

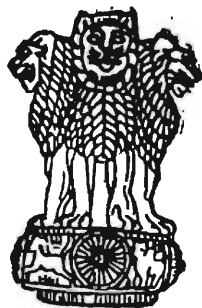
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ON SOME HOLOTHURIANS FROM THE GULF OF
MANNAR, INDIA

By

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Zoological Survey of India, Calcutta

INTRODUCTION

The gulf of Mannar is a part of the Indian ocean on the south point of India and west of Ceylon. It embraces several islands like Pamban, Krusadai and Rameswaram etc. Our knowledge of holothurians of this area is based on the works of Bell (1888 & 1889), Thurston (1894), Pearson (1903), Koehler & Veney (1908), Gravely (1927), Nair (1946), Nair & Mahadevan (1965) and James (1969). The total number of species until now recorded from this area is 39.

The present paper is based on sporadic collections made from the gulf by the various survey parties of the Zoological Survey of India. The material contains ten species, none of which is, however, new to science but three of them show new locality records. (Marked with astericks).

As the work was carried out on sufficiently old and preserved material, the unvarying skletal characters were considered for their identification. Synonyms were reduced to avoid repetition. The paper also furnishes a list of species hitherto known from the gulf water together with their distribution in the Indian region.

Key to species

- | | |
|---|---|
| 1. Tube feet present ; spicules include tables, rods,
and plates. ... | Aspidochirotida & Dendro-
chirotida 2 |
| 1'. Tube feet absent ; worm like bodies, spicules
are wheels, anchors and anchor plates. ... | Apodida, <i>Synapta maculata</i> . |
| 2. Body curved, (U-shaped) ; tentacles richly
branched. ... | Dendrochirotidae & <i>Actinocucumis</i>
<i>typicus</i> . |
| 2.' Body never curved ; tentacles leaf shaped. ... | Aspidochirotida 3 |

3. Double gonadial tufts ; spicules include 'O' shaped and branched rods and tables but no button. ...	Stichopodidae & <i>Stichopus chloronotus</i> .
3'. Single gonadial tuft ; spicules with tables and buttons but never 'O' shaped rod. ...	Holothuriidae 4
4. Spicules consisting of tables in combination with rosettes and rods but never button. ...	... 5
4'. Spicules with tables in combination with buttons always. ...	... 7
5. Spicules consisting of curved and spiny rods, spines are of various grades, tables with small and reduced discs. ...	<i>Holothuria (Semperothuria) cinerascens</i> .
5'. Rods never present, tables with reduced disc and rosettes are of various sizes. ...	<i>Holothuria (Helodeima) spp.</i> 6
6. Rosettes abundant, tables with long spire but reduced disc. ; colour uniformly black. ...	<i>Holothuria (Helodeima) atra</i> .
6'. Tables with disc wanting ; colour greyish dorsally, lighter ventrally. ...	<i>Holothuria (Helodeima) edulis</i> .
7. Table disc smooth, buttons simple or knobbed. ...	... 8
7'. Table disc spiny, button smooth or transformed into pseudobuttons. ...	... 9
8. Buttons smooth and thin, table disc with more than eight peripheral holes. ...	<i>Holothuria (Thymiosycia) hilla</i> .
8'. Buttons knobbed, arranged irregularly, table disc with numerous holes. ...	<i>Holothuria (Metriatyla) ocellata</i> .
9. Stout tables with knobs, sometimes developing into fenestrated spheres, buttons knobbed with three pairs of holes which may be obscured by the emensity of the knobs. ...	<i>Holothuria (Cystipus) rigida</i> .
9'. Tables variously developed with short spire, rim of disc upturned like a saucer, pseudobuttons abundant and are various configurations. ...	<i>Holothuria (Lessonothuria) pardalis</i> .

GLOSSARY

Spicules : skeletal elements of the body wall.

- a. Anchors : spicules looking like anchors with two arms and a pillar or stalk.
- b. Anchor plates : large, quadrangular, perforated plates having a arched and cross bar or bridge across the narrower posterior end with which the stalk of anchor remains attached.

- c. Buttons : elongated or oval plates perforated by paired holes with smooth or knobbed surface.
- d. Pseudobuttons : usual type of button, twisted or reduced to a simple row of holes.
- e. Tables : Three dimensional bodies having a base made up of perforated disc and 2-4 vertical pillars joined by transverse bars to make a spire.
- f. Fenestrated spheres : modified tables forming hollow perforated bodies.
- g. Rods : elongated, bar like, branched or unbranched, spinous or lobed or smooth structures.
- h. Rosettes : button like two dimensional perforated bodies derived from branched rods with irregular holes.

Tentacles : perioral circle of modified tube feet.

Tube-feet : soft, cylindrical tube like prjection from the body wall, their lumen being continuous with the water vascular system. Those on the dorsal side are nonlocomotory and called papillae while those of the ventral side are locomotary and called pedicels. These may be restricted in rows or scattered over the whole body.

SYSTEMATIC ACCOUNT

Order : ASPIDOCHIROTIDA

Family : HOLOTHURIIDAE

Holothuria (Lessonothuria) pardalis Selenka

(Fig. 1)

Holothuria pardalis Selenka, 1867. *Z. wiss. Zool.*, **17** : 336, pl. 19, fig. 85.

Holothuria (Lessonothuria) pardalis : Rowe 1969. *Bull. Br. Mus. nat. Hist. (Zool.)*, **18** (4) : 149, fig. 15.

Material : exs., Z.S.I. Reg. No. E810/1, from dead coral reef, Krusadai Is., 30.iv.1955, *H. C. Roy* coll ; 3 exs., Z.S.I. Reg. No. E856/1, Galaxea reef, Krusadai Is., 4.v.1955, *H. C. Roy* coll. ; 3 exs, Z.S.I. Reg. No. E907/1, Pulli Is., 5 miles from Krusadai Is., 17.v.1955, *H. C. Roy* coll. ; 2 exs., Z.S.I. Reg. No. E1449/1, Sandy Point, among rocks, Krusadai Is., 2.ix.1925, *S. L. Hora* coll. ; 2 exs., Z.S.I. Reg. No. E1595/1, Krusadai Is., March 1950, *Hora & Menon* coll.

Description : Spicules comprise of tables, buttons and smooth curved rods ; table disc usually spinose, occasionally smooth, rim of disc appear upturned like soccer when looked from sides, diameter of disc 0.5 mm., spire moderately high terminating in a ring of small

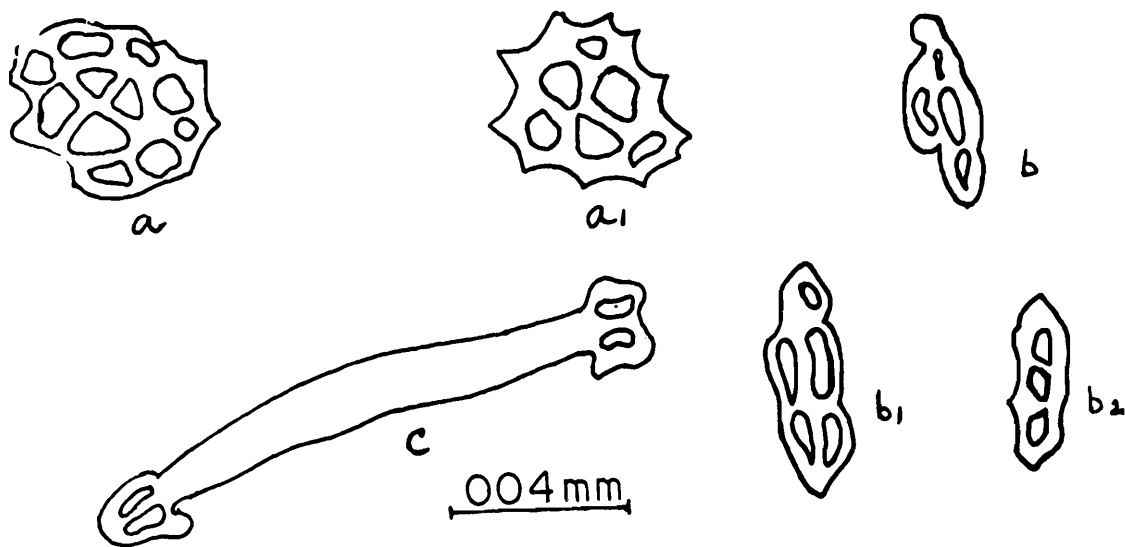


Fig. 1. *Holothuria (Lessonothuria) pardalis* Selenka a, a₁. Table disc ; b b₁, b₂. Pseudobuttons ; c. rod.

spines ; buttons variously modified as pseudobuttons, irregular and sometimes represent half of a button with a single row of 3-4 holes, sometimes regular buttons are also found with 3-4 pairs of small holes, length of buttons .04-.05 mm., rods bent and perforated at ends measuring .14 mm. in length approximately.

Distribution : Throughout the tropical Indopacific littoral waters.

***Holothuria (Semperothuria) cinerascens* (Brandt)**

(Fig. 2)

Stichopus (Gymnochirotia) cinerascens Brandt, 1835. *Prodromus descriptionis animalium ab H. Mertensio in orbis terrarum circumnavigatione*. Petropoli, 1 : 51.

Holothuria (Semperothuria) cinerascens, Rowe, 1969. *Bull. Br. Mus. nat. Hist. (Zool.)*, 18 (4) : 135.

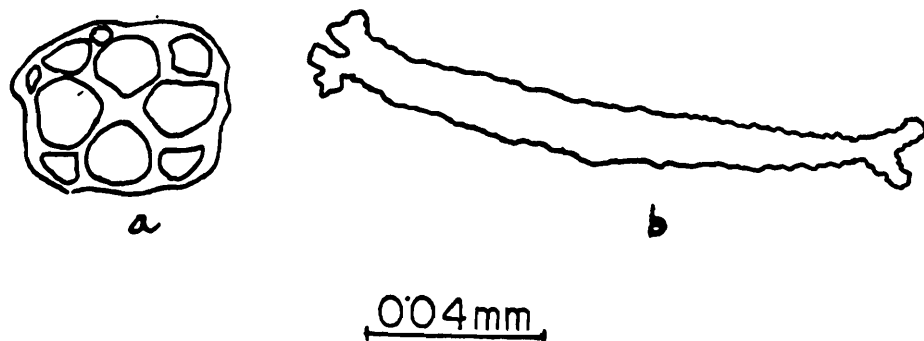


Fig. 2. *Holothuria (Semperothuria) cinerascens* (Brandt) a. table disc ; b. spinose rod.

Material : 1 ex., Z. S. I. Reg. No. E1590/1, Krusadai Is., March 1950, *S. L. Hora* and *A. G. K. Menon* coll.

Description : Spicules are tables in combination with rods ; tables with disc reduced, quadrangular measuring $.05 \times .04$ mm., with four larger holes alternating with four smaller holes at four corners, spire moderately high, terminating in a few spines forming a single or double maltase cross when viewed from above, rods curved and spinose throughout their length, bifid at ends which again may be branched and spinose, length of rods .14 mm.

Distribution : Widely distributed in the Indopacific littoral waters.

***Holothuria (Helodeima) atra* Jaeger,**

(Fig. 3)

Holothuria atra Jaeger 1833. De Holothuris Diss. inaug. Turici : 22.

Holothuria (Halodeima) atra : Pearson, 1914. *Spolia zeylan.*, 9 (35) : 170, pl. 9, fig. 11.

Material : 3 exs., Z. S. I. Reg. No. E1626/1, 5 miles S. of Mandapam camp, 20.2.1962, *V. K. Premkumar* coll. ; 4 exs., Z. S. I. Reg. No. E1604/1, Krusadai Is., March, 1925, *S. L. Hora* coll. ; 6 exs., Z. S. I. Reg. No. E1040/1, Krusadai Is., near Pamban, Feb. 1925, *B. Chopra* and *H. S. Rao* coll. ; 3 exs., Z. S. I. Reg. No. E1092/1, 8 miles SW. of Mandapam camp, 6.5.1955, *M. A. S. Menon* coll. ; 6 exs., Z. S. I. Reg. No. E1195/1, Krusadai Is., March 1950, *S. L. Hora* and *A. G. K. Menon* coll.

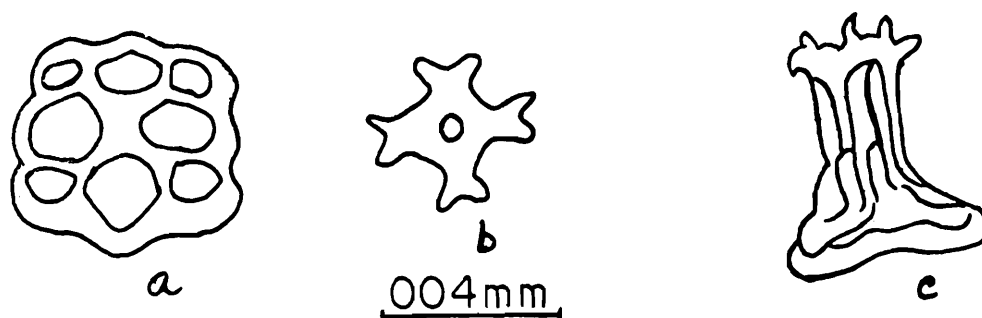


Fig. 3. *Holothuria (Helodeima) atra* Jaeger a. table disc ; b. top of spire ; c. side view of table.

Description : Spicules are tables in combination with rosettes, buttons never present ; table disc spiny, sometime smooth, much reduced, measuring 0.05 mm. with alternately arranged smaller and larger holes or with a circle of small holes at the periphery ; rosettes are of various configurations and measures .02-.025 mm.

Distribution : Universally distributed, principally in the Indo-Pacific region, also found in the Atlantic.

Holothuria (Halodeima) edulis Lesson

(Fig. 4)

Holothuria edulis Lesson, 1830. *Centurie zoologique ou choix d' animaux rares, nouveaux ou imparfaitement connues*. Paris : 125, pl. 46, fig. 2.

Holothuria (Halodeima) edulis : Rowe, 1969. *Bull. Br. Mus. nat. Hist. (Zool.)*, **18** (4) ; 138.

Material : 4 exs., Z. S. I. Reg. No. E1631/1, Pearl Bank, Tuticorin, 12 miles from shore, 9-10 fms., March 1926 ; 2 exs., Z. S. I. Reg. No. E1632/1, Oyster bed, Tholoyiram parr, in the gulf of Mannar, 5 miles from Tuticorin, 21.4.1955, H. C. Roy coll.

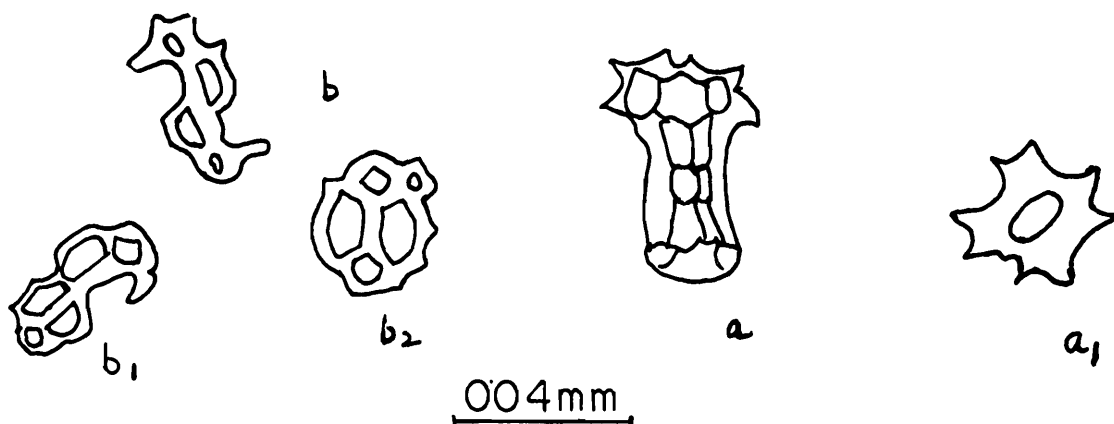


Fig. 4. *Holothuria (Halodeima) edulis* Lesson a. table ; a₁ crown of the same ; b, b₁, b₂, rosettes.

Description : Spicules consisting of tables and rosettes ; tables are most peculiar in having disc developed poorly or reduced almost to a ring, spire high, ending in a large squarish crown so that the upper end looks broader than the narrower lower end, the crown have three teeth pointing three sides, length of tables .05-.06 mm. ; rosettes are of two types, regular ones having two to three pairs of holes, one or two pairs at the sides and one pair at the ends, irregular ones are having less number of complete holes, average size of rosettes .035-.04 mm.

Distribution : A most common Indo-Pacific littoral form.

Holothuria (Metriatyla) ocellata Jaeger *

(Fig. 5)

Holothuria ocellata Jaeger 1833 : *De Hologhuris. Diss. inaug.* Turici : 27.

Holothuria (Metriatyla) ocellata : Rowe 1969. *Bull. Brit. Mus. nat. Hist. (Zool.)*, **18** (4) ; 160.

Material : 1 ex., Z. S. I. Reg. No. E1633/1, Kundugal point, Pamban, inshore area of the gulf of Mannar, 2.10.1960, A. Daniel coll.

Description : Spicules consist of tables and knobbed buttons ; table disc smooth and wavy with one central hole, sarrounded by smaller holes at the periphery or disc perforated by numerous holes, greatest

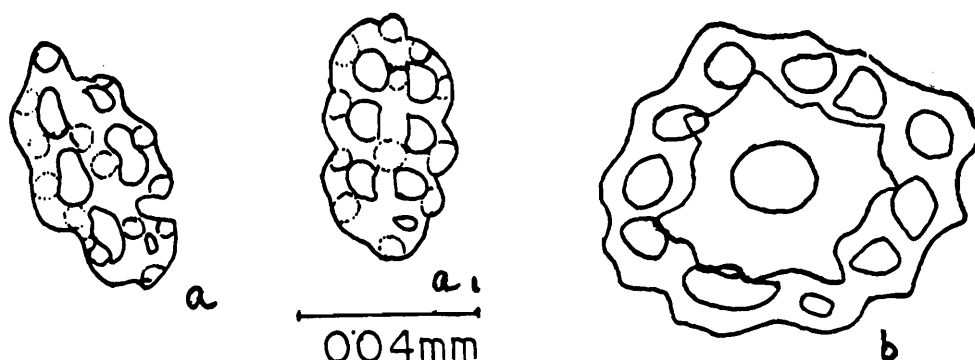


Fig. 5. *Holothuria (Metriatyla) ocellata* Jaeger. a, a₁. Knobbed buttons ; b. table disc.

diameter of disc .08-.09 mm., spire high or moderately high, ending in a number of spines ; buttons .05-.06 mm. long, knobbed with mostly 3 pairs of large holes, though the number may go upto ten pairs.

Distribution : Indian ocean, North Australia, China and S Japan.

***Holothuria (Cystipus) rigida* Selenka ***

(Fig. 6)

Stichopus rigida Selenka, 1867. *Z. wiss. Zool.*, **17** : 317, pl. 18, figs. 30-31.

Holothuria (Cystipus) rigida : Rowe, 1969. *Bull. Br. Mus. nat. Hist. (Zool.)*, **18** (4) : 155, fig. 18.

Material : 1 ex., Z. S. I. Reg. No. E1189/1, Krusadai Is., 18.2.1962, V. K. Premkumar coll. ; 1 ex., Z. S. I. Reg. No. E1343/1, inshore area, one mile E of Mandapam camp, 22.2.1962, V. K. Premkumar coll. ; 3 exs., Z. S. I. Reg. No. E1344/1, inshore area of gulf of Mannar at Krusadai Is., 1.10.1960, A. Daniel coll. ; 3 exs., Z. S. I. Reg. No. E1627/1, Manoli Is., 20.2.1962., V. K. Premkumar coll. ; 2 exs., Z. S. I. Reg. No. E1628/1, rocky shore in the gulf of Mannar, Mandapam camp, 11.5.1955, H. C. Roy coll. ; 2 exs., Z. S. I. Reg. No. E1629/1, Kundugal point, Pamban, inshore area of gulf of Mannar, 2.10.1960, A. Daniel coll. ; 2 exs., Z. S. I. Reg. No. E1630/1, Vedalai, 2 miles away from Mandapam camp, 30.9.1960, A. Daniel coll.

Description : Spicules consisting of knobbed table, knobbed buttons and supporting rods ; table with low spire, terminating into a few to numerous short blunt and closely crowded spines which sometimes obscure the disc or get connected to the knobbs of the margin to

form what is known as fenestrated sphere, diameter of disc .09-.12 mm.; buttons simple with large and regularly arranged knobbs, holes small and may be even obliterated by the emensity of the knobs, sometimes entire button may be transformed into fenestrated ellipsoids, average length of buttons .04 mm.; rods lobed, blunt and perforated at the ends measuring .15 mm.

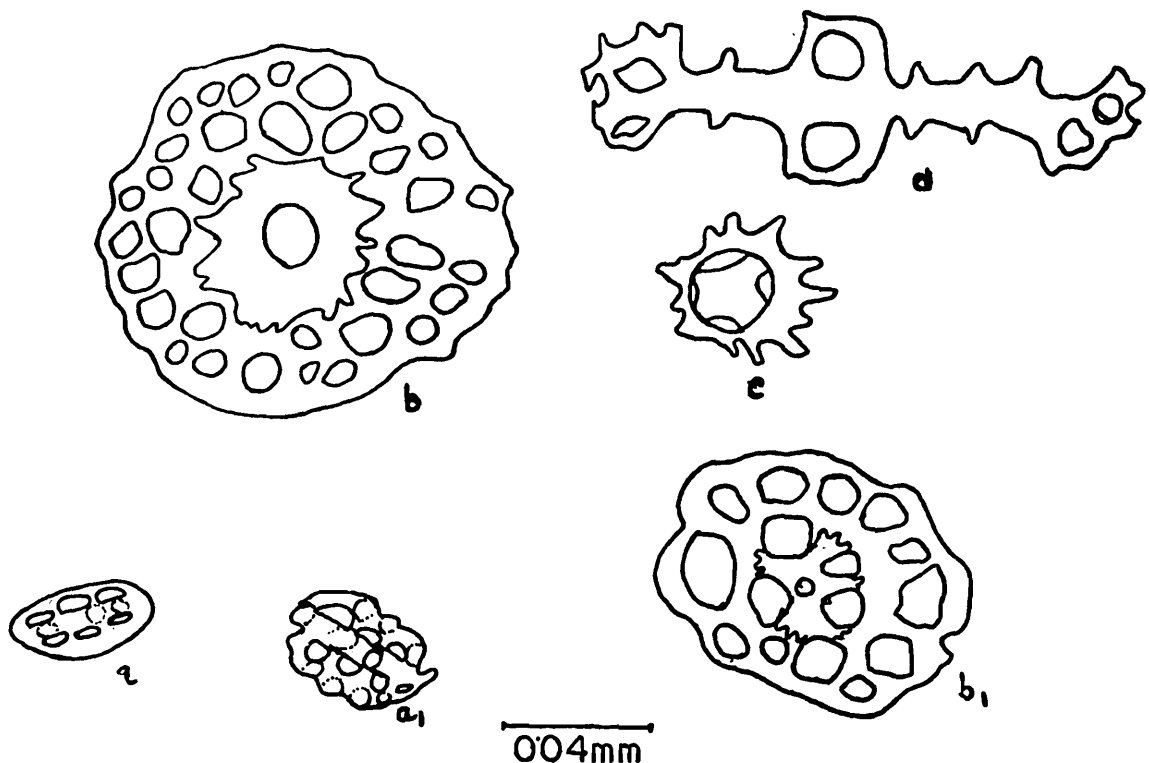


Fig. 6. *Holothuria (Cystipus) rigida* Selenka a, a₁. buttons; b, b₁. table disc; c. top of spire; d. rod from pedicel.

Distribution : From Mascarene Is. to Red sea and from East Indies to South Pacific Is., of the Indo-West Pacific area.

***Holothuria (Thymiosycia) hilla* Lesson**

(Fig. 7)

Holothuria hilla Lesson, 1830. *Centurie Zoologique ou choix d' animaux rares nouveaux on imparfaitement connues* Paris : 226, pl. 79.

Holothuria (Thymiosycia) hilla : Rowe, 1969. *Bull. Brit. Mus. nat. Hist. (Zool.)*, 18 (4) : 147.

Material : 2 exs., Z. S. I. Reg. No. E906/1, Pulli Is., 5 miles from Krusadai Is., 17.5.1955, H. C. Roy coll.; 2 exs., Z. S. I. Reg. No. E1153/1, Krusadai Island, 7.9.1925, S. L. Horra coll., 1 ex., Z. S. I. Reg. No. E1634/1, Vedalai, 2 miles from Mandapam Camp, Inshore area of gulf of Mannar, 30.9.1960. A Daniel, coll.; 1 ex., Z. S. I. Reg. No. E1346/1; Hare Is., Tuticorin 27.4.1955, H. C. Roy, coll.

Description : Spicules consisting of smooth tables and buttons; table disc smooth, glossy, oval or squarish having one central hole and

more than eight peripheral holes, the number may go upto a dozen, spire low, ending in a number of small spines, diameter of disc 0.055 mm ; buttons with smooth or wavy outline and with three or more pairs of comparatively large holes, average length of button .06-.07 mm.

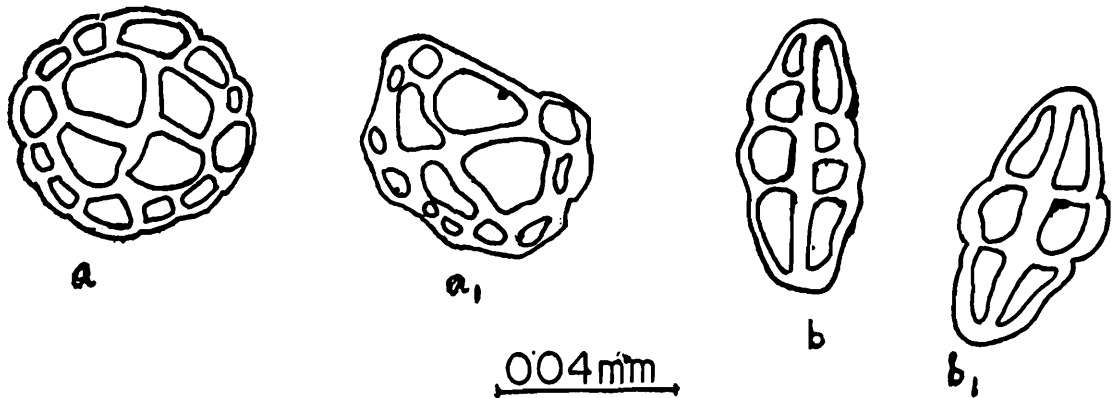


Fig. 7. *Holothuria (Thymiosycia) hilla* Lesson a, a₁. table disc ; b, b₁. buttons.

Distribution : Tropical Indo-Pacific regions.

Family : STICHOPODIDAE

Stichopus chloronotus Brandt.

(Fig. 8)

Stichopus (perideris) chloronotus Brandt, 1835. *Prodromous descriptions animalium ab H Mertensio in orbis Circumnavigatione*. Petropoli, 1 : 50.

Stichopus chloronotus : Clark, 1922. *Bull. Mus. Comp. Zool. Harv.*, 65 : 53, pl. 2, figs. 1-10.

Material : 11 exs., ZSI Reg. No. E 1635/1, Rameswaram, 11.9.1935, H. S. Rao, coll.

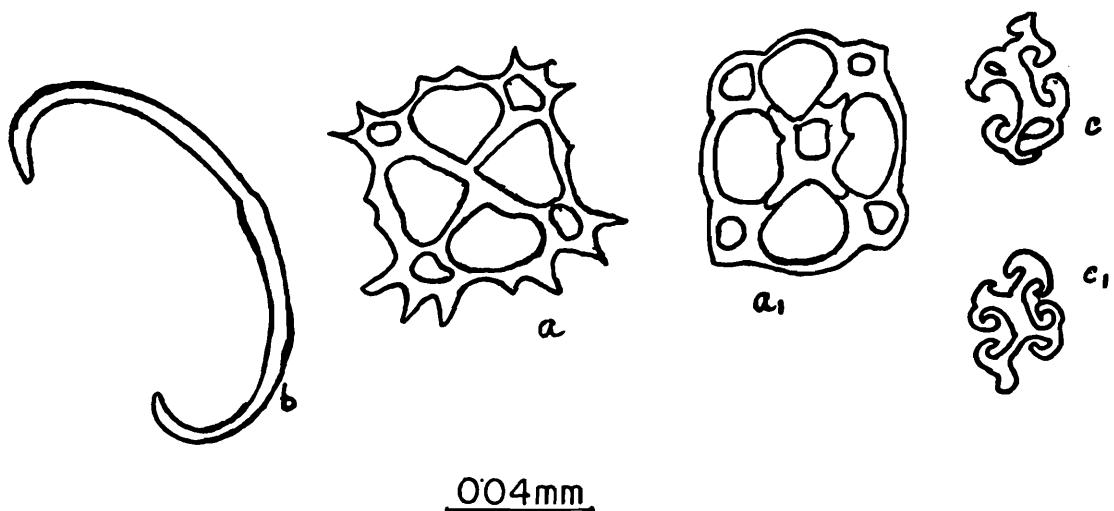


Fig. 8. *Stichopus chloronotus* Brandt a, a₁. table disc ; b. rod ; c, c₁. rosettes.

Description : Spicules consist of tables, 'C' shaped rods and a few rosettes ; tables with quadrangular disc and smooth margin, occasionally spinous with a large central hole and smaller holes at corners,

diameters of disc .065-.08 mm. spire low, ending in small spines, 'C' shaped rods are abundant and are of various configurations, some with a definite central lobe, branched rods are also present, rosettes few, measuring .04 mm. on average.

Distribution : Littoral area of Indo-West Pacific oceans.

Order : DENDROCHIROTIDA

Family : PHYLLOPHORIDAE

Actinocucumis typicus Ludwig

(Fig. 9)

Actinocucumis typica Ludwig, 1875. *Arb. Zool. Zoot. Inst. Worzburg*, 2 (2) : 91 pl. vi, fig. 24.

Material : 2 exs, ZSI Reg. No. 1675/1, Pamban, 19.9.1925, H. S. Rao, coll.

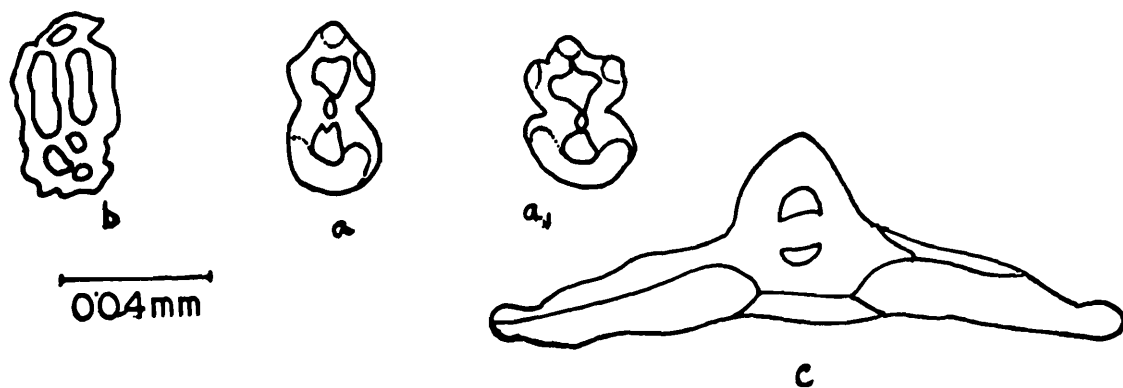


Fig. 9. *Actinocucumis typicus* Ludwig a, a₁. buttons ; b. rosette ; c. table.

Description : Spicules are tables and buttons ; buttons look like figure of eight shaped fenestrated ellipsoids and measure .04-.05 mm. ; tables irregular, spires eccentric and made up of four strong pillars ; pedicels contain abundant rosette like plates with four holes, two larger and longer at sides and two smaller at the upper and lower ends, average length of rosettes .05 mm.

Distribution : From west coast of India to North Australia except Maldives, China and S. Japan.

Order : APODIDA

Family : SYNAPTIDAE

Synapta maculata (Chamisso & Eysenhardt)*

(Fig. 10)

Holothuria maculata Chamisso and Eysenhardt, 1821. *Nova Acta Acad. Caesar. Leop. Carol.*, 10 : 352, pl. 25.

Synapta maculata : Heding, 1928. *Vidensk. Meddr. dansk naturh. Foren.*, 85 : 113, fig. 2 (1-10).

Material : 2 exs., Z.S.I. Reg. No. E.1594/1 Krusadai Is. March 1950, A. G. K. Menon coll.

Spicules consisting of massive anchors and anchor plates ; anchor. .21 mm. in length, quite large, with long unbranched stalk, arms smooth and large with blunt end, apex depressed, with no minute speherical bodies, anchor plates oblong or subrectangular with broad posterior

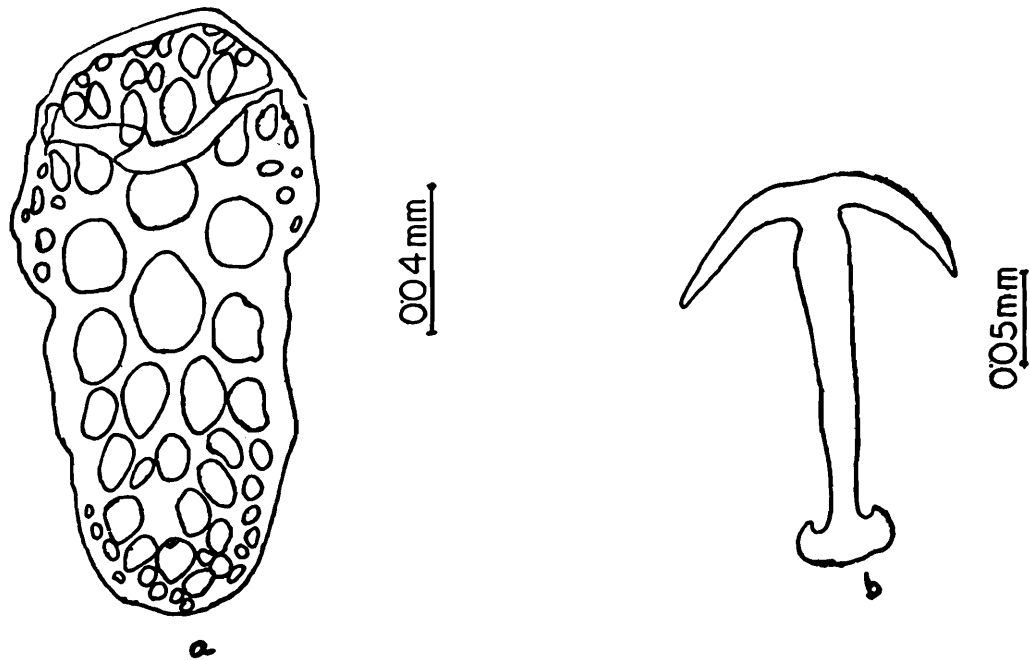


Fig. 10. *Synapta maculata* (Chamisso & Eysenhardt) a. anchor plate ; b. anchor.

end; holes smooth and numerous, larger at the centre, bridge across the lower end quite distinct, anchor plate measure .16-.17 mm. in length and .09 mm. at the greatest breadth.

Distribution : Throughout the Indo-west Pacific area except Hawaii.

Chart showing the holothurians hitherto known from the different places of the gulf of Mannar together with their distribution elsewhere in the Indian region.

Name of the species	Localities in the gulf of Mannar	Other Indian localities.
Order Aspidochirotida		
Family Holothuriidae		
<i>Holothuria (Cystipus) rigida</i> Selenka	...	Andaman Is. (16)
<i>Holothuria (Helodeima) atra</i> Jaeger	Tuticorin (2) Krusadai Is. (4) Mandapam (7) Pamban (17) Gulf of Mannar (14)	Andaman Is (1) (8) (16) Minicoy-(Laccadive) (13) Laccadive (10) Nicobari Is. (16)

Name of the species	Localities in the gulf of Mannar	Other Indian localities
<i>Holothuria (Helodeima) edulis</i> Lesson = <i>Holothuria albida</i> Bell	Mandapam & Tuticorin (7)	Andaman Is. (1) (8)
<i>Holothuria (Lessonothuria) pardalis</i> Selenka	Krusadai Is. (4) Pulli is. (7)	Andaman Is. (1) (7) (8) (16) Minicoy Is. (7) (12) Chetlat Is. (Laccadive) (7) Gulf of Kutch (7) (9) Bombay (15)
<i>Holothuria (Metensiothuria) leucospilota</i> (Brandt) = <i>Holothuria vagabunda</i> Brandt	Tuticorin (2) (7) (17) Kilakarai (7)	Andaman (1) (8) (16) Nicobar, (16) Vizingam, Karwar & Minicoy (7) Laccadives (8) & (10)
<i>Holothuria (Metriatyla) ocellata</i> Jaeger	...	Laccadive-Sea (8) Gulf of Kutch (9)
<i>Holothuria (Metriatyla) scabra</i> Jaeger = <i>Holothuria cadelli</i> Bell	Krusadai Is. (4) Mandapam & Pamban (7)	Bedi port, Gulf of Kutch (7) Andaman Is. (1) (8)-(16)
<i>Holothuria (Selenkothuria) moebii</i> Ludwig = <i>Holothuria lubrica</i> Ludwig	Mandapam (7) Krusadai Is. (4)	Vizingam (7) Andaman Is. (8)
<i>Holothuria (Semperothuria) cineracens</i> Brandt	Mandapam (7)	Andaman (16) Vizingam, Andaman Is. & Minicoy (7) Laccadive (10)
<i>Holothuria (Theelothuria) kurti</i> Ludwig	Pearl bank (14) Palk Strait (8) Mandapam (7)	...
<i>Holothuria (Theelothuria) spinifera</i> Theel	Mandapam (7)	...
<i>Holothuria (Thymiosycia) hills</i> Lesson = <i>Holothuria monacaria</i> (Lesson)	Tuticorin (2) Krusadai Is. (4) Kilakarai (7) Gulf of Mannar (14) Pamban (17)	Andaman Is. (1) (7) (8) Minicoy Is. (7) (13) Laccadive Is. (8) (10)

Name of the species	Localities in the gulf of Mannar	Other Indian localities
<i>Bohadschia argus</i> Jaeger = <i>Holothuria argus</i> (Jaeger)	Mandapam (7)	...
<i>Bohadschia marmorata</i> Jaeger	Tuticorin (2)	Andaman Is. (1) (7)
<i>Holothuria marmorata</i> (Jaeger)	Pamban (17)	(16) Minicoy Is. (7) (13) Laccadive (10)
<i>Bohadschia tenuissima</i> = <i>Holothuria tenuissima</i>	Gulf of Manner (14)	...
Family Stichopodidae		
<i>Stichopus chloronotus</i> Brandt	Pearl bank (14) Krusadai Is. (4)	Nicobar Is. (16) Andaman Is. (1) (7)
= <i>Stichopus chloronotus</i> var. <i>fuscus</i> Pearson		(16) Nicobar Is. & Chetlat Is. (7)
<i>Stichopus variegatus</i> Semper	Vedalai & Tuticorin (7)	Andaman Is. (1) (7)(8). Minicoy (13)
Family Psolidae		
<i>Psolus complanatus</i> Semper	Krusadai Is. (4)	...
Order Dendrochirotida		
Family Cucumariidae		
<i>Cucumaria turbinata</i> (Hutton)	Gulf of Mannar (14)	...
<i>Hemithyone semperi</i> (Bell) = <i>Cucumaria semperi</i> Bell	Rameswaram (3) Pamban (7) (17)	...
<i>Pentacta quadraangularis</i> (Lesson) = <i>Colochirus quadrangularis</i>	Tuticorin (3) (17) Vedalai (7)	...
<i>Stolus buccalis</i> (Stimpson) = <i>Thyone sacellus</i> (Selenka)	Krusadai Is. (4) Rameswaram & Man- dapam (6) (7) Palk Bay (6)	Madras coast (3) Gulf of Kutch (9)
<i>Stolus conjugans</i> (Semper) = <i>Cucumaria conjugans</i> (Semper) = <i>Thyone conjugans</i> Semper	Pearl bank (14)	Bombay (15)

Name of the species	Localities in the gulf of Mannar	Other Indian localities
<i>Pseudocolochirus tricolor</i> (Sluiter) = <i>Cucumaria tricolor</i> Sluiter	Donnan's Par (14)	...
<i>Pseudocolochirus violaceus</i> (Theel) = <i>Colochirus violaceus</i> Theel	Mandapam & Pamban (7)	Ganjam coast Orissa (8)
<i>Trachythyone imbricata</i> (Semper) = <i>Cucumaria imbricata</i> Semper	Pearl bank (14)	Gangam coast Orissa coast & Madras coast (8)
<i>Havelockia herdmani</i> Pearson = <i>Thyone herdmani</i> (Pearson)	Adam's bridge (14) Mandapam (7)	...
<i>Thyone papuensis</i> Theel = <i>Thyone fuscus</i> var <i>papuensis</i> Theel	Gulf of Mannar (14)	...
<i>Cucumaria frauenfeldi</i> Ludwig	Krusadai Is. (4)	...
Family Phyllophoridae		
<i>Actinocucumis typicus</i> Ludwig = <i>Actinocucumia difficilis</i> Bell	Rameswaram (3) Krusadai Is. (4) Mandapam (7) Pamban (7) (17)	Bombay (15) Gulf of Kutch (9)
<i>Phyllophorus</i> (<i>Phyllophorella</i>) <i>pervipedes</i> H.L. Clark	Vedalai (5) & (7)	...
<i>Phyllophorus</i> (<i>Phyllothuria</i>) <i>cebuensis</i> (Semmer)	Gulf of Mannar (14)	...

Name of the species	Localities in the gulf of Mannar	Other Indian localities
Order Molpadida		
Family Molpadidae		
<i>Molpadia australis</i> (Semper)	Tuticorin (2) & (17)	Mouth of river Hoogly, Andaman Is. Coast of Bengal (8)
= <i>Haplodactyla australis</i> Semper		
<i>Acaudina iranica</i> (Heding)	Tuticorin (7)	...
Order Apodida		
Family Synaptidae		
<i>Synaptula recta</i> (Semper)	Pamban (17)	...
= <i>Synapta recta</i> Semper	Krusadai Is (4)	
= <i>Chondrocloea recta</i> (Semper)	Mandapam (7)	
= <i>Synaptula varians</i> (Nair)	Pamban (11)	Madras Harbaur (11)
= <i>Chonorocloea varians</i> Nair		
<i>Synaptula striata</i> (Sluiter)	Tuticorin (7) & (12)	Detriot de Malacca, Is. —Nicobar (8)
= <i>Chondrocloea striata</i> Sluiter		Nicobar Is. (16 Andaman Is. (7) (8) (16)
<i>Synapta maculata</i> (Chamisso & Eysenhardt)		Minocoy (7) (13) Laccadive Is. (8)
= <i>Chondrocloea baselli</i> (Jaeger)		
<i>Protankyra pseudodigitata</i> (Semper)	Tuticorin (7)	Andaman Is. (8)

*The number (s) in the chart correspond to those in the list of the references.

SUMMARY

The paper deals with 10 species of holothurians from the different areas pertaining to the gulf of Mannar with 3 new locality records. An upto date list of holothurians hitherto known from the area together with their distribution in the Indian region is also furnished.

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ENVIRONMENTAL FACTORS AND REPRODUCTIVE SEASONALITY IN THE INDIAN LANGUR, *PRESBYTIS ENTELLUS*, ON THE INDIAN SUBCONTINENT

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INTRODUCTION

Mammalian and avian reproductive cycles are the result of interaction between endogenous and exogenous factors. It has been demonstrated repeatedly that endogenous factors alone cannot maintain a regular periodicity of birth seasons indefinitely but must be triggered

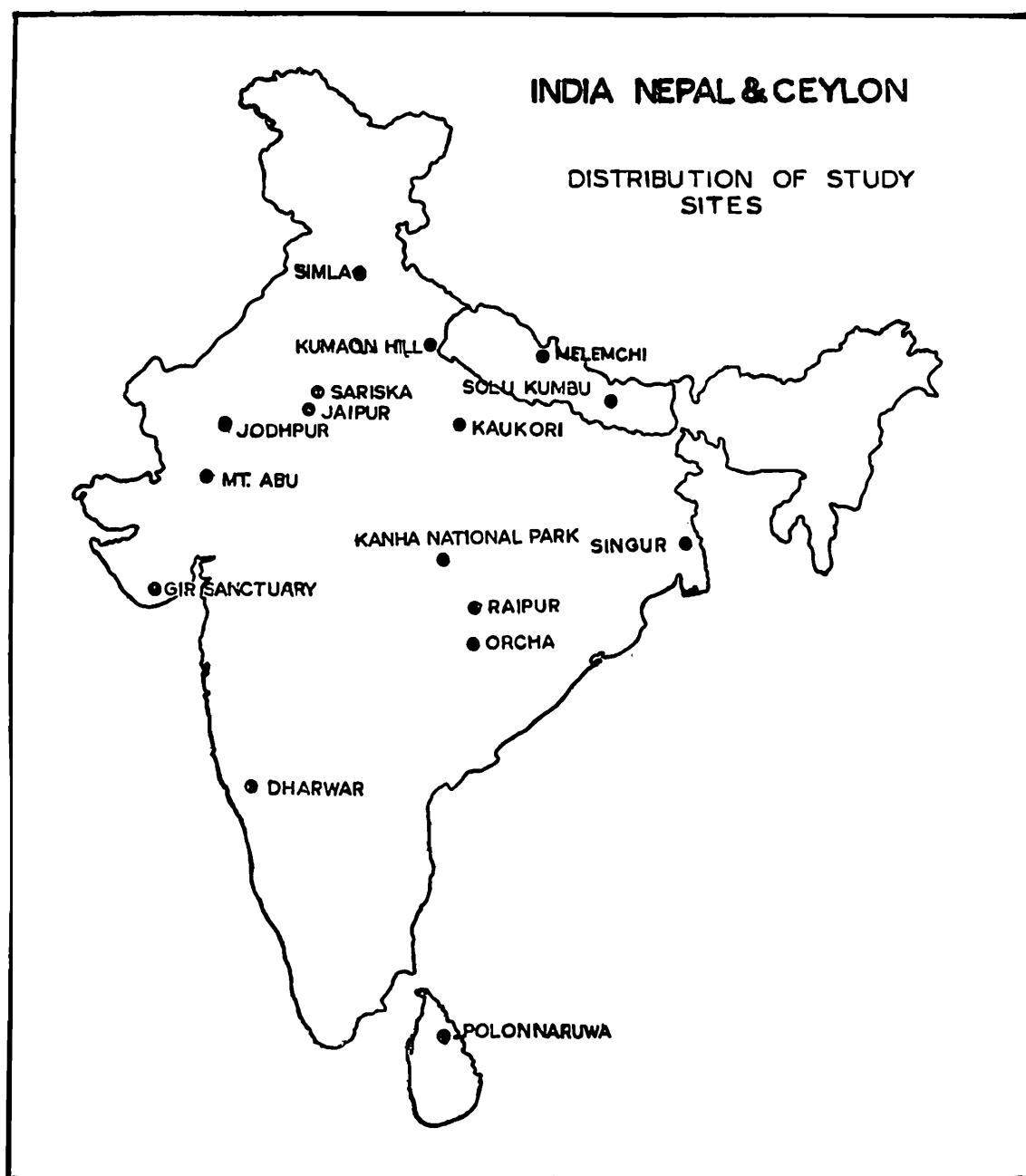


Fig. 1. Map of India, Nepal and Ceylon showing distribution of study sites.

and synchronized by stimuli external to the animal (Vandenbergh and Drickamer, 1974). These external stimuli are apparently combinations of climatological variables such as sunlight or ultraviolet light, relative humidity, temperature, rainfall and other factors that exhibit a seasonal rhythm and may mediate interindividual response. There appear to be three reproductive patterns among primates : truly seasonal breeders (e. g., *Macaca mulatta* ; Lindberg, 1971), mating throughout the year with a peak in breeding activities (e.g., *Presbytis entellus*, Dolhinow, 1972 ; Boggess, 1980 ; *Papio anubis*, Devore and Hall, 1965), and lack of an apparent peak period (e.g., *Papio ursinus*, Devore and Hall, 1965, *Pan troglodytes*, Wrangham, 1977).

TABLE 1. The Latitudinal, Longitudinal And Altitudinal Differences Between Weather Stations And Actual Study Area.

Sl. No.	Locality/(Weather Stations)	Latitude	Longitude	Altitude (m)
1.	Simla	31°06'N	77°10'E	1500-3200
2.	Kumaun Hills (Nanital)	29°22'N	79°30'E	900-1500 1953
3.	Solu Khumbu, E. Nepal (Thyangboche)	27°45'N 27°50'N	86°30'E 86°45'E	2433-3505 4000
4.	Jaipur	26°55'N	75°53'E	
5.	Sariska (Jaipur)	21°12'N 26°49'N	77°20'E 75°48'E	400
6.	Kaukori (Lucknow)	26°50'N 26°55'N	80°45'E 80°59'E	122 122
7.	Jodhpur	26°18'N	73°04'E	241
8.	Mt Abu	24°40'N	72°45'E	1300
9.	Singur (Bagati)	22°45'N 22°59'N	88°10'E 88°22'E	7
10.	Kanha National Park (Mandla)	22°15'N 22°35'N	80°35'E 80°58'E	
11.	Raipur	21°15'N	81°41'E	290
12.	Gir Sanctuary (Veraval)	21°00'N 20°53'N	71°00'E 70°26'E	226-648
13.	Orcha (Kanker)	19°10'N 20°15'N	81°30'E 81°32'E	762
14.	Dharwar (Gadag)	15°27'N 15°25'N	75°05'E 75°42'E	550-760
15.	Polonnaruwa (Batticaloa)	07°56'N 07°43'N	81°02'E 81°42'E	

Places in parenthesis are weather stations.

The primary purpose of this paper is to correlate meteorological data for different langur study sites throughout the Indian subcontinent (Fig. 1) with reported mating and birth peaks (Table 1). Association between periodicity of flowering, and production of young leaves and langur reproductive patterns is also examined.

METHODS

The environmental factors considered for correlation with reproductive events are rainfall, maximum and minimum temperatures, morning and evening relative humidities, daylight hours, and numerical abundance of different phenological stages of plants on which langurs feed. The climatological data were obtained from weather stations of various Government Meteorological departments located in or close to each study area. The daylight hours (in minutes) for study area are calculated on the basis of their longitude, adopting standard procedure. The climatological data (temperature, humidity and rainfall) were collected for the duration of the study period reported by different authors (Table 2). Each variable was then calculated in terms of "monthly average" and plotted on the graphs (Fig. 2) for each locality along with birth and mating peaks. It is the trend and not the exact temperature, humidity, rainfall which was correlated with reproductive events.

The availability of preferred food in different months is presented in Table 3, listing localities for which the number of food plants and their phenological cycles are available. Different phenological periods such as flowering, and production of young leaves were plotted by locality according to season of availability based on published records. The number of plant parts from all plant species available to langur populations during each month is indicated in Table 3. For example, number 12 in January at Dharwar indicates that langurs had twelve different phytophases of the total of thirty-seven plants species at their disposal. Because the relative densities of the plant species utilized by langurs are not known for sites other than Dharwar, Table 3 indicates comparative abundance of fruits, leaves and flowers over the year.

The data on population and breeding activities of *Presbytis entellus* were taken from published works from thirteen different locations through out India, Nepal and Sri Lanka, including six of the fifteen subspecies of *P. entellus* (Table 2).

TABLE 2. Summary of the work Done on the Hanuman Langur, *Presbytis entellus* in different localities.

Sl. No.	Localities	Investigator	Period of Study	Subspecies	Habitat	Kind of Group	Density Heads/km ²	Average Group Size	Home Range km ² /Group	Adult Male/Adult Female	Infant/Adult Female	References
1	2	3	4	5	6	7	8	9	10	11	12	13
	1. Simla	Sugiyama,	Aug. 72-Jan. 73	<i>schistaceus</i>	Himalayan moist temperate forest	Onemale Multimale All-male	24.6	46.8	1.9	0.27	0.42	Sugiyama, 1976
	2. Kumaon Hills	Vogel, C.	Sept. 68-Nov. 68	<i>entellus</i>	High altitude mountain forest	(Onemale) (Multimale) All-male	97.0	23.0 10.0	0.2	0.2	0.22	Vogel, 1971 Vogel, 1977
	3. Melemchi	Bishop, N.H.	Nov. 71-Sep. 72	<i>schistaceus</i>	Himalayan temperate forest	Multimale All-male	15.2	32.0	2.1	(0.77)	(0.75)	Bishop, 1979 Vogel, 1977
	4. Solu Kumbu	Curtin, R.A.	Oct. 72-Feb. 74	<i>achilles</i>	Coniferous & mixed broad leave forest	Onemale Multimale	(1.1)	11.0	(7.76)	(0.56)	—	Curtin 1975
	5. Jaipur	Prakash, I.	Feb. 56-Oct. 60	<i>entellus</i>	City & semiarid	Onemale (All-male)	—	15.0	—	0.06	—	Prakash, 1962
	6. Sariska	Vogel, C.	Sep. 68-Nov. 68	<i>entellus</i>	Dry scrub	Onemale (Multimale) All-male	104.0	64.0 21.0	6.0	0.38	—	Vogel, 1971 Vogel, 1977
	7. Kaukori	Jay, P.	Dec. 59-Mar. 60	<i>schistaceus</i>	Cultivated field	field Multi-male All-male	2.6	54.0	7.76	0.31	0.74	Dolhinow, 1972

TABLE 2. (Concluded)

1	2	3	4	5	6	7	8	9	10	11	12	13
8.	Jodhpur	Mohnot, S.M.	Jul. 67-Aug. 68	<i>entellus</i>	Open scrub	Onemale All-male	19.0	18.0	0.5	0.04	—	Mohnot, 1971 Vogel, 1977
9.	Mt Abu	Hrdy, S.B.	Jun. 71-Oct. 75	<i>entellus</i>	Dry scrub	Onemale Multimale	50.2	24.0	0.38	0.18	0.70	Hrdy, 1974
10.	Singur	Oppenheimer, J. R.	Jan. 71-Aug. 72	<i>entellus</i>	Village	Onemale	4.6	12.8	0.43	0.18	0.5	Oppenheimer, 1977
11.	Kanha National Park	Kankane, P.L.	Mar. 77-Apr. 77	<i>entellus</i>	Dry & moist deciduous	Onemale Multimale	—	17.4	0.7	0.15	0.32	Kankane, 1980
12.	Raipur	Jay, P. Sugiyama, Y.	Nov. 62-	<i>entellus</i>	Dry & old scrub	Onemale Multimale	—	29.1	—	0.81	0.31	Jay, 1965 Sugiyama, 1976
13.	Gir Sanctuary	Rahaman, H.	Jul. 71-Aug. 71	<i>entellus</i>	Riverine & deciduous trees	Onemale Multimale All-male	—	(30.4)	(3.25)	(0.19)	(0.29)	Rahaman, 1973 Vogel, 1977
14.	Orcha	Jay, P.	Nov. 58-Nov. 59	<i>anchises</i>	Moist deciduous	Onemale (2.7-6.2) Multimale All-male	22.0	3.88	0.17	—	—	Dolhinow, 1972
15.	Dharwar	Sugiyama, Y.	Apr. 61-Apr. 68	<i>achates</i>	Dry deciduous	Onemale All-male	16.6	17.1	1.5	0.16	0.24-0.3	Sugiyama, 1965 Sugiyama, 1975
16.	Polonнаруwa	Ripley, S.	Oct. 62-May 63	<i>thersites</i>	Dry deciduous	Multimale	58.0	25.0	0.43	—	—	Vogel, 1977 Ripley, 1967

() Estimated or calculated by the present author.

TABLE 3. Comparative Availability of Different Phenological Stages of Preferred Food In Different Months.

Locality	Total No. of Plants Reported	Total No. of Plants Cited	J	F	M	A	M	J	J	A	S	O	N	D	References
Simla	26	21	0	4	10	12	12	8	2	4	4*	4*	2*	0	Collett, 1971
Jodhpur	53	52	17	17	16	16	13	13	14	29	39*	43*	37*	30*	Bhandari, 1978
Dharwar	39	37	12	9	7	10	27*	23*	19*	17*	18*	19*	8	9	Yoshiba, 1967
Singur	22	11	3	2	6	7	11	8	3	3	3	2	2	4	Bennet, 1979

*Mating peak reported during these months.

Presbytis entellus—An Overview

The whole of the northern peninsula is hot throughout the year except in the hills, and the wettest period extends from July to October. Though the rainfall pattern is maintained through intermonsoonal convectional currents, the effect of the dry season becomes pronounced as temperature rise, reaching a peak before the start of the yearly monsoon. With the arrival of the monsoon the temperature starts decreasing and continues to do so for the next two to three months.

On the Indian subcontinent langur populations live in a wide range of geographic and climatic variations. The study areas (Fig. 1) fall between 07°56'N to 31°06'N latitude and 70°00'E to 88°10'E longitudes, while the elevation varies from 7 m to 3505 m (though Bishop, 1977, has reported its occurrence at 4250 m at Routang in Nepal) above mean sea level. The temperature of their habitat ranges from subzero (−13°) to as high as 41°C, the relative humidity from 12% to 91% and the total annual precipitation from 408 mm to 1940 mm. There is a difference of nearly 24 degrees latitude between the northernmost populations of the Himalayan region (Simla) and the southernmost populations in Sri Lanka (Polonnaruwa). The maximum variation in the daylight hours between Simla and Polonnaruwa is 93 minutes in the month of January while the minimum is seven minutes in May. The overall difference irrespective of any month is 146 minutes. Simla experiences the highest variation in daylight hours which is 843 minutes (maximum) in July and 608 minutes (minimum) in January, a difference of 235 minutes. The climatic variables shown in Table 4 reveal the conditions prevailing in the beginning and at the end of the mating peak.

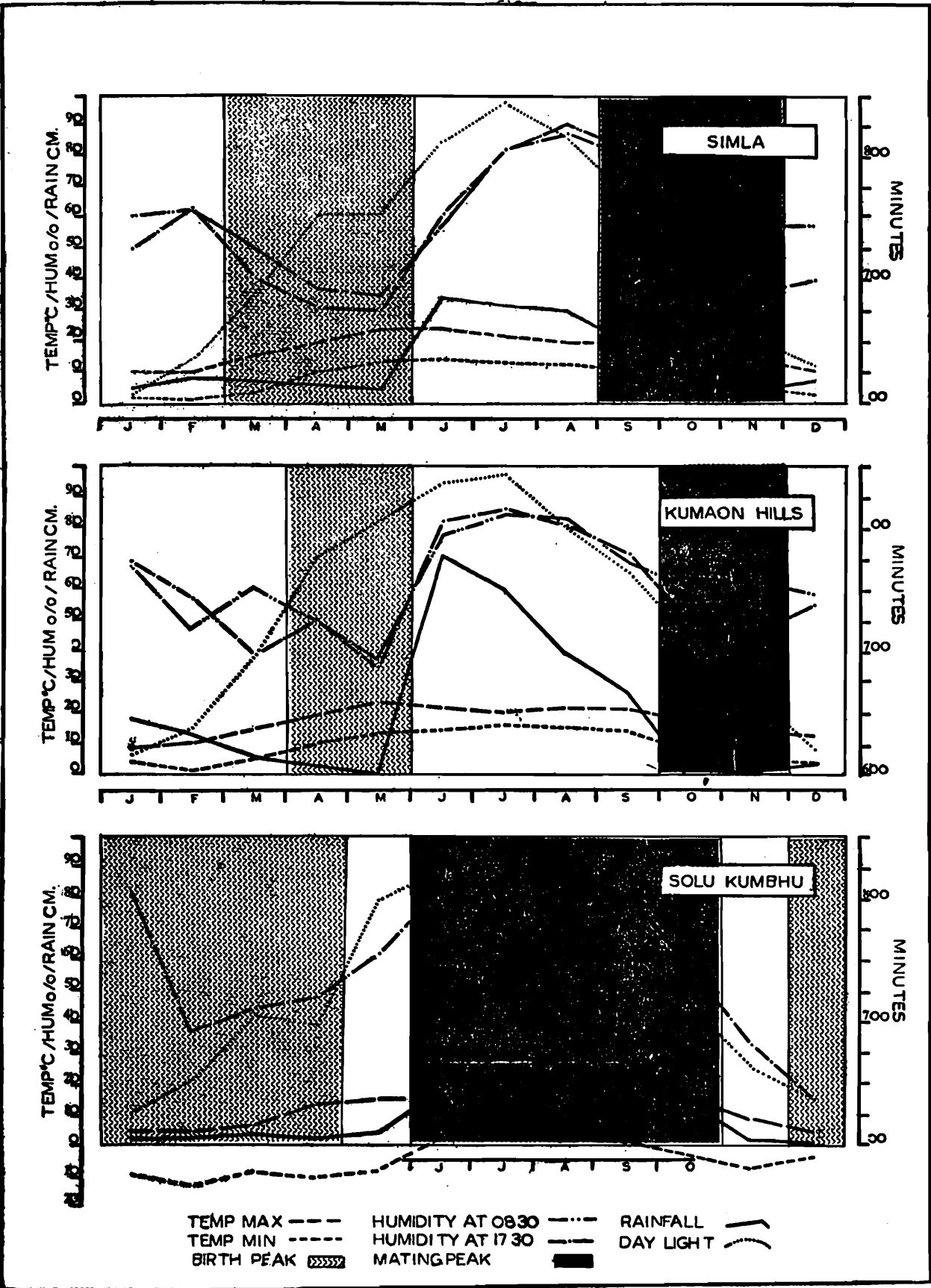
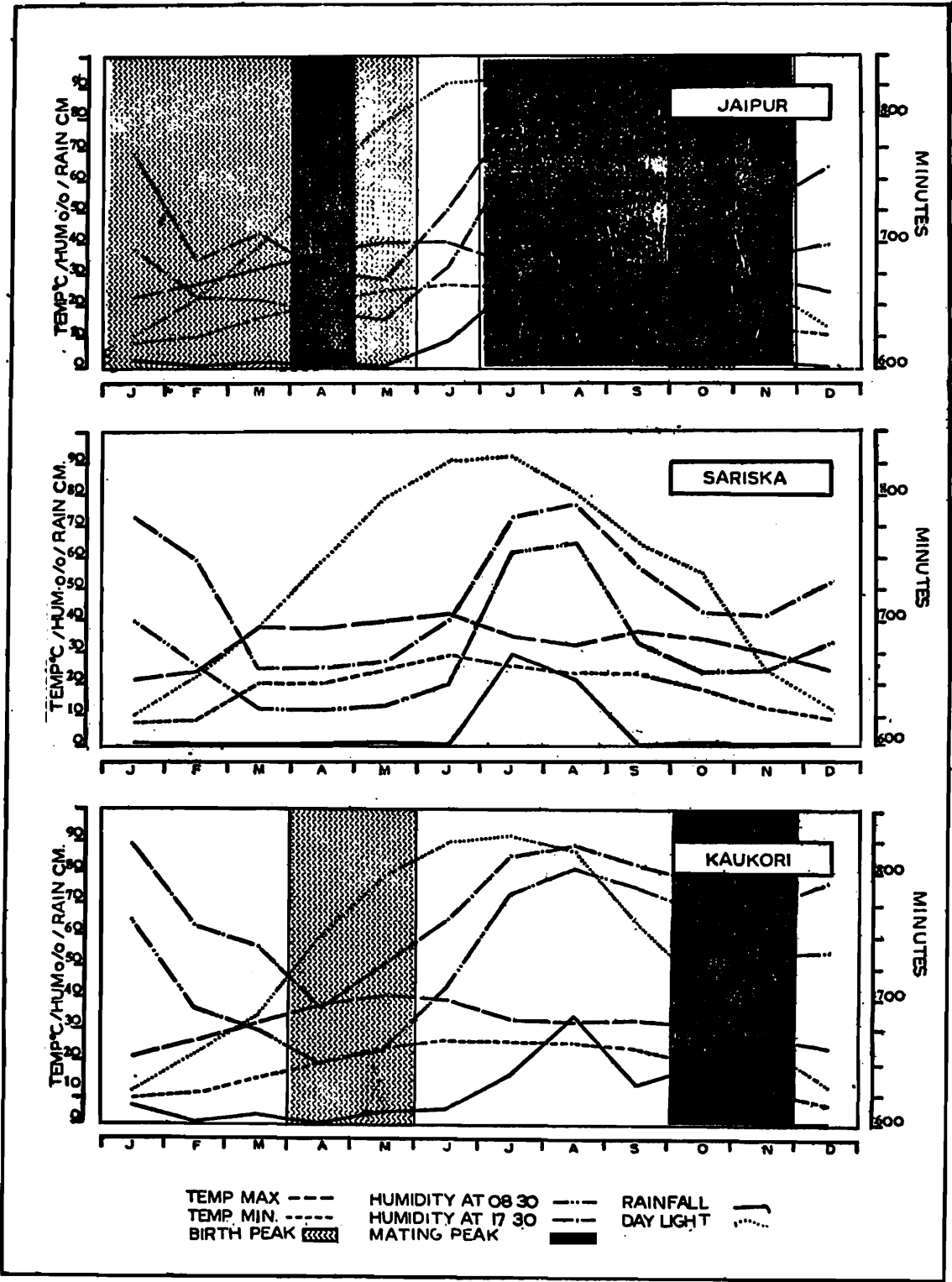


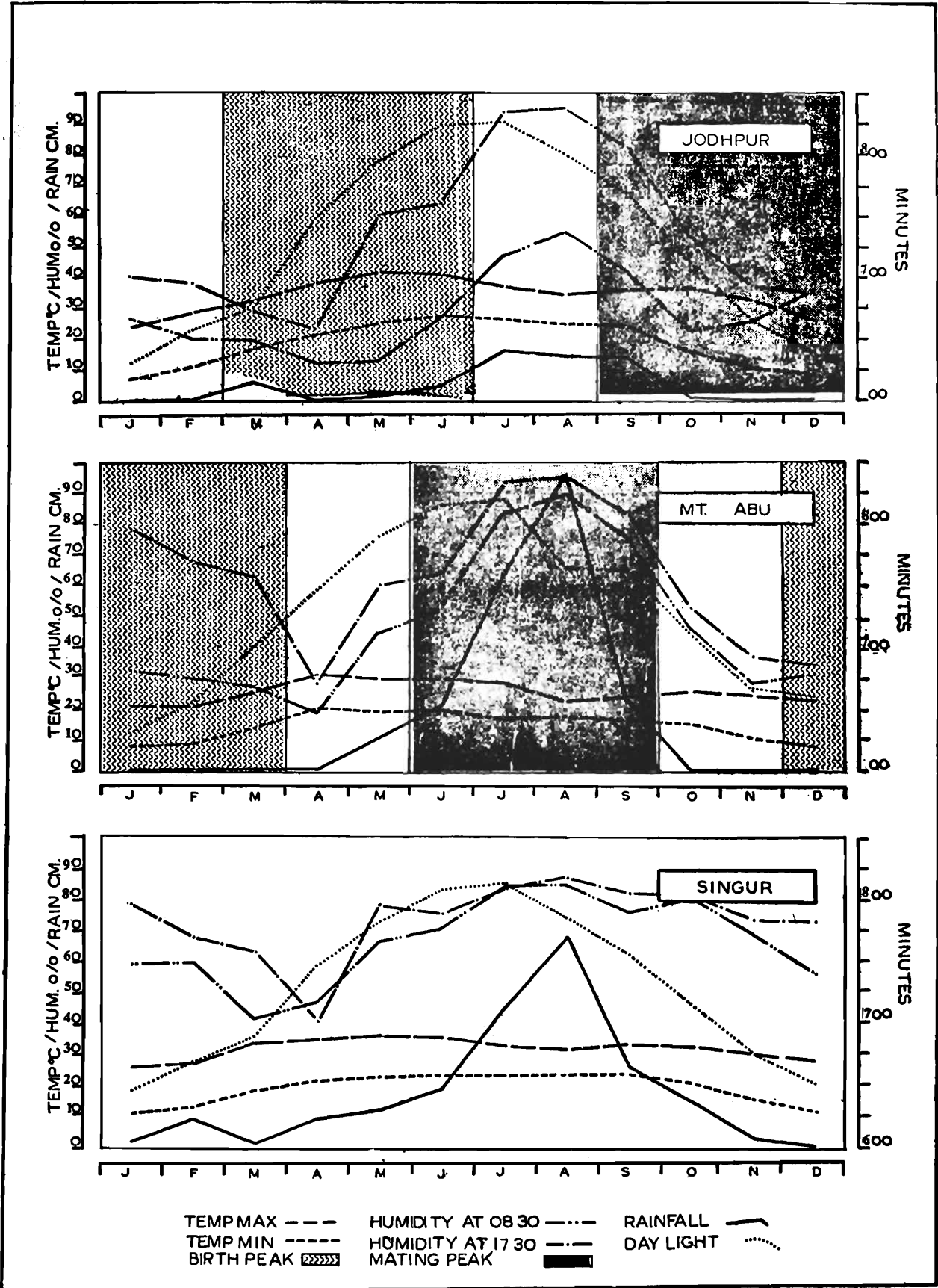
Fig. 2. The mating and birth peaks in the reproductive cycles of langurs in relation to average monthly maximum and minimum temperature morning and evening relative humidity, rainfall and daylight hours.

(in five sheets)

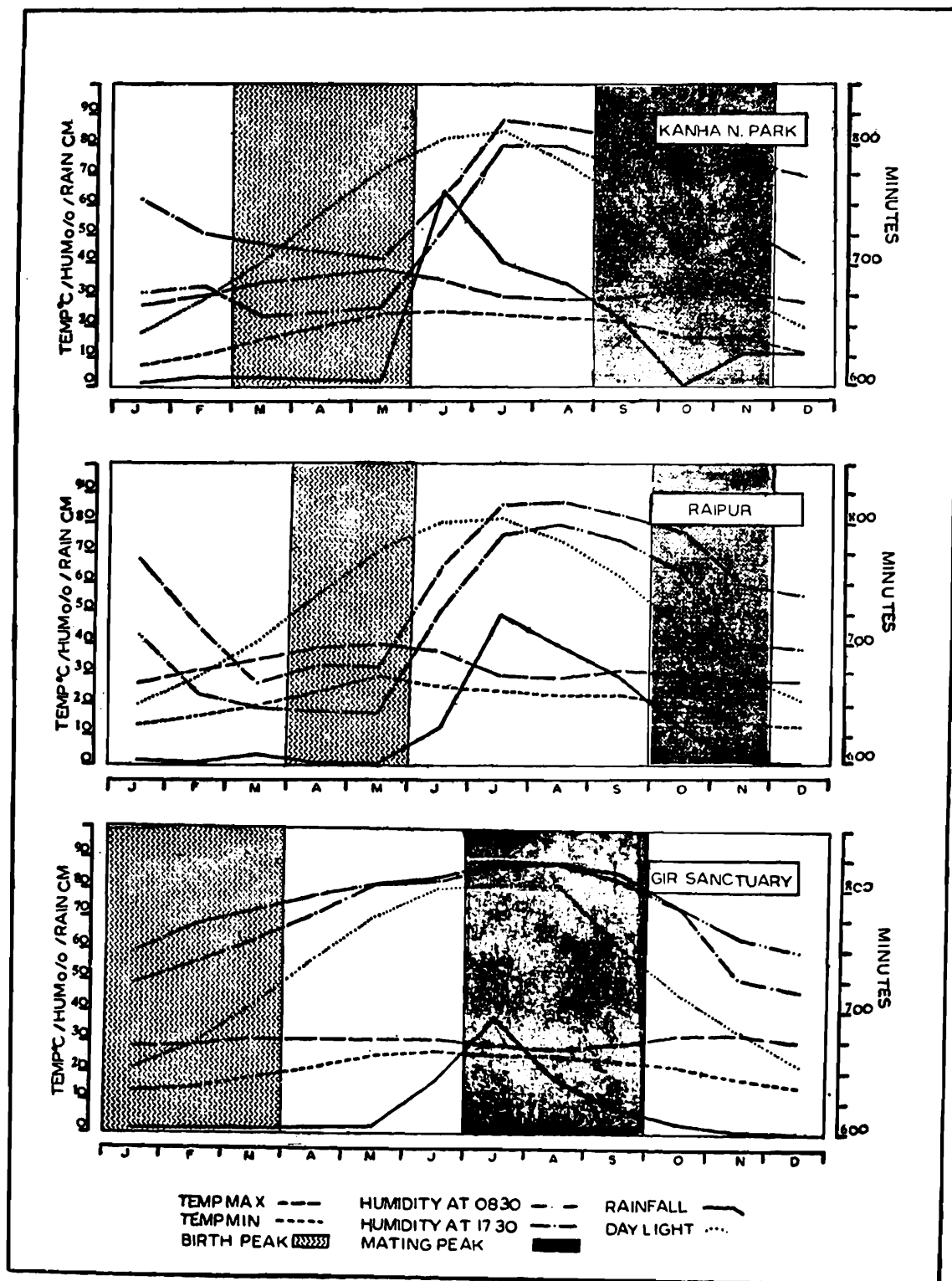
Sheet 1 depicts Simla, Kumaun Hills Solu Kumbhu



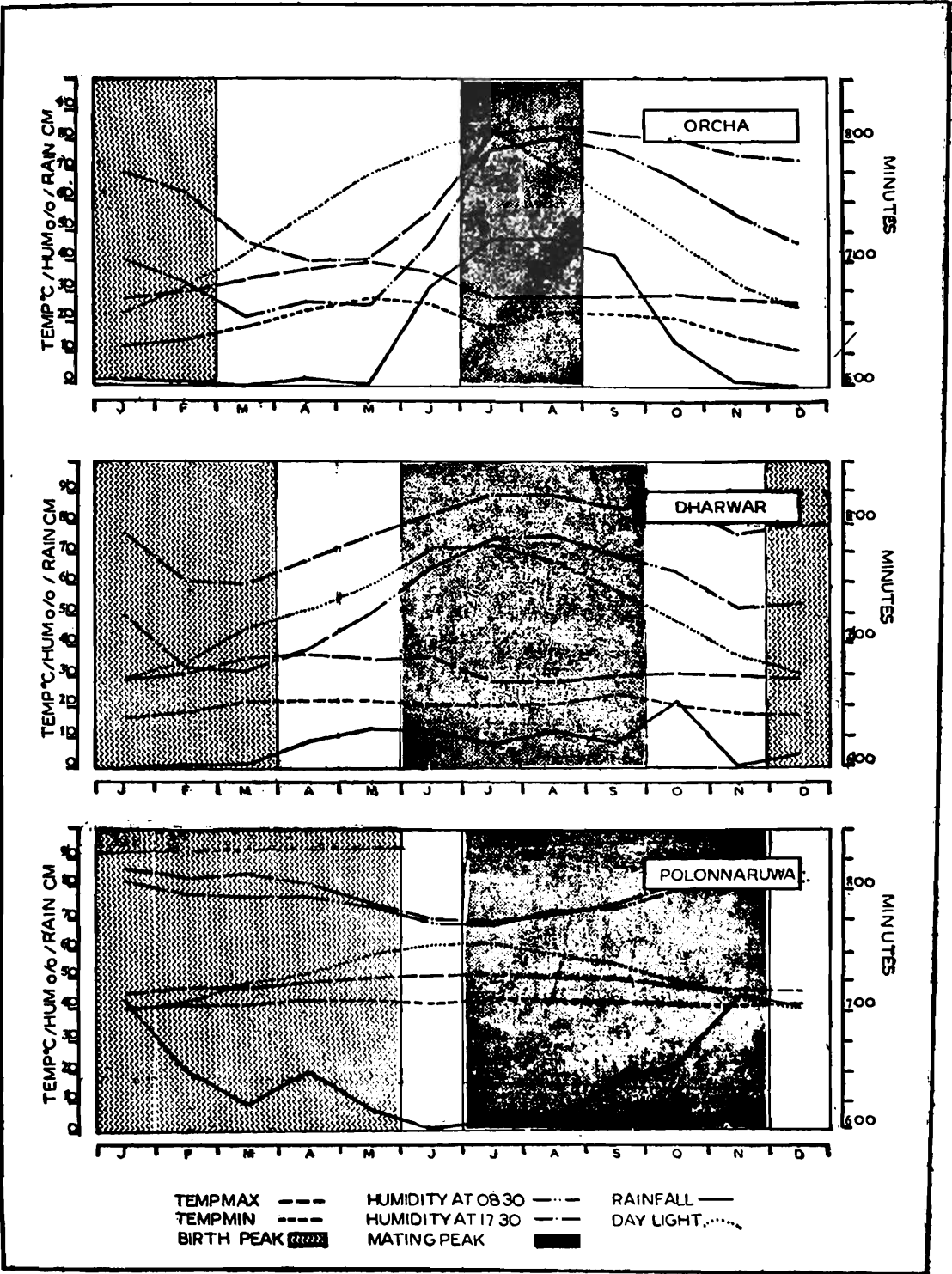
Sheet 2 depicts Jaipur, Sariska, Kaukori



Sheet 3 depicts Jodhpur, Mt. Abu, Singur



Sheet 4 depicts Kanha National Park, Raipur, Gir Sanctuary



Sheet 5 depicts Orcha, Dharwar, Polonnaruwa

Group Studies : Since the pioneering work of Prakash (1958, 1962), extensive field studies on Indian langurs in all regions of the subcontinent have revealed a wealth of information on the ecology and behavior of the species. The reported studies (Table 2) represent all types of social structure ; one-male, multi-male and all-male groups. Group size varies from 1 to 64 individuals and population density from 1.1 to 104 individuals/sq km. The highest number of males in comparison to females was recorded at Raipur (0.81) and lowest at Jodhpur (0.04) (SUGIYAMA, 1964) whereas the infant female ratio is highest at Melemchi (1 : 0.75) and lowest in the Kumaon Hills (1 : 0.22).

Reproductive Cycle : Female langurs reach sexual maturity at from 3-4 years of age (Dolhinow, 1972, Bogess 1976), and their first menstruation occurs at about 3.5 years (Harley, 1983). Menstrual bleeding occurs at about thirty day intervals and estrus midway between menstrual periods. Ovulation takes place on the 9th day from the start of menstrual bleeding. The female shows sign of receptivity during the menstrual cycle two days prior and 2-3 days after ovulation (Newman 1974). During this period females quiver their heads, lower their tails, and present themselves to males. The gestation period is recorded as 200 ± 10 days, or between six and seven months (Harley, 1983), followed by a lactation period of ten to twelve months (Dolhinow, 1972). The birth interval has been reported as 15-30 months ; during much of this time a mother is nursing her previous infant (Hrdy, 1977). The author has observed nursing females presenting to males. Hrdy (1977) has also reported this for a female of Toad Rock troop who gave birth to infants only fifteen months apart. The timing of these patterns of langur cycles vary across the Indian subcontinent, possibly in response to local and regional climatic factors (Vogel, 1977; Curtin and Dolhinow, 1978).

Pattern of Birth : A study of Table 4 reveals that all langur populations display distinct birth peaks, except those in Sariska and Singur. The range of peaks is 1-5 months within the annual cycle, usually in the first half of the year. All populations studied display a single birth peak, except in Jaipur where there are two. The birth peak occurs between December and June.

Because females of this species are polyestrous, there is a more or less uniform pattern of births throughout the year. Various factors may cause a deflection from this uniform pattern, leading to comparatively higher numbers of successful matings and resultant births in a particular period of the year (Moore, 1984). Such factors may be climatic, vegetational, social or psychological, but they are always

mediated through the physiology of the species. Such a condition may be brought about in females by the postponement or absence of ovulation, while in the male it may be through delayed spermatogenesis. No single factor is known to be responsible for these phenomena. An attempt has been made here to show how different factors play their roles.

Climatic Factors : A study of the Fig. 2 reveals that, in general, the onset of the peak in mating is associated with comparatively higher degree of precipitation, increasing humidity and decreasing temperature in almost all the study areas. Further investigations suggest two distinct orders in this general pattern. In the first, a mating peak coincides with the advent of the rainy season (Solu Kumbu, Jaipur, Mt. Abu, Gir Sanctuary, Orcha, and Dharwar). In the second, such a peak begins one to three months after the rainy season begins (Simla, Kumaon Hills, Kaukori, Jodhpur, Kanha National Park, Raipur and Polonnaruwa). It is hypothesized that these two different patterns may be attributed to the time rain takes to produce an increase in food supply. Apparently there is no association between the onset of a mating peak and the number of daylight hours.

Vegetation : The studies of the feeding ecology of Asian colobines have demonstrated the importance of diet to patterns of social behavior (Ripley 1968, Yoshida 1967). Table 3 shows the association between seasonal vegetational changes and langur reproductive events. The data indicate that the numerical abundance of plant species in different phenological stages coincides with the peak period of mating at Jodhpur and Dharwar and with a peak period of birth at Simla. A detailed study on the density of plants consumed by langurs is available only for Dharwar. Yoshida's 1967 data reveal that five species of plants (*Lantana aculeata* 20.3%, *Zizyphus rugosa* 19.2%, *Zizyphus xylopyra* 9.6%, *Zizyphus oenoplea* 7.3% and *Phyllanthus emblica* 5.1%) constituting more than 70% of the vegetation of the study area (Dharwar) had either fruits, flowers or fresh leaves during the peak mating period. Indirect information of food availability is available for Mt. Abu and Solu Khumbu, though without details on density. These data also support the idea that a mating peak coincides with abundance of food supply (Laws and Vonder Haar Laws, 1984).

Hrady (1977) wrote that "It would be significant, however, that an infant born in Dec. or Jan. would be taking some solid food by the time of the next monsoon (which is the period of mating peak). Maximum availability of nutritious food would coincide then with an

exceedingly vulnerable transition point in the life of a weaning infant." It is noteworthy that in the Himalayas the birth season comes in middle to late winter and spring. "Curtin (1975) notes that this places an additional burden on mothers at a time when food shortages are most severe. However the advantage to the growing infant of abundant moist foods from spring through fall (which is again the period of mating peak) may outweigh the hazards of winter birth" (Bishop, 1979).

DISCUSSION

The factors responsible for peak mating activities in langurs occur at different levels. Major environmental factors such as phenological patterns, modified by the pattern of rainfall, may act as a general timing influence that interacts with intrinsic mechanisms. Final co-ordination between the individuals within a group at the start of mating may then depend upon the female stimuli activating male responses and interactions between females. To confirm these hypotheses, information is needed on the influence of such factors as rainfall pattern and subsequent phenological changes based on field studies of longer duration.

All climatic variables considered independently fail to reveal any correlation between a mating peak and climatic factors. However, it is suggested that the seasonal pattern of rainfall that follows a marked drop in temperature, increase in humidity and change in phytophase agrees with the results of other studies available (*Presbytis senex*, Rudran, 1973; *Macaca mulatta*, Koford 1965). The amount of rain that could initiate a mating peak varies from 5% in dry scrub habitat to 100% where the habitat is cultivated field (Table 4). Though no generalization could be made with respect to the kind of habitat and amount of rainfall required to initiate a peak, it is most likely the result of a combination of more than one variable, including precipitation.

CONCLUSIONS

The following general points emerge from the study.

1. There is no simple correlation of latitude with the onset of peak in conception, and hence with number of daylight hours.
2. Different amounts of rain could initiate the breeding activities. It may range from 5% to 100% of the total rainfall in the particular locality. Probably it depends on the percentage of rainfall that could produce desired effects, which may vary from place to place and individual to individual.

TABLE 4. Various Environmental Factors At The Beginning And End of The Mating Peak In D

AT BEGINNING OF MATING PEAK

RAIN*	TEMPERATURE °C		HUMIDITY%		DAY L.	HABITAT	J F M A M J J A S O N D												LOCALITY
	MAX.	MIN.	8 AM	5 PM															
90 D	20 D	12 D	80 D	83 D	768 D	MOIST TEMPERAT			○	○	○								SIMLA
90 D	18 D	9 D	49 D	61 I	710 D	HIGH ALTD. M. F.				○	○								KUMAON HILL
			DATA INSUFFICIENT			HIMALAYA TEMP, F.			○	○	○								MELEMCHI
10 I	15 S	2 I	88 I	—	823 I	CONIFEROUS F.	○	○	○	○								○	SOLU KUMBU
10 I	33 I	25 D	79 I	65 I	829 S	CITY DWELLING	○	○	○	○	○								JAIPUR
100 D	NO MATING PEAK					DRY SCRUB													SARISKA
100 D	28 D	11 D	69 I	54 S	663 D	CULTIVATED FIELD				○	○								KAUKORI
80 S	36 D	24 S	68 D	41 D	771 D	OPEN SCRUB			○	○	○								JODHPUR
5 I	30 D	20 D	64 I	52 I	814 I	DRY SCRUB	○	○	○										Mt ABU
	NO MATING PEAK					VILLAGE DWELL.													SINGUR
80 D	29 I	22 D	83 D	73 D	756 D	DRY & MOIST DEC.			○	○	○								KANHA N. P.
80 D	31 D	21 D	77 D	64 D	713 D	DRY OLD SCRUB				○	○								RAIPUR
20 I	29 S	26 S	88 S	89 S	804 S	DECIDUOUS	○	○	○										GIR SANCT.
20 I	28 S	21 I	89 I	74 I	782 D	MOIST DECIDUOUS	○	○											ORCHA
26 I	31 S	21 S	83 I	65 I	780 I	DRY DECIDUOUS	○	○	○										DHARWAR
44 I	51 S	43 S	68 I	67 I	754 D	DRY DECIDUOUS					○								POLONNARUW

* Percent of the total rain till mating peak starts

D Decreasing trend

I Increasing trend

● Mating peak

S Steady trend

○ Birth peak

◇ Rainy season

fferent Localities.

AT END OF MATING PEAK

SUBSPECIES	TEMPERATURE °C		HUMIDITY %		DAY L.
	MAX.	MIN.	8 AM	5 PM	
SCHISTACEUS	15 D	7 D	36 I	58 S	652 D
S ENTELLUS	15 D	6 D	46 I	64 D	660 D
SCHISTACEUS	DATA INSUFFICIENT				
ACHILIES	9 D	7 D	33 I	66	661 D
ENTEELLUS	29 D	13 D	53 I	35 I	663 D
ENTEELLUS	NO MATING PEAK				
SCHISTACEUS	25 D	10 D	76 I	55 I	633 D
ENTEELLUS	25 D	12 D	61 D	35 D	636 D
ENTEELLUS	24 S	17 S	82 D	75 D	762 D
ENTEELLUS	NO MATING PEAK				
ENTEELLUS	31 D	17 D	75 D	53 D	665 D
ENTEELLUS	29 D	15 D	60 D	40 D	677 D
ENTEELLUS	30 I	25 D	86 D	84 D	754 D
ANCHISES	29 S	24 S	85 D	80 D	778 D
ACHATES	30 S	20 S	85 D	68 D	746 D
A THERSITES	46 S	41 S	88 I	81 I	709 D

3. There are two pattern, either mating peak coincide with peak in rainfall or it follows 1-3 months after peak period of rainfall. The probable reason for these two patterns is the different amount of time that rain takes to increase available food, cause a drop in annual temperature and increase humidity.

4. The climatic data, especially distinct peaks in rainfall at Sariska and Singur suggest that studies of longer duration may reveal the existence of peak periods of breeding in these localities.

SUMMARY

The reproductive activities of *Presbytis entellus* are correlated with various environmental factors. It was found that, in general, the mating peak in the annual reproductive cycle of langur populations is associated with higher degree of precipitation, increasing humidity and decreasing annual temperature. Within this trend there are two distinct patterns : (1) peaks in mating and rainfall coincide, or (2) the peak in mating follows one to three months after the peak period of rainfall.

Key words : *Presbytis entellus* : Indian subcontinent ; reproductive cycle, environmental factors.

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COMPARATIVE ANATOMY OF THE THORAX OF LARVAL ODONATA, PROTHORAX

By

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INTRODUCTION

Both adult and larval thorax in Odonata have been studied by several morphologists. Asahina (1954) and Chao (1953) have taken up the thorax of adult Azygopterous forms. Cowley (1941) gave descriptive terms to the pterothorax, Hakim (1963) has described the thorax of twelve species of adult Odonata and Trottier (1969) has made attempts at the morphology of certain *Sympetrum* larvae. But none of the workers have, however, paid attention to the thorax of the larvae of Zygopterous forms. In the present paper, detailed morphology of the prothorax of six species of zygopterous larvae namely *Pseudagrion decorum*, *Copera marginipes*, *Ischnura delicata*, *Ischnura senegalensis* of the Coenagriidae family, *Ceriagrion coromandelianum* of Platycnemidae and *Libellago lineata* belonging to the Chlorocyphidae family have been taken up in order to elucidate this aspect. The methods employed are the same as described by Hakim (1963).

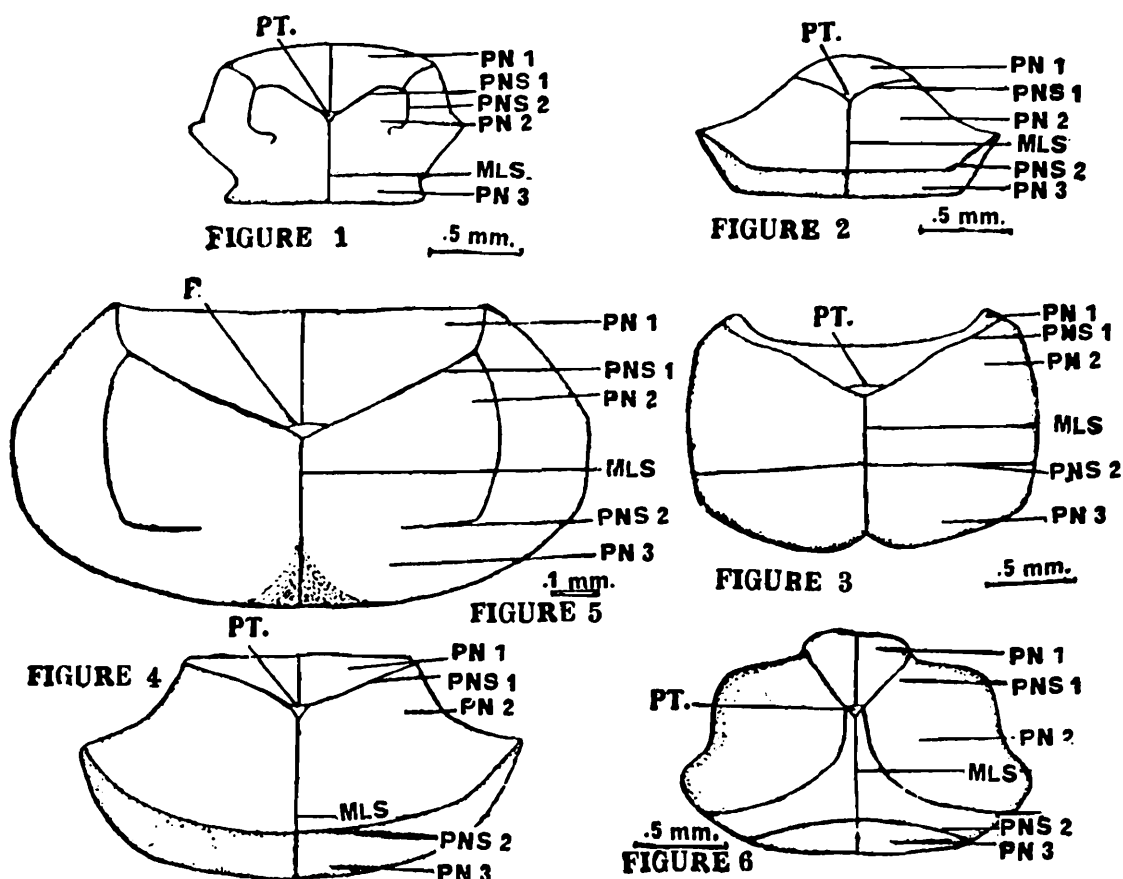
THE PROTHORAX

It is the shortest of the three thoracic segments and is separated from the mesothorax by a membrane.

The *pronotum* (Fig. 1 to 6). It is a strongly sclerotised plate and is divisible into three sub-regions, an anterior, a middle and a posterior. The anterior pronotal sclerite (PN 1) occupies about one fourth of the entire pronotal region. It is demarcated from the middle sclerite by the first pronotal sulcus (PNs 1). In the middle of this sulcus is a pit (PT) which leads into a long pronotal apophysis. The middle pronotal sclerite (PN 2) lies in between the first and the third divisions of pronotum; it is usually the largest of the three sub-divisions and constitutes about half of the pronotum. The hind limit of this sclerite is marked by the second pronotal sulcus (PNS 2). The middle sclerite is traversed by a short mid longitudinal sulcus (MLS) which joins the

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first pronotal sulcus in the front and the second pronotal sulcus behind. The posterior pronotal sclerite (PN 3) is almost as large as the anterior sclerite.



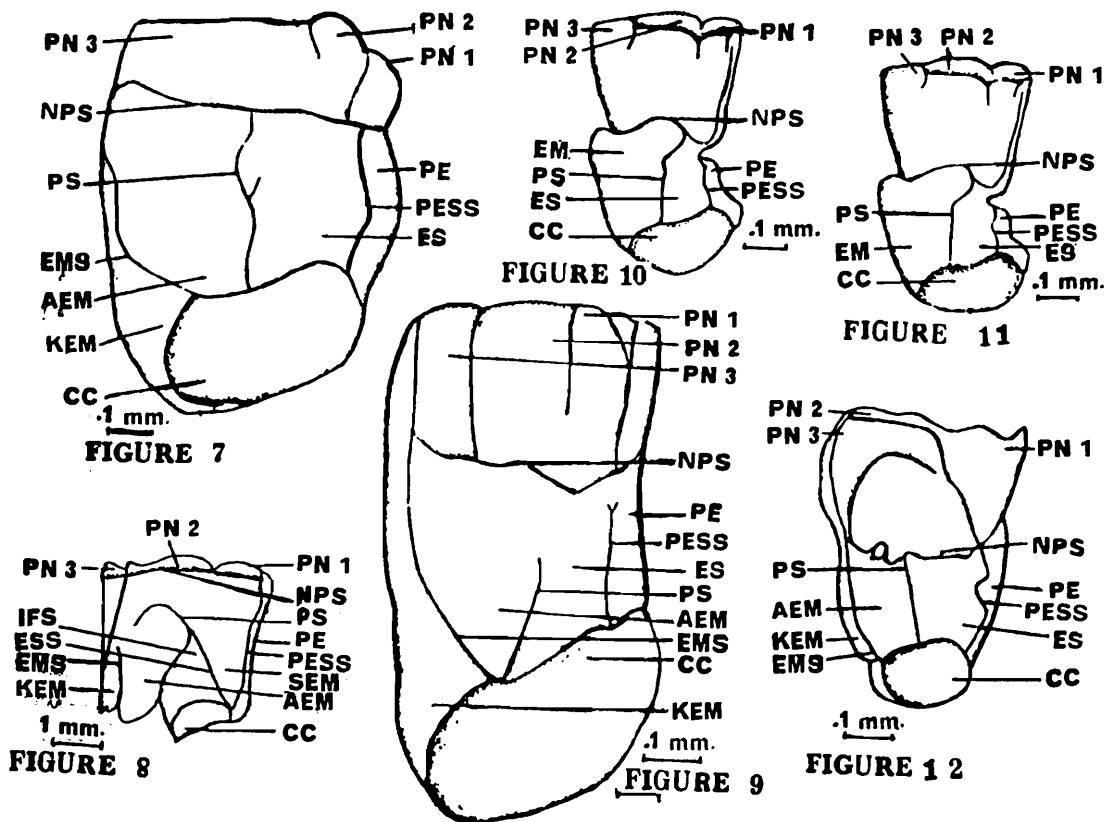
Figs. 1-6. Dorsal view of the Prothorax of Larval forms.

1. *Copera marginipes*, 2. *Pseudagrion decorum*, 3. *Ceriagrion coromandelianum*,
4. *Ischnura delicata*, 5. *Ischnura senegalensis*, 6. *Libellago lineata*.

In *Copera marginipes*, *Ischnura delicata*, *Ischnura senegalensis* and *Libellago lineata* the anterior pronotal sclerite is sub-divided into two lateral parts by a median longitudinal sulcus (MLS) it remains undivided in *Pseudagrion decorum* and *Ceriagrion coromandelianum*. The sclerite is triangular in all the species. The middle pronotal sclerite remains clearly differentiated from the posterior pronotal sclerite by a complete second pronotal sulcus (PNS 2) in *Pseudagrion decorum*, *Ceriagrion coromandelianum*, *Ischnura delicata* and *Libellago lineata*. Second pronotal sulcus is incomplete in *Copera marginipes* and *Ischnura senegalensis*.

The *propleuron* (Fig. 7 to 12). It is also a large sclerotised plate and is united with the notum above, the junction being marked by a sulcus the notopleural sulcus (NPS). Ventrally the pleuron is united with the sternum in its front and in the hind part it forms the dorsal margin of the coxal cavity (CC). The propleuron is differentiated into three parts, the pre-episternum, episternum and epimeron which are situated one behind the other.

The *pre-episternum* (PES) is the anterior most of the pleuron and is slightly overlapped by the second lateral cervical sclerite. Its shape, relative size and position varies in different forms. The pre-episternum extends from notopleural to the sternopleural junction. It is a narrow, biconvex sclerite. This sclerite remains marked posteriorly by the pre-episternal sulcus (PESS).



Figs. 7-12. Lateral view of the Prothorax of Larval forms.

7. *Copera marginipea*, 8. *Pseudagrion decorum*, 9. *Ceriagrion coromandelianum*, 10. *Ischnura delicata*, 11. *Ischnura senegalensis*, 12. *Libellago lineata*.

The *episternum* (ES) is some what traingular, the base of which is formed by its ventral margin and its apex is dorsal. It occupies about half of the pleuron, the episternum is demarcated from epimeron behind by a pleural sulcus (PS). The front part of the base of the episternum is limited by the sternopleural sulcus and the hind part by the coxal cavity (CC). The entire ventral margin of the episternum forms the upper boundary of the coxal cavity.

In *Copera marginipes*, *Ischnura delicata*, *Ischnura senegalensis* and *Libellago lineata* the pleural sulcus is complete and reaches the noto pleural sulcus (NPS). It is incomplete in *Pseudagrion decorum* and *Ceriagrion coromandelianum*.

The *epimeron* (EM) is also some what triangular and occupies almost half of the pleural region. Its dorsal and anterior limits are marked by notopleural (NPS) and pleural sulcus (PS) respectively.

The posterior margin is slightly wavy in *Copera marginipes* rounded in *Pseudagrion decorum*, *Ischnura delicata*, *Libellago lineata* and straight in *Ceriagrion coromandelianum* and *Ischnura senegalensis*. In *Copera marginipes*, *Pseudagrion decorum*, *Ceriagrion coromandelianum*, *Libellago lineata* the epimeron is differentiated into an anterior large *anepimeron* (AEM) and a posterior, narrow, *katepimeron* (KEM) by an epimeral sulcus (EMS) which extends from the ventral ends of the pleural sulcus, dorsal upto the notopleural junction.

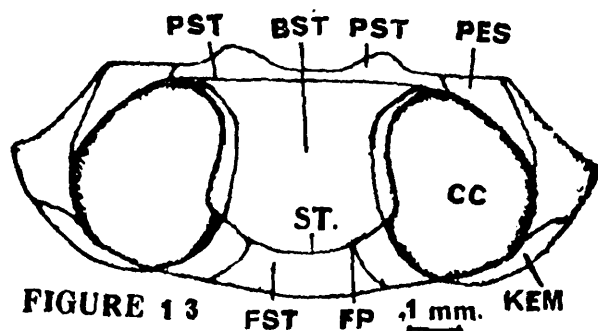


FIGURE 13

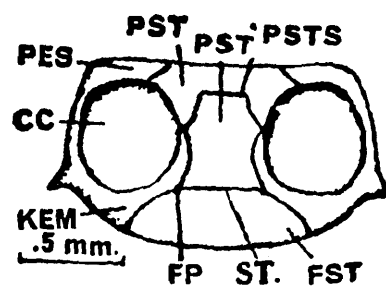


FIGURE 14

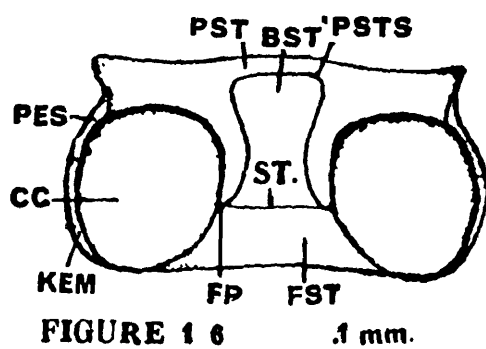


FIGURE 15

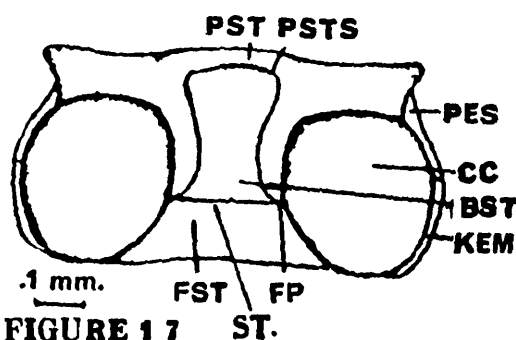


FIGURE 16

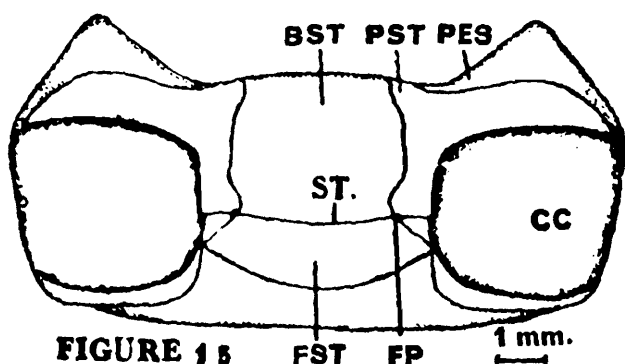


FIGURE 17

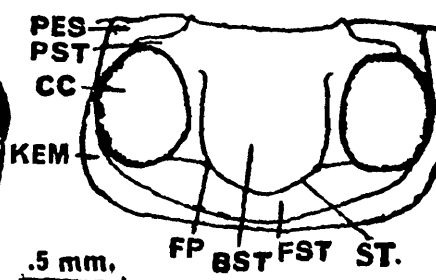


FIGURE 18

Figs. 13-18. Ventral view of the Prothorax of Larval forms.

13. *Copera marginipes*, 14. *Pseudagrion decorum*, 15. *Ceriagrion coromandelianum*, 16. *Ischnura delicata*, 17. *Ischnura senegalensis*, 18. *Libellago lineata*.

The *prosternum* (Fig. 13 to 18). It is a well sclerotised mid ventral area of the segment which is broader than long. Laterally the sternum is united with the pleuron. The sternum consists of presternum, basisternum and the furcasternum, situated one behind the other.

The *presternum* (PST) shows remarkable differences in its position, shape and size in different forms. In *Copera marginipes*, *Pseudagrion decorum*, *Ischnura delicata* and *Ischnura senegalensis*, it is characterized

by broad lateral areas and a narrow middle region which forms a bridge uniting the two lateral areas. The latter are situated one on either side of basisternum and the middle area lies in front of the basisternum. The uniting bridge is much reduced in *Ceriagrion coromandelianum* and *Libellago lineata*. The pre-episternum is demarcated from the basisternum by a presternal sulcus (PSTS).

The *basisternum* (BST) is broad, plate like structure. It lies behind presternal sulcus, the sternal suture (ST) separates the basisternum and the furcasternum (FST). A pair of furcal pits lie between the two coxal cavities. The position of furcal pits differs from species to species. The furcal pits in *Ischnura delicata* and *Ischnura senegalensis* are situated some what nearer to the coxal cavities, in *Copera marginipes*, *Pseudagrion decorum*, *Ceriagrion coromandelianum* and *Libellago lineata* they are situated at a farer distance from it.

DISCUSSION

In larval forms the *pronotum* is divisible into three regions, an anterior (PN 1), a middle (PN 2) and a posterior (PN 3) as in adult Odonata (Hakim 1963). The anterior pronotal sclerite is demarcated from the middle sclerite by first pronotal sulcus (PNS 1) bearing pronotal apophysis. This has been regarded as phragma of the pronotum by Garman (1917), Clark (1940) and Asahina (1954), Hakim (1963) interpretes this as an apophysis. We agree to Hakim's interpretation. In *Copera marginipes*, *Ischnura delicata*, and *Libellago lineata* the anterior pronotal sclerite is traversed by a mid longitudinal sulcus while in *Pseudagrion decorum* and *Ceriagrion coromandelianum*, the mid longitudinal sulcus is absent as in adult forms (Hakim, 1963). The hind limit of first pronotal sclerite is marked by second pronotal sulcus (PNS 2) which is incomplete in *Copera marginipes*, and *Ischnura senegalensis* as in *Hemimax* and complete in *Ceriagrion coromandelianum*, *Ischnura delicata*, and *Libellago lineata* as in *Ictinogomphus* and *Crocothemis* (Hakim, 1963). The middle pronotal sclerite is also traversed by a mid longitudinal sulcus which joins the first pronotal sulcus in front and second pronotal sulcus behind as in adult Odonata (Hakim, 1963). The mid longitudinal sulcus extends on the posterior pronotal sclerite through out it's mid length and not for a short distance as in *Hemianax* (Hakim, 1963).

In all the larval forms the *propleuron* is united with the notum above, the junction is marked by a complete notopleural sulcus (NPS) as in *Lestis* (Hakim, 1963). Ventrally the pleuron is united with the sternum in its front part and in the hind part it forms the margin of

the coxal cavity (CC) as in adult forms (Hakim, 1963). The propleuron is differentiated into pre-episternum, episternum and epimeron. The *pre-episternum* (PES) is the anterior most region of pleuron. In *Copera marginipes*, *Pseudagrion decorum*, *Ceriagrion coromandelianum* and *Libellago lineata*, it extends from notopleural to sterno pleural junction as in *Lestes*, it is narrow and by convex sclerite in *Ischnura delicata*, and *Ischnura senegalensis* as in *Ictinogomphus* (Hakim, 1963). This sclerite is marked posteriorly by the pre-episternal sulcus (PESS) in all the larval forms while it is absent in adult Libulids (Hakim, 1963). The *episternum* (ES) occupies about half of the pleuron in all the larval forms as in adult Zogoptera, it occupies only one third of it in Azygopterous adult forms (Hakim, 1963). The episternum remains demarcated from the epimeron by a pleural sulcus (PS). The pleural sulcus is complete in *Copera marginipes*, *Ischnura delicata*, *Ischnura senegalensis* and *Libellago lineata* as in adult *Lestes*, *Hemianax*, *Ictinogomphus* and *Crocothemis*, it is incomplete in *Pseudagrion decorum* and *Ceriagrion coromandelianum*, as in adult *Pseudogrion* (Hakim, 1963). The episternum is undivided and is not differentiated into supra and infra episternum as in adult *Hemianax* (Hakim, 1963). *Epimeron* (EM) occupies half of the pleural region and is differentiated into an anterior large anepimeron (AEM) and a posterior narrow *Katepimeron* (KEM) by a epimeral sulcus (EMS) as in adult forms (Hakim, 1963). These observations are at variance with those of previous workers (Snodgrass, 1909 ; Tillyard, 1917 ; Garman, 1917 and Chao, 1953) who regarded the epimeron as an undifferentiated sclerite and consider the kat-epimeron as the ventral extension of the posterior notal sclerite.

The *prosternum* consists of pre-sternum (PST) ; basisternum (BST) and furca sternum (FST). In *Copera marginipes*, *Pseudagrion decorum*, *Ischnura delicata* and *Ischnura senegalensis* the presternum (PST) is characterised by broad lateral and a narrow middle region which form a bridge uniting the two lateral areas as in *Ictinogomphus* and *Hemianax* (Hakim, 1963). The uniting bridge is much reduced in *Ceriagrion coromandelianum*. In *Copera marginipes*, *Ceriagrion coromandelianum* and *Libellago lineata* the pre-sternal sulcus is transverse as in *Ictinogomphus* and *Hemianax*, it is inverted V shaped in *Pseudagrion decorum*, *Ischnura delicata*, and *Ischnura senegalensis* as in adult pseudagrion (Hakim, 1963). The *basisternum* is plate like the sternal suture separates the basisternum (BST) and the furca sternum (FST). In *Ischnura delicata*, *Ischnura senegalensis* furcal pits (FP) are situated nearer to the coxal cavities. In *Copera marginipes*, *Pseudagrion decorum*, *Ceriagrion coromandelianum* and *Libellago lineata* these lie at a distance

from the coxal cavities. The *furcasternum* is quite large and forms half of the sternal region as in adult zygepterous forms (Hakim, 1963).

SUMMARY

The prothorasic pronotum is divisible into anterior, middle and posterior pronotal sclerites. The first pronotal sulcus demarcates the anterior sclerite. The second pronotal sulcus separates middle and the posterior sclerites. Middle and posterior pronotal sclerites are traversed by a mid longitudinal sulcus.

The propleuron is demarcated from notum by, notopleural and from sternum by sterno pleural sulcus. The propleuron is differentiated into three parts the pre episternum episternum and epimeron. The pre-episternum extends from noto pleural to the sterno-pleural junction. The episternum is a triangular plate like structure and remains demarcated from epimeron behind by a pleural sulcus. The epimeron is differentiated into an anterior epimeron and a posterior katepimeron by an epimeral sulcus.

The prosternum is longer than its breadth. It forms the ventral boundary of the coxal cavities. It consists of presternum, basisternum and the furcasternum situated one behind the other. The presternum is demarcated from the basisternum by presternal sulcus. The sternal suture separates the basisternum and the furca sternum. The position of furcal pits differs in various species.

Extent of various sclerites of prothorax and demarcations of sulci have been described and their interspecific variations discussed.

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ABBREVIATIONS

AEM—Anepimeron, BST—Basisternum, CC—Coxal cavity, EM—Epimeron, EMS—Epimeral sulcus, ES—Episternum, ESS—Episternal sulcus, FP—Furcal pit, EST—Furca sternum, IFS—Infra episternum, KEM—Kat epimeron, MLS—Mid longitudinal sulcus, NPS—Notopleural sulcus, PES—Pre episternum, PESS—Pre episternal sulcus, PN1—Anterior pronotal sclerite, PN2—Middle pronotal sclerite, PN3—Posterior pronotal sclerite, PNS—1—First pronotal sulcus, PNS2—Second pronotal sulcus, PS—Pleural sulcus, PST—Pre-sternum, PSTS—Pre-sternal sulcus, PT—Pit, ST—Sternal suture.

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A NEW SPECIES OF PALM CIVET FROM ORISSA, INDIA

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AND

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INTRODUCTION

Faunal survey of the Tiger Reserves in India were taken up by the Wildlife & Conservation Division of the Zoological Survey of India since 1983. In this connection a team of scientists visited the Simlipal Tiger Reserve, Mayurbhanj district, Orissa from January 23 to February 10, 1986. During the survey several species of mammals were collected. Of which a Palm Civet was found to be interesting. On examination, it proved to be a new species which is being described below.

***Paradoxurus jorandensis* sp. nov.**

(Plate I, Figs. 1-6)

Material examined : Holotype, ZSI, Reg. No. 21496, subadult male, Joranda (Lat. 20°45'N Long. 85°40'E, Alt. 440m), Simlipal, Mayurbhanj, Orissa, India ; 30 Jan 1986 ; collector *S. M. Ali* ; study-skin and skull.

External measurements (mm) : Head and body 463 ; tail 518 ; hind-foot 70 ; ear 50. Weight 4.8 kg.

Cranial measurements (mm) : Greatest length 96 ; condylobasal 95.2 ; occipitonasal 89.1 ; palate 43.3 ; Zygomatic width 48.3 ; interorbital width 15.3 ; postorbital width 13.8 ; maxillary width 14.7 ; cranial width 31.8 ; bulla 15.2 ; nasal 20.3 ; anterior palatal foramina 4.35 ; pm⁴ 7.2 ; m₁ 8.7 ; mandibular length 69.1.

Medium-sized, head and body smaller than tail ; latter about seven and a half times longer than hindfoot.

Head broad, muzzle narrow, without white patch on either side ; facial vibrissae black ; rhinal sulcate ; ears large and erect ; preaural white patch absent ; eyes greenish black, with a continuous subcircular thin white patch beneath and one superciliary above them ; upper eyelids, each with three long hairs, identical to facial vibrissae in length and colour.

Digits of hindfoot five in number, evenly spaced except third and fourth which have their pads joined proximally ; plantar pads white and naked ; claws white, protected with sheaths and full retractile.

Scent gland simple in structure, represented by a fold of skin ; space between anus and posterior edge of fraenum of penis hairy.

Coat : Luxuriant ; dorsal surface of body grey, grizzled black and white. Pelage consists of two types of hairs : (a) long and entirely black ; (b) short and tricoloured, grey on basal one-third, white in middle and black at tip ; underwool grey. Body has a distinct white band (50 to 80 mm in width) encircling abdomen ; distal half of tail white ; nearly half of hand, and hindfoot up to heel white.

On ventral surface, white band extends posteriorly along mid-line up to anus and also continues up to inner side of hindlegs to merge with white stockings. A distinct white V-shaped marking on chest present, with its arms extending to elbow.

Skull : Skull not ossified ; in each half of both jaws there are three incisors, one canine and four cheekteeth, presumably three premolars and one molar. First premolar and second molar have not erupted.

Relationship : *Paradoxurus jorandensis* sp. nov. is close to *Paradoxurus hermaphroditus* (Pallas) but differs from it in the following characters :

<i>Paradoxurus jorandensis</i>	<i>Paradoxurus hermaphroditus</i>
1. Stripes and spots over body absent but a broad white band encircling the abdomen present.	1. Longitudinal stripes on back and shoulders and spots on flanks and thighs present.
2. Underwool grey.	2. Underwool whitish or yellowish.
3. Limbs with distinct white markings.	3. Limbs dark brown or black.
4. Space between anus and posterior edge of fraenum of penis hairy.	4. Space between anus and posterior edge of fraenum of penis naked.
5. Preaural white patch absent.	5. A preaural white patch present.

Distribution : This animal is said to be common in southern part of Simlipal Tiger Reserve, Orissa, covering the area south of Joranda, namely, Gorandi, Janabil and upper Barakamra. Animal of similar description is also said to occur in Hazaribagh National Park, Bihar (Per. Comm. Shri A. C. Chatterjee, Field Director, Palamau Tiger Reserve, Bihar).

Ecological notes : The animal was sighted at about 19.30 hrs near a stream c 300 m SW of Joranda Forest Rest House. On being alerted it climbed on a nearby tree from where it was collected.

Its stomach contained boiled rice, potatoes, green peas, besides fragments of spices. It shows that this animal was partially surviving on the food refuges of tourists.

Discussion : Taylor (1891) described a new species of palm civet, namely *Paradoxurus nictitans*, based on an immature specimen collected from Kondmal, Orissa. Pocock (1934) opined that the above specimen in all probability was albinistic. But since it possessed some characters which markedly differed from *P. hermaphroditus* he (loc. cit.) provisionally admitted it as a distinct subspecies of *P. hermaphroditus*, pending the collection of additional material. He also assigned two more male specimens (unmeasured and undated) from the type locality, collected by Taylor, and present in the British Museum, to this subspecies and remarked that all the three are albinistic.

The type specimen of *P. nictitans* had only the head and shoulders normally coloured, the rest being white. The other two skins assigned to this subspecies have a broad white belt encircling the hind body and extending forwards and backwards over the ventral surface ; the feet and the terminal third or more of the tail are white, but the extent of the white varies in the two.

We have no comment on the validity of the species, *P. nictitans*. But our specimen from Simlipal is not albinistic as its eyes were greenish black and the claws white at the time of death. Further, it differs from *P. nictitans* in colour pattern. Our specimen tallies well with the description of the two undated, unnumbered and unmeasured skins present in the British Museum. It appears that Pocock (1934) erroneously assigned those two skins to *nictitans*. Taylor (1891) has neither mentioned nor included those skins in his original description of the species. Since the colour pattern is very distinct in all the three examples including those two skins of British Museum and a population occurs in nature since 1934, if not earlier, hence we accommodate our specimen under a new species, *P. jorandensis*. Further, it is proposed that those two skins of British Museum may also be placed under this new species.

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1



2

Paradoxurus jorandensis sp. nov.

Fig. 1. Dorsal view of *P. jorandensis* sp. nov.

Fig. 2. Ventral view of the above.

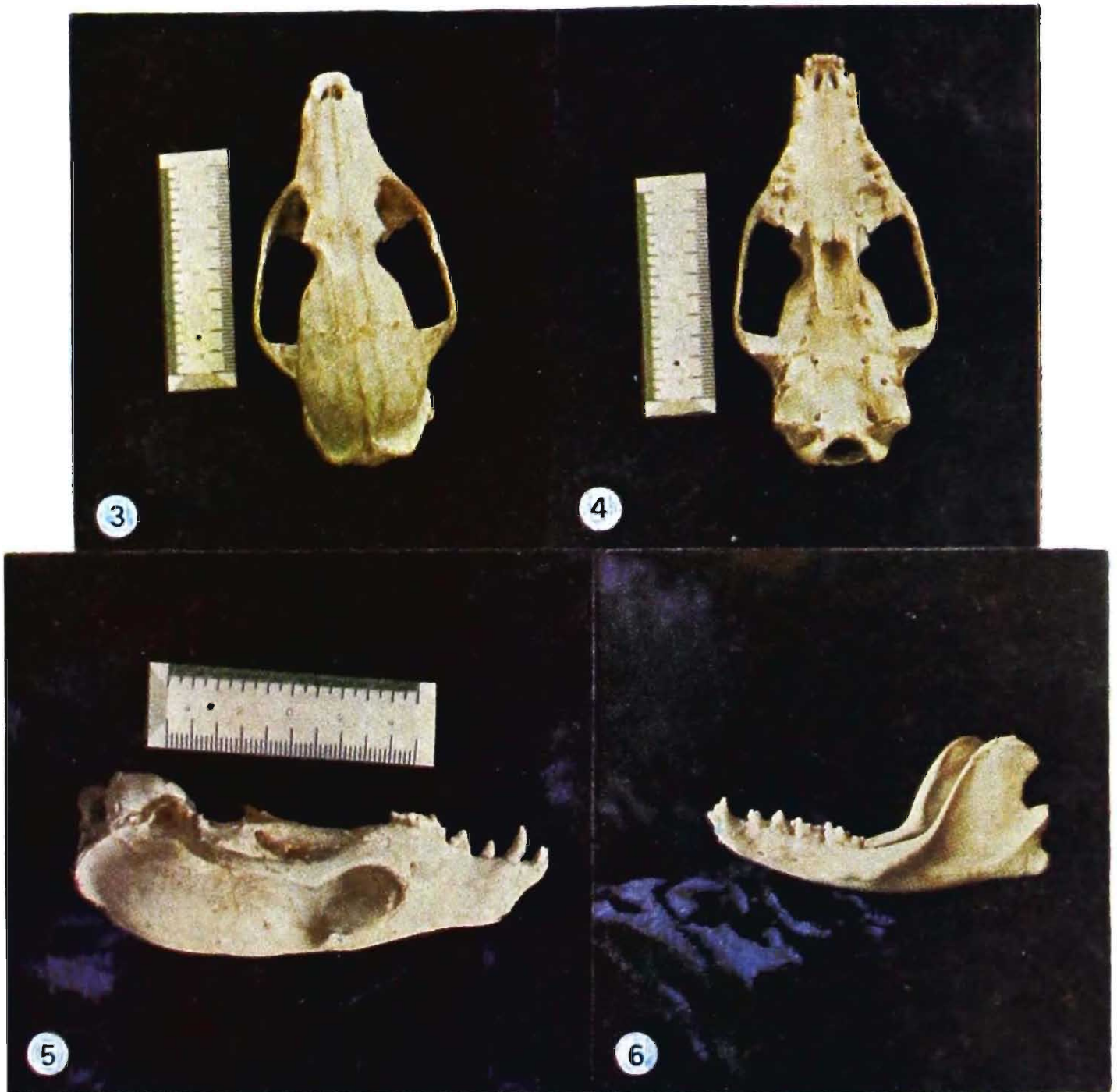


Fig. 3. Dorsal view of its skull.
Fig. 4. Ventral view of its skull.
Fig. 5. Lateral view of the skull.
Fig. 6. Lateral view of the lower jaw

FAUNISTIC COMPOSITION OF AQUATIC INSECTS OF
EASTERN BIHAR WITH NOTES ON THEIR SOME
ASPECTS OF ECOLOGY

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INTRODUCTION

In the present studies about 71 species of aquatic insects belonging to orders Coleoptera, Hemiptera, Diptera, Odonata and Ephemeroptera have been encountered and enlisted from various freshwater bodies of eastern Bihar. In Coleoptera, the families Dytiscidae and Hydrophilidae and in Hemiptera, the families Corixidae, Nepidae, Notonectidae and Belostomatidae were found to be dominant by their adults and larvae/nymphs. In Diptera members of the family Chironomidae and in Ephemeroptera the members of the family Baetidae were found to be dominant in such aquatic systems. In Odonata the members belonging to families Gomphidae, Libellulidae, Cordulegastridae and Coenagriidae have been recorded. The abundance of these insects in the aquatic environment has been found to be correlated with the seasonal growth of floating and submerged vegetations.

Insects are the earth's most varied organisms and play an important role in biological or ecological regulation of the environment. About 50.8 per cent of the species of living beings and 72 percent of all animals are insects (Daly *et al.*, 1978). About 3% of the total insects or about 25,000 to 30,000 species of insects are aquatic or semiaquatic (Cheng. 1976). Of these only a fraction, perhaps several hundred species are marine or intertidal. These insects live in or on the surface of the still or running waters and are more or less specially adapted to the peculiarities of this mode of life. They are derived from the terrestrial insects and there is no demarcation line between terrestrial and aquatic insects. These insects are generally the most conspicuous forms of life in aquatic systems which in view of their extremely varied habits, wide distribution and countless adaptation, have occupied a dominant position in the freshwater communities.

The aquatic insects are taxonomically diverse and fascinating in structure and biology, and some of them such as mosquitoes and midges, are of great importance to public health. These insects constitute an integral part of the freshwater communities. They also

form natural fish foods in nurseries and rearing fish ponds. Certain aquatic insects are however, predators and parasitoids on fish fry populations and compete directly with them for food. The structural and functional analysis of the aquatic insect community will be helpful in the detection of pollution of inland waters and therefore, considered promising organisms for use in pollution monitoring because of their ease of collection and large number of species (Hilsenhoff, 1977). Their eggs and early larval stages are particularly sensitive to water quality (Roy and Sharma, 1983). These insects are also of concern to those involved in outdoor recreational activities since certain of its members are frequently pests of man and animals in water-based recreational environments. Thus, amongst the various components of freshwater ecosystem, the subsystem comprising aquatic insects play an important role in energy flow, detection and prevention of pollution, control of aquatic weeds and regulation of aquatic environment.

Since the publication of fauna of British India, Odonata (Vol. 1-3) by Fraser (1933, 1936) and Rhynchota (Vol. 3-5) by Distant (1906, 1910), a number of important treatises on Odonata and Rhynchota-Heteroptera have appeared. The taxonomy of larval odonates from Dehradun Valley has been studied in recent years by Kumar (1973a, b). Coleoptera as a whole has been received much attention from early taxonomists, morphologists and fishery biologists (Sharp, 1890 ; Wilson, 1923-24 and Balfour-Browne, 1950). However, field observations on this interesting group are few. Tonapi (1959) and Tonapi and Ozarkar (1969) have studied the taxonomy of Heteroptera and Coleoptera of Poona (Maharashtra). Vazirani (1967) in his series of papers has studied certain aspects of taxonomy of aquatic beetles specially of family Dytiscidae. The beetles of the families Dytiscidae, Haliplidae and Amphizoidae of the Indian Region has been intensively investigated in a series of papers (Guignot, 1954a, b). The Asian Hydrophilidae, Gyrinidae and beetles belonging to various other aquatic and semi-aquatic families and very poorly known. Alfred (1973) has studied the taxonomy of family Chironomidae at Madurai (South India).

Practically no information is available regarding the aquatic insect fauna and their systematic position inhabiting the freshwaters of this north-eastern region of India. In the present studies an attempt has been made to enumerate the aquatic insects inhabiting the freshwaters of eastern Bihar.

MATERIALS AND METHODS

The aquatic insects were collected from the lentic (ponds) as well lotic (Ganges) systems covering areas from Barauni to Farakka from

littoral, limnetic and benthic zones of these water bodies. These insects were collected at fortnightly intervals by an insect collecting net made of nylon cloth (mesh size 40 to 80/cm²). The D-frame aquatic net is made according to Merritt and Cummins (1978) and the samples were taken by the method used by Allan (1975). The samples were brought to the laboratory and preserved in 70% alcohol after sorting. Identification of insects were made in the laboratory and it is further confirmed by sending the specimens to the Zoological Survey of India, Calcutta. After identification the number of species in each hauling were counted and their relative abundance was determined. If more than fifty specimens were recorded during five haulings, the species were considered to be abundant, if twentyfive specimens were recorded, the species has been regarded as common and if only a specimen or two were collected at a time of hauling and it was not found again than it has been regarded as rare. All the collected specimens has been deposited in the museum of Post-Graduate Department of Zoology, Bhagalpur University, Bhagalpur-812007.

RESULTS AND DISCUSSION

The aquatic insect fauna surveyed during the present study belong to five orders. They are : (i) Coleoptera, (ii) Hemiptera, (iii) Diptera, (iv) Odonata, and (v) Ephemeroptera. In case of Coleoptera both larvae/nymphs and adults were present in the samples whereas in the case of Diptera, Odonata and Ephemeroptera only larvae/nymphs were collected and adults being the aerial or amphibious in habit. The relative abundances and faunal composition of these insects are shown in the Table I.

TABLE—I

Genera/Species	Relative Abundance		
	Abundant	Common	Rare
1	2	3	4
A. Order—Coleoptera			
Family—Dytiscidae			
<i>Cybister confusus</i> Sharp	—	—	+
<i>Cybister regulosus</i> Redt.	—	—	+
<i>Cybister limbatus</i> Fabr.	—	—	+
<i>Cybister tripunctatus asiaticus</i> Sharp	—	—	+
<i>Laccophilus chinensis inefficiens</i> Boh.	—	—	+
<i>L. parvulus</i> Aube	+	—	—
<i>L. anticatus</i> Sharp	+	—	—
<i>Hyphoporous</i> sp.	—	—	+

TABLE—I (Continued)

1	2	3	4
<i>Hyphydrus indicus</i> Sharp	—	—	+
<i>Hydrocoptus subvittatus</i> Mot	—	+	—
<i>Canthydrus laetabilis</i> Walk	+	—	—
<i>Canthydrus</i> sp.	+	—	—
<i>Eretes sticticus</i> L.	—	+	—
<i>Sandracottus festivus</i> Illinger	—	—	+
<i>Guignotus pradhani</i> Vazirani	—	+	—
<i>Hydaticus vittatus</i>	—	+	—
Family—Hydrophilidae			
<i>Sternolophus rufipes</i> Fabr.	+	—	—
<i>Amphiops</i> sp.	+	—	—
<i>Helochaeres anchoralis</i> Sharp.	—	+	—
<i>Berosus pulchellus</i> M'Leay	—	+	—
<i>B. indicus</i> Mots	—	+	—
<i>Regimbartia attenuata</i> Fabr.	+	—	—
<i>Hydrophilus olivaceous</i> Fabr.	+	—	—
<i>H. indicus</i> Bedel.	+	—	—
<i>Enochrus</i> sp.	—	+	—
<i>Hydraena</i> sp.	—	+	—
<i>Laccobius</i> sp.	—	—	+
Family—Gyrinidae			
<i>Orectochaerus gangeticus</i> Wied.	+	—	—
<i>Dineutes spinosus</i> Fabr.	—	+	—
Family—Halipidae			
<i>Halipus pulchellus</i> Fabr.	+	—	—
<i>Halipus</i>	—	+	—
B. Order—Hemiptera			
Family—Corixidae			
<i>Corixa hieroglyphica</i> Duf	—	+	—
<i>C. promontoria</i> Dist.	+	—	—
<i>Micronecta merope</i> Dist.	+	—	—
<i>M. proba</i> Dist.	—	+	—
<i>M. scutellaris</i> Stal.	+	—	—
<i>M. striata</i> Dist.	—	+	—
Family—Notonectidae			
<i>Anisops sardea</i> Herr-Schaff	+	—	—
<i>A. breddini</i> Kirk.	—	+	—
<i>Enithares</i> sp.	—	—	+
Family—Pleidae			
<i>Plea frontalis</i> Fieb.	+	—	—
<i>P.</i> sp.	+	—	—
Family—Gerridae			
<i>Gerris fossarum</i> Fabr.	+	—	—
<i>G. spinole</i> Leth. et. Sevn.	+	—	—

TABLE—I (Concluded)

1	2	3	4
Family—Mesovellidae			
<i>Mesovelis</i> sp.	—	—	+
Family—Hydrometridae			
<i>Hydrometra vittata</i> Stal	—	+	—
Family—Nepidae			
<i>Ranatra fliformis</i> Fabr.	+	—	—
<i>R. elongata</i> Fabr.	+	—	—
<i>Laccotrephes griseus</i> Guer.	+	—	—
<i>L. ruber</i> Linn.	—	+	—
Family—Belostomatidae			
<i>Diplonychnus annulatum</i> Fabr.	+	—	—
<i>Sphaerodema rusticum</i> Fabr.	—	+	—
<i>Belostoma indicum</i> Lep. et. Serv.	—	—	+
C. Order—Odonata			
Suborder—Anisoptera			
Family—Gomphidae			
<i>Mesogomphus lineatus</i> Selys	+	—	—
Family—Libellulidae			
<i>Potomarcha obscura</i> Rambur	+	—	—
<i>Zyxomma petiolatum</i> Rambur	—	+	—
Family—Cordulegasteridae			
<i>Cordulegaeter</i> sp.	—	+	—
Suborder—Zygoptera			
Family—Coenagriidae			
<i>Ischnura delicata</i> Hagen	+	—	—
<i>I. senegalensis</i> Rambur	+	—	—
<i>Rhodischnura nursei</i> Morton	—	+	—
<i>Agrioconemis</i> sp.	—	—	+
D. Order—Diptera			
Family—Chironomidae			
<i>Chironomus</i> sp.	+	—	—
<i>Monopelopia</i> sp.	+	—	—
<i>Conchapelopia</i> sp.	—	+	—
<i>Clinotanypus</i> sp.	+	—	—
Family—Culicidae			
<i>Anopheles</i> sp.	+	—	—
<i>Culex</i> sp.	+	—	—
E. Order—Ephemeroptera			
Family—Baetidae			
<i>Baetis</i> sp.	+	—	—
<i>Cloeon</i> sp.	+	—	—
<i>Ephemerella</i> sp.	+	—	—

Thus, in the present survey 31 species of Coleoptera, 23 species of Hemiptera, 8 species of Odonata, 6 species of Diptera and 3 species of Ephemeroptera have been recorded. It appears from this study that aquatic insect fauna are well represented by their larvae/nymphs and adults in various water bodies. It was found that appreciable seasonal faunal composition of aquatic insects have been correlated with the appearance and disappearance of macro-vegetations of these water bodies. The emergent portions of the plants afford shelter to the adult stages of insects. The floating vegetation constitutes a biotope with so many ecological niches that almost all the aquatic insect groups are represented in this vegetation type, which may be considered the most species-rich biotope of the fresh-water ecosystems. The submerged, above ground parts of plants forms the habitat for sedentary insects. Macrophytes are also frequently colonized by mining (*Chironomus* larvae) and are periodically used by various free-swimming species of insects (Pieczynska and Ozimek, 1976).

In the present survey it was noticed that in big rivers like Ganges, and other factors like wave action, wind velocity and scarcity of macro-vegetations probably discourage the colonization of aquatic insects in such water bodies. In water bodies having abundance of macrophytic vegetations such as *Eichhornia crassipes* ; *Potamogeton crispus* ; *Hydrilla verticillata* ; *Ceratophyllum demersum* and *Vallisneria* sp. etc. provide necessary shelter, shade and suitable substrate for the colonization of these aquatic insects. Thus, plants form an important element of the aquatic environment manufacturing and providing food and shelter for these insects. A diverse flora is responsible for the establishment of stable insect communities. A complex flora allows for a greater diversity of faunal components and more complex food webs (Boyd, 1971).

In Coleoptera the members of the family Hydrophilidae are poor swimmers, consequently they live on vegetations of very shallow waters. The members of the family Dytiscidae, however, are efficient swimmers and are found in deep waters also. The gyrimids actively found swimming on open water surface column. They actively whirl and gyrate on the surface of the water, therefore, they are also called as "whirligig and waltzing beetles" and also "scuttle bug". The haliplids are commonly called as the "crawling beetles" and are fairly good swimmers. The aquatic and semi-aquatic Hemiptera in general, are predators at intermediate stages in the food-chains of the ecosystem. The corixids are found on the bottom of the water bodies and are responsible for the conversion of the decomposed plant materials into

animal food, thus, helpful in the prevention of pollution of inland waters. The corixids and hydrophilids are all detritivores and scavengers feeding on detritus and decomposed organic matters and are responsible for the natural filter of the aquatic environment. The nymphal odonates are predaceous and spend their entire nymphal period in the inland waters. These insects are carnivorous, feeding on various zooplankton, aquatic insects, fish-fry and fingerlings and are secondary and tertiary consumers (Roy, 1980). Aquatic Diptera specially of chironomids form high proportion of zoobenthos and are very important link in energy transfer in aquatic ecosystems. Their significance as an important component of fish food is widely known. They also take part in organic matter degradation. Mayfly nymphs are often called as "cattle" or "rabbit" of the aquatic environment as they are subsisting on algae and other plant materials for food (Roy and Sharma, 1982). In the littoral fauna mayfly nymphs and chironomid larvae serve as primary converters of plant materials into animal protoplasm. Thus, such basic herbivores serve as the "key industries" in the ecosystem because they are smaller in size but large in numbers and are responsible for the transfer of energy to higher food-chain (Roy and Sharma, 1983).

Thus, the aquatic insects are the dominant members of the littoral as well as benthic fauna of the freshwater ecosystems. The benthic insects are considered promising organisms for use in "biological indicator" of pollution, because of their ease of collection, large number of species and sensitivity to water quality. The structural and functional analysis of these insect community will be helpful in the detection of pollution of inland waters and therefore, they can be helpful in the monitoring of the system.

SUMMARY

Thus, aquatic insects do not comprise a systematic group but are scattered through a large number of orders. These insects are species that are more or less closely associated with water at least for any one phase of their life cycle. They fall into two major groups : (i) Insects having aquatic larval and pupal stages and (ii) those spending their entire life cycle in or near the free water areas. The former group includes the Ephemeroptera, Odonata and Diptera. The second group includes aquatic Hemiptera and Coleoptera, whose entire life cycle is passed in water. Their seasonality and periodicity depend upon the seasonal appearance and disappearance of macro-vegetations

of the aquatic systems. These insects have undergone certain morpho-anatomical, behavioural and phenological adaptations for aquatic mode of life.

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ON A COLLECTION OF SPIDERS OF THE FAMILY
GNAPHOSIDAE FROM INDIA (ARANEAE : ARACHNIDA)

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The spiders of the family Gnaphosidae are very little known in the Indian Fauna. Even the classical work of Pocock (1900) on Indian spiders contains no reference to this family. Caporiacco (1934) was the pioneer worker and he has described 10 species from Himalaya. Recently Tikader (1962, 1964, 1966, 1973), Tikader and Gajbe (1975, 1976, 1979), Gajbe (1979) described many species from various parts of India. Patel and Patel (1975) described three species from Gujarat.

This paper dealt with 25 species contained in 11 genera.

I have deposited studied material whose registration number is given in this paper in the collection of Zoological Survey of India, Calcutta and other material in the collection of Central Regional Station, Zoological Survey of India, Jabalpur.

Family GNAPHOSIDAE (Gna-phos'i-dae)

- 1898. *Gnaphosidae* Pocock, *Ann. Mag. nat. Hist.* **2** (7) : 219.
- 1922. *Gnaphosidae* : Chamberlin, *Proc. biol. Soc. Wash.*, **35** : 145-172.
- 1940. *Gnaphosidae* : Comstock, *The Spider Book*, New York. 321.
- 1951. *Gnaphosidae* : Locket & Millidge, *British Spiders*, **1** : 95-123.
- 1962. *Gnaphosidae* : Tikader, *Proc. First All-India Congress of Zoology* (1959) : 570-573.
- 1973. *Gnaphosidae* : Tikader, *Proc. Indian Acad. Sci.*, Bangalore, **77** (5) : 186-189.
- 1973. *Gnaphosidae* : Ubick & Roth, *Amer. Arachnology*, **9** : 1-12.
- 1975. *Gnaphosidae* : Platnick & Shadab, *Bull. Am. Mus. nat. Hist.*, **155** (1) : 1-66.
- 1975. *Gnaphosidae* : Tikader & Gajbe, *Oriental Ins.*, **9** (3) : 273-281.
- 1979. *Gnaphosidae* : Gajbe, *Bull. zool. Surv. India*, **2** (1) : 69-74.

Type-genus : **Gnaphosa** Latreille

Distribution : All over the world.

Originally the family Gnaphosidae was a part of the family Drassidae, Pocock (1898) proposed to replace Drassidae when *Drassus* was shown to be an objective junior synonym of *Gnaphosa*.

The gnaphosidae family formerly known as Drassidae are those spiders which have eight eyes, heterogenous, arranged in two rows. In these spiders the cephalic part is not sharply sent off from the thoracic, the cephalothorax is hardly elevated. The chelicerae have a boss and scopula and the margins of the cheliceral fang furrow are oblique and usually armed. The teeth may be considerably reduced in size to minute denticles, or a single denticle, or the inner margin may have a keeled lamina in place of teeth. The labium is longer than broad, with maxillae converging more or less and provided with scopulae. Usually the maxillae have an oblique or transverse depression. The posterior coxae are more or less separated by the sternum. The legs are generally spinose and the tarsi furnished with scopulae, two claws, and claw tufts. Leg formula 4123. The claw are similar and pectinate in a single row. The abdomen is oval and usually rather flattened and in most males provided with a dorsal scutum on the abdomen. Many species are uniformly coloured, more often dark than light and without markings. Some species have a striking or colourful pattern of lines or spots. The anterior spinnerets are cylindrical, longer and more heavily sclerotized than the posterior, and widely separated.

Most gnaphosids are found under stones or bark or in moss. A few live on the leaves of plants which they roll like the clubionids or at the most they spin an irregular retreat at the time of oviposition. Some of the species that live under stones make a silken sac within which they live and in which the egg-sac is made.

Key to the genera

- | | | | |
|---|-----|-----|---|
| 1. Inner margin of cheliceral fang furrow with a keeled lamina. | ... | ... | 2 |
| Inner margin of cheliceral fang furrow smooth, or with one or more distinct teeth or denticles. | ... | ... | 4 |
| 2. Inner margin of ohelicera with a wide serrated lamina posterior row of eyes much longer than the anterior, with the medians nearer to each other than to the laterals. Maxillae rounded. | ... | | |
| Inner margin of chelicera without serrated lamina. Posterior row of eyes slightly longer than the anterior, with the medians nearer to the laterals than to each other. Maxillae not rounded. | ... | ... | 3 |

**Gnaphosa* Latereille

- | | | | |
|-----|---|-----|-------------------------------|
| 8. | Inner margin of chelicera with two or three translucent-laminae. Posterior median eyes rectangular in shape. | ... | <i>Eilica</i> Keyserling |
| | Inner margin of chelicera with a broad keel or a narrow lamina. Posterior median eyes oval in shape. | ... | <i>*Callilepis</i> Westring |
| 4. | Carapace with no fovea. Anterior spinnerets close to each other. Spiders clothed with squamiform hairs. | ... | <i>Micaria</i> Westring |
| | Carapace with a fovea. Anterior spinnerets well apart from each other. Spiders not clothed with squamiform hairs. | ... | 5 |
| 5. | Chelicerae noticeably narrow, bearing no teeth, but with an angular projection apically inside. | ... | <i>Phaeocedus</i> Simon |
| | Chelicerae noticeably broad, bearing teeth, without an angular projection apically inside. | ... | 6 |
| 6. | Posterior row of eyes very strongly procurved, semicircular or nearly so. | ... | 7 |
| | Posterior row of eyes not strongly procurved... | ... | 8 |
| 7. | Inner margin of furrow of chelicera with one tooth. Bulb of palpus of male with a stout median apophysis. | ... | <i>*Scopodes</i> Chamberlin |
| | Inner margin of furrow of chelicera without tooth. Bulb of palpus of male simple, with no true apophysis. | ... | <i>*Megamyrmecon</i> Reuss |
| 8. | Eyes of posterior row nearly equal in size and equidistant from each other. | ... | <i>*Scotophaeus</i> Simon |
| | Eyes of posterior row not equal in size and not equidistant from each other. | ... | 9 |
| 9. | Tibia IV with two, or less commonly with three or five, median dorsal spines, III with one or two. | ... | 10 |
| | Tibia IV with a single median dorsal spine or with none. | ... | 13 |
| 10. | Posterior median eyes much larger than the posterior laterals and closer to laterals than to each other. Inner margin of chelicera without tooth. | ... | <i>*Liodrassus</i> Chamberlin |
| | Posterior median eyes not much larger than the posterior laterals and closer to each other than to posterior laterals. Inner margin of chelicera with tooth or teeth. | ... | 11 |

11. Inner margin of furrow of chelicera with a single tooth. *Geodrassus* Chamberlin.
 Inner margin of furrow of chelicera with two or three teeth. ... 12
12. Eyes rows close together, posterior median eyes well separated, being only a little farther from the laterals than from each other. ... *Sosticus* Chamberlin
 Eyes rows widely separated, posterior median eyes much nearer to each other than to the laterals. ... **Drassodes* Westring
13. Upper margin of furrow of chelicera unarmed, or with a keel, or with three serrations or teeth, rarely more, the lower margin unarmed or with but a single tooth or nodule; bulb of male palpus with no apophyses, at most with one or several small teeth near base of embolus. ... 14
 Upper margin of furrow of chelicera with from three to six distinct teeth, the lower margin with two or three, or rarely with only one; bulb of male palpus one or more apophyses. ... 17
14. Posterior row of eyes more or less recurved. ... 15
 Posterior row of eyes more or less procurved, or sometimes straight. ... 16
15. Tibia III with a median dorsal spine; carapace without distinct median furrow. ... **Sergiolus* Simon
 Tibia III with no median dorsal spine; carapace with a distinct median furrow. ... *Poecilochroa* Westring
16. Lower margin of furrow of chelicera smooth, wholly unarmed; anterior median eyes usually obviously smaller than the laterals. Posterior median eyes slightly larger than the laterals .. *Nodocion* Chamberlin
 Lower margin of furrow of chelicera with one tooth or nodule; anterior median eyes usually as large as or larger than the laterals. Posterior median eyes always well separated from each other and smaller than or at most as large as the laterals. ... *Herpyllus* Hentz
17. Upper margin of furrow of chelicera with three teeth, the lower with two, all well developed. Posterior median eyes large and oblique, typically close together but well removed from the laterals. .. **Haplodrassus* Chamberlin

Upper margin of furrow of chelicera with from four to six teeth, the lower margin with two to three small teeth or nodules, or rarely the upper margin with only three weak teeth and the lower with but one. ...

... 15

18. Posterior row of eyes straight, or but little procurved the eyes typically nearly equidistant, the medians small or at most but little larger than the laterals. ...

**Zelotes* Gistel

Posterior row of eyes procurved, the medians close together of contiguous, larger than the laterals, usually much so, oblique. ...

**Drassyllus* Chamberlin

Note :—Those genera names marked by a asterisk are dealt with in this paper and not marked by asterisk are included in the key just to satisfy the couplet characters.

1. *Gnaphosa poonaensis* Tikader

1973. *Gnaphosa poonaensis* Tikader, *Proc. Indian Acad. Sci.*, 77 (5) : 188.

Specimens examined : 1 ♀, Macherla, District Guntur, Andhra Pradesh, Coll. *I. N. Maligi*, 14.9.1962 (Reg. No. 4013/18), 1 ♀, Nandikonda Valley, Andhra Pradesh, Coll. *I. N. Maligi*, 17.8.1962. 1 ♀, Behind camp laboratory, Nagarjuna Valley, Andhra Pradesh, Coll. *I. N. Maligi*, 1.8.1962 (Reg. No. 4012/18).

2 ♀ ♀, Okha, District Jamnagar, Gujrat, Coll. *S. K. Gupta*, 16.12.1973 (Reg. No. 3869/18). 1 ♂, Patara Rest House compound, Mahsana, Gujrat, Coll. *B. Dutta*, 25.1.1974. (Reg. No. 3870/18). 1 ♂, Wadgaon, Banaskansa District, Gujrat, Coll. *B. Dutta*, 15.11.1974. (Reg. No. 3870/18).

6 ♀ ♀, Pooh, Kinaur, District Solan, H. P. Coll. *K. K. Mahajan*, 30.3.1971. (Reg. No. 5029/18). 3 ♀ ♀, Pooh, Kinaur, District, Solan, H. P. Coll. *K. K. Mahajan*, 31.3.1971. (Reg. No. 4027/18). 1 ♀, Pooh, village, Kinaur, District Solan, H. P. Coll. *K. K. Mahajan*, 26.4.1970.

1 ♂, Barwani, District Khargone, M. P. Coll. *V. V. Rao* 9.2.1971.

1 ♀, 1 ♂, Rajputana, Sardarshahr, Churu, Dist. Rajasthan, Coll. *B. Biswas*, 27.1.1957. (Reg. No. 3936/18). 1 ♀, Panchpadra Salt Depo, near Circuit House Jodhpur, Rajasthan, Coll. *K. K. Tiwari*, 13.2.1958. (Reg. No. 3927/18). 1 ♂, Kolu, 13 miles from phalodi on Jodhpur Road, District, Jodhpur, Rajasthan, Coll. *K. K. Tiwari*, 17.12.1957. (Reg. No. 3928/18). 1 ♀, Gudha Colony, Nagaur District Rajasthan, Coll. *K. K. Tiwari*, 22.2.1958 (Reg. No. 3932/18). 2 ♀ ♀, 1 ♂, Jaisalmer, 1/3

km. West of Daklum glow, Rajasthan, *K. K. Tiwari*, 31.12.1957. (Reg. No. 3929/18). 2 ♀ ♀, near Bikaner, Rajasthan, Coll. *K. K. Tiwari*, 6.2.1953. (Reg. No. 3934/18). 1 ♀, 1 ♂, Gudha, Nagaur Dist. Rajasthan, Coll. *A. K. Mukherjee*, 19.12.1957. (Reg. No. 3938/18). 1 ♀, Pachpadra salt Depo, Circuit House, Rajasthan, Coll. *K. K. Tiwari*, 15.2.1958. (Reg. No. 3931/18). 1 ♀, Sambhar lake, Rajasthan Coll. *T. G. D.*, 23.3.1951. (Reg. No. 3937/18). 1 ♂, Jaysalmer, Rajasthan, Coll. *K. K. Tiwari*, 9.1.1958. (Reg. No. 3935/18). 1 ♀, Taranagar, Churu Dist. Rajasthan, Coll. *B. Biswas*, 26.10.1960. (Reg. No. 3939/18). 4 ♀ ♀, 2 ♀, Near Dak bungalow, Jaysalmer, Rajasthan, Coll. *K. K. Tiwari*, 29.12.1957. (Reg. No. 3930/18).

1 ♀, Khairajpur, Dist. Karnal, U. P. Coll. *Asket Singh*, 10.3.1971 (Reg. No. 4069/18). 4 ♀ ♀, Goniana, District Bhatinda, U. P. Coll. *Asket Singh*, 23.2.1971 (Reg. No. 4070/18). 1 ♀, 1 ♂, Kalhpuria, Dist. Almora, U. P. Coll. *M. Prasad*, 17.12.1968. 1 ♀, Ferozpur on Ludhiana Road, District Ferozpur, U. P. Coll. *Asket Singh*, 17.12.1971. (Reg. No. 4071/18).

Distribution : Andhra Pradesh, Gujrat, Himachal Pradesh, Madhya Pradesh, Punjab, Rajasthan, Uttar Pradesh, INDIA.

2. *Gnaphosa pauriensis* Tikader and Gajbe

1977. *Gnaphosa pauriensis* Tikader and Gajbe, *Rec. zool. Surv. India*, 73 (1-4) : 44-45.

Specimens examined : 1 ♀, Bokaro steel city, Dhanbad, Bihar, Coll. *R. Tilak*, 20.11.1968. (Reg. No. 4016/18).

3 ♀ ♀, Dholra rest house, Dist. Bilaspur, H. P. Coll. *A. Hussain*, 15.2.1965. (Reg. No. 4024/18). 1 ♀, Bank of river Beas, civil rest house Mandi, District. Mandi, H. P. Coll. *A. Hussain*, 8.2.1965. (Reg. No. 4025/18). 1 ♀, Dharamsala, Dist. Kangra, H. P. Coll. *R. K. Bhatnagar*, 5.1.1963. (Reg. No. 4026/18).

1 ♀, Jhabber khad down the Noonpur town, District Kangra, Punjab, Coll. *A. Hussain*, 24.1.1965. (Reg. No. 4162/18). 1 ♀, Badani, District Gurdaspur, Punjab, Coll. *Asket Singh*, 19.1.1967, (Reg. No. 4163/18). 1 ♀, Nalagarh, District Ambala, Punjab, Coll. *T. D. Soota*, 18.1.1964.

1 ♀, Dharmawala forest Block Timli Forest Range, Dist. Dehra Dun, U. P. Coll. *T. D. Soota*, 19.12.1964. (Reg. No. 4072/18).

Distribution : Bihar, Himachal Pradesh, Orissa, Punjab, Uttar Pradesh, INDIA.

3. *Gnaphosa jodhpurensis* Tikader and Gajbe

1977. *Gnaphosa jodhpurensis* Tikader and Gajbe, *Rec. zool. Surv. India*, **73** (1-4) : 45-47.

Specimens examined : 1 ♀, Bhurd Bhaker, near Jodhpur, Rajasthan. Coll. *Survey party*, 28.4.1964. (Reg. No. 3949/18). 1 ♀, Umed sagar, Talwaria village District Jodhpur, Rajasthan. Coll. *R. N. Bhargawa*, 10.4.1962. (Reg. No. 3950/18). 1 ♀, Barli village, North west of Jodhpur, Rajasthan, Coll. *A. K. Dutta*, 4.2.1962. (Reg. No. 3948/18). 1 ♀, Barwani, District Khargone, M. P. Coll. *H. Khajuria*, 22.2.1971.

1 ♀, Denowal, Balchar Road, District Hoshiarpur, U. P. Coll. *R. K. Bhatnagar*, 21.12.1963. (Reg. No. 4136/18).

Distribution : Madhya Pradesh, Rajasthan, Uttar Pradesh, INDIA.

4. *Callilepis rukminiae* Tikader and Gajbe

1977. *Callilepis rukminiae* Tikader and Gajbe, *Rec. zool. Surv. India*, **73** (1-4) : 49-50.

Specimen examined : 2 ♀ ♀, on the bank of Gambhir river near the slope of forest Chitorgarh, District Chitorgarh, Rajasthan, Coll. *S. Biswas*, 9.9.1965. (Reg. No. 3951/18). 1 ♀, Forest Chitorgarh, Rajasthan, Coll. *S. Biswas*, 6.9.1965. (Reg. No. 3947/18). 6 ♀ ♀, Harur, 3000 Ft. District Salem, Tamil Nadu, Coll. *H. S. Pruthi*, 17.6.1929. 1 ♀, Near Pariat tank, Jabalpur, M. P. Coll. *U. A. Gajbe*, 16.9.1980

Distribution : Jabalpur, Madhya Pradesh, Poona, Maharashtra, Chitorgarh, Rajasthan, Salem, Tamil Nadu, INDIA.

5. *Callilepis lambai* Tikader and Gajbe

1977. *Callilepis lambai* Tikader and Gajbe, *Rec. zool. Surv. India*, **73** (1-4) : 50-52.

Specimen examined : 1 ♀, Baddowar forest, Jaijan forest block, Garh shankar range, District Hoshiarpur, Punjab. Coll. *R. K. Bhatnagar*, 23.12.1962. (Reg. No. 4138/18). 1 ♀, Amkhas District Jabalpur, M. P. Coll. *P. D. Rane*, 6.5.1975.

Distribution : Madhya Pradesh, Mysore, Punjab, INDIA.

6. *Scopodes maitraiae* Tikader and Gajbe

1977. *Scopodes maitraiae* Tikader and Gajbe, *Rec. zool. Surv. India*, **73** (1-4) : 14-16.

Specimens examined : 1 ♀, Siripur, District Saran, Bihar, Coll. *Mackenzie*, 15.8.1913.

1 ♀, Sarnath, Gujrat, Coll. *V. D. Srivastava*, 25.2.1975 (Reg. No. 4293/18).

1 ♀, Budhagarh, District Jabalpur, M. P. Coll. *V. V. Rao*, 14.4.1970.
 1 ♀, Shikara village District Seoni, M. P. Coll. *U. A. Gajbe*, 19.10.1981.
 1 ♀, Mazoli, District Jabalpur, M. P. Coll. *S. K. Mishra*, 30.12.1980.
 1 ♀, Lalitpur, District Jabalpur, M. P. Coll. *Laxman Prasad*, 14.10.1981.

1 ♂, Mayurbhang, District Mayurbhang, Orissa, Coll. *J. K. Sen*, 17.11.1972.

Distribution : Maharashtra, Gujrat, Madhya Pradesh, Orissa, INDIA.

7. *Megamyrmeleon ashae* Tikader and Gajbe

1977. *Megamyrmeleon ashae* Tikader and Gajbe, *Rec. zool. Surv. India*, **73** (1-4) : 16-18.

Specimen examined : 1 ♀, Near Dakbunglow, Jaisalmer, Rajasthan, Coll. *K. K. Tiwari*, 29.12.1957. (Reg. No. 4292/18).

1 ♀, Left bank of Narmada River Beyond Shahdol, District Khar-gone, M. P. Coll. *V. V. Rao*, 8.2.1971.

Distribution : Madhya Pradesh, Maharashtra, Rajasthan, INDIA.

8. *Scotophaeus madalasae* Tikader and Gajbe

1977. *Scotophaeus madalasae* Tikader and Gajbe, *Rec. zool. Surv. India*, **73** (1-4) : 18-20.

Specimens examined : 1 ♀, Occh-gahi, District Solan, Himachal Pradesh, Coll. *Mahesh Chandra*, 23.12.1970. (Reg. No. 4030/18). 1 ♀, Dholra Rest House, District Bilaspur, Himachal Pradesh, Coll. *A. Hussain*, 15.2.1965. (Reg. No. 4031/18).

4 ♀ ♀, Narendra Nagar, District. Tehri Garhwal, Uttar Pradesh, Coll. *T. D. Soota*, 8.2.1964. (Reg. No. 4128/18). 1 ♀, Narendra Nagar, District Tehri, Uttar Pradesh, Coll. *T. D. Soota*, 8.2.1964 (Reg. No. 4129/18). 1 ♀, Cart Road Area, Dharmasala, District Kangra, Uttar Pradesh, Coll. *R. K. Bhatnagar*, 5.1.1963. (Reg. No. 4130/18).

2 ♀ ♀, 1 ♂, Bong Basti, Kalimpong, District, Darjeeling, West Bengal, Coll. *G. K. Srivastava*, 3.1.1974. (Reg. No. 4334/18).

Distribution : Uttar Pradesh, Himachal Pradesh West Bengal, INDIA.

9. *Liodrassus mandae* Tikader and Gajbe

1977. *Liodrassus mandae* Tikader and Gajbe, *Rec. zool. Surv. India*, **73** (1-4) : 20-21.

Specimen examined : 1 ♀, Ranipur Forest, District Saharanpur, Uttar Pradesh, Coll. *T. D. Soota*, 12. 2. 1964.

Distribution : Himachal Pradesh, Uttar Pradesh INDIA.

10. Drassodes gangeticus Tikader and Gajbe

1975. *Drassodes gangeticus* Tikader and Gajbe, *Oriental Insects*, 9 (3) : 278-279.

Specimens examined : 1 ♀, Wangdu, phodrung, Bhutan, Coll. S. K. Mitra, 25.2.1969. (Reg. No. 3851/18).

2 ♀ ♀, Dholra Rest House, District Bilaspur, H. P. Coll. A. Hussain, 15.2.1965.

Distribution : Uttar Pradesh, Himachal Pradesh, Bhutan, INDIA.

11. Drassodes oppenheimeri Tikader

1973. *Drassodes oppenheimeri*, Tikader *Proc. Indian. Acad. Sci.*, 77 (5) : 186.

Specimens examined : 1 ♀, Dawarka, District Jamnagar, Gujrat, Coll. V. D. Srivastava, 18.2.1975. (Reg. No. 3871/18).

1 ♀, Kamleswarpur, Mainpat, District Serguja, M. P. Coll. H. Khajuria, 13.1.1975.

2 ♀ ♀, P. W. D. Banglow, Bongigarh, District Sundargarh, Orissa, Coll. D. P. Sanyal, 15.6.1972.

Distribution : Gujrat, Orissa, Maharashtra, Madhya Pradesh, West Bengal, INDIA.

12. Drassodes deoprayagensis Tikader and Gajbe

1975. *Drassodes deoprayagensis* Tikader and Gajbe, *Oriental Insects* 9 (3) : 279-280.

Specimens examined : 9 ♀ ♀, Kathpuria, District, Almora, U. P. Coll. M. Prasad, 22.12.1968. (Reg. No. 4078/18).

Distribution : Uttar Pradesh, Himachal Pradesh, INDIA.

13. Drassodes sitae Tikader and Gajbe

1975. *Drassodes sitae* Tikader and Gajbe, *Oriental Insects* 9 (3) : 275-276.

Specimens examined : 1 ♀, Kalpa Kinaur, District Solan, H. P. Coll. K. K. Mahajan, 6.4.1971 (Reg. No. 4041/18) 1 ♀, Pooh, Kinaur, District Solan, H. P. Coll. K. K. Mahajan 30.3.1971 (Reg. No. 4038/18). 7 ♂ ♂, Pooh, Kinaur, District Solan, H. P. Coll. K. K. Mahajan, 29.3.1971. (Reg. No. 4039/18) 1 ♀, Deoti, Bilaspur District H. P. Coll. A. Hussain, 13.2.1965. (Reg. No. 4042/18). 1 ♀, Pooh, Kinaur, District Solan, H.P. Coll. K. K. Mahajan, 31.3.1971. (Reg. No. 4040/18). 1 ♀, Kalha river, Solan, H. P. Coll. K. K. Mahajan, 9.4.1971. (Reg. No. 4040/18).

1 ♀, Jhabber Khad down the Noonpur town, District Kangra, Punjab, Coll. A. Hussain, 24.1.1965. (Reg. No. 4160/18).

2 ♀ ♀, Kathpuria, District Almora, U. P. Coll. *M. Prasad*, 22.12.1968. (Reg. No. 4068/11). 1 ♀, Painsur, District Tehri Garhwal, West Himalaya, U. P. Coll. *Tytler*, 11.4.1914. (Reg. No. 4066/18). 2 ♀ ♀, Dharmashala, District Kangra, U. P. Coll. *R. K. Bhatnagar*, 5.1.1963. (Reg. No. 4064/18).

Distribution : Himachal Pradesh, Punjab, Uttar Pradesh, INDIA.

14. *Drassodes himalayensis* Tikader and Gajbe

1975. *Drassodes himalayensis* Tikader and Gajbe, *Oriental Insects*, 9 (3) : 274-275.

Specimens examined : 2 ♀ ♀, Cherapunji, Assam, Coll. *S. L. Hora*, 20.2.1923. (Reg. No. 3960/18).

1 ♀, Shamgong, Central Bhutan, Coll. *B. Biswas*, 1.12.1967. (Reg. No. 3850/18). 1 ♀, Simtokha, Bhutan, Coll. *S. K. Mitra*, 19.2.1969 (Reg. No. 3853/18). 1 ♀, Shangong, Central Bhutan, Coll. *B. Biswas*, 2.12.1969. (Reg. No. 3851/18).

11 ♀, Mataur, District Kangra, H. P. Coll. *Asket Singh*, 23.1.197. (Reg. No. 4046/18). 3 ♀ ♀, Rainuka to Nahan Road (Rainuka lake) District Sirmour, H. P. Coll. *T. D. Soota*, 7.1.1964 (Reg. No. 4048/18). 1 ♀, Chakki, District Kangra, H. P. Coll. *Asket Singh*, 15.1.1967 (Reg. No. 4044/18). 5 ♀ ♀, Deoti, Bilaspur District, H. P. Coll. *A. Hussain*, 13.2.1965 (Reg. No. 4045/18). 3 ♀ ♀, on the bank of river Beas, civil rest house, Mandi, District Mandi, H. P. Coll. *A. Hussain*, 8.2.1965. (Reg. No. 4047/18).

1 ♀, Aishmugam, Jammu and Kashmir, Coll. *S. K. Gupta*, 1.11.1976. (Reg. No. 3865/18).

2 ♀ ♀, Bardai, District Seoni, M.P. Coll. *V.D. Shrivastava*, 1.12.1971. (Reg. No. 4139/18). 1 ♀, Mainpat, District Serguja, M. P. Coll. *R. K. Singh*, 12.1.1975.

1 ♀, Kamong, F. Division, NEFA, Coll. *K. C. Jayaramakrishnan*, 10.4.1961, (Reg. No. 3863/18). 1 ♀, 1 ♂, Abor exped. NEFA, Coll. *S. W. Kemp*, 17.1.1962, (Reg. No. 3862/18). 7 ♀ ♀, Shegaon village kamong Frontier Division NEFA, Coll. *K. C. Jayaramakrishnan*, 29.3.1961 (Reg. No. 3864/18), 3 ♀ ♀, Dirang, NEFA, Coll. *S. K. Tandon*, 12.3.1973 (Reg. No. 3854/18). 1 ♀, Rapa, NEFA, Coll. *S. K. Tandon*, 13.3.1973 (Reg. No. Dunn) Bridge, NEFA, Coll. *A.N.T. Joseph*, 21.4.1966 (Reg. No. 3857/19) 1 ♀, Rapa Camp. Tenga, NEFA, Coll. *S. K. Bhattacharya*, 20.12.1965. (Reg. No. 3856/18). 2 ♀ ♀, Sapper, NEFA, Coll. *S. K. Tandon*, 13.3.1973. (Reg. No. 3859/18). 2 ♀ ♀, Chako Road, NEFA, Coll. *S. K. Tandon*, 17.3.1973 (Reg. No. 3861/18). 2 ♀ ♀,

Bomdila Road, NEFA, Coll. *S. K. Tandon*, 18.3.1973. (Reg. No. 3855/18). 4 ♀ ♀, 1 ♂, Dirang, NEFA Coll. *S. K. Tandon*, 11.3.1973. (Reg. No. 3860/18). 1 ♀, Sangti chu River bank NEFA, Coll. *K. C. Jayarama-krishnan*, 12.4.1961 (Reg. No. 3955/18).

1 ♀, Forest Rest House, Chandili District Koraput, Orissa, Coll. *D. P. Sanyal*, 26.11.1973 (Reg. No. 4123/18).

1 ♀, Jaysalmer, West of Daklum glow, Rajasthan, Coll. *K. K. Tiwari*, 31.12.1957. (Reg. No. 3945/18).

2 ♀ ♀, Malan Sanctuary, District Bijnaur, U. P. Coll. *T. D. Soota*, 3.3.1965. (Reg. No. 4074/18). 3 ♀ ♀, on the bank of Kest River, Garjia, Ramnagar, District Nainital, U. P. Coll. *T. D. Soota*, 2.1.1966. (Reg. No. 4074/18), 1 ♀, Khaniagaon, Ramkhet, U. P. Coll. *S. K. Bhattacharya*, 21.4.1971. (Reg. No. 4075/18). 3 ♀ ♀, Painsur above Lomba, 7500 Ft. Garhwal, W. Himalayas, Coll. *Tytlar*, 28.4.1914. (Reg. No. 4073/18).

1 ♀, Singla, Drajeeling District, North Bengal, Coll. *Lord Carmichael*, 10.3.1913. (Reg. No. 4332/18). 1 ♀, Eagle's Hill, Kurseong, 5000 Ft. E. Himalayas, Coll. *M. Sheriff*, 10.3.1926. 3 ♀ ♀, Kalimpong, District Darjeeling, Coll. *Sutherland* date was not mentioned. (Reg. No. 4333/18). 2 ♀ ♀, Kalimpong, District Darjeeling, West Bengal, Coll. *J. M. Julka*, 8.1.1971.

Distribution : Assam, Bhutan, Himachal Pradesh, Jammu and Kashmir, Madhya Pradesh, NEFA, Orissa, Rajasthan, Uttar Pradesh, West Bengal, INDIA.

15. *Drassodes indraprastha* Tikader and Gajbe

1975. *Drassodes indraprastha* Tikader and Gajbe, *Oriental Insects*, 9 (3) : 276-278.

Specimen examined : 1 ♀, Dwarka, Jamnagar District Gujrat, Coll. *V. D. Srivastava*, 20.2.1975. (Reg. No. 3866/18).

1 ♀, Cochin state (now Kerala), Coll. *F. H. Gravely*, September, 1914. (Reg. No. 4011/18).

Distribution : Gujrat, Uttar Pradesh, Kerala, INDIA.

16. *Drassodes pashanensis* Tikader and Gajbe

1977. *Drassodes pashanensis* Tikader and Gajbe, *Rec. zool. Surv. India*, 73 (1-4) : 64-66.

Specimen examined : 1 ♀, Susuma, Bhutan, Coll. *B. Biswas*, 8.2.1969. (Reg. No. 3852/18).

1 ♀, Sita Pahad, District Jabalpur, M. P. Coll. V. S. Durve, 20.3.1969. 2 ♀ ♀, Amkhas, District Jabalpur, M. P. Coll. V. V. Rao, 4.7.1969. 2 ♂ ♂, 1 ♀, Budhager village, District Jabalpur, M. P. Coll. H. S. Sharma, 16.12.1968.

1 ♀, Bonaigarh, Orissa, Coll. D. P. Sanyal, 16.6.1972. (Reg. No. 3959/18).

2 ♀ ♀, Resin factory, Nahan Forest, District Simour, Punjab. Coll. R. K. Bhatnagar, 30.12.1963. (Reg. No. 4159/18). 2 ♀ ♀, Sutlej sadan, Nangal, District Hoshiarpur, Punjab. Coll. T. D. Soota, 22.1.1964, (Reg. No. 415 /18). 1 ♀, Gurgaon Dist. Gurgaon, Punjab. Coll. S. K. Mitra, 22.4.1964. (Reg. No. 4158/18). 1 ♀, Nangal, District Hoshiarpur, Punjab, Coll. T. D. Soota, 23.1.1964. (Reg. No. 4157/18).

Distribution : Madhya Pradesh, Orissa, Punjab, Bhutan, Maharashtra, INDIA.

17. *Sergiolus singhi* Tikader and Gajbe

1976. *Sergiolus singhi* Tikader and Gajbe, *Proc. Indian Acad. Sci.*, 84 B (5) : 189-191.

Specimens examined : 1 ♀, Karamli, District Bhandara, Maharashtra, Coll. V. D. Srivastava, 10.2.1970. (Reg. No. 4017/18).

Distribution : Karnataka, Maharashtra, INDIA.

18. *Sergiolus poonaensis* Tikader and Gajbe

1976. *Sergiolus poonaensis* Tikader and Gajbe, *Proc. Indian Acad. Sci.*, 84 B (5) : 186-187.

Specimen examined : 1 ♀, Barela, District Jabalpur M. P. Coll. U. A. Gajbe, 5.5.1979.

Distribution : Poona, Maharashtra, Jabalpur, Madhya Pradesh, INDIA.

19. *Haplodrassus tehriensis* Tikader and Gajbe

1977. *Haplodrassus tehriensis* Tikader and Gajbe, *Rec. zool. Surv. India*, 73 : 68-69.

Specimen examined : 1 ♀, Rangul, Kalpa District Solan, H. P. Coll. K. K. Mahajan, 15.4.1970.

1 ♀, Therikal and Ghumkhal, District Pauri, U. P. Coll. T. D. Soota, 8.3.1965 (Reg. No. 4132/18).

Distribution : Himachal Pradesh, Uttar Pradesh, INDIA.

20. Haplodrassus sataraensis Tikader and Gajbe

1977. *Haplodrassus sataraensis* Tikader and Gajbe, *Rec. zool. Surv. India*, **73** (1-4) : 70-71.

Specimens examined : 1 ♀, Bilaspur, H. P. Coll. *A. Hussain*, 14.2.1965. (Reg. No. 4035/18). 1 ♀, Dholra rest house, District Bilaspur, H. P. Coll. *A. Hussain*, 15.2.1965. (Reg. No. 4032/18). 1 ♂, Nahan forest Range, District Sirmor, H. P. Coll. *R. K. Bhatnagar*, 31.12.1963. (Reg. No. 4036/18). 1 ♀, Trilokpur near Nahan, District Sirmor, H. P. Coll. *T. D. Soota*, 11.1.1964. (Reg. No. 4036/18). 1 ♀, Nahan Forest Range District Sirmor, H. P. Coll. *R. K. Bhatnagar*, 29.12.1963. (Reg. No. 4033/18). 1 ♀, Nahan Forest Range, District Sirmor, H. P. Coll. *R. K. Bhatnagar*, 31.12.1963. (Reg. No. 4037/18).

1 ♂, Joga, District Hoshangabad, M. P. Coll. *H. P. Agrawal*, 14.12.1965. (Reg. No. 4145/18). 1 ♂, Mainpat, Dist. Serguja, M. P. Coll. *R. K. Singh*, 12.1.1975. 1 ♀, Mainpat, District Serguja, M. P. Coll. *R. K. Singh*, 27.1.1975. 1 ♀, Serguja, District Serguja, M. P. Coll. *R. K. Singh*, 29.1.1975.

1 ♂, Around Engineering college, Jharsuguda, Dist. Sambalpur, Orissa, Coll. *P. K. Maity*, 7.1.1972. (Reg. No. 3961/18).

1 ♀, Korsina, District Jaipur Rajasthan, Coll. *K. K. Tiwari*, 31.5.1959. (Reg. No. 3946/18).

2 ♀ ♀, Ramnagar, District Nainital, U. P. Coll. *M. Prasad*, 30.12.1968 (Reg. No. 4131/18).

2 ♂ ♂, Nangal township, Taluka-Una, District Hoshiarpur, Punjab, Coll. *A. Hussain*, 19.1.1965. (Reg. No. 41/5118). 2 ♀ ♀, Jhabber khad, District Kangra, Punjab, Coll. *A. Hussain*, 24.1.1985. (Reg. No. 4152/18). 2 ♀ ♀, Sutlej Sadan, Nangal Dist. Punjab. Coll. *T. D. Soota*, 22.1.1964. (Reg. No. 4153/18). 2 ♂ ♂, Ruper, District Ambala, Punjab, Coll. *T. D. Soota*, 17.1.1964. (Reg. No. 4155/18). 1 ♀, Ranuka lake, District Sirmur, Punjab, Coll. *T. D. Soota*, 1964. 1 ♂, Nala Garh, District Ambala, Punjab, Coll. *T. D. Soota*, 18.1.1964. 1 ♀, Nangal, District Hoshiarpur, Punjab. Coll. *T. D. Soota*, 23.1.1964.

Distribution : Maharashtra, Himachal Pradesh, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh, Punjab, INDIA.

21. Zelotes poonaensis Tikader and Gajbe

1976. *Zelotes poonaensis* Tikader and Gajbe, *Proc. Indian Acad. Sci.*, **83 B** (3) : 115-116.

Specimen examined : 2 ♀ ♀, 1 ♂, Fort, Chitorgarh, Rajasthan, Coll. *S. Biswas*, 6.9.1965. (Reg. No. 3944/18).

Distribution : Maharashtra, Rajasthan, INDIA.

22. *Zelotes sajali* Tikader and Gajbe

1979. *Zelotes sajali* Tikader and Gajbe, *Bull. zool. Surv. India*, **2** (1) : 84-85.

Specimens examined : 1 ♀, Patara Rest House Compound Mahsana District, Gujrat, Coll. *B. Dutta*, 25.1.1974 (Reg. No. 4126/18).

Distribution : Maharashtra, Gujrat, INDIA.

23. *Zelotes sataraisensis* Tikader and Gajbe

1979. *Zelotes sataraisensis* Tikader and Gajbe, *Bull. zool. Surv. India*, **2** (1) : 87-88.

Specimens examined : 1 ♀, Vijaypuri Hills, Andhra Pradesh, Coll. *B. Nath*, 29.8.1962. (Reg. No. 4008/18). 1 ♀, 1 ♂, Vijaypuri Hills, Andhra Pradesh, Coll. *B. Nath*, 26.8.1962. (Reg. No. 4007/18).

1 ♀, 1 ♂, Nahan Forest Range, District Sirmor, Himachal Pradesh, Coll. *R. K. Bhatnagar*, 31.12.1969. (Reg. No. 4020/18).

1 ♀, Hanigunda village, 5 Km S. W. of Sudarshan Guest House, Karnataka, Coll. *G. Ramakrishna*, 2.3.1966. (Reg. No. 4006/18).

1 ♀, Seoni, District. Seoni, Madhya Pradesh, Coll. *V. D. Srivastava*, 10.3.1970. (Reg. No. 4142/18). 2 ♀ ♀, Near pariat tank, District, Jabalpur, M. P. Coll. *U. A. Gajbe*, 16.9.1980.

1 ♀, Gambhir River near the slope of Forest Chotorgarh Rajasthan, Coll. *B. Biswas*, 9.9.1965. (Reg. No. 3942/19). 1 ♀, Panchpadra salt Depo near Circuit House Jodhpur, Rajasthan, Coll. *K. K. Tiwari*, 14.2.1958. (Reg. No. 3943/18). 1 ♀, Panchpadra salt Depo near circuit house, Jodhpur, Rajasthan, Coll. *K. K. Tiwari*, 15.2.1958. (Reg. No. 3940/18). 1 ♀, Balana, East of Mohangarh, Rajasthan, Coll. *K. K. Tiwari*, 14.1.1952. (Reg. No. 3942/18).

1 ♀, Khajanwara Forest, District Saharanpur, U. P. Coll. *T. D. Soota*, 7.3.1963. (Reg. No. 4134/18).

1 ♀, Asandha, District Karnal, Uttar Pradesh, Coll. *R. K. Bhatnagar*, 19.2.1962. (Reg. No. 4135/18).

Distribution : Andhra Pradesh, Himachal Pradesh, Karnataka, Maharashtra, Madhya Pradesh, Rajasthan, Uttar Pradesh, INDIA.

24. *Zelotes mandlaensis* Tikader and Gajbe

1976. *Zelotes mandlaensis* Tikader and Gajbe, *Proc. Indian Acad. Sci.*, **83 B** (3) : 112-114.

Specimens examined : 1 ♀, Pachmarhi, M. P. Coll. *H. S. Prithi*, 15.12.1927. (Reg. No. 4143/18). 1 ♀, Pandhurna, M. P. Coll. *V. D. Srivastava*, 16.11.1971. (Reg. No. 4144/18).

2 ♀ ♀, No. Nalagarh, Dist. Ambala, Punjab. Coll. *T. D. Soota*, 18.1.1964. (Reg. No. 4164/18).

Distribution : Madhya Pradesh, Punjab, INDIA.

25. *Drassyllus khajuriai* Tikader and Gajbe

1976. *Drassyllus khajuriai* Tikader and Gajbe, *Oriental Insects*. **10** (3) : 432-434.

Specimen examined : 1 ♀, Bakhari near Sioni, District Seoni, M. P. Coll. *N. K. Sinha*, 30.11.1973. (Reg. No. 4141/18). 1 ♀, Bakhari near Sioni, District Seoni, M. P. Coll. *N. K. Sinha*, 3.11.1973. (Reg. No. 4141/18).

Distribution : Madhya Pradesh, Mandla, Seoni, INDIA.

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ON A COLLECTION OF CHEWING-LICE (PHTHIRAPTERA :
INSECTA) FROM NEPAL

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Piaget (1881) is the earliest report on the chewing-lice from Nepal. Kellogg & Paine (1914) is the first systematic work dealing with Indian Museum collections (now National Zoological collections of the Zoological Survey of India), some of which were collections from Nepal. Unfortunately, the four species from Nepal included in it were lost during River Varuna floods at Varanasi (cf. Lakshminarayana, 1982a), and no longer available in Z. S. I., collections. Since then stray reports appeared from time to time. Emerson (1971, 1973) also include species reported from Nepal, on birds and mammals respectively based on his collections. In addition to these published records, a few species are available in the British Museum (Nat. History), London, which the author examined during his visit, and some of them have also not been reported in print. Lakshminarayana (1979a, 1982b) included so far known species including the non-recorded species referred to. Thus so far, 32 genera and 83 species have been recorded on Nepalese birds and mammals.

My erstwhile esteemed colleague Dr Biswamoy Biswas carried out an ornithological survey in Nepal during 1947, and incidentally collected some specimens from these birds. These collections were placed at the author's disposal for study. The following is a report on this material together with some species generously donated by Dr. K. C. Emerson, and now incorporated in Z. S. I. collections. Some of the species have now been recorded for the first time from Nepal, while others are on new host species/subspecies, and therefore of interest.

Reference is invited to Lakshminarayana (1972, 1975) for literature from India and adjacent countries including Nepal. In the literature cited in the end, all references mentioned under synonymy, those references listed in Keler (1960), Eichler *et al.* (1969, 1973), and Lakshminarayana (1972, 1975) have not been provided for brevity, and references not given in these works alone are cited. The measurements are given in mm.

SYSTEMATIC ACCOUNT

Order : PHTHIRAPTERA

Sub-order : AMBLYCEROPHTHIRINA

Family : LAEMOBOTHRIDAE

1. *Laemobothrion maximum* (Scopoli, 1763)

(Pl. I, figs. 1-2 ; Pl. II, figs. 1-4)

Pediculus maximus Scopoli, 1763. *Ent. Carniolica* : 382. Type host : (*Falco buteo*) *Buteo buteo* (Linne).

Liotheum (*Laemobothrion*) *giganteum* Nitzsch, 1818. *German's Mag. Ent.*, 3 : 201. *Nomen novum* for *maximus* Scopoli, etc.

Laemobothrion indica Sen, 1942. *Indian J. vet. Sci. Anim. Husb.*, 12 : 169. Type host : *Milvus migrans govinda* Sykes.

"*Pediculus maximus*" : Clay & Hopkins, 1951. *Bull. Br. Mus. nat. (Ent.)*, 2 (1) : 5.

Laemobothrion maximum : Hopkins & Clay, 1952. *A Check List of Genera and species of Mallophaga* : 185 ; Nelson & Price, 1965. *J. Med. Entomol.*, 2 (3) : 253, figs. 1, 2, 8, 12, & 16-18 ; Price & Emerson, 1969. *Proc. ent. Soc. Wash.*, 69 (3) : 251 ; Lakshminarayana, 1979. *Rec. zool. Surv. India*, 75 : 115.

Only the more important synonymies are given here, and for a fuller list attention is invited to Nelson & Price (1965). These authors thoroughly reviewed the species of *Laemobothrion* off Falconiformes and concluded only four species are valid though several names were given to local populations or on hosts in various parts of the world. Lakshminarayana (1970) discussed the evolutionary trends in the *Laemobothrion*--complex, and recognized the following genera, viz., *Laemobothrion* Nitzsch parasitic on Falconiformes, *Eulaemobothrion* Ewing on Gruiformes, *Ciconicola* Lakshminarayana on Ciconiiformes (*Hagedashia*), and *Ornithopeplechthos* Eichler on Galliformes (*Opisthocormus* only).

Clay & Hopkins (1951, 1954, 1960) discussed the early literature and recognized *L. maximum* Scopoli as the valid name for this species. Nelson & Price (*op. cit.*) provided excellent redescription.

The specimens collected now from *Milvus migrans lineatus* (J. E. Gray) are referable to *L. maximum* (Scopoli) (Pl. 1 figs 1-2 ; Pl. 2 figs. 1-4) by the key characters, viz., sitophore sclerite of the hypopharynx with two large holes and more or less reduced U-shaped structure (Pl. 1 fig. 1) ; spiniform setae on the proximodorsal aspect of the femora II less than 4 ; a medial unpigmented area to the abdominal tergites absent ; and absence of a postvulval pigment spot (cf. Nelson & Price, 1965). Male genitalia as in Pl. 1 fig. 2 ; Pl. 2 fig. 2.

Material : Four ♂♂ and eight ♀♀ off *Milvus migrans lineatus* (J. E. Gray) (B 1/21.vi.1947), Hitaura, 21.vi.1947, coll. B. Biswas (Reg. Nos. 679/H 16 (2♂♂, 1♀), 680/H 16 (2♀♀), 904/H 16 (1♀), 905/H 16 (1♀), & 906/H 16 (1♀), & 907/H 16 (1♂, 2♀♀).

Measurements

	<i>Male</i>		<i>Female</i>	
	Length	Width	Length	Width
Head	1.02-1.05		1.16-1.30	
Pre-antennal		0.88-0.95		0.98-1.02
Temples		1.09-1.28		1.30-1.33
Prothorax	0.63-0.88		0.81-0.84	0.98-1.02
Pterothorax	0.91-1.02	1.26-1.33	1.02-1.05	1.58-1.65
Abdomen	3.2-3.6	1.65-1.75	4.24-4.77	2.1
Genitalia	1.37-1.61			
Total	5.8-6.3			

Remarks : This species has been reported from various parts of the world on different species of Falconiformes including *Milvus migrans lineatus* (J. E. Gray) on which the present collections were made and attention is invited to Nelson & Price (*op. cit.*) for known hosts.

In India and adjacent, the species was reported as *L. titan* on (*Baza jerdoni*) *Aviceda jerdoni* (Blyth) from Kurseong (Kellogg & Nakayama, 1916), as *L. giganteum* from Shembaganur and Madurai (Kéler, 1937), as *L. indicum* on *Milvus migrans govinda* Sykes from India (Sen, 1952), on the same host from Lyallpur, Pakistan, (Ansari, 1951), as *L. circi* on *Circus ae. aeruginosus* (Linne) from India (Clay & Hopkins, 1954), as *L. siddiqui* on *Circaetus g. gallicas* (Gmelin) from Pakistan, and as *L. hieraaeti* on (*Hieraaetis pennatus*) *Hieraaetus pennatus* (Gmelin) from Shujaval, Pakistan (Ansari, 1955, 1956 a, b); *L. maximum* from *Milvus/migrans/lineatus* from Burma, *Haliastur indus* (Boddaert) from Sri Lanka and India, *Accipter badius* (Gmelin), *Buteo rufinus* (Cretzschmar) and *Butastur teesa* (Franklin) from India (Nelson & Price, 1965). The find on *M. migrans lineatus* (Gray) though on a known host is the first record from Nepal. These specimens are also slightly smaller than those studied by Nelson & Price (1965) and Clay & Hopkins (1954).

Lakshminarayana (1970) while discussing the evolutionary trends in *Laemobothrion*-complex, placed *L. maximum* (Scopoli) at a higher plane than *L. vulturis* (J. C. Fabricius) on the basis of sitophore sclerite with in *Laemobothrion sens. str.*

Family : MENOPONIDAE

2. *Amyrsidea minuta* Emerson, 1961

(Pl. I, fig. 3 ; Pl. II, fig. 5)

Amyrsidea minuta Emerson, 1961. *Fla. Entomol.*, 44 (3) : 117, figs. 1-3. Type host : *Pavo cristatus* Linne.

Clay (1947) pointed that *Amyrsidea* off *Pavo cristatus* contain apparently two species of which the larger one was described as *A. phaeostoma* (Nitzsch), while the smaller remained undescribed. The smaller form was described as *A. minuta* in Emerson (1961) from material collected on the type host from Canada, British Isles, and United States of America. While working on *Amyrsidea* from India, the present author requested Dr Emerson for a ♂ and ♀ of *A. minuta*. Dr Emerson was kind enough to donate them from material collected from Nepal in his project.

Though the description was meagre, the excellent figures of Emerson (1961) readily help us in identifying the species.

These specimens along with those collected by Dr B. Biswas from Halon Valley, Madhya Pradesh (India) showed some minor variations which may be worth mentioning. (Pl. 2 fig. 5). Occipital margin bears 8 long setae, posterior prothoracic margin is fringed with 12-13 setae in ♀ and 14 in ♂, plus a spine-like seta in the middle. Hind femora with brush of setae of 15 in ♀, and 19-23 in ♂. Male genitalia as in (Pl. 1 fig. 3). Vulval margin is provided with 8 setae.

Material : One ♂ and one ♀ off *Pavo cristatus* Linne, Bhogbhanpur, Banke Dist., Nepal, 5.v. 1968, coll K. C. Emerson (coll. No. NP 460) Reg. No. 776/H16).

Measurements

	<i>Male</i>		<i>Female</i>	
	Length	Width	Length	Width
Head	0.21		0.25	
Pre-ocular		0.32		0.29
Temples		0.35		0.42
Prothorax	0.18	0.31	0.21	0.36
Pterothorax	0.18	0.31	0.18	0.45
Abdomen	0.79	0.37	0.86	0.59
Genitalia	0.31			
Total	1.33			

Remarks : Emerson (1961) stated that this species can be easily recognized by its short parameres which are little curved distally, and endomeres in male. It has been reported from Vancouver ; London ; Bridgnorth, Shropshire ; New Orleans, Louisiana ; Portland, Oregon ; McAllen, Texas. The credit of the present record from Nepal should infact, goes to Dr Emerson, though not reported by himself. Further it also confirms, *P. cristatus* as a natural host for this species, since the type material was collected from zoo garden host. The present record is the first report from Nepal, which together with Halon Valley material also forms the first report from the Indian Region.

Sub-Order : ISCHNOCEROPHTHIRINA

Family : PHILOPTERIDAE

3. *Goniodes ocellatus* (Rudow, 1869)

(Pl. I, figs 4-6 ; Pl. II, figs 6-7)

Goniocotes ocellatus Rudow, 1869. *Beitr. Kennt. Malloph.* : 23. Type host : (*Nycthemerus linearis*) *Lophura nycthemerus lineatus* (Vigors).

Goniocotes dentatus Rudow, 1870. *Z. ges. Nat. Wiss.*, 35 : 476. Type host : (*Nycthemerus linearis*) *Lophura nycthemerus lineatus* (Vigors).

Goniocotes dentatus : Piaget, 1880. *Pediculines* : 232.

Goniodes dentatus : Clay, 1940. *Proc. zool. Soc. Lond.*, (B) 110 : 53, figs. 35, 36, & 37 ; Emerson, 1973. In McClure & Ratanaworabhan's *Some ectoparasites of the birds of Asia* : 91.

Goniodes ocellatus : Hopkins & Clay, 1952. *A Check List of Genera and species of Mallophaga* : 157 ; In McClure & Ratanaworabhan's *Some ectoparasites of the birds of Asia* : 91 ; Lakshminarayana, 1979. *Rec. zool. Surv. India*, 75 : 107.

Rudow (1869) described the species from (*Nycthemerus linearis*) *Lophura nycthemerus lineatus* (Vigors) as *Gonicotes ocellatus*, and in a later paper as *G. dentatus* (Rudow, 1870). Since the original description seems to be that of a female *Goniodes* from that host, and the author himself compared with related *Goniodes* spp., Clay (1940) treated it as *Goniodes* and not as *Goniocotes* and used the specific appellation *dentatus*. This was however, corrected to *G. ocellatus* (Rudow) for priority reasons in Hopkins & Clay (1952). Emerson (1973) unfortunately used both the names in his list of ectoparasites of the birds of Asia.

Clay (1940) included this species in Group I of *Goniodes* in her revisionary studies. This group is fairly a large one with species having larger bodies, head showing sexual dimorphism, male (Pl. 1 fig. 4 ; Pl. 2 fig. 6) with little and female with greatly expanded temples, (Pl. 2 fig. 7) ; partly membraneous coni, antenna with or without an appendage

to the enlarged segment I, III produced in male, but simple and filiform in female. Meso-metasternal setae absent. Male genital opening unmodified, bifid process to the internal genital organs absent in the female, vulva with setae concentrated at the lateral corners, a spinous process present on the genital region. The specimens under discussion are referable to this group and *G. ocellatus* in particular. It is characterised as follows: Head as in Pl. 1 fig 4 and Pl. 2 figs 6 & 7. Coni small, antennal segment I enlarged bearing a small appendix, occipital angles in female sharp and temples produced. Prothorax rectangular, pterothorax trapezoidal with two lateral and four marginal setae on each side. Abdomen oval with two sterno-central setae to segments I-VII, and the anterior ones may have 2-4 additional setae, tergo-central setae to the female 6-8. Male genitalia characteristic (Pl. 1 fig. 5) reaching near the base of hind coxae. Terminal segments of the female as in (Pl. 1 fig. 6). with setae at the lateral corners of the vulva and with pediculate spiniform setae.

Material: Four ♂♂ and four ♀♀ from *Lophura leucomelana* (Latham), Nepal, 18.vi.1947, coll. *B. Biswas* (Reg. Nos. 628/H 16 (♂), 629/H 16 (♂, ♀), 630/H 16 (1♂, 2♀♀, 1 X), 824/H 16 (1♂, 2♀♀), 825/H 16 (2♂♂, 1♀)).

Measurements

	<i>Male</i>		<i>Female</i>	
	Length	Width	Length	Width
Head	0.66-0.69	0.72-0.76	0.72-0.76	0.94-1.08
Prothorax	0.32-0.36	0.43-0.47	0.32-0.36	0.40-0.47
Pterothorax	0.29-0.36	1.04-1.12	0.32-0.43	1.01-1.22
Abdomen	1.22-1.33	2.09-2.23	1.22-1.33	1.26-1.33
Genitalia	0.81-0.86			
Total	2.09-2.23		2.09-2.66	

Remarks: Clay (1940) reported the species off (*Gennaesus leucomelanas hamiltonii*) *Lophura leucomelana hamiltonii* (J. E. Gray) on a captive bird from Himalaya in London zoo, and also Central Himalaya (Nepal?), on (*G. l. leucomelanos*) *L. leucomelana* (Latham) from Nepal, (*G. nycthemerus horsfieldii*) *L. leucomelana lathamii* (J. E. Gray) from Assam, (*G. n. oatesi*) *L. leucomelana oatesi* (Ogilvie-Grant) from Burma. Specimens off *Pucrasia m. macrolopha* (Lesson) from Himalaya, and *P. m. biddulphi* Marshall from Kashmir, India according to that author are indistinguishable from *G. ocellatus*. Piaget (1880) reported it on the

type host. The present material off *Lophura leucomelana* (Latham) was collected from a wild bird shot by Dr. Biswas confirms it as a natural host.

4. *Goniodes mayuri* (Lakshminarayana & Emerson, 1971)

(Pl. I, figs. 7 & 8 ; Pl. II, fig 8)

Goniocotes mayuri Lakshminarayana & Emerson, 1971. *Oriental Ins.*, 5 (1) : 98, figs. 5-9. Type host : *Pavo cristatus* Linne.

Goniocotes rectangulatus Nitzsch : Emerson & Elbel, 1957, *Proc. Ent. Soc. Wash.*, 59 (5) : 241, fig. 11 (Figure only) ; Emerson, 1964. *Check List of the Mallophaga of North America (North of Mexico)*, Pt. I : 60 (Error).

Goniocotes mayuri : Lakshminarayana, 1979. *Rec. zool. Surv. India*, 75 : 102 ; Lakshminarayana, 1982. *Misc. Publ. Occ. pap. Rec. zool. Surv. India*, No. 33 : 13.

Goniodes mayuri : Lakshminarayana, 1982. *Rec. zool. Surv. India*, 80 : 78.

Goniodes mayuri was originally well described and figured by Lakshminarayana & Emerson (1971). Following after Hopkins & Clay (1952) it was placed under the genus *Goniocotes* along with *Gc. parviceps* (Piaget) the other member in the sympatric pair with which it was confused. The male of *G. mayuri* is separable from *G. parviceps* in the temporal margin slightly constricted, marginal temporal carina narrow, provided with smaller and thinner temporal marginal setae, antennal appendage with a lanceolate seta ; nearly rectangular prothoracic margins ; abdominal tergite strongly projecting into thorax anterolaterally, tergite VII with 4 setae, terminal abdominal tergite with 6 long setae, and by the presence of characteristic symmetrical genitalia (Pl. 1 fig. 8 ; Pl. 2 fig. 8) as against the asymmetrical ones in *parviceps*. The females of both the species are difficult to separate : however, the female of *mayuri* is usually of larger size, the terminal abdominal tergite provided with 8 setae, and a prominent internal circular-shaped vulval chamber.

Material : One ♂ off *Pavo cristatus* Linne, Tamispur, Navalpur, Parasi Dist., 15.ii.1968, Coll. R. E. Lewis (Iowa State Univ. Ames). Coll. No. Np. 313 (Paratype), (Reg. No. 668/H 16 (♂) (Dr Emerson's donation).

For measurements cf. Lakshminarayana & Emerson, 1971.

Remarks : Lakshminarayana & Emerson (1971, 1978), Lakshminarayana (1977, 1979 b, c), Lakshminarayana & Price (1980) discussed the evolutionary trend in *G. mayuri* and *G. parviceps* and the evolution of the hosts involved viz., *Pavo cristatus* Linne and *P. muticus* Linne, the secondary infestation and establishment, and the role of Asymmetry in the speciation of the lice.

5. *Lipeurus brunneipictus* (Giebel, 1877)

(Pl. I, fig. 9 ; Pl. II, fig. 9)

Nirmus brunneipictus Giebel, 1877. *Z. ges. Nat. Wiss.*, 49 : 530. Type host : (*Lophalector vieilloti*) *Lophura rufa* (Raffles).
Lipeurus intermedius Piaget, 1880. *Pediculines* : 368, Pl. 29 fig. 7. Type host : (*Euplocamus ignitus*) *Lophura ignita* (partim).
Degeeriella brunneipicta : Harrison, 1916. *Parasitology*, 9 : 109.
Lipeurus brunneipictus : Clay, 1938. *Proc. zool. Soc. Lond.*, (B) 108 : 121, figs. 4e, 5e, 7c & 9a ; pl. 2 fig. 1 ; Hopkins & Clay, 1952. *A Check List of Genera and species of Mallophaga* : 192.

Clay (1938) while revising the mallophaga of gallinaceous hosts, stated that *Lipeurus intermedius* Piaget (1880) was based on composite species viz., a male of *brunneipictus* and female of *Oxylipeurus piageti* Clay (later emended to *piagetinus* in Hopkins, 1950). The author further remarked that some of the females in Piaget's collections resemble the drawings of *L. brunneipictus* provided by Dr K  ler based on Giebel's material (before part of it was destroyed in the Halle Museum now housed in Museum fuer Naturkunden der Humboldt Universit  t, Berlin and not available during the present author's visit and apparently lost (of. Goellner-Scheiding, 1973).

The material under study comprise four ♀ ♀ from *Lophura leucomelana* (Latham) (Pl. 2 Fig. 9) resemble very much the female of *L. brunneipictus* (Giebel) *sensu* Clay (1939), with very minor variations. The ♀ of this species is quite close to the ♀ of *L. keleri* Clay, but differs from the latter by the narrow preantennal region and chaetotaxy of the genital region (Pl. 1 Fig. 9). The vulval setae are longer ranging from 8-10 in a row and another series of 4-6 spiniform setae above.

Material : Four ♀ ♀ from *Lophura leucomelana leucomelana* (Latham) (B.15/18/4/47), Nepal, 18.iv.1947. Coll. *B. Biswas* (Reg. Nos. 620/H 16 (♀), 621/H 16 (2 ♀ ♀), 622/H 16 (♀)).

Measurements

		Female
Head	0.48-0.52	
Pre-antennal		0.28-0.35
Temples		0.35-0.38
Prothorax	0.14-0.16	0.22-0.27
Pterothorax	0.25-0.26	0.46
Abdomen	1.22-2.0	0.39-0.49
Total	2.16-2.25	

Remarks : Clay (1939) reported the species from skins of *Lophura rufa* (Raffles) from Sumatra, and one male from *L. i. ignita* (Shaw) in Piaget's collections. Though, Kellogg reported the occurrence of *L. Intermedius* Piaget on *Pucrasia melanolopha* (Lesson), on examination the material was found conspecific with *Reticuligeurus pucrasia* (Clay). The present record is therefore interesting for two reasons viz., firstly, the host is a new record, and secondly the species is reported for the first time from the Indian Region. Although Emerson (1973b) recorded *L. introductus* Kellogg on *Lophura leucomelana* the present specimens appear more like *brunneipictus* only.

6. *Upupicola upupae* (Schränk, 1803)

(Pl. I, fig. 10 ; Pl. II, fig. 10)

Pediculus upupae Schränk, 1803. *Fauna Boica* : 189. Type host : (Wiedehopf) *Upupa e. epops* Linne.

Docophorus upupae Denny, 1842. *Mon. Anopl. Brit.* : 45, 92, pl. 8, fig. 1. Type host : *Upupa e. epops* Linne.

Nirmus melanophrys Nitzsch, 1866. In Giebel's *Z. ges. Nat. Wiss.* 28 : 369. Type host : *Upupa e. epops* Linne.

Nirmus melanophrys : Giebel, 1874. *Insecta Epizoa* : 146 ; Piaget, 1880. *Pediculines* : 149, pl. 12 fig. 7 ; Kellogg, 1908. *Genera Insectorum (Mallophaga)*, 66 : 27.

Philopterus upupae : Harrison, 1916. *Parasitology*, 9 : 106.

Degeeriella upupae : Harrison, 1916. *Parasitology*, 9. Not mentioned under *Degeeriella*, though a reference was indicated on p. 106 ; Harrison, 1916, *Parasitology*, 9 : 125, a *nomen nudum* ; Séguy, 1944, *Faune de France*, 43 : 309, fig. 470.

Degeeriella melanophrys : Harrison, 1916, *Parasitology*, 9 : 117.

Upupicola melanophrys : Ansari, 1947. *Proc. nat. Inst. Sci. India*, 13 (6) : 283 ; Hopkins & Clay, 1952. *A Check List of Genera and species of Mallophaga* : 360.

Upupicola upupae : Hopkins & Clay, 1952. *A Check list of Genera and species of Mallophaga* : 361 ; Ansari, 1966. *Indian J. Ent.*, (1955), 17 (3) : 397 ; Ansari, 1959. *Indian J. Ent.*, (1958), 20 (2) : 91 ; Clay, & Hopkins, 1960. *Bull. Br. Mus. nat. Hist. (Ent.)*, 9 (1) : 12, figs. 13-18, pl. 2 figs. 1 & 2.

Schränk (1803) described the species from *Upupa e. epops* Linne, which was believed identical with Piaget's figure of *Nirmus melanophrys* Nitzsch (Piaget, 1880), and the description in Giebel (1866, 1874), a sketch in Nitzsch's manuscript, and Piaget's specimens labelled as *N. melanophrys* in British museum (Nat. Hist.) (cf. Clay & Hopkins, 1960). Denny (1842) independently described *Docophorus npupae* for specimens off the same host. His syntypes found in British Museum (Nat. Hist.) were also found to be identical with *U. upupae*. Harrison (1916) considered *upupae* Schränk as a *Philopterus*, and *upupae* Denny as a *Degeeriella*, and *melanophrys* Nitzsch as conspecific with *D. upupae*.

Clay & Meinertzhagen (1939) established the genus *Upupicola* with *D. melanophrys* (Nitzsch) as the type species. Now that *upupae* Schrank, *upupae* Denny, and *melanophrys* Nitzsch are all conspecific the genus contains a single species.

The single male and female from *Upupa epops saturata* Lönnerberg (Pl. 2 fig. 10) in the present collections agree with redescription and figures of *U. upupae* (Schrank) *sensu* Clay & Hopkins (1960) and the generic description of *Upupicola* Clay & Meinertzhagen (1939). Male genitalia as in Pl. 1 fig. 10.

Material: One ♂ and ♀ from *Upupa epops saturata* Lönnerberg (B6/5.4.47), Gowcharan, Nepal, 5.iv.1947, Coll. B. Biswas.

Measurements

	Male		Female	
	Length	Width	Length	Width
Head	0.39	0.25	0.47	0.43
Prothorax	0.13	0.18	0.14	0.22
Pterothorax	0.16	0.25	0.20	0.40
Abdomen	0.94	0.51	1.15	0.59
Genitalia	0.31			
Total	1.56			

Remarks: Schrank (1803), Denny (1842), 'Nitzsch' (1866), Piaget (1880), and Séguy (1944) recorded the species on *Upupa epops* Linne. Blagoveshtchenskii (1951) reported on the same host from Kondora as *D. upupae* (Denny). Bedford (1932) also reported under the latter name on *U. africana* Bechst from S. Africa. Clay & Hopkins (1960) designated neotype from material off the type host from Hodonin, Czechoslovakia and neoparatypes from France, Italy, Portugal. Czechoslovakia, Asia Minor, India and Pakistan. Ansari (1947) reported it as *U. melanophrys* (Nitzsch) on (*U. e. orientalis*) *Upupa epops ceylonensis* Reichenbach from Lyallpur (Pakistan) and later corrected it to *U. upupae* (Schrank).

The present record from *Upupa epops saturata* Lönnerberg is the first report Nepal and also on a new subspecies of the type host. The specimens are smaller than those of clay & Hopkins (1960), but the male is smaller and female is larger than those of Ansari (1947). The male however, agrees with the size of the male but the female is larger than those of Piaget (1880), and Séguy (1944).

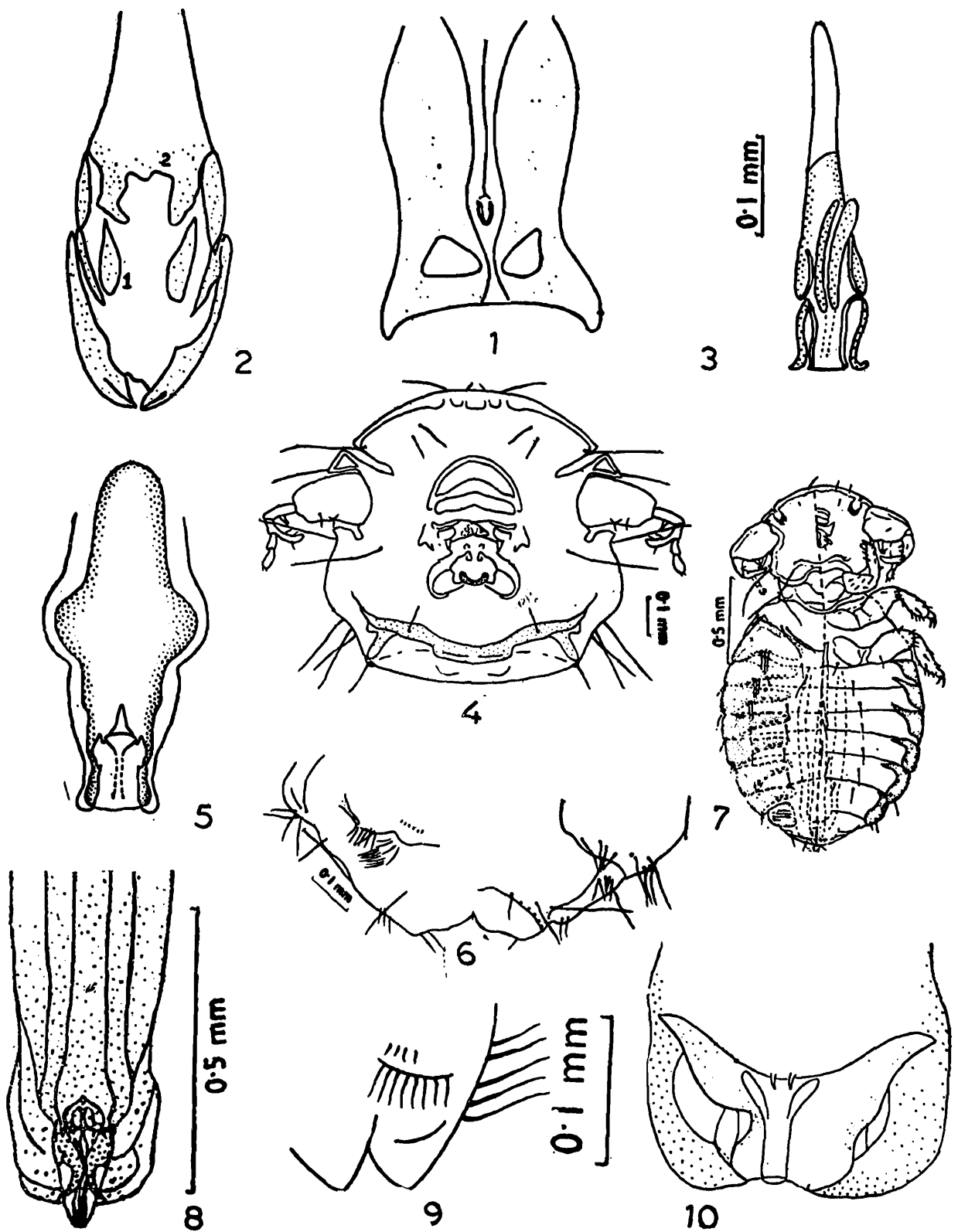


Fig. 1-10. 1-2. *Laemobothrion maximum* : 1. Sitophore sclerite ; 2. ♂ genitalia.
 3. *Amyrsidea minuta* : ♂ genitalia.
 4-6. *Goniodes ocellatus* : 4. ♂ head ; 5. ♂ genitalia ; 6. Terminal abdominal segments of the ♀
 7-8. *Goniodes mayuri* : 7. ♂ entire ; 8. ♂ genitalia.
 9. *Lipeurus brunneipictus* : ♀ terminal sternal chaetotaxy.
 10. *Upupicola upupae* : Distal portion of ♂ genitalia.

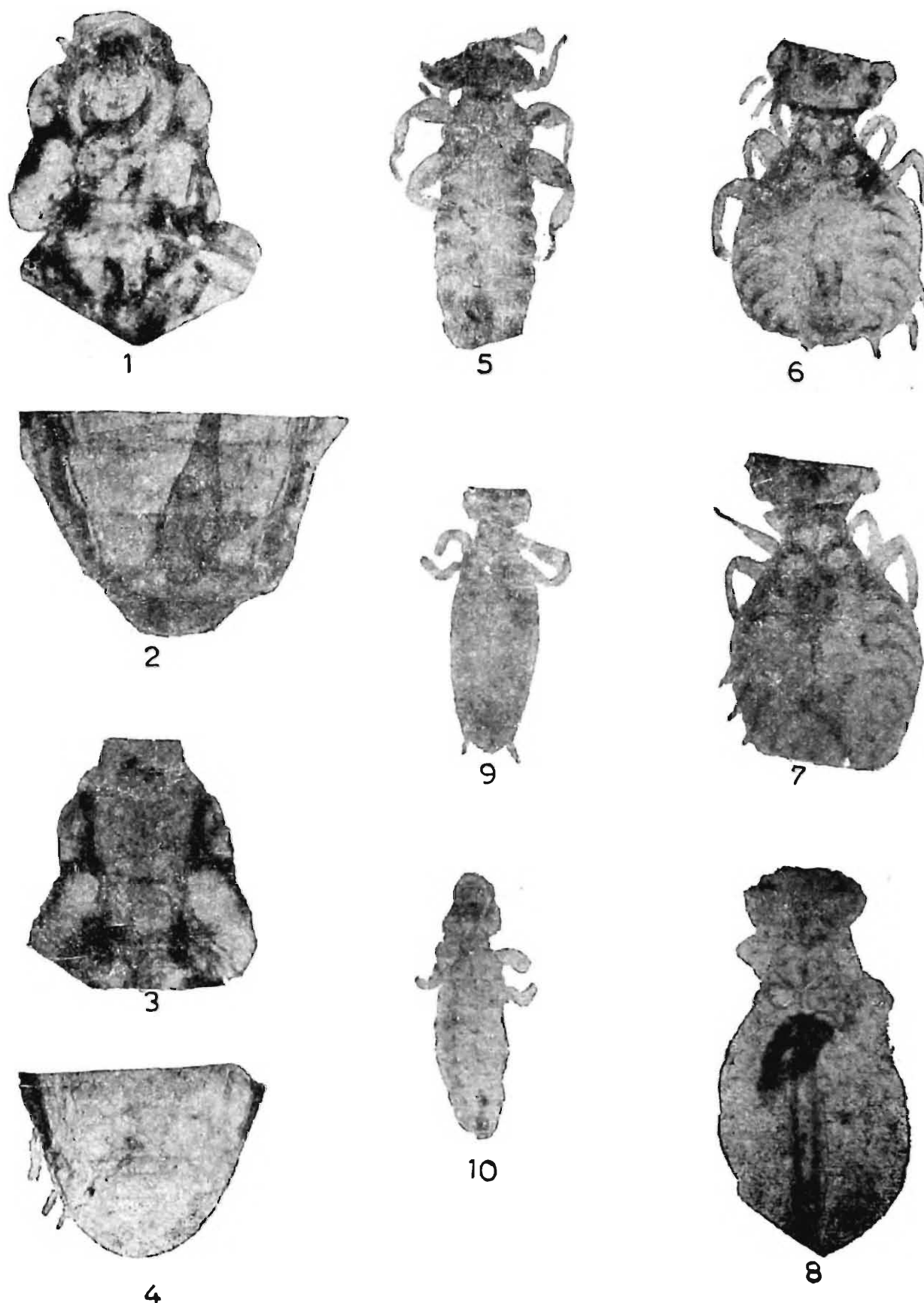


Fig. 1-10. 1-4. *Laemobothrion maximum* : 1. ♂ head ; 2. Terminal abdominal segments showing ♂ genitalia ; 3. ♀ head ; 4. Terminal ♀ abdominal segments.

5. *Amyrsidea minuta* ; ♂.

6-7. *Goniodes ocellatus* : 6. ♂ : 7. ♀.

8. *Goniodes mayuri* : ♂.

9. *L. brunneipictus* : ♀.

10. *Upupicola upupae* : ♂.

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PLANKTONIC ROTIFERA OF NORTHEAST INDIA

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INTRODUCTION

In his previous paper, Patil (1976) recorded some cladocerans fauna of Northeast India. From the same samples collected during 1975-76, Patil (1978) recorded some rotifers from this region which appear merely in list of rotifers. In the present paper, 27 species are briefly commented alongwith distributions in India. The measurements provided are given in micron (μ).

MATERIAL AND METHODS

Plankton samples were collected with the help of a bolting silk (200 meshes/cm) conical net. Samples were collected especially from the comparatively undisturbed part of waterbodies. Only qualitative plankton samples were obtained and preserved in 10% formalin. Some live samples were isolated and studied in living condition for perfect identification. Fixation, preservation and preparation of microscopic slide were made as given by Arora (1962).

SYSTEMATIC ACCOUNT

Phylum : ROTIFERA

Class : BDELLOIDEA

Order : BDELLOIDA

Family : PHILODINIDAE

Rotaria neptunia (Ehrenberg, 1832)

This is a large rotifer, recorded for the first time from Indian subcontinent.

Distribution : Meghalaya (present record)

Measurements : Length tip of carona to the tip of foot 600 ; maximum body width 60.

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Class : MONOGONOTA
Order : FLOSCULARIDAE
Family : HEXARTHRIIDAE

Hexarthra mira (Hudson, 1871)

The forms agree with description and measurements given by Voigt (1957). However, present specimen are bigger than Green's (1972) specimens recorded from lake Kotto, West Cameroon.

Distribution : Meghalaya & Manipur (present record)

Measurements : Length of body 170-210 ; Maximum width of body 120.

Family TESTUDINELLIDAE

Filinia longiseta (Ehrenberg, 1834)

Agree with the description of Nagpur specimen (Arora, 1962).

Distribution : Nagpur (Arora, 1962), Baroda (Wulfert, 1966), Chandigarh (Varisht & Gupta, 1967), Bihar (Nasar, 1973), Rajasthan (Nayar, 1968), West Bengal (Sharma, 1978 b), Orissa (Shaama, 1980) and Meghalaya (present record).

Measurements : Length of body 140 ; Maximum width of body 60 ; length of each lateral spine 240 ; length of the posterior spine 165.

Order : PLOIMA

Family : ASPLANCHNIDAE

Asplanchna priodonta Gosse, 1850

The specimens found in the present collection, are smaller than earlier described specimen.

Distribution : Baroda (Wulfert, 1966) and Bihar (Nasar, 1973), Meghalaya (present record).

Measurements : Length of the body 1100 ; Maximum width 440.

Family : BRACHIONIDAE

Anuraeopsis fissa Gosse, 1851

These forms agree with the length range as given by Green, (1972).

Distribution : Baroda (Wulfert, 1966) and Meghalaya (present record).

Measurements : Length of body 80 ; Maximum width 60.

Brachionus angularis Gosse, 1851

Identical with the specimen of Nagpur (Arora, 1963 a).

Distribution : Madras (Ahlstorm, 1940), Punjab and Kashmir (Edmondson & Hutchinson, 1934), Rajasthan (Nayar, 1968), Kerala (Nayar & Nair, 1969) N. W. India (Vasisht & Battish, 1971 a and Sharma, 1976), Bihar (Nasar, 1973), Andhra Pradesh (Dhanapathi, 1974 and Chandra Mohan & Rao, 1976) West Bengal (Sharma, 1979a), Maharashtra Nagpur (Arora, 1963) Orissa (Sharma, 1980), Meghalaya, Manipur (present record).

Measurements : Length of the body 95-110, Maximum width 90-100.

Brachionus caudatus Barrois and Daday, 1894

Identical with the specimen from Nagpur (Arora, 1963a).

Distribution : Madras (Ahlstorm, 1940), Pilani (Nayar, 1968), Chandigarh (Vasisht & Battish, 1971a), Nagpur (Arora, 1963a), Bihar (Nasar, 1973), Orissa (Sharma, 1980), Meghalaya (present record).

Measurements : Length of the body 160 ; width of body 140.

Brachionus calyciflorus Pallas, 1796

Cosmopolitan species and has been recorded from many continents.

Distribution : Punjab & Kashmir (Edmondson and Hutchinson, 1934), Delhi (George, 1961), Nagpur (Arora, 1963a), Rajasthan (Nayar, 1965a), Bihar (Nasar, 1973), Chandigarh (Vasisht & Gupta, 1965), Orissa (Sharma, 1980), N. W. India (Sharma, 1976) and Meghalaya, Assam & Manipur (present record).

Measurements : Length of body 360 ; width of body 220.

Brachionus falcatus Zacharias, 1898

Slightly bigger in size than those described by Sachse (1912), Kutikowa (1970), Green (1972) and Arora (1963a).

Distribution : Nagpur (Arora, 1963a), Baroda (Wulfert, 1966), Rajasthan (Nayar, 1968), Kerala (Nayar & Nair 1969), N. W. India (Vasisht & Battish, 1971a and Sharma, 1976), Bihar (Nasar, 1973), Andhra Pradesh (Dhanapathi, 1974), W. Bengal (Tiwari & Sharma, 1977 and Sharma, 1979a), Orissa (Sharma, 1980) and Assam (present record).

Measurements : Length of body 190 ; width of body 200.

Brachionus quadridentatus Hermann, 1783

Earlier reported from India from many regions.

Distribution : West Bengal (Anderson, 1889) (Sewell, 1935 ; Sharma 1979a), Nagpur (Arora, 1963a), Rajasthan (Nayar, 1968), Kerala, (Nayar and Nair, 1969), N. W. India (Vasisht & Battish, 1969), Bihar (Nasar, 1973) and (Sharma, 1976), Andhra Pradesh (Dhanapathi, 1974), Orissa (Sharma, 1980), Meghalaya (present record).

Measurements : Length of body 180 ; width of body 140.

Brachionus urceolaris Muller, 1773

Very few individuals were observed.

Distribution : Nagpur (Arora 1963 a), Vijayawada (Naidu, 1967) West Bengal (Sharma, 1979a) and Assam (present record).

Measurements : Length of the body 260 ; width of the body 240.

Brachionus rubens Ehrenberg, 1838

Foot opening is characteristic of this species for its identification from its allied species *B. urceolaris*.

Distribution : West Bengal (Sewell, 1935 ; Tiwari & Sharma, 1977 and Sharma, 1979a), Rajasthan (Nayar, 1968) and North West India (Vasisht & Battish, 1971a and Sharma, 1976), Orissa (Sharma, 1980) and Assam (present record).

Measurements : Length of the body 280 ; width of the body 180.

Epiphanes macrourus (Barrois & Daday, 1894)

The present form agrees with the description of the specimens of Nagpur (Arora, 1965).

Distribution : Nagpur (Arora, 1965) and Meghalaya & Assam (present record).

Measurements : Length of the body 200 ; width of the body 190.

Euchlanis dilatata 1832

This species observed in the littoral sample.

Distribution : Punjab, Kashmir and Ladak (Edmondson & Hutchinson, 1934), West Bengal (Sewell, 1935 and Sharma, 1979a), Baroda

(Wulfert, 1966), North West India (Vasisht and Battish, 1971c, Das & Akhtar, 1976 and Sharma, 1976) and Orissa (Sharma, 1980), Meghalaya and Assam (present record).

Measurements : Length of the body 300 ; width of the body 140 ; toes 95.

***Mytilina ventralis* (Ehrenberg, 1832)**

Lorica anteriorly stippled & narrow at posterior end

Distribution : West Bengal (Anderson, 1889) and Sharma, 1979a), Punjab, Kashmir, Ladak (Edmondson & Hutchinson, 1934), Nagpur (Arora, 1965), Baroda (Wulfert, 1966), Rajasthan (Nayar, 1968), Kerala (Nayar & Nair, 1969 and Nair & Nayar, 1971), North West India (Vasisht and Battish, 1971c) Andhra Pradesh (Dhanapathi, 1974), Orissa (Sharma, 1980) and Assam (present record).

Measurements : Length of body 200 ; width of body 102.

***Trichotria tetractis* (Ehrenberg 1830)**

These forms identical with those from Nagpur (Arora 1966a).

Distribution : Punjab, Kashmir & Nilgiri Hills (Edmondson & Hutchinson, 1934), Nagpur (Arora, 1966a), Baroda (Wulfert, 1966), Kerala (Nayar & Nair, 1969 and Nair & Nayar, 1971), Andhra Pradesh (Dhanapati, 1974), North West India (Das & Akhtar, 1976 and Sharma, 1976), West Bengal (Sharma, 1979b), Orissa (Sharma, 1980), Meghalaya (present record).

Measurements : Length of the body including toes 300 ; width of the body 110.

***Keratella cochlearis* Gosse, 1851**

This species earlier recorded from Nagpur (Arora, 1966a). Agree with description of Nagpur specimen.

Distribution : Kashmir (Edmondson & Hutchinson, 1934), Nagpur (Arora, 1966a), Meghalaya and Manipur (present record).

Measurements : Length of body 90 ; width of body 55 ; length of posterior spine 38.

***Keratella tropica* (Apstein, 1907)**

This species has been recorded earlier from India by Edmondson & Hutchinson, (1934), in Indonesia by Hauer (1938a), in Africa by Green (1967).

Distribution : Kashmir (Edmondson & Hutchinson, 1934), Nagpur (Arora, 1966a) and Meghalaya and Manipur (present record).

Measurements : Length of the body, 140, width of the body 75 ; right posterior spine 80 ; left posterior spine 40.

***Keratella valga* (Ehrenberg, 1834)**

Very few individuals were found. Identical with the description of Arora's (1966) specimen recorded from Nagpur.

Distribution : Nagpur (Arora, 1966a) and Manipur (present record).

Measurements : Length of the body 210 ; width of the body 78 ; right posterior spine 82 ; left posterior spine 25.

Family : LECANIDAE

***Lecane* (M) *bull*a Gosse, 1951**

The forms in my collection are identical in all respects with *bull*a as described by Haring & Myers (1926), Maxvoigt (1957) and Rudescu (1960).

Distribution : West Bengal (Anderson, 1889 and Sharma, 1978 a), Punjab, Kashmir and Ladak (Edmondson, 1934), Nagpur (Arora, 1965), Baroda (Wulfert, 1966), Rajasthan (Nayar, 1968), N. W. India (Vasisht & Gupta, 1967 and Vasisht & Battish, 1971 d) and Andhra Pradesh (Dhanapathi, 1976), Orissa (Sharma, 1980) and Meghalaya (present record).

Measurements : Length of the body 130 ; width of the body 90 ; toes 50 ; claws 24.

***Lecane closterocerca* (Schmarda, 1839)**

Anterior median sinus is found in the present form.

Distribution : Punjab, Ladak and Nilgiri Hills (Edmondson Hutchinson, 1934), Baroda (Wulfert, 1966), Rajasthan (Nayar, 1968), N. W. India (Vasisht & Battish, 1971 b), West Bengal (Sharma, 1978 a), Orissa (Sharma, 1980) and Meghalaya (present record).

Measurements : Length of the body 73 ; width of the body 65 ; length of the toes 36.

***Lecane longidactylus* Arora, 1965**

This species has been recorded by Arora (1965) from Nagpur, India. The present form resembled in most respects with *longidactylus* as described by him.

Distribution : Nagpur (Arora, 1965) and Meghalaya (present record).

Measurements : Length of the dorsal plate 137 ; length of the ventral plate 138 ; width of the dorsal plate 99, width of ventral plate 102. toes 61, claws 10.

***Lecane (L) tessellata* Arora, 1965**

Ventral plate with three transverse ridges but only two are visible. First foot joint as well as second too, is clearly visible in the present specimen.

Distribution : Nagpur (Arora, 1965) Meghalaya (present record).

Measurements : Length of the dorsal plate 124, length of the ventral plate 119 ; width of the dorsal plate 97 ; width of ventral plate 110.

Family : NOTOMMATIDAE

***Scaridium longicaudum* Muller, 1786**

The present form agrees with the description as given by Donner (1943a).

Distribution : Assam (present record), North India (Vasisht & Battish, 1969).

Measurements : Length of the body 150 ; width of the body 120 ; length of the toes 140.

Family : SYNCHAETIDAE

***Polyarthra dolichoptera* Idelson, 1925**

The present form has lateral appendages which protrude well beyond the body.

Distribution : Manipur (present record).

Measurements : Length of the body 150 ; width of the body 120.

***Polyarthra vulgaris* Carlin, 1943**

The occurrence of this species in India has been reported earlier by workers like Michael (1964), George (1966) and Patil (1976) while working on plankton ecology from various states.

Distribution : Delhi (George, 1966), Calcutta (Michael, 1964), Nagpur (Patil, 1976), West Bengal (Sharma, 1979b), Orissa (Sharma, 1980) and Meghalaya (present record).

Measurements : Length of the body 120 ; width of the body 80.

Family : TRICHOCERCIDAE

Trichocerca cylindrica Imhoff 1891

This form agrees with the description of Jennings (1903) but the present specimen is smaller than the species recorded by Chengalath & Mulamoottil (1974).

Distribution : Meghalaya (present record).

Measurements : Length of the body 260 ; width of the body 180.

SUMMARY

In this paper author has recorded 27 species of planktonic rotifera belonging to 15 genera, 9 families, 3 orders and 2 classes, for the first time from Northeast India. All these species dealt here and briefly commented and their distributions in India is also provided along with measurements.

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DISTRIBUTIONAL PATTERN OF GRASSHOPPERS OF INDIA :
THE DISTRIBUTION OF OXYINAE (ORTHOPTERA :
ACRIDOIDEA : ACRIDIDAE) IN INDIAN REGION

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INTRODUCTION

The Oxyinae is a subfamily of Acrididae that now includes an array of 21 genera and is Old World in distribution. Majority of the species of Oxyinae are widely known to be pests of rice, sugarcane and other crops in India, Pakistan, Bangladesh, Nepal, and throughout the Indo-Malayan region, China, South east U. S. S. R. and the Australian region (Fig. 1). The members of this subfamily are typically phytophilie and are usually found in grasses and dense vegetation specially near moist and shady areas. The hind tibia and tarsus of these insects are expanded and oar-like enabling the insects to swim. They are thus ecologically adapted to the moist environment. In Indian region this subfamily is represented by nine genera. The genera are *Caryanda* Stål, *Cercina* Stål, *Chitaura* I. Bolivar, *Gesonula* Uvarov, *Hygracris* Uvarov, *Ochlandriphaga* Henry, *Oxya* Serville, *Oxyina* Hollis and *Oxytauchira* Ramme.

According to Uvarov (1966) the nongregarious grasshoppers in many countries are more serious enemies of agriculture than locusts and their number is continually increasing particularly in newly developed countries. In India we have very little information about the distribution of nongregarious grasshoppers while their ecology and habits are very poorly known. The present contribution will throw light on the distribution of this economically important subfamily in the Indian region with notes on the habitat of some of the species.

DISTRIBUTION

1. Genus *Caryanda* Stål

(Fig. 2)

The genus *Caryanda* is represented by fifteen species from the world of which four are represented from Indian region, where they occur in the north-eastern region with the exception of *C. diminuta* which also occurs in Andaman and Nicobar Islands. The genus has

so far been known from Central Africa ; India ; Bhutan ; Burma ; China ; Vietnam and West Indonesia (Hollis, 1975), *C. diminuta* (Walker) is reported from India (Assam) ; and Burma (Willemse, 1925, 1953 ; Hollis, 1971), *C. cachara* Kirby occurs in Assam (Cachar) Kirby, 1914), *C. paravicina* (Willemse) is confined to north-eastern India (Willemse, 1925) and *C. sanguineoannulata*, Brunner von Wattenwyl

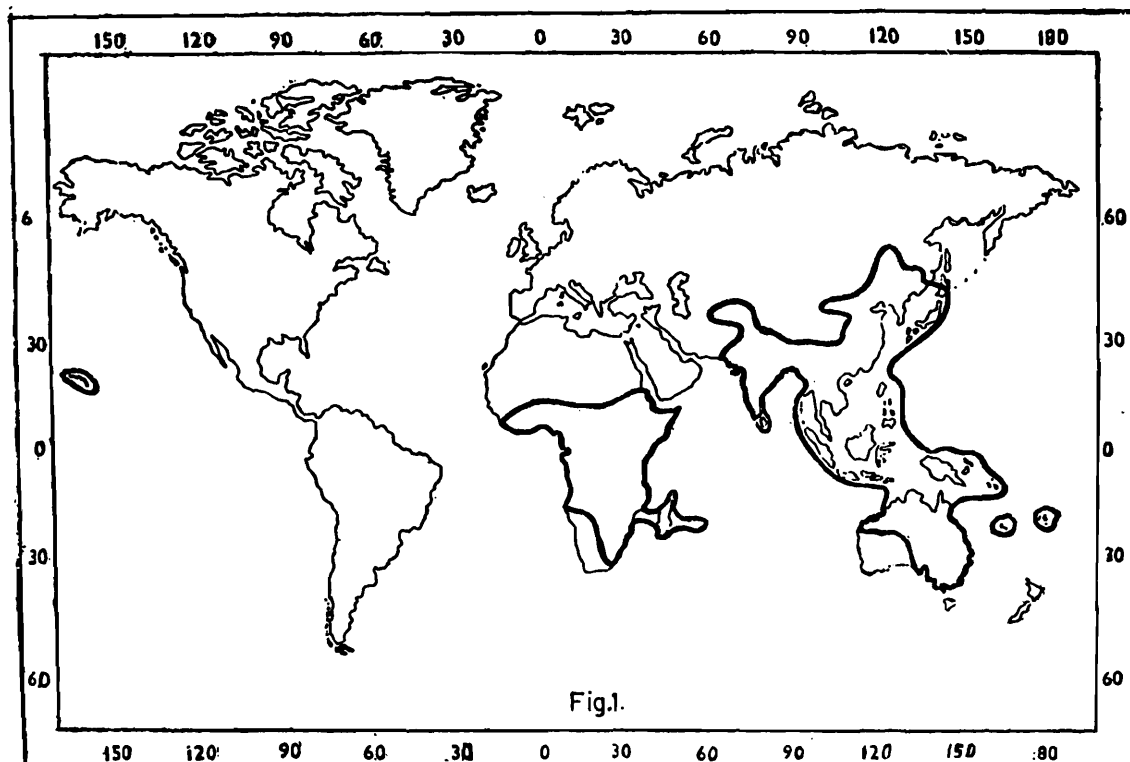


Fig. 1. Range of subfamily *Oxyinae* (After Mischenko, 1952).

from Bhutan and Burma, (Willemse, 1955). In north-eastern region the genus is usually found in thick and short grasses adjoining cultivated fields or under large trees.

2. Genus *Cercina* Stål

(Fig. 2)

Cercina is endemic to the Indian region and is confined to Sri Lanka. The genus is known by two species (Sandrasagara, 1950 ; Tandon, 1976a). *C. obtusa* extends from Ohiyo, Harkgula Horton plains to Eliya in Central provinces (Sandrasagara, 1950) and *C. phillipsi* Henry is known from Gammaduwa in Central and Pandoloya in Uva Province (Henry, 1933).

3. Genus *Chitaura* I. Bolivar

(Fig. 2)

Chitaura is wholly Oriental and is so-far known only from southern India, West Indonesia, Sulawesi and Maluku (Hollis, 1975). The

genus is poorly represented in India. Of the sixteen species known so far only one occurs in Indian region. *C. indica* Uvarov, occurs in the Deccan plateau (Uvarov, 1929). Recently I have come across a few specimens of this species from Kerala (Kottayam), which extends the distribution of this species further south.

4. Genus *Gesonula* Uvarov

(Fig. 2)

Gesonula occurs in Indian region, eastwards to North Australia and Soloman Islands (Hollis, 1975). Of the three species known so far

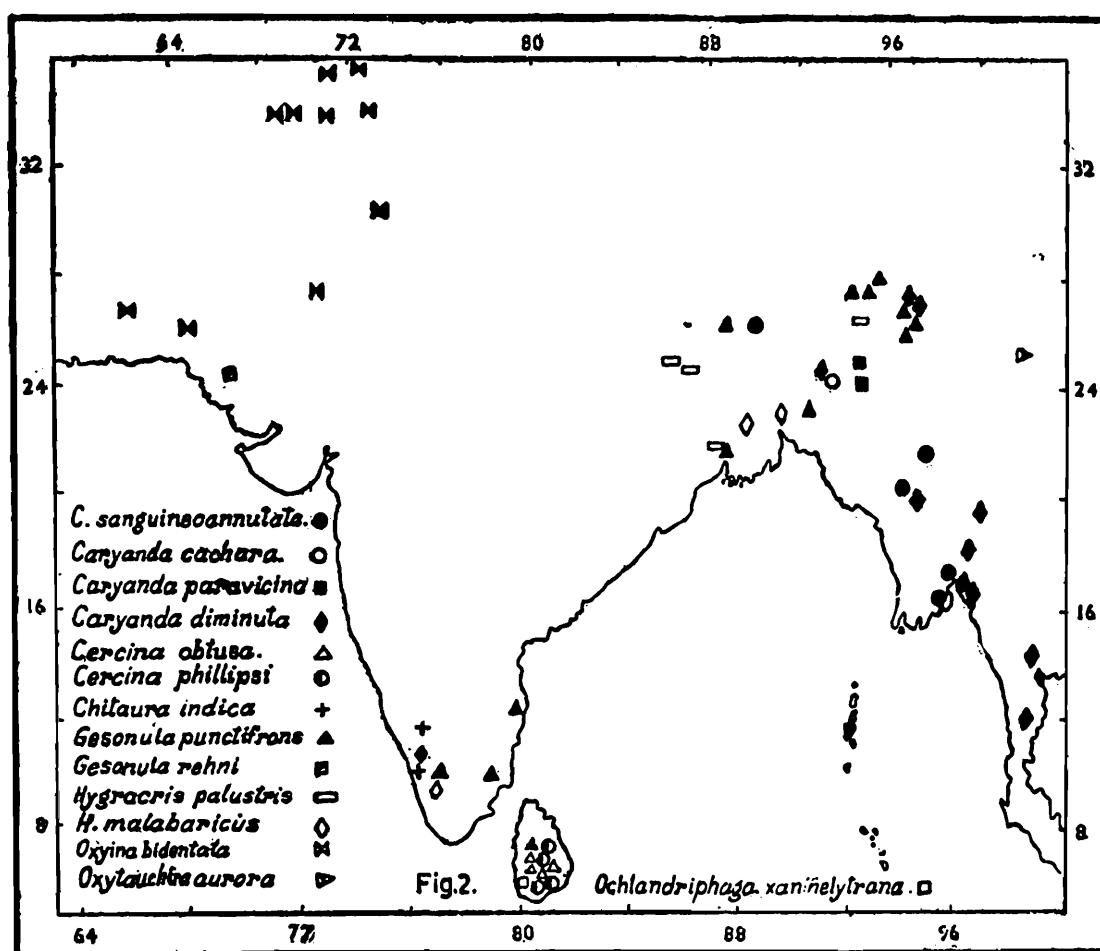


Fig. 2. Distribution of species of *Caryanda*, *Cercina*, *Chitaura*, *Gesonula*, *Hygracris*, *Oxyina*, *Oxytauchira*, *Ochlandriphaga*.

only two occur in the Indian region (Tandon, 1976a). *G. punctifrons* occurs in Indian region in, north eastern India, southern India and Sri Lanka. It extends from Indo-Malayan region to China and Japan (Willemse, 1955). In north eastern India this species is always associated with moist localities and usually found along pools or streams in low vegetation adjoining forest paths and cultivated fields (Tandon and Khera, 1978). *G. rehni* has so far been known only from Pakistan (Akbar and Balock, 1970).

5. Genus *Hygracris* Uvarov

(Fig. 2)

Hygracris is endemic to Indian region and is represented by two species in India (Tandon, 1976a). *H. palustris* occurs in Bihar, Bengal and Assam (Uvarov, 1921). *H. malabaricus* from Malabar, Kerala (Willemse, 1962). The present day discontinuity in distribution of this genus is probably a relict of former continuous distribution. The genus is an inhabitant of moist localities along road-sides in tropical forest in north-eastern India (Tandon and Khera, 1978).

6. Genus *Ochlandriphaga* Henry

(Fig. 2)

The genus *Ochlandriphaga* is endemic to Sri Lanka and is monotypic (Henry, 1933). Records of *O. xanthelytrana* from Sri Lanka are limited to type species from Labugama Western Province.

7. Genus *Oxya* Serville

(Fig. 3)

The genera *Oxya* occurs in Ethiopian, S. E. Palaearctic, Oriental, Austro-Oriental and Australian regions (Hollis, 1975). *Oxya* represents the most dominant genus of Oxyinae of Indian region and includes seven species and sub-species, the distribution of which is summarized under. In Indian region the genus is associated with paddy, sugarcane and other crops. *O. chinensis* was recorded from Himalaya by Kirby (1914) without specifying any locality. There is no record of its occurrence after Kirby's work. This species is widely distributed in China, Taiwan, Korea, Japan, Vietnam and U. S. S. R. (Maritime Province) (Willemse, 1955 ; Hollis 1971). *O. fuscovittata* occurs in Indian regions in Pakistan, Kashmir, sub-himalayan tract of Uttar Pradesh, Assam region, and in southern India. This species is also known from (south western) U. S. S. R. and Afghanistan (Hollis, 1971 ; Willemse, 1955). Recently the species has been recorded from Jodhpur (Rajasthan), Garhwal (Uttar Pradesh), Udhampur (Jammu and Kashmir), Chotanagpur (Tandon and Shishodia 1976 b-d). *O. hyla hyla* is the most widely distributed species in India, Sri Lanka, Bangladesh, eastern Himalaya, Gangetic Plains, Chotanagpur, southern India, Malabar mountains, and in north up to Kashmir. The distribution is scanty in desert regions and central India. This species is widely distributed in Africa and Madagascar. Tandon and Khera, 1978 found this species confined to moist localities adjoining tropical, subtropical forest belts,

and cultivated fields in Arunachal Pradesh. *O. hyla intricata* in Indian region is confined only to Burma (Hollis, 1971). *O. japonica japonica* occurs on the west coast of India, north-eastern India, Andaman and Nicobar Islands, Burma, Bangladesh and Sri Lanka (Hollis, 1971). This species is widely distributed in Indo-Malayan region and Japan. *Oxya*

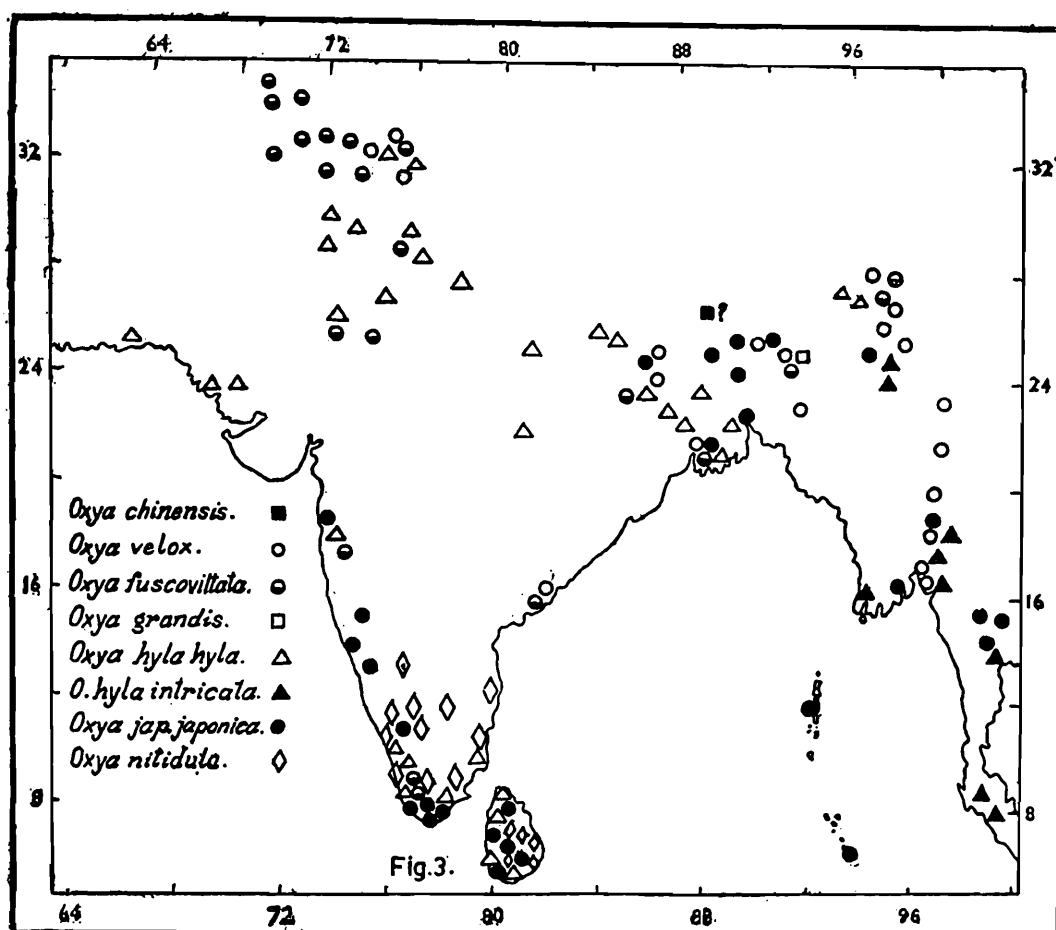


Fig. 3. Distribution of species of genus *Oxya*.

nitidula is confined to southern Indian and Sri Lanka. *Oxya velox* is also the northern most representative of the genus, but it has been more successful in invading the north-eastern India, Bangladesh, Burma, and then on to Indo-Malayan region. Record from south is limited at present on to eastern coast in Andhra Pradesh. *O. grandis* is known from north eastern India and record of its distribution is limited only to type series.

8. Genus *Oxyina* Hollis

(Fig. 2)

Oxyina is very close to *Oxya* and is at present known from Iran, Afghanistan and Pakistan (Hollis, 1975). It now includes three species formerly included in the genus *Oxya* of which *O. bidentata* (Willemse) occurs in Indian region and is confined only to north-western region.

9. Genus *Oxytauchira* Ramme

(Fig. 2)

The genus is known by two species in Oriental region (Hollis, 1975) of which one is represented from Indian region *O. aurora* is confined to northern Burma.

DISTRIBUTIONAL PATTERN

Analysis of the distributional pattern of various genera of Oxyinae so far known from Indian region reveals that *Cercina*, *Hygracris* and *Ochlandriphaga* are endemic to the Oriental of India. *Oxytauchira* and *Chitaura* are purely Oriental; *Oxya* is too common to Oriental, Palaearctic, Ethiopian and Australian regions, whereas *Oxyina* is common to south east Palaearctic and Oriental. *Caryanda* is common to Oriental, Ethiopian and *Gesonula* extends from Palaearctic to Oriental and Australian region. The Oxyinae is thus predominantly Oriental in composition and is a complex of Indo-Chinese and Malayan faunal derivatives. The discontinuity in distribution of *Gesonula* and *Hygracris* is probably a relict of former continuous distribution. Mani (1974; see chapters XXIV) has very lucidly explained the origin of the discontinuous distribution that characterises diverse group in India.

TABLE 1. List of the species of subfamily Oxyinae occurring in Indian region and their distribution.

Sl. No.	Species	Distribution
Genus <i>Caryanda</i> Stal, 1878		
1.	<i>C. diminuta</i> (Walker, 1871)	India : Assam, Andaman Islands ; Burma ; Vietnam ; Cambodia ; Thailand ; Malay Peninsula ; Sumatra Isl. Nias ; Singapore ; Laos.
2.	<i>C. cachara</i> Kirby, 1914	India : Assam, Cachar ; China.
3.	<i>C. paravicina</i> (Walker, 1925)	India : (North-East Assam, Manipur).
4.	<i>C. sanguineoannulata</i> Brunner von Wattenwyl	Burma : Mandalay, Lamaing, Mt. Popa, Hamaubi, Rangoon, Pegu, Palon ; Bhutan.
Genus <i>Cercina</i> Stal, 1878		
5.	<i>C. obtusa</i> Stal, 1876	Sri Lanka : Ohiya, Hakgala, Horton, Plains ; Nuwara, Eliya (Central Provinces).
6.	<i>C. philippsi</i> Henry, 1933	Sri Lanka : Mavusakanda, Gammaduwa ;
	Genus <i>Chitaura</i> I. Bolivar, 1918	Patnagala (Central Province), Punduloga (Uva Province).

TABLE 1. (Continued)

Sl. No.	Species	Distribution
7.	<i>C. indica</i> Uvarov, 1929 Genus <i>Gesonula</i> Uvarov, 1940	India : Mysore, Coorg (Karnataka), Kottayam (Kerala).
8.	<i>G. punctifrons</i> (Stål, 1861)	India : Assam (near Ledo), Arunachal Pradesh, Manipur, Tripura, Calcutta, (West Bengal), Tamil Nadu, Madras, Coimbatore, Tanjore ; Burma ; Sri Lanka ; Japan ; China : Vietnam ; Thailand ; Singapore ; Philippines ; Borneo and Java.
9.	<i>G. rehni</i> Akbar and Balock, 1970 Genus <i>Hygracris</i> Uvarov, 1921	Pakistan : Sind, Janshoro.
10.	<i>Hygracris palustris</i> Uvarov, 1921	India : Bihar (Pusa, Darbhanga), Assam (North-Lakhimpur), Arunachal Pradesh (Lekhabali).
11.	<i>H. malabaricus</i> Willemse, 1962 Genus <i>Ochlandriphaga</i> Henry, 1933	India : Kerala, Malabar.
12.	<i>O. xanthelytrana</i> Henry, 1933 Genus <i>Gxya</i> Serville, 1831	Sri Lanka : Labugama (Western Province).
13.	<i>O. chinensis</i> (Thunberg, 1815)	India : Himalaya ; USSR (Maritime Province) ; China ; Taiwan ; Korea ; Japan and Vietnam.
14.	<i>O. fuscovittata</i> (Marschal, 1836)	India : Assam, Meghalaya, Manipur, Tripura, Arunachal Pradesh, W. Bengal, Andhra Pradesh, Tamil Nadu, Kerala, Maharashtra, Kashmir, Rajasthan, Uttar Pradesh, Chotanagpur ; Pakistan and Bangladesh, USSR (South West) ; Afghanistan.
15.	<i>O. grandis</i> Willemse, 1925	India : Assam, Gauhati, (Brahmaputra river valley).
16.	<i>Oxya hyla hyla</i> Serville, 1831	India : Kashmir, Rajasthan, Gujarat, Maharashtra, Kerala, Tamil Nadu, Orissa, Uttar Pradesh, Bihar, Bengal, Assam, Arunachal Pradesh, Manipur, Tripura ; Sri Lanka (common throught) ; Nepal ; Africa : Mali ; Senegal ; Gambia ; Guinea ; Sierra Leone ; Ivory Coast ; Ghana ; Dahomey ; Niger ; Nigeria ; Niger ; Cameroun ; Fernando ; Principe ; Sao Thome ; Central-African Republic ; Gabon ; Congo ; Sudan ; Ethiopia ; Kenya ; Uganda ; Tanzania ; Angola ; Mozambique ; Rhodesia ; Malawi and Zambia ; Iran ; Afghanistan.

TABLE 1. (Concluded)

Sl. No.	Species	Distribution
17.	<i>Oxya hyla intricata</i> (Stal, 1861)	Burma ; Taiwan ; Thailand ; Vietnam ; West Malaysia ; Singapore ; Sumatra ; Java ; Krakatau ; Philippines ; Palaus Island.
18.	<i>Oxya japonica japonica</i> (Thunberg, 1824)	India : Western Coast (Maharashtra, Karnataka, Kerala), Bihar, Bengal, Assam, Manipur, Tripura and Arunachal Pradesh, Andamans. Sri Lanka ; Burma, Bangladesh ; China ; Taiwan ; Japan ; Thailand ; Vietnam ; West Malaysia ; Singapore ; Sumatra ; Java ; Lombok ; Timor ; Philippines ; Palaus Is.) ; Borneo ; Celebes ; Sula Is. Halmahera Island ; Hawai Island.
19.	<i>Oxya nitidula</i> (Walker, 1870)	India : Karnataka, Tamil Nadu, Andhra Pradesh. Sri Lanka (common throughout).
20.	<i>Oxya velox</i> (Fabricius, 1787)	India : Kashmir, Uttar Pradesh, Bihar, Pradesh, Bihar, Bengal, Assam. Burma ; Bangladesh ; China ; Thailand.
	Genus <i>Oxyina</i> Hollis, 1975	
21.	<i>Oxyina bidentata</i> (Willemse, 1925)	Pakistan ; Afghanistan ; Iran.
	Genus <i>Oxytauchira</i> Ramme, 1941	
22.	<i>Oxytauchira auroro</i> (Bruner von Wattenwyl, 1893)	Burma (Teinzo)

SUMMARY

The subfamily Oxyinae is represented in the Indian region by 9 genera and 22 species. The distribution of the species of various genera is discussed in some detail. Three genera of Oxyinae are endemic to the region. A list of the species of Oxyinae of Indian region and their distribution is given in table 1. The Oxyinae is predominantly Oriental in composition and is a complex of Indo-Chinese and Malayan faunal derivatives.

ACKNOWLEDGEMENT

The author is very grateful the Director, Zoological Survey of India for his suggestions and encouragements.

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TWO NEW SPECIES OF ORIBATID MITES (Acari) OF THE GENUS
HOPLOPHTHIRACARUS JACOT, FROM DARJEELING, INDIA

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INTRODUCTION

Two new species of the genus *Hoplophthiracarus* Jacot (Acari : Oribatei, Phthiracaridae), viz., *H. tropicus* and *H. punctatus* are described from the forest and tea fields of the district of Darjeeling, West Bengal, India.

The genus *Hoplophthiracarus* was established by Jacot (1933) with *Hoploderma histricinum* Berlese, 1908 as the type-species. Aoki (1980) revised the genus *Hoplophthiracarus* incorporating two more new species. Sixteen species have so far been described under the genus. All measurements are in microns.

Key to the species

- | | |
|--|--|
| 1 (2) Aspis foveolated ; notogaster and anal plates with irregular unevenly rounded ornamentations ; rostral setae almost bent at right angle ; lamellar setae less than one third the length of interlamellar setae ; notogastral setae distinctly barbed at distal half to one third ; setae <i>ps</i> ₂ and <i>ps</i> ₃ inserted in deep tubes ; anal, adanal and genital setae smooth ; claws with two teeth at the inner margin ... | <i>Hoplophthiracarus tropicus</i>
sp. nov. |
| 2 (1) Aspis mainly punctate but anterodorsally foveolated, notogaster and anal plates with punctations ; rostral setae erect ; lamellar setae almost half the length of interlamellar setae ; notogastral setae faintly barbed at distal one third ; setae <i>ps</i> ₂ and <i>ps</i> ₃ not inserted in deep tubes ; anal, adanal and genital setae faintly barbed distally ; claws without any tooth at the inner margin ... | <i>Hoplophthiracarus punctatus</i>
sp. nov. |

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Hoplophthiracarus tropicus sp. nov.

(Figs. 1-2)

Female : Colour deep brown to brown ; length of the aspis : 265-270 ; height of the aspis : 112-117 ; length of the notogaster : 517-531 ; height of the notogaster : 432-472.

Aspis longer than broad, coarsely foveolated, posterior part almost rounded, flat in the middle ; lateral carinae distinct one fourth ; rostral setae smooth, short, bent almost at right angle, the two halves

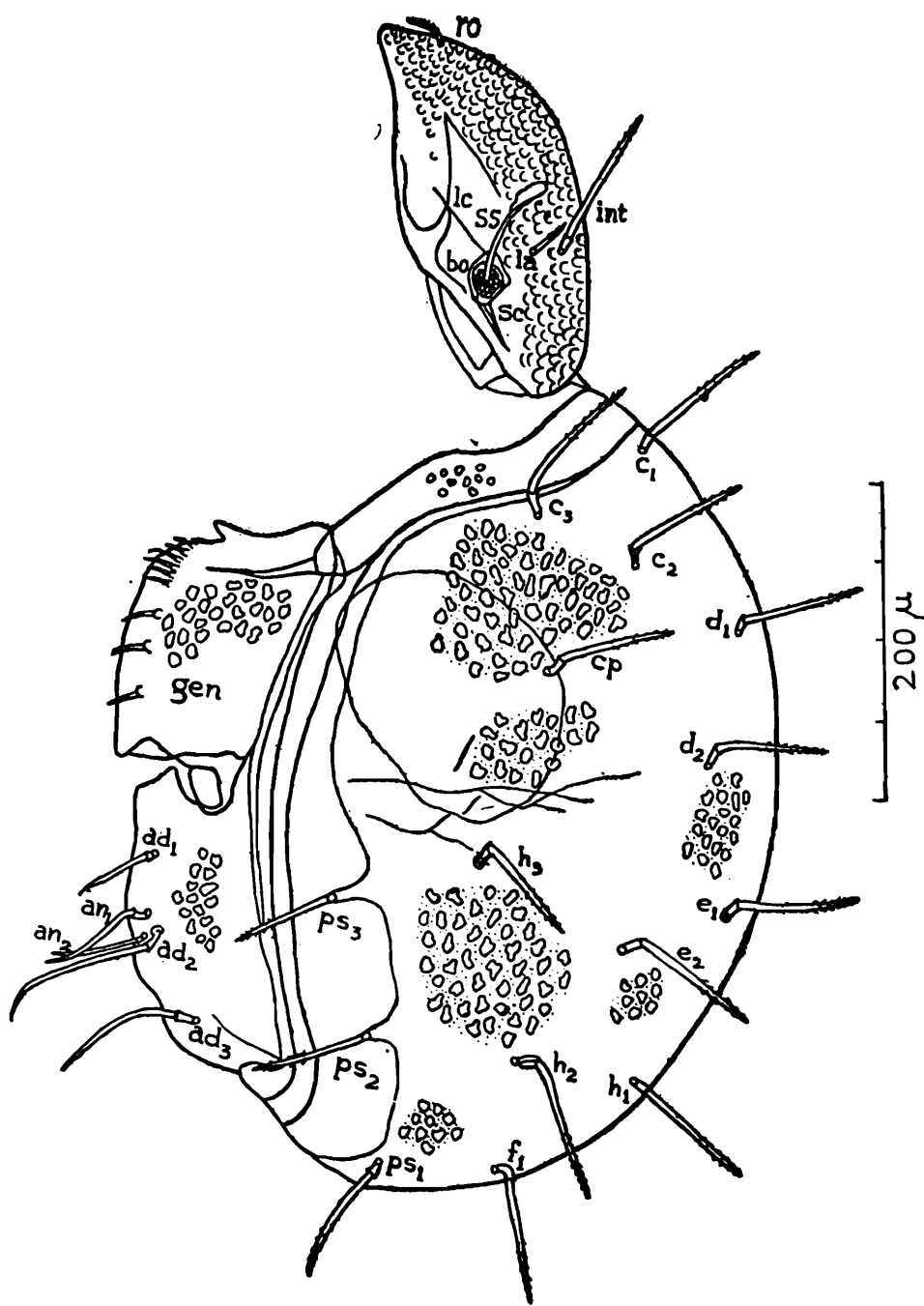


Fig.-1

Fig. 1. *Hoplophthiracarus tropicus* sp. nov. (Lateral view), ro=rostral seta, la=lamellar seta, int=interlamellar seta, ss=sensillus, bo=bothridium, sc=bothridial scale, lc=lateral carinae, c₁, c₂, c₃, cp, d₁, d₂, e₁, e₂, f₁, h₁, h₂, h₃, ps₁, ps₂, ps₃=notogastral setae.

of the setae being unequal, 23-27 long ; lamellar setae finely barbed distally, 22-25 long, less than one third the length of interlamellar setae ; interlamellar setae long, erect, stout, barbed at the distal one third, 103-121 long ; bothridium depressed cup-shaped, covered with scales ; sensillus slender, distal one third widening, surrounded anteriorly with uneven rounded brims, directed antero-laterad, 68-103 long.

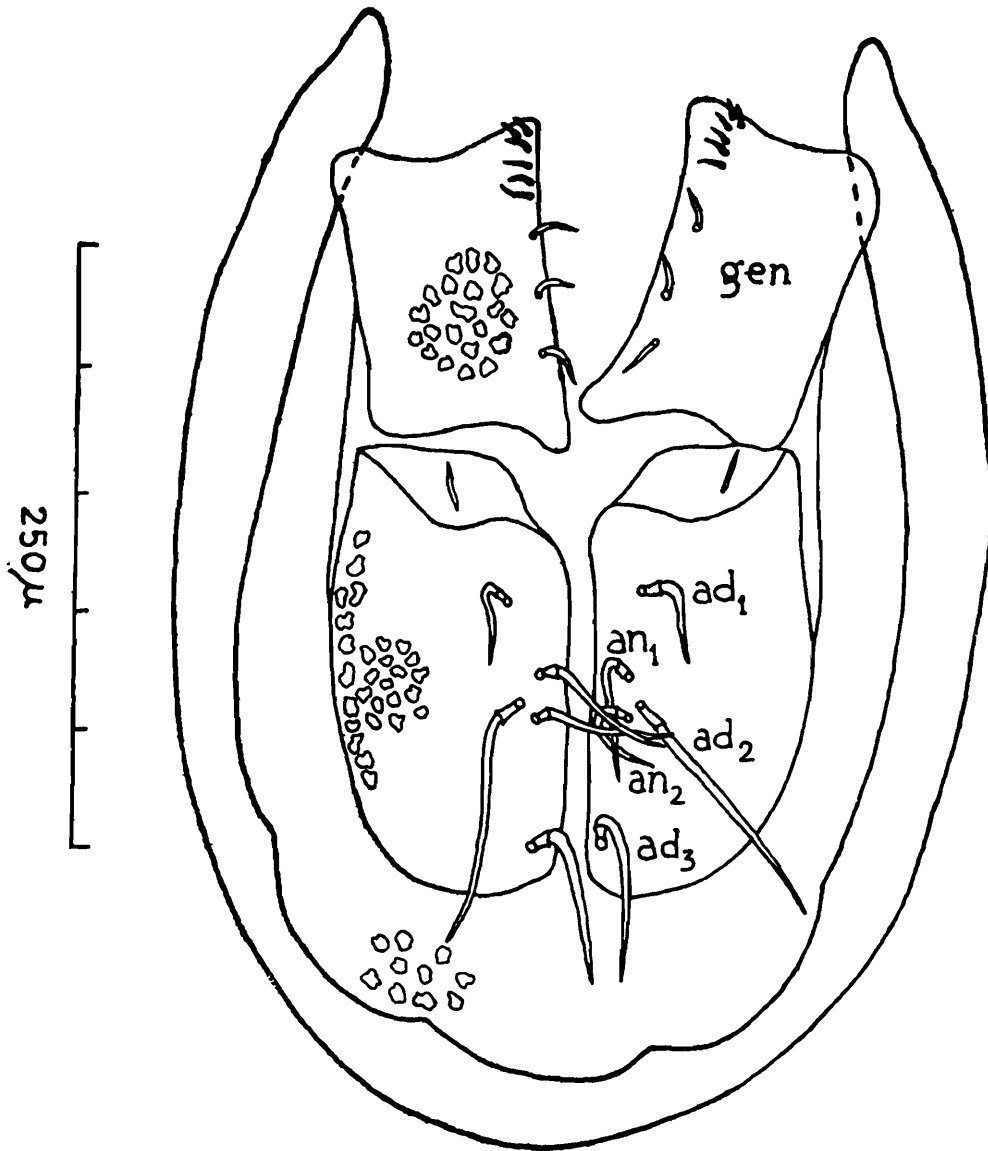


Fig. - 2

Fig. 2. *Hoplophthiracarus tropicus* sp. nov. (Ventral view), an_1, an_2 = anal setae, ad_1, ad_2, ad_3 = adanal setae, *gen* = genital plate.

Notogaster with broad collar, punctate, with irregular unevenly rounded ornamentations ; notogastral setae fifteen pairs, approximately equally long, erect, stiff, distal half to one third barbed, with blunt tips, 68-117 long ; setae c_1, c_2 antero-dorsal, c_3, cp antero-lateral, d_1, d_2, e_1 mid-dorsal, h_3, e_2 mid-lateral, h_1, f_1 postero-dorsal, h_2 postero-lateral, and ps_1, ps_2, ps_3 postero-marginal ; ps_2, ps_3 each situated in deep tubes.

Each anal plate almost twice as long as broad, with irregular unevenly rounded ornamentations ; anal setae two pairs, nearly equal, simple, with sharp pointed tips, closely approximated at the inner margin of the anal plates medially, 63-70 long ; adanal setae three pairs, unequal, smooth, with sub-pointed tips, 48-117 long ; setae $ad_2 > ad_3 > ad_1$, ad_3 postero-marginal, ad_2 in between an_2 and an_1 , slightly lateral to the both and ad_1 anterior, slightly lateral above an_1 , separated by a distance which is slightly shorter than the length of the setae ; setal base of an_1 , ad_2 and an_2 forms an imaginary obtuse angle triangle ; anterior part of the anal plates with a curve line directed backwards, terminating far above ad_1 , converging but not meeting medially ; genital plate rectangular of same microsculptures as that of anal plate, each plate with nine smooth, fine setae, arranged in an inner marginal row, 9-23 long, the posterior three setae longer, equal to each other, the anterior ones shorter and of variable lengths.

Legs monodactylous ; claws strongly curved, each with two teeth in the proximal inner margin.

Holotype : Adult ♀, INDIA : W. Bengal : Darjeeling, Darjeeling forest Div., Tonglu forest range, Palmajua forest bungalow area (from rotten leaves of *Cryptomeria japonica*), 2300 m., 16.viii.1977 (B. K. Mondal Coll.) ; paratypes : 7 adult ♀ ♀, same data as for holotype ; paratypes : 2 adult ♀ ♀, INDIA : W. Bengal : Darjeeling, Darjeeling forest Div., Singalila forest range, Sandakphu forest block (from loose soil with litter and humus under a *Rhododendron* plant, *R. arboreum*), 3000 m., 20.viii.1977 (B. K. Mondal Coll.) ; paratypes : 2 adult ♀ ♀, INDIA : W. Bengal : Darjeeling, Lohagarh Tea Estate (from soil under a tea plant, *Thea sinensis*), 350 m., 29.x.1978 (B. K. Mondal Coll.) ; deposited in the laboratory of the department of Zoology, Presidency College, Calcutta.

This species approaches close to *Hoplophthiracarus foveolatus* Aoki, 1980 in having clear, well visible foveolation on body surface, position of rostral, lamellar, interlamellar and notogastral setae, besides a few other characters. It can, however, be differentiated from *foveolatus* in possessing greatly bent rostral setae, thicker and barbed lamellar setae, sensillus with uneven rounded brims, notogastral setae with pointed tips.

Hoplophthiracarus punctatus sp. nov.

(Figs. 3-4)

Female : Colour light brown to brown ; length of the aspis : 347-360 ; height of the aspis : 144-162 ; length of the notogaster : 644-653 ; height of the notogaster : 545-635.

Aspis longer than broad, flat in the middle, almost rounded posteriorly, densely punctate, foveolated anterodorsally; lateral carinae indistinct, short; rostral setae smooth, simple, erect, 28-32 long; lamellar setae finely barbed distally 53-58 long, less than half as long as the interlamellar setae; interlamellar setae long, erect, stout, distal half finely barbed, 124-134 long; bothridium depressed cup-shaped, covered with bothridial scales; sensillus with slender stalk, anteriorly widening, distal one third surrounded with uneven rounded brims, 70-81 long, directed antero-laterad.

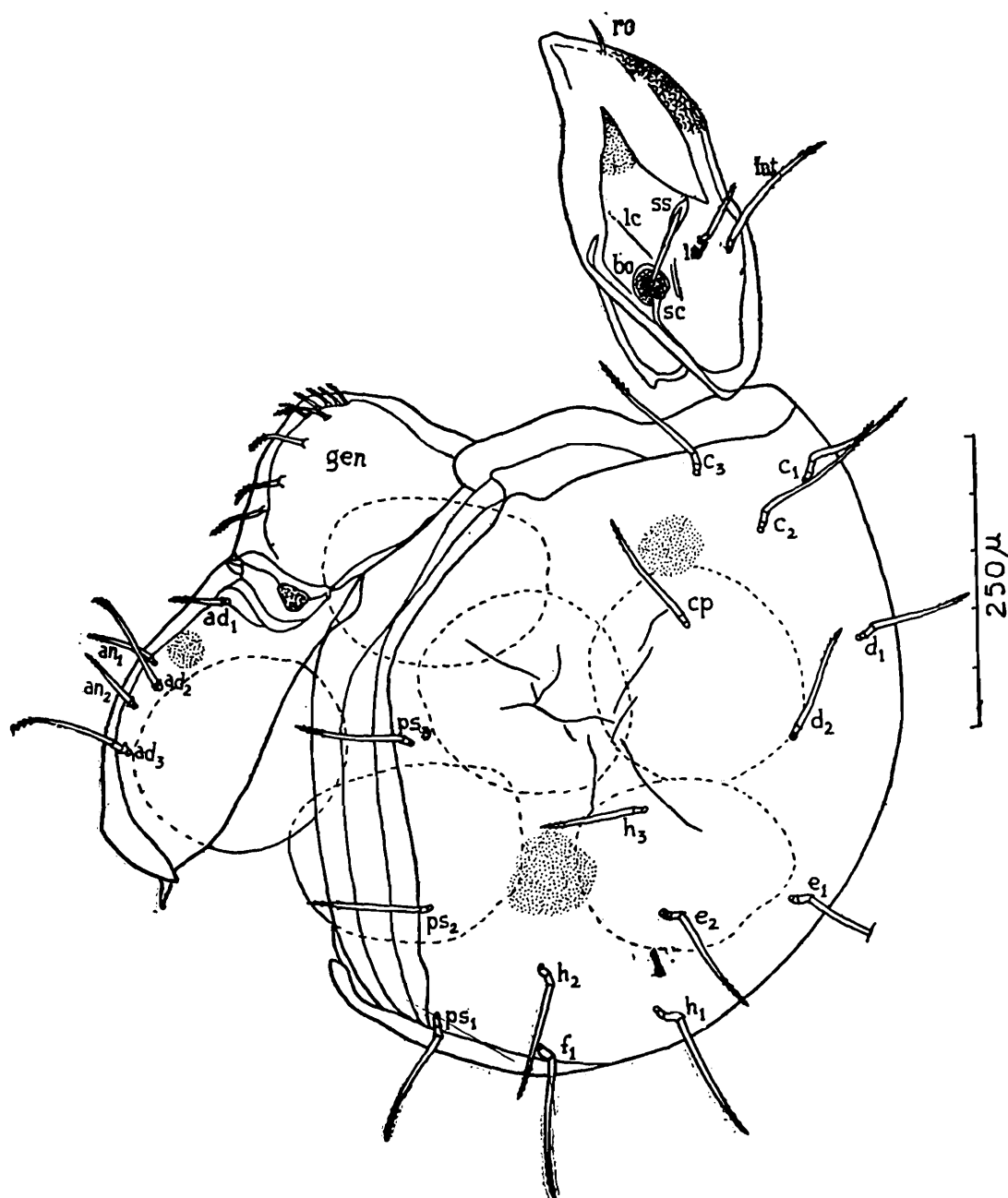


Fig. 3

Fig. 3. *Hoplophthiracarus punctatus* sp. nov. (Lateral view), ro=rostral seta, la=lamellar seta, int=interlamellar seta, ss=sensillus, bo=bothridium, sc=bothridial scale, lc=lateral carinae, c_1 , c_2 , c_3 , cp, d_1 , d_2 , e_1 , e_2 , f_1 , h_1 , h_2 , h_3 , ps_1 , ps_2 , ps_3 =notogastral setae.

Notogaster with broad collar, densely punctate ; notogastral setae fifteen pairs, almost equal, stiff, erect, distal one third faintly barbed, with blunt tips, 92-144 long ; setae c_1, c_2 antero-dorsal, c_3, cp antero-lateral, d_1, d_2, e_1 mid-dorsal, h_3, e_2 mid-lateral, h_1, f_1 postero-dorsal, h_2 postero-lateral and ps_1, ps_2, ps_3 postero-marginal.

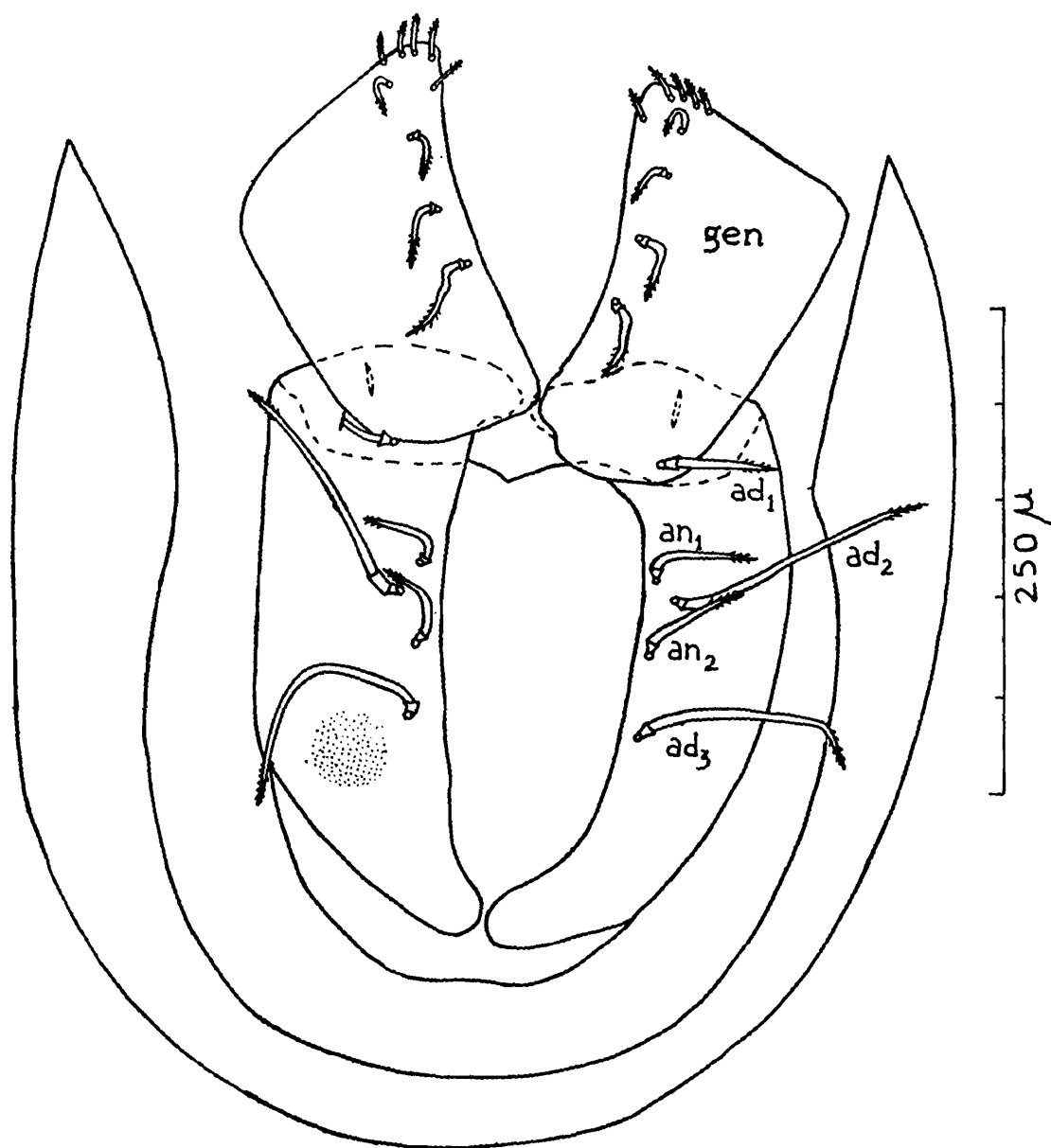


Fig. - 4

Fig. 4. *Hoplophthiracarus punctatus* sp. nov. (Ventral view), an_1, an_2 = anal setae, ad_1, ad_2, ad_3 = adanal setae, *gen* = genital plate.

Each anal plate about two times as long as broad ; anal setae two pairs, equal in length, distal one fourth faintly barbed, closely inserted at the inner margin of the anal plates medially, 45-68 long ; adanal setae three pairs, distal one third to one sixth faintly barbed, with sub-pointed tips, unequal, 50-113 long ; setae $ad_3 > ad_2 > ad_1$, ad_3 anterior to the posterior half at the inner margin, ad_2 slightly lateral to an_1 and an_2 and inserted in between them, ad_1 more anterior and slightly lateral above an_1 , setal base of an_1, ad_2 and an_2 forms an imaginary obtuse

angle triangle ; anterior part of the anal plates with a curve line directed backwards, converging and meeting medially ; each genital plate rectangular in shape ; genital setae nine pairs, distal half to one third faintly barbed, inserted on the inner margin, 23-54 long, the posterior three setae longer, nearly equal in length, the anterior ones shorter and of variable lengths.

Legs monodactylous, claws strongly curved and sickle-shaped, without any tooth.

Holotype : Adult ♀, INDIA : W. Bengal : Darjeeling, Darjeeling forest Div., Tonglu forest range, Palmajua forest bungalow area (from rotten leaves of *Cryptomeria japonica*), 2300 m., 16.viii.1977 (B. K. Mondal Coll.) ; paratypes : 2 adult ♀ ♀, data same as for holotype ; paratype : 1 adult ♀, INDIA : W. Bengal : Darjeeling, Darjeeling forest Div., Ghum-Simana forest range, Sukiapokhri forest block (from loose humus under *Quercus liniata*), 2100 m., 21.ix.1978 (B. K. Mondal Coll.) ; deposited in the laboratory of the Department of Zoology, Presidency College, Calcutta.

This species has the closest affinity with *Hoplophthiracarus kugohi siamensis* Aoki, 1959 (comb. n. Aoki, 1980) in the position of rostral, lamellar, interlamellar and notogastral setae, structure of bothridium and sensillus, nature of adanal and anal setae. It is, however, distinguishable from *H. k. siamensis* in having shorter carinae, erect rostral setae, longer and barbed lamellar setae, punctate aspis, notogaster and anal plates.

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SUMMARY

This paper deals with the description of two new species of the genus *Hoplophthiracarus* Jacot (Acari : Oribatei, Phthiracaridae), viz., *H. tropicus* and *H. punctatus* from the forest and tea fields of the district of Darjeeling, West Bengal, India.

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BUTTERFLIES FROM TRIPURA STATE, INDIA
(LEPIDOPTERA : RHOPALOCERA)

By

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INTRODUCTION

Biologically the North-eastern India is a very interesting region. It provides diverse ecological zones, from high peaks of the Himalayas, scores of discontinuous hills, to vast river valleys and plains. It is a recognized meeting place of Indian peninsular and Malaysian and Chinese elements of fauna and flora. The butterfly fauna of this region is extremely rich and has received wide attention (Varshney & Chanda, 1971).

There is, however, no report so far on the butterflies and moths of Tripura (Varshney, 1977). Here we present a report on the butterflies of Tripura. The reports on neighbouring areas are also scanty and old : on Sylhet by Hope (1943), on "Bengal" by Moore (1865, 1867) and Robbe (1892), and on Arakan coast including Chittagong and Cheringa by Emmet (1948).

MATERIAL AND METHOD

The present report is based on specimens collected by various parties of the Zoological Survey of India during the period 1969 to 1974, particularly in the leadership of Dr. V. C. Agrawal [VCA] in Nov. 1969, Feb. 1971, and Dec. 1972 ; and by Shri M. S. Shishodia [MSS] in Oct.-Nov. 1974.

The paper reports 48 species/subspecies under 27 genera in 7 families. Only Forewing length [FW] from its joining point with body to the apex has been measured. Gross distribution of the species have been compiled to project the range of occurrence and also in some cases the status of abundance.

HABITAT

Tripura lies between 23°2' and 24°N latitude and 90°34' and 91°22'E longitude and has an area of 6658 Sq. Km. It appears that the State

owes its name to the dominions of the Raja of Hill Tippera Estate. It is a hilly region with alluvial plains, intersected by hillocks and rivers. It is bound by the districts of Mymensingh and Noakhali (Bangladesh) in north and south, by the Hill of Tippera in east, and in west by the districts of Mymensingh, Dacca and Faridpur separated by the Meghna river (Bangladesh).

A series of low forest as clad hills run to the eastern side of the State, and the easternmost range adjoins the Lushai Hills of Mizoram. During rains the drainage passes on west and south-west through the Meghna river to the Bay of Bengal.

Rivers like Gumti and Dakatia originate from Hill Tippera in the east of flow westwards. Elevations arise from the plains of Sylhet (Bangladesh) in north and run towards south-west to the adjoining Chittagong Hill Tracts (Bangladesh). Almost 30% of the area of the State is a hilly tract and the rest is level alluvial plain, well cultivated and traversed by rivers like Gumti, Dakatia etc. flowing westwards.

The climate of this State is moist ; very high humidity (average 86% R. H.). Temperature is moderate, (78° to 91°F.). The average rainfall is 75", which commences early in March—April and ends in October, with deluge in June—July.

LIST OF BUTTERFLY SPECIES

Family HESPERIIDAE

1. **Baoris farri farri** (Moore). The Paint brush Swift.

1 ♂ Ambassa (alt. 200-250 m.), Nov. 1974 (MSS).

FW : 22 mm.

Distribution : India (U. P., Madhya Pradesh, S. India, Bengal, Sikkim, Assam) and Burma.

2. **Coladenia agni agni** (de Nicéville). The Brown Pied Flat.

1 ♂, Teliamura, Nov. 1974 (MSS).

FW : 17 mm.

Distribution : This subspecies is so far known from India (Assam, Sikkim) and Burma.

3. **Matapa aria** (Moore). The Common Redeye.

1 ♀, Manu, (alt. 300 m.), Nov. 1974 (MSS).

FW : 20 mm.

Distribution : India (Himalayas, Madhya Pradesh, S. India, Orissa, Bengal, Assam, Andamans) ; Burma and Sri Lanka.

4. **M. druna** (Moore). The Dark-brand Redeye.
1 ♂, Ganga Nagar (east), Dec. 1972 (VCA).
FW : 21 mm.

Distribution : Recorded from Andaman Islands (Wood-Mason & de Nicéville, 1880) and also known from Indian mainland (Bengal, Assam, Sikkim) and Burma.

5. **Notocrypta curvifascia curvifascia** (Felder). The Restricted Demon
1 ♂, Ambassa forest (north), Nov. 1974 (MSS).
FW : 17 mm.

Distribution : Known from India (Assam, S. India) and Burma.

6. **Parnara naso bada** (Moore). The Straight Swift
2 ♀, 2 ♂ : 1 ♀ Agartala, Oct. 1974 ; 1 ♀ 1 ♂ Ambassa (alt. 200-250 m.) 1 ♂ ; Garjee, Nov. 1974 (MSS).
FW : ♀ 16 mm., ♂ 15-16 mm.

Distribution : The subspecies is known from India (Kashmir, Madhya Pradesh, S. India, Bengal, Assam, Sikkim) ; and Sri Lanka and Burma.

7. **Pelopidas mathias mathias** (Fabricius). The Small Branded Swift
4 ♀ 3 ♂ : 1 ♀ Garjee, 1 ♂ Abhoy Barpathari (at light), Dec. 1969 (VCA) ; 3 ♀, 1 ♂, Agertala, Oct., 1974 ; 1 ♂ Garjee (east), Nov. 1974 (MSS).
FW : ♀ 18-19 mm ; ♂ 17 mm.

Distribution : India (Kashmir, Rajasthan, Punjab, Uttar Pradesh, Madhya Pradesh, S. India, Orissa, Bengal, Assam, Sikkim) ; Sri Lanka and Burma.

8. **Tagiades japetus ravi** (Moore). The Common Snow Flat
1 ♀ 2 ♂ : 1 ♀ Garjee Chara forest ; 1 ♂ Ambassa (alt. 250 m.) ; 1 ♂ Manu ; Nov. 1974 (MSS).
FW : ♀ 26 mm, ♂ 23 mm—24 mm.

Distribution : This subspecies is so far known from India (U. P., Orissa, Bengal, Sikkim, Assam) and Burma.

9. **Telicota ancilla bambusa** (Moore). The Pale Palm Dart.
1 ♀ Agartala, Oct. 1974 (MSS).
FW : 18 mm.

Distribution : This subspecies is known from India (N. W. Himalayas, Bengal, Sikkim, Orissa, Madhya Pradesh, S. India) and Burma.

Family PAPILIONIDAE

10. **Atrophaneura aristolochiae aristolochiae** (Fabr.).

The Common Rose.

2 ♀ 2 ♂ : 1 ♀ Teliamura ; 1 ♀ 1 ♂ Garjee ; 1 ♂ Ambassa forest (south) ; Nov. 1974 (MSS).

FW : ♀ 43-46 mm., ♂ 50-51 mm.

Distribution : The whole of Indian region except Burma. Common.

11. **Papilio clytia clytia** Linn. The Common Mime

1 ♂ Garjee, Nov. 1974 (MSS).

FW : 40 mm.

Distribution : Southern India to the North-West Himalayas. Not rare.

12. **P. memnon agenor f. agenor** Linn. The Great Mormon

1 ♀ 1 ♂ : 1 ♀ Teliamura ; 1 ♂ Garjee ; Nov. 1974 (MSS).

FW : ♀ 77 mm ; ♂ 74 mm.

Distribution : Sikkim to Southern Burma and the Nicobar Is. Found sometimes on alt. 7000 ft. in the Himalayas.

13. **P. polytes** Linnaeus. The Common Mormon

8 ♀ 8 ♂ : 4 ♀ 7 ♂ Teliamura, 1 ♀ Garjee Chara forest, 1 ♀ Ambasse, 1 ♂ Manu, Nov. 1974 ; 2 ♀ Agartala, Oct. 1974, (MSS).

14. (i) **P. polytes f. romulus** Cramer

5 ♂ : 4 ♂ Teliamura ; 1 ♂ Manu (alt. 300 m.) ; Nov. 1974 (MSS).

FW : ♂ 39-53 mm.

15. (ii) **P. polytes f. stichius** Huebner

6 ♀ : 2 ♀ Agartala, 1 ♀ Garjee Chara forest, Oct. 1974 ; 2 ♀ Teliamura, 1 ♀ Ambassa forest, Nov. 1974 (MSS).

FW : ♀ 46-56 mm.

Distribution : The Loo-Choo Is., West China, India to the Molluccas, Timor and neighbouring Is.

16. **Troides helena cerberus** (C. & R. Felder). The Common Bird-wing.

1 ♂ Agartala, Oct. 1974 (MSS).

FW : 84 mm.

Distribution : Widely distributed from Hainan to Northern India to New Guinea.

Family PIERIDAE

17. **Catopsilia crocale crocale** (Cramer). The Common Emigrant
1 ♂ Ganga Nagar, Dec. 1972 (VCA).

FW : 31 mm.

Distribution : India, Burma, Sri Lanka, Andman Is. to South China, Philippines, Borneo, Sumatra and Java. Common, but rare on Andaman Is.

18. **C. florella** (Fabricius). The African Emigrant

1 ♀ 1 ♂ : 1 ♂ Agartala, Oct. 1974 ; 1 ♀ Manu (alt. 300 m.)
Nov. 1974 (MSS).

FW ; ♀ 34 mm., ♂ 32 mm.

Distribution : Africa to Arabia, Iran, India, Sri Lanka, Burma to Indo-China, Hainan and South China. Common, but rare in Andaman Is.

19. (i) **C. florella gnoma** (Fabr.)

1 ♂ Manu, Nov. 1974 (MSS).

FW : 34 mm.

20. **C. pyranthe pyranthe** (Linn.). The Mottled Emigrant

1 ♀ 3 ♂ : 1 ♀ 2 ♂ Agartala, Oct.-Nov. 1974 ; 1 ♂ Ambassa (alt. 200-250 m.), Nov. 1974 (MSS).

FW : ♀ 26 mm., ♂ 29-37 mm.

Distribution : Sri Lanka, India including Andaman Is., Burma, extending to Hainan, Taiwan, S. China and Far east.

21. **Delias pasithoe** (Linn.). The Red-base Jezebel

1 ♂ Agartala, Nov. 1974 (MSS).

FW : 39 mm.

Distribution : Nepal to Assam and Burma (alt. 2000-7000 ft.) ; and also in SW China and Yunnan. Not rare.

22. **D. descombesi descombesi** (Boisd.). The Red-Spot Jezebel
4 ♀ 11 ♂ : 1 ♂ Abhoya, Dec. 1969 (VCA) ; 3 ♀ 4 ♂ Teliamura,
Nov. 1974 (MSS) ; 1 ♀ 1 ♂ Ganga Nagar, Dec. 1972 (VCA) ; 2 ♂
Ambassa, Jan. 1973 (VCA) ; 1 ♂ Agartala, 1 ♂ Ambassa (alt.
200-250 m.). 1 ♂ Manu (alt. 300 m.), Nov. 1974 (MSS).

FW : ♀ 38-42 mm., ♂ 40-43 mm.

Distribution : Nepal to Burma (alt. 2000-5000 ft.). Also in Thailand, Annam, Saigon and Cochin-China. Not rare.

23. **D. eucharis** (Drury). The Common Jezebel

1 ♀ 2 ♂ Teliamura, Nov. 1974 (MSS).

FW : ♀ 42 mm., ♂ 40-41 mm.*Distribution* : Sri Lanka and Peninsular India as far as the lower slopes of Himalayas.24. **Eurema hecabe contubernalis** (Moore). The Common Grass Yellow.

2 ♀ 7 ♂ : 3 ♂ 1 ♀ Teliamura, 4 ♂ 1 ♀ Agartala, Nov. 1974 (MSS).

FW : ♀ 21-24 mm., ♂ 21-26 mm.*Distribution* : Bengal to Sikkim, Burma and the Malay Peninsula. Very common.25. **Pieris canidia indica** (Evans). The Indian Cabbage White

1 ♀ Chailengta, Dec. 1972 (VCA).

FW : 27 mm.*Distribution* : N. Baluchistan and Chitral to the Dawna Range, Burma. Very Common.

Family DANAIIDAE

26. **Danaus chrysippus chrysippus** (Linn.). The Plain Tiger

16 ♀ 10 ♂ : 1 ♀ Ambassa, Nov. 1973 (VCA) ; 7 ♀ 5 ♂ Teliamura, 8 ♀ 5 ♂ Agartala, Oct.-Nov. 1974 (MSS).

FW : ♀ 35-43 mm., ♂ 36-48 mm.*Distribution* : Whole Indian region to Far-east countries, China, Asia Minor. Very Common.27. **D. genutia genutia** (Cramer). The Common Tiger

1 ♀, 3 ♂ : 2 ♂ Teliamura, 1 ♂ Ambassa, 1 ♀ Sukhanchara, Feb. 1971 (VCA).

FW : ♀ 40 mm., ♂ 41-47 mm.*Distribution* : Whole of Indian region with Afghanistan in west, and S. China, Tong-King, Thailand etc. in east. Very Common.28. **D. limniace leopardus** (Butler). The Blue Tiger.

1 ♂ Agartala, Nov. 1974 (MSS).

FW : 49 mm.*Distribution* : Baluchistan to Kumaon, Orissa, Bengal, Sikkim, Assam, Andaman-Nicobar Is., Burma, Sri Lanka, extended to Far-eastern countries. Common, but not in Sikkim and Assam (Talbot, 1947).

29. *Euploea core core* (Cramer). The Common Indian Crow

21 ♂ : 3 ♂ Agartala, 1 ♂ Garjee, 1 ♂ Perathia, Nov. 1969 (VCA) ;
16 ♂ Garjee, Nov. 1974 (MSS).

FW : 38 —48 mm.

Distribution : Throughout continental India and the Himalayas, upto alt. ca 5000 ft. Common.

30. *E. mulciber mulciber* (Cramer). The Striped Blue Crow.

1 ♂ Ambassa (alt. 250 m.), Nov. 1974 (MSS).

FW : 45 mm.

Distribution : Simla to Kumaon, Nepal, Naga hills, Chin hills, Burma, extending to China, Malaysia etc. Common.

Family SATYRIDAE

31. *Elymnias hypermnestra undularis* (Drury). The Common Palmfly

2 ♀ 4 ♂ : 3 ♂ Agartala, 2 ♀ 1 ♂ Teliamura, Oct.—Nov. 1974 (MSS).

FW : ♀ 42 mm., ♂ 34-36 mm.

Distribution : Bengal, and in Himalayas from Dun to N. Burma. Common.

32. *E. malelas malelas* (Hewitson). The Spotted Palmfly

1 ♀ 5 ♂ : 3 ♂ 1 ♀ Manu (alt. 300 m.), 1 ♂ Garjee Chara forest, 1 ♂ Teliamura, Nov. 1974 (MSS).

FW : ♀ 42 mm., ♂ 42-44 mm.

Distribution : Sikkim to Burma. Not rare. It is very common in the plantain gardens during wet season.

33. *Melanitis leda ismene* (Cramer). The Common Evening Brown

10 ♀ 9 ♂ : 1 ♀ Cherilan, 1 ♀ Hathalia, Nov.—Dec. 1969 (VCA) ;
1 ♀ Fatik Roy, Dec. 1972 (VCA) ; 6 ♂ Agartala, 1 ♂ 2 ♀
Teliamura, 1 ♂ 3 ♀ Garjee, 1 ♂ 2 ♀ Ambassa, Oct.—Nov. 1974 (MSS).

FW : ♀ 36-39 mm., ♂ 35-41 mm.

Distribution : Sri Lanka, India including Andaman-Nicobar Is., Burma, extended to Japan, Taiwan, Malaysia, Indonesia. Very common, but not so in desert parts of W. India, Nicobar Is. and Japan.

34. **Orsotrioena medus medus** (Fabr.). The Nigger

5 ♀ 10 ♂ : 3 ♂ 2 ♀ Ganga Nagar, 1 ♂ Kumar ghat, Dec. 1972 (VCA); 1 ♀ 1 ♂ Garjee, 1 ♀ 1 ♂ Teliamura, 2 ♂ 1 ♀ Ambassa forest (alt. 200-250 m.), 2 ♂ Manu, Nov. 1974 (MSS).

FW : ♀ 26-29 mm., ♂ 24-27 mm.

Distribution : Nepal, Sikkim to Burma and Andaman Is. Also recorded from Tong-King, Hainan, extending southwards to New Guinea and Australia. Common.

35. **Ypthima baldus baldus** (Fabr.). The Common Five-ring

5 ♀ 2 ♂ : 1 ♀ Ganga Nagar (east), Dec. 1972 (VCA); 2 ♀ 1 ♂ Garjee, 2 ♀ Teliamura, 1 ♂ Ambassa forest (south) Nov. 1974 (MSS).

FW : ♀ 19-20 mm., ♂ 18-20 mm.

Distribution : From Chamba in NW Himalayas to Assam and Burma. Also recorded from South Bihar (Varshney et al., 1981). Very common.

36. **Y. ceylonica huebneri** Kirby. The Common Four-ring

1 ♂ Kumar ghat, Dec. 1972 (VCA).

FW : 17 mm.

Distribution : Sri Lanka, Peninsular India to Assam, Burma and Malaysia. Very common.

37. **Y. inica** Hewitson. The Lesser Three-ring.

1 ♂ Ganga Nagar (east), Dec. 1972 (VCA).

FW : 20 mm.

Distribution : Punjab to Bengal. Not rare.

Family NYMPHALIDAE

38. **Ariadne ariadne** (Linn.). The Angled Castor

1 ♀ 1 ♂ : 1 ♀ Garjee, 1 ♂ Ambassa (alt. 200-250 m.), Nov. 1974 (MSS).

FW : ♀ 24 mm., ♂ 25 mm.

Distribution : Sri Lanka, S. India to Bengal, Mussoorie to Burma. Common.

39. **A. merione** (Cramer). The Common Castor.

2 ♀ 3 ♂ : 3 ♂ 1 ♀ Agartala, Oct. 1974 ; 1 ♀ Teliamura, Nov. 1974 (MSS).

FW : ♀ 29-30 mm., ♂ 29 mm.

Distribution : Sri Lanka, S. India to Bombay, M. P., Orissa, Kashmir to Kumaon, Sikkim to North Burma. Common.

40. **Polyura arja** (Felder). The Pallid Nawab.

1 ♂ Ambassa (alt. 200-250 m.), Nov. 1974 (MSS).

FW : 33 mm.

Distribution : Sikkim, Assam, Burma and Tenasserim.

41. **Limenitis procris procris** (Cramer). The Commander

1 ♀ Garjee, Nov. 1974 (MSS).

FW : 36 mm.

Distribution : Peninsular India (heavy rainfall areas), Assam, Burma, Tenasserim, extending into the Malayan subregion.

42. **Precis almana** (Linn.). The Peacock Pansy

4 ♀ 10 ♂ : 1 ♂ Charilan forest, Nov. 1969 ; 1 ♂ Garjee, Dec. 1969 (VCA) ; 1 ♀ Ganga Nager (east), Dec. 1972 ; 1 ♂ Ambassa, Jan. 1973 (VCA) ; 1 ♀ 2 ♂ Agartala, 2 ♂ Garjee, 1 ♂ Teliamura, 2 ♀ Ambassa, 2 ♂ Manu ; Oct.—Nov. 1974 (MSS).

FW : ♀ ♂ 28-30 mm.

Distribution : Throughout the Indian region, and also found in Japan, China and the Malayan subregion.

43. **P. atlites** (Linnaeus). The Grey Pansy

5 ♀ 10 ♂ : 1 ♀ Agartala, 1 ♂ Perathia, 1 ♂ Garjee, 1 ♀ Abhoya Barpathan (at light), Nov.—Dec. 1969 (VCA) ; 2 ♂ 1 ♀ Agartala, 3 ♂ Garjee Chara forest, 2 ♂ 1 ♀ Garjee, 1 ♀ 1 ♂ Teliamura, Oct.—Nov. 1974 (MSS).

FW : ♀ 29—31 mm., ♂ 29—32 mm.

Distribution : Terai at the foot of Himalayas from Kumaon to Sikkim, M. P., Karnataka, Bengal, Assam, Bangladesh, Burma, extending to the Malayan subregion.

44. **P. hierta** (Fabr.). The Yellow Pansy

3 ♀ : 2 ♀ Garjee, 1 ♀ Ambassa (alt. 200-250 m.), Nov. 1974 (MSS).

FW : 26-28 mm.

Distribution : Throughout the Indian region countries, extending to China.

45. **P. iphita** (Cramer). The Chocolate Pansy

2 ♀ 1 ♂ Teliamura, Nov. 1974 (MSS).

FW : ♀ 32 mm., ♂ 31-32 mm.

Distribution : Throughout the Indian region, extending to China and Sumatra.

46. **P. lemonias** (Linn.) The Lemon Pansy

2 ♂ : 1 ♂ Agartala, Oct. 1974 ; 1 ♂ Garjee (east), Nov. 1974 (MSS).

FW : 28 mm.

Distribution : Throughout the Indian region countries.

47. **Neptis hylas** (Linn.). The Common Sailer.

1 ♀ 2 ♂ : 1 ♀ 1 ♂ Ganga Nagar, Dec. 1972 (VCA) ; 1 ♂ Ambassa (alt. 200-250 m.), Nov. 1974 (MSS).

FW : ♀ ♂ 28-30 mm.

Distribution : S. India, Kashmir to Kumaon, to Sikkim, Assam, Burma and Sri Lanka.

Family RIODINIDAE

48. **Zemeros flegyas indicus** Fruh. The Punchinello

2 ♀ : 1 ♀ Garjee, 1 ♀ Manu, Nov. 1974 (MSS).

FW : 19 mm.

Distribution : Himalayas : Mussoorie to Sikkim, Bhutan, Assam, Burma and Tenasserim extending to the Malay peninsula and China.

GENERAL REMARKS

As expected, most of the species collected in Tripura, have Burma and / or Bengal (including Bangladesh) in their distributional range. Only the following catches are interesting : *Papilio c. clytia*, *Troides helena cerberus*, *Delias eucharis* and *Ariadne merione*, since they were

collected somewhat away from their recorded distribution. All the species/subspecies listed here are first records from Tripura.

A significant absence is Family Lycaenidae. We believe that it does occur in Tripura, but as its members are small and inconspicuous, they were missed by the collecting parties.

Generally a butterfly is not a night flier. But some of them have been found at night, when attracted by light, as reported earlier (Shull & Nadkarny, 1967 ; Varshney & Nandi, 1970). In the present material the following two species were taken at light : *Pelopidas m. mathias*¹ and *Precis atlites*.

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* Not seen in original.

OBSERVATIONS ON THE POPULATION ECOLOGY OF AQUATIC
INSECTS IN TWO COLDWATER KUMAON LAKES WITH
REFERENCE TO ABIOTIC FACTORS

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INTRODUCTION

The occurrence and abundance of a species or a group of insects is dependent on the complex interactions of ecological factors. Unfortunately, meagre information is available on the population ecology of Indian aquatic insects. Tonapi (1959) is probably the first who contributed a note on the population ecology of aquatic bugs of Poona. Other contributions on this aspect of ecology are mainly by Michael (1968), Julka (1973, 1977), Tonapi and Ozarkar (1970), Raghunatha Rao (1978), Bose and Sen (1978).

Although some recent papers on the ecology of aquatic insects of Kumaon are in literature (Bisht, 1979 ; Bisht and Das, 1979a, 1979b, 1979c, 1979d, 1979e, 1980a, 1980b, 1982a, 1982b ; Das and Bisht, 1979), there is no comprehensive report on the population ecology of these insects so far as the high altitude Kumaon lakes are concerned. Due to this paucity of knowledge and the significance of aquatic insects especially in fish and fisheries, the study of population ecology have been incorporated in the present paper.

MATERIALS AND METHODS

Five stations were established around the lake, Nainital and Bhimtal for quantitative estimations of different groups of aquatic insects. These were surveyed fortnightly and standard hauls made of about 5 meters to and fro by a pole hand net of conventional design (30 cm in diameter), using organdie cloth of about 40 mesh. A container having a capacity of one litre was held in position at the end of the net. Standard net sweeps were made for a two year period (1977-1979). The speed of the sweeps was kept reasonably constant. For surface dwelling, macrophytic and substratal insects the net was operated separately in the respective supporting areas. In laboratory the samples

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were thoroughly washed with the help of a seive of 40 mesh for further study. Seasonal fluctuations in population of different insect orders was determined by calculating monthly average values of each haul at five stations in each lake.

RESULT AND DISCUSSION

The annual percentage composition of the insect orders, Ephemeroptera, Odonata, Hemiptera, Coleoptera, Trichoptera and Diptera during 1977-78 and 1978-79 was observed to differ radically in the two lakes, Nainital (eutrophic and polluted) and Bhimtal (oligotrophic) (Table 1, figs 1-4). In Nainital the order Diptera showed a marked predominance with an annual percentage composition of 54.6 and 59.4 during the first and second years respectively. Case-building red *Chironomus* and *Simulium* larvae were the principal components of this order. Coleoptera, Trichoptera, Hemiptera, Odonata and Ephemeroptera were the next in a descending order of predominance (Table 1). On the other hand in lake Bhimtal, Coleoptera constituted the major part of the population spectrum with annual percentage composition 34.5 and 35.9 during the first and second years respectively. Next in order of abundance, Hemiptera, Diptera, Odonata, Ephemeroptera and Trichoptera were found to be present in that order (Table 1).

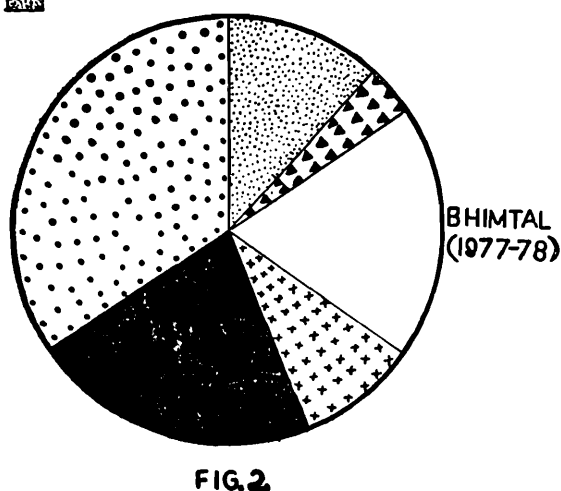
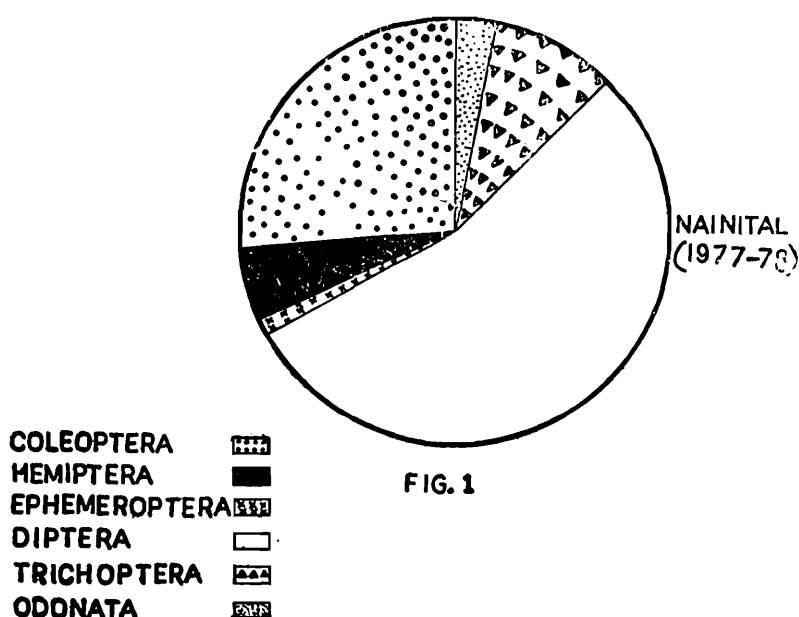
The data on the seasonal fluctuations in population of different orders of aquatic insects in lake Nainital and Bhimtal during the two years study have been presented in figures 5 to 8.

TABLE 1. Percentage composition of different orders of aquatic insects.

Order	Annual percentage composition				
	Nainital		Bhimtal		
	1977-78	1978-79	1977-78	1978-79	
Diptera	54.6	59.4	Coleoptera	34.5	35.9
Coleoptera	26.4	25.0	Hemiptera	21.8	21.1
Trichoptera	9.8	7.6	Diptera	19.5	19.6
Hemiptera	5.5	4.6	Odonata	11.2	10.5
Odonata	2.8	2.7	Ephemeroptera	9.1	7.5
Ephemeroptera	0.9	0.7	Trichoptera	3.9	5.4

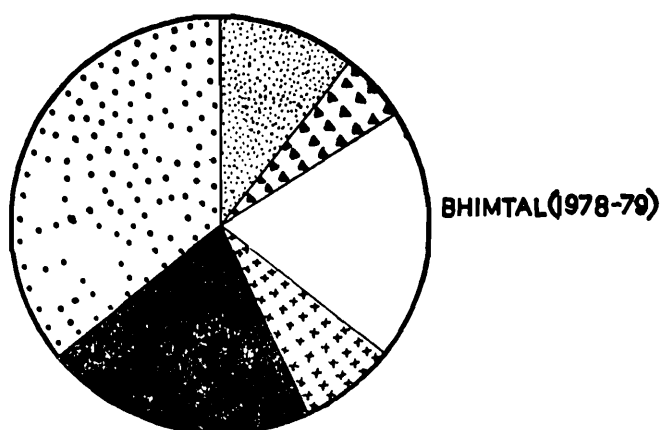
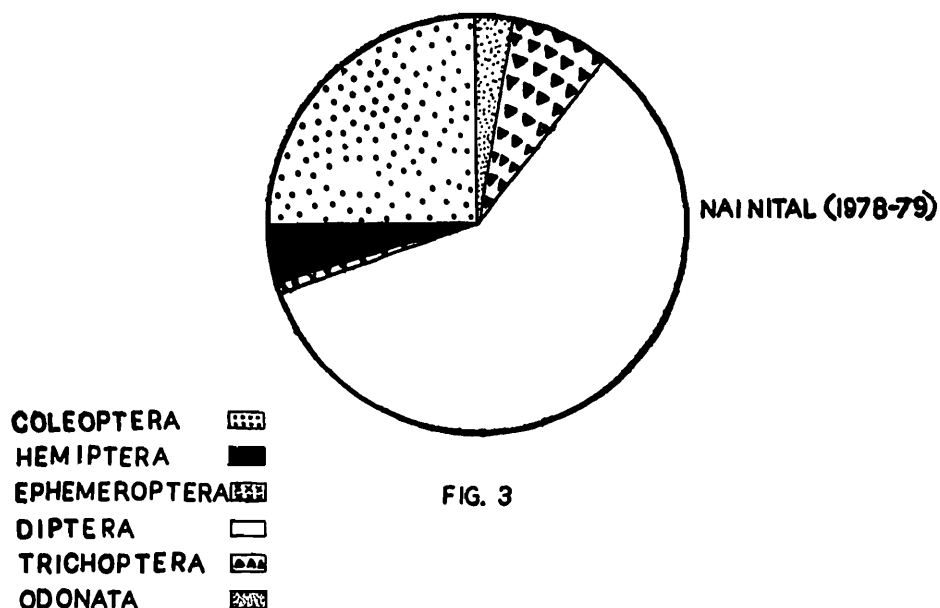
Some of the interesting features in terms of abiotic and biotic factors that governed the potentiality and seasonal fluctuations in population of aquatic insects of the two Kumaon lakes are : 1. *Texture*

of lake substratum : The nature of lake substratum has a direct influence on the population of aquatic insects (Bisht and Das, 1980b), and is very true for saxicoline and detrital community of aquatic insects. It may determine the potentiality of a species or a group in a given environment. This potentiality was shown by the fluctuations in population, as is evident in some dominant forms of aquatic insects such as *Chironomus*, *Simulium* (Diptera) and *Hyphoporus aper* (Coleoptera) of lake Nainital and *Micronecta* spp., *Heleocoris vicinus* (Hemiptera); *Sternolophus rufipes*, *Helochaeres crenatus* (Coleoptera) of lake Bhimtal.



Observations (figs 1-4) reveal that out of six orders of aquatic insects in lake Nainital the order Diptera (predominated by *Chironomus* and *Simulium*) showed a marked predominance over all the other groups. This is attributed to the muddy and detrital bottom of lake Nainital, a favourable abiotic for high Chironomid population. On the other hand, lake Bhimtal which has a sandy, rocky or mixed type of substratum with small amount of detritus at some places, also reveals that the population of case building chironomids is low due to lack of sufficient suitable substratum. These observations are in support of

the view of Wene (1940), Curry (1962), Oliver (1971) and Forsyth and Fox (1976), who stated that the sand is not a preferred substrate for the web-spinning and case-building chironomids.



The presence of saxicoline community of aquatic insects such as *Micronecta merope*, *Heleocoris vicinus* (Hemiptera) and *Caenis*, *Leptophlebia*, *Ephemerella* (Ephemeroptera) in lake Bhimtal and their absence in lake Nainital (Bisht and Das, 1980b), is another evidence to show the affect of lake substratum on the qualitative and quantitative distribution of aquatic insects. Moreover, in general it was also observed that most of the species show considerable numerical variations at different stations in the lakes due to fluctuations dependent upon the nature of lake substratum.

2. *Quality of water and pollution* : The quality of water appears to be an important factor in determing the qualitative and quantitative variations in lacustrine insects of Kumaon. The physico-chemical features such as high turbidity, CO_2 , (specially during winter), methyl orange alkalinity and total hardness and low dissolved oxygen have clearly shown that lake Naintal is eutrophic and highly polluted (Das,

1978 ; Das and Bisht, 1979). Observations in this lake reveal that the species composition (Bisht and Das, 1983) and the population of different groups of aquatic insects in general and Ephemeroptera (smallest portion of spectrum ; figs 1 and 3) in particular, is greatly reduced by eutrophication and organic pollution. These observations are in close agreement with Clark et. al. (1967) that pollution and anoxia are quite common causes of death specially those which respire through gills, such as ephemeropterans in the present study. On the contrary, lake Bhimtal which is oligotrophic shows diversified and higher populations of aquatic insects than lake Nainital.

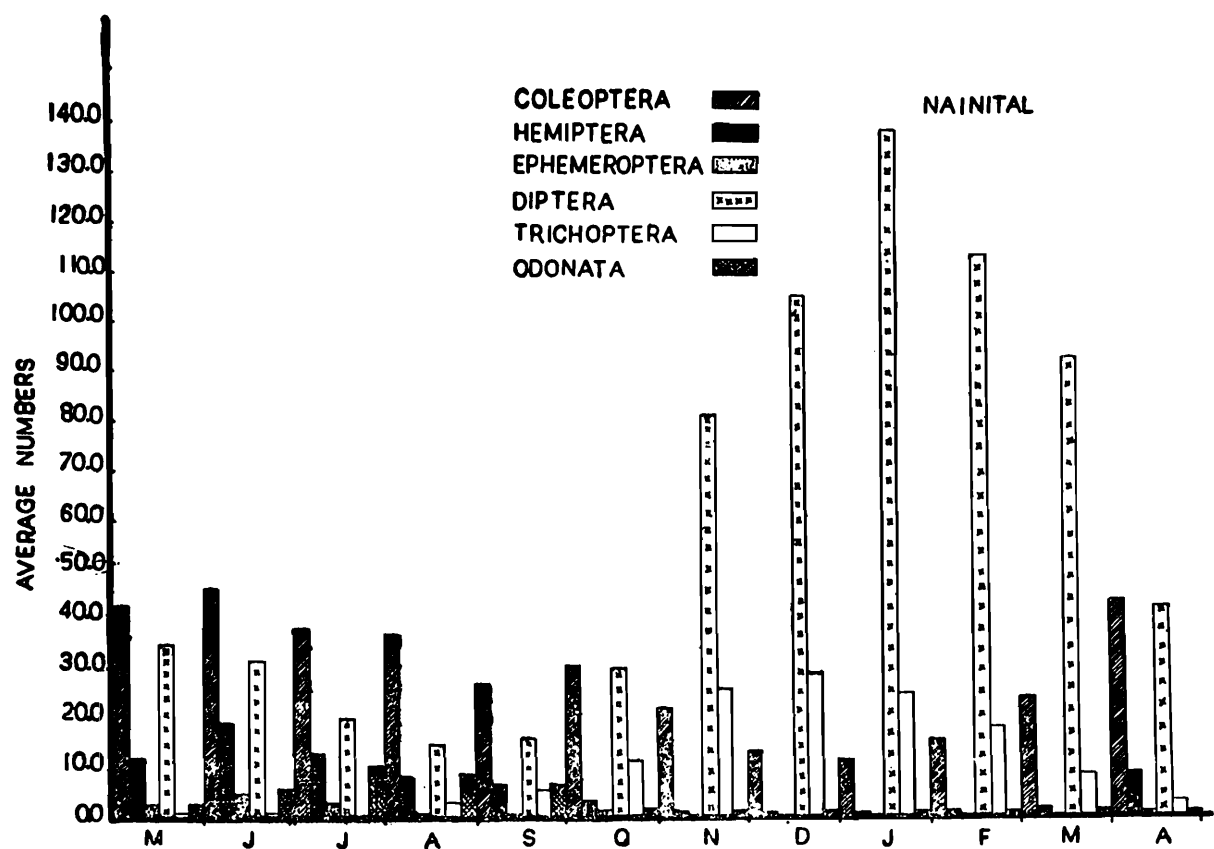


FIG. 5

The chironomids which can live at low concentrations of oxygen for a considerable time (Macan, 1963), oxygen does not appear to have any adverse effect on their population. Moreover, the largest portion of the spectrum of Diptera (Table 1 ; figs. 1 and 3) predominated by chironomids (*Chironomus*, *Simulium*) and their high population in lake Nainital during winter months (figs 5 and 7) (with average DO-4.3-9.7 ppm ; Methyl orange alkalinity, 113.0-240.0 ppm ; total hardness 289.6-396.2 ppm ; Co₂ 5.85-22.0 ppm and Turbidity 90.0-116.5 ppm ; with lake colour dirty green to brown green) shows them to be resistant to pollution. Therefore, these insects have been considered as the biological indicators of pollution (Das, 1978 ; Bisht and Das, 1980b) along with other insects (e. g. *Hyphoporus aper*, Bisht and Das,

1979c). Observations on physicochemical parameters on aquatic insects have also revealed that the range of these parameters varies from species to species (Das and Bisht, 1979 ; Bisht and Das, 1983) which in its turn affects the distribution and the abundance of a species.

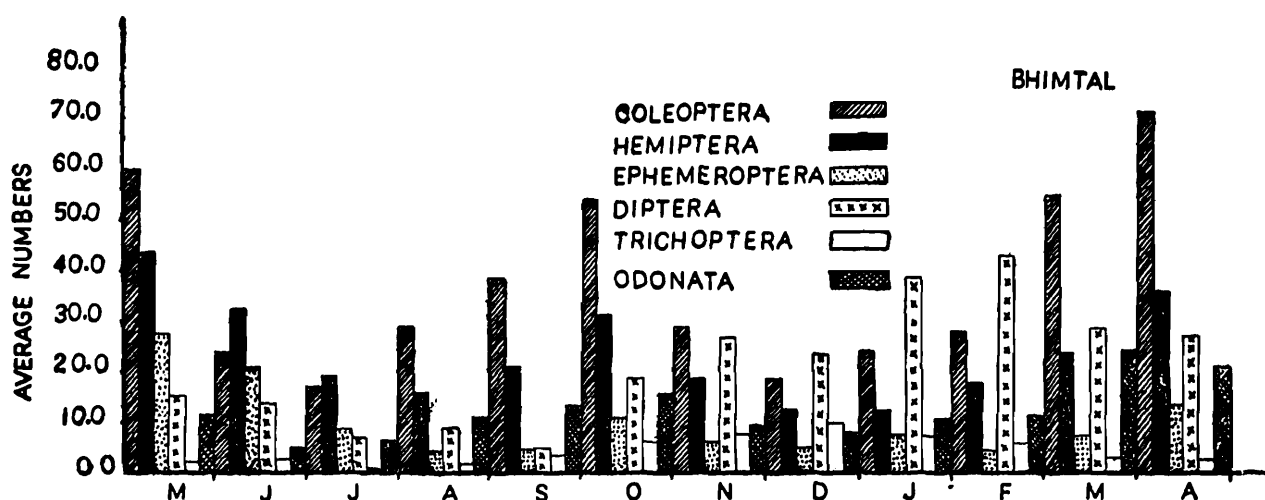


FIG. 6

3. *Fluctuation in water level* : Fluctuations in water level due to rains, drinking water supply from the lakes and natural process of evaporation are common features of Kumaon lakes. Moreover, in lake Bhimtal as the sluice gate is opened for irrigation purposed during the late summer, there is a sudden fall in water level (5 to 7 meters), which in turn adversely affects the population of aquatic insects. During rains the water level rose up in the lakes, which have an adverse effect on the population abundance of insects, especially those which pass most of their lives at the shallow bottom such as Diptera, Ephemeroptera in the present study (Figs 5 to 8). This is not only due to water level but also due to silting during the rains.

4. *Quality and quantity of hydrophytes* : It has been well established that quality and quantity of aquatic vegetation greatly affects the biological potential of aquatic insects. Poor quality and quantity of hydrophytes results a poor entomofauna and vice versa (Bisht and Das, 1980b). Population studies (figs 5 to 8) also reveal that all the insect orders except the case—building Diptera and Trichoptera were present with higher numbers in lake Bhimtal (with rich quality and abundant hydrophytes). Macan (1963) also recorded that in big lakes the scarcity of emerged vegetation presumably act as a deterrent.

5. *Temperature variations of air and water and light* : Temperature seem to be the most important ecological factor governing the population of aquatic insects in Kumaon lakes. Being at a higher altitude

(1220-1938 m asl) the Kumaon lakes have a lower air and water temperatures than in the plains of India. Aquatic insects such as most of the bugs and beetles hibernate during winter (November to February), overwinter as adults and during this period the resultant population is in a declining stage. This is very true for insects in lake Nainital. On the approach of spring (March) due to increase in temperature the metabolic activities of these insects are increased, the gonads are activated and breeding takes place, which in turn give rise to new generations with resultant higher population.

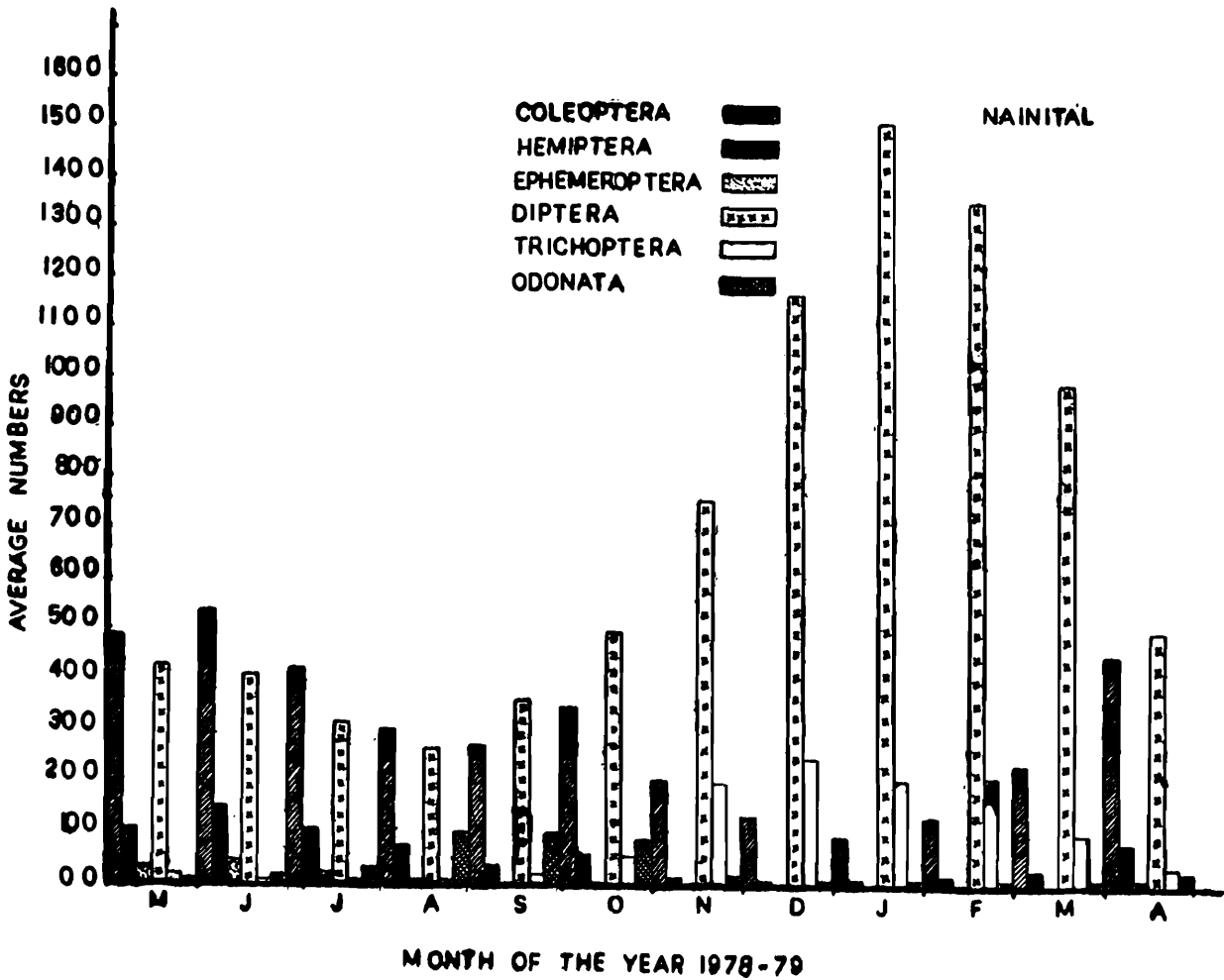
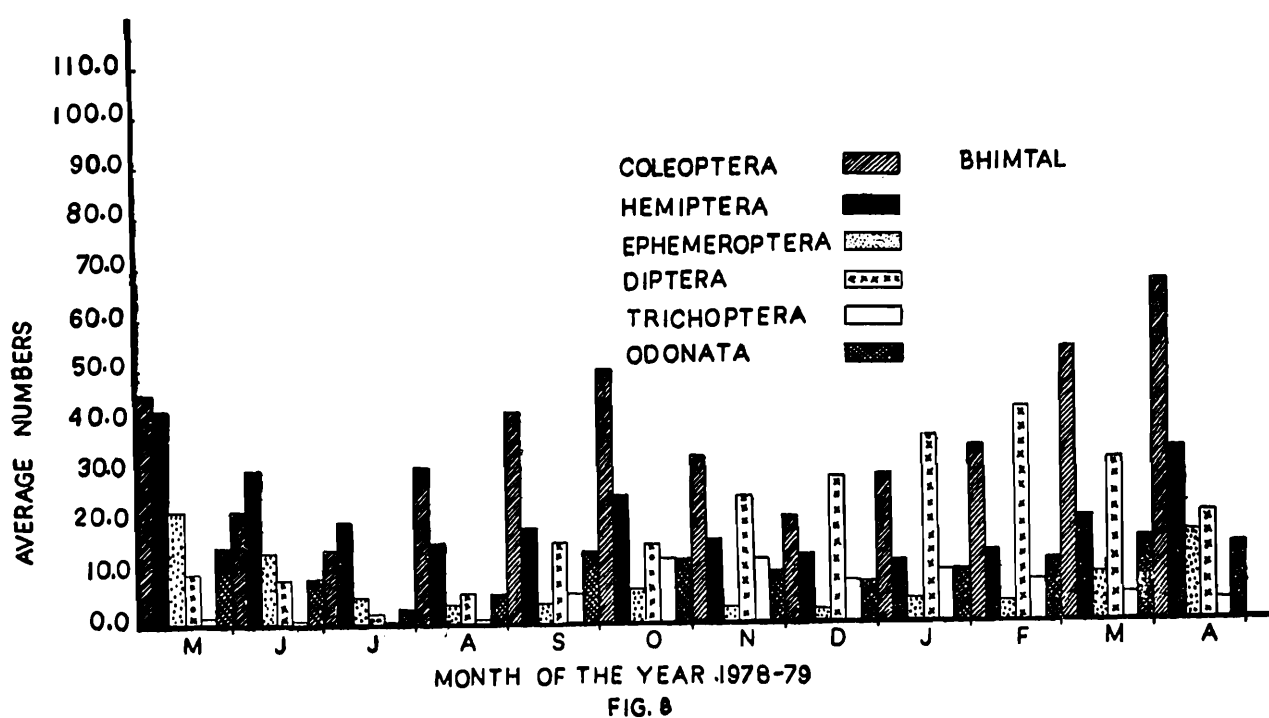


FIG. 7

Population fluctuation studies in lake Nainital and Bhimtal have revealed that the population of aquatic insects except Diptera and Trichoptera remain maximum during summer (figs 5 to 8) (with higher air and water temperatures and more sunlight); while it was lowest during winter months (with lower values of air and water temperatures and less amount of sunlight). It is significant to note that aquatic Hemiptera and Coleoptera of this region remain abundant during March to June (summer) (Das and Bisht, 1979). However, in the plains of India the hemipterans remain most abundant from July to March (Tonapi et al 1970).

6. *Season of emergence of preimaginal forms of aquatic insect*: The population of some Diptera (*Chironomus*, *Simulium*) and trichopteran larvae in Kumaon lakes decreases due to the emergence of adults mainly during early summer as a result of increase in temperature. Similarly ephemeropterans (*Leptoplebia*, *Caenis*, *Baetis*, *Cloeon* and *Ephemera*) have been observed by the authors to emerge mainly during the summer, with corresponding decline in the population. These observations are in close agreement with Mani (1957) who noticed the Ephemeroptera, Trichoptera and Diptera at extreme high altitude (3600 m asl) remain as larvae whole year and emerge as adults during the sunny summer afternoons in the succeeding year.



7. *Capacity of flight in aquatic Hemiptera and Coleoptera*: Flight is rather an uncommon phenomenon for Kumaon aquatic bugs and beetles. It was observed to occur in some aquatic bugs (viz. *Micronecta fulva*, *M. wui*, *M. siva*) and beetles (viz. *Rhantus*, *Agabus*, *Cybister*, *Eretes*, *Berosus*, *Sternolophus*, *Hydrophilus*, *Laccobius*, *Helochares* and *Regimbartia*) of Kumaon lakes, but only during the summer months (May-June), when the temperature of both air and water are high. Due to infrequent flight in these insects, they do not have much significance in migration, colonization and population fluctuations. This is in contrast to the plains of India where aquatic insects are known to be regular fliers and continuously move from one water body to another, since Tagore et al (1974) collected aquatic bugs and beetles at light in Madurai area even during winter months at mid night in appreciable quality and quantity. Flight and its significance in colonization and population of aquatic insects of Indian plains has

also been observed by Tonapi et al (1970), Julka (1977), Bose and Sen (1978). Thus it is evident that flight is probably associated with higher temperatures which prevails in this part of the country only during summer.

8. *Other features* : In addition to the abovementioned factors, the slopes of the lake bottom and least disturbance of the water was observed to favour the abundance of aquatic insects in Kumaon lakes. It is notable that rainfall doesnot appear to have any significant effect on the period of maximum abundance of aquatic bugs in Kumaon. These results are in contrast to the conditions prevailing in the Indian plains, where rainfall has an augmentative effect on the fluctuations in population of aquatic bugs (Tonapi, 1959 ; Julka, 1977).

Of the biotic factors the predatory action of fishes and other biota upon nymphs/larvae and adults of aquatic insects (Bisht and Das, 1979b, 1979d, 1980a) may also cause a decline in population of insects.

SUMMARY

(1) The annual percentage compositions of aquatic Ephemeroptera, Odonata, Hemiptera, Coleoptera, Trichoptera and Diptera were found to differ radically in the two Kumaon lakes (1220-1938 m asl) ; Nainital (eutrophic and polluted) and Bhimtal (oligotrophic). Data gathered during the years 1977-78 and 1978-79 from these lakes has revealed that Diptera and Coleoptera respectively show a marked predominance over other insect orders. The predominance of Diptera in lake Nainital (due to abundance of *Chironomus* and *Simulium* larvae) has been found to occur mainly due to muddy and detrital texture of lake bottom.

(2) Except the biological indicators of pollution (Das, 1978 ; Bisht & Das, 1979c), the qualitative and quantitative expression of aquatic insects in general and the ephemeropterans in particular has been found to deter by high turbidity, CO₂, Methyl orange alkalinity, total hardness and low dissolved O₂ and pollutants.

(3) Fluctuations in water level also affects the population ecology of aquatic entomofauna in Kumaon lakes.

(4) Poor quality and quantity of hydrophytes has resulted in poor entomofauna ; while their rich quality and quantity has resulted in rich entomofauna, both qualitatively and quantitatively.

(5) Temperature as an ecological factor has been shown to be responsible for the abundance of aquatic entomofauna in Kumaon. Being at a higher altitude than the Indian plains the maximum abundance of bugs and beetles was found during summer (March to June)

rather than July to September for bugs (Tonapi, 1959 ; Julka, 1977) and July to March for beetles (Tonapi et al, 1970).

(6) Certain other ecological factors, such as emergence of preimaginal forms of Ephemeroptera. Trichoptera, and Diptera ; capacity of flight in bugs and beetles and its significance and some physical and biotic factors affecting the population of aquatic entomofauna in Kumaon lakes are also discussed.

ACKNOWLEDGEMENTS

The authors are grateful to DST (Govt. of India) for financial assistance in the form of a project. Thanks are also due to Dr. N. C. Pant for the encouragement given.

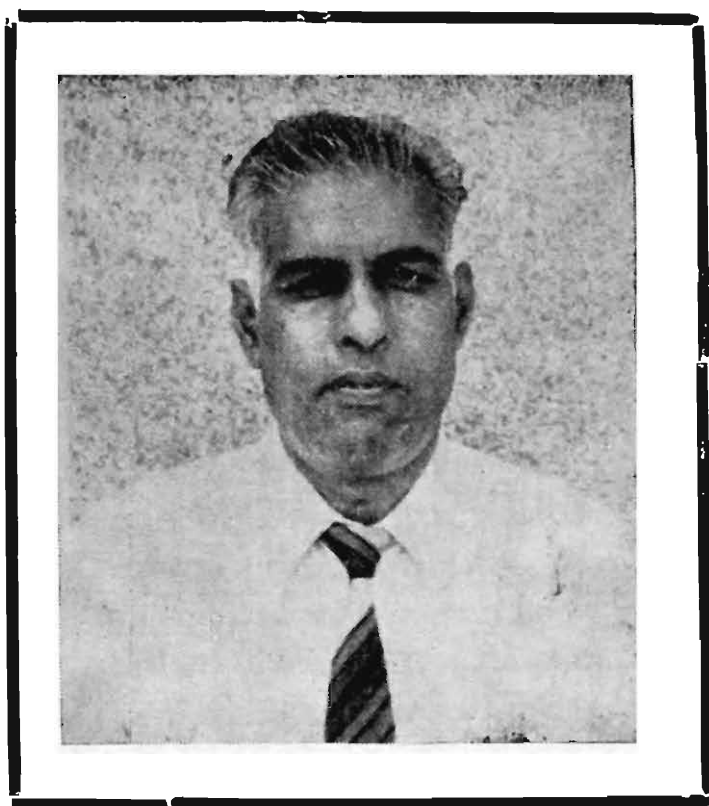
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Obituary



DR KOSARAJU REDDIAH (1933-1988)—A TRIBUTE

Dr. K. Reddiah, Scientist 'SE' and late Officer-in-Charge, Fresh Water Biological Station, Zoological Survey of India, Hyderabad, was born at Pedapulivarru (Repalle Taluk, Guntur District, Andhra Pradesh) on 4.7.1933 in an agriculturist family. After his early school education, he joined I.Sc., (Bi. P. C.) in Hindu College, Machilipatnam in 1949. In 1951, he joined B.Sc., Degree course with Zoology Main, Chemistry & Botany as subsidiaries in Andhra Christian College, Guntur. He took his M.Sc., Degree from Agra College, Agra in 1955 under the eminent herpetologist, Prof. Dr B. C. Mahendra, D.Sc., F.A.Z., with Fish & Fisheries as a special subject. He stood second in the Agra University during that year. He then joined as Research Assistant in Sericultural Research Station at Dehra Dun. He also worked as a Lecturer in Zoology in Andhra Christian College, Guntur, for about a year. Thereafter he went to Liverpool on his own, and obtained the Ph. D. Degree, submitting his thesis in a record time. During the course of his Ph. D. work, he discovered new breeding grounds of edible bivalves in U. K., and was very much appreciated. Simultaneously, he also worked on parasitic copepods of bivalves and contributed a series of papers on the subject in reputed foreign journals. A staunch Nationalist, that he was, he returned to India, ignoring the opportunities he had in the West unlike many at that period and joined as Pool Officer in Annamalai University. In 1960 he was selected

to the post of Zoologist and joined as Officer-in-Charge of Eastern Regional Station, ZSI, Shillong and was responsible for the development of the Station which was at its infancy. Consequent to the First Reviewing Committee's recommendations that the services of this well trained Marine Zoologist should be better utilized, he was transferred to Southern Regional Station, ZSI, Madras, on 4.2.1962 as its Officer-in-Charge, a position he held till 12.1.1972. During this tenure, being a good marksman, he added a good number of specimens of birds and mammals, and laid the foundation for a scientific museum at the Station. He was selected Superintending Zoologist (17.3.1965) as a direct recruit again, and later was posted to the Publication Division (Hqrs.), Calcutta (29.2.1972). During his tenure there, he was assigned the special task of locating corals of medicinal importance, in view of his expertise on corals and coral reefs of India, a task he admirably fulfilled, by locating them around Andaman Islands. He was later transferred to the Western Regional Station, Pune (28.7.1975), and consequent to his promotion as Deputy Director, he was posted Officer-in-Charge, Central Regional Station, Jabalpur from 29.9.1976 to March, 1984. From there he was transferred to the Marine Biological Station, Madras. A few months before his sudden and untimely demise on 30.1.1988, he was transferred to the Fresh Water Biological Station, Z. S. I., Hyderabad (July, 1987) as Officer-in-Charge.

A stickler for rules, regulations and administrative protocol, Dr Reddiah was equally well known for his uncanny ability to fight for justice, rights or privileges and therefore remained an enigmatic personality. An advocate for decentralization of powers, he allowed his junior scientists to pursue researches freely in their fields of interest. Being one of the top scientists in the Department, he expected that one day he may have to head it, and therefore had a lot of perspective plans for its development which he discussed, at times, with a selected few. Unfortunately, these plans remained dormant with him—for, he neither had the opportunity to head it, nor could these be utilized and he being an introvert by nature, never discussed them with those in power to avoid controversies. He was one with a great vision and one of his unpublished works on the organization, development of marine survey and taxonomy of the marine animals and its future, would have been a useful compendium had he completed and published it. Long before the Fishery Survey of India came into being, he felt the need for such an organization in India within the Zoological Survey. An authority on corals and coral reef development, likewise, his expertise and observations on Corals died along with him.

Born in a rich family of Kammas, Dr Kosaraju Reddiah Choudary, was a down-to-earth person and took the earliest opportunity to drop the suffix indicating his caste. Dr Reddiah's noblest trait was "Forgive & Forget", and therefore, those who knew him intimately are aware that he regarded none his enemy and never harboured ill-will, trying to avoid confrontations except when he was fighting for justice. Even when he lost his fight, he quickly reconciled himself like a philosopher, a fact only a very few appreciated. He used to get agitated when his inner philosophy of contentment clashed with the denial of basic rights and this coupled with his introvert nature, made him the least understood of personalities in the Z.S.I.

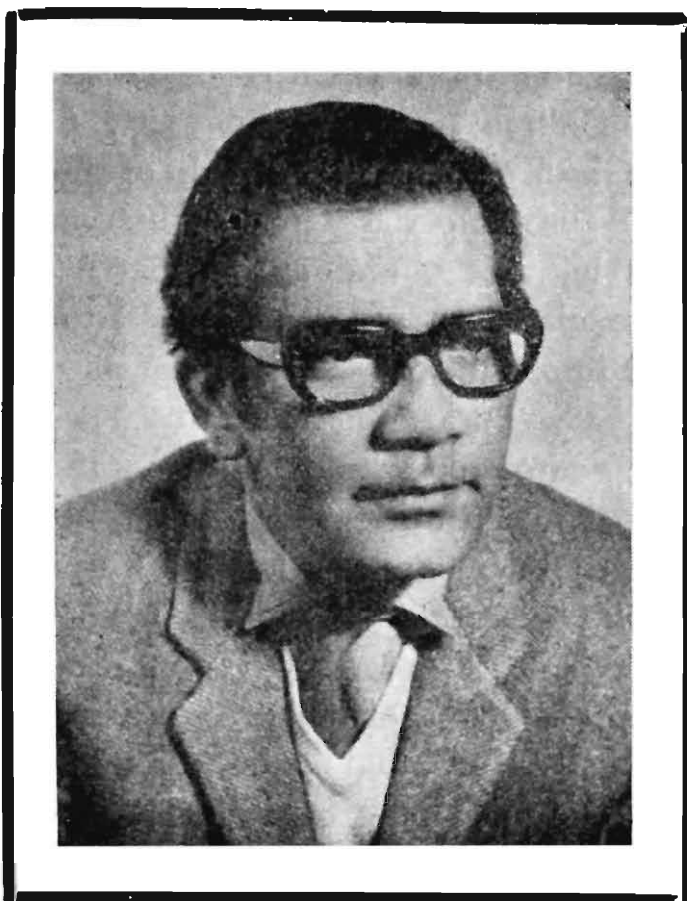
Dr. Reddiah, was very generous and helped many in need with both cash and kind without other's knowledge and never bothered about its return, timing or reciprocation. The fact that his colleagues in the Zoological Survey of India, Madras, where he worked for a considerable time, though at various spells, spontaneously paid homage to him through the newspaper shows their deep sense of affection and appreciation to this noble soul. He was an excellent host and many have enjoyed his hospitality both at home and outside. Dr Reddiah was also a good swimmer and an outstanding chess player and won the Open All England Chess Championship in 1958.

In Dr Reddiah's passing away, the Department has lost a good marine zoologist and a very honest officer who loved the Department very deeply, in spite of the ordeals and tribulations, he had undergone. Dr. Reddiah leaves behind his wife, and four sons. He always wished for the prosperity of his colleagues and friends. Many of us, his colleagues, would miss his spontaneous, uncontrollable laughter, which would come only from a man with pure heart.

May his soul rest in peace by Providential Grace.

K. V. LAKSHMINARAYANA

Obituary



Professor ANIL KUMAR DATTAGUPTA
(1924-1988)

The announcement of the sudden and untimely death of Professor A. K. Dattagupta, an eminent educationist, on 2nd April, 1988 due to cardiac failure was a sort of news for those who knew him found difficult to believe. For, Prof. Dattagupta was a man so active but calm and quiet, with such varied interests, that one did not associate any cessation of activities—let alone death—with him so early in life. In his passing away, world has lost another giant among pioneers who did yeoman service to echiuran biology.

Born in an educated family of the then East Bengal on October 30, 1924, he had his early education in Mymensing, Chittagong, Calcutta and Cooch Behar due to his father's transferable job. After passing Matriculation Examination in 1941 with first class marks and merit scholarship he joined Victoria College in Cooch Behar. But within a year he participated in Freedom Struggle Movement and as a result he had to leave the place and found shelter at Calcutta. Like others, Prof. Dattagupta had to face great sufferings in 1942 August Quit India Movement for Independence. Afterwards, he joined the University College of Science, Calcutta, from where he took his B. Sc. (Honours in Zoology) and M. Sc. (Zoology) degrees in 1945 and 1947, respectively.

As most of his family members were either teachers or physicians he chose the profession of a teacher. From 1948 to 1953 he served at the Maharaja's College in Orissa and City College at Calcutta. Receiving G. P. Ghosh (Lump) Scholarship of the Calcutta University in 1953 he joined the Imperial College in London for doctoral study. Before leaving for London he married a lady who was then a research scholar in the Zoology Department of the Calcutta University. At the Imperial College he worked on the insect toxicology and was awarded Ph. D. degree in 1956. There he took various courses in applied entomology and received the Diploma of the Imperial College. On returning from abroad he joined as a reader at the Birla College, Pilani (presently Birla Institute of Technology and Science—BITS) and soon became Professor and Head of the Department of Zoology. There he felt that knowledge of physical science is a must for a student of biology and vice versa. As a result, in the biological science course he introduced the relevant components from the sister discipline in 1964. In an Exchange Visitor's Programme between BITS and MIT (Massachusetts Institute of Technology) he joined in the Biology Department of MIT in 1966. After returning to BITS in 1967 with fresh ideas he reoriented the biology programme of the Institute. He received responses from all corners—students, colleagues and administration and as a result Microbiology, General Biochemistry, Cytology, Genetics, Ecology and Instrumentation were common for the Zoology and Botany students. A Fresher Course in Biology was introduced in 1968 for Chemical and Electronics Engineering students and by 1971 this course was applicable to all students who joined the BITS. He served the BITS up to March, 1976, of which last 6 years as Dean of the Faculty of Sciences. Then he joined the Kurukshetra University as Professor and Head of the Department of Zoology and also shouldered the responsibilities as Dean of Sciences and Dean of Students' Welfare until retirement. Here he inspired his students, colleagues and friends to write the observations on natural history in Hindi and as a result, *Jeevanti*, a natural history journal in Hindi came out in 1978 due to his initiative and this is being continued till-date. Prof. Dattagupta is to be well remembered for his valuable service he rendered for the development of the Biology Departments at BITS, Pilani and at Kurukshetra University, Kurukshetra. He is also well remembered by his students as a good teacher, doing good justice to the subjects he taught.

Besides his teaching capability, he was a dynamic worker in the field of research. Though he trained himself in the field of insect toxicology and other branches of entomology, yet to-day he is known as an echinuran

biologist in the world. Along with this, he started work on biology of the rotifers during his later life. Incidentally, both the groups (Echiura and Rotifera) receive less attention in the zoological realm. With indefatigable energy and tireless work, he gave ample encouragement and valuable guidance to his students that resulted in the publication of over sixty useful research papers on diverse aspects and 27 students obtained their doctoral degrees under his able supervision.

His studies on Echiura led him to travel widely in the Indian mainland, and insular areas as well as abroad. Side by side he gained experience in the field of biology, ecology taxonomy and morphology of various invertebrate groups of animals. My first acquaintance with Prof. Dattagupta dates back to 1970 when he participated in an International Symposium on the Biology of Sipuncula and Echiura at Kotor, Yugoslavia, sponsored by the Smithsonian Institution, Washington and Marine Biological Station, Kotor. He presented his work on Indian echiurans while the author on Indian sipunculans. He was the moderator of one of the Sessions of the Echiuran Biology. He had been invited as an author for the "Result of Biogas Missions" in the Bay of Biscay, France in 1972 and his article on the deep sea adaptation of the bonellids attracted the other workers. He regretted his missing the two chances in the participation of the Atlantic Expedition Cruise of the C. O. B., France, for some reasons which were beyond his control. He visited some parts of Europe and the U. S. A. on academic ground in 1982 and 1983.

After his retirement from Kurukshetra University in January, 1985, he joined as Scientist Emeritus of the C. S. I. R. first at Bhubaneswar and later at the Zoological Survey of India, Calcutta, since 1986 until death. Besides his own project on Indian echiurans, he was actively engaged on the taxonomy of the deep sea echiurans of the Atlantic and Pacific Oceans.

As a man he was very simple, generous and kind-hearted and particularly liked and helped diligent students. He had been a sportsman, too, all along playing hockey, tennis and billiards. In his leisure time he used to paint or play on his sitar.

To Mrs. Gitika Dattagupta and their daughter, Mrs. Swati Sen, we extend our deep sympathy.

LIST OF PUBLICATIONS OF PROFESSOR A. K. DATTAGUPTA

1955. A biometrical study of components of insecticidal resistance. Ph. D. thesis. London University.
1956. Relative response of closely related species to insecticide. *Proc. zool. Soc., Calcutta*, **9** : 97-103.
1957. On the growth ratio of *Poecillocerus pictus* Fabr. (Acrididae). *Sci. Cult.*, **23** : 147-148. (with P. P. H. Sunder Singh)
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1960. Wing venation of Coleoptera. Part I. Studies on the wing venation of five species of Meloidae. *Proc. Raj. Acad. Sci.*, **7** : 63-66. (with S. Munshi)
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1961. A study on the abundance of certain insects of Pilani with the help of light trap. *Ibid.*, **8** : 79-87. (with B. B. Gupta & H. L. Kundu)
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