, **Fig. 8.** postabdomen; *Alonella clathratula* Sars : **Fig. 9.** parthenogenetic female, **Fig. 10.** postabdomen; *Chydorus ventricosus* Daday : **Fig. 11.** parthenogenetic female, **Fig. 12.** parthenogenetic female (anterior view), **Fig. 13.** postabdomen.

Characters : Body sub-globular in outline; posterior ventral angle of valves without denticle, posterior ventral margins of valves bent outwardly, flattened and forming a kind of flange. Valves with faint polygons with wavy margins. Labral plate small and cuneiform. Postabdomen slightly narrowing distally, preanal corner distinct, anal margin slightly concave; with 9-10 marginal anal spines diminishing proximally and with groups of setae. Claw with setae on concave margin; with long slender basal spine and with seta attached sub-terminally on concave margin.

Differential diagnosis : This chydorid is differentiated from its allied species by the characteristic and peculiar outwardly bend posterior ventral margins of valves.

Distribution : India : Rajasthan, Kerala, Tamil Nadu, Maharashtra, Gujarat. Elsewhere : Sri Lanka, China, Java, East Africa and South America.

Remarks : Represents a new record from N.E. India.

***Alona guttata tuberculata* (Kurz, 1875)**

(Figs. 14-15)

1875. *Alona tuberculata* Kurz, Sitz. Ber. Math. Naturw. Kl. K.k. Akad. Wissench. **70**, p. 51, Plate-II, Fig. 1.

1971. *Alona guttata tuberculata* (Kurz) : Smirnov, *The World Chydorid Fauna*. USSR Acad. Sci. Zool. Inst. Nova ser. **101**, p. 468, Fig. 456-457.

Material examined : 3 exs., Bor beel, Dibrugarh district, Assam, 11.05.2008, coll. B.K. Sharma.

Characters : Body oval in outline; valves with rounded posterior dorsal and ventral corners. Head shield and valves with rounded pits. Three main head pores with a narrow connection between them. Antennules reaching apex of rostrum. Labral plate rounded. Postabdomen with projecting pre-anal corner; distal dorsal end pointed and projecting beyond base of claws. Postabdomen with 8-10 anal spines. Claw with a basal spine and setae on its concave margin.

Differential diagnosis : It differs from *A. guttata* s. str. by rounded pits or tubercles on its head shield and valves.

Distribution : India : Meghalaya. Elsewhere : Europe, Columbia, Kunashir island (USSR).

Remarks : Represents a new record from Assam.

***Alona monacantha tridentata* (Stingelin, 1905)**

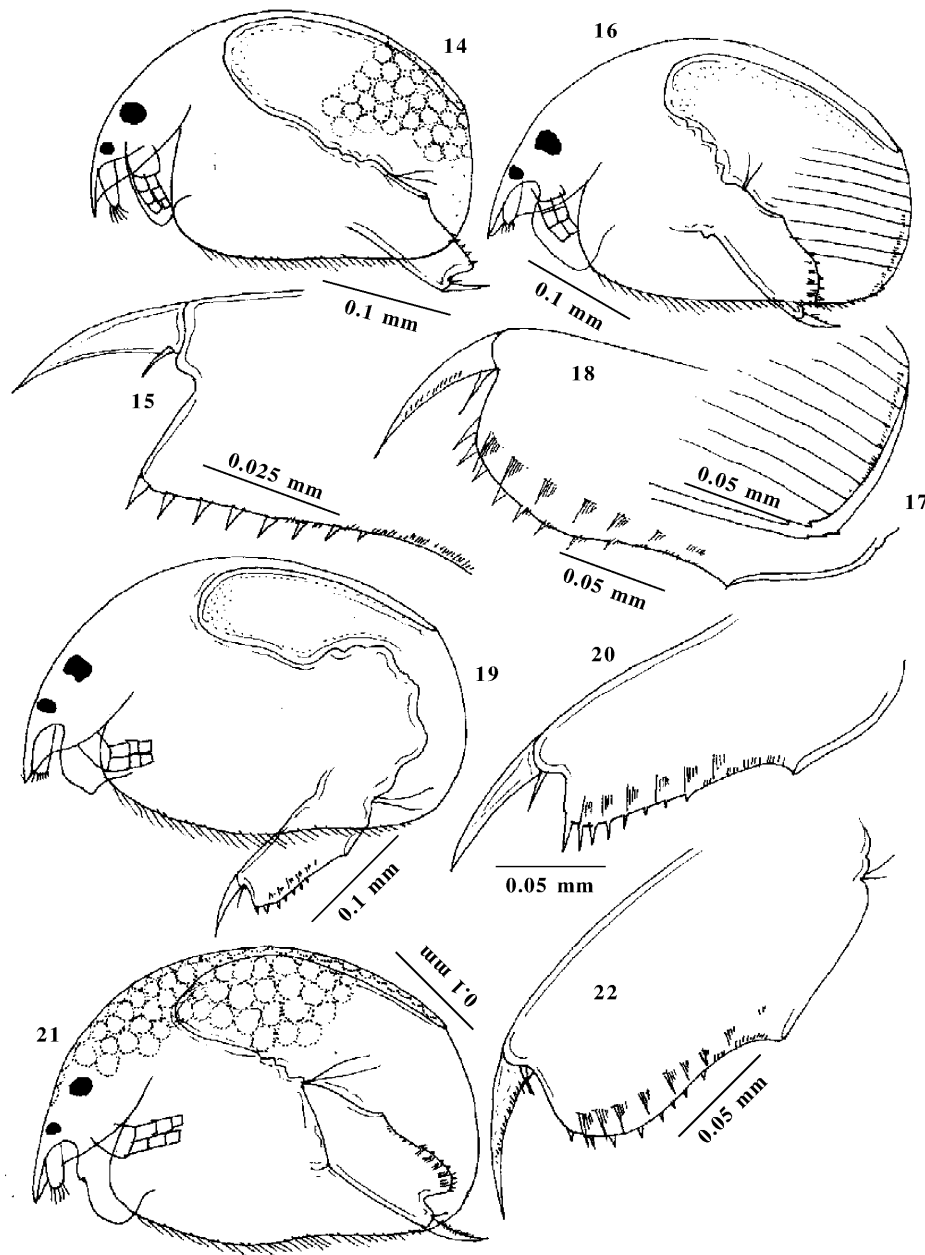
(Figs. 16-18)

1905. *Alona acuticostata* var. *tridentata* Stingelin, Zool. Jb. Abt. Syst. Geogr und Biol. **21**, p. 349-350, Pl. 12, Figs. 18-19.

1971. *Alona monacantha tridentata* (Stingelin) : Smirnov, *The World Chydorid Fauna*. USSR Acad. Sci. Zool. Inst. Nova ser. **101**, p. 440, Fig. 413.

Material examined : 4 exs., Maghuri beel, Tinsukia district, Assam, 11.05.2008, coll. B.K. Sharma.

Characters : Body oval, valves with longitudinal lines; posterior ventral corner of valves with 2-3 denticles. Rostrum long and blunt, antennules not reaching apex of rostrum. Postabdomen with distinct preanal corner, with about 10 anal spines and groups of lateral setae; distal seta in each group longest and a few distal setae projecting beyond dorsal margin of postabdomen. Claw with a basal spine and setae on concave margin.



Alona guttata tuberculata (Kurz); **Fig. 14.** parthenogenetic female, **Fig. 15.** postabdomen; *A. monacantha tridentata* (Stingelin) : **Fig. 16.** parthenogenetic female, **Fig. 17.** posterior ventral valve margins, **Fig. 18.** postabdomen; *A. pulchella* King : **Fig. 19.** parthenogenetic female, **Fig. 20.** postabdomen; *A. verrucosa* Sars : **Fig. 21.** parthenogenetic female, **Fig. 22.** postabdomen.

Differential diagnosis : It is characterized by 2-3 denticles on posterior ventral corner of its valves.

Distribution : India : Meghalaya, Tamil Nadu and Bihar. Elsewhere : Thailand.

Remarks : Represents a new record from Assam.

***Alona pulchella* King, 1853**
(Figs. 19-20)

1853. *Alona pulchella* King, *Pap. Proc. R. Soc. Tasmania*, 2, p. 260, pl. VIII B.

Material examined : 3 exs, Amuri beel, Morigaon district, Assam, 09.06.2007, coll. B.K. Sharma.

Characters : Body broadly oval; valves punctuate, with rounded postero-dorsal and postero-ventral corners. Rostrum blunt, head-shield with three main head pores, not connected to one another. Labral plate with convex anterior margin and blunt apex. Antennules not reaching apex of rostrum. Postabdomen with nearly straight dorsal and ventral margins, preanal corner

distinct; 8-10 anal denticles increasing in size distally, lateral setae in groups and distal seta longest in each group. Claw with a basal spine.

Distribution : India : Meghalaya, Tripura, West Bengal, Gujarat, Rajasthan and Tamil Nadu. Elsewhere : Cosmotropical.

Remarks : Represents a new record from Assam.

***Alona verrucosa* Sars, 1901**

(Figs. 21-22)

1901. *Alona verrucosa* Sars, Arch. Math. Naturvidensk. Christinia, **23**, p. 56-57, pl. IX, Fig. 7, 7a.
 1971. *Biapertura pseudoverrucosa verrucosa* Smirnov, The World Chydorid Fauna. USSR Acad. Sci. Zool. Inst. Nova ser. **101**, p. 480-481, Fig. 606.
 1974. *Biapertura verrucosa* (Sars) : Fernando, 1974, Int. Rev. ges. Hydrobiol., **65**, Figs. 114-115, 171 H.

Material examined : 5 exs., Jogra beel, Dhubri district, Assam, 21.04.2008, coll., B.K. Sharma.

Characters : Body oval; valves with characteristic tubercles, posterior dorsal and ventral corners rounded. Labral plate with a denticle on its anterior end. Two main connected head pores; lateral pores elevated. Postabdomen short, with curved dorsal and rounded distal margins. Anal spines 6-8; lateral setae in groups, distal seta largest in each group. Claw with a basal spine and setae on the concave margin.

Differential diagnosis : *A. verrucosa* can be differentiated from its allied species by the distinct shapes of its labral plate and postabdomen as well as presence of characteristic tubercles on valves.

Distribution : India : West Bengal, Gujarat and Tamil Nadu. Elsewhere : Indo-Malayan, Ethiopian and Neotropical regions.

Remarks : Represents a new record from N.E. India.

DISCUSSION

Nine species of Cladocera belonging to four families and six genera are recorded here from Assam. Amongst these, four species namely *Diaphanosoma tropicum*, *Sarsilatona serricauda*, *Chydorus ventricosus* and *Alona verrucosa* are new records from Northeastern India while *Streblocerus serricaudatus*, *Alonella clathratula*, *Alona guttata tuberculata*, *A. monacantha tridentata* and *A. pulchella* are new records from Assam.

Significantly, the documented taxa represent two phylogenetic stems of this group i.e., Ctenopoda and Anomopoda and form rare and interesting elements in our collections. The examined samples include only parthenogenetic females and no males are observed in the present study.

Diaphanosoma tropicum, an interesting member of the Sididae belonging to *D. modigliani*-*D. dubium* species group, was described by Korovchinsky (1998) based on analyses of inter population morphological variability, duly supplemented by its geographical distribution. This species was erroneously identified under the name '*D. modigliani* Richard' by Idris and Fernando (1981), Rajapaksa (1981), Kanduru (1981) and Rajapaksa and Fernando (1982) from Malaysia, Sri Lanka and South India respectively. However, *D. tropicum* can be diagnosed correctly from *D. modigliani* by its characteristic features, geographical distribution and preference for different aquatic environs. In addition, this species is confused (Korovchinsky, 2000) with *D. dubium* Manuilova (= *D. dubia*, name amended by Korovchinsky and Mirabdullaev, 1994). Further, *D. tropicum* is a relatively large bodied species of the genus *Diaphanosoma*; its large size may negatively affect distribution of such taxa in tropical waters, with high predation pressure (Kerfoot and Lynch, 1987; Gliwicz, 1994). Nevertheless, its long swimming antenna and massive muscles testify to good swimming ability, which perhaps helps it to co-exist with predators (Korovchinsky 2000). Interestingly, *D. tropicum* is so far known to occur in India only from Tamil Nadu. The present study, the second confirmed report of this interesting species from India, considerably extends its distributional range to N.E. region and, hence, reflects presence of distant disjunct populations of the species in this country.

Sarsilatona is reported to occur in the tropics and subtropics (Korovchinsky, 1992; Negrea *et al.* 1999). The sole earlier report of this genus from Asia refers to *Latonopsis fernandoi*-a new species described by Rane (1983) from Madhya Pradesh which was, in turn, treated as a synonym of *Sarsilatona serricauda* (Sars) by Sharma and Sharma (1990). The specimens of *S. serricauda* examined from Assam, therefore, represent

its second record from the Asian continent and its present report, therefore, deserve special mention as an example of global biogeographical significance.

Chydorus ventricosus, an anomalous chydorid, was re-described by Rajapaksa and Fernando (1986). This species is known from Sri Lanka, Java, Africa and South America while it is so far observed in this country from Southern, Central and Western India. The present report of *C. ventricosus* extends its occurrence to N.E. India and indicates example of regional distributional interest.

Alona verrucosa is another interesting addition to the cladoceran fauna of Northeastern India. This species is so far represented by its disjunct Indian populations from Gujarat, Tamil Nadu, and West Bengal; the specimens from the last state, however, lacked the presence of diagnostic tubercles on their valves (= *A. verrucosa pseudoverrucosa*). On the other hand, the specimens examined from Assam belong to *A. verrucosa s. str.*

Alonella clathratula was formerly treated as a subspecies of *A. excisa* by Smirnov (1971) who subsequently (Smirnov, 1996) resurrected its specific status. These two species exhibit different distributional ranges; the former is reported from the Australian, Ethiopian and Neotropical regions and, Java while the later shows cosmopolitan distribution. *A. clathratula* is so far represented by its disjunct Indian populations examined from Bihar (Sharma and Sharma, 2001) and Meghalaya (Sharma, 2008). The present report further extends its distributional range to the adjoining state of Assam. Smirnov and Timms (1983) indicated occurrence of this species in acidic waters in Australia. Interestingly, it was collected earlier from an acidic wetland (pH : 6.0) from South Garo Hills district of Meghalaya (Sharma, 2008). The present report of *A. clathratula* in acidic waters from Assam affirms the acidophilus character of this chydorid.

Alona tuberculata was treated as a subspecies of *A. guttata* by Smirnov (1971). This subspecies is recorded so far only from Europe, Columbia and USSR as against the nominate *A. guttata s. str.* which apparently shows cosmopolitan distribution. *A. guttata*

tuberculata is, however, recently documented in India from Meghalaya (Sharma, 2008). The present report of this rare and interesting taxon further extends its distributional range within Northeastern India.

Alona monacantha tridentata, a new record from Assam, has earlier been reported from this country from the states of Tripura (Venkataraman and Das, 2000) and Meghalaya (Sharma, 2008) of North-Eastern region. The cosmotropical *A. pulchella* is relatively widely distributed in India with records from West Bengal, Gujarat, Rajasthan and Tamil Nadu. It is known in Northeastern region from the state of Tripura (Venkataraman and Das, 2000); our observations extend its distributional range in the stated region. *Streblocerus serricaudatus*, another new record from Assam, is a lesser known Macrothricidae from India with reports from Meghalaya, Manipur and Rajasthan.

SUMMARY

Plankton samples examined from Assam reveal nine species of rare and interesting Cladocera belonging to four families and six genera. *Diaphanosoma tropicum*, *Sarsilatona serricauda*, *Chydorus ventricosus* and *Alona verrucosa* are new records from N.E. India. In addition, *Streblocerus serricaudatus*, *Alonella clathratula*, *Alona guttata tuberculata*, *A. monacantha tridentata* and *A. pulchella* are new records from Assam. Interestingly enough, *Diaphanosoma tropicum* and *Sarsilatona serricauda* are records of global biogeographical significance while the reports of other taxa are important from the view point of regional or local distribution.

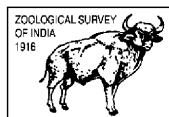
ACKNOWLEDGEMENTS

This study is part of the senior authors investigations on 'Faunal diversity of zooplankton of North-Eastern India' undertaken under the 'Potential for Excellence Program (Focused Area : Biosciences)' of North-Eastern Hill University, Shillong. The senior author is thankful to the Head, Department of Zoology, North-Eastern Hill University, Shillong for laboratory facilities. One of the authors (SS) is thankful to the Director, Zoological Survey of India and the Officer-in-charge, Eastern Regional Station, Zoological Survey of India, Shillong.

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Rec. zool. Surv. India : **110**(Part-2) : 49-55, 2010

NOTES ON NEW RECORDS OF MONOGONONT ROTIFERS (ROTIFERA : EUROTATORIA) FROM FLOODPLAIN LAKES OF ASSAM

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INTRODUCTION

Although systematic studies on the Indian Rotifera began more than one century ago, the related investigations from North-Eastern India, one of the global biodiversity 'hot-spots', were initiated in the later half of 20th century. The status of faunal diversity of Rotifera of N.E. region is reviewed by Sharma and Sharma (2005a). In addition, several new records of interesting taxa from this region have been reported by Sharma (2004, 2005, 2007).

The present study, a part of comprehensive survey of the Rotifera biodiversity in N.E. India, deals with ten species of rare and interesting monogonont rotifers collected from the floodplain lakes (beels) of the Brahmaputra river basin of Assam. The documented species include four new records from India, four new reports from Northeastern region and two new records from Assam. All the examined species are briefly diagnosed and illustrated and remarks are made their distribution.

MATERIALS AND METHODS

The present observations are based on plankton samples collected during January-December, 2007 from various floodplain lakes (beels) of the Brahmaputra river basin of Assam by towing a nylobolt plankton net (No. 25) and preserved in 5% formalin. The samples are screened, the rotifer taxa are isolated and mounted individually in Polyvinyl alcohol-lectophenol mixture.

The different species are identified following the works of Kutikova (1970), Koste (1978), Koste and Shiel (1989), Segers (1995) and Sharma (1998, 2007). The drawings are made with a Leitz-Dialux phase contrast stereoscopic microscope using a drawing tube attachment and measurements are indicated in micrometers (μm). Segers (2002) is followed for the recent system of nomenclature of Rotifera and remarks on the distribution are made *vide* Segers (2007). The reference materials are deposited in the holdings of the senior author (BKS) at, Department of Zoology, North-Eastern Hill University, Shillong.

LIST OF THE EXAMINED SPECIES

Phylum	ROTIFERA
Class	EUROTATORIA
Subclass	MONOGONONTA
Order	PLOIMA
Family	EUCHLANIDAE

Tripleuchlanis plicata (Levander, 1894)**

Family LEPADELLIDAE

Colurella colurus (Ehrenberg, 1830)*

Lepadella bicornis Vasisht & Battish, 1971***

L. elongata Koste, 1992*

L. latusinus (Hilgendorf, 1889)*

L. rhomboidula (Bryce, 1890)**

L. triptera alata (Myers, 1934)*

Family LECANIDAE

Lecane aspasia Myers, 1947**

L. elegans Harring, 1914***

L. elongata Harring & Myers, 1926**

TAXONOMIC NOTES

Tripleuchlanis plicata (Levander, 1894)

(Figs. 1-3)

Material examined : 6 examples, R/BKS/Assam/211-216, Deepor beel, Dharapur (Kamrup district), 26.08.2006, coll. B.K. Sharma.

Characters : Lorica rigid and ovoid, with double cuticular folds between dorsal and ventral plates. Foot robust, three-segmented and often projecting beyond lorica. Toes short, parallel-sided and with pointed tips.

Distribution : N.E. India : New record India : West Bengal, Andhra Pradesh and Tamil Nadu. Elsewhere : Cosmopolitan.

Colurella colurus (Ehrenberg, 1830)

(Figs. 4-5)

Material examined : 3 examples, R/BKS/Assam/231-233, Padmakhua beel (Morigaon district), 20.03.2007, coll. B.K. Sharma.

Characters : Lorica oblong in outline, with maximum width slightly before its middle and rounded posterior end; anterior lorica margin rounded. Foot three-segmented; toes long, slender and pointed.

Distribution : India : new record. Elsewhere : Cosmopolitan.

Lepadella bicornis Vasisht & Battish, 1971

(Figs. 6-7)

Material examined : 3 examples, R/BKS/Assam/241-243, Amuri beel, (Morigaon district), 18.09.2007, coll. B.K. Sharma.

Characters : Lorica broadly ovate, moderately compressed dorso-ventrally; with prominent acutely pointed broad-based corners laterally. Anterior dorsal margin concave and anterior ventral sinus v-shaped. Foot-groove shallow. Foot 4-segmented, distal foot-segment longest; toes equal and pointed.

Distribution : N.E. India : New record. India : Chandigarh (U.T.). Elsewhere : Brazil.

Lepadella elongata Koste, 1992

(Figs. 8-9)

Material examined : 4 examples, R/BKS/Assam/247-250, Muijan beel, (Dibrugarh district), 26.08.2006, coll. B.K. Sharma.

Characters : Lorica oblong in outline, with maximum width in its middle region; posterior end of lorica narrower and slightly truncate. Anterior opening deep, nearly U-shaped dorsally and V-shaped ventrally. Foot-opening elongated, nearly parallel-sided; toes long and pointed.

Distribution : India : new record. Elsewhere : Neotropical, Oriental and Pacific regions.

Lepadella latusinus (Hilgendorf, 1889)

(Figs. 10-12)

Material examined : 4 examples, R/BKS/Assam/252-255, Maghuri beel, Guijan (Tinsukia district), 12.05.2008, coll. B.K. Sharma.

Characters : Lorica elongated-oval, broadest in middle and then tapering slightly to each end; vaulted hemispherical in cross-section. Occipital margin cowl-like and ventrally protruding; head aperture small, with slightly convex dorsal margin and a deep U-shaped ventral sinus. Foot-opening wide and with outwardly curved corners; last foot-segment $< \frac{1}{2}$ toe length. Toes elongated, pointed and ventrally directed.

Distribution : India : new record. Elsewhere : Cosmopolitan.

Lepadella rhomboidula (Bryce, 1890)

(Figs. 13-15)

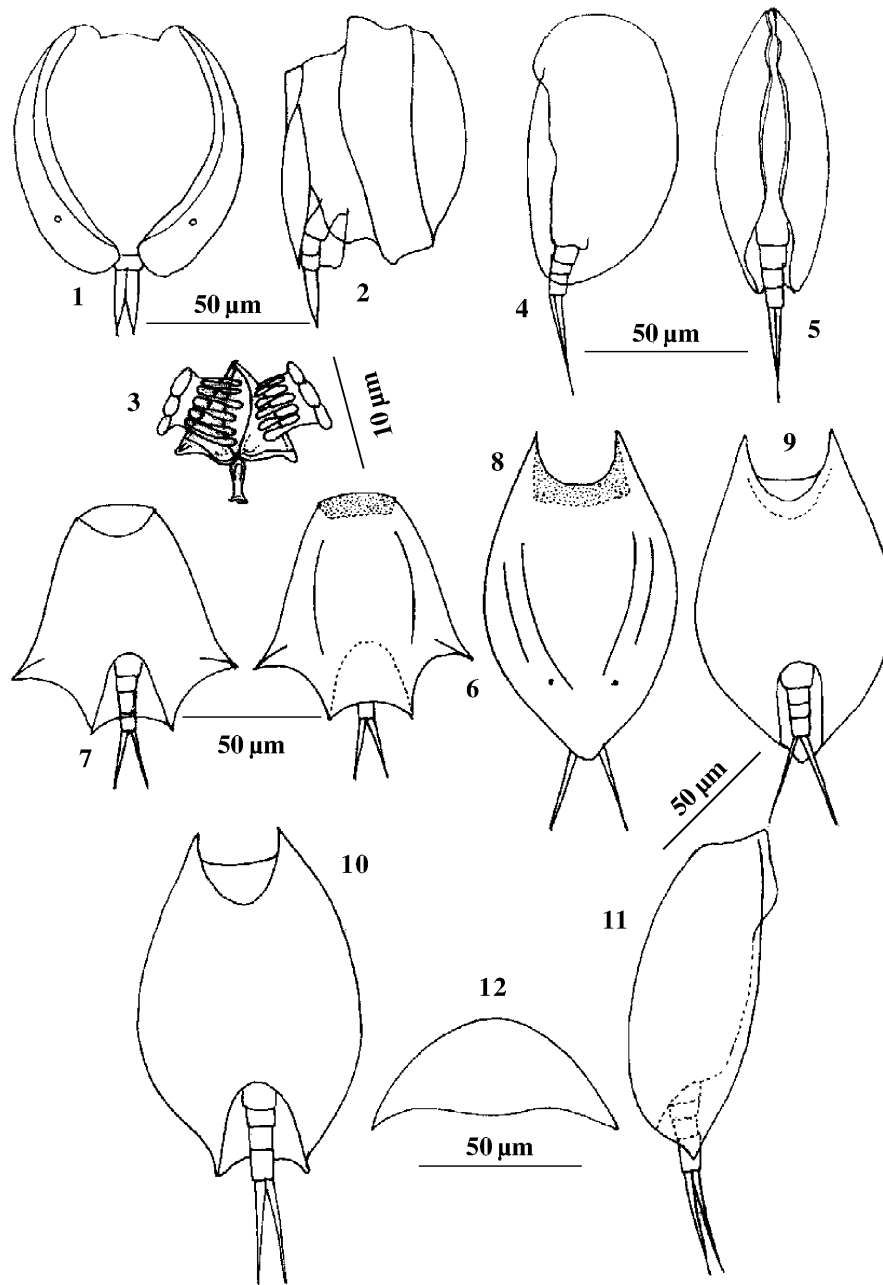
Material examined : 3 examples, R/BKS/Assam/259-261, Deepor beel, Dharapur (Kamrup district), 26.08.2006, coll. B.K. Sharma.

Characters : Lorica rhomboidal in outline, with moderately high dorsal keel and maximum width in its middle region. Dorsal sinus lacking. Ventral sinus shallow and semicircular. Foot-groove inverted U-shaped; toes short and pointed.

* New record from India

** New Record from N.E. India

*** New record from Assam



Tripleuchlanis plicata (Levander, 1894) : **Fig. 1.** dorsal view; **Fig. 2.** lateral view, **Fig. 3.** trophi; *Colurella colurus* (Ehrenberg, 1830) : **Fig. 4.** lateral view, **Fig. 5.** ventral view : *Lepadella bicornis* Vasisht & Battish, 1971; **Fig. 6.** dorsal view, **Fig. 7.** ventral view; *Lepadella elongata* Koste, 1992; **Fig. 8.** dorsal view, **Fig. 9.** ventral view; *Lepadella latusinus* (Hilgendorf, 1889); **Fig. 10.** ventral view, **Fig. 11.** lateral view, **Fig. 12.** cross-section.

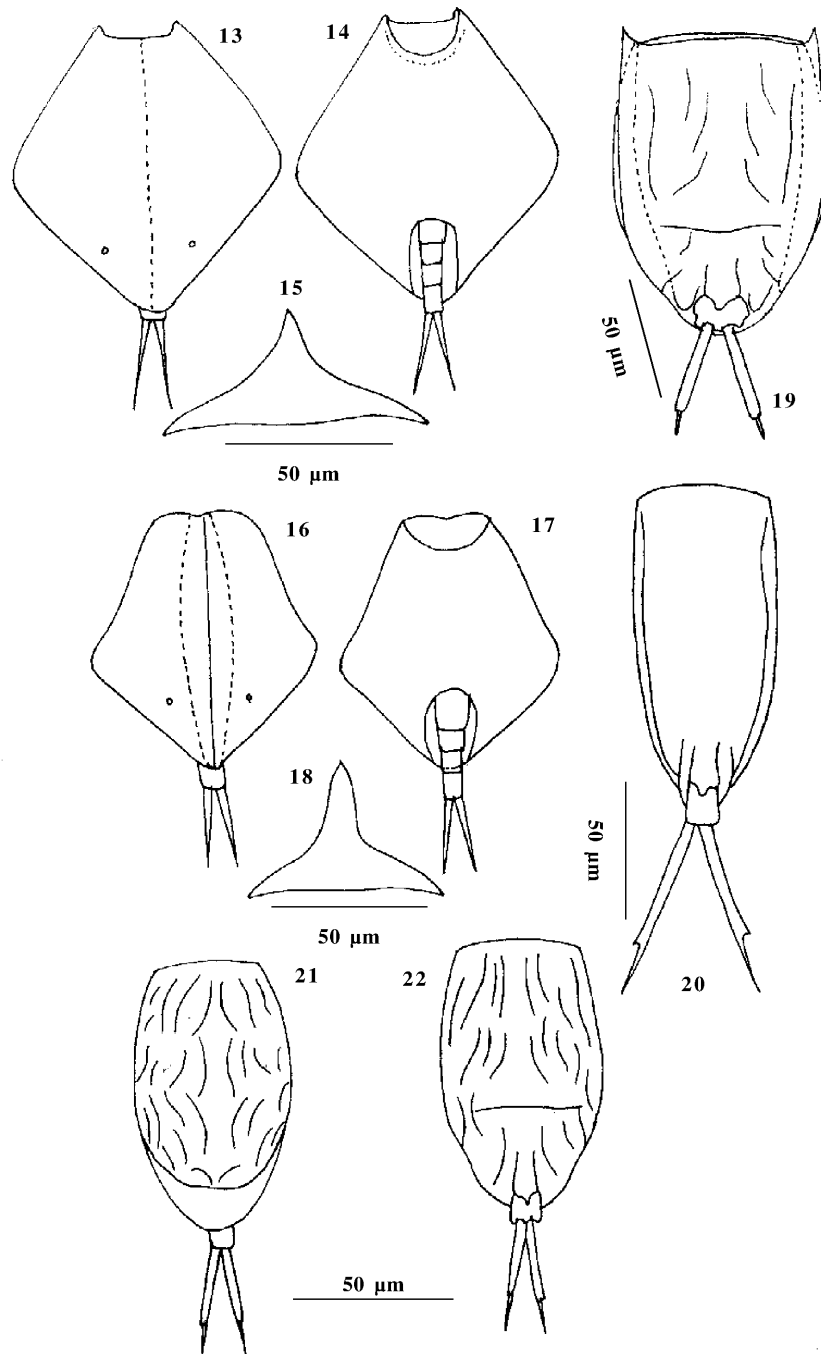
Distribution : N.E. India : New record. India : West Bengal. Elsewhere : African, Australian, Oriental and Palaearctic regions.

Lepadella triptera alata (Myers, 1934)
(Figs. 16-18)

Material examined : 4 examples, R/BKS/Assam/265-268, Deepor beel, Dharapur (Kamrup district), 26.08.2006, coll. B.K. Sharma.

Characters : Lorica small, rhombic in outline, broadest in its middle region. Dorsal surface of lorica vaulted, with high median keel and slightly produced posterior end. Head aperture small, with a slight median notch dorsally and shallow U-shaped sinus ventrally. Foot-opening small and oval. Toes short and pointed.

Distribution : N.E. India : New record. India : new record. Elsewhere : Cosmopolitan.



Lepadella rhomboidula (Bryce, 1890); **Fig. 13.** dorsal view; **Fig. 14.** ventral view; **Fig. 16.** cross-section; *Lepadella triptera alata* (Myers, 1934); **Fig. 16.** dorsal view; **Fig. 17.** ventral view, **Fig. 18.** cross-section; *Lecane aspasia* Myers, 1947; **Fig. 19.** ventral view; *Lecane elegans* Harring, 1914; **Fig. 20.** ventral view; *Lecane elongata* Harring & Myers, 1926; **Fig. 21.** dorsal view, **Fig. 22.** ventral view.

***Lecane aspasia* Myers, 1947**
(Figs. 19)

Material examined : 3 examples, R/BKS/Assam/280-282, Itakhuli beel, (Dibrugarh district), 12.05.2008, coll. B.K. Sharma.

Characters : Lorica elongated, lateral sulci shallow; anterior margins nearly straight and coincident and

ventral occipital margin with small antero-lateral spines. Dorsal plate narrow anteriorly, nearly as wide as ventral plate and ornamented. Ventral plate longer than wide, with incomplete transverse fold and few longitudinal folds. Posterior segment rounded. Foot pseudo segment wider than long and slightly projecting. Toes parallel-sided, with sharp completely separated claws.

Distribution : N.E. India : New record. India : Delhi.
Elsewhere : Cosmopolitan.

Lecane elegans Harring, 1914
(Fig. 20)

Material examined : 2 examples, R/BKS/Assam/289-290, Memdubi beel, Guijan (Tinsukia district), 15.05.2008, coll. B.K. Sharma.

Characters : Lorica smooth, elongated and slender, anterior occipital margins nearly straight and coincident. Lateral sluci indistinct. Ventral plate with few longitudinal folds. Foot plate large. Second foot-segment elongated and projects beyond lorica. Toes long, parallel-sided and slightly curved distally. Pseudo-claws long, curved and with distinct denticles and pointed tips.

Distribution : N.E. India : New record from Assam. India : Manipur. Elsewhere : Pantropical.

Lecane elongata Harring & Myers, 1926
(Figs. 21-22)

Material examined : 3 examples, R/BKS/Assam/294-296, Butikor beel, Dhemaji (Dhemaji district), 26.08.2006, coll. B.K. Sharma.

Characters : Lorica elongate, lateral sluci shallow; anterior margins coincident, anterior-lateral corners angulated. Dorsal plate ornamented, medially wider than ventral plate. Ventral plate elongate, with longitudinal and transverse folds. Posterior segment rounded. Foot plate narrow, coxal plates rounded. Foot pseudo-segment elongate and projecting. Toes parallel-sided and with long completely separated claws.

Distribution : N.E. India : New record. India : Delhi. Elsewhere : Holarctic region.

REMARKS

Ten interesting species of monogonont rotifers belonging to three eurotatorien families and four genera are recorded from the floodplain lakes of the Brahmaputra river basin. Amongst these, *Colurella colurus*, *Lepadella elongata*, *L. latusinus* and *L. triptera alata* are new records from India. In addition, four species namely *Tripleuchlanis plicata*, *Lepadella rhomboidula*, *Lecane aspasia* and *L. elongata* are new records from Northeastern India while *Lepadella bicornis* and *Lecane elegans* are new records from the

state of Assam. The recorded taxa are rare elements in the examined material and these include six Cosmopolitan, one Holarctic, one Palaeotropical and one Pantropical elements while one species is so far known from the Neotropical, Oriental and Palaearctic regions.

Among the members of the Lepadellidae, *Lepadella elongata* merits distributional interest with earlier reports from Brazil, Ecuador and Nigeria and, its only report from the Oriental region dealt with occurrence in Thailand (Sanoamuang and Savatentalinton, 1999). The present second report of this species from the Oriental region now extends its distributional range to the Indian subcontinent. *L. latusinus* is another interesting addition to the Rotifera fauna of this subcontinent though it is known to exhibit wider global distribution (Segers, 2007). *L. triptera alata*, yet another new record of the Lepadellidae from India, differs from the typical *L. triptera* (Ehrenberg) in the characteristic shape of lorica and restricted occurrence in spite of its apparently cosmopolitan nature.

Lepadella bicornis was originally described by Vasisht and Battish (1971) from a fish pond at Chandigarh (North India) and was not known from the Indian subcontinent since its description. Segers *et al.* (1993) provided the only confirmed report of this species from the Rio Abobral and Rio Paraguai (Pantal region, Brazil). On the other hand, it was erroneously identified as *L. ehrenbergi* from Rio Tapajos (Koste, 1974) and as *L. pterygoida* from Rio Nhamunda (Brandorff *et al.*, 1982) from the Amazon region, Brazil. The recent report (Sharma, 2007) of this interesting palaeotropical species from Loktak lake (a Ramsar site) represents the second Indian record since its description. The present report of this species from Assam adds further to extension of its distributional range within N.E. India. In addition, *L. rhomboidula* is so far known from India only from West Bengal (Sharma, 1978); the present second report of this rare species from this country, extends its distributional range to N.E. Region.

The cosmopolitan *Colurella colurus*, a new report from India, is another interesting member of the Lepadellidae. It is often confused with *C. adriatica* but can be differentiated by the rounded or blunt-spined posterior lorica.

The Lecanidae includes three species with regional biogeographical importance in the Indian fauna. Among these, the Holarctic *L. elongata* is so far recorded from the back waters of the river Yamuna at Delhi (Arora and Mehra, 2003). Its present disjunct report from the floodplains of the Brahmaputra river basin, therefore, extends its distribution to Northeastern India. The cosmopolitan *L. aspasia* is so far known from this country from Delhi (Segers *et al.*, 1994). The occurrence of this lecanid in a floodplain lake of Assam is yet another example of extension of its distributional range to N.E. region. The pantropical *L. elegans*, third member of the Lecanidae, is recorded recently from India from Loktak lake, Manipur (Sharma, 2007) and is now examined from the state of Assam.

The genus *Tripleuchlanis* (Family : Euchlanidae) is represented by only one species i.e., *T. plicata* from the Indian inland waters. This euchlanid was first reported from India from West Bengal (Sharma, 1979) and is so far recorded from Andhra Pradesh and Tamil Nadu. The present report, therefore, extends its distributional range to Northeastern region. Interestingly, this species is currently examined from Deepor beel (a Ramsar site) but was not observed so far in our earlier collections from this wetland since the last one decade.

The present report raises the Rotifera richness known so far from Northeastern India (Sharma and Sharma, 2005a) to 210 species belonging to 44 genera and 21 families. The occurrence of the stated new records highlights our earlier comments (Sharma, 2005, Sharma and Sharma, loc cit.) on the global importance of the floodplain lakes of the Brahmaputra basin as 'hotspots' for the Rotifer biodiversity and also lays emphasis on analysis of more extensive collections from

these ecotones. Interesting, three taxa are new additions to the rotifer fauna of Deepor beel studied earlier by Sharma and Sharma (2005b), thereby, raising total richness from this Ramsar site to 113 species-the second highest qualitative diversity of Phylum Rotifera so far reported from any floodplain lakes of the Indian subcontinent.

SUMMARY

Plankton samples examined from the floodplain lakes of the Brahmaputra river basin revealed 10 species of interesting monogonont Rotifera belonging to three families and four genera. Among these, *Colurella colurus*, *Lepadella elongata*, *L. latusinus* and *L. triptera alata* are new records from India; *Tripleuchlanis plicata*, *Lepadella rhomboidula*, *Lecane aspasia* and *L. elongata* are new records from Northeastern India and, *Lepadella bicornis* and *Lecane elegans* are new records from the state of Assam. The recorded taxa are rare elements in the examined material and these include six Cosmopolitan, one Holarctic, one Palaetropical and one Pantropical elements while one species is so far known from Neotropical, Oriental and Palaearctic regions.

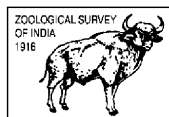
ACKNOWLEDGEMENTS

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Rec. zool. Surv. India : **110**(Part-2) : 57-80, 2010

TAXONOMIC STUDIES OF HORNET WASPS (HYMENOPTERA : VESPIDAE) VESPA LINNAEUS OF INDIA

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INTRODUCTION

The members of the genus *Vespa* Linnaeus are commonly known as Hornet wasps. They are highly evolved social wasps. They built their nest by using wood pulp. They have large colonies consisting of a single female queen, a large number of sterile workers and males. Hornet wasps are mainly distributed in Oriental and Palaearctic Regions of the world. There are 23 valid species known from the world so far of which 16 species from Indian subcontinent and 15 species from India (Carpenter & Kojima, 1997). Economically, hornet wasps can be both beneficial and harmful. They are beneficial as predators of agricultural, forest and hygienic pests. The larvae and pupae of *Vespa* are utilized as food by man in some parts of the world. They are harmful as they sting human beings and domesticated animals. They are the natural enemies of honey bees and they damage fruits by feeding on them, just prior to harvest.

Some important works on the taxonomy and distribution of the hornet wasps are: Archer (1989, 1991a, 1991b, 1999), Bequaert (1936), Bingham (1897), du Buysson (1905), Carpenter (1987), Carpenter & Kojima (1997), Das & Gupta (1989), Harris & Patrick (1997), Jacobson (1986) and van der Vecht (1957, 1959). Some recent works on hornet wasps published from India are: Girish Kumar & Srinivasan (2009), Gupta (1997a, 1997b), Gusenleitner (2006), Jonathan & Kundu (2003), Jonathan *et al.* (1999, 2000a, 2000b), Kundu *et al.* (in press) and Roy & Kundu (1985).

Carpenter & Kojima (1997) published the detailed synonyms of each species. So the same is not provided

here. Since it is a taxonomic paper, we generally used the term 'Female' instead of 'Queen' and 'Worker' and mentioned the terms 'Fertile female' and 'Sterile female' wherever it is necessary.

All specimens studied are properly registered and deposited. Most of the specimens are deposited at 'National Zoological Collections' of the Hymenoptera Section, Zoological Survey of India, Kolkata (NZSI) and the rest of the specimens are deposited at Arunachal Pradesh Field Station, Zoological Survey of India, Itanagar (APFS/ZSI).

Genus *Vespa* Linnaeus

1758. *Vespa* Linnaeus, *Syst. Nat.*, ed. 10, **1** : 343, 572, Genus (17 species).

Type species : "*Vespa crabro*, Fab." [= *Vespa crabro* Linnaeus, 1758], by subsequent designation of Latreille, 1810, *Consid. Gen. Crust. Arachn. Ins.* : 438.

1904. *Macrovespa* Dalla Torre, *Gen. Ins.* **19** : 64, group of genus *Vespa* Linnaeus.

Type species : *Vespa crabro* Linnaeus, 1758, by subsequent designation of Bequaert, 1930, *Bull. Brooklyn Ent. Soc.* **25** : 64.

1959. *Nyctovespa* van der Vecht, *Zool. Meded., Leiden* **36** (13) : 210, subgenus of *Vespa* Linnaeus.

Type species : *Vespa binghami* du Buysson, 1905, by original designation.

Diagnosis : Large sized wasps usually over 20 mm long; clypeus with short hairs on its apical third only; ocelli small (except in *Vespa binghami* du Buysson), posterior ocelli at the level of the centre of eyes; vertex and temple comparatively wider; male antenna with tyloids (except in *V. binghami* du Buysson); occipital carina present laterally and extending to base of

mandible, absent dorsally; pronotal carina strong with a pit or a fovea close to its posterior edge in the lower half; fore wing with prestigma 3x as long as stigma; first cubital cell shorter than the distance between its apex and tip of fore wing; hamuli of hind wing originating before the tip of subcostella.

Van der Vecht (1957, 1959), Matsuura and Yamane (1990) discussed biology and nest building activities of various *Vespa* species in detail.

Distribution : Oriental and Palaearctic Regions including North Africa, Wallacea, Japan and New Zealand.

Key to the Indian species of *Vespa* Linnaeus

(Based on females)

1. Ocelli large (Fig. 1); interocellar distance a little longer than ocellocular distance (Fig. 1); nocturnal in habits *binghami* du Buysson.
- Ocelli small (Fig. 4); interocellar distance shorter than ocellocular distance (Fig. 4); diurnal in habits 2
2. Apical margin of clypeus with a broad and deep apical emargination forming lateral lobes and with a median triangular tooth projecting only half the length of the lateral lobes (Fig. 2) *analís* Fabricius.
- Apical margin of clypeus emarginate without a median tooth (Figs. 6, 7, 8 & 13) 3
3. Head strongly widened and produced behind eyes; temple in profile view more than 1.8x as wide as eye (Fig. 3); posterior ocelli 3x or more than 3x farther from occiput than from eye (Fig. 4) 4
- Head normal; temple less than 1.8x as wide as eye (Fig. 12); posterior ocelli less than 3x farther from occiput than from eye (Figs. 9 & 10) 5
4. Area around ocelli without black markings; thorax usually black, rarely reddish; abdomen reddish brown with narrow yellow apical bands on first to fifth tergites; last tergite yellowish brown; proportionately wider gena (Fig. 3) *mandarinia* Smith.
- Area around ocelli with black markings; scutellum, postscutellum, two marks on propodeum and often with anterior border of pronotum yellow or orange red; first and second gastral tergites yellow and usually with reddish brown or black stripes in the middle; third to sixth tergites wholly black; proportionately thinner gena (Fig. 5) *soror* du Buysson.
5. Clypeus coarsely punctate; thorax black and head black to red, not marked with yellow; gaster brown or black with second tergite yellow 6
- Clypeus subpolished and with scattered punctures; head, thorax and gaster black to brown, with reddish or yellow areas 9
6. Apical margin of clypeus with a bluntly triangular tooth on each side of the median emargination (Fig. 6); body covered with strong and stiff hairs 7
- Apical margin of clypeus with short broadly rounded lobes on each side of the median emargination (Fig. 7); body hairs fine, shorter and comparatively dense 8
7. First and second gastral tergites orange with a narrow apical black band; fifth and sixth gastral tergites black; clypeus orange red; vertex orange yellow *ducalis* Smith
- First gastral tergum usually entirely black or blackish brown and sometimes with a narrow yellow band on the posterior margin and second gastral tergum orange yellow with a narrow brownish black band basally; clypeus and vertex either black or orange red, if orange red then the apical margin of clypeus black *tropica* (Linnaeus)
8. Punctures on vertex, temple, mesoscutum, scutellum, postscutellum, metapleuron and propodeum small and crowded; second gastral tergum largely or entirely orange yellow *affinis* (Linnaeus)
- Vertex, temple, postscutellum and propodeum sparsely and rather finely punctate; scutellum and metapleuron almost impunctate; second gastral tergum black or dark brown with almost a narrow yellow to reddish brown apical band *mocsaryana* du Buysson
9. Clypeus rather flat and elongate, as wide as long or a little longer (Fig. 8), with scattered moderately sized punctures, its lateral emargination long and convergent; body dorsally less hairy, hairs on head

- and thorax short, sparse, stiff and bristle-like; gaster almost hairless dorsally; body brown with clypeus, frons and third and fourth gastral tergites yellow
orientalis Linnaeus
- Clypeus convex, wider than long, not elongate (Fig. 13), its lateral emargination short, punctures on clypeus finer; head and thorax dorsally covered with dense and long black or yellowish brown hairs; gaster with hairs; body largely black or yellow.....10
10. Second to fifth gastral tergites entirely black.....11
- Second to fifth gastral tergites not entirely black, either largely yellow or black mixed with brown or yellow 12
11. Antennal flagellomeres black; sixth gastral tergum orange yellow; posterior ocelli more than 2x farther from occiput than from eye (Fig. 9); vertex not depressed at medially (Fig. 9); clypeus subpolished with scattered punctures**fumida** van der Vecht
- Antennal flagellomeres usually orange, rarely reddish brown; sixth gastral tergum black; posterior ocelli less than 1x farther from occiput than from eye (Fig. 10); vertex depressed at medially (Fig. 10); clypeus almost impunctate **basalis** Smith
12. Thorax sulphur yellow with mesoscutum, a mark below tegula, a median line on scutellum, margins of postscutellum, Y- shaped mark at junction of postscutellum and propodeum and line between mesopleuron and metapleuron black; gaster largely yellow; legs entirely yellow **bicolor** Fabricius
- Thorax black or black mixed with brown; gaster black mixed with brownish or yellowish bands; legs never entirely yellow 13
13. Head yellow with a ring- like black mark on frons (Fig. 11); gastral tergites black with yellow markings apically, yellow band on third tergum broadly emarginate and covering three by fourth portion .
..... **vivax** Smith
- Head orange red to reddish brown with or without black marks on frons and vertex; if black mark present on frons, it never ring- like; gastral tergites black with reddish brown markings 14
14. Thorax black mixed with reddish brown markings; head reddish brown without black markings
..... **auraria** Smith
- Thorax entirely black without reddish brown markings; upper half of head largely black
..... **velutina** Lepeletier.
1. **Vespa binghami** du Buysson
(Plate I-1)
1905. *Vespa binghami* du Buysson, *Ann. Soc. Ent. France*, **73** : 488 (Key), 523.
- Diagnosis** : Head yellowish brown; antenna, legs and gaster reddish brown; thorax red to reddish brown; body covered with fine reddish erect pubescence; ocelli large (Fig. 1); interocellar distance a little longer than ocellocular distance in female (Fig. 1); clypeus emarginate in female; apical half of clypeus densely punctate, basal half finer; temple wider than eye in profile.
- Size** : Sterile female: 24-25 mm.
- Material examined** : 1 Female, India : Arunachal Pradesh; Kameng; Jhum La, 8.x.1961, Alt. 9000 ft, Coll. F. Schmid, Reg. No. 10892/H3. 1 Female, India: Sikkim, v. 1912, Coll. Unknown, Reg. No. 1036/H3. 1 Female, India: West Bengal; Darjeeling Dt., xi.1941, Coll. H. A. Hafiz, Reg. No. 2270/H3 (NZSI).
- Distribution** : India : Arunachal Pradesh, Meghalaya, Sikkim (new record) and West Bengal.
- Elsewhere** : Bhutan, China, Korea, Laos, Myanmar, Russia, Thailand and Vietnam.
- F. Schmid collected the specimen from Jhum La; Assam in 1961 and now the locality Jhum La comes under Arunachal Pradesh state.
- Remarks** : It is a nocturnal hornet wasp. This is a very rare species. In India, it is distributed in Himalayan ranges.
2. **Vespa analis** Fabricius
(Plate I-2)
1775. *Vespa analis* Fabricius, *Syst. Ent.* : 363.
1903. *Vespa nigrans* du Buysson, *Bull. Soc. Ent. France* : 175.
1905. *Vespa analis* var. *tenebrosa* du Buysson, *Ann. Soc. Ent. France* **73** : 516.
- Diagnosis** : Head reddish brown; vertex without black markings around ocelli; thorax largely reddish brown; pronotum, a triangular spot under each wing base, scutellum and postscutellum reddish brown; mesoscutum anteriorly with reddish brown parallel

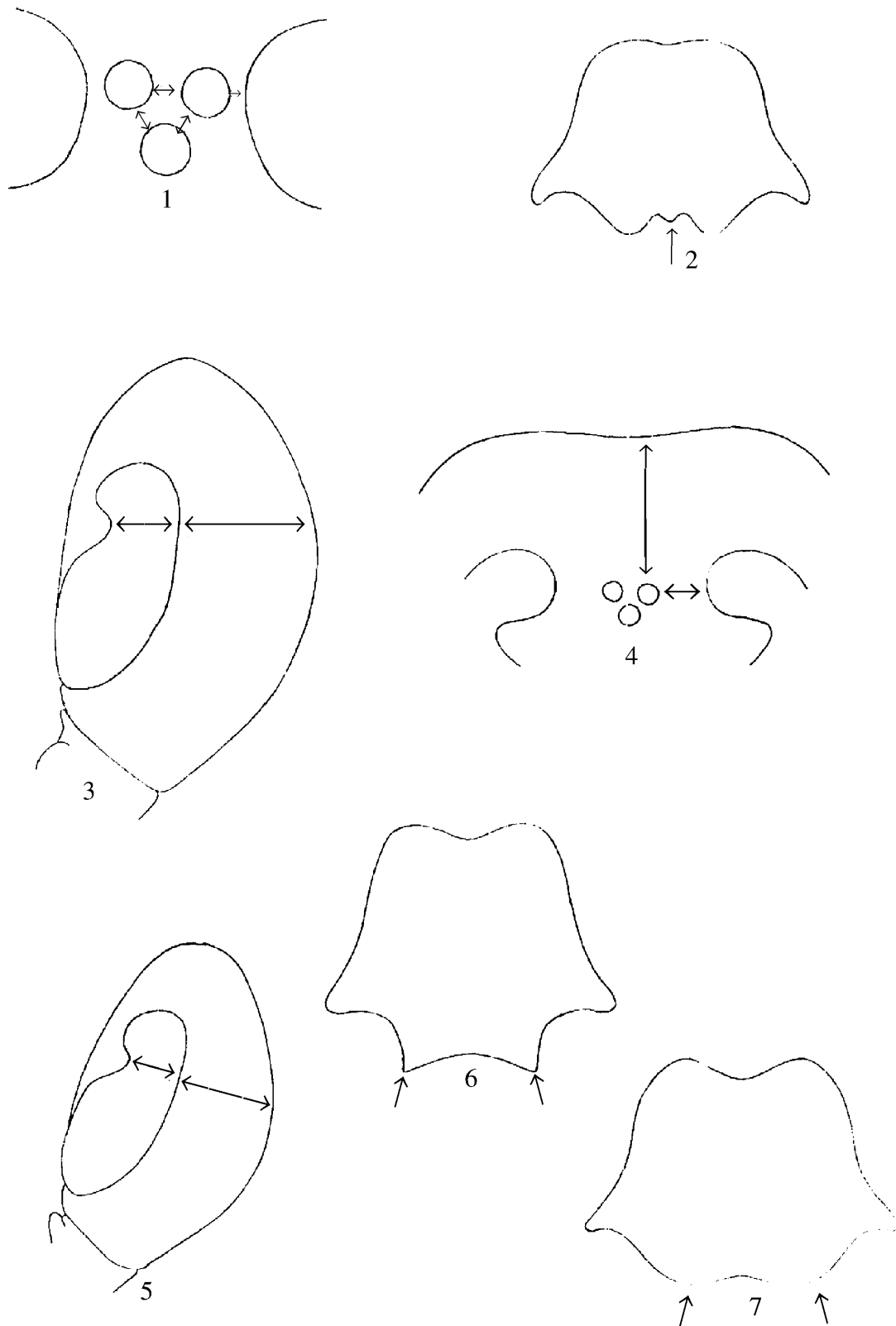


Fig. 1. *Vespa binghami* du Buysson. Female. Part of head dorsal view showing ocelli and inner margin of eye; **Fig. 2.** *V. analis* Fabricius. Female. Clypeus; **Fig. 3.** *V. mandarinia* Smith. Female. Head profile view; **Fig. 4.** *V. mandarinia* Smith. Female. Part of head dorsal view; **Fig. 5.** *V. soror* du Buysson. Female. Head profile view; **Fig. 6.** *V. tropica* (Linnaeus). Female. Clypeus; **Fig. 7.** *V. affinis* (Linnaeus). Female. Clypeus.

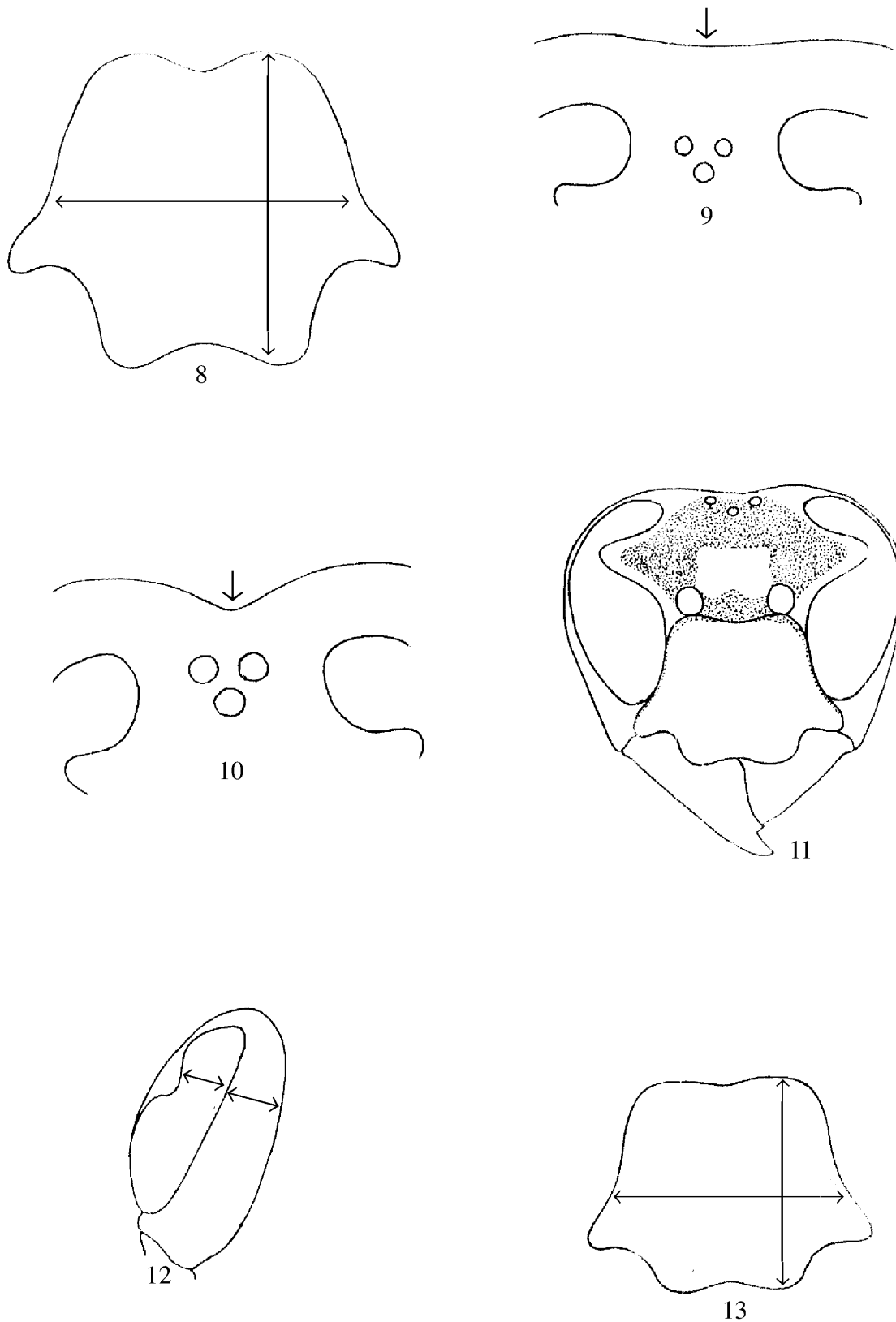


Fig. 8. *V. orientalis* Linnaeus. Female. Clypeus; **Fig. 9.** *V. fumida* van der Vecht. Female. Part of head dorsal view; **Fig. 10.** *V. basalis* Smith. Female. Part of head dorsal view; **Fig. 11.** *V. vivax* Smith. Female. Head front view; **Fig. 12.** *V. auraria* Smith. Female. Head profile view; **Fig. 13.** *V. velutina* Lepeletier. Female. Clypeus.

lines not connected to form a U-shaped mark; gaster largely blackish brown; sixth tergum and sixth sternum yellow; legs brownish black to black; wings infusate; apical margin of clypeus with broad and deep emargination and forming lateral lobes and with a median triangular tooth projecting half the length of the lateral lobes in females (Fig. 2); in males, the median tooth is rather indistinct or replaced by a short median carina.

Size : Sterile female : 23-27 mm.

Variations : Head sometimes yellow to orange yellow. In one specimen studied from Arunachal Pradesh, thorax more darker, there is no reddish brown parallel marks on mesoscutum anteriorly and scutellum and postscutellum black.

Material examined : 1 Female, India : Uttarakhand; Garhwal, 17.iv.1914, Coll. Tytler, Reg. No. 10893/H3. 1 Female, India : Arunachal Pradesh; East Siang Dt.; Ranaghat, Alt. 219 m, 24.ix.2002, Coll. M. Sil & Party, Reg. No. 10895/H3 (NZSI).

Distribution : India : Arunachal Pradesh (new record), Assam, Jammu & Kashmir, Meghalaya, Sikkim, Tamil Nadu, Uttarakhand and West Bengal.

Elsewhere : China, Indonesia, Japan, Korea, Laos, Malaysia, Myanmar, Nepal, Russia, Singapore, Taiwan and Thailand.

Published records from Tamil Nadu appear to be a misidentification. Published records from Kumaun Hills of Uttar Pradesh is also need to change because Kumaun Hills are now situated in the newly formed Uttarakhand state.

Remarks : This species is not so common. In India, it is distributed in Himalayan ranges.

3. *Vespa mandarinia* Smith (Plate I-3)

1852. *Vespa mandarinia* Smith, *Trans. Ent. Soc. Lond.* 2 (2) : 38, pl. VIII fig. 1.

Diagnosis : Head and scape orange red; flagellum black; thorax black; gaster brown with faint yellow apical bands on first to fifth tergites; sixth tergite yellowish brown; wings fuscous brown; area around ocelli without black markings; head strongly widened and produced behind eyes; temple in profile more than 2x as wide as eye (Fig. 3); posterior ocelli more than 3x farther from occiput than from eye (Fig. 4); clypeus

coarsely punctate; in females clypeus strongly emarginate apically, lateral lobes largely and broadly rounded.

Size : Fertile female : 30-42 mm; Sterile female: 23-35 mm.

Variations : One specimen from Arunachal Pradesh having head and scape yellow. In one specimen from Darjeeling Hills of West Bengal head and scape red. In some specimens studied hind corner of pronotum, two marks on mesoscutum anteriorly, tegula and a spot near wing margin brown.

Material examined : 1 Female, India: Arunachal Pradesh; Kameng; Khelong, 29.ix.1961, Coll. S. Biswas, Reg. No. 3424/H3. 1 Female, India: Arunachal Pradesh; Namdapha National Park, 11.iv.1981, Coll. S. Biswas, Reg. No. 10896/H3. 1 Female, India : Arunachal Pradesh; Namdapha National Park, 13.ix.1981, Coll. S. Biswas & Party, Reg. No. 10897/H3. 2 Females, India : Arunachal Pradesh; West Siang Dt.; Payum village, 3.xii.2002, Coll. N. Tahar & G. Lollen, Reg. Nos. 10898/H3 & 10899/H3. 1 Female, India : Himachal Pradesh; Shimla Dt.; Solan; Kandoli, 3.iv.2006, Coll. R. Babu & Party, Reg. No. 10900/H3. 1 Female, India : Manipur; 16 miles north of Imphal on Dimapur road, Alt. 8500 ft., xi.1945, Coll. M. L. Roonwal, Reg. No. 10901/H3. 1 Female, India: Manipur; 16 miles north of Imphal on Dimapur road, Alt. 8500 ft., 3.xii.1945, Coll. M. L. Roonwal, Reg. No. 10902/H3. 4 Females, India: Mizoram; Aizawl Dt.; Murlen National Park, Alt. 850 m, 16.xii.1993, Coll. S. S. Saha & Party, Reg. Nos. 10903/H3 to 10906/H3. 2 Females, India : Sikkim; East Sikkim Dt.; Tumin, Alt. 1800 m; 28.ix.1988, Coll. V. C. Agrawal & Party, Reg. Nos. 10907/H3 & 10908/H3. 1 Female, India : West Bengal; Darjeeling Dt.; Darjeeling, Alt. 7000 ft., 28.iv-14.v.1915, Coll. F. H. Graveli, Reg. No. 10910/H3. 1 Female, India : West Bengal; Darjeeling Dt.; Rangiroom, Alt. 1700 m, 3.x.1978, Coll. A. N. T. Joseph & Party, Reg. No. 10911/H3 (NZSI). 4 Females, India: Arunachal Pradesh; Tawang Dt.; Tawang, 9.xii.2005, Coll. G. Srinivasan, Reg. Nos. 6/Inv. to 9/Inv. (APFS/ZSI).

Distribution : India : Arunachal Pradesh, Assam, Himachal Pradesh, Manipur (new record), Meghalaya, Mizoram (new record), Sikkim, Uttarakhand and West Bengal. *Elsewhere*: Bhutan, China, Japan, Korea, Laos, Malaysia, Myanmar, Nepal, Russia, Sri Lanka, Taiwan and Thailand.

Records of this species from Sri Lanka appear incorrect (Das & Gupta, 1989).

Remarks : This is the largest hornet wasp in India. The size of the female is up to 42 mm in length. In India it is widely distributed in Himalayan ranges.

4. *Vespa soror* du Buysson (Plate I-4)

1905. *Vespa ducalis* var. *soror* du Buysson, *Ann. Soc. Ent. France* **73** : 490 (key), 519.

1957. *Vespa mandarinia soror* du Buysson: van der Vecht, *Zool. Verh.* **43** : 16.

1991. *Vespa soror* du Buysson: Archer, *Entmol. Mon. Mag.* **127** : 161.

Diagnosis : Head, scutellum, postscutellum, two large marks on propodeum, area around propodeal spiracle and often anterior border of pronotum yellow or brownish yellow; area around ocelli black; first and second gastral tergites yellow with reddish brown stripe in the middle; third and sixth gastral tergites wholly black. Head strongly widened and produced behind the eyes; temple in profile more than 1.8x as wide as eye (Fig. 5); posterior ocelli 3x farther from occiput than from eye; clypeus coarsely punctate. In females clypeus strongly emarginate apically, lateral lobes largely and broadly rounded.

Size : Sterile female : 23-29 mm.

Variations : In some specimens pronotum completely black without any yellow or brownish yellow marks anteriorly. In some specimens propodeum almost completely covered by yellow colour rather than two large marks posteriorly. In some specimens the brown patches are present in lower area of pronotum, mesosternum, dorsal metapleuron and ventral metapleuron.

Material examined : 2 Females, India : Arunachal Pradesh; West Kameng Dt.; Rigam, 2.x.2001, Coll. B. Mitra & Party, Reg. Nos. 10947/ H3 & 10948/H3. 1 Female, India: Meghalaya; East Garo Hills Dt.; Songsak Reserve forest, 18.xi.1973, Coll. S. Biswas, Reg. No. 10912/H3 (NZSI). 1 Female, India: Arunachal Pradesh; Papumpare Dt.; Itanagar, 26.xi.2004, Coll. G. Srinivasan, Reg. No. 1/ Inv. 1 Female, same collection data as above except the date of collection, 6.x.2005, Reg. No. 2/ Inv. 1 Female, India: Arunachal Pradesh; Tawang Dt.; Kitpi village, 25.x.2007, Coll. G. Srinivasan, Reg. No.

3/ Inv. 1 Female, India: Arunachal Pradesh; Papumpare Dt.; Itanagar Wildlife Sanctuary; Ganga lakeside, 23.xi.2007, Coll. G. Srinivasan, Reg. No. 4/ Inv. 1 Female, same collection data as above except the date of collection, 24.ii.2008, Reg. No. 5/ Inv. (APFS/ZSI).

Distribution : India : Arunachal Pradesh and Meghalaya (new record).

Elsewhere : China, Laos, Myanmar, Thailand and Vietnam.

Remarks : This is a moderately large sized hornet wasp. In India, it is distributed in high altitudes of North eastern regions.

5. *Vespa ducalis* Smith

1852. *Vespa ducalis* Smith, *Trans. Ent. Soc. Lond.* **2** (2) : 39.

Diagnosis : Head orange yellow; clypeus orange; first and second gastral tergites orange with a narrow apical black band (Nguyen & Carpenter, 2002).

Material examined : No specimen studied.

Distribution : India : Meghalaya and Sikkim. *Elsewhere*: China, Japan, Korea, Myanmar, Nepal, Russia, Taiwan, Thailand and Vietnam.

Remarks : This species comes close to *Vespa tropica* (Linnaeus) but differs in having : (1). First and second gastral tergites orange with a narrow apical black band (in *V. tropica* first gastral tergum usually entirely black or blackish brown and sometimes with a narrow yellow band on the posterior margin and second gastral tergum orange yellow with a narrow brownish black band basally); (2). Clypeus orange red and vertex orange yellow (in *V. tropica* clypeus and vertex either black or orange red, if orange red then the apical margin of clypeus black).

This species is reported in literature as occurring in India. According to Das & Gupta (1989) the record of this species from India may be incorrect.

6. *Vespa tropica* (Linnaeus) (Plate II-5)

1758. *Sphex tropica* Linnaeus, *Syst. Nat.*, ed. 10, 1-517.

1775. *Vespa cincta* Fabricius, *Syst. Ent.* : 362.

1905. *Vespa eulemoides* du Buysson, *Ann. Soc. Ent. France* **73** : 491 (key), 530.

1936. *Vespa tropica tropica* (Linnaeus): Bequaert, *Treubia* **15** (4) : 328, key, des., fig.

1936. *Vespa tropica* var. *haematodes* Bequaert, *Treubia* **15** (4) : 336 (key), 338.

1957. *Vespa tropica leefmansii* van der Vecht, *Zool. Verh., Leiden* **34** : 19.

Diagnosis : Body rather large and thick, covered with strong and stiff hairs; clypeus coarsely punctate, apical margin hairy; in females clypeus apically with a broad emargination, its apicolateral angle triangular (Fig. 6); lower vertical area of pronotum with strong transverse ridges near pronotal pit; second gastral tergite yellow with a slight brown area basally.

Size : Fertile female : 36-40 mm; Sterile female : 19-30 mm.

Comments : Three distinct colour forms of this species are found in India (Archer et. al., 1988). They are : (1). The Indian colour form; (2). The Malayan colour form and (3). The Andaman colour form. The Indian colour form is characterized by reddish brown markings on head and thorax and only the second gastral tergum is orange. It is distributed in India and south China. In India, it is widely distributed in all over India. In the Malayan colour form head and thorax completely black. It is distributed in Indo-China, Malaya, Sumatra and Borneo. In India, it is distributed in North eastern regions, Sikkim and Darjeeling district of West Bengal. In the Andaman colour forms from Andaman & Nicobar Islands, all the gastral tergites are orange except the first. In the Andaman colour forms, head and thorax with reddish brown markings.

Bequaert (1936), van der Vecht (1957), Kojima (1982) and Kojima & Reyes (1984 & 1986) erected various subspecies based on the different colour forms. But Archer (1991) limited all these subspecies into three distinct species namely *Vespa tropica* (Linnaeus), *V. ducalis* Smith and *V. philippinensis* de Saussure.

Variations : In one specimen from Tripura, two small black spots present on second tergum submedially. Another specimen from Tripura, those with predominantly reddish brown head, having a large black area on frons and scutellum completely black.

Material examined :

(1) The Indian color form.

1 Female, India: Karnataka; Chitradurga Dt.; Chitradurga, 22.xi.1980, Coll. S. K. Gupta & Party, Reg.

No. 10998/H3. 1 Female, India: Karnataka; Shimoga Dt.; Shimoga, 23.ix.2008, Coll. S. K. Mandal & Party, Reg. No. 10999/H3. 1 Female, India: Kerala; Idukki Dt.; Painavu, 26.x.1983, Coll. P. T. Cherian, Reg. No. 11000/H3. 1 Female, India: Orissa; Ganjam Dt.; Chilka lake; Barkuda Island, 25.vii- 4.viii.1917, Coll. Annandale, Reg. No. 3164/H2. 1 Female, India: Orissa; Ganjam Dt.; Chilka lake; Barkuda Island, 18.viii.1920, Coll. Unknown, Reg. No. 11001/H3. 1 Female, India: Tamil Nadu; Thirunelveli Dt.; Kalakad Mundanthurai Tiger Reserve, 28.viii.1992, Coll. S. S. Saha & Party, Reg. No. 11002/H3. 1 Female, India: Tripura; West Tripura Dt.; Barjala, 7.viii.1979, Coll. K. P. Singh & Party, Reg. No. 11003/H3. 2 Females, India: Tripura; North Tripura Dt.; Kanchenchera, 11.vi.1988, Coll. V. T. Darlong & Party, Reg. Nos. 11004/H3 & 11005/H3. 1 Female, India: Tripura; Dhalai Dt.; Kamalpur, 10.v.1992, Coll. M. Sil, Reg. No. 11006/H3. 1 Female, India: Uttarakhand; Naini Tal Dt.; Gola forest; 1.x.1974, Coll. P. K. Maity & Party, Reg. No. 11007/H3. 1 Female, India: Uttarakhand; Pauri Garhwal Dt.; Srinagar, 14.ix.2000, Coll. G. C. Sen & Party, Reg. No. 11008/H3. 1 Female, India: Uttarakhand; Almora Dt.; Chopra, 11.x.2001, Coll. B. C. Das & Party, Reg. No. 11009/H3. 1 Female, India: West Bengal; Birbhum Dt.; Palispur, 3.x.1987, Coll. M. Prasad, Reg. No. 11019/H3 (NZSI).

(2) The Malayan colour form

1 Female, India : Arunachal Pradesh; Changlang Dt.; Namdapha National Park, 23.ix.1981, Coll. S. Biswas & Party, Reg. No. 11020/H3. 1 Female, India : Arunachal Pradesh; Lower Subansiri Dt.; Yazuli, 30.x.1981, Coll. S. K. Gupta & Party, Reg. No. 11021/H3. 1 Female, India : Arunachal Pradesh; Tawang Dt.; Kitpi, 5.ix.1998, Coll. A. R. Lahiri & Party, Reg. No. 11022/H3. 1 Female, India : Arunachal Pradesh; West Kameng Dt.; Bhalukpong, 6.ix.1998, Coll. A. R. Lahiri & Party, Reg. No. 11023/H3. 1 Female, India : Arunachal Pradesh; Tirap Dt.; Khonsa, 12.ix.2000, Coll. A. R. Lahiri & Party, Reg. No. 11024/H3. 1 Female, India : Arunachal Pradesh; Dibang Valley Dt.; Roing, 18.ix.2000, Coll. A. R. Lahiri & Party, Reg. No. 11025/H3. 1 Female, India : Arunachal Pradesh; Upper Subansiri Dt.; Daporijo, 18.iv.2001, Coll. S. Sheela & Party, Reg. No. 11026/H3. 1 Female, India : Arunachal Pradesh; Papumpare Dt.; Itanagar, Senkei Valley, 16.vii.2002, Coll. P. T. Bhutia, Reg. No. 11027/H3. 1

Female, India : Arunachal Pradesh; East Siang Dt.; Ranaghat, 24.ix.2002, Coll. M. Sil, Reg. No. 11028/H3. 1 Female, India : Meghalaya; West Garo Hills; Dari, 20.xi.1973, Coll. S. Biswas, Reg. No. 11030/H3. 1 Female, India : Meghalaya; East Khasi Hills Dt.; Shillong; Malki forest, 18.x.1975, Coll. R. S. Giri, Reg. No. 11031/H3. 1 Female, India : Meghalaya; East Khasi Hills Dt.; Shillong; Risa Colony, 2.ix.1976, Coll. D. Lama, Reg. No. 11032/H3. 1 Female, India : Meghalaya; West Khasi Hills Dt.; Nongstoin, 29.ix.1988, Coll. A. R. Lahiri & Party, Reg. No. 11033/H3. 1 Female, India: Meghalaya; West Garo Hills Dt.; Chaipani, 14.x.1988, Coll. K. K. Ray & Party, Reg. No. 11034/H3. 1 Female, India : Mizoram; Aizawl Dt.; Champhai, 15.x.1995, Coll. A. K. Sanyal & Party, Reg. No. 11035/H3. 1 Female, India : Nagaland; Wokha Dt.; Lungsang, 14.x.1998, Coll. T. K. Pal & Party, Reg. No. 11036/H3. 1 Female, India : Nagaland; Mokokchung Dt.; Sungkomen, Alt. 1260 m, 18.x.1998, Coll. T. K. Pal & Party, Reg. No. 11037/H3. 1 Female, India : Sikkim; East Sikkim Dt.; Tumin, Alt. 1475 m, 1.x.1988, Coll. V. C. Agrawal & Party, Reg. No. 11038/H3. 3 Females, India: West Bengal; Darjeeling Dt.; Singla, Alt. 1500 ft.; ii.1913, Coll. Lord Carmichael, Reg. No. 1067/H3, 1068/H3 & 1069/H3 (NZSI). 1 Female, India : Arunachal Pradesh; Papumpare Dt.; Itanagar Wildlife Sanctuary; 2.xi.2004, Coll. G. Srinivasan, Reg. No. 14/Inv. 3 Females, India : Arunachal Pradesh; Papumpare Dt.; Itanagar; ZSI Complex, 6.x.2005, Coll. G. Srinivasan, Reg. Nos. 15/ Inv. to 17/Inv. 1 Female, India : Arunachal Pradesh; West Kameng Dt.; Tippi forest, 15.xi.2005, Coll. G. Srinivasan, Reg. No. 18/Inv. 3 Females, India : Arunachal Pradesh; Papumpare Dt.; Itanagar Wildlife Sanctuary, 6-10.x.2008, Coll. G. Srinivasan, Reg. Nos. 19/Inv. to 21/Inv. (APFS/ZSI).

(3) The Andaman colour form.

1 Female, India : Andaman & Nicobar Islands; South Andaman; Carbynscore, 19.v.1981, Coll. R. M. Sharma, Reg. No. 10949/H3. 1 Female, India : Andaman & Nicobar Islands; Port Blair, 1.ix.1983, Coll. David, Reg. No. 10950/H3. 1 Female, India : Andaman & Nicobar Islands; Port Blair, 13.vii.1984, Coll. V. Arumugam, Reg. No. 10995/H3. 1 Female, India : Andaman & Nicobar Islands; Port Blair, 18.ix.1985, Coll. N. K. Bhowmik, Reg. No. 10996/H3. 1 Female, India : Andaman & Nicobar Islands; North Andaman; Mayabunder, 4.ii.1998, Coll. Raja Ram & Party, Reg. No. 10997/H3 (NZSI).

Distribution : India : Andaman & Nicobar Islands, Arunachal Pradesh, Assam, Bihar, Haryana, Himachal Pradesh, Karnataka, Kerala, Maharashtra, Manipur (new record), Meghalaya, Mizoram (new record), Nagaland (new record), Orissa (new record), Pondicherry, Sikkim, Tamil Nadu, Uttarakhand and West Bengal.

Elsewhere : Afghanistan, Bhutan, Cambodia, China, Indonesia, Japan, Laos, Malaysia, Myanmar, Nepal, Pakistan, Papua New Guinea, Philippines, Sri Lanka, Thailand and Vietnam.

Remarks : This is one of the most common and abundant hornet wasp distributed throughout India, including Andaman & Nicobar Islands. This species is seen in both plains and high altitudes.

7. *Vespa affinis* (Linnaeus)

(Plate II-6)

1764. *Apis affinis* Linnaeus, *Mus. Ludov. Ulricae* : 417.
 1905. *Vespa cincta* var. *picea* du Buysson, *Ann. Soc. Ent. France* **73** : 488 (key), 537.
 1910. *Vespa indosinensis* Perez, *Act. Soc. Linn. Bordeaux* **64** : 8.
 1936. *Vespa affinis continentalis* Bequaert, *Treubia* **15** (4) : 346 (key), 350.
 1936. *Vespa affinis affinis* (Linnaeus): Bequaert, *Treubia* **15** (4) : 347.
 1936. *Vespa affinis indosinensis* Perez: Bequaert, *Treubia* **15** (4) : 349.

Diagnosis : Body slender and moderate in size; apical margin of clypeus less hairy and in females with short broadly rounded lobes on each side of the median emargination (Fig. 7); punctures on vertex, temple, mesoscutum, scutellum, postscutellum, metapleuron and propodeum small and crowded; second gastral tergum largely or entirely orange yellow; body hairs fine, shorter and comparatively dense.

Size : Sterile female : 16-23 mm.

Comments : There are three distinct colour forms of this species are found in India. They are as follows :

(1) Predominantly black head with first tergite extensively orange yellow colour form : This colour forms are distributed in North eastern India. Bequaert (1936) erected it as a separate subspecies namely *Vespa affinis indosinensis* (Perez). Thorax entirely black in this colour form. All specimens studied in this colour form having a reddish brown inner orbit.

(2) Predominantly reddish brown head with first tergite extensively orange yellow colour form : This colour forms are distributed throughout mainland India. Bequaert (1936) erected it as a separate subspecies namely *Vespa affinis affinis* (Linnaeus). In this colour form thorax black except pronotum, tegula and scutellum reddish brown. All specimens studied in this colour form having supraclypeal area black.

(3) Predominantly reddish brown head with a very narrow orange yellow stripe on the apex of first tergite colour form : This colour forms are distributed in southern India. Bequaert (1936) erected it as a separate subspecies namely *Vespa affinis continentalis* Bequaert. In some specimens the very narrow orange yellow stripe on first tergite may be incomplete or absent. Thorax entirely black in this colour form. All specimens studied in this colour form having black markings on supraclypeal area and lateral sides of clypeus; mandibles are also black.

Variations :

(1) Predominantly black head with first tergite extensively orange yellow colour form shows the following colour variations : In some specimens tip of mandible reddish brown. In some other specimens the reddish brown markings extended from inner orbits to front, leading to vertex and upper half of temple near occiput. In one specimen from Meghalaya reddish brown marking extended to clypeus submedially. In one specimen from Arunachal Pradesh a large portion of postscutellum reddish brown apically and in another specimen from Arunachal Pradesh having a reddish brown colour on clypeus at apex.

(2) Predominantly reddish brown head with first tergite extensively orange yellow colour form shows the following colour variations : Two specimens from Darjeeling hills of West Bengal having more extended black colouration. The black markings extends to mandibles, clypeus, antennal sockets, area around ocelli extending to vertex and lower half of temple.

(3) Predominantly reddish brown head with a very narrow orange yellow stripe on the apex of first tergite colour form shows the following colour variations: Two specimens from Tamil Nadu having more blackish marks on head. Two male specimens from Bengaluru having a small reddish brown spot on pronotum.

Material examined :

(1) Predominantly black head with first tergite extensively orange yellow colour form.

2 Females, India: Arunachal Pradesh; Papumpare Dt.; Sonajuli; Chessa, 20.x.1996, Coll. S. K. Mandal & Party, Reg. Nos. 11039/H3 & 11040/H3. 1 Female, India: Arunachal Pradesh; East Siang Dt.; D' Ering Memorial (Lali) Wildlife Sanctuary; Sibiamukh, 19.i.2000, Coll. S. K. Mandal & Party, Reg. No. 11041/H3. 1 Female, India: Arunachal Pradesh; East Siang Dt.; Ranaghat, 24.ix.2002, Coll. M. Sil & Party, Reg. No. 11042/H3. 2 Females, India: Arunachal Pradesh; Papumpare Dt.; Itanagar, 16.vii.2003, Coll. P. T. Bhutia, Reg. Nos. 11043/H3 & 11044/H3. 1 Female, India: Assam; Manas National Park; 29.iii.1986, Coll. S. S. Saha, Reg. No. 11045/H3. 1 Female, India: Meghalaya; Jaintia Hills Dt.; Umkiang, 19.ix.1972, Coll. A. K. Ghosh & Party, Reg. No. 11046/H3. 1 Female, India: Meghalaya; East Garo Hills; Dainadubi, Alt. 340 m, 8-13.v.1979, Coll. J. K. Jonathan & Party, Reg. No. 11047/H3. 1 Female, India: Meghalaya; West Garo Hills; Phulbari, 24.x.1988, Coll. K. K. Roy & Party, Reg. No. 11048/H3. 1 Female, India: Nagaland; Dimapur Dt.; Dimapur, 11.ix.1994, Coll. R. S. Mridha, Reg. No. 11049/H3 (NZSI). 7 Females, India: Arunachal Pradesh; Papumpare Dt.; Itanagar; 6.x.2005, Coll. G. Srinivasan, Reg. Nos. 22/Inv. to 28/Inv. (APFS/ZSI).

(2) Predominantly reddish brown head with first tergite extensively orange yellow colour form.

1 Female, India : Tamil Nadu; Coimbatore Dt.; Coimbatore, 9.iv.2006, Coll. S. K. Mandal & Party, Reg. No. 11050/H3. 1 Female, India : Tripura; North Tripura Dt.; Debsai Chowdhury para, 16.iv.1998, Coll. V. T. Darlong, Reg. No. 11051/H3. 1 Female, India : West Bengal; Birbhum Dt.; Santiniketan, 13.ix.1988, Coll. Sudipta Chatterjee, Reg. No. 11052/H3. 1 Female, India : West Bengal; Darjeeling Dt.; Naxalbari, 7.iv.1984, Coll. M. Prasad & Party, Reg. No. 11053/H3. 1 Female, India : West Bengal; Darjeeling Dt.; Ambari, 9.iv.1984, Coll. M. Prasad & Party, Reg. No. 11054/H3 (NZSI).

(3) Predominantly reddish brown head with a very narrow orange yellow stripe on the apex of first tergite colour form.

2 Females & 2 Males, India: Karnataka; Bengaluru; 26.vii.1979, Coll. Unknown, Reg. Nos. 11055/H3 to

11058/H3. 3 Females, India : Karnataka; Mysore Dt.; Rajiv Gandhi National Park, 12.ix.2008, Coll. S. K. Mandal & Party, Reg. Nos. 11059/H3 to 11061/H3. 2 Females, India: Karnataka; Chikmangalore Dt.; Bhadra Wildlife Sanctuary; Muthodi, 21.ix.2008, Coll. S. K. Mandal & Party, Reg. No. 11062/H3 & 11063/H3. 1 Female, India : Kerala; Pathanamthitta Dt.; Mudomoozhi, 9.x.2003, Coll. S. K. Mandal & Party, Reg. No. 11064/H3. 1 Female, India : Kerala; Idukki Dt.; Thekkadi, 16.x.2003, Coll. S. K. Mandal & Party, Reg. No. 11065/H3. 2 Females, India : Tamil Nadu; Thirunelveli Dt.; Kalakad Mundanthurai Tiger Reserve; Sengatheru, 30.viii-3.ix.1992, Coll. S. S. Saha & Party, Reg. Nos. 11066/H3 & 11067/H3 (NZSI).

Distribution : India : Arunachal Pradesh (new record), Assam, Bihar, Himachal Pradesh, Karnataka, Kerala, Maharashtra, Meghalaya (new record), Nagaland (new record), Sikkim, Tamil Nadu, Tripura (new record), Uttarakhand, Uttar Pradesh and West Bengal. *Elsewhere:* China, Indonesia, Japan (in Ryukyu Island), Laos, Malaysia, Myanmar, Papua New Guinea, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, Vietnam and New Zealand.

Remarks : This is one of the most common and widely distributed hornet wasp throughout the main land of India.

8. *Vespa mocsaryana* du Buysson

1905. *Vespa mocsaryana* du Buysson, *Ann. Soc. Ent. France* **73** : 490 (key), 537, pl. VII, fig. 3.

Diagnosis : Apical margin of clypeus less hairy and in females with short broadly rounded lobes on each side of the median emargination; punctures on vertex, temple, postscutellum and propodeum sparsely and rather finely punctate; scutellum and metapleuron almost impunctate; second gastral tergum black or dark brown with almost a narrow yellow to reddish brown apical band (Das & Gupta, 1989; Nguyen & carpenter, 2002).

Material examined : No specimen studied.

Distribution : India : Assam, Meghalaya and Sikkim.

Elsewhere : China, Indonesia, Laos, Malaysia, Myanmar, Thailand and Vietnam.

Remarks : This species comes close to *Vespa affinis* (Linnaeus) but differs in having: (1). Vertex,

temple, postscutellum and propodeum sparsely and rather finely punctate and scutellum and metapleuron almost impunctate (in *V. affinis* punctures on vertex, temple, mesoscutum, scutellum, postscutellum, metapleuron and propodeum small and crowded); (2). Second gastral tergum black or dark brown with almost a narrow yellow to reddish brown apical band (in *V. affinis* second gastral tergum largely or entirely orange yellow).

This species is distributed in eastern Himalayas (From published datas).

9. *Vespa orientalis* Linnaeus

(Plate II-7)

1771. *Vespa orientalis* Linnaeus, *Mant. Plant.*, ed. **2** : 540.

Diagnosis : Body brown with clypeus, frons, scape ventrally, apical margin of first gastral tergum narrowly, third and fourth tergites almost entirely, posterolateral corner of second gastral sternum, third sternum almost entirely and fourth sternum partly yellow. Third and fourth tergites with blackish brown spot laterally. The yellow marks on first tergum emarginate medially; third tergum with a median triangular blackish mark basally. Clypeus rather flat and elongate, as wide as long or a little longer (Fig. 8), with scattered moderate sized punctures, in females apical margin emarginate with rounded lateral lobes. Hairs on head and thorax short, sparse, stiff and bristle-like; gaster almost hairless dorsally.

Size : Fertile female : 22-28 mm; Sterile female : 17-22 mm.

Material examined : 1 Female, India : Jammu & Kashmir; Jammu; Tilak tiloo, 1.x.1977, Coll. R. C. Basu & Party, Reg. No. 11068/H3. 3 Females, India : Bihar; Bhagalpur Dt.; Mandar, 8.xii.1967, Coll. Raj Tilak & Party, Reg. Nos. 11069/H3 to 11071/H3. 2 Females, India : Jharkhand; Bokaro Dt.; Bandhudih, 5.viii.2009, Coll. Arun Kumar Roy Mahato, Reg. Nos. 11853/H3 & 11854/H3. 1 Female, India : Orissa; Keonjhar Dt.; Barahal, 27.ix.1972, Coll. K. Rai & Party, Reg. No. 11072/H3. 2 Females, India : Uttar Pradesh; Mirzapur Dt.; Dhaudraul, 24.iii.1979, Coll. R. L. Chowdhury, Reg. Nos. 11074/H3 & 11075/H3. 1 Female, India : Uttar Pradesh; Ghaziabad Dt.; Muradnagar, 4.vi.1989, Coll. M. S. Shishodia & Party, Reg. No. 11076/H3. 1 Female, India : Uttar Pradesh; Pratapgarh Dt.; Ranigunge, 15.vi.1989, Coll. A. K. Sanyal & Party, Reg.

No. 11077/H3. 1 Female, India: Uttar Pradesh; Azamgarh Dt.; Azamgarh, 29.iv.1990, Coll. T. R. Mitra & Party, Reg. No. 11078/H3. 4 Females, India : Uttar Pradesh; Aligarh Dt.; Aligarh, 1.x.2001, Coll. M. Prasad & Party, Reg. Nos. 11079/H3 to 11082/H3. 1 Female, India: Uttar Pradesh; Bulandshahr Dt.; Narora, 2.x.2001, Coll. M. Prasad & Party, Reg. No. 11083/H3. 1 Female, India : Uttar Pradesh; Agra Dt.; Fatehpur Sikri, 9.iii.2006, Coll. S. Biswas & Party, Reg. No. 11084/H3. 2 Females, India : Uttar Pradesh; Ballia Dt.; Ballia, 19.iii.2006, Coll. B. C. Das & Party, Reg. Nos. 11085/H3 & 11086/H3. 2 Females, India : Uttar Pradesh; Varanasi Dt.; Banaras, 22.iii.2006, Coll. B. C. Das & Party, Reg. Nos. 11087/H3 & 11088/H3. 4 Females, India : Uttar Pradesh; Rae Bareilly Dt.; Jagadishpur, 15.ix.2006, Coll. M. Sil & Party, Reg. Nos. 11090/H3 to 11093/H3. 2 Females, India : Uttar Pradesh; Sultanpur Dt.; Bahadurpur, 17.ix.2006, Coll. M. Sil & Party, Reg. Nos. 11094/H3 & 11095/H3. 3 Females, India : Uttar Pradesh; Sultanpur Dt.; Prayagpur, 18.ix.2006, Coll. M. Sil & Party, Reg. Nos. 11096/H3 to 11098/H3. 1 Female, India : Uttar Pradesh; Sultanpur; Pachupiran, 19.ix.2006, Coll. M. Sil & Party, Reg. No. 11099/H3. 1 Female, India : Uttar Pradesh; Sitapur Dt.; Gangagange, 23.ix.2006, Coll. M. Sil & Party, Reg. No. 11100/H3. 1 Female, India : Uttar Pradesh; Bareilly Dt.; Shahi, 27.ix.2006, M. Sil & Party, Reg. No. 11101/H3. 1 Female, India : Uttar Pradesh; Bareilly Dt.; Gyani, 28.ix.2006, Coll. R. S. Mridha, Reg. No. 11102/H3. 5 Females, India : Uttar Pradesh; Moradabad Dt.; Bojpur, 11.x.2006, Coll. Animesh Bal & Party, Reg. Nos. 11103/H3 to 11107/H3. 2 Females, India : Uttar Pradesh; Shahjahanpur Dt.; Banda, 14.x.2006, Coll. Animesh Bal & Party, Reg. Nos. 11108/H3 & 11109/H3. 2 Females, India : Uttar Pradesh; Shahjahanpur; Jalalabad, 15.x.2006, Coll. Animesh Bal & Party, Reg. Nos. 11110/H3 & 11111/H3. 1 Female, India : Uttar Pradesh; Sultanpur Dt.; Pachupiran, 19.ix.2006, Coll. M. Sil & Party, Reg. No. 11112/H3. 2 Females, India : Uttar Pradesh; Etawa Dt.; Etawa, 14.iii.2008, Coll. P. Mukhopadhyay & Party, Reg. Nos. 11117/H3 & 11118/H3. 2 Females, India : West Bengal; Medinipur Dt.; Midnapur; Kheoriaghat, 15.iii.1984, Coll. K. K. Ray & Party, Reg. Nos. 11119/H3 & 11120/H3. 1 Female, India : West Bengal; Medinipur Dt.; Midnapur; Garbata, 16.iii.1984, Coll. K. K. Ray & Party, Reg. No. 11121/H3. 1 Female, India : West Bengal; Bankura Dt.; Ramsagar, 7.x.1985, Coll. K. K. Ray & Party, Reg. No. 11122/H3. 1

Female, India : West Bengal; Bankura Dt.; Simlapal, 31.x.1985, Coll. M. Dutta & Party, Reg. No. 11123/H3. 4 Females, India : West Bengal; Bankura Dt.; Susnia, 9.xi.1985, Coll. K. K. Ray & Party, Reg. Nos. 11124/H3 to 11127/H3. 1 Female, India : West Bengal; Bankura Dt.; Bankura, 11.iii.1986, Coll. K. P. Mukherjee & Party, Reg. No. 11128/H3. 2 Females, India : West Bengal; Malda Dt.; Mahidipur, 18.vii.1986, Coll. M. S. Shishodia & Party, Reg. Nos. 11129/H3 & 11130/H3. 2 Females, India : West Bengal; Malda Dt.; Chanchali, 20.vii.1986, Coll. M. S. Shishodia & Party, Reg. Nos. 11131/H3 & 11132/H3. 4 Females, India : West Bengal; Bankura Dt.; Coochar, 4.ix.1986, Coll. P. Mukhopadhyay & Party, Reg. Nos. 11133/H3 to 11136/H3. 4 Females, India : West Bengal; Bardhaman Dt.; Adra, 8.ix.1986, Coll. K. K. Ray & Party, Reg. Nos. 11137/H3 to 11140/H3. 1 Female, India : West Bengal; Puruliya Dt.; Kejurdanga, 2.xii.1986, Coll. T. R. Mitra & Party, Reg. No. 11141/H3 (NZSI).

Distribution : India : Andhra Pradesh, Bihar, Delhi, Haryana, Jammu & Kashmir, Jharkhand (new record), Maharashtra, Orissa (new record), Punjab, Rajasthan, Uttarakhand, Uttar Pradesh and West Bengal. *Elsewhere*: Afghanistan, Albania, Algeria, Bahrein, Bulgaria, China, Cyprus, Egypt, Ethiopia, Greece, Iran, Iraq, Israel, Italy, Jordan, Lebanon, Libya, Madagascar, Malta, Nepal, Oman, Pakistan, Palestine, Romania, Russia, Saudi Arabia, Somalia, Syria, Tajikistan, Turkmenistan, Turkey, U.A.E., Uzbekistan and Yemen.

Jonathan *et al.* (2000) wrongly reported it from Meghalaya.

Remarks : This is one of the widely distributed hornet wasp in India. It is especially abundant in Indo-Gangetic plains. This wasp commonly seen in human inhabited areas and usually seen in bazaars attracted to sweets and gur.

10. *Vespa fumida* van der Vecht (Plate II-8)

1905. *Vespa fumida* van der Vecht, *Ann. Soc. Ent. France* **73** : 490 (key), 522, 627.

Diagnosis : Head orange brown; antenna black with orange brown scape and pedicel; thorax black; first to fifth gastral segments black, sixth orange yellow; posterior ocelli 2.14x farther from occiput than from eye (Fig. 9); vertex not depressed at medially (Fig. 9); clypeus subpolished with scattered punctures.

Size : Sterile female : 24 mm.

Variations : The single specimen studied here having thorax and first gastral segment entirely black. But Das & Gupta (1989) described as follows : Thorax black with two brownish marks on pronotum, a brown mark on outer margin of tegula and first tergum with a brownish yellow narrow and medially interrupted apical band. This colour difference can be considered as variations.

Material examined : 1 Female, India : West Bengal; Darjeeling Dt.; Pankhasari ridge, 24.xi.1982, Coll. R. K. Kacker & Party, Reg. No. 11142/H3 (NZSI).

Distribution : India : Arunachal Pradesh, Assam, Sikkim and West Bengal. *Elsewhere*: Bhutan, China, Myanmar and Nepal.

Remarks : This species is not so common. In India it is distributed in eastern Himalayan ranges.

11. *Vespa basalis* Smith (Plate III-9)

1852. *Vespa basalis* Smith, *Trans. Ent. Soc. Lond.* **2** (2) : 46.

Diagnosis : Head and antenna orange to reddish brown; mandible concolorous with head except at apex including teeth and baso-lateral corner black; thorax black with following reddish brown patches : a long band on pronotal collar, pronotum almost entirely, a large spot on mesoscutum postero-medially, scutellum, postscutellum, tegula and mesepimeron anteriorly; legs predominantly reddish brown with black areas on coxa, trochanter and femur of all legs; gaster black except a narrow reddish brown stripe at the apex of first gastral tergum; posterior ocelli 0.77x farther from occiput than from eye (Fig. 10); clypeus almost impunctate; vertex depressed medially (Fig. 10), depression more pronounced in fertile females; ovipositor sheath strongly curved; body hairs rather long and dense, yellowish brown in colour.

Size : Fertile female : 24-25 mm; Sterile female: 15-21 mm.

Variations : In one specimen from Rajabhatkhawa of Cooch Behar district of West Bengal having a brownish black colour at the tip of last flagellar segment of the antenna, rest orange. In two sterile females collected from Sitargunge of Naini Tal district of Uttarakhand having second and third tooth almost

fused. In some specimens the reddish brown patches extended to propodeum posteriorly, propodeal valvula and ventral metapleuron posteriorly. Two specimens studied from Simlipal Tiger Reserve, Orissa having widely spread reddish brown patches on thorax. In these specimens pronotal collar and pronotum almost entirely, mesoscutum with a broad band longitudinally in the middle and two narrow bands on lateral sides, scutellum, postscutellum and propodeum completely, propleuron posteriorly, mesopleuron and metapleuron largely reddish brown. Narrow reddish brown stripe at apex of gaster is completely absent in some sterile females; in fertile females reddish brown stripe at apex of gaster more expanded.

Material examined : 1 Female, India : Arunachal Pradesh; West Siang Dt.; Likabali, 14.x.1981, Coll. S. K. Gupta & M. Prasad, Reg. No. 11144/H3. 1 Female, India: Arunachal Pradesh; Changlang Dt.; Namdapha National Park; Deban North, 28.ix.1981, Coll. S. Biswas & Party, Reg. No. 11145/H3. 1 Female, India: Arunachal Pradesh; Changlang Dt.; Namdapha National Park, Jiffons land, 17.xii.1982, Coll. S. Biswas & Party, Reg. No. 11146/H3. 4 Females, India: Arunachal Pradesh; West Kameng Dt.; Munna, 10.x.1996, Coll. S. K. Mandal & Party, Reg. Nos. 11147/H3 to 11150/H3. 1 Female, India : Arunachal Pradesh; Papumpare Dt.; Sonaguli, Sessa, 20.x.1996, Coll. S. K. Mandal & Party, Reg. No. 11151/H3. 5 Females, India : Arunachal Pradesh; West Kameng Dt.; Bhalukpong, 1.x.2001, Coll. B. Mitra & Party, Reg. Nos. 11152/H3 to 11156/H3. 3 Females, India : Arunachal Pradesh; West Kameng Dt.; Tanga, 2.x.2001, Coll. B. Mitra & Party, Reg. Nos. 11157/H3 to 11159/H3. 3 Females, India : Himachal Pradesh; Shimla Dt.; Solan; Chail, Alt. 1200 m, 29.x.1978, Coll. R. K. Varshney & Party, Reg. Nos. 11160/H3 to 11162/H3. 1 Female, India : Himachal Pradesh; Shimla Dt.; Solan, Alt. 1150 m, 29.x.1978, Coll. R. K. Varshney & Party, Reg. No. 11163/H3. 1 Female, India : Himachal Pradesh; Kangra Dt.; Palampur, 15.iv.2006, Coll. R. Babu & Party, Reg. No. 11164/H3. 3 Females, India : Himachal Pradesh; Hamirpur Dt.; Sujanpur, 19.iv.2006, Coll. R. Babu & Party, Reg. Nos. 11165/H3 to 11167/H3. 1 Female, India : Himachal Pradesh; Shimla Dt.; Rampur, 20.x.2006, Coll. R. Babu & Party, Reg. No. 11168/H3. 1 Female, India : Meghalaya; Jaintia Hills Dt.; Garampani forest, 11.xii. 1975, Coll. S. K. Chandra, Reg. No. 11169/H3. 1 Female, India : Meghalaya; East Khasi Hills Dt.; Shillong; Motinagar forest, 6.xi.1980,

Coll. M. S. Jyrwa, Reg. No. 11170/H3. 6 Females, India : Mizoram; Chhimtuipui Dt.; Saiha, 9.xi.1995, Coll. P. H. Roy & Party, Reg. No. 11171/H3 to 11176/H3. 1 Female, India : Mizoram; Aizawl Dt.; Aizawl, 10.xi.1995, Coll. P. H. Roy & Party, Reg. No. 11177/H3. 1 Female, India : Mizoram; Aizawl Dt.; Sairang, 27.xi.1996, Coll. S. C. Mitra & Party, Reg. No. 11178/H3. 1 Female, India : Orissa; Mayurbhang Dt.; Simlipal National Park; Burrupani, Alt. 2500 ft., 6-9.iv.1923, Coll. R. P. Mullins, Reg. No. 1037/H3. 1 Female, India : Orissa; Mayurbhang Dt.; Simlipal National Park; Joranda, 3.ii.1986, Coll. S. M. Ali & Party, Reg. No. 11179/H3. 1 Female, India : Sikkim; East Sikkim Dt.; Rangpo, 8.xi.1981, Coll. S. K. Gupta, Reg. No. 11180/H3. 3 Females, India : Uttarakhand; Dehra Dun Dt.; Mazra, 24.ix.2000, Coll. G. C. Sen & Party, Reg. Nos. 11192/H3 to 11194/H3. 2 Females, India : Uttarakhand; Pauri Garhwal Dt.; Srinagar, 9.xi.2000, Coll. B. C. Das & Party, Reg. Nos. 11195/H3 to 11196/H3. 1 Female, India : Uttarakhand; Naini Tal Dt.; Jeolikote, 11.xi.2000, Coll. S. K. Mandal & Party, Reg. No. 11197/H3. 1 Female, India : Uttarakhand; Naini Tal Dt.; Chunoti, 13.xi.2000, Coll. S. K. Mandal & Party, Reg. No. 11198/H3. 1 Female, India : Uttarakhand; Almora Dt.; Binsar Wildlife Sanctuary, 17.xi. 2000, Coll. S. K. Mandal & Party, Reg. No. 11199/H3. 4 Females, India : Uttarakhand; Almora Dt.; Ranikhet, 29.ix.2001, Coll. Animesh Bal & Party, Reg. Nos. 11200/H3 to 11203/H3. 1 Female, India : Uttarakhand; Almora Dt.; Artola, 29.ix.2001, Coll. P. Mukhopadhyay & Party, Reg. No. 11204/H3. 1 Female, India : Uttarakhand; Uttar Kashi Dt.; Uttar Kashi Forest Rest House, 11.x.2001, Coll. S. K. Mandal & Party, Reg. No. 11205/H3. 2 Females, India: Uttarakhand; Uttar Kashi Dt.; Gangotri, 12.x. 2001, Coll. S. K. Mandal & Party, Reg. Nos. 11206/H3 & 11207/H3. 1 Female, India : Uttarakhand; Tehri Garhwal Dt.; Gulae, 23.ix.2002, Coll. Animesh Bal & Party, Reg. No. 11208/H3. 5 Females, India : Uttarakhand; Naini Tal Dt.; Haldwani, 24.ix.2002, Coll. P. H. Roy & Party, Reg. Nos. 11209/H3 to 11213/H3. 5 Females, India : Uttarakhand; Naini Tal Dt.; Sitargang, 26.ix.2002, Coll. P. H. Roy & Party, Reg. Nos. 11214/H3 to 11218/H3. 1 Female, India : Uttarakhand; Pauri Garhwal Dt.; Srinagar, 29.x.2002, Coll. M. Prasad & Party, Reg. No. 11219/H3. 2 Females, India: Uttarakhand; Chamoli Dt.; Karnaprayag, 29.x.2002, Coll. P. Mukhopadhyay & Party, Reg. Nos. 11220/H3 & 11221/H3. 2 Females, India : Uttarakhand,

Rudraprayag Dt.; Nagrasu, 7.xi.2002, Coll. P. Mukhopadhyay & Party, Reg. Nos. 11222/H3 & 11223/H3. 1 Female, India : Uttarakhand; Almora Dt.; Koshi, 18.ix.2003, Coll. B. Mitra & Party, Reg. No. 11224/H3. 1 Female, India : Uttarakhand; Naini Tal Dt.; Bhawali Forest Rest House, Alt. 1920 m, 20.ix.2004, Coll. D. R. Maulik & Party, Reg. No. 11225/H3. 1 Female, India : Uttarakhand; Pithoragarh Dt.; Pacholi, 22.ix.2004, Coll. B. Mitra & Party, Reg. No. 11226/H3. 1 Female, India : Uttarakhand; Pithoragarh Dt.; Dharchula, 26.ix.2004, Coll. B. Mitra & Party, Reg. No. 11227/H3. 1 Female, India : Uttarakhand; Pithoragarh Dt.; Charchum, 27.ix.2004, Coll. B. Mitra & Party, Reg. No. 11228/H3. 1 Female, India : Uttarakhand; Bageshwar Dt.; Kotbhamari, 29.ix.2004, Coll. M. Ghosh & Party, Reg. No. 11229/H3. 3 Females, India : Uttarakhand; Almora Dt.; Brechhina, 5.x.2004, Coll. D. R. Maulik & Party, Reg. Nos. 11230/H3 to 11232/H3. 5 Females, India : Uttar Pradesh; Saharanpur Dt.; Mohand forest, 7.xi.1978, Coll. R. K. Varshney & Party, Reg. Nos. 11233/H3 to 11237/H3. 1 Female, India : West Bengal; Cooch Behar Dt.; Rajabhatkhawa, 22.xi.1983, Coll. A. K. Sanyal & Party, Reg. No. 11238/H3 (NZSI).

3 Females, India : Arunachal Pradesh; Papumpare Dt.; Itanagar, 28.ii.2008, Coll. G. Srinivasan, Reg. Nos. 29/Inv. to 31/Inv. (APFS/ZSI).

Distribution : India : Arunachal Pradesh, Assam, Himachal Pradesh, Meghalaya, Mizoram (new record), Orissa (new record), Sikkim, Uttarakhand, Uttar Pradesh (new record) and West Bengal.

Elsewhere : China, Indonesia, Laos, Myanmar, Nepal, Pakistan, Taiwan, Thailand and Vietnam.

Remarks : This is a moderately sized hornet wasp. It is one of the common species found in northern, eastern and north eastern India.

12. *Vespa bicolor* Fabricius (Plate III-10)

1787. *Vespa bicolor* Fabricius, *Mant. Ins.* 1 : 288.

Diagnosis : Body sulphur yellow; Black colour as follows: apex of mandible including teeth, head dorsally including antennal scrobe and lateral margins of clypeus, mesoscutum entirely, a mark below tegula, a median line on scutellum, margins of postscutellum, a Y-shaped mark at junction of postscutellum and propodeum, mesopleuron ventrally near to fore coxa,

line between mesopleuron and metapleuron and base of first tergite. Antenna black dorsally; brownish bands on first gastral tergum subapically and base of second tergum widely; legs yellow; wings flavohyaline, darker along costal margin of fore wing; clypeus almost impunctate; body dorsally covered with fine, rather stiff erect blackish hairs.

Size : Fertile female : 18-21 mm; Sterile female : 15-19 mm.

Variations : In some specimens the general body colour changes from sulphur yellow to brownish yellow. In some specimens brownish band on base of second gastral tergum becomes black. The extend of brown colour on tergites are varying in different specimens.

Material examined : 2 Females, India : Arunachal Pradesh; West Siang Dt.; Aalo; Basar, 22.x.1981, Coll. S. K. Gupta & Party, Reg. Nos. 11239/H3 & 11240/H3. 1 Female, India : Arunachal Pradesh; Papumpare Dt.; Itanagar, 3.xi.1981, Coll. S. K. Gupta & Party, Reg. No. 11241/H3. 1 Female, India : Arunachal Pradesh; Changlang Dt.; Namdapha National Park; Debon, 9.xii.1982, Coll. S. Biswas & Party, Reg. No. 11242/H3. 3 Females, India : Arunachal Pradesh; Changlang Dt.; Namdapha National Park, Giffons Land, 17.xii.1982, Coll. S. Biswas & Party, Reg. No. 11243/H3 to 11245/H3. 1 Female, India : Arunachal Pradesh; Debang Valley Dt.; Nizam ghat, Alt. 550 m, 11.xi.1985, Coll. G. K. Srivastava & Party, Reg. No. 11246/H3. 1 Female, India : Arunachal Pradesh; West Kameng Dt.; Bhalukpong, 4.ix.1998, Coll. A. R. Lahiri & Party, Reg. No. 11247/H3. 2 Females, India : Arunachal Pradesh; West Kameng Dt.; Bhalukpong, 1.x.2001, Coll. B. Mitra & Party, Reg. Nos. 11248/H3 & 11249/H3. 1 Female, India : Arunachal Pradesh; Upper Siang Dt.; Jenjjing, 14.ix.2002, Coll. M. Sil & Party, Reg. No. 11250/H3. 1 Female, India : Arunachal Pradesh; Upper Siang Dt.; Ramsing, 17.ix.2002, Coll. M. Sil & Party, Reg. No. 11251/H3. 1 Female, India : Arunachal Pradesh; Papumpare Dt.; Konkon Nallah; Naharlagun, 11.ix.2003, Coll. N. Tahar, Reg. No. 11252/H3. 2 Females, India : Manipur; Ukhurul Dt.; Ukhurul, 9.x.1975, Coll. M. S. Shishodia & Party, Reg. Nos. 11253/H3 & 11254/H3. 1 Female, India : Meghalaya; East Garo Hills Dt.; Songsak, 13.iv.1973, Coll. S. Biswas, Reg. No. 11255/H3. 2 Females, India : Meghalaya; Jaintia Hills Dt.; Garam pani, 19.ix.1979,

Coll. C. Radhakrishnan, Reg. Nos. 11256/H3 & 11257/H3. 2 Females, India : Meghalaya; Jaintia Hills Dt.; Garam pani, 10.xii.1995, Coll. B. K. Chanda, Reg. Nos. 11258/H3 & 11259/H3. 1 Female, India : Sikkim; South Sikkim Dt.; Jorethang, 5.xi.1994, Coll. G. C. Sen & Party, Reg. No. 11260/H3. 1 Female, India : West Bengal; Darjeeling Dt.; Rangpo, 14.ix.1978, Coll. A. N. T. Joseph & Party, Reg. No. 11261/H3. 1 Female, India : West Bengal; Jalpaiguri Dt.; Gazaldoba, 9.x.1987, Coll. S. K. Tandon & Party, Reg. No. 11262/H3 (NZSI). 1 Female, India : Arunachal Pradesh; West Kameng Dt.; Sessa, 20.xi.2005, Coll. G. Srinivasan, Reg. No. 32/Inv. (APFS/ZSI).

Distribution : India : Arunachal Pradesh, Assam, Manipur (new record), Meghalaya, Sikkim, Uttarakhand and West Bengal.

Elsewhere : Bhutan, Cambodia, China, Laos, Myanmar, Nepal, Thailand and Vietnam.

Das & Gupta (1989) reported this species from Kumaun hills of Uttar Pradesh. Kumaun hills are now under newly formed Uttarakhand state.

Remarks : This is one of the very common species distributed in Himalayan ranges.

13. *Vespa vivax* Smith

(Plate III-11)

1870. *Vespa vivax* Smith, *Trans. Zool. Soc. Lond.* 7 (3) : 190, pl XXI, fig.9.

Diagnosis : Body black with the following yellow parts: head, apex of femora, tibiae and tarsi, broad apical band on first and third gastral tergites (that on third broadly emarginate), narrow apical bands on second, fourth and fifth tergites, sixth tergite entirely, broad apical bands on second and third sternites, narrow bands on fourth and fifth sternites and sixth sternum entirely. A black mark on frons covering anterior ocelli extending to antennal scrobe and supraclypeal area to form a ring-like structure (Fig. 11). Scape and pedicel ventrally yellow; brownish yellow band on first gastral tergite medially; wings brownish hyaline. Head, thorax and gaster covered with long, erect, somewhat thick black hairs.

Size : Sterile female : 18-21 mm.

Material examined : 1 Female, India : Uttarakhand; Chamoli Dt.; Hanumanchati, 1.ii.2002, Coll. P.

Mukhopadhyay & Party, Reg. No. 11263/H3 (NZSI).

Distribution : India : Jammu & Kashmir, Himachal Pradesh, Sikkim and Uttarakhand.

Elsewhere : China, Myanmar, Nepal, Taiwan and Thailand.

Smith (1870) originally described this species based on the type specimen collected from Binsar, Kumaun hills of Uttar Pradesh state. Now Binsar of Kumaun hills comes under the newly constituted Uttarakhand state.

Remarks : This is not a common hornet wasp. In India it is widely distributed in Himalayan ranges.

14. *Vespa auraria* Smith
(Plate III-12)

1852. *Vespa auraria* Smith, *Trans. Ent. Soc. Lond.* **2** (2) : 46, pl. VIII, fig. 8.

1959. *Vespa velutina pruthii* van der Vecht, *Zool. Meded., Leiden*. **36** (13) : 228.

Diagnosis : Body black. Reddish brown markings as follows : head, pronotal collar posteriorly, pronotum, tegula, scutellum, two lateral spots on postscutellum, propleuron ventrally and usually a triangular mark on mesopleuron. Antenna reddish or blackish brown. Mandible concolorous with clypeus except at apex including teeth black. Mesoscutum dark brown with a U-shaped mark touching scutellum, with golden brown glistening pubescence. Fore leg yellowish brown except inner basal corner of coxa, trochanter and basally in front of femur black. Mid and hind legs black except at apex of femur, apex of tibia and tarsi entirely reddish brown or yellowish brown. Bases of first and second gastral tergites brownish black or black, their margins and the visible part of the following segments usually yellowish brown. Base of second gastral sternum brownish black or black, their margins and visible part of the following sternites usually yellowish brown. Wings brownish hyaline. Head, thorax and gaster covered with fine blackish erect hairs. Gaster with a velvet appearance. Clypeus moderately convex, its apical third depressed and punctate, apical margin emarginate, with distinct lateral lobes in females and quadrate in males.

Size : Fertile female : 22-25 mm.; Sterile female : 15-21 mm; Male : 15-17 mm.

Variations : Yellowish brown markings on tergites greatly varying. Some specimens from Jammu & Kashmir having tergites almost entirely yellowish brown. Van der Vecht (1959) erected it as a separate subspecies namely *Vespa velutina pruthii* van der Vecht. Some specimens from Mizoram, Nagaland and Uttarakhand having more blackish tergites. In some specimens, there is no reddish brown marks on mesopleuron below tegula and gaster more blackish. In some specimens from Uttarakhand the antennal flagellomeres more blackish.

Material examined : 2 Females, India : Himachal Pradesh; Shimla Dt.; Solan, 30.x.1970, Coll. R. K. Varshney & Party, Reg. Nos. 11266/H3 & 11267/H3. 4 Females, India : Himachal Pradesh; Mandi Dt.; Chail, Alt. 1200 m, 29.x.1978, Coll. R. K. Varshney & Party, Reg. Nos. 11268/H3 to 11271/H3. 1 Female, India : Himachal Pradesh; Shimla Dt.; Solan; Kandali, 3.iv.2006, Coll. R. Babu & Party, Reg. No. 11272/H3. 1 Female, India: Himachal Pradesh; Kangra Dt.; Palampur, 16.iv.2006, Coll. R. Babu & Party, Reg. No. 11273/H3. 2 Females, India: Himachal Pradesh; Shimla Dt.; Rampur, 20.x.2006, Coll. R. Babu & Party, Reg. Nos. 11274/H3 & 11275/H3. 4 Females, India: Jammu & Kashmir; Srinagar Dt.; Lalmandi, 10.ix.1977, Coll. R. C. Basu & Party, Reg. Nos. 11276/H3 to 11279/H3. 3 Females, India: Jammu & Kashmir; Srinagar Dt.; Shalimar Garden, 11.ix.1977, Coll. R. C. Basu & Party, Reg. Nos. 11280/H3 to 11282/H3. 4 Females, India: Jammu & Kashmir; Anantnag Dt.; Bijbehara, 22.ix.1977, Coll. R. C. Basu & Party, Reg. Nos. 11283/H3 to 11286/H3. 1 Female, India: Jharkhand; Ranchi Dt.; Netarhat, 23.i.1954, Coll. A. P. Kapur, Reg. No. 11287/H3. 2 Females, India : Madhya Pradesh; Chindwara Dt.; Patakot, 20.x.1992, Coll. R. K. Singh & Party, Reg. Nos. 11288/H3 & 11289/H3. 1 Female, India: Meghalaya; East Khasi Hills Dt.; Shillong, 25.v.1968, Coll. R. K. Varshney, Reg. No. 11290/H3. 1 Female, India: Meghalaya; East Khasi Dt.; Shillong, 30.x.1974, Coll. S. K. Gupta & Party, Reg. No. 11291/H3. 1 Female, India: Meghalaya; East Khasi Hills Dt.; Shillong, 4.x.1977, Coll. A. R. Lahiri, Reg. No. 11292/H3. 1 Female, India: Meghalaya; East Khasi hills Dt.; Shillong; Fruit garden, 22.ii.1978, Coll. M. S. Jyrwa, Reg. No. 11293/H3. 1 Female, India : Meghalaya; East Khasi Hills Dt.; Cherrapunjee, 23-26.iv.1979, Coll. J. K. Jonathan & Party, Reg. No. 11294/

- H3. 1 Female, India : Meghalaya; East Khasi hills Dt.; Shillong, 21.viii.1980, Coll. A. Singh & Party, Reg. No. 11295/H3. 1 Female, India : Meghalaya, East Khasi Hills Dt.; Cherrapunjee, 26.ix.1988, Coll. A. R. Lahiri & Party, Reg. No. 11296/H3. 1 Female, India : Meghalaya; East Khasi Hills Dt.; Umtynagar, Alt. 1800 m, 21.ix.1991, Coll. R. K. Varshney & Party, Reg. No. 11297/H3. 3 Females, India : Mizoram; Lunglei Dt.; Lunglei, 19.ix.1993, Coll. A. R. Lahiri & Party, Reg. Nos. 11298/H3 to 11300/H3. 2 Females, India : Mizoram; Lunglei Dt.; Tlabung, 1.x.1993, Coll. A. R. Lahiri & Party, Reg. Nos. 11301/H3 & 11302/H3. 1 Female, India : Mizoram; Aizawl Dt.; Khawhai, 4.iv.1994, Coll. A. K. Hazra & Party, Reg. No. 11303/H3. 1 Male, India : Mizoram; Aizawl Dt.; Lengpui, 23.xi.1996, Coll. P. H. Roy & Party, Reg. No. 11304/H3. 1 Female, India: Mizoram; Aizawl Dt.; Sairang, 28.xi.1996, Coll. S. C. Mitra & Party, Reg. No. 11305/H3. 1 Female, India : Nagaland; Tuensang Dt.; Tuensang, 29.xi.1983, Coll. S. K. Gupta & B. C. Saha, Reg. No. 11306/H3. 1 Female, India : Nagaland; Kohima Dt.; Kohima, 15.ix.1994, Coll. R. S. Mridha, Reg. No. 11307/H3. 1 Female, India : Nagaland; Kohima Dt.; Kohima, 11.x.1998, Coll. T. K. Pal & Party, Reg. No. 11308/H3. 4 Females, India : Tripura; South Tripura Dt.; Kalibazar, 1.x.1977, Coll. N. Muraleedharan, Reg. No. 11309/H3 to 11312/H3. 2 Females, India : Uttarakhand; Chamoli Dt.; Chinka, 2.ix. 1972, Coll. T. K. Chakraborty, Reg. Nos. 11313/H3 & 11314/H3. 1 Female, India: Uttarakhand; Dehra Dun Dt.; Mussorie; Kempty Fall, Alt. 1220 m, 4.xi.1978, Coll. R. K. Varshney & Party, Reg. No. 11315/H3. 3 Females, India : Uttarakhand; Dehra Dun Dt.; Sahastradhara, Alt. 900 m, 6.xi.1978, Coll. R. K. Varshney & Party, Reg. Nos. 11316/H3 to 11318/H3. 1 Female, India : Uttarakhand; Chamoli Dt.; Joshimath, 14.xi.1986, Coll. G. K. Srivastava & Party, Reg. No. 11319/H3. 1 Female, India : Uttarakhand; Tehri Garhwal Dt.; Dogadda, 6.ii.1989, Coll. S. K. Gupta & Party, Reg. No. 11320/H3. 1 Female, India : Uttarakhand; Chamoli Dt.; Pipalkoti, 24.x.1989, Coll. S. K. Gupta & Party, Reg. No. 11321/H3. 1 Male, India : Uttarakhand; Rudraprayag Dt.; Chopta, 21.xi.1999, Coll. B. C. Das & Party, Reg. No. 11322/H3. 1 Female, India : Uttarakhand; Almora Dt.; Kheroa, 22.xi.1999, Coll. B. C. Das & Party, Reg. No. 11323/H3. 1 Male, India : Uttarakhand; Almora Dt.; Narasingh Rao Bori, 23.xi.1999, Coll. B. C. Das & Party, Reg. No. 11324/H3. 3 Females, India : Uttarakhand; Almora Dt.; Ranikhet, 25.xi.1999, Coll. B.C. Das & Party, Reg. Nos. 11325/H3 to 11327/H3. 1 Female, India : Uttarakhand; Dehra Dun Dt.; Dehra Dun, 18.ix.2000, Coll. G. C. Sen & Party, Reg. No. 11328/H3. 1 Female, India : Uttarakhand; Dehra Dun Dt.; Mussorie; Kempty Fall, 26.x.2000, Coll. P. Mukhopadhyay & Party, Reg. No. 11329/H3. 1 Female, India : Uttarakhand; Dehra Dun Dt.; Sahastradhara, 6.xi.2000, Coll. B. C. Das & Party, Reg. No. 11330/H3. 1 Female, India : Uttarakhand; Naini Tal Dt.; Chunoti, 13.xi.2000, Coll. S. K. Mandal & Party, Reg. No. 11331/H3. 1 Female, India : Uttarakhand; Almora Dt.; Sitalakhet, 25.ix.2001, Coll. Animesh Bal & Party, Reg. No. 11332/H3. 4 Females, India : Uttarakhand; Dehra Dun Dt.; Chakrada road, 4.x.2001, Coll. S. K. Mandal & Party, Reg. Nos. 11333/H3 to 11336/H3. 1 Female, India : Uttarakhand; Almora Dt.; Kosi, 12.x.2001, Coll. B. C. Das & Party, Reg. No. 11337/H3. 1 Female, India; Uttarakhand, Almora Dt.; Chopra, 11.x.2001, Coll. B. C. Das & Party, Reg. No. 11338/H3. 2 Females, India : Uttarakhand; Tehri Garhwal Dt.; Chamba, Alt. 1676 m, 16.x.2001, Coll. G. C. Sen & Party, Reg. Nos. 11339/H3 & 11340/H3. 1 Female, India: Uttarakhand; Almora Dt.; Kausani, 22.x.2001, Coll. B.C. Das & Party, Reg. No. 11341/H3. 1 Female, India : Uttarakhand; Chamoli Dt.; Govindghat, 28.viii.2002, Coll. S. K. Mandal & Party, Reg. No. 11342/H3. 2 Females, India : Uttarakhand; Tehri Garhwal Dt.; Chamba, 14.ix.2002, Coll. Animesh Bal & Party, Reg. Nos. 11343/H3 & 11344/H3. 1 Female, India : Uttarakhand; Tehri Garhwal Dt.; Gular, 23.ix.2002, Coll. Animesh Bal & Party, Reg. No. 11345/H3. 1 Female, India : Uttarakhand; Dehra Dun Dt.; Koulagarh; 27.ix.2002, Coll. Animesh Bal & Party, Reg. No. 11346/H3. 1 Female, India : Uttarakhand; Tehri Garhwal Dt.; Baysi, 24.ix.2002, Coll. Animesh Bal & Party, Reg. No. 11347/H3. 1 Female, India : Uttarakhand; Pauri Garhwal Dt.; Srinagar, 29.x.2002, Coll. M. Prasad & Party, Reg. No. 11348/H3. 6 Females, India: Uttarakhand; Dehra Dun Dt.; Dehra Dun, 3.x.2002, Coll. M. Prasad & Party, Reg. Nos. 11349/H3 to 11354/H3. 2 Females, India : Uttarakhand; Dehra Dun Dt.; Dhanolti, 4.xi.2002, Coll. M. Prasad & Party, Reg. Nos. 11355/H3 & 11356/H3. 1 Female, India : Uttarakhand; Chamoli Dt.; Tangari, Alt. 1550 m, 5.xi.2002, Coll. P. Mukhopadhyay & Party, Reg. No. 11357/H3. 2 Females, India : Uttarakhand; Bageshwar Dt.; Rakhauli, 27.ix.2003, Coll. B. Mitra & Party, Reg. Nos. 11360/H3 & 11361/H3. 1 Female, India :

Uttarakhand; Almora Dt.; Chilianaula, 29.ix.2003, Coll. B. Mitra & Party, Reg. No. 11362/H3. 1 Female, India : Uttarakhand; Almora Dt.; Lamgara, 23.ix.2004, Coll. M. Ghosh & Party, Reg. No. 11363/H3. 2 Females, India : Uttarakhand; Almora Dt.; Khairna, 24.ix.2004, Coll. M. Ghosh & Party, Reg. Nos. 11364/H3 & 11365/H3. 1 Female, India : Uttarakhand; Pithoragarh Dt.; Bhagichora, 25.ix.2004, Coll. B. Mitra & Party, Reg. No. 11366/H3. 1 Female, India : Uttarakhand; Almora Dt.; Khairna, Alt. 1756 m, 25.ix.2004, Coll. D. R. Maulik & Party, Reg. No. 11367/H3. 2 Females, India : Uttar Pradesh; Saharanpur Dt.; Mohand forest, 7.xi.1978, Coll. R. K. Varshney & Party, Reg. Nos. 11377/H3 & 11378/H3. 3 Females, India : West Bengal; Puruliya Dt.; Ajodhya, 3.xi.1985, Coll. M. Dutta & Party, Reg. Nos. 11379/H3 to 11381/H3 (NZSI).

Distribution : India : Arunachal Pradesh, Assam, Jammu & Kashmir, Jharkhand (new record), Himachal Pradesh, Madhya Pradesh (new record), Meghalaya, Mizoram (new record), Nagaland (new record), Punjab, Sikkim, Tripura (new record), Uttarakhand, Uttar Pradesh (new record) and West Bengal. *Elsewhere:* Afghanistan, China, Laos, Malaysia, Myanmar, Nepal, Pakistan, Thailand and Yemen.

Remarks : This is a widely distributed species in the high ranges of Himalayas and extends in to the plains of Northern, Eastern and Central India.

15. *Vespa velutina* Lepeletier
(Plate IV-13)

1836. *Vespa velutina* Lepeletier, *Hist. Nat. Ins. Hym.* 1 : 507.
1905. *Vespa auraria* var. *nigrithorax* du Buysson, *Ann. Soc. Ent. France* 73 : 553.

Diagnosis : Upper half of head including upper half of temple largely black; antenna black dorsally and reddish brown ventrally; clypeus orange or reddish brown coloured; mandible concolorous with clypeus except at apex including teeth brownish black to black; lower half of temple reddish brown; thorax wholly black; legs black with tarsi yellowish brown; first, second and third gastral tergites black with yellow or yellowish brown bands at apical margin; visible part of remaining tergites yellowish brown; second and third sternites black with yellow or yellowish brown band apically, bands strongly emarginate at medially;

visible part of remaining sternites yellowish brown; wings brownish hyaline; head, thorax and gaster covered with fine blackish erect hairs; apical margins of clypeus emarginate with distinct lateral lobes in females and quadrate in males.

Size : Sterile female : 17-19 mm; Male : 16 mm.

Variations : The yellowish brown colour pattern of fourth to the remaining gastral tergites and sternites are variable.

Material examined : 1 Male, India: Arunachal Pradesh; West Kameng Dt.; Sessa, 29.x.1985, Coll. G. K. Srivastava & Party, Reg. No. 11382/H3. 1 Female, India: Sikkim; North Sikkim Dt.; Phensang, 16.ix.1978, Coll. A. N. T. Joseph & Party, Reg. No. 11383/H3. 1 Female, India: Sikkim; East Sikkim Dt.; Rangpo, 6.x.1988, Coll. V. C. Agrawal & party, Reg. No. 11384/H3 (NZSI).

Distribution : India : Arunachal Pradesh (new record), Assam, Sikkim and West Bengal.

Elsewhere : Bhutan, China, Indonesia, Laos, Malaysia, Myanmar, Taiwan. Thailand and Vietnam.

Remarks : This species is not so common. In India it is widely distributed in Eastern Himalayan ranges.

SUMMARY

Hornet wasps of India are taxonomically treated in this work. 15 valid species are present in India so far. 26 new records of different species of hornet wasps are reported here from various states. An illustrated key to species of India is also provided.

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PLATE I



Vespa binghami du Buysson. Female.



V. analis Fabricius. Female.

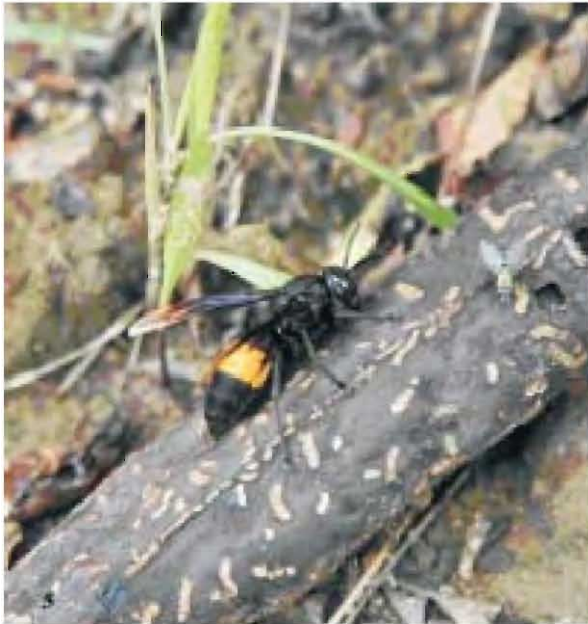


V. mandarinia Smith. Female.

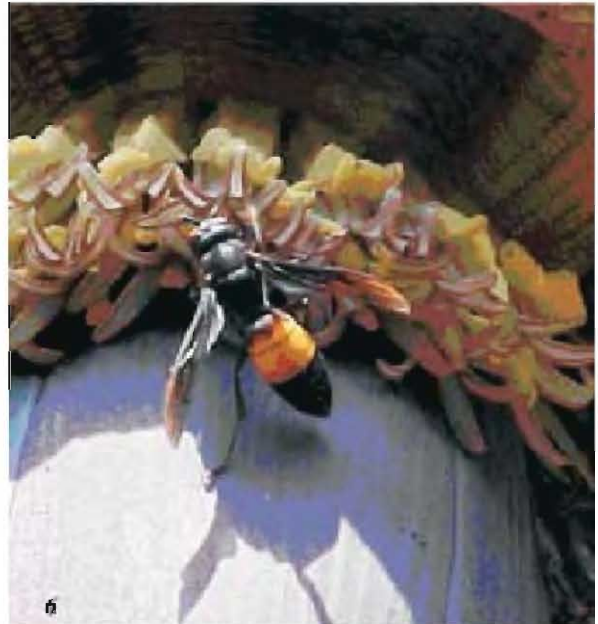


V. soror du Buysson. Female.

PLATE II



V. tropica (Linnaeus). Female.



V. affinis (Linnaeus). Female.



V. orientalis Linnaeus. Female.



V. fumida van der Vecht. Female.

PLATE III



V. basalis Smith. Female.



V. bicolor Fabricius. Female.



V. vivax Smith. Female.



V. auraria Smith. Female.

PLATE IV



V. velutina Lepeletier. Female.



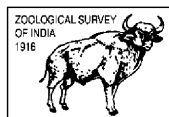
Nest of *V. affinis* Linnaeus.



A single comb of *V. affinis* Linnaeus.



V. affinis Linnaeus taking predation on the *Apis* (*Micrapis*) *florea* Fabricius larvae on its comb.



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FRESHWATER CILIATES (PROTOZOA) FROM KOLKATA WETLANDS

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INTRODUCTION

The ciliophorans coming under the phylum ciliophora are universally distributed in water bodies like freshwater ponds, streams and rivers and some species occur in wet soils and mosses. These freeliving ciliates play an important role in the aquatic ecosystem and form an important component of the environment monitoring surveillance and these aquatic animalcules occupy an important position in the aquatic food chain. In West Bengal, in all 152 species of ciliates, belonging to 2 classes, 16 orders, 52 families and 75 genera have been recorded by several investigators since 1840s (Das *et al.*, 1993; Piyali and Das, 1997). Ghosh (1918-29) in a series of papers recorded 29 species of ciliates from Kolkata, while Mahajan and Nair (1965), Das (1971), Das *et al.* (1993) and Piyali and Das (1997) reported a considerable number of species from different freshwater ecosystems of Kolkata. Although Kolkata metropolis abounds with innumerable freshwater wetlands and even though several water bodies were surveyed from different parts of this mega city, the diversity and distribution of ciliates suggests that purposeful wetland specific surveys have not been conducted year round.

The present communication deals with 23 species of freeliving freshwater ciliates based on the survey conducted from April 2006 to December 2007 from Kolkata wetlands including Rabindra Sarovar, a National Lake, representing an important freshwater wetland in the heart of the metrocity of Kolkata.

MATERIALS AND METHODS

Water samples collected from various ponds, tanks and lakes along with some algae, water weeds and flocculent matter were kept in the laboratory for some

days for considerable increase in protozoa population in them. These samples were then thoroughly examined under the microscope from time to time. The freeliving ciliates occurring in them were isolated and examined in living condition by keeping them in a drop of natural medium. Schaudinn's fixative was used for making permanent slides which is very effective for keeping the exact shape of the specimen. For staining Heidenhain's iron haematoxylin was used. Dry silver impregnation method was also employed for studying the ciliates and the slides were mounted in DPX.

RESULTS AND DISCUSSION

A total of 23 species were identified of which 5 species are new reports from Kolkata wetlands viz., *Dileptus monilatus*, *Loxophyllum levigatum*, *L. undulatum*, *Loxodes vorax* and *Leptopharynx torpens*. These 23 species belonging to 7 orders and 13 families.

(A) SYSTEMATIC LIST OF CILIATES RECORDED FROM KOLKATA WETLANDS

- | | |
|------------|----------------------|
| Subkingdom | PROTOZOA |
| Phylum | CILIOPHORA |
| Class | KINETOPHRAGMINOPHORA |
| Subclass | GYMNOSTOMATA |
| Order | PROSTOMATIDA |
| Suborder | PROSTOMATINA |
| Family | HOLOPHRYIDAE |
1. *Holophrya bengalensis* Ghosh
 2. *Holophrya annandale* Ghosh
- | | |
|----------|---------------|
| Suborder | PRORODONTINA |
| Family | PRORODONTIDAE |
3. *Prorodon discolor* (Ehrenberg)
 4. *Prorodon teres* Ehrenberg

- Family COLEPIDAE
5. *Coleps hirtus* (Muller)
- Suborder HAPTORINA
- Family ENCHELYIDAE
6. *Lacrymaria olor* (Muller)
- Family TRACHELIIDAE
7. *Dileptus monilatus* (Stokes)
8. *Trachelius ovum* Ehrenberg
- Order PLEUROSOMATIDA
- Family AMPHILEPTIDAE
9. *Loxophyllum levigatum* Sauerby
10. *Loxophyllum undulatum* Sauerby
11. *Litonotus fasciola* (Ehrenberg)
- Order KARYORELICTIDA
- Family LOXODIDAE
12. *Loxodes vorax* Stokes
13. *Loxodes magnus* Stokes
14. *Loxodes striatus* (Engelmann)
- Order COLPODIDA
- Family COLPODIDAE
15. *Colpoda aspera* Kahl
16. *Colpoda cucullus* Muller
- Order NASSULIDA
- Family NASSULIDAE
17. *Nassula ornata* Ehrenberg
- Suborder MICROTHORACINA
- Family LEPTOPHARYNGIDAE
18. *Leptopharynx torpens* (Kahl)
19. *Pseudomicrothorax agilis* Mermod
- Family MICROTHORACIDAE
20. *Microthorax pusillus* Engelmann
- Order CRYPTOPHORIDA
- Suborder CHLAMYDODONTINA
- Family CHILODONELLIDAE
21. *Chilodonella cucullus* (Muller)
22. *Chilodonella uncinata* (Ehrenberg)
- Order HYMENOSTOMATIDA
- Suborder PENICULINA
- Family PARAMECIDAE
23. *Paramecium caudatum* Ehrenberg

(B) SYSTEMATIC ACCOUNT

- Subkingdom PROTOZOA
- Phylum CILIOPHORA
- Class KINETOPHRAGMINOPHORA
- Subclass GYMNOSTOMATA
- Order PROSTOMATIDA
- Suborder PROSTOMATINA
- Family HOLOPHRYIDAE

Body radially symmetrical, ciliation uniform, cytopharyngeal apparatus simple rhabdos type.

Genus *Holophrya* Ehrenberg

Cytostome round, simple and without any ciliary ring around it, cytopharynx absent or a short simple tube with or without trichites.

Key to the species

- 1(2) Macronucleus single, spindle shaped; contractile vacuole single, subterminal close to one side *H. bengalensis*
- 2(1) Macronuclei two, spherical, contractile vacuole single, lateral and located at anterior half *H. annandalei*

1. *Holophrya bengalensis* Ghosh

1919. *Holophrya bengalensis* Ghosh, *Rec. Indian Mus.*, **16**, p. 41, fig. 1.

Material examined : 2 exs. Rabindra Sarobar, Kolkata, 3.vii.2006.

Diagnosis : Body cylindrical, rounded at both ends; cytostome apical and circular : cytopharynx absent; macronucleus single, spindle -shaped; contractile vacuole single, subterminal and close to one side; size 70 µm to 40 µm.

Distribution : India : West Bengal (Kolkata); Rajasthan.

Remarks : Mahajan (1965) recorded this species from Rajasthan and created a subspecies *minor* on the size difference (75 µm × 37 µm in *bengalensis* by Das *et al.* from West Bengal versus 34.2-48.9 µm × 16.-19.5 µm in *bengalensis minor*).

2. *Holophrya annandalei* Ghosh

1919. *Holophrya annandalei* Ghosh, *Rec. Indian Mus.*, **16**, p. 41.

Diagnosis : Body cylindrical with rounded ends; cytostome subapical and circular; cytopharynx a slight depression; macronuclei two, spherical; contractile vacuole single, lateral and located at anterior half; size 60.3 µm-31.5 µm.

Distribution : India : West Bengal (Kolkata).

Suborder PRORODONTINA

Key to the families

- 1(2) Body barrel- shaped bearing armoured plates in longitudinal rows, cytostome round, without any prominent ciliation near anterior end
.....COLEPIDAE
- 2(1) Body oval to elongate, without bearing any armoured plate, cytostome and ciliation as above
..... PRORODONTIDAE

Family PRORODONTIDAE

3. *Prorodon discolor* (Ehrenberg)

1835. *Holophrya discolor* Ehrenberg, Abh. Preuss. Akad. Wiss., Berlin, p. 251.
1930. *Prorodon (Holophrya) discolor* Kahl, Urtiere order protozoa, (in : Dahl's Tierwelt Disch.) Jena, pt. 18, p. 76, fig. 8(4).

Material examined : 1 ex. Rabindra Sadan, 5.viii.2007; 2 exs. Pond in lake garden. 16.viii.2007.

Diagnosis : Body oval, narrower posteriorly, mouth terminocentral, pharyngeal tube with trichites extending above one-fourth of the body; macronucleus single, rounded; contractile vacuole single and situated near posterior end; size 75-80 µm × 46-53 µm.

Distribution : India : West Bengal (Kolkata).

4. *Prorodon teres* Ehrenberg

1838. *Prorodon teres* Ehrenberg, *Die Infusionsthierehen als Vollkommene organismen*, Leipzig, p. 316, pt. 32, fig. 11.

Material examined : 1 ex. Indian Museum tank, 25.viii.2006; 2 exs. lake garden pond, 13.vi.2007.

Diagnosis : Body ovoid, anterior end slightly narrowed and posterior end considerably rounded; mouth terminal, pharyngeal tube slightly conical and with trichites, extending about one-fourth of the body length; contractile vacuole single and terminal, macronucleus spherical; size 68.4 µm × 55.2 µm.

Distribution : India : West Bengal (Kolkata).

Remarks : This species was reported from West Bengal by Mahajan and Nair (1971) and Das *et al.* (1993).

Family COLEPIDAE

5. *Coleps hirtus* (Muller)

1786. *Cercaria hirta* O.F. Muller, *Hafniae et Lipsidae*, p. 128, pl. 19, figs. 17-18.
1817. *Coleps hirtus* 3, Nitzsch, *Neue Schrift d. naturf. Ges. In Helle*, p. 4.

Material examined : 1 ex. Rabindra Sarobar, 4.ix.2006; 1 ex. Brace bridge Jheel. 21.viii.2006.

Diagnosis : Body barrel-shaped, ectoplasmic plates 18-20, anterior margin denticulate, posterior end with three spinous projections, cytostome apical and terminal, surrounded with slightly larger cilia; size 110 µm × 124 µm.

Remarks : Mahajan (1965) described this species from Rajasthan as *Hirtus minor* being smaller in size (75 µm × 46 µm).

Distribution : India : West Bengal : Rajasthan, Jammu and Kashmir.

Suborder HAPTORINA

Key to the families

- 1(2) Body of variable shape, but anterior end not truncate, cytostome in many species located at distal end of long flexible neck ... ENCHELYIDAE
- 2(1) Cytostome at the base of proboscis, located at considerable distance from anterior end of the body TRACHELIIDAE

Family ENCHELYIDAE

6. *Lacrymaria olor* (Muller)

1786. *Vibrio olor* Muller, *Animalc, fluviat et. marina. etc.*, *Havniae et Lipsiae*, p. 75, pl. 10. Figs. 12-15.
1832. *Lacrymaria olor*, Ehrenberg, Abh. Preuss. Akad. Wiss., Berlin, p. 105.

Material examined : 1 ex. Indian Museum Tank, 5.xi.2006; 2 exs. Maidan pond, 8.x.2006.

Diagnosis : Body elongate, posterior portion cylindrical with pointed posterior end; neck long, highly contractile oral cone well developed, contractile vacuoles two in number and located on either end of cylindrical body portion; macronucleus with two rounded parts united together; size 99 µm × 28 µm.

Distribution : India : West Bengal, Orissa, Rajasthan.

Family TRACHELIIDAE

7. *Dileptus monilatus* (Stokes)

1986. *Amphileptus monilatus* Stokes, *Ann. Mag. Nat. Hist.*, (5) **17**.

Material examined : 1 ex. Indian museum tank. 15.x.2006.

Diagnosis : Body elongated, posterior end uniformly cuspidate, neck elongated contractile and about one-fourth to one-half the length of the trunk; cytostome resembling previous species; macronucleus moniliform, contractile vacuole many; size $190\ \mu\text{m} \times 49\ \mu\text{m}$.

Distribution : India : West Bengal (Hugli district).

Remarks : First report from Kolkata wetlands.

8. *Trachelius ovum* Ehrenberg

1833. *Trachelius ovum* Ehrenberg, *Abd. Preuss. Akad. Wiss.*, Berlin, 1835, pp. 265, 277.

Material examined : 1 ex. Indian museum tank, 28.xii.2006; 1 ex. Maidan pond, 13.xii.2006.

Diagnosis : Body spheroidal to ellipsoid, anterior end with finger like proboscis curved dorsally and posterior end broadly rounded; cytostome located at the base of the proboscis, macronucleus sausage shaped; contractile vacuole many; size $66\ \mu\text{m} \times 52\ \mu\text{m}$.

Distribution : India : West Bengal, Rajasthan.

Family AMPHILEPTIDAE

Body lanceolate and laterally compressed; slit-like cytostome located at the convex ventral border of the anterior part of the body. Under this family two genera (*Loxophyllum* and *Litonotus*) are represented from this survey.

Genus *Loxophyllum* Dujardin

1(2) Body leaf-like with smooth border macronuclei 7-15 in number, globular and scattered

..... *L. levigatum*

2(1) Body leaf-like with undulating border, macronuclei many, elliptical and arranged along ventral line

..... *L. undulatum*

9. *Loxophyllum levigatum* Sauerby

1928. *Loxophyllum levigatum* Sauerby, *Arch. Protistenk.*, Jena, **62**, p. 377.

Material examined : 1 ex. Rabindra Sarobar, 3.ii.2007.

Diagnosis : Body leaf-like, anterior end with distinct beak, posterior end rounded; body margin smooth; macronuclei 7-15 in number, globular and scattered; contractile vacuole single and located at posterior end on dorsal side.

Distribution : India : West Bengal.

Remarks : First report from Kolkata wetlands.

10. *Loxophyllum undulatum* Sauerby

1928. *Loxophyllum undulatum* Sauerby, *Arch. Protistenk.*, Jena, **62**, p. 378.

Material examined : 1 ex. Rabindra Sarobar, 22.i.2007.

Diagnosis : Body flat, leaf-like, distinct beak at anterior end, posterior end very broadly rounded, vacuole single and located at posterior end on dorsal side.

Distribution : West Bengal.

Remarks : First report from Kolkata Wetlands.

11. *Litonotus fasciola* (Ehrenberg)

1838. *Amphileptus fasciola* Ehrenberg, *Die Infusionsthierchen als vollkommene organismen*, Leipzig, p. 356, pl. 38, fig. 17.

Material examined : 1 ex. Brace bridge Jheel. 7.i.2007.

Diagnosis : Body elongate, non contractile, neck not always sharply distinguished from body; macronucleus subcentral, consisting of two spherical lobes united to one another by a thread; contractile vacuole single and located near the posterior end of the body.

Distribution : India : West Bengal, Maharashtra, Rajasthan, Jammu & Kashmir.

Family LOXODIDAE

Genus *Loxodes* Ehrenberg

Leaf-like, flattened, anterior end with beak curved ventrally, right surface slightly convex, uniform ciliation on several longitudinal rows, macronuclei two or more, 2-25 strongly refractile Muller's vesicles in dorsal region.

Key to the species

1(4) Macronuclei two in number

2(3) Body leaf-like with rounded posterior end; both the macronuclei lying close to each other
..... *L. vorax*

3(2) Body leaf-like with pointed posterior end, both macronuclei are some distance apart from each other
..... *L. striatus*

- 4(1) Macronuclei many and scattered in endoplasm ..
..... *L. magnus*

12. *Loxodes vorax* Stokes

1885. *Loxodes vorax* Stokes, *Amer. Mon. micr. J.*, **6**, pp. 121-127.

Material examined : 1 ex. Rabindra Sarobar. 5.iii.2007.

Diagnosis : General body shape and size as in *L. striatus* but posterior end rounded; macronuclei two in number and lying very close to each other; size 200 $\mu\text{m} \times 280 \mu\text{m}$.

Distribution : India : West Bengal.

Remarks : First report from Kolkata wetlands.

13. *Loxodes magnus* Stokes

1887. *Loxodes magnus* Stokes, *Ann. Mag. Nat. Hist.*, London, **20**, pp. 104-114, pl. 1.

Material examined : 1 ex. Rabindra Sarobar, 21.iv.2007; 1 ex. Indian Museum Tank, 3.iii.2007.

Diagnosis : leaf like, large in size, flattened, anterior end beak-like and curved ventrally, posterior end rounded; macronuclei many and scattered in endoplasm; 380 $\mu\text{m} \times 690 \mu\text{m}$.

Distribution : India : West Bengal.

14. *Loxodes striatus* (Engelmann)

1862. *Drepanomonas striatum* Engelmann, *Z. Wiss. Zool., Leipzig*, **11**, pp. 382-383, pl. 21, fig. 7.

Material examined : 1 ex. Rabindra Sarobar, 8.vii.2006; 1 ex. Indian Museum Tank, 15.vi.2006. 1 ex. Brace Bridge Jheel, 25.viii.2007.

Diagnosis : Leaf-like, but smaller in size than *L. magnus*; posterior end pointed; macronuclei two in number; size 120 $\mu\text{m} \times 52 \mu\text{m}$.

Distribution : India : West Bengal, Jammu & Kashmir, Rajasthan.

Family COLPODIDAE

Body typically reniform, with distorted ciliary rows, no conspicuous ciliary tuft at anterior end.

15. *Colpoda aspera* Kahl

1926. *Colpoda aspera* Kahl, *Arch. Protistenk.*, Jena, **55**, pp. 322-323, fig. 10(a-c).

Material examined : 1 ex. Rabindra Sarobar, 11.iv.2007; 1 ex. Lakegarden pond, 18.ix.2007.

Diagnosis : Body somewhat bean shaped; cytostome at about one-third from the anterior end;

frontal dentations 6-7 and meridians 14-16, macronucleus spherical, contractile vacuole single and posterior; size 78 $\mu\text{m} \times 109 \mu\text{m}$.

Distribution : India : West Bengal.

17. *Colpoda cucullus* Muller

1773. *Colpoda cucullus* O.F. Muller, *Verminum terrest. et. Fluvialit. S. animal infusor. etc. historia.*, Hafniane et Lipsiae, I & II.

Material examined : 1 ex. Indian Museum Pond, 29.x.2007; 1 ex. Lakegarden pond, 15.xi.2007.

Diagnosis : Body typically kidney-shaped, cytostome located about middle of the body, frontal dentations 8-10 and meridians 29-34; macronucleus oval; contractile vacuole single and posterior; size 40.5 $\mu\text{m} \times 30.7 \mu\text{m}$.

Distribution : India : West Bengal, Andhra Pradesh, Assam, Karnataka, Maharashtra, Orissa, Tamil Nadu, Uttar Pradesh.

Family NASSULIDAE

Body ciliated all over the body, ciliation usually denser on ventral side than on dorsal one, hypostomial fringe short but multiple, cytopharyngeal apparatus prominent.

17. *Nassula ornata* Ehrenberg

1833. *Nassula ornata* Ehrenberg, *Abh. Preuss. Akad. Wiss., Berlin*, p. 169, pl. 1, fig. 2.

Material examined : 1 ex. Rabindra Sarobar, 30.x.2006; 1 ex. Indian Museum tank, 6.ii.2007; 1 ex.

Diagnosis : Body broadly oval, both end broadly rounded, macronucleus round, contractile vacuole single, located little below the middle of the body; size 125 $\mu\text{m} \times 151 \mu\text{m}$.

Distribution : India : West Bengal, Rajasthan.

Family LEPTOPHARYNGIDAE

Key to the genera

- 1(2) Body more or less compressed, body surface marked with a broad longitudinal ridge with cross striation, furrows canal like.....
..... *Pseudomicrothoax*
- 2(1) Body compressed, body surface with longitudinal furrows but without cross striations, canal like furrow absent..... *Leptopharynx*

18. *Leptopharynx torpens* (Kahl)

1931. *Trichopelma torpens* Kahl, *Urtiere order Protozoa* (in Dahl's *Tierwelt Disch.*), Jena, pt. 21, p. 303, fig. 51.

Material examined : 1 ex. Rabindra Sarobar, 15.viii.2006; 1 ex. Indian Museum Tank, 23.ii.2007.

Diagnosis : Ovoid in shape, with convex right margin and more or less straight ventral margin; ventral ridges unite to form a distinct beak near anterior end, pharyngeal basket lacking, presence of spines at the beginning of the cytostome; macronucleus oval; contractile vacuoles two and located below middle of the body; cytoplasm without green ingested food matter; size $160\ \mu\text{m} \times 180\ \mu\text{m}$.

Distribution : India : West Bengal.

Remarks : First report from Kolkata wetlands.

19. *Pseudomicrothorax agilis* Mermod

1914. *Pseudomicrothorax agilis* Mermod, *Rev. Suisse Zool.*, 22.

Material examined : 1 ex. Indian Museum Tank, 12.xii.2007; 1 ex. Pond in Lakegarden, 26.viii.2007.

Diagnosis : Oval, smaller in dimension, ciliary meridian 12 in number, macronucleus spherical and located at the posterior half; size $65\ \mu\text{m} \times 78\ \mu\text{m}$.

Distribution : India : West Bengal.

Family MICROTHORACIDAE

20. *Microthorax pusillus* Engelmann

1862. *Microthorax pusillus* Engelmann, *Zeitschr. f. wiss. zool.*, 11, pp. 347-393.

Material examined : 1 ex. Indian Museum Tank, 10.i.2008; 1 ex. Brace Bridge Jheel, 12.vi.2007.

Diagnosis : Body small, ovoid, with left border slightly sigmoid and right border more or less straight; oral depression on the dorsal side at the vicinity of ventral border; macronucleus spherical; contractile vacuole two in number and located below the middle half of the body; size $63\ \mu\text{m} \times 72\ \mu\text{m}$.

Distribution : India : West Bengal.

Family CHILODONELLIDAE

Genus *Chilodonella*

Ovoid, dorsal surface convex, ventral surface flat and with ciliary rows, a cross-row of bristles on anteriorly flattened dorsal surface.

21. *Chilodonella cucullus* (Muller)

1883. *Kolpoda cucullus* Muller, *Verminum terrest, et. fluviatil S. animal infusor., etc. historia, Hafniae et Lipsiae*, p. 158.

Material examined : 1 ex. Indian Museum Tank, 4.v.2007; 1 ex. Rabindra Sarobar, 21.ix.2007.

Diagnosis : Body dorso-ventrally flattened, cytopharynx long and straight, macronucleus oval, contractile vacuole many and scattered; size $75\ \mu\text{m} \times 151\ \mu\text{m}$.

Distribution : India : West Bengal; Jammu & Kashmir, Maharashtra, Rajasthan.

22. *Chilodonella uncinata* (Ehrenberg)

1838. *Chilodon uncinata* Ehrenberg, *Abh. Preuss. Akad. Wiss.*, Berlin, p. 337.

Material examined : 1 ex. Indian Museum Tank, 19.ix.2007; 1 ex. Pond in Salt Lake, 13.v.2007.

Diagnosis : Body dorsoventrally flattened, cytopharynx wider in front, narrow behind and spirally curved; macronucleus oval and not surrounded by any clear space, contractile vacuole single and terminal; size $65\ \mu\text{m} \times 136\ \mu\text{m}$.

Distribution : India : West Bengal.

Family PARAMECIDAE

Genus *Paramecium* Hill

Cigar- shaped, peristome long, broad and slightly oblique, cytopharynx moderately long, with a row of very fine cilia attached to its dorsal wall.

23. *Paramecium caudatum* Ehrenberg

1833. *Paramecium caudatum* Ehrenberg, *Abhandl. D. konigl. Akad. d. Wissensch. Zu Berlin*, pp. 268, 323, pl. 3, fig. 2.

Material examined : 3 exs. Rabindra Sarobar, 28.v.2006; 2 exs. Indian Museum Tank, 24.viii.2007; 2 exs. Bracebridge Jheel, 17.viii.2006; 3 exs. Lakegarden pond, 2.vii.2007; 2 exs. Pond in Salt Lake, 5.ix.2007.

Diagnosis : Cigar shaped, anterior end broader and rounded and posterior end gradually tapering; micronuclei single and compact, lying close to massive and egg-shaped macronucleus; contractile vacuoles two; size $98\ \mu\text{m} \times 42\ \mu\text{m}$.

Distribution : India : West Bengal, Orissa, Rajasthan, Uttar Pradesh, Jammu & Kashmir.

Table 1 : Occurrence of the species in different wetlands

Names of species	Names of wetlands					
	RS	IMT	BBJ	LGP	SLP	MP
1. <i>Holophrya bengalensis</i> Ghosh	+		+		+	
2. <i>Holophrya annandalei</i> Ghosh	+		+		+	+
3. <i>Prorodon discolor</i> (Ehrenberg)	+		+	+		
4. <i>Prorodon teres</i> Ehrenberg		+		+	+	
5. <i>Coleps hirtus</i> (Muller)	+		+	+		
6. <i>Lacrymaria olor</i> (Muller)		+			+	+
7. <i>Dileptus monilatus</i> (Stokes)		+				
8. <i>Trachelius ovum</i> Ehrenberg		+				+
9. <i>Loxophyllum levigatum</i> Sauerby	+					
10. <i>Loxophyllum undulatum</i> Sauerby	+					
11. <i>Litonotus fasciola</i> (Ehrenberg)			+			
12. <i>Loxodes vorax</i> Stokes	+					
13. <i>Loxodes magnus</i> Stokes	+	+				
14. <i>Loxodes striatus</i> (Engelmann)	+	+	+			
15. <i>Colpoda aspera</i> Kahl	+	+		+		
16. <i>Colpoda cucullus</i> Muller		+		+		+
17. <i>Nassula ornata</i> Ehrenberg	+	+				+
18. <i>Leptopharynx torpens</i> (Kahl)	+	+				
19. <i>Pseudomicrothorax agilis</i> Mermod		+		+		+
20. <i>Microthorax pusillus</i> Engelmann		+	+			+
21. <i>Chilodonella cucullus</i> (Muller)	+	+			+	+
22. <i>Chilodonella uncinata</i> (Ehrenberg)		+		+		+
23. <i>Paramecium caudatum</i> Ehrenberg	+	+	+	+	+	

RS–Rabindra Sarovar; IMT–Indian Museum Tank; BBJ–Brace Bridge Jheel; LGP–Pond in Lake Garden; SLP–Salt Lake Pond; MP–Maidan Pond.

(D) GENERAL REMARKS ON DISTRIBUTION

A perusal of literature of distribution in Kolkata reveals that the highest diversity of ciliates were recorded from the water body of Wellington square followed by Rabindra Sarobar and Indian Museum Tank. The 102 species recorded representing 60 genera under 46 families and 15 orders occurring in ponds, tanks and lakes of urban Kolkata. Of these 15 orders, peritrichid ciliates represent 19 species, followed by 15 species, each of prostomatid and heterotrichid ciliates. Incidentally wetland ecosystems of urban Kolkata represents the highest diversity of ciliate fauna in West Bengal. More than three and half times greater documentation of species is noted in Kolkata in

comparison to the next highest of 27 species from adjacent South 24-Parganas district.

SUMMARY

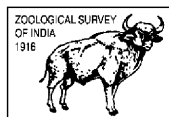
The paper deals with description, distribution and key for identification of 23 species under 16 genera of freeliving ciliates (protozoa) from Kolkata wetlands of which 5 species are reported for the first time from Kolkata wetlands.

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Rec. zool. Surv. India : **110**(Part-2) : 89-93, 2010

STUDIES ON THE SEASONAL FLUCTUATION OF SOIL NEMATODES POPULATION IN SANDY AND LATERITE SOIL OF BALASORE AND MAYURBHANJ DISTRICTS OF ORISSA

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INTRODUCTION

The soil in a particular area contains various organic and inorganic matter and supports a number of plants and animals including micro organisms. Usually nematodes both free living and plant parasitic exist in communities containing many species which exhibit efficient dispersal, polyphagy, weak interspecific competition. As most of the workers like Choudhury (1985), Choudhury and Phukan (1990, 1992), Roy and Parija (1987), Khan and Sharma (1990), Khan *et al.* (1980), Khan, Adhami and Saxena (1971), Sabir (2000), Srivastava *et al.* (2000), Dwivedi and Upadhyay (2001), De *et al.* (2004), Sen *et al.* (2008) studied the population structure of soil nematodes associated with the different crops. Very few workers like Nilova (1961), Khakinov (1971), Das and Mukhopadhyay (1990), Choudhury and Sivakumar (1999), studied the population fluctuation and vertical distribution of soil nematodes in cultivated and uncultivated soil and in different soil types. So an attempt was made to study the population structure together with the vertical distribution of the soil nematodes present in sandy and laterite types of soil in Balasore and Mayurbhanj districts of Orissa.

MATERIALS AND METHODS

The present study was undertaken during 2005-2006 in the specific areas of Balasore and Mayurbhanj districts of Orissa. In the Balasore district the soil is sandy in nature and in the forest area of Mayurbhanj district the soil is of laterite type. Four surveys were undertaken in January, March, July and November, 2006. Collections were mainly made from the grass land and paddy field after harvest in the Balasore district and

from the forest areas of the Mayurbhanj district. Collections were made in two depths one from 0 to 10 cm and other from 10-20 cm to study the vertical distribution. For the assessment of the nematode population 250 c.c. of soil samples were processed by sieving and decanting using 250 and 325 mesh and the nematodes were extracted by modified Baermann's funnel technique (Christie and Perry, 1951). The nematodes were counted under low power binocular microscope in a counting dish.

Apart from the extraction of the soil nematodes the soil samples were analysed to determine the pH and moisture content of the soil samples using Systronics pH metre and Infra red moisture balance respectively. Soil temperatures were recorded at the time of sampling the soil by inserting soil thermometer in the soil.

RESULTS AND DISCUSSION

The average moisture content of the sandy soil collected from Balasore district was 7.3%, 15.5% and 12% and that of laterite soil collected from Mayurbhanj district was 3%, 10.5% and 4.5% in premonsoon, monsoon and post monsoon period respectively. The moisture content of the upper and lower layer's soil samples (i.e., 0-10 cm and 10-20 cm depth) shows slight difference in both types of soil. In pre- and postmonsoon collections the moisture content of the lower layer's samples was slightly higher and this difference ranges from 0.5% to 1.5% in pre monsoon and 0.2% to 0.6% in postmonsoon period in sandy soil and in laterite soil it ranges from 0.7% to 0.8% in premonsoon and 1% to 1.2% in post monsoon. But in the monsoon the moisture content of the upper layer

(i.e., 0-10 cm) collections was more higher than that in the lower layer's collection in both types of soil and the difference of moisture content ranges from 2% to 5% and 1% to 3% in sandy and laterite soil respectively. The average soil temperature was 29°C, 28°C and 21°C in sandy soil and 31°C, 28°C and 21°C in laterite soil in pre monsoon, monsoon and post monsoon period respectively. The pH of soil samples were slightly alkaline in nature in both types of soil in all the seasons and it ranges from 7.1 to 7.8 and only the samples collected from paddy field the pH was slightly acedic in nature.

As regards the population of the soil nematodes in two types of soil the total population was always

higher in sandy soil than that in the laterite soil. The average number of soil nematodes in both the layers together (0-20 cm depth) in sandy soil was 42.5, 95 and 48 that in laterite soil was 30.2, 52.5 and 33.2 in pre monsoon, monsoon and post monsoon period respectively.

The vertical distribution of the soil nematodes population in the sandy and laterite soil was also studied and it was observed that the total population was slightly higher in the lower layer (i.e., 10-20 cm depth) in pre monsoon and post monsoon period where as in monsoon the upper layer's population was almost double than that in the lower layer in both types of soil (Table-1).

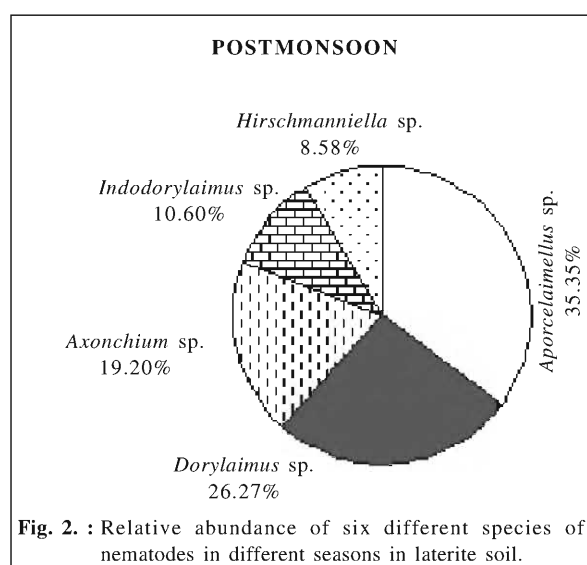
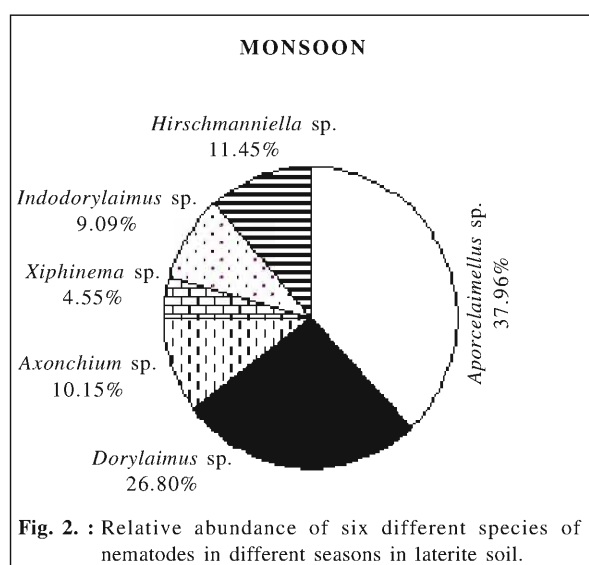
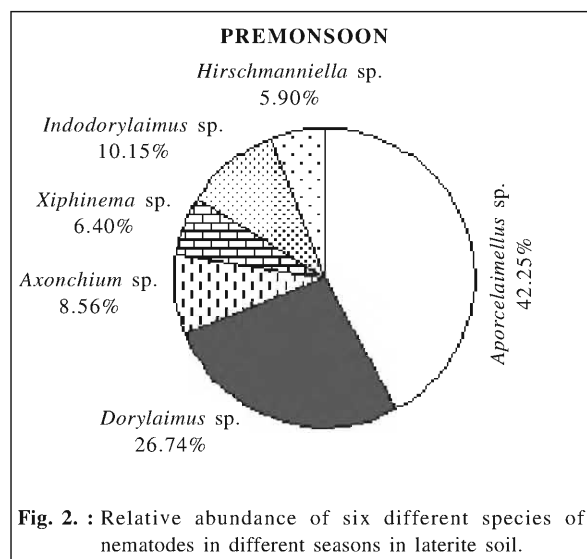
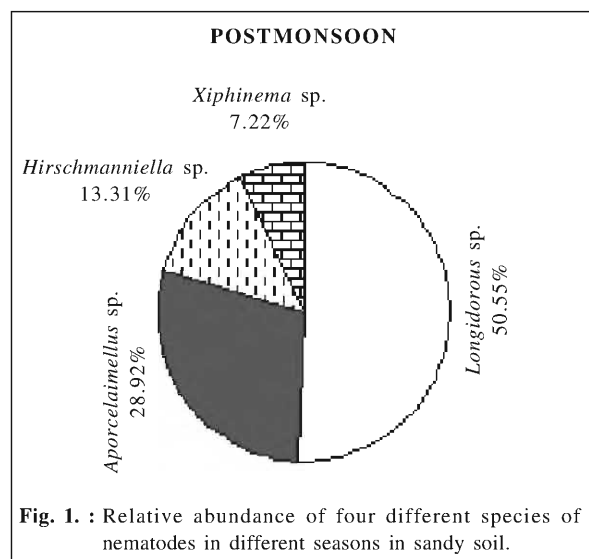
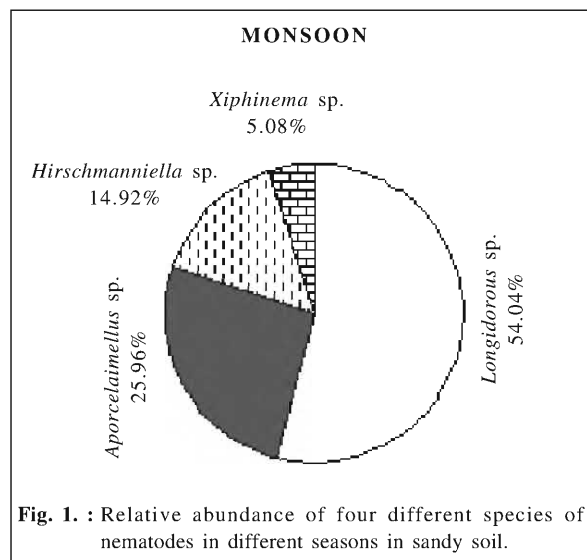
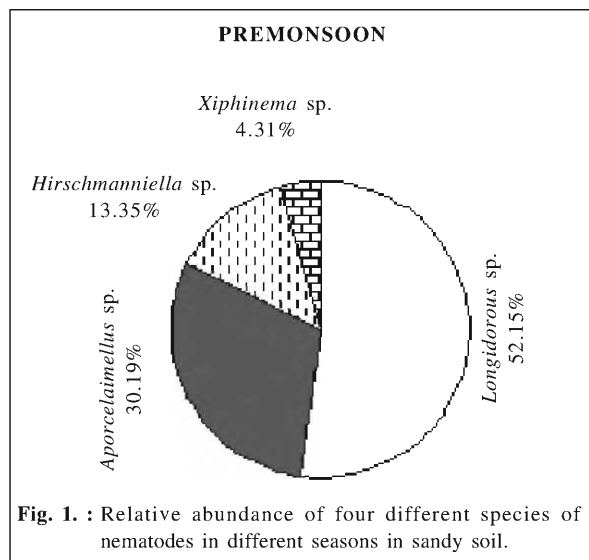
Table-1 : Shows the average soil moisture, pH, soil temperature and nematode population in two types of soil in different seasons.

Particulars	Soil types/Seasons					
	Sandy soil			Laterite soil		
	Pre-monsoon	Monsoon	Post-monsoon	Pre-monsoon	Monsoon	Post-monsoon
Average Moisture (%)	7.3	15.5	12	3	10.5	4.5
Average Temperature (°C)	29	28	21	31	28	21
Average pH	7.1	7.6	7.1	7.3	7.6	7.8
Average Nematode population in 250 ml soil (0-20 cm depth)	42.5	95	48	30.2	55	33.2
Average Nematode population in 250 ml soil in (0-10 cm depth)	16.66	58.16	20.66	12.7	36.25	13.2
Average Nematode population in 250 ml soil in (10-20 cm depth)	25.84	36.84	27.34	17.5	18.75	20

Altogether seven species of nematodes have been identified up to generic level from two types of soil. In the sandy soil only four species are available but in the laterite soil there are six species. In the sandy soil the available species are *Longidorus* sp., *Aporcelaimellus* sp., *Hirschmanniella* sp. And *Xiphinema* sp. and in the laterite soil the available species are *Aporcelaimellus* sp., *Dorylaimus* sp., *Indodorylaimus* sp., *Hirschmanniella* sp., *Axionchium* sp. And *Xiphinema* sp. In the sandy soil *Longidorus* sp. dominated the population occupying about 52.15%, 54.04% and 50.55% of the total population in

premonsoon, monsoon and postmonsoon period where as in the same time *Aporcelaimellus* sp. dominating the population of the laterite soil occupying 42.25%, 37.96% and 35.35% of the total population in the premonsoon, monsoon and post monsoon respectively. In the sandy soil the genus *Aporcelaimellus* occupying the second position but in the laterite soil the second position was occupied by the genus *Dorylaimus* (Fig. 1 & 2).

Many factors are responsible for the seasonal fluctuations of nematodes. Among these fecundity, fertility, duration of life cycle, longevity and substrate



availability are important (Norton, 1978). Along with these factors, temperature, moisture content, relative humidity and agricultural practices also influence the population.

The higher number of nematodes in all the seasons in sandy soil than that in the laterite soil is may be due to the well aeration due to the presence of grass roots and higher moisture content of the soil in all the seasons. The low population in the pre-monsoon and post monsoon period than that in the monsoon in both types of soil is may be due to the high temperature and low moisture content of the soil. The influence of atmospheric temperature can be correlated to the change in nematode population mostly in the surface layers where there is little difference between soil temperature and atmospheric temperature (Norton, 1978).

So the low population of the nematodes in the upper layer in premonsoon in both the soil types may be due to the high temperature and low moisture content of the soil. The higher numbers of nematodes in the upper layer in the monsoon in both soil types is may be due to the high moisture of the soil in monsoon due to rainfall.

SUMMARY

Population fluctuation and vertical distribution of the soil nematodes in sandy soil of Balasore and laterite soil of Mayurbhanj districts of Orissa was studied. Altogether seven species belonging to seven genera were identified and the relative abundance of the species in different seasons in both types of soil were analysed. In the monsoon the upper layer's population and the total population were higher in both types of soil. The Genus *Longidorous* and *Aporcelaimellus* dominated the population in sandy soil and laterite soil respectively.

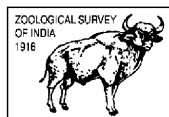
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Rec. zool. Surv. India : **110**(Part-2) : 95-107, 2010

DIVERSITY OF FLOWER-VISITING FLIES (INSECTA : DIPTERA) IN INDIA AND THEIR ROLE IN POLLINATION

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INTRODUCTION

Nectar is one of the most important foods for majority of dipterans with respect to adult energetic requirements for flight in dispersing, finding mates, mating, and searching sites for oviposition (Larson *et al.*, 2001). The flies therefore spend much of their time on flowers. The true flies of late Jurassic period with long mouth parts also support their nectar feeding ability. Many species of Diptera visit flowers, and their abundance on plants could indicate their importance as pollinators as well as the importance of flowers in their diet. So knowledge on dipteran flower visitors is required as they perform vital role in pollination.

Very little work has been done on the flower-visiting dipteran species in India. Important contributors to this subject are Priti (1998), Priti and Sihag (1997, 1998), Mishra & Kumar (1993), Mitra & Parui (2002), Mitra *et al.* (2003, 2004, 2005, 2006), Dhara Jothi & Tandon (1993), Datta & Chakraborty (1983), and Bhatnagar (1986). Apart from this, Sharma *et al.* (1998) studied and developed an easy and quick method of breeding of flies for pollination of mango blossoms. In a recent study in Madhya Pradesh, Mishra *et al.* (2004) reported 30 species of flies from the flowers of *Zizyphus mauritiana*. But most of the studies in India on fly pollination have been made with other insect pollinator groups and research activity on flower visiting flies remained in a state of neglect. Therefore, it is imperative to prepare an inventory of flower visiting flies involved in the process of pollination of different plant species.

Keeping in view, the Diptera section of Zoological Survey of India has initiated a study to generate the

basic data on the flower-visiting flies of India. This communication has culminated in documenting 116 dipteran species belonging to 16 families as flower visitors and pollinators of 92 plant species (Table-1).

DIVERSITY OF FLOWER-VISITING FLIES

Flies are one of the major successors of the insect world, and classified into about 10,000 genera, 150 families, 22-32 superfamilies, 8-10 infraorders and 2 suborders: Nematocera and Brachycera (Yeates & Wiegmann, 1999). A preliminary estimate (Buchmann & Nabhan, 1998) indicates that 14,126 species of Diptera are involved in the process of pollination in the tropical world. Inouye (2001) stated that the diversity of Diptera can rival or exceed of Hymenoptera in tropical areas. A total of 42 families (Nematocera 12 and Brachycera 30) of Diptera are reported as pollinators in the tropical world (Roubik, 1995), of which 37 families (Nematocera 12 and Brachycera 25) are found in India.

Flies that are confirmed as pollinators differ widely in their effectiveness. About one third of Nematoceran families obtain food from flowers, as well as other sources (Gilbert & Jervis, 1998; Larson *et al.* 2001). Obligate nectar-feeders occur apparently in tropical Culicidae (Snodgrass, 1959; Schremmar, 1961) and Simuliidae (Gilbert & Jervis, 1998). These primitive flies mainly visit flowers with readily accessible nectar in tubes that are short or somewhat hidden. The Brachycera contains wider variety of flower visitors and nectar-feeders which are mostly widespread in lower Brachycera. Obligate nectarivorous flies are recorded in Bombyliidae (Gilbert & Jervis, 1998). Moreover, there are some species of long-tongued families that visit

deeper tubed flowers. It has also been observed that most of the cyclorrhaphan families are nectarivorous.

The following dipteran families are reported as flower visitors and pollinators in India

Family BOMBYLIIDAE

Bee flies have generally been considered to be primarily nectarivorous although it has been known for some time that at least some bombyliids consume pollen. They are one of the important pollinator families of Diptera, which have long, sucking mouthparts especially suitable for visiting tubular flowers.

Some of the recent works on bee flies in India are contributed by Mitra & Parui (2002), Mitra *et al.* (2005, 2006) and Banerjee & Mitra (2002). Their studies revealed that the bee flies are mostly attracted to the plants of Solanaceae family (Table-1). Little is known about diurnal activities of bee flies. Mitra *et al.* (2006) stated that the bee flies are active throughout the day which supports their effective role in pollination. Banerjee & Mitra (2002) have collected 7 species of bee flies as flower visitors of agricultural crops from Arunachal Pradesh. Altogether 18 species of flower visiting bee-flies are reported from India. Recently, Mitra (unpublished) collected one bombyliid species from the flowers of *Foeniculum* and *Anthemum spp.* (Family Umbelliferae) in Uttar Pradesh.

Family CALLIPHORIDAE

Flies of the family Calliphoridae are stout, medium to large sized, with shiny metallic coloration, and commonly known as green bottles or bluebottles and blowflies. Adult blowfly feeds on nectar, honey dew and other sweet liquid or liquid products of organic decomposition. They are mostly active during day time. Their pollination ability is not well studied thoroughly. 12 species of calliphorid flies are reported as flower visitors and pollinators in India. Priti (1998), Priti & Sihag (1997, 1998) observed that blowflies are the major pollinators of onion, carrot and cauliflower after bees and wasps. According to Mitra & Parui (2002) blowflies are the common flower visitors of cultivated and non-cultivated plants. Moreover, Mitra *et al.* (2005) identified 3 species of calliphorid flies as pollinators of medicinal plants in West Bengal. Mitra *et al.* (2006) observed a large number of *Stomorphina discolor* hovering on the

flowers of *Zizyphus* and *Anogeissus spp.* in Gujarat. Sharma & Thakur (1997) also recorded *Lucilia sp.* as a pollinator of a medicinal herb (*Ammi majus* Linn.). Bhatnagar (1986) recorded 4 species of blow flies as pollinator of Asclepiadaceae from Central India.

Family CERATOPOGONIDAE

The Ceratopogonidae, commonly known as biting midges, no-see-ums or punkies have a bad reputation as being nasty biters that pester humans and domestic animals and in some instances, transmit harmful diseases. However, few people realise that this group of flies provide some important services in ecological systems. Some species are important pollinators of plants such as cacao and rubber trees. But little is known about their foraging activities in India. Bhatnagar (1986) reported only 2 species of the genus *Forcipomya* as pollinators of Asclepiadaceae from India.

Family CULICIDAE

Mosquitoes are small and delicate. The adult females are pests to humans and many other animals as they feed on blood. Adult mosquitoes occasionally obtain nectar from flowers, but they are not significant pollinators in temperate climate. Usually male mosquitoes frequent flowers more than females. Nothing is known on the pollination ability of mosquitoes in India. Recently Mitra *et al.* (2005) recorded one species of *Culex* as flower visitor of *Polygonum chinensis* in West Bengal.

Family DIOPSIDAE

Diopsids, commonly known as stalk-eyed flies, are generally distributed throughout the World. Adults are easily identified by their characteristic eye stalks, found in all taxa, although the stalk lengths vary considerably. Barring a single species of diopsid fly as flower visitors of family Asclepiadaceae (Bhatnagar, 1986) nothing is known about other species.

Family DROSOPHILIDAE

These small, delicate-looking tan or brown flies occasionally suck nectar from flowers, but they are more likely to visit rotting fruit or fermenting sap. They are not referred as a significant pollinator group of Diptera. Bhatnagar (1986) reported only one species as pollinator of *Cosmostigma racemosum* (Family Asclepiadaceae) from Dehradun. (Table-1)

Family MUSCIDAE

The members of this family are stout, robustly-built, medium-sized, grey or black, with darker stripes and other patterns. The adults occasionally visit flowers with exposed nectaries, particularly in the Carrot family. Altogether 19 species of house flies reported as flower visitors and pollinators from India. Priti (1998), Priti & Sihag (1997, 1998), Mishra & Kumar (1993) stated that the members of this family are the important pollinators of cauliflower, carrot, onion, rape seed, almond etc. Bhatnagar (1986) identified 10 species of house flies as pollinators of Asclepiadaceae. Mitra *et al.* (2002, 2004) also collected muscid flies from the flowers of garden, orchard, and agricultural plants. Mitra *et al.* (2006) reported two species of muscids as a pollinators of medicinal plants.

Family OESTRIDAE

Species of Gasterophilinae of the Family Oestridae are commonly known as horse bot flies. They are medium-sized to large, rather thickset flies, the body covered with dense short or long hair, without thick bristles. Oestrid flower visitors got 7th rank as per their efficiency in pollination of cauliflower and carrot. (Priti & Sihag, 1997, 1998).

Family SARCOPHAGIDAE

The Sarcophagidae, commonly called as “flesh flies” comprises a group of medium-sized to fairly large and generally grayish to black flies. The adults occasionally feed on flowers with exposed nectaries. Priti (1998), Priti & Sihag (1997, 1998) reported sarcophagid species as pollinators of onion, cauliflower, and carrot. In all the studies *Sarcophaga sp* was ranked 6th as per pollinating efficiency.

Family SEPSIDAE

The Black Scavenger Flies are small, shiny black, with round heads and base of abdomen strongly constricted. The most common genus, *Sepsis*, has a pigmented spot on the tip of the wing. This family is not recognised pollinator group and only 4 species have been reported as pollinators of the family Asclepiadaceae from India (Bhatnagar, 1986).

Family STRATIOMYIDAE

Soldier flies are true flies which often superficially resemble wasps in their appearance and behaviour.

However, these flies do not bite or sting. Adults are pollen or nectar feeders. The members of the family are well known flower visitors and pollinators. But only 3 species of soldier flies are so far reported as flower visitors and pollinators from India. Mitra *et al.* (2006) observed that the foraging activity of *Adoxomyia heminopla* is mostly restricted in early morning and they are the common visitors of the flowers of upper canopy. They are also found to visit the flowers of *Tagetes patula* (Mitra *et al.* 2005).

Family SYRPHIDAE

These are small to medium-sized flies that can hover motionless in the air. They visit flowers as bees and wasps. These flies feed on nectar and are major pollinators of some flowering plants in world over & in India.

So far 46 species of hover flies have been reported as flower visitors and pollinators from India. Datta & Chakraborty (1983) reported 25 species from Jammu & Kashmir. Dhara Jothi & Tandon (1993) observed that there is no significant difference in pollinating activities of *Eristalinus arvorum* in between forenoon and afternoon on *Zizyphus mauritiana*. Mishra & Kumar (1993) reported hoverflies as one of the major pollinator groups of rapeseed and almond. Priti & Sihag (1997, 1998) also observed the pollinating efficiency of hover flies on cauliflower, carrot and onion. Several workers like, Kumar & Kumar (1997), Mishra *et al.* (2004), Sharma & Thakur (1997), Mitra *et al.* (2003, 2004, 2005) have also studied the syrphid pollination. Recently, Mitra (unpublished) collected 3 syrphid species as flower visitors of *Foeniculum* and *Anthemum spp.* of the family Umbelliferae from Uttar Pradesh.

Family TABANIDAE

The tabanids or horse flies are stout, bristle less, medium to large-sized flies (5-25 mm long) belonging to the suborder Brachycera. The eyes are large, covering most of the head. The adults may obtain nectar from flowers, but are not important pollinators. The adult Horseflies are more likely to use flowers as a place to perch. Only two species are reported from India as pollinators. Priti (1998) and Priti & Sihag (1998) reported *Chrysops dispar* as a pollinator of carrot and onion. Mitra *et al.* (2004) also reported

Hybomitra hirta as flower visitors from Himachal Pradesh (Table-1).

Family TACHINIDAE

These are stout, medium to large sized flies, very bristly, particularly around the posterior of the abdomen. They are often grey with checkered patterns, but sometimes appear solid black or brown. The adults are nectar feeder and are the common visitors of many wildflowers. In India, only 3 species are reported as flower visitors. Bhatnagar (1986) reported their role in pollination of the family Asclepiadaceae.

Family TEPHRITIDAE

The members of the family Tephritidae are commonly called as “fruit flies”, although the majority of the world’s species are not frugivorous. The adult tephritids typically rest on flowers, fruit or vegetation with flex wings and oviposit on the flower heads of the family Asteraceae. They are not well known pollinating group in India, only 3 species are reported as flower visitors. Bhatnagar(1986) and Mitra *et al.* (2004) studied their

pollinating activities in India.

REMARKS

The present communication reports 116 species belonging to 16 families of Diptera along with their 92 visited plant species belonging to 39 families (Table-1). It is revealed that the family Syrphidae is the dominant group among the flower visiting flies of India (46 plant species) and the family Asteraceae (17 species) is the most favoured plant family by dipterans.

It is hoped that more and more works will take up the studies on the important aspect of pollination and pollinators especially dipterans and this work can serve as ground work for future research work

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Table-1 : List of Flower visiting-flies along with their visited plant species

	POLLINATOR	PLANT	FAMILY
1. Family BOMBYLIIDAE			
1	<i>Anthrax distigma</i> (Wiedemann)	<i>Cucurbita maxima</i>	Cucurbitaceae
2	<i>Argyromoeba duvaucelli</i> (Macquart)	<i>Cassia tora</i>	Leguminosae
3	<i>Bombomyia maculata</i> Fabricius	<i>Sorghum vulgare</i>	Graminae
4	<i>Ligyra oenomous</i> (Ronadani)	<i>Tephrosia purpurea</i>	Papilionaceae
5	<i>Ligyra aurantiaca</i> (Guerin-Meneville)	<i>Tephrosia purpurea</i>	Papilionaceae
6	<i>Ligyra tantalus</i> (Fabricius)	<i>Wild orchid</i>	
7	<i>Petrorossia albofulva</i> (Walker)	<i>Solanum melongena</i>	Solanaceae
		<i>Capsicum sp.</i>	Solanaceae
		<i>Lycopersicon esculentum</i>	Solanaceae
8	<i>Petrorossia ceylonica</i> (Brunetti)	<i>Mimosa pudica</i>	Leguminosae
9	<i>Petrorossia nigrofemorata</i> (Brunetti)	<i>Coriandrum sativum</i>	Apiaceae
10	<i>Heterolania (Isotamia) insulate</i> (Walker)	<i>Capsicum frutescens</i>	Solanaceae
		<i>Ipomea sp</i>	Convolvulaceae
		<i>Cassia tora</i>	Fabaceae
		<i>Lycopersicon esculentum</i>	Solanaceae
		<i>Solanum melongena</i>	Solanaceae
11	<i>Exoprosopa flammea</i> Brunetti	<i>Foeniculum vulgare</i> Mill	Umbelliferae
		<i>Anethum graveolens</i> Linnaeus	Umbelliferae
12	<i>Toxophora javana</i> Wiedemann	<i>Cassia auriculata</i>	Leguminosae
13	<i>Thyridanthrax (Exhylanthrax) absolom</i> (Wied.)	<i>Solanum melongena</i>	Solanaceae
		<i>Cassia tora</i>	Leguminosae
		<i>Capsicum frutescens</i>	Solanaceae
		<i>Lycopersicon esculentum</i>	Solanaceae
14	<i>Villa aperta</i> (Walker)	<i>Lycopersicon esculentum</i>	Solanaceae
15	<i>Villa aureohirta</i> (Brunetti)	<i>Scaevola sericea</i>	Goodeniaceae
16	<i>Villa panisca</i> (Rossi)	<i>Scaevola sericea</i>	Goodeniaceae
		<i>Dahlia sp.</i>	Asteraceae
		<i>Tagetes patula</i>	Asteraceae
17	<i>Litorhynchus lar</i> (Fabricius)	<i>Capsicum frutescens</i>	Solanaceae
		<i>Solanum melongena</i>	Solanaceae
18	<i>Ligyra oenomaus</i> (Rondani)	<i>Wild orchid</i>	
2. Family CALLIPHORIDAE			
19	<i>Isomyia viridaurea</i> (Wiedemann)	<i>Catharanthus roseus</i>	Apocyanaceae
20	<i>Phaenicia cuprina</i> (Wiedemann)	<i>Tabernaemontana. coronaria</i>	Apocyanaceae
21	<i>Phaenicia sericata</i> (Meigen)	<i>Tabernaemontana. coronaria</i>	Apocyanaceae
		<i>Begonia sp.</i>	Begoniaceae
22	<i>Chrysomya bezziana</i> (Villeneuve)	<i>Allium cepa</i>	Liliaceae
		<i>Daucas carota</i>	Umbelliferae
		<i>Brassica oleraceae v. botrytis</i>	Cruciferae
23	<i>Chrysomya megacephala</i> (Fabricius)	<i>Holarrhena antidysenterica</i>	Apocyanaceae
		<i>Mikania cordata</i>	Asteraceae
		<i>Lantana camara</i>	Verbenaceae

Table-1 : Cont'd.

	POLLINATOR	PLANT	FAMILY
		<i>Tectona grandis</i>	Verbanaceae
		<i>Althaea rosea</i>	Malvaceae
		<i>Zizyphus mauritiana</i>	Rhamnaceae
24	<i>Chrysomya rufifacies</i> (Macquart)	<i>Cosmostigma racemosum</i>	Asclepiadaceae
25	<i>Hemipyrellia liguirriens</i> (Wiedemann)	<i>Polygonum chinensis</i>	Polygoniaceae
26	<i>Hemipyrellia pulchra</i> (Wiedemann)	<i>Santalum album</i>	Santalaceae
		<i>Psidium guajava</i>	Myrtaceae
		<i>Cosmostigma racemosum</i>	Asclepiadaceae
27	<i>Lucilia</i> sp.	<i>Ammi majus</i>	Apiaceae
28	<i>Lucilia porphyria</i> (Walker)	<i>Scaevola sericea</i>	Goodeniaceae
29	<i>Pyrellia scintillans</i> Bigot	<i>Cosmostigma racemosum</i>	Asclepiadaceae
30	<i>Stomorhina discolor</i> (Fabricius)	<i>Tagetes patula</i>	Asteraceae
		<i>Anogeissus pendula</i>	Combretaceae
		<i>Zizyphus</i> sp	Rhamnaceae
		<i>Tagetes patula</i>	Asteraceae
		<i>Syzygium jambos</i>	Myrtaceae
		<i>Callistemon citrinus</i>	Myrtaceae
		<i>Zizyphus mauritiana</i>	Rhamnaceae
		<i>Polygonum chinensis</i>	Polygoniaceae
		<i>Cosmostigma racemosum</i>	Asclepiadaceae
3. Family CERATOPOGONIDAE			
31	<i>Forcipomya</i> sp. (1)	<i>Ceropogia bulbaza</i>	Asclepiadaceae
32	<i>Forcipomya</i> (2)	<i>C. lushi</i> v. <i>acuminata</i>	Asclepiadaceae
4. Family CULICIDAE			
33	<i>Culex</i> sp.	<i>Polygonum chinensis</i>	Polygoniaceae
5. Family DIOPSIDAE			
34	<i>Sphyracephala hearsiana</i> (Wiedemann)	<i>Cosmostigma racemosum</i>	Asclepiadaceae
6. Family DROSOPHILIDAE			
35	<i>Drosophila (Sopophora) rufa</i> Kikkawa & Peng	<i>Cosmostigma racemosum</i>	Asclepiadaceae
7. Family MUSCIDAE			
36	<i>Musca (M) domestica</i> Linnaeus	<i>Wedelia calendulaceae</i>	Asteraceae
		<i>Allium cepa</i>	Liliaceae
		<i>Daucus carota</i>	Umbelliferae
		<i>Brassica oleracea</i> v. <i>botrytis</i>	Cruciferae
		<i>Zizyphus mauritiana</i>	Rhamnaceae
		<i>Ammi majusa</i>	Apiaceae
		<i>Cosmostigma racemosum</i>	Asclepiadaceae
37	<i>Musca (Philaematomyia) crassirostris</i> Stein	<i>Allium cepa</i> L.	Liliaceae
38	<i>Musca (Byomya) conducens</i> Walker	<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
39	<i>Musca (Byomya) pattoni</i> Austen	<i>Cosmostigma racemosum</i>	Asclepiadaceae
40	<i>Musca (Byomya) sorbens</i> Wiedemann	<i>Cosmostigma racemosum</i>	Asclepiadaceae
		<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
41	<i>Musca (Byomya) ventrosa</i> Wiedemann	<i>Polianthes tuberosa</i>	Amoryllidaceae

Table-1 : Cont'd.

	POLLINATOR	PLANT	FAMILY
42	<i>Musca</i> sp.	<i>Brassica campestris</i> v.sarson	Cruciferae
43	<i>Dichaetomyia luteiventris</i> (Rondani)	<i>Cosmostigma racemosum</i>	Asclepiadaceae
44	<i>Orthellia timorensis</i> (Robineau-Desvoidy)	<i>Scaevola sericea</i>	Goodeniaceae
		<i>Althaea rosea</i>	Malvaceae
45	<i>Orthellia viridis</i> (Wiedemann)	<i>Castanea sativa</i>	Fagaceae
		<i>Aesculus indica</i>	Hippocastanaceae
		<i>Unidentified Aster</i>	Asteraceae
46	<i>Orthellia</i> sp.	<i>Brassica campestris</i> v.sarson	Cruciferae
		<i>Almond</i>	
47	<i>Atherigona</i> (<i>Atherigona</i>) <i>falcata</i> (Thomson)	<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
		<i>Cosmostigma racemosum</i>	Asclepiadaceae
	<i>Atherigona</i> (<i>Atherigona</i>) <i>punctata</i> Karl	<i>Cosmostigma racemosum</i>	Asclepiadaceae
48	<i>Atherigona</i> (<i>Acritochaeta</i>) <i>oreintalis</i> Schiner	<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
		<i>Cosmostigma racemosum</i>	Asclepiadaceae
49	<i>Myospila lenticeps</i> (Thomson)	<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
		<i>Cosmostigma racemosum</i>	Asclepiadaceae
50	<i>Myospila laevis</i> (Stein)	<i>Cosmostigma racemosum</i>	Asclepiadaceae
51	<i>Limnophora</i> sp.	<i>Cosmostigma racemosum</i>	Asclepiadaceae
8. Family ULIDIDAE			
52	<i>Physiphora aenea</i> (Fabricius)	<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
9. Family OESTRIDAE			
53	<i>Gasterophilus</i> sp.	<i>Brassica oleraceae</i> v. <i>botrytis</i>	Cruciferae
		<i>Daucus carota</i>	Umbelliferae
		<i>Allium cepa</i>	Liliaceaea
10. Family SARCOPHAGIDAE			
54	<i>Iranihindia futilis</i> (Senior- White)	<i>Tabernaemontana. Coronaria</i>	Apocyanaceae
55	<i>Sarcophaga</i> sp.	<i>Brassica oleraceae</i> v. <i>botrytis</i>	Cruciferae
		<i>Daucus carota</i>	Umbelliferae
		<i>Allium cepa</i>	Liliaceaea
		<i>Ammi majusa</i>	Apiaceae
11. Family SEPSIDAE			
56	<i>Sepsis rufa</i> Macquart	<i>Cosmostigma racemosum</i>	Asclepiadaceae
57	<i>Sepsis nitens</i> Wiedemann	<i>Cosmostigma racemosum</i>	Asclepiadaceae
58	<i>Australosepsis frontalis</i> (Walker)	<i>Cosmostigma racemosum</i>	Asclepiadaceae
59	<i>Australosepsis niveipennis</i> (Becker)	<i>Cosmostigma racemosum</i>	Asclepiadaceae
12. Family STRATIOMYIDAE			
60	<i>Sargus metallinus</i> (Fabricius)	<i>Bauhinia variegata</i> v. <i>candida</i>	Leguminosae
61	<i>Oplodontha rubrithorax</i> (Macquart)	<i>Tagetes patula</i>	Asteraceae
62	<i>Adoxomyia heminopla</i> Wiedmann	<i>Nerium indicum</i>	Apocyanaceae
		<i>Zizyphus sp</i>	Rhamnaceae
63	<i>Microchrysa flaviventris</i> (Wiedemann)	<i>Tagetes patula</i>	Asteraceae
13. Family SYRPHIDAE			
64	<i>Asarkina</i> (<i>Asarkina</i>) <i>ericetorum</i> (Fabricius)	<i>Amaranthus spinosa</i>	Amaranthaceae

Table-1 : Cont'd.

	POLLINATOR	PLANT	FAMILY
		<i>Commelina sp</i>	Commelinaceae
		<i>Commelina bengalensis</i>	Commelinaceae
		<i>Cassia tora</i>	Fabaceae
		<i>Solanum nigrum</i>	Solanaceae
		<i>Lantana camara</i>	Verbenaceae
		<i>Sida acuta</i>	Malvaceae
		<i>Polygonum chinensis</i>	Polygoniceae
65	<i>Baccha (Allobaccha) amphithoe</i> (Walker)	<i>Helichrysum sp.</i>	Asteraceae
66	<i>Chrysotoxum baphyrus</i> (Walker)	<i>Climatis sp</i>	Ranunculaceae
		<i>Ipomea sp</i>	Convolvulaceae
		<i>Cynodon sp.</i>	Gramineae
67	<i>Eristalinus (Eristalinus) arvorum</i> (Fabricius)	<i>Tagetes patula</i>	Asteraceae
		<i>Helichrysum sp</i>	Asteraceae
		<i>Santalum album</i>	Santalaceae
		<i>Mangifera indica</i>	Anacardiaceae
		<i>Zizyphus mauritiana</i>	Rhamnaceae
		<i>Polygonum chinensis</i>	Polygoniceae
		<i>Brassica campestris v.sarson</i>	Cruciferae
68	<i>Eristalis (Eoseristalis) arbustorum</i> (Linnaeus)	<i>Sida rhombifolia</i>	Malvaceae
		<i>Chrysanthemum sp</i>	Asteraceae
		<i>Tagetes patula</i>	Asteraceae
		<i>Sonchus asper</i>	Asteraceae
		<i>Melilotus alba</i>	Leguminosae
		<i>Lindenbergia sp.</i>	Scrophulariaceae
69	<i>Episyrphus balteatus</i> (De Geer)	<i>Launea aspleniifolia</i>	Asteraceae
		<i>Commelina bengalensis</i>	Commelinaceae
		<i>Wedelia calendulaceae</i>	Asteraceae
		<i>Coriandrum sativum</i>	Umbelliferae
		<i>Lantana camera</i>	Verbenaceae
		<i>Nicotiana plumbaginifolia</i>	Solanaceae
		<i>Justica simplex</i>	Acanthaceae
		<i>Commelina obliqua</i>	Commelinaceae
		<i>Climatis sp</i>	Ranunculaceae
		<i>Cannabis sp.</i>	Cannabiaceae
		<i>Zinnia elegance</i>	Asteraceae
		<i>Duranta plumieri</i>	Verbeneceae
		<i>Foeniculum vulgare</i>	Umbelliferae
		<i>Trifolium repens</i>	Umbelliferae
		<i>Rubus elipticus</i>	Rosaceae
		<i>Solanum nigrum</i>	Solanaceae
		<i>Anacardium occidentale</i>	Anacardiaceae
		<i>Sorghum vulgare</i>	Graminae
		<i>Solanum melongena,</i>	Solanaceae

Table-1 : Cont'd.

	POLLINATOR	PLANT	FAMILY
		<i>Capsicum frutescens</i>	Solanaceae
		<i>Malus domestica</i>	Rosaceae
		<i>Brassica campestris</i> v.sarson	Cruciferae
		<i>Almond</i>	
		<i>Foeniculum vulgare</i> Mill	Umbelliferae
		<i>Anethum graveolens</i> Linnaeus	Umbelliferae
70	<i>Dideopsis aegrotus</i> Fabricius	<i>Foeniculum vulgare</i> Mill	Umbelliferae
		<i>Anethum graveolens</i> Linnaeus	Umbelliferae
71	<i>Eristalis</i> sp.	<i>Brassica oleracea</i> v. botrytis	Cruciferae
		<i>Daucus carota</i>	Umbelliferae
		<i>Allium cepa</i>	Liliaceae
		<i>Ammi majusa</i>	Apiaceae
		<i>Almond</i>	
72	<i>Eristalis (Eoseristalis) cerealis</i> (Fabricius)	<i>Sonchus asper</i>	Asteraceae
		<i>Tagetes patula</i>	Asteraceae
		<i>Chrysanthemum</i> sp	Asteraceae
		<i>Helianthus</i> sp	Asteraceae
		<i>Xanthium strumarium</i>	Asteraceae
		<i>Dahlia</i> sp.	Asteraceae
		<i>Erigeron licifolia</i>	
		<i>Ricinus communis</i>	Euphorbiaceae
		<i>Melilotus alba</i>	Leguminosae
		<i>Unidentified Aster</i>	Asteraceae
73	<i>Eristalinus laetus</i> (Wiedemann)	<i>Tagetes patula</i>	Asteraceae
74	<i>Eristalinus (E) obscuritarsis</i> (de Meijere)	<i>Aegle marmelos</i>	Rutaceae
		<i>Tagetes patula</i>	Asteraceae
75	<i>Eristalinus quinquestratus</i> (Fabricius)	<i>Tagetes patula</i>	Asteraceae
76	<i>Eristalinus taphicus</i> (Wiedemann)	<i>Tridax</i> sp.	Asteraceae
		<i>Zinnia</i> sp	Asteraceae
		<i>Tagetes patula</i>	Asteraceae
77	<i>Eristalis paria</i> (Bigot)	<i>Helianthus</i> sp.	Asteraceae
78	<i>Eristalis (Eristalis) tenax</i> (Linnaeus)	<i>Ammi majus</i>	Apiaceae
		<i>Blumea</i> sp.	Asteraceae
		<i>Tagetes patula</i>	Asteraceae
		<i>Chrysanthemum</i> sp	Asteraceae
		<i>Helianthus</i> sp.	Asteraceae
		<i>Sonchus asper</i>	Asteraceae
		<i>Dahlia</i> sp.	Asteraceae
		<i>Pyrus amygdalus</i>	Rosaceae
		<i>Brassica campestris</i> v.sarson	Cruciferae
		<i>Almond</i>	
		<i>Foeniculum vulgare</i> Mill	Umbelliferae
		<i>Allium cepa</i>	Liliaceae

Table-1 : Cont'd.

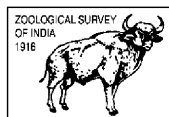
	POLLINATOR	PLANT	FAMILY
		<i>Anethum graveolens</i> Linnaeus	Umbelliferae
		<i>Unidentified Aster</i>	Asteraceae
79	<i>Eristalis angustimarginalis</i> Brunetti	<i>Brassica campestris</i> v.sarson	Cruciferae
		<i>Almond</i>	
80	<i>Eristalis polymacharus</i> (Brunetti)	<i>Brassica campestris</i> v.sarson	Cruciferae
81	<i>Graptomyza brevirostris</i> Wiedemann	<i>Herpestis</i> sp.	Scrophulariaceae
82	<i>Ischiodon scutellaris</i> (Fabricius)	<i>Anogeissus pendula</i>	Combretaceae
		<i>Cassia tora</i>	Fabaceae
		<i>Panicum</i> sp.	Graminae
		<i>Tagetes patula</i>	Asteraceae
		<i>Solanum melongena</i>	Solanaceae
		<i>Capsicum frutescens</i>	Solanaceae
		<i>Brassica campestris</i> v.sarson	Cruciferae
		<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
83	<i>Ischyrosyrphus</i> sp.	<i>Cannabis sativa</i>	Cannabiaceae
84	<i>Melanostoma</i> sp.	<i>Solanum nigrum</i>	Solanaceae
		<i>Cynodon</i> sp.	Graminae
		<i>Chrysanthemum</i> sp	Asteraceae
		<i>Cannabis</i> sp.	Cannabiaceae
		<i>Eleusine indica</i>	Graminae
85	<i>Melanostoma orientale</i> (Wiedemann)	<i>Solanum nigrum</i>	Solanaceae
		<i>Rubus elipticus</i>	Rosaceae
		<i>Justica simplex</i>	Acanthaceae
		<i>Cannabis sativa</i>	Cannabiaceae
		<i>Digitaria sanguinalis</i>	Graminae
		<i>Cynodon</i> sp.	Graminae
		<i>Ammania</i> sp.	
		<i>Sida</i> sp.	Malvaceae
		<i>Lantana camara</i>	Verbanaceae
		<i>Digitalis purpurea</i>	Scrophulariaceae
86	<i>Melanostoma univittatum</i> Wiedemann	<i>Brassica campestris</i> v.sarson	Cruciferae
87	<i>Mesembrius bengalensis</i> (Wiedemann)	<i>Sida acuta</i>	Malvaceae
		<i>Wedelia calendulaceae</i>	Asteraceae
		<i>Tagetes patula</i>	Asteraceae
		<i>Polygonum chinensis</i>	Polygoniaceae
		<i>Spilanthus acmella</i>	Asteraceae
		<i>Rhodiola</i> sp.	Crassulaceae
88	<i>Mesembrius quadrivittatus</i> (Wiedemann)	<i>Wedelia calendulaceae</i>	Asteraceae
		<i>Aegle marmelos</i>	Rutaceae
	<i>Rauvolfia serpentina</i>	Apocyanaceae	
		<i>Polygonum chinensis</i>	Polygoniaceae
		<i>Spilanthus acmella</i>	Asteraceae
		<i>Foeniculum vulgare</i> Mill	Umbelliferae
	<i>Anethum graveolens</i> Linnaeus	Umbelliferae	

Table-1 : Cont'd.

	POLLINATOR	PLANT	FAMILY
89	<i>Metasyrphus (Metasyrphus) corollae</i> (Fabricius)	<i>Brassica campestris</i> v.sarson	Cruciferae
		<i>Almond</i>	
90	<i>Metasyrphus (M) latifasciatus</i> (Macquart)	<i>Rosa webbiana</i>	Rosaceae
		<i>Cannabis sativa</i>	Cannabiaceae
91	<i>Paragus (Paragus) serratus</i> (Fabricius)	<i>Polygonum orientale</i>	Polygonaceae
		<i>Solanum nigrum</i>	Solanaceae
		<i>Lantana camera</i>	Verbenaceae
		<i>Wedelia calendulaceae</i>	Asteraceae
		<i>Ageratum conyzoides</i>	Asteraceae
		<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
92	<i>Paragus (Pandasyophthalmus) atratus</i> de Meijere	<i>Cynodon sp.</i>	Graminae
		<i>Solanum nigrum</i>	Solanaceae
93	<i>Paragus (Pandasyophthalmus) tibialis</i> (Fallen)	<i>Cynodon sp.</i>	Graminae
		<i>Amaranthus spinosa</i>	Amaranthaceae
		<i>Solanum nigrum</i>	Solanaceae
94	<i>Paragus (Pandasyophthalmus) rufiventris</i> (Brunetti)	<i>Lantana camera</i>	Verbenaceae
		<i>Cynodon sp.</i>	Graminae
		<i>Solanum nigrum</i>	Solanaceae
95	<i>Paragus bicolor</i> Fabricius	<i>Choerophyllum sp.</i>	Umbelliferae
96	<i>Phytomia(Phytomia) errans</i> (Fabricius)	<i>Lantana camera</i>	Verbenaceae
97	<i>Phytomia(Dolichomerus) crassa</i>	<i>Foeniculum vulgare</i> Mill	Umbelliferae
		<i>Anethum graveolens</i> Linnaeus	Umbelliferae
98	<i>Sphaerophoria sp.</i>	<i>Justica simplex</i>	Acanthaceae
		<i>Eleusine indica</i>	Graminae
		<i>Sonchus asper</i>	Asteraceae
99	<i>Sphaerophoria indiana</i> Bigot	<i>Brassica campestris</i> v.sarson	Cruciferae
100	<i>Sphaerophoria scripta</i> (Linnaeus)	<i>Tridax sp.</i>	Asteraceae
		<i>Cynodon sp.</i>	Graminae
		<i>Chenopodium ambrosoides</i>	Chenopodiaceae
		<i>Digitaria sanguinalis</i>	Graminae
		<i>Duranta plumieri</i>	Verbeneceae
		<i>Foeniculum vulgare</i>	Umbelliferae
		<i>Justica simplex</i>	Acanthaceae
		<i>Nicotiana plumbaginifolia</i>	Solanaceae
		<i>Chrysanthemum sp</i>	Asteraceae
		<i>Cannabis sativa</i>	Cannabiaceae
		<i>Solanum nigrum</i>	Solanaceae
		<i>Sida sp.</i>	Malvaceae
		<i>Sonchus asper</i>	Asteraceae
		<i>Polygonum orientale</i>	Polygonaceae
		<i>Launea sp.</i>	Asteraceae
		<i>Lantana camara</i>	Verbanaceae
		<i>Ammania sp.</i>	

Table-1 : Cont'd.

	POLLINATOR	PLANT	FAMILY
		<i>Eleusine sp.</i>	Graminae
		<i>Eleusine indica</i>	Graminae
		<i>Panicum sp.</i>	Graminae
101	<i>Syrphus latifasciatus</i> (Macquart)	<i>Cannabis sp.</i>	Cannabiaceae
		<i>Polygonum sp.</i>	Polygonaceae
		<i>Justica simplex</i>	Acanthaceae
102	<i>Betasyrphus serarius</i> (Wiedemann)	<i>Ammi majusa</i>	Apiaceae
103	<i>Syrphus torvus</i> Osten-Sacken	<i>Ammi majusa</i>	Apiaceae
104	<i>Syrpitta orientalis</i> Macquart	<i>Ephedra geardiana</i>	Ephedraceae
105	<i>Syrpitta indica</i> (Wiedemann)	<i>Polygonum chinensis</i>	Polygoniaceae
106	<i>Syrpitta pipiens</i> (Linnaeus)	<i>Anthemis cotula</i>	Asteraceae
		<i>Solanum nigrum</i>	Solanaceae
		<i>Panicum sp.</i>	Graminae
		<i>Cynodon dactylon</i>	Graminae
		<i>Cynodon sp.</i>	Graminae
		<i>Amaranthus spinosa</i>	Amaranthaceae
		<i>Nicotiana plumbaginifolia</i>	Solanaceae
		<i>Cannabis sativa</i>	Cannabiaceae
		<i>Eleusine indica</i>	Graminae
		<i>Eleusine sp.</i>	Graminae
		<i>Chloris sp</i>	
		<i>Duranta plumieri</i>	Verbanaceae
		<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
107	<i>Scaeva latimaculata</i> (Brunetti)	<i>Melilotus officinalis</i>	Leguminosae
		<i>Brassica campestris</i> v.sarson	Cruciferae
108	<i>Scaeva selenitica</i> (Meigen)	<i>Scrophularia sp.</i>	Scrophulariaceae
14. Family TABANIDAE			
109	<i>Chrysops dispar</i> (Fabricius)	<i>Merremia vitifolia</i>	Convolvulaceae
	<i>Allium cepa</i> L.	Liliaceae	
	<i>Daucus carota</i>	Umbelliferae	
110	<i>Hybomitra hirta</i> (Walker)	<i>Anacardium occidentale</i>	Anacardiaceae
		<i>Sorghum vulgare</i>	Graminae
		<i>Coriandrum sativum</i>	Umbelliferae
15. Family TEPHRITIDAE			
111	<i>Bactrocera (Zeugodacus) cucurbitae</i> Coquilett	<i>Cucurbita maxima</i>	Cucurbitaceae
		<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
		<i>Cosmostigma racemosum</i>	Asclepiadaceae
112	<i>Euphranta (Staurella) crux</i> (Fabricius)	<i>Lantana camera</i>	Verbenaceae
		<i>Tectona grandis</i>	Verbanaceae
113	<i>Campiglossa cribellata</i> Bezzi	<i>Polygonum chinensis</i>	Polygoniaceae
16. Family TACHINIDAE			
114	<i>Thelaira macropus</i> (Wiedemann)	<i>Helichrysum sp.</i>	Asteraceae
		<i>Psidium guajava</i>	Myrtaceae
115	<i>Blepharipa</i> sp.	<i>Cosmostigma racemosum</i>	Asclepiadaceae
116	<i>Lophosia imbuta</i> (Wiedemann)	<i>Cosmostigma racemosum</i>	Asclepiadaceae



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STUDIES ON THE COCKROACH FAUNA OF KARNATAKA (INSECTA : BLATTODEA)

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INTRODUCTION

Cockroaches are one of the oldest insect orders with a fossil history extending back more than 300 million years. There are 4000 known species worldwide belonging to six families, Blattidae, Cryptoceridae, Polyphagidae, Nocticolidae, Blattellidae and Blaberidae (Roth, 1999 & 2003) under 445 genera. The American cockroach *Periplaneta americana* (Linnaeus) and the Oriental cockroach *Blatta orientalis* Linnaeus are common species known to India. However, the vast majority of cockroach species (more than 99%) lives in the wild and are probably playing an important role in the food web of forest eco system (Bhoopathy, 1997 & Jayakumar *et al.*, 1994). However, there are a few species that thrive in and around human habitations. They are pests because they destroy food and contaminate it with their smelly excreta. The present inventory of Cockroaches is far from complete and further surveys are needed to get a clear picture of their distribution in Karnataka. Out of 57 genera and 156 species accommodated under 5 families reported from India (Mandal, S.K., *et. al.*, 1995 & 2000), the present study records 11 genera and 12 species under 4 families from Karnataka.

SYTEMATIC ACCOUNT

Family BLATTELLIDAE

Subfamily BLATTELLINAE

Genus **Blattella** Caudell, 1903

1. *Blattella germanica* (Linnaeus, 1767)
2. *Blattella humbertiana* (Saussure, 1863)
3. *Blattella biligata* (Walker, 1868)

Subfamily PSEUDOPHYLLODROMIINAE

Genus **Supella** Shelford, 1911

Subgenus *Supella* Shelford, 1911

4. *Supella (Supella) longipalpa* (Fabricius)

Family BLABERIDAE

Subfamily EPILAMPRINAE

Genus **Stictolampra** Hanitsch, 1930

5. *Stictolampra plicata* (Navas, 1904)*

Subfamily PYCNOSCELINAE

Genus **Pycnoscelus** Scudder, 1862

6. *Pycnoscelus surinamensis* (Linnaeus, 1758)

Subfamily PERISPHAERIINAE

Genus **Pseudoglomeris** Brunner von Wattenwyl, 1893

7. *Pseudoglomeris glomeris* (Saussure)*

Genus **Trichoblatta** Saussure & Zehnter, 1895

8. *Trichoblatta sericea* (Saussure, 1863) *

Subfamily EPILAMPRINAE

Genus **Thorax** Saussure, 1862

9. *Thorax porcellana* Saussure, 1862

Family BLATTIDAE

Subfamily BLATTINAE

Genus **Periplaneta** Burmeister, 1838

10. *Periplaneta americana* (Linnaeus, 1758)
11. *Periplaneta australasiae* (Fabricius, 1775)
12. *Periplaneta ceylonica* Karny, 1908*
13. *Periplaneta brunnea* Burmeister, 1838*

Genus **Blatta** Linnaeus, 1758

14. *Blatta orientalis* Linnaeus, 1758

Genus *Neostylopyga* Shelford, 1911

15. *Neostylopyga rhombifolia* (Stål, 1813)

16. *Neostylopyga sexpustulata* (Walker, 1871)*

Family POLYPHAGIDAE

Subfamily POLYPHAGINAE

Genus *Polyphaga* Brullé, 1835

17. *Polyphaga indica* Walker, 1868

Genus *Therea* Billberg, 1820

18. *Therea petiveriana* (Linnaeus, 1758)

19. *Therea hyperguttata* Grandcolas, 1993*

Order BLATTODEA

Family BLATTELLIDAE

Subfamily BLATTELLINAE

Genus *Blattella* Caudal, 1903

1. *Blattella germanica* (Linnaeus, 1767)

(Plate IIc)

1767. *Blatta germanica* Linnaeus, *Syst. Naturae* **1**(2) (ed.12) : 688.

1893. *Ischnoptera parallela* Tepper, *Trans. R. Soc. S. Austral.*, **17** : 53.

1895. *Phyllodromia germanica* : Tepper, *Trans. R. Soc. S. Austral.*, **19** : 150

1908. *Blattella germanica shuguroffi* Karny, *Denkschr. med.-naturw. Ges. Jena* **13** : 377.

1925. *Phyllodromia cuneivittata* Hanitsch, *Sarawak Mus. J.* **3** : 77.

1969. *Blatta germanica*: Princis, *Orthopt. Catalog.* Part **13** : 807-823

Material examined : 1 ex., Uthegabundae, 9.xii.2005; 5 exs., Sunuvara, 10.xii.2005; 3 exs., Kogglahalli, 11.xii.2005; 5exs., Konganjayahundi, 15.xii.2005; 15 exs., Vajmangala, 17.xii.2005; 6 exs., K.Gudi, 21.xii.2005; 5 exs., Ahulibetta, 9.ix.2006; 8 exs., Madhavpatna, 14.ix.06; 15 exs., Mangalore Port Trust, 17.ix.2006; 28 exs., Uttegaseeguda, 22.ix.06; 18exs., Kollukondahalli, 26.ix.2006; 7 exs., Attibelle, Lot-1, 27.ix.2006; 5 exs., Besmapahalli, Lot-2, 27.ix.2006; 11exs., Hallayalla, 13.ix.2007; 23 exs., Kondajji, 17.ix.07; 18 exs., Chellakere, 20.ix.07; 11 exs., Thanganahalli, 23.ix.07; 40 exs., Nagg erhalli, 25.ix.07, coll; 21 exs., Beerandahalli, 28.ix.07, coll. S. Prabakaran.

Diagnosis : Small in size. Head with vertex exposed. Pronotum transeverse, gradually rounded laterally. Tegmen relatively elongated, the subcosta is shorter than anal field, discoidal vein forked before median point. 2 to 7 abdominal tergites with latero

caudal portion produced as lobes, 7 and 8 tergites narrowly visible. Supra anal plate semi circular or subtriangular, with lateral margin moderately convergent, weakly convex at the posterior region. Subgenital plate with posterior margin forming a large broad rounded lobe.

Distribution : Widely distributed species in the world.

2. *Blattella humbertiana* (Saussure, 1863)

(Plate IIIC)

1863. *Polyzosteria humbertiana* Saussure, *Mem. Soc. Geneve*, **17** : 131.

1904. *Phyllodromia humbertiana* Kirby, *Syn. Cat.Orth.*, **1** : 90.

1960. *Blattella humbertiana* Princis, *Ark. Zool.*, (2) **1** : 27.

1969. *Blattella humbertiana* : Princis, *Orthopt. Catalog.* Part **13** : 842-843.

Material examined : 1 ex., Bhagamandala, 13.ix.2006; 6exs., Abayathmangala, 15.ix.06; 4exs., Kollur, 21.ix.2006; 14exs., Uttegaseeguda, 22.ix.06; 7exs., Attibelle, 26.ix.06; 3exs., Ranibennur wildlife sanctuary, 14.ix.07; 6 exs., Kondajji, 17.ix.07; 8 exs., Chellekere; 5 exs., Naggerhalli, 25.ix.07; 9 exs., Beerandahalli, 28.ix.07, coll. S. Prabakaran.

Diagnosis : Brown in colour, head yellow, frontal region yellowish brown. Small in size. Head with vertex exposed. Cerci slender. Supra anal plate strongly transverse, with distal margin broadly convex. Subgenital plate symmetrical. Female plate simple, free margin broadly convex but suddenly and distinctly concave below cerci.

Distribution : India (Karnataka, Meghalaya, West Bengal, Tripura and Arunachal Pradesh), widely distributed in the world.

3. *Blattella biligata* (Walker, 1868)

1868. *Blatta cercalis* Walker, Catalogue of the Specimens of Blattariae in the Collection of the British Museum 214.

1871. *Blatta fasciceps* Walker, Catalogue of the Specimens of Dermaptera Saltatoria in the Collection of the British Museum. V. *Supplement to the Catalogue of Blattariae.* 25

1902. *Blatta mellea* Krauss. *Anz. Akad. Wiss. Wien, math.-naturw. Kl.* 39 : 54

1915. *Ischnoptera modestiformis* Karny. *Suppl. ent.*, **4** : 62

1924. *Ischnoptera fulvastra* Chopard. *Rec. Ind. Mus.*, **26** : 168.

1935. *Symploce persica* Bei-Bienko. *Konowia*, **14** : 125.

*Not recorded in this study

Material examined : 2exs, Malenallasundara, 10.xii.2005; 7 exs, Kondajji, 17.ix.2006; 8 exs, Uttegaseeguda, 22.ix.2006; 11 exs, Besmapalli, 27.ix.2006; coll. S. Prabakaran.

Diagnosis : Male with subgenital plate strongly asymmetrical; styles relatively short and heavy, symmetrical or not, female with subgenital plate simple, not valvate.

Distribution : India (Tamilnadu, Karnataka), Sri Lanka, Pakistan, Kenya, Israel, Mozambique.

Subfamily PSEUDOPHYLLODROMIINAE

Genus *Supella* Shelford, 1911

Subgenus *Supella* Shelford, 1911

4. *Supella (Supella) longipalpa* (Fabricius, 1798)

1798. *Blatta longipalpa* Fabricius, *Suppl. Ent. Syst. Hafniae.*, 185.
1839. *Blatta (Phyllodromia) supellectilium* Serville, *Hist. Nat. Ins., Orth.*, 114.
1868. *Blatta extenuate* Walker, *Catalogue of the Specimens of Blattariae in the Collection of the British Museum* : 221.
1868. *Blatta incisa* Walker, *Catalogue of the Specimens of Blattariae in the Collection of the British Museum* 109.
1868. *Ischnoptera vacillans* Walker, *Catalogue of the Specimens of Blattariae in the Collection of the British Museum*, 114.
1871. *Blatta subfasciata* Walker, *Catalogue of the Specimens of Dermaptera Saltatoria in the Collection of the British Museum. V. Supplement to the Catalogue of Blattariae* : 26.
1871. *Blatta transversalis* Walker, *Catalogue of the Specimens of Dermaptera Saltatoria in the Collection of the British Museum V. Supplement to the Catalogue of Blattariae* : 25.
1969. *Supella (Supella) longipalpa* (Fabricius) : Princis, In Beier [Ed.]. *Blattariae: Subordo Epilamproidea. Fam.: Blattellidae. Orthopterorum Catalogus* (13) : 920.

Material examined : 3 exs, Pettikere, 23.ix.2005; 1 ex, Karigowdanakoppulu, 27.xii.05; 11 exs, Kuthyeru, 11.ix.2006; 3 exs., Madhavapatna, 14.ix.2006; 11exs., Uttega seegode, 22.ix.2006; 24exs, Kollukondahalli, 26.ix.2006; 18exs, Attibelle, Lot-127.ix.2006; 16exs., Besmapahalli, 27.ix.2006; 5exs., Ranibennur Wildlife Sanctuary, 14.ix.2007; 18exs., Kondajji, 17.ix.2007; 15exs., Chellakere reserve forest, 20.ix.07; 13 exs. Devarayana Durga, 22.ix.2007; 21 exs., Naggerhalli, 25.ix.2007; 18 exs. 28.ix.07, coll : S. Prabakaran.

Diagnosis : Pronotum blackish brown with broad yellowish lateral margin; tegmina yellow with a large reddish brown basal spot and also a small oblique paler band. It is winged of a brown colour with varied dark markings. General colour light brown. Sexes are dissimilar. Near the apex of the anal fields a broad pale coloured band crosses the tegmina. Based on the colour pattern it is commonly called as brown banded cockroaches. Because of its light body it flies rapidly.

Distribution : India (Karnataka, West Bengal, and Tamilnadu).

Remarks : A fairly well distributed species throughout the tropical regions.

Family BLABERIDAE

Subfamily EPILAMPRINAE

Genus *Thorax* Saussure, 1862

5. *Thorax porcellana* Saussure, 1862

1862. *Thorax porcellana* Saussure, *Mag. Zool.* 2(14) : 228.
1865. *Paraphoraspis notata* Brunner von Wattenwyl, 1865. *Nouveau Systeme Blattaires* 163.
1967. *Thorax porcellana* : Princis : Blattariae : Subordo [sic] Epilamproidea. Fam. : Nyctiboridae, Epilampridae. *Orthopterorum Catalogus* (11) : 640.

Material examined : 2 exs, Pettikere, 23.xii.05; 2exs, Sidhapura, 24.xii.05; 2exs, Abayathmangala, 15.ix.06; 4exs, Kollur, 21.ix.06; 7exs, Kollukondahalli, 26.ix.06, 2exs, Besmapahalli, 27.ix.06; 5exs, Kondajji, 17.ix.07; 3exs, Chellakerelake, 20.ix.07; 2exs, Devarayanadurga, 22.ix.07, coll. S. Prabakaran.

Diagnosis : Blackish brown in colour. Supra anal plate is similar to that of the male in having hairs and reddish brown spots on the surface. The ootheca which is smooth and flexible. It has a reduced, poorly sclerotized ovipositor. The veins are atrophied in the wings and the entire wing apparatus is reduced in both sexes; the tegmina of this species are hard and tough in both sexes affording mechanical protection, in the female the tegmina are broad and serve to protect the Ist and IInd nymphal stages.

Distribution : Tamilnadu, Karnataka.

Genus *Stictolampra* Hanitsch, 1930

6. *Stictolampra plicata* (Navas, 1904)*

1904. *Opisthoplatia plicata* Navás. *Bol. Soc. aragon. cienc. nat.*, 3 : 130.
1910. *Rhcnoda plicata* : Shelford. *Gem. Ins.*, 101 : 9.

1967. *Stictolampra plicata* : Princis, In Beier [Ed.]. Blattariae : Suborbo [sic] Epilamproidea. Fam.: Nyctiboridae, Epilampridae. *Orthopterorum Catalogus* (II) : 683.

Diagnosis : Brownish testaceous in colour. Pronotum testaceous with irregular black spots. Head with vertex covered by pronotum. Pronotum broader than long, anterior margin truncated or slightly convex, lateral sides obtusely angular. Tegmina and wings absent. Anteroventral margin of front femur with equal shaped strong spines and distally bristle shaped spines arranged regularly. Supra anal plate with anterior margin convex, posterior margin more or less straight.

Distribution : India, (Tripura, Meghalaya, Orissa, Karnataka and West Bengal), Borneo, Java and Malaysia.

Subfamily PYCNOSCELINAE

Genus *Pycnoscelus* Scudder, 1862

7. *Pycnoscelus surinamensis* (Linnaeus, 1758) (Plate Ib)

1758. *Blatta surinamensis* Linnaeus, *Syst. Naturae*. 10th Ed.) 1 : 424.

1903. *Pycnoscelus surinamensis* : Rehn, *Trans. Am. Ent. Soc.*, 29 : 131-136.

1964. *Pycnoscelus surinamensis* : Princis, *Orthopt. Catalog.*, 6 : 264.

Material examined : 2exs, Attolipura, 20.xii.2005; 2exs. Pettikere, 23.xii.2005; 2exs., Sidhapura, 24.xii.2005; 3exs., Siddlukallu, 27.xii.2005; 8exs, Ummathur, 11.ix.2006; 1ex., Mangalore port trust, 17.ix.2006; 2exs., Sringeri, 23.ix.2006; 3exs., Anekal, 26.ix.2006; 4exs., Besmapahalli, 27.ix.2006; 3 exs., Byadgi, 15.ix.07; 14 exs., Kondajji, 17.ix.07, 6 exs., Davarayandurga, 22.ix.08.; Tanganahalli, 23.ix.07.; 11 exs., Urdigal, 24.ix.07.; 20 exs., Nagerhalli, 25.ix.07, coll. S. Prabakaran.

Diagnosis : Pronotum shiny blackish brown with yellowish margin anteriorly; tegmina dark brwn in colour. Medium size, head with vertex exposed, ocelli large, approximate to the eye. Pronotum laterally rounded, posterior margin convex. Tegmina and wings extending scarcely upto the apex of the abdomen; subgenital plate with unequally rounded at apex; antroventral margin of front femur with row of slender piliform spinules and terminates in one large spines.

Distribution : India (West Bengal, Tamilnadu and Karnataka). A fairly well distributed species throughout Oriental region and also in Surinam (South America).

Subfamily PERISPHAERIINAE

Genus *Pseudoglomeris* Brunner von Wattenwyl, 1893

8. *Pseudoglomeris glomeris* (Saussure)*

1863. *Perisphaeria glomeris* Saussure, *Me'm. Soc. Gene've*, 17 : 135.

1869. *Derocolymma glomeris*: Saussure, *Me'm. Soc. Gene've*, 20 : 277.

1895. *Pseudoglomeris glomeris*: Saussure and Zehntner, *Rev. Suisse Zool.*, 3 : 33-40.

1904. *Pseudoglomeris glomeris* : Kirby, *Syn. Cat. Orth.*, 1 : 190.

Diagnosis : Dark in colour, tip of antennae, tarsi and cerci are golden yellow colour; Pronotum pink in colour. Small in size, Body strongly arched shaped, convex. Head with vertex covered by pronotum, ocelli large. Pronotum elevated on the back side, parabolic, irregularly punctured, front margin wide, posterior margin subspherical, Tegmen extends beyond the last abdominal segment. Front femur with anteroventral margin equal shaped strong spines and bristle shaped spines arranged regularly. Cerci bow shaped and inwardly curved. Supra anal plate with posterior margin triangulate. In female pronotum unequal, strongly arched in shape.

Distribution : India (Meghalaya, Orissa, Tamilnadu, Karnataka and West Bengal), Burma, Ceylon, Java and Malaysia.

Genus *Trichoblatta* Saussure & Zehntner, 1895

9. *Trichoblatta sericea* (Saussure, 1863)*

1863. *Perisphaeria blepharodera sericea* Saussure, *Mem. Soc. Geneve*, 17 : 138.

1895. *Trichoblatta sericea* : Saussure and Zehntner, *Rev. Suisse zool.*, 3 : 45.

1964. *Trichoblatta sericea* Princis *Orthopt. Catalog.*, part 6 : 208.

Diagnosis : Black or reddish black in colour, head black with a yellow spot at base of each antenna; antennae uniformly yellowish brown; palpi yellow; thorax uniformly black; Elytra elongate, basally punctate, apex rounded; Anteroventral margin of front femur with serially arranged small spines. Supra anal plate a little arched posteriorly. Subgenital plate transverse. Abdomen black in colour, eight segmented. This species ovo-viviparous. Body length 15-30 mm.

Distribution : India (Gujarat, Maharashtra, Bihar, West Bengal, Orissa, Meghalaya, Arunachal Pradesh,

Sikkim, Tamilnadu, Karnataka and Kerala). This species so far not recorded other than India.

Family BLATTIDAE

Subfamily BLATTINAE

Genus *Periplaneta* Burmeister, 1838

10. *Periplaneta americana* (Linnaeus, 1758)

(Plate IIb)

1758. *Blatta americana* Linnaeus, *Syst. Naturae*, (10th Ed.), **1** : 424.

1868. *Periplaneta americana* : Walker, *Cat. Blatt. Brit. Mus.*, London : 124.

1924. *Periplaneta americana* : Chopard, *Rec. Indian Mus.*, **26** : 173.

1966. *Periplaneta americana* : Princis, *Orthopt. Catalog.*, **7** : 405.

Material examined : 6 exs., Abyathmangala, 15.ix.2006; 6 exs., Mangalore port trust, 17.ix.2006; 14exs., Ballighatta, 19.ix.2006; 1 ex., Sringeri, 23.ix.2006; 12 exs., Kollukondahalli, 26.ix.2006; 8 exs., Attibelle, 27.ix.2006; 11 exs., Besmapahalli, 27.ix.2006; 9 exs., Chellekere, 20.ix.2007; 5 exs., Ramasagar, 27.ix.2007, coll. S. Prabakaran.

Diagnosis : Reddish brown in colour. Pronotum with a yellow narrow band at lateral margin. Tegmina uniformly reddish brown in colour. Large in size. Head with vertex exposed; interocular distance narrower than the width of antennal socket. Ocelli small. Pronotum flattened, smooth subelliptical, sides deflexed, wider behind the middle and all angles broadly rounded. Femora and tibiae strongly spined, posterior metatarsus longer than the remaining joints. Subgenital plate symmetrical and divided at the posterior margin. In female subgenital plate with mesodistal portion with valves.

Distribution : This is cosmopolitan species and one of the most important domestic cockroach pest and thrives in tropical and subtropical climates all over the world.

11. *Periplaneta australasiae* (Fabricius, 1775)

1775. *Blatta australasiae* Fabricius, *Syst. Ent.*, 271.

1966. *Periplaneta australasiae*: Princis, *Orthopteran Catalogus*, **8** : 447.

Materials examined : 3exs, K.Gudi, 21.xii.2005; 1ex, Siddhikallu, 27.xii.2005; 2exs, Seeguda,

22.ix.2006; 4exs, Thanganahalli, 23.ix.2007; 6exs, Beerahandahalli, 28.ix.2007, coll : S. Prabakaran.

Diagnosis : It is pale reddish brown in colour with a conspicuous humeral stripe at the base of each tegmina and a yellow area around the margin of the pronotum which forms a double dark blotch on the dorsum. In this Australian cockroach is similar to that of American cockroaches, the size is smaller than the American cockroaches. Tegmina and wings are elongated, extend beyond the abdomen. Anterior dorsal surface of the abdomen coloured alternately pale yellow and dark brown in colour. Posterior segments of the abdomen dark brown. In this Australian cockroach is not a native of that continent but is probably indigenous to Malaysia.

Distribution : It is cosmopolitan species.

Remarks : Australian cockroach, so far not recorded from Karnataka state. It is the new record of this state.

12. *Periplaneta ceylonica* Karny, 1908*

1908. *Periplaneta ceylonica*, Karny, *Wiss. Ergebn. Exp. Filchner nach China u. Tibet*, **10**(1) : 18.

1957. *Periplaneta fallax* Bei-Bienko, *Ent. Obozr.*, **36** : 896.

Diagnosis : Both sexes similar. Antennae very long, slender. Pronotum trapezoidal, not covering vertex of head, sides deflexed, its greatest width behind the middle. Posterior angles of meso- and metanotum not produced as slender membranous processes. Tegmina and wings usually extending considerably beyond the apex of the abdomen, the former coriaceous. Cerci and genital styles long.

13. *Periplaneta brunnea* Burmeister, 1838*

1838. *Periplaneta brunnea* Burmeister, *Handb. Ent.*, **2**(2) : 503.

1868. *Periplaneta concolor* Walker, *Catalogue of the Specimens of Blattariae in the Collection of the British Museum* : 135.

1868. *Periplaneta patens* Walker, *Catalogue of the Specimens of Blattariae in the Collection of the British Museum* : 127.

1892. *Periplaneta truncate* Krauss, *Zool. Anz.*, **15** : 165.

Diagnosis : The brown cockroach is often mistaken for an American cockroach. The adult is reddish-brown, but is somewhat darker in color. It is 1¼-1½ inch long; males have cerci and styli while females have cerci. The cercus of the brown cockroach

is stout and triangular in shape; whereas the American cockroach cercus is long and thin. The brown cockroach occurs mainly outdoors, under the bark of trees and in sewers. The life cycle of the brown cockroach requires 339-351 days to complete. The egg capsules are glued onto surfaces, usually hidden with debris, and may be guarded by the female. This species has a pale border around the pronotum as do most *Periplaneta* but it lacks the pale areas on the forewings, characteristic of *P. australasiae*. It reaches 37 mm in length. Both sexes are winged and can fly.

Genus **Blatta** Linnaeus, 1758

14. **Blatta orientalis** Linnaeus, 1758
(Plate IIa)

1758. *Blatta orientalis* Linnaeus, *Systema naturae*, 1 (10th ed.) *Holmiae* : 424.
1851. *Blatta castanea* Blanchard, *In Gay. Hist. fis. polit. de Chile*, Zool. 6, Paris 18.
1863. *Blatta badia* Saussure, *Mem. Soc. Geneve*, **17** : 150
1909. *Stylopyga orientalis spontanea*, Semenov-Tian-Shansky, 205.
1966. *Blatta orientalis*: Princis, *In Beier [Ed.]. Blattariae: Suborbo [sic] Blattoidea. Fam. Blattidae, Nocticolidae. Orthopterorum Catalogus*, **8** : 475-492.

Material examined : 4exs. Madhavapatna, 14.ix.06; 3exs. Ballighatta, 19.ix.06; 18exs, Uttegrdeeguda, 22.ix.06; 7exs., Kollukondahalli, 26.ix.06; 3exs., Ranibennur Wildlife Sanctuary, 14.ix.2007; 14exs., Kondajji, 17.ix.07; 4exs., Chellekere, 20.ix.07, 5exs., Ramasagar, 22.ix.07; 9exs., Thamganahalli, 23.ix.07, coll. S. Prabakaran.

Diagnosis : The oriental cockroach is a large species of cockroach. It is dark brown to black in colour and has a glossy body. Male head with vertex exposed. Tegmina and wings reduced, covering only about two third of abdominal terga. Anteroventral margin of front. Subgenital plate obtusely rounded at apex. In female cockroach anteroventral margin of front femur with strongly spined. Tegmina short. Hind wings absent. Supra anal plate with mediolongitudinal ridge, posterior margin angulate emerginate. Subgenital plate triangular, lateral margin a little concave. It has a wider body than the male.

Distribution : Widely distributed species throughout the World. (Cosmopolitan).

Genus **Neostylopyga** Shelford, 1911

15. **Neostylopyga rhombifolia** (Stoll, 1813)

1813. *Blatta rhombifolia* Stoll, *Repreents. Exact. Coloree d'apres nature d. Specters etc.*, **2** : 5
1822. *Blatta signata* Eschscholtz, *Entomographien. Erst. Lief. Berlin* : Reimer 88.
1864. *Periplaneta hiatrio* Saussure, *Blattarum novarum species aliquot. Rev. Mag. Zool.*, (2)**16** : 318.
1865. *Periplaneta decorate* Brunner Von Wattenwyl, *Nouveau Systeme Blattaires*, 244.
1871. *Polyzosteria heterospila* Walker, *Catalogue of the Specimens of Dermaptera . Saltatoria in the collection of the British Museum. Part V. Supplemnt to the.Catalogue of Blattariae*, 35.
1915. *Stylopyga rhombifolia* : Hanitsch, *J. Straits Br. R. Asiat*, **69** : 105,163.
1966. *Neostylopyga rhombifolia* (Stoll) : Princis, *In Beier [Ed.]. Blattariae : Suborbo [sic]. Blattoidea. Fam. Blattidae, Nocticolidae. Orthopterorum Catalogus*, **8** : 534.

Material examined : 3exs., Kollur, 21.ix.2006; 13exs., Kollukonda halli, 26.ix.2006; 16exs., Bydagi, 15.ix.07; 3exs., Devarayandurga, 22.ix.2007, 8 exs, Thanganahalli, 23.ix.2007; 21exs., Urdigere, 24.ix.2007, 16exs., Attibelle, 27.ix.2007; 11exs., Beerahanda halli, 28.ix.2007, coll. S. Prabakaran.

Diagnosis : Male – Size medim. Vertex little exposed. Pronotum with anterior margin a little convex or entire, posterior margin straight, lateral margin rounded, and maximum width just at the posterior margin. Tegmina reduced. Wings absent. Posterolateral tergite a little indented. Supra anal plate with deeply notched medially. Subgenital plate compressed with obtuse apex. Style thin and slender. In female, anterior margin of pronotum a little concave medially. Posterior margin with maximum width. Tegmina with posterior margin obtusely rounded. Supra anal plate slightly depressed medially.

Distribution : India (Karnataka, Meghalaya, Andaman and Nicobar Islands, Andhra Pradesh, Bihar, Madhya Pradesh, Orissa, Utter Pradesh and West Bengal).

Remarks : This species is easily identified by tegminal rudiments with variegated markings.

16. **Neostylopyga sexpustulata** (Walker, 1871)*

1871. *Polyzosteria sexpustulata* Walker, *Cat. Derm. Salt. Mus., V suppl. Blatt.*, : 36.

1966. *Neostylopyga sexpustulata* : Princis, *Orthopterorum Catalogues*, **8** : 537.

Diagnosis : Colour; Brown or dark brown, six brown spots present on the body. Male head with vertex covered by pronotum; intraocular space narrower than the distance between the antennal sockets; pronotum wider than long, anterior margin truncate, posterior margin a little convex medially; tegmina with small lateral pads; supra anal plate symmetrical; sub genital plate broad, posteriorly conical, anteroventral margin of front femur with 3 distally placed large spines.

Distribution : India (Karnataka, Andhra Pradesh, Utter Pradesh, Bihar and Orissa), Java, Indonesia.

Family POLYPHAGIDAE

Subfamily POLYPHAGINAE

Genus *Polyphaga* Brullé, 1835

17. *Polyphaga indica* Walker, 1868

1868. *Polyphaga indica* Walker, Catalogue of the specimens of Blattariae in the collection of British Museum : 14.

1893. *Pseudoglomeris planiuscula* Brunner von Wattenwyl, *Annali Mus. civ. Stor. nat. Genova*, **33** : 44.

1893. *Heterogamia indica*: Saussure, *Rev. Suisse. Zool.*, **1** : 3

1957. *Polyphaga indica*: Princis, *Opusc. Ent.*, **22** : 89.

Material examined : 3exs, Chamrajnagar, 9.ix.06; 2exs, Abayathmangala, 15.ix.06; 3exs, Ullal, 19.ix.06, 5 exs, Uttega seegode, 22.ix.2006; 5exs, Anekal, 26.ix.06; 3exs., Kondajji, 17.ix.2007; 4exs., Nagerhalli, 25.ix.2007, coll. S. Prabakaran.

Diagnosis : Body deep brown in colour, pronotum with anterior and lateral margin with golden yellow line. Head completely covered by pronotum; intraocular space narrow, ocelli large; tegmina extended beyond the abdomen, supra anal plate symmetrical, posterior margin transeverse; both of the lateral margin with tubercular spines; anteroventral margin of front femur with serially presence of hairs and distally with a large spine. In female, wings and tegmina absent; subgenital plate large, posterior margin rounded.

Distribution : India (Andhra Pradesh, Maharastra, Orissa, Rajasthan and Karnataka), Iran.

Genus *Therea* Billberg, 1820

18. *Therea petiveriana* (Linnaeus, 1758) (Plate Ia)

1758. *Blatta orientalis* Linnaeus, *Systema naturae*, 1(10th ed.) *Holmiae* : 364.

1820. *Cassida petiveriana* Linnaeus, *Syst. Nat.* (ed.10) **1** : 346.

1964. *Theria petiveriana* : Princis, *Orthopteran Catalogus*, **4** : 346.

Material examined : 2exs, Pettikere, 23.xii.2005; 2exs., Siddlukallu, 27.xii.2005; 4exs, Kollukondahalli, 26.ix.2006; 7exs, Attibelle, 27.ix.2006; 3 exs. Devarayan Durga, 22.ix.2007; 5exs. Beerandahalli (K.G.F) 28.ix.2007, coll. S. Prabakaran.

Diagnosis : Head with pronoun black in colour; tegmina black with four pair of large golden yellow spots; legs are black. Body medium size, head with vertex completely covered by pronotum; interocular space less than the distance between antennal sockets; ocelli distinct; pronotum covered with cilia like hairs, anterior and posterior margin rounded, lateral margin convex; tegmina extended upto the end of the abdomen; wings vestigial; supra anal plate hairy, asymmetrical; subgenital plate hairy asymmetrical with a pair of symmetrical styles; hind margin semicircular; anterior margin of front femur without spine.

Distribution : India (Andhra Pradesh, Kerala, Pondicherry, Karnataka and Tamilnadu).

19. *Therea hyperguttata* Grandcolas, 1993*

1993. *Therea hyperguttata* Grandcolas, *Canadian Journal of Zoology* **71**(9) : 1820.

Remarks : Described from Karnataka.

SUMMARY

From the distribution point of view 4% of the globally distributed Cockroaches occur in India. Karnataka having 19 species accounts for 12% of Indian occurrences. Within Karnataka the Southern districts appear to hold more species due to the presence of more forested terrains. In this work, it is reaffirmed that 12 species of the known 19 species do occur in the Southern districts of Karnataka, necessitating further studies.

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* Not recorded in this study

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PLATE I : COCKROACHES OF KARNATAKA



a. *Therea petiveriana* (Linnaeus)



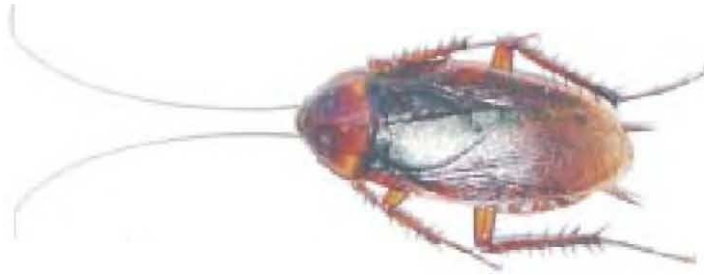
b. *Pycnoscelus surinamensis* (Linnaeus)



c. *Trichoblatta sericea* (Saussure)

PLATE II : COCKROACHES OF KARNATAKA

a. *Blatta orientalis* (Linnaeus)



b. *Periplaneta americana* (Linnaeus)



c. *Blattella germanica* (Linnaeus)

PLATE III : COCKROACHES OF KARNATAKA



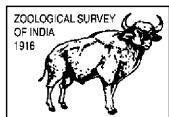
a. *Neostylopyga rhombifolia* (Stål)



b. *Periplaneta australasiae* (Fabricius)



c. *Blattella humbertiana* (Saussure)



Rec. zool. Surv. India : **110**(Part-2) : 121-129, 2010

A REPORT ON THE PIERID BUTTERFLIES (LEPIDOPTERA : INSECTA) FROM INDRA GANDHI NATIONAL PARK AND WILDLIFE SANCTUARY, TAMILNADU

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INTRODUCTION

Indira Gandhi Wildlife Sanctuary and National Park (formerly known as the Anamalai Wildlife Sanctuary) lies in the Coimbatore District of Tamil Nadu from 10°12½' to 11°07'N latitude and 76°00' to 77°56½'E longitude at the southern part of the Nilgiri Biosphere Reserve in the Anamalai Hills. Altitude ranges from 340m to 2,510m and annual rainfall varies between 800 mm to 4500 mm. The climate is moderately warm almost throughout the year and fairly cold during the winter months of November and December (Sekar and Ganesan, 2003).

Indira Gandhi Wildlife Sanctuary and National Park is one of the hot spots of biodiversity in the Western Ghats covering 958 sq. kms. Indira Gandhi Wildlife Sanctuary and National Park is a significant segment of the Western Ghats, which possesses many endemic species and is a unique ecological tract rich in biodiversity. The IGWLS, declared as a Wildlife Sanctuary in 1976, falls within three taluks of the Coimbatore District namely Pollachi, Valparai (Valpaarai) and Udumalpet with six territorial ranges—Pollachi, Valparai, Ulandy (Top Slip), Manamboly, Udumalpet and Amaravathi. The forest tract of the Anamalais exhibits a wide diversity in terrain, elevation and climate thus supporting diverse vegetation with striking differences—from luxuriant tropical evergreen forest to thorn forest and scrub jungles.

Indira Gandhi Wildlife Sanctuary and National Park is an Indomalayan Malabar Rainforest and the Tropical

Humid biome comprises primarily of wet evergreen, sub-tropical evergreen, moist deciduous, dry deciduous, semi-evergreen and montane-shola grasslands. The terrain here is thickly wooded hills, plateaus, deep valleys and rolling grasslands. Both southwest and northeast monsoons occur here. The area is drained by several perennial and semi-perennial river systems like the Kallar and Sholaiar rivers and contains man-made reservoirs such as Aliar and Thirumurthy. The main geological formations in the area are hornblende-biotite and garnetiferous biotite gneiss, charnockites and plagioclase porphyry dykes. Soil on the slopes consists of sandy loam. The unique ecological tract has an undulating topography and climate variations which support a wide variety of flora and fauna. The floral diversity is enormously rich as the terrain offers a wide range of natural parameters like topography, climate, temperature, rainfall etc. The floral wealth is estimated to be over 2000 species of which about 400 and odd species are of prime medicinal value. Top Slip's outstanding rainforest patches hold a number of South Indian endemic butterflies.

Butterflies belong to the order Lepidoptera, from either of the superfamilies Hesperioidea (the skippers) or Papilionoidea (all other butterflies).

India has a rich butterfly fauna comprising 1501 species out of 16, 823 species recorded from all over the world (Gaonkar, 1996). Of the various butterfly habitats found in India, the Western Ghats is one of the most diversified areas containing a wide variety of

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species due to the typical ecoclimatic and geographic features.

The Indira Gandhi Wildlife Sanctuary and National Park is now recognized as a biodiversity hotspot due to the incredible richness of flora and fauna it supports. For example, the Indira Gandhi Wildlife Sanctuary and National Park is home to 315 species (<http://www.discoverwild.in/butterflies.htm>) of butterfly; nearly 95% of Western Ghat's butterflies and one five of Indian's butterflies fauna. Of these 315 species, most of the species are endemic. However, this diversity is extremely threatened and the conservation of the forest is essential if we are to preserve it.

The Pieridae are members of the Superfamily Papilionoidea, the true butterflies. Worldwide in distribution, most species are found in the tropics. Adults have medium to small wings that are white, yellow, or orange, with some black or red, and many have hidden ultraviolet patterns that are used in courtship. Species with more than one generation usually have distinct seasonal variation in appearance. The sexes usually differ, often in the pattern or number of the black markings. Adults of all species visit flowers for nectar, and adults of both sexes have three pairs of walking legs. Males patrol in search of receptive mates, and females lay columnar eggs on leaves, buds, and stems. The larvae (caterpillars) of some of these species feed on brassicas, and are agricultural pests. Males of many species involve in gregarious mud-puddling. Of the 1051 species of pierids occurring in the world, 81 species in 21 genera are found in India.

The family Pieridae has four subfamilies, of which the whites and the yellows are well represented in India.

Kingdom ANIMALIA
Phylum ARTHROPODA
Class INSECTA
Order LEPIDOPTERA
Suborder DITRYZIA
Superfamily PAPILIONOIDEA
Family PIERIDAE
Subfamilies DISMORPHIINAE
PSEUDOPONTIINAE
PIERINAE
COLIADINAE

- Dismorphiinae (6 genera of Neotropical butterflies and one genus Leptidae in the palearctic region but not occurring in India).
- Pseudopontiinae (A single species in tropical West Africa).
- Pierinae or the Whites.
- Coliadinae or the Yellow.

In the present study, 26 species belonging to 14 genera under family Pieridae have been recorded.

Keywords : *Butterflies, Pieridae, Indira Gandhi National Park and Wildlife Sanctuary, Biodiversity hot spot.*

METHODOLOGY

The study was carried out in 2005 to 2006, by sampling butterflies in different sites from Indira Gandhi Wildlife Sanctuary and National Park. Different types of habitats were sampled. Butterflies were monitored in different seasons by hand net. Samplings were carried out every day, by collecting adults on a fixed transect of 200 meters within the investigated sites, following Pollard (1977) and Pollard and Yates (1993) methodology. In the present study, the "catch and release" method was used : the collected adults were identified in field and released at the end of the sampling, with the exception of some uncertain species, which were collected and identified in laboratory. Samplings were carried out in sunny conditions at fixed time, walking on a fixed trajectory and observing both sides of the transect.

Status : Status of these species has been given as per IUCN 2006, CITES 2007 and Indian Wild Life (Protection) Act, 1972. The recorded species in not listed in the above three catogories, then general remarks were put under the status head according to number of sighting during the study.

SYSTEMATIC ACCOUNT

Family PIERIDAE DUPONCHEL, 1844
1844. Pieridae, Duponchel, *Cat. Meth. Lepi. Eur.*, p.23.

Diagnostic characters : Fore wing with veins R_2 and R_1 usually from the cell, rarely is R_2 absent; R_3 usually present; R_5 usually coincident with R_4 and stalked with R_3 , M_1 usually stalked with them; M_2 usually from above middle of cell; 1a not forked at the base. Hind wing with veins 3A and 1A + 2A present,

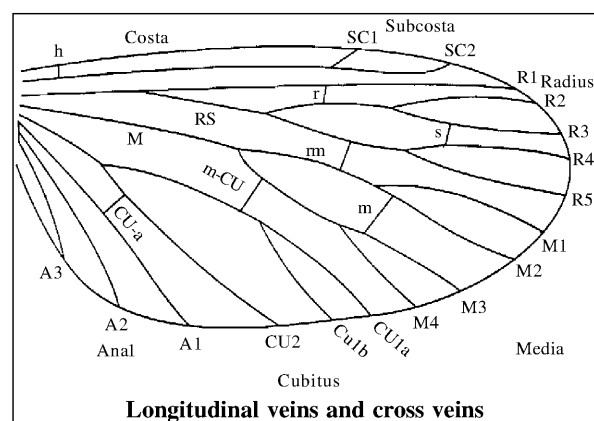
the inner area broad, with the margin channelled to receive the abdomen; precostal absent or reduced in some genera. Both wings with cell closed; discocellular (udc) usually absent on the fore wing.

The venation is more variable in the fore wing, development having proceeded by an upward movement of the veins, resulting in the fusion and apparent loss of some; the more primitive forms have veins R_5 , R_4 , R_3 , R_2 and R_1 all present. In *Baltia* vein M_2 has moved up, leaving only one discocellular (idc) present. The position of veins 7+8 and 9 is variable, these two veins being sometimes very short and forming a minute fork at the apex of the wing in *Leptosia* vein R_3 has disappeared, in *Delias* vein R_2 is missing, whilst in *Colias* vein R_2 is stalked with R_3 . Generally, however, veins R_2 and R_1 are more stable than the three preceding veins.

Antennae of variable length, the club more or less ovate (abrupt), or short and thickened (incrassate) gradually to the apex.

Legs fully developed, claws bifid; paronychium absent in *Colias* and *Baltia*; pulvillus absent in *Gonepteryx*, *Colias*, and *Baltia*.

Scent organs are found in the males of many genera, e.g., brands (*Colias*), plume-scales (*Delias*, *Pieris*), abdominal brushes (*Appias*).



CLASSIFICATION

The pieridae were formerly treated as a subfamily of the papilionidae, but they differ considerably from these. The family is included by some with the Nymphaline forms under the superfamily Nymphaloidae, but they differ in several ways from these, especially in the fully developed fore legs.

The family has been divided into four subfamilies comprising 63 genera. In the Indian area only the subfamilies Pierinae and Coliadinae occur, with 22 genera.

The Pierids are to be found in all parts of the world where butterflies can live, in the far Arctic and high mountain areas, and in desert areas as well as in tropical forests.

Most of the twenty two Indian genera are strictly Indo-Malayan, none being peculiar to the Indian area; six are Palaearctic, and two (*Colotis* and *Anapheis*) are to be regarded as African.

Key to the Subfamilies

1. Hind wing with well developed precostal vein, curved distad, Palpi always hairy Pierinae
2. Hind wing with Precostal vein absent or very short and directed basad, Palpi usually not hairy Coliadinae

Subfamily PIERINAE SWAINS, 1840

1840. Pierinae, Swainson, *Cab. Cycl.*

Diagnostic characters : Hind wing with a well-developed precostal vein which is directed distad. Fore wing with R_2 to Sc veins, Palpi with segments 1 and 2 furnished with hair or bristles below. This subfamily may be divided into two groups : (a) fore wing with vein M_1 given off from R_5 ; (b) fore wing with vein M_1 from the upper angle of the cell or just above it. This latter group was treated by Aurivillius as a distinct subfamily.

Key to the genera of Pierinae

- A. Fore wing with veins R_5 and R_4 coincident
 1. Fore wing with vein R_2 from the cell *Delias* Hubn.
 - Fore wing with vein R_2 absent 2
 2. Fore wing with vein R_3 absent *Leptosia* hub.
 - Fore wing with vein R_3 present, stalked with $R_5 + R_4$ 3
 3. Fore wing with costa serrate *Prioneris* Wall
 - Fore wing with costa not serrate 4
 4. Fore wing with vein R_1 anastomosing with Sc *Belenois* Hubn.
 - Fore wing with vein M_1 given off nearer the cell than to fork of $R_5 + R_4$ and R_3 5

5. Fore wing with vein R_3 emitted from $R_5 + R_4$ very close to the apex, the stalk long *Pieris* Schr.
- Fore wing with vein R_3 emitted from $R_5 + R_4$ further from the apex, the stalk shorter 6
6. ♂ with a tuft of hair arising between the 7th and 8th abdominal segments *Appias* Hubn.
- ♂ without hair-pensils on the abdomen 7
7. Pulpus with 3rd segment slender, as long as the 2nd. Fore wing with vein M_1 from the stem of $R_5 + R_4$ and R_3 , nearly mid-way between fork and end of cell, and not nearer apex of cell than is vein R_2 *Cepora* Billb.
- Pulpus with 3rd segment short and oval. Fore wing with vein M_1 from the stem of $R_5 + R_4$ and R_3 , nearer the cell than to the fork, and nearer apex of cell than is vein R_2 *Ixias* Hubn.
8. Fore wing with vein M_1 from the upper angle of cell *Colotis* Hubn.
- Fore wing with vein M_1 from the junction of *ude* and *mde*, *ude* very short *Hebomoia* Hubn.
- B. Fore wing with veins $R_5 + R_4$ separate
9. Fore wing with vein M_1 from upper angle of cell *Pareronia* Bingham

Subfamily COLIADINAE AURIVILLIUS, 1910

1910. Coliadinæ, Aurivillius, In Seitz, *Macrolep.*, xiii, p.63.

Diagnostic characters : Wing coloration usually yellow or orange. Fore wing with vein M_1 always emitted from R_5 ; $R_5 + R_4$ coincident. Hind wing with the precostal vein greatly reduced or absent. Body robust. Palpus with third segment very short; underside of palpus smoothly scaled or rarely clothed with bristles and hairs; antennal club gradual, a raised line present.

Key to the genera of Coliadinae

1. Hind wing with precostal vein absent or obsolete 2
- Hind wing with precostal vein thick and rather short *Catopsilia* Hubn.
2. Fore wing with vein R_2 from the stem of $R_5 + R_4$ and R_3 *Colias* Fabr.
- Fore wing with vein R_2 and R_1 from the cell, M_1 from the stem of $R_5 + R_4$ and R_3 3
3. Hind wing with Precostal vein absent or very greatly reduced *Eurema* Hubner

1. *Delias eucharis* (Drury, 1773), Common Jezebel

1773. *Papilio eucharis*, Drury, *Illustr. Nat. Hist.*, i.
 1857. *Pieris eucharis*, Horsfield & Moore, *Cat. Lep. Ins. Mus. E.i.C.*, i, p. 80.
 1881. *Delias eucharis*, Moore, *Lep. Ceylon*, i, p. 140.
 1904. *Piccarda eucharis*, Moore, *Lep. Indica*, vi, p.175.
 1907. *Delias eucharis*, Bingham, *Fauna Brit. Ind., Butterflies*, ii, p. 141.

Material examined : Sethumadai, 1 ex. 23.xii. 2005. Top slip, 2 exs. 26.Xii.2005. Aliyar dam, 2 ex., 01.i.2006. Sholaiyar, 2exs. 04.i.2006. Thirumurtinagar, 2 exs. 09.iv.2006. Amaravathi Nagar, 2 exs., 15.iv.2006. Top slip, 1 ex. 28.xi.2006.

Larval Host Plants : The larvae of the *D. eucharis* feed on *Loranthus* sp.

Distribution : It is found in all over India (except the desert tracts), Sri Lanka and North Burma, North Myanmar and Thailand. The butterfly may be found wherever there are trees, even in towns and cities, flying high among the trees and visiting flowers.

Status : Common.

2. *Leptosia nina* (Fabricius, 1793), Psyche

1781. *Papilio xiphia*, Fabricius, *Spec. Ins.*, ii, p. 43.
 1793. *Papilio nina*, Fabricius, *Ent. Syst.*, ii, p. 194.
 1881. *Nychitona xiphia*, Moore, *Lep. Ceylon*, i, p. 118.
 1898. *Leptosia xiphia*, Mackinnon & de Niceville, *J. Bomb. Nat. Hist. Soc.*, xi, p. 585.

Material examined : Sethumadai, 2 exs., 23.xii.2005, Mannam, 1 ex. 24.xii. 2005. Top slip, 1 ex., 27.xii.2005. Iyarpadi, Valparai, 2 exs., 03.i.2006. Upper canal, 2 exs., 05.iv.2006. Thirumurtinagar, 1 ex., 09.iv.2006. Upper Aliyar, 1 ex. 02.xii.2006.

Larval Host Plants : The larval food plant are *Capparis heyneana* and *Crataeva religiosa* and *Cleome visiana*.

Distribution : In India all the part of Southern India, Sri Lanka, Myanmar and Australia.

Status : Common

3. *Prioneris sita* (C. & R. Felder, 1865),

Painted Sawtooth

1865. *Pieris sita*, C. & R. Felder, *Reise Navara, Lep.*, ii, p. 161.
 1881. *Prioneris sita*, Moore, *Lep. Ceylon*, i, p. 141.

Material examined : Top slip, 2 exs., 26.xii.2005. Kozhikamukki, IGNP & WLS, 1 ex. 28.xii.2005. Upper

canal, 2 exs. 05.iv.2006. Upper Aliyar, 1 ex. 07.iv.2006. Kottore, 1 ex. 03.xii.2006.

Larval Host Plants : The larvae feeds capers.

Distribution : In India all the part of Southern India, Mumbai (Western Ghats) and Sri Lanka.

Status : Very common.

4. *Belenois aurota* (Fabricius, 1793), Brown-veined white or Caper White or Pioneer

1793. *Papilio aurota*, Fabricius, *Ent. Sys.*, iii, p. 197.

1932. *Anapheis aurota*, Hemming, *Trans. Ent. Soc. Lond.*, p. 283.

1886. *Belenois auriginea*, Butler, *Proc. Zool. Soc. Lond.*, p. 374.

Material examined : Sethumadai, 2 exs., 23.xii.2005, Top slip, 1 ex., 27.xii.2005. Blandy Valley, Valparai, 3 exs., 06.I.2006. Thirumurtinagar, 1 ex., 09.iv.2006. Amaravathi nagar, 1 ex., 15.iv.2006. Top Slip, 1 ex. 29.xi.2006.

Larval Host Plants : The larval host plants of these butterflies are *Capparis leoides*, *C. herbacea*, *C. spinosa*, *C. sepiaria*, *C. fphylla*, *C. heyneana*, *C. galeata*, *Maerua triphylla*, *M. crassifolia*, *M. arenaria*, *Boscia senegalensis*, *B. albitrunca* and *Cadaba indica*.

Distribution : All the part of India, Sri Lanka, Pakistan, Afghanistan, Baluchistan, Arabia, SAF, Tropical Africa.

Status : Very common.

5. *Pieris canidia* (Sparrman, 1768),
Indian Cabbage White

1768. *Papilio canidia*, Sparrman, *Aman. Acad.*, vii, 504.

Material Observed : Sarkarpathi, 2 exs., 23.xii.2005. Blandy Valley, 1 ex., 06.I.2006. Upper canal, 2 exs., 05.iv.2006. Thirumurtinagar, 2 exs., 09.iv.2006. Attakatti, 2 ex. 23.xi.2006.

Larval Host Plants : The larval host plants of these butterflies are *Cardamine flexuosa*, *C. scutata*, *Lepidium virginicum*, *Raphanus acanthiformis*, *Brassica alboglabra*, *Cleome gynandra*, *C. spinosa*, *Alstonia scholaris*, *Arabis hirsuta*, *A. stelleri* and *Rorippa indica*.

Distribution : In India it is found in Nilgiri hills, Palni hills, Kerala, Himalaya, Assam and Tibet China and Burma.

Status : Common.

6. *Appias indra* (Moore, 1857), Plain Puffin

1857. *Pieris indra*, Moore, *Cat. Lep. Mus. E.I.C.*, i, p.103.

1867. *Tachyris indra*, Wallace, *Trans. Ent. Soc. Lond.*, iv, p. 381.

1887. *Hyposcritia indra*, Wood-Mason & de Niceville, *J. As. Soc. Beng.*, ii, p. 372.

1907. *Applias indra*, Bingham, *Fauna Brit. Ind.*, Butterflies, ii, p. 205.

Material examined : Varakaliyar, 2 exs., 28.xii.2005. Solaiyar, 1 ex. 04.i.2006. Upper canal, 2 exs., 05.iv.2006. Sholaiar Nagar, 1 ex. 08.iv.2006. Top Slip, 1 ex. 28.xi.2006.

Larval Host Plants : The larvae feed on the leaves of *Crataeva religiosa* and *Capparis sepiaria*.

Distribution : It is distributed to South India and Assam, Sri Lanka, Nepal and Myanmar.

Status : Generally common and not threatened.

7. *Appias libythea* (Fabricius, 1775),
Striped Albatross

1775. *Papilio libythea*, Fabricius, *Sys. Ent.*, p. 471.

1881. *Appias libythea*, Moore, *Lep. Ceylon.* i, p. 134.

Material examined : Varakaliyar, 1 ex., 28.xii.2005. Anapady, 2 exs., 29.xii.2005. Thirumurtinagar, 2 exs., 09.iv.2006. Top Slip, 1 ex. 29.xi.2006.

Larval Host Plants : The larvae feed on the leaves of *Crataeva religiosa*, *Capparis sepiaria*, *C. roxburghii*, *C. horrida*.

Distribution : This butterflies commonly available in India including Nicobar Islands, Sri Lanka and Myanmar.

Status : Generally common and not threatened.

8. *Appias albina* (Boisduval, 1836), Common
Albatross or White Albatross

1836. *Pieris albina*, Boisduval, *Spec. Gen.*, p. 480.

Material examined : Mannam, 1 ex. 24.xii.2005. Varakaliyar, 1 exs, 28.xii.2005. Solaiyar, 1 ex. 04.i.2005. Upper canal, 1 exs., 05.iv.2006. Thirumurtinagar, 2 exs., 09.iv.2006. Manampalli, 1 ex. 23.xi.2005.

Larval Host Plants : The larvae feed on the leaves of *Drypetes oblongitalia*, *D. venusta* and *D. rexburghii*.

Distribution : It is distributed to South India and to Sikkim, Sri Lanka, Burma and Australia.

Status : Generally common.

9. *Cepora nerissa* (Fabricius, 1775), Common Gull

1775. *Papilio nerissa*, Fabricius, *Sys. Ent.*, p. 471.

1775. *Papilio coronis*, Cramer, *Pap. Exot.*, p. 69.
 1886. *Huphina nerissa*, Doherty, *J. As. Soc. Beng.*, p. 135.
 1867. *Pieris copia*, Wallace, *Trans. Ent. Soc. Lon.*, p. 340.

Material examined : Upper Aliyar, 1 exs., 31.xii.2005. Korangumudi, 1 exs., 04.i.2005. Sholaiar Nagar, 1ex. 08.iv.2006. Thirumurtinagar, 2 exs., 09.iv.2006. Amaravathi nagar, 1 ex., 15.iv.2006.

Larval Host Plants : The larvae feed on the leaves of *Capparis* spp.

Distribution : It is found in South India, Himalayas, Nepal, Sikkim, Bengal, Bhutan, Sri Lanka and Burma.

Status : Generally common.

10. *Ixias pyrene* (Linnaeus, 1764),

Yellow Orange Tip

1764. *Papilio pyrene*, Linnaeus, *Mus. Lud. Ulr.* p. 241.

Material examined : Sethumadai, Pollachi, 1 ex., 23.xii.2005. Varakaliyar, 1 ex, 28.xii.2005. Upper canal, 1 exs., 05.iv.2006. Sholaiar Nagar, 1ex. 08.iv.2006. Thirumurtinagar, 2 exs., 09.iv.2006. Attakatti, 1 ex. 24.xi.2006.

Larval Host Plants : The larvae feed on the leaves of *Capparis sepiaria* and *C. religiosa*.

Distribution : These butterflies are commonly available in South India, Bengal, Himalayas, Assam, Myanmar and Sri Lanka.

Status : Generally common.

11. *Ixias marianne* (Cramer, 1779),

White Orange Tip

1779. *Papilio marianne*, Cramer, *Pap. Exot.*, p. 41.
 1865. *Thestias Marianne*, Moore, *Proc. Zool. Soc. Lon.*, p. 491.
 1871. *Ixias Marianne*, Butler, *Lep. Exot.*, p. 253.
 1877. *Ixias agnivena*, Moore, *Ann. Mag. Nat. Hist.*, p. 50.
 1883. *Ixias depalpura*, Butler, *Proc. Zool. Soc. Lond.*, p. 153.
 1885. *Ixias meridionalis*, Swinhoe, *Proc. Zool. Soc. Lond.*, p. 140.
 1885. *Ixias cumballa*, Swinhoe, *Proc. Zool. Soc. Lond.*, p. 141.

Material examined : Sarkarpathi, 1 ex. 23.xii.2005. Attakatti, 1 ex. 31.xii.2005. Upper canal, 1 exs., 05.iv.2006. Sholaiar Nagar, 1ex. 08.iv.2006. Amaravathi nagar, 1 ex., 15.iv.2006. Upper Aliyar, 1 ex. 02.xii.2006.

Larval Host Plants : The larvae feed on the leaves of *Capparis sepiaria*, *C. divaricata*, *C. aphylla* and *C. grandis*.

Distribution : It is found in South India, Punjab, Bengal and Sri Lanka.

Status : Generally common.

12. *Colotis amata* (Fabricius, 1775),

Small Salmon Arab

1779. *Papilio amata*, Fabricius, *Syst. Ent.*, p. 476.
 1829. *Pontia dynamene*, Klug, *Symb. Phys.*, p. 6.
 1907. *Colotis amata*, Bingham, *Fauna Brit. Ind.*, Butterflies, p. 261.

Material examined : Mannam, 1 ex. 24.xii.2005. Water Falls, 1 ex. 1.i.2006. Sholaiar Nagar, 1ex. 08.iv.2006. Amaravathi nagar, 1 ex., 15.iv.2006. Vengolimalai, 2 exs. 29.xi.2006.

Larval Host Plants : The larvae feed on the leaves of *Salvadora persica*.

Distribution : It is commonly available in India, AF, Swaziland, Zululand, Transyall, Botswana, South West Africa, Rhodesia and Sri Lanka.

Status : Generally common.

13. *Colotis etrida* (Boisduval, 1836), Small

Orange-Tip or Little Orange-Tip

1836. *Anthocharis setida*, Boisduval, *Spec. Gen. Lep.*, p. 576.
 1857. *Callosune etrida*, Moore, *Cat. Lep. Mus. E.I.C.*, p. 69.
 1870. *Teracolus etrida*, Butler, *Cist. Ent.*, i, p. 726.
 1907. *Colotis etrida*, Bingham, *Fauna Brit. Ind.*, Butterflies, ii, p. 270.

Material examined : Samanampathi, 1 ex. 25.xii.2005. Nadumalai, 3.i.2005. Upper canal, 1 exs., 05.iv.2006. Thirumurtinagar, 2 exs., 09.iv.2006. Top slip, 1 ex. 29.xi.2006.

Larval Host Plants : The larvae feed on the leaves of *Cadaba indica*.

Distribution : It is commonly available in South India to Himalays and Sri Lanka.

Status : Generally common.

14. *Colotis danae* (Fabricius, 1775), Crimson-Tip

1775. *Papilio danae*, Fabricius, *Syst. Ent.*, p. 476.
 1781. *Papilio eborea*, Stoll, *Uitl. Kapellen*, iv, p. 121.
 1857. *Callosune danae*, Moore, *Cat. Lep. Mus. E.I.C.*, p. 69.
 1876. *Teracolus danaa*, Butler, *Proc. Zool. Soc. Lond.*, p. 157.
 1907. *Colotis danae*, Bingham, *Fauna Brit. Ind.*, Butterflies, ii, p. 271.

Material examined : Varakaliyar, 1 exs, 28.xii.2005. Thirumorthymalai, 1 ex. 2.i.2005. Upper canal, 1 exs.,

05.iv.2006. Sholaiar Nagar, 1 ex. 08.iv.2006. Thirumurtinagar, 2 exs., 09.iv.2006. Amaravathi nagar, 1 ex., 15.iv.2006.

Larval Host Plants : The larvae feed on the leaves of *Cadaba indica*, *Capparis sepiaria*, *C. divaricata* and *Maerua arenaria*.

Distribution : It is commonly available in South India to Madhya Pradesh, and Sri Lanka, Ethiopia and AF

Status : Generally common.

15. *Colotis fausta* (Olivier, 1804),
Large Salmon Arab

1804. *Papilio fausta*, Olivier, *Voi. L'Emp. Othoman. Atl.*, p. 4.

1857. *Idmais fausta*, Moore, *Cat. Lep. Mus. E.I.C.*, p. 68.

1876. *Teracolus fausta*, Butler, *Proc. Zool. Soc. Lond.*, p. 409.

1907. *Colotis fausta*, Bingham, *Fauna Brit. Ind.*, Butterflies, ii, p. 266.

Material examined : Kozhikamukki, 1 ex. 28.xii.2005. Varakaliyar, 1 exs, 28.xii.2005. Vellimalai, 1 ex. 5.i.2006. Upper canal, 1 exs., 05.iv.2006. Sholaiar Nagar, 1 ex. 08.iv.2006. Thirumurtinagar, 2 exs., 09.iv.2006.

Larval Host Plants : The larvae feed on the leaves of *Capparis herbacea*.

Distribution : It is distributed to South India, West India, and Sri Lanka, Lebanon, Baluchistan and Syria.

Status : Generally common.

16. *Hebomoia glaucippe* (Linnaeus, 1758),
Great Orange Tip

1758. *Papilio glaucippe*, Linnaeus, *Syst. Nat.* p. 469.

1865. *Hebomoia glaucippe*, Moore, *Proc. Zool. Soc. Lond.*, p. 759.

Material examined : Vasudevar shoal, 1 ex. 27.xii.2005. Thirumorthymalai, 1 ex. 2.i.2005. Upper canal, 1 exs., 05.iv.2006. Sholaiar Nagar, 1 ex. 08.iv.2006. Amaravathi nagar, 1 ex., 15.iv.2006.

Larval Host Plants : The larvae feed on the leaves of *Capparis moonii* and *Crateva religiosa*.

Distribution : It is commonly available in South India, Assam, Sri Lanka, Nepal to Myanmar, Japan and Australia.

Status : Generally common.

17. *Pareronia ceylonica* (C. & R. Felder, 1865),
Dark Wanderer

1865. *Eronia ceylonica*, C. & R. Felder, *Reise Fregatte Novara, Lep. Rhop.* P. 191.

1881. *Nepheronia ceylonica*, Moore, *Lep. Ceylon*, i, p. 138.

1907. *Pareronia pingasa*, Bingham, *Fauna Brit. Ind.*, Butterflies, ii, p. 280.

Material examined : Annapari river, 1 ex. 23.xii.2005. Peruvuripallam, 1 ex. 26.xii.2005. Upper canal, 1 exs., 05.iv.2006. Sholaiar Nagar, 1 ex. 08.iv.2006. Thirumurtinagar, 2 exs., 09.iv.2006.

Larval Host Plants : The larvae feed on the leaves of *Capparis heyneana*.

Distribution : It is distributed to Southern Western Ghats, and Sri Lanka.

Status : Rare.

18. *Pareronia valeria* (Cramer, 1776),
Common Wanderer

1776. *Papilio valeria*, Cramer, *Uitl. Kapellen*, p. 133.

Material examined : Sethumadai, 1 ex. 23.xii.2005. Varakaliyar, 1 exs, 28.xii.2005. Upper canal, 1 exs., 05.iv.2006. Sholaiar Nagar, 1 ex. 08.iv.2006. Amaravathi nagar, 1 ex., 15.iv.2006. Attakatti, 1 ex. 24.xi.2005.

Larval Host Plants : The larvae feed on the leaves of *Capparis heyneana*, *C. rheedii* and *C. zeylanica*.

Distribution : It is distributed over India to Myanmar and other parts of the Orinental region.

Status : Generally common.

19. *Catopsilia pomona* (Fabricius, 1775), Common
Emigrant or Lemon Emigrant or Lemon Emigrant

1776. *Papilio pomona*, Fabricius, *Syst. Ent.*, p. 479.

1907. *Catopsilia Pomona*, Rober, *Fauna Palaearctica*, I, p. 60.

1775. *Papilio crocale*, Cramer, *Uitl. Kapellen*, p. 87.

1777. *Papilio jugurtha*, Cramer, *Uitl. Kapellen* 2 : 138.

1779. *Papilio nigropunctatus* Goeze, *Ent. Beytrage* 3(1) : 185.

1779. *Papilio catilla*, Cramer, *Uitl. Kapellen* 3 : 63.

1781. *Papilio hilaria*, Stoll, *Uitl. Kapellen* 4 : 95.

1792. *Papilio lalage*, Herbst, *Natursyst. Ins.*, *Schmett.* 5 : 163.

1793. *Papilio alcmeone*, Fabricius, *Ent. Syst.* 3 (1) : 193.

1798. *Papilio titania*, Fabricius, *Ent. Syst. (Suppl.)* : 428.

1819. *Colias jugurthina*, Godart, *Ency. meth.* (2) : 96.

1832. *Callidryas endeer*, Boisduval, *Voyage de Découvertes de l'Astrolabe*, p. 63.

1867. *Callidryas phlegus*, Wallace, *Trans. ent. Soc. Lond.* P. 401.

1885. *Catopsilia heera*, Swinhoe, *Proc. zool. Soc. Lond.* (1) : 140.

Material examined : Sarkarpathi, 1 ex. 23.xii.2005. Kozhikamukki, 1 exs, 26.xii.2005. Sholaiar Nagar, 1ex. 08.iv.2006. Thirumurtinagar, 2 exs., 09.iv.2006. Amaravathi nagar, 1 ex., 15.iv.2006.

Larval Host Plants : The larvae feed on the leaves of *Butea monosperma*, *Cassia fistula*, *Bauhinia racemosa*, *Pterocarpus indicus*, *Senna alata* and *Sesbania* sps.

Distribution : It is distributed to India, Myanmar, Sri Lanka, Malaya, New Guinea and Australia.

Status : Generally common.

20. *Catopsilia pyranthe* (Linnaeus, 1758),

Common Mottled Emigrant

1758. *Papilio pyranthe*, Linnaeus, *Syst. Nat.*, p. 469.

1857. *Catopsilia pyranthe*, Moore, *Cat. Lep. Mus.*, E.I.C., p. 56.

1881. *Catopsilia pyranthe*, Moore, *Lep. Ceylon*, p. 124.

Material examined : Ambulivasudevar, 1 ex. 29.xii.205. Varakaliyar, 1 exs, 28.xii.2005. Upper canal, 1 exs., 05.iv.2006. Thirumurtinagar, 2 exs., 09.iv.2006. Amaravathi nagar, 1 ex., 15.iv.2006. Upper Aliyar, 1 ex. 03.xii.2006.

Larval Host Plants : The larvae feed on the leaves of *Cassia fistula*, *C. alata*, *C. brewsteri*, *C. javanica*, *C. auriculata*, *Senna alata*, *Crotalaria* spp. *Ormocarpum cochinchinense*, *Sesbania* spp and *Colocasia* sps.

Distribution : It is distributed in India, Myanmar, Sri Lanka and Australia.

Status : Generally common.

21. *Colias nilgiriensis* C. & R. Felder, 1859,

Common Nilgiri Clouded Yellow

1859. *Colias nilgiriensis*, C. & R. Felder, *Wien. Ent. Mon.*, p. 395.

Material examined : Navamalai, 1 ex. 30.xii.2005. Blandy Valley, 1 ex. 6.i.2006. Upper canal, 1 exs., 05.iv.2006. Sholaiar Nagar, 1 ex. 08.iv.2006. Amaravathi nagar, 1 ex., 15.iv.2006.

Larval Host Plants : The larvae feed on the leaves of *Parochetus communis*.

Distribution : It is endemic to the higher reaches of the Southern Western Ghats.

Status : Rare.

22. *Eurema brigitta* (Stoll, 1780),

Common Small Grass Yellow

1780. *Papilio brigitta*, Stoll, *Uitl. Kapellen*, p. 82.

1893. *Maiva sulphurea*, Gross-Smith & Kirby, *Rhop. Exot.*, p. 21.

Material examined : Mamman, 1 ex. 24.xii.2005. Varakaliyar, 1 exs, 28.xii.2005. Upper canal, 1 exs., 05.iv.2006. Amaravathi nagar, 1 ex., 15.iv.2006.

Larval Host Plants : The larvae feed on the leaves of *Hypericum aethiopicum* and *Cassia mimosoides*.

Distribution : It is distributed to India, Australia, Tropical Africa and South Africa.

Status : Generally common.

23. *Eurema laeta* (Boisduval, 1836),

Spotless Grass Yellow

1836. *Terias laeta*, Boisduval, *Hist. Nat. Ins., Spec. gen. lipid.*, p. 674.

1857. *Terias venata*, Moore, *Cat. Lep. Ins. Mus. East India Coy.* P. 65.

Material examined : Thambampathi, 1 ex. 25.xii.2005. Karian shoal, 2 exs. 27.xii.2005. Varakaliyar, 1 exs, 28.xii.2005. Upper canal, 1 exs., 05.iv.2006. Sholaiar Nagar, 1ex. 08.iv.2006. Thirumurtinagar, 2 exs., 09.iv.2006.

Larval Host Plants : The larvae feed on the leaves of *Cassia mimosoides*.

Distribution : It is distributed to India, Australia, Sri Lanka, Myanmar, Japan and China.

Status : Generally very common.

24. *Eurema andersoni* (Moore, 1886),

One-Spot Grass Yellow

1886. *Terias andersoni*, Moore, *J. Linn. Soc. Lond., Zool.*, p. 47.

Material examined : Sarkarpathi, 1 ex. 23.xii.2005. Upper Aliyar, 1 ex. 31.xii.2005. Upper canal, 1 exs., 05.iv.2006. Thirumurtinagar, 2 exs., 09.iv.2006. Amaravathi nagar, 1 ex., 15.iv.2006.

Larval Host Plants : The larvae feed on the leaves of *Cassia mimosoides*.

Distribution : It is distributed to South India, Sikkim-Assam, Sri Lanka, Myanmar.

Status : Rare.

25. *Eurema hecabe* (Linnaeus, 1758),

Common Grass Yellow

1758. *Papilio hecabe*, Linnaeus, *Syst. Nat.*, p. 470.

1764. *Papilio hecabe*, Linnaeus, *Mus. Lud. Ulr.*, p. 249.

1764. *Papilio luzoniensis*, Linnaeus, *Mus. Lud. Ulr.*, p. 249.

1790. *Papilio chrysopterus*, Gmelin, *Syst. Nat.*, p. 2261.

Material examined : Sethumadai, 1 ex. 23.xii.2005. Sholaiyar Nagar, 1 ex. 4.i.2006. Upper canal, 1 exs., 05.iv.2006. Sholaiar Nagar, 1 ex. 08.iv.2006. Thirumurtinagar, 2 exs., 09.iv.2006. Top Slip, 2 exs. 29.xi.2006.

Larval Host Plants : The larvae feed on the leaves of Cassia, Wagatea, Acacia, Serbania, Caesalpinia and Albizzia, etc.

Distribution : It is distributed to India, South Africa and Australia.

Status : Generally common.

26. ***Eurema blanda*** (Boisduval, 1836),

Three-spot Grass Yellow

1836. *Terias blanda*, Boisduval, *Hist. nt. Ins., Spec. Gen. Lepid.*, p. 672.

Material examined : Varakaliyar, 1 exs, 28.xii.2005. Korangumudi, 1 ex. 04.i.2005. Upper canal, 1 exs., 05.iv.2006. Thirumurtinagar, 2 exs., 09.iv.2006. Amaravathi nagar, 1 ex., 15.iv.2006. Attakatti, 1 ex. 23.xi.2006.

Larval Host Plants : The larvae feed on the leaves of *Wagatea spicata* and *Delonix regia*.

Distribution :

It is distributed to Southern India to Sikkim, Assam, Myanmar, Japan and Sri Lanka.

Status : Generally common.

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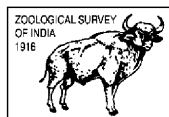
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Short Communication

PRELIMINARY OBSERVATIONS ON THE BUTTERFLY FAUNA OF KALESAR WILDLIFE SANCTUARY, HARYANA, INDIA

INTRODUCTION

Kalesar Wildlife Sanctuary (133 Km²) lies in the northern Shivalic tract to the west of Yamuna river in Haryana. The whole gamut of natural habitat and rich phytodiversity of the sanctuary provides excellent habitat for the whole variety of fauna, more so for butterflies like Common Mormon, Common Emigrant, Evening Brown, Common Grass Yellow, Yellow Orange Tip, Plain Tiger, Common Indian Crows and Blues. No systematic study on butterfly fauna was undertaken in this sanctuary. During the amphibian faunal survey conducted recently in the protected area, 35 species of butterflies under 24 genera and 5 families were observed, which are documented in this paper.

STUDY AREA

Kalesar Wildlife Sanctuary [30°24' N 77°32' E; (Fig. 1)] is situated 5500 feet above sea level having an area of 133 Km² and the terrain varies from plains to hills rising up to 700 m. There are narrow valleys locally called 'Khol's' present between the hills. The sanctuary has a number of water bodies, both natural and man made which provide the wetland habitats in the reserve.

MATERIAL AND METHODS

The vast stretch of the protected area was surveyed randomly. Field observations on butterflies were made by randomly laying transects in the reserve in different habitats. The sites chosen represented the varied habitat types in the study area. Each transect (100-200 m.) laid was covered for observations, between 8 am. and 12 noon and the distribution of butterflies studied on an abundance/frequency scale (Taylor, Green & Stout, 2002). A long handle, simple butterfly net (30 cm. diameter) was used for netting butterflies. The

taxonomic identification was done based on the works of Evans, 1932; Wynter-Blyth, 1957; Kunte, 2000 and Gupta and Shukla, 1987&1988. The scheme of systematic classification followed is after Ackery, 1984.

RESULTS AND DISCUSSION

The butterflies recorded, represents all the major families like Nymphalidae, Papilionidae, Pieridae, Lycaenidae and Hesperidae. The study records distribution of 35 species of butterflies under 24 genera and 5 families (Table 1). The family Nymphalidae (14 species) was well represented throughout, occurring commonly, followed by Pieridae (10 species), Papilionidae (8 species), Lycaenidae (2 species) and Hesperidae (1 species). The genera *Papilio* & *Catopsilia* exhibit high species diversity with 3 species each. Only 2 species of pansy have been observed in this reserve out of 6 found in peninsular India. The family Lycaenidae was represented by only 2 species in the sanctuary. Hesperidae, being the third largest family represented only one species at the time of observation. Some rare species protected under Schedule such as *Hypolimnas misippus* (Schedule-I & II), *Pachliopta hector* (Schedule-I), *Cepora nerissa* (Schedule-II) and *Euploea core* (Schedule -IV) (Anon, 1990) were observed in the sanctuary.

The habitat association of butterflies discussed here is based on the observed distribution in various habitats. Significant variation was observed in habitat preferences between the butterflies in the forest under storey and forest canopy. This Sanctuary having various host plants like *Lantana camara*, *Agerotun conyzoides* & *Carissa spinaru. etc.* are ideal habitats for butterflies in some region (Figs. 2 & 3). Invariably, the butterflies (Common Mormon, Common Jezebel, Common



Fig 1.

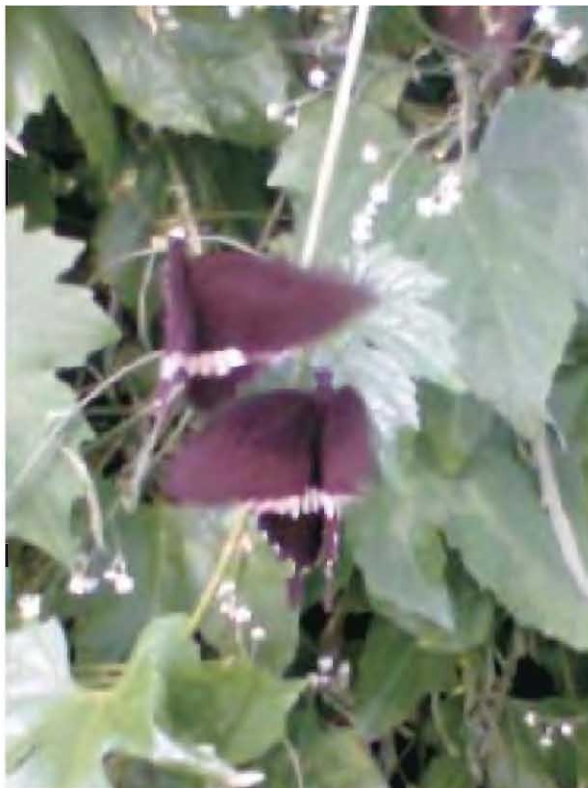


Fig 2.

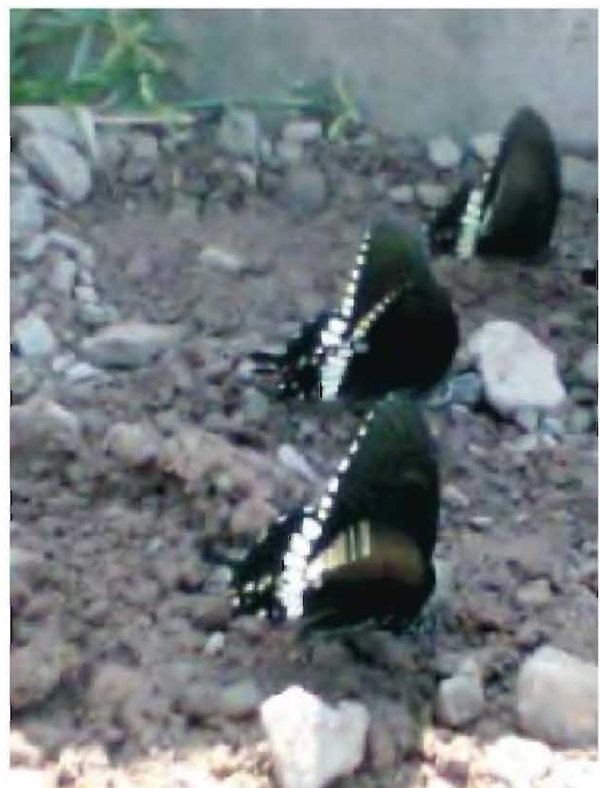


Fig 3.

Emigrant) were observed to congregate in the cool and shady places around streams and rivers. The riverine habitat (Yamuna river bank) was found to be most rich in species, probably due to availability of water, mineral and salts. Most of the butterflies were also observed in human settlements (around the sanctuary), probably due to availability of various plant resources. The family Nymphalidae exhibited for greater diversity in species content (richness). Common Mormon, Common Leopard, Small Grass Yellow, Common Grass yellow, Mottled Emigrant & Yellow Orange Tip were found abundant (> 50 %). Common Gull, Common Emigrant

& Lemon Emigrant were common (10-50%), while Common Sailor, Plain Tiger, Lemon Pansy, Chocolate Pansy, Lime Butterfly, Dinead Eggfly, Great Egg fly Common Rose, Common Indian Crow, Common Pierrot were frequent (1-10%) in the sanctuary.

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AND

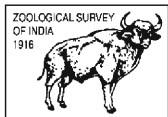
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Table-1 : List of butterflies in Kalesar Wildlife Sanctuary, Haryana

Sl. No.	Family & Species	Wing Span (mm)	Relative abundance
	Papilionidae (Swallow tails)		
1.	<i>Graphium doson eleius</i> (Frushstorfer, 1939)	76-78	Frequent
2.	<i>Princeps nephelus nephelus</i> (Boisduval, 1836)	70-100	Frequent
3.	<i>Papilio polytes</i> Linnaeus, 1758 Common Mormon	90-100	Common
4.	<i>Papilio demoleus</i> (Linnaeus, 1758), Lime Butterfly	80-100	Frequent
5.	<i>Papilio agestor</i> (Gray, 1832), Tawny mime	65-90	Frequent
6.	<i>Pachliopata aristolochiae</i> Fabricius, Common Rose	80-110	Frequent
7.	<i>Pachliopata hector</i> (Linnaeus), Crimson rose	65-100	Frequent
8.	<i>Leptosia nina</i> (Fabricius) The Psyche	25-53	Common
	Pieridae (White & Yellows)		
9.	<i>Delias eucharis</i> Drury, Common Jezebel	66-83	Common
10.	<i>Cepora nerissa</i> (Common gull)	40-65	Common
11.	<i>Terias hecabe</i> (Linnaeus, 1881) Common Grass yellow	40- 50	Frequent
12.	<i>Terias brigitta</i> (Stoll) Small Grass yellow	30-40	Frequent
13.	<i>Catopsilia pomona</i> Fabricius, Common Emigrant.	50-70	Common
14.	<i>Catopsilia pyranthe</i> (Linnaeus, 1758) Mottled Emigrant	50-70	Abundant
15.	<i>Catopsilia crocale</i> (Linnaeus, 1758) Lemon Emigrant	50-70	Common
16.	<i>Ixias pyrene</i> (Yellow orange tip)	50-70	Abundant
17.	<i>Ixas marianne</i> (Cramer) White Orange Tip	50-55	Common
18.	<i>Hebomia glaucippe</i> Butler (Great orange tip)	65-100	Abundant
	Nymphalidae (Brush footed butterflies)		
19.	<i>Phalanta Phalanta</i> (Drury, 1770), Common Leopard	58- 64	Abundant
20.	<i>Junonia lemonias</i> Linnaeus, 1758, Lemon Pansy	45-60	Frequent
21.	<i>Junonia iphita</i> , Cramer, 1782, Chocolate Pansy	60-70	Frequent
22.	<i>Neptis hylas</i> , Linnaeus, 1758, Common Sailor	50-60	Frequent
23.	<i>Danaus chrysippus</i> (Linnaeus, 1758), Plain Tiger	70-80	Frequent
24.	<i>Danaus genutia</i> (Cramer, 1779), Striped Tiger	72-100	Frequent
25.	<i>Parantica aglea</i> (Stoll, 1984), Glassy Tiger	60-85	Frequent
26.	<i>Euploea core</i> (Cramer, 1780), Common Indian crow	85-95	Frequent
27.	<i>Hypolimnas misippus</i> Linnaeus, 1764 Danaid Eggfly	72	Frequent
28.	<i>Hypolimnas bolina</i> (Linnaeus, 1758), Great Eggfly	70-110	Frequent
29.	<i>Mycalesis tubitha</i> (Fabricius, 1763) Common Bush brown	45-50	Common
30.	<i>Mycalesis mineus</i> (Linnaeus) Dark brand bush brown	48-80	Frequent
31.	<i>Melanitis leda</i> Linnaeus, Common Evening brown	56-80	Common
32.	<i>Euthalia nais</i> Forster, 1771, Baronet	58-70	Frequent
	Lycaenidae (Blues)		
33.	<i>Catalius rosimon</i> , Common Pierrot	45-50	Frequent
34.	<i>Catochrysops strabo</i> (Forget me not)	23-32	Frequent
	Hesperiidae (Skippers)		
35.	<i>Zizula hylax</i> (Fabricius, 1775) Tiny grass blue	15-20	Frequent

*Abundant: >50%, Common: 10-50% & Frequent: 1-10%.



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Short Communication

ON THE OCCURRENCE OF A FLYING FISH, *PAREXOCOETUS MENTO* (VALENCIENNES) FROM ORISSA COAST

INTRODUCTION

The marine and estuarine fish fauna of Orissa was recently studied and updated by Barman *et al.* (2007) which included only two flying fishes (Beloniformes: Exocoetidae), viz., *Cypselurus poecilopterus* (Valenciennes) and *Exocoetus volitans* Linnaeus, from the coastal waters of Orissa. The authors came across another species of flying fish while examining the fishes from the Bahuda estuary collected during December 2006 which was turned out to be *Parexocoetus mento* (Valenciennes), a species hitherto not reported from Orissa coast. Bahuda estuary is located between the inter-state border of Orissa and Andhra Pradesh, draining into the Bay of Bengal at 18° 04' N latitude and 84° 24' E longitude. The specimens were collected by shore seine dragged onto the shore close to the mouth of the estuary.

Parexocoetus mento (Valenciennes)

1846. *Exocoetus mento* Valenciennes, in Cuvier and Valenciennes, *Hist. nat. poiss.*, **19** : 124 (Pondicherry).

2006. *Parexocoetus mento*: Barman and Mishra, *Rec. zool. Surv. India, Occ. Paper*, No. **256** : 24.

Material examined : 2 ex., 90-96 mm SL, Reg. No. ZSI/EBS F-5728, Bahuda estuary, Orissa, S. Rath and party, 19.xii.2006, deposited with Estuarine Biological Regional Centre, Z.S.I., Gopalpur-on-Sea.

Diagnosis : D 10-11; A 10-11; P i, 12; predorsal scales 19-20; LL 38-39. Depth 4.5-4.6 and head 3.9-4.0 times in standard length. Depressed dorsal fin not or just reaching origin of upper caudal fin lobe. Pectoral fin long, 52-53% of standard length. Pelvic fin not reaching to level of anus. Lateral line with a branch rising to pectoral fin base. Dark iridescent greenish-blue dorsally, pale silvery-white ventrally. Dorsal fin black; pectoral and caudal fin grayish; anal and ventral fin transparent.

Distribution : Indo-Pacific.

Remarks : Although, Parin (1984, 1996) consider the presence of *Parexocoetus mento* (Valenciennes) in Indian Ocean, no reliable record of this species was available from northern Bay of Bengal, particularly



Parexocoetus mento (Valenciennes) (ZSI/EBS F-5728)

from Orissa coast. No flying fish has been recorded from West Bengal coast (Talwar *et al.*, 1992). Barman *et al.* (2004) included this species in the list of marine and estuarine fish fauna of Andhra Pradesh, but its northern distributional limit is not clear. Till date, only two species of flying fish were reported from Orissa coast (Barman *et al.*, 2007), viz., *Cypselurus poecilopterus* (Valenciennes) and *Exocoetus volitans* Linnaeus, the former basically on a collection present in the National Zoological Collections, Kolkata and the other based on the report of Mishra *et al.* (1999). This forms the third species of this family from this region of Indian coast, indicating its northern distributional limit being the Ganjam coast along the east coast of India. Further, as observed by Krishnan and Mishra (1993), the northward extension of this species possibly deterred by Gangetic Fan Effect. The

northern Bay of Bengal is mostly covered by the Gangetic fan. The enormous amount of water drained by the Ganges and the Brahmaputra River brings down the salinity gradient of the northern Bay of Bengal as low as an estuarine condition. This is also supplemented by the Brahmani-Baitarani and the Mahanadi drainage at mid-Orissa coast. Such a low salinity gradient of the Gangetic fan could have been a possible deterrent to the northward extension of several species like *Parexocoetus mento* (Valenciennes).

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