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SPIDER FAUNA OF SIKKIM

By

B. K. TIKADER

Zoological Survey of India, Calcutta-16

(With 49 text-figures)

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I—INTRODUCTION

This paper deals with the spiders (Arachnida: Araneae) from East Sikkim, West Sikkim and northern parts of West Bengal (between lat. 27°5' and 20°9' long. 87°56' and 90°5'), covering an area of about 7,428 square kilometres. These areas are largely covered by evergreen mountain forests. The study is based on the collections made by me as a member of the Indo-Swiss Zoological Expedition, 1959.

In the course of my investigations of above mentioned material of spiders, I have had numerous opportunities of comparing most of the species identified by me with the type specimens of several species in the collection of the Zoological Survey of India. I have recorded here a number of known species, not reported since they were first described nearly half a century ago. I have also revised the descriptions of a number of known species, which are at present very imperfectly and often inaccurately characterized. In addition to descriptions, I have added, as far as possible, keys, notes on affinities, synonymies, distribution and main characters of the families and genera.

Altogether sixty-five species, contained in thirty-three genera, distributed in the families Uloboridae, Homalonychidae, Theridiidae, Linyphiidae, Argiopidae, Thomisidae, Agelenidae, Hahniidae, Pisau-

ridae, Lycosidae and Oxyopidae are dealt with in this paper. Of these, 44 species are new to science.

II — SYSTEMATIC ACCOUNT

All types are deposited in the National Zoological Collections, Zoological Survey of India, Calcutta. The figures, which illustrate this paper were all prepared with the help of camera lucida.

Key to the families of Sikkim spiders

1. Eyes eight	...	...	...	2
Eyes six	...	...	...	<i>Scytodidae*</i>
2. Cribellum and calamistrum present	...	...	...	<i>Uloboridae</i>
Cribellum and calamistrum absent	...	...	...	3
3. Palpal tarsus with claw in female	...	...	...	4
Palpal tarsus without claw in female	...	...	...	<i>Pholcidae*</i>
4. Eyes heterogenous	...	...	...	<i>Linyphiidae</i>
Eyes homogenous	...	...	...	5
5. Tarsi bear three claws	...	...	...	6
Tarsi bear two claws	...	...	...	13
6. Tibiae and metatarsi without a pro-row of spines	...	...	...	<i>Argiopidae</i>
Tibiae and metatarsi with pro-row of spines	...	...	...	7
7. Trachial spiracle advanced far in front of spinners	...	...	...	<i>Hahniidae</i>
Trachial spiracle immediately in front of spinners	...	...	...	8
8. Chelicera without a lateral condyle	...	...	...	<i>Hersillidae *</i>
Chelicera with a distinct lateral condyle	...	...	...	9
9. Trochanters without notch	...	...	...	<i>Agelenidae</i>
Trochanters deeply notched	...	...	...	10
10. All trochanters not deeply notched.	...	...	...	
Only fourth trochanters deeply notched	...	...	...	<i>Oxyopidae</i>
All trochanters deeply notched	...	...	...	11
11. Fourth tarsi with a ventral row of serrated bristles	...	...	...	<i>Theridiidae</i>
Fourth tarsi without ventral row of serrated bristles	...	...	...	12
12. Paired claws with numerous teeth	...	...	...	
Median claw with two or three teeth	...	...	...	<i>Pisauridae</i>
Paired claws with few teeth.	...	...	...	
Median claw with one or no tooth	...	...	...	<i>Lycosidae</i>
13. Tarsal claw smooth	...	...	...	<i>Homalonychidae</i>
Tarsal claws toothed	...	...	...	<i>Thomisidae</i>

Family I. ULOBORIDAE

Characters.—Eyes dark in colour, the lateral eyes on each side farther apart from the median eyes; and the posterior median eyes moderate in size. Chelicerae moderately robust, nearly parallel-sided. Anterior legs longest. Femora with dorsal trichobothria; tarsi with three foot-claws. Metatarsus IV, bearing the calamistrum, somewhat curved, at least along its dorsal edge. Anal tubercle well developed in *Uloborus* Latreille but less conspicuous in *Hyptiotes* Walckenaer, and close to posterior spinners.

Genus 1. *Uloborus* Latreille

1806. *Uloborus* Latreille, *Gen. Crust. Ins., etc.*, 1, p. 109

1850. *Phillyra* Hentz, *Bost. J. H. H.*, 6, p. 25.

1874. *Uloborus*: Simon, *Ar. Fr.*, p. 244.

1895. *Uloborus*: Simon, *Hist. Nat. Araignees*, Paris, 1, p. 214.

1940. *Uloborus*: Comstock, *The Spider Book*, New York, p. 262.

Characters.—Anal tubercle prominent in the female, diminished in the male. Legs I pair much longer and stronger than the rest. Male tibia of I with six to seven dorsal spines, almost in the form of teeth.

*Not dealt with in this paper

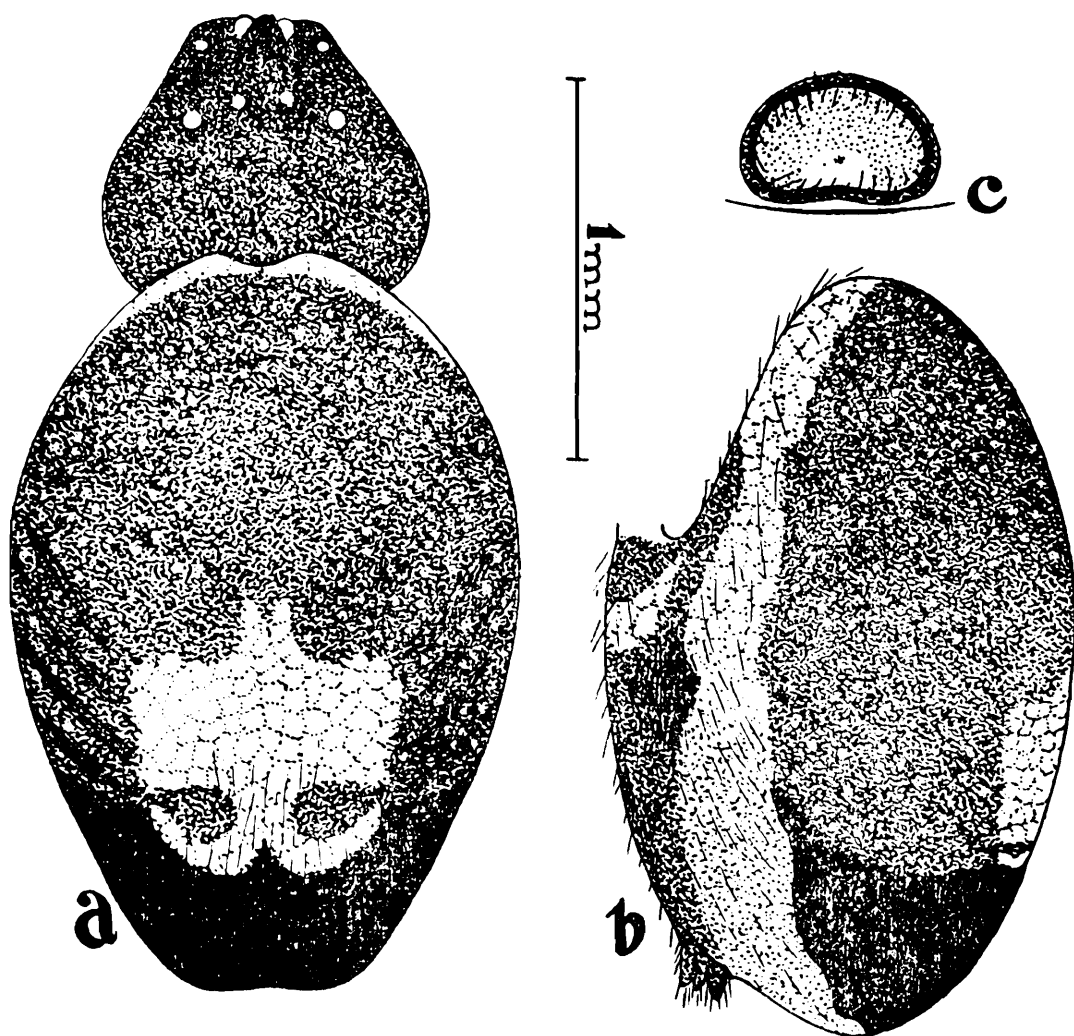
Type-species.—*Uloborus walckenaerius* Latreille.

Distribution.—Europe, Africa, Madagascar, Asia, Malaysia, America.

1. *Uloborus krishnae* sp. n.

General.—Cephalothorax and abdomen deep-brown to black, legs brownish-green. Total length 3.70 mm. Carapace 1.40 mm. long, 1.40 mm. wide; abdomen 2.50 mm. long, 2.50 mm. wide.

Cephalothorax.—Nearly as long as wide, moderately convex, clothed with fine pubescence, cephalic region slightly high. Eyes pearly white, both rows recurved but posterior row longer than anterior, anterior median eyes larger than others, but posterior lateral eye larger than posterior medians. Sternum oval, pointed behind, deep-brown colour, clothed with fine hairs. Legs with transverse deep-brown or black bands, I and IV legs longer than II and III pairs, clothed with hairs; upper side of metatarsi of IV provided with distinct calamistrum.



TEXT-FIG. 1. *Ulobornus krishnae* sp. n. (a) Dorsal view of female, legs omitted. (b) Lateral view of female, legs omitted. (c) Epigyne.

Abdomen.—Slightly longer than wide, broad in front and narrowing behind, clothed with fine pubescence. A conspicuous white patch mid-dorsally just behind the middle half and a similar white patch encircles the entire lateral margins of abdomen, as in text-fig. 1, a, b. Ventral side light brown to deep brown in colour. Epigyne as in text-fig. 1, c.

Holotype one female in spirit.

Type-locality.—Legship, West Sikkim, 2.10.1959. Coll. B. K. Tikader.

This species resembles *Uloborus walckenaerius* Latreille from Europe but it is separated as follows: (i) Cephalothorax uniform deep brown but in *U. walckenaerius* cephalothorax brown with lighter median and lateral longitudinal bands. (ii) Abdomen deep brown and dorsally just behind the middle with a conspicuous white patch but in *U. walckenaerius* abdomen whitish with a darker grey-green median and two lateral longitudinal stripes. (iii) Epigyne structurally different.

Family II. HOMALONYCHIDAE

Characters.—The genus *Homalonychus*, formerly regarded as belonging to the Zorariidae, has been placed recently in a family of its own. Tarsal claws two, similar and smooth, completely lacking denticles. The tarsi provided with a brush of terminal tenent hairs and a pair of spurious claws. The eight eyes placed in two rows of four each, the last row very strongly recurved, and much wider than the first row.

Genus 2. *Homalonychus* Marx

1891. *Homalonychus* Marx, *Proceed. Ent. Soc.*, Wash., 2(1), p.2.

1895. *Homalonychus* : Simon, *Hist. Nat. Araignees*, 1, p. 413.

1940. *Homalonychus* : Comstock, *The Spider Book*, New York, p. 338.

Characters.—The generic characters are the same as those given above for family. This genus is being recorded here for the first time from India.

Type-species.—*Homalonychus selenopoides* Marx.

Distribution.—America, India.

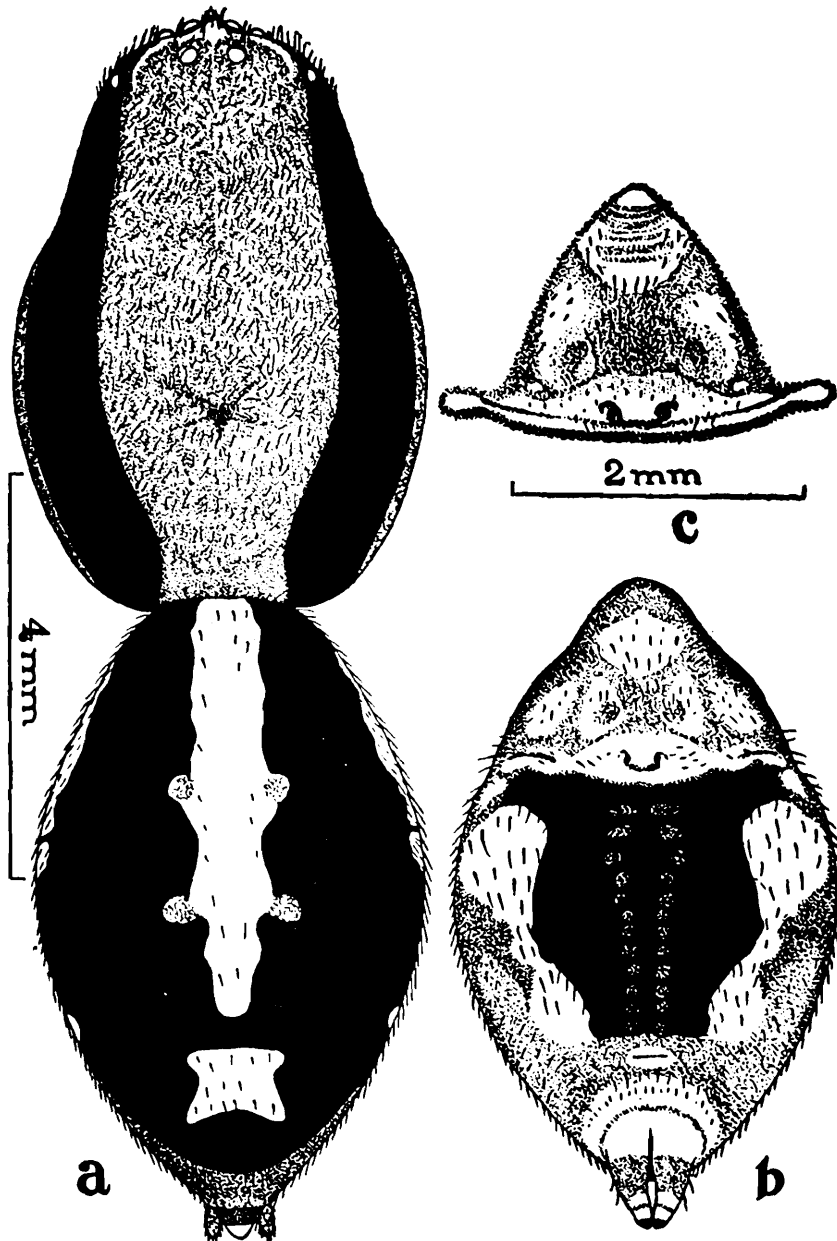
2. *Homalonychus joyaus* sp. n.

General.—Cephalothorax and abdomen black, legs brownish-green. Total length 14.50 mm. Carapace 7.40 mm. long, 5.50 mm. wide; abdomen 8.00 mm. long, 5.20 mm. wide.

Cephalothorax.—Longer than wide, slightly convex, narrowing in front; mid-dorsal provided with a broad longitudinal brown patch and this portion clothed with fine grey hairs; lateral margins of thorax also provided longitudinal brown patch, centre of the thorax with a deep foveal impression. Eyes dark, posterior row strongly recurved and much wider than anterior row; anterior row short and procurved and middle eyes slightly larger than laterals. Clypeus high. Chelicerae without tooth on the margin. Sternum broad, clothed with spiny hairs, and posterior coxae widely separated. Legs strong and robust, clothed with thick hairs. Tarsal claw two, similar in size and without denticle. The tarsi provided with a brush of terminal tenent hairs. I and II pairs of legs longer than III and IV.

Abdomen.—Longer than wide, clothed with thick hairs. Mid-dorsal provided with a longitudinal white line extending from base to end, as in text-fig. 2, a and clothed with thick grey hairs; anterior lateral margin also provided with longitudinal similar white line. Ventral side black but lateral sides provided with longitudinal white line. Epigyne as in text-fig. 2, c. Male similar colour like female.

Holotype, one female. *Paratypes*, four females. *Allotype*, one immature male.



TEXT-FIG. 2. *Homalonychus joyaus* sp. n. (a) Dorsal view of female, legs omitted. (b) Ventral view of abdomen. (c) Epigyne.

Type-locality.—Bank of Great Rangit river, West Sikkim, 20.9.1959. Coll. B. K. Tikader.

This species resembles *Homalonychus selenopoides* Marx from America but it is separated as follows : (i) Cephalothorax black and mid-dorsally with a broad longitudinal brown patch but in *H. selenopoides* cephalothorax brown with black patches. (ii) Abdomen black with a conspicuous white line extending from base to end of abdomen but in *H. selenopoides* abdomen brown with black patches. (iii) Epigyne also structurally different.

Family III. THERIDIIDAE

Characters.—Cephalothorax variable in profile; sometimes flat, cephalic region sometimes elevated. Clypeus variable in width; usually wider than in Argiopidae. Eyes heterogenous, generally anterior medians dark, the rest light. Abdomen variable in shape. Males and many females, possess a stridulating organ, but in some genera this organ poorly developed and difficult to see. Chelicerae usually vertical and not very large. Legs bearing bristles and hairs, but few spines. Female palp with a claw. Tibia and patella of male palp with no apophysis; paracymbium absent and palpal organs relatively simple.

Key to Indian genera of *Theridiidae*

- | | | | | |
|---|-----|-----|-----|---------------------------|
| 1. Colulus absent | ... | ... | ... | 2 |
| Colulus present or colulus replaced by two setae | ... | ... | ... | <i>Argyrodes</i> Simon |
| 2. Lower margin of furrow of the chelicerae with a very small tooth | ... | ... | ... | <i>Theridion</i> Walck. |
| Lower margin of furrow of the chelicerae without teeth | ... | ... | ... | 3 |
| 3. Male palpus without conductor, no median apophysis | ... | ... | ... | <i>Theridula</i> Emerton |
| Male palpus with conductor, with median apophysis | ... | ... | ... | 4 |
| 4. Median apophysis broadly attached to tegulum or to embolus, never separate sclerite; abdomen usually higher than long often with dark patches on sides, sometimes with a posterior dorsal tubercle | ... | ... | ... | <i>Achaearanea</i> Strand |

Genus 3. *Theridion* Walckenaer

1805. *Theridion* Walckenaer, *Tabl. Araneides*, p. 72.

1895. *Theridion*: Simon, *Hist. Nat. Araignees*, 1, p. 550.

1963. *Theridion*: Levi, *Bull. Mus. Comp. Zool.*, Harvard, 129(10), pp. 483-592.

Characters.—Eyes anterior medians equal or smaller than posterior medians and usually a little wider apart, and lateral eyes contiguous. Abdomen globular in females usually bearing a distinct pattern. Chelicerae usually weak; some males have them large and divergent. Legs relatively long and thin.

Type-species.—*Theridion lunatum* Clerck.

Distribution.—Europe, Africa, Asia, Australia and America.

3. *Theridion manjithar* sp. n.

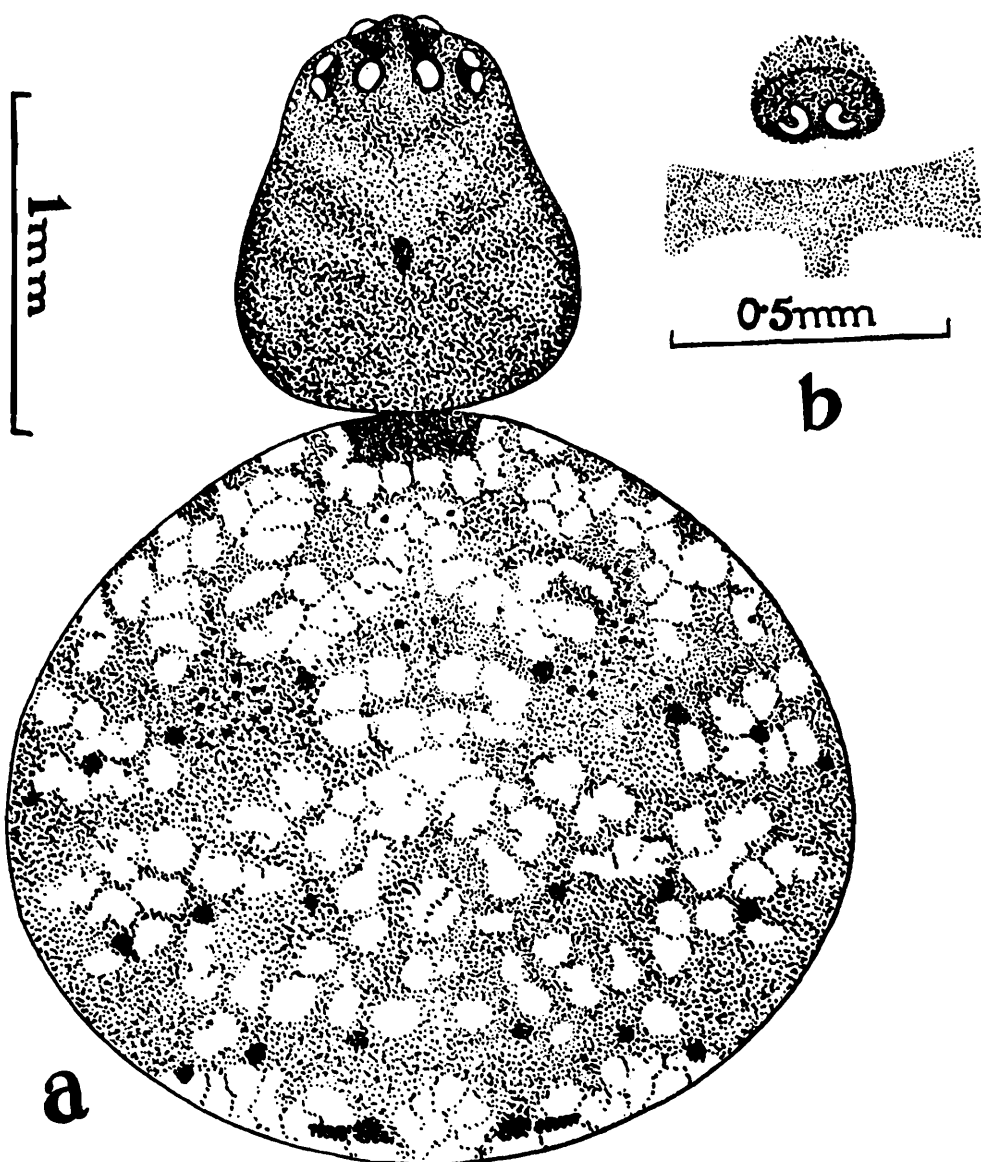
General.—Cephalothorax and legs light brownish-green, abdomen dirty white with black spots. Total length 3.50 mm. Carapace 1.20 mm. long, 1.00 mm. wide; abdomen 2.20 mm. long, 2.50 mm. wide.

Cephalothorax.—Slightly longer than wide, convex, moderately narrowing in front, clothed with fine hairs. Eyes pearly white, lateral eyes contiguous, ocular quad longer than wide. Sternum heart-shaped, pointed behind. Legs stout and strong, clothed with hairs, banded with deep brown transverse band. Tarsi of IV pair of legs with distinct comb like setae.

Abdomen.—Round, slightly wider than long, broadest just behind the middle. Dorsal side beautifully coloured with admixture of irregular white and black spots, as in text-fig. 3, a. Ventral side almost similar to dorsal side, only black spots less conspicuous. Epigyne as in text-fig. 3, b.

Holotype one female in spirit.

Type-locality.—Manjithar, West Sikkim 29.9.1959. Coll. B. K. Tikader.



TEXT-FIG. 3. *Theridion manjithar* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne.

This species resembles *Theridion lunatum* (Clerck) from Europe but it is separated as follows: (i) Cephalothorax brownish-green but in *T. lunatum* cephalothorax yellow to red-brown. (ii) Abdomen dirty chalk-white and beautifully coloured with admixture of irregular white and black spots but in *T. lunatum* abdomen totally black. (iii) The structure of epigyne is also quite different.

Genus 4. *Argyroides* Simon

- 1864. *Argyroides* Simon, *Hist. Nat. Araignees*, **1**, p. 253.
- 1869. *Ariamnes* Thorell, *Nova Act. Reg. Sci.*, Uppsala, **3**(7), p. 37.
- 1872. *Rhomphaea* Koch, *Die. Ara. Austra.*, p. 289.
- 1962. *Argyroides* : Exline and Levi, *Bull. Mus. Comp. Zool.*, Harvard, **127**(2), p. 78.

Characters.—Cephalothorax flat, posterior portion low, a transverse thoracic depression generally present. Ocular region and clypeus high. Males with ocular region, or clypeus, or both modified with projections, hump, an open groove or seam below eyes, or with clypeus projection

ventrally, or projecting and bearing a groove. Abdomen variable in shape with uneven coloration, often with silvery patches or all silvery. Legs long and thin, I leg longest, IV leg second in length, III leg always very short.

Argyroides may live in host webs without constructing any web of their own, but often they add fine lines between the spirals of an orb-web, and occasionally they live independently, making their own small theridiid webs. *Argyroides* species hang in the web upside-down with the front pairs of legs folded. They are usually inconspicuous, resembling seed, pieces of bark, or lichen accidentally attached to the web. When disturbed they jump, usually sideways, and drop, leaving a line attached to the resting place.

Type-species.—*Argyroides argyroides* Walckenaer.

Distribution.—Europe, Africa, Asia, Australia and America.

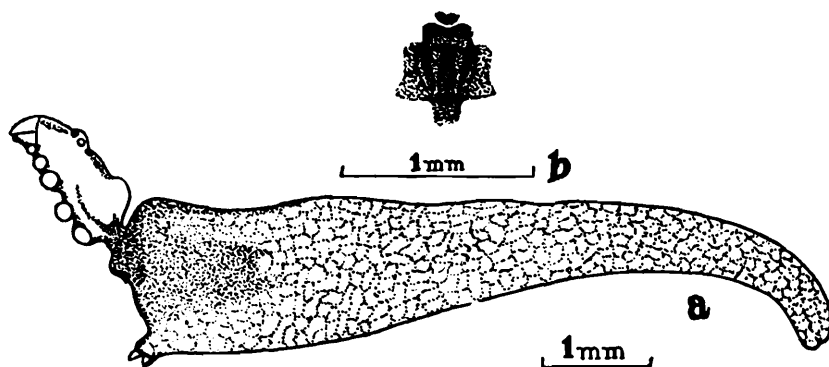
Key to Indian species of *Argyroides* Simon

- | | |
|---|------------------------------|
| 1. Abdomen very long worm-like, extensively prolonged beyond the spinners | <i>A. ambalikae</i> sp. n. |
| Abdomen not very long, nearly as long as wide, not extensively prolonged beyond the spinners | 2 |
| 2. Posterior end of abdomen with a triangular shaped projection | <i>A. projeles</i> sp. n. |
| Posterior end of abdomen without triangular shaped projection | 3 |
| 3. Posterior end of abdomen with a prominent tubercle, and a conspicuous white patch | <i>A. gazingensis</i> sp. n. |
| Posterior end of abdomen without tubercle, but with a conspicuous black patch | <i>A. gazedes</i> sp. n. |

4. *Argyroides ambalikae* sp. n.

General.—Cephalothorax and legs light green, abdomen silver-white, Total length 8.00 mm. Carapace 1.00 mm. long, 0.50 mm. wide; abdomen 5.50 mm. long, 1.00 mm. wide.

Cephalothorax.—Longer than wide, convex, middle portion high and ocular area also slightly raised. Eyes pearly white except anterior medians, middle eyes of both rows prominent but lateral eyes very small and contiguous. Sternum heart-shaped, longer than wide, posteriorly pointed. Legs long and very slender.



TEXT-FIG. 4. *Argpyroides ambalikae* sp. n. (a) Lateral view of female, legs omitted. (b) Epigyne.

Abdomen.—Long, remarkably slender and extensively prolonged far beyond the spinners, as in text-fig. 4, a. Abdomen provided with silvery white patches. Epigyne as in text-fig. 4, b.

Holotype one female. *Paratypes*, two females in spirit.

Type-locality.—Legship, West Sikkim, India, 2.10.1959. Coll. B. K. Tikader.

This species resembles *Argyrodes fictilium* (Hentz) from America but it is separated as follows: (i) Cephalothorax light green but in *A. fictilium* cephalothorax pale yellow. (ii) Abdomen long and silvery-white but in *A. fictilium* abdomen with a mid-dorsal longitudinal dark band. (iii) Epigyne structure also different.

5. *Argyrodes gazeles* sp. n.

General.—Cephalothorax light brown, legs deep brown and abdomen greenish with silver-white. Total length 3.50 mm. Carapace 1.40 mm. long, 1.10 mm. wide; abdomen 2.50 mm. long, 2.50 mm. wide.

Cephalothorax.—Longer than wide, cephalic region high, provided with transverse furrow extending across the middle of the cephalothorax. Eyes pearly white, lateral eyes small and contiguous, anterior medians larger than posterior medians; ocular area situated on the elevated region of cephalothorax. Sternum heart-shaped, pointed behind. Legs long and slender.

Abdomen.—Nearly as long as wide, clothed with fine hairs, abdomen extends posteriorly beyond the spinners. Posterior end of abdomen with a conspicuous black mark. Ventral side uniform in colour but anterior and posterior side of spinners provided with two black dots. Epigyne as in text-fig. 5, b. The head of male bears two horns and two median pairs of eyes borne by the hinder horn, as in text-fig. 5, c. Legs of male longer and slender than female.

Holotype one female. *Paratypes*, two females and *Allotypes*, three males in spirit.

Type-locality.—Legship, West Sikkim, 2.10.1959. Coll. B. K. Tikader.

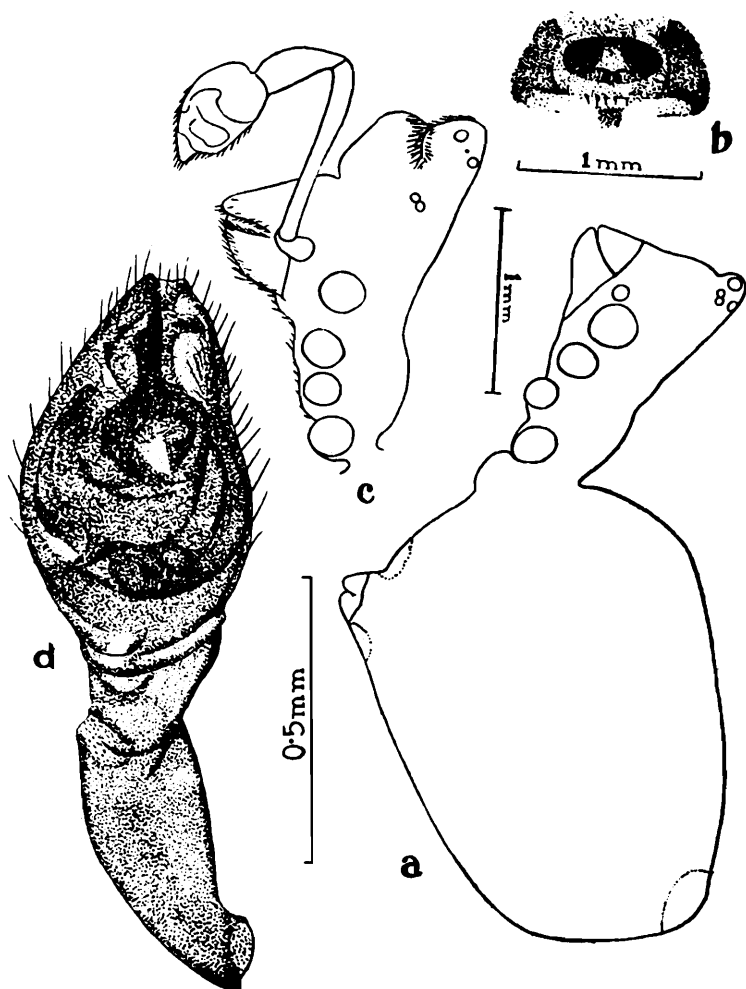
This species resembles *Argyrodes cyrtophore* Tikader from India but it is separated as follows: (i) Cephalothorax light brown but in *A. cyrtophore* cephalothorax black. (ii) Carapace of male bears two horns and two median pairs of eyes borne by the hinder horn but in *A. cyrtophore* carapace of male bears single horn. (iii) Posterior end of abdomen with a conspicuous black spot but in *A. cyrtophore* no such spot on the abdomen.

6. *Argyrodes gazingensis* sp. n.

General.—Cephalothorax, abdomen and legs reddish-brown. Total length 3.10 mm. Carapace 1.00 mm. long, 0.50 mm. wide; abdomen 2.50 mm. long, 2.00 mm. wide.

Cephalothorax.—Longer than wide, convex, cephalic region high provided with transverse furrow extending across the middle of cephalothorax. Eyes pearly white, lateral eyes not very small and contiguous, anterior medians larger than posterior medians; ocular area projecting

forward. Clypeus rounded, ventrally with deep groove under eyes. Sternum heart-shaped, pointed behind. Legs long and slender.



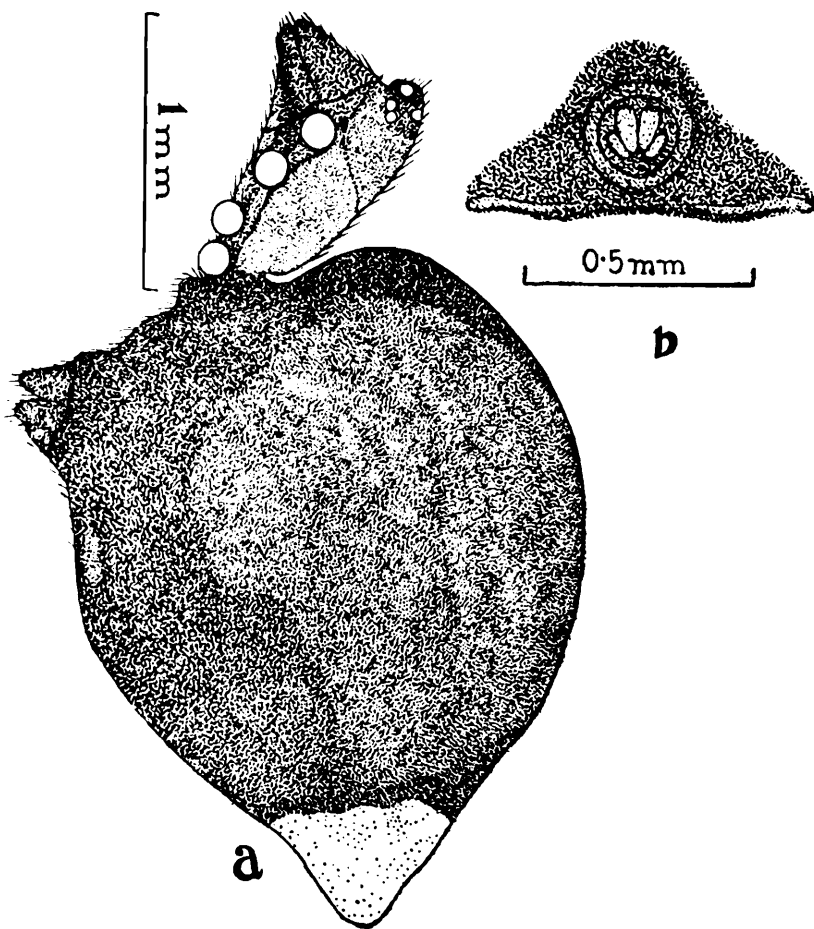
TEXT-FIG. 5. *Argyrodes gazedes* sp. n. (a) Lateral view of female, legs omitted. (b) Epigyne. (c) Lateral view of head of male. (d) Male palp.

Abdomen.—Wider than long, clothed with fine hairs ; strongly overlapping the posterior region of cephalothorax in front, broadest in the middle, abdomen extended behind spinners, posterior end elevated and provided with a conspicuous white patch as in text-fig. 6, a. Epigyne as in text-fig. 6, b.

Holotype one female in spirit.

Type-locality.—Gazing, West Sikkim, 28.9.1959. Coll. B. K. Tikader.

This species resembles the foregoing species i.e. *Argyrodes gazedes* sp. n. but it is separated as follows : (i) Abdomen reddish-brown but in *A. gazedes* abdomen greenish with silvery white. (ii) Posterior end of abdomen elevated and provided with conspicuous white patch but in *A. gazedes* posterior end of abdomen provided with a conspicuous black spot. (iii) Epigyne structurally different.



TEXT-FIG. 6. *Argyrodes gazingensis* sp. n. (a) Lateral view of female, legs omitted. (b) Epigyne.

7. *Argyrodes projeles* sp. n.

General.—Cephalothorax deep brown, abdomen silver-white and legs light brownish-green. Total length 7.00 mm. Carapace 2.00 mm. long, 1.30 mm. wide; abdomen 4.80 mm. long, 2.50 mm. wide.

Cephalothorax.—Longer than wide, convex, cephalic region very high, provided with transverse furrow extending across the middle of cephalothorax. Eyes white, lateral eyes small and contiguous, anterior medians larger than posterior medians, ocular area situated on the elevated region of cephalothorax. Sternum heart-shaped, pointed behind. Legs long and slender.

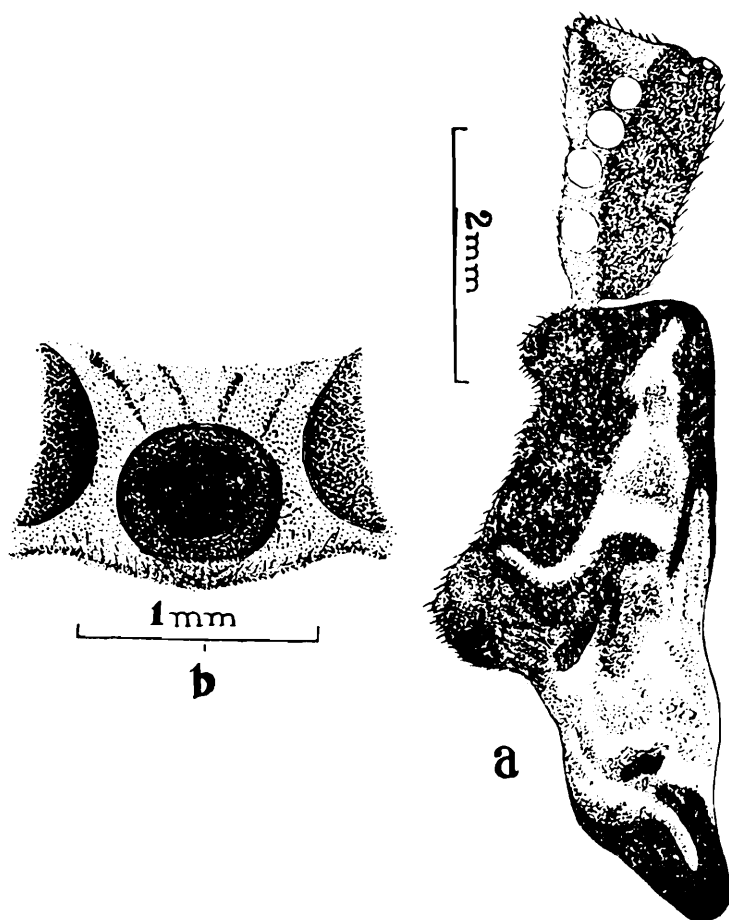
Abdomen.—Longer than wide, clothed with fine hairs; abdomen greatly extends posteriorly beyond the spinners, triangular when seen from the side. Lateral side of abdomen provided with irregular conspicuous black patches. Epigyne as in text-fig. 7, b.

Holotype one female in spirit.

Type-locality.—Legship, West Sikkim, 2.10.1959. Coll. B. K. Tikader.

This species was collected from the web of *Nephila clavata* Koch. It resembles *Argyrodes rossi* Exlin and Levi from America but it is separated as follows: (i) Abdomen high, no postero-lateral humps and lateral sides of abdomen with conspicuous black markings but in

A. rossi abdomen high with small postero-lateral humps and a conspicuous posterior protuberance. (ii) Anterior median eyes larger than the posterior medians but in *A. rossi* both median eyes nearly equal in size. (iii) Epigyne also structurally different.



TEXT-FIG. 7. *Argyrodes projeles* sp. n. (a) Lateral view of female, legs, omitted. (b) Epigyne.

Cenus 5. *Theridula* Emerton

1882. *Theridula* Emerton, *Trans. Conn. Acad.*, 6, p. 25.

1895. *Theridula* : Simon, *Hist. Nat. Araignees*, 1, p. 551.

1940. *Theridula* : Comstock, *The Spider Book*, New York, pp. 369.

1962. *Theridula* : Levi and Levi, *Bull. Mus. Comp. Zool.*, Harvard, 127(1), p. 42.

Characters.—The anterior row of eyes procurved. Abdomen in female at least wider than long, with a hump on each side in the middle of its length; the tibia of the palp of the male enormously developed, concave on the inner side, and overlaps the tarsus half its length. Chelicerae with two teeth on anterior margin and without tooth on posterior margin. Palp very simple, conductor, median apophysis, radix absent. Haematodocha fastens both ends of tegulum to the cymbium.

This genus is being recorded here for the first time from India.

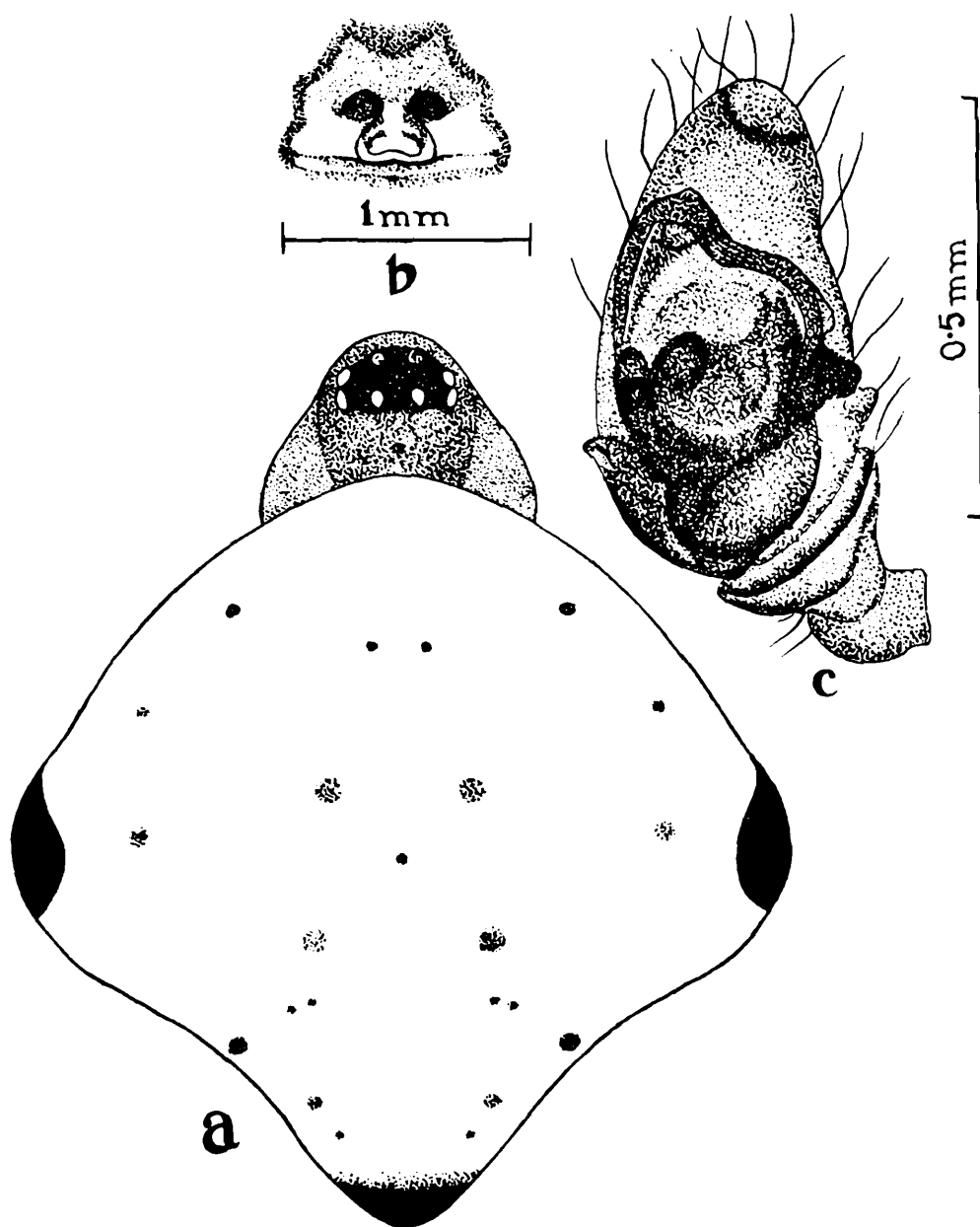
Type-species.—*Theridula opulenta* Walckenaer.

Distribution.—Africa, Asia and America.

8. *Theridula angula* sp. n.

General.—Cephalothorax and legs reddish-yellow, abdomen yellow. Total length 3.80 mm. Carapace 1.00 mm. long, 1.20 mm. wide; abdomen 3.00 mm. long, 3.00 mm. wide.

Cephalothorax.—Slightly wider than long, clothed with fine pubescence, cephalic region elevated and thoracic region flat. Eyes pearly white except anterior medians, ocular area covered with a conspicuous



TEXT-FIG. 8. *Theridula angula* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne. (c) Male palp.

deep-brown patch. Anterior row slightly recurved, and posterior row almost straight, lateral eyes contiguous. Sternum heart-shaped. Legs long and slender, clothed with hairs and spines. All legs from anterior end to tip of the tarsi provided with conspicuous deep reddish-brown colour.

Abdomen.—Nearly as long as wide, rhomboidal, broadest near the middle; strongly overlapping the posterior region of cephalothorax in front, lateral corners elevated, lateral corners and posterior end of abdomen provided with conspicuous black spot. Epigyne as in text-fig. 8, b. Male coloured like female but legs longer and smaller in size. Male palp as in text-fig. 8, c.

Holotype one female. *Paratypes*, ten females. *Allotypes*, seven males in spirit.

Type-locality.—Bank of Great Rangit river, West Sikkim, 20.9.1959. Coll. B. K. Tikader.

This species resembles *Theridula opulenta* Walckenaer from America but it is separated as follows: (i) Cephalothorax with reddish-yellow and ocular area covered with a conspicuous deep-brown patch but in *T. opulenta* cephalothorax uniformly deep-brown. (ii) Abdomen yellow and black spots on posterior end as well as lateral elevated portion of each side but in *T. opulenta* abdomen yellowish grey with a greenish white spot in the middle and a black spot on a slight elevated portion of each side. (iii) Epigyne and male palp also structurally different.

Genus 6. *Achaeearanea* Strand

1929. *Achaeearanea* Strand, *Acta Univ. Latviensis*, 20, p. 11.

1963. *Achaeearanea*: Levi, *Bull. Mus. Comp. Zool.*, Harvard, 129(3), p. 190.

Characters.—The median apophysis of the palp broadly attached to the tegulum or attached to the embolus, with which it may form one sclerite. The radix absent. The cymbium often extends beyond the alveolus. *Theridion* differs by having median apophysis and embolus as separate sclerites and radix usually present. Unlike *Theridion* the abdomen of many species higher than long, often with a hump, rarely longer than high.

Type-species.—*Achaeearanea trapezoidalis* (Taczanowski).

Distribution.—America and India.

9. *Achaeearanea budana* sp. n.

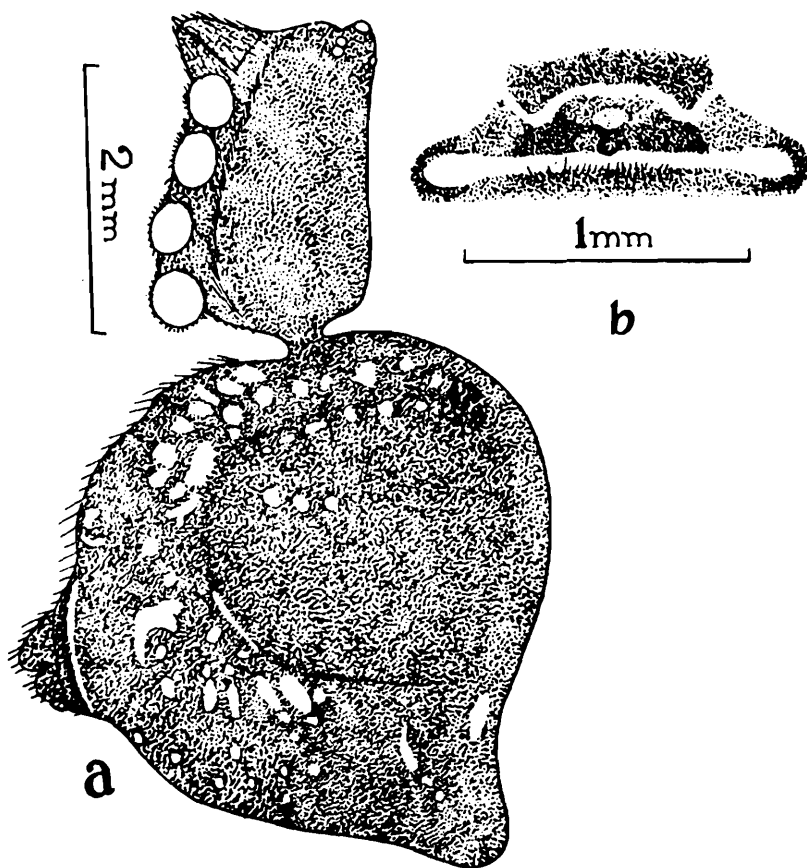
General.—Cephalothorax and legs light brown, abdomen dark-brown. Total length 6.80 mm. Carapace 2.10 mm. long, 2.00 mm. wide; abdomen 4.10 mm. long, 4.00 mm. wide.

Cephalothorax.—Longer than wide, convex, clothed with fine hairs. Eyes pearly white, lateral eyes contiguous, ocular quad longer than wide. Sternum heart-shaped, longer than wide. Clypeus rounded, ventrally with a deep groove just below the anterior row of eyes. Legs robust and clothed with thick hairs, banded with deep brown bands. Tarsi of IV pairs of legs with distinct comb like setae.

Abdomen.—Globular, slightly overlapping the posterior region of cephalothorax in front. Spinners just behind the middle of the abdomen, posterior end with a conspicuously elevated knob having a posterior white mark, lateral abdominal sides provided with inconspicuous irregular green patches. Epigyne as in text-fig. 9, b.

Holotype one female. *Paratypes* two females in spirit.

Type-locality.—Bank of Great Rangit river, West Sikkim, 20.9.1959.
Coll. B. K. Tikader.



TEXT-FIG. 9. *Achaearanea budana* sp. n. (a) Lateral view of female, legs omitted. (b) Epigyne.

This species resembles *Achaearanea hirta* (Taczanowski) from America but it is separated as follows: (i) Abdomen dark-brown with lateral irregular green patches and posterior end elevated but in *A. hirta* abdomen marked with black, white and red-brown and posterior end pointed. (ii) The total length of female 6.80 to 7.20 mm. but in *A. hirta* the total length of female 1.90 to 2.90 mm. (iii) The structure of epigyne is quite different.

10. *Achaearanea durgae* sp. n.

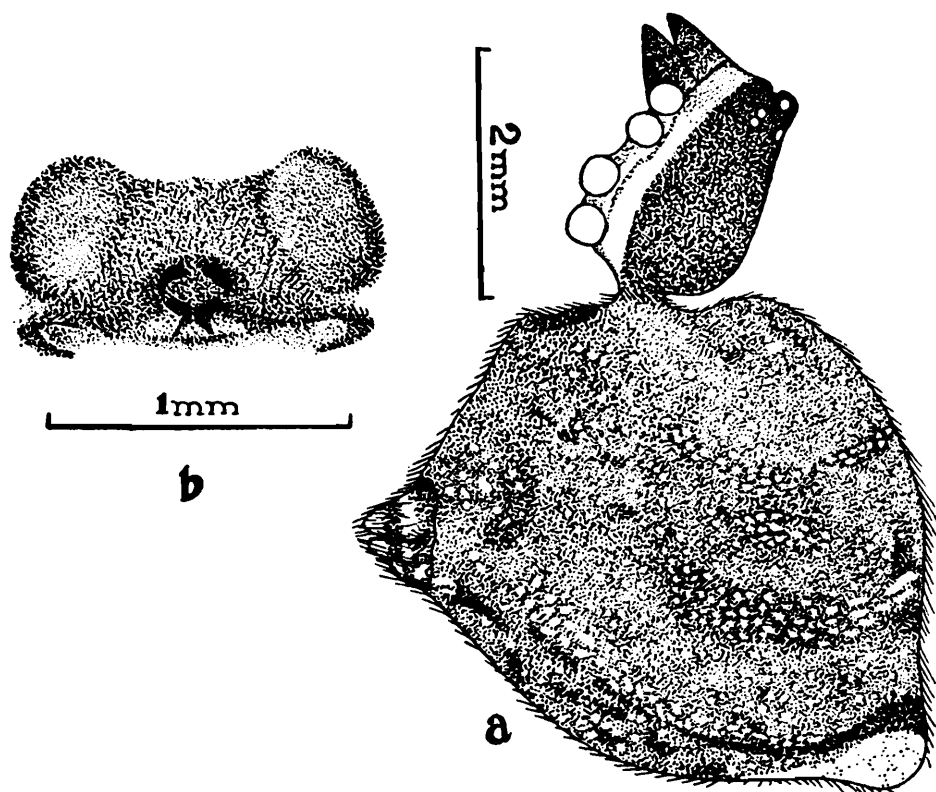
General.—Cephalothorax and abdomen greenish-brown, legs light green. Total length 5.50 mm. Carapace 2.00 mm. long, 1.50 mm. wide; abdomen 4.20 mm. long, 4.10 mm. wide.

Cephalothorax.—Slightly longer than wide, convex, narrowing in front; clothed with fine hairs. Eyes pearly white except anterior medians, lateral eyes contiguous, ocular quad longer than wide. Clypeus round and deep groove under eyes. Sternum heart-shaped, longer than wide, pointed behind, clothed with fine hairs. Legs robust, clothed with thick hairs. Tarsi of IV pairs of legs with distinct comb-like setae.

Abdomen.—Globular nearly as long as wide, clothed with fine hairs, slightly overlapping the posterior region of cephalothorax in front. Spinners behind the middle of the abdomen with an elevated knob having posteriorly a yellowish-white mark. Abdomen provided with irregular white patches. Epigyne as in text-fig. 10, b.

Holotype one female in spirit.

Type-locality.—Legship, West Sikkim, 2.10.1959. Coll. B. K. Tikader.



TEXT-FIG. 10. *Achaearanea durgae* sp. n. (a) Lateral view of female, legs omitted. (b) Epigyne.

This species resembles the foregoing species, i.e., *Achaearanea budana* sp. n. but it is separated as follows: (i) Abdomen greenish-brown and end moderately elevated posteriorly with a knob having yellowish-white mark but in *A. budana* abdomen dark brown with posterior dorsal end more elevated, with white mark. (ii) Epigyne also different.

Family IV. LINYPHIIDAE

Characters.—Cephalothorax widely variable in proportions. In the sub-family Erigoninae the male head often raised into a lobe or bears cornicules or other protuberances, or sulci (grooves) running backwards from the posterior eyes, or holes in the sides. In the sub-family Linyphiinae there are no such lobes etc., but the head occasionally raised anteriorly. Clypeus variable in width, but generally wider than in Argiopidae. Eyes two rows, heterogeneous, with anterior medians slightly darker. Abdomen usually without pattern dorsally, but some Linyphiinae species with well-defined patterns. Sternum heart shaped, but may be relatively wide or narrow; pointed or truncated posteriorly. Legs may relatively short and stout, as in most Erigoninae, but in Linyphiinae legs relatively long and thin.

Key to Indian genera of *Linyphiidae*

1. Posterior eyes not closely set. Median ocular area not longer than wide ... *Linyphia* Latreille
- Posterior eyes closely set. Median ocular area longer than wide ... 2
2. Eyes fairly large ... *Lepthyphantes* Menge
- Eyes fairly small ... *Lafulla* Simon

Genus 7. *Linyphia* Latreille

1804. *Linyphia* Latreille, *Nouv. Dict. Hist. Nat.*, 24, p. 134.

1884. *Linyphia* : Simon, *Ar. Fr.*, 5, p. 262.

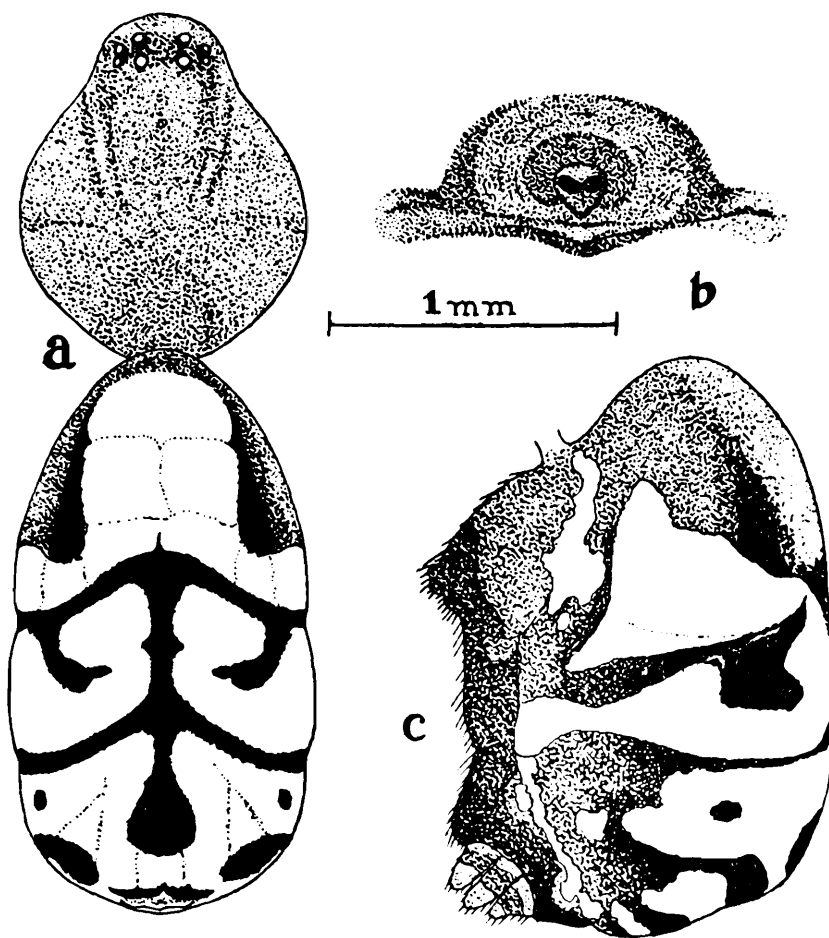
Characters.—Eyes fairly small, widely spaced ; on large black spots. Abdomen with a dorsal pattern. Legs usually long, metatarsi almost twice as long as tarsi. Male palp paracymbium very slender and conspicuous.

Type-species.—*Linyphia triangularis* Clerck.

Distribution.—Europe, Africa, Asia, Australia and America.

11. *Linyphia urbasae* sp. n.

General.—Cephalothorax brown, abdomen chalk-white and legs green. Total length 3.10 mm. Carapace 1.20 mm. long, 1.00 mm. wide; abdomen 2.00 mm. long, 1.10 mm. wide.



TEXT-FIG. 11. *Linyphia urbasae* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne. (c) Lateral view of abdomen of female.

Cephalothorax.—Longer than wide, convex, middle broadest and narrowing in front, cephalic region slightly raised. Eyes pearly white, anterior row recurved, posterior row straight lateral eyes small, contiguous, and the base of all eyes encircled by black patches. Sternum heart-shaped, longer than wide and pointed behind. Legs long, clothed with fine hairs and spines.

Abdomen.—Longer than wide, ventral side clothed with thick hairs. Dorsal side conspicuously marked by a longitudinal and two transverse black bars, as in text-figs. 11, a, c. Ventral side dark in colour. Epigyne as in text-fig. 11, b.

Holotype one female in spirit.

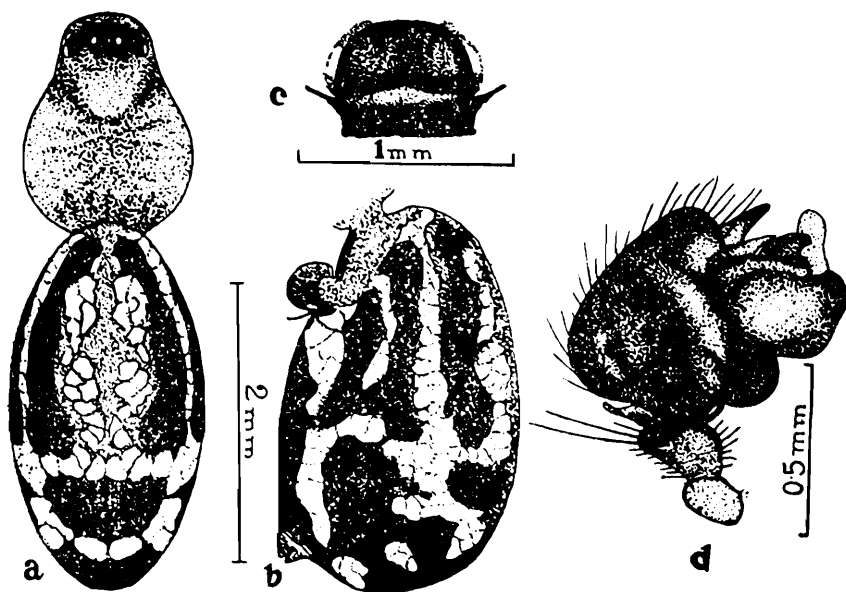
Type-locality.—Bank of Great Rangit river, West Sikkim, 20.9.1959. Coll. B. K. Tikader.

This species resembles *Linyphia clathrata* Sundevall from America but it is separated as follows: (i) Cephalothorax uniformly brown but in *L. clathrata* cephalothorax brown to dark-brown with faint darker striae. (ii) Abdomen chalk-white and dorsal side conspicuously marked with a longitudinal and two transverse black bars but in *L. clathrata* abdomen pale brown, thickly spotted with white and marked with brownish-black bars. (iii) Epigyne also differs.

12. *Linyphia sikkimensis* sp. n.

General.—Cephalothorax and legs brownish-green, abdomen chalk-white. Total length 4.10 mm. Carapace 1.60 mm. long, 1.20 mm. wide: abdomen 2.60 mm. long, 1.50 mm. wide.

Cephalothorax.—Longer than wide, flat, broadest in the middle and narrowing in front, cephalic region slightly raised. Eyes pearly white, anterior row recurved, posterior row straight, lateral eyes small and contiguous, all eyes encircled by black patches. Ocular area provided with deep brown patches; ocular quad longer than wide. Sternum black, heart-shaped. Legs long, clothed with fine hairs.



TEXT-FIG. 12. *Linyphia sikkimensis* sp. n. (a) Dorsal view of female, legs omitted. (b) Lateral view of abdomen of female. (c) Epigyne. (d) Male palp.

Abdomen.—Longer than wide, broadest behind the middle. Anterior half of dorsal side provided with two longitudinal broad black lines extending from base to just behind the middle and posteriorly with two broad transverse black patches. Lateral sides also provided with black bands as in text-fig. 13, a. Ventral side black. Epigyne as in text-fig. 12, c. Male longer than female, legs long, male palp as in text-fig. 12, d.

Holotype one female. *Paratypes*, twelve females. *Allotypes*, three males in spirit.

Type-locality.—Gazing, West Sikkim, 11.10.1959. Coll. B. K. Tikader.

This species resembles the foregoing species i.e. *Linyphia urbasae* sp. n. but it is separated as follows : (i) Anterior half of abdomen provided with two longitudinal broad black lines extending from base to just behind the middle and posteriorly two transverse broad black patches but in *L. urbasae* abdomen conspicuously marked with a longitudinal and two transverse black bars. (ii) Epigyne is also different.

Genus 8. *Labulla* Simon

1884. *Labulla* Simon, *Ar. Fr.*, 5, p. 261.

1953. *Labulla* : Locket and Millidge, *British Spiders*, London, 2, p., 375.

Characters.—Eyes large, all approximately equal in size. Abdomen with dorsal pattern. Legs long, metatarsus IV without a trichobothrium, femora each with a long spine dorsally.

Type-species.—*Labulla thoracica* Wider.

Distribution.—Europe, Asia and America.

13. *Labulla nepula* sp. n.

General.—Cephalothorax and legs brown, abdomen dirty white. Total length 6.50 mm. Carapace 2.50 mm. long, 2.00 mm. wide ; abdomen 4.40 mm. long, 2.50 mm. wide.

Cephalothorax.—Longer than wide, flat, cephalic region slightly high, broadest on the middle, middle and lateral sides provided with longitudinal deep broad lines. Eyes pearly white ; anterior eyes large, equal in size and slightly recurved line. Ocular quad longer than wide and about as wide in front as behind. Posterior row straight ; lateral eyes small and contiguous. Sternum heart-shaped, deep brown, pointed behind. Legs long, clothed with fine long hairs and spines.

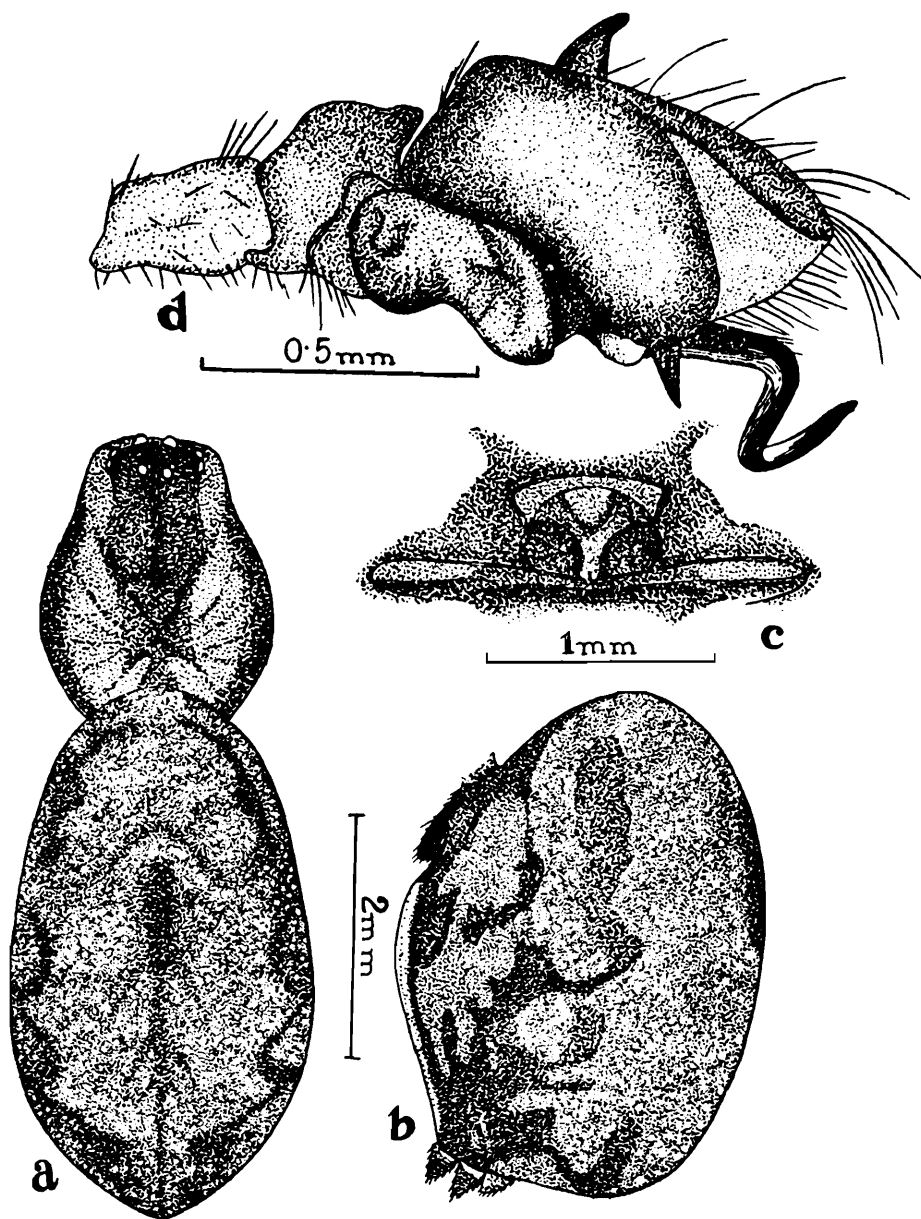
Abdomen.—Longer than wide, nearly egg-shaped, dorsally provided with minute white dots mixed with deep brown patches as in text-fig. 13, a. Ventral side darker than dorsal side. Epigyne as in text-fig. 13, c. Male longer in size, legs very long, male palp as in text-fig. 13, d.

Holotype one female. *Paratype* one female. *Allotype* one male in spirit.

Type-locality.—Bank of Great Rangit river, West Sikkim, 20.9.1959. Coll. B. K. Tikader.

This species resembles *Labulla thoracica* (Wider) from Europe but it is separated as follows : (i) Cephalic region clothed with fine hairs but in *L. thoracica* cephalic region with numerous slender spines directed

forward. (ii) Eyes of anterior medians larger than posterior median but in *L. thoracica* anterior and posterior medians equal in size. (iii) Epigyne and male palp different.



TEXT-FIG. 13. *Labulla nepula* sp. n. (a) Dorsal view of female, legs omitted. (b) Lateral view of abdomen of female. (c) Epigyne. (d) Male palp.

Genus 9. *Lephtyphantes* Menge

1866. *Lephtyphantes* Menge, *Preuss. Spinn.*, 1, p. 95.

1895. *Lephtyphantes* : Simon, *Hist. Nat. Araig.*, 1, p. 705.

Characters.—Cephalothorax narrowed anteriorly. Eyes fairly large, with black spots. Anterior median eyes smaller than posterior medians. Clypeus slightly concave. Abdomen with or without dorsal pattern.

Type-species.—*Lephtyphantes nebulosus* Sundevall.

Distribution.—Europe, Africa, Asia, Australia and America.

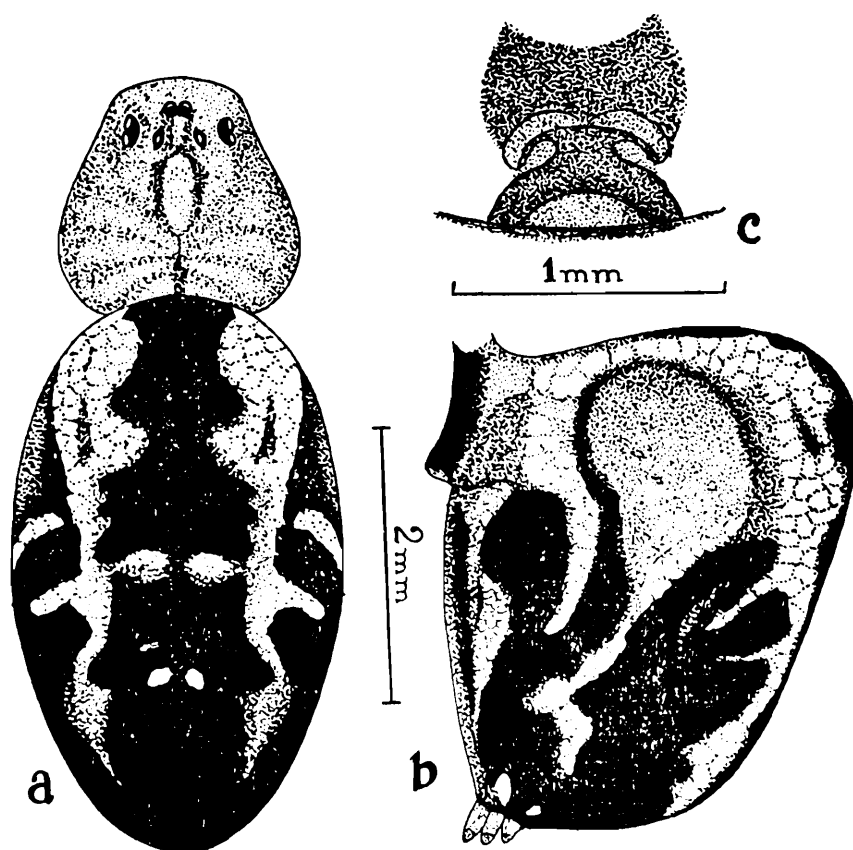
Key to Indian species of *Lepthyphantes* Menge

Abdomen nearly triangular when viewed laterally	...	2
Abdomen not triangular when viewed laterally	...	<i>L. rudrai</i> sp. n.
Anterior portion of abdomen high	...	<i>L. bhudbari</i> sp. n.
Posterior portion of abdomen high	...	<i>L. lingsoka</i> sp. n.

14. *Lepthyphantes bhudbari* sp. n.

General.—Cephalothorax and legs brownish green, abdomen brownish white. Total length 5.50 mm. Carapace 1.80 mm. long, 1.80 mm. wide; abdomen 4.00 mm. long, 2.50 mm. wide.

Cephalothorax.—As long as wide, flat, cephalic region slightly raised, finely pubescent. Middle and two lateral sides provided with longitudinal deep-brown patches. Eyes not pearly white but base of all eyes encircled by black patches; anterior row strongly recurved, posterior row straight; lateral and anterior median eyes contiguous. Anterior median eyes smaller than others. Sternum triangular, black or deep brown, pointed behind, clothed with hairs. Legs strong, clothed with fine hairs and spines.



TEXT-FIG. 14. *Lepthyphantes bhudbari* sp. n. (a) Dorsal view of female, legs omitted. (b) Lateral view of abdomen of female. (c) Epigyne.

Abdomen.—Egg-shaped when viewed dorsally but nearly triangular when viewed laterally, mid-dorsally with a longitudinal broad black bar extending from base to end of abdomen and lateral sides provided with irregular chalk-white patches. Ventral side deep-brown or black. Epigyne as in text-fig. 14, c.

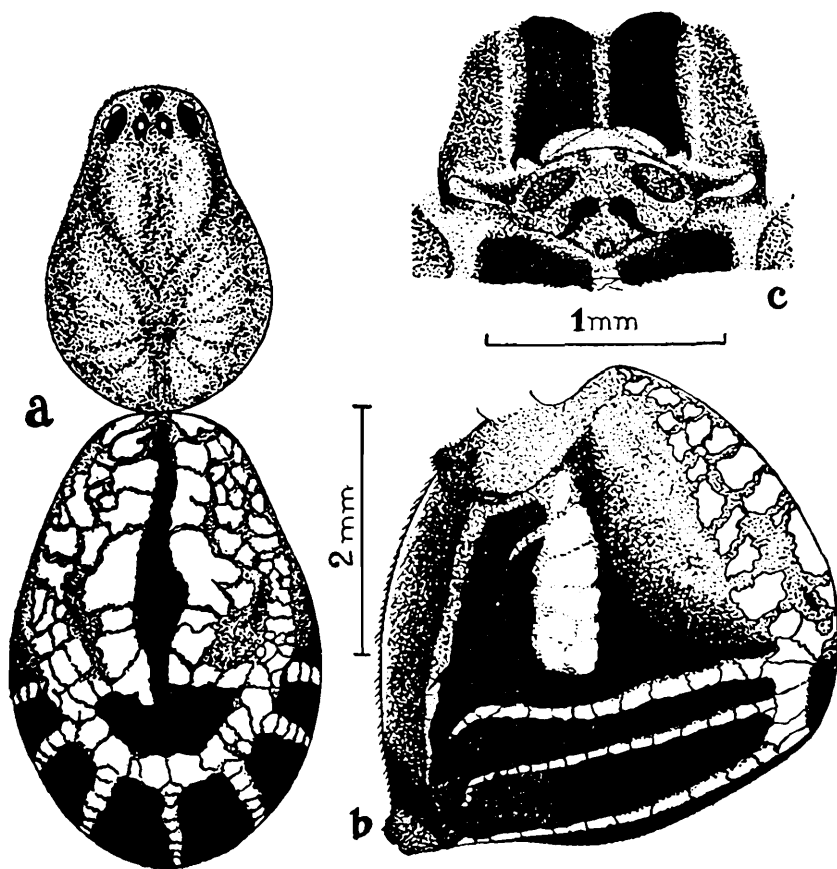
Holotype one female. *Paratypes* nine females in spirit.

Type-locality.—Bhudbari, Dist. Darjeeling, West Bengal, India, 15.9.1959, Coll. B. K. Tikader.

This species resembles *Lepthyphantes leprosus* (Ohlert) from America but it is separated as follows: (i) Total length 4 to 5.50 mm. but in *L. leprosus* total length 2 to 3 mm. (ii) Abdomen provided with irregular chalk-white lateral patches and mid-dorsally with a longitudinal broad black bar extending from base to end of abdomen but in *L. leprosus* abdomen no such markings. (iii) Epigyne different.

15. *Lepthyphantes lingsoka* sp. n.

General.—Cephalothorax brown, legs brownish-green, abdomen dirty-white. Total length 6.50 mm. Carapace 2.50 mm. long, 1.90 mm. wide; abdomen 3.80 mm. long, 2.50 mm. wide.



TEXT-FIG. 15. *Lepthyphantes lingsoka* sp. n. (a) Dorsal view of female, legs omitted. (b) Lateral view of abdomen of female. (c) Epigyne.

Cephalothorax.—Longer than wide, flat, clothed with fine pubescence, centrally depressed, narrowing in front, cephalic region slightly raised. Eyes pearly white, bases encircled by black patch, anterior row strongly recurved, posterior row straight, lateral and anterior median eyes contiguous. Sternum triangular, narrowed behind, densely clothed with black hairs. Legs strong, clothed with hairs and spines.

Abdomen.—Egg-shaped when viewed dorsally but triangular laterally, dorsal side decorated by irregular chalk-white and black patches as in text-figs. 15, a, b.

Holotype one female. *Paratypes* four females in spirit.

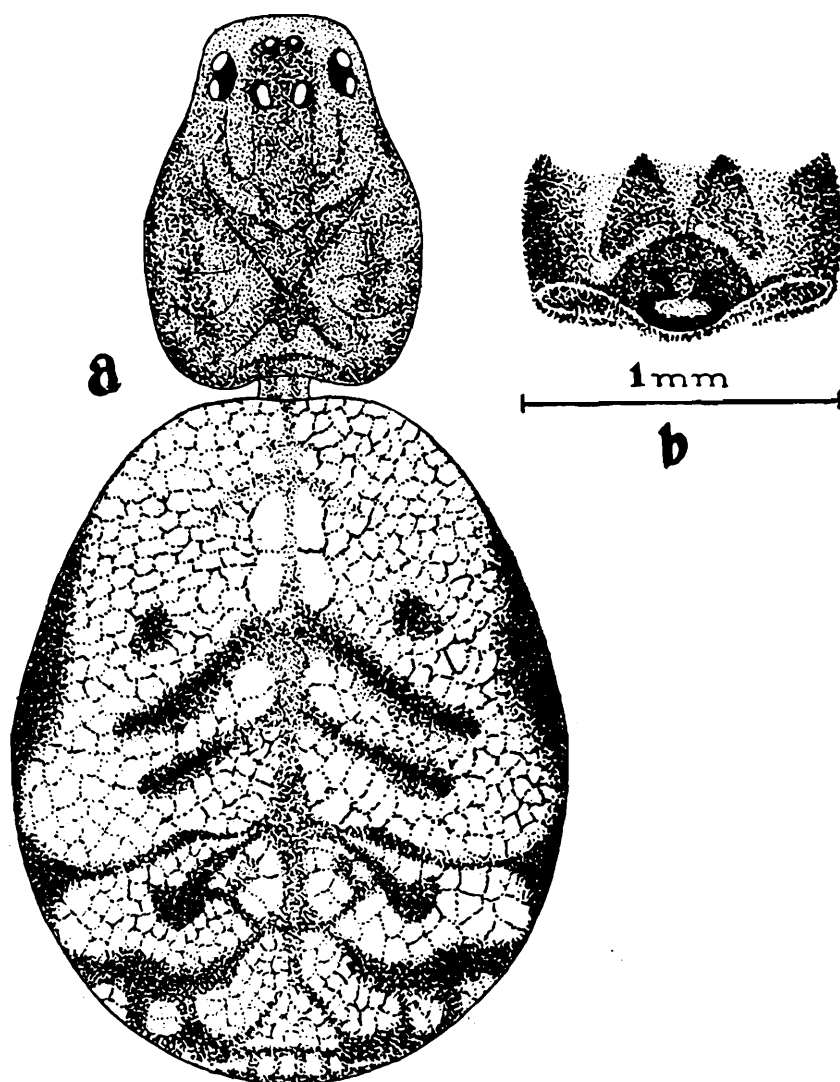
Type-locality.—Lingsoka, Dist. Darjeeling, West Bengal, India.
9.9.1959. Coll. B. K. Tikader.

This species resembles the foregoing species i.e. *Lephtyphantes bhudbari* sp. n. but it is separated as follows: (i) Cephalothorax longer than wide, narrowing in front but in *L. bhudbari* cephalothorax nearly as long as wide and middle and lateral sides provided with longitudinal deep-brown patches. (ii) Posterior end of abdomen provided with radiating white lines extending from centre to near the spinners but in *L. bhudbari* posterior end of abdomen without such line. (iii) Epigyne also structurally different.

16. *Lephtyphantes rudrai* sp. n.

General.—Cephalothorax brown, abdomen dirty chalk-white and legs green. Total length 3.40 mm. Carapace 1.10 mm. long, 0.80 mm. wide; abdomen 2.10 mm. long, 1.80 mm. wide.

Cephalothorax.—Longer than wide, flat, finely pubescent, centre depressed, narrow in front, cephalic region slightly raised. Eyes pearly white, surrounded by black patches, anterior row strongly recurved, posterior row straight, lateral and anterior medians contiguous but anterior medians smaller than others. Sternum triangular,



TEXT-FIG. 16. *Lephtyphantes rudrai* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne.

pointed behind, deep brown in colour. Legs long and slender, clothed with hairs, anterior end of tibiae and patella provided with faint brown transverse bands.

Abdomen.—Longer than wide, nearly oval, abdomen provided with chalk-white minute patches; with a longitudinal dark brown band mid-dorsally and similar lateral dark-brown bars. Ventral side deep brown with two broad longitudinal white lines extending from base to near the spinners. Epigyne as in text-fig. 16, b.

Holotype one female in spirit.

Type-locality.—Bank of Great Rangit river, West Sikkim, India, 20.9.1959.

This species resembles *Lepthyphantes nebulosus* (Sundevall) from America but it is separated as follows: (i) Cephalothorax brown but in *L. nebulosus* cephalothorax yellow-brown, with median dark line, anteriorly bifurcated. (ii) Abdomen provided with chalk-white minute patches and mid-dorsal with a longitudinal dark-brown band with similar lateral bars arising from longitudinal bar but in *L. nebulosus* abdomen greyish with transverse black bars. (iii) Epigyne structurally different.

Family V ARGIOPIDAE

Characters.—Cephalothorax usually flat, thoracic region oval or nearly circular, separated from head by an oblique depression. Eyes not very different in size. Medians may form either a square or a trapezium; laterals close to one another and often projecting. Clypeus narrower than the ocular area. Sternum heart-shaped or triangular, coxa IV being nearly contiguous. Legs furnished with numerous spines, with three tarsal claws. This is the only family of spiders that spins true orb-webs.

Key to the Indian genera of *Argiopidae*

- | | | | | | |
|--|-----|-----|-----|-----|----------------------------|
| 1. Abdomen hard | ... | ... | ... | 2 | |
| Abdomen soft | ... | ... | ... | 3 | |
| 2. Spinners encircled by a horny ring. Abdomen armed with six marginal spines | ... | ... | ... | in | <i>Gasteracantha</i> Sund. |
| Spinners not encircled by horny ring. Abdomen high in front irregularly tuberculated on the dorsum | ... | ... | ... | ... | <i>Caerostris</i> Thorell |
| 3. Eyes of posterior line strongly procurved | ... | ... | ... | 4 | |
| Eyes of posterior line not or scarcely procurved | ... | ... | ... | 5 | |
| 4. Abdomen colourful mainly transverse bands above | ... | ... | ... | ... | <i>Argiope</i> Savigny |
| Abdomen nearly triangular not so much colourful | ... | ... | ... | ... | <i>Araneus</i> Clerck |
| 5. Abdomen produced beyond the spinners into pointed tail | 6 | | | | |
| Abdomen not produced beyond the spinners into a tail | 7 | | | | |
| 6. Pointed tail of abdomen without branch and worm like spine | ... | ... | ... | ... | <i>Eucta</i> Simon |
| Pointed tail of abdomen with branches | ... | ... | ... | ... | <i>Arachnura</i> Vinson |
| 7. Abdomen silvery in colour | ... | ... | ... | 8 | |
| Abdomen not silvery in colour | ... | ... | ... | 9 | |
| 8. Head and thorax separated by a deep cervical groove in the female | ... | ... | ... | ... | <i>Cyclosa</i> Menge |
| Head and thorax not separated by cervical groove in the female | ... | ... | ... | ... | <i>Leucauge</i> White |
| 9. Abdomen with paired tubercles | ... | ... | ... | ... | <i>Cyrtophora</i> Simon |
| Abdomen without paired tubercles | ... | ... | ... | 10 | |
| 10. Large spider | ... | ... | ... | ... | <i>Nephila</i> Leach |
| Small spider | ... | ... | ... | ... | <i>Singa</i> Koch |

Genus 10. *Argiope* Savigny

1825. *Argiope* Savigny, *In Aud. and Sav. Egypte Hist. Nat.*, **12**, p. 121.
 1892. *Argiope* : Simon, *Histoire Naturelle des Araignees*, **1**, p. 769.
 1900. *Argyope* : Pocock, *Fauna Brit. India*, Arach., p. 220.
 1935. *Argiope* : Dayal, *Bull. Zool. Punjab Univ.*, **1**, p. 189.

Characters.—Cephalothorax flat, clothed with metallic white pubescence; ocular quadrangle much longer than wide. Eyes of posterior row very strongly procurved, laterals contiguous. Abdomen usually longer than wide, varying in shape, posterior half wider than anterior. Legs stout, armed with hairs and spines. Males relatively very small.

Type-species.—*Argiope lobata* Pallas.

Distribution.—Europe, Africa, Asia, Australia and America.

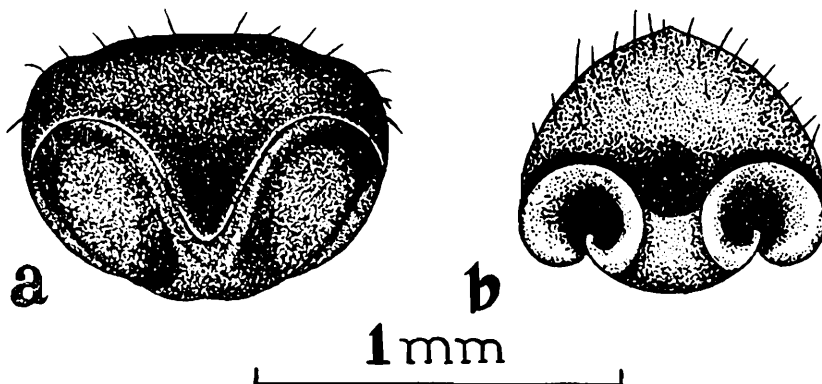
Key to Indian species of *Argiope* Savigny

- | | | | | |
|---|-----|-----|-----|------------------------------|
| 1. Abdomen pentagonal | ... | ... | ... | 2 |
| Abdomen not pentagonal | ... | ... | ... | <i>A. aemula</i> (Walck.) |
| 2. Legs yellow and strongly banded with black | ... | ... | ... | <i>A. pulchella</i> Thorell |
| Legs black and without band | ... | ... | ... | <i>A. sikkimensis</i> sp. n. |

17. *Argiope pulchella* Thorell

1881. *Argiope pulchella* Thorell, *Ann. Mus. Genova*, **17**, p. 74.
 1900. *Argyope pulchella* : Pocock, *Fauna Brit. India*, Arach., p. 221.
 1921. *Argiope pulchella* : Gravely, *Rec. Indian Mus.*, Calcutta, **22**, p. 12.
 1951. *Argiope pulchella* : Sinha, *Rec. Indian Mus.*, Calcutta, **49**, p. 73.

Specimens examined.—10 ♀, Rhenock, East Sikkim, 7.9.1959. 2 ♀, Samabiyong, East Sikkim, 13.9.1959. 1 ♀, Lingsoka, East Sikkim, 9.9.1959. Coll. B. K. Tikader.



TEXT-FIG. 17. *Argiope pulchella* Thorell (a) Epigyne. *Argiope aemula* (Walck.) (b) Epigyne.

General.—Cephalothorax and legs deep reddish-brown, abdomen yellow. Total length 15.00 mm. Carapace 5.00 mm. long, 4.00 mm. wide; abdomen 9.00 mm. long, 8.00 mm. wide.

Cephalothorax.—Slightly longer than wide, narrowing in front, clothed with silky white hairs. Eyes pearly white, lateral eyes contiguous and situated on the elevated stock. Sternum yellow or yellowish white. Legs sometimes yellow and strongly banded with black, sometimes more uniformly dark, palp yellow.

Abdomen.—Pentagonal, truncate in front, broadest behind the middle. Abdomen yellow or whitish above, ornamented with a large triangular olive-black patch behind, a transverse bar of the same colour in front, and two close-set narrow lines forming together a stripe in the anterior half; the dark patches relieved by small white spots. Ventral surface blackish, spotted, with a pair of yellow stripes running on each side from the epigastric fold. Epigyne as in text-fig. 17, a.

Distribution.—India: Andaman and Laccadiv Islands, West Bengal, Madhya Pradesh, Assam, Poona; Sikkim; Ceylon; Burma; Singapore.

18. *Argiope sikkimensis* sp. n.

General.—Cephalothorax brown, abdomen yellowish-brown, legs deep brown or black. Total length 22.00 mm. Carapace 9.00 mm. long, 8.00 mm. wide; abdomen 14.00 mm. long, 12.00 mm. wide.

Cephalothorax.—Slightly longer than wide, flat, cephalic region narrowing in front and slightly high, clothed with fine grey pubescence. Eyes pearly white, lateral eyes contiguous and situated on the elevated portion of cephalothorax, base of posterior median eyes encircled by a black ring. Ocular quad longer than wide and narrowing in front. Sternum black, heart-shaped, pointed behind, clothed with hairs; middle of sternum provided with a longitudinal yellow broad band. Padipalp yellowish white. Legs robust and clothed with hairs and spines; legs formula 1 2 3 4 and measurements of legs as below:

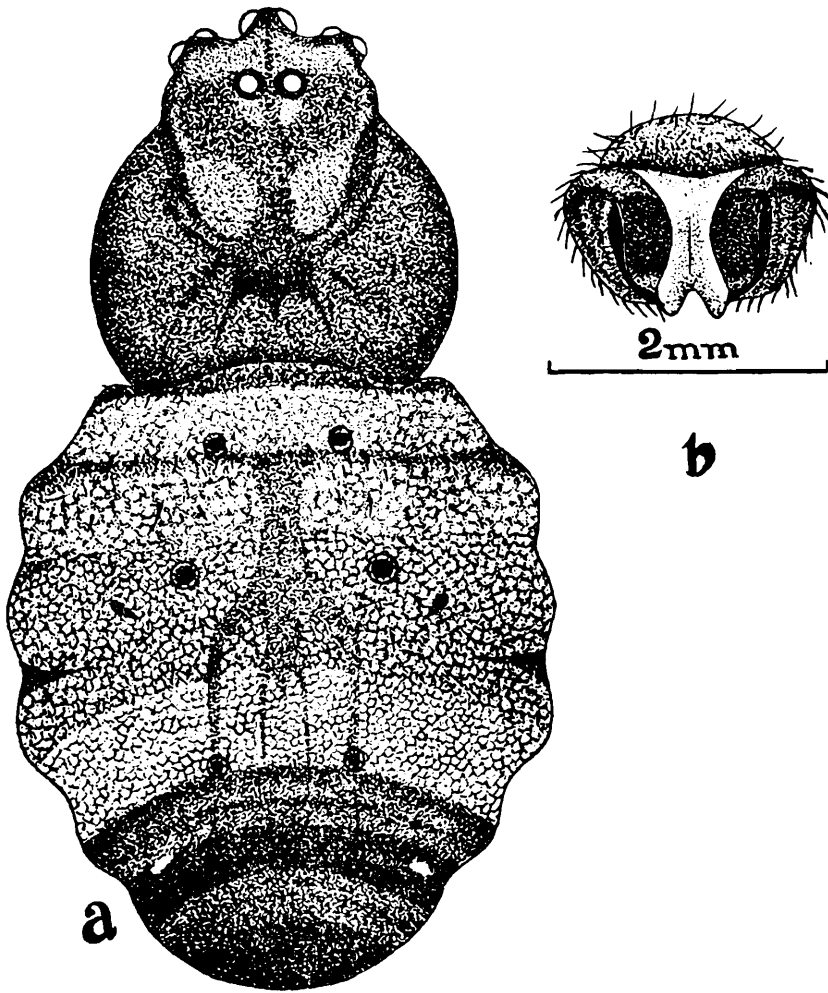
	I (mm.)	II (mm.)	III (mm.)	IV (mm.)
Femur	13.00	13.00	9.00	13.00
Patella	4.00	4.00	3.00	4.00
Tibia	10.00	10.00	5.00	9.00
Metatarsus	14.00	14.00	7.00	12.00
Tarsus	3.00	3.00	2.50	2.50
Total	44.00	44.00	26.50	40.50

Abdomen.—Longer than wide, clothed with small spines. Dorsum provided with six conspicuous sigella, arranged longitudinally in two rows, abdomen with transverse broad bands of deep brown, pale and yellow colour as in text-fig. 18, a. Ventral side deep brown but lateral sides provided with two longitudinal yellow broad bands extending from epigastric fold to near the spinners. Epigyne as in text-fig. 18, b.

Holotype one female. **Paratypes**, four females in spirit.

Type-locality.—Rongli, East Sikkim, 5.9.1959. Coll. B. K. Tikader.

This species appears to come close to *Argiope kalimpongensis* Sinha from Kalimpong but it is separated as follows: (i) The tip of median piece of vulva is bifurcate but in *A. kalimpongensis* the tip of median piece of vulva is round. (ii) The female padipalp yellowish-white but in *A. kalimpongensis* padipalp yellow and the apical segment brownish with black hairs. (iii) Abdomen dorsum provided with six conspicuous sigella, arranged longitudinally in two rows, but in *A. kalimpongensis* no such sigella on the abdomen.

19. *Argiope aemula* (Walck.)1837. *Epeira aemula* Walck., *Ins. Apt.*, 2, p. 118.1900. *Argiope aemula* : Pocock, *Fauna Brit. India*, Arach., p. 223.*Specimen examined*.—1 ♀, Darjeeling, West Bengal, India, 19.10.59
Coll. B. K. Tikader.*General*.—Cephalothorax and legs deep brown, abdomen brownish-white. Total length 20.00 mm. Carapace 8.00 mm. long, 6.00 mm. wide; abdomen 14.00 mm. long, 11.00 mm. wide.TEXT-FIG. 18. *Argiope sikkimensis* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne.*Cephalothorax*.—Slightly longer than wide, narrowing in front, clothed with thick silky white hairs. Eyes pearly white, lateral eyes contiguous. Sternum heart-shaped, middle with yellowish white markings and sides with black. Legs deep brown with yellow bands, palp yellow.*Abdomen*.—Longer than wide, oval, truncate in front, sides evenly and lightly rounded. Dorsal side with black stripe and posterior black patch, broken up into series of transverse black lines by intervening broader pale bands. Ventral surface blackish with a pair of yellow stripes running on each side from the epigastric fold. Epigyne as in text-fig. 17, b.*Distribution*.—India : Poona, Trivandram, Nilgiri, Gujarat, West Bengal, Nicobar Island. Ceylon; Burma; Austro-Malaysia.

Genus 11. *Araneus* Clerck

1757. *Araneus* Clerck, *Syenska Spindlar.*, p. 22.
 1895. *Araneus* : Simon, *Hist. Nat. Araign.*, 1, p. 829.
 1900. *Araneus* : Pocock, *Fauna Brit. India*, Arach., p. 223.

Characters.—Carapace convex ; eyes of posterior line slightly or strongly recurved ; quadrangle a little longer than wide ; lateral eyes separated or in contact. Legs strong ; protarsi shorter than tibiae and patella. Female with distinct vulva. Male with complicated palp.

Type-species.—*Araneus angulatus* Clerck.

Distribution.—Europe, Africa, Asia, Australia and America.

20. *Araneus dehaanii* (Doleschall)

1859. *Epeira dehaanii* Doleschall, *Verh. Nat. Vereen Nederland India*, 5, p. 33.
 1900. *Araneus dehaanii* : Pocock, *Fauna Brit. India*, Arach., p. 225.
 1951. *Aranaeus dehaanii* : Sinha, *Rec. Indian Mus.*, Calcutta, 49, p. 84.

Specimens examined.—5 ♀, Nayabazar, West Sikkim, 17.10.1959.
 Coll. B. K. Tikader.

General.—Cephalothorax and legs reddish, abdomen brown. Total length 22.00 mm. Carapace 9.00 mm. long, 5.50 mm. wide ; abdomen 14.00 mm. long, 12.00 mm. wide.

Cephalothorax.—Longer than wide, clothed with thick fine white hairs, anterior lateral border of carapace provided with a spine like tubercle on each side above the lateral eyes. Eyes pearly white, four median eyes situated on the elevated middle portion of carapace and anterior medians larger than the posterior ; lateral eyes small and situated near the base of anterior lateral spine. Legs long and strong, clothed with white hairs and spines.

Abdomen.—Triangular, broad, with large sharp shoulder-points in front, pointed behind, and ending in three prominences set in a vertical series. Epigyne vulva small, with very stout scape.

Distribution.—India : Kanara, Cochin, Mysore, Darjeeling and Kalimpong in West Bengal, Assam. Ceylon ; Sikkim ; Malay Peninsula and Austro-Malaysia.

Genus 12. *Arachnura* Vinson

1863. *Arxhnue* Vinson, *Aran. Reun.*, etc. p. 287.
 1863. *Hapaloctrota* : Keyserling, *Sitz. Isis. Z. Dresden*, p. 82.
 1872. *Epeira* Koch, *Ar. Austr.*, p. 120.
 1892. *Arachnura* : Simon, *Hist. Nat. Araign.*, 1, p. 777.

Characters.—Cephalothorax long, cephalic region narrow. Abdomen long, narrowing behind like a tail, and anteriorly with large sharp shoulder-pointed.

Type-species.—*Arachnura scorpionides* Vinson.

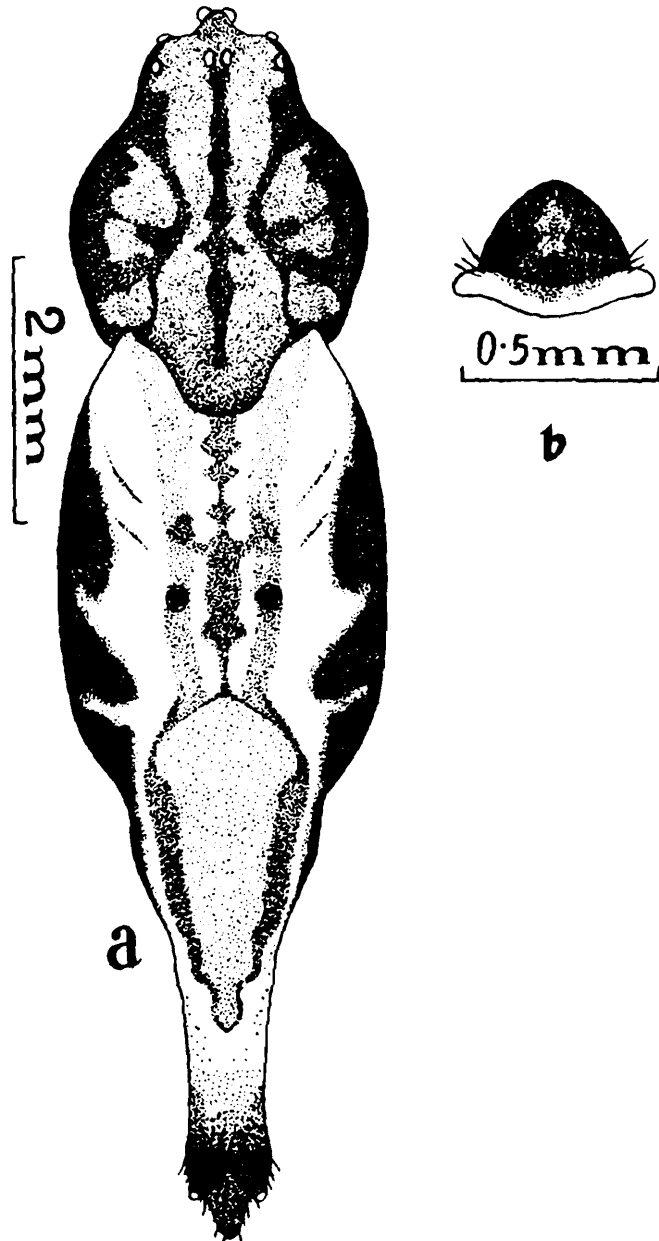
Distribution.—Asia : India ; Malaysia ; Africa ; Australia.

21. *Arachnura angura* sp. n.

General.—Cephalothorax and legs green, abdomen brown. Total length 9.20 mm. Carapace 3.00 mm. long, 2.10 mm. wide ; abdomen 7.00 mm. long, 2.20 mm. wide.

Cephalothorax.—Longer than wide, cephalic region narrow in front and slightly high, lateral sides provided with longitudinal deep brown

patches and mid-dorsally with a conspicuous longitudinal deep brown line extending from posterior median eyes to base of the thorax. Eyes pearly white, anterior row recurved and anterior median eyes larger than laterals and situated on the elevated knob; posterior row straight, lateral eyes not contiguous. Sternum heart-shaped, clothed with hairs. Legs long and strong, I and II pairs longer than III and IV, clothed with hairs and few spines.



TEXT-FIG 19. *Arachnura angura* sp. n. (a) Dorsal view of female, legs omitted.
(b) Epigyne.

Abdomen.—Long, narrowing behind like a tail, and anteriorly with large sharp shoulder-points; mid-dorsally with a longitudinal white patch extending from base to end of abdomen. Anterior half of abdomen on the dorsal side provided with a pair of conspicuous sigella. Near the end of tail provided with two elevated knobs on the dorsal side. Ventral side deep brown, clothed with hairs. Epigyne as in text-fig. 19, b.

Holotype one female. *Paratypes*, two females in spirit.

Type-locality.—Gazing, West Sikkim, 11.10.1959. Coll. B. K. Tikader.

This species resembles *Arachnura melanura* Simon from Africa but it is separated as follows : (i) Cephalothorax lateral sides provided with longitudinal deep brown patches and mid-dorsally with a longitudinal deep brown line extending from posterior median eyes to base of thorax but in *A. melanura* cephalothorax no such longitudinal brown patch or line. (ii) Abdomen mid-dorsally with a longitudinal white patch extending from base to end of abdomen but in *A. melanura* abdomen uniform brown colour. (iii) Epigyne also different.

Genus 13. *Cyrtophora* Simon

1864. *Cyrtophora* Simon, *Hist. Nat. Araign.*, p. 261.
 1895. *Cyrtophora* : McCook, *Amer. Spiders*, 3, p. 235.
 1895. *Cyrtophora* : Simon, *Hist. Nat. Araign.*, 1, p. 775.
 1900. *Araneus* : Pocock, *Fauna Brit. India, Arach.*, p. 226.

Characters.—Cephalothorax short, cephalic region long and high ; eyes in three groups, the laterals widely separated. Ocular quad a little longer than wide. Legs I, II, IV, III and stout, scantily armed. Abdomen conical, tuberculated, nearly perpendicular to plane of cephalothorax.

The spiders of this genus remain hanging downwards from the apex of the inverted bowl-shaped web. The genus is remarkable for its architectural mechanism of orb webbing.

Type-species.—*Cyrtophora citricola* Forskal.

Distribution.—Africa, Asia, Australia and America.

22 *Cyrtophora moluccensis* (Doleschall)

1875. *Epeira moluccensis* Doleschall, *Nat. Tijdschr. Nederland Indie*, 13, p. 41.
 1900. *Araneus moluccensis* Pocock, *Fauna Brit. India, Arach.*, p. 226.
 1962. *Cyrtophora moluccensis* Tikader, *J. Linn. Soc. London*, 44(300), p. 562.

Specimens examined.—5 ♀, Kalimpong, Dist. Darjeeling, 6.9.1959. 15 ♀, Darjeeling, West Bengal, 12.10.1959. 6 ♀, Rongli, East Sikkim, 1.9.1959. Coll. B. K. Tikader.

General.—Cephalothorax and legs blackish, abdomen yellowish-white. Total length 20.00 mm. Carapace 9.00 mm. long, 7.00 mm. wide; abdomen 14.50 mm. long, 8.50 mm. wide.

Cephalothorax.—Longer than wide, clothed with grey pubescence, with prominent cephalic groove, cephalic region slightly high. Eyes of the posterior line nearly much longer than wide. Clypeus moderate. Sternum triangular, pointed behind, black with an incomplete median longitudinal white line. Legs long and strong, armed with slender spines, coxae yellowish.

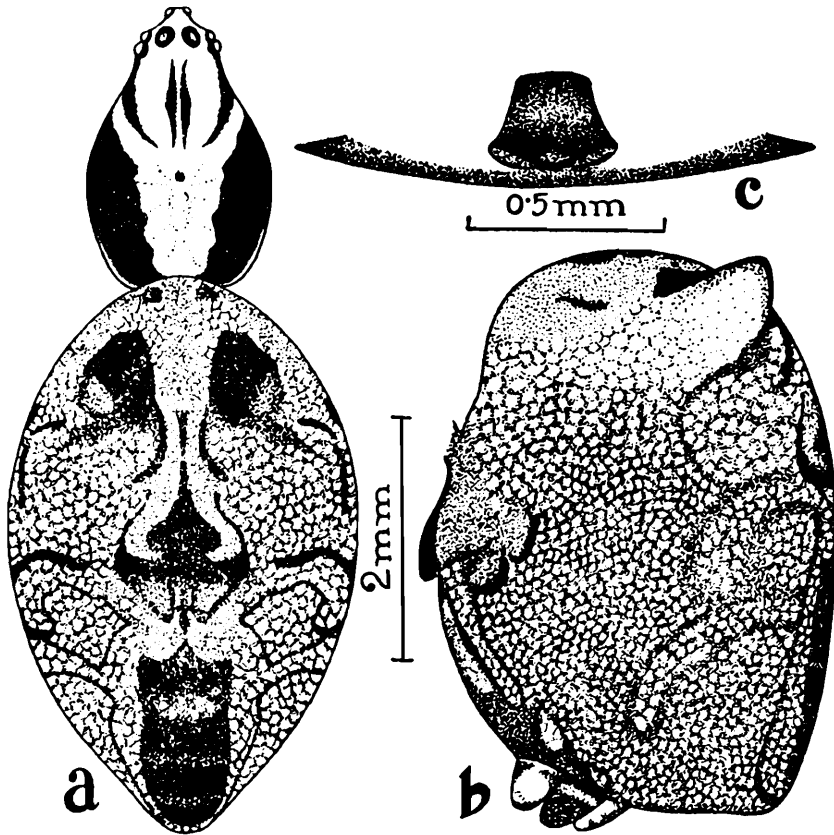
Abdomen.—Oval, clothed with whitish pubescence ; two distinct shoulder prominence on the dorsum, and three pairs of sigella behind the shoulder prominences.

Distribution.—India : Trivandrum, Nilgiri Hills, Madhya Pradesh, Kalimpong, Darjeeling ; Ceylon ; Sikkim ; Burma : Tharrawaddy, Rangoon, Moulmein ; Austro-Malaysia.

23. *Cyrtophora bidenta* sp. n.

General.—Cephalothorax and legs light green, abdomen yellowish-brown. Total length 6.60 mm. Carapace 2.20 mm. long, 1.40 mm. wide; abdomen 4.50 mm. long, 2.90 mm. wide.

Cephalothorax.—Longer than wide, clothed with fine grey pubescence; cephalic region high and narrowing in front, with two lateral longitudinal black broad bands extending from ocular area to base of thorax. Eyes pearly white, anterior row recurved and posterior row straight, lateral eyes contiguous, base of the posterior median eyes encircled by black patch. Clypeus narrow. Sternum heart-shaped, black, pointed behind. Legs long, clothed with hairs and spines with some brown spots.



TEXT-FIG. 20. *Cyrtophora bidenta* sp. n. (a) Dorsal view of female, legs omitted. (b) Lateral view of abdomen of female. (c) Epigyne.

Abdomen.—Oblong rounded at the base, clothed with fine grey pubescence, the anterior portion with one pair of pointed tubercles and inner side of these tubercles with black colour, mid-dorsally with a longitudinal discontinuous black patch extending from base of tubercles to end of abdomen as in text-fig. 20, a, b. Dorsal and lateral sides of abdomen ornamented by irregular white and brown pigments. Ventral side deep brown with a pair of longitudinal white dotted lines extending from epigastric fold to the base of spinners. Epigyne as in text-fig. 20, c.

Holotype one female. **Paratype**, one female in spirit.

Type-locality.—Bank of Great Rangit river, West Sikkim, 20.9.1959. Coll. B. K. Tikader.

This species resembles *Cyrtophora cicatrosa*, (Stoliczka) from India but it is separated as follows: (i) Anterior portion of abdomen provided with a pair of pointed tubercles but in *C. cicatrosa* anterior portion of abdomen provided with two pairs of pointed tubercles. (ii) Legs provided with some brown dots but in *C. cicatrosa* legs I and II with a pair of black longitudinal stripes on the dorsal side of femora. (iii) Epigyne also differs.

Genus 14. *Caerostris* Thorell1868. *Caerostris* Thorell, *K. Sy. Freg. Resa, etc. Zool.*, p. 3.1838. *Casteracantha* Koch, *Uebers Arach. Syst.*, p. 18.1892. *Caerostris* Simon, *Hist. Nat. Araign.*, 1, p. 831.

Characters.—Cephalothorax wide and narrowing in front and cephalic region high and projecting upward. Abdomen wide and upper side ornamented with conspicuous tubercles.

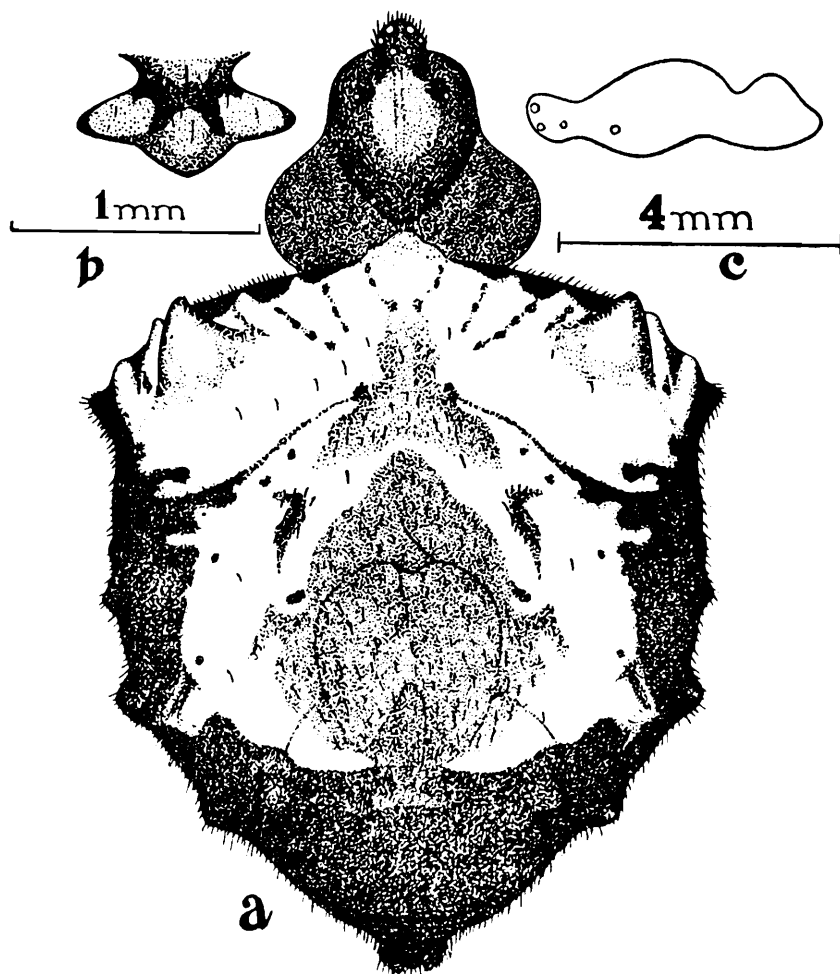
Type-species.—*Caerostris mitralis* Vinson.

Distribution.—Asia : India, Malaysia; Africa : Madagascar.

24. *Caerostris bhabanii* sp. n.

General.—Cephalothorax reddish-brown, legs and abdomen deep brown. Total length 14.00 mm. Carapace 3.80 mm. long, 3.50 mm. wide; abdomen 10.00 mm. long, 8.20 mm. wide.

Cephalothorax.—Slightly longer than wide, very much narrowing in front, clothed with fine hairs; cephalic region raised and pointed in front, and both the median eyes situated on the pointed head. Eyes small and pearly white, lateral eyes not contiguous and situated far away from each other; ocular quad longer than wide. Sternum heart-shaped pointed behind, clothed with hairs and spines also provided with transverse light bands.



TEXT-FIG. 21. *Caerostris bhabanii* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne. (c) Lateral view of cephalothorax of female.

Abdomen.—Longer than wide, clothed with small and fine hairs, mid-dorsally with a conspicuous large white patch and posterior portion of this patch again provided with a small reddish patch. Anterior lateral border raised in front into a pair of large pointed protuberances and lateral sides of abdomen provided with four pairs of small tubercles, arranged longitudinally. Ventral side deep to light brown in colour. Epigyne as in text-fig. 21, b.

Holotype one female in spirit.

Type-locality.—Nayabazar, West Sikkim, 17.10.1959. Coll. B. K. Tikader.

This species resembles *Caerostria sexcuspidata* Fabr. from Malaysia but it is separated as follows: (i) Anterior abdominal tubercle pointed and posteriorly followed by four pairs of small tubercles and mid-dorsally with a conspicuous white patch but in *C. sexcuspidata* anterior abdominal tubercle very long and blunt and no other tubercles or white patch. (ii) Ocular quad longer than wide but in *C. sexcuspidata* ocular quad wider than long. (iii) Epigyne also differs.

Genus 15. *Singa* Koch

1836. *Singa* Koch, *Ar.*, 3, p. 42.

1837. *Singa* : Koch, *Uebers. Arachn. Syst.*, p. 1.

1940. *Singa* : Comstock, *The Spider Book*, New York, p. 475.

Characters.—The spiders of this genus differ from those in the genus *Araneus*, Clerck in having a shiny surface, on the abdomen and clothed with few hairs, always oval in shape. Legs relatively short without ventral femoral spines, almost always present in *Araneus*, Clerck. The males have no protuberances on coxae I and II. The male palpal organs are all rather similar.

Type-species.—*Singa hamata* Koch.

Distribution.—Europe, Asia, and America.

25. *Singa chota* sp. n.

General.—Cephalothorax and legs light green, abdomen shiny-white. Total length 3.90 mm. Carapace 1.60 mm. long, 1.20 mm. wide; abdomen 2.40 mm. long, 1.50 mm. wide.

Cephalothorax.—Longer than wide, cephalic region slightly narrow and high, provided with conspicuous reddish brown colour. Eyes pearly white, posterior row straight, anterior row recurved, posterior median eyes close to each other than to the posterior lateral eyes, lateral eyes almost contiguous. Ocular quad longer than wide and narrowing behind. Sternum heart-shaped, pointed behind, deep brown colour. Legs long and strong, clothed with hairs and few spines.

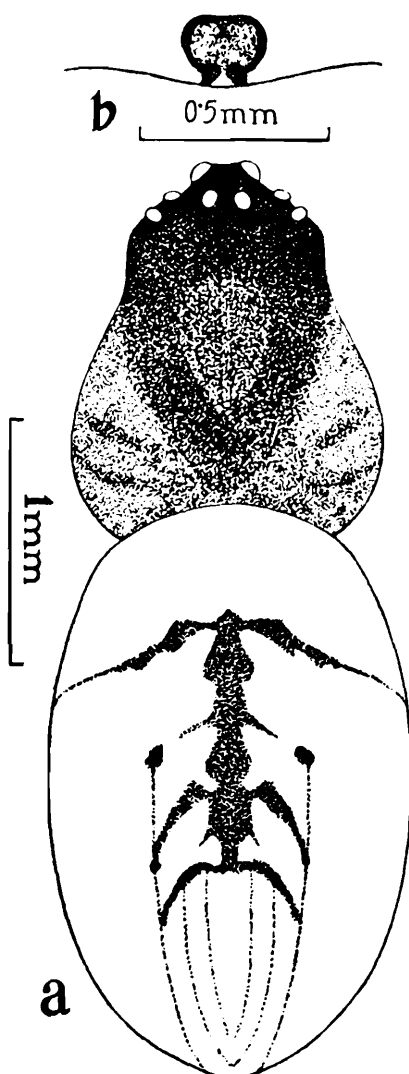
Abdomen.—Elliptical in outline. Dorsal side with shiny white, provided with a longitudinal brown cracked line or lines as in text-fig. 22, a. Ventral side brown. Epigyne as in text-fig. 22, b.

Holotype one female. *Paratypes*, nine females in spirit.

Type-locality.—Bank of Great Rangit river, West Sikkim, 20.9.1959. Coll. B. K. Tikader.

This species resembles *Singa albovittata* (Westring) from America but it is separated as follows: (i) Thoracic region light green and

cephalic region reddish-brown but in *S. albovittata* thoracic region dark-brown and cephalic region lighter. (ii) Abdomen shiny-white and



TEXT-FIG. 22. *Singa chota* sp. n. (a) Dorsal view of female, legs omitted.
(b) Epigyne.

mid-dorsally with a longitudinal brown cracked line but in *S. albovittata* abdomen light brown and margin banded with deep brown. (iii) Epigyne also different.

Genus 16. *Cyclosa* Menge

1866. *Cyclosa* Menge, *Preuss. Spinn.*, 1, p. 73.

1895. *Cyclosa* : Simon, *Hist. Nat. Araignees*, 1, p. 783.

Characters.—Eyes subequal, the posterior medians almost in contact; the median ocular area wider in front than behind; both rows of eyes recurved; the head and thorax separated by a deep cervical groove.

Type-species.—*Cyclosa conica* Pallas.

Distribution.—Europe, Africa, Asia, Australia and America.

26. *Cyclosa insulana* (Costa)1834. *Epeira insulana* Costa, *Cenni. Zool. etc.*, p. 65.1894. *Epeira insulana* Workman, *Malaysian Spiders*, Belfast, 36.1921. *Cyclosa insulana* Gravely, *Rec. Indian Mus.*, Calcutta, 22, p. 413.

Specimens examined.—10 ♀, Nayabazar, West Sikkim, 23.9.1959.
20 ♀, Legship, West Sikkim, 11.10.1959. Coll. B. K. Tikader.

General.—Cephalothorax and legs yellowish-green, dorsal surface of abdomen beautifully coloured with admixture of silvery-white, brown and yellow. Total length 7.00 mm. Carapace 2.00 mm. long, 1.50 mm. wide; abdomen 5.50 mm. long, 3.00 mm. wide.

Cephalothorax.—Longer than wide, depressed but cephalic region high, lateral sides provided with deep brown band. Eyes white, posterior medians and both lateral eyes contiguous. Legs banded with dark or deep brown transverse band. Sternum heart-shaped with light colour.

Abdomen.—Longer than wide, anterior end pointed with a short horn like projection, two pairs of lateral tubercles or projection on the posterior half of the abdomen and posterior end produced like a short tail and slightly bent downward. Ventral side with numerous deep brown spots.

Distribution.—India : Poona, West Bengal, Shillong. Nepal. Sikkim ; Ceylon and Burma.

Genus 17. *Eucta* Simon1881. *Eucta* Simon, *Ar. Fr.*, 5, p. 5.1895. *Eucta* : Thorell, *Spiders of Burma*, p. 146.1921. *Eucta* : Gravely, *Rec. Indian Mus.*, Calcutta, 22, p. 446.

Characters.—The genus *Eucta* abundant near water, differs from *Tetragnatha* Latreille in having the abdomen produced beyond the spinners into a pointed tail.

Type-species.—*Eucta gallica* Simon.

Distribution.—Europe; Africa; Asia: Japan, India, Malaysia, America.

27. *Eucta javana* Thorell1895. *Eucta javana* Thorell, *Spiders of Burma*, p. 146.1921. *Eucta javana* : Gravely, *Rec. Indian Mus.*, Calcutta, 22, p. 447.

Specimens examined.—5 ♀ Rothak near Nayabazar, West Sikkim, 8.10.1959. 10 ♀, Legship, West Sikkim, 11.10.1959. Coll. B. K. Tikader.

Cephalothorax.—Long and flat, cephalic region slightly high, with prominent cephalic groove. Anterior row of eyes straight, posterior row strongly recurved. Clypeus narrow. In female the first tooth on either side of the fang-groove situated at the base of the fang; in the ventral row second tooth situated far from the first tooth; second dorsal tooth opposite the third ventral, third opposite the fourth on ventral side and so on. Each row consists of about six to eight teeth, but usually one or two lesser in the dorsal row than ventral. In the well developed specimen in addition to these teeth a conical denticle also present at about the middle of the dorsal surface on the inner side. Legs long, slender, clothed with hairs and scanty spines, I pair of legs very long and stout.

Abdomen.—Very long, pointed behind, slightly overlapping the posterior region of cephalothorax in front, anterior extremity slightly depressed; abdomen produced beyond the spinners into a pointed tail.

Distribution.—India : Western Ghats, Travancore, Bangalore, Mysore, Ootacamund, Nilgiri Hills, Chilka Lake, Madras, Orissa, Bihar, Birbhum, Calcutta and Darjeeling, West Bengal, Shillong, Sikkim.

Genus 18. *Gasteracantha* Sundevall

1833. *Gasteracantha* Sundevall, *Consp. Arachn.*, p. 14.

1895. *Gasteracantha* : Simon, *Hist. Nat. Araign.*, 1, p. 845.

1900. *Gasteracantha* : Pocock, *Fauna Brit. India. Arach.*, p. 231.

Characters.—Carapace with thoracic portion low, cephalic portion elevated ; ocular quadrangle narrower in front. Abdomen large, subquadrate, transversely oblong, or narrowed laterally ; integument horny, impressed with large sigilla and armed on each side with an anterior, a median and a posterior spines ; spinners encircled by a horny ring.

Type-species.—*Gasteracantha cancriformis* Linnaeus.

Distribution.—All tropical countries of the world.

Key to Indian species of *Gasteracantha* Sundevall

- | | | |
|---|-----|--------------------------------|
| 1. Ventral tubercle present in front of spinners | ... | 2 |
| Ventral tubercle absent in front of spinners | ... | <i>G. hasseltii</i> Koch |
| 2. Anterior and median spines widely separated | ... | 3 |
| Anterior and median spines not widely separated | ... | <i>G. diadestia</i> Thorell |
| 3. Posterior spines abruptly narrowed at apex | ... | 4 |
| Posterior spines not abruptly narrowed at the apex | ... | <i>G. leucomelaena</i> (Dole.) |
| 4. Median spines prominent and narrowed at the apex | ... | <i>G. unguifera</i> Simon |
| Median spines minute and simple | ... | <i>G. brevispina</i> (Dole.) |

28. *Gasteracantha unguifera* Simon

1889. *Gasteracantha unguifera* Simon, *J. Asiat. Soc. Bengal*, 58, p. 336.

1900. *Gasteracantha unguifera* : Pocock, *Fauna Brit. India, Arach.*, p. 234.

Specimens examined.—20 ♀, Legship, West Sikkim, 16.9.1959. 30 ♀, Gazing, West Sikkim, 20.9.1959. 10 ♀, Nayabazar, West Sikkim, 23.9.1959. Coll. B. K. Tikader.

General.—Cephalothorax and legs reddish-brown, abdomen light to dark and variable in colour. Total length 6.00 mm. Carapace 2.00 mm. long, 1.50 mm. wide ; abdomen 5.00 mm. long, 9.00 mm. wide.

Cephalothorax.—Slightly longer than wide, broad in front, clothed with grey hairs. Cephalic region flat but thoracic region abruptly down behind. Sternum heart-shaped, brown with yellow patch. Legs clothed with grey hairs.

Abdomen.—Nearly twice as long as wide, strongly concave dorsally, anterior border rather strongly convex, anterior spines small acuminate ; median spines much large with the basal portion exceedingly stout and distally expanded, then abruptly narrowed, the terminal portion normally slender and rising from the middle of the expanded end of the basal portion ; posterior spines also with basal portion stout, but not so abruptly narrowed as in the case of the median spines.

Distribution.—India : Himalayas, Jaunsar, Thadyar, Sikkim.

29. *Gasteracantha brevispina* (Doleschall)

1857. *Plectana brevispina* Doleschall, *Nat. Tij. Nederland Indie*, 13, p. 423.

1900. *Gasteracantha brevispina* Pocock, *Fauna Brit. India, Arach.*, p. 235.

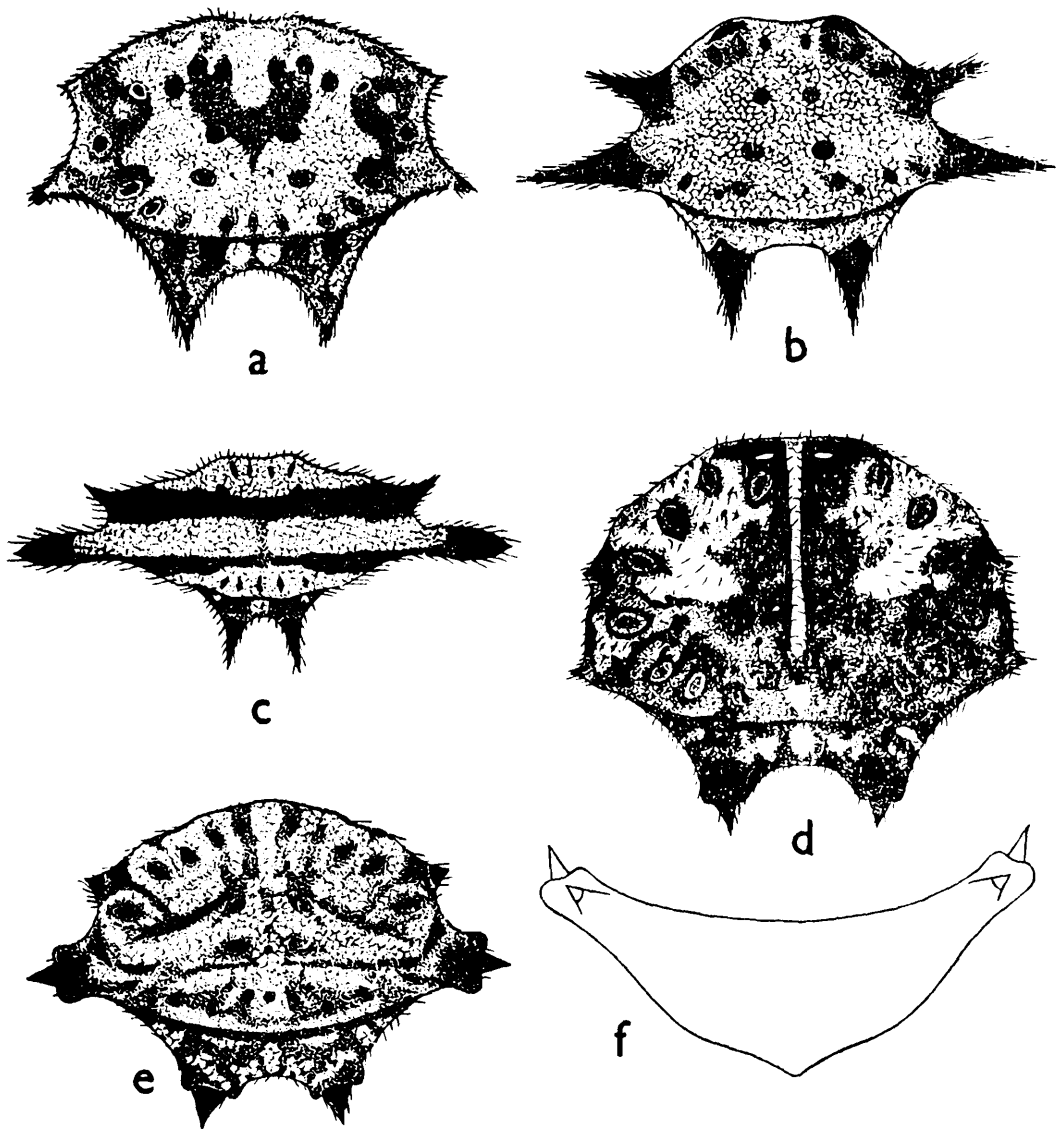
1921. *Gasteracantha brevispina* : Gravely, *Rec. Indian Mus.*, Calcutta, 22, p. 416.

1951. *Gasteracantha brevispina* : Sinha, *Rec. Indian Mus.*, Calcutta, 49, p. 83.

Specimens examined.—2 ♀ .Kalimpong, West Bengal, 17.9.1959. 10 ♀ Darjeeling, West Bengal, India, 20.9.1959. Coll. B. K. Tikader.

General.—Cephalothorax, legs and abdomen reddish-brown. Total length 9.00 mm. Carapace 2.00 mm. long, 1.50 mm. wide ; abdomen 8.00 mm. long, 10.00 mm. wide.

Cephalothorax.—Slightly longer than wide, broad in front, clothed with grey hairs. Cephalic region flat but thoracic region abruptly down behind. Sternum heart-shaped, deep brown but middle with a reddish patch. Legs clothed with grey hairs.



TEXT-FIG. 23. *Gasteracantha leucomelaena* (Dol.) (a) Dorsal view of abdomen. *Gasteracantha hasseltii* Koch (b) Dorsal view of abdomen. *Gasteracantha diadestia* Thorell (c) Dorsal view of abdomen. *Gasteracantha brevispina* (Dol.) (d) Dorsal view of abdomen. *Gasteracantha unguifera* Simon (e) Dorsal view of abdomen. (f) Profile view of abdomen.

Abdomen.—A little wider than long, very variable in colour sometimes black, sometimes yellow predominating ; usually with a large triangular black patch on each side and a pair of large yellow ocelliform

spots near the middle ; anterior and lateral spines very short but posterior spines very stout at the base and abruptly narrowed at the apex. Ventral side light to deep brown.

Distribution.—India : Madras, Dehra Dun, Poona, Bombay, Andaman and Nicobar Islands, Darjeeling. Calcutta, Bihar, Shillong, Orissa ; East Pakistan ; Burma ; Sikkim ; Ceylon ; Austro-Malaysia ; Japan.

30. *Gasteracantha leucomelaena* (Doleschall)

1859. *Plectana leucomelaena* Doleschall, *Verh. Nat. Vereen. Nederland Indie* 5(5), p. 42.

1887. *Gasteracantha leucomelaena* Thorell, *Ann. Mus. Genova*, 25, p. 232.

1900. *Gasteracantha leucomelaena* : Pocock, *Fauna Brit. India, Arach.*, p. 235.

Specimens examined.—1 ♀, Nayabazar, West Sikkim, 17.10.1959. 5 ♀, Gazing, West Sikkim, India, 12.10.1959. Coll. B. K. Tikader.

General.—Cephalothorax and legs yellowish-brown, abdomen whitish or yellow. Total length 7.00 mm. Carapace 2.00 mm. long, 1.50 mm. wide ; abdomen 6.00 mm. long, 8.00 mm. wide.

Cephalothorax.—Slightly longer than wide, broad in front, clothed with grey hairs. Cephalic region flat but thoracic region abruptly down behind. Sternum heart-shaped, yellow, with posterior end black or deep brown spot. Legs clothed with brown hairs and with black or deep brown bands.

Abdomen.—Nearly one third wider than long ; upper side of abdomen with median black V-shaped mark and a large black patch at base of spines, the patches sometimes uniting with the ends of the arms and with the stem of the V to form transverse bars of black. The spines small, acuminate, the median and posterior spines subequal and much larger than the anterior spines. Ventral side deep brown with yellow spots.

Distribution.—India : Calcutta, Darjeeling, Kalimpong, Bihar, Assam, Andaman and Nicobar Islands. Bhutan, Sikkim, Burma, Malaysia and Japan.

31. *Gasteracantha diadestia* Thorell

1887. *Gasteracantha diadestia* Thorell, *Ann. Mus. Genova*, 25, p. 225.

1900. *Gasteracantha diadestia* ; Pocock, *Fauna Brit. India, Arach.*, p. 234.

Specimens examined.—2 ♀, Legship, West Sikkim, 13.9.1959. 5 ♀, Rishi, West Sikkim, 29.9.1959. 8 ♀, Kalimpong, West Bengal, 17.9.1959. 5 ♀, Nayabazar, West Sikkim, 17.10.1959. Coll. B. K. Tikader.

General.—Cephalothorax and legs black, abdomen yellow. Total length 9.00 mm. Carapace 4.00 mm. long, 3.00 mm. wide ; abdomen 9.00 mm. long, 19 mm. wide.

Cephalothorax.—Slightly longer than wide, broad in front, clothed with grey hairs. Cephalic region flat but thoracic region abruptly down behind. Sternum heart-shaped, black with yellow spots. Legs clothed with grey hairs.

Abdomen.—Nearly twice as wide as long, concave, three conspicuous transverse black bands on the dorsum, first band situated near the anterior spines, second band in between median and posterior spines and third band near the posterior spines. Anterior and posterior spines with pointed end but median spines not thin and evenly attenuate, but

thicker and with its anterior border distinctly swollen. Ventral side black with yellow spots.

Distribution.—India : Kalimpong, West Bengal. Sikkim ; Burma : Tharrawaddy, Tounghoo, Rangoon. Thailand.

32. *Gasteracantha hasseltii* Koch

1838. *Gasteracantha hasseltii* Koch *Arachnida*, 4, p. 29.

1900. *Gasteracantha hasseltii* Pocock, *Fauna Brit. India*, Arach., p. 233.

1921. *Gasteracantha hasseltii* Gravely, *Rec. Indian Mus.*, Calcutta, 22, p. 416.

1951. *Gasteracantha hasseltii* Sinha, *Rec. Indian Mus.*, Calcutta, 49(1), p. 82.

Specimens examined.—10 ♀, Bank of Great Rangit river, West Sikkim, 20.9.1959. 2 ♀, Nayabazar, West Sikkim, 17.10.1959. Coll. B. K. Tikader.

General.—Cephalothorax black, legs yellowish-green, abdomen whitish-yellow. Total length 6.00 mm. Carapace 2.00 mm. long, 1.50 mm. wide ; abdomen 5.00 mm. long, 10.00 mm. wide.

Cephalothorax.—Slightly longer than wide, broad in front, clothed with black hairs. Cephalic region flat but thoracic region abruptly down behind. Sternum heart-shaped, yellow. Legs clothed with brown hairs and provided with brown spots.

Abdomen.—Nearly twice as long as wide (including spines). All spines black and pointed ; median spines typically attenuate, not very long, their length hardly exceeding half the width of the abdomen, as in text-fig. 23, f.

Distribution.—India : Assam, Kalimpong and Darjeeling. Burma : Tharrawaddy, Rangoon. Sikkim.

Genus 19. *Leucauge* White

1841. *Leucauge* White, *Ann. Mag. Nat. Hist.*, 7, p. 473.

1884. *Argyropeira* Emerton, *Trans. Conn. Acad. Art., Sci.*, 6, p. 331.

1900. *Argyropeira* : Pocock, *Fauna Brit. India*, Arach., p. 215.

1921. *Leucauge* : Gravely, *Rec. Indian Mus.*, Calcutta, 22, p. 450.

1935. *Leucauge* : Dayal, *Bull. Zool. Punjab Univ.*, 1, p. 157.

Characters.—Cephalothorax truncate in front, legs long and slender, especially the first two pairs ; the posterior femora with fringe of long hairs. Abdomen twice as long as wide, blunt at both ends and ornamented with bands or spots of silvery pigment.

Type-species.—*Leucauge hortorum* (Hentz).

Distribution.—Europe, Africa, Asia and America.

Key to Indian species of *Leucauge* White

- | | | |
|---|-----|---------------------------------|
| 1. Anterior end of abdomen conically elevated | ... | 2 |
| Anterior end of abdomen not conically elevated | ... | 3 |
| 2. Posterior end of abdomen strongly conically produced | ... | <i>L. decorata</i> (Blackwall) |
| Posterior end of abdomen moderately conically produced | ... | <i>L. celebesiana</i> (Walcke.) |
| 3. Tibia of IV legs plumose | ... | <i>L. tessellata</i> (Thorell) |
| Tibia of IV legs not plumose | ... | <i>L. pondae</i> sp. n. |

33. *Leucauge decorata* (Blackwall)

1864. *Tetragnatha decorata* Blackwall, *Ann. Mag. Nat. Hist.*, 14, p. 36.

1869. *Nephila angustata* Stoliczka, *J. Asia. Soc. Bengal*, 38, p. 241.

1900. *Argyropeira celebesiana* Pocock, *Fauna Brit. India*, Arach., p. 216.

1921. *Leucauge decorata* : Gravely, *Rec. Indian Mus.*, Calcutta, 22, p. 454.

1962. *Leucauge decorata* : Tikader, *J. Linn. Soc. London*, 44(300), p. 564.

Specimens examined.—5 ♀, Rhenock, East Sikkim, 7.9.1959. 10 ♀, Chongton, Dist. Darjeeling, West Bengal, 16.4.1957. Coll. B. K. Tikader.

General.—Cephalothorax brown, legs brownish-green, abdomen silvery-white. Total length 8.30 mm. Carapace 2.20 mm. long, 1.80 mm. wide; abdomen 6.10 mm. long, 2.80 mm. wide.

Cephalothorax.—Longer than wide, flat, a deep groove in the middle; ocular quad longer than wide, lateral eyes contiguous. Clypeus narrow. Sternum deep brown, triangular, pointed behind. Legs clothed with long hairs and scanty spines; anterior half of tibiae-deep brown.

Abdomen.—Nearly oval in shape, but narrowing behind, strongly overlapping the posterior region of cephalothorax in front. Anterior extremity of abdomen low but furnished with two shoulder prominences, posterior end of abdomen produced into a conical caudal process; dorsal surface decorated like *L. celebesiana* (Walck.) but has some yellow tint on the silvery colour.

Distribution.—India: Bangalore, Mysore, Coonoor, Nilgiri Hills, Madras, Barkul, Dehra Dun, Katihar, Sirpur, Darjeeling, Calcutta. Sikkim; Ceylon.

34. *Leucauge celebesiana* (Walckenaer)

1837. *Tetragnatha celebesiana* Walckenaer, *Ins. Apt.*, 2, p. 222.

1921. *Leucauge celebesiana*: Gravely, *Rec. Indian Mus.*, Calcutta, 22, p. 450.

1962. *Leucauge celebesiana*: Tikader, *J. Linn. Soc. London*, 44(300), p. 564.

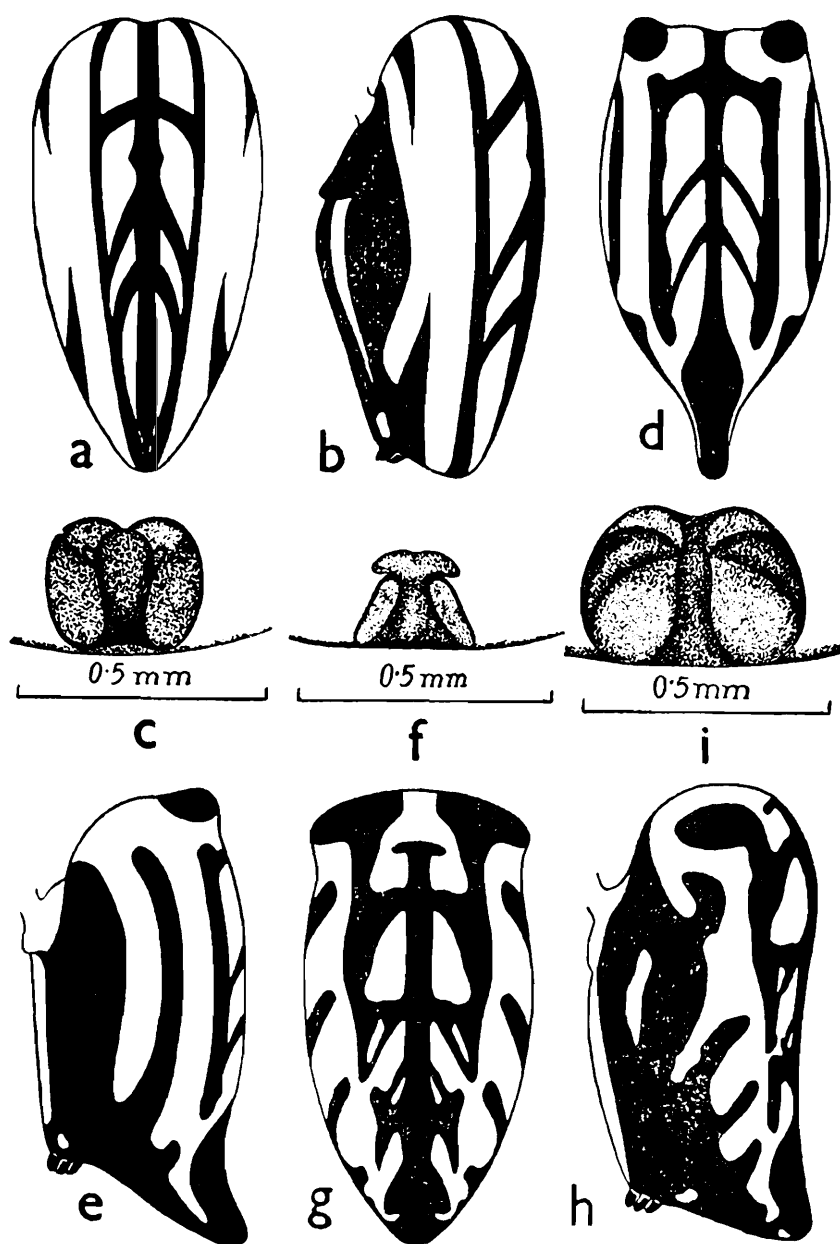
Specimens examined.—50 ♀, and 10 ♂, Chongtong, Dist. Darjeeling, West Bengal, 16.4.1957. 2 ♀, and 1 ♂, Ramtang, Sikkim, 14.10.1959. 4 ♀ and 1 ♂, Tingling, Sikkim, 28.9.1959. 5 ♀, and 1 ♂, Samabiyong, Sikkim, 14.9.1959. 2 ♀, Gangtok, Sikkim, 19.8.1959. 7 ♀, and 1 ♂, Bhudbari, Sikkim, 15.9.1959. 3 ♀, Rongli, Sikkim, 31.8.1959. Coll. B. K. Tikader.

General.—Cephalothorax brownish, legs brownish-green, abdomen silvery-white. Total length 9.40 mm. Carapace 2.10 mm. long, 1.70 mm. wide; abdomen 6.40 mm. long, 3.00 mm. wide.

Cephalothorax.—Longer than wide, flat, relatively broader in front, with a deep groove on the middle. Lateral eyes contiguous and nearer to the medians than in *L. bengalensis* Gravely ocular quad longer than wide, anterior medians slightly smaller than posterior medians. Clypeus narrow. Sternum deep brown, pointed behind. Legs clothed with long hairs and scanty spines.

Abdomen.—Nearly oval in shape, slightly overlapping the posterior region of cephalothorax in front; anterior extremity slightly low, on the dorsum three longitudinal black lines from base to tip of abdomen and another three pairs of black transverse line from the longitudinal middle line to lateral sides. Ventral surface deep brown with two longitudinal silvery-white lines from epigynal fold to base of spinners.

Distribution.—India: Ootacamund, Poona, Calcutta, Darjeeling, Kalimpong, Gapaldhara, Ghaumti, Kurseong, Shillong, Cherrapunji, Khasi Hills, Assam. Sikkim; Ceylon; Burma: Tharrawaddy, Rangoon, Celebes.



TEXT-FIG. 24. *Leucauge celebesiana* (Walck.) (a) Dorsal view of abdomen. (b) Lateral view of abdomen. (c) Epigyne. *Leucauge decoraia* (Blackwall) (d) Dorsal view of abdomen. (e) Lateral view of abdomen. (f) Epigyne. *Leucauge tessellata* (Thorell) (g) Dorsal view of abdomen. (h) Lateral view of abdomen. (i) Epigyne.

35. *Leucauge tessellata* (Thorell)

1887. *Argyropeira tessellata* Thorell, *Ann. Mus. Civ. Genova*, **25**, p. 135.
 1900. *Argyropeira tessellata* : Pocock, *Fauna Brit. India*, Arach., p. 216.
 1921. *Leucauge tessellata* : Gravely, *Rec. Indian Mus.*, Calcutta, **22**, p. 455.
 1962. *Leucauge tessellata* : Tikader, *J. Linn. Soc. London*, **44**(300), p. 566.

Specimens examined.—25 ♀, Kalimpong, Dist. Darjeeling, 17.9.1959. 1 ♀, Samabiyong, Sikkim, 14.9.1959. 1 ♀, Rongli, East Sikkim, 5.9.1959. Coll. B. K. Tikader.

General.—Cephalothorax and legs light brown, abdomen silvery-white, with blackish tint. Total length 8.30 mm. Carapace 3.70 mm. long, 2.70 mm. wide; abdomen 5.00 mm. long, 3.00 mm. wide.

Cephalothorax.—Longer than wide, clothed with hairs, lateral eyes contiguous, ocular quad longer than wide, anterior median eyes slightly smaller than the posterior medians. Clypeus narrow. Sternum

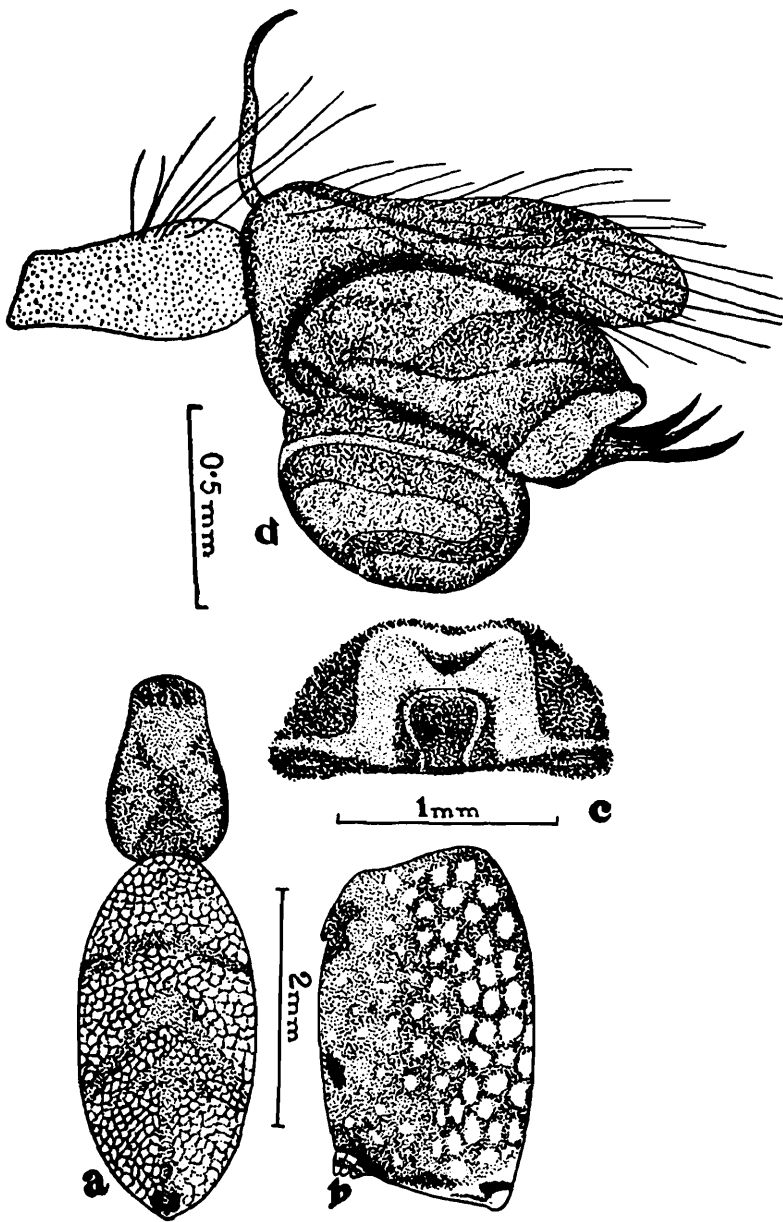
triangular, pale brown, clothed with hairs. Legs long, stout, clothed with hairs, distal two third of the tibiae of the IV legs deep brown and this portion provided with scopulae.

Abdomen.—Oval, the anterior extremity of abdomen rounded, not elevated, and antero-laterally with deep brown patches; on the mid-dorsal three longitudinal deep brown lines and these three lines transversely cut by four lines. Ventral surface dark, with a pair of clearly defined longitudinal silvery bands.

Distribution.—India: Cochin, Gopaladhara, Kalimpong, Sonarpur, Assam. Sikkim; Bhutan; Burma.

36. *Leucauge pondae* sp. n.

General.—Cephalothorax light brown, legs green, abdomen silvery-white. Total length 4.60 mm. Carapace 1.60 mm. long, 1.00 mm. wide; abdomen 3.00 mm. long, 1.50 mm. wide.



TEXT-FIG. 25. *Leucauge pondae* sp. n. (a) Dorsal view of female, legs omitted. (b) Lateral view of abdomen. (c) Epigyne. (d) Male palp.

Cephalothorax.—Longer than wide, flat, finely pubescent. Eyes pearly white, bases surrounded by black patches. Lateral eyes contiguous, median eyes close, anterior median eyes slightly smaller than the posterior. Ocular quad longer than wide and narrowing in front. Clypeus narrow. Sternum triangular, pointed behind. Legs slender, clothed with fine long hairs. Base of femora of IV legs provided with fringes of hairs posteriorly.

Abdomen.—Nearly oval, extreme posterior end with a pair of transverse black spots. Ventral side uniformly light brown with two black spots in front of spinners. Epigyne as in text-fig. 25, c. Male palp as in text-fig. 25, d. Male long, legs slender and abdomen less silvery than the female.

Holotype one female. *Paratypes*, three females and *Allotype*, one male in spirit.

Type-locality.—Bank of Great Rangit river, West Sikkim, 20.9.1959. Coll. B. K. Tikader.

This species resembles *Leucauge culta* (Cambridge) from India but it is separated as follows : (i) Posterior extremity of abdomen with a pair of black transversely arranged spots but in *L. culta* posterior extremity of abdomen with a black spot and additionally three pairs of black spots in front of it and anterior most pair smaller than the rest. (ii) Epigyne and male palp also structurally different.

Genus 20. *Nephila* Leach

1815. *Nephila* Leach, *Zool. Misc.*, 2, p. 133.

1900. *Nephila* Pocock : *Fauna Brit. India*, Arach., p. 217.

1951. *Nephila* : Sinha : *Rec. Indian Mus.*, Calcutta, 40, p. 68.

Characters.—Cephalic region convex and moderately high, generally armed posteriorly with two tubercles; ocular quad nearly square. Legs very long, clothed with spines, metatarsi longer than tibiae and patella. Vulva not well developed. Male very small, with simple palp.

Type-species.—*Nephila maculata* (Fabr).

Distribution.—All tropical countries of the world.

37. *Nephila maculata* (Fabricius)

1793. *Aranea maculata* Fabricius, *Ent. Syst.*, 2, p. 425.

1900. *Nephila maculata* : Pocock, *Fauna Brit. India*, Arach., p. 217.

1923. *Nephila maculata* : Gravely, *J. Bombay nat. Hist. Soc.*, 28, p. 1046.

1962. *Nephila maculata* : Tikader, *J. Linn. Soc. London*, 44(300), p. 567.

Specimens examined.—5 ♀, Kalimpong, 17.9.1959. 10 ♀, Gazing West Sikkim, 11.10.1959. 5 ♀, Rongli, East Sikkim, 5.9.1959. Coll. B. K. Tikader.

General.—Cephalothorax and legs black, abdomen olive-brown. Total length 30.00 mm. Carapace 10.50 mm. long, 8.00 mm. wide; abdomen 22.00 mm. long, 6.50 mm. wide.

Cephalothorax.—Longer than wide, clothed with silky-greyish-yellow pubescence, relatively broad in front; a deep groove in the middle and with a pair of sharp tubercles in front. Ocular quad square and slightly high. Clypeus narrow. Sternum dark, triangular, pointed behind. Legs very long, clothed with hairs and spines; coxae of legs and first half of palp yellow.

Distribution.—India: Tinevelly, Trivandrum, Ootacamand, Mysore, Kanara, Poona, Dehra Dun, Madhya Pradesh, Darjeeling, Assam, Nicobar Island. Sikkim. Ceylon; Burma; China and Australia.

38. *Nephila clavata* Koch

1877. *Nephila clavata* Koch, *Verh. Z.b. Ges. Wien.*, 27, p. 741.

1900. *Nephila clavata*: Pocock, *Fauna Brit. India*, Arach., p. 218.

1951. *Nephila clavata*: Sinha, *Rec. Indian Mus.*, Calcutta, 40, p. 69.

Specimens examined.—20 ♀, Gazing, West Sikkim, 11.10.1959. Coll. B. K. Tikader.

General.—Cephalothorax and legs deep brown, abdomen yellow. Total length 23.00 mm. Carapace 8.00 mm. long, 5.00 mm. wide; abdomen 16.00 mm. long, 9.00 mm. wide.

Cephalothorax.—Longer than wide, clothed with grey pubescence, carapace with yellow patch behind the cephalic region and yellow border and carapace without tubercles. Sternum dark, triangular, pointed behind with a conspicuous median yellow band. Legs long, clothed with hairs and yellow bands.

Abdomen.—Very long, slightly overlapping the posterior region of cephalothorax in front. Dorsally with transverse indistinct fuscous stripes. Ventral side black, varied with yellow lines and spots, with a pink band behind which laterally spreads on to the sides of the abdomen.

Distribution.—India: Darjeeling, Shillong. Bhutan; Sikkim; Burma, Japan, China and Formosa.

Family VI. THOMISIDAE

Characters.—The typical members of this family have a peculiarly crab-like appearance. Carapace and abdomen usually short and broad; but somewhat elongate in *Tibellus* Simon and *Thanatus* Koch. Eyes small, particularly the posterior usually circled with black, both rows being recurved. First two pairs of legs long and stout and frequently move sideways as done by a crab; the legs less obviously laterigrade in the genera *Philodromus* Walck. and *Thanatus* Koch and not at all in *Tibellus* Simon. The members of the genus *Oxyptila* Simon the integument furnished with some characteristic clavate setae, but in the other genera the hairs are normal.

Key to Indian genera of *Thomisidae*

- | | | | |
|---|-----|-----|---------------------------|
| 1. Lateral eyes on strong conical tubercle | ... | ... | <i>Thomisus</i> Walck. |
| Lateral eyes on shallow tubercles | ... | ... | 2 |
| 2. Abdomen truncated behind | ... | ... | <i>Pistius</i> Simon |
| Abdomen not truncated behind | ... | ... | 3 |
| 3. Median ocular trapezium longer than broad | ... | ... | <i>Platythomisus</i> Dol. |
| Median ocular trapezium square or broader than long | ... | ... | <i>Xysticus</i> Koch |

Genus 21. *Thomisus* Walckenaer

1805. *Thomisus* Walckenaer, *Tabl. Aran.*, p. 28.

1870. *Thomisus*: Thorell, *On European Spiders*, p. 170.

1895. *Thomisus*: Simon, *Hist. Nat. Araignees*, 1, p. 1023.

1935. *Thomisus*: Dyal, *Bull. Zool. Punjab Univ.*, 1, p. 200.

Characters.—Cephalothorax truncated in front, with the upper fore-corners strongly and conically protuberant and divergent, bearing

the lateral eyes. Eyes very small. Abdomen narrow and truncated in front, enlarging to a considerable width behind, where at either corner of the dorsal side a short blunt conical protuberance. Legs long, I and II much longer than III and IV

Type-species.—*Thomisus albus* Gmelin.

Distribution.—Europe, Africa, Asia, Australia and America.

39. *Thomisus sikkimensis* Tikader

1962. *Thomisus sikkimensis* Tikader, *J. Linn. Soc. London*, 44(300), p. 569.

Specimen examined.—1 ♀, Rishi, West Sikkim. 24.9.1959. Coll. B. K. Tikader.

General.—Cephalothorax and legs brownish-green; ocular area yellowish-brown, with small chalk-white patches. Abdomen chalk-white. Total length 9.20 mm. Carapace 4.60 mm. long, 4.60 mm. wide; abdomen 5.00 mm. long, 6.20 mm. wide.

Cephalothorax.—Broadest posteriorly, slightly narrowing in front, as long as wide. Antero-lateral sides with conspicuous longitudinal black bars. Ocular area encircled by a yellowish-brown triangle. Eyes black, posterior median eyes somewhat smaller than anterior medians. Clypeus long, subrectangular. Legs long and stout, I and II legs longer than III and IV legs. I and II legs with conspicuous black spots on trochanter, basally and apically below on femur, a black transverse band apically on patella and tibia. Tibia of I apically with two pairs of ventral spines and metatarsi with five pairs of stout ventral spines; III and IV pairs of legs unspotted and without spines.

Abdomen.—Pentagonal, slightly overlapping the posterior region of cephalothorax in front, broadest just behind the middle; a black transverse incomplete line on the broadest region and two black spots just in front of the transverse line sublaterally with broad black patch; posterior end with conspicuous transverse muscular corrugation.

Distribution.—Rishi, West Sikkim.

40. *Thomisus rishus* sp. n.

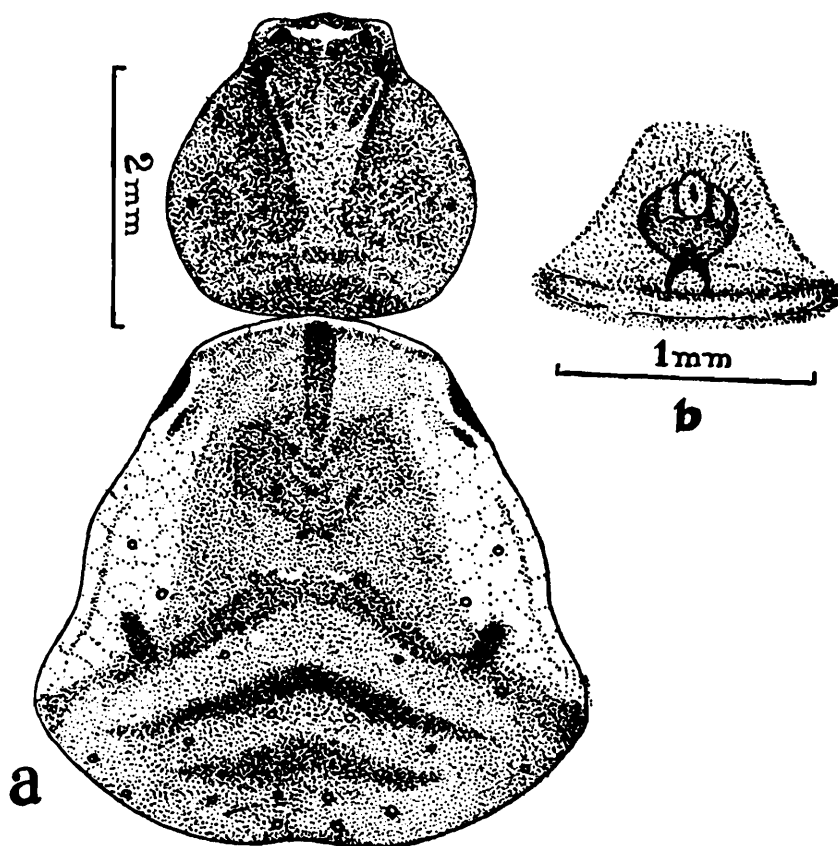
General.—Cephalothorax and legs deep-brown, abdomen dirty chalk-white. Total length 6.50 mm. Carapace 2.30 mm. long, 2.20 mm. wide; abdomen 4.00 mm. long, 4.20 mm. wide.

Cephalothorax.—Nearly as long as wide, convex, narrowing in front. Eyes black and tuberculate, both rows recurved but posterior row more recurved than the anterior row. Lateral eyes larger than others. Ocular quad nearly as long as wide, a transverse muscular elevated ridge passing through the middle of ocular area. Clypeus long, subrectangular. Legs long and stout, I and II longer than III and IV. Tibiae and metatarsi of I and II provided with five and seven pairs of ventral spines respectively, III and IV legs without spine.

Abdomen.—Nearly pentagonal, broadest behind the middle; minute brownish dots scattered irregularly all over the dorsum; posterior end with inconspicuous transverse muscular corrugation. Epigyne as in text-fig. 26, b.

Holotype one female in spirit.

Type-locality.—Rishi, West Sikkim, 25.9.1959. Coll. B. K. Tikader.



TEXT-FIG. 26. *Thomisus rishus* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne.

This species resembles *Thomisus onustus* Walckenaer from Europe but it is separated as follows: (i) Carapace centrally light brown or deep brown but in *T. onustus* carapace centrally whitish-yellow. (ii) Cephalothorax almost uniformly deep brown but in *T. onustus* lateral sides of cephalothorax provided with deep brown longitudinal patches. (iii) Epigyne also structurally different.

Genus 22. *Platythomisus* Dolesch.

1859. *Platythomisus* Dolesch., *Tweede Bijdr., etc.*, p. 50.

1845. *Thomisus* Koch, *Ar.*, 12, p. 18.

1895. *Platythomisus* : Simon, *Hist. Nat. Araignees*, 1, p. 1017.

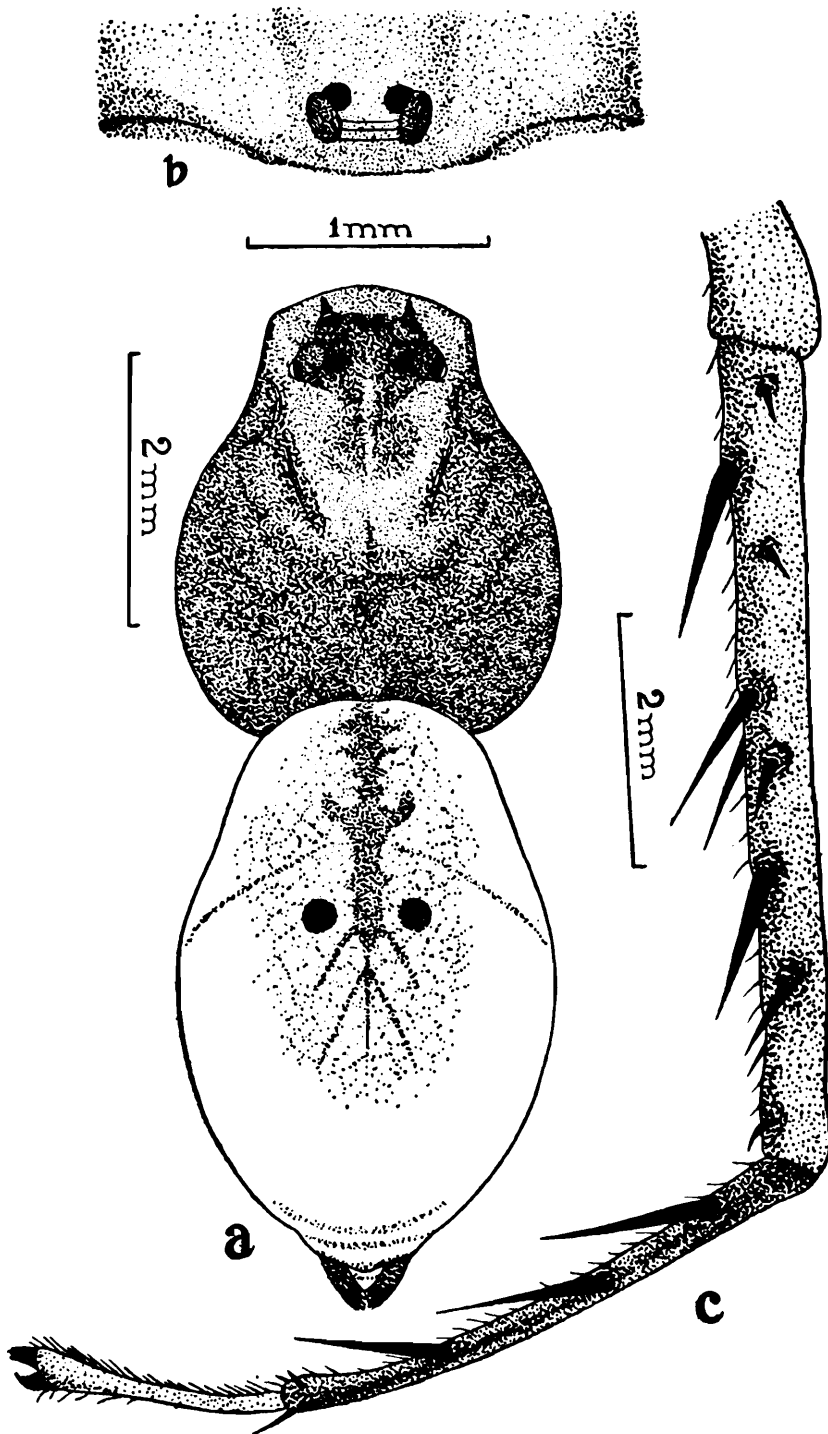
Characters.—Cephalothorax longer than wide, convex, cephalic region slightly high. Eyes black and tuberculated; both rows of eyes nearly straight. Ocular quad longer than wide and narrowing in front. Legs long and stout, I and II longer than III and IV; all legs provided with hairs and spines. Tibiae and metatarsi of I and II provided with conspicuous ventral spines.

Type-species.—*Platythomisus octomaculatus* (Koch).

Distribution.—Africa and Asia. This genus is being recorded here for the first time from Sikkim.

41. *Platythomisus bazarus* sp. n.

General.—Cephalothorax and legs light brownish-green, abdomen dirty chalk-white. Total length 7.10 mm. Carapace 3.20 mm. long, 2.80 mm. wide; abdomen 4.00 mm. long, 2.80 mm. wide.



TEXT-FIG. 27. *Platythomisus bazarus* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne. (c) Distal end of I leg.

Cephalothorax.—Longer than wide, cephalic region high. Eyes black with prominent tubercles, both rows straight but posterior row longer, lateral eyes larger; tubercles of two laterals and posterior median eyes contiguous. Ocular quad longer than wide and narrowing in front. Sternum heart-shaped. Legs long and stout, I and II longer than III and IV; all legs provided with hairs and conspicuous spines. Tibiae and metatarsi of I and II provided with five and three pairs of ventral robust spines respectively. Tarsal scopulae weakly developed and claw tufts prominent.

Abdomen.—Longer than wide, posterior half wide and end tapering, irregular chalk-white small patches all over the dorsum. Mid-dorsally a longitudinal deep brown bar extending from base to behind the

middle and two conspicuous reddish-brown dot-like depression near the middle, as in text-fig. 27, a. Epigyne as in text-fig. 27, b.

Holotype one female in spirit.

Type-locality.—Nayabazar, West Sikkim, 23.9.1959. Coll. B. K. Tikader.

This species resembles *Platythomisus octomaculatus* (Koch) from Africa but it is separated as follows : (i) Abdomen dorsally provided with two conspicuous reddish-brown dot-like depressions near the middle but in *P. octomaculatus* abdomen dorsally provided with seven conspicuous black spots. (ii) Cephalothorax light brownish-green but in *P. octomaculatus* cephalothorax brown with two conspicuous black spots on the thorax. (iii) Epigyne also structurally different.

Genus 23. *Xysticus* Koch

1835. *Xysticus* Koch, *H. Schaeff. Deutschl. Ins.*, p. 35.

1892. *Xysticus* : Simon, *Hist. Nat. Araignees*, 1, p. 1035.

1940. *Xysticus* : Comstock, *The Spider Book*, New York, p. 545.

1951. *Xysticus* : Locket and Millidge, *British Spiders*, Ray Soc., London, 1, pp. 172.

Characters.—Cephalothorax rather square-fronted, clothed with simple, isolated hairs and spines, rarely blunt, but never clavate. Posterior eyes nearly equidistant, medians smaller than laterals ; the anterior medians usually a little further from each other than from the anterior laterals. The lateral eyes situated in low subconfluent tubercles. The tibiae and metatarsi of the anterior legs usually furnished with more than three pairs of inferior spines. Tarsal claws furnished with five or six isolated teeth. Abdomen much wider behind than in front, usually bearing a dentated band on its dorsal surface. These spiders live under stone and leaves or under loose bark ; a few live on low plants and bushes.

Type-species.—*Xysticus brevipes* Hahn.

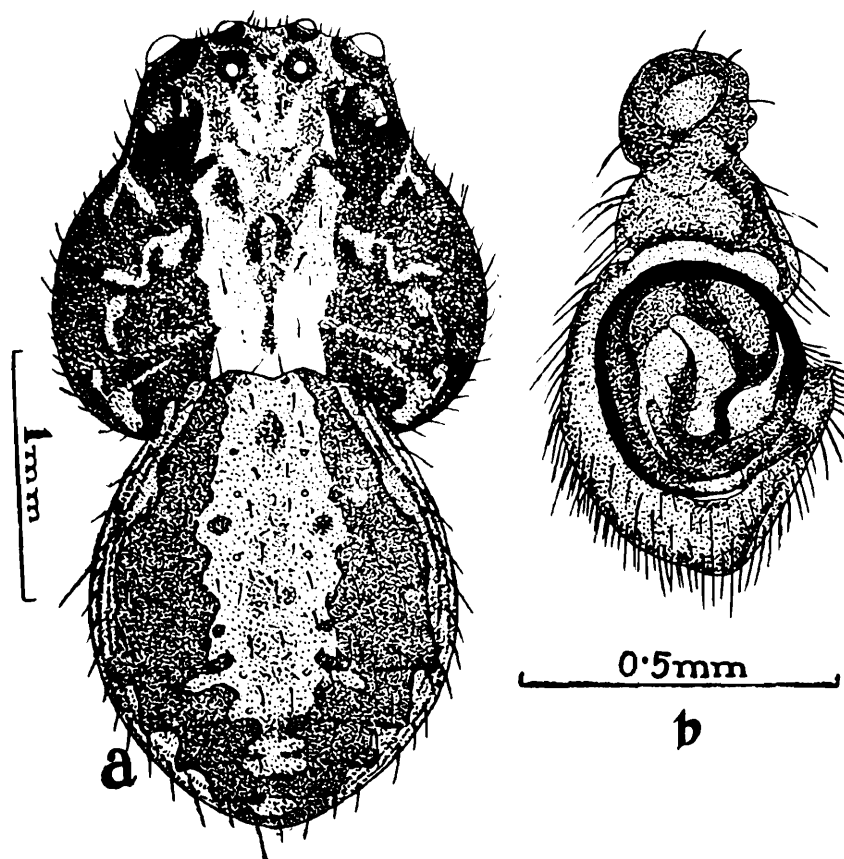
Distribution.—All tropical countries of the world.

42. *Xysticus sikkimus* sp. n.

General.—Cephalothorax, legs and abdomen dark brown. Total length 3.10 mm. Carapace 1.60 mm. long, 1.70 mm. wide ; abdomen 1.80 mm. long, 1.50 mm. wide.

Cephalothorax.—Nearly as long as wide, densely and conspicuously spined, middle of cephalothorax provided with a broad longitudinal light patch from ocular area to base of thorax. Eyes round, black, lateral eyes large and ringed with contiguous brown tubercles, ocular quad wider than long, medians almost equal in size. Sternum broadly oval, slightly pointed behind, dark in colour. Legs strong and spined, I and II longer than III and IV ; I and II legs from base to patella provided with deep brown and remaining portion pale in colour. Tibiae and metatarsi of I and II with three and four pairs of ventral spines respectively.

Abdomen.—Shortly ovate, wider behind, clothed with numerous spines, mid-dorsally with a longitudinal broad light patch, extending from base to end of abdomen. Ventral side deep brown or black. Male palp as in text-fig. 28, b.



TEXT-FIG. 28. *Xysticus sikkimus* sp. n. (a) Dorsal view of male, legs omitted. (b) Male palp.

Holotype one male in spirit.

Type-locality.—Satmila (near Gangtok) East Sikkim, 23.8.1959. Coll. B. K. Tikader.

This species resembles *Xysticus sujatai* Tikader from Shillong, India, but it is separated as follows: (i) Cephalothorax mid-dorsally with a longitudinal broad light patch but in *X. sujatai* lateral margin of cephalothorax with two dark brown bands extending from both the lateral eyes to nearly the base of thorax. (ii) Abdomen mid-dorsally with a longitudinal broad light patch, extending from base to end of abdomen but in *X. sujatai* abdomen dorsally with paired transverse white lines. (iii) Male palp also structurally different.

Genus 24. *Pistius* Simon

1875. *Pistius* Simon, *Ar. Fr.*, 2, p. 257.

1951. *Pistius* : Locket and Millidge, *British Spiders*, Ray Soc., London, 1, pp. 175

Characters.—Carapace armed with a few only very short fine spines. Eyes small, medians forming practically a square; lateral eyes on the shallow tubercle, anterior eyes subequal. Abdomen much wider and truncated behind, particularly in the female.

Type-species.—*Pistius truncatus* (Pallas).

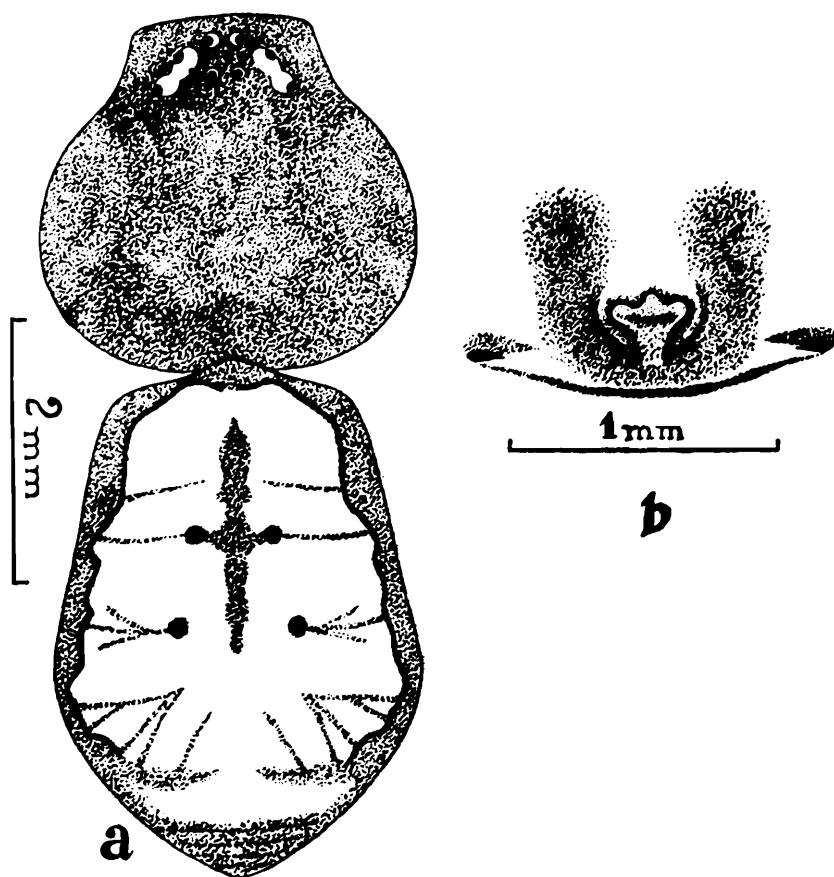
Distribution.—Europe and Asia.

43. *Pistius kalimpus* sp. n.

General.—Cephalothorax and legs green, abdomen chalk-white.

Total length 6.50 mm. Carapace 2.80 mm. long, 2.90 mm. wide; abdomen 4.00 mm. long, 2.90 mm. wide.

Cephalothorax.—Nearly as long as wide, convex, oval in outline, somewhat narrow in front. Eyes black, posterior medians slightly closer than anterior medians; the median ocular area longer than wide, lateral eyes large and provided with contiguous white tubercles; the eyes of anterior row equidistant, subequal, recurved, the posterior row less recurved than the anterior row. Clypeus high and obtuse, margin provided with small hairs. Sternum oval, pointed behind. Legs I and II much longer than III and IV; tibiae and metatarsi I and II armed ventrally with four and six pairs of spines respectively.



TEXT-FIG. 29. *Pistius kalimpus* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne.

Abdomen.—Longer than wide, dorsally with chalk-white patches and mixed with some yellow tint on it, lateral and front sides of these patches encircled by a conspicuous black line. Ventral side uniform pale colour. Epigyne as in text-fig. 29, b.

Holotype one female in spirit.

Type-locality.—Kalimpong, Dist. Darjeeling, West Bengal, India. 17.9.1959. Coll. B. K. Tikader.

This species resembles *Pistius sreepanchamii* Tikader from Shillong, India but it is separated as follows: (i) Cephalothorax uniform green in colour but in *P. sreepanchamii* cephalothorax whitish mottled deep green and all dots centrally with a small spine. (ii) Tibiae and metatarsi I and II armed ventrally with four and six pairs of spines respectively

but in *P. sreepanchamii* tibiae and metatarsi I and II armed ventrally with three and eight pairs of spines respectively. (iii) Epigyne also differs.

Family VII. AGELENIDAE

Characters.—Cephalothorax oval attenuated in front with a longitudinal fovea. Eyes not very different in size. Abdomen oval, a transverse slit near the spinners usually very difficult to see. The eyes may be either silvery-white or dark or both types may be present ; usually the anterior median eyes silvery-white, the others dark ; the eyes in two rows. The posterior spinners very long.

Genus 25. *Agelena* Walckenaer

1805. *Agelena* Walckenaer, *Tabl. Aran.*, p. 51.

1897. *Agelena* : Simon, *Hist. Nat. Araignees*, 2, p. 258.

1940. *Agelena* : Comstock, *The Spider Book*, New York, p. 600.

1953. *Agelena* : Locket and Millidge, *British Spiders*, Ray Soc., London, 2, p. 6.

Characters.—Cephalothorax rather long, the cephalic region narrowed. Eyes nearly equal in size, both rows strongly procurved, so that the posterior lateral and the anterior median form a nearly straight line. Anterior spinners clearly separated, posterior much longer and provided with two segments ; the apical segment longer than the basal and tapering.

Type-species.—*Agelena labyrinthica* Clerk.

Distribution.—Europe, Africa, Asia and America.

44. *Agelena satmila* sp. n.

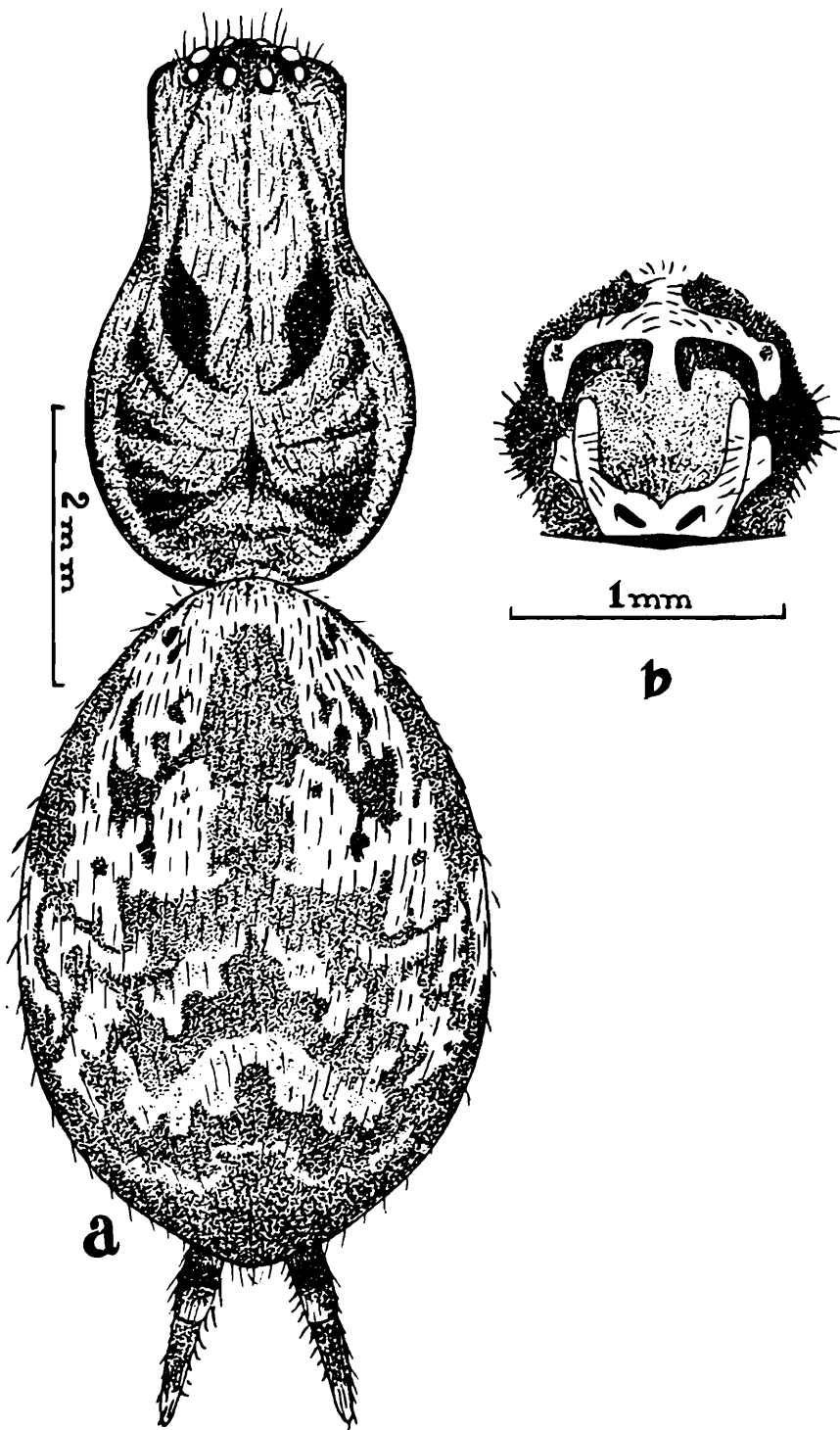
General.—Cephalothorax, leg and abdomen brownish-green. Total length 8.90 mm. Carapace 4.00 mm. long, 2.40 mm. wide ; abdomen 5.00 mm. long, 3.50 mm. wide.

Cephalothorax.—Rather long, clothed with hairs, cephalic region narrow and conspicuously high, thoracic region convex, with a sharp fovea and radiating striae. Eyes pearly white, both rows procurved (as seen from above and from in front). Anterior median eyes smaller than laterals and posterior median eyes larger than laterals. Clypeus narrow and vertical. Sternum oval, pointed behind, clothed with hairs. Legs long and stout, moderately densely clothed with long hairs and spines ; all femora provided with conspicuous transverse deep brown bands.

Abdomen.—Nearly egg-shaped, clothed with hairs, dorsum provided with deep brown patches and they form like chevrons. Anterior spinners distinctly separated, posterior spinners much longer than others and two segmented, the apical segment longer than the basal and tapering. Epigyne as in text-fig. 30, b.

Holotype one female. *Paratypes*, two females in spirit.

Type-locality.—Satmila (near Gangtok) East Sikkim, 23.8.1959. Coll. B. K. Tikader.



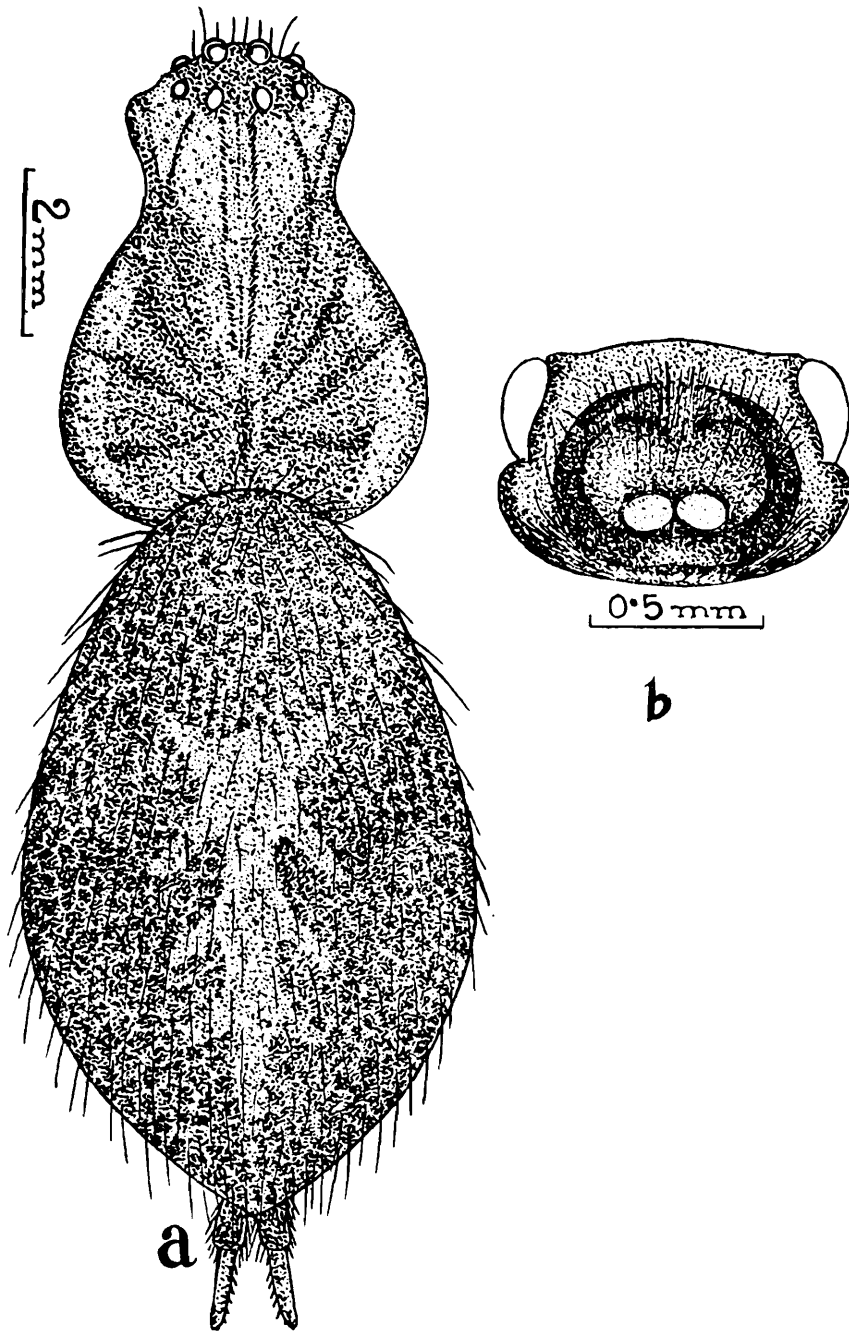
TEXT-FIG. 30. *Agelena satmila* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne.

This species resembles *Agelena gautami* Tikader from Shillong, India but it is separated as follows : (i) Anterior median eyes smaller than laterals but in *A. gautami* anterior median eyes slightly larger than laterals. (ii) Abdomen provided with deep brown chevrons and clothed with fine hairs but in *A. gautami* abdomen uniform dark brown and densely clothed with hairs. (iii) Epigyne also structurally different.

45. *Agelena barunae* sp. n.

General.—Cephalothorax light brown, legs green, abdomen dark

brown. Total length 15.00 mm. Carapace 6.50 mm. long, 4.20 mm. wide ; abdomen 9.00 mm. long, 5.50 mm. wide.



TEXT-FIG. 31. *Agelena barunae* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne.

Cephalothorax.—Longer than wide, cephalic region narrow and conspicuously high ; thoracic region flat, clothed with fine hairs and provided with a fovea like depression on the middle of thorax. Eyes white, nearly equal in size but anterior median slightly larger than others ; both rows procurved (as seen from front). Clypeus high and vertical. Sternum oval, pointed behind, clothed with hairs. Legs long and stout, moderately clothed with long hairs and spines.

Abdomen.—Broadly elliptical, dark brown, densely clothed with brown and grey hairs. Ventral side lighter than dorsal but middle

provided with a broad longitudinal brown line extending from epigastric fold to spinners. Anterior spinners separated and posterior spinners much longer than others and two segmented, the apical segment longer than the basal and tapering. Epigyne as in text-fig. 31, b.

Holotype one female in spirit.

Type-locality.—Bank of Great Rangit river, West Sikkim, 20.9.1959. Coll. B. K. Tikader.

This species resembles the foregoing species i.e. *Agelena satmila*, sp. n. but is separated as follows: (i) Anterior median eyes larger than laterals but in *A. satmila* anterior median eyes smaller than laterals. (ii) Abdomen dark brown, dorsally clothed with brown and grey hairs but in *A. satmila* abdomen provided with deep brown chevrons and clothed with fine hairs. (iii) Epigyne also structurally different.

Genus 26. *Tegenaria* Latreille

1804. *Tegenaria* Latreille, *Nouv. Dict. Hist. Nat.*, 24, p. 134.

1875. *Tegenaria* : Simon, *Ar. Fr.*, 2, p. 54.

1897. *Tegenaria* : Simon, *Hist. Nat. Araignees*, 2, p. 259.

1940. *Tegenaria* : Comstock, *The Spider Book*, New York, p. 607.

1953. *Tegenaria* : Iocket and Millidge, *British Spiders*, Ray Soc., London, 2, p. 8.

Characters.—Cephalothorax as in *Agelena* Walck. Eyes anterior row procurved (viewed in front); eyes equal or the medians smaller than the laterals. Posterior row a little longer, slightly procurved. The chelicerae usually but slightly convex; and the lower margin of the furrow of the chelicerae usually armed with four to six teeth, rarely with only three.

Type-species.—*Tegenaria domestica* Clerck.

Distribution.—Europe, Africa, Asia and America.

46. *Tegenaria chhanguensis* sp. n.

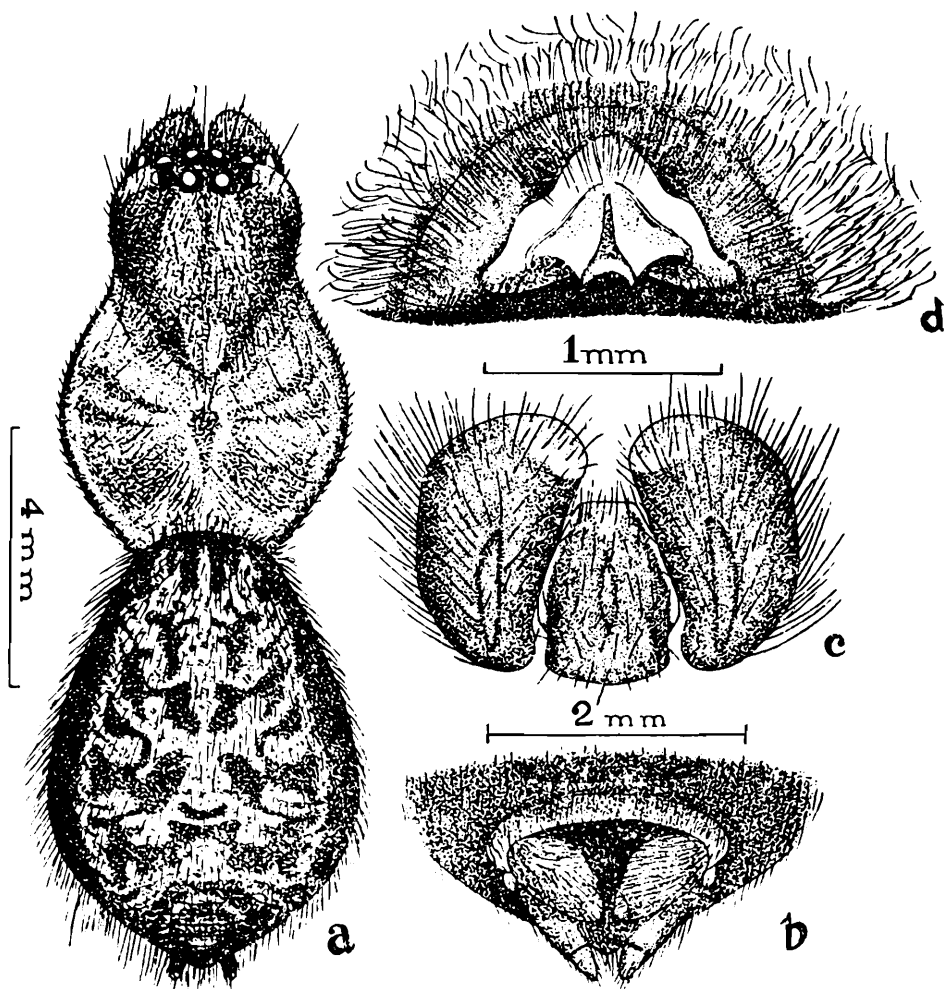
General.—Cephalothorax and legs greenish-brown, abdomen whitish-brown. Total length 12.20 mm. Carapace 6.00 mm. long, 4.80 mm. wide; abdomen 6.80 mm. long, 5.00 mm. wide.

Cephalothorax.—Longer than wide, relatively broad in front, convex, clothed with fine and stiff hairs; cephalic region high, thoracic region with a deep fovea and radiating striae. Eyes pearly white, anterior row viewed in front, very slightly procurved, medians slightly smaller than laterals. Posterior row longer than anterior row and slightly recurved, median eyes slightly closer to each other than to adjacent laterals. Clypeus narrow. Sternum oval, pointed behind, clothed with spiny hairs. Maxillae and labium as in text-fig. 32, c. Chelicerae deep brown, strong, inner margin without tooth but outer margin provided with a large tooth. Legs robust, clothed with hairs and spines; tibiae and metatarsi of I and II with two and three pairs of ventral spines respectively.

Abdomen.—Longer than wide, clothed with thick hairs, narrowing in front, slightly overlapping the posterior region of cephalothorax in front, dorsum provided with a queer design of dark brown patches. Epigyne and spinners as in text-fig. 32, d and b.

Holotype one female in spirit.

Type-locality.—Chhangu (near Changu lake) East Sikkim, 26.8.1959. Coll. B. K. Tikader.



TEXT-FIG. 32. *Tegenaria chhanguensis* sp. n. (a) Dorsal view of female, legs omitted. (b) Spinners. (c) Labium and Maxillae. (d) Epigyne.

This species resembles *Tegenaria lunakensis* Tikader from Nepal but it is separated as follows : (i) Inner margin of chelicerae without tooth but in *T. lunakensis* inner margin with two teeth. (ii) Epigyne complicated with a median piece but in *T. lunakensis* epigyne simple with a elliptical genital pore. (iii) Abdomen clothed with thick long hairs but in *T. lunakensis* abdomen clothed with fine pubescence.

Family VIII. HAHNIIDAE

The family was formerly placed as a subfamily of the *Agelenidae*, but is sharply distinguished from the agelenids and other related spiders by the arrangement of the spinners in a single transverse row. The longer hind spinners occupy the end of the row and the other four spinners situated in between them.

Genus 27. *Hahnia* Koch1841. *Hahnia* Koch, *Ar.*, 8, p. 61.1897. *Hahnia* : Simon, *Hist. Nat. Araig.*, 2, p. 274.1940. *Hahnia* : Comstock, *Spider Book*, New York, p. 614.1953. *Hahnia* : Locket and Millidge, *British Spiders*, Ray Society, London, 2, p. 27

Characters.—Cephalothorax oval, narrowed in front; foveal streak usually clear. Anterior median eyes much smaller than the anterior laterals. Abdomen with or without a pattern. Spinners in a transverse row. Sternum heart-shaped, broadly truncate between coxae IV. Labium wider than long. Legs stout and robust with a few spines.

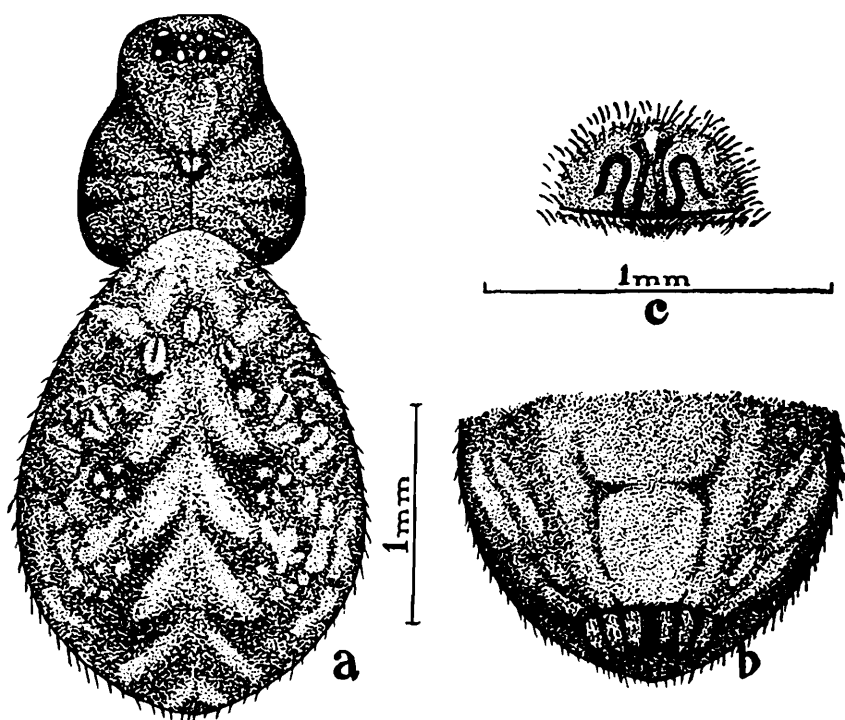
Type-species.—*Hahnia pusilla* Koch.

Distribution.—Europe; Asia: India; Japan; America.

47. *Hahnia mridulae* sp. n.

General.—Cephalothorax deep brown, abdomen light brown and legs brownish-green. Total length 3.20 mm. Carapace 1.20 mm. long, 0.90 mm. wide; abdomen 2.20 mm. long, 1.50 mm. wide.

Cephalothorax.—Longer than wide, slightly narrowing in front, convex and cephalic region high, thoracic region flat with a dark fovea and radiating striae. Clypeus moderate. Eyes pearly white, both rows of eyes straight and anterior median eyes smaller than the others; posterior row slightly longer than anterior, row and posterior median eyes larger than others. Ocular area provided with black patches. Sternum heart-shaped, pointed behind. Labium wider than long. Legs stout, clothed with stiff hairs and few spines.



TEXT-FIG. 33. *Hahnia mridulae* sp. n. (a) Dorsal view of female, legs omitted. (b) Ventral view of abdomen with spinners. (c) Epigyne.

Abdomen.—Egg-shaped, clothed with fine hairs, overlapping the posterior region of cephalothorax in front, mid-dorsally with a row of inverted V-shaped white chevrons (with the apex of the V pointed

forward) remaining portion with white dots. Epigyne and spinners as in text-fig. 33, b and c.

Holotype one female in spirit.

Type-locality.—Churong, North Sikkim, 9.10.1959. Coll. B. K. Tikader.

This species resembles *Hahnia alini* Tikader from Nepal but it is separated as follows: (i) Cephalothorax deep brown but in *H. alini* cephalothorax dark reddish-brown. (ii) Ocular area provided with black patches but in *H. alini* ocular area without black patches. (iii) Epigyne structurally different.

Family IX. PISAURIDAE

Characters.—The spiders of this family are intermediate in structure between the Lycosidae and the Agelenidae. They are distinguished from the former family by four obvious characters. Second row of eyes much shorter than the third row; the distance between the posterior eyes being more than double the distance of each eye from the corresponding eye in the second row. Foot claws larger than in Lycosidae, and two claws, bearing many teeth. The females carry their egg-cocoons in their chelicerae and not attached to the spinners, as do the Lycosidae.

Genus 28. *Pisaura* Simon

1885. *Pisaura* Simon, *Ann. Soc. Ent.*, France, p. 354.

1940. *Pisaura*: Comstock, *The Spider Book*, New York, p. 615.

1951. *Pisaura*: Locket and Millidge, *British Spiders*, Ray Soc., London, 1, p. 292.

Characters.—The median ocular area a little longer than wide, lower margin of the furrow of the chelicerae armed with three teeth. Abdomen tapering behind and covered with a dense pubescence.

Type-species.—*Pisaura mirabilis* (Clerck).

Distribution.—Europe, Africa, Asia.

48. *Pisaura gitae* sp. n.

General.—Cephalothorax and abdomen light to deep brown, legs green. Total length 9.20 mm. Carapace 3.90 mm. long, 3.00 mm. wide; abdomen 5.50 mm. long, 3.00 mm. wide.

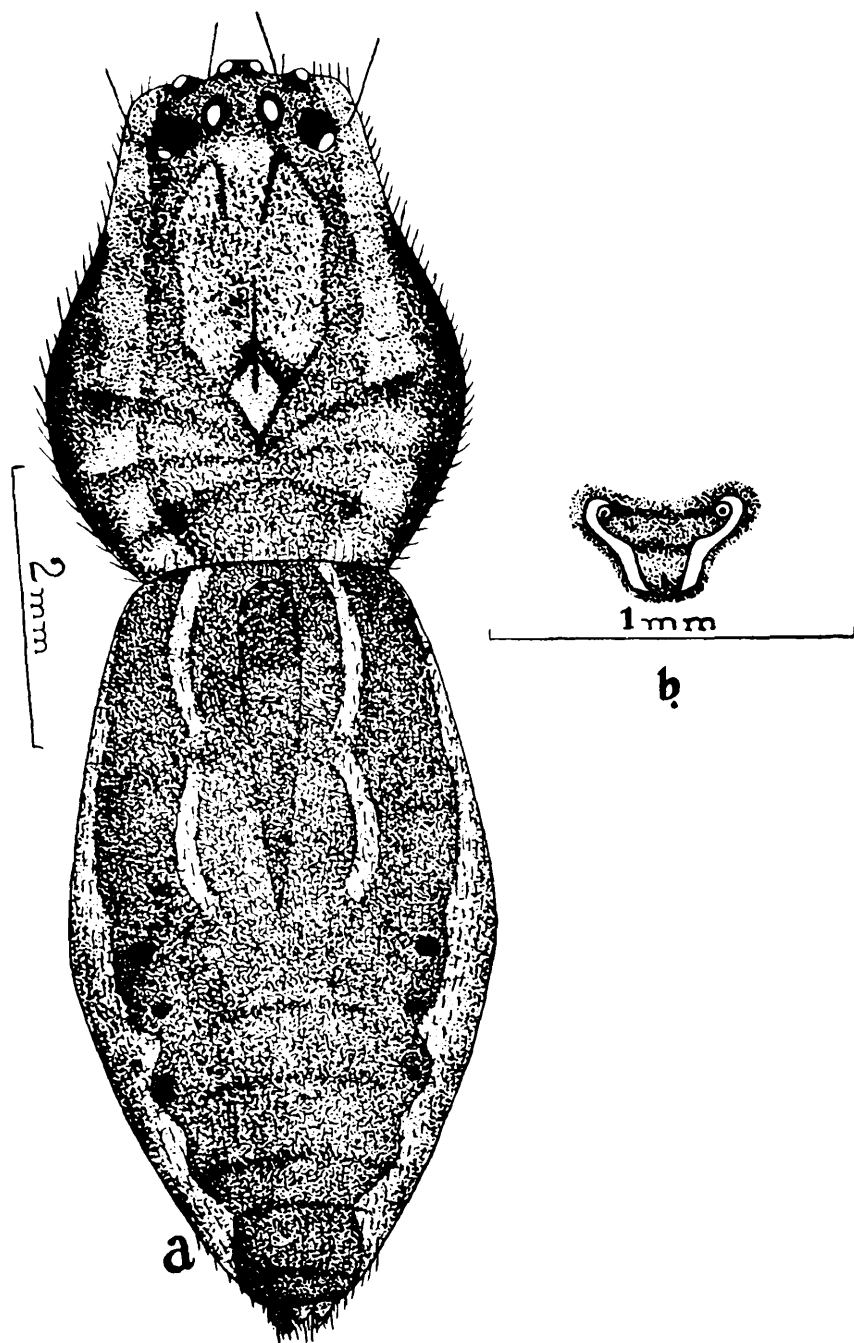
Cephalothorax.—Longer than wide, convex, cephalic region slightly high, clothed with thick fine hairs, middle and lateral margins provided with longitudinal brown patches. Eyes anterior row slightly short, recurved and almost similar in size. Posterior row of eyes more recurved than anterior row and nearly equal in size and base of each eye encircled with black patch. Ocular quad longer than wide and narrowing in front. The lower margin of furrow of the chelicerae armed with three teeth. Sternum heart-shaped, pointed behind, clothed with hairs. Legs long and strong, clothed with hairs and spines.

Abdomen.—Longer than wide, clothed with thick hairs, anterior half of abdomen with two longitudinal white lines and both lateral margins provided with broad longitudinal white lines extending from base to end of abdomen. Ventral side pale in colour, clothed with fine hairs. Epigyne as in text-fig. 34, b.

Holotype one female. *Paratypes*, four females in spirit.

Type-locality.—*Holotype* from Darjeeling, West Bengal, India

19.10.1959. *Paratype* from Nayabazar, West Sikkim, 23.9.1959. Coll. B. K. Tikader.



TEXT-FIG. 34. *Pisaura gitae* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne.

This species resembles *Pisaura mirabilis* (Clerck) from Europe but it is separated as follows : (i) Cephalothorax light to deep brown but in *P. mirabilis* cephalothorax red-brown, with a narrow longitudinal yellowish stripe reaching up to front of head. (ii) Epigyne also structurally different.

Genus 29. *Tinus* Cambridge

1901. *Tinus* Cambridge, *Biol. Centr. Amer. Ar.*, 2, p. 310.

1940. *Tinus* : Comstock, *The Spider Book*, New York, p. 631.

Characters.—The lower margin of the furrow of the chelicerae armed with three teeth. The first row of eyes slightly procurved, the

median eyes larger than the lateral and closer to them. The posterior row of eyes recurved, the eyes equal in size, somewhat larger than those of the anterior row. The median ocular quadrangle wider behind than in front.

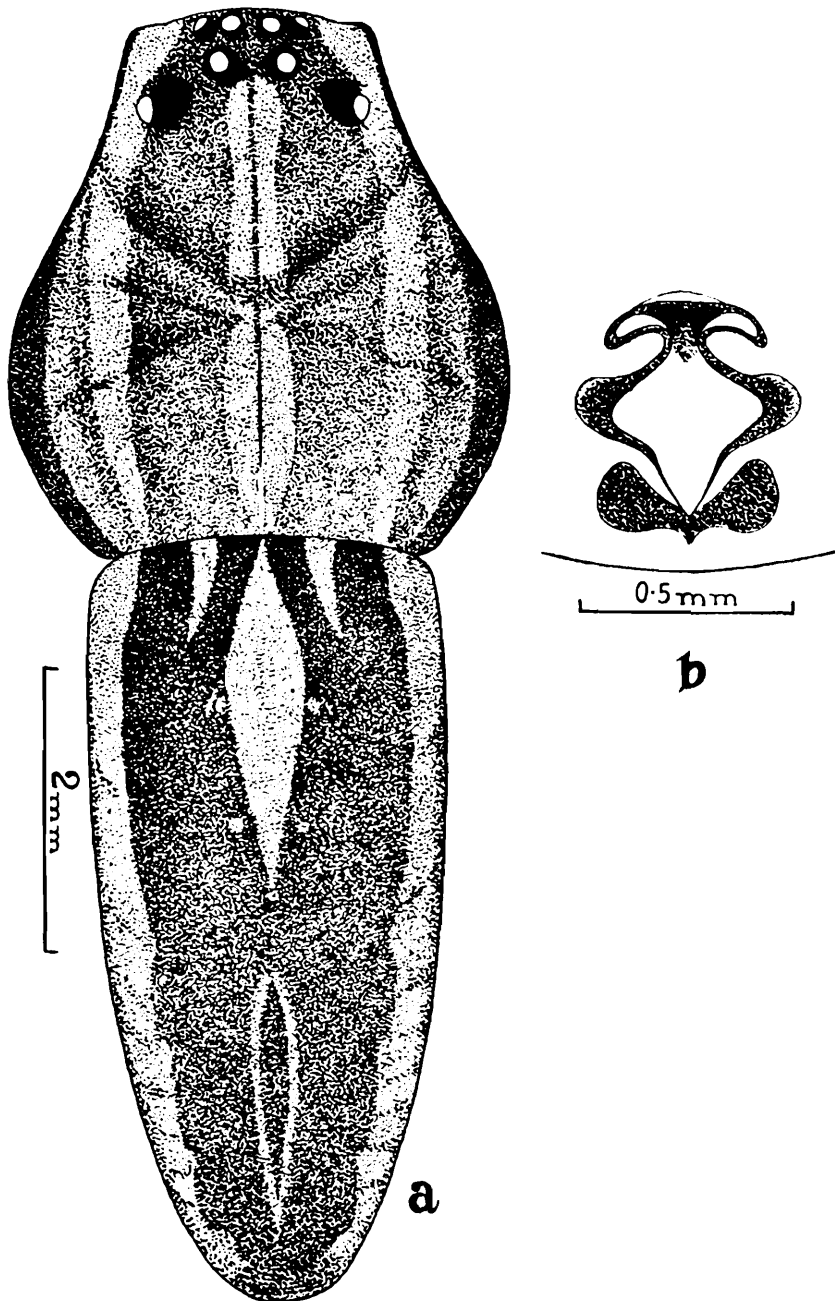
Type-species.—*Tinus nigrinus* Cambridge.

Distribution.—America and Asia : India.

49. *Tinus sikkimus* sp. n.

General.—Cephalothorax brown, legs green and abdomen deep brown. Total length 9 or 10 mm. Carapace 3.90 mm. long, 3.50 mm. wide; abdomen 5.50 mm. long, 2.50 mm. wide.

Cephalothorax.—Slightly longer than wide, convex, cephalic region



TEXT-FIG. 35. *Tinus sikkimus* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne.

slightly high, narrowing in front, middle with a broad longitudinal brown patch and centre provided with a conspicuous fovea. Eyes

anterior row short, slightly procurved, the middle eyes large and little close to the lateral. Posterior row strongly recurved and nearly equal in size, somewhat larger than the anterior row. The median ocular quadrangle broader behind than in front. The lower margin of furrow of the chelicerae armed with three teeth. Sternum heart-shaped, pointed behind, pale in colour, clothed with hairs; near the base of corresponding coxa provided with deep brown patch. Legs very long and strong, clothed with hairs and spines.

Abdomen.—Longer than wide, lateral sides provided with a longitudinal whitish band and middle on the anterior half of abdomen with a lance-shaped light brown patch as in text-fig. 35, b.

Holotype one female (legs broken). *Paratypes*, two females in spirit.

Type-locality.—Rothak, near Nayabazar, West Sikkim, 24.9.1959. Coll. B. K. Tikader.

This species resembles *Tinus peregrinus* Cambridge from America but it is separated as follows: (i) Legs green, clothed with hairs but in *T. peregrinus* legs reddish-brown, with indistinct darker bands on the femora. (ii) Abdomen lateral sides with longitudinal whitish bands but in *T. peregrinus* abdomen marked with a dull brown band and margin provided with narrow light lines; (iii) Epigyne also different.

Family X. LYCOSIDAE

Characters.—Cephalothorax high, narrowing in front; eyes of anterior row small, forming straight or slightly curved line, eyes of posterior row strongly recurved. Legs spiny, III legs shorter than the others, tarsi with three claws and claw-tufts absent. Abdomen oval or elongated, spinners forming a compact group, generally subequal in length.

These spiders, commonly called the hunting or wolf spiders, are very fast runners. They catch their prey on foot. Only a few genera of this family, such as *Hippasa* Simon spin a tubular retreat, which expands externally into a broad sheet. Other members of the family dig a tubular tunnel in the ground.

Genus 30. *Hippasa* Simon

1885. *Hippasa* Simon, *Bull. Soc. Zool.*, France, 10, p. 31.

1898. *Hippasa*: Simon, *Hist. Nat. Araign.*, 2, p. 326.

1900. *Hippasa*: Pocock, *Fauna Brit. India*, Arach., p. 249.

1935. *Hippasa*: Dyal, *Bull. Zool. Punjab Univ.*, 1, 142.

Characters.—Anterior row of eyes wider than posterior row, posterior eyes more widely separated. Posterior spinners conspicuously longer than the anterior. These spiders spin a silken thread, which expands into a sheet-like snare.

Type-species.—*Hippasa agelenoides* Simon.

Distribution.—Africa, Madagascar; Asia; Arabia, India, Malaysia.

50. *Hippasa pantherina* Pocock

1899. *Hippasa pantherina* Pocock, *J. Bombay nat. Hist. Soc.*, 12, p. 752.

1924. *Hippasa pantherina*: Gravely, *Rec. Indian Mus.*, Calcutta, 26(6), p. 594.
Africa; Madagascar; Asia; Arabia; India; Malaysia.

Specimens examined.—7 ♀, Nayabazar, West Sikkim, 23.9.1959. 7 ♀, Bank of Great Rangit river, West Sikkim, India. 25.9.1959. Coll. B. K. Tikader.

General.—Cephalothorax and legs brownish-green, abdomen whitish-brown. Total length 16.50 mm. Carapace 7.00 mm. long, 5.50 mm. wide; abdomen 10.00 mm. long, 4.00 mm. wide.

Cephalothorax.—Longer than wide, convex cephalic region row slightly high, clothed with short thick black hairs. Eyes anterior short and straight and almost equal in size; second and third row of eyes nearly equal in size and bases encircled by black patch. Sternum heart-shaped, pointed behind, middle provided with a conspicuous longitudinal black line, clothed with hairs. Legs long and strong, clothed with hairs and spines.

Abdomen.—Longer than wide, pointed behind, dorsum provided with irregular black or deep brown dots and also provided with whitish chevrons. Ventral side more light colour than dorsal and provided with irregular black or deep brown dots.

Distribution.—India : Barkuda Island, Chilka Lake, Orissa, Madras, Trivandrum, Travancore, Trichur, Cochin, Krusadai Island, Gulf of Manaar, Bangalore, East Khandesh, Western India, Poona, Darjeeling, Sikkim.

Genus 31. *Lycosa* Latreille

1804. *Lycosa* Latreille, *Nouv. Dict. d'Hist. Nat.*, 25, p. 135.

1898. *Lycosa* : Simon, *Hist. Nat. Araign.*, 2, p. 345.

1900. *Lycosa* : Pocock, *Fauna Brit. India*, Arach., p. 252.

1924. *Lycosa* : Gravely, *Rec. Indian Mus.*, Calcutta, 26, p. 588.

1935. *Lycosa* : Dyal, *Bull. Zool. Punjab Univ.*, 1, p. 134.

Characters.—Cephalic region high, four posterior eyes very large and arranged in a quadrangle, and little wider behind than in front; eyes of anterior row small and straight. Legs with short spines, tibia II with three pairs of ventral spines.

Type-species.—*Lycosa tarentula* Rossi.

Distribution.—All over the world.

Key to the Indian species of *Lycosa* Latreille

1. Area occupied by posterior eyes nearly square ... 2
Area occupied by posterior eyes broader behind than in front ... 4
2. Anterior portion of median piece of vulva hidden beneath the anterior chitinized margin of the cavity ... *L. kupupa* sp. n.
Anterior portion of median piece of vulva exposed throughout ... 3
3. Longitudinal portion of median piece of vulva broad.
Anterior row of eyes straight ... *L. kempi* Gravely
Longitudinal portion of median piece of vulva narrow.
Anterior row of eyes recurved ... *L. tista* sp. n.
4. Anterior portion of median piece of vulva hidden beneath the anterior chitinized margin of the cavity ... 5
Anterior portion of median piece of vulva exposed throughout ... *L. rothaka* sp. n.
5. Ocular area without deep brown or black ... 6
Ocular area with deep brown or black ... *L. carmichaeli* Gravely
6. Anterior row of eyes straight. Longitudinal portion of median piece of vulva narrow, T-shaped ... *L. shyamae* sp. n.
Anterior row of eyes recurved. Longitudinal portion of median piece of vulva narrow and dumb-bell-shaped ... *L. rhenockensis* sp. n.

51. *Lycosa carmichaeli* Gravely

1924. *Lycosa carmichaeli* Gravely, *Rec. Indian Mus.*, Calcutta, 26, p. 604.

Specimens examined.—1 ♀, and 1 ♂, Manjithar, West Sikkim, 22.9.1959. Coll. B. K. Tikader.

General.—Cephalothorax brown, legs green, abdomen dark brown. Total length 15.00 mm. Carapace 8.00 mm. long, 5.00 mm. wide; abdomen 8.00 mm. long, 5.00 mm. wide.

Cephalothorax.—Longer than wide, cephalic region raised and clothed with hairs; centre provided with a fovea. Eyes black, first row short and straight, medians larger than laterals; second row of eyes larger than others. Ocular area deep brown. Legs long and strong, clothed with hairs and spines; III and IV pairs longer than I and II.

Abdomen.—Longer than wide, clothed with mouse hairs. Ventral side pale. Cavity of vulva widely expanded in front, its floor raised in the middle line behind forming the stem of the T-shaped median piece. Cleft of vulva narrow behind, with more or less circular expansion in front.

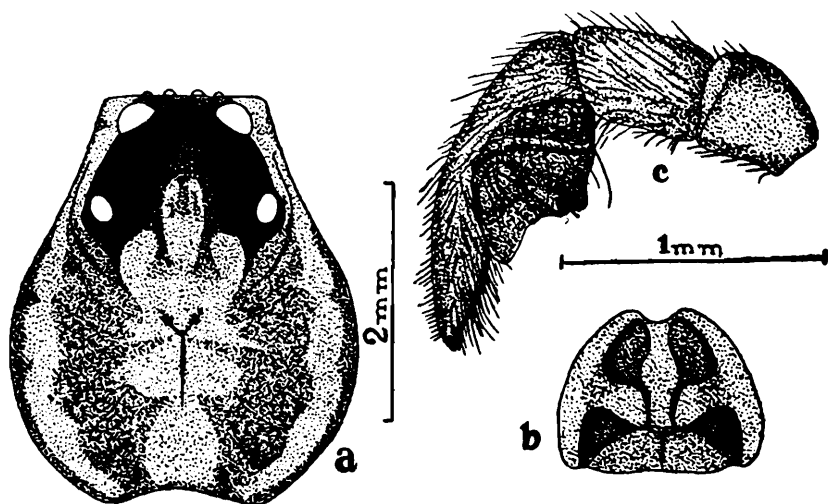
Distribution.—India: Kathgodam, Western Himalaya; Darjeeling; Assam. Bhutan and Sikkim.

52. *Lycosa rothaka* sp. n.

General.—Cephalothorax and legs light to deep brownish-green, abdomen pale blackish. Total length 9.20 mm. Carapace 3.40 mm. long, 3.00 mm. wide; abdomen 6.00 mm. long, 3.00 mm. wide.

Cephalothorax.—Longer than wide, convex, cephalic region slightly high and narrowing in front; ocular area with a conspicuous black patch, mid-dorsally with a longitudinal broad light patch extending from ocular area to base of cephalothorax, centre provided with distinct fovea. Eyes anterior row short and straight, anterior medians larger than laterals. Second row of eyes larger and situated closer together than the third row. Sternum oval, light pale colour with fine hairs. Legs long and strong, clothed with hairs and spines.

Abdomen.—Longer than wide, clothed with fine hairs, broadest behind the middle, dorsally provided with a dirty-white chevrons. Ventral side uniform light pale colour. Epigyne as in text-fig. 36, b. Anterior portion of median piece of vulva exposed throughout. Cleft of vulva more or less parallel-sided or ill-defined. Male similar in colour as female but smaller in size. Male palp as in text-fig. 36, c.



TEXT-FIG. 36. *Lycosa rothaka* sp. n.: (a) Dorsal view of cephalothorax of female, (b) Epigyne, (c) Male palp.

Holotype one female. *Paratype*, one female and *Allotype*, one male in spirit.

Type-locality.—Rothak near Nayabazar, West Sikkim, 24.9.1959. Coll. B. K. Tikader.

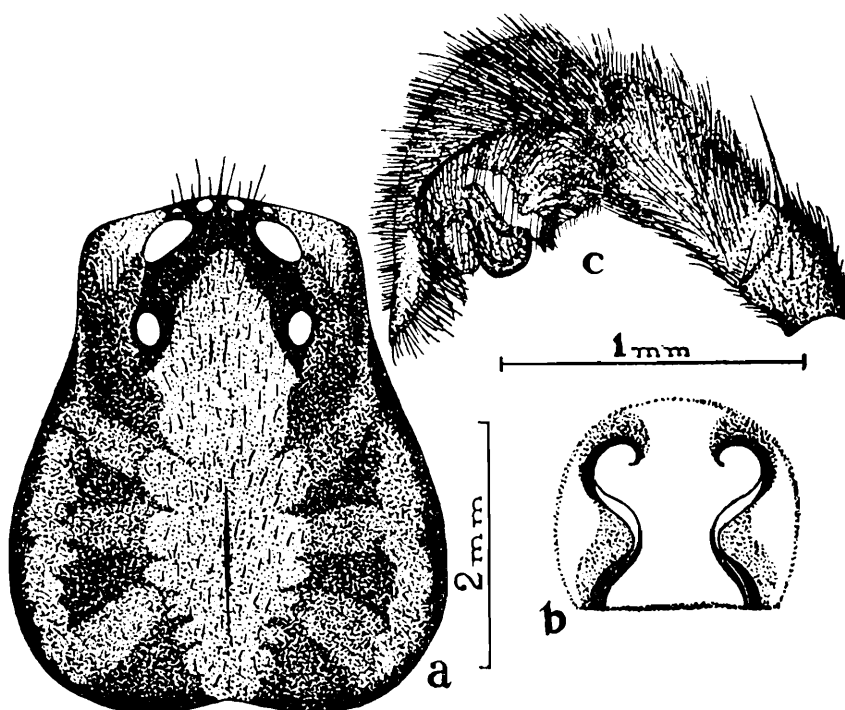
This species resembles *Lycosa kemp* Gravely from Darjeeling, India, but it is separated as follows : (i) Ocular area with conspicuous black patch but in *L. kemp* ocular area without black patch. (ii) Epigyne and male palp also structurally different.

53. *Lycosa kemp* Gravely

1924. *Lycosa kemp* Gravely, *Rec. Indian Mus.*, Calcutta, 26(6), p. 602.

Specimens examined.—1 ♀, and 1 ♂, Sambiyong, Dist. Darjeeling, West Bengal. 14.9.1959. 1 ♀, Rishi, West Sikkim, 25.9.1959. Coll. B. K. Tikader.

General.—Cephalothorax and abdomen light to deep greyish black, legs brownish-green. Total length 13.50 mm. Carapace 5.50 mm. long, 5.00 mm. wide; abdomen 8.50 mm. long, 5.50 mm. wide.



TEXT-FIG. 37. *Lycosa kemp* Gravely (a) Dorsal view of cephalothorax of female. (b) Epigyne. (c) Male palp.

Cephalothorax.—Longer than wide, convex, clothed with fine hairs, mid-dorsally with a conspicuous longitudinal broad light line, extending from the base of second row of eyes to base of thorax; centre provided with distinct fovea. Eyes anterior row short and straight, anterior medians larger than anterior laterals. Second row of eyes fairly large and slightly closer together than the third row. Sternum oval, pointed behind, clothed with hairs. Legs long and strong, clothed with hairs and spines.

Abdomen.—Longer than wide, nearly egg-shaped, clothed with thick fine hairs; broadest behind the middle. Ventral side pale in colour. Epigyne as in text-fig. 37, b. Anterior portion of median piece of vulva exposed throughout and longitudinal portion of median piece of

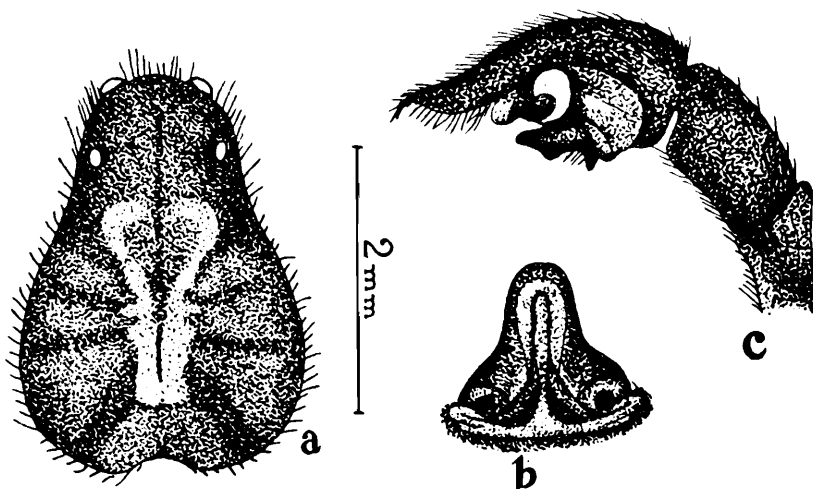
vulva broad. Male similar colour as female but smaller in size. Male palp as in text-fig. 37, c.

Distribution.—India : Assam (Type-locality), Darjeeling. Bhutan ; Sikkim.

54. *Lycosa kupupa* sp. n.

General.—Cephalothorax and legs deep brown, abdomen less brown than cephalothorax. Total length 7.70 mm. Carapace 3.60 mm. long, 3.00 mm. wide; abdomen 4.20 mm. long, 2.90 mm. wide.

Cephalothorax.—Longer than wide, convex, clothed with fine hairs, slightly high and narrowing in front, middle provided with a conspicuous broad longitudinal light patch and centre provided with a longitudinal sharp blackish line. Eyes anterior row short and slightly procurved, space of two anterior middle eyes wider than the laterals. Second row of eyes larger and closer together than third row. Area occupied by posterior row of eyes nearly square. Sternum heart-shaped, pointed behind, dark and clothed with hairs. Legs strong and long but IV legs conspicuously longer than others, legs provided with irregular bands or patches of deep brown and light brown colour, clothed with hairs and spines.



TEXT-FIG. 38. *Lycosa kupupa* sp. n. (a) Dorsal view of cephalothorax of female. (b) Epigyne. (c) Male palp.

Abdomen.—Longer than wide, clothed with thick hairs, variable in colour, some with light brown chevrons and some without chevron, broadest behind the middle. Ventral side more light colour than dorsal side. Epigyne as in text-fig. 38, b. Anterior portion of median piece of vulva hidden beneath the anterior chitinized margin of the cavity. Male similar with female but abdomen smaller than female, male palp as in text-fig. 38, c.

Holotype one female. *Paratypes*, thirteen females and *Allotypes*, five males in spirit.

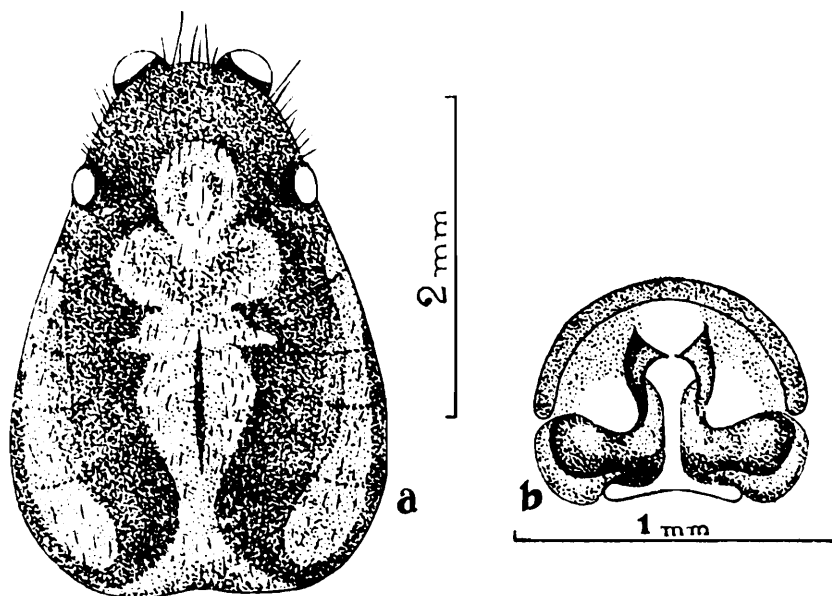
Type-locality.—Kupup, East Sikkim, 28.8.1959. Coll. B. K. Tikader.

This species is closely related to *Lycosa nigrotibialis* (Simon) from India but it differs as follows: (i) Average length 7-8 mm. but in *L. nigrotibialis* average length 20 mm. long. (ii) Ventral side of abdomen light colour than dorsal but in *L. nigrotibialis* ventral side uniform dark black. (iii) Epigyne and male palp also different.

55. *Lycosa shyamae* sp. n.

General.—Cephalothorax, legs and abdomen light to deep brown. Total length 9.50 mm. Carapace 5.00 mm. long, 4.00 mm. wide; abdomen 4.50 mm. long, 2.50 mm. wide.

Cephalothorax.—Longer than wide, convex, clothed with hairs, cephalic region slightly high and narrowing in front. Ocular area deep brown and provided with some long spines, mid-dorsally with a cross longitudinal broad patch and centre provided with a sharp fovea as in text-fig. 39, a. Eyes anterior row short and straight, placed in equal distance. Second row of eyes larger and situated much closer together than the third row. Sternum oval, slightly pointed behind, light colour clothed with hairs. Legs long and stout, clothed with hairs and spines, provided with transverse deep brown irregular bands.



TEXT-FIG. 39. *Lycosa shyamae* sp. n. (a) Dorsal view of cephalothorax of female. (b) Epigyne.

Abdomen.—Longer than wide, clothed with thick hairs, mid-dorsally with a longitudinal broad patch. Ventral side light colour and provided with thick hairs. Epigyne as in text-fig. 39, b. Longitudinal portion of median piece of vulva narrow and T-shaped.

Holotype one female. *Paratypes*, four females in spirit.

Type-locality.—Samabiyong, Dist. Darjeeling, West Bengal, India. 14.9.1959. Coll. B. K. Tikader.

This species is closely related to the foregoing species i.e. *Lycosa kupupa* sp. n. but it differs as follows: (i) Cephalothorax with cross longitudinal broad light patch with a sharp fovea but in *L. kupupa* cephalothorax with a heart-shaped broad light patch. (iii) Epigyne structurally different.

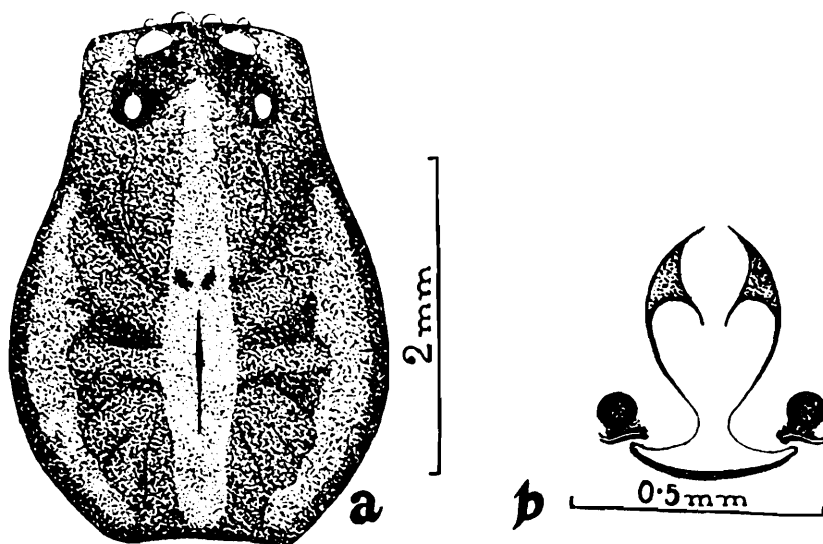
56. *Lycosa tista* sp. n.

General.—Cephalothorax and legs brownish-green, abdomen dark-brown. Total length 9.00 mm. Carapace 5.00 mm. long, 2.40 mm. wide; abdomen 4.00 mm. long, 3.00 mm. wide.

Cephalothorax.—Longer than wide, convex, clothed with fine hairs, ocular area deep brown or dark patch, lateral two sides provided with

longitudinal broad deep brown patch. Eyes anterior row short and slightly recurved, median larger than laterals. Second row of eyes large and situated close together than the third row. Sternum oval, pale in colour and clothed with hairs. Legs long and strong, clothed with hairs and spines.

Abdomen.—Longer than wide, dorsally provided with minute greyish dots, broadest behind the middle. Ventral side uniform light colour. Epigyne as in text-fig. 40, b. Longitudinal portion of median piece of vulva narrow.



TEXT-FIG. 40. *Lycosa tista* sp. n. (a) Dorsal view of cephalothorax of female. (b) Epigyne.

Holotype one female in spirit.

Type-locality.—Rothak near Nayabazar, West Sikkim, 24.9.1959. Coll. B. K. Tikader.

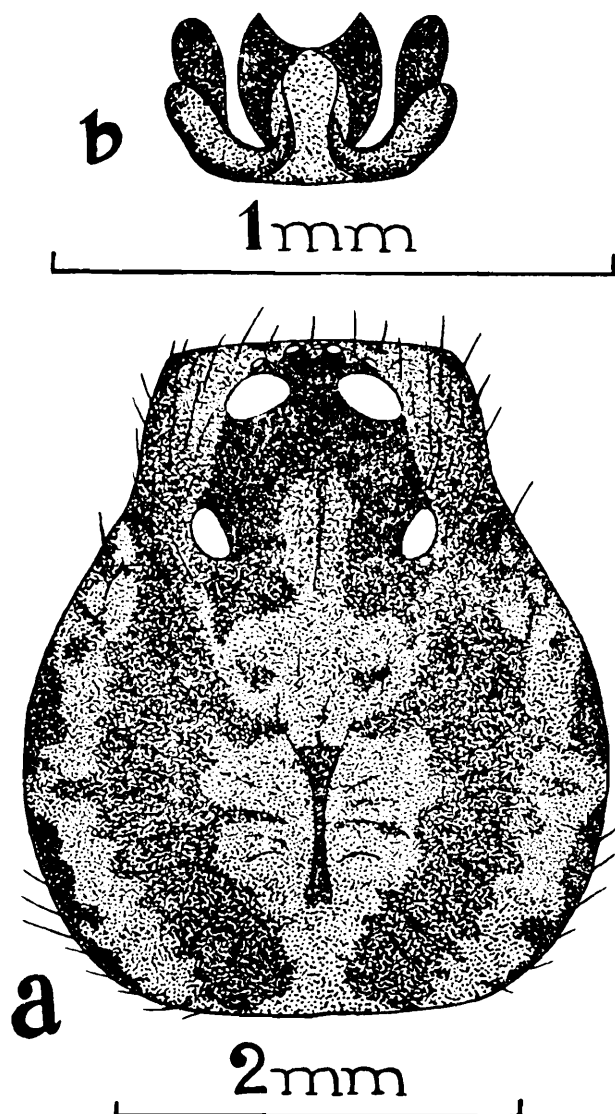
This species resembles *Lycosa carmichaeli* Gravely from India but it is separated as follows: (i) Maximum total length 9.00 mm. but in *L. carmichaeli* maximum total length 19.00 mm. (ii) Abdomen dorsally provided with minute greyish dots but in *L. carmichaeli* abdomen marked with narrow transverse bands of a more snowy white. (iii) Epigyne structurally different.

57. *Lycosa rhenockensis* sp. n.

General.—Cephalothorax, legs and abdomen light brown. Total length 8.50 mm. Carapace 3.50 mm. long, 2.90 mm. wide; abdomen 5.00 mm. long., 3.20 mm. wide.

Cephalothorax.—Longer than wide, convex, clothed with fine hairs and few spines, cephalic region slightly high and narrowing in front. Ocular area deep brown and provided with some long spines; lateral sides with deep brown longitudinal patches and centre provided with a sharp fovea. Eyes anterior row short and recurved, placed at equal distance. Second row of eyes large and situated much closer together than the third row. Sternum nearly oval, slightly pointed behind, light colour and clothed with hairs. Legs long and stout, clothed with hairs and spines, provided with some brown irregular bands or patches.

Abdomen.—Longer than wide, clothed with thin hairs, dorsally



TEXT-FIG. 41. *Lycosa rhenockensis* sp. n. (a) Dorsal view of cephalothorax of female. (b) Epigyne.

provided with light chevrons. Ventral side uniform pale colour. Epigyne as in text-fig. 41, b. Longitudinal portion of median piece of vulva narrow and dumb-bell-shaped.

Holotype one female. *Paratypes*, ten females in spirit.

Type-locality.—Rhenock, East Sikkim, 2.9.1959. Coll. B. K. Tikader.

This species is closely related to the foregoing species i.e. *Lycosa shyamae* sp. n. but it differs as follows: (i) Cephalothorax and abdomen remarkably different. (ii) Epigyne also structurally different.

Family XI. OXYOPIDAE

Characters.—Cephalothorax oval, high; cephalic region narrow, subacuminate; eyes forming a compact subcircular group, those of the posterior line being typically strongly procurved and those of the anterior recurved, the anterior medians minute; clypeus very high, vertical. Mandibles long and acuminate; fang short; fang-groove unarmed or weakly armed; maxillae and labium very long. Legs, slender, armed with long black, conspicuous spines, not scopulate;

three claws. Abdomen generally oval, narrowed behind; spinning-mamilla short, subequal; a small colulus present.

Genus 32. *Oxyopes* Latreille

1804. *Oxyopes* Latreille, *Hist. Nat. Arach.*, France, 14(7), p. 144.

1900. *Oxyopes*: Pocock, *Fauna Brit. India.*, Arach., p. 255.

Characters.—Posterior row of eyes strongly procurved and equidistant from each other. Ocular quadrangle longer than wide and limited by the posterior median eyes and the anterior lateral eyes.

Type species.—*Oxyopes heterophthalmus* Latreille.

Distribution.—Europe, Africa, Asia, Australia, and America.

Key to the Indian species of *Oxyopes* Latreille

1. Clypeus provided with two black lines extending from anterior median eyes to the base of fang ... 2
Clypeus not provided with black line ... 6
2. Cephalothorax clothed with spatulate hairs ... 3
Cephalothorax clothed with normal hairs ... 4
3. Upper side of femora of all legs provided with a longitudinal black line ... *O. ratnae* sp. n.
Lower side of femora of all legs provided with a longitudinal black line ... *O. sunandae* sp. n.
4. Abdomen broad ... *O. sakuntalae* sp. n.
Abdomen narrowed ... 5
5. Lower side of femora of all legs provided with two conspicuous longitudinal black lines ... *O. sitae* sp. n.
Lower side femora of all legs provided with only one longitudinal black line ... *O. shewta* sp. n.
6. Cephalothorax clothed with fine hairs. Abdomen provided with irregular net like white minute patches ... *O. subhadrae* sp. n.
Cephalothorax clothed with short and blunt deep brown hairs. Abdomen provided with irregular dirty white and deep brown hairs ... *O. sikkimensis* sp. n.

58. *Oxyopes ratnae* sp. n.

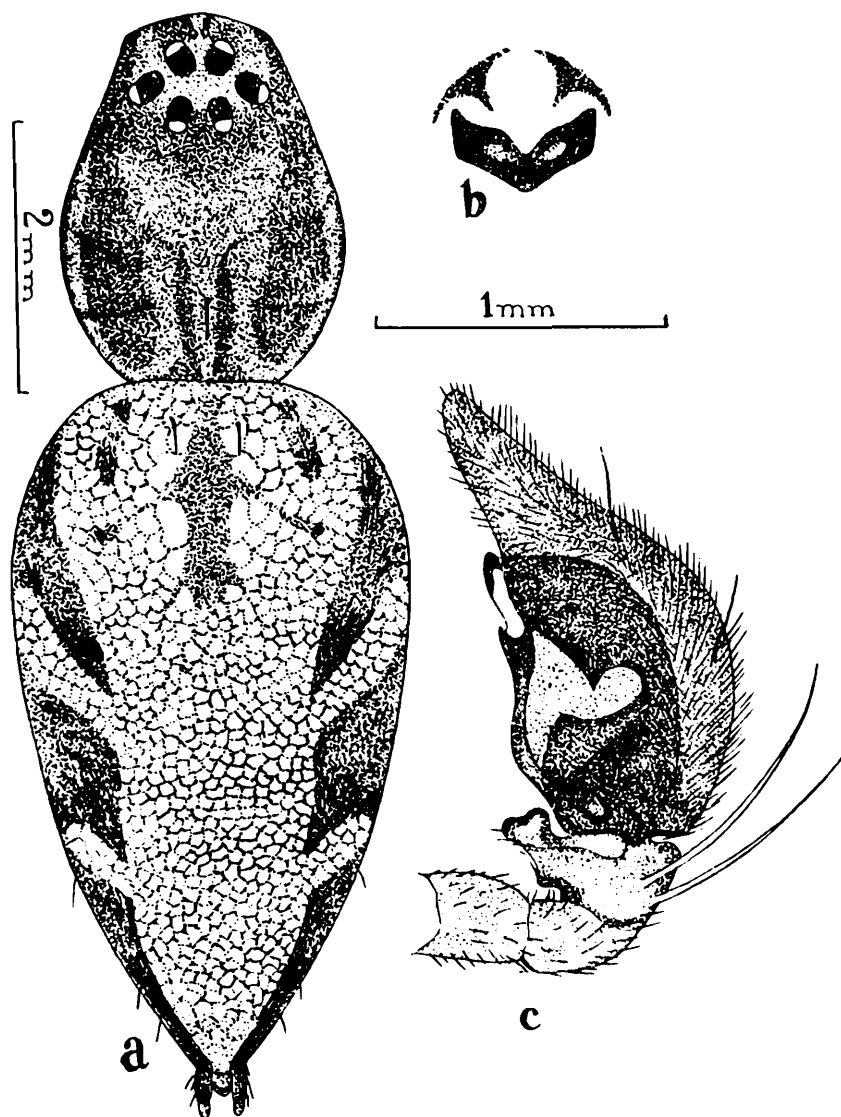
General.—Cephalothorax and legs brownish-green, abdomen dirty white. Total length 10.00 mm. Carapace 3.50 mm. long, 3.00 mm. wide; abdomen 7.00 mm. long, 4.00 mm. wide.

Cephalothorax.—Longer than wide, convex, cephalic region slightly high, clothed with short spatulate deep brown hairs; centre of thorax provided with fine fovea. Eyes posterior row procurved and situated in equal distance, base of each eye encircled with a black patch. Clypeus long and provided with two black lines extending from anterior median eyes to near the base of fang of chelicerae. Sternum heart-shaped, pointed behind, clothed with hairs and spines. Legs long and strong, clothed with hairs and conspicuous long spines, upper side of femora of all legs provided with a longitudinal deep brown line.

Abdomen.—Longer than wide, narrowing behind, clothed with fine and some spatulate hairs. Lateral sides with deep brown patch and mid-dorsally with a dirty-white longitudinal broad patch, posterior half with dirty-white chevrons. Ventral side uniform dirty white but middle provided with conspicuous longitudinal broad black line,

extending from epigastric fold to base of spinners. Epigyne as in text-fig. 42, b. Male smaller than female, male palp as in text-fig. 42, c.

Holotype one female. *Paratypes*, two females and *Allotypes*, two males in spirit.



TEXT-FIG. 42. *Oxyopes ratnae* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne. (c) Male palp.

Type-locality.—Legship, West Sikkim, 1.10.1959. Coll. B. K. Tikader.

This species resembles *Oxyopes rufisternis* Pocock from India but it is separated as follows : (i) Cephalothorax brownish-green and clothed with short spatulate deep brown hairs but in *O. rufisternis* cephalothorax deep mahogany brown and clothed with white hairs. (ii) Abdomen dirty white, clothed with some spatulate deep brown hairs but in *O. rufisternis* abdomen olive yellow above varied with white and reddish hairs. (iii) Epigyne and male palp structurally different.

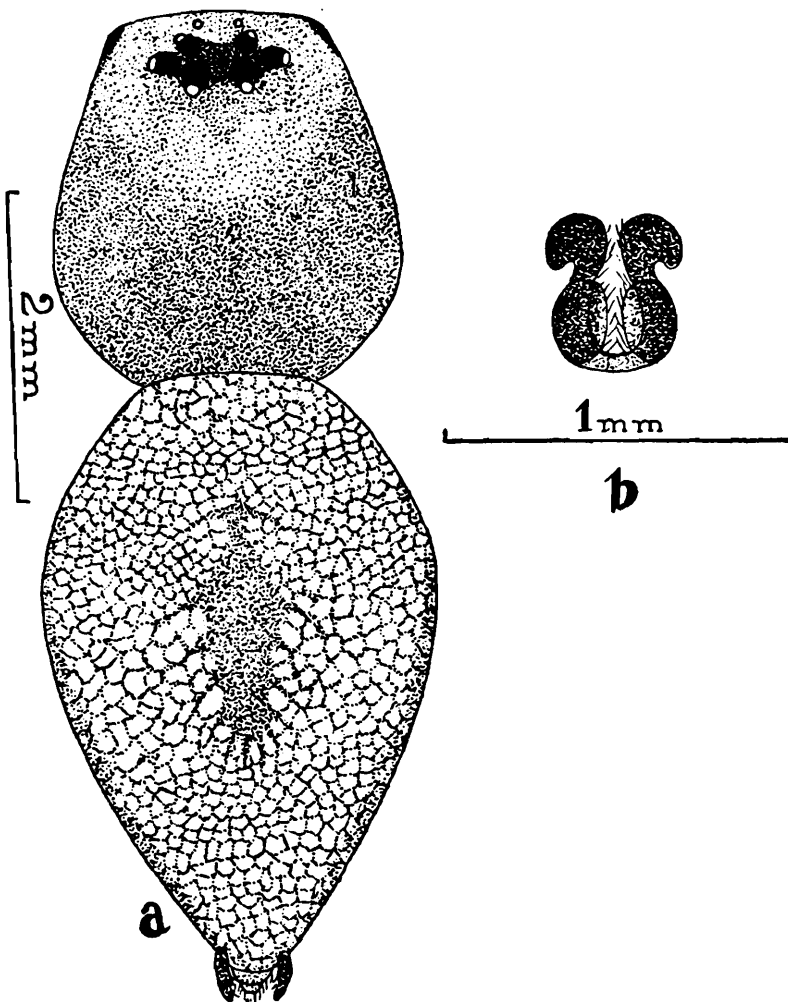
59. *Oxyopes subhadrae* sp. n.

General.—Cephalothorax and legs brownish-green, abdomen dirty white. Total length 8.00 mm. Carapace 3.30 mm. long, 2.60 mm. wide ; abdomen 5.00 mm. long, 3.40 mm. wide.

Cephalothorax.—Longer than wide, convex, clothed with fine hairs, cephalic region slightly high and broad, centre provided with sharp fine fovea. Eyes posterior row strongly recurved, middle eyes small, base of each eye encircled by a black patch and rest of the ocular area blackish in appearance. Clypeus long, clothed with grey hairs. Sternum heart-shaped, pointed behind, clothed with fine hairs. Legs long and strong, clothed with fine hairs and conspicuous long spines.

Abdomen.—Longer than wide, narrowing behind, clothed with fine hairs, mid-dorsally with a lance-shaped brown patch and all over the abdomen provided with irregular net-like white minute patches as in text-fig. 43, a. Ventral side uniform light brown colour and clothed with short and stout deep brown hairs. Epigyne as in text-fig. 43, b.

Holotype one female in spirit.



TEXT-FIG. 43. *Oxyopes subhadrae* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne.

Type-locality.—Legship, West Sikkim, 1.10.1959. Coll B. K. Tikader.

This species resembles the foregoing species i.e. *Oxyopes ratnae* but it is separated as follows : (i) Cephalothorax in front slightly high and broad, clothed with fine hairs but in *O. ratnae* cephalothorax in front slightly narrow and clothed with short spatulate deep brown hairs. (ii) Abdomen provided with uniform net-like white patches and mid-dorsally with a lance-shaped brown patch but in *O. ratnae* abdomen laterally

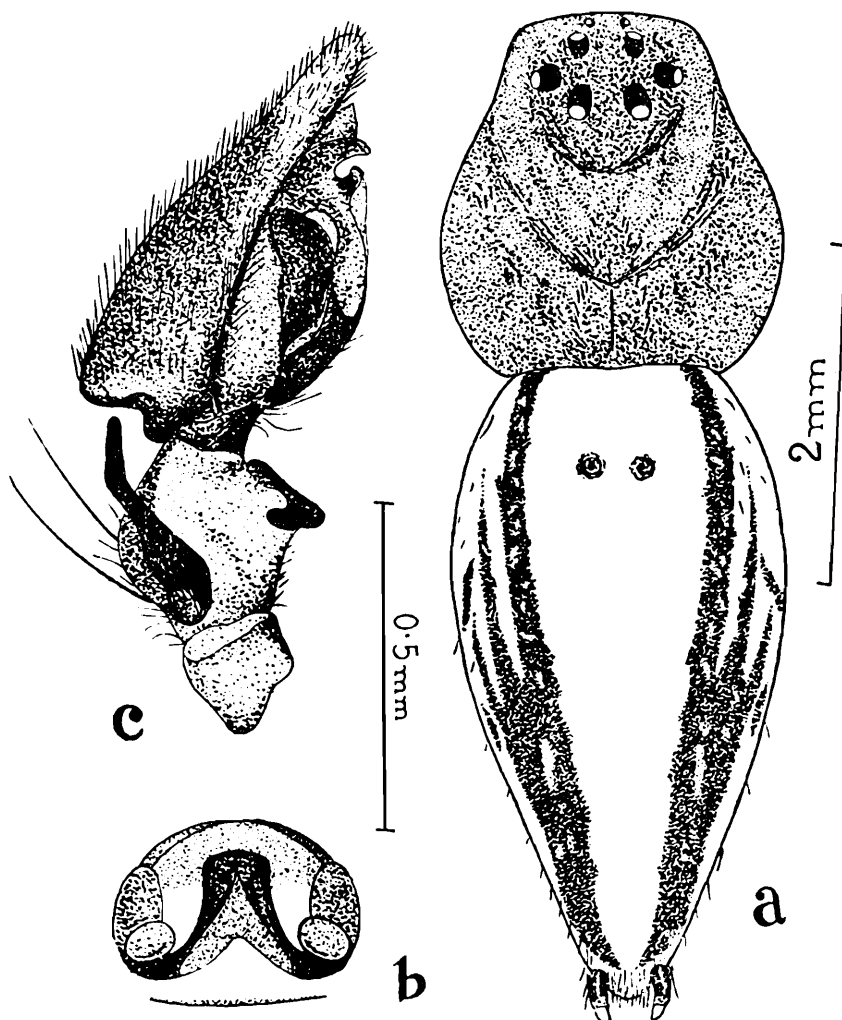
provided with deep brown marking and clothed with some spatulate hairs. (iii) Epigyne structurally different.

60. *Oxyopes sakuntalae* sp. n.

General.—Cephalothorax, legs and abdomen brownish-green. Total length 8.50 mm. Carapace 3.20 mm. long, 2.50 mm. wide; abdomen 5.50 mm. long, 2.40 mm. wide.

Cephalothorax.—Slightly longer than wide, convex, cephalic region slightly high and broad, clothed with fine hairs, centre provided with sharp fovea. Eyes pearly white, posterior row procurved and situated at equal distance, base of each eye encircled with a black patch. Anterior row strongly recurved and middle eyes small. Clypeus long and provided with two black lines extending from anterior median eyes to near the base of fang of chelicerae. Sternum oval, pointed behind, clothed with fine hairs and spines. Legs long and strong, clothed with fine hairs and conspicuous long spines, all legs provided with longitudinal deep-brown discontinuous lines, one situated dorsally and one ventrally.

Abdomen.—Broad, longer than wide, narrowing behind, clothed with fine hairs; lateral sides provided with an irregular longitudinal broad line, extending from base to end of abdomen. Ventral side uniform pale colour but middle provided with a conspicuous longitudinal broad black line extending from epigastric fold to base of spinners. Epigyne as in text-fig. 44, b. Male like female, male palp as in text-fig. 44, c.



TEXT-FIG. 44. *Oxyopes sakuntalae* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne. (c) Male palp.

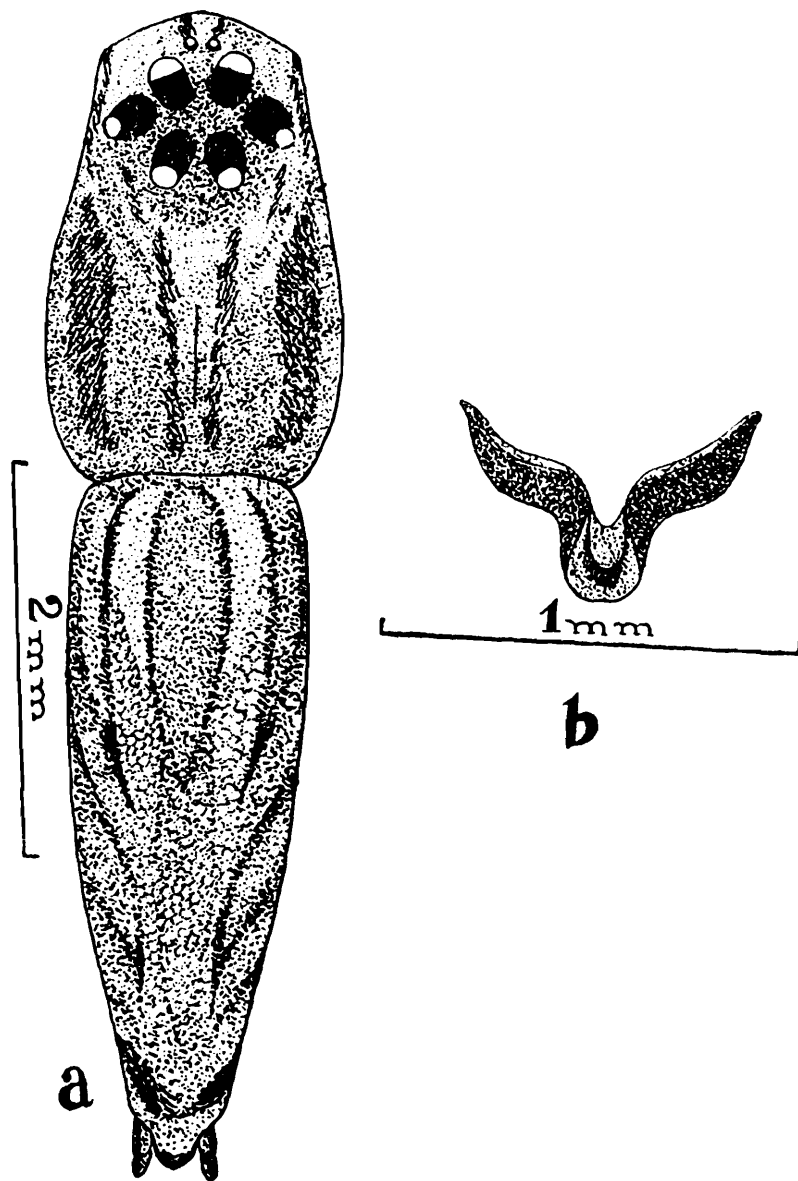
Holotype one female. *Paratypes*, two females. *Allotype*, one male in spirit.

Type-locality.—Bhudbari, Dist. Darjeeling, West Bengal, India. 15.9.1959. Coll. B. K. Tikader.

This species resembles *Oxyopes ratnae*, but it is separated as follows: (i) Cephalothorax slightly high in front and broad, clothed with fine hairs but in *O. ratnae* cephalothorax slightly narrow in front and clothed with short spatulate deep brown hairs. (ii) Abdomen brownish-green lateral sides provided with an irregular longitudinal black line extending from base to end of abdomen and clothed with fine hairs but in *O. ratnae* abdomen dirty white with irregular net-like minute patches clothed with some spatulate deep brown hairs. (iii) Epigyne and male palp also structurally different.

61. *Oxyopes sunandae* sp. n.

General.—Cephalothorax and legs light brownish-green; abdomen dirty-white. Total length 8.00 mm. Carapace 3.60 mm. long, 2.80 mm. wide; abdomen 4.50 mm. long, 2.00 mm. wide.



TEXT-FIG. 45. *Oxyopes sunandae* sp. n. (a) Dorsal view of female, legs omitted.
(b) Epigyne.

Cephalothorax.—Longer than wide, convex, clothed with fine hairs and some deep-brown special type of blunt or spatulate hairs mainly on the thoracic region as in text-fig. 45, a. and centre of thorax with fine fovea. Eyes pearly white, posterior row procurved and situated in equal distance and anterior row strongly recurved, anterior lateral eyes large and medians small; base of each eye encircled with a black patch. Clypeus long, provided with two black lines, extending from anterior median eyes to near the base of fang of chelicerae. Sternum heart-shaped pointed behind, clothed with fine hairs and conspicuous long spines, lower side of femora of all legs provided with a longitudinal black line.

Abdomen.—Long, narrowing behind, clothed with fine grey hairs, anterior mid-dorsally with a lance-shaped yellowish-brown patch, lateral sides provided with longitudinal deep-brown discontinuous lines. Ventral side pale-yellowish colour but middle provided with a conspicuous deep-brown broad longitudinal line, extending from epigastric fold to spinners. Epigyne as in text-fig. 45, b.

Holotype one female. *Paratype*, one female in spirit.

Type-locality.—Legship, West Sikkim, 1.10.1959. Coll. B. K. Tikader.

This species resembles the foregoing species i.e. *Oxyopes sakuntalae* but it is separated as follows: (i) Cephalothorax much longer than wide, clothed with fine hairs and some deep-brown special type of blunt hairs mainly on the thoracic region but in *O. sakuntalae* cephalothorax slightly longer than wide clothed with fine hairs. (ii) Abdomen narrow clothed with fine grey hairs, anterior mid-dorsally with a lance-shaped yellowish-brown patch and lateral sides provided with longitudinal deep brown discontinuous lines but in *O. sakuntalae* abdomen longer than wide, lateral sides provided with an irregular longitudinal black broad line extending from base of end of abdomen. (iii) Epigyne structurally different.

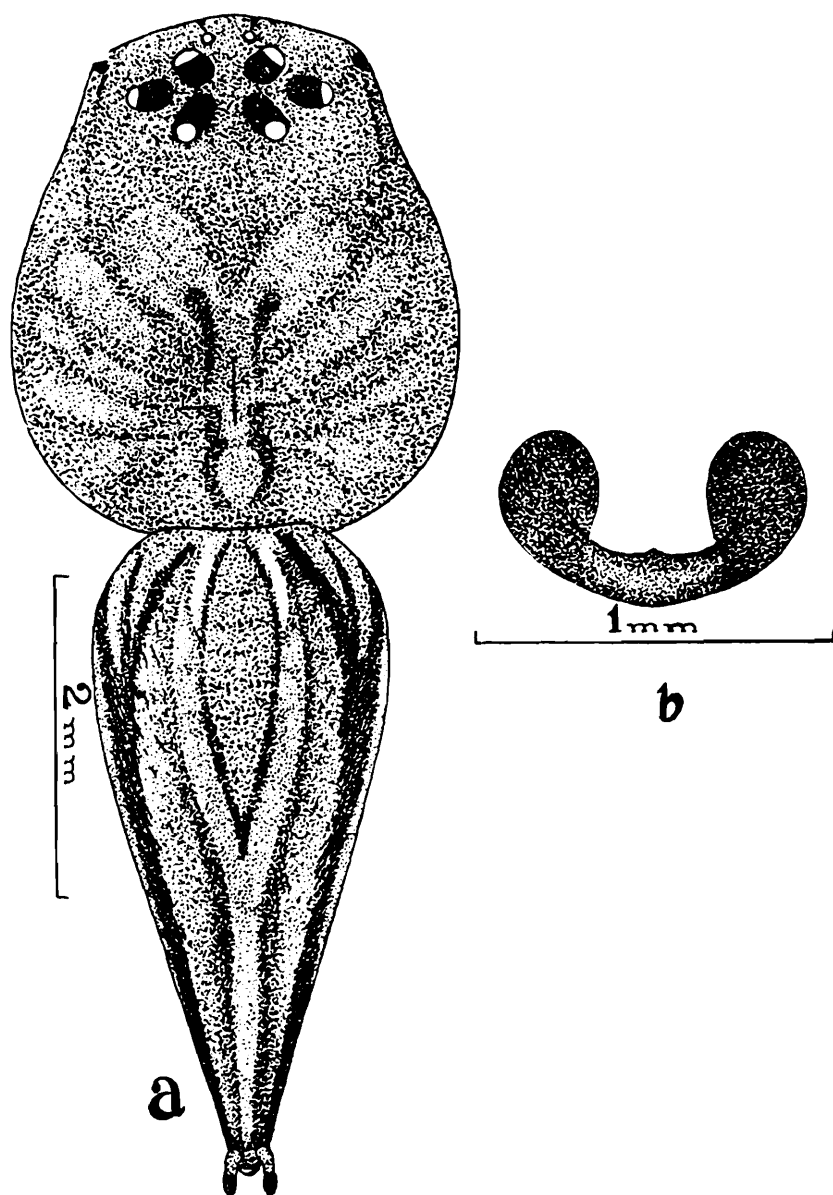
62. *Oxyopes sitae* sp. n.

General.—Cephalothorax and legs brownish-green, abdomen pale-brown. Total length 11.60 mm. Carapace 5.20 mm. long, 4.00 mm. wide; abdomen 7.00 mm. long, 2.00 mm. wide.

Cephalothorax.—Longer than wide, convex, cephalic region high and broad, clothed with fine hairs; centre of thorax with a sharp fovea. Eyes posterior row procurved and situated at equal distance, base of each eye encircled with a black patch. Clypeus long and provided with two black lines extending from anterior median eyes to near the base of fang of chelicerae. Sternum heart-shaped, pointed behind, clothed with fine hairs and spines. Legs long and strong, clothed with fine hairs and conspicuous long spines; lower side of femora of all legs provided with two and dorsal side of patella and tibiae with one conspicuous longitudinal black line.

Abdomen.—Long, narrowing behind, clothed with fine grey and dark hairs. Anterior mid-dorsally with a lance-shaped black patch and lateral sides provided with longitudinal black line extending from base to end of abdomen. Ventral side uniform pale colour but middle

provided with a conspicuous longitudinal broad black line extending from epigastric fold to spinners. Epigyne as in text-fig. 46, b.



TEXT-FIG. 46. *Oxyopes sitae* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne.

Holotype one female in spirit.

Type-locality.—Rothak, near Nayabazar, West Sikkim, 24.9.1959. Coll. B. K. Tikader.

This species also resembles *Oxyopes sakuntalae* but it is separated as follows: (i) Cephalothorax in front high and broader than in *O. sakuntalae*. (ii) Abdomen narrower than in *O. sakuntalae*. (iii) Epigyne also structurally different.

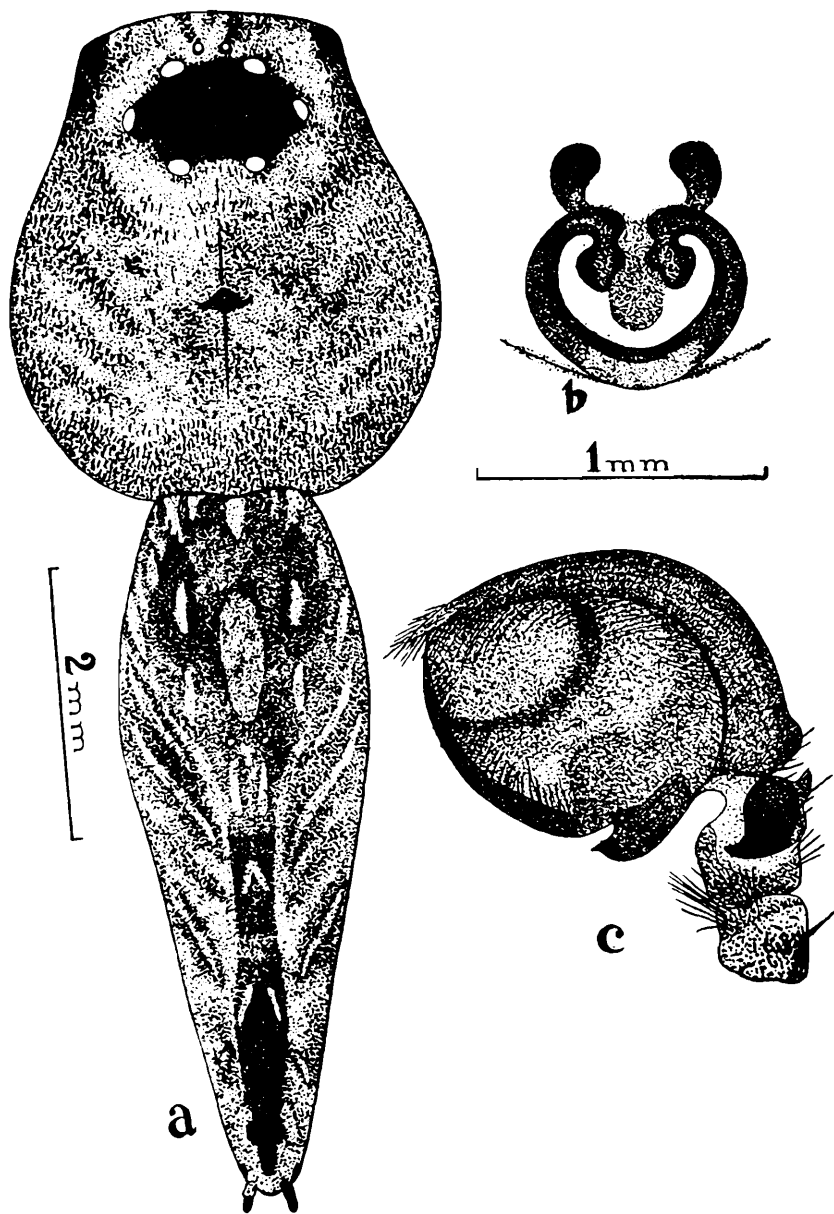
63. *Oxyopes sikkimensis* sp. n.

General.—Cephalothorax and legs brownish-green, abdomen blackish. Total length 14.50 mm. Carapace 6.00 mm. long, 5.00 mm. wide; abdomen 9.50 mm. long, 1.90 mm. wide.

Cephalothorax.—Slightly longer than wide, convex, cephalic region,

high, clothed with short and blunt deep brown hairs. Eyes posterior row procurved and situated at equal distance, anterior row strongly recurved, middle eyes small, ocular area with conspicuous black patch. Clypeus long, clothed with similar hairs like cephalothorax, lateral end of margin with a black spot. Sternum heart-shaped, pointed behind, clothed with hairs and small spines. Legs long and strong, clothed with hairs and conspicuous long spines; front side of each femora provided with a longitudinal deep-brown line.

Abdomen.—Long, narrowing behind, clothed with fine grey and brown hairs; dorsum provided with irregular dirty-white and deep-brown bars. Ventral side uniform light-brown colour, but middle provided with two conspicuous blackish lines, extending from epigastric fold to base of spinners and end of two lines join together near the spinners. Epigyne as in text-fig. 47, b. Male almost similar but smaller than female, male palp as in text-fig. 47, c.



TEXT-FIG. 47. *Oxyopes sikkimensis* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne. (c) Male palp.

Holotype one female. *Paratypes*, four females. *Allotypes*, two males in spirit.

Type-locality.—Legship, West Sikkim, 2.10.1959. *Allotype*, from Nayabazar, West Sikkim, 2.10.1959. Coll. B. K. Tikader.

This species resembles *Oxyopes sitae* but it is separated as follows : (i) Cephalothorax clothed with short and blunt deep brown hairs and ocular area with conspicuous black patch but in *O. sitae* cephalothorax clothed with fine hairs and ocular area no such black patch. (ii) Abdomen provided with irregular dirty white and deep brown bars but in *O. sitae* abdomen lateral sides provided with longitudinal black line extending from base to end of abdomen. (iii) Epigyne structurally different.

64. *Oxyopes shweta* sp. n.

General.—Cephalothorax and legs light brownish-green, abdomen chalk-white. Total length 12.00 mm. Carapace 4.90 mm. long, 3.50 mm. wide ; abdomen 8.50 mm. long, 2.50 mm. wide.

Cephalothorax.—Longer than wide ; convex, cephalic region high, clothed with fine hairs, posterior lateral side of thorax provided with patches of deep brown, short and blunt hairs ; two longitudinal black lines of either side of cephalic region ; centre of thorax with a prominent fovea. Eyes posterior row procurved and situated at equal distance, base of each eye encircled with a black patch. Anterior row strongly recurved, anterior lateral eyes larger and median smaller. Clypeus long, and provided with two black lines extending from anterior median eyes to near the base of fang of chelicerae. Sternum oval, pointed behind, clothed with fine hairs. Legs long and strong, clothed with fine hairs and conspicuous long spines, ventral side of femora of all legs provided with a longitudinal black line.

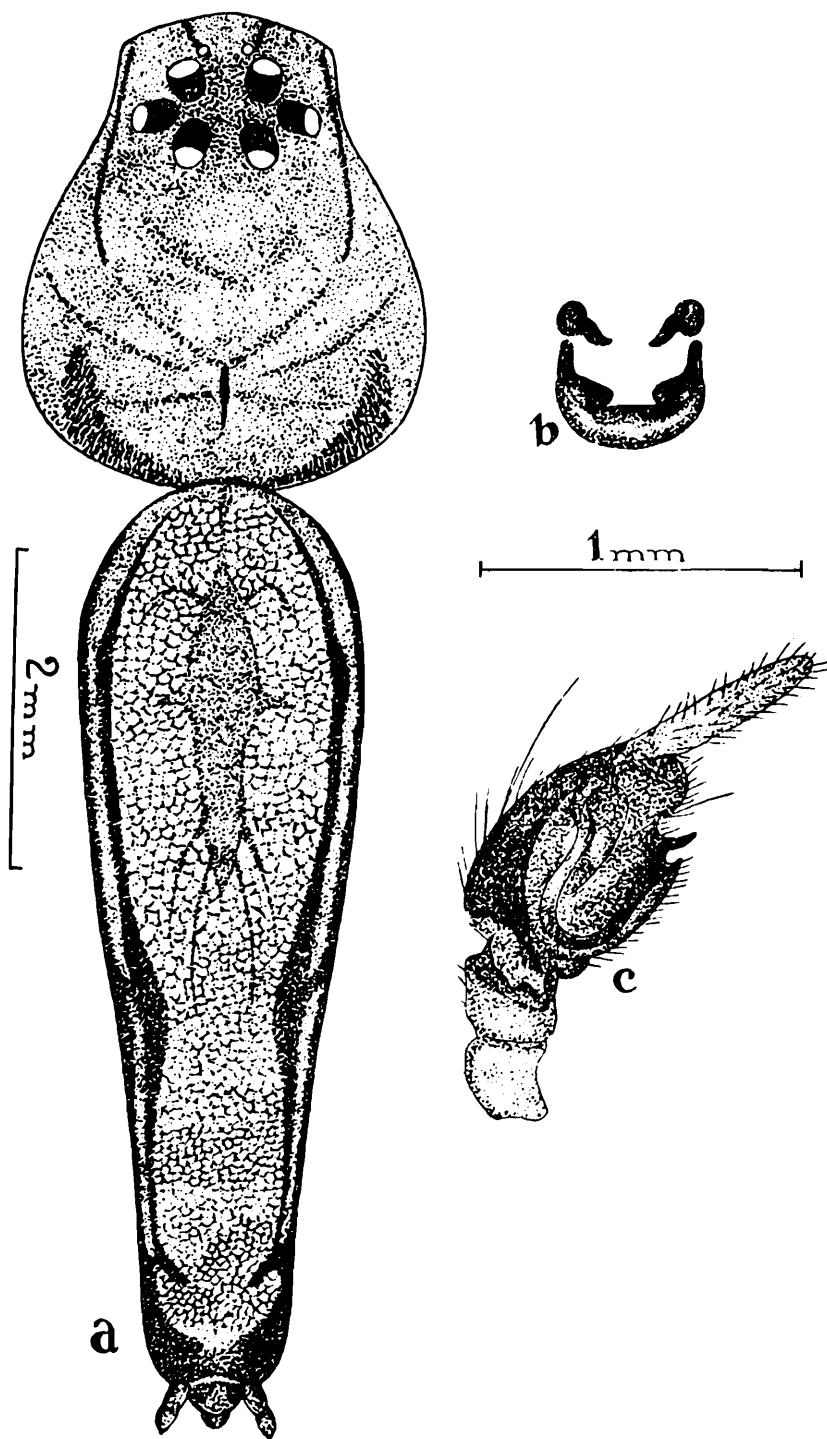
Abdomen.—Long, narrowing behind, anterior mid-dorsally, with a lance-shaped brown patch ; lateral sides with longitudinal blackish line extending from base to end of abdomen ; dorsum with minute net-like chalkwhite patches. Ventral side similar chalk-white nets but middle provided with a longitudinal broad brown line extending from epigastric fold to spinners. Epigyne as in text-fig. 48, b.

Male almost similar like female, but smaller in size ; male palp as in text-fig. 48, c.

Holotype one female. *Paratypes*, three females. *Allotype*, one male in spirit.

Type-locality.—Manjithar, West Sikkim, 22.9.1959, Coll. B. K. Tikader.

This species resembles *Oxyopes sikkimensis* but it is separated as follows : (i) Cephalothorax narrow in front, clothed with fine hairs, posterior lateral sides of thorax provided with patches of deep brown, short and blunt hairs but in *O. sikkimensis* cephalothorax broad in front, clothed with deep brown short and blunt hairs only. (ii) Base of eyes with black patch but in *O. sikkimensis* entire ocular area with conspicuous black patch. (iii) Abdomen chalkwhite and lateral sides with longitudinal blackish line extending from base to end of abdomen but in *O. sikkimensis* abdomen blackish with irregular dirty white and deep brown hairs. (iv) Epigyne also structurally different.



TEXT-FIG 48. *Oxyopes shweta* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne. (c) Male palp.

Genus 33. *Peucetia* Thorell

1869. *Peucetia* Thorell, *On European Spiders*, Uppsala, 7, p. 196.
 1940. *Peucetia* : Comstock and Gertsch, *The Spider Book*, New York, p. 666.
 1964. *Peucetia* : Brady, *Bull. Mus. Comp. Zool.*, Harvard, 131(13) pp. 505-518.

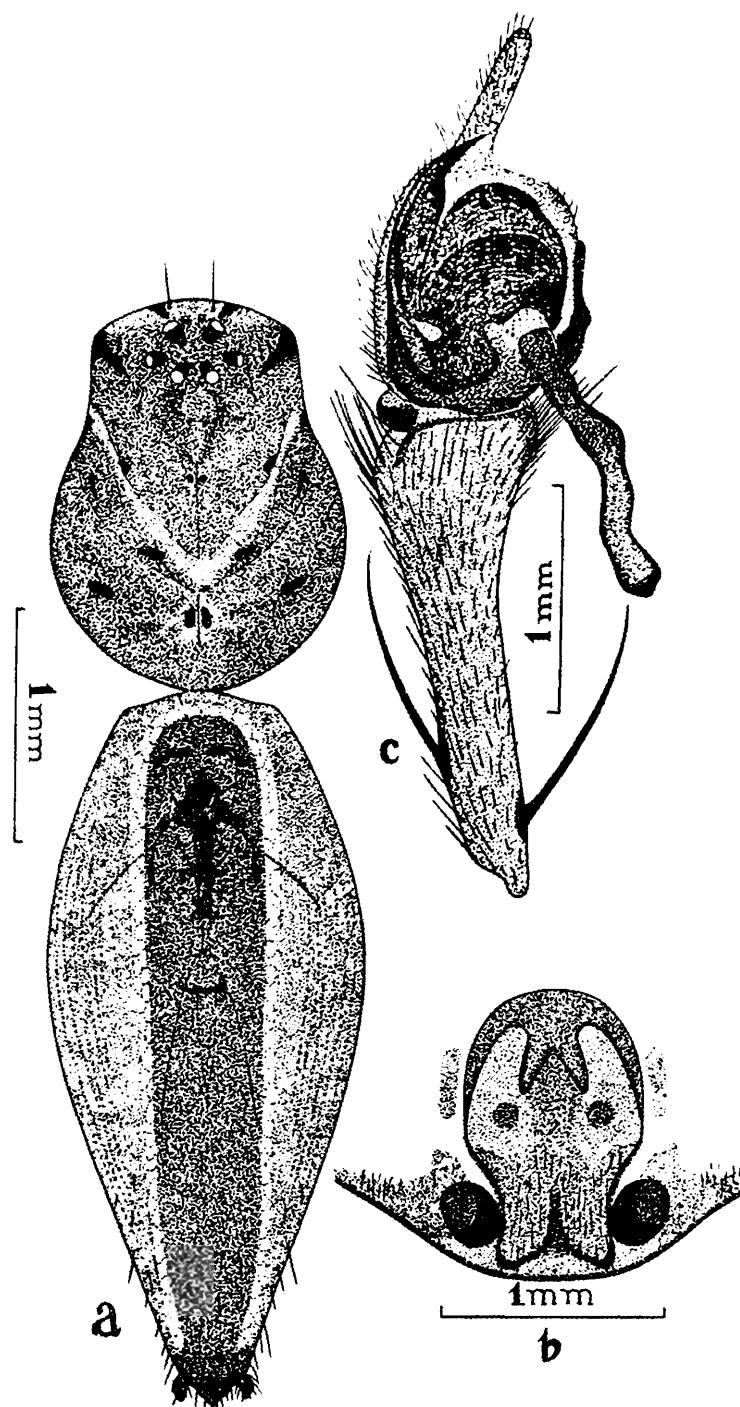
Characters.—Anterior median eyes smallest ; posterior lateral eyes forming a slightly procurved row, not so procurved as in *Oxyopes*, Latreille. Cephalothorax not so high or convex as that of *Oxyopes*. Male palp with characteristic paracymbial process in each species, sometimes partly broken off during mating.

Type-species.—*Peucetia viridis* Blackwall.

Distribution.—Europe, Africa, Asia and America.

65. *Peucetia latikae* sp. n.

General.—Cephalothorax, legs and abdomen green. Total length 20.00 mm. Carapace 7.00 mm. long, 5.00 mm. wide ; abdomen 13.00 mm. long, 6.00 mm. wide



TEXT-FIG. 49. *Peucetia latikae* sp. n. (a) Dorsal view of female, legs omitted. (b) Epigyne. (c) Male palp.

Cephalothorax.—Longer than wide, moderately high provided with conspicuous black spots and cephalic region high and broad clothed with a few spines, centre provided with a sharp fovea. Eyes posterior row

slightly procurved and situated in equal distance, bases of all eyes encircled by black patch. Anterior row strongly recurved and middle eyes small. Clypeus long and provided with four black lines extending from ocular area to near the base of fang of chelicerae. Sternum oval, pointed behind, clothed with spiny hairs. Legs long and strong, clothed with conspicuous black spots and black long spines.

Abdomen.—Long, narrowing behind, clothed with fine hairs; mid-dorsally with a longitudinal broad brown band and this band encircled by a white line as in text-fig. 49, c. Ventral side more light colour than dorsal. Epigyne as in text-fig. 49, b. Male like female, male palp as in text-fig. 49, c.

Holotype one female. *Paratype*, one female. *Allotype*, one male in spirit.

Type-locality.—Manjithar, West Sikkim, 22.9.1959. Coll. B. K. Tikader.

This species is closely related to *Peucetia viridans* (Hentz) from America but it is separated as follows: (i) Cephalothorax provided with conspicuous black spots but in *P. viridans* cephalothorax without black spot. (ii) Legs provided with conspicuous black spots and black spines but in *P. viridans* legs provided with long spines and only femora provided with black spots. (iii) Epigyne and male palp also differs.

III—ACKNOWLEDGEMENTS

I take this opportunity of expressing my sincere thanks to Dr. M. L. Roonwal, Director, Zoological Survey of India, Calcutta, for placing the valuable collection of spiders from Sikkim, available for my studies. I am indebted to Dr. M. S. Mani, Deputy Director, Zoological Survey of India, Calcutta, for constant encouragement in research work and for going through the manuscript and offering valuable suggestions. I am also thankful to Dr. F. Schmid, member of the Swiss Zoological party of this Expedition, for numerous courtesies. The illustrations used in this paper are prepared by Shri Sitaram Mandal, Artist, to whom thanks are also due.

IV—SUMMARY

Sixty-five species of spiders are described in this paper. Of these, 20 are known and 45 are new to science. The new species belong to 33 genera distributed in the families Uloboridae, Homalonychidae, Theridiidae, Linyphidae, Argiopidae, Thomisidae, Agelenidae, Hahniidae, Pisauridae, Lycosidae and Oxyopidae.

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FISH FAUNA OF THE KUMAON HILLS

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I—INTRODUCTION

The Kumaon lakes are of considerable importance for fishing as well as entertainment. Angling is very popular here and provides good sport but our knowledge about the fish fauna of Kumaon hills is scanty. Day (1878, 1889) was the first to undertake the scientific survey of the fishes of India and published his work in two volumes. Walker (1888) recorded five species from the Nainital lake. Hora (1937*a,b,c*) recorded seventeen species of fishes belonging to different families from Kumaon hills. His collections were mainly from lower waters of Nandhaur and Kalaunia rivers and from Kosi river near Khairna. Menon (1949 *a, b*) gave a list of twentythree species of fishes from the lake and rivulets of Nainital. He also collected fishes from Kosi river (Khairna) and from Almora proper. Menon (1954, 1962) published a long list of fishes from the Himalayas. This is based on a collection from 'Assam Himalayas', 'Nepal Himalayas', 'Punjab Himalayas' and 'Kumaon Himalayas'

As the fish fauna so far described from the Kumaon Himalayas is mainly from Nainital district, it was considered desirable to make an extensive collection from Almora and Pithoragarh districts of this region (Table I). The fishes were collected during the period 1963-64 and were brought to the Zoological Laboratories of this College for identification. The present paper also includes a brief report on the methods employed by the local people for catching fishes.

II—LOCALITIES SURVEYED

The following localities were not easily accessible in the past due to which an account of the fish fauna of this area is not available. An extension of the transport facilities to these hilly areas helped in the collection of fishes from these places for the first time.

<i>River</i>	<i>Place of collection</i>	<i>Elevation above sea level</i>
(A) <i>Almora District</i>		(Meters)
1. Sarju	Bageshwar	1579
2. Western Ram Ganga	Chaukhutia	976
	Bhikiasan	1036
3. Kosi	Someshwar	1066
	Hawalbagh	1194

4. Garur Ganga	Garur (Bajinath)	1080
5. Gomati	Bageshwar	1579
	Garur (Bajinath)	1080
6. Lohawati	Lohaghat	1679
7. Gagas	Gagas	975
8. Suyal	Almora	1584

(B) *Pithoragarh District*

1. Dhauli	Tawaghat	914
2. Kali	Dharchula	914
	Balua Koat	1066
	Jauljibi	890
3. Gori	Jauljibi	890
4. Eastern Ram Ganga	Thal	1066
	Gangolihat	1584
	Rameshwar Ghat	1036
5. Charma Gar	Askote	1219
6. Small Ponds at	Berinag	1554
	Barechina	1993
	Gangolihat	1584

III — SYSTEMATIC LIST OF SPECIES

Tor tor (Hamilton)

1822. *Cyprinus tor* Hamilton, *Fish Ganges*, pp. 305, 388. (*Type-locality*: Mahanada)

1959. *Tor tor* : Misra, *Rec. Indian Mus.*, 57 (1-4), p. 150.

Local Name.—Mahaseer.

Specimens examined.—15 specimens, from Almora and Pithoragarh districts, 200 mm. to 525 mm. in Standard length.

Distribution.—Fresh waters of East Punjab, U.P., Western and Eastern Himalayas, Nepal, Darjeeling, West Bengal and Assam. This is the first record from the Pithoragarh district.

Tor putitora (Hamilton)

1822. *Cyprinus putitora* Hamilton, *Fish Ganges*, pp. 303, 388. (*Type-locality* Eastern parts of Bengal).

1959. *Tor putitora* : Misra, *Rec. Indian Mus.*, 57 (1-4), p. 150.

Local Name.—Mahaseer.

Specimens examined.—13 specimens, from Almora and Pithoragarh districts, 250 mm. to 500 mm. in Standard length.

Distribution.—East Punjab, Assam, Western and Eastern Himalayas, Darjeeling, Kumaon Himalayas, U.P. and West Bengal. This is the first record from the Pithoragarh district.

Puntius chilinoides (McClelland)

1807. *Barbus chilinoides* McClelland, *Indian Cyprinidae*, pp. 271, 340.

1962. *Puntius chilinoides* : Menon, *J. zool. Soc. India*, 14 (1-2), p. 26.

Local Name.—Karnchula.

Specimens examined.—75 specimens, from Almora and Pithoragarh districts, 125 mm. to 225 mm. in Standard length.

Distribution.—All along the Himalayas, Darjeeling, U.P., Kumaon Himalayas and Assam. This is the first record from the Pithoragarh district.

***Puntius ticto* (Hamilton)**

1822. *Cyprinus ticto* Hamilton, *Fish Ganges*, p. 314.

1959. *Puntius ticto* : Misra, *Rec. Indian Mus.*, 57 (1-4), p. 156.

Local Name.—Dumrua.

Specimens examined.—50 specimens, from Almora and Pithoragarh districts, 37 mm. to 80 mm. in Standard length.

Distribution.—It is reported from throughout India. This is the first record from Pithoragarh district.

***Puntius conchoni* (Hamilton)**

1822. *Cyprinus conchoni* Hamilton, *Fish Ganges*, p. 317.

1959. *Puntius conchoni* : Misra, *Rec. Indian Mus.*, 57 (1-4), p. 152.

Local Name.—Dumrua.

Specimens examined.—32 specimens, from Almora and Pithoragarh districts, 51 mm. to 102 mm. in Standard length.

Distribution.—Freshwaters of East Punjab, U.P., Western and Eastern Himalayas, Bihar, West Bengal and Assam. This is the first record from Almora and Pithoragarh district.

***Puntius gelius* (Hamilton)**

1822. *Cyprinus gelius* Hamilton, *Fish Ganges*, pp. 320, 390.

1962. *Puntius gelius* : Menon, *J. zool. Soc. India*, 14 (1-2), p. 26.

Local Name.—Dumrua.

Specimens examined.—7 specimens from Almora district, 30 mm. to 75 mm. in Standard length.

Distribution.—Orissa, Bengal, and Assam.

***Crossocheilus latius* (Hamilton)**

1822. *Cyprinus latius* Hamilton, *Fish Ganges*, pp. 345, 393.

1959. *Crossocheilus latius latius* : Misra, *Rec. Indian Mus.*, 57 (1-4), p. 169.

Local Name.—Saknera.

Specimens examined.—17 specimens, from Almora district, 115 mm. to 200 mm. in Standard length.

Distribution.—Hill streams, from plains to 1000 m., U.P., Bihar and West Bengal. This is the first record from Almora district.

***Schizothorax plagiostomus* (Heckel)**

1838. *Schizothorax plagiostomus* Heckel, *Fische aus Cashmir*, p. 16.

Specimens examined.—20 specimens, from Almora and Pithoragarh districts, 115 mm. to 300 mm. in Standard length.

Distribution.—Afghanistan, Kashmir and Bhutan. This is the first record from Pithoragarh district.

***Schizothorax sinuatus* (Heckel)**

1838. *Schizothorax sinuatus* Heckel, *Fische aus Caschmir*, p. 21.

Specimens examined.—3 specimens from Almora and Pithoragarh

districts, 100 mm. to 225 mm. in standard length.

Distribution.—Himalayan rivers, but not extending in the plains to far from their bases. This is the first record from Pithoragarh.

Schizothorax richardsoni (Gray & Hardwicke)

1832. *Cyprinus richardsoni* Gray & Hardwicke, *Illust. Ind. Zoology*.

1962. *Schizothorax richardsonii* : Menon, *J. zool. Soc. India*, **14** (1-2), p. 27.

Specimens examined.—15 specimens, from Almora and Pithoragarh districts, 125 mm. to 550 mm. in standard length.

Distribution.—Sub-Himalayan range, Darjeeling, Bhutan and Nepal. This is the first record from Pithoragarh district.

Garra gotyla gotyla (Gray)

1832. *Cyprinus gotyla* Gray, *Ill. Indian Zool.*, London, **1**, p. 88, Figs. 3, 3a.

1964. *Garra gotyla gotyla* : Menon, *Mem. Indian Mus.*, **14**, p. 233.

Local Name.—Bhagnera.

Specimens examined.—13 specimens, from Almora and Pithoragarh districts, 80 mm. to 225 mm. in standard length.

Distribution.—Assam all along the Himalayas, Chota Nagpur plateau and the Vindhya-Satpura mountains of the Peninsula. Extends to Burma and West Punjab in West Pakistan. This is the first record from the Almora and Pithoragarh districts.

Garra lamta (Hamilton)

1822. *Cyprinus lamta* Hamilton, *Fish Ganges*, pp. 343, 393.

1962. *Garra lamta* : Menon, *J. zool. Soc. India*, **14** (1-2), p. 27.

Local Name.—Bhagnera.

Specimens examined.—5 specimens, from Almora and Pithoragarh district, from 60 mm. to 100 mm. in standard length.

Distribution.—Throughout India. This is the first record from Pithoragarh district.

Labeo dero (Hamilton)

1822. *Cyprinus dero* Hamilton, *Fish Ganges*, p. 277.

1959. *Labeo dero* : Misra, *Rec. Indian Mus.*, **57** (1-4), p. 161.

Local Name.—Unera.

Specimens examined.—15 specimens, from Almora and Pithoragarh districts, 175 mm. to 250 mm. in standard length.

Distribution.—Assam, Darjeeling, Western and Eastern Himalayas, East Punjab, U.P., and Kumaon Himalayas. This is the first record from Pithoragarh district.

Labeo dyocheilus (McClelland)

1807. *Cyprinus dyocheilus* McClelland, *Indian Cyprinidae*, p. 268.

1962. *Labeo dyocheilus* : Menon, *J. zool. Soc. India*, **14** (1-2), p. 27.

Local Name.—Unera.

Specimens examined.—3 specimens, from Almora district, 152 mm. to 200 mm. in standard length.

Distribution.—All along the Himalayas, U.P., (Dehra Dun) and Sind Hills.

Barilius barna (Hamilton)

1827. *Cyprinus barna* Hamilton, *Fish Ganges*, pp. 268, 384.

1889. *Barilius barna* : Day, *Fauna Brit. India*, Fish, 1, p. 592.

Local Name.—Dhaur.

Specimens examined.—7 specimens from Almora district, 75 mm. to 135 mm. in standard length.

Distribution.—Assam, Bengal, U.P., and Orissa.

Barilius bendelisis (Hamilton)

1807. *Cyprinus bendelisis* Hamilton, *Journey Mysore*, 3, p. 345.

1959. *Barilius bendelisis* : Misra, *Rec. Indian Mus.*, 57 (1-4), p. 141.

Local Name.—Dhaur.

Specimens examined.—32 specimens from Almora and Pithoragarh districts, 75 mm. to 152 mm. in standard length.

Distribution.—Assam, Western and Eastern Himalayas, West Bengal, Simla, Punjab, U.P., Bihar, Nilgiris and Palaghat. This is the first record from Pithoragarh district.

Barilius vagra (Hamilton)

1822. *Cyprinus vagra* Hamilton, *Fish Ganges*, pp. 269, 385.

1889. *Barilius vagra* : Day, *Fauna British India*, Fish, 1, p. 589.

Local Name.—Dhaur.

Specimens examined.—5 specimens, from Almora and Pithoragarh districts, 70 mm. to 125 mm. in standard length.

Distribution.—Himalayan and Sub-Himalayan Range, Sind Hills, Jumna and Ganges, Punjab and Assam. This is the first record from Pithoragarh district.

Noemacheilus botia Hamilton

1822. *Noemacheilus botia* Hamilton, *Fish Ganges*, pp. 350, 358, 394 & 395.

1959. *Noemacheilus botia* : Misra, *Rec. Indian Mus.*, 57, (1-4), p. 18.

Local Name.—Gadera.

Specimens examined.—22 specimens, from Almora and Pithoragarh districts, 60 mm. to 92 mm. in standard length.

Distribution.—Assam, all along the Himalayas. This is the first record from the Pithoragarh district.

Noemacheilus multifasciatus Day

1889. *Noemacheilus multifasciatus* Day, *Fauna British India*, Fish, 1, p. 617.

Local Name.—Gadera.

Specimens examined.—7 specimens, from Almora and Pithoragarh districts, 50 mm. to 97 mm. in standard length.

Distribution.—Assam and Darjeeling. This is the first record from Almora and Pithoragarh district.

Noemacheilus beavani Günther

1831. *Noemacheilus beavani* Günther, *Cat. Fish British Mus.*, 7, p. 350.

Local Name.—Gadera.

Specimens examined.—32 specimens Almora and Pithoragarh

districts, 50 mm. to 103 mm. in standard length.

Distribution.—Madras, Mysore and Orissa. This is the first record from Pithoragarh district.

Noemacheilus rupicola (McClelland)

1807. *Schistura rupicola* McClelland, *J. Asiat. Soc., Beng.*, 7, Pl. 55 and *Indian Cyprinidae*, pp. 307, 441.

1889. *Noemacheilus rupicola* : Day, *Fauna British India*, Fish, 1, p. 616.

Local Name.—Gadera.

Specimens examined.—17 specimens, from Almora and Pithoragarh districts, 75 mm. to 98 mm. in standard length.

Distribution.—All along the Himalayas, Tibet, at 16,000 ft. above the Sea level. This is the first record from Pithoragarh district.

Noemacheilus rupicola inglisi Hora

1938. *Noemacheilus rupicola inglisi* Hora, *J. Roy. Asiat. Soc. Beng.*, 3, p. 27.

Local Name.—Gadera.

Specimens examined.—8 specimens, from Almora and Pithoragarh districts, 72 mm. to 90 mm. in standard length.

Distribution.—All along the Himalayas. This is the first record from Pithoragarh district.

Botia almorhae Day

1889. *Botia almorhae* Day, *Fauna British India*, Fish, 1, p. 607.

Local Name.—Chittal.

Specimens examined.—5 specimens, from Almora district, 105 mm. to 150 mm. in standard length.

Distribution.—Kashmir, Almora, and Khasi Hills.

Homaloptera brucei Day

1867. *Homaloptera brucei* Day, *Proc. zool. Soc. Lond.*, p. 348.

Local Name.—Pathruea.

Specimens examined.—7 specimens, from Almora district, 100 mm. to 130 mm. in standard length.

Distribution.—Himalayas, Darjeeling, Assam, Madras and Bhutan. This is the first record from Almora district.

Glyptothorax pectinopterum McClelland

1807. *Glyptosternum pectinopterum* McClelland, *Cal. J. nat. Hist.*, 2, p. 587.

Local Name.—Kathruea.

Specimens examined.—25 specimens, from Almora and Pithoragarh districts, 90 mm. to 200 mm. in standard length.

Distribution.—Western and Eastern Himalayas, Punjab, Simla and Dehra Dun. This is the first record from Pithoragarh district.

Euchiloglanis hodgarti Hora

1952. *Euchiloglanis hodgarti* Hora & Silas, *Rec. Indian Mus.*, 49 (1), pp. 5-30.

Local Name.—Kathruea.

Specimens examined.—4 specimens, from Pithoragarh district,

75 mm. to 105 mm. in standard length.

Distribution.—Western and Eastern Himalayas, West Bengal, Kameng Frontier Division (NEFA). This is the first record from Pithoragarh district.

***Pseudecheneis sulcatus* (McClelland)**

1807. *Glyptosternum sulcatus* McClelland, *Cal. J. nat. Hist.*, p. 587.

1964. *Pseudecheneis sulcatus* : Jayaram & Majumdar, *J. Bombay nat. Hist. Soc.*, 61 (2), p. 586.

Local Name.—Kathrua.

Specimens examined.—100 specimens, from Pithoragarh district, 100 mm. to 200 mm. in standard length.

Distribution.—Western Himalayas and Kameng Frontier Division (NEFA). This is the first record from Pithoragarh district.

***Channa gachua* (Hamilton)**

1822. *Ophiocephalus gachua* Hamilton, *Fish Ganges*, p. 68.

1959. *Channa gachua* : Misra, *Rec. Indian Mus.*, 57 (1-4), p. 218.

Local Name.—Shoyn.

Specimens examined.—11 specimens, from Almora and Pithoragarh districts, 75 mm. to 153 mm. in standard length.

Distribution.—Freshwaters of East Punjab, Western and Eastern Himalayas, Assam, Orissa, Travancore, Madras, Bombay, Poona, West Bengal, Delhi and U.P. This is the first record from Pithoragarh district.

***Mastocembelus armatus* Lacépède**

1800. *Mastacembelus armatus* Lacépède, *Hist. Nat. Poiss*, 2, p. 283.

Local Name.—Bayan.

Specimens examined.—13 specimens, from Almora and Pithoragarh districts, 125 mm. to 885 mm. in standard length.

Distribution.—Fresh and brackish waters all over India. This is the first record from the Pithoragarh district.

***Amblyceps mangois* (Hamilton)**

1822. *Pimelodus mangois* Hamilton, *Fish Ganges*, pp. 179, 379.

1933. *Amblyceps mangois* : Hora, *Rec. Indian Mus.*, 35, pp. 617, 621.

Local Name.—Nain.

Specimens examined.—5 specimens, from Almora district, 60 mm. to 105 mm. in standard length.

Distribution.—Kangar, W Himalayas, U.P., and Darjeeling. This is the first record from Almora district.

IV—METHODS OF CATCHING FISHES

The following methods are commonly employed for catching fishes in different parts of Kumaon hills:

(a) *By bait and hooks*.—This is a simple method in which a long thread and a hook or thorn is tied to a long bamboo stick. Various types of baits are used depending upon the species of the fish.

(b) *By using hair of horse*.—A bait is not used in this method. A piece of lead about 6" to 8" in length is tied to a long thread which in turn is connected with a bamboo or a wooden stick. A number of hair with a loop at the end are tied perpendicularly to the long axis of the lead. Fishes, while swimming, get entangled inside the hair loop which gets tightened automatically.

(c) *Ghagharia net*.—It is a circular net used very commonly in all parts of the Kumaon hills and is made up of strings in the form of an umbrella. Lead weights or iron weights are tied round the net. The cord is held tightly by the hand while net is thrown into the water where it spreads and the fishes get trapped inside the net. The meshes of the net are made according to the size of the fish available in the area.

(d) *Bag net*.—It is a small rectangular net made up of strings and is called 'Phatyala' by the people. Its meshes are about 8 mm. wide and it is used for catching small fishes.

(e) *Dip net*.—A very small conical net prepared from strings or cloth, resembling an insect collecting net, is used for catching very small fishes or fry.

(f) *Kyari net*.—This is a fixed type of net and is called 'Kyari' by local people. It is fairly big in size and is made of strings and ropes. Some lead weights are tied along its lower margin. The net is stretched in the river from one bank to another and is fixed by poles and stones. A sac-like 'Bhog' commonly present in the fixed nets used elsewhere, is absent in this case. The fisherman drifts down the fishes which are ultimately caught by the net. A large number of fishes can be collected by this method.

(g) *Gowda Trap*.—This method is a unique one and is probably restricted to the hilly areas. It is in the form of a conical basket made of bamboo sticks. The mouth of this, known as 'Bhog', is kept open by means of a circular bamboo stick. This is generally used in shallow waters, streams and tributaries and is fixed during the night at selected places where the water current is fast. Fishes during downward migration get entrapped inside the 'Gowda' and cannot escape.

(h) *By hand*.—Some hill stream fishes live under the stones in stagnant and shallow water. These are caught by hand specially during summer.

(i) *Dynamiting process*.—In this process explosives are used to cause terrific shock in the water. A large number of fishes come up on the surface and float with their bellies upwards. They are then collected easily. This is a cruel method and causes a great disturbance in the water.

(j) *Damming of the pools*.—Small streams or tributaries are drained into small side pools into which the fishes enter and are collected by hand.

V—ACKNOWLEDGEMENTS

The author is grateful to Dr. A. G. K. Menon for help in the identification of some fishes of my collection. My thanks are also due to the C.S.I.R., New Delhi, for the award of a Research Fellowship. This work was carried out under the supervision of Dr. S. S. Khanna, Professor of Zoology, D.S.B. Government College, Nainital.

VI—SUMMARY

An extensive collection of fishes was made from Almora and Pithoragarh districts of the Kumaon hills during the year 1963-64. In all twenty-nine species from Almora district and twenty-three from Pithoragarh were collected and identified. The places visited for collection have been indicated. A brief account of the methods employed by the local people for catching fishes has been given.

VII—REFERENCES

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- *(Not consulted in original)

TABLE I.—LIST OF FISHES FROM ALMORA AND PITHORAGARH DISTRICTS, WITH THEIR DISTRIBUTION :—

Sl. No.	Species	Almora Dist. Rivers							Pithoragarh Dist. Rivers							Range of distribution as known at present
		Sarju	West Ram Ganga	Kosi	Garur Ganga	Gomati	Lohawati	Gagas	Suyal	Dhauri	Kali	Gori	East Ram Ganga	Charma Gar	Small ponds	
Order : CYPRINIFORMES.																
Division : CYPRINI.																
Family : CYPRINIDAE.																
1.	<i>Tor tor</i> (Hamilton)	+	+	+	—	+	+	+	—	+	+	+	+	—	—	East Punjab, U.P., Western and Eastern Himalayas, Nepal, West Bengal and Assam.
2.	<i>Tor putitora</i> (Hamilton)	+	+	+	—	+	+	+	—	+	+	+	+	—	—	East Punjab, U.P., Assam, Western & Eastern Himalayas, Darjeeling, Kumaon Himalayas, and West Bengal.
3.	<i>Puntius chilinoides</i> (McClelland)	+	+	+	+	+	+	+	+	—	—	—	+	+	—	All along the Himalayas, Darjeeling, U.P., Kumaon Himalayas and Assam.
4.	<i>Puntius ticto</i> (Hamilton)	—	+	+	+	+	+	+	+	—	—	—	—	+	+	It is reported from throughout India.
5.	<i>Puntius conchoni</i> (Hamilton)	—	+	—	+	—	—	—	+	—	—	—	—	+	+	East Punjab, U.P., Western and Eastern Himalayas, Bihar, West Bengal and Assam.
6.	<i>Puntius gelius</i> (Hamilton)	—	—	—	+	—	—	—	+	—	—	—	—	—	—	Orissa, Bengal and Assam.
7.	<i>Crossocheilus latius latius</i> (Hamilton)	—	+	+	—	—	—	—	+	—	—	—	+	+	—	Hill streams, from plains to 2000', U.P., Bihar and West Bengal.
8.	<i>Schizothorax plagiostomus</i> (Heckel)	+	+	+	—	—	—	—	—	+	+	+	—	—	—	Afghanistan, Kashmir and Bhutan.
9.	<i>Schizothorax sinuatus</i> (Heckel)	+	+	+	—	—	+	—	—	—	+	+	+	—	—	Himalayan rivers but not extending in the plains to far from their bases.
10.	<i>Schizothorax richardsoni</i> (Gray & Hardw.)	+	+	—	—	—	+	—	—	—	+	+	+	—	—	Sub Himalayan range, Darjeeling, Bhutan, and Nepal.
11.	<i>Garra gotyla gotyla</i> (Gray)	+	+	+	+	—	—	+	+	—	—	—	+	+	—	Assam, all along the Himalayas, Chota

Contd.

TABLE 1.—Contd.

Sl. No.	Species	Almora Dist. Rivers								Pithoragarh Dist. Rivers.					Range of distribution as known at present			
		Sarju	West Ram Ganga	Kosi	Garur Ganga	Gomati	Lohawati	Gagas	Suyal	Dhauri	Kali	Gori	East Ram Ganga	Charama Gar	Small ponds			
12.	<i>Garra lamta</i> (Hamilton)	—	+	+	+	—	—	—	—	—	—	—	+	+	—	Nagpur plateau and the Vindhya-Satpura mountains of the Peninsula. Extends to Burma and West Punjab in West Pakistan.		
13.	<i>Labeo dero</i> (Hamilton)	+	+	+	—	—	—	—	—	—	+	+	+	—	—	Throughout India.		
14.	<i>Labeo dyocheilus</i> (McClelland)	+	+	+	—	—	—	—	—	—	+	+	—	—	—	Assam, Darjeeling, Western and Eastern Himalayas, East Punjab, U.P., and Kumaon Himalayas.		
15.	<i>Barilius barna</i> (Hamilton)	—	+	+	+	+	+	—	+	—	—	—	+	+	—	All along the Himalayas, U.P., and Sind Hills.		
16.	<i>Barilius bendelisis</i> (Hamilton)	+	+	+	+	+	+	+	+	—	+	+	+	+	—	Assam, Ganges, Bengal, U.P., and Orissa.		
17.	<i>Barilius vagra</i> (Hamilton)	—	+	+	+	+	—	+	—	—	—	—	—	+	—	Assam, Western and Eastern Himalayas, West Bengal, Simla, Punjab, Bihar, U.P., Nilgiris and Palaghat.		
	Family : COBITIDAE.															Himalayas and Sub Himalayas range, Sind Hills, Jumna and Ganges, Punjab, and Assam.		
18.	<i>Noemacheilus botia</i> Hamilton	—	+	+	+	+	—	—	—	—	—	—	—	+	+	Assam and all along the Himalayas.		
19.	<i>Noemacheilus multifasciatus</i> Day	—	+	+	+	+	—	—	—	—	—	—	+	+	+	Assam and Darjeeling.		
20.	<i>Noemacheilus beavani</i> Günther	—	+	+	+	+	+	+	+	—	—	—	+	+	+	Madras, Mysore and Orissa.		
21.	<i>Noemacheilus rupicola</i> (McClelland)	—	+	+	+	+	+	+	+	—	—	—	+	+	+	All along the Himalayas, Tibet, at 16,000' above the Sea level.		

Contd.

22. <i>Noemacheilus rupicola inglisi</i> Hora	—	—	+	+	+	+	+	+	—	—	—	—	+	+	All along the Himalayas.
23. <i>Botia almorhae</i> Day	—	+	—	—	—	—	—	+	—	—	—	—	—	—	Kashmir, Almora and Khasi Hills.
Family : HOMALOPTERIDAE.															
24. <i>Homaloptera brucei</i> Day	+	—	—	—	—	—	—	—	—	—	—	—	—	—	Himalayas, Darjeeling, Assam, Khasi Hills, Madras, Bhutan.
Division : SILURI.															
Family : SISORIDAE.															
25. <i>Glyptosternum pectinopterum</i> (McClelland)	—	+	—	—	—	—	—	—	—	+	+	+	+	—	Western and Eastern Himalayas, Punjab, Simla and Dehra Dun.
26. <i>Euchiloglanis hodgarti</i> Hora & Gilas	—	—	—	—	—	—	—	—	—	+	—	—	—	—	Western and Eastern Himalayas, West Bengal, Kameng Frontier Division, (NEFA)
27. <i>Pseudecheneis sulcatus</i> (McClell.)	—	—	—	—	—	—	—	—	—	+	+	+	—	—	Western Himalayas and Kameng Frontier Division (NEFA).
Order : OPHIOCEPHALIFORMES															
Family : CHANNIDAE															
28. <i>Channa gachua</i> (Ham.)	—	+	—	+	—	—	—	—	—	—	—	—	—	—	East Punjab, Western and Eastern Himalayas, Assam, Orissa, Travancore, Madras, Bombay, Poona, West Bengal, U.P., and Delhi.
Order : MASTOCEMBELIFORMES.															
Family : MASTOCEMBELIDAE.															
29. <i>Mastocembelus armatus</i> (Lacépède)	—	+	+	+	—	—	—	—	—	—	—	+	—	—	Fresh and blackish waters all over India.
Family : AMBLYCEPIDAE.															
30. <i>Amblyceps mangois</i> (Hamilton)	—	+	—	—	—	—	—	—	—	—	—	—	—	—	Kangra, W Himalayas, Darjeeling and U.P.

NOTE :— In the above list the symbol + indicates presence and — its absence from the area.

ON *HUTTONIELLA CLOUDSLEYTHOMPSONI* SP. N.
(DIPLOPODA) FROM SOUTH INDIA

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(With 1 text-figure)

I—INTRODUCTION

Pocock (1903) described *Hendersonula collina*, a species of Chor-deumoidea, from India. Until now no other species of diplopods has been described from this region (see Attems, 1936). This paper contains the description of another species of this order from South India.

The species, described here, belongs to the genus *Huttoniella* (Pocock, 1903) as it has the largest external tubercle on the median segments and also as the internal tubercle, on the posterior segments, are not lateral. However, it differs from the other known species of the genus (Pocock, 1903) chiefly in the number of the trunk segments and ocelli. It is therefore described here as a new species.

II—SYSTEMATIC ACCOUNT

Class DIPLOPODA
Order CHORDEUMOIDEA
Family HETEROCHORNEUMOIDAE

Genus *Huttoniella*
*Huttoniella cloudsleythompsoni** sp.n.

Material.—23 specimens, Alagarkoil forests (Madras State), South India, ca. 9° 55' N. lat. and 78° 10' E. long., Coll. Sundara Rajulu, 7-vii-1965; found in soft mud under stones and in organic debris.

Description.—Adult (Text-fig. 1).

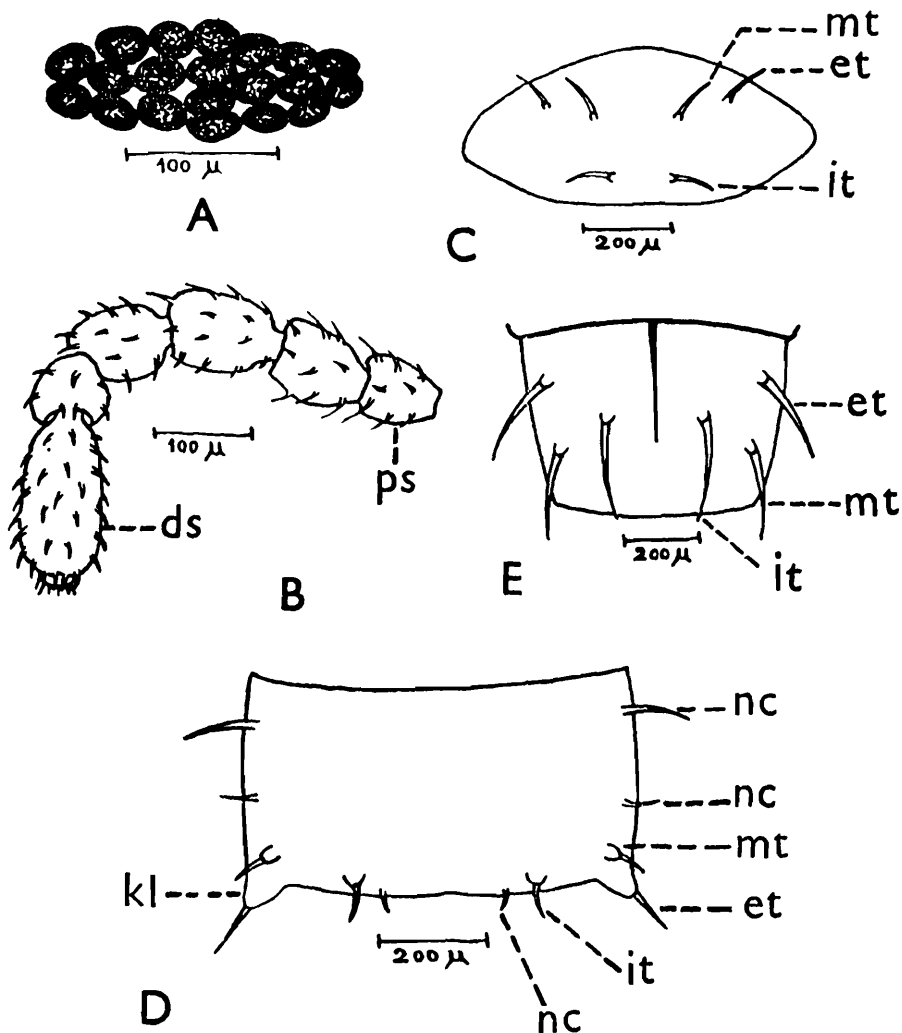
General.—Body creamy white or faintly flavous and cylindrical. Total length (without antenna) 3.5 to 4.0 mm. and 0.4 to 0.5 mm. wide.

Head.—Slightly larger than the trunk segments and ovate. Eyes: consisting of 20 contiguous ocelli arranged in 7 vertical rows of 2, 3, 3, 4, 3, 3, and 2 (A in text-fig.) Antenna: Incrassate and club-shaped, thicker at the distal end and narrow at the proximal end; 0.7 mm. long and 6-segmented; distal segment longest of all (B in text-fig.). Mouth parts: Hypognathous.

Trunk.—18-segmented, segments with small setiferous, tuberculi-form prominences. Terga: coriaceous with fine polygonal ornamentation. On the first tergal plate the intermediate tubercles are nearer to the external than to the internal; the external and intermediate

Rec. Zool. Surv. India, 64 (1-4) [1966], 1970.

tubercles are directed anterolateral, while the internal is directed lateral (C in text-fig.); the external and intermediate tubercles on the median segments are laterally aggregated and remote from the inner (D in text-fig.); the external tubercles are very large and form small ventero-lateral keels, which are less than half the width of the median tergal



TEXT-FIG. 1. *Huttoniella cloudsleythompsoni* Sundra Rajulu sp. n.

(A) Eye. (B) Antenna. (C) First tergal plate. (D) Seventh tergal plate. (E) Last tergal plate.

ds., distal segment ; et., external tubercle ;
 it., internal tubercle ; kl., keel ;
 mt., intermediate tubercle ; nc., non-tuberculate chaeta ;
 ps., proximal segment.

area (D in text-fig.). Anterior border of the keel concave and the posterior border is convex. 3 pairs of non-tuberculate chaetae are present in addition ; of these 2 pairs are lateral and the third pair is near the internal tubercle (D in text-fig.). On the last three segments, the external and intermediate tubercles retain their lateral position on each side, while the internal tubercles are not lateral, but widely separated from each other in the middle line (E in text-fig.).

Type specimens.—*Holotype*: An adult, Z.S.I. Reg. No. 3281/18 in spirit in a vial, Alagarkoil forests (Madras State), 7-vii-1965, coll. Sundara Rajulu, deposited in the National Zoological Collections, Zoological Survey of India, Calcutta. *Paratypes*: The same data as for the holotype; deposited as follows: (i) One adult, Z.S.I. Reg. No. 3282/18 in spirit in a vial, with Zoological Survey of India; (ii) one adult in spirit in a vial in the Zoology Museum, Thiagarajar College, Madurai; (iii) one adult with Professor J. L. Cloudsley-Thompson, Department of Zoology, Khartoum University, Khartoum, Sudan; (iv) The remaining are deposited in the personal collections of the author.

Type locality.—INDIA: Alagarkoil forests (Madras State), ca. 9° 55' N. latitude and 78° 10' E. longitude.

Geographical distribution.—INDIA: Alagarkoil Hills, Madras State. Known only from the type-locality.

Remarks.—*Hutteniella cloudsleythompsoni* sp. n. is similar to *H. trisetosa* Poc., but it is distinguishable by the following features: (i) 18-segmented trunk, (ii) 20 ocelli arranged in 7 vertical rows, (iii) distal segment is the longest of all in the antenna, and (iv) the external and intermediate tubercles on the median segments laterally aggregated and remote from the inner.

In *H. trisetosa* Pocock, the trunk is 32-segmented, 25 ocelli arranged in 5 vertical rows, 3rd segment is the longest in the antenna, and all the three tubercles on the median segments are close together and laterally aggregated (Pocock, 1903).

III—ACKNOWLEDGEMENTS

I am greatly indebted to Professor J. L. Cloudsley-Thompson, Head of the Zoology Department, University of Khartoum, Khartoum, Sudan, for his kind interest in this work. I am happy to acknowledge my debt to Mr. K. Hariharan for help during collection of the specimens.

IV—SUMMARY

The genus *Hutteniella* is known from India so far by a single species *H. collina*. A second species *H. cloudsleythompsoni* from South India is described in this paper.

V—REFERENCES

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DESCRIPTION OF *SABELLIPHILUS FOLIACEA* SP. N. (COPEPODA, CYCLOPOIDA) WITH NOTES ON THE AFFINITIES OF THE SPECIES *

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(With 2 text-figures)

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I—INTRODUCTION

Six female and five male specimens of a new species of copepod were obtained from the body cavity of *Holothuria atra* collected from the Gulf of Mannar on 13th November 1960.

The species derives its name from the peculiar, flattened, leaf-like structures that are present on the distal outer angle of the basal protopod segment, both in second and third legs.

The holotype (one female), allotype (one male) and paratypes (two female and one male) are deposited in the Reference Collection Museum of Central Marine Fisheries Research Institute, Mandapam Camp and bear the registered numbers C.M.F.R.I., No. 61, No. 62 and No. 63, respectively.

I am thankful to Dr. S. Jones, Director, Central Marine Fisheries Research Institute for his encouraging guidance and helpful suggestions during the course of this study.

II—DESCRIPTION OF THE SPECIES

Sabelliphilus foliacea sp. n.

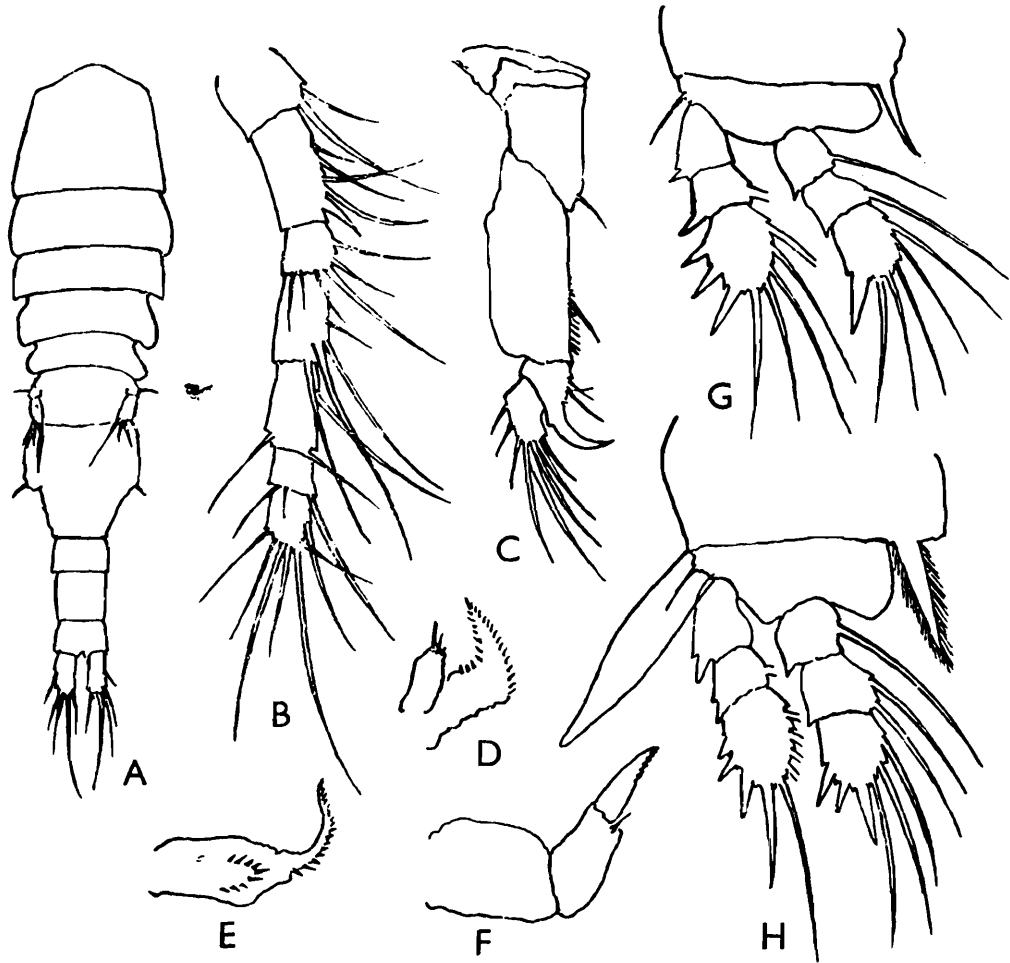
Female.—Body (Text-fig. 1, A) elongate, narrow with the demarcation between prosome and urosome rather inconspicuous. Cephalosome fused with first pedigerous segment, but trace of division still visible. Urosome composed of five segments, genital segment equivalent in length to three abdominal segments combined together. Caudal ramus a little longer than last abdominal segment; bears four setae terminally and a single seta on its outer margin at about midlength. Longest apical seta, second from inner side, characteristically incurved in its distal half. Female bears a pair of gracefully cylindrical, egg sacs reaching middle of caudal rami.

Antennule (Text-fig. 1, B) 7-segmented, short, hardly reaching posterior margin of cephalosome. Antennular segments have following relative lengths:

1	2	3	4	5	6	7	
12.3	18.8	11.5	16.0	23.7	7.4	10.3	100

A digitiform spine on the antero-lateral corner of second segment in antennule present. Antenna (Text-fig. 1, C) 4-segmented,

prehensile ; a little shorter than antennule, but much more stoutly built. First and second segment each with a seta. Third segment bears a strong claw and three spines. Last segment carries eight setae of varying lengths. Other mouthparts (Text-fig. 1, D-F) typically lichomolgid, being highly reduced.



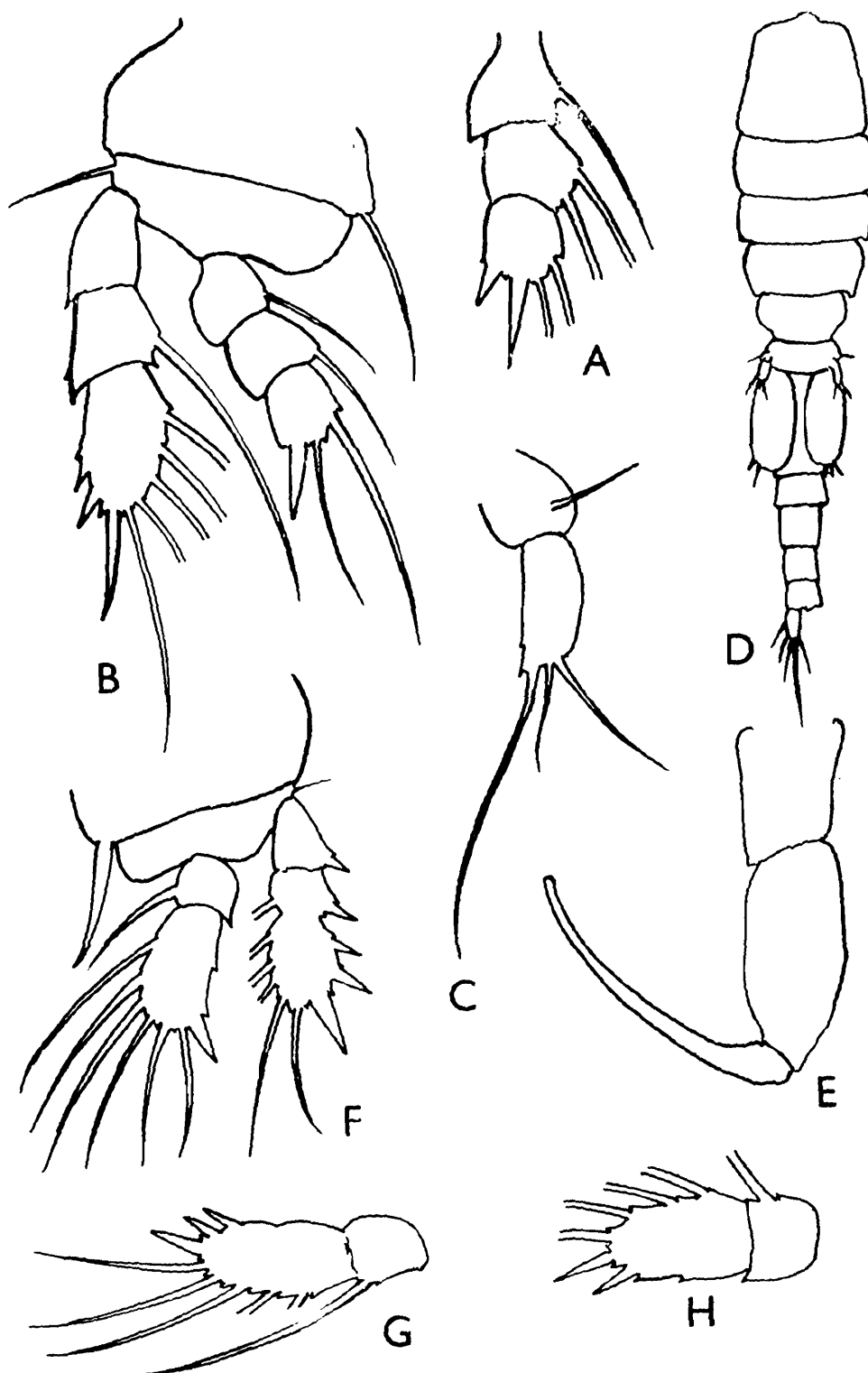
TEXT-FIG. 1. *Sabelliphilus foliacea* n. sp. A. Female, Dorsal view. B. Female antennule. C. Female, antenna. D-F. Female, mouth parts. G-H. Female, swimming legs.

All four pairs of swimming legs (Text-fig. 1, G, H ; Text-fig. 2, A, B) biramous, ramus being 3-segmented. Rami of equal length and constituting segments rather stout. Second and third legs differ conspicuously from first and fourth ; in the former two distal outer angle of basal protopod segment drawn out on its posterior face, into large foliaceous structure ; this structure in second leg almost as large as ramus, but in third leg a little shorter. In first three pairs of legs seta on inner distal angle of basal protopod segment highly flattened, in fourth leg normal. Ornamentation of the swimming leg as below :

	Protopod			Endopod						Exopod					
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	Si	Se		Si	Se		Si	Se		Si	Se		Si	Se	
F1	1	0		0	1		1	0		4	1	1	0	1	
F3	1	*F		0	1		1	0		2	1	1	0	1	
F2	1	*F		0	1		1	0		3	1	1	0	1	
F4	1	0		0	1		1	0		1	1	1	0	1	

(F) Represents foliaceous structures.

In fifth leg (Text-fig. 2, C) basal segment fused with body and indicated by a seta. Distal segment stout, cylindrical, almost twice as long as wide and bearing two setae of unequal lengths terminally. Size: 0.79 mm.



TEXT-FIG. 2. *Sabelliphilus foliacea* sp. n. A, B. Female, swimming legs. C. Female, fifth leg. D. Male, dorsal view. E. Male, maxilliped. F-H. Male, swimming legs.

Male : (Text-fig. 2, D) shows sexual dimorphism. Urosome 6-segmented and consists of fifth leg-bearing segment, genital segment bearing rudimentary sixth pair of legs and four abdominal segments. Caudal rami and setae identical to those of female.

Maxilliped (Text-fig. 2, E) geniculate and large with a well developed terminal claw ; other mouthparts, antennule, antenna quite normal. First four pairs of legs (Text-fig. 2, F, G) exhibit very interesting modifications. Second and third segments of endopods of all these legs indistinctly separated ; constrictions between them, clear ; some of setae and spines borne by segments similar to that of female. This phenomenon is observed in all five male specimens examined. Size: male, 0.75 mm.

Type-locality.—Gulf of Mannar, Bay of Bengal, India.

Distribution.—Gulf of Mannar, Bay of Bengal.

III—REMARKS

Etymology.—The species described above differs from all other known representatives of the subfamily Sabelliphilinae of the family Lichomolgidae in the following characters: (i) The ornamentation of swimming legs is unique as given in the text. (ii) Foliate outgrowths are developed on the proximal protopod segments of second and third legs. (iii) Differences are noted between the two sexes in the segmentation of endopod and exopod of the swimming legs.

It is difficult in view of these unique characters to assign the present species to any particular genus. However, there are two known genera, *Sabelliphilus* Sars and *Diogenidium* C. L. Edwards which should be considered for accommodating it. The present material agrees with *Sabelliphilus* in several morphological characters, including the general shape of the body and presence of a claw on third antennal segment, but it differs from it not only in the characters listed earlier but also in the structure of the antenna. The latter is prehensile in both cases. In *Sabelliphilus* the prehensility is attained by the development of strong teeth on second segment and stout claws on third and fourth segments. In the present material, however, antenna is simpler. There is a single claw on third segment and several spine-like setae on fourth segment. There are no teeth on second segment. The genus *Diogenidium* also differs from *Sabelliphilus* in the structure of antenna. In the former genus no tooth is present on second segment and the prehensility is attained by the subchelate, curved claw and short spines on fourth segment. In these two points it also differs from the present species, but it agrees with the latter in the habits, both being found in association with a holothurian.

It is probable that all these three forms represent only a single flexible genus whose members live not only in association with sabellids but also with a variety of other hosts. A strong support to this proposition is the fact that in recent years several lichomolgid species have been reported with a wide range of host preference. The life in association with tube-dwelling polychaetes is not probably very different from the life inside the body cavity of a holothurian. Nicholls (1944) has indicated that the number of setae and spines on swimming legs cannot be solely relied upon for generic distinction among the poecilostomes and Sewell (1949) has included under his new genus *Preherrmannella* several forms, some of them with a prehensile antenna and others without such antenna. It is, therefore, obvious that the structure of antenna alone cannot be taken as the criterion of generic separation. The foliate outgrowths of swimming legs of the present material

and the teeth on second antennal segment of *Sabelliphilus* appear to be only of specific importance. The aberrant nature of *Sabelliphilus* has already been recognized by G. O. Sars (1913-18). When dealing with such aberrant representatives, care should be taken not to lay too much stress on such characters. It would seem probable that the genus *Diogenidium* is synonymous with *Sabelliphilus*. The former lives in association with holothurians, and the latter with Sabellids. Although the present species differs from both these genera in some structural details, it has been placed under *Sabelliphilus* in the belief that all these forms constitute a single closely related group which, however, has diverged in some structural peculiarities, in order to meet the demands of their habits.

IV—SUMMARY

A new species of cyclopoid copepod, *Sabelliphilus foliacea* sp. n. is described. Because of its structural peculiarities and also because of its similarities with another genus, *Diogenidium*, the generic assignment of the species has been difficult. The reasons for designating the species under *Sabelliphilus* are discussed in the paper. It would seem probable that the genera *Sabelliphilus* and *Diogenidium* are synonymous.

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NOTES ON A SMALL COLLECTION OF LEECHES IN THE ZOOLOGICAL SURVEY OF INDIA

By

MAHESH CHANDRA

Zoological Survey of India, Calcutta

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I—INTRODUCTION

The material of leeches dealt with in this paper was collected from various localities in Uttar Pradesh, West Bengal, Assam, Sikkim and N.E.F.A. by the Officers of Zoological Survey of India during the period 1956-62. It consists of individuals belonging to the following five species :—

(1) *Hirudinaria granulosa* (Savigny), (2) *Hirudinaria viridis* Moore, (3) *Haemadipsa montana* Moore, (4) *Haemadipsa sylvestries* Blanchard, (5) *Haemadipsa zeylanica* Moquin-Tandon, (6) *Haemadipsa zeylanica agilis* Moore, and (7) *Haemadipsa zeylanica montivindicis* Moore. The second species which is peninsular in distribution is recorded for the first time from Uttar Pradesh.

Thanks are due to the Director, Zoological Survey of India for affording facilities to work out the collection.

II—SYSTEMATIC ACCOUNT

Order	...	HIRUDINEA
Suborder	...	ARHYNCHOBDELLAE
Family	...	HIRUDIDAE
Subfamily	...	<i>HIRUDINAE</i>
Genus	...	<i>Hirudinaria</i> Whitman

1. *Hirudinaria* (*Poecilobdella*) *granulosa* (Savigny)

1820 (1822). *Sanquisuga granulosa* Savigny : *Système des Annelides*, Paris, p. 115.
(Type-locality : Pondicherry).

1927. *Hirudinaria* (*Poecilobdella*) *granulosa* (Savigny), Moore, *Fauna Brit. India, Hirudinea*, London, p. 226, pl. 4, fig. 5.

Material.—(i) 1 example, Nishangara, Bahraich, Uttar Pradesh, 26. viii. 56. (ii) 1 example, Raipur, W. of Dehra Dun, Uttar Pradesh, 28. viii. 56. Coll. H. Khajuria.

2. *Hirudinaria (Poecilobdella) viridis* Moore

1927. *Hirudinaria (Poecilobdella) viridis* Moore : *Fauna Brit. India, Hirudinea*, London, p. 239, pl. 8, figs. 31-33. (*Type-locality*: Shasthancottah, Kerala State).

Material.—6 examples, pond in Varanasi Cantt., U.P., 20. x. 56 (*H. Khajuria*).

Remarks.—*Hirudinaria viridis* possesses a bright green colour. So far it has been recorded from Kerala and Madras, and is being recorded for the first time from Varanasi Cantt., U.P.

Subfamily	...	HAEMADIPSINAE
Genus	...	Haemadipsa Tennent

3. *Haemadipsa montana* Moore

1927. *Haemadipsa montana* Moore, *Fauna Brit. India, Hirudinea*, London, p. 269, pl. 9, figs. 38-40 (*Type-locality* : near Kukhal, Palni Hills, Madras).

Material.—(i) 1 example, Moshing valley, Kameng F.D., N.E.F.A., 6. vi. 61 (*K. C. Jayaramakrishnan*). (ii) 1 example between Domkho and Shergaon valley, N.E.F.A., 2. ix. 61 (*S. Biswas*). (iii) 1 example chug valley, Kameng F.D., N.E.F.A., 12. viii. 61 (*S. Biswas*). (iv) 1 example, Shergaon valley, Kameng, F.D., N.E.F.A., 3. ix. 61 (*S. Biswas*). (v) 2 examples, Gey, Sikkim, 20. v. 59 (*A. G. K. Menon*). (vi) 1 example, Makaibari, Sikkim, 30. iv. 62 (*G. Ramakrishna*). (vii) 3 examples, Aplane, Sikkim, 22. v. 62 (*G. Ramakrishna*).

Remarks.—Markings variable ; consisting of bold longitudinal stripes, median dorsal black stripe and pale or white marginal stripes. Recorded for the first time from N.E.F.A.

4. *Haemadipsa sylvestris* Blanchard

1894. *Haemadipsa sylvestria* Blanchard, *Ann. Mus. Civico stor. Naturelle*, Genova, (2) 14, p. 115. (*Type-Localities* : Carin Mountains, Burma).
 1927. *Haemadipsa sylvestris*: Moore, *Fauna Brit. India., Hirudinea*, London, p. 276, pl. 5 figs. 9-10, pl. 9, fig. 41.

Material.—(i) 14 examples, Nishangara, Bahraich, U.P., 7. ix. 56 (*H. Khajuria*). (ii) 2 examples, Nishangara, Bahraich, U.P., 26. viii. 56 (*H. Khajuria*). (iii) 1 example, Raimona, Goalpara, Assam, 3. iv. 57 (*B. K. Tikadar*). (iv) 1 example, Tarkhola, Darjeeling, 21. viii. 58 (*H. Khajuria*). (v) 3 examples, Amatulla, Kameng F.D., N.E.F.A., 18. v. 61 (*K. C. Jayaramakrishnan*). (vi) 10 examples, between Jhumla and Moshing, Kameng F.D., N.E.F.A., 12. v. 61 (*K. C. Jayaramakrishnan*). (vii) 44 examples, Dorkochu, Kameng F.D., N.E.F.A., 25. iii. 61 (*K. C. Jayaramakrishnan*). (viii) 20 examples, Camp No. 31, Shergaon village, N.E.F.A., 3. ix. 61 (*S. Biswas*). (ix) 3 examples, Camp No. 35, Sangloo, Kameng F.D., N.E.F.A., 12. ix. 61 (*S. Biswas*). (x) 2 examples, Camp No. 39, Domkho Kameng, N.E.F.A., 23. ix. 61 (*S. Biswas*). (xi) 13 examples, Padamchen, Sikkim, 1. v. 62 (*G. Ramakrishna*).

Remarks.—Colour brown, usually with three black dorsal stripes. Recorded for the first time from N.E.F.A., Bahraich in U.P. and Sikkim.

5. *Haemadipsa zeylanica* (Moquin-Tandon)

1826. *Sanguisuga zeylanica* Moquin-Tandon, *Monographie de la famille des Hirudinees*, Montpellier, p. 120 (*Type-locality* : Ceylon).

1927. *Haemadipsa zeylanica* Moquin-Tandon : Moore, *Fauna Brit. India Hirudinea*, London, p. 255, pl. 5, fig. 7.

Material.—1 example, Ankaling village, Kameng F.D., N.E.F.A., 24. v. 61 (K. C. Jayaramakrishnan).

Remarks.—Colour pattern usually mottled with a medial dorsal light or dark stripe. Recorded for the first time from N.E.F.A.

6. *Haemadipsa zeylanica agilis* Moore

1927. *Haemadipsa zeylanica agilis* Moore, *Fauna Brit. India. Hirudinea*, London, p. 266, pl. 4, fig. 6 (*Type-locality* : Shigadh, Nainital).

Material.—1 example, two miles S. of Ankaling Village, Kameng F.D., N.E.F.A., 24. v. 61 (K. C. Jayaramakrishnan).

Remarks.—Ground colour variable, but dark blotched pattern constant. Recorded for the first time from N.E.F.A.

7. *Haemadipsa zeylanica montivindicis* Moore

1927. *Haemadipsa zeylanica montivindicis* Moore, *Fauna Brit. India, Hirudinea*. London, p. 267, pl. 5, fig. 8, pl. 9, Fig. 37. (*Type-locality* : Sureil, Darjeeling).

Material.—(i) 6 examples, Palmjua, Darjeeling, 4. vii. 58 (*H. Khajuria*). (ii) 1 example, 2 miles s. of Ankaling village, Kameng F.D., N.E.F.A., 24. v. 61 (K. C. Jayaramakrishnan). (iii) 2 examples, Mangan, Singhik, Sikkim, 8. v. 62 (*G. Ramakrishna*). (iv) 24 examples, Kewzing, Sikkim, 17. v. 62 (*G. Ramakrishna*). (v) 19 examples, Lingjok, Kewzing, Sikkim, 20. v. 62 (*G. Ramakrishna*). (vi) 2 examples, Padamachen, Sikkim, 1. v. 62 (*G. Ramakrishna*). (vii) 3 examples, Makaibari, Sikkim, 30. iv. 62 (*G. Ramakrishna*). (viii) 7 examples, Aplane, Sikkim, 22. v. 62 (*G. Ramakrishna*). (ix) 15 examples, Kewzing, Sikkim, 19. v. 62 (*G. Ramakrishna*). (x) 5 examples, Lingship, Sikkim, 18. v. 62 (*G. Ramakrishna*). (xi) 14 examples, Singhik, Sikkim, 14. iv. 62 (*G. Ramakrishna*). (xii) 2 examples, sta. 7, Gangtok, Sikkim, 5. v. 62 (*G. Ramakrishna*).

Remarks.—Ground colour variable and dark spots or blotches absent or obscure. Recorded for the first time from N.E.F.A.

III—SUMMARY

The collection worked out is represented by two genera, five species and two subspecies. The extension of distributional range of the species dealt with is also shown.

A NEW SPECIES OF *MERISTA* CHAPUIS (1895) (INSECTA:
COLEOPTERA: CHRYSOMELIDAE) FROM INDIA

By

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Zoological Survey of India, Calcutta

(With 1 text-figure)

I—INTRODUCTION

In the material collected by my colleagues Dr. K. C. Jayaram and Shri S. Biswas, from Kameng Division of North East Frontier Agency and Assam are present a few insects of genus *Merista* Chapuis (Coleoptera: Chrysomelidae: Gallerucinae). These specimens apparently belong to a hitherto unknown species, which is described below. This species is named after its first collector.

II—DESCRIPTION

Merista jayarami sp. n.

Material.—4603/H4A Holotype (♂), N.E.F.A.: Kameng Div.: Bomko, 10. v. 1961, (Coll. K. C. Jayaram).

Paratypes: 4604/H4A, 1 example, same particulars as holotype; N.E.F.A.: Kameng Div.: 4605/H4A, 1 example, Bomdila 30. vi. 1961; 4606/H4A, 1 example, Moshing, 3. vi. 1961; 4607/H4A, 1 example, 6. vi. 1961; 4608/H4A — 4609/H4A, 2 examples, Nyukmadong Village, 21. iv. 1961; 4610/H4A — 4611/H4A, 2 examples, Naphra, 26. vi. 1961 (all Coll. K. C. Jayaram) 4612/H4A — 4614/H4A 3 examples, Naphra, But, 4-6. viii. 1961 (Coll. S. Biswas).

All the types are deposited in the National Zoological Collection, Zoological Survey of India, Calcutta.

Body elongate ovate, pronotum deeply metallic blue, each elytron with two violet transverse maculae, antennae with basal segment metallic blue-black and the rest dull black, legs of deep violet to black colour.

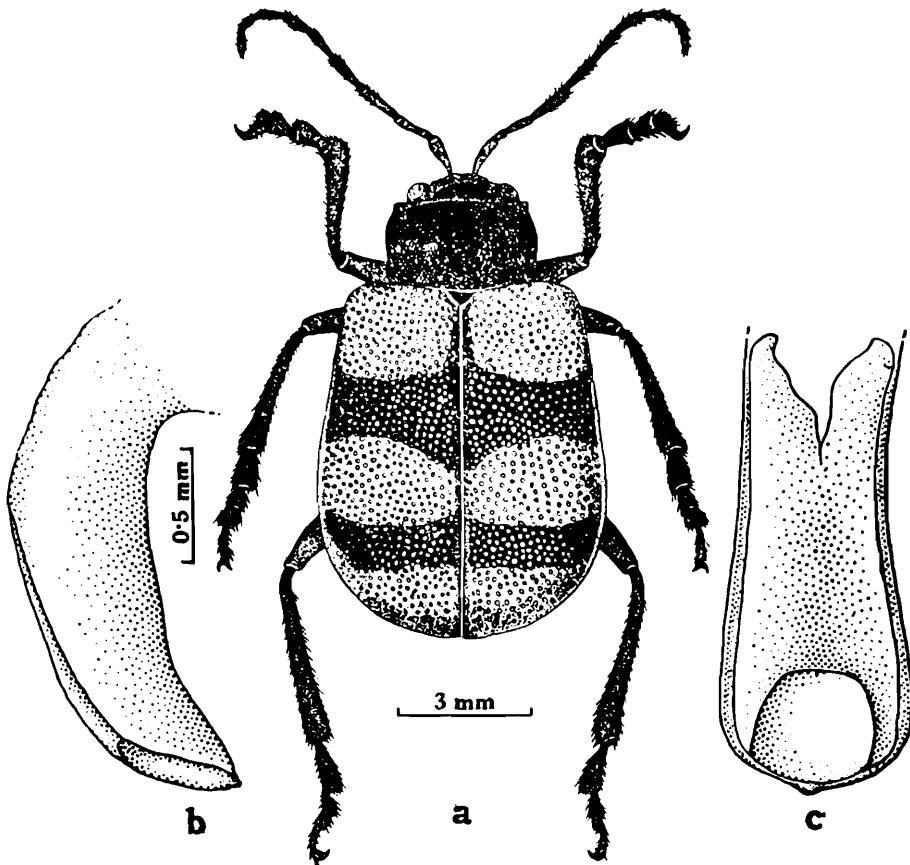
Head metallic green-blue; surface somewhat rugose; a longitudinal impression between the base of antennae; on the frons a deep fovea surrounded by four small tubercles; antennae long and slender, extending well beyond the middle of elytra, the basal segments at least equal to the second and third segments combined together, second segment very short, fourth segment longer than third, fifth segment smaller than fourth, segments fifth to eighth subequal, ninth and tenth segments more slender than preceding segments and subequal, apical segment a little longer and more slender than tenth.

Pronotum metallic blue with the sides narrowly margined, anterior angles produced a little, surface uneven, with a few scattered punctures.

Scutellum triangular, of the same colour as pronotum, impunctate.

Elytra pale reddish-brown, with two transverse moderately broad (breadth somewhat variable) deep violet metallic coloured maculae, one antemedian and other postmedian, a very narrow deep violet metallic coloured stripe along the suture; punctures moderate and well impressed, almost regularly arranged but not striate, on the disc separated by 1-1½ times their own diameter.

Ventral side generally black, abdominal sternites with the sides reddish brown, legs deep violet to black; metasternum with a few and fine transverse striations, punctures very fine, few and scattered; abdominal sternites with transverse striations more impressed, punctures fine, scattered, and with small hair; tibiae with golden pubescence on the inner side getting denser from base to apex.



TEXT-FIG. 1. *Merista jayarami* (a) dorsal view of Holotype, (b) aedeagus—lateral view of Paratype, (c) aedeagus—dorsal view of Paratype.

Aedeagus (Text-fig. 1 *b, c*) with the median lobe tubular, moderately inflexed on the dorsal side, broadened a little from the middle to the subrounded apex; on the dorsal side progressively and regularly depressed (forming a dorsal concavity) up to and around the median foramen (gonopore), ventral side rather flattened towards the apex; internal sac membranous, without visible sclerotised armature.

Length 9.0—12.0 mm. *Breadth* 5.5—6.7 mm.

Remarks.—This species comes near to *M. sexmaculata* (Kollar & Redtenbacher), found in E. & W. Himalaya, Sikkim and Orissa, in the deep violet-blue-black colouration but differs from it in having (i) abdominal sternites black, with the sides reddish brown as against uniformly black, (ii) elytra having only two transverse maculae of deep violet metallic colour against three such maculae, (iii) scutellum smaller in size and (iv) pronotum without longitudinal striae.

III—SUMMARY

A new species of *Merista* Chapuis from the Kameng Frontier Division, N.E.F.A. is described in this paper.

THE GENUS *EURYTE* PHILIPPI (COPEPODA, CYCLOPOIDA) IN INDIAN WATERS

By

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(With 1 text-figure)

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I—INTRODUCTION

The copepod genus *Euryte* Philippi has wide distribution in all the oceans and Sewell (1949) has briefly outlined its distributional records. *Euryte robusta* Geisbrecht and *E. brevicauda* Sewell are recorded from the Indian Ocean (Sewell, *loc. cit.*) and the present communication reports a third species which appears to be *E. propinqua* Brady.

With such extensive distribution it is but natural, examples that exhibit small differences should have been described either as variations of the known species or as new species. Added to this are the facts that reports of occurrence have been from scattered localities and in most cases the number of specimens collected have been very meagre. At present the genus is supposed to contain the following species and varieties:

E. longicauda Philippi, 1843

E. minor, Scott, 1905

E. curticornis Sars, 1915

E. longiseta Grandori, 1925

E. robusta Geisbrecht, 1900

E. propinqua Brady, 1910

E. longicauda var. *antarctica* Thompson, 1863

E. similis Scott, 1912

E. brevicauda Sewell, 1949

The material for the present study was obtained from the Gulf of Mannar off Mandapam during the tenure of a Govt. of India Scholarship at the Central Marine Fisheries Research Institute and contains *E. robusta*, *E. brevicauda* and *E. propinqua*. The last species was described by Brady (1910) from the Antarctic and has never again been reported. The reasons for assigning the present material to *E. propinqua* are dealt with later. I am thankful to Dr. S. Jones, Director, Central Marine Fisheries Research Institute for his encouragement and for giving facilities for the collection of the materials, and to Dr. A. P. Kapur, Director, Zoological Survey of India for his kind suggestions for the improvement of the paper.

II—SYSTEMATIC ACCOUNT

Euryte robusta Giesbrecht, 1900

1900. *Euryte robusta* Giesbrecht, p. 58, pl. iv, figs. 1-14, 16 and 18.
1949. *Euryte robusta*: Sewell, pp. 31-33, fig. 2.

Three male and two female specimens of this species have been obtained from weed washings of the Gulf of Mannar on 23rd September, 1960. Sewell (*loc. cit.*) has described this species in some detail. The present material corresponds in all features with his description. However, some fresh sketches (Text-fig. 1, A, B) are given here to facilitate comparison with other species discussed in the present work. Male (Text-fig. 1, C) shows usual points of sexual dimorphism. Antennule is 16-jointed and geniculate. Urosome is 6-segmented, the genital segment carrying at each of its postero-lateral corners a pair of spines of unequal length. The spines are borne on small prominence which represents the sixth pair of legs. Caudal ramus is four times longer than wide and is only a little shorter than the last two abdominal segments combined. Size: female, 0.80 mm. and male, 0.61 mm.

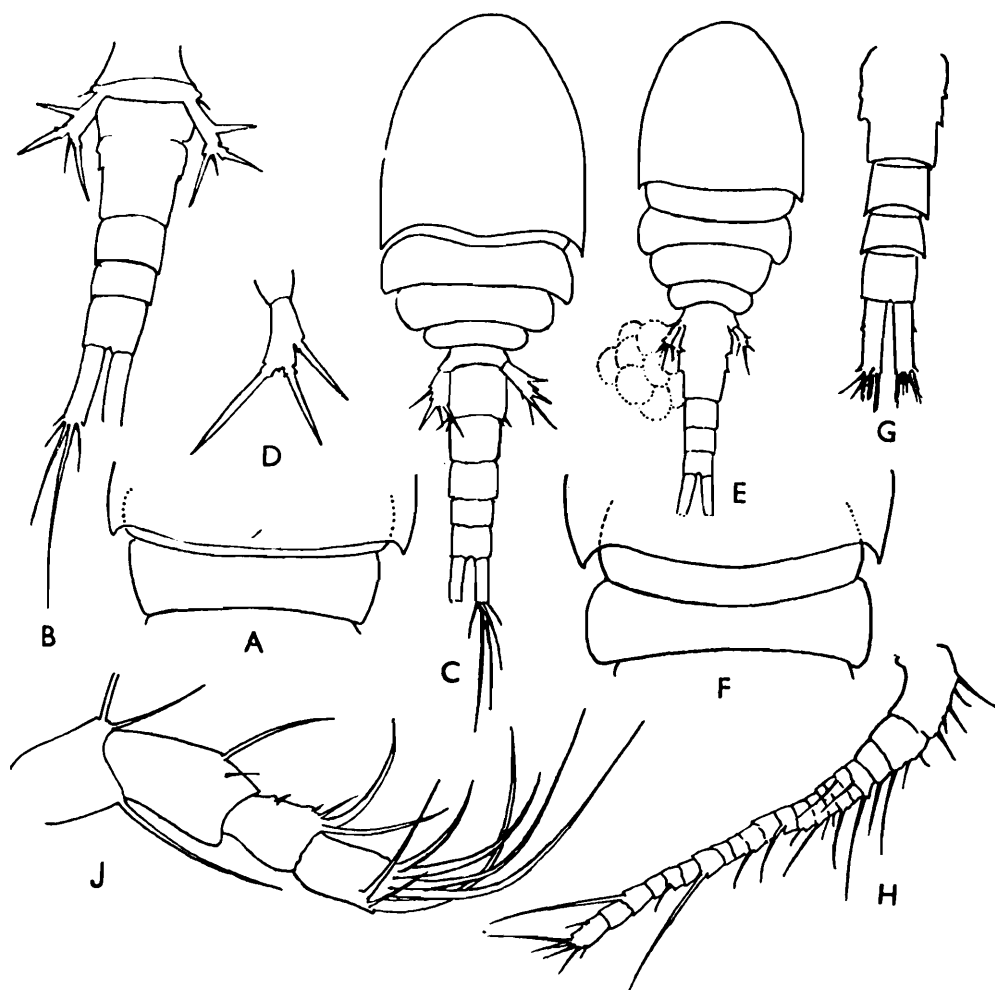
Euryte brevicauda Sewell, 1949

1949. *Euryte brevicauda* Sewell, pp. 33-35, fig. 3.

One female and two male specimens of this species were collected on 16th September, 1960 from amongst the weeds of the Gulf of Mannar off Mandapam. Female of this species is described by Sewell (*loc. cit.*) and the male is described by Ummerkutty (In Press).

Prosoma is apparently 5-segmented, the fusion between cephalosome and first pedigerous segment being incomplete. The genital segment which is the result of the coalescence of the two segments is broader in its proximal part, and is a little shorter than the three abdominal segments combined. Caudal rami and last abdominal segment are of equal length. The spine on the outer lateral margin of fifth leg (Text-fig. 1, D) is as long as the outer apical spine; the inner apical spine is a little longer than both the other spines; the apical seta is slender.

Like the other species of the genus male (Text-fig. 1, E) differs from female in the smaller size and the sexual dimorphism manifested in the antennule and urosome. The former is 16-segmented and strongly hinged, reaching to posterior margin of the prosomal segment. Urosome is 6-segmented. Caudal rami are slightly longer than the last abdominal segment. Size: female, 0.75 mm. and male 0.56 mm.



TEXT-FIG.—1. A-C. *Euryte robusta*. A, female first, second and third prosomal segments ; B, female urosome with fifth legs ; C, male dorsal view. D & E. *Euryte brevicauda*. D, female fifth leg ; E, male dorsal view. F-I. *Euryte propinqua*. F, female dorsal view ; G, female labrum ; H, female antennule ; J, female antenna.

***Euryte propinqua* Brady, 1910**

1910. *Euryte propinqua* Brady, p. 566, fig. 53.

1912. *Euryte similis* T. Scott, p. 570, pl. i, figs. 14-22.

1863. *Euryte longicauda* var. *antarctica* Thompson, p. 95, pl. v, figs. 15-19.

Five female specimens of this species were collected on 23rd Sept. 1960 from weed washings, of the Gulf of Mannar.

In life, a beautiful pinkish tinge is seen over the length of caudal rami, margins of prosomal and urosomal segments, joints of segments of swimming legs and along the mid-dorsal cephalosome. In formalin-preserved specimens the bright pink colour fades out and

persists only in caudal rami. Prosome is apparently 5-segmented, the fusion between cephalosome and first pedigerous segment being incomplete. The latter segment is, however, much narrower than the cephalosome and the second pedigerous segment. In urosome (Text-fig. 1, F) the genital segment is equal to the three abdominal segments combined together. Caudal ramus is four and a half times longer than wide and is little shorter than the last two abdominal segments combined. There are six setae on each ramus, two of which are jointed. The rostrum is incurved and broad. The labrum is a wavy structure with about nine stout teeth on either convex sides (Text-fig. 1, G).

Antennule (Text-fig. 1, H) is 21-segmented, the constituting segments having the following relative lengths:

1	2	3	4	5	6	7	8	9	10	11
15.4	8.0	5.0	3.0	3.5	3.2	1.8	3.0	3.9	4.3	4.2
12	13	14	15	16	17	18	19	20	21	
4.3	3.6	3.0	5.0	3.6	3.6	4.0	5.4	5.4	8.0	= 100

Antenna (Text-fig. 1, J) oral appendages and the swimming legs are very close to those of the earlier species. Fifth leg is rectangular, about three times as long as wide. A striking difference from the earlier two species is noticed in the lengths of spine on the fifth legs. The spines on outer margin of distal segment is just as long as the outer terminal spine; the inner terminal spine as in other species is the longest; the seta on the apex is slender and rather sharp. Size: female, 0.75 mm.

III--REMARKS

Sewell recognized only four species in this genus: *E. robusta*, *E. longicauda*, *E. curticornis* and *E. brevicauda*. *E. propinqua* and *E. similis* are considered by Gurney (1927) as synonymous and Sewell (1949) "as slight variations of *E. robusta*" Sewell thinks that *E. longicauda* var. *antarctica* comes much nearer to *E. robusta* as the caudal ramus figured by Thompson is four times longer than wide which is much shorter than that of *E. longicauda*.

E. propinqua, *E. similis* and *E. longicauda* var. *antarctica* are reported from the same general geographical area and it would appear that these three forms are synonymous. *E. propinqua* has priority over *E. similis*, *E. longicauda* var. *antarctica* having been described only as a variety. However, the earlier description of all these three forms are very inadequate and the correct identification of the species on the basis of these descriptions is very difficult. The present material is thought to represent *E. propinqua* because, it certainly differs from *E. robusta* in many characters and appears to exhibit all the salient features indicated by Thompson, Brady and Scott. Further, it is not desired to add as new name for the present material to confuse the already complex nomenclature. *E. propinqua* and *E. robusta* are compared and contrasted in table I.

Table I — Differences between *E. robusta* and *E. propinqua*.

<i>E. robusta</i> Giesbrecht	<i>E. propinqua</i> Brady
1. Prosome is oval both in dorsal and lateral view.	Prosome is oval only in dorsal view; in lateral view the posterior half is much narrower than the anterior half.
2. First pedigerous segment is more or less fused with cephalosome.	The fusion between the first pedigerous segment and the cephalosome is incomplete and former is distinct from the latter.
3. First prosomal segment is more than twice as long as all other prosomal segments combined, the ratio being 5:2.	First prosomal segment is just one and a half times as long as the rest of the prosomal segments combined, the ratio being 3:2.
4. The proportions of urosomal segments and caudal ramus are as follows: 14.0 32.0 11.3 8.7 13.0 21.0 100.	The proportions of urosomal segments and caudal ramus are as follows: 15.0 29.0 13.5 11.0 12.5 19.0 100.
5. In fifth legs the relative lengths of outer marginal, outer apical and inner apical spines are: 35.8 32.7 28.8 100.	In fifth legs the relative lengths of outer marginal, outer apical and inner apical spines are: 39.2 35.3 25.5 100.
6. In life, caudal rami are dirty brown in colour. Formalin preserved specimens become opaque.	In life, caudal rami are pinkish in colour and this persists even in formalin preserved specimens.

Broadly speaking it would appear that the genus *Euryte* contains two groups of species, *robusta*-group and *longicauda*-group. The former contains *E. robusta*, *E. propinqua* and *E. brevicauda*, and it has its area of distribution mainly in the southern hemisphere, the Antarctic, Indian Ocean, the south Pacific and presumably the south Atlantic. That *E. robusta* or its related forms have managed to extend their distribution also to the warmer regions of the northern hemisphere is proved by the fact that the former species has been recorded by Gurney in Suez canal. As already noted, both *E. robusta* and *E. brevicauda* have been recorded from the Malay Archipelago. The present studies indicate that all these three species are common also in South east coast of India.

The *longicauda*-group contains four species: *E. longicauda*, *E. curticornis*, *E. longiseta*, and *E. minor*. The first three appear to be valid species. Sewell (*loc. cit.*) did not mention *E. minor* in his discussion of the genus. Sars (1921) has reported this species from the Norwegian coast. "This form was considered by Scott and also by

myself as only a variety of *E. longicauda*. I am, however, now of the opinion that it should more properly be regarded as a separate though closely related species" (p. 107). According to Sars, *E. minor* is different from *E. longicauda* in the size, in the more slender form of the body, in the nature of the genital segment and in the less divergent ovisacs. Kiefer (1929) includes this form in *E. longicauda*, but Lang (1946) distinguished it as a separate species by the relatively longer abdomen and the divergent caudal rami. Gooding (1957) follows T. Scott (1905) and considers it a variety of *E. longicauda*. In any case, both species are closely related, separate from other species of the genus. Species of the *longicauda*-group have so far been recorded from the northern temperate and cold waters.

E. longicauda is separable from all other species by its exceedingly long caudal rami, "equalling in length to the last three segments combined" *E. brevicauda* probably presents the other extreme with short caudal rami while in other species various gradations from these levels are noticed. The suggested separation of the *robusta* group and *longicauda* group is purely tentative and is mainly based on distributional tendencies.

IV—SUMMARY

Euryte robusta, *E. brevicauda* and *E. propinqua* are briefly described; the last species is reported here for the first time after its original description. It is tentatively suggested that the species of the genus *Euryte* are separable into *robusta*-group and *longicauda*-group. The former includes *E. robusta*, *E. propinqua* and *E. brevicauda*, and the latter *E. longicauda*, *E. similis*, *E. curticornis* and *E. longiseta*.

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CATALOGUE OF THE FISHES FIGURED IN DAY'S "FISHES OF INDIA" AND DEPOSITED IN THE ZOOLOGICAL SURVEY OF INDIA, CALCUTTA

PART I.—PLEURONECTIFORMES, TETRAODONTIFORMES, LOPHIIFORMES
BATRACHOIDIFORMES AND BELONIFORMES

By

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Zoological Survey of India, Calcutta

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I—INTRODUCTION

Day (1875-1888)* in his "Fishes of India" figured 2025 specimens most of which are deposited in the British Museum (Natural History), London, the Australian Museum, Sydney and the National Zoological Collections in the Zoological Survey of India, Calcutta. The value of these specimens, especially the type specimens of the species described by Day and Day's figured specimens which formed the basis of new species by later workers, is very great as is evidenced in the innumerable enquiries received from Ichthyologists all over the world from time to time regarding the availability of these specimens in the Zoological Survey of India. In order to facilitate the work of those interested in the examination of Day's figured specimens, the present catalogue has been prepared.

Thirty-six species of Pleuronectiformes, thirty-eight of Tetraodontiformes, three of Lophiiformes, two of Batrachoidiformes and sixteen of Beloniformes are figured by Day. Of these twenty-four species of Pleuronectiformes, eighteen of Tetraodontiformes, two each of Lophiiformes and Batrachoidiformes, and eight of Beloniformes are available in the collections. Thus, a total of fifty-four species are catalogued in this paper. The measurement given represents the standard length. The registration numbers of Day's figured specimens are given in the same order as they are treated under synonyms.

*Day, F. 1875-1878. The Fishes of India. Parts I and II. Williams & Norgate, London, I-XX, 1-816, 195 pls.

II—SYSTEMATIC LIST

Order 1. PLEURONECTIFORMES

Family 1. BOTHIDAE

1. *Bothus pantherinus* Rüppell1828. *Bothus pantherinus* Rüppell, *Fische. roth. Meers.*, p. 121, pl. 31, fig. 1.1877. *Platophrys pantherinus* : Day, *Fish. India*, p. 425, pl. 92, figs. 3 & 4.

ZSI* No. 1189; 128 mm.; Andamans.

ZSI No. 2357; 92 mm.; Andamans.

Remarks.—The specimen numbered 2357 slightly distorted at the opercular region.2. *Pseudorhombus arsius* (Hamilton)1822. *Pleuronectes arsius* Hamilton, *Fish. Ganges*, p. 128.1877. *Pseudorhombus arsius* : Day, *Fish. India*, p. 423, pl. 91, fig. 5.

ZSI No. 1187; 152 mm.; Andamans.

Remarks.—Caudal fin slightly damaged.3. *Pseudorhombus elevatus* Ogilby1877. *Pseudorhombus javanicus* Day (part), *Fish. India*, p. 424, pl. 92, fig. 2.1912. *Pseudorhombus elevatus* Ogilby, *Mem. Queensland Mus.*, 1, p. 45.

ZSI No. 1184; 86 mm.; Madras.

Remarks.—Caudal fin slightly damaged.4. *Pseudorhombus macrognathus* Norman1877. *Pseudorhombus javanicus* Day (part), *Fish. India*, p. 424, pl. 92, fig. 2.1927. *Pseudorhombus micrognathus* Norman, *Rec. Indian Mus.*, 29, p. 16.

ZSI No. 1184; 86 mm.; Madras.

Remarks.—Caudal fin slightly damaged.5. *Pseudorhombus triocellatus* (Bloch & Schneider)1801. *Pleuronectes triocellatus* Bloch & Schneider, *Syst. Ichth.*, p. 145.1877. *Pseudorhombus triocellatus* : Day, *Fish. India*, p. 424, pl. 92, fig. 1.

ZSI No. 1185; 103 mm.; Madras.

Family 2. CYNOGLOSSIDAE

6. *Cynoglossus brevirostris* Day1877. *Cynoglossus brevirostris* Day, *Fish. India*, p. 437, pl. 97, fig. 6.

ZSI No. 2690; 101 mm.; Madras.

Remarks.—Caudal damaged.7. *Cynoglossus brevis* Günther1862. *Cynoglossus brevis* Günther, *Cat. Fish. Brit. Mus.*, 4, p. 500.1877. *Cynoglossus brevis* : Day, *Fish. India*, p. 437, pl. 97, fig. 2.

ZSI No. 1459; 90 mm.; Calcutta.

* ZSI = Zoological Survey of India, Calcutta (India).

8. **Cynoglossus dispar** Day

1877. *Cynoglossus dispar* Day, *Fish. India*, p. 434, pl. 96, fig. 2.

ZSI No. 2715 ; 263 mm. ; Sind (Pakistan).

9. **Cynoglossus lida** (Bleeker)

1851. *Plagusia lida* Bleeker, *Natuurk. Tijdschr. Ned.—Indië.*, 1, p. 413.

1877. *Cynoglossus lida* : Day, *Fish. India*, p. 436, pl. 97, fig. 3.

ZSI No. 2688 ; 108 mm. ; Burma.

Remarks.—Caudal totally mutilated.

10. **Cynoglossus lingua** Hamilton

1822. *Cynoglossus lingua* Hamilton, *Fish. Ganges*, pp. 32, 365.

1877. *Cynoglossus elongatus* Day, *Fish. India*, p. 433, pl. 90, fig. 5.

1877. *Cynoglossus lingua* : Day, *Fish. India*, p. 433, pl. 96, fig. 1.

ZSI No. 2716 ; 168 mm. ; Madras.

ZSI No. 1208 ; 220 mm. ; Calcutta.

11. **Cynoglossus macrolepidotus** (Bleeker)

1850. *Plagusia macrolepidotus* Bleeker, *Natuurk. Tijdschr. Ned.—Indië.*, 1, p. 415.

1877. *Cynoglossus macrolepidotus* : Day, *Fish. India*, p. 434, pl. 96, fig. 3.

1877. *Cynoglossus oligolepis* Day, *Fish. India*, p. 433, pl. 95, fig. 4.

ZSI No. 1143 ; 119 mm. ; Madras.

ZSI No. 1458 ; 115 mm. ; Madras.

12. **Cynoglossus macrostomus** Norman

1877. *Cynoglossus hamiltonii* Day (*nec.* Günther) *Fish. India*, p. 436, pl. 95, fig. 3.

1928. *Cynoglossus macrostomus* Norman, *Rec. Indian Mus.*, 30, p. 204.

ZSI No. 1460 ; 120 mm. ; Calcutta.

13. **Cynoglossus puncticeps** (Richardson)

1845. *Plagusia puncticeps* Richardson, (1846), *Rept. Brit. Assoc. Adv. Sci.*, p. 280.

1877. *Cynoglossus brachyrhynchus* Day, *Fish. India*, p. 435, pl. 96, fig. 4.

1877. *Cynoglossus puncticeps* : Day, *Fish. India*, p. 437, pl. 97, fig. 1.

ZSI No. 1462 ; 146 mm. ; Moulmein, (Burma).

ZSI No. 2693 ; 142 mm. ; Madras.

14. **Cynoglossus quinquelineatus** Day

1877. *Cynoglossus quinquelineatus* Day, *Fish. India*, p. 432, pl. 98, fig. 1.

ZSI No. 1265 ; 230 mm. ; Madras.

15. **Cynoglossus semifasciatus** Day

1877. *Cynoglossus semifasciatus* Day, *Fish. India*, p. 436, p. 97, fig. 5.

ZSI No. 2692 ; 102 mm. ; Loc. ?

Remarks.—Caudal slightly damaged.

16. **Paraplagusia bilineatus** (Bloch)

1784. *Pleuronectus bilineatus* Bloch, *Naturges. ausland. Fische*, 3, p. 29.
 1877. *Plagusia marmorata* Day, *Fish. India*, p. 431, pl. 95, fig. 1.

ZSI No. 2359 ; 200 mm. ; Madras.

Remarks.—Caudal mutilated.

Family 3. SOLEIDAE

17. **Aesopia cornuta** Kaup

1858. *Aesopia cornuta* Kaup, *Arch. Naturg.*, p. 98.
 1877. *Synaptura cornuta* Day, *Fish. India*, p. 430, pl. 94, fig. 4.

ZSI No. 798 ; 103 mm. ; Madras.

18. **Brachirus albomaculatus** (Kaup)

1858. *Synaptura albomaculata* Kaup, *Arch. Naturg.*, p. 96.
 1877. *Synaptura albomaculata* : Day, *Fish. India*, p. 429, pl. 93, fig. 5.

ZSI No. 1149 ; 165 mm. ; Madras.

19. **Brachirus commersoni** (Swainson)

1839. *Brachirus commersoni* Swainson, *Nat. Hist. Fish*, 11, p. 303.
 1877. *Synaptura commersoniana* Day, *Fish. India*, p. 428, pl. 94, fig. 1.

ZSI No. 1150 ; 280 mm. ; South Canara (Mysore State).

Remarks.—Caudal damaged.

20. **Brachirus orientalis** (Bloch & Schneider)

1801. *Pleuronectes orientalis* Bloch & Schneider, *Syst. Ichth.*, p. 157.
 1877. *Synaptura orientalis* : Day, *Fish. India*, p. 429, pl. 93, fig. 4 & pl. 94, fig. 2

ZSI No. 1155 ; 132 mm. ; Canara (Mysore State).

ZSI No. 796 ; 109 mm. ; Madras.

21. **Brachirus pan** (Hamilton)

1822. *Pleuronectes pan* Hamilton, *Fish. Ganges*, pp. 130, 373, pl. 24, fig. 42.
 1877. *Synaptura pan* : Day, *Fish. India*, p. 429, pl. 93, fig. 3.

ZSI No. 1496 ; 83 mm. ; Calcutta.

22. **Microbuglossus ovatus** (Richardson)

1846. *Solea ovata* Richardson, *Ichth. China Japan*, p. 279.
 1877. *Solea ovata* : Day, *Fish. India*, p. 426, pl. 93, fig. 1.

ZSI No. 1091 ; 88 mm. ; Madras.

23. **Zebrias quagga** (Kaup)

1858. *Aesopia quagga* Kaup, *Arch. Naturg.*, p. 98.
 1877. *Synaptura zebra* Day, *Fish. India*, p. 430, pl. 94, fig. 3.

ZSI No. 797 ; 119 mm. ; Madras.

Family 4. PSETTODIDAE

24. **Psettodes erumei** (Bloch & Schneider)

1801. *Pleuronectes erumei* Bloch & Schneider, *Syst. Ichth.*, p. 150.

1877. *Psettodes erumei* Day, *Fish. India*, p. 422, pl. 91, fig. 4.

ZSI No. 1188 ; 164 mm. ; Andamans.

Order 2. TETRAODONTIFORMES

Family 1. ALUTERIDAE

25. **Alutera monoceros** (Osbeck)

1757. *Balistes monoceros* Osbeck, *Iter Chinensis*, p. 110.

1878. *Monocanthus monoceros* : Day, *Fish. India*, p. 693, pl. 179, fig. 2.

ZSI No. 2161 ; 340 mm. ; Andamans.

Family 2. BALISTIDAE

26. **Abalistes stellatus** (Lacépède)

1798. *Balistes stellatus* Lacépède, *Hist. nat. Poiss.*, 1, p. 350.

1878. *Balistes stellatus* : Day, *Fish. India*, p. 687, pl. 177, fig. 1.

ZSI No. 2254 ; 138 mm. ; Madras.

27. **Balistes chrysopterus** Bloch & Schneider

1801. *Balistes chrysopterus* Bloch & Schneider, *Syst. Ichth.*, p. 466.

1878. *Balistes niger* Day, *Fish. India*, p. 688, pl. 181, fig. 1.

ZSI No. 2713 ; 104 mm. ; Malay Archipelago.

28. **Canthidermis rotundatus** (Procé)

1822. *Balistes rotundatus* Procé, *Bull. Soc. Philom. Paris*, p. 130.

1878. *Balistes maculatus* Day, *Fish. India*, p. 687, pl. 175, fig. 3.

ZSI No. 2249 ; 136 mm. ; Madras.

29. **Odonus erythrodon** (Günther)

1870. *Balistes erythrodon* Günther, *Cat. Fish Brit. Mus.*, 8, p. 228.

1878. *Balistes erythrodon* : Day, *Fish. India*, p. 692, pl. 175, fig. 4.

ZSI No. 2250 ; 237 mm. ; Mangalore.

30. **Pseudobalistes flavimarginatus** (Rüppell)

1828. *Balistes flavimarginatus* Rüppell, *Atlas Reise N. Afrika*, p. 33.

1878. *Balistes flavimarginatus* : Day, *Fish. India*, p. 690, pl. 178, fig. 1.

ZSI No. 2251 ; 151 mm. ; Andamans.

31. **Rhinecanthus aculeatus** (Linnaeus)

1758. *Balistes aculeatus* Linnaeus, *Syst. Nat.* (ed. 10), p. 328.

1878. *Balistes aculeatus* : Day, *Fish. India*, p. 690, pl. 178, fig. 3.

ZSI No. 2253 ; 165 mm. ; Andamans.

32. *Rhinecanthus echarpe* (Lacépède)

1798. *Balistes echarpe* Lacépède, *Hist. nat. Poiss.*, 1, p. 333.
 1878. *Balistes rectangulus* Day, *Fish. India*, p. 691, pl. 178, fig. 2.
 ZSI No. 2252 ; 161 mm. ; Malay Archipelago.

Family 3. DIODONTIDAE

33. *Diodon hystrix* Linnaeus

1758. *Diodon hystrix* Linnaeus, *Syst. Nat.* (ed. 10), p. 335.
 1878. *Diodon hystrix* : Day, *Fish. India*, p. 708, pl. 179, fig. 4.
 ZSI No. 2164 ; 223 mm. ; Andamans.

Family 4. TETRAODONTIDAE

34. *Chonerhinus naritus* (Richardson)

1848. *Tetraodon naritus* Richardson, *Zool. Voyage Sammarang, Fisches*, p. 18.
 1878. *Xenopterus naritus* : Day, *Fish. India*, p. 699, pl. 182, fig. 1.
 ZSI No. 2232 ; 148 mm. ; Burma.

35. *Sphoeroides florealis* (Cope)

1871. *Tetrodon florealis* Cope, *Trans. Am. Phil. Soc.*, 14, p. 479.
 1878. *Tetrodon hypselogention* Day, *Fish. India*, p. 702, pl. 183, fig. 5.
 ZSI No. 2227 ; 82 mm. ; Madras.

36. *Sphoeroides lunaris* (Bloch & Schneider)

1801. *Tetrodon lunaris* Bloch & Schneider, *Syst. Ichth.*, p. 505.
 1878. *Tetrodon lunaris* : Day (part), *Fish. India*, p. 701, pl. 182, fig. 2.
 ZSI No. 2228 ; 163 mm. ; Madras.

37. *Tetraodon inermis* Schlegel

1850. *Tetraodon inermis* Schlegel, *Fauna Japonica, Pisces*, p. 278.
 1878. *Tetrodon inermis* : Day, *Fish. India*, p. 701, pl. 180, fig. 1.
 ZSI No. 2263 ; 125 mm. ; Madras.
Remarks.—Specimen damaged.

38. *Tetraodon stellatus* Bloch & Schneider

1801. *Tetrodon lagocephalus* var. *stellatus* Bloch & Schneider, *Syst. Ichth.*, p. 503.
 1878. *Tetrodon stellatus* : Day, *Fish. India*, p. 705, pl. 183, fig. 3.
 ZSI No. 2225 ; 182 mm. ; Madras.

Family 5. TRIACANTHIDAE

39. *Pseudotriacanthus strigilifer* (Cantor)

1850. *Triacanthus strigilifer* Cantor, *J. Asiat. Soc., Beng.*, 18 (2), p. 1345.
 1878. *Triacanthus strigilifer* : Day, *Fish. India*, p. 685, pl. 175, fig. 2.
 ZSI No. 2247 ; 150 mm. ; Madras.

40. **Triacanthus brevirostris** Schlegel

1850. *Triacanthus brevirostris* Schlegel, *Fauna Japonica, Pisces*, pl. 6, p. 294.
1878. *Triacanthus brevirostris* : Day, *Fish. India*, p. 685, pl. 175, fig. 1.

ZSI No. 2248 ; 139 mm. ; Madras.

Family 6. OSTRACIONTIDAE

41. **Ostracion meleagris** Shaw

1796. *Ostracion meleagris* Shaw, *Nat. Miscell.*, 7, pl. 253.
1878. *Ostracion punctatus* Day, *Fish. India*, p. 696, pl. 181, fig. 2.

ZSI No. 2497 ; 80 mm. ; Malay Archipelago.

42. **Ostracion tuberculatus** Linnaeus

1758. *Ostracion tuberculatus* Linnaeus, *Mus. Adolphi. Friederici*, p. 59.
1878. *Ostracion cubicus* Day, *Fish. India*, p. 696, pl. 181, fig. 3.

ZSI No. 2166 ; 123 mm. ; Loc. ?

Remarks.—Caudal slightly damaged.

Order 3. LOPHIIFORMES

Family 1. ANTENNARIIDAE

43. **Antennarius hispidus** (Bloch & Schneider)

1801. *Lophius hispidus* Bloch & Schneider, *Syst. Ichth.*, p. 142.
1876. *Antennarius hispidus* : Day, *Fish. India*, p. 271, pl. 60, fig. 2.

ZSI No. 1812 ; 70 mm. ; Madras.

44. **Antennarius nummifer** (Cuvier)

1817. *Chironectes nummifer* Cuvier, *Mem. Mus. Hist. nat.*, 3, p. 430.
1876. *Antennarius nummifer* : Day, *Fish. India*, p. 272, pl. 59, fig. 2.

ZSI No. 2078 ; 74 mm. ; Madras.

Order 4. BATRACHOIDIFORMES

Family 1. BATRACHOIDIDAE

45. **Austrobatrachus dussumieri** (Valenciennes)

1846. *Batrachus dussumieri* Valenciennes, *Hist. nat. Poiss.*, 12, p. 474.
1876. *Batrachus grunniens* Day, *Fish. India*, p. 269, pl. 59, fig. 1.

ZSI No. 1804 ; 151 mm. ; Madras.

Remarks.—Caudal damaged.

46. **Batrachthys grunniens** (Linnaeus)

1758. *Cottus grunniens* Linnaeus, *Syst. Nat.*, p. 1209.
1876. *Batrachus gangene* Day, *Fish. India*, p. 270, pl. 60, fig. 1.

ZSI No. 2099 ; 154 mm. ; Calcutta.

Order 5. BELONIFORMES

Family 1. BELONIDAE

47. *Tylosurus crocodilus* (Le Sueur)

1821. *Belone crocodilus* Le Sueur, *J. Acad. nat. Sci. Philad.*, **2**, p. 129.

1877. *Belone choram* Day, *Fish. India*, p. 510, pl. 118, fig. 4.

ZSI No. 1215 ; 330 mm. ; Andamans.

Remarks.—Jaws and caudal damaged.

48. *Xenentodon cancila* (Hamilton)

1822. *Esox cancila* Hamilton, *Fish. Ganges*, pp. 213, 380.

1877. *Belone cancila* : Day, *Fish. India*, p. 511, pl. 118, fig. 5.

ZSI No. 1295 ; 165 mm. ; Punjab.

Remarks.—Jaws and caudal damaged.

Family 2. HEMIRHAMPHIDAE

49. *Hyporhamphus cantori* (Bleeker)

1866-72. *Hemirhamphus cantori* Bleeker, *Atl. Ichth.*, **6**, p. 53.

1877. *Hemirhamphus cantori* : Day, *Fish. India*, p. 514, pl. 119, fig. 1.

ZSI No. 1300 ; 152 mm. ; Bombay.

Remarks.—Lower jaw and caudal damaged.

50. *Hyporhamphus gaimardi* (Valenciennes)

1846. *Hemirhamphus gaimardi* Valenciennes, *Hist. nat. Poiss.*, **19**, p. 36.

1877. *Hemirhamphus limbatus* Day, *Fish. India*, p. 516, pl. 119, fig. 3.

ZSI No. 1299 ; 135 mm. ; Bombay.

Remarks.—Caudal fin damaged.

51. *Hyporhamphus xanthopterus* (Valenciennes)

1864. *Hemirhamphus xanthopterus* Valenciennes, *Hist. nat. Poiss.*, **19**, p. 19.

1877. *Hemirhamphus xanthopterus* : Day, *Fish. India*, p. 514, pl. 119, fig. 2.

ZSI No. 1296 ; 135 mm. ; Malabar.

52. *Zenarchopterus buffonis* (Valenciennes)

1846. *Hemirhamphus buffonis* Cuvier & Valenciennes, *Hist. nat. Poiss.*, **19**, p. 48.

1877. *Hemirhamphus buffonis* : Day, *Fish. India*, p. 516, pl. 119, fig. 4.

ZSI No. 1297 ; 125 mm. ; Loc. ?

Remarks.—Caudal slightly broken.

53. *Zenarchopterus dispar* (Valenciennes)

1846. *Hemirhamphus dispar* Valenciennes, *Hist. nat. Poiss.*, **19**, p. 58.

1877. *Hemirhamphus dispar* : Day, *Fish. India*, p. 517, pl. 119, fig. 5.

ZSI No. 1301 ; 89 mm. ; Andamans.

Remarks.—Lower jaw completely and caudal fin partly damaged.

Family 3. EXOCOETIDAE

54. *Cypselurus bahiensis* (Ranzani)

1842. *Exocoetus bahiensis* Ranzani, *Novi Comm. Acad. Sci. Inst. Bonon.*, 5, p. 362, pl. 38.

1877. *Exocoetus bahiensis* : Day, *Fish. India*, p. 518, pl. 121, fig. 10.

ZSI No. 1473 ; 143 mm. ; Red Sea.

Remarks.—Caudal slightly damaged.

III—SUMMARY

This paper contains a catalogue of specimens figured in Day's "Fishes of India" and present in the Zoological Survey of India. 54 species of five orders are listed.

IV—ACKNOWLEDGEMENTS

The authors are grateful to Dr. A. P. Kapur, Director, for encouragement and to Dr. A. G. K. Menon, Superintending Zoologist, Zoological Survey of India, for suggesting the line of work and for his sustained help during the preparation of this paper.

ON A COLLECTION OF FISH FROM RIVER KEN IN BANDA DISTRICT (U.P.)

By

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I—INTRODUCTION

The fish collection reported in this paper was made during June—July, 1964, while conducting the Spawn Prospecting Investigations on river Ken in Banda district of Uttar Pradesh.

River Ken is essentially a hill stream which originates near Deori in Madhya Pradesh and joins river Jamuna at Chilla *ca.* 60 km. from Banda, passing through hilly tracts of the Vindhya Ranges. It has a common catchment area with Narbada river system on one hand and river Jamuna and its tributaries on the other. This factor has much influence on its fish fauna, which shows a mixture of the fish fauna of two river systems. Hora (1949) described the fish fauna of Rihand river and Hora & Nair (1941) described the fishes of Narbada river at Hoshangabad. No record of the fish fauna of river Ken is available.

Fish collection was made in a stretch from Chilla, the confluence of the river Ken with the river Jamuna, to Naraini in Banda district about 45 km. upstream of river Ken, with the help of cast net, drag net and fry collection net. Some specimens were purchased from the local fishermen fishing in the area with the help of indigenous gears. The collection contains 58 species belonging to 36 genera and 16 families.

II—LIST OF SPECIES

Order: CLUPEIFORMES

Family: CLUPEIDAE

1. *Gudusia chapra* (Hamilton)
2. *Goniolosa manimina* (Hamilton)

* Present address : Zoological Survey of India, 8, Lindsay Street, Calcutta-16.
Rec. Zool. Surv. India, 64 (1-4)[1966], 1970.

3. *Corica soborna* (Hamilton)

4. *Ilisha motius* (Hamilton)

Family: NOTOPTERIDAE

5. *Notopterus chitala* (Hamilton)

6. *Notopterus notopterus* (Pallas)

Order: CYPRINIFORMES

Family: CYPRINIDAE

7. *Oxygaster bacaila* (Hamilton)

8. *Barilius barila* (Hamilton)

9. *Barilius barna* Hamilton

10. *Barilius bendelisis* (Hamilton)

11. *Barilius bola* (Hamilton)

12. *Danio* (*Brachydanio*) *rerio* (Hamilton)

13. *Rasbora daniconius* (Hamilton)

14. *Aspidoparia morar* (Hamilton)

15. *Amblypharyngodon mola* (Hamilton)

16. *Puntius chagunio* (Hamilton)

17. *Puntius sarana* (Hamilton)

18. *Puntius sophore* (Cuvier & Valenciennes)

19. *Puntius ticto ticto* (Hamilton)

20. *Tor tor tor* (Hamilton)

21. *Labeo calbasu* (Hamilton)

22. *Labeo fimbriatus* (Hamilton)

23. *Labeo goni* (Hamilton)

24. *Labeo rohita* (Hamilton)

25. *Cirrhinus mrigala* (Hamilton)

26. *Cirrhinus reba* (Hamilton)

27. *Catla catla* (Hamilton)

28. *Osteobrama cotio* (Hamilton)

29. *Crossocheilus latius latius* (Hamilton)

Family: COBITIDAE

30. *Noemacheilus botia* (Hamilton)

31. *Noemacheilus rupicola inglisi* Hora

Family: BAGRIDAE

32. *Mystus* (*Aorichthys*) *aor* (Hamilton)

33. *Mystus* (*Aorichthys*) *seenghala* (Sykes)

34. *Mystus* (*Mystus*) *bleekeri* (Day)

35. *Mystus* (*Mystus*) *cavasi* (Hamilton)

36. *Mystus* (*Mystus*) *vittatus* (Bloch)

37. *Rita rita* (Hamilton)

Family: SCHILBEIDAE

38. *Ailia coila* (Hamilton)

39. *Clupisoma garua* (Hamilton)

40. *Eutropiichthys murius* (Hamilton)

41. *Eutropiichthys vacha* (Hamilton)

42. *Silonia silondia* (Hamilton)

Family: SILURIDAE

43. *Wallago attu* (Bloch)

Family: SISORIDAE

- 44. *Glyptothorax telchitta* (Hamilton)
- 45. *Pseudeutropius atherenoides* (Bloch)

Order: PERCIFORMES

Family: CENTROPOMIDAE

- 46. *Ambassis nama* (Hamilton)
- 47. *Ambassis ranga* (Hamilton)

Family: NANDIDAE

- 48. *Nandus nandus* (Hamilton)
- 49. *Badis badis* (Hamilton)

Family: SCIAENIDAE

- 50. *Pama pama* (Hamilton)

Family: GOBIIDAE

- 51. *Glossogobius giuris giuris* (Hamilton)

Order: OPHICEPHALIFORMES

Family: CHANNIDAE

- 52. *Channa marulius* (Hamilton)
- 53. *Channa punctatus* (Bloch)

Order: BELONIFORMES

Family: BELONIDAE

- 54. *Xenentodon cancila* (Hamilton)

Order: MASTOCEMBELIFORMES

Family: MASTOCEMBELIDAE

- 55. *Macrogathus aculeatus* (Bloch)
- 56. *Mastocembelus armatus* (Lacépède)
- 57. *Mastocembelus pancalus* (Hamilton)

Order: TETRAODONTIFORMES

Family: TETRAODONTIDAE

- 58. *Tetraodon cutcutia* (Hamilton)

III—NOTES ON SOME FISHES

Corica soborna (Hamilton)

1822. *Corica soborna* Hamilton, *Fish Gang.* pp. 253, 383.

1962. *Corica soborna* Karamchandani, *Trop. Ecol.*, 3 (1 & 2) pp. 81-83.

A number of specimens of this species were collected in the spawn collection nets at Goribaba village, 6 km. west of Banda. The species is estuarine in distribution. Motwani & David (1957) extended its distribution in freshwater upto Dehri-on-Sone on river Sone. Karamchandani (1962) recorded it from river Ganga at Dighwara. This record extends its distribution further upstream.

Ilisha motius (Hamilton)

1822. *Clupanodon motius* Hamilton, *Fish Gang.*, pp. 251, 383.

1878. *Pellona motius* : Day, *Fish India.*, p. 643, pl. clxv, fig. 3.

The range of this species was originally confined to Assam, Bengal and Orissa. Motwani & David (*loc. cit.*), Karamchandani (*loc. cit.*)

extended it to Dehri-on-Sone (river Sone) and Dighwara (river Ganga), respectively.

Gudusia chapra (Hamilton)

1822. *Clupanodon chapra* Hamilton, *Fish gang.*, pp. 248, 383.

1878. *Clupea chapra* : Day, *Fish India.*, p. 369, pl. clxi, fig. 1.

Large number of specimens of this species ranging from 25-87 mm. were collected in fry collection nets. In younger stages the upper part of the body is colourless while the belly portion is silvery white (10-19 mm.). From 20 to 38 mm. the whole body becomes silvery white. From 39 mm. onwards a diffused black shoulder spot, some distance from operculum, is visible, becoming quite prominent when the fish has attained a size of 50 mm. and above.

Pama pama (Hamilton)

1822. *Bola pama* Hamilton, *Fish gang.*, pp. 79, 368, pl. xxxii, fig. 28.

1878. *Sciaenoides pama* : Day, *Fish India.*, p. 193.

Larval forms and adult specimens of this species were collected from Dighwara (river Ganga), and its distribution extended upto Buxar on river Ganga by Motwani, Jhingran & Karamchandani (1954). The maximum size recorded by these authors was 245 mm. Large number of specimens are available from rivers Ganga and Jamuna at Allahabad though there is no published record. Our specimen measures 457 mm.

IV—ACKNOWLEDGEMENTS

The authors express their grateful thanks to Dr. V. G. Jhingran, Director, Central Inland Fisheries Research Institute, Barrackpore, under whose guidance the work was carried out. Thanks are also due to Dr. K. C. Jayaram, Superintending Zoologist, Zoological Survey of India, Calcutta, for kindly going through the manuscript.

V—SUMMARY

A small collection of fish from river Ken was studied. The specimens belong to 58 species of 36 genera. Field notes on some species of fishes have also been given.

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STUDIES ON HELMINTH PARASITES OF CROWS.—
TWO NEW SPECIES OF THE GENUS *LUTZTREMA*
TRAVASSOS FROM *CORVUS SPLENDENS* (VIEILLOT)
AND A DISCUSSION ON THE GENUS *LUTZTREMA*

By

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(With 2 text-figures)

I—DESCRIPTION

Lutztrema singhi sp. n.

DIAGNOSIS.—*Body* lanceolate, measuring 3.94-5.31 mm. x 0.30-0.52 mm. *Oral sucker* usually sub-terminal measuring 0.10-0.16 x 0.09-0.15 mm. *Ventral sucker* 0.20-0.26 mm. x 0.21-0.29 mm. Ratio between oral and ventral sucker 2:3.

Testes usually larger than ventral sucker but sometimes as large as ventral sucker; anterior measures 0.25-0.4 mm. x 0.19-0.45 mm. and posterior 0.26-0.52 mm. x 0.19-0.4 mm. in size. *Cirrus sac* pre-acetabular 0.17-0.27 mm. x 0.07-0.09 mm. in size. *Ovary* post-testicular measuring 0.16-0.21 mm. x 0.16-0.24 mm. *Eggs* operculate, measure 0.0297-0.0363 mm. x 0.0198-0.0231 mm. *Excretory bladder* tubular with terminal excretory pore.

DESCRIPTION.—The writer collected several specimens of this trematode on four occasions from gall bladder and liver of *Corvus splendens* (Vieillot).

Body elongated, lanceolate, with blunt rounded anterior and a blunt conical posterior end; broadest in region of ventral sucker and tapers gradually from behind ventral sucker towards posterior end; entire body covered with minute spines, and measures 3.94-5.31 mm. x 0.30-0.52 mm. in size.

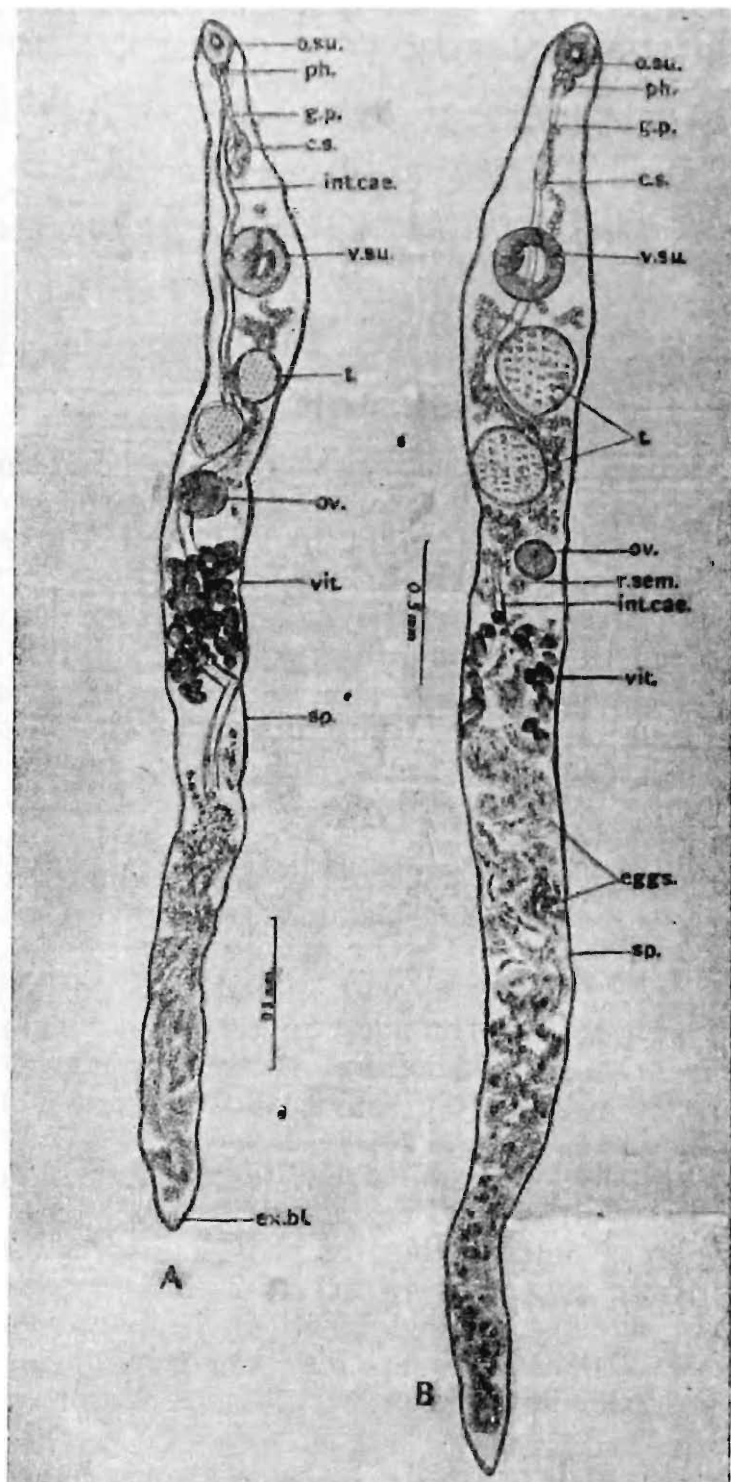
Oral sucker usually sub-terminal but sometimes terminal; measures 0.10-0.16 mm. x 0.09-0.15 mm. *Ventral sucker* larger than oral, situated in posterior region of anterior third of body, measures 0.20-0.26 mm. x 0.21-0.29 mm. Ratio between two suckers 2:3.

Mouth leads directly into globular or oval pharynx, measuring 0.037-0.087 mm. x 0.05-0.087 mm. *Oesophagus* continued into a single intestinal caecum extending upto a level about one third of body length from hind end.

Testes large, round or oval, margins entire, situated somewhat obliquely one behind other in hind region of anterior third of body; usually larger than ventral sucker but sometimes equal to it. Anterior testis measures 0.25-0.4 mm. x 0.19-0.45 mm.; posterior one 0.26-0.52 mm. x 0.19-0.40 mm.

Cirrus sac an elongated flask-shaped structure, situated a short distance in front of ventral sucker; measures 0.17-0.27 mm. x 0.07-0.09 mm.; encloses a tubular, convoluted vesicula seminalis, an ejaculatory

duct and cirrus. A *pars prostatica* present, not clearly distinguishable in whole mounts but clearly seen in sectioned material.

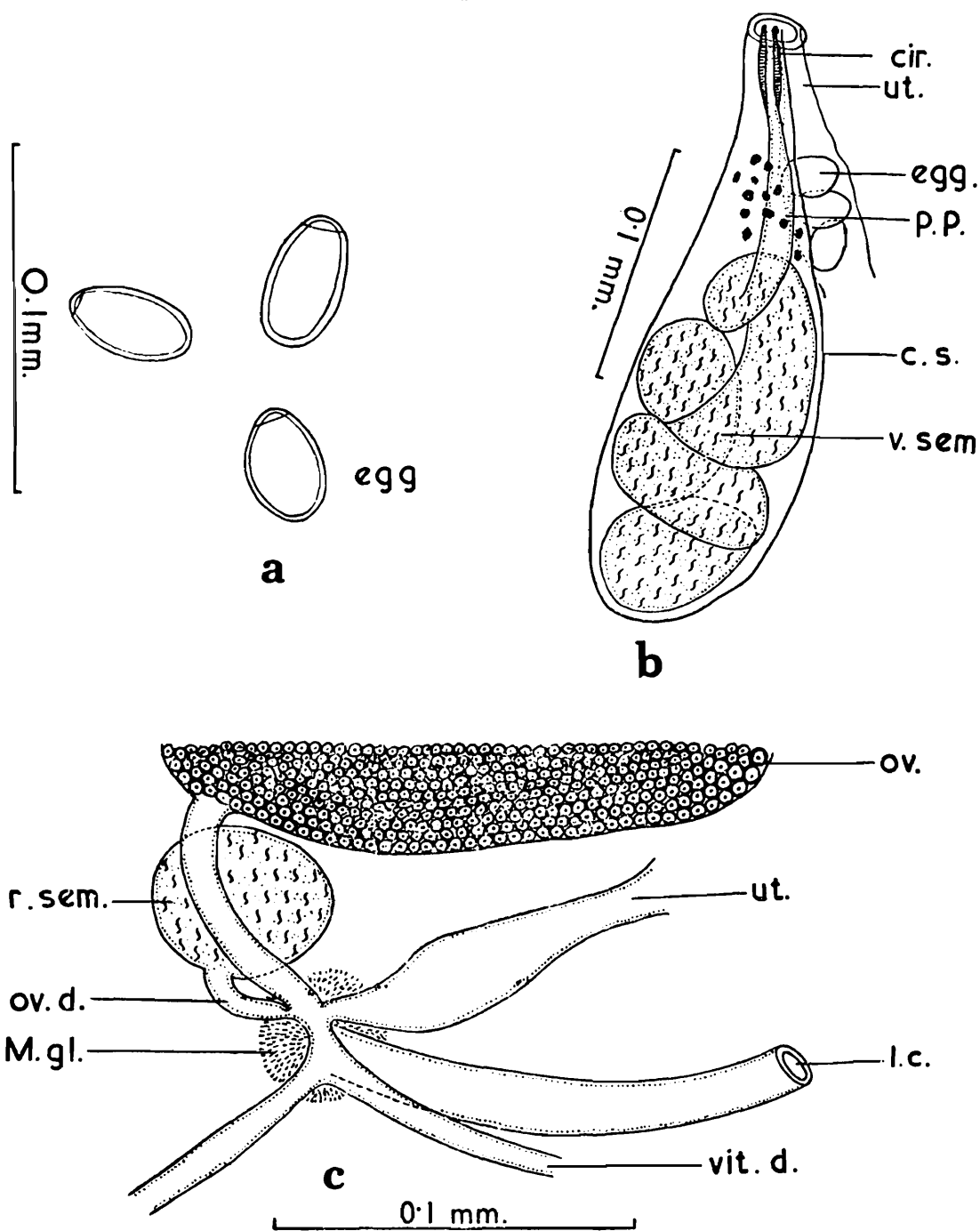


TEXT-FIG. 1. A. *Lutztrema stunkardi* sp. n. Type, ventral view.
B. *Lutztrema singhi* sp. n. Type, ventral view.

Genital pore present midway between oral and ventral sucker.

Ovary globular or sub-globular, smaller than testes, post-testicular, situated near about junction of anterior and middle thirds of body, measures 0.16-0.21 mm. x 0.16-0.24 mm. *Mehlis gland complex* situated behind ovary. Oviduct, duct from receptaculum seminis, common

vitelline duct, Laurer's canal open at common point surrounded by glands. *Uterus* arises from this point.



TEXT-FIG. 2. *Lutztrema singhi* sp. n., a. Eggs; b. Structure of cirrus sac drawn from paratype; c. Mehlis' gland complex in live specimen.

Receptaculum seminis present behind ovary; measures 0.05-0.06 mm. $\times$ 0.06 mm. *Vitellaria* pre-equatorial in position. *Vitelline follicles* large, present on both sides of body, tending to merge in median line.

Uterus with both descending and ascending limbs; uterine coils profusely developed, extend posteriorly up to end of body; anteriorly, ascending limb of uterus passes first between ovary and posterior testis and then between the two testes; eventually runs in a sinuous course, by right side of cirrus sac and opens outside by genital pore. *Eggs* oval, *thick-shelled*, dark-brown and operculate; measure 0.0297-0.063 mm. $\times$ 0.0198-0.0231 mm.

Excretory bladder tubular with terminal excretory pore.

RELATIONSHIP.—The present species differs from *L. monenteron* (Price & McIntosh, 1935) Travassos, 1941, in having a comparatively narrower body, covered with spines, in having smaller ventral sucker and in having a larger ovary than that present in *L. monenteron*. Further, the eggs of the present form are also larger than those of *L. monenteron*.

The present species differs from *L. stunkardi* n. sp., another species described by the author in having a larger body, larger testes and larger eggs but a comparatively smaller cirrus sac and smaller ovary. The testes are larger than the ventral sucker in the present species but they are smaller than the ventral sucker in *L. stunkardi*. Further, the ovary is smaller than testes in the present species but the ovary is as large as or even larger than testes in *L. stunkardi*. The vitelline follicles are present separately on both the sides of the body in *L. singhi* but the follicles form a separate mass in *L. stunkardi*.

The ratio between oral and ventral sucker is 2:3 in *L. singhi*, but it is 1:2 in *L. stunkardi*.

Lutztrema stunkardi sp. n.

DIAGNOSIS.—*Body* slender and elongate, measuring 2.32-4.06 mm. $\times$ 0.30-0.36 mm. in maximum width. *Oral sucker* usually sub-terminal, rarely terminal, 0.112-0.15 $\times$ 0.087-0.112 mm.; *ventral sucker* measures 0.20-0.24 mm. $\times$ 0.19-0.22 mm. Ratio between oral and ventral sucker approximately 1:2. *Pharynx* measuring 0.05-0.06 mm. $\times$ 0.05-0.06 mm. *Testes* tandem, anterior one measuring 0.11-0.187 mm $\times$ 0.125-0.162 mm. and posterior 0.125-0.187 mm $\times$ 0.125-0.15 mm. *Cirrus sac* pre-acetabular, measuring 0.112-0.187 mm. $\times$ 0.05-0.06 mm. *Ovary* post-testicular, measures 0.125-0.162 mm. $\times$ 0.15-0.2 mm. *Genital pore* 0.275-0.55 mm., behind anterior end of body. *Eggs* operculate, measure 0.026-0.033 mm. $\times$ 0.016-0.020 mm.

DESCRIPTION.—In all twenty specimens of this trematode were collected on two occasions (Eight on 2.5.64 and twelve on 11.8.64).

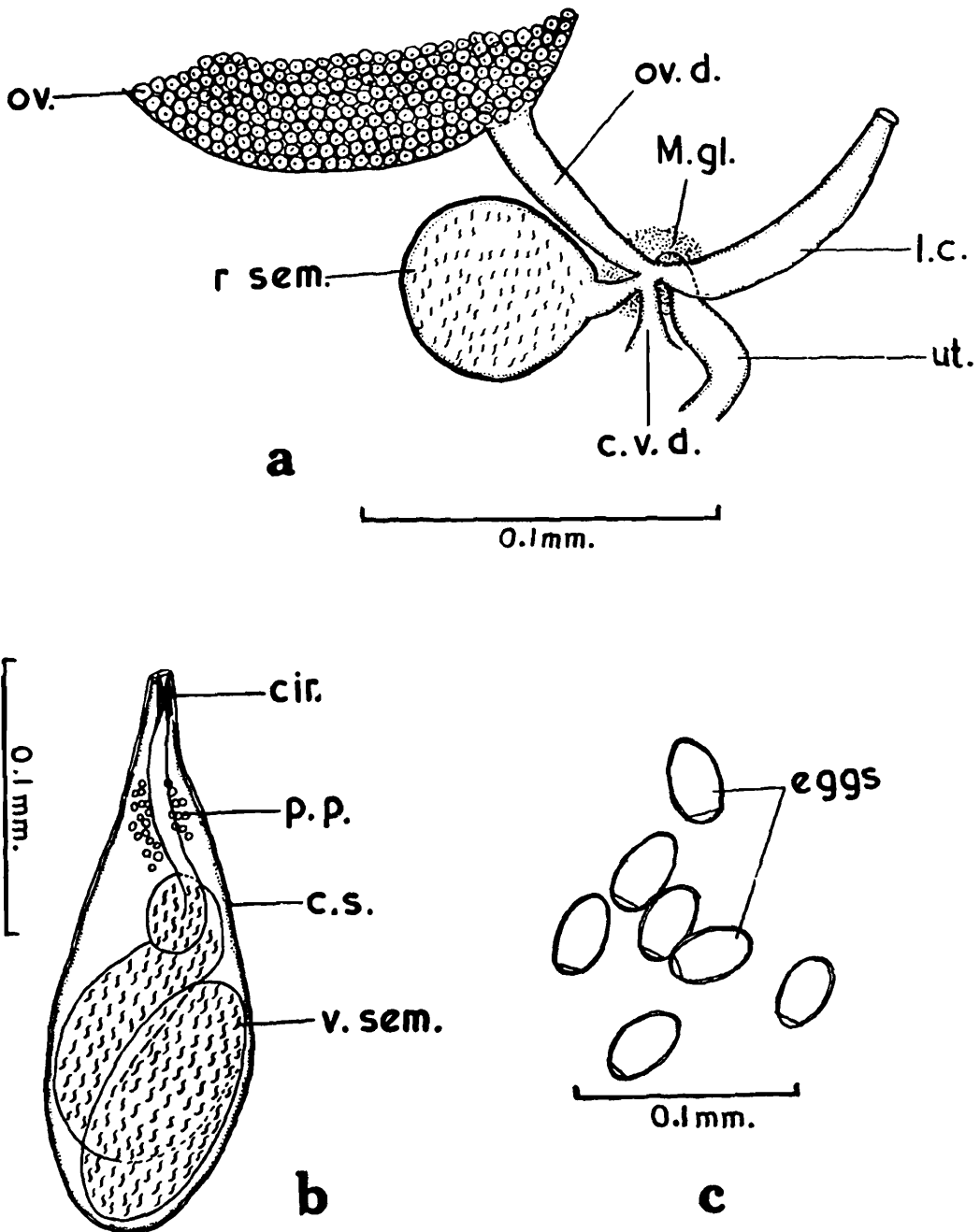
Body spinose, slender and elongated with a blunt anterior and pointed posterior end; broadest in acetabular region, from behind this region, gradually tapering towards posterior end, measures 2.32-4.06 mm. in length and 0.30-0.36 mm. in width, in region of ventral sucker.

Oral sucker subterminal, rarely terminal, measures 0.112-0.15 mm. $\times$ 0.087-0.112 mm. in size. *Ventral sucker* larger than oral and located at about a quarter of body length from anterior end; measures 0.20-0.24 mm. $\times$ 0.19-0.22 mm. Ratio between oral and ventral sucker approximately 1:2.

Mouth leads directly into muscular pharynx, measuring 0.05-0.06 mm. $\times$ 0.05-0.06 mm. *Oesophagus* not sharply set off from intestinal caecum, measures approximately 0.086-0.137 mm. in length, oesophagus followed by a single intestinal caecum, extending posteriorly beyond region of vitellaria and terminating near end of middle-third of body.

Testes usually round with entire margins but sometimes longitudinally oval, obliquely tandem, and located posteriorly in anterior half

of body ; in most specimens more or less equal in size but in some, posterior testis slightly larger than anterior ; anterior testis measures 0.11-0.187 mm. x 0.125-0.162 mm., posterior 0.125-0.187 mm. x 0.125-0.15 mm.



TEXT-FIG. 3. *Lutztrema stunkardi* sp. n., a. Mehlis' gland complex studied in live specimens ; b. Cirrus sac, drawn from paratype ; c. Eggs.

Cirrus pouch situated midway between oral and ventral suckers, measures 0.112-0.187 mm. x 0.05-0.06 mm., encloses a convoluted vesicula-seminalis, a narrow, coiled ejaculatory duct terminating into a cirrus. A *pars prostatica* present.

Genital pore located midway between anterior border of ventral sucker and anterior end of body.

Ovary round or oval, post-testicular in position, measures 0.125-0.162 mm. x 0.15-0.2 mm. in size. *Mehl's gland complex* situated

behind ovary. The two ducts from vitellaria of either side meet forming a common vitelline duct. The common vitelline duct, oviduct, the duct from receptaculum seminis, meet at a point surrounded by Mehlis' glands. Uterus arises from this point. *Receptaculum seminis* present but often not visible in fixed specimens. *Vitellaria* comprise large follicles, arranged not in distinct groups at sides of body but discretely in a mass behind ovary.

Uterus, with descending and ascending limbs, extensively developed, its coils filling up almost entire post-ovarian region of body; ascending limb of uterus passes between the two testes in its final course making several coils in front of anterior testis, runs forward subsequently dorsal to ventral sucker and opening to exterior behind the anterior end of body by means of a genital pore, measuring 0.275-0.55 mm.

Eggs oval, light-brown, operculate; measure 0.026-0.033 mm. x 0.016-0.02 mm.

Excretory bladder tubular with terminal excretory pore.

II—DISCUSSION

Travassos (1941) instituted the genus *Lutztrema* with *Lyperosomum obliquum* Travassos, 1917, as type-species. He included *Lyperosomum monenteron* Price et McIntosh, 1935, and *L. transversum* Travassos, 1917 under his newly erected genus. Besides, he described three new species *Lutztrema marinholutzi*, *L. verrucosum* and *L. insigne*. He characterised the genus *Lutztrema* by the presence either of a single intestinal caecum or double, but rudimentary intestinal caeca.

Again, Travassos (1944) in his monograph on *Dicrocoeliidae* Odhner, 1910, further placed *Lutztrema attenuatum* Dujardin, 1845, *L. donicum* (Isaïtschikoff, 1919), *L. transversogenitalis* (Layman, 1922), *L. kakea* (Bhalerao, 1926), and *L. colorosum* (Patwardhan, 1935) which have two rudimentary caeca.

Yamaguti, 1958 in his monograph "Systema Helminthum" followed Travassos (1941) and (1944) in retaining species with two rudimentary intestinal caeca under *Lutztrema*.

The writer begs to differ from Travassos (1944) and Yamaguti (1958) in including species of *Lyperosomum* Looss, 1889 with two intestinal caeca under the genus *Lutztrema*. The genus *Lutztrema*, in author's opinion, should be restricted to include species with only one intestinal caecum. Hence, the writer is of the opinion that the species with rudimentary double caeca namely, *Lutztrema attenuatum*, *L. alaudae* Layman, 1926, *L. kakea* and *L. colorosum* should be removed from the genus *Lutztrema* and reinstated to their original generic position under *Lyperosomum*. In the author's opinion only the following species, *Lutztrema obliquum*, *L. transversum*, *L. monenteron*, *L. marinholutzi*, *L. verrucosum* and *L. insigne* having only one intestinal caecum should be retained under *Lutztrema*.

Of the known species of this genus, the present form closely resembles *L. monenteron* (Price and McIntosh, 1935), from which it can be distinguished by smaller size of body, relative size of the gonads and ventral sucker. The testes are smaller than ventral sucker. Further, the ovary in the present form is as large as or larger than testes, whereas in *L. monenteron*, the testes are larger than the ventral sucker and the ovary is smaller than testes. The size of eggs is also

almost same as the eggs of *L. monenteron* when the size of the body is decidedly smaller. The present form differs from *L. singhi* n. sp. in having smaller body, testes and in having comparatively larger ovary. The ratio between oral and ventral sucker in present form is 1:2, while in *L. singhi* it is 2:3. The testes are larger than ventral sucker in *L. singhi*, but they are as large as or smaller than ventral sucker in present form.

III—SUMMARY

Two new species of the genus *Lutztrema* Travassos, helminth parasites of *Corvus*, are described in this paper. It is proposed to include in the genus *Lutztrema* only species with one intestinal caecum. Accordingly only six species are considered under the genus.

IV—ACKNOWLEDGEMENTS

The writer is highly obliged to Prof. M. B. Lal, previously Head of the Zoology Department, Lucknow University for his valuable guidance and for providing various facilities for research. The writer is also thankful to Prof. P. D. Gupta for giving valuable suggestions. The writer is thankful to the Government of India for the award of C.S.I.R. Junior Research Fellowship during the years 1963-65.

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ABBREVIATIONS USED IN TEXT-FIGURES

Cir	...	Cirrus
C.S.	...	Cirrus sac
Ex.bl.	...	Excretory bladder
g.p.	...	genital pore
int. cae	...	intestinal caecum
L.C.	...	Laurer's Canal
M.Gl.	...	Mehlis' gland
Ov.	...	Ovary
O. Su.	...	Oral Sucker
P.P.	...	Pars-prostatica
Ph.	...	Pharynx
r. sem.	...	receptaculum seminis
Sp.	...	Spine
t.	...	testis
ut.	...	uterus
v. sem.	...	vesicula seminalis
vit.	...	vitellaria
vit. d.	...	vitelline duct.
v. su.	...	ventral ucker

NATURE AND SIGNIFICANCE OF THE EVOLU-
TIONARY TRENDS OF THE SIPHONOSTOMATOUS
CYCLOPOIDES LIVING IN ASSOCIATION WITH
ECHINODERMS, WITH NOTES ON *STEPHOPONTIUS*
TYPICUS THOMPSON AND SCOTT

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(With 2 text-figures)

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I—INTRODUCTION

Copepods have been found frequently living in association with various other animals. The nature of association varies greatly and ranges from pure, highly degenerate to the simple, relatively unmodified condition. Various terms have been employed to denote this relationship between the copepods and their hosts. “Copepod associates” suggested by Gooding (1957) seems to express the actual relationship better than any other term. It is desired to emphasise, however, that while some groups are still hesitant to depart from their free living existence for a thoroughly associated life, there are other groups which appear to be definitely on tracks towards obligatory parasitism. One such group is constituted by a number of siphonostome cyclopoids living in association with echinoderms. Most of them seem to be incapable of free existence, nor are they found to be associated with other hosts. Further,

the members of this copepod assemblage share with each other many common characteristics which are not found outside the group.

According to the original definition, the siphonostome cyclopoids formed a coherent group and are characterised by the presence of an oral siphon. However, both Giesbrecht (1899) and Sars (1915) have recognised Cancerillidae as an exception to the rule for in this family the siphon was only feebly developed. Recently some more families (Micropontiidae Gooding, 1957; Stellicomitidae Humes & Cressey, 1958; Nanaspidae Humes & Cressey, 1959) have been added, whereas in Cancerillidae, the siphon is absent or reduced to a very short extension of the labrum and the labium. The facts that all these forms are associates of echinoderms and that they all share many common features in contrast to the rest of the siphonostomes suggest that the members of these families have taken an altogether separate evolutionary track. This view is necessarily suggestive of an early divergence among siphonostomes and a possible splitting of the latter into two tribes, one tribe with a well-developed siphon and a non-prehensile antenna, and the other with a highly reduced siphon and prehensile antenna.

The family Micropontiidae is monogeneric, containing the genus *Micropontius* Gooding, 1957. The Stellicomitidae contains three genera: *Onycopygus* Humes & Cressey, 1958, *Asterocomes* Rao, 1962, and *Stellicomes* Humes & Cressey, 1958, the first two genera being monotypic. Cancerillidae contains four genera: *Cancerilla* Dalyell, 1851, *Parartotrogus* T. A. Scott, 1893, *Concerillopsis* Stephensen, 1933 and *Ophiopsyllus* Stock *et al.* 1963.

Changeux (1958) described a new genus of copepod *Allantogynus* from ophiuroid host and referred it to Cancerillidae, but later on (1960) the same author created a new family Allantogynidae to accomodate it. Bresciani and Lutzen in : Stock *et al.* (1962) have called attention to the similarities existing between Nanaspidae and Allantogynidae and indicated that the latter is only a synonym of the former. However, there are sufficient differences between *Nanaspis* and *Allantogynus* to retain their separate identities. *Allantogynus* will thus form the second genus of the family Nanaspidae.

There is another interesting genus *Stephopontius* obtained "in the general washings of dredged invertebrates" described by Thompson & Scott (1903). The species has never been reported after its original description. I have now obtained this species from the washings of *Holothuria atra* from the Gulf of Mannar. Humes & Cressey (*loc. cit.*) discussed the possible systematic relationships of this species and indicated that it is related to *Nanaspis*. I am convinced that *Stephopontius* could fit into the definition of the family Nanaspidae as modified by Stock *et al.* (1962). But the differences between the two genera are described in table I.

TABLE I—The differences between *Nanaspis* Humes & Cressey and *Stephopontius* Thompson & Scott

<i>Nanaspis</i> Humes & Cressey	<i>Stephopontius</i> Thompson & Scott
Prosome is 2-segmented. First segment is the cephalosome and second segment is the result of fusion of all the four pedigerous segments.	Prosome is 3-segmented. First segment is the cephalothorax formed by the fusion of cephalosome and first pedigerous segment. Second segment is the result of fusion of the succeeding two pedigerous segments. Last segment is the fourth pedigerous segment.
Last segment of prosome does not carry any accessory appendage.	Last segment of prosome carries two pairs of expanded structures, one pair on each side in female ; in male no such appendage is seen.
Urosome in both sexes consists of a leg-bearing first segment and genital segment. Genital segment a sub-rectangular complex.	Urosome is incompletely 2-segmented in female and incompletely 3-segmented in male. First segment carries foliaceous fifth legs. The genital segment carries sixth pair of legs in male.
Geniculate male antennule is 6-jointed.	The geniculate male antennule is 2-jointed.
Exopods of second and third legs are each 3-jointed.	Exopods of second and third legs are each 2-jointed.

Before proceeding further with the phylogenetic relations and the question of speciation in these echinoderm associates, it is desirable to give a brief description of *Stephopontius typicus* Thompson & Scott. The latter authors have presented the salient features of the species. The following notes are supplementary to it.

II—DESCRIPTION OF *Stephopontius typicus* THOMPSON & SCOTT

1903. *Stephopontius typicus* Thompson and Scott, p. 203, pl. XX.

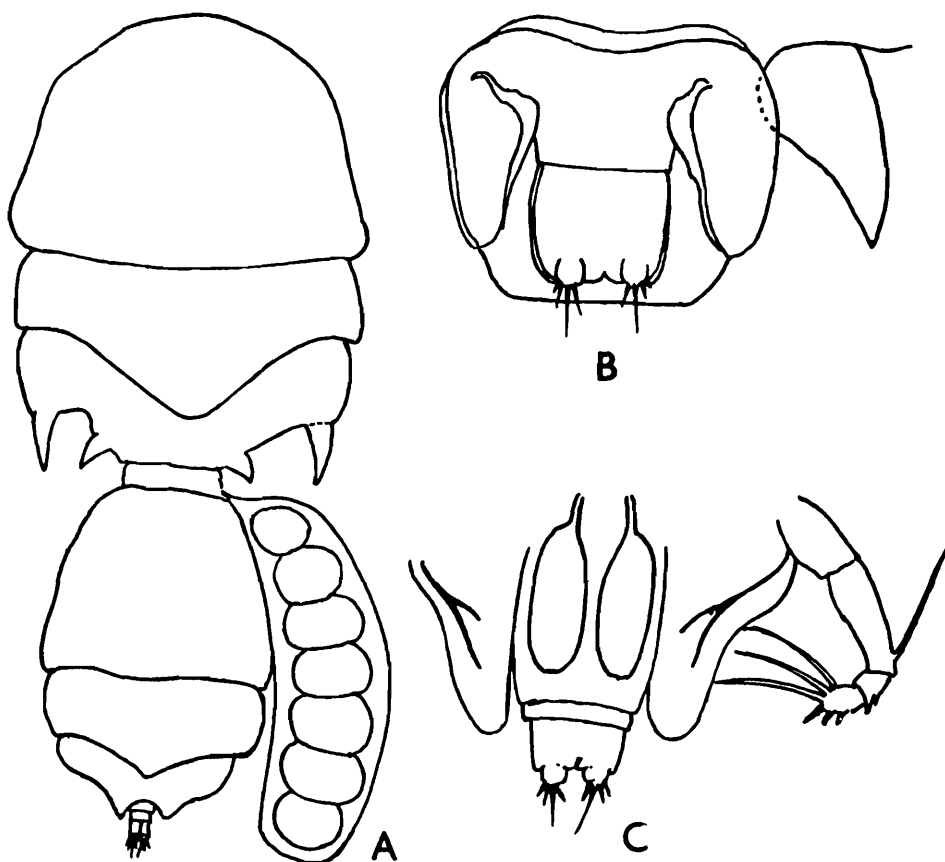
1959. *Stephopontius typicus*: Humes and Cressey, p. 212.

One female and two male specimens (one male and female in paired state) were obtained from washings of *Holothuria atra* from the Gulf of Mannar on 15th December 1960.

Thompson & Scott (*loc. cit.*) reported the sizes of the two sexes as 6.0 and 8.0 mm., respectively. This is, as Humes & Cressey have pointed out, obviously a typographical error. In their figures of adult female and male they have given a magnification scale. According to this scale, male is smaller than female, their respective sizes being 0.5 mm. and 0.65 mm. This is the same size range as that of the present examples.

Prosome (Text-fig. 1 A) is 3-segmented. First segment is the cephalothorax, having been formed by fusion of cephalosome and first pedigerous segment. Second segment is the result of fusion of second and

third pedigerous segments and bears those legs. Last segment carries fourth pair of legs. An elongated, rather spindle-shaped process is borne on each of the postero-lateral corners of the last prosomal segment. At about the junction of this segment with urosome a pair of foliaceous structures is borne, one on either side (Text-fig. 1 B). They can be compared to the somewhat similar structures found in *Micropontius ovoides*.

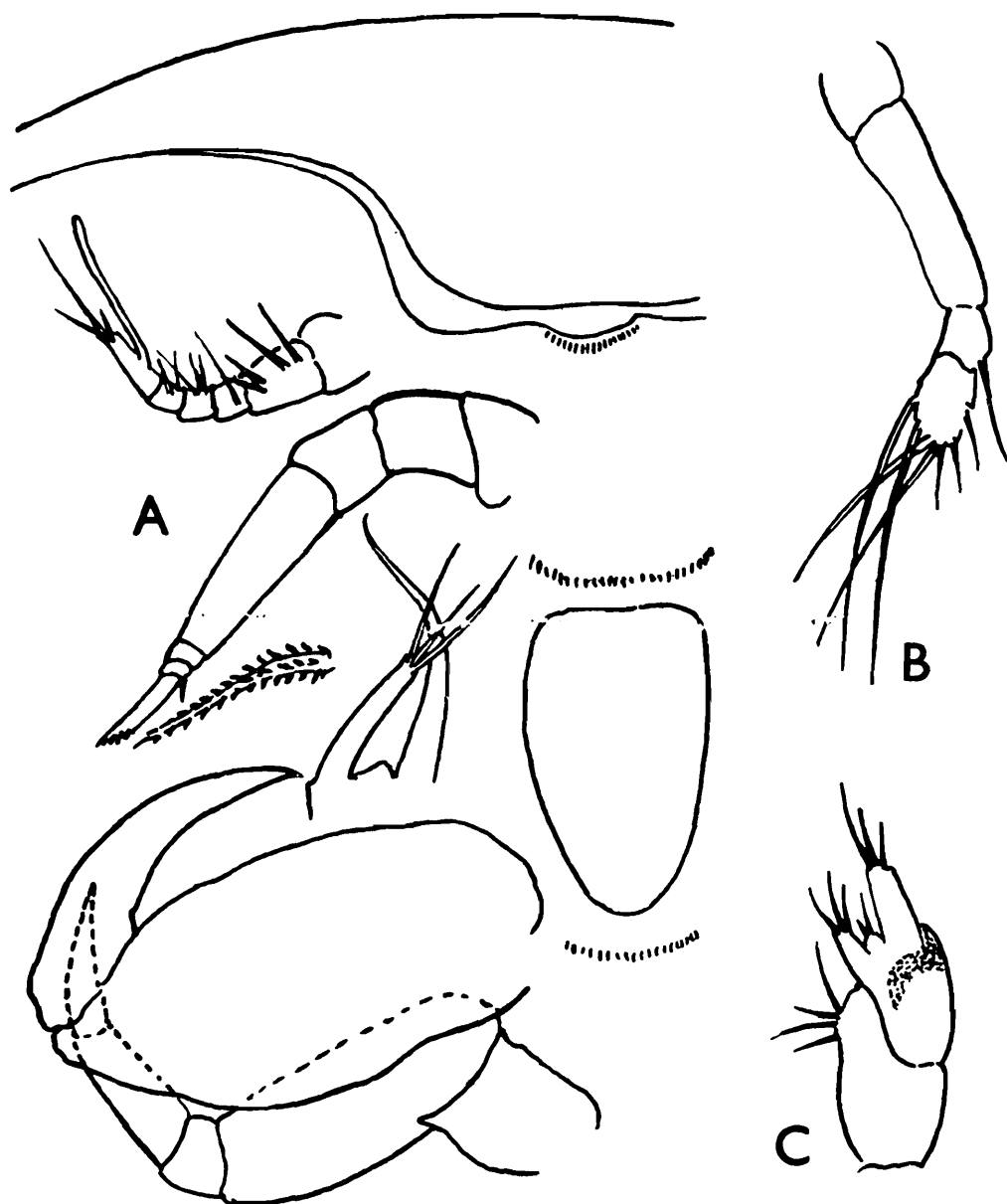


TEXT-FIG. 1A. Adult female and male in paired condition. (Only one ovisac is shown in female). B. Female urosome, ventral view. C. Male urosome, ventral view.

There is a pair of egg sacs, each egg sac is cylindrical, a little incurved containing 5-7 eggs, arranged one above the other. The cephalosomal appendages (Text-fig. 2 A) and third leg (Text-fig. 2 B) are figured. The third leg differs from the fourth leg in possessing three spines and four setae on the second exopod segment. Fifth leg is foliaceous and uniarticulate without any accessory process. Urosome is a rectangular mass, with a slight indication of division into two segments. Fifth legs are borne on the antero-lateral corners of the proximal segment. Caudal rami are small sub-spherical structures borne on the posterior side of urosome, one on either side. Each ramus carries four setae which are flattened and non-jointed. These structural details are not seen in dorsal view as they are covered by a flap.

Male differs from female in the smaller size, in the geniculation of the antennule and in the presence of sixth pair of legs. Antennule (Text-fig. 2 C) is a highly modified structure, apparently 2-segmented,

but possibly containing more segments. The first segment is simple, carrying three setae on anterior margin ; the second segment is covered



TEXT-FIG. 2A. Ventral view of cephalosome of female showing various appendages. B. Female third leg. C. Male antennule.

by a transparent flap on dorsal side. In ventral view it is seen to terminate in three lobes, all carrying a number of setae. Both segments are highly calcified. Urosome (Text-fig. 1 C) is 3-segmented, the division between first and second segments being indistinct on ventral side. The sixth leg consists of a small rounded lobe, bearing three setae. It is borne on the postero-lateral corners of second urosomal segment. Size: Female 0.66 mm. and male 0.55 mm.

Thompson & Scott (*loc. cit.*) reported this species from the Ceylon Pearl Banks and the present record is the first rediscovery of this species.

III—DISCUSSION

Stock *et. al.* (1963) have discussed a possible relationship between Cancerillidae, Nanaspidae, Stellicomitidae and Micropontiidae. The asso-

ciation of each of these families with different classes of echinoderms is noteworthy; Cancerillidae with ophiuroids, Nanaspidae with holothuroids, Stellicomitidae with asteroids and Micropontiidae with echinoids. Their phylogenetic affinity is all the more supported by the structural gradations that are exhibited by *Asterocomes* Rao whose many characters are "partly shared by some of the genera of the related families, namely *Micropontius* Gooding (Micropontiidae) and *Nanaspis* Humes & Cressey (Nanaspidae)" Rao (*loc. cit.*). The salient features of the four families are compared and contrasted in table II.

Stock *et. al.* (1963) suggested that Micropontiidae "are not closely related to the others, since they exhibit differences in the structure of the first antenna and leg 1." This view, however, cannot be extended too far. A large number of segments in the antennule is also met with in *Asterocomes* Rao. The elongated first endopods could well be considered as specialised development for firmer attachment to the spiny echinoid body. It is interesting to note that *Asterocomes* also shows many semblances to *Nanaspis* like the extreme suppression of swimming legs. It would appear that though the four families constitute four coherent groups, the different genera in these families exhibit many ~~kinships one way or the other.~~ It is likely that the discovery of newer genera would further contribute towards bridging the structural gradations between them. One is more inclined to emphasise the development of those basic characters which are meant for an associated existence with different classes of echinoderms. The important differences between these four families of copepods on the one hand and the rest of the siphonostomes on the other are presented in table III.

In considering the nature and significance of the evolutionary trends of the siphonostomatous cyclopoids living in association with echinoderms following features are noteworthy:

- (a) Smaller size ;
- (b) General reduction of appendages and fusion of body segments ;
- (c) Prehensile antenna ; and
- (d) Absence of siphon.

It is not known whether these copepods have any specificity in relation to their hosts, or any special preference for particular area on the host body. The occurrence of *Stellicomes tumidulus* on such widely separated hosts as *Pentaceros hedemanni* (Lutken) in the Gulf of Mannar and *Protoreaster lincki* (Blainville) off Nossi Be, Madagascar probably provides a negative data regarding specificity. Rao (1962) reported the occurrence of *S. tumidulus*, *S. guineensis* and *Asterocomes indicus* on the same host, *Pentaceros hedemanni*. Also it is likely that they occur anywhere on the host body, including the tube-feet areas and the topographical crevices and elevations found on the surface of the host body. It is understandable that in order to be of greatest adaptation for living in these restricted spaces on the host body the animals should necessarily be very small. The actual size range found in these copepods generally is from 0.30 mm. to 0.60 mm. with the exception of a few species belonging to *Cancerilla* and *Parartotrogus*, and the latter situation is probably the consequence of their frequent free existence.

A streamlined body with as much fusion of different segments of the body as possible would similarly contribute towards a firmer hold on the host body. The circulation of waters around the hosts will pass by a smooth surface, but is likely to create a frictional force on animals with protruding angular edges and points, constantly trying to dislodge them. Accordingly, we find that in all these echinoderm associate copepods, except, again, in some of the Cancerillids caught independently of the host, there is a cohesive fusion of different body segments and there is hardly any distinction between prosome and urosome. Not only is the fusion very complete, but often the body presents very smooth outer surface.

Antennae are quite strongly developed and prehensile. In these copepods the premium has been on the general reduction of appendages, particularly those which aid in swimming and mastication. However, an associated animal, coming to depend more and more on the host, must develop clinging devices and this is actually rendered by the antennae. In fact it is the most powerfully grown organ of the animal. It is articulate and provided with strong claws. Presumably they function for attachment to the host body.

Absence of siphon is another interesting point. Echinoderms are benthic organisms and their movements, if at all, are of a restricted nature. Consequently there is a constant accumulation of decaying organic matter, both settled and excreted, on the external surfaces of the host. In such circumstances there is hardly any need for the copepod associate to develop complex and elongate tubular apparatus for sucking in the food materials which are available in plenty and almost all the time. As a matter of fact none of the species belonging to these four copepod families have any distinctly developed siphon. At the most the labrum and labium get fused to form a circular or oval disc or ridge, the mouth being situated in its center.

The foregoing discussion demonstrates that the siphonostomatous families Cancerillidae, Micropontiidae, Stellicomitidae and Nanaspididae have evolved quite a bit towards 'parasitising' the echinoderms. It must, however, be added that the relation is not strictly parasitism or semiparasitism, for the copepods do not feed at the expense of echinoderms. It may probably be qualified as symbiosis, but how far essential the copepods are to the echinoderms as cleaning agents is not definitely known. None of these copepods have been reared or experimented upon in the laboratory. More informations of biological and ecological nature are required for any definite statement.

As we have already found, after their deviation from the rest of siphonosomes many specialised characters, have been developed in these copepods towards a close associated existence with the echinoderms. However, our knowledge of this copepod group is in an imperfect state and we do not know whether the limited number of species and genera known under different families indicate the real state of affairs or only the insufficiency of our knowledge of these forms. In any case it appears that the relationship of these copepods with their hosts is very intimate and ancient. This view is supported not only by the many characteristic morphological features discussed earlier, but also by the world-wide distribution of some species. *Stellicomes tumudulus* has already been referred to. Another species, *S. guineensis* is recorded

from the east Atlantic (off the coast of Cape Sierra Leone) and the northern Indian Ocean (off the south east coast of India) on such widely separated hosts as *Oreaster clavatus* Muller and *Pentaceros hedemanni* (Lutken) respectively. *Micropontius ovoides* Gooding has been recorded from Plymouth, off Mediterranean (Stock, 1960) and off Swedish coasts (Bresciani & Lutzen, 1962) and *M. glaber* Stock *et. al.* which differs only in some structural details from *M. ovoides*, has been recorded from the other side of the Atlantic, off Jamaica.

Within the group the evolutionary changes appear to have been very slow, particularly so for smaller taxonomic categories. Stock *et. al.* (1962) reports: "More than one species of *Nanaspis* may occur in a single locality as seen in the case of *N. poolens* and *N. exigua* both of which were found at Drunkenmans Cay, Jamaica." They added: "It is worth noticing that three *Nanaspis* species (*N. poolens*, *N. exigua* and *N. media*) may occur on the same species of holothurian, thus raising interesting but as yet unanswerable questions on the nature and causes of speciation in this genus" It is, again, interesting to note that although substantial differences exist between different families and genera, the distinguishing marks between the species are rather insignificant, and there is hardly any variation between individuals at all. One is tempted to say that the evolution within the lower taxonomic categories of this copepod group has been monotonously slow.

IV—SUMMARY

A group of Siphonostome Cyclopoids living in association with Echinoderms and belonging to the families Cancerillidae, Micropontiidae, Stellicomitidae and Nanaspidae are peculiar in that the oral siphon in these forms are highly reduced or altogether absent. Their exclusive association with various classes of Echinoderms coupled with some structural peculiarities point to the possibility of an early divergence of these echinoderm associate copepods from the main evolutionary stem of the siphonostome cyclopoids.

Stephopontius typicus is described for the first time after its original description by Thompson and Scott in 1903. Brief notes are added on the species and its relations are discussed.

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TABLE II

Salient features of the Families Cancerillidae, Micropontiidae, Stellicomitidae and Nanaspidae

Cancerillidae	Micropontiidae	Stellicomitidae	Nanaspidae
1. Prosome & urosome often distinct with segments clearly marked. Sexual dimorphism well-developed except in <i>Ophiopsyllus</i> .	1. Little distinction between prosome and urosome and little flexibility between segments. Sexual dimorphism feebly developed.	1. Little distinction between prosome and urosome and hardly any segmentation. Sexual dimorphism feebly developed.	1. Little distinction between prosome and urosome. Segmentation little developed. Sexual dimorphism feebly developed in <i>Nanaspis</i> and strongly developed in <i>Stephopontius</i> .
2. Urosome ill-developed short, with varying number of segments.	2. Urosome a single sub-rectangular complex, bearing fifth legs in the proximal half.	2. Urosome minute, 1-segmented.	2. Urosome 1-segmented in <i>Nanaspis</i> . In <i>Stephopontius</i> it is 1-segmented in female but 3-segmented in male.
3. Female antennule 6 to 9 segmented. Male antennule 6 to 10 segmented, may or may not be geniculate.	3. Female antennule 14-segmented; male antennule 13-segmented and doubly geniculate.	3. Female antennule 3-or 4-jointed in <i>Onycopygus</i> and <i>Stellicomes</i> and 14-jointed in <i>Asterocomes</i> . No geniculation in male antennule.	3. Female antennule 8-jointed in <i>Nanaspis</i> , 6-jointed in <i>Stephopontius</i> . Male antennule 5- or 6-jointed in <i>Nanaspis</i> and only 2-jointed in <i>Stephopontius</i> ; in both cases geniculate, weakly.
4. Antenna, prehensile with powerful claw, 3 or 4 segmented. Exopod, when present, very rudimentary.	4. Antenna prehensile, strong, 4-segmented with terminal claw. No exopod.	4. Antennule 4-jointed with terminal claw. No exopod.	4. Antenna prehensile, and 4-jointed in <i>Nanaspis</i> ; weakly prehensile and 5-jointed in <i>Stephopontius</i> .
5. Siphon obsolete.	5. No siphon. Mouth slightly protruding, labrum and labium fused into a flattened structure.	5. The sucking apparatus formed of labrum and labium; shows sexual dimorphism.	5. Sucking apparatus formed of labrum and labium as a flat disc.

(Contd.)

TABLE II—Continued

Cancerillidae	Microponiidae	Stellicomitidae	Nanaspidae
6. Mandibles short, extending straight inward, palp absent.	6. Mandible consists of masticatory blade and palp; former protrudes into the mouth through the gaps of the labrolabial complex.	6. Mandible simple spine; adjacent seta is palp.	6. Mandible minute, simple spine; no palp.
7. Outer lobe of maxillule present only in <i>Parartotrogus</i> and <i>Ophiopsyllus</i> ; inner lobe short and stout terminating in 3 setae.	7. Maxillule biramous, rami ending in setae.	7. Maxillule biramous, ramus bearing setae in <i>Onycopyous</i> and <i>Stellicomes</i> , spine and setae in <i>Asterocomes</i> .	7. Maxillule biramous, seta like.
8. Maxilla and maxillipeds of asterocherid type.	8. Maxilla 2-segmented, second segment modified to a strong claw. Maxilliped asterocherid.	8. Maxilla 2-jointed, maxilliped asterochrid type.	8. Maxilla 2-segmented, second segment a claw. Maxilliped of asterocherid type.
9. First to fourth legs showing varying stages of reduction usually of generic significance. Even when best developed (<i>Parartotrogus</i> & <i>Cancerillina</i>) first leg is more reduced than second leg; fifth leg usually present, rudimentary.	9. First and second legs biramous, each 3-segmented, In third and fourth legs only exopods are present both 3-segmented.	9. Swimming legs biramous, Endopod a single segment. Exopod 3 jointed except in first leg where it is 1 jointed in <i>Stellicomes</i> and <i>Onycopygus</i> and 2-jointed in <i>Asterocomes</i> .	9. First and second legs biramous, rami 1-jointed in the former; in second leg, 3rdopod is 2-segmented; exopod consists of 2 joints in <i>Stephopontius</i> and 3 joint in <i>Nanaspis</i> . Third and fourth legs uniramous; former consists of 3 joints in <i>Stephopontius</i> rami 2-jointed in fourth leg.
10. Caudal rami normal.	10. Caudal rami normal.	10. Caudal rami minute, variable in form.	10. Caudal rami minute with setae.

Table III—The differences between echinoderm associate copepods
and other siphonostomatous copepods.

Echinoderm associate copepods	Other siphonostomatous copepods
The group at present contains four families, Cancerillidae, Micropontiidae, Stellicomitidae and Nanaspidae. Live in association with different classes of echinoderms.	Includes all other siphonostomatous cyclopods. Free living or living in loose or close relation with a variety of invertebrates.
Very small, below 1 mm. (with rare exceptions), and mostly below 0.5 mm. Hardly any distinction between prosome and urosome (again with rare exceptions) and segmentation of the body little exhibited.	Usually large in size, with well-developed prosome and urosome. Body segments mostly clearly demarcated.
Female antennule usually 3 to 7 segmented except in <i>Micropontius</i> and <i>Asterocomes</i> where they are 14-segmented. Male antennule always geniculate and composed of a smaller number of segments.	Female antennule 9-to 21-segmented and fairly large. Male antennule geniculate; in <i>Asterocheridae</i> it consists of smaller number of segments and in <i>Artotrogidae</i> of a larger number of segments than the female antennule. Varying situations are met with in other families.
Antenne prehensile and strongly developed. 3- or 4-segmented. Exopod is absent except in the case of <i>Parartotrogus</i> where it is present as a delicate setiferous lamella. Mostly ending in a terminal claw.	Antenna non-prehensile, composed of 4 or 5 joints. Exopod vestigial in most cases, attached to second endopod segment. Exopod is probably most developed in <i>Acontiophoridae</i> .
Siphon absent. Labrum and labium may just meet making a protrusion.	“Oral parts not adapted for mastication, the anterior and posterior lips being generally produced to form a prominent one termination in long or short siphon” (Sars, loc. cit.)
Mandible and maxillule feebly developed. Maxilla and maxilliped of the <i>asterocherid</i> type.	Mouth parts usually well-developed and adapted for mastication.
Swimming legs exhibiting varying degrees of reduction. Maximum reduction probably in <i>Asterocomes</i> . Fifth legs present, but in reduced or modified form. Sixth legs often present in males.	Swimming legs usually well-developed. Normally biramous, rami being 3 jointed. Independent reduction of segments and rami of the legs takes place in different general and families. (Ummerkutty, 1962, 1966). Fifth legs always present. Sixth legs often present in males,

STUDIES ON INDIAN COPEPODS 10. DESCRIPTION
OF *PARAPELTIDIUM NICHOLLSI* SP N., *PORCELLI-
LIDIUM UNICUS* SP N. AND *ECHINOLAOPHONTE
TROPICA* SP N OBTAINED FROM THE SOUTH
EAST COAST OF INDIA*

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(With 3 text-figures)

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I—INTRODUCTION

The present communication contains the description of three new species of harpacticoids. They are all associated with various algae living in the littoral areas of the Gulf of Mannar and the Palk Bay. No attempt was made to identify the algae since monospecific algal colonies are not generally found in the area. During the several visits to the littoral areas, algae were hand-picked and washed into large beakers. Often the washed out organisms were brought alive to the laboratory for examination. Mostly samples were preserved in 5% formalin immediately after collection. The different species were later sorted out under a binocular microscope. Of the three species dealt with in this paper, *Parapeltidium nichollsi* was represented by a few specimens only, while the other species are abundantly gathered.

I am thankful to Dr. S. Jones, Director, Central Marine Fisheries Research Institute for his encouragements and guidance during the course of this study. My deep gratitude is also due to Dr. A. G. Nicholls of Australia who kindly went through and criticised the systematic parts of this series of study on Indian copepods.

II—SYSTEMATIC ACCOUNT

Parapeltidium nichollsi sp. n.

Material examined.—Six adult females and five adult males of this species were collected from washings of littoral weeds from the Palk Bay at Mandapam on 19th July, 1960. The holotype, allotype and paratypes are deposited in the Reference Collection Museum of the Central Marine Fisheries Research Institute and bear the register numbers J. 673/16, J. 674/16 and J. 675/16 respectively.

Descriptive notes.—*Female*.—Body ovoid, very stout, dead specimens always being as sketched (Text-fig. 1, A & B); apparently six segments; abdomen more or less hidden from dorsal view. First segment widest part of body, only a little less than length of rest of body. Mid-dorsal areas of all segments elevated to moderately sized crests; margins as well as median crests highly chitinised with a beautiful violet tinge. Abdomen 2-segmented, completely covered from dorsal view. Caudal ramus short, twice as long as wide, each ramus carrying one marginal and five apical spine-like setae.

Antennule 7-segmented, very short. First and second segments subequal; third and fourth segments much smaller, each bearing fairly long aesthetascs. Last three segments very small, all carrying a good number of setae except the sixth which has only two setae. Small sensory filaments also distributed on segments. Relative lengths of constituting segments given as below:—

1	2	3	4	5	6	7
35.2	29.0	14.0	7.5	3.4	2.5	8.4

Antenna (Text-fig. 1, C) 3-segmented with a very rudimentary exopod attached to middle of second joint, and with a number of sensory filaments. Mandible and maxilliped resemble those of *P. cristatum* Nicholls. Maxillule and maxilla as in figure (Text-fig. 1, D).

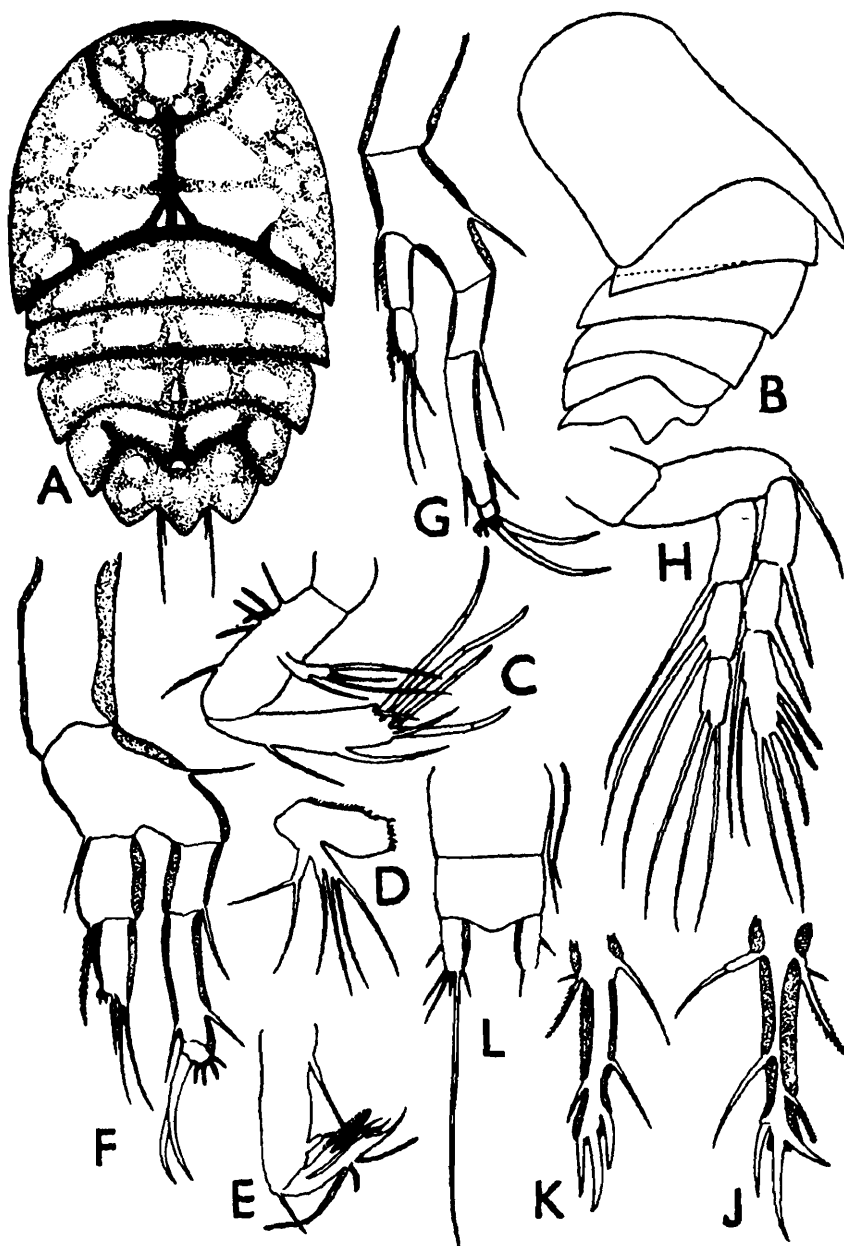
First legs (Text-fig. 1, F) exopod 3-segmented; endopod 2-segmented. Protopod segments long; second segment bearing a seta on outer mid-length and a seta on inner distal angle. Basal exopod segment with a seta on distal inner angle; middle exopod segment with two spines, one on either side, both in distal part; terminal exopod segment provided with two long stout spines and four sensory appendages. Basal segment in endopod carries an inner seta in distal angle; distal segment carries two apical spines and one inner spine; three sensory appendages near the base of latter. Next three pairs of legs (Text-fig. 1, H, J) typical of the genus. Fifth leg (Text-fig. 1, J) 1-segmented. Basal part corresponding to proximal segment of genus *Peltidium* carries, as in that genus, a broad-based seta on outer side. On inner side it carries a spine and seta. Distal part of fifth leg with two spines on outer, two apical and one on inner margin. Fifth legs highly chitinised. Size, 1.35 mm.

Male.—Differs from female in structure of antennule, first pair of legs and also in presence of a sixth pair of legs.

Antennule 7-segmented, with following relative lengths:

1	2	3	4	5	6	7	
30.0	30.0	13.6	8.2	6.4	3.6	8.2	= 100

Segments rather stout and bear larger number of setae than in female. Third and fourth segments, as in female, carry aesthetascs. Protopod segments as well as two rami of first pair of legs (Text-fig. 1, G) much narrower; but with same number of setae and spines as in female, excepting the inner marginal spine of distal endopod segment which is longer and thinner than that of female. Sixth pair



TEXT-FIG. 1 *Prapeltidium nichollsi* sp. n. A. Female [dorsal view; B. Female lateral view; C. Female antenna; D. Female maxillulae; E. Female maxilla; F. Female first leg; G. Male first leg; H. Female second leg; J. Female fifth leg; K. Male fifth leg; L. Male sixth leg with urosome.

of legs present; parallel to lateral margins of urosomal segments. (Text-fig. 1, L). Each leg consists of a long, flat strip with two apical setae. Sixth leg just exceeds posterior margin of first urosomal segment. Size, male 1.15 mm.

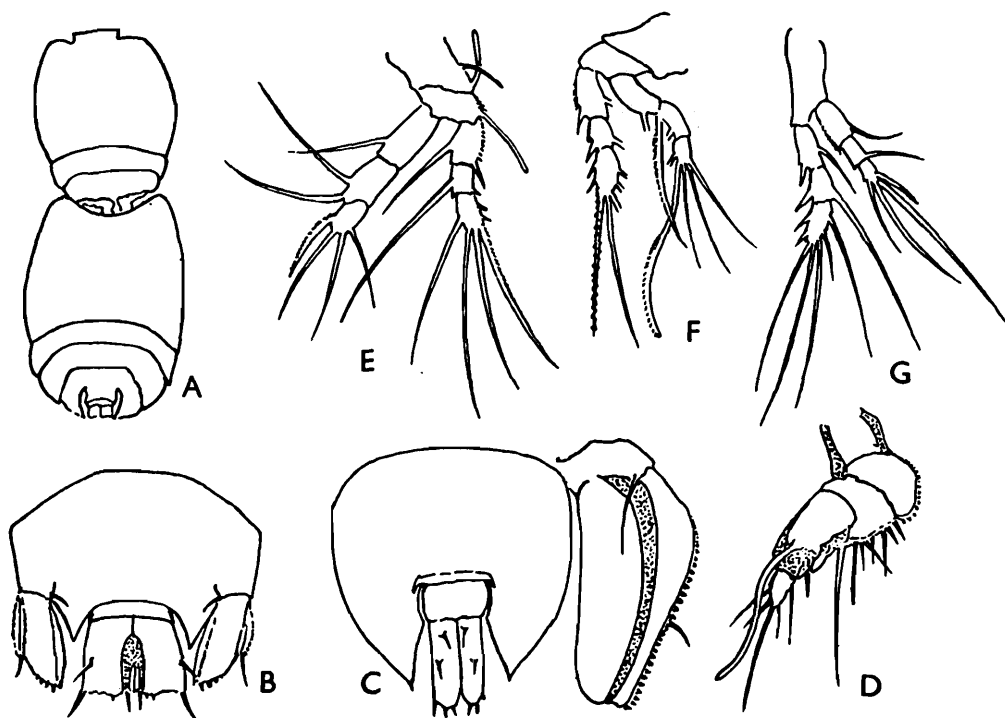
The present species is named after Dr. A. G. Nicholls of Australia whose contributions to the knowledge of the copepod fauna of the Indo-Pacific are valuable.

Porcellidium unicus sp. n.

Material examined.—About two hundred female and one hundred and fifty male specimens of this copepod were obtained from the washings of algae off Vedalai, in the Gulf of Mannar on 16th July, 1960. Holotype, allotype and paratypes are deposited in the Reference Collection Museum of the Central Marine Fisheries Research Institute and bear the registered numbers J. 732/18, J. 749/18 and J. 750/18 respectively.

Descriptive notes—Female.—The yellow colour of this species, bright in life and immediately after killing and faint after a few days of formalin preservation is very peculiar.

Body (Text-fig. 2, A.) elongate, ovate, typically of porcellidiid type with a squared rostrum at anterior side. Ratio of length and breadth of body 1.5:1.0. Second segment as broad as first, but other body segments smoothly narrowed down to posterior side. Genital segment (Text-fig. 2, C) expanded backwards, the expansion reaching three-fourth length of caudal rami. Each such expansion sharply tapers and terminates in a fine spinule. Abdominal segment very short, inserted



TEXT-FIG. 2. *Porcellidium unicus* sp. n. A. Male and young female in paired condition; B. Male urosome with fifth leg; C. Female urosome fifth leg; D. Male antennule; E. Female second leg; F. Female third leg; G. Female fourth leg.

between genital segment and caudal rami. Anterior margin bordered by chitinous band with a stout backwardly directed spine on either end. Caudal rami thin and cylindrical, carrying three setae terminally and two setae ventrally. Antennule, antenna, mandible, maxillule, maxilla, maxilliped and first pairs of legs typical of genus. Next three pairs of legs (Text-fig. 2, E, F, G) remarkable in possessing only two external spines on terminal exopod segments. Ornamentation of three pairs of legs given as below:

		Protopod				Endopod					Exopod							
		1		2		1		2		3	1		2		3			
	si	se	si	se	si	se	si	se	si	st	se	si	se	si	se	si	st	se
P2	0	A	0	A	1	0	2	0	1	2	1	1	I	1	I	2	2	II
P3	0	0	0	0	1	0	2	0	2	2	1	1	I	1	I	3	2	II
P4	0	0	0	0	1	0	I	0	I	2	1	1	I	1	I	3	2	II

Inner setae on terminal segment of second endopod, proximal seta on second segment of third endopod, and terminal seta of terminal segment of same leg modified as in other species of this genus. Inner distal margins of these setae carry a number of sharp bristles giving it a comb-like appearance. Inner setae on second and third segments of fourth endopod modified into spine-like structures with bristles on margins. Fifth leg (Text-fig. 2, C) 2-segmented, rather hexagonal. First segment short, bearing one seta. Distal segment with a pronounced calciferous ridge, running along its entire length, dividing it into two halves. Outer margin of distal segment carries a number of spinules of entire posterior two-third of its length, this spinular area divisible into more or less equal halves by a seta. A number of fine sensory hairs also present on outer margin of distal segment. Size, 0.75 mm.

Male.—General shape of body (Text-fig. 2, A) identical to female, but anterior margin of first prosomal segment highly concave. Posterior end of fifth copepodite female fits very well into this concavity of male. Antennule (Text-fig. 2, D) geniculate and apparently 5-segmented. Fourth segment with an aesthetask. Segments highly shortened, their margins calcified. Margins of second segment with numerous bristles. Fifth leg very small, 2-segmented. First segment devoid of any seta or spine. Second segment pentagonal, outer margin divisible into proximal and distal halves, former bordered by a thick ridge carrying numerous fine bristles. Distal part with one setae in its proximal part, and three spines in its distal part; margins of these spines not fringed as in other species. In urosome (Text-fig. 2, B) genital and anal segments quite short; former just exceeds anterior margin of latter. Caudal rami short, squarish with three setae on posterior margin and one on ventral face. The sides of rami calcified. Size 0.63 mm.

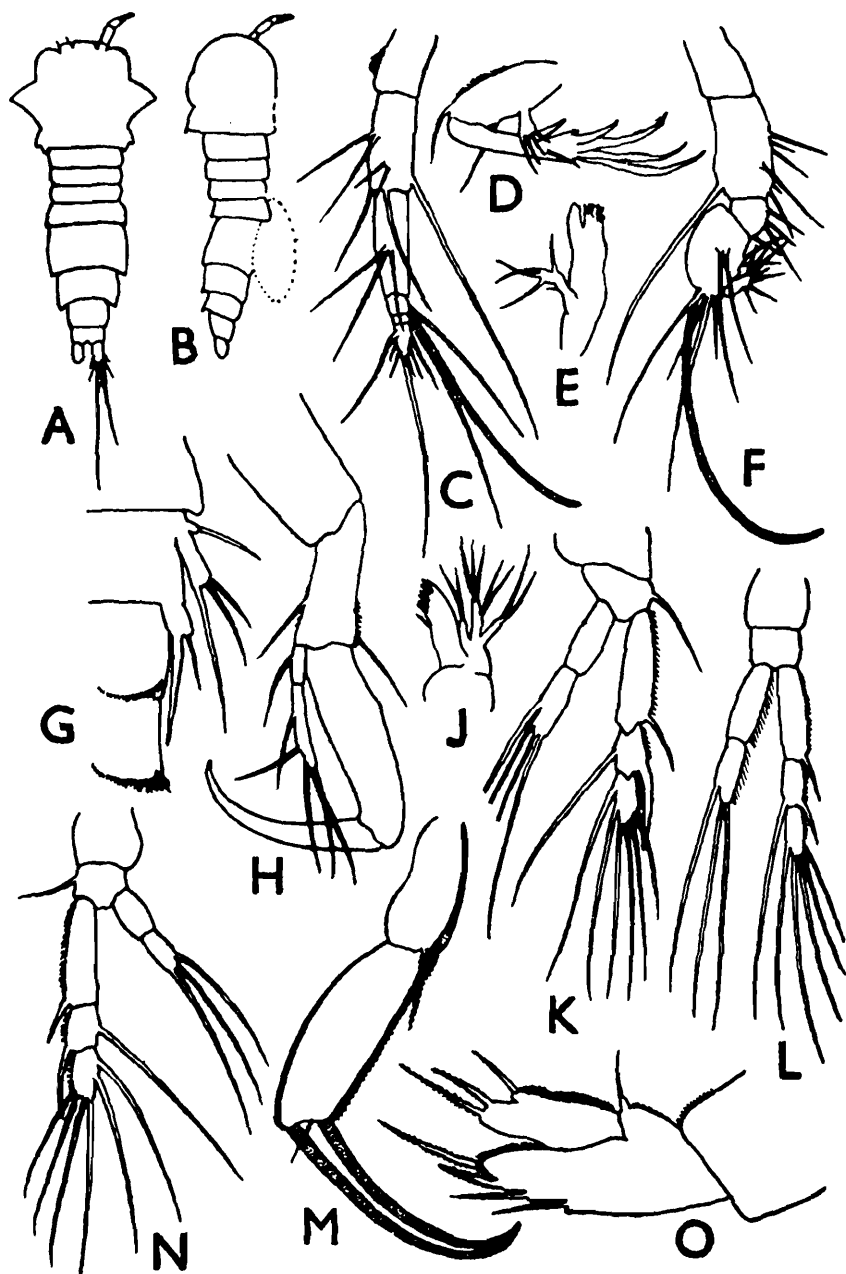
Echinolaophonte tropica sp. n.

Material examined.—Numerous specimens of both sexes of this copepod were collected from the Gulf of Mannar on 3rd July, 1960, from weed washings. The holotype, allotype and paratypes are deposited in the Reference Collection Museum of the Central Marine Fisheries Research Institute and bear the register numbers J. 680/17, J. 681/17 and J. 682/17 respectively.

Descriptive notes. Female.—Cephalosome with (Text-fig. 3, A, B) a tripartite division, anterior, posterior and an intervening middle region with lateral wings. Four pedigerous segments besides cephalosome; first three more or less of equal dimensions, the last one larger than others. Genital segment quite large, much wider than long. Abdominal segments, diminish both in length and width

towards posterior side. Caudal ramus less than twice as long as wide, bearing six setae, two of which much longer than others, and widened in proximal region. In lateral view, posterodorsal margins of cephalosome produced into spines. Similar spine-like projections also noticed in some of prosomal and urosomal segments.

Antennule (Text-fig. 3, C) 6-segmented, fourth segment bearing a fairly long aesthetask. Proportionate lengths of the constituting segments as follows:



TEXT-FIG. 3. *Echinolaophonte tropica* sp. n. A. Female dorsal view; B. Female lateral view; C. Female antennule; D. Female antenna; E. Female mandible; F. Male antennule; G. Male urosome showing fifth and sixth legs; H. Female first leg; J. Female maxillulae; K. Female third leg; L. Female second leg; M. Female maxilliped; N. Female fourth leg; O. Female fifth leg.

1	2	3	4	5	6	
19.2	29.8	31.2	7.1	2.8	9.9	= 100

Antenna (Text-fig. 3, D) 2-segmented; exopod 1-segmented, very

short, with four setae and borne on outer margin of basal antennal segment; latter bears two setae, one each on its distal outer and inner corners. Second antennal segment bears four apical, one subapical spines, and a small seta in inner distal region; all spines with a bent appearance, and with serrated medial areas. Mandible (Text-fig. 3, E) quite normal with a masticatory blade and 1-segmented palp. Maxillule (Text-fig. 3, J) and maxilla typical of genus. Terminal claw as Maxilliped characteristically incurved, with setae at distal margins of first and second segments moderately developed. Inner margins of second segment finely ciliated.

In first pair of legs (Text-fig. 3, H) both endopod and exopod biramous; endopod quite well-developed, basal segment bearing one seta and second segment bearing one terminal claw and an accessory seta. Exopod very fragile, just exceeding half length of basal endopod segment. Five setae on the distal segment, three apical and two outer; proximal segment bears an outer seta. Basal segment devoid of any seta in Protopod; proximal segment has a seta on each margin. Ornamentation of swimming legs 2-4 as follows (Text-fig. 3, K, L and N).

	Protopod				Endopod					Exopod						
	1		2		1		2			1		2		3		
	si	sc	si	se	si	se	si	sc	st	si	se	si	se	si	st	se
P2	0	0	0	1	0	0	2	2	1	0	I	1	I	2	2	II
P3	0	0	0	1	0	0	1	2	0	0	I	1	I	1	2	II
P4	0	0	0	1	0	0	1	2	0	0	I	1	I	2	2	II

Fifth leg (Text-fig. 3, O) very similar to that of other representatives of genus. Proximal segment, quite large, its inner projection reaching almost whole length of distal segment and with a single seta on outer, and four setae on inner margin. Distal segment bears three setae on outer side. Size 0.85-0.95 mm.

Male.—Sexually dimorphic, with modifications in antennule, third, fourth, fifth and sixth legs and urosome. Antennule (Text-fig. 3, F) geniculate apparently 5-segmented. As in female aesthetascope borne on the much swollen, thick margined fourth segment. Terminal segment short narrow, but with a large number of setae along its margins. Exopod of third leg very powerfully developed with all joints considerably thickened; spine very coarse and setae of inner edge short, spiniform. Endopod of third leg of usual structure. Exopod in fourth leg much coarser than in female, setae of inner edge spiniferous. Fifth leg (Text-fig. 3, G) much different from female. Each leg is rectangular in shape; basal segment indicated by a broad-based seta; distal segment with unequal seta at apex. Sixth leg also rectangular carrying at its apex two setae, one strong and spine-like. An additional segment in urosome (Text-fig. 3, G); genital segment not as large as in female. Size 0.65 — 0.75 mm.

III—SUMMARY

Three new species of harpacticoid copepods, *Parapeltidium nicholli*, *Porcellidium unicus* and *Echinolaophonte tropica* obtained

from the south-east coast of India are described in detail. All the species are represented by both the sexes, and in all cases the usual sexual dimorphism is well expressed. It is further found that the new porcellidiid obtained is very peculiar in that the ornamentation of the swimming legs is unique for the genus.

THE SYSTEMATIC STATUS OF *OTOLITHES* *VERSICOLOR* CUVIER (PISCES, SCIAENIDAE)

By

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(With 1 text-figure)

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I—INTRODUCTION

It is clear from recent literature on the sciaenid fishes of the Indo-Pacific region that considerable uncertainty exists about the status and identity of *Otolithes versicolor* Cuvier. Cuvier (1829) erected *Otolithes versicolor* based on the description and figure of 'Potee Kanasah' of Rüßell (1803) having the dorsal formula $X + 1.21$. Since Rüßell's original discovery of an *Otolithes* with D. $X + 1.21$ from Visakhapatnam (India), no specimen with the same dorsal count has been obtained by subsequent workers.

During our studies on the sciaenid fishes of the Indian seas, two specimens of *Otolithes* collected from the Maharashtra coast on 22nd November, 1955 were found having the same dorsal formula as Rüßell's 'Potee Kanasah' (i.e. *Otolithes versicolor* Cuvier). The present study indicates that *Otolithes versicolor* Cuvier is a distinct species and not conspecific with *O. lateoides* Bleeker. Since no adequate description of *O. versicolor* is available, a redescription is given below.

II—DESCRIPTION OF THE SPECIES

Otolithes versicolor Cuvier

1829. *Otolithes versicolor* Cuvier, *Regne Animal*, 2, p. 173 (on 'Potee Kanasah' Russell, 1803, *Fishes of Coromandel*, 2, p. 7, pl. 109).

Material—2 exs., 80 mm. and 95 mm. in standard length; Alibag (Maharashtra, India), 22.11.1955, Dr. K. K. Tiwari Coll., Zoological Survey of India, Reg. No. F. 5873/2.

Description.—D. X + 1.20-21; A 11.7; P 15-16; LI 48-51; Gill rakers 5+12.

Depth of body 28.4 — 31.2; length of head 32.5 — 34.3; diameter of eye 10.5 — 11.2; snout 8.9 — 10.0; length of pectoral fin 23.1; length of ventral fin 20.0; snout to pectoral 31.0 — 33.7; snout to ventral 35.7 — 37.5; pectoral to dorsal 20.0; base of second dorsal 34.3 — 34.7; base of anal 9.3 — 10.5; depth of caudal peduncle 8.4 — 8.7; all in percentages of the standard length.

Body compressed, not much elongate. Snout pointedly convex with three pores. Mouth terminal, strongly oblique, maxillary concealed, its distal expansion truncate; lower jaw prominent, on both sides below symphysis two small pores. Preopercle rounded, denticulate; opercle with two blunt weak spines; post-temporal fimbriate. Two rows of teeth in both jaws, the outer row enlarged, anteriorly with three to four canines of moderate size. Scales cycloid on head and below pectorals, elsewhere ctenoid.

Spinous dorsal deeply notched with weak spines. Base of anal 4.5 in base of soft dorsal. Origin of anal below the tenth dorsal ray. Caudal slightly rhomboidal. Gas-bladder typical Otolithine type (Text-fig. 1) (Trewavas, 1962) with nineteen pairs of hollow arborescent appendages on each side of the main bladder. No sonific muscles in the male specimen dissected.

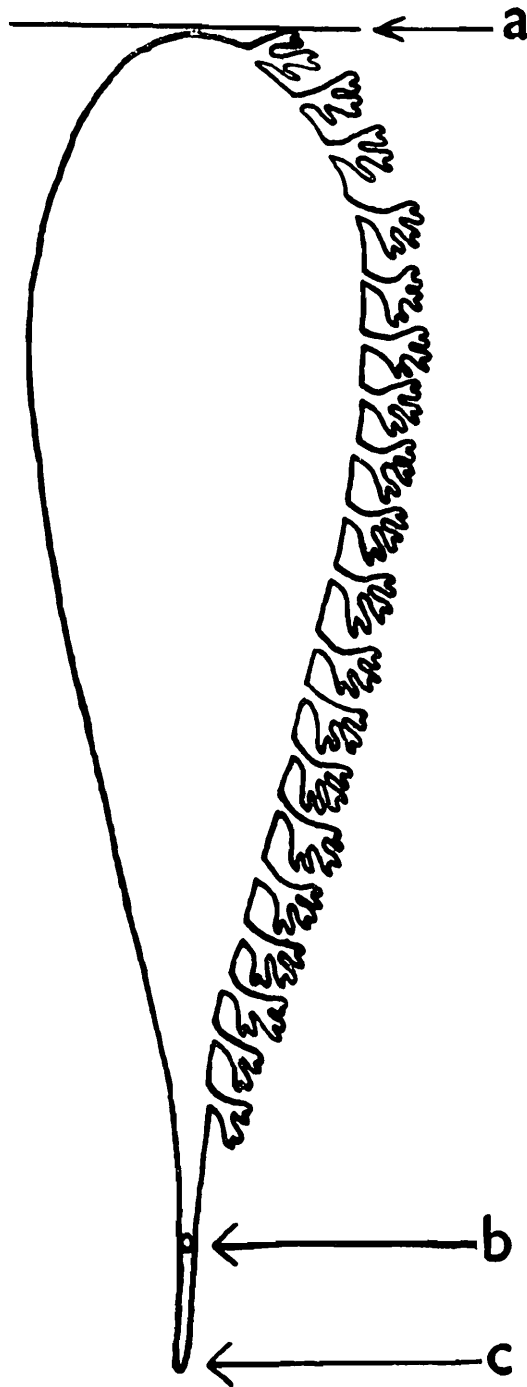
Colour in alcohol.—Head and back greyish brown, below and on sides silvery; tips of dorsal, caudal, and pectoral axil dusky; a dark blotch on operculum.

III—REMARKS

Cantor (1849) doubtfully referred a specimen with a dorsal count of X + 1.25 from Penang to *Otolithes versicolor* Cuvier. Bleeker (1850) treated this as a new species viz., *O. lateoides*. Günther (1860) and Day (1876) considered *O. versicolor* as a dubious species. Fowler (1933) synonymised *O. lateoides* Blkr. with *O. versicolor* Cuvier and gave its distribution as India, Penang and the East Indies. Weber and de Beaufort (1936) treated *O. versicolor* as described by Cantor (*l.c.*) and Fowler (*l.c.*) as synonyms of *O. lateoides* and stated that “as neither Day nor any other author on Indian fishes has neither *versicolor* nor *lateoides* reported in India, it is, therefore, safer not to use the dubious name *versicolor*.” Trewavas (1967 — personal communication) carefully looked into the question of *O. versicolor* and compared its description and figure with *O. lateoides* and concluded that it was an ‘unidentifiable species.’

Since the time of the original description of *Otolithes versicolor* Cuvier, no specimen of this fish has been known which could definitely be assigned to this species. It is on the number of soft dorsal rays

that the discrepancy between Cuvier's description of *O. versicolor* and subsequent accounts has been noted. Cuvier (*loc. cit.*) gives the number



TEXT-FIG. 1. Gas-bladder of *Otolithes versicolor* in ventral view with appendages shown on one side only. a. Position of septum transversum. b. Position of vent. c. Position of base of first anal spine.

of soft dorsal rays in *O. versicolor* as 21. The range of the dorsal rays in *O. lateoides* is usually given as 24-27.

Otolithes versicolor may be distinguished from *O. lateoides* in addition to the character enumerated above, by the following meristic counts and proportional measurements: fewer gill rakers in the lower

arm (12 versus 14), lesser number of scales in the lateral series (48—51 versus 54—60), depth of body-in-standard length value (3.2—3.5 versus 4.0—4.4), head length-in-standard length value (2.9—3.0 versus 3.7—4.0) and eye diameter-in-head length value (3.0—3.1 versus 4.6—5.6). Further, the anal fin originates below the tenth dorsal ray in *Otolithes versicolor* against eighth ray in *O. lateoides*. Although absence of intergradation is not proof in itself of the distinctness of species, its presence is regarded as an indication that the forms under consideration are conspecific. No intergradation between *O. versicolor* and *O. lateoides* is known. It, therefore, seems reasonable to conclude that both are distinct species, the former probably restricted to the Indian coast and the latter species to the East Indies.

IV—SUMMARY

Data establishing the validity of *Otolithes versicolor* Cuvier are presented. It is shown that *O. versicolor* and *O. lateoides* Blkr. are not conspecific.

V—ACKNOWLEDGMENTS

We are extremely grateful to Dr. A. P. Kapur, Director, Zoological Survey of India, Calcutta for encouragement and helpful criticism of the manuscript. We are also thankful to Dr. E. Trewavas, British Museum (Natural History), London and Dr. A. G. K. Menon, Zoological Survey of India for their valuable suggestions.

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ESTIMATION OF AN APPARENTLY SUDDEN POPULATION BUILD-UP IN THE SNAIL, *MACROCHLAMYS INDICA* BENSON IN CALCUTTA

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I—INTRODUCTION

The Dhakuria Lake, Calcutta is a freshwater lake, created about fifty years ago by the excavation of a previously existing marshy area. It is about 1.7 km. long, about 250 m. wide at its broadest point and has three islands in a line. The public is not allowed to visit these islands and approach is only by boat. The middle island is roughly S-shaped and is about 135 m. long. The northern side is about 50 m. and southern side about 35 m. off from the mainland.

Ecologically, this island could be divided into three distinct zones. Zone No. I, forming the eastern part of the island has little vegetation. A few tall trees grow here which afford roosting for cormorants and darter birds. The soil is dry, covered over by dry litter and bird dropping which emits a strong ammoniacal odour. Undergrowth is absent. The snail population in this zone is very small, constituted by a few wandering animals which apparently do not survive for long periods. Zone No. II is the middle one, covered over by a thick mat of creepers all the year round. The soil is moist with decomposing foliage. This zone is at a lower elevation than the two other zones and most of it is either sodden or partially submerged during the monsoon rains, when the level of water in the lake rises by as much as a metre or more. But for a few shrubs, this zone is open. Almost the entire population of *Macrochlamys indica* aggregates here. Most of the marking and recapture of snails were done in this zone. Zone No. III is elevated, with a thick growth of tall shrubs and many trees. The undergrowth is little and the soil is dry with litter and bird droppings. The trees provide roosting places for herons and cormorants. In this zone also, snails are very few and restricted to fringes.

The middle island was being visited for the last two years in connection with the study of certain aquatic littoral populations during the course of which abrupt fluctuations of the snail population have

been noticed. The present paper is the outcome of an effort to estimate the size of this population.

The principle involved (Lincoln, 1930) is to mark and release in the same area a known number of animals. After a suitable interval, a sample of the population is taken and the proportion of the marked to unmarked individuals is noted. From this, the total population is estimated on the simple proportion

$$\frac{M}{X} = \frac{m}{x}$$

where M, represents the number of animals marked and released ; X, represents the total population ; m, represents the marked animals recaptured and x, unmarked animals captured together with the marked ones. The total population thus is calculated from the formula

$$X = \frac{Mx}{m}$$

Jackson (1936, 1939) developed this method further, extrapolating backwards from the date when tsetse flies were recaptured to the date when they were released. For this he recaptured flies on a number of occasions instead of only one (positive method) and alternatively marked on a number of occasions and recaptured once (negative method). These methods have been cited and supported by Andrewartha (1961). The positive method of approach has been made use of in the present study.

We are grateful to the Director, Zoological Survey of India, Calcutta for providing facilities for this work. Thanks are also due to Calcutta Improvement Trust for kindly making the boat available to us for visiting the island.

II—OBSERVATIONS AND RESULTS

After marking the snails with a red shade of waterproof nail varnish, they were released at the points of capture. Sometime before the commencement of the marking experiments, a few snails were marked differently and released at one spot. After a week, the adjoining area of about three metres was scoured. Only one out of the seven marked ones was recaptured from this area which shows that the snails were sufficiently active and cruised over fairly wide areas and a marked snail has a good chance of mixing at random with the rest of the population within a period of seven days.

The study was started in October 1966 when, soon after the few showers, the snails are very abundant and active. On October 19th, 24 stations were selected at random, the creepers cleared to open up an area of one metre across and all the snails of the area were marked and released and the clearing covered up. The number of snails collected for marking from these 24 stations ranged from 11 to 117, with an average of 57 snails per station. A total of 1370 snails were marked and released in all. Five recaptures were made at intervals of seven days. On the 35th day of marking, there were signs of abrasion of the nail varnish and further recaptures were not made thereafter. The recapture data are given in the table.

TABLE I—*Total number of capture with number of marked and unmarked examples of Macrochlamys indica*

Date	Total captured	No. of marked	No. of unmarked
26-10-1966	430	10	420
2-11-1966	593	6	587
9-11-1966	487	6	481
16-11-1966	501	6	495
23-11-1966	355	4	351
TOTAL	2366	32	2334

As is evident from the table, from a total of 1370 snails marked on 19-10-1966, the number of recaptures on various dates varied, these being 430, 593, 487 etc. These figures could be simplified and corrected as if 100 snails were originally marked and the same number recaptured on all successive dates. This corrected figure of recapture on 26-10-1966 which is called y_1 will be

$$\frac{10 \times 100 \times 100}{1370 \times 430} = 0.1698$$

The similar corresponding corrected figure for date 2-11-1966 or y_2 will be

$$\frac{6 \times 100 \times 100}{1370 \times 593} = 0.0739$$

The other figures will be

$$y_3 = 0.0899$$

$$y_4 = 0.0874$$

$$y_5 = 0.0822$$

By extrapolation from this series, we require to find y_0 , the corrected figure that would have been recaptured on 19-11-1966, had we been able to recapture immediately after releasing. Jackson (1939) calls this figure a . In order to calculate a , $\frac{y_n}{y_{n-1}}$ or r has to be first calculated, this being the weighted or average ratio of each value of y to the value preceeding it. When k is more than 4, Jackson calculates it from the formula

$$r = \frac{y_3 + y_4 + \dots + y_n}{y_1 + y_2 + \dots + y_{n-2}} = \frac{y_3 + y_4 + y_5}{y_1 + y_2 + y_3}$$

Applying the present value for snails, this is

$$\sqrt{\frac{0.0899 + 0.0874 + 0.0822}{0.1698 + 0.0739 + 0.0899}} = 0.8820.$$

now a is calculated from r as follows:

$$a = \frac{y_1 + y_2 + \dots + y_{n-1}}{r} - (y_1 + y_2 + \dots + y_{n-2})$$

$$= \frac{0.1698 + 0.0739 + 0.0899 + 0.0874}{0.8820} - (0.1698 + 0.0739 + 0.0899)$$

$$= 0.1437$$

By these calculations, we have the corrected values of y and a for 100

snails marked and 100 snails recaptured every time. Now, we can estimate the population by the Lincoln Index formula,

$$X = \frac{100 \times 100}{a} = \frac{100 \times 100}{0.1437} = 69,589.42$$

Hence the total population of the snail, *Macrochlamys indica* on 19-10-1966 on the island is estimated at 69,600. This high peak of snail population is attained in October-November, but by the end of December, most of them close the mouth of the shell with a white epiphragm and enter hibernation. During the warm months of the year, very few snails are found. The factors controlling the sudden increase and subsequent mortality would be a very interesting study.

III—SUMMARY

A population study of the snail *Macrochlamys indica* Benson in an island in the Dhakuria lake, Calcutta was undertaken during 1966. A total of 1370 snails were marked and released from 24 stations on an average of 57 snails per station. The total population on 19-10-1966 was estimated as 69,600 with a high peak during October-November.

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A TAXO-ECOLOGICAL STUDY OF THE EARTH-WORM FAUNA OF DOON VALLEY

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I—INTRODUCTION

The most recent reference on the taxonomy of the earthworms of Doon Valley is Gate's "Studies on the Earthworm Fauna of Saharanpur, Dehra Dun and Mussoorie" (1951). But as regards the ecology of these worms, not only from the above area but even from the whole of India, very little attention has been paid in this country. However Prashad (1916) dealt with the seasonal distribution and other ecological factors of earthworms of Lahore; Shrikhande and Pathak (1948) included data on the relationship between earthworms and soil-fertility in Kanpur; and Roy (1957) contributed certain observations on the cast formation and light-sensitivity of earthworms of Baranagore (West Bengal) and Giridih (Bihar).

In order to concentrate exclusively on the taxo-ecological aspects of these earthworms, the author undertook the present studies during 1963-65. The present paper includes only the general taxonomic aspects of the group.

II—SURVEY AND COLLECTION

During the above period weekly visits were made to Rajaji Sanctuary and neighbouring areas of the Doon Valley to collect specimens and ecological data. About 3,000 examples, both juveniles and adults, were obtained and a large collection of ecological data recorded.

It may be stated here that the collection of specimens was made both by the usual digging process as well as by the "wet method" recommended by Evans & Guild (1947), namely, uniformly spraying an area approximately measuring 8 sq. ft. with a solution of 1/4-1/2 oz. of potassium permanganate dissolved in one gallon of water.

In the monsoon (July to September) when the soil was damp and the worms generally occurred near the surface layers, the "wet method" yielded very quick results, in that within two to five minutes after the

spraying the specimens appeared above the surface, enabling their collection within the brief period of half an hour or so. An interesting observation is that after the spraying, when the soil dried up before the worms were collected, the latter tended to become desiccated and ultimately a little later to be attacked by ants.

III—LOCALITIES

The following are the collecting stations. (N.R.S. denotes Northern Regional Station of the Zoological Survey of India).

<i>Station numbers</i>	<i>Particulars</i>
1.	N.R.S. premises and neighbouring areas.
2.	Along the section of Rajpur Road between 5-10 Kms. N of N.R.S.
3.	Along the section of Mussoorie Road between 10-20 Kms. N of N.R.S.
4.	Along the section of Sahastradhara Road between 6-10 Kms. NE of N.R.S.
5.	Nearby areas and banks of the Sahastradhara stream close to Sulphur Spring, about 16 Kms. NE of N.R.S.
6.	Plots near the water storage tank, Raipur, about 12 Kms. E of N.R.S.
7.	A grassy plot by the side of a canal, Nehrugram, about 15 Kms. SE of N.R.S.
8.	A tract, between hills and leading to Robber's Cave from Guchhupani, a terminus area at the end of a metalled road, about 8 Kms. NW of N.R.S.
9.	Premises of Forest Research Institute, about 8 Kms. NW of N.R.S.
10.	A paddy field, Poeliyon Village, Nathuwala, about 10 Kms. NW of N.R.S.
11.	Along the section of Chakrata Road between 10-20 Kms. NW of N.R.S.
12.	A paddy field, Bahmanpur Village, about 45 Kms. NW of N.R.S.
13.	A grassy plot near Asoka Rock on the bank of a stream, Kalsi, about 50 Kms. NW. of N.R.S.
14.	Banks of Assan river, Herbetpur, about 40 Kms. SW of N.R.S.
15.	Premises and surrounding areas of Timli Forest Rest House, about 45 Kms. SW of N.R.S.
16.	Sides of Bijapur Dam, "Ghattikhola", about 8 Kms. W of N.R.S.
17.	A plot near a burning ghat on the banks of a stream, Chandarmani, about 9 Kms. NW of N.R.S.
18.	A pasture plot and the banks of a seasonal stream both on the eastern side of Saharanpur Road near P.W.D. Bridge no. 141/8, about 13.8 Kms. S of N.R.S.
19.	Grassy plots on the eastern bank of a seasonal stream near Asarori Forest Rest House on Saharanpur Road, about 13.9 Kms. S of N.R.S.
20.	Grassy plots near Mohund Tunnel on Saharanpur Road, about 14 Kms. S of N.R.S.
21.	A grassy plot between P.W.D. Bridges no. 139/6 and 139/7 along Saharanpur Road, about 18.1 Kms. S of N.R.S.
22.	The stony and bushy banks of a stream below "Lalpul", a P.W.D. Bridge no. 135/21 along Saharanpur Road, about 24.2 Kms. S of N.R.S.

23. Grassy plots between P.W.D. Bridges no. 134/17 and 135/1 along Saharanpur Road, about 25.6 Kms. S of N.R.S.
24. A cultivated plot in Ganeshpur Village along Saharanpur Road, about 35 Kms. S of N.R.S.
25. Along the section of Hardwar Road between 20-25 Kms. S of N.R.S.
26. Along the section of Hardwar Road between 30-50 Kms S of N.R.S.

IV—MATERIAL

Class CHAETOPODA Order OLIGOCHAETA

Family 1. MEGASCOLECIDAE

Perionyx excavatus E. Perrier

1872. *Perionyx excavatus* E. Perr., *N. Arch. Mus. Paris*, **8**, p. 126, pl. iv, figs. 73, 74.
 1895. *Perionyx excavatus* + *P. intermedius* + *P. gruenewaldi*: Beddard, *Monog.*, pp. 436, 437.
 1900. *Perionyx excavatus* + *P. intermedius*: Michaelsen, *Tierreich*, **10**, pp. 208, 209.
 1916. *Perionyx fulvus*: Stephenson, *Rec. Indian Mus.*, **12**, p. 322, pl. xxi, fig. 16.
 1923. *Perionyx excavatus* + *P. fulvus*, Stephenson, *Oligochaeta, Fauna Brit. India*, pp. 329, 333.
 1933. *Perionyx excavatus*: Gates, *Rec. Indian Mus.*, **35**, p. 549.

Main characteristic features.—Dorsal pores from 4/5. Clitellum xiii-xvii. Male pores very close together in a slight depression. Spermathecal pores 2 pairs, close together in 7/8 and 8/9. Calciferous glands in xiii. Last heart in xiii. Penial setae almost straight, tips slightly curved, distal end ornamented with about twelve rings of rather long fine spines.

Remarks.—This was a perennially occurring species of the Doon Valley and its neighbourhood and was found in the damp soil round about pools, puddles and rivulets as well as in smaller water pockets.

Distribution.—The species has so far been recorded from the following localities in India—Dibrugarh & Sadiya (Assam); Abor Country (NEFA); Calcutta & Darjeeling (West Bengal); Dehra Dun, Kumaun hills & Pilibhit (Uttar Pradesh); Simla (Himachal Pradesh); & Little Andaman (Andaman Islands).

Pheretima anomala Michaelsen

1907. *Pheretima anomala* Michaelsen, *Mitt. Mus. Hamb.*, **24**, p. 167.
 1923. *Pheretima anomala*: Stephenson, *Oligochaeta, Fauna Brit. India* p. 294.
 1937. *Pheretima anomala*: Gates, *Rec. Indian Mus.*, **39**, p. 193.

Main characteristic features.—Male pores on large conical papillae on xx. Spermathecal pores 3 pairs in 5/6-7/8. Genital markings paired in xviii, xix, xxi, and xxii.

Remarks.—This species was not very common.

Distribution.—The species has so far been recorded from the following localities in India—Calcutta & Darjeeling (West Bengal); and Dehra Dun (Uttar Pradesh).

Pheretima birmanica (Rosa)

1888. *Perichaeta birmanica* Rosa, *Ann. Mus. Genova*, (2) 6, p. 164.
 1898. *Perichaeta birmanica* : Beddard, *Monog.* p. 405.
 1900. *Amyntas birmanicus* : Beddard, *P.Z.S.*, p. 637.
 1900. *Pheretima birmanica* : Michaelsen, *Tierreich*, 10, p. 255.
 1945. *Pheretima birmanica* : Gates, *Sci. & Cult.*, 10(9), p. 403.

Main characteristic features.—Male pores on slightly swollen areas. Spermathecal pores 3 pairs in 5/6-7/8. No genital markings. Spermathecal ampulla oval, duct short, diverticulum in the form of a stalked oval sac in which lies a much convoluted tube.

Remarks.—This species was rather uncommon.

Distribution.—The species has so far been recorded in India only from Dehra Dun (Uttar Pradesh).

Pheretima houlleti E. Perrier

1872. *Perichaeta houlleti* E. Perrier, *N. Arch. Mus. Paris*, 8, p. 99.
 1889. *Megascolex houlleti* : Vaillant, *Hist. Nat. Annel.*, 3(1), p. 75.
 1898. *Perichaeta crescentica* Fedarb, *Proc. zool. Soc. Lond.*, 1898, p. 447.
 1898. *Perichaeta travancorensis* Fedarb, *J. Bombay nat. Hist. Soc.*, 11, p. 435.
 1916. *Pheretima trivandran*a Stephenson, *Rec. Indian Mus.*, 12, p. 335.
 1923. *Pheretima houlleti* (part, excl. *campanulata* and the distribution of *guillelmi* and *meridiana*) + *P. travancorensis* + *P. trivandran*a : Stephenson, *Oligochaeta, Fauna Brit. India*, pp. 304, 313 and 314.
 1934. *Pheretima houlleti* : Gates, *Rec. Indian Mus.*, 36, p. 259.
 1937. *Pheretima houlleti* : Gates, *Rec. Indian Mus.*, 39, p. 203.

Main characteristic features.—Male pores on papillae about 1/3 of circumference apart in line with *h*. Spermathecal pores 3 pairs in 6/7-8/9. No genital markings. Spermathecal ampulla irregularly-shaped or pear-shaped, duct as long as ampulla, diverticulum long, tubular, with its ental portion much convoluted.

Remarks.—This species was fairly common.

Distribution.—The species has so far been recorded from the following localities in India.—Cherrapunji (Assam); Calcutta & Rani-ganj (West Bengal); Allahabad, Bhim Tal & Dehra Dun (Uttar Pradesh); Bandra, Bombay, Buldana & Matheran (Maharashtra); Bangalore, Mangalore, Mercara & Shimoga (Mysore); Trichur & Trivandrum (Kerala); Salem (Madras); and Andaman Islands.

Pheretima morrisi Beddard

1892. *Perichaeta morrisi* Beddard, *Proc. zool. Soc. Lond.*, 1892, p. 166.
 1898. *Perichaeta cupulifera* Fedarb, *Proc. zool. Soc. Lond.*, 1898, p. 445.
 1900. *Pheretima barbadensis* (part, excluding sexthecal forms) + *P. morrisi*, Michaelsen, *Tierreich*, 10, pp. 254 & 287.
 1900. *Amyntas hawayanus* (part), Beddard, *Proc. zool. Soc. Lond.*, 1900, p. 645 (excluding sexthecal forms).
 1923. *Pheretima hawayana* (part, excl. sexthecal forms): Stephenson, *Oligochaeta, Fauna Brit. India* p. 300.
 1937. *Pheretima morrisi* : Gates, *Rec. Indian Mus.*, 39, p. 205.

Main characteristic features.—Male pores superficial. Spermathecal pores 2 pairs in 5/6-6/7. Genital markings near the male pores. Spermathecal ampulla oval-shaped, duct narrow, diverticulum narrow, tubular, somewhat coiled, nearly equal in length to main pouch with small terminal pear-shaped dilation.

Remarks.—This species was quite uncommon.

Distribution.—The species has so far been recorded from the following localities in India.—Imphal (Manipur); Kalimpong (West Bengal); Dehra Dun (Uttar Pradesh); Udaipur (Rajasthan) and Bombay (Maharashtra).

***Pheretima posthuma* (L. Vaillant)**

1868. *Perichaeta posthuma* L. Vaillant, *Ann. Sci. Nat.* (5), 10, p. 228.
 1883. *Megascolex affinis* Beddard, *Ann. Mag. nat. Hist.* (5), 12, p. 214.
 1889. *Megascolex posthuma* : L. Vaillant, *Hist. Nat. Annel.*, 3(1), p. 72.
 1900. *Pheretima posthuma* : Michaelsen, *Tierreich*, 10, p. 295.
 1923. *Pheretima posthuma* : Stephenson, *Oligochaeta, Fauna Brit. India*, p. 309.
 1937. *Pheretima posthuma* : Gates, *Rec. Indian Mus.*, 39, p. 207.

Main characteristic features.—Male pores in setal zones. Spermathecal pores 4 pairs, segmental, in 5/6-8/9. Genital markings 2 pairs in setal circles on xvii and xix. Spermathecal ampulla ovoid, diverticulum of variable length.

Remarks.—This species was quite uncommon.

Distribution.—The species has so far been recorded from the following localities in India.—Calcutta & Raniganj (West Bengal); Bhagalpur, Purneah & Pusa (Bihar); Agra, Allahabad, Dehra Dun, Lucknow & Saharanpur (Uttar Pradesh); Ferozepore, Hoshiarpur, Jullundur, Ludhiana & Phagwara (Punjab); Kalka (Himachal Pradesh); Ajmer & Udaipur (Rajasthan); Gwalior (Madhya Pradesh); Baroda (Gujarat); Bombay (Maharashtra) and Andaman Islands.

***Pheretima diffringens* (Baird)**

1869. *Megascolex diffringens* Baird, *Proc. zool. Soc. Lond.*, 1869, p. 40.
 1887. *Perichaeta mirabilis* Bourne, *Proc. zool. Soc. Lond.*, 1886, p. 668.
 1900. *Amyntas heterochaetes* (part), Beddard, *Proc. zool. Soc. Lond.*, 1900, p. 622.
 1909. *Pheretima heterochaeta* : Michaelsen, *Mem. Indian Mus.*, 1, pp. 110 and 189.
 1923. *Pheretima heterochaeta* (part, excl. Synonymy and distribution of forms with copulatory chambers), Stephenson, *Oligochaeta, Fauna Brit. India*, p. 302.
 1934. *Pheretima mirabilis* : Gates, *Rec. Indian Mus.*, 36, p. 260.
 1937. *Pheretima diffringens* : Gates, *Rec. Indian Mus.*, 39, p. 198.

Main characteristic features.—Clitellum xiv-xvi. Male pores on elevated papillae about 2/5 of circumference apart. Spermathecal pores 4 pairs in 5/6-8/9. Genital papillae paired anteriorly on vii and viii and sometimes on ix also. Spermathecal ampulla pear-shaped, duct almost equal in length to ampulla, diverticulum long, tubular, dilated at its ental end to a knob-like seminal chamber.

Remarks.—This species was not so common.

Distribution.—The species has so far been recorded from the following localities in India.—Cherrapunji, Kobo, Sadiya & Shillong (Assam); Imphal (Manipur); Darjeeling, Kalimpong, Kurseong & Siliguri (West Bengal); Nainital (Uttar Pradesh); Dharmasala, Kangra, Palampur & Simla (Himachal Pradesh); Bababudan Hills (Mysore); and Coonoor & Kodaikanal (Madras). The species thus forms the first record from the Doon Valley.

Pheretima alexandri (Beddard)

1900. *Amyntas alexandri* Beddard, *Proc. zool. Soc. Lond.*, 1900, p. 998.
 1909. *Pheretima alexandri*: Michaelsen, *Mem. Indian Mus.*, 1, p. 109.
 1914. *Pheretima lignicola* Stephenson, *Rec. Indian Mus.*, 8, p. 399.
 1922. *Pheretima suctoria* Stephenson, *Rec. Indian Mus.*, 24, p. 434.
 1923. *Pheretima alexandri* + *P. lignicola* + *P. suctoria* (part, excl. Andaman Island forms): Stephenson, *Oligochaeta, Fauna Brit. India*, pp. 291, 305 and 311.
 1925. *Pheretima suctoria* var. *mullani*, Stephenson, *Proc. zool. Soc. Lond.*, 1925, p. 893.
 1931. *Pheretima alexandri*: Stephenson, *Rec. Indian Mus.*, 33, p. 182.
 1937. *Pheretima alexandri*: Gates, *Rec. Indian Mus.*, 39, p. 192.

Main characteristic features.—Clitellum xiv-xvi. Male pores inconspicuous, in front and behind the pores are slightly curved grooves. Spermathecal pores 4 pairs in 5/6-8/9. No genital papillae. Spermathecal ampulla pear-shaped, duct longer than ampulla, diverticulum longer than main pouch and consisting of a duct and a moniliform chamber.

Remarks.—This species was met with rarely.

Distribution.—The species has so far been recorded from the following localities in India.—Dibrugarh (Assam); Calcutta (West Bengal); Bombay (Maharashtra); and Andaman Islands. The species thus forms the first record from the Doon Valley.

Family 2 OCTOCHACTIDAE

Octochaetoides beatrizx (Beddard)

1902. *Octochaetus beatrix* Beddard, *Ann. Mag. nat. Hist.* (7), 9, p. 456.
 1914. *Octochaetus dasi* Stephenson, *Rec. Indian Mus.*, 10, p. 346.
 1922. *Octochaetus beatrix*: Stephenson, *Rec. Indian Mus.*, 24, p. 436.
 1923. *Octochaetus* (*Octochaetoides*) *beatrix*: Stephenson, *Oligochaeta, Fauna Brit. India*, p. 376.
 1951. *Octochaetoides beatrix*: Gates, *Proc. natn. Acad. Sci. India* (B), 21, p. 18.

Main characteristic features.—Clitellum xiii-xvii. Spermathecal pores on viii and ix. Prostatic pores medial from *a*. Seminal grooves bowed outwards. No genital markings. Calciferous glands in xv, large and much lobed. Last heart in xiii. Spermathecae small, ampulla pear-shaped, duct short, diverticulum pear-shaped, half as long as ampulla. Penial setae nearly straight, slightly bent at the distal end with a few teeth lying flat against the shaft.

Remarks.—This species was quite uncommon.

Distribution.—The species has so far been recorded from the following localities in India.—Calcutta (West Bengal); Dehra Dun (Uttar Pradesh); Baroda (Gujarat); and Bombay (Maharashtra).

Eutyphoeus incommodus (Beddard)

1901. *Typhoeus incommodus* Beddard, *Proc. zool. Soc. Lond.*, pp. 200 and 206.
 1903. *Eutyphoeus incommodus*: Michaelsen, *Geogr. Verbr.*, p. 109.
 1914. *Eutyphoeus incommodus* + *E. mohammedi*, Stephenson, *Rec. Indian Mus.*, 10, pp. 349 and 350.
 1916. *Eutyphoeus incommodus* + *E. annandalei* var. *fulgidus*, Stephenson, *Rec. Indian Mus.*, 12, p. 342.
 1923. *Eutyphoeus incommodus* + *E. mohammedi*, Stephenson, *Oligochaeta, Fauna Brit. India*, pp. 438 and 443.
 1938. *Eutyphoeus incommodus*: Gates, *Rec. Indian Mus.*, 40, p. 83.

Main characteristic features.—Avestibulate and apenile. Male pores within slight transversely placed grooves, the centres on/or close to *b*. Genital markings paired, post-setal in *ab* on xiii-xvi. Female pores paired. Spermathecal pores in the median half of *bc*. Supra-intestinal glands in lxii-lxxii. Dorsal blood vessel continued into iii. Holandric. Seminal chambers forming a circle around the spermathecal duct.

Remarks.—The species was quite uncommon.

Distribution.—The species has so far been recorded from the following localities in India.—Calcutta (West Bengal); Pusa & Rajmahal (Bihar); Agra, Allahabad, Anwargunj and Dehra Dun (Uttar Pradesh); Hoshiarpur (Punjab); Ambala (Haryana); Kasauli (Himachal Pradesh) and Bharatpur (Rajasthan).

***Eutyphoeus waltoni* (Michaelson)**

1907. *Eutyphoeus waltoni* (part, excluding specimens of *nicholsoni* from Faizabad) + *E. bengalensis*, Michaelson, *Mitt. Mus. Hamb.*, 24, pp. 179 and 183.
 1909. *Eutyphoeus bengalensis* + *E. waltoni* (part, as above), Michaelson, *Mem. Indian Mus.*, 1, pp. 111, 112, 218, 219, 229 & 235.
 1914. *Eutyphoeus waltoni* + *E. ibrahimi*, Stephenson, *Rec. Indian Mus.*, 10, pp. 352 & 357.
 1923. *Eutyphoeus ibrahimi* + *E. waltoni*, Stephenson, *Oligochaeta, Fauna Brit. India*, pp. 438 & 455.
 1938. *Eutyphoeus waltoni*: Gates, *Rec. Indian Mus.*, 40, p. 112.

Main characteristic features.—Bivestibulate and penile, penes long. Genital markings paired in *ab*, intersegmental, on 14/15-15/16, 18/19. Spermathecal pores with centres on *c*. Supra-intestinal glands in lxxviii-lxxxii. Dorsal blood vessel ends with hearts of vii. Metandric. Spermathecal diverticula paired, median and lateral.

Remarks.—This species was quite uncommon.

Distribution.—This species has so far been recorded from the following localities in India.—Manipur; Calcutta (West Bengal); Pusa & Rajmahal (Bihar); Agra, Dehra Dun, Faizabad, Kanpur & Lucknow (Uttar Pradesh); Delhi; Hoshiarpur & Kapurthala (Punjab) and Baroda (Gujarat).

***Eutyphoeus orientalis* (Beddard)**

1883. *Typhoeus orientalis* Beddard, *Ann. Mag. nat. Hist.* (5), 12, p. 219.
 1900. *Eutyphoeus orientalis* + *E. masoni*: Michaelson, *Tierreich*, 10 pp. 322 and 323.
 1923. *Eutyphoeus bishambari* + *E. masoni* + *E. orientalis* + *E. paivai* + *E. waltoni* (part, including only specimens with genital markings on xvi), Stephenson *Oligochaeta, Fauna Brit. India*, pp. 431, 442, 448, 449 and 455.
 1938. *Eutyphoeus orientalis*: Gates, *Rec. Indian Mus.*, 40, p. 98.

Main characteristic features.—Bivestibulate and penile, penes short and annular. Genital markings paired in *ab* on xv and usually on xvi also. Spermathecal apertures in *bc*. Dorsal blood vessel terminates with hearts of vii. Metandric. Spermathecal diverticula paired, median and lateral.

Remarks.—This species, which is robust and large-sized, is mound-forming in habits and was always observed to retain its anterior end deep inside the mound, a posture possibly aiding it in readily escaping into the soil when disturbed. Though the species was quite common throughout the Valley occurring in quite a variety of habitats, generally

fully matured forms were met with only during the months of August and September when the monsoons were in full swing. In the month of October, however, with the cessation of rains, the worms generally began dwindling in population as well as in body size, so that by November, with the onset of winter, hardly a few individuals were available and these were generally weak and inactive and buried about a foot deep below the soil; and subsequently from December to May the members of the species were not at all available, thereafter only juveniles appearing during June-July.

Distribution.—The species has so far been recorded from the following localities in India.—Calcutta (West Bengal); Pusa (Bihar); and Dehra Dun (Uttar Pradesh).

***Eutyphoeus nicholsoni* (Beddard)**

1901. *Typhoeus nicholsoni* Beddard, *Proc. zool. Soc. Lond.*, pp. 195 and 206.
 1909. *Eutyphoeus khani* + *E. nicholsoni* + *E. provincialis* (lapsus) + *E. waltoni* (part only, one specimen from Fyzabad), Michaelsen, *Mem. Indian Mus.*, 1, pp. 111, 112, 218, 219, 229, 233.
 1923. *Eutyphoeus nicholsoni* : Stephenson, *Oligochaeta, Fauna Brit. India*, p. 446.
 1938. *Eutyphoeus nicholsoni* : Gates, *Rec. Indian Mus.*, 40, p. 94.

Main characteristic features.—Bivestibulate and penile, apertures transversely slit-like about in *ab*, penes long. Genital markings paired on 15/16 with margins united at the mid-ventral line reaching laterally into *bc*. Spermathecal pores in 7/8 just lateral to *a*. Metandric. Seminal chambers in one or two clusters or a semi-circular row on the posterior face of the spermathecal duct.

Remarks.—This species, which is also fairly large and robust, and mound-forming in habits, occurs quite commonly during the monsoon periods all over the Saharanpur district as well as extending into the adjoining southern portion of Dehra Dun Forest Division where it was sometimes found in association with *E. orientalis* (Beddard); and though its stages of maturity and the time of its appearance coincided practically with the said species, it was always numerically greater and more robust in the overlapping ranges.

Distribution.—The species has so far been recorded from the following localities in India.—Calcutta (West Bengal); Rajmahal (Bihar), and Faizabad, Kanpur, Lucknow and Saharanpur (Uttar Pradesh). Now it is being recorded for the first time from Dehra Dun Forest Division, though its occurrence in the area is rather marginal.

Family 3. DIPLOCARDIDAE

***Dichogaster bolau* (Michaelson)**

1891. *Benhamia bolau* Michaelsen, *Jb. hamb wiss. Anst.*, 8, p. 9.
 1895. *Benhamia bolau* : Beddard, *Monogr. Oligochaeta*, p. 565.
 1900. *Dichogaster bolau* : Michaelsen, *Tierreich*, 10, p. 340.
 1916. *Dichogaster bolau* subsp. *palmicola* Stephenson, *Rec. Indian Mus.*, 12, p. 348.
 1917. *Dichogaster bolau* : Stephenson, *Rec. Indian Mus.*, 13, p. 413.
 1918. *Dischogaster bolau* : Stephenson, *Mem. Indian Mus.*, 7, p. 257.
 1923. *Dichogaster bolau* : Stephenson, *Oligochaeta, Fauna Brit. India*, p. 472.

Main characteristic features.—Clitellum saddle-shaped on xiv-xviii. Prostatic pores on xvii and xix. Seminal grooves straight. Spermathecal pores 2 pairs. Calciferous glands 3 pairs in xv-xvii. Prostates

almost straight. Spermathecal ampulla sac-like, duct thick, diverticulum small and club-shaped. Penial setae of two forms-1/ with about eight sharp, short teeth on the concave side of the distal end, tip slightly hooked. 2/ with slightly thickened distal end which is broadened in the form of a spatula and hollowed.

Remarks.—This species seems to be quite rare.

Distribution.—The species has so far been recorded from the following localities in India—Calcutta (West Bengal); Bayana (Rajasthan); Baroda and Junagadh (Gujarat); Bassein & Bombay (Maharashtra); and Ernakulum and Trivandrum (Kerala).

Family 4. LUMBRICIDAE

Bimastos parvus (Eisen)

1874. *Allolobophora parva* : Eisen, *Ofv. Vet. Ak. Forh.*, **31**, p. 36.
 1894. *Allolobophora beddardi* Michaelsen, *Zool. Jb. Syst.*, **8**, p. 182.
 1900. *Allolobophora (Bimastos) parva* + *A. (B.) beddardi*, *Helodrilus (B.) parva* + *H. (B.) beddardi*, Michaelsen, *Abh. naturw. Ver. Hamburg*, **16**, pp. 14-31, *H. (B.) parvus*, Michaelsen, *Tierreich*, **10**, p. 502.
 1917. *Helodrilus (Bimastos) parvus* + *H. (B.) beddardi*, Smith, *Proc. U.S. natn. Mus.*, **52**, p. 173.
 1923. *Allolobophora (Bimastos) parva*, Stephenson, *Oligochaeta, Fauna Brit. India*, p. 506.
 1940. *Bimastos parvus* + *B. beddardi*, Kobayashi, *Sci. Rep., Tohoku Univ.*, **15**, pp. 297, 298.
 1947. *Bimastos beddardi* : Cernosvitov & Evans, *Linn. Soc. London, Synopses British Fauna*, **6**, p. 80.
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 1958. *Bimastos parvus* : Gates, *Breviora*, **91**, p. 4.

Main characteristic features.—Seta *ab* greater than *cd*. Dorsal pores from 5/6. Spermathecae absent. Clitellum 24-30 segments (7 segments).

Remarks.—This species was met with very rarely.

Distribution.—This species has so far been recorded from the following localities in India.—Darjeeling (West Bengal); Patna (Bihar); Allahabad, Nainital & Saharanpur (Uttar Pradesh); Ferozepore (Punjab); Kasauli (Himachal Pradesh); Srinagar (Kashmir); and Partabgarh (Rajasthan). The species as well as its genus thus form the first record from the Doon Valley.

V—SUMMARY

The paper deals with the taxo-ecological aspects of earthworms from the Doon Valley. Out of the total recorded number of fourteen species, only eleven were collected. Four species including one genus, have been recorded for the first time from this area. Data on the seasonal distribution of the worms and other ecological observations, as well as the analyses of the habitat-soils, for some of the species, have also been included.

Survey trips for the above purposes were made mainly from 26 selected stations within a radius of 40 Kms., though there were also a few beyond this formally imposed limit; and the surveys were conducted for a period of about two years by the author during 1963-65.

VI—ACKNOWLEDGMENTS

The author offers his profound thanks to Dr. A. P. Kapur, Director, Zoological Survey of India and Dr. B. S. Chauhan, Deputy Director, Zoological Survey of India, for the interest and facilities extended for the completion of this paper. Thanks are also being extended to the Forest Research Institute, Dehra Dun, for kindly undertaking the soil analysis.

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VIII—SOIL ANALYSIS

		<i>Eutyphoeus orientalis</i> (Beddard)		<i>Eutyphoeus nicholsoni</i> (Beddard)	
		Surface soil (up to 3")	Mound	Surface soil (up to 3")	Mound
Sl. No.		Sta. Sta. 18	Sta. 18	Sta. 23/Site 1 Sta. 23/Site2	Sta. 23/Site1
1.	Fractions of soil %	11.48	00.47	35.00	01.86
		88.52	99.53	65.00	98.14
2.	Mechanical composition				
	Conser. sand %	28.85	28.20	25.80	21.30
	Fine sand %	30.75	38.75	51.50	39.75
	Silt %	25.00	25.00	10.00	17.50
	Clay %	12.50	07.50	07.50	17.50
3.	Air over dry moisture %	01.20	01.60	00.67	01.86
4.	Water holding capacity %	40.92	46.29	41.80	50.92
5.	Moisture equivalent %	27.07	29.85	29.89	33.73
6.	Organic carbon %	01.30	01.22	01.08	01.42
7.	Nitrogen %	0.114	0.139	0.111	0.142
8.	C/N ratio %	11.40	08.78	09.73	10.00
9.	Organic matter %	02.06	02.62	1.862	2.448
10.	Loss on ignition %	5.5	6.4	3.5	6.1

(Contd.)

V--SOIL ANALYSIS (Contd.)

		<i>Eutyphoeus orientalis</i> (Beddard)		<i>Eutyphoeus nicholsoni</i> (Beddard)		
		Surface soil (up to 3")	Mound	Surface soil (up to 3")		
Sl. No.		Sta. Sta. 18	Sta. 18	Sta. 23/Site 1	Sta. 23/Site2	Sta.23/Site1
11.	HCL insolubles %	87.1	86.2	86.0	89.2	83.9
12.	R203 %	8.38	8.40	7.26	7.04	9.02
	Fe203 %	2.5546	2.0758	2.8742	2.5548	3.1936
	Al203 %	5.8252	6.1242	4.3858	4.7852	5.9264
	CaO %	0.196	0.224	1.764	0.532	1.568
	Mgo %	0.1411	0.1815	0.3225	0.4838	0.4838
	K20 %	0.4603	0.4748	0.1778	0.2351	0.4831
	P205 %	0.1668	0.1514	0.0433	0.0371	0.0803
13.	PH	6	6.4	8	7.5	8
14.	Available nutrients					
	K20 %	0.0312	0.028	0.039	0.023	0.0255
	P205 %	0.0036	0.0005	0.0029	0.004	0.0025
15.	Calcareousness	0	0	+++	+	++
+++ = High		++ = Less high		+ = Slight		0 = Nil

THE EFFECT OF INFESTED LEAVES ON THE OVIPOSITION OF *PHYTOMYZA ATRICORNIS* MEIGEN* (DIPTERA AGROMYZIDAE)

By

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Zoological Survey of India, Calcutta

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I—INTRODUCTION

The biology and life history of *Phytomyza atricornis* Meigen has been studied by Smulyan (1914), de Meijere (1926), Melis (1935), and Ahmad & Gupta (1941). Recently, Tandon (in press) has made an extensive study on the bionomics, ecology and life history of this important pest which attacks *Brassica campestris* L. and a number of vegetable and ornamental plants. The present paper deals with the effect of infested leaves on oviposition during the non-availability of healthy leaves to the ovipositing females. In other words, if the female *Phytomyza atricornis* were forced to lay the eggs on previously infested leaves, would the latter stimulate oviposition or inhibit the rate of egg-laying. To investigate this effect, the following experiment was carried out with the pea leaf-miner *Phytomyza atricornis* under normal laboratory conditions of temperature and humidity during February-March, 1964.

This work was carried out at the School of Entomology, St. John's College, Agra. I offer my grateful thanks to Dr. T. Singh, Professor of Zoology & Entomology, St. John's College, Agra, for providing me necessary facilities for work. My thanks are due to Dr. Santokh Singh, Lecturer in Zoology & Entomology for helping me during the course of the work. Thanks are also due to C.S.I.R. for the award of a Senior Research Fellowship, which enabled me to carry out the present investigations. The final draft of the paper was prepared at Zoological Survey of India, Calcutta. I am grateful to Dr. A. P. Kapur, Director, Zoological Survey of India, Calcutta for the facilities afforded.

II—TECHNIQUE

30 glass tubes (4" × 1") and 30 glass jars (10" × 8") were used. The glass tubes and the jars were divided into three sets, each consisting

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of 10 tubes and 10 jars. In each tube of the first set was placed an infested leaf with its petiole immersed in water. The mouth of the tube was covered with muslin secured by rubber band. In each of the second set of ten tubes was placed a sound unfested leaf, while in each tube of the third set was placed a sound leaf with artificial punctures made on its surface.

Each tube was then covered by an inverted jar (10" × 8") and in each jar were introduced a pair of *Phytomyza atricornis* (a male and a female of the same age). The leaves were changed daily and the eggs laid were counted and the results tabulated.

TABLE 1.—Statement showing the number of eggs laid by mated female of *Phytomyza atricornis* on sound leaves, infested leaves and leaves with artificial punctures, respectively.

Number of Trials	Number of Eggs laid on		
	Sound leaves	Infested leaves	Leaves with artificial punctures
1.	514	731	543
2.	507	731	540
3.	573	743	498
4.	520	745	528
5.	530	705	546
6.	503	717	499
7.	609	700	487
8.	413	678	515
9.	639	741	505
10.	406	715	493
TOTAL EGGS :	5214	7206	5154
AVERAGE :	521.4	720.6	515.4

III—DISCUSSION

A glance at the above table reveals that the previous infestation of leaves, contrary to expectation, stimulated the rate of egg-laying and the number of eggs laid increased from the normal 521.4 eggs per leaf to 720.6 per leaf, exhibiting a significant increase of 38.3%.

There can be probably only two differences between sound leaves and infested ones viz., (i) the smell of infested leaves, and (ii) the punctures found on infested leaves.

It is quite clear by comparing the second and last column of the table that artificial punctures made on sound leaves did not make any change in the number of eggs laid.

These results indicate that presumably the smell of infested leaves was at the back of this increase in the number of eggs laid. This smell might have acted as a stimulant to oviposition.

IV—SUMMARY

1. Forcing the females of *Phytomyza atricornis* to oviposit only on previously infested leaves results in a significant increase of approximately 38.3% in the number of eggs laid.

2. There was not much difference between the number of eggs laid on sound leaves and those with artificial punctures made on them.
3. The smell given off from the infested leaves probably acted as a stimulant to oviposition.

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NOTES ON A COLLECTION OF COLEOPTERA: RUTELIDAE FROM SIKKIM

By

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I—INTRODUCTION

The present paper deals with the material of Rutelidae (Coleoptera) collected by Dr. A. G. K. Menon during the period from 14.3.59 to 21.8.59 from the areas visited by him in Sikkim, while acting as a Liaison Officer to Dr. F. Schmid of the Zoological Museum of Lausanne, Switzerland.

The coleopterous material of the family Rutelidae collected from twenty different localities in Sikkim comprises of 5 genera and 17 species.

The specimens were collected from the following localities, the altitudes ranging from 542 metres to 3,879 metres: Manul (1,485 m.), Tong (1,501 m.), Chungthang (1,515 m.), Sachu (2,879 m.), Lachen (2,706 m.), Thombyak (3,879 m.), Yathang (3,530 m.), Thangu (3,842 m.), Bichhu (2,727 m.), Lachung (2,727 m.), Dambang (2,985 m.), Manshitang (1,576 m.), Teng (1,515 m.), Tong (1,394 m.), Naga (1,515 m.), Singhik (1,575 m.), Mangan (1,576 m.), Dickchu (542 m.) and Thombu (3,167 m.) in the north, and Singtam (1,515 m.) in the West Sikkim.

The Coleoptera fauna of Sikkim bears resemblance with that of Darjeeling and other eastern Himalayan localities.

Of the 193 examples of beetles, 118 belong to the species *Callistopopillia iris* (Candeze), which clearly indicates its commonness in the area. This species shows considerable variation in colouration, while other species show very minor or slight variations. Nine species viz., (1) *Popillia cupricollis* Hope, (2) *Mimela passerinii* Hope, (3) *Mimela pectoralis* Blanchard, (4) *Mimela schneideri* Ohaus, (5) *Anomala signaticollis* Nonfried, (6) *Anomala xanthoptera* Blanchard, (7) *Anomala stoliczkae* Sharp, (8) *Anomala tumidicauda* Arrow, and (9) *Anomala erythroptera* (Kraatz) are recorded for the first time from the area.

The abbreviations *Ex.*, *Exs.*, and *m.*, are used for example (specimen), and examples (specimens) and metres, respectively. Only the species *Anomala xanthoptera* Blanchard is recorded from the western Sikkim, while the other species are reported from the northern Sikkim.

II—SYSTEMATIC ACCOUNT

Order	COLEOPTERA
Superfamily	SCARABAEOIDEA
Family	RUTELIDAE

1. *Dactylopopillia virescens* (Hope)

1831. *Popillia virescens* Hope, *Gray's Zool. Miscell.*, p. 23.

1917. *Dactylopopillia virescens*. Arrow, *Fauna Brit. India, Coleoptera : Lamellicornia*, pt. 2, p. 56.

Material.—2 exs. as follows: 1 ex., Manshitang (1,576 m.), 26. vii. 59; and lex., Teng (1,515 m.), 30 vii. 59.

Remarks.—Originally described from Nepal, this species has been recorded from West Bengal (Darjeeling, Mongphu, Soom, Pedong, Kurseong, Gopaldhara, Rungbong Valley) and also from Sikkim (upper Tiesta). The colour of the specimens examined varies from those described originally, the elytra being brown chocolate with greenish metallic lusture. Pronotum rugosely punctured except for the basal part.

2. *Popillia cyanea* Hope

1831. *Popillia cyanea* Hope, *Gray's Zool. Miscell.*, p. 23.

1917. *Popillia cyanea*: Arrow, *Fauna Brit. India, Coleoptera : Lamellicornia*, pt. 2, p. 62.

Material.—19 exs. as follows: 2 exs., Yathang (3,530 m.), 17. vi. 59; 4 exs., Chungthang (1,551 m.), 23. vii. 59, 29. vii. 59; 5 exs., Manshitang (1,576 m.), 26. vii. 59; 7 exs., Naga (1,515 m.), 2. vii. 59; 1 ex., Dickchu (542 m.), 14. viii. 59.

Remarks.—The species was first recorded from Nepal. It is known to occur in West Bengal (Siliguri, Darjeeling, Kurseong, Mongphu, Peshok, Gopaldhara), Assam (Khasi hills), U.P. (Nainital, Almora), Sikkim (Upper Tiesta) and Nepal (Kathmandu, Sundrijal, Gowhar, Chandra Giri).

3. *Popillia nitida* var. *concolor* Kraatz

1831. *Popillia nitida* Hope, *Gray's Zool. Miscell.*, p. 23.

1917. *Popillia nitida* var. *concolor* Kraatz, Arrow, *Fauna Brit. India, Coleoptera : Lamellicornia*, pt. 2, p. 70.

Material.—6 exs. as follows: 1 ex., Thombu (3,167 m.), 14. vi. 59; 1 ex., Yathang (3,530 m.), 15. vi. 59; 3 exs., Lachen (2,706 m.), 30. vi. 59; 1 ex. Bichhu (2,727 m.), 14. vii. 59.

Remarks.—*P. nitida* var. *concolor* was described from Sikkim. The species *P. nitida* has already been reported from West Bengal (Darjeeling, Kurseong), Assam (Khasi Hills), Manipur and Sikkim (Gangtok, Laching), besides Nepal (which is the type locality).

4. *Popillia cupricollis* Hope

1831. *Popillia cupricollis* Hope, *Gray's Zool. Miscell.*, p. 23.

1917. *Popillia cupricollis*: Arrow, *Fauna Brit. India, Coleoptera : Lamellicornia*, pt. 2, p. 73.

Material.—4 exs. as follows : 1 ex., Manshitang (1,576 m.), 26.vii.59; 1 ex., Tong (1,394 m.), 1.viii.59; 1 ex., Naga (1,515 m.) 2.viii.59; 1 ex., Dickchu (542 m.), 13.viii.59.

Remarks.—It is a very widely distributed species in the Himalayan belt and it has been recorded from the Punjab (Kangra Valley, Kulu, Kasauli), Himachal Pradesh (Simla), U.P. (Nainital, Kumaon, Mussoorie), West Bengal (Darjeeling, Kurseong, Pedong, Soom), and Nepal (which is its type locality). It is now reported from the above localities in Sikkim, thus extending the limits of its distribution eastward.

5. *Callistopopillia iris* (Candeze)

1869. *Anomala iris* Candeze, *Col. Hafte*, 5, p. 43.

1917. *Callistopopillia iris*: Arrow, *Fauna Brit. India, Coleoptera Lamellicornia*, pt. 2, p. 93.

Material.—118 exs. as follows: 22 exs., Lachen (2,706 m.), 9.vi.59; 3 exs., Yathang (3,530 m.), 15.vi.59, 17.vi.59; 90 exs., Thangu (3,842 m.), 18.vi.59; 3 exs., Lachung (2,727 m.), 30.vi.59.

Remarks.—A long series of specimens of the species is present in the collection examined. The species is already known from West Bengal (Darjeeling, Kurseong, Mongphu, Murshidabad), Jammu & Kashmir (Ladakh), Tibet (Yatong) and Sikkim.

In this species the colouration varies considerably. Originally described as bright metallic green and side of the elytra fiery red, but in some of the specimens examined the colour of elytra is completely reddish, with faint green metallic lustre and the fiery red band is completely obscure. The general appearance of elytra in these specimens is somewhat dull as compared to the typical specimen of the species.

6. *Mimela passerinii* Hope

1842. *Mimela passerinii* Hope, *Proc. Linn. Soc.*, 1, p. 128.

1917. *Mimela passerinii*: Arrow, *Fauna Brit. India, Coleoptera: Lamellicornia*, pt. 2, p. 105.

Material.—22 exs. as follows: 11 exs., Lachen (2,706 m.), 21.vi.59; 6 exs., Lachung (2,727 m.), 30.vi.59; 2 exs., Chungthang (1,515 m.), 2.vii.59; 2 exs., Dambang (2,985 m.) 10-11.vii.59; 1 exs., Naga (1,516 m.), 4.viii.59.

Remarks.—This species is already known from Sikkim (Lachen Valley), West Bengal (Darjeeling, Soom, Birchil hill, Mongphu, Jal Pahar), Jammu & Kashmir (Cambellpur), Tibet and West China.

7. *Mimela pectoralis* Blanchard

1851. *Mimela pectoralis* Blanchard, *Cat. Coll. Ent. Mus.*, Paris, (1850), p. 197.

1917. *Mimela pectoralis*: Arrow. *Fauna Brit. India, Coleoptera: Lamellicornia*, pt. 2, p. 107.

Material.—Singhik (1,576 m.), 5.viii.59; 1 ex., Mangan (1,576 m.).

Remarks.—This species has been previously recorded from West-Pakistan (Lahore), India: Himachal Pradesh (Simla), and Nepal. It is now reported for the first time from the above localities in northern Sikkim.

8. *Mimela schneideri* Ohaus

1905. *Mimela schneideri* Ohaus, *Deutsche, Ent. Zeits.*, p. 89.

1917. *Mimela schneideri*: Arrow, *Fauna Brit. India, Coleoptera : Lamellicornia*, pt. 2, p. 108.

Material.—3 exs. as follows: 1 ex., Thombyak (3,879 m.), 2.vi.69; 2 ex., Lachen (2,706 m.), 4.vi.59.

Remarks.—This species has already been recorded from Assam (Kohima, Naga hills), Manipur, Burma (Ruby mines, Maymyo). It is now reported from the above localities in northern Sikkim.

9. *Mimela princeps* Hope

1842. *Mimela princeps* Hope, *Trans. ent. Soc. London*, 3 p.65.

1917. *Mimela princeps*: Arrow, *Fauna Brit. India, Coleoptera : Lamellicornia*, pt. 2, p. 115.

Material.—3 exs. as follows : 1 ex., Tong (1,394 m.), 1.viii.59; 1 ex., Singhik (1,576 m.), 6.viii.59; 1 ex., Mangon (1,576 m.), 11.viii.59.

Remarks.—It is known to occur in West Bengal (Siliguri Darjeeling, Ghumti, Pashok, Gopaldhara, Rungbong Valley, Mongphu), Assam (Khasi Hills, Shillong, Namothe Cachar), Burma (Tonkin), Bhutan and Sikkim.

10. *Mimela heterochropus* Blanchard

1851. *Mimela heterochropus* Blanchard, *Cat. Coll. Ent. Mus., Paris*, (1850), p. 196.

1917. *Mimela heterochropus*: Arrow, *Fauna Brit. India, Coleoptera : Lamellicornia*, pt. 2, p. 117.

Material.—2 exs., Dickchu (542 m.), 15.viii.59.

Remarks.—The species was originally recorded from Nepal. It is also known to occur in Sikkim, U.P. (Nishangarh Dist. Bahraich), West Bengal (Lebong Mongphu, Rungbong, Kurseong, Darjeeling), Assam (Naga Hills), Burma and Tonkin.

11. *Anomala signaticollis* Nonfried

1893. *Anomala signaticollis* Nonfried, *Berl. Ent. Zeitschr.*, p. 334.

1917. *Anomala signaticollis*, Arrow, *Fauna Brit. India, Coleoptera : Lamellicornia*, pt. 2, p. 198.

Material.—1 ex., Lachen (2,706 m.), 5.vi.59.

Remarks.—This species is known from U.P. (Dehra Dun), Assam (Khasi Hills, Shillong, Cherrapunji) and Manipur. It is now recorded from Sikkim. The specimens of this species have an undivided prothoracic dark patch (c.f. *A. fulviventris* Bl.)

12. *Anomala agilis* Arrow

1917. *Anomala agilis* Arrow, *Fauna Brit. India, Coleoptera : Lamellicornia*, pt. 2, p. 207.

Material.—1 ex., Chungthang (1,551 m.), 23.viii.59.

Remarks.—This species is known to occur in West Bengal (Darjeeling, Kurseong, Soom, Pashok, Mongphu), and Bhutan. It is now recorded from Sikkim.

13. *Anomala xanthoptera* Blanchard

1851. *Anomala xanthoptera* Blanchard, *Cat. Coll. Ent. Mus. Paris*, (1850), p. 195.

1917. *Anomala xanthoptera*: Arrow, *Fauna Brit. India, Coleoptera : Lamellicornia*, pt. 2, p. 224.

Material.—1 ex. from western Sikkim, Singtam (1,515 m.), 5.iv.59.

Remarks.—This species has been reported from the Himanchal Pradesh (Kulu Valley and Kangra Valley), and U.P. (Dehra Dun). The present record from the western Sikkim is of interest.

14. *Anomala perplexa* (Hope)

1839. *Euchlora perplexa* Hope, *Proc. zool. Soc.*, 2, p. 70.

1917. *Anomala perplexa*: Arrow, *Fauna Brit. India, Coleoptera : Lamellicornia*, pt. 2, p. 228.

Material.—4 exs. as follows: 3 exs., Dickchu (542 m.), 3.viii.59; 1 ex., Naga (1,515 m.), 2.viii.59.

Remarks.—The species is already recorded from West Bengal (Darjeeling, Gopaldhara, Rungbong Valley, Pedong, Mongphu), Sikkim (Gangtok), Bhutan (Maria Basti) and Nepal.

15. *Anomala stoliczkae* Sharp

1873. *Anomala (Callistethus) stoliczkae* Sharp, *J. Roy. Asiat. Soc. Bombay*, 48, 2, p. 173.

1917. *Anomala stoliczkae*: Arrow, *Fauna Brit. India, Coleoptera : Lamellicornia*, pt. 2, p. 243.

Material.—2 exs., Sachu (2,879 m.), 16.v.59; 1 ex., Lachung (2,727 m.), 2.vii.59.

Remarks.—This species is known to occur in West Pakistan (Murree), India, U.P. (Jaunsar), West Bengal (Darjeeling), Tibet and West China. The elytra are pea-green in colour, and the humeral and apical calli are ruby red.

16. *Anomala tumidicauda* Arrow

1912. *Anomala (Callistethus) tumidicauda* Arrow, *Ann. Mag. nat., Hist.*, (8) 9, p. 83.

1917. *Anomala tumidicauda*: Arrow, *Fauna Brit. India, Coleoptera : Lamellicornia*, pt. 2, p. 247.

Material.—2 exs. as follows: 1 ex., Lachung (2,727 m.), 30.vi.59; 1 ex., Lachen (2,706 m.), 2.vi.59.

Remarks.—This species is known to occur in West Bengal (Darjeeling, Kurseong, Labong). It is now recorded from Sikkim.

17. *Anomala erythroptera* (Kraatz)

1892. *Ischnopopillia erythroptera* Kraatz, *Deutsche Ent. Zeits.*, p. 295.

1917. *Anomala erythroptera*: Arrow, *Fauna Brit. India, Coleoptera : Lamellicornia*, pt. 2, p. 262.

Material.—1 ex., Manul (1,485 m.), 10.vi.59.

Remarks.—This species is recorded from Assam (Khasi Hills, Shillong), and West Bengal (Kurseong, Darjeeling, Suriel, Mongphu). It is now being recorded from the above locality in Sikkim.

III—SUMMARY

The paper deals with 193 examples of Coleoptera of the family Rutelidae, comprising of 5 genera and 17 species. Nine species are new records from Sikkim area.

IV—ACKNOWLEDGEMENTS

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POPULATION DYNAMICS AND MORPHOMETRY OF THE 1954 — DESERT LOCUST POPULATION IN INDIA IN RELATION TO EYE-STRIPES AND SEX-RATIOS

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(With 15 Tables and 15 Text-figures)

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I — CHARACTERISTICS OF THE 1954-POPULATION

1. *General*

The year 1954 was the last but one year (the sixth year) of the ninth (documented) Desert Locust Cycle (1949-55) in India. The initial concentration (*the Kakko population* of 1949), which initiated this cycle in 1949 was studied earlier by Misra (1952), from the material obtained from Kakko village in the Bikaner District of Rajasthan.

The results of the study of the morphometric characters, related ratios, eye-stripe composition and sex-ratios for the 1954-population are presented here.

To ascertain the correct status and facies of the 1954-population, it is compared with the earlier known populations representing various degrees of phase-transformation, *viz.*, with the typical *solitarias* and *gregarias* of Roonwal *et al.* (1945, 1945 *a*, 1951, 1952); with the *Kakko concentration* of 1949 (Misra, 1952, 1953); with the *Ajmer Swarm* of 1950 (Roonwal and Misra, 1952) and with the group I of the 1955-population (Roonwal and Bhanotar, 1966).

2. *Locust situation in India during 1954*

The year 1954 was the peak year (heavy swarming activity) of the 1949-55 cycle. The influx of the seasonal exotic swarms in India from the western region started from 11th April and continued upto the first fortnight of December. A total of 174 mature and immature swarms invaded India.

No swarm over-wintered in India during the period December, 1953 to March, 1954. The population of scattered locusts remained low (January-March 1954).

3. *History of the 1954-population*

(a) *General*

The 1954 was a critical year of the 1949-55 cycle. Roonwal (1954), from the studies based on the composition of eye-stripes and sex-ratios of a Dehra Dun swarm in 1954, hinted at the possible decline of the cycle which was then in its sixth year (which, as judged by the locust situation, was the peak year). The evidence of this decline is seen in the appearance of 7-striped individuals in the swarming populations (which are always 6-striped in swarms), in the early and later part of the year, even though the equilibrium in the sex-ratios and morphometric characters remained comparatively stable.

The effective role of eye-stripes as an indicator of phase-transformation is, thus, apparent.

(b) *Population densities*

(i) *First period (January-April 1954):*

The population remained fluctuating, the density ranging from 40 to "countless"* per square mile. The individuals were either collected

* The expression used in the reports of the Plant Protection Adviser to the Government of India who supplied the material.

singly or from thin concentrations. But owing to a sudden influx from the west, the density in many areas became very great during the second fortnight of April. The specimens were of the "mixed type" (grey, pink and yellow). The temperature remained very low during the period.

(ii) *Second period (May-August, 1954):*

The density remained very high. The majority of individuals were collected from dense (mature) swarms, or singly from dense concentrations where the population was very high. Furthermore due to the exceptionally heavy and wide-spread rainfall, causing favourable conditions for egg-laying (suitable soil moisture), the concentration of swarms and individuals was heavy during the period. The density ranged from 80 to "countless" per square mile. The temperature and humidity remained above normal.

(iii) *Third period (September-December, 1954):*

The density ranged from 80 to "countless" per square mile. A few swarms over-wintered. The third generation of the *gregaria* breeding was reported from many parts of Rajasthan. The individuals (mixed type) were collected singly or from dense concentrations. The temperature remained below normal (extremely cold).

Except for the first period, the individuals of the remaining two periods had swarming antecedents.

4. Abbreviations used

Except where otherwise stated, the following abbreviations have been used throughout:—

- O, Width of head at ocular level.
- C, Width of head at genal level.
- P, Length of pronotum.
- H, Height of pronotum.
- M, Width of pronotum at the constriction.
- E, Length of elytron.
- W₁, Restricted width of elytron.
- F, Length of hind-femur.
- S.E., Standard error.
- S.D., Standard deviation.
- S.D.P., Sexual dimorphism percentage.
- 6-*gregaria* or 6-*greg.* or *greg.*, or *greg.* (6), typical 6-striped phase *gregaria* individuals.
- 6-7-*solitaria*, 6-*sol.*, 7-*sol.*, or *sol.* (6) or *sol.* (7), Typical 6- or 7-striped phase *solitaria* individuals.
- 6-7- striped, 6- or 7- eye-striped.
- 5-8- striped, 5- or 8- eye-striped.
- Group I or Gr. I, 1954 Group I populations.
- Group II or Gr. II, 1954 Group II populations.
- Group III or Gr. III, 1954 Group III populations.
- 1955-Gr. I, 1955 Group I populations.
- Gr. I(6) or Gr. I(7), 6- or 7-striped individuals of Group I.
- Gr. II(6) or Gr. II(7), 6- or 7-striped individuals of Group II.

Gr. III(6) or Gr. III(7), 6- or 7-striped individuals of Group III. *Kakko pop.*, *Kakko Conc.* or *K* or *Ini. Conc.*, Initial concentration of locusts, Kakko village (Rajasthan) in 1949 (Misra, 1952).

Ajmer Sw., or *Ajm. sw.* or *Ajm. (6)*, Ajmer Swarm population of 1950 (Roonwal & Misra, 1952).

K (6) or *K (7)*, 6- or 7-striped individuals of initial or *Kakko Concentration* (1949).

NS, not significant.

n, number of examples.

*, Significant at 5% level.

**, Significant at 1% level.

***, Significant at 0.1% level.

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II — MATERIAL AND METHODS

1. General

(Tables 1 and 2)

For the 1954-population, 1819 individuals were studied from the following contiguous localities and districts of Rajasthan and West Punjab (India), the figures in bracket showing the number of individuals.

- | | |
|--------------------|-----------------------|
| 1. Bikaner (766) | 7. Jhunjhunu (36) |
| 2. Jaisalmer (348) | 8. Sikar (29) |
| 3. Jodhpur (183) | 9. Nagaur (100) |
| 4. Ganganagar (30) | 10. Mohindergarh (55) |
| 5. Jalore (34) | 11. Barmer (20) |
| 6. Narnaul (51) | 12. Churu (167) |

The month-wise distribution of the number of samples are as follows :—

- | | |
|----------------|-------------------|
| 1. January, 7 | 7. July, 490 |
| 2. February, 7 | 8. August, 152 |
| 3. March, 6 | 9. September, 173 |
| 4. April, 54 | 10. October, 127 |
| 5. May, 83 | 11. November, 1 |
| 6. June, 556 | 12. December, 163 |

Measurements: The morphometric measurements were taken according to method laid down in the Third International Locust Conference, London (1934); and as taken earlier by Roonwal *et al.* (1945, 1947, 1949, 1952, 1966); Misra *et al.* (1952), Rao (1942, 1960, fig. 17 *a, b*, facing page 295).

2. *Grouping of the random samples*

The population was *grouped* into three natural groups, based on consideration of the chronological position of the generations, and also on the well known seasonal periodicity and waves of swarming and immigrations that has so far been observed to have taken place in Rajasthan (western India).

For purpose of analysis, the 1819 individuals are grouped, as follows:—

(i) *Group I (74)*: First generation individuals. Specimens collected in January-April, from scattered populations as well as from thin concentrations. No swarm over-wintered in India during the period.

(ii) *Group II (1281)*: Second generation individuals. Specimens collected in May-August singly or from dense concentrations or from swarms.

(iii) *Group III (464)*: Third generation individuals. Specimens collected in September-December from the over-wintered swarms and from high concentrations.

III — STATISTICAL CHARACTERISTICS OF THE 1954-POPULATION

Randomness of the sample-data

In collecting the data of the 1954-population, no random sampling plan was designed before hand. But it seems hardly necessary to have such pre-determined scheme for the morphometrical studies as the samples in huge numbers were drawn regularly from all over the region, thus maintaining the randomness of the sample and validity of the results derived here. Only for estimating the population in the field, statistical technique of drawing random samples could have been adopted. For studying the seasonal fluctuation within a year in morphometrics, specimens were collected all over the year and from the geographical region having broadly the same latitude and longitude, similar temperature and humidity, uniform velocity of air, and more or less equal amount of rainfall, thus making the sample representative and homogenous.

Statistical technique

For the study of population characteristics, it is necessary to estimate some statistical parameters of the parent population from the information given by the sample. For this purpose, the 'point' method of estimation was employed. The common measures of location (mean) and dispersion (standard deviation) for describing and comparing populations were adopted. For the assessment of the status of the population under study with respect to typical phases and other known populations, parameters of each morphometric character or ratio were compared separately between two populations. Instead of applying the multivariate test of significance, the univariate method was used, firstly for judging the efficacy of each morphometric character independently without interacting with others and secondly for avoidance of complex statistical procedures. The difference of mean dimensions for two populations was expressed as a ratio to the standard error of their

difference and referred to normal-curve table for significance, if the sample-size were large. In the case of sample size being small and variances equal, the students' *t* test was applied for testing the hypotheses that the two groups of measurements were samples drawn from the same normally distributed populations. But when a decided difference in the variances for the two samples was noted by applying variance-ratio test, a more exact test procedure was used. Firstly, following the usual procedure, *t* was evaluated and then instead of referring it to the value given in "Students" *t* distribution table, a weighted *t* value was computed, the weights being the square of the standard errors of the two samples. For judging the significance of difference, the calculated *t* was compared with the weighted one. The minimum level of significance chosen was the 5 per cent point of probability.

IV—EYE-STRIPE COMPOSITION AND SEX-RATIOS

(a) *Eye-stripes* (Tables 2, 4 and 5)

Unlike the 1955-population (Roonwal and Bhanotar, 1966), no 5- or 8- eye-striped individuals were obtained in the 1954-population, only the 6- and 7-striped ones occurring as follows :—

Eye-stripe distribution (and % $\pm$ S.E.) in 1954-population

Group	6-striped	7-striped
I (74 exs.)	63(85.14 $\pm$ 4.13)	11(14.86 $\pm$ 4.14)
II (1281 exs.)	1278(99.77 $\pm$ 0.13)	3(0.23 $\pm$ 0.14)
III (464 exs.)	454(97.84 $\pm$ 0.62)	10(2.16 $\pm$ 0.69)

Distribution by sex- and eye-stripes (and % $\pm$ S.E.), in 1954-population

Group	Males		Females	
	6-striped	7-striped	6-striped	7-striped
I	32 (91.43 $\pm$ 4.75)	3 (8.57 $\pm$ 4.75)	31 (79.49 $\pm$ 6.75)	8 (20.51 $\pm$ 6.45)
II	697 (100)	0 (0)	581 (99.49 $\pm$ 0.29)	3 (0.51 $\pm$ 0.29)
III	3 (97.05 $\pm$ 1.09)	7 (2.95 $\pm$ 1.09)	224 (98.68 $\pm$ 0.76)	3 (1.32 $\pm$ 0.76)

(b) *Sex-ratios* (Tables 3 and 4)

Irrespective of eye-stripes, the lumped percentage of sex-ratio in the three population-groups is as follows:—

Gr. I	— ♂ ♂ ,	49.32 $\pm$ 5.81 ;	♀ ♀ ,	52.70 $\pm$ 5.81
Gr. II	— ♂ ♂ ,	54.41 $\pm$ 1.43 ;	♀ ♀ ,	45.59 $\pm$ 1.42
Gr. III	— ♂ ♂ ,	51.08 $\pm$ 2.37 ;	♀ ♀ ,	48.92 $\pm$ 2.37

The distribution (% $\pm$ S.E.) of the sex-ratio in the various eye-stripe categories is as follows:—

Group		6-striped		7-striped
I	♂ ♂ :	50.79 ± 6.30	♂ ♂ :	27.27 ± 13.45
	♀ ♀ :	49.21 ± 6.30	♂ ♂ :	72.73 ± 13.43
	♂ ♂ :	54.54 ± 1.39	♀ ♀ :	0.0
II	♀ ♀ :	45.46 ± 1.39	♀ ♀ :	0.0
	♂ ♂ :	50.66 ± 2.35	♂ ♂ :	70.00 ± 14.49
	♂ ♂ :		♂ ♂ :	
III	♀ ♀ :	49.34 ± 2.35	♀ ♀ :	30.00 ± 14.49
	♂ ♂ :		♂ ♂ :	

(c) Discussion

The phase position and facies of the three population-groups, in relation to eye-stripe category and sex-ratios, may now be discussed in the light of Roonwal's Hypotheses (1945):

Group I — The high percentage (85.14 ± 4.13) of 6-striped individuals (value above Roonwal's figure of 80%) and the near equality of sex-ratio (♂ : 50.79 ± 6.30 ; ♀ : 49.21 ± 6.30), indicate a *gregaria* facies of the population.

Group II — Here too, the high percentage (99.77 ± 0.13) of 6-striped individuals, with a fairly equalised sex-ratio (♂ : 54.54 ± 1.39 ; ♀ : 45.46 ± 1.39) indicate a phase *gregaria* facies of the population.

Group III — Finally, here again the high percentage (97.84 ± 0.69) of 6-striped individuals, with an almost equal sex-ratio (♂ : 50.66 ± 2.35 ; ♀ : 49.34 ± 2.35) indicate a phase *gregaria* facies of the population.

Thus throughout 1954, the population remained towards phase *gregaria*. But the emergence of a few 7-striped individuals in Group I ($14.86 \pm 4.14\%$), Group II ($0.23 \pm 0.14\%$) and Group III ($2.16 \pm 0.69\%$), indicates the general "mildness" of *gregaria*-ness and a possible trend towards *solitaria*-ness for the future population (of 1955). In actual facts, the 1955-population moved still closer to *solitaria*, and this was indeed the last year of the 1949-55 Cycle.

V — MORPHOMETRIC CHARACTERS

(SIZE OF BODY-PARTS)

(Tables 6, 7, 10-12, 14 and 15)

1. General

The following important and sensitive phase-characters were studied for the three population- Groups :—

1. Width of head at ocular level (O).
2. Maximum width of head at the genal level (C).
3. Length of pronotum at the keel (P).
4. Maximum height of pronotum (H).
5. Width of pronotum at the constriction (M).
6. Length of elytron (E).
7. Restricted width of elytron (W_1).
8. Length of hind-femur (F).

The data of the three Groups (I-III) were first compared among themselves (inter-group comparison). Each group was then compared with the following known populations (inter-population comparison), the data of which are now available in the literature :—

(i) 6- and 7-striped individuals of “typical phase *solitaria*”, 1936-47 (Roonwal, 1949 ; and Roonwal & Nag, 1951).

(ii) 6-striped individuals of “typical phase *gregaria*” 1936-47 (Roonwal, 1949 ; and Roonwal & Nag, 1951).

(iii) 6-striped (♂ and ♀) and 7-striped (♀) of the *Kakko concentration* of 1949 (first year of the 1949-55 cycle) (Misra, 1952).

(iv) 6-striped (♂ and ♀) of the *Ajmer Swarm* population of 1950 (second year of the 1949-55 cycle) (Roonwal & Misra, 1952).

(v) 6-striped (♂ and ♀) and 7-striped (♂) of Group I (1955-population in India, the last year of the 1949-55 Cycle) (Roonwal & Bhanotar, 1966).

2. Width of head at ocular level (O).

(Tables 6, 7 and 12 and Text-fig. 1)

(a) Mean width

The mean width (mm.) $\pm$ S.E. varies as follows :—

Group (and eye-stripes)	Males	Females	Difference
Gr. I(6)	6.40 $\pm$ 0.07	6.81 $\pm$ 0.13	0.41 $\pm$ 0.15
Gr. II(6)	6.44 $\pm$ 0.01	6.76 $\pm$ 0.01	0.32 $\pm$ 0.01
Gr. III(6)	6.41 $\pm$ 0.02	6.68 $\pm$ 0.02	0.27 $\pm$ 0.03
Gr. I(7)	6.60 $\pm$ 0.50	7.00 $\pm$ 0.06	0.40 $\pm$ 0.50
Gr. II(7)	—	7.00 $\pm$ 0.12	—
Gr. III(7)	6.33 $\pm$ 0.12	7.05 $\pm$ 0.07	0.72 $\pm$ 0.23

(b) Inter-group comparison (Table 7)

(i) *6-striped : Males* : The values in Grs. I-III are not significantly different from each other at all levels. *Females* : The value in Gr. I is not significantly different from Grs. II and III ; it is significantly higher in Gr. II than in Gr. III at all levels.

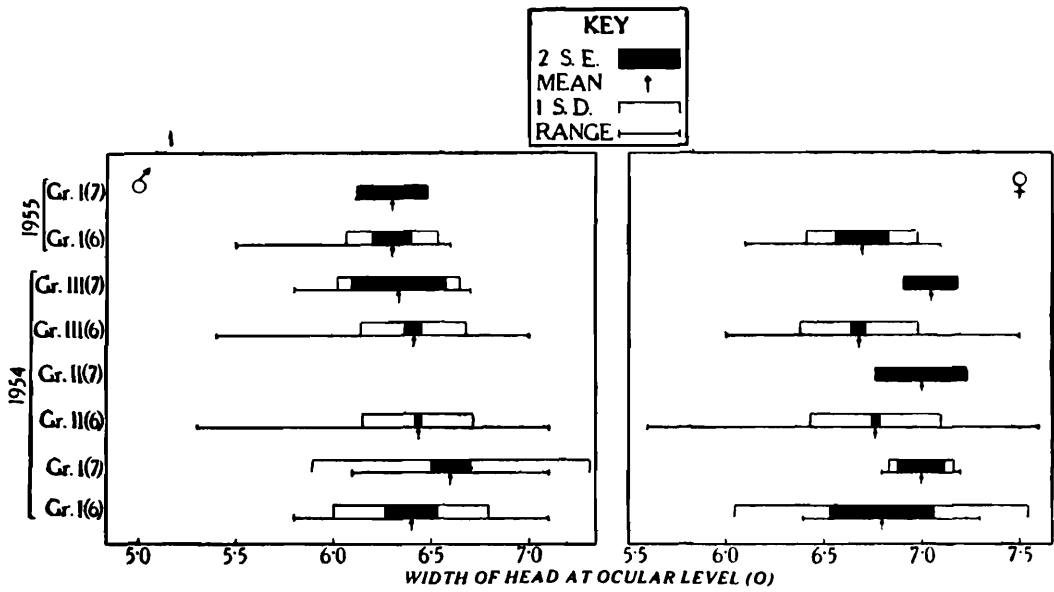
(ii) *7-striped : Males* : The value in Gr. I is not significantly different from Gr. III ; no males occurred in Gr. II. *Females* : The values in Grs. I-III are not significantly different from each other.

(c) Inter-sex comparison (Table 6)

In both 6- and 7- eye-striped categories, the value in corresponding females is significantly higher than in males at all levels, except for Gr. I(7), where no sexual difference is noticed.

(d) Inter-eye-stripe comparison (Table 8)

Males : Within the same eye-stripe group and sex, the values in 6-striped forms in Grs. I and III are not significantly different from that in 7-striped ones at all levels. No males occurred in Gr. II(7). *Females* : Within the same eye-stripe group and sex, the value in 6-striped individuals is not significantly different from that in 7-striped ones at all levels.



TEXT-FIG. 1. *Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding width of head at ocular level (O). 1954-Gr. I(6), I(7), II(6), II(7), III(6) and III(7), 6- and 7- striped individuals of 1954-Groups; 1955-Gr. I(6) and I(7), 6- and 7- striped individuals of 1955-Groups Also see text.

(e) Inter-population comparison (Table 12)

The three 1954-Groups compare with 1955-Group I population as follows (no comparison could be made with other population due to lack of data). The head-width (O) in the 1955-Gr. I varies thus:

1955-population	Mean (mm.) $\pm$ S.E.	
	Males	Females
Gr. I(6)	6.30 $\pm$ 0.050	6.71 $\pm$ 0.067
Gr. I(7)	6.27 $\pm$ 0.088	—

(i) 6-striped males: The value in 1954-Gr. I is not significantly different than that in 1955-Gr. I. But those in Grs. II and III are significantly higher than in 1955-Gr. I at 1% and 5% levels respectively.

(ii) 6-striped females: The values in 1954-Grs. I-III are not significantly different from the 1955-Gr. I at all levels.

(iii) 7-striped males: The values in 1954-Grs. I and III are not significantly different from the 1955-Gr. I at all levels. No males occurred in Gr. II.

(iv) 7-striped females: No females occurred in 1955-Gr. I, hence no comparison could be made.

(f) Sexual Dimorphism Percentage (S.D.P.)

The S.D.P. $\pm$ S.E. varies as follows:—

1954-population (and eye-stripes)	S.D.P.	Other populations (and eye-stripes)	S.D.P.
Gr. I(6)	6.41 $\pm$ 2.41	1955-Gr. I(6)	6.51 $\pm$ 1.36
Gr. I(7)	6.06	1955-Gr. II(6)	6.09 $\pm$ 0.31
Gr. II(6)	4.97 $\pm$ 0.27	1955-Gr. III(6)	8.17 $\pm$ 2.19
Gr. III(6)	4.21 $\pm$ 0.43		
Gr. III(7)	11.37		

In the 6-striped category, the values in the 1954-Grs. I-III are not significantly different from that in 1955-Grs. I and III. But the values in 1954-Grs. II and III are significantly lower than in 1955-Gr. II at 1% and 0.1% levels respectively. No comparison could be made in 7-striped category due to lack of data.

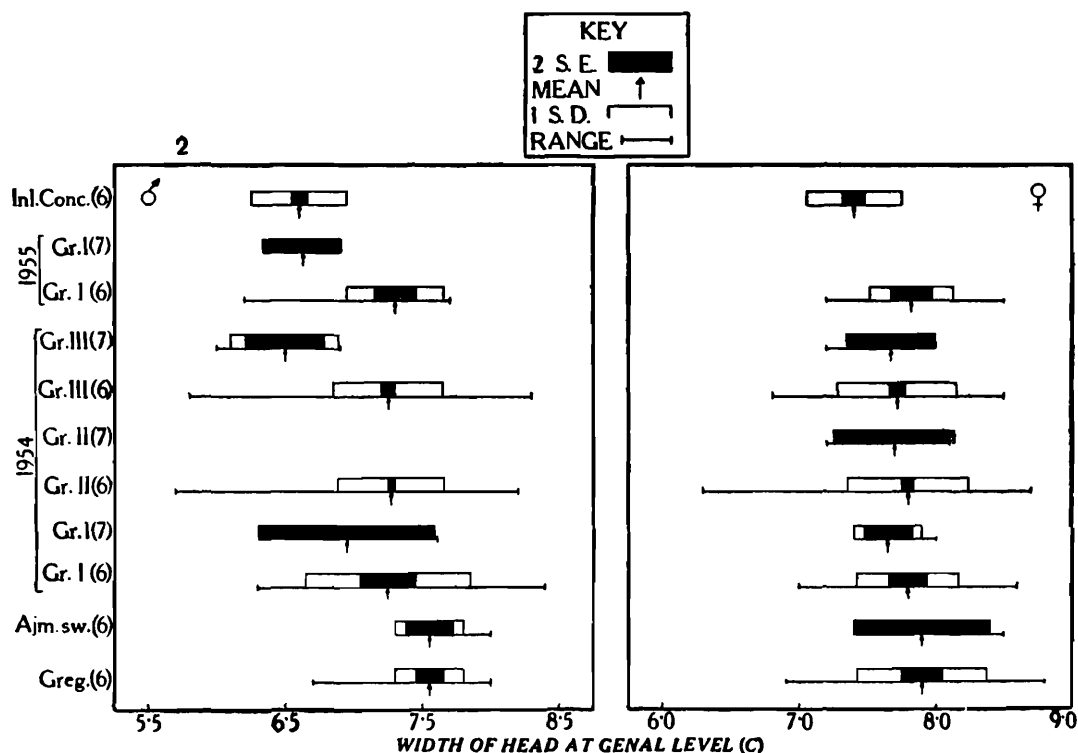
3. Width of head at genal level (C)

(Tables 6-7, 10-12, 14 and 15 and Text-Fig. 2)

(a) Mean width

The mean width (mm.) $\pm$ S.E. varies as follows:—

Group (and eye-stripes)	Males	Females	Differences
Gr. I(6)	7.26 ± 0.10	7.98 ± 0.07	0.72 ± 0.12
Gr. II(6)	7.27 ± 0.01	7.79 ± 0.02	0.52 ± 0.02
Gr. III(6)	7.26 ± 0.02	7.73 ± 0.03	0.47 ± 0.04
Gr. I(7)	6.97 ± 0.32	7.65 ± 0.09	0.68 ± 0.33
Gr. II(7)	—	7.70 ± 0.22	—
Gr. III(7)	6.50 ± 0.14	7.67 ± 0.16	1.17 ± 0.24



TEXT-FIG. 2. *Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding width of head at genal level (C). *Inl. Conc.* (6), 6-striped individuals of initial (or *Kakko*) concentration of 1949 (Misra, 1952), *Ajm. Sw.* (6), 6-striped individuals of Ajmer Swarm of 1950 (Roonwal and Misra, 1952); *Greg.* (6), 6-striped "typical" phase *gregaria*. Also see text-figure 1 and the text.

(b) Inter-group comparison (Table 7)

(i) 6-striped : Males : The values in Grs. I-III are not significantly different from each other at all levels. Females : The value in Gr. I

is significantly higher than in Gr. II (at 1% level) and Gr. III (at all levels). The value in Gr. II is significantly higher than in Gr. III (at all levels).

(ii) *7-striped*: In both sexes, the value in each sex-group is not significantly different from those in other groups. No males occurred in Gr. II.

(c) *Inter-sex comparison* (Table 6)

In both the 6- and 7-eye-striped categories, the value in corresponding females in each group is significantly higher than in males at all levels.

(d) *Inter-eye-stripe comparison* (Table 6)

(i) *Males*: Within the same eye-stripe group and sex, the value in Gr. I(6) is not significantly different from that in Gr. I(7), but the value in Gr. III(6) is significantly higher (at all levels) than in Gr. III(7). No males occurred in Gr. II(7). (ii) *Females*: Within the same eye-stripe group and sex, the values in Gr. I(6) and Gr. III(6) are significantly higher than in Gr. I(7) at 5% level and Gr. III(7) at all levels respectively. No significant difference is seen in Grs. II(6) and II(7).

(e) *Inter-population comparison* (Tables 10-12, 14, 15)

The three 1954-Groups compare with other populations (data given below) as follows:—

<i>Other populations (and eye-stripes)</i>	<i>Mean (mm.) $\pm$ S.E.</i>	
	<i>Males</i>	<i>Females</i>
<i>6-greg.</i>	7.55 ± 0.045	7.89 ± 0.074
<i>Ajmer Sw. (6)</i>	7.53 ± 0.082	7.90 ± 0.248
<i>Kakko Conc. (6)</i>	6.60 ± 0.033	7.41 ± 0.041
1955-Gr. I(6)	7.31 ± 0.071	7.83 ± 0.074
1955-Gr. I(7)	6.63 ± 0.144	—

(i) *6-striped males*: The values in 1954-Grs. I-III are significantly lower (at 1%, 0.1% and 0.1% levels respectively) than in *6-greg.*, but are higher than in *Kakko Conc.* (at all levels). The values in 1954-Grs. II and III are significantly lower than in *Ajmer Sw.* (at 1% level), but Gr. I shows no significant difference. The 1954-Grs. I-III do not show significant difference from the 1955-Gr. I.

(ii) *6-striped females*: The value in 1954-Gr. III is significantly lower (at 5% level) than in *6-greg.*, but Grs. I and II show no significant difference. The values in 1954-Grs. I-III are significantly higher than in the *Kakko Conc.* (at all levels), but are not significantly different from the *Ajmer Sw.*

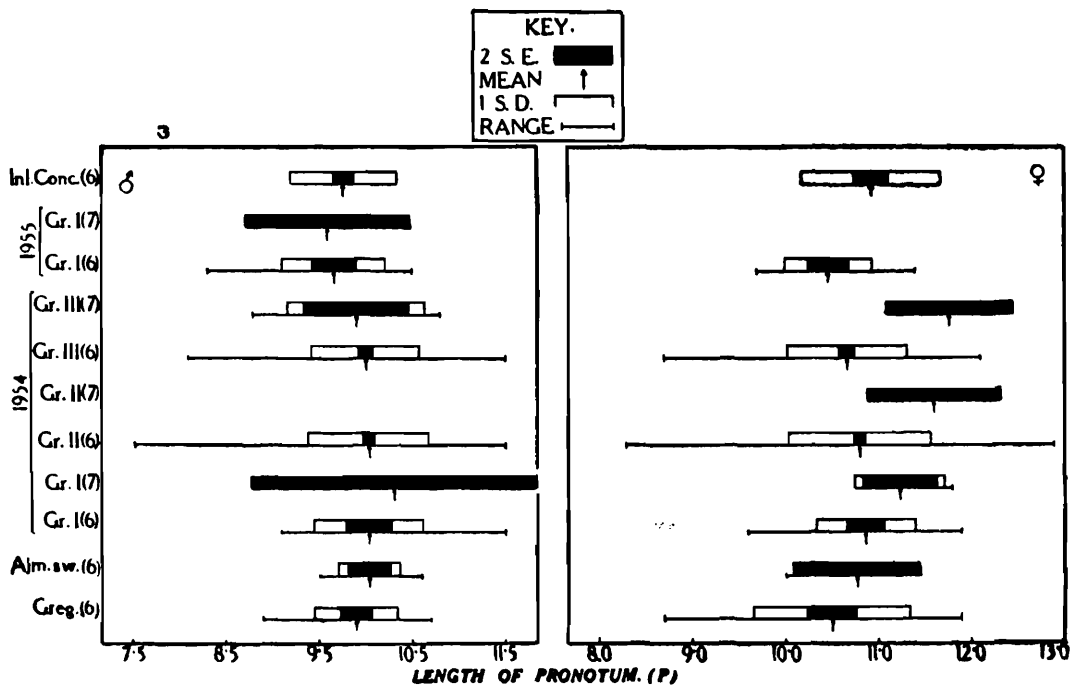
(iii) *7-striped males*: The values in 1954-Grs. I and III are not significantly different from the 1955-Gr. I at all levels. No males occurred in Gr. II.

(iv) *7-striped females*: No comparison could be made due to lack of data. No females occurred in 1955-Gr. I.

(f) Sexual Dimorphism Percentage (S.D.P.)

The S.D.P. $\pm$ S.E. varies as follows:—

1954-population (and eye-stripes)		Other populations (and eye-stripes)	
	S.D.P.		S.D.P.
Gr. I(6)	9.92 ± 1.83	1955-Gr. I(6)	7.11 ± 1.46
Gr. I(7)	9.76	Kakko Conc. (6)	12.27 ± 0.8
Gr. II(6)	7.15 ± 0.34	6-greg.	4.50 ± 1.50
Gr. III(6)	6.47 ± 0.50		
Gr. III(7)	18.00		



TEXT-FIG. 3. *Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding length of pronotum (P). For explanations see text and text-figures 1 and 2.

In the 6-striped category, the values in 1954-Grs. I-III are not significantly different from that in 1955-Gr. I. But the values in 1954-Grs. I and II are significantly higher than in 6-greg., but the 1954-Gr. III does not differ significantly. The values in the 1954-Grs. II and III are significantly lower (at all levels) than in the *Kakko Conc.*, but those of Gr. I do not differ in this respect. No comparison could be made in the 7-striped category, due to lack of data.

4. Length of pronotum at the keel (P)
(Tables 6-7, 10-12, 14 and 15 and Text-fig. 3)

(a) Mean length

The mean length (mm.) $\pm$ S.E. varies as follows:—

Group (and eye-stripes)	Males	Females	Differences
Gr. I(6)	10.06 ± 0.12	10.86 ± 0.10	0.80 ± 0.16
Gr. II(6)	10.04 ± 0.03	10.81 ± 0.03	0.77 ± 0.04
Gr. III(6)	10.00 ± 0.04	10.66 ± 0.04	0.66 ± 0.06
Gr. I(7)	10.30 ± 0.78	11.22 ± 0.20	0.92 ± 0.59
Gr. II(7)	—	11.60 ± 0.36	—
Gr. III(7)	9.90 ± 0.28	11.77 ± 0.34	1.87 ± 0.49

(b) *Inter-group comparison* (Table 7)

(i) *6-striped : Males* : Groups I-III are not significantly different from each other at all levels. *Females* : Gr. I shows no significant difference from Grs. II and III, but that in Gr. II is significantly higher (at 1% level) than in Gr. III.

(ii) *7-striped : Males* : Group I is not significantly different from Gr. III ; no males occurred in Gr. II. *Females* : Groups I-III are not significantly different from each other.

(c) *Inter-sex comparison* (Table 6)

Except for Gr. I(7), in both 6- and 7-striped categories, the value in the corresponding females is significantly higher than in males at all levels.

(d) *Inter-eye-stripe comparison* (Table 6)

Males : Within the same group, the values in 6-striped forms in Grs. I and III is not significantly different from that in 7-striped ones. No males occurred in Gr. II(7) *Females* : Within the same group, the values in 6-striped forms in Grs. I and II are not significantly different from those in 7-striped ones, but the value in Gr. III(6) is significantly lower (at 1% level) than in Gr. III(7).

(e) *Inter-population comparison*

(Tables 10-12, 14 and 15)

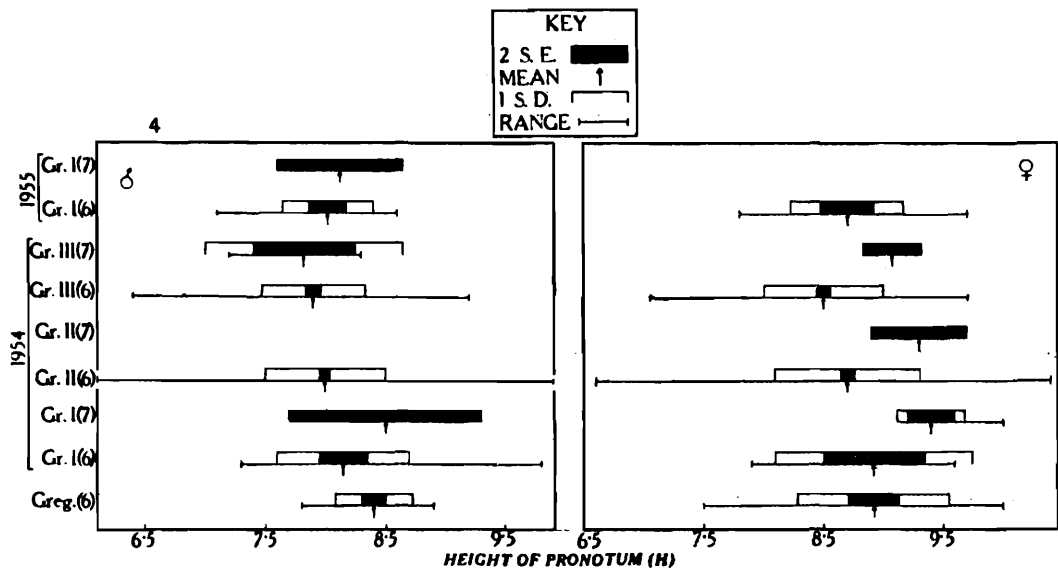
The three 1954-groups compare with other populations (data given below) as follows:—

<i>Other populations (and eye-stripes)</i>	<i>Mean (mm.) $\pm$ S.E.</i>	
	<i>Males</i>	<i>Females</i>
<i>6-greg.</i>	9.87 ± 0.079	10.49 ± 0.133
<i>Ajmer Sw. (6)</i>	10.01 ± 0.108	10.78 ± 0.343
<i>Kakko Conc. (6)</i>	9.76 ± 0.054	10.94 ± 0.088
<i>1955-Gr. 1 (6)</i>	9.66 ± 0.114	10.47 ± 0.113
<i>1955-Gr. I(7)</i>	9.67 ± 0.44	—

(i) *6-striped males* : The values in 1954-Grs. I and III are not significantly different from *6-greg.* at all levels, but that in Gr. II is significantly higher at the 5% level. The 1954-Grs. I-III are not significantly different from the *Ajmer Sw.* (at all levels), but have significantly higher values (at all levels) than those in the *Kakko Conc.* and the 1955-Gr. I.

(ii) *6-striped females* : The values in 1954-Grs. I and II are significantly higher than in *6-greg.* (at 5% level), but Gr. III shows no significant difference. The 1954-Grs. I-III show no difference from the *Ajmer Sw.* at all levels. Except for Gr. III, where the value is significantly lower (at 1% level) than in the *Kakko Conc.*, Grs. I-III show no significant difference. The values in 1954-Grs. I-III are significantly higher (at 1% level) than in 1955-Gr. I.

(iii) *7-striped males* : The values in 1954-Grs. I and III are not significantly different from that in 1955-Gr. I at all levels. No males occurred in Gr. II.



TEXT-FIG. 4. *Schistocerca gregaria*. Diccgram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding height of pronotum (H). For explanations see text and text-figures 1 and 2.

(iv) *7-striped females*: No comparison could be made due to lack of data. No females occurred in 1955-Gr. I.

(f) *Sexual Dimorphism Percentage (S.D.P.)*

The S. D. P. $\pm$ S.E. varies as follows:—

1954-populations (and eye-stripes)	S.D.P.	Other populations (and eye-stripes)	S.D.P.
Gr. I(6)	7.95 ± 1.55	1955-Gr. I(6)	8.38 ± 1.74
Gr. I(7)	8.93	Kakko Conc.(6)	12.09 ± 1.09
Gr. II(6)	7.67 ± 0.42	6-greg.	6.28 ± 1.60
Gr. III(6)	6.60 ± 0.60	—	—
Gr. III(7)	18.89	—	—

In the 6-striped category, the values in the 1954-Grs. I-III are not significantly different from those in 1955-Gr. 1 and 6 greg., but are significantly lower than in the *Kakko Conc.* at all levels. No comparison could be made in 7-striped category due to lack of data.

5. *Height of pronotum (H)*

(Tables 6-7 and 12 and Text-fig. 4)

(a) *Mean height*

The mean height (mm.) $\pm$ S.E. varies as follows:—

Group (and eye-stripes)	Males	Females	Difference
Gr. I(6)	8.16 ± 0.10	8.93 ± 0.07	0.77 ± 0.12
Gr. II(6)	7.99 ± 0.02	8.69 ± 0.03	0.70 ± 0.04
Gr. III(6)	7.90 ± 0.03	8.49 ± 0.03	0.59 ± 0.04
Gr. I(7)	8.50 ± 0.40	9.39 ± 0.10	0.89 ± 0.40
Gr. II(7)	—	9.30 ± 0.20	—
Gr. III(7)	7.83 ± 0.16	9.07 ± 0.12	1.24 ± 0.25

(b) Inter-group comparison (Table 7)

(i) *6-striped : Males* : The value in Gr. I is not significantly different from that in Gr. II, but is higher (at 1% level) than in Gr. III. The value in Gr. II is significantly higher than in Gr. III at the 5% level. *Females* : The value in Gr. I is significantly higher than in Gr. II (at 1% level) and Gr. III (at all levels). The value in Gr. II is significantly higher (at all levels) than in Gr. III.

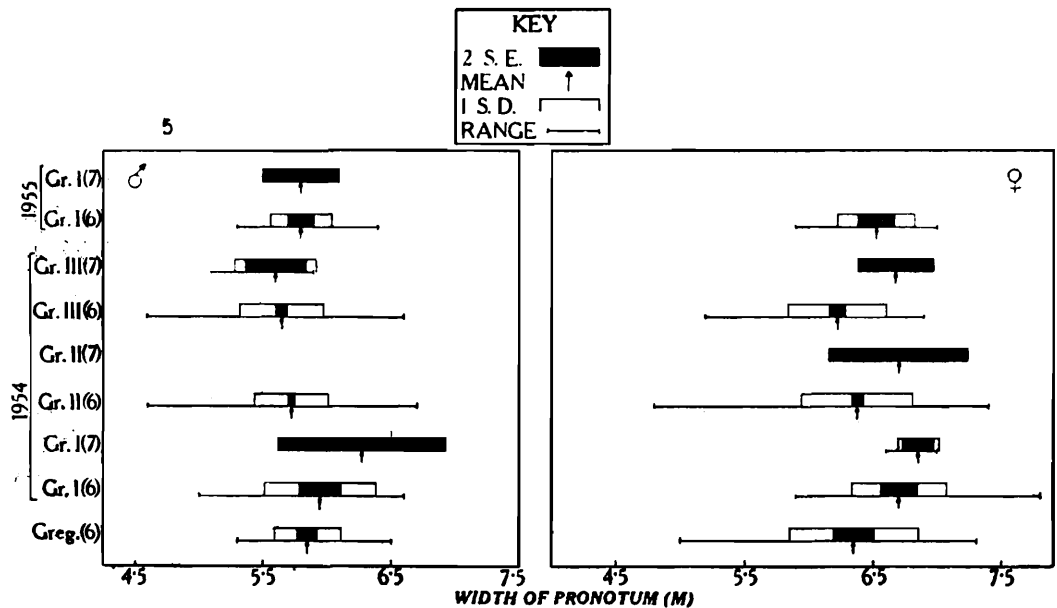
(ii) *7-striped : Males* : The value in Gr. I is not significantly different (at all levels) than in Gr. III ; no males occurred in Gr. II. *Females* : The value in Grs. I-III are not significantly different from one other.

(c) Inter-sex comparison (Table 6)

In both 6- and 7-eye-striped categories, the value in corresponding females is significantly higher than in males at all levels.

(d) Inter-eye-stripe comparison (Table 6)

(i) *Males* : Within the same group, the values in 6-striped forms in Grs. I and III are not significantly different from that in 7-striped ones at all levels ; no males occurred in Gr. II(7). (ii) *Females* : Within the same group, the value in 6-striped forms in Gr. II is not significantly different than that in Gr. II(7) ; but those in Grs. I(6) and III(6) are significantly lower than in Gr. I(7) at the 1% level and Gr. III(7) at the 5% level respectively.



TEXT-FIG. 5. *Schistocerca gregaria*. Dickeygram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding width of pronotum (M). For explanations see text and text-figures 1 and 2.

(e) Inter-population comparison (Table 12)

The three 1954-Groups compare with other populations (data given below) as follows:—

1955-population (and eye-stripes)	Mean (mm.) ± S.E.	
	Males	Females
Gr. I(6)	8.03 ± 0.079	8.70 ± 0.111
Gr. I(7)	8.13 ± 0.262	—

In both sexes in the 6-striped category, the values in 1954-Grs. I-III are not significantly different (at all levels) from that in 1955-Gr. I(6). In the 7-striped category, the male values in 1954-Grs. I and III are not significantly different (at all levels) from that in 1955-Gr. I; no males occurred in Gr. II. The females could not be compared due to lack of data.

(f) *Sexual Dimorphism Percentage (S.D.P.)*

The S.D.P. $\pm$ S.E. varies as follows :—

1954-population (and eye-stripes)	S.D.P.	Other populations (and eye-stripes)	S.D.P.
Gr. I(6)	9.44 $\pm$ 1.58	1955-Gr. I(6)	8.34 $\pm$ 1.74
Gr. I(7)	10.47	1955-Gr. II(6)	10.32 $\pm$ 0.43
Gr. II(6)	8.76 $\pm$ 0.41	1955-Gr. III(6)	10.98 $\pm$ 3.37
Gr. III(6)	7.47 $\pm$ 0.57		
Gr. III(7)	15.84		

In the 6-striped category, the values in 1954-Grs. I-III show no significant difference from those in 1955-Grs. I and III; but Grs. II and III have significantly lower values (at all levels) than the 1955-Gr. II, while Gr. I shows no significant difference, in this respect. No comparison could be made in 7-striped category due to lack of data.

6. *Width of pronotum at the constriction (M)*

(Tables 6, 7 and 12 and Text-fig. 5)

(a) *Mean width*

The mean width (mm.) $\pm$ S.E. varies as follows :—

Group (and eye-stripes)	Males	Females	Difference
Gr. I(6)	5.95 $\pm$ 0.08	6.71 $\pm$ 0.07	0.76 $\pm$ 0.11
Gr. II(6)	5.73 $\pm$ 0.01	6.38 $\pm$ 0.02	0.65 $\pm$ 0.02
Gr. III(6)	5.64 $\pm$ 0.02	6.23 $\pm$ 0.03	0.59 $\pm$ 0.04
Gr. I(7)	6.27 $\pm$ 0.33	6.85 $\pm$ 0.06	0.58 $\pm$ 0.34
Gr. II(7)	—	6.70 $\pm$ 0.27	—
Gr. III(7)	5.59 $\pm$ 0.12	6.67 $\pm$ 0.15	1.08 $\pm$ 0.21

(b) *Inter-group comparison (Table 7)*

(i) *6-striped : Males* : The value in Gr. I is significantly higher than in Gr. II (at 1% level) and Gr. III (at all levels). The value in Gr. II is significantly higher than in Gr. III at all levels. *Females* : The value in Gr. I is significantly higher than in Grs. II and III (at all levels) and that in Gr. II is higher than in Gr. III at all levels.

(ii) *7-striped : Males* : The value in Gr. I is significantly higher than in Gr. III at the 5% level; no males occurred in Gr. II. *Females* : The values in Grs. I-III are not significantly different from one other.

(c) *Inter-sex comparison (Table 6)*

In both 6- and 7-eye-striped categories, the values in corresponding females are significantly higher than in males at all levels, except for Gr. I(7), where no sexual difference is noticed.

(d) Inter-eye-stripe comparison (Table 6)

(i) *Males*: Within the same group, the values in Grs. I(6) and III(6) are not significantly different from those in Grs. I(7) and III(7) respectively at all levels ; no males occurred in Gr. II(7). (ii) *Females*: Within the same group, the values in Grs. I(6) and II(6) are not significantly different from those in Grs. I(7) and II(7) respectively, but the value in Gr. III(7) is higher than in Gr. III(6) at the 5% level.

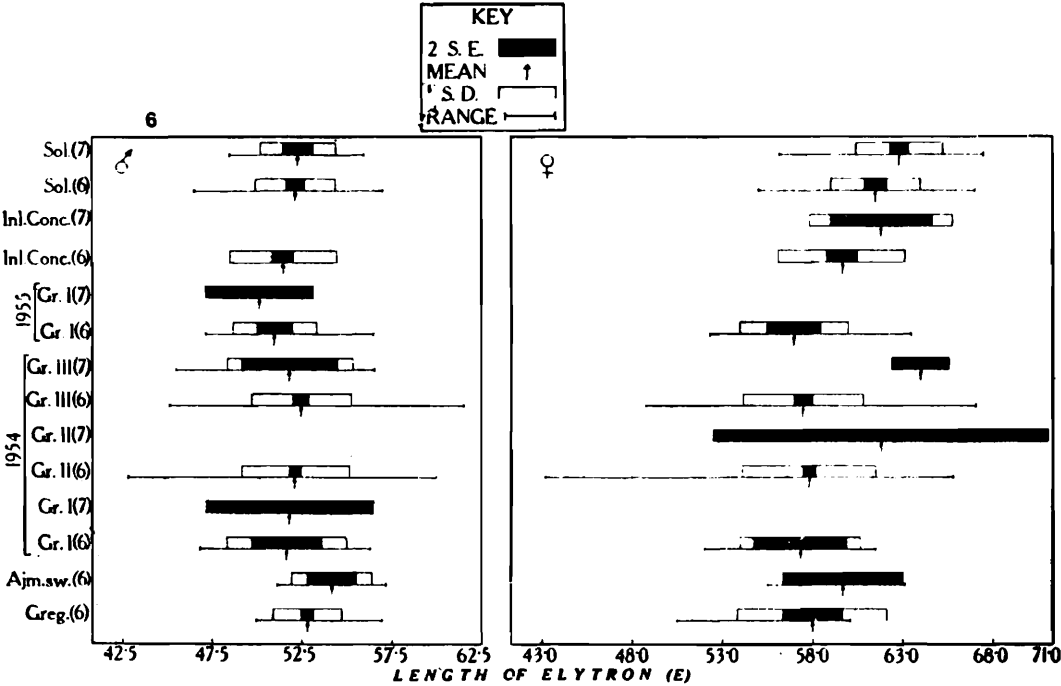
(e) Inter-population comparison (Table 12)

The three 1954-groups compare with other populations (data given below) as follows:—

1955-population (and eye-stripes)	Mean (mm.) ± S.E.	
	Males	Females
Gr. I(6)	5.80 ± 0.049	6.52 ± 0.071
Gr. I(7)	5.80 ± 0.15	—

(i) *6-striped males and females* : The values in 1954-Grs. I and II are not significantly different from that in 1955-Gr. I, but 1954-Gr. III has significantly lower values (at the 1% level in males and at all levels in females).

(ii) *7-striped : Males* : The values in 1954-Gr. I and Gr. III are not significantly different from that in 1955-Gr. I at all levels. No males occurred in Gr. II. *Females* : No comparison could be made due to lack of data.



TEXT-FIG. 6. *Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.E.) in various populations regarding length of elytron (E). sol. (6) & (7), 6- and 7-striped typical phase *solitaria* ; Inl. Conc. (7) 7-striped individuals of the initial Kakko Concentration of 1949 (Misra, 1952). Also see text and text-figures 1 and 2.

(f) *Sexual Dimorphism Percentage (S.D.P.)*

The S.D.P. $\pm$ S.E. varies as follows :—

<i>1954-population (and eye-stripes)</i>	<i>S.D.P.</i>	<i>Other populations (and eye-stripes)</i>	<i>S.D.P.</i>
Gr. I(6)	12.77 ± 1.86	1955-Gr. I(6)	12.41 ± 1.56
Gr. I(7)	9.25	1955-Gr. II(6)	12.18 ± 0.40
Gr. II(6)	11.34 ± 0.74	1955-Gr. III(6)	14.21 ± 2.58
Gr. III(6)	10.46 ± 0.62		
Gr. III(7)	19.32		

In the 6-striped category, the values in 1954-Grs. I-III are not significantly different from those in 1955-Grs. I-III at all levels ; no comparison could be made in the 7-striped category due to lack of data.

7. *Length of elytron (E)*

(Tables 6, 7, 10-12, 14 and 15 ; and Text-fig. 6)

(a) *Mean length*

The mean length (mm.) $\pm$ S.E. varies as follows :—

<i>Group (and eye-stripes)</i>	<i>Males</i>	<i>Females</i>	<i>Difference</i>
Gr. I(6)	51.71 ± 0.97	57.24 ± 1.27	6.53 ± 1.60
Gr. II(6)	52.25 ± 0.13	57.90 ± 0.18	5.65 ± 2.22
Gr. III(6)	52.41 ± 0.21	57.51 ± 0.25	5.10 ± 0.33
Gr. I(7)	51.83 ± 2.32	—	—
Gr. II(7)	—	61.90 ± 4.65	—
Gr. III(7)	51.77 ± 1.32	64.10 ± 0.80	12.33 ± 2.62

(b) *Inter-group comparison (Table 7)*

(i) *6-striped* : Within each sex category, in both sexes, the values in Grs. I-III are not significantly different from one other.

(ii) *7-striped* : *Males* : The value in Gr. I is not significantly different (at all levels) from that in Gr. III ; no males occurred in Gr. II. *Females* : The values in Gr. II and III are not significantly different from each other ; only one female occurred in Gr. I.

(c) *Inter-sex comparison (Table 6)*

In both 6- and 7-eye-striped categories, the value in corresponding females is significantly higher than in males at all levels.

(d) *Inter-eye-stripe comparison (Table 6)*

Males : Within the same group, the values in Grs. I(6) and III(6) are not significantly different from those in Grs. I(7) and III(7) ; no males occurred in Gr. II(7).

Females : Within the same group, the value in Gr. II(6) is not significantly different from Gr. II(7) ; but that in Gr. III(6) is significantly lower than in Gr. III(7) at the 1% level.

(e) Inter-population comparison

(Tables 10-12, 14 and 15).

The three 1954-Groups compare with other populations (data given below) as follows :—

Other-populations (and eye-stripes)	Mean (mm.) $\pm$ S.E.	
	Males	Females
6-greg.	52.85 $\pm$ 0.52	58.01 $\pm$ 0.81
Ajmer Sw. (6)	54.16 $\pm$ 0.70	59.70 $\pm$ 1.68
Kakko Conc. (6)	51.46 $\pm$ 0.29	59.73 $\pm$ 0.42
Kakko Conc. (7)	—	61.83 $\pm$ 1.41
6-sol.	52.15 $\pm$ 0.24	61.56 $\pm$ 0.31
7-sol.	52.38 $\pm$ 0.42	62.90 $\pm$ 0.26
1955-Gr. I(6)	51.01 $\pm$ 0.49	57.09 $\pm$ 0.72
1955-Gr. I(7)	50.23 $\pm$ 1.51	—

(i) *6-striped males* : The values in 1954-Grs. I-III are not significantly different (at all levels) from those in 6-greg. and 6-sol. The values in 1954-Grs. II and III are significantly lower than in *Ajmer Sw.* (at 1% and 5% levels respectively), but are higher than the *Kakko Conc.* (at 5% level) and 1955-Gr. I (at 1% level). The 1954-Gr. I shows no significant difference in this respect.

(ii) *6-striped females* : The values in 1954-Grs. I-III are not significantly different (at all levels) from those in 6-greg., the *Ajmer Sw.* and 1955-Gr. I, but are lower than in 6-sol. (at all levels). But the values in 1954-Grs. II and III are significantly lower than in the *Kakko Conc.* (at all levels); Gr. I shows no significant difference.

(iii) *7-striped males* : The values in 1954-Grs. I and III are not significantly different from those in 7-sol. and 1955-Gr. I; no males occurred in 1954-Gr. II, *Ajmer Sw.* and *Kakko Conc.*

(iv) *7-striped females* : The values in 1954-Grs. II and III are not significantly different from those in 7-sol. and the *Kakko Conc.*, only one male occurred in 1954-Gr. I and no females in 1955-Gr. I.

(f) Sexual Dimorphism Percentage (S.D.P.)

The S.D.P. $\pm$ S.E. varies as follows :—

1954-population (and eye-stripes)	S.D.P.	Other populations (and eye-stripes)	S.D.P.
Gr. I(6)	10.69 $\pm$ 3.22	1955-Gr. I(6)	11.92 $\pm$ 1.78
Gr. II(6)	10.81 $\pm$ 0.45	6-greg.	9.76 $\pm$ 1.88
Gr. III(6)	9.73 $\pm$ 0.65	6-sol.	18.04 $\pm$ 0.80
Gr. III(7)	23.82		

In the 6-striped category, the values in 1954-Gr. I-III are not significantly different from those in 1955-Gr. I and 6-greg. at all levels, but are lower than in 6-sol. at all levels.

8. Restricted width of elytron (W_1)

(Tables 6, 7 and 12 and Fig. 7)

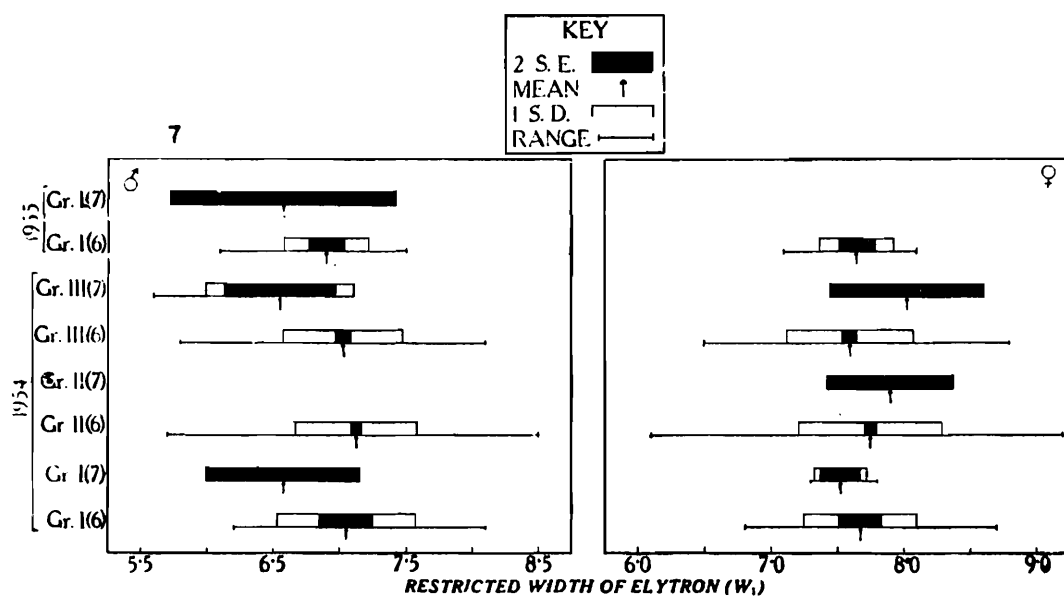
(a) Mean width

 The mean width (mm.) $\pm$ S.E. varies as follows :—

Group (and eye-stripes)	Males	Females	Difference
Gr. I(6)	7.05 ± 0.10	7.67 ± 0.08	0.62 ± 0.13
Gr. II(6)	7.13 ± 0.02	7.76 ± 0.02	0.63 ± 0.03
Gr. III(6)	7.02 ± 0.03	7.60 ± 0.03	0.58 ± 0.04
Gr. I(7)	6.57 ± 0.29	7.52 ± 0.07	0.95 ± 0.30
Gr. II(7)	—	7.90 ± 0.24	—
Gr. III(7)	6.54 ± 0.21	8.03 ± 0.29	1.49 ± 0.38

(b) Inter-group comparison (Table 7)

(i) *6-striped : Males* : The values in Grs. I-III do not differ significantly from one another at all levels. *Females* : The value in Gr. I is not significantly different from Grs. II and III ; but the value in Gr. II is higher than in Gr. III at all levels.



TEXT-FIG. 7. *Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding restricted width of elytron (W_1). For explanations see text and text-figure 1.

(ii) *7-striped : Males* : The value in Gr. I is not significantly different from Gr. III ; no males occurred in Gr. II. *Females* : The values in Grs. I-III are not significantly different from one another.

(c) Inter-sex comparison (Table 6)

In both 6- and 7-striped categories, the value in corresponding females is significantly higher than in males at all levels.

(d) Inter-eye-stripe comparison (Table 6)

Males: Within the same group, the value in Gr. I(6) is not significantly different from that in Gr. I(7) ; but that in Gr. III(6) is higher than in Gr. III(7) at the 1% level. No males occurred in Gr. II. **Females:** Within the same group, the values in Grs. I(6), II(6) and III(6) are not significantly different from those in Grs. I(7), II(7) and III(7) respectively.

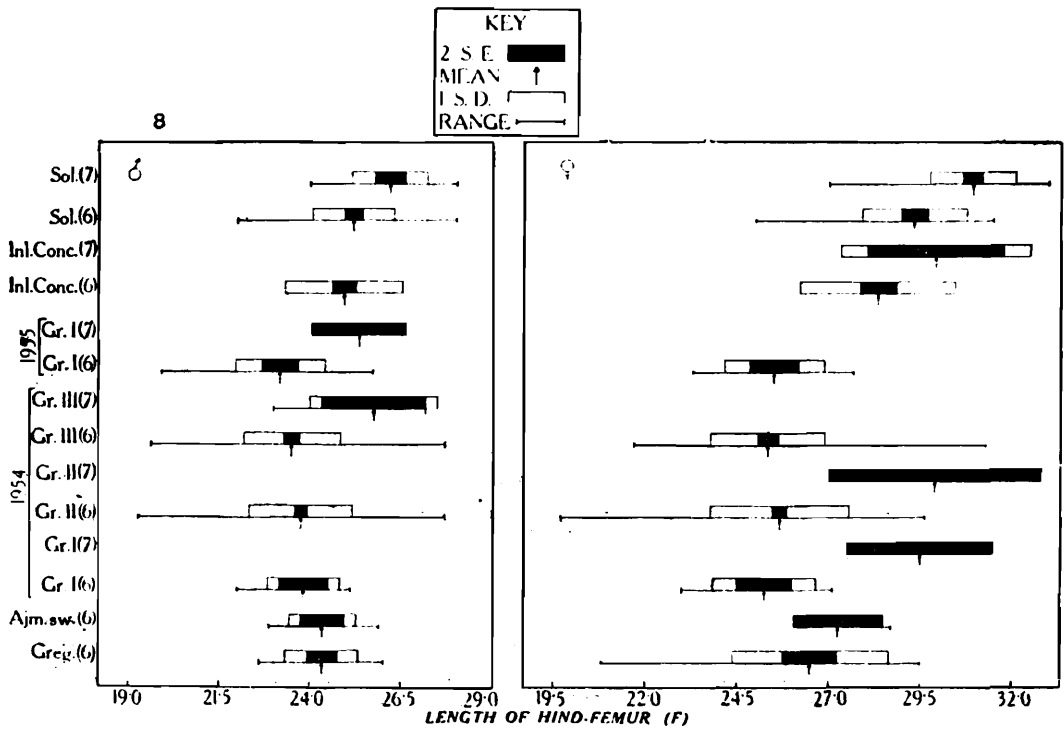
(e) Inter-population comparison (Table 12)

The three 1954-Groups compare with other populations (data given below) as follows :—

Other-populations (and eye-stripes)	Mean (mm.) ± S.E.	
	Males	Females
1955-Gr. I(6)	6.89 ± 0.067	7.66 ± 0.066
1955-Gr. I(7)	6.57 ± 0.43	—

(i) **6-striped: Males:** The values in 1954-Gr. I and III are not significantly different from that in 1955-Gr. I at all levels, but that in Gr. II is higher at all levels. **Females:** The values in 1954-Gr. I-III are not significantly different from that in 1955-Gr. I at all levels.

(ii) **7-striped: Males:** The values in 1954-Gr. I and II are not significantly different from that in 1955-Gr. I at all levels ; no males occurred in Gr. II. **Females:** No comparison could be made due to lack of data.



TEXT-FIG. 8. *Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding length of hind-femur (F). For explanations see text and text-figures 1, 2 and 6.

(f) Sexual Dimorphism Percentage (S.D.P.)

The S.D.P. $\pm$ S.E. varies as follows :—

1954-population (and eye-stripes)	S.D.P.	Other populations (and eye-stripes)	S.D.P.
Gr. I(6)	8.79 ± 1.85	1955-Gr. I(6)	11.18 ± 1.44
Gr. I(7)	14.46	1955-Gr. II(6)	10.14 ± 0.47
Gr. II(6)	8.84 ± 0.42	1955-Gr. III(6)	10.51 ± 2.60
Gr. III(6)	8.26 ± 0.67		
Gr. III(7)	22.78		

In the 6-striped category, the values in 1954-Grs. I-III are not significantly different (at all levels) from those in 1955-Grs. I-III ; no comparison could be made in 7-striped category due to lack of data.

9. Length of hind-femur (F)

(Tables 6, 7, 10-12, 14 and 15 and Fig. 8)

(a) Mean length

The mean length (mm.) $\pm$ S.E. varies as follows :—

Group (and eye-stripes)	Males	Females	Difference
Gr. I(6)	23.88 ± 0.33	25.25 ± 0.39	1.37 ± 0.54
Gr. II(6)	23.76 ± 0.07	25.71 ± 0.10	1.95 ± 0.12
Gr. III(6)	23.54 ± 0.11	25.36 ± 0.14	1.82 ± 0.18
Gr. I(7)	—	29.50 ± 1.00	—
Gr. II(7)	—	29.90 ± 1.45	—
Gr. III(7)	25.73 ± 0.71	—	—

(b) Inter-group comparison (Table 7)

(i) 6-striped : *Males* : The values in Grs. I, II and III are not significantly different from one another at all levels. *Females* : The value in Gr. I is not significantly different (at all levels) from those in Grs. II and III ; but the value in Gr. II is significantly higher than in Gr. III at the 5% level.

(ii) 7-striped : *Males* : The value in Gr. III could not be compared with Grs. I and II, as only one male occurred in the Gr. I ; and none in Gr. II. *Females* : The value in Gr. I is not significantly different from that in Gr. II at all levels ; no females occurred in Gr. III.

(c) Inter-sex comparison (Table 6)

In both the 6- and 7-eye-striped categories, the value in the females is significantly higher than in corresponding males at all levels.

(d) Inter-eye-stripe comparison (Table 6)

Males : Within the same group, the value in Gr. III(6) is significantly lower than in Gr. III(7) at all levels. Only one male occurred in Gr. I(7) and none in Gr. II(7). *Females* : Within the same group, the values in Grs. I(6) and II(6) are significantly higher than in Gr. I(7) (at 5% level) and Gr. II(7) (at all levels) ; no females occurred in Gr. III(7).

(e) *Inter-population comparison*

(Tables 10-12, 14 and 15)

The three 1954-Groups compare with other populations (data given below) as follows :—

<i>Other-populations (and eye-stripes)</i>	<i>Mean (mm.) ± S.E.</i>	
	<i>Males</i>	<i>Females</i>
<i>6-greg.</i>	24.32 ± 0.20	26.44 ± 0.37
<i>Ajmer Sw. (6)</i>	24.37 ± 0.29	27.28 ± 0.61
<i>Kakko Conc. (6)</i>	24.92 ± 0.16	28.35 ± 0.25
<i>Kakko Conc. (7)</i>	—	29.94 ± 0.92
<i>6-sol.</i>	25.40 ± 0.12	29.37 ± 0.18
<i>7-sol.</i>	26.13 ± 0.21	30.92 ± 0.13
1955-Gr. I(6)	23.11 ± 0.26	25.52 ± 0.34
1955-Gr. I(7)	25.30 ± 0.64	—

(i) *6-striped males*: The values in 1954-Grs. II and III are significantly lower than in *6-greg.* (at all levels), the *Ajmer Sw.* (at 1% level) and the *Kakko Conc.* (at all levels); but Gr. I does not show significant difference in this respect. The values in 1954-Grs. I-III are significantly lower (at all levels) than in *6-sol.* Except for 1954-Gr. II, which shows significantly higher values from the 1955-Gr. I, Grs. I and III show no significant difference in the two years.

(ii) *6-striped females*: The values in 1954-Grs. I-III are significantly lower than in *6-sol.* (at all levels) and in *6-greg.* at 1% level (except for Gr. II which show no difference). The values in Grs. II and III are significantly lower than in *Ajmer Sw.* (at 1% level) and *Kakko Conc.* (at all levels); but Gr. I shows no significant difference. Except for 1954-Gr. II which shows significantly higher values from the 1955-Gr. I, Grs. I and III of these two years show no difference.

(iii) *7-striped: Males*: The value in 1954-Gr. III is not significantly different from that in *7-sol.* and 1955-Gr. I (at all levels); no males occurred in *Ajmer Sw.*, the *Kakko Conc.* and 1954-Gr. II, and only one in 1954-Gr. I. *Females*: The values in Grs. I and II are not significantly different from those in *7-sol.* and the *Kakko Conc.* at all levels. No females occurred in 1954-Gr. III and 1955-Gr. I.

(f) *Sexual Dimorphism Percentage (S.D.P.)*

The S.D.P. ± S.E. varies as follows :—

<i>1954-population (and eye-stripes)</i>	<i>S.D.P.</i>	<i>Other populations (and eye-stripes)</i>	<i>S.D.P.</i>
Gr. I(6)	5.74 ± 2.43	1955-Gr. I(6)	10.43 ± 1.94
Gr. II(6)	8.21 ± 0.54	<i>6-greg.</i>	8.72 ± 1.76
Gr. III(6)	7.73 ± 0.80	<i>6-sol.</i>	15.63 ± 0.89

In the 6-striped category, the values in 1954-Grs. I-III are significantly lower than in *6-sol.* (at all levels); but do not differ from *6-greg.* The values in 1954-Grs. I and III are not significantly different from that in 1955-Gr. I(6), but Gr. II is significantly lower at 1%

level. No comparison could be made in the 7-striped category due to lack of data.

10. *General conclusions regarding size of body-parts*

(a) *Inter-group variation in the 1954-population*

(i) No appreciable difference is found in males for characters O, C, P, E and F. Group divergence is best seen in characters H, M and W_1 for males.

In 6-striped males, values of H differentiate Grs. I and II from Gr. III; the former two not differing from each other. Character W_1 shows difference between Grs. II and III only, the value in the former being significantly higher. Considerable group differences are seen in M (width of pronotum), the values in Grs. I and II are significantly higher than in Gr. III at all levels; the former also differ from each other (at all levels). In both sexes, E shows no group difference.

In 6-striped females, group-difference is more pronounced, the most sensitive characters in this respect being C, H, M, W_1 , and to some extent, O, F and P. For C, M and H, the value in Gr. I is significantly higher than in Gr. II, and both are higher than in Gr. III. For O, P, W_1 and F, the value in Gr. II is significantly higher than in Gr. III.

(ii) From inter-sex comparison, it is seen that sexual difference is seen in all the groups for all the characters, females having higher values than males.

(iii) Within the same group and sex, the value of O in 6- and 7-eye-striped forms, in both sexes, do not differ. In males, 7-striped forms are smaller than 6-striped ones for characters C and W_1 and larger for F (in Gr. III only). In females, significant differences are seen in C, P, H, M, E and F.

(b) *Inter-relation between the 1954-population and the 1955-(Gr. I) population*

The three groups of the 1954-population were compared with the 1955-Gr. I population (the immediately succeeding population), which was *gregaria* in nature (Roonwal and Bhanotar, 1966) in respect of eight characters *viz.*, O, C, P, H, M, E, W_1 and F, with the following results:—

(i) *1954-Gr. I versus 1955-Gr. I.*—There is no difference in most of the characters, but in the 6-striped category, in both sexes, the length of the pronotum (P) has a significantly higher value in the 1954-population.

(ii) *1954-Gr. II versus 1955-Gr. I.*—In 6-striped males the values of W_1 (at all levels) of O and P (at 1% level) and E and F (at 5% level) are higher in the 1954-Gr. II. In 6-striped females, only P is significantly different, the values being higher in the 1954-Gr. II.

(iii) *1954-Gr. III versus 1955-Gr. I.*—In 6-striped males, the values of P and E (at 1% level) and O (at 5% level) are significantly higher in the 1954-Gr. III. In females, only M differs, the value being lower in the 1954-Gr. III.

(c) *The 1954-Groups versus the Ajmer Swarm (1950) and the Kakko Concentration (1949)*

For further comparison of the 1954-population, comparison with two earlier populations, namely, the *Ajmer Swarm* of 1950 and the *Kakko Concentration* of 1949 (the former *gregaria* and the latter near *solitaria*) were made for four characters (C, P, E and F) with the following results:—

(i) *C*: In 6-striped males, the 1954-Gr. I does not differ from the *Ajmer Sw.*, but the value in Gr. II is significantly lower and in Gr. III still lower. The values in Grs. I and II are significantly higher and in Gr. III still higher than in the *Kakko Conc.* In 6-striped females, the values in Grs. I and II do not differ from the *Ajmer Sw.*, but are significantly higher than in the *Kakko Conc.*, and in Gr. III higher still when compared to the *Kakko Conc.*

(ii) *P*: In 6-striped males, the values in Grs. I-III are significantly higher than in the *Kakko Conc.*, but are not different from the *Ajmer Sw.* In 6-striped females, Grs. I and II show no difference from the *Kakko Conc.*, but the males in Gr. III is significantly lower.

(iii) *E*: In 6-striped males, Gr. I shows no significant difference from the *Ajmer Sw.* and the *Kakko Conc.*, but values in Grs. II and III are significantly lower than in *Ajmer Sw.* and all these are higher than the *Kakko Concentration*. In 6-striped females, the value in Grs. II and III are significantly lower than in the *Kakko Conc.*

(iv) *F*: In 6-striped males, the values in Gr. I do not show significant difference from the *Ajmer Sw.* and the *Kakko Conc.*, but those in Grs. II and III are significantly lower. In 6-striped females, the values in Grs. I-III are significantly lower than in the *Ajmer Sw.* and the *Kakko Conc.*

(d) *Phase status of the 1954-Groups*

For assessing the phase status of the 1954-Groups, four sensitive body-parts viz., C, P, E and F, were utilized. But for "*solitaria*" phase, data for only two characters, E and F, are available so that a detailed comparison could not be made. The results of the test of differences in values are given for each group separately, as follows:—

(i) *C*: The values in 6-striped males, for Grs. I-III are significantly smaller than in typical *gregaria*. In 6-striped females, the value in Gr. III is significantly lower than in *gregaria*, but Grs. I and II show no difference from *gregaria*.

(ii) *P*: In 6-striped males, the value in Gr. II is significantly higher than in typical *gregaria*, but Grs. I and III do not differ. In 6-striped females, the value in Grs. I and II is significantly higher than in typical *gregaria*, but Gr. III shows no difference.

In the 7-striped category, the value for males in Grs. I and III is not significantly different from that in typical *gregaria*. No males occurred in Gr. II. In females, however, the values in Grs. I, II and III are significantly higher than in typical *gregaria*.

(iii) *E*: In 6-striped males, the value in Grs. I, II and III is not significantly different from those in 6-*solitaria* and typical *gregaria*.

In 6-striped females, the values in Grs. I, II, III are not significantly different than in typical *gregaria*, but are significantly lower than that in *6-solitaria*.

In the 7-striped category, the value for males in Grs. I and III and for males in Grs. II and III, is not significantly different than in *7-solitaria*. No males occurred in Gr. II.

(iv) *F* : In 6-striped males, the value in Gr. I does not differ from 6-striped *gregaria*, but is significantly lower than in 6- and 7-striped *solitaria*. The value in Gr. II is significantly lower than in 6-*gregaria* and 6-and 7-*solitaria*. In 6-striped females, the value in Gr. I is significantly lower than in *gregaria* and 6-and 7-*solitaria* ; Gr. II shows no difference from *gregaria*, but the values are lower than in 6- and 7-*solitaria*. It is interesting to note that for both sexes and in 6-striped forms, the value in Gr. III is significantly higher (at all levels) from both phases *gregaria* and *solitaria*.

(e) General conclusion

From the above, discussion, it will be seen that the phase-status of the three groups of the 1954-population is as follows :—

Group I : Its morphometry indicates closer affinity to the typical phase *gregaria* and the *Ajmer Swarm* (1950) populations. The degree of gregarization appears to be complete. The group differs from Grs. II and III in the case of females.

Group II and III : Morphometry indicates a close affinity between these two groups. The population of both is of a weak *gregaria* type. Gregarization appears to be lesser in degree than in Gr. I, and the groups lie somewhere between the *Ajmer Swarm* (1950) and the *Kakko Concentration* (1949).

VI — MORPHOMETRIC RATIOS

1. General

The following seven ratios relating to the morphometric characters were studied :—

1. Length of pronotum (P)
Width of head at genal level (C)
2. Width of pronotum (M)
Width of head at genal level (C)
3. Height of pronotum (H)
Width of head at genal level (C)
4. Length of elytron (E)
Restricted width of elytron (W_1)
5. Length of elytron (E)
Length of hind-femur (F)
6. Length of elytron (E)
Width of head at genal level (C)
7. Length of hind-femur (F)
Width of head at genal level (C)

Note : The values of ratios were obtained for each specimen separately and then the means $\pm$ S.E., etc., calculated.

2. Ratio P/C

(Tables 8-11, 13-15 and Text-fig. 9)

(a) Mean values

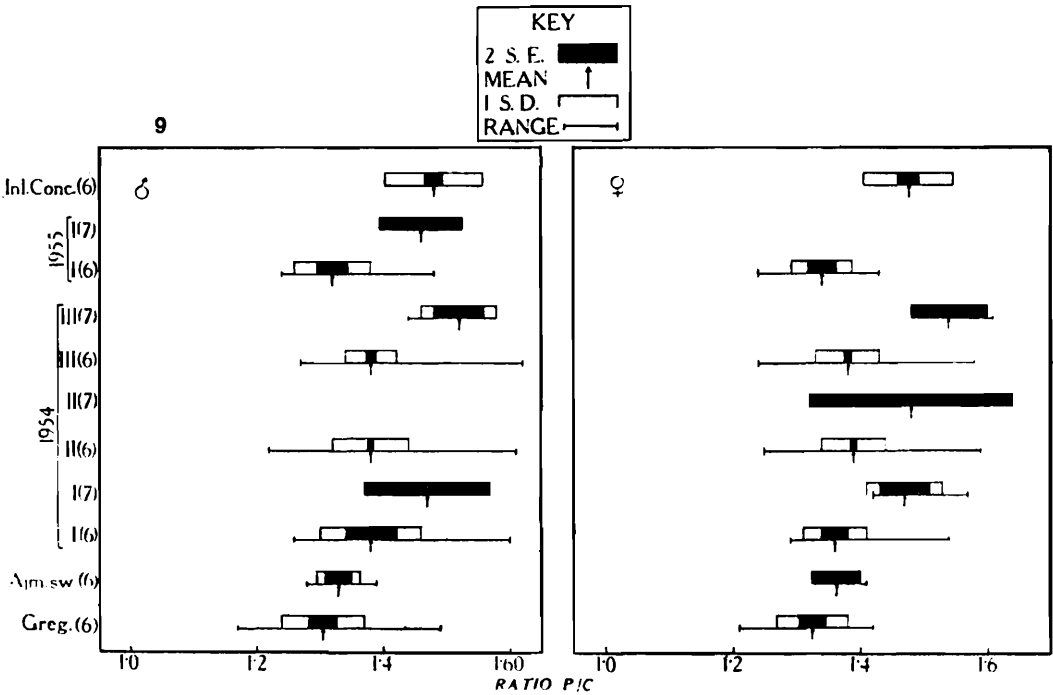
The mean values of P/C are as follows :—

Group (and eye-stripes)	Males	Females	Difference
Gr. I(6)	1.38 ± 0.02	1.36 ± 0.01	0.02 ± 0.02
Gr. II(6)	1.38 ± 0.002	1.39 ± 0.002	0.01 ± 0.003
Gr. III(6)	1.38 ± 0.004	1.38 ± 0.003	0.0 ± 0.0
Gr. I(7)	1.47 ± 0.05	1.47 ± 0.02	0.0 ± 0.0
Gr. II(7)	—	1.48 ± 0.08	—
Gr. III(7)	1.52 ± 0.02	1.54 ± 0.03	0.02 ± 0.04

(b) Inter-group comparison (Table 9)

6-striped : Males : The values in Grs. I-III are not significantly different from each other. **Females :** The value in Gr. I is significantly lower than in Gr. II and Gr. III at the 1% and 5% level respectively. The value in Gr. II is significantly higher than in Gr. III at the 5% level.

7-striped : Males : The value in Gr. I is not significantly different from that in Gr. III at all levels ; no males occurred in Gr. II. **Females :** The values in Grs. I-III are not significantly different from each other at all levels.



TEXT-FIG. 9. *Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding the ratio P/C (Length of pronotum/width of head at genal level).
For explanations see text and text-figures 1 and 2.

(c) *Inter-sex comparison* (Table 8)

In both 6- and 7-eye-striped categories, the value in corresponding males is not significantly different from that in females except for in Gr. II(6), where they are smaller at all levels.

(d) *Inter-eye-stripe comparison* (Table 8)

Males: Within the same group, the value in Gr. I(6), is not significantly different from that in Gr. I(7) at all levels, but that in Gr. III(6) is significantly lower than in Gr. III(7). No males occurred in Gr. II. *Females*: Within the same group, in 6-striped category, the value in Grs. I-III are significantly lower than in 7-striped ones at all levels.

(e) *Inter-population comparison* (Tables 10, 11, 13-15)

The three 1954-Groups compare with other populations (data given below) as follows:—

Other populations (and eye-stripes)	Mean $\pm$ S.E.	
	Males	Females
6-greg.	1.305 $\pm$ 0.011	1.324 $\pm$ 0.009
Ajmer Sw. (6)	1.330 $\pm$ 0.011	1.363 $\pm$ 0.018
Kakko Conc. (6)	1.483 $\pm$ 0.007	1.477 $\pm$ 0.008
1955-Gr. I(6)	1.32 $\pm$ 0.012	1.34 $\pm$ 0.011
1955-Gr. I(7)	1.46 $\pm$ 0.033	—

(i) *6-striped males*: The values in 1954-Grs. I-III are significantly higher than in typical 6-greg. (at 5% level) and the *Ajmer Sw.* (at all levels), but are significantly lower (at all levels) than in the *Kakko Conc.* The values in 1954-Grs. I and III are significantly higher than in 1955-Gr. I (at all levels), but Gr. II shows no significant difference.

(ii) *6-striped females*: The values in 1954-Grs. I-III are significantly higher than in typical 6-greg. (at 1% and at all levels); but are significantly lower (at all levels) than in the *Kakko Conc.*, but are not significantly different from the *Ajmer Sw.* The values in Grs. II and III are significantly higher (at all levels) than the 1955-Gr. I, but Gr. I show no significant difference.

(iii) *7-striped: Males*: The value in 1954-Grs. I and III are not significantly different from that in 1955-Gr. I at all levels. No males occurred in Gr. II. *Females*: No comparison could be made due to lack of data; and no females occurred in 1955-Gr. I.

(f) *Sexual Dimorphism Percentage (S.D.P.)*

1954-population (and eye-stripes)	S.D.P.	Other populations (and eye-stripes)	S.D.P.
Gr. I(6)	-1.45 $\pm$ 1.27	1955-Gr. I(6)	1.52 $\pm$ 1.27
Gr. I(7)	0.0	Kakko Conc. (6)	-0.40 $\pm$ 0.72
Gr. II(6)	0.72 $\pm$ 0.23	6-greg.	1.46 $\pm$ 1.10
Gr. III(6)	0.0 $\pm$ 0.37		
Gr. III(7)	1.32		

In the 6-striped category, the values in 1954-Gr. I-III are not significantly different from those in 1955-Gr. I, typical *6-greg.* and the *Kakko Conc.* at all levels; no comparison could be made in 7-striped category due to lack of data.

3. Ratio M/C

(Tables 8, 9 and 13 and Text-fig. 10)

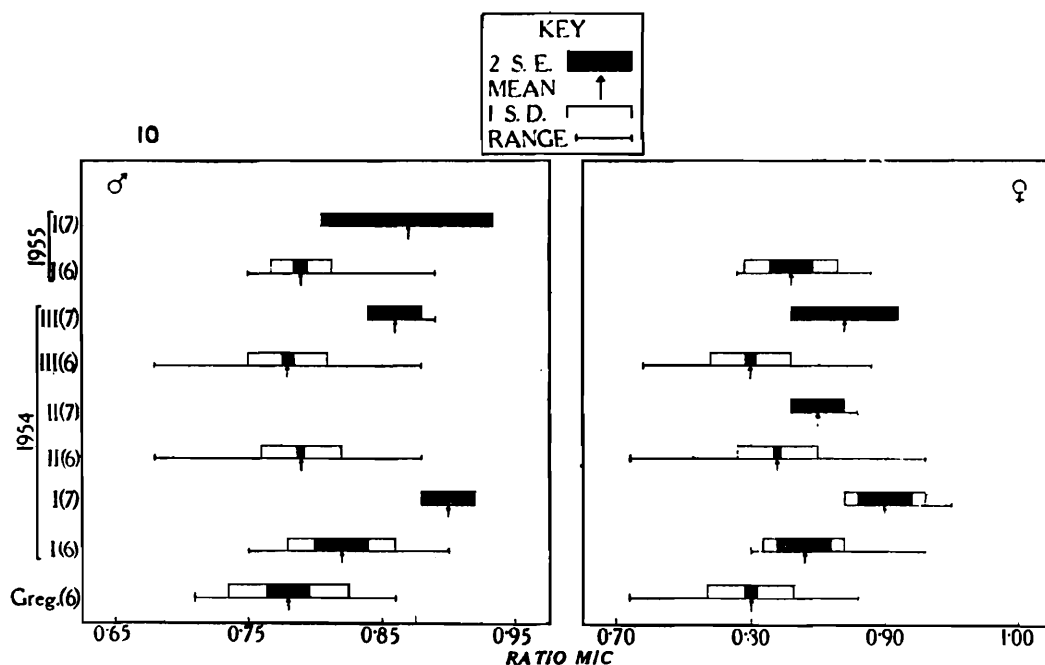
(a) Mean values

The values of M/C are as follows:—

Group (and eye-stripes)	Males	Females	Difference
Gr. I(6)	0.82 ± 0.01	0.84 ± 0.01	0.02 ± 0.014
Gr. II(6)	0.79 ± 0.001	0.82 ± 0.001	0.06 ± 0.01
Gr. III(6)	0.78 ± 0.002	0.80 ± 0.002	0.02 ± 0.003
Gr. I(7)	0.90 ± 0.01	0.90 ± 0.01	0.0 ± 0.0
Gr. II(7)	—	0.85 ± 0.01	—
Gr. III(7)	0.86 ± 0.01	0.87 ± 0.02	0.01 ± 0.02

(b) Inter-group comparison (Table 9)

(i) *6-striped: Males:* The value in Gr. I is significantly higher than in Gr. II (at 1% level) and Gr. III. (at all levels). The value in Gr. II is significantly higher than in Gr. III at 5% level. *Females:* The value in Gr. I is significantly higher than in Gr. II (at 1% level) and Gr. III (at 5% level) and that in Gr. II is significantly higher (at 5% level) than in Gr. III.



TEXT-FIG. 10. *Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits ($\pm$ S.E.) and standard deviation (S.D.) in various populations regarding the ratio M/C (Width of pronotum /width of head at genal level).
For explanations see text and text-figures 1 and 2.

(ii) *7-striped : Males* : The value in Gr. I is significantly higher (at 1% level) than in Gr. III ; no males occurred in Gr. II. *Females* : The values in Grs. I-III are not significantly different from each other at all levels.

(c) *Inter-sex comparison* (Table 8)

Within each group, the value in males is not significantly different from that in females, except in Grs. II(6) and III(6) where females are significantly larger (at all levels).

(d) *Inter-eye-stripe comparison* (Table 8)

Males : Within the same group, the values in Grs. I(6) and III(6) are significantly lower (at all levels) than in Grs. I(7) and III(7) respectively ; no males occurred in Gr. II. *Females* : Within the same group, in 6-striped category, the values in Grs. I-III are significantly lower (at all levels) than in 7-striped ones.

(e) *Inter-population comparison* (Table 13)

The three 1954-Groups compare with other populations (data given below) as follows :—

<i>Other populations (and eye-stripes)</i>	<i>Mean $\pm$ S.E.</i>	
	<i>Males</i>	<i>Females</i>
1955-Gr. I(6)	0.79 ± 0.005	0.83 ± 0.008
1955-Gr. I(7)	0.87 ± 0.032	—

(i) *6-striped : Males* : The value in 1955-Gr. I is significantly lower (at 1% level) from that in 1954-Gr. I and significantly higher (at 5% level) than in Gr. III, but is not significantly different from that in Gr. II. *Females* : The value in 1955-Gr. I is not significantly different from that in 1954-Grs. I and II (at all levels), but is significantly higher than in Gr. III (at all levels).

(ii) *7-striped : Males* : The value in 1955-Gr. I is not significantly different from that in 1954-Grs. I and III at all levels ; no male occurred in Gr. II. *Females* : No comparison could be made due to lack of data ; no females occurred in 1955-Gr. I.

(f) *Sexual Dimorphism Percentage (S.D.P.)*

The S.D.P. $\pm$ S.E. varies as follows :—

<i>1954-population (and eye-stripes)</i>	<i>S.D.P.</i>	<i>Other populations (and eye-stripes)</i>	<i>S.D.P.</i>
Gr. I(6)	2.44 ± 1.04	1955-Gr. I(6)	5.06 ± 1.22
Gr. I(7)	0.0	1955-Gr. II(6)	2.68 ± 0.23
Gr. II(6)	3.80 ± 0.22	1955-Gr. III(6)	0.90 ± 1.36
Gr. III(6)	2.56 ± 0.36		
Gr. III(7)	1.16		

In the 6-striped category, the values in 1954-Grs. I and II are not significantly different from that in 1955-Gr. I, but is significantly higher than in 1954-Gr. III. The value in 1954-Grs. I and III show no significant difference from that in 1955-Grs. II and III, but that in 1954-Gr. II is significantly higher than in 1955-Grs. II and III.

No comparison was possible in 7-striped category due to lack of data.

4. Ratio H/C

(Tables 8, 9 and 13 ; and Text-fig. 11)

(a) Mean values

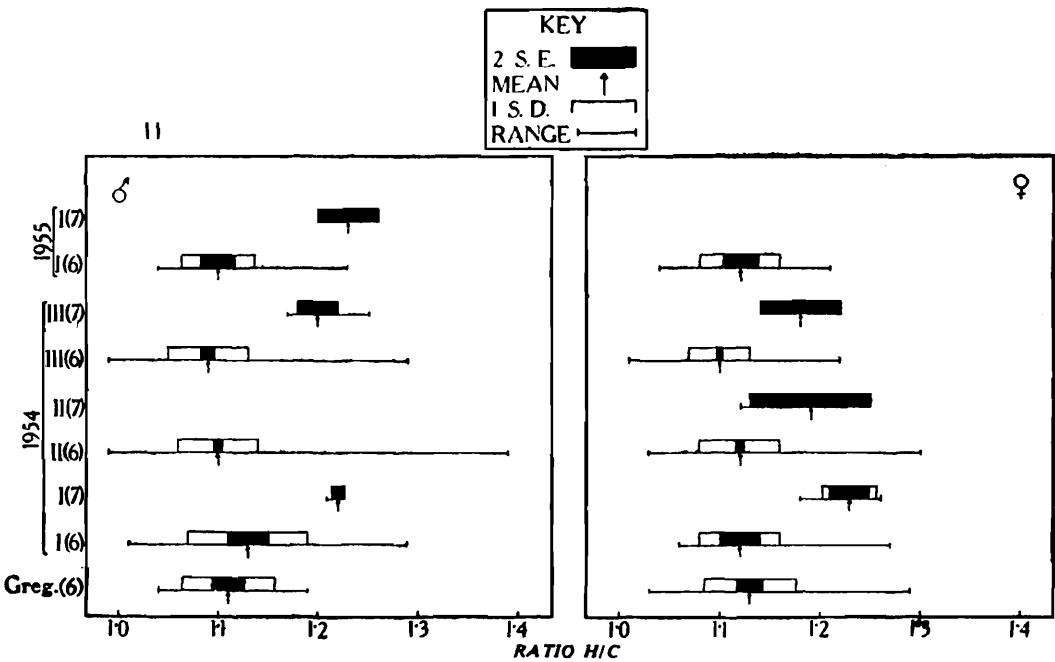
The values of H/C are as follows :—

Group (and eye-stripes)	Males	Females	Difference
Gr. I(6)	1.13 ± 0.01	1.12 ± 0.01	0.01 ± 0.014
Gr. II(6)	1.10 ± 0.002	1.12 ± 0.002	0.02 ± 0.003
Gr. III(6)	1.09 ± 0.003	1.10 ± 0.002	0.01 ± 0.004
Gr. I(7)	1.22 ± 0.004	1.23 ± 0.009	0.01 ± 0.02
Gr. II(7)	—	1.19 ± 0.03	—
Gr. III(7)	1.20 ± 0.01	1.18 ± 0.02	0.02 ± 0.018

(b) Inter-group comparison (Table 9)

(i) 6-striped : *Males* : The value in Gr. I is significantly higher than in Gr. II (at 1% level) and in Gr. III (at all levels). The value in Gr. II is significantly higher (at 5% level) than in Gr. III. *Females* : The value in Gr. I is not significantly different from that in Gr. II at all levels, but is significantly higher (at 5% level) than in Gr. III. The value in Gr. II is significantly higher (at all levels) than in Gr. III.

(ii) 7-striped : *Males* : The value in Gr. I is not significantly different from that in Gr. III ; no males occurred in Gr. II. *Females* : The value in Gr. II is not significantly different from those in Grs. I and III, but that in Gr. I is significantly higher (at 5% level) than in Gr. III.



TEXT-FIG. 11. *Schistocerca gregaria*. Diccogram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding the ratio H/C (Height of pronotum/width of head at genal level).
For explanations see text and text-figures 1 and 2.

(c) *Inter-sex comparison* (Table 8)

Within each group, the value in males is not significantly different from that in females, except in Grs. II(6) and III(6), where the values in females are significantly higher (at 0.1% and 5% levels) respectively.

(d) *Inter-eye-stripe comparison* (Table 8)

Males: Within the same group, the values in Grs. I(6) and III(6) are significantly lower than in Gr. I(7) and Gr. III(7) at all levels; no males occurred in Gr. II. *Females*: Within the same group, in 6-striped category, the values in Grs. I-III are significantly lower than in 7-striped ones at all levels.

(e) *Inter-population comparison* (Table 13)

The three 1954-Groups compare with 1955-Gr. I population (data given below) as follows:—

1955-population (and eye-stripes)	Mean $\pm$ S.E.	
	Males	Females
Gr. I(6)	1.10 $\pm$ 0.008	1.12 $\pm$ 0.009
Gr. I(7)	1.23 $\pm$ 0.014	—

(i) *6-striped*: *Males*: The value in 1955-Gr. I is not significantly different from those in 1954-Grs. II and III (at all levels), but is significantly lower than in Gr. I at 5% levels. *Females*: The value in 1955-Gr. I is not significantly different from those in 1954-Grs. I and II, but is significantly higher than in Gr. III at the 5% level.

(ii) *7-striped*: *Males*: The value in 1955-Gr. I is not significantly different from those in 1954-Grs. I and III; no males occurred in Gr. II. *Females*: The value in 1954-Grs. I-III could not be compared due to lack of data in other populations; no females occurred in 1955-Gr. I.

(f) *Sexual Dimorphism Percentage* (S.D.P.)

The S.D.P. $\pm$ S.E. varies as follows:—

1954-population (and eye-stripes)	S.D.P.	Other populations (and eye-stripes)	S.D.P.
Gr. I(6)	-0.88 $\pm$ 1.16	1955-Gr. I(6)	1.82 $\pm$ 1.10
Gr. I(7)	0.82	1955-Gr. II(6)	0.88 $\pm$ 0.22
Gr. II(6)	1.82 $\pm$ 0.20	1955-Gr. III(6)	-0.80 $\pm$ 1.35
Gr. III(6)	0.92 $\pm$ 0.31		
Gr. III(7)	-1.67		

In the 6-striped category, the values in 1954-Grs. I-III are not significantly different from those in 1955-Grs. I-III; no comparisons were possible in 7-striped category due to lack of data.

5. *Ratio E/W₁*

(Tables 8, 9 and 13 and Text-fig. 12)

(a) *Mean values*

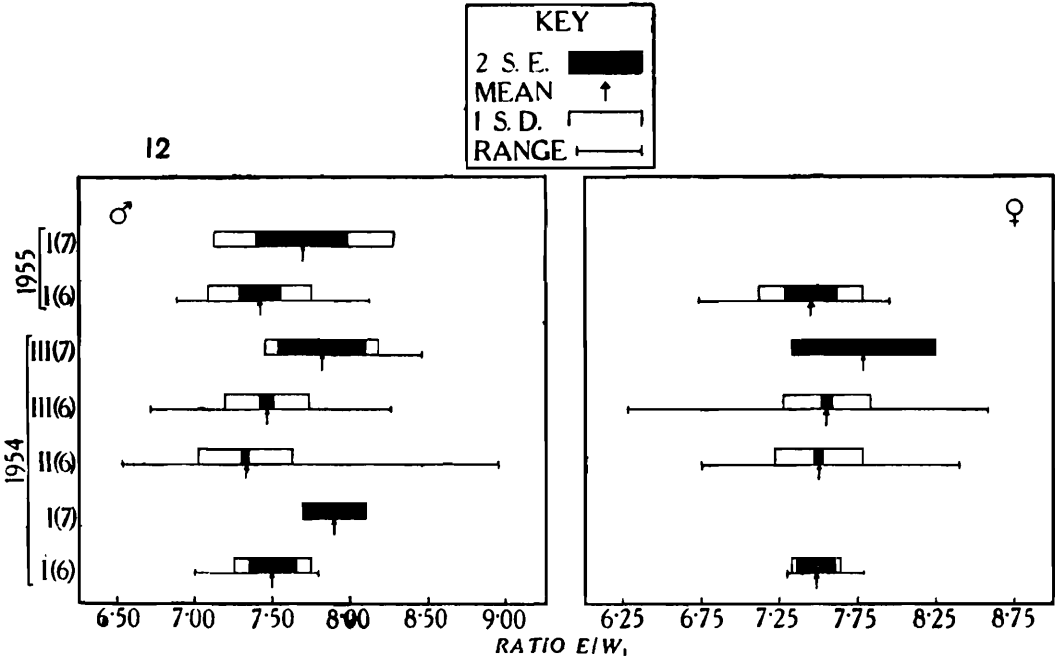
The values for E/W₁ are as follows:—

Groups (and eye-stripes)	Males	Females	Difference
Gr. I(6)	7.49 ± 0.08	7.58 ± 0.06	0.09 ± 0.11
Gr. II(6)	7.32 ± 0.01	7.49 ± 0.01	0.17 ± 0.014
Gr. III(6)	7.47 ± 0.02	7.55 ± 0.02	0.08 ± 0.03
Gr. I(7)	7.90 ± 0.10	—	—
Gr. II(7)	—	—	—
Gr. III(7)	7.82 ± 0.14	7.78 ± 0.23	0.04 ± 0.28

(b) Inter-group comparison (Table 9)

(i) 6-striped : *Males* : The value in Gr. I is not significantly different from those in Grs. II and III, but that in Gr. II is significantly lower than in Gr. III at all levels. *Females* : The value in Gr. I is not significantly different from those in Grs. II and III, but that in Gr. II is significantly lower than in Gr. III at 1% level.

(ii) 7-striped : *Males* : The value in Gr. I is not significantly different from that in Gr. III ; no males occurred in Gr. II. *Females* : No comparisons could be made due to lack of data, only one female occurred in Grs. I and II.



TEXT-FIG. 12. *Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding the ratio E/W_1 (Length of elytron/restricted width of elytron).
For explanations see text and text-figure 1.

(c) Inter-sex comparison (Table 8)

Within each group, the values in males is not significantly different from that in females except for Grs. II(6) and III(6) where the values in females are significantly higher at all levels and 1% level respectively.

(d) Inter-eye-stripe comparison (Table 8)

Males : Within the same group, in the 6-striped category, the values in Grs. I and III are significantly lower than in 7-striped ones at the

5% and at all levels respectively. *Females*: Within the same group, the value in Gr. III(6) is not significantly different from that in Gr. III(7); only one female occurred in Grs. I and II.

(e) *Inter-population comparison* (Table 13)

The three 1954-Groups compare with other populations (data given below) as follows:—

1955-population (and eye-stripes)	Mean $\pm$ S.E.	
	Males	Females
Gr. I(6)	7.41 ± 0.068	7.45 ± 0.081
Gr. I(7)	7.69 ± 0.285	—

(i) *6-striped*: In both males and females, the values in 1955-Gr. I are not significantly different from those in 1954-Grs. I-III at all levels.

(ii) *7-striped*: *Males*: The value in 1955-Gr. I is not significantly different from those in 1954-Grs. I and III; no males occurred in Gr. II. *Females*: No comparison could be made due to lack of data in other populations; no females occurred in 1955-Gr. I.

(f) *Sexual Dimorphism Percentage* (S.D.P.)

The S.D.P. $\pm$ S.E. varies as follows:—

1954-population (and eye-stripes)	S.D.P.	Other populations (and eye-stripes)	S.D.P.
Gr. I(6)	1.20 ± 1.29	1955-Gr. I(6)	0.54 ± 1.43
Gr. II(6)	2.32 ± 0.26	1955-Gr. II(6)	2.02 ± 0.30
Gr. III(6)	1.07 ± 0.40	1955-Gr. III(6)	2.79 ± 1.63
Gr. III(7)	—0.51		

In the 6-eye-striped category, the values in 1954-Grs. I-III are not significantly different from those in 1955-Grs. I-III; no comparison could be made in 7-striped category due to lack of data.

6. *Ratio E/F*

(Tables 8-11, 13-15 and Text-fig. 13)

(a) *Mean values*

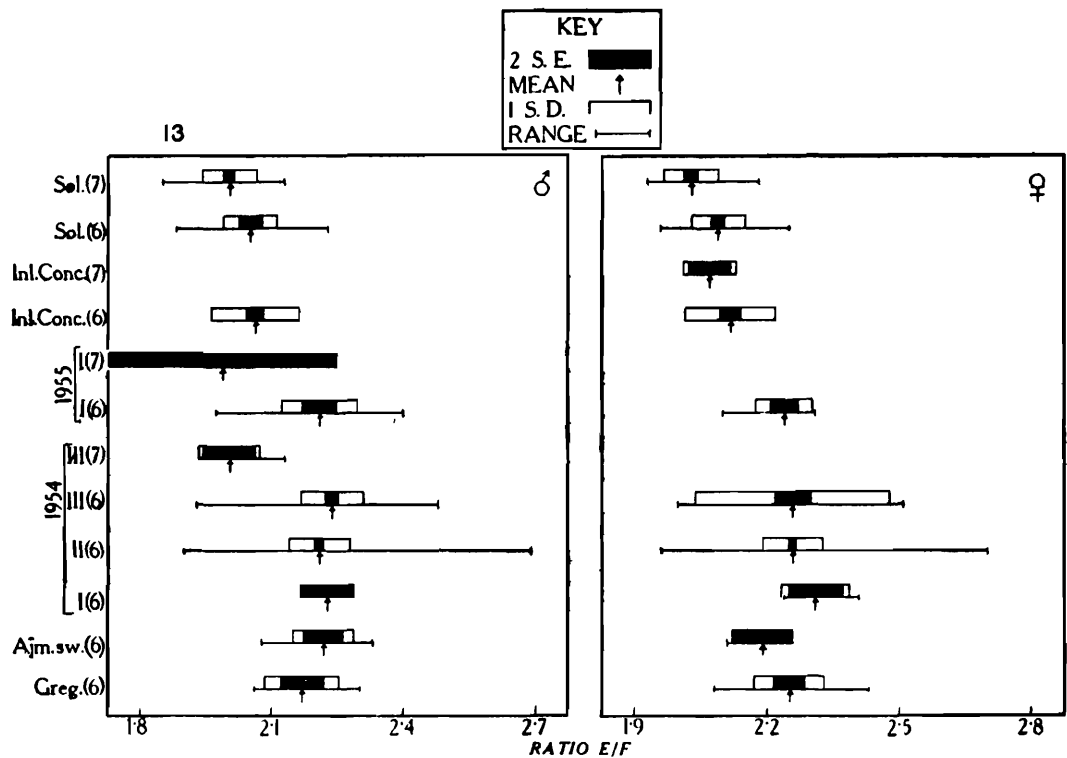
The values of E/F varies as follows:—

Group (and eye-stripes)	Males	Females	Difference
Gr. I(6)	2.23 ± 0.03	2.31 ± 0.03	0.081 ± 0.06
Gr. II(6)	2.21 ± 0.004	2.26 ± 0.004	0.05 ± 0.006
Gr. III(6)	2.22 ± 0.007	2.26 ± 0.02	0.04 ± 0.021
Gr. I(7)	—	—	—
Gr. II(7)	—	—	—
Gr. III(7)	2.00 ± 0.03	—	—

(b) *Inter-group comparison* (Table 9)

(i) *6-striped*: In both sexes, the values in Grs. I-III are not significantly different from each other.

(ii) *7-striped*: No males occurred in Gr. II, and only one in Gr. I. One female occurred in Grs. I and II and none in Gr. III.



TEXT-FIG. 13. *Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding the ratio E/F (Length of elytron/length of hind-femur).
For explanations see text and text-figures 1, 2 and 6.

(c) *Inter-sex comparison* (Table 8)

Within each group, the value in males is not significantly different from that in females, except in Gr. II(6), where the value in females is significantly larger at all levels.

(d) *Inter-eye-stripe comparison* (Table 8)

Males: Within the same group, the value in Gr. III(6) is not significantly different from that in Gr. III(7). No 7-striped males occurred in Gr. II and only one in Gr. I. *Females*: Only one 7-striped female occurred in Grs. I and II, and none in Gr. III.

(e) *Inter-population comparison*

(Tables 10-11 and 13-15)

The three 1954-Groups compare with other populations (data given below) as follows :—

Other populations (and eye-stripes)	Mean $\pm$ S.E.	
	Males	Females
6-greg.	2.17 $\pm$ 0.024	2.25 $\pm$ 0.017
Ajmer Sw. (6)	2.22 $\pm$ 0.023	2.19 $\pm$ 0.035
Kakko Conc. (6)	2.06 $\pm$ 0.010	2.12 $\pm$ 0.011
Kakko Conc. (7)	—	2.07 $\pm$ 0.022
6-sol.	2.05 $\pm$ 0.012	2.09 $\pm$ 0.008
7-sol.	2.00 $\pm$ 0.006	2.03 $\pm$ 0.007
1955-Gr. I(6)	2.21 $\pm$ 0.018	2.24 $\pm$ 0.016
1955-Gr. I(7)	1.99 $\pm$ 0.013	—

(i) *6-striped males* : The values in 1954-Grs. I and II are not significantly different from that in typical *6-greg.*; but the value in Gr. III is significantly higher (at 5% level). The values in 1954-Grs. I-III are significantly higher than in typical *6-sol.* at all levels, but are not significantly different from the *Ajmer Sw.* and the 1955-Gr. I. The values in *Kakko Conc.* is significantly lower than that in 1954-Gr. I (at 5% level) and Grs. II and III at all levels.

(ii) *6-striped females* : The values in 1954-Grs. I-III are not significantly different from that in *6-greg.*; but are significantly higher than in *6-sol.*, at all levels. The value in 1954-Grs. I and III are not significantly different from that in *Ajmer Sw.*, but that in Gr. II is significantly higher (at 5% level). The value in the *Kakko Conc.* is significantly lower (at all levels) from 1954-Grs. I-III. The 1954-Gr. I is not significantly different from that in 1955-Gr. I, but Grs. II and III are significantly higher at 1% and 5% levels.

(iii) *7-striped males* : The value in 1954-Gr. III is not significantly different from that in *7-sol.* and 1955-Gr. I. No males occurred in *Kakko Conc.* and in 1954-Gr. II and only one in 1954-Gr. I.

(iv) *7-striped females* : No data are available for comparison, only one female occurring in Grs. I and II and none in Gr. III.

(f) Sexual Dimorphism Percentage (S.D.P.)

The S.D.P. $\pm$ S.E. varies as follows :—

1954-population (and eye-stripes)	S.D.P.	Other populations (and eye-stripes)	S.D.P.
Gr. I(6)	3.59 ± 2.22	1955-Gr. I(6)	1.36 ± 1.10
Gr. II(6)	2.26 ± 0.28	<i>Kakko Conc.</i> (6)	2.91 ± 0.73
Gr. III(6)	1.80 ± 1.03	<i>6-greg.</i>	3.69 ± 1.40

In the 6-striped category, the values in 1954-Grs. I-III are not significantly different from those in 1955-Gr. I, *6-greg.* and the *Kakko Conc.* at all levels. No comparison was made in 7-striped category due to lack of data.

7. Ratio E/C

(Tables 8, 9 and 13 and Text-fig. 14)

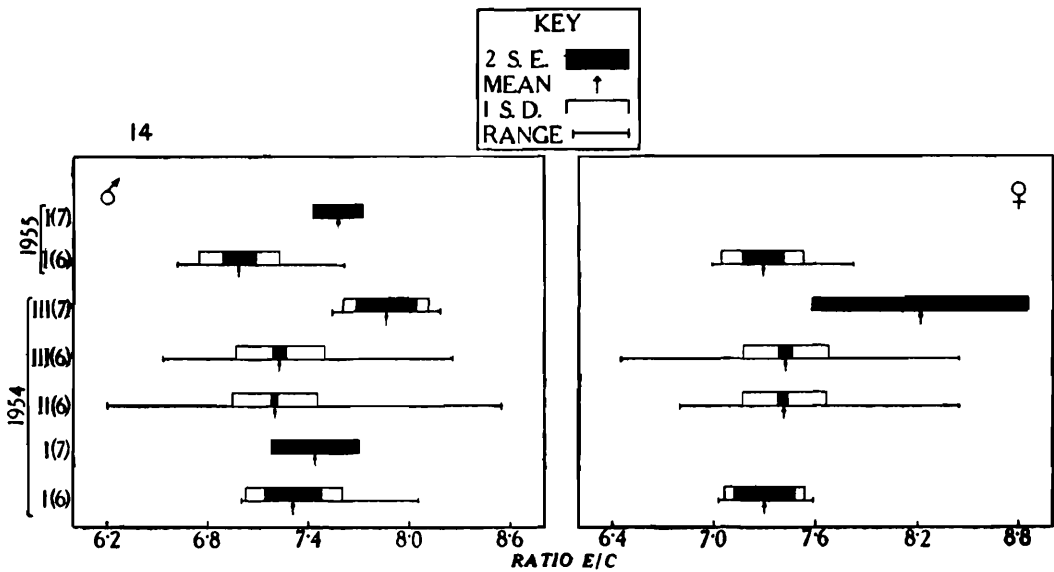
(a) Mean values

The values for E/C are as follows :—

Group (and eye-stripes)	Males	Females	Difference
Gr. I(6)	7.31 ± 0.08	7.30 ± 0.09	0.01 ± 0.13
Gr. II(6)	7.20 ± 0.01	7.45 ± 0.01	0.25 ± 0.014
Gr. III(6)	7.21 ± 0.02	7.43 ± 0.02	0.22 ± 0.03
Gr. I(7)	7.44 ± 0.13	—	—
Gr. II(7)	—	—	—
Gr. III(7)	7.86 ± 0.09	8.22 ± 0.32	0.36 ± 0.23

(b) Inter-group comparison (Table 9)

6-striped : In both sexes, the values in Grs. I-III are not significantly different from one another.



TEXT-FIG. 14. *Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding the ratio E/C (Length of elytron/width of head at genal level). For explanations see text and text-figure 1.

7-striped : Males : The value in Gr. I is significantly lower than in Gr. III at the 5% level ; no males occurred in Gr. II. **Females :** Only one female occurred in Grs. I and II ; hence comparison could not be made.

(c) *Inter-sex comparison* (Table 8)

Within each group, the values in males are not significantly different from females, except in Grs. II(6) and III(6), where the values in females are significantly higher at all levels.

(d) *Inter-eye-stripe comparison* (Table 8)

Males : Within the same group, the value in Gr. I(6) is not significantly different from that in Gr. I(7), but that in Gr. III(6) is significantly lower than that in Gr. III(7) at all levels. **Females :** Within the same group, the value in Gr. III(6) is significantly lower than in Gr. III(7) at all levels. Only one female occurred in Grs. I(7) and II(7).

(e) *Inter-population comparison* (Table 13)

The three 1954-Groups compare with other populations (data given below) as follows :—

Other populations (and eye-stripes)	Mean ± S.E.	
	Males	Females
1955-Gr. I(6)	6.98 ± 0.05	7.79 ± 0.058
1955-Gr. I(7)	7.57 ± 0.075	—

(i) **6-striped : Males :** The value in the 1955-Gr. I is significantly lower than in 1954-Grs. I-III at all levels. **Females :** The value in 1955-Gr. I is not significantly different from that in 1954-Gr. I, but is significantly lower than in Gr. II (at 1% level) and Gr. III (at 5% level).

(ii) *7-striped: Males*: The value in 1955-Gr. I is not significantly different from that in 1954-Grs. I and III; no males occurred in Gr. II. *Females*: No comparison could be made due to lack of data, no females occurred in 1955-Gr. I.

(f) *Sexual Dimorphism Percentage (S.D.P.)*

The S.D.P. $\pm$ S.E. varies as follows:—

1954-population (and eye-stripes)		Other populations (and eye-stripes)	
	S.D.P.		S.D.P.
Gr. I(6)	-0.14 ± 1.66	1955-Gr. I(6)	4.44 ± 1.12
Gr. II(6)	3.47 ± 0.23	1955-Gr. II(6)	2.74 ± 0.25
Gr. III(6)	3.05 ± 0.39	1955-Gr. III(6)	0.63 ± 1.79
Gr. III(7)	4.58		

In the 6-striped category, the values in 1954-Grs. I-III are not significantly different from those in 1955-Grs. I-III. No comparisons were possible in 7-striped category due to lack of data.

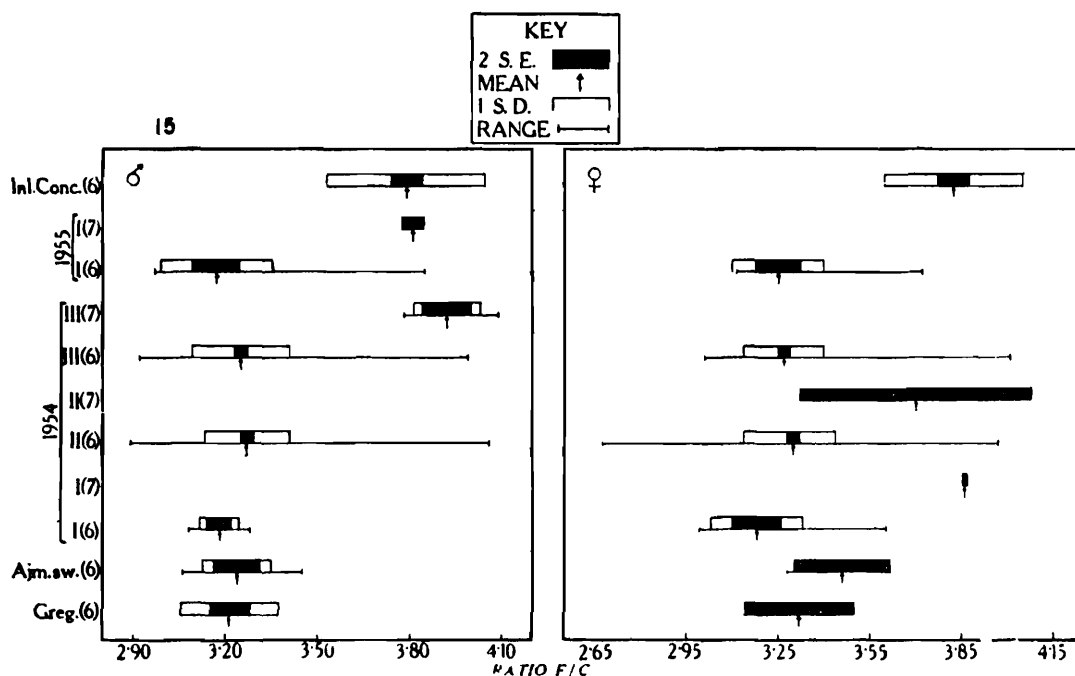
8. *Ratio F/C*

(Tables 8-11, 13-15 and Text-fig. 15)

(a) *Mean values*

The values for F/C are as follows:—

Groups (and eye-stripes)	Males	Females	Difference
Gr. I(6)	3.18 ± 0.02	3.18 ± 0.04	0.0 ± 0.0
Gr. II(6)	3.27 ± 0.01	3.30 ± 0.01	0.03 ± 0.01
Gr. III(6)	3.25 ± 0.01	3.27 ± 0.01	0.02 ± 0.01
Gr. I(7)	—	3.86 ± 0.007	—
Gr. II(7)	—	3.70 ± 0.19	—
Gr. III(7)	3.92 ± 0.04	—	—



TEXT-FIG. 15. *Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits (2 S. E.) and standard deviation (S.D.) in various populations regarding the ratio F/C (Length of hind-femur/width of head at genal level). For explanations see text and text-figures 1, 2 and 6.

(b) *Inter-group comparison* (Table 9)

6-striped: Males: The value in Gr. I is significantly lower than in Grs. II and III at all levels, and that in Gr. II is significantly higher from that in Gr. III (at 5% level). *Females:* The value in Gr. I is significantly lower than in Gr. II (at 1% level) and Gr. III (at 5% level). The value in Gr. II is significantly higher than in Gr. III at 1% level.

7-striped: Males: Only one male occurred in Gr. I and none in Gr. II; hence no comparison could be made. *Females:* The value in Gr. I is not significantly different from that in Gr. II; no females occurred in Gr. III.

(c) *Inter-sex comparison* (Table 8)

Within each group, the value in males is significantly lower than in females, except in Gr. I(6) where no significant difference is noticed between the sexes.

(d) *Inter-eye-stripe comparison* (Table 8)

Males: Within the same group, in the 6-striped category, the value in Gr. III is significantly lower than that in 7-striped ones at all levels. Only one male occurred in Gr. I(7) and none in Gr. II(7). *Females:* Within the same group, in the 6-striped category, the values in Grs. I and II are significantly lower than in the 7-striped one at all levels and 5% levels respectively. No females occurred in Gr. III(7).

(e) *Inter-population comparison*

(Tables 10, 11, 13-15)

The three 1954-Groups compare with other populations (data given below) as follows:—

<i>Other populations (and eye-stripes)</i>	<i>Mean $\pm$ S.E.</i>	
	<i>Males</i>	<i>Females</i>
<i>6-greg.</i>	3.223 $\pm$ 0.032	3.320 $\pm$ 0.032
<i>Ajmer Sw. (6)</i>	3.237 $\pm$ 0.036	3.458 $\pm$ 0.079
<i>Kakko Conc. (6)</i>	3.790 $\pm$ 0.024	3.824 $\pm$ 0.027
1955-Gr. I(6)	3.17 $\pm$ 0.038	3.25 $\pm$ 0.037
1955-Gr. I(7)	3.81 $\pm$ 0.016	—

(i) *6-striped males:* The values in 1954-Grs. I-III are not significantly different from those in typical *6-greg.* and the *Ajmer Sw.*, but are significantly lower (at all levels) than in the *Kakko Conc.* The value in 1954-Gr. I is not significantly different from that in 1955-Gr. I, but the values in 1954-Grs. II and III are significantly higher (at 5% level) than in 1955-Gr. I.

(ii) *6-striped females:* The value in 1954-Grs. II and III are not significantly different (at all levels) than in typical *6-greg.*, but that in Gr. I is significantly lower (at 5% level). The value in 1954-Grs. I-III is significantly lower than in the *Ajmer Sw.* at 1%, 5% and 5% levels respectively; and from the *Kakko Conc.* at all levels. The value in 1954-Grs. I-III is not significantly different than in 1955-Gr. I.

(iii) *7-striped males*: The value in 1954-Gr. III is not significantly different from that in 1955-Gr. I at all levels. No males occurred in Gr. II and only one in Gr. I.

(iv) *7-striped females*: The value in 1954-Grs. I and II could not be compared with others due to lack of data; no females occurred in Gr. III.

(f) *Sexual Dimorphism Percentage (S.D.P.)*

The S.D.P. $\pm$ S.E. varies as follows:—

<i>1954-population (and eye-stripes)</i>	<i>S.D.P.</i>	<i>Other populations (and eye-stripes)</i>	<i>S.D.P.</i>
Gr. I(6)	0.0 $\pm$ 1.51	1955-Gr. I(6)	2.52 $\pm$ 1.71
Gr. II(6)	0.92 $\pm$ 0.32	<i>Kakko Conc.</i> (6)	0.90 $\pm$ 0.96
Gr. III(6)	0.62 $\pm$ 0.54	<i>6-greg.</i>	2.69 $\pm$ 1.42

In the 6-striped category, the values in 1954-Grs. I-III are not significantly different from those in 1955-Gr. I, typical *6-greg.* and the *Kakko Conc.* No comparison was possible in the 7-striped category due to lack of data.

9. *General conclusions regarding morphometric ratios*

(a) *Inter-group variation in the 1954-population*

(i) In the 6-striped category males do not show much group differences in the ratios P/C, E/F and E/C. Females, however, show pronounced group divergence particularly in the ratios P/C, M/C, H/C, E/W₁, and F/C. The ratio E/F shows no group difference in either sex. The most significant and sensitive ratios are M/C, H/C and F/C for both the sexes. Compared to the morphometric measurements, the results obtained from the ratios are almost similar. In females, Gr. I differs from Grs. II and III in almost all the ratios; the latter two groups also differ from each other particularly in ratios P/C, M/C, H/C and F/C.

(ii) From inter-sex comparison, it is seen that in the 6-striped individuals, females outstrip the ratio for males and the values are significantly higher, more particularly in Group II (and for ratios E/W₁, F/C, E/C, H/C and M/C in Group III).

(iii) In inter-eye-stripe comparison, it is seen that 6-striped individuals have significantly smaller ratios than 7-striped ones in all Groups.

(b) *Inter-relation between 1954-population and 1955-Gr. I population*

The ratios P/C, M/C, H/C, E/W₁, E/F, E/C and F/C have been utilized for comparing the 1954-Grs. I-III and the 1955-Gr. I population, which was the succeeding population to 1954-population (particularly to the 1954-Gr. III) and which, according to Roonwal and Bhanotar (1966), was of a *gregaria* nature.

(i) *1954-Gr. I versus 1955-Gr. I: Males*: In the 6-striped category, the ratio P/C, M/C, E/C (at 1% level) and H/C (at 5% level) have significantly higher values in 1954-Gr. I than in 1955-Gr. I. *Females*: No significant difference is found in 6-striped specimens.

(ii) *1954-Gr. II versus 1955-Gr. I : Males* : In the 6-striped category, the ratios E/C (at all levels) and F/C (at 5% level) have significantly higher values in the 1954-Gr. II than in the 1955-Gr. I population. *Females* : In the 6-striped category, the ratios P/C and E/C have significantly higher values in 1954-Gr. II than in 1955-Gr. I (at 0.1% and 1% levels respectively).

(iii) *1954-Gr. III versus 1955-Gr. I : Males* : In the 6-striped category, significant differences are noted between 1954-Gr. III and 1955-Gr. I in the ratios P/C, E/C (at all levels) and M/C and F/C (at 5% level) the former (1954-Gr. III) having higher values for ratios P/C, E/C and F/C than the latter (1955-Gr. I), except in M/C, where the value in 1954-Gr. III is significantly lower than in 1955-Gr. I at 5% level. *Females* : In the 6-striped category, the ratios P/C and E/C are significantly higher (at all levels and at the 5% level respectively) and M/C and H/C lower (at all levels and at the 5% level respectively) in 1954-Gr. III than in 1955-Gr. I.

(c) *Comparison between the 1954-Groups, the Ajmer Sw. and the Kakko Conc.*

The most sensitive ratios viz., P/C, E/F and F/C, were used for finding the affinity between the 1954-population (Grs. I-III), the *Ajmer Swarm* of 1950 (*gregaria* in nature) and the *Kakko Conc.* of 1949 (intermediate between *gregaria* and *solitaria*) and the results are discussed below:—

P/C : In the 6-striped category, the value for males and females in Grs. I and II are significantly higher than in the *Ajmer Sw.*, but lower than in the *Kakko Conc.*, the value in Gr. III is significantly higher than in the *Ajmer Sw.* and lower than in the *Kakko Conc.*

E/F : In the 6-striped category, the values for males in Grs. I, II and III are significantly higher than in the *Kakko Conc.*; the value in Gr. III is significantly lower than in the *Ajmer Sw.* For females, the value in Grs. I and II are significantly higher than in the *Kakko Conc.*, and in Gr. III it is lower. The Gr. II value is significantly higher than in the *Ajmer Sw.*

F/C : In the 6-striped category, for males, the value in Grs. I and II are significantly lower, and in Gr. III higher, than in the *Kakko Conc.* For females, the values in Grs. I-III are significantly lower than in both the *Ajmer Sw.* and the *Kakko Conc.*

(d) *Phase status of the 1954-Groups (I-III) regarding ratios*

The ratios (P/C, E/F and F/C) for the 1954-Groups are compared below with those in the typical *gregaria* and one ratio (E/F) in typical *solitaria* populations (the data for the other ratios are not available).

P/C : In both sexes, the 6- and 7- eye-striped individuals (in Grs. I-III) have significantly higher ratios (at 1% and at all levels) than in the typical *6-gregaria*.

E/F : In the 6-striped category, in both sexes (in Grs. I-III) no difference is found from the *6-greg.* (except for Gr. III, where the value

is significantly higher than in 6-greg.). But they are significantly larger than 6- and 7- striped *sol.* (at all levels).

F/C: Only in females, for Gr. I, in the 6-striped category, the ratio is significantly lower (at 5% level) than in 6-greg.

VII—DISCUSSION AND CONCLUSIONS

The divergence between the three groups (I-III) of the 1954-population is more pronounced in females than in males, and in 6-striped individuals than in 7-striped ones. The divergences are best noticeable in the width of pronotum at the constriction (M). In males, characters O, C, P, E and F show no significant difference between the groups. It is not clear whether Gr. I is more in agreement with Gr. II than with Gr. III, but a decided difference is seen between the latter two groups, particularly in the case of females. A high degree of sexual dimorphism occurs in all the groups. Eye-stripes (6- and 7-) variation is markedly high in Gr. III.

The three groups are best differentiated by the ratios M/C, F/C and H/C, and least so by the ratios E/F, E/C and P/C (for males only). It appears that Gr. I is as much apart from Gr. II as from Gr. III, the latter two groups being highly discordant. Sexual difference is uniformly high for all ratios in Gr. II and moderately high for Gr. III, but in Gr. I no such difference is noted. Among the 7-striped individuals, inter-group and inter-sex differences are the lowest. Inter-eye-stripe differences are well marked in respect of the ratios, and the difference is more pronounced in Gr. III, than in any other group.

For examining the gradual change from *gregariaform* to *solitariaform* morphometry that might have occurred in the 1954-population, it is compared with the 1955-Gr. I with regard to eight body-parts and seven ratios. Regarding morphometric characters the 1954-Gr. I is nearer the 1955-Gr. I, than are 1954-Grs. II and III, particularly for males. Females and 7-striped forms show less difference between the groups. It is interesting to note that the length of pronotum (P) is found to be the best differentiating character for such comparison. In respect of morphometric ratios, the 1954-Gr. II appears to be less at variance with 1955-Gr. I as compared to the other groups.

Comparison of the 1954-Groups with the *Ajmer Swarm* (1950) and the *Kakko Concentration* (1949), has been made, utilizing four morphometric characters (C, P, E and F) and three ratios (P/C, E/F and F/C). Generally speaking, the 1954-Groups are intermediate between the *Ajmer Swarm* and the *Kakko Concentration*, but are closer to the former. As to the degree of this affinity of each of the groups, it can be stated that Gr. I is nearer to the *Ajmer Swarm* than are Grs. II and III.

The phase-status of the 1954-Groups has been assessed by utilizing four characters (C, P, E and F) and three ratios (P/C, E/F and F/C). Only E, F and E/F are, however, available for comparison in phase *solitaria*. The following are the noteworthy points as evidenced by each of the characters and ratios:—

For C in the 1954-Groups, females differ less from *gregaria* than do males. For P, the disparity between *gregaria* and the 1954-Groups, particularly Grs. I and III, is less pronounced. For E, females show a decided difference between the 1954-Groups and phase *solitaria*, but males show no such difference from either phase. For F, the 1954-Groups differ more from *solitaria* than from *gregaria*. The ratio P/C shows considerable difference between the 1954-groups and phase *gregaria*, E/F differentiates the 1954-Groups from the phase *solitaria* appreciably, but not from phase *gregaria*, F/C show very little or no difference between the 1954-groups and phase *gregaria*.

For judging the affinity of the groups to either of the phases, only E, F and E/F for which data are available for both *solitaria* and *gregaria* phases are taken into consideration. On the basis of these three variables, the 1954-groups may be considered closer to the *gregaria* than to the *solitaria* phase. Another notable point is that the length of hind-femur (F) is found to be a very sensitive character in detecting variation between the 1954-Groups and the typical phases.

The occurrence of over 80% 6-eye-striped individuals and of an equal proportion of the sexes (in 6-striped forms) in all the 1954-Groups (I-III), point towards the *gregaria* features of the population in accordance with Roonwal's Hypotheses (Roonwal, 1945). Furthermore, the occurrence of 7-eye-striped individuals in Grs. I (14.86%), II (0.23%) and III (2.16%) would suggest that the *gregaria* character is being "softened", as indicated by Roonwal (1955) for that same population.

Trends in the 1954-population

One of the characteristics of the phase *gregaria* population is that during swarming period, the "constancy" in various characters is maintained in eye-stripe composition, sex-ratios and morphometric characters and, as stated by Roonwal (1954), this phase is a variation-stable. This stability appears to be shaken in the 1954-population, particularly in the characters relating to the pronotum, head and hind-femur viz., M, M/C, H/C and F/C and this further confirms the decline of the *gregaria* nature of the 1954-population.

Thus, one more lacuna (that for the 1954-population) has been filled in our knowledge of the dynamics of the morphometric characteristics and changes occurring in the various populations of the 1949-55 Swarming Cycle in India. Data for some crucial periods in the cycle have already been provided by Misra (1952) for the *Kakko Concentration* of 1949 (which started this cycle), Roonwal and Misra (1952) for a swarm of 1950, Roonwal (1955) for a small swarm of 1954 and Roonwal and Bhanotar (1966) for the 1955-population.

VIII—SUMMARY

1. For the 1954-Desert Locust population in India, random samples, consisting of 1819 individuals, were obtained for analysis, grouped under three homogenous groups, viz., I (January—April), II (May—August) and III (September—December). The results are summarized below :

2. *Sex-ratios*: In the 6-striped category, the proportion of the two sexes are almost equal in all the three 1954-Groups, thereby indicating the *gregaria* nature of the population (Roonwal's Second Hypotheses, 1945).

3. *Eye-stripe composition*: The high proportion of 6- eye-striped individuals in the 1954-Gr. I (85.14%), II (99.77%) and III (97.84%), further points towards the *gregaria* nature of the population (Roonwal's first Hypotheses, 1945).

4. However, in such a *gregaria* population the appearance of 7-striped individuals, in all the three groups lead us to presume that a "softening" of the *gregaria* phase has occurred and this gives us a hint of the probable decline of the cycle in India, as also indicated by Roonwal (1955), for a small 1954-swarm, and as was confirmed by subsequent events (the 1949-55 Cycle having ended in 1955).

5. *Inter-group comparison*: The character C (for females) and H and M (for both sexes), show a high degree of divergence in the three groups; this is true to some extent for characters O, P, F and W_1 (females only). The character E is less sensitive in this respect. The characters O, C, P, E and F show no difference among the groups in males. On the whole, for majority of the characters, Group I differs from Grs. II and III in the case of females only, and the latter two groups show maximum difference among themselves (for both sexes).

6. *Inter-sex comparison*: In the majority of the morphometric characters, the values in females are significantly higher than in males.

7. *Ratios*: The three groups are best differentiated by the ratios H/C, M/C and F/C.

8. From the inter-population comparison of the 1954-Groups (I-III) with 1955-Gr. I (of *gregaria* nature), it is seen that the 1954-Gr. I is nearer the 1955-Gr. I, as is best demonstrated by the length of the pronotum (P). On comparison with the *Ajmer Swarm* (1950) and the *Kakko concentration* (1949) populations—the former for *gregaria* facies and latter intermediate between *gregaria* and *solitaria*—the 1954-groups are found to be closer to the *Ajmer Swarm* and this is especially so in respect of the 1954-Gr. I.

9. Comparison with "typical" phase data (*i.e.* typical *gregaria* and *solitaria*), the ratio P/C shows a marked difference between the 1954-groups and ph. *gregaria*; E shows a lesser difference. The character F is found to be the most sensitive in detecting variation between the 1954-groups and the phases.

10. It may be concluded that the stability of characters and eye-stripes, which is characteristic of a *gregaria* or swarming population, appears to be shaken in the 1954-population in India which, though broadly *gregaria* in nature, indicates a softening or weakening of the *gregaria* characteristics. The effect of this weakening is evident in the immediately succeeding populations of the year 1955, in which year the cycle came to an end. Thus, one more lacuna has been filled in our knowledge of the characteristics of a Desert Locust population in the Swarming Cycle of 1949-55, the characteristics of some of the other crucial years (1949 and 1955) having already been studied earlier.

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TABLE 1.—*Schistocerca gregaria*. Groupwise and monthly distribution of eye-stripe composition (6- and 7- striped) and sex-ratios in 1954-population in India.

Abbreviations : As in text.

Group	Month	6-striped		7-striped		Total	
		♂	♀	♂	♀	♂	♀
I	January	4 (100%)	0 (0%)	2 (66.7%)	1 (33.3%)	6 (85.7%)	1 (14.3%)
	February	4 (80%)	1 (20%)	1 (50%)	1 (50%)	5 (71.4%)	2 (28.6%)
	March	1 (50%)	1 (50%)	0 (0%)	4 (100%)	1 (16.7%)	5 (83.3%)
	April	23 (44.2%)	29 (55.8%)	0 (0%)	2 (100%)	23 (42.6%)	31 (57.4%)
Total for Group I		32 (50.8%)	31 (49.2%)	3 (27.3%)	8 (72.7%)	35 (49.3%)	39 (52.7%)

TABLE 1.—(Continued)

Group	Month	6-striped		7-striped		Total	
		♂	♀	♂	♀	♂	♀
II	May	48 (57.8%)	35 (42.2%)	0 (0%)	0 (0%)	48 (57.8%)	35 (42.2%)
	June	296 (53.4%)	258 (46.6%)	0 (0%)	2 (100%)	296 (53.2%)	260 (46.8%)
	July	259 (53%)	230 (47%)	0 (0%)	1 (100%)	259 (52.9%)	231 (47.1)
	August	94 (61.8%)	58 (38.2%)	0 (0%)	0 (0%)	94 (61.8%)	53 (38.2%)
Total for Group II		697 (54.5%)	581 (45.5%)	0 (0%)	3 (100%)	697 (54.4%)	584 (45.6%)
III	September	99 (59.3%)	68 (40.7%)	4 (66.7%)	2 (33.3%)	103 (59.5%)	70 (40.5%)
	October	46 (36.2%)	81 (63.8%)	0 (0%)	0 (0%)	46 (36.2%)	81 (63.8%)
	November	1 (100%)	0 (0%)	0 (0%)	0 (0%)	1 (100%)	0 (0%)
	December	84 (52.8%)	75 (47.2%)	3 (75%)	1 (25%)	87 (53.4%)	76 (46.6%)
Total for Group III		230 (50.7%)	224 (49.3%)	7 (70%)	3 (30%)	237 (51.1%)	227 (48.9%)

TABLE 2. — *Schistocerca gregaria*. Number and distribution of samples Groups (I-III) according to sex and eye-strips in the 1954-population in India.

Abbreviations : As in text.

Group (and period)	Number of individuals						Number of individuals in both sexes		
	♂			♀					
	6-eye-strips	7-eye-strips	Total (6 & 7)	6-eye-strips	7-eye-strips	Total (6 & 7)	6-eye-strips	7-eye-strips	Total (6 & 7)
Gr. I (January-April)	32	3	35	31	8	39	63	11	74
Gr. II (May-August)	697	—	697	581	3	584	1278	3	1281
Gr. III (September-December)	230	7	237	224	3	227	454	10	464
All Groups (I-III)	959	10	969	836	14	850	1795	24	1819

TABLE 3. — *Schistocerca gregaria*. Sex ratio (irrespective of eye-stripes) in the 1954-population in India.*Abbreviations* : As in text.

Groups (and period)	Percentage of each sex + S.E.	
	♂	♀
Gr. I (January-April)	59.32±5.81	52.70±5.81
Gr. II (May-August)	54.41±1.43	45.59±1.42
Gr. III (September-December)	51.08±2.37	48.92±2.37
Total (all groups)	53.27±1.17	46.73±1.17

TABLE 4. — *Schistocerca gregaria*. Percentage of eye-stripes (6- and 7-) irrespective of sexes and their distribution in sexes in the 1954-population in India.

Abbreviations : As in text.

Group	Percentage of eye-stripes irrespective of sex $\pm$ S.E.*		Sex-ratio ($\pm$ S.E.*) in each eye-stripe group			
	6-eye-stripes	7-eye-stripes	6-eye-stripes		7-eye-stripes	
			♂	♀	♂	♀
I	85.14 $\pm$ 4.13	14.86 $\pm$ 4.14	50.79 $\pm$ 6.30	49.21 $\pm$ 6.30	27.27 $\pm$ 13.45	72.73 $\pm$ 13.43
II	99.77 $\pm$ 0.13	0.23 $\pm$ 0.14	54.54 $\pm$ 1.39	45.46 $\pm$ 1.39	0	0
III	97.84 $\pm$ 0.69	2.16 $\pm$ 0.69	50.66 $\pm$ 2.35	49.34 $\pm$ 2.35	70.00 $\pm$ 14.49	30.00 $\pm$ 14.49
All groups	98.68 $\pm$ 0.27	1.32 $\pm$ 0.27	53.43 $\pm$ 1.18	46.57 $\pm$ 1.18	41.67 $\pm$ 10.06	58.33 $\pm$ 10.06

*S.E., Standard Error.

TABLE 5. — *Schistocerca gregaria*. Sex-ratio and proportion of 6- and 7- eye-stripes individuals in the 1954-population in India.

Abbreviations : As in text.

Groups	Percentage of eye-stripes in each sex±S.E.*			
	♂		♀	
	6-eye-stripes	7-eye-stripes	6-eye-stripes	7-eye stripes
I	91.43±4.75	8.57±4.75	79.49±6.45	20.51±6.45
II	100.00	0	99.49±0.29	0.51±0.29
III	97.05±1.09	2.95±1.09	98.63±0.76	1.32±0.76
All groups	98.97±0.31	1.03±0.32	98.35±0.45	1.65±0.45

*S.E., Standard Error.

TABLE 6. — *Schistocerca gregaria*. Inter-sex and inter-eye-stripe comparison of morphometric characters between Groups I-III of the 1954-population in India.

Abbreviations : As in text.

Groups, sex and eye-stripes	Characters							
	O	C	P	H	M	E	W ₁	F
	1. Inter-sex							
6-eye-stripes								
I ♂ : I ♀	**	***	***	***	***	**	***	*
II ♂ : II ♀	***	***	***	***	***	***	***	***
III ♂ : III ♀	***	***	***	***	***	***	***	***
7-eye-stripes								
I ♂ : I ♀	NS	*	NS	*	NS	—	**	—
II ♂ : II ♀	—	—	—	—	—	—	—	—
III ♂ : III ♀	*	**	**	**	***	**	**	—
2. Inter-eye-stripes								
Males								
I(6) : I(7)	NS	NS	NS	NS	NS	NS	NS	—
II(6) : II(7)	—	—	—	—	—	—	—	—
III(6) : III(7)	NS	***	NS	NS	NS	NS	**	***
Females								
I(6) : I(7)	NS	*	NS	**	NS	—	NS	**
II(6) : II(7)	NS	NS	NS	NS	NS	NS	NS	***
III(6) : III(7)	NS	***	**	*	*	**	NS	—

TABLE 7.—*Schistocerca gregaria*. Inter-group comparison of morphometric characters (within same sex and eye-stripe category between Group I-III of 1954-population in India.

Abbreviations : As in text.

Groups, sex and eye-stripes	Characters							
	O	C	P	H	M	E	W ₁	F
	Inter-group comparison							
<i>Males</i>								
I(6) : II(6)	NS	NS	NS	NS	**	NS	NS	NS
I(6) : III(6)	NS	NS	NS	**	***	NS	NS	NS
I(7) : II(7)	—	—	—	—	—	—	—	—
I(7) : III(7)	NS	NS	NS	NS	*	NS	NS	—
II(6) : III(6)	NS	NS	NS	*	***	NS	**	NS
II(7) : III(7)	—	—	—	—	—	—	—	—
<i>Females</i>								
I(6) : II(6)	NS	**	NS	**	***	NS	NS	NS
I(6) : III(6)	NS	***	NS	***	***	NS	NS	NS
I(7) : II(7)	NS	NS	NS	NS	NS	—	NS	NS
I(7) : III(7)	NS	NS	NS	NS	NS	—	NS	—
II(6) : III(6)	***	***	**	***	***	NS	***	*
II(7) : III(7)	NS	NS	NS	NS	NS	NS	NS	—

TABLE 8. — *Schistocerca gregaria*. Inter-sex and inter-eye-stripe comparison of various ratios between Groups I-III of 1954-population in India.

Abbreviations : As in text.

Groups, sex and eye-stripes	Ratios						
	P/C	M/C	H/C	E/W ₁	E/F	E/C	F/C
1. <i>Inter-sex comparison</i>							
<i>6-eye-stripes</i>							
I ♂ : I ♀	NS	NS	NS	NS	NS	NS	NS
II ♂ : II ♀	***	***	***	***	***	***	**
III ♂ : III ♀	NS	***	*	**	NS	***	*
<i>7-eye-stripes</i>							
I ♂ : I ♀	NS	NS	NS	—	—	—	—
II ♂ : II ♀	—	—	—	—	—	—	—
III ♂ : III ♀	NS	NS	NS	NS	—	NS	—
2. <i>Inter-eye-stripes comparison</i>							
<i>Males</i>							
I(6) : I(7)	NS	***	***	*	—	NS	—
II(6) : II(7)	—	—	—	—	—	—	—
III(6) : III(7)	***	***	***	***	NS	***	***
<i>Females</i>							
I(6) : I(7)	***	***	***	—	—	—	***
II(6) : II(7)	**	NS	**	—	—	—	*
III(6) : III(7)	***	***	***	NS	—	***	—

TABLE 9. — *Schistocerca gregaria*. Inter-group comparison of ratios (within same sex and eye-stripe category) between Groups I-III of 1954-population in India.

Abbreviations : As in text.

Groups, sex and eye-stripes	Ratios						
	P/C	M/C	H/C	E/W ₁	E/F	E/C	F/C
	<i>Inter-group comparison</i>						
<i>Males</i>							
I(6) : II(6)	NS	**	**	NS	NS	NS	***
I(6) : III(6)	NS	***	***	NS	NS	NS	***
I(7) : II(7)	—	—	—	—	—	—	—
I(7) : III(7)	NS	**	NS	NS	—	*	—
II(6) : III(6)	NS	***	*	***	NS	NS	*
II(7) : III(7)	—	—	—	—	—	—	—
<i>Females</i>							
I(6) : II(6)	**	***	NS	NS	NS	NS	**
I(6) : III(6)	*	***	*	NS	NS	NS	*
I(7) : II(7)	NS	**	NS	—	—	—	NS
I(7) : III(7)	NS	NS	*	—	—	—	—
II(6) : III(6)	*	***	***	**	NS	NS	**
II(7) : III(7)	NS	NS	NS	—	—	—	—

TABLE 10.—*Schistocerca gregaria*. Inter-population comparison of mean $\pm$ S.E. values, for characters C, P, E, F and ratios P/C, E/F, F/C between Gr. I-1954-population and other known populations (Ajmer Swarm of 1950 and Kakko Concentration of 1949 in India.

Abbreviations : *Ajm.*, Ajmer Swarm of 1950; *K.*, Kakko Concentration of 1949; For further explanation and other abbreviations, see text.

1954-Gr. I Compared with known populations	Characters				Ratios		
	C	P	E	F	P/C	E/F	F/C
<i>Males</i>							
I(6) : Ajm(6)	NS	NS	NS	NS	*	NS	NS
I(6) : K(6)	***	*	NS	NS	***	*	***
I(7) : Ajm(6)	*	NS	NS	—	***	—	—
I(7) : K(6)	NS	NS	NS	—	NS	—	—
<i>Females</i>							
I(6) : Ajm(6)	NS	NS	NS	*	NS	NS	**
I(6) : K(6)	***	NS	NS	***	***	***	***
I(6) : K(7)	—	—	*	***	—	***	—
I(7) : Ajm(6)	NS	NS	—	NS	*	—	***
I(7) : K(6)	NS	NS	—	NS	NS	—	NS
I(7) : K(7)	—	—	—	NS	—	—	—

TABLE 11.—*Schistocerca gregaria*. Inter-population comparison of mean $\pm$ S.E. values, for characters C, P, E, F and ratios P/C, E/F, F/C, between Grs. II and III of 1954-population and other known populations (Ajmer Swarm of 1950 and Kakko Concentration of 1949) in India.

Abbreviations : As in Table 10.

1954-Gr. II and III compared with known populations	Characters				Ratios		
	C	P	E	F	P/C	E/F	F/C
<i>Males</i>							
II(6) : Ajm(6)	**	NS	**	*	***	NS	NS
II(6) : K(6)	***	***	*	***	***	***	***
II(7) : Ajm(6)	—	—	—	—	—	—	—
II(7) : K(6)	—	—	—	—	—	—	—
<i>Females</i>							
II(6) : Ajm(6)	NS	NS	NS	*	NS	*	*
II(6) : K(6)	***	NS	***	***	***	***	***
II(6) : K(7)	—	—	**	***	—	***	—
II(7) : Ajm(6)	NS	NS	NS	NS	NS	—	NS
II(7) : K(6)	NS	NS	NS	NS	NS	—	NS
II(7) : K(7)	—	—	NS	NS	—	—	—
<i>Males</i>							
III(6) : Ajm(6)	**	NS	*	**	***	NS	NS
III(6) : K(6)	***	***	**	***	***	***	***
III(7) : Ajm(6)	***	NS	NS	NS	***	***	***
III(7) : K(6)	NS	NS	NS	NS	NS	NS	NS
<i>Females</i>							
III(6) : Ajm(6)	NS	NS	NS	**	NS	NS	*
III(6) : K(6)	***	**	***	***	***	***	***
III(6) : K(7)	—	—	**	***	—	***	—
III(7) : Ajm(6)	NS	*	NS	—	**	—	—
III(7) : K(6)	NS	NS	NS	—	NS	—	—
III(7) : K(7)	—	—	NS	—	—	—	—

TABLE 12. — *Schistocerca gregaria*. Inter-population comparison of mean $\pm$ S.E. values for morphometric characters between 1954-Groups (I-III) and 1955-Gr. I population in India.

Abbreviations : As in text.

Groups		Characters							
1954	1955	O	C	P	H	M	E	W ₁	F
<i>Males</i>									
I(6) : I(6)		NS	NS	*	NS	NS	NS	NS	NS
I(6) : I(7)		NS	NS	NS	NS	NS	NS	NS	NS
I(7) : I(6)		NS	NS	NS	NS	NS	NS	NS	NS
I(7) : I(7)		NS	NS	NS	NS	NS	NS	NS	NS
<i>Females</i>									
I(6) : I(6)		NS	NS	**	NS	NS	NS	NS	NS
I(6) : I(7)		—	—	—	—	—	—	—	—
I(7) : I(6)		**	NS	**	***	***	—	NS	**
I(7) : I(7)		—	—	—	—	—	—	—	—
<i>Males</i>									
II(6) : I(6)		**	NS	**	NS	NS	*	***	*
II(6) : I(7)		NS	***	NS	NS	NS	NS	NS	*
II(7) : I(6)		—	—	—	—	—	—	—	—
II(7) : I(7)		—	—	—	—	—	—	—	—
<i>Females</i>									
II(6) : I(6)		NS	NS	**	NS	NS	NS	NS	NS
II(6) : I(7)		—	—	—	—	—	—	—	—
II(7) : I(6)		NS	NS	**	NS	NS	NS	NS	***
II(7) : I(7)		—	—	—	—	—	—	—	—
<i>Males</i>									
III(6) : I(6)		*	NS	**	NS	**	**	NS	NS
III(6) : I(7)		NS	***	NS	NS	NS	NS	NS	**
III(7) : I(6)		NS	***	NS	NS	NS	NS	NS	***
III(7) : I(7)		NS	NS	NS	NS	NS	NS	NS	NS
<i>Females</i>									
III(6) : I(6)		NS	NS	NS	NS	***	NS	NS	NS
III(6) : I(7)		—	—	—	—	—	—	—	—
III(7) : I(6)		NS	NS	***	NS	NS	**	NS	—
III(7) : I(7)		—	—	—	—	—	—	—	—

TABLE 13. — *Schistocerca gregaria*. Inter-population comparison of mean $\pm$ S.E., for various ratios between 1954-Groups (I-III) and 1955-Gr. I-population.

Groups		Ratios						
1954	1955	P/C	M/C	H/C	E/W ₁	E/F	E/C	F/C
<i>Males</i>								
I(6) : I(6)		**	**	*	NS	NS	***	NS
I(6) : I(7)		NS	*	**	NS	**	NS	***
I(7) : I(6)		***	***	***	*	—	**	—
I(7) : I(7)		NS	NS	NS	NS	—	NS	—
<i>Females</i>								
I(6) : I(6)		NS	NS	NS	NS	NS	NS	NS
I(6) : I(7)		—	—	—	—	—	—	—
I(7) : I(6)		***	***	***	—	—	—	***
I(7) : I(7)		—	—	—	—	—	—	—
<i>Males</i>								
II(6) : I(6)		NS	NS	NS	NS	NS	***	*
II(6) : I(7)		*	*	***	NS	***	***	***
III(7) : I(6)		—	—	—	—	—	—	—
II(7) : I(7)		—	—	—	—	—	—	—
<i>Females</i>								
II(6) : I(6)		***	NS	NS	NS	NS	**	NS
II(6) : I(7)		—	—	—	—	—	—	—
II(7) : I(6)		NS	NS	*	—	—	—	*
II(7) : I(7)		—	—	—	—	—	—	—
<i>Males</i>								
III(6) : I(6)		***	*	NS	NS	NS	***	*
III(6) : I(7)		*	**	***	NS	***	***	***
III(7) : I(6)		***	***	***	**	***	***	***
III(7) : I(7)		NS	NS	NS	NS	NS	NS	NS
<i>Females</i>								
III(6) : I(6)		***	***	*	NS	NS	*	NS
III(6) : I(7)		—	—	—	—	—	—	—
III(7) : I(6)		***	NS	*	NS	—	***	—
III(7) : I(7)		—	—	—	—	—	—	—

TABLE 14. — *Schistocerca gregaria*. Inter-population comparison of mean $\pm$ S. E. values for morphometric characters C, P, E, F and ratios P/C, E/F, F/C-between Gr. I-1954 population and typical phases (*gregaria* and *solitaria*) in India.

Abbreviations : As in text.

1954-Gr. I compared with typical phases	Characters				Ratios		
	C	P	E	F	P/C	E/F	F/C
<i>Males</i>							
I(6) : greg. (6)	**	NS	NS	NS	***	NS	NS
I(6) : sol. (6)	—	—	NS	***	—	***	—
I(6) : sol. (7)	—	—	NS	***	—	***	—
I(7) : greg. (6)	NS	NS	NS	—	***	—	—
I(7) : sol. (6)	—	—	NS	—	—	—	—
I(7) : sol. (7)	—	—	NS	—	—	—	—
<i>Females</i>							
I(6) : greg. (6)	NS	*	NS	*	**	NS	*
I(6) : sol. (6)	—	—	***	***	—	***	—
I(6) : sol. (7)	—	—	***	***	—	***	—
I(7) : greg. (6)	*	*	—	NS	***	—	—
I(7) : sol. (6)	—	—	—	NS	—	—	—
I(7) : sol. (7)	—	—	—	NS	—	—	—

TABLE 15. — *Schistocerca gregaria*. Inter-population comparison of mean $\pm$ S.E. values for morphometric characters C, P, E, F and ratios P/C, E/F and F/C between Grs. II and III — 1954-population and typical phases (*gregaria* and *solitaria*) in India.

Abbreviations : As in text.

1954-Gr. II and III compared with typical phases.	Characters				Ratios		
	C	P	E	F	P/C	E/F	F/C
<i>Males</i>							
II(6) : greg. (6)	***	*	NS	**	***	NS	NS
II(6) : sol. (6)	—	—	NS	***	—	***	—
II(6) : sol. (7)	—	—	NS	***	—	***	—
II(7) : greg. (6)	—	—	—	—	—	—	—
II(7) : sol. (6)	—	—	—	—	—	—	—
II(7) : sol. (7)	—	—	—	—	—	—	—
<i>Females</i>							
II(6) : greg. (6)	NS	*	NS	NS	***	NS	NS
II(6) : sol. (6)	—	—	***	***	—	***	—
II(6) : sol. (7)	—	—	***	***	—	***	—
II(7) : greg. (6)	NS	*	NS	*	NS	—	*
II(7) : sol. (6)	—	—	NS	NS	—	—	—
II(7) : sol. (7)	—	—	NS	NS	—	—	—
<i>Males</i>							
III(6) : greg. (6)	***	NS	NS	***	***	*	NS
III(6) : sol. (6)	—	—	NS	***	—	***	—
III(6) : sol. (7)	—	—	NS	***	—	***	—
III(7) : greg. (6)	***	NS	NS	NS	***	***	***
III(7) : sol. (6)	—	—	NS	NS	—	NS	—
III(7) : sol. (7)	—	—	NS	NS	—	NS	—
<i>Females</i>							
III(6) : greg. (6)	*	NS	NS	**	***	NS	NS
III(6) : sol. (6)	—	—	***	***	—	***	—
III(6) : sol. (7)	—	—	***	***	—	***	—
III(7) : greg. (6)	NS	*	*	—	***	—	—
III(7) : sol. (6)	—	—	NS	—	—	—	—
III(7) : sol. (7)	—	—	NS	—	—	—	—

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