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(A Journal of Indian Zoology)

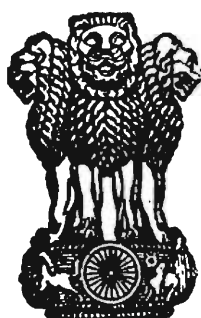
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ON SOME FRESHWATER CILIATES (PROTOZOA) FROM CALCUTTA AND ITS ENVIRONS

By

K. K. MAHAJAN AND K. N. NAIR

Zoological Survey of India, Calcutta

(With 1 Table and 4 Text-figures.)

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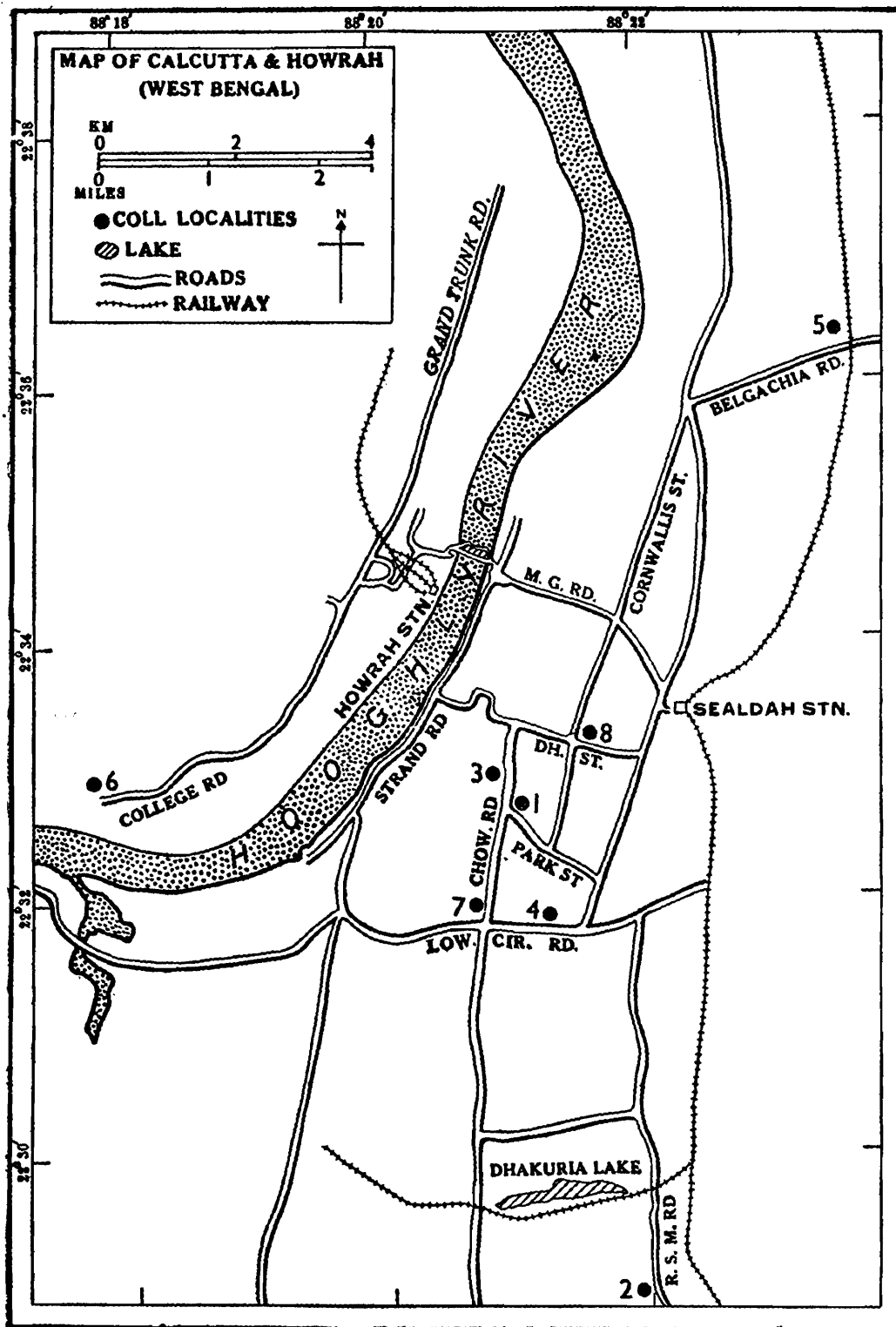
I—INTRODUCTION

(a) General

This paper deals with nineteen species and one variety of freshwater ciliates (Protozoa) collected during the faunistic survey of the freshwater

-Rec. zool. Surv. India, 63 (1—4), 1971.

Protozoa of the perennial and temporary ponds and pools of Calcutta and its vicinity (Sibpur, District Howrah) in West Bengal. (Text-fig.-1)



TEXT-FIG. 1.—Sketch map of Calcutta city and its environs, showing the localities of collection for Protozoa.

1. Indian Museum Tank. 2. Jadavpur (Indian Association for the Cultivation of Science compound). 3. Manohar Das Thadak (Tank). 4. Minto Square Tank. 5. Shahid Colony. 6. Sibpur (Indian Botanic Garden). 7. St. Paul's Cathedral Tank. 8. Wellington Square Park.

CHOW. RD., Chowringhee Road ; DH. ST., Dharamtalla Street; H. R. STN., Howrah Railway Station ; M. G. RD., Mahatma Gandhi Road ; R.S.M. RD., Raja Subodh Mullick Road.

Very little attention has hitherto been devoted to the ciliate fauna of this area. The earliest account is that of Cantor (1842) in which he referred about G. W. Grant (no published work by Grant) as having observed in Calcutta six species of freshwater Protozoa. Among these, only two were ciliates, viz., *Coleps hirtus* Ehrenberg and *Vorticella patellina* Müller. Simmons (1889, 1891) recorded ciliates belonging to 12 genera from Calcutta, without giving any specific identification of the forms. Ghosh (1918-29) recorded 29 species of free-living ciliates from Calcutta and its vicinity. Only 18 species belonging to 11 genera are directly referred as pondwater forms and the rest as either sewer-water or vegetable-infusion forms. Nair (1960) reported one new record of a ciliate from Sibpur (Howrah District).

A survey of the freshwater ciliates of Calcutta was started by the Zoological Survey of India a few years ago and the present paper is a result of that work. Nineteen species (and a new variety) belonging to 14 genera, 11 families and 6 orders are described here. Of these, 18 species are new records from India (as restricted after separation of Pakistan—some having been reported from Lahore, West Pakistan, by Bhatia, (1936), and 4 are new records from Calcutta. The species *Neobursaridium gigas* Balech is reported here for the first time from Asia.

The descriptions are mainly based on observations made on living specimens kept in hanging drops of natural medium, but the number of examples mentioned under 'Material' for each species refers only to those present on prepared slides, and not to the number actually observed in the living condition which was usually about 20-30. 'Methocel' was used for slowing down the fast-moving forms, and Lugol's solution was used as a killing agent and also for detecting the peripheral organellae. Schaudinn's fixative and Carnoy's fluid were used as fixatives. The majority of the specimens were stained with Heidenhain's iron haematoxylin and counterstained with eosin. Some specimens were also stained with Delafields' haematoxylin. Silver impregnation (dry method) was also employed in some cases.

(b) Acknowledgements

Our thanks are due to John O. Corliss, Associate Professor of Zoology, University of Illinois, Illinois, U. S. A., for the identification of our material of *Neobursaridium gigas*. We are highly grateful to Dr. M. L. Roonwal, Director, Zoological Survey of India, for his helpful suggestions and guidance in the preparation of this paper. Thanks are due to the staff of the Protozoology Section for the help rendered in collecting some of the specimens.

II—LIST OF CALCUTTA CILIATES DEALT WITH

In the following list, the orders, genera and species are given a running number.

Records of the Zoological Survey of India

Class CILIATA Perty

Subclass (A) HOLOTRICHA Stein

Order 1. GYMNOSTOMATIDA Bütschli

Suborder (i) RHABDOPHORINA Faure-Fremiet

Family (a) ENCHELYIDAE Ehrenberg

Genus (1) *Prorodon* Ehrenberg1. *Prorodon edentatus* Claparède & Lachmann2. *Prorodon discolor* (Ehrenberg)3. *Prorodon teres* Ehrenberg

Family (b) LOXODIDAE Bütschli

Genus (2) *Loxodes* Ehrenberg4. *Loxodes magnus* Stokes5. *Loxodes striatus* (Engelmann)

Order 2. TRICHOSTOMATIDA Bütschli

Family (c) COLPODIDAE Ehrenberg

Genus (3) *Colpoda* Müller6. *Colpoda aspera* Kahl

Family (d) PLAGIOPYLIDAE Schewiakoff

Genus (4) *Plagiopyla* Stein7. *Plagiopyla nasuta* Stein

Order 3. HYMENOSTOMATIDA Délage and Hérour

Suborder (i) TETRAHYMENINA Faure-Fremiet

Family (e) TETRAHYMENIDAE Corliss

Genus (5) *Glaucoma* Ehrenberg8. *Glaucoma pyriformis* (Ehrenberg)

Suborder (ii) PLEURONEMATINA Faure-Fremiet

Family (f) PLEURONEMATIDAE Faure-Fremiet

Genus (6) *Pleuronema* Dujardin

9. *Pleuronema crassum* Dujardin

Order 4. PERITRICHIDA Stein

Suborder (i) *SESSILINA* Kahl

Family (g) VAGINICOLIDAE de Fromentel

Genus (7) *Platycola* Kent

10. *Platycola decumbens* (Ehrenberg)

Genus (8) *Pyxicola* Kent

11. *Pyxicola affinis* Kent

Genus (9) *Vaginicola* Lamarck

12. *Vaginicola crystallina* Ehrenberg

Subclass (B) *SPIROTRICHA* Bütschli

Order 5. HETEROTRICHIDA Stein

Suborder (i) *HETEROTRICHINA* Stein

Family (h) BURSARIIDAE Perty

Genus (10) *Neobursaridium* Balech

13. *Neobursaridium gigas* Balech

Family (i) GYROCORYTHIDAE Stein

Genus (11) *Caenomorpha* Perty

14. *Caenomorpha medusula* Perty

Genus (12) *Metopus* Claparède & Lachmann

15. *Metopus es es* Müller

15. (a) *Metopus es* Müller var. *minor*

16. *Metopus nasutus* Da Cunha

17. *Metopus spiralis* Smith

Family (j) SPIROSTOMATIDAE Stein

Genus (13) *Blepharisma* Perty

18. *Blepharisma intermedium* Bhandary

Order 6. OLIGOTRICHIDA Bütschli

Family (k) HALTERIIDAE Claparède & Lachmann

Genus (14) *Halteria* Dujardin19. *Halteria grandinella* (Müller)

III—KEY TO SPECIES OF CALCUTTA CILIATES DEALT WITH

- 1 (6). Body housed in a lorica, animal sedentary.
- 2 (3). Animal with an operculum (to close the lorica) and a stalk. *Pyxicola affinis*
- 3 (2). Animal without an operculum and without a stalk.
- 4 (5). Lorica straight, attached by posterior end. *Vaginicola crystallina*
- 5 (4). Lorica decumbent, fixed entirely on one side *Platycola decumbens*
- 6 (1). Body not housed in a lorica, animal free-living.
- 7 (8). Body ciliation restricted to anterior end, body with bristles . . . *Halteria grandinella*
- 8 (7). Body ciliation all over the body, body without bristles.
- 9 (24). Body ciliation uniform, no adoral zone of spirally arranged cilia.
- 10 (15). Cytostome apical, followed by a pharyngeal tube.
- 11 (12). Pharyngeal tube simple, without trichites. *Prorodon edentatus*
- 12 (11). Pharyngeal tube with trichites.
- 13 (14). Posterior end of body narrow . . . *Prorodon discolor*
- 14 (13). Posterior end of body rounded . . . *Prorodon teres*
- 15 (10). Cytostome not apical but on one side at anterior part.

- 16 (17). With denticles above the peristomial region. *Colpoda aspera*
- 17 (16). Without denticles.
- 18 (19). Peristome at right angles to body and without tetrahymenous structures . . . *Plagiopyla nasuta*
- 19 (18). Peristome obliquely placed and with tetrahymenous structures . . . *Glaucoma pyriformis*
- 20 (21). Peristome with a large undulating membrane; body oval *Pleuronema crassum*
- 21 (20). Peristome without any undulating membrane; body leaf-like; peristome sickle-shaped
- 22 (23). with two macronuclei *Loxodes striatus*
- 23 (22). with more than two macronuclei *Loxodes magnus*
- 24 (9). Body ciliation not uniform; generally buccal ciliation well developed; with adoral zone of membranellae.
- 25 (26). Animal pink coloured *Blepharisma intermedium*
- 26 (25). Animal colourless.
- 27 (28). Body purse-shaped; with two contractile vacuoles having radiating canals *Neobursaridium gigas*
- 28 (27). Body not purse-shaped; with a single contractile vacuole.
- 29 (30). With a caudal projection to the body *Caenomorpha medusula*]
- 30 (29). Without caudal projection.
- 31 (32). With a proboscis-like process at anterior end *Metopus nasutus*
- 32 (31). Without a proboscis-like process at anterior end.
- 33 (34). Body sigmoidal in shape; the macronucleus nearly sausage-shaped and lying below peristome *Metopus es*
- 34 (33). Body more oval; macronucleus spherical and placed above peristome *Metopus spiralis*

IV—SYSTEMATIC ACCOUNT

1. *Prorodon edentatus* Claparède & Lachmann

(Text-fig. 2A)

1858. *Prorodon edentatus* Claparède & Lachmann, *Mém. Inst. Genevois*, Geneve, 6, pp. 320-321, pl. XVIII, fig. 4.
1930. *Prorodon edentatus* : Kahl, *Urtiere oder Protozoa* (in : Dahl's *Tierwelt Dtsch.*), Jena, pt. 18, p. 73.
1936. *Prorodon edentatus* : Bhatia, *Faun. Brit. India*, London (Taylor & Francis, Ltd.), Protozoa : Ciliophora, p. 82.

Material.—2 examples : Wellington Square fountain tank, Calcutta, 24. v. 1959.

Diagnosis.—Body ovoid, with green algal fragments in endoplasm ; mouth terminal and eccentric, followed by a long tube-like pharynx extending upto middle of the body diagonally ; macronucleus single and oval, slightly elongate.; with a single contractile vacuole at the posterior end ; body ciliation uniform ; average size $43 \times 30 \mu$.

Distribution.—*Calcutta* : As above (first-record from India). *Elsewhere* : Lahore, W Pakistan.

Remarks.—Our specimens are very small. Kahl (1930) recorded a length of $100-150 \mu$ and Bhatia (1936) gave the size as $74 \times 24 \mu$. The species is not common, and is observed in water with plenty of *Oscillatoria*.

2. *Prorodon discolor* (Ehrenberg)

(Text-fig. 2B)

1835. *Holophrya discolor* Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin [1833], p. 251.
1930. *Prorodon (Holophrya) discolor* Ehrenberg : Kahl, *Urtiere oder Protozoa*, (in: Dahl's *Tierwelt Dtsch.*), Jena, pt. 18, p. 76, fig. 8 (4).

Material.—One example : Wellington Square fountain tank, Calcutta, 20. vi. 1959.

Diagnosis.—Body oval, narrower posteriorly; whitish in colour when not full with food vacuoles ; covered with fine cilia arranged in longitudinal rows, ciliary lines converging at the aboral end ; mouth termino-central, followed by an oral basket with trichites which extends for about one-fourth the distance from the anterior end ; macronucleus single, rounded ; contractile vacuole situated at the posterior end ; average size $155 \times 92 \mu$.

Distribution.—*Calcutta* : As above (first record from India). *Elsewhere* : Germany.

Remarks.—Our specimen is longer than those reported by Kahl (1930, length 100-130 μ). It resembles *P. platydon* Blochmann in having the oral basket placed at an angle to the long axis of the body but differs in body-size (length of *P. platydon* ranges between 200-300 μ).

3. *Prorodon teres* Ehrenberg

(Text-fig. 2c)

1838. *Prorodon teres* Ehrenberg, *Die Infusionsthierchen als vollkommene Organismen*, Leipzig, p. 316, pl. XXXII, fig. 11.

1930. *Prorodon teres* : Kahl, *Urtiere oder Protozoa*, (in : *Dahl's Tierwelt Dtsch.*), Jena, pt. 18, p. 80, fig. 8 (10-13).

1936. *Prorodon teres* : Bhatia, *Faun. Brit. India*, London (Taylor & Francis, Ltd.), Protozoa : Ciliophora, p. 84, fig. 86.

Material.—2 examples : Wellington Square fountain tank, Calcutta, 5. iv. 1959.

Diagnosis.—Body ovoid ; anterior end rather truncated, posterior end more rounded ; body ciliation uniform, with very fine cilia ; mouth slit-like, opening into an oral basket supported by trichites and extending about one-fourth the length from the anterior end ; contractile vacuole terminal ; macronucleus spherical ; size 115 $\times$ 86 μ .

Distribution.—*Calcutta* : As above (first record from India). *Elsewhere* : Lahore, W. Pakistan.

Remarks.—The specimens resemble *P. discolor* in fixed preparations but can be distinguished from the latter in having a more rounded posterior end and a waist-like depression in the middle portion as observed in locomotion. They are of medium size. Kahl (1930) recorded a length of 130-200 μ and Bhatia (1936) gave the size 63-84 $\times$ 45 μ .

4. *Loxodes magnus* Stokes

(Text-fig. 2E)

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

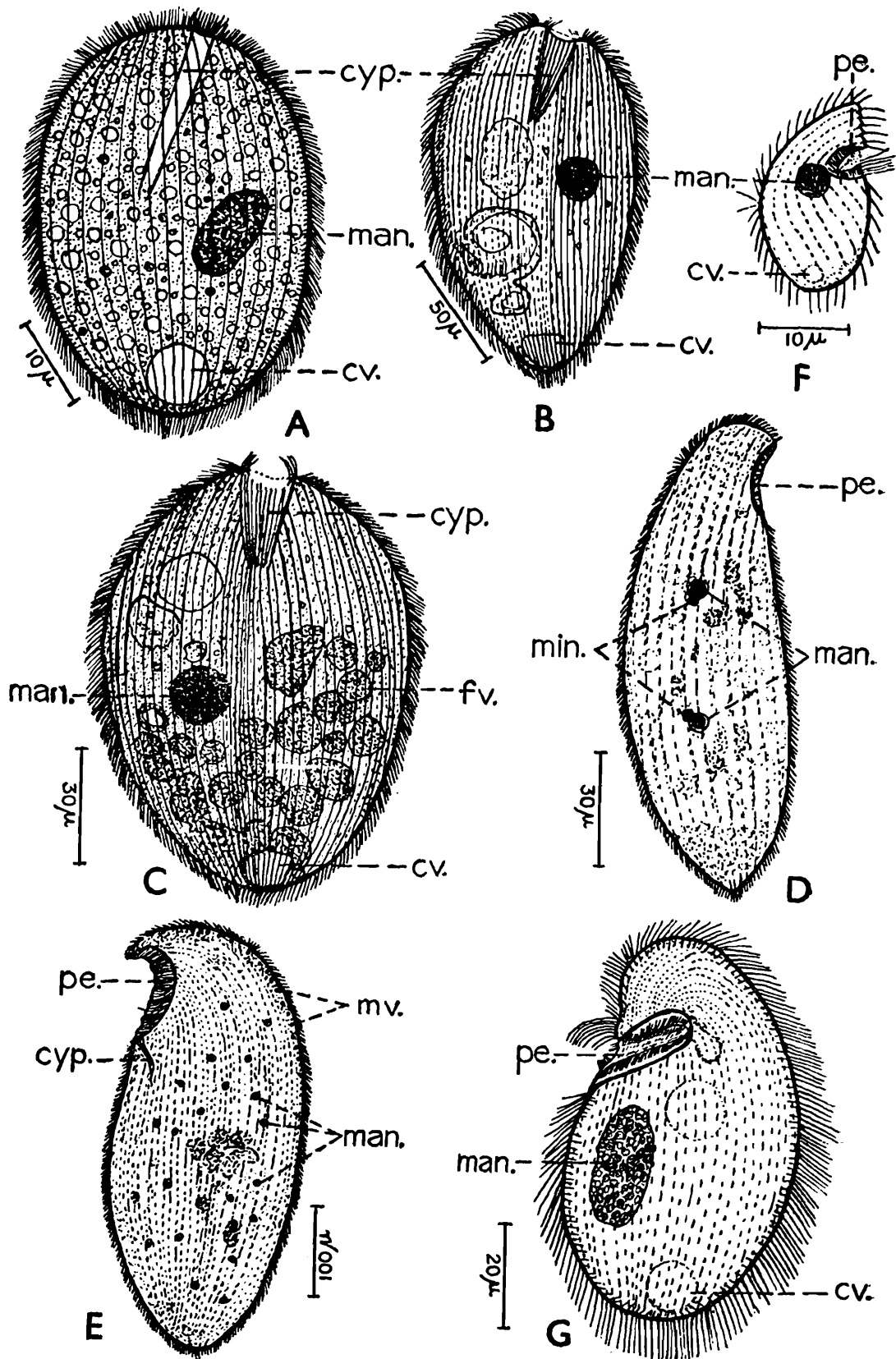
1931. *Loxodes magnus* : Kahl, *Urtiere oder Protozoa* (in : *Dahl's Tierwelt Dtsch.*), Jena, pt. 21, p. 215, fig. 35(1).

Material.—3 examples : A Tank in Jadavpur, Calcutta, 30. xi. 1961.

Diagnosis.—Large leaf-like form with a bent beak-like anterior end ; slightly brownish in colour ; covered with very fine small cilia arranged in longitudinal rows ; a few refractile bodies (Müller's vesicles) in a row present at the dorsal margin ; mouth sickle-shaped with a conical tube-like pharynx ; with many macronuclei scattered in the endoplasm ; no contractile vacuole and micronuclei observed, size 368 $\times$ 231 μ .

Distribution.—*Calcutta* : As above (first record from India). *Elsewhere* : North America.

Remarks.—The length as given by Stokes (1887) is 700μ in extended condition but our specimens average only 368μ . The row of bristle-like cilia shown on the ventral margin by Stokes in his drawings is absent in our specimens.



TEXT-FIG. 2.—Freshwater Ciliates of Calcutta and its environs.

(A) *Prorodon edentatus* Claparède & Lachmann. (B) *Prorodon discolor* (Ehrenberg). (C) *Prorodon teres* Ehrenberg. (D) *Loxodes striatus* (Engelmann). (E) *Loxodes m. agnus* Stokes. (F) *Colpoda aspera* Kahl. (G) *Plagiopyla nasuta* Stein. For lettering of text-figures please see p. 22.

5. *Loxodes striatus* (Engelmann)

(Text-fig. 2D)

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

1917. *Loxodes striatus* (Engelmann) : Penard, *Rev. suisse Zool.*, Genève, 25, pp. 471-476, figs. 5-12.

Material.—(i) 6 examples : A Tank in Jadavpur, Calcutta, 24. xi. 1959;
(ii) 2 examples : A Tank in Shahid Colony, Calcutta, 29. xi. 1962.

Diagnosis.—Body flattened and leaf-like, with a beak-like anterior end ; body ciliation uniform, cilia fine and small, cytostome cleft along the curved anterior part and followed by a tube-like pharyngeal tube, with two vesicular macronuclei ; the two micronuclei situated at the posterior pole of the anterior and the anterior pole of the posterior macronucleus ; size $125 \times 43 \mu$.

Distribution.—*Calcutta* : As above. *Elsewhere* : India : Srinagar (Kashmir).

Remarks.—The specimens resemble *Loxodes vorax* Stokes, 1887 in size but differ in having a pointed posterior end and in the disposition of micronuclei. Commonly observed with plenty of ingested algal fragments and diatoms. No Müllers corpuscles and tactile bristles observed. Specimens are small, nearly half of those recorded length by Kahl (length 200μ).

6. *Colpoda aspera* Kahl

(Text-fig. 2F)

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

1940. *Colpoda aspera* : Burt, *Trans. Amer. micr. Soc.*, Lancaster, 59 (4), pp. 422-425, figs. 2E ; 3E-G ; 4A-D.

Material.—4 examples : A Tank in Shahid Colony, Calcutta, 18. xii. 1962.

Diagnosis.—Body somewhat bean-shaped, anteriorly more narrowed ; with 5-7 frontal dentations above the cytostome ; cytostome situated at the bottom of a depression located about one-third the length from anterior end ; body ciliation uniform ; contractile vacuole single and posterior ; macronucleus spherical and centrally placed ; size $24 \times 12 \mu$.

Distribution.—*Calcutta* : As above (first record from India). *Elsewhere* : Germany.

Remarks.—The specimens were observed in water samples mixed with hay infusion, kept in the laboratory. These resemble *Colpoda stenii* Maupas in size but differ in not having a long caudal cilia and a

beard. The specimens are of average size. Mackinnon and Hawes (1961) gave the length as 12-42 μ .

7. *Plagiopyla nasuta* Stein

(Text-fig. 2G)

1860. *Plagiopyla nasuta* Stein, *S. B. bohn. Ges Wiss.*, Prague, p. 58.

1931. *Plagiopyla nasuta* : Kahl, *Urtiere oder Protozoa* (in : Dahl's *Tierwelt Dtsch.*, Jena, pt. 21, pp. 264-265, fig. 45 (1).

1960. *Plagiopyla nasuta* : Kudo, *Protozoology*, London (Charles C. Thomas), pp. 740-741, fig. 315a.

Material.—6 examples : Minto Square Tank, Calcutta, 5. ii. 1963.

Diagnosis.—Body broadly reniform or ovoid, narrower anteriorly ; with a prominent peristome in the anterior region and a broad ventrally open groove ; cytostome situated near median line at end of the peristome ; cytopharynx long ; body ciliation uniform, cilia in peristome short except in the anterior region where a tuft of longer cilia is present ; contractile vacuole single and terminal, macronucleus rounded ; size 72 $\times$ 45 μ .

Distribution.—*Calcutta* : As above (first record from India). *Elsewhere* : Cosmopolitan.

Remarks.—Rare ; encountered in the bottom debris of pond-water kept in bottles. The striped band described by Kahl (1931) was not observed in these specimens. In certain specimens a secondary contractile vacuole was also observed, lying anterior to the terminal one. Our specimens are smaller than those of Kahl (1931, length 80-180 μ) and Kudo (1960, length 100 μ).

8. *Glaucoma pyriformis* (Ehrenberg)

(Text-fig. 3A)

1838. *Leucophys pyriformis* Ehrenberg, *Die Infusionsthierchen als vollkommene Organismen*, Leipzig, pp. 312-313, pl. XXXII, fig. 4.

1889. *Glaucoma pyriformis* (Ehrenberg) : Schewiakoff, *Bibl. zool.*, Leipzig, 5, pp. 35-36, pl. IV, figs. 54-55.

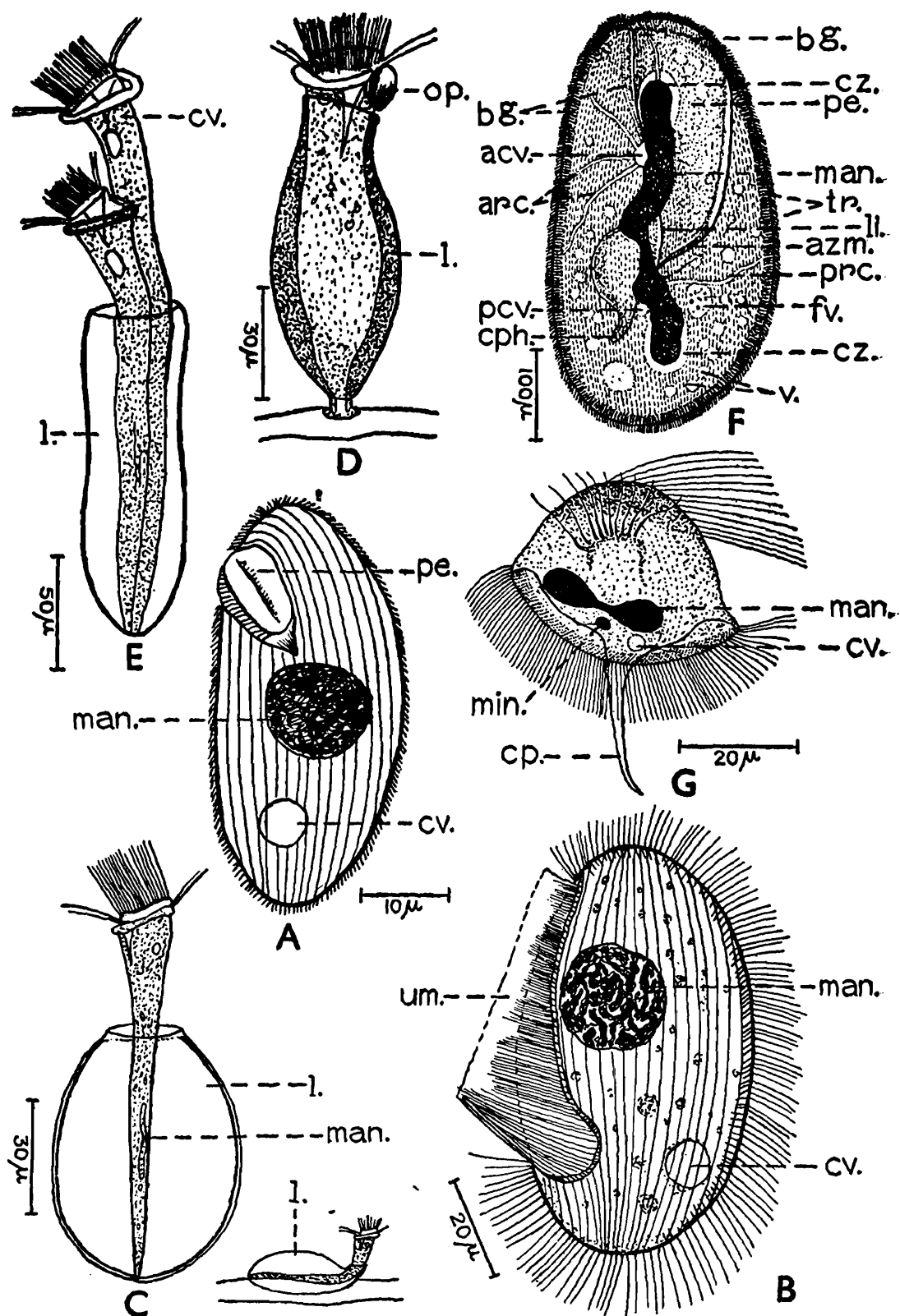
1931. *Glaucoma pyriformis* : Kahl, *Urtiere oder Protozoa* (in : Dahl's *Tierwelt Dtsch.*) Jena, pt. 21, pp. 330, fig. 58(13).

Material.—4 examples : A Tank near St. Paul's Cathedral, Calcutta, 11.ix.1963.

Diagnosis.—Body pyriform ; size small to medium, cytostome about one-fourth of the body-length ; situated in anterior third of the body, and placed a little obliquely, with an inconspicuous undulating membrane on right side of peristome and seven postoral ciliary meridians ; body ciliation uniform ; macronucleus rounded and central ; micronucleus small ; contractile vacuole single and lying in posterior one-fourth of the body, slightly towards one side ; size 52 $\times$ 22 μ .

Distribution.—*Calcutta* : As above (first record), *Elsewhere* : India : Srinagar (Kashmir).

Remarks.—Our specimens are medium-sized when compared to those of Kahl (1931, length 38-80 μ).



TEXT-FIG. 3.—Freshwater Ciliates of Calcutta and its environs (lettering as in Text-fig. 2).

(A) *Glaucoma pyriformis* (Ehrenberg). (B) *Pleuronema crassum* Dujardin. (C) *Platycola decumbens* (Ehrenberg). (D) *Pyxicola affinis* Kent. (E) *Vaginicola crystallina* Ehrenberg. (F) *Neobrusaridium gigas* Balech. (G) *Caenomorpha medusula* Perty. For lettering of text-figures please see p. 22.

9. *Pleuronema crassum* Dujardin

(Text-fig. 3B)

1841. *Pleuronema crassa* Dujardin, *Histoire nat. des Zoophytes Infusoires*, Paris, pp. 474-475, pl. vi, fig. 1 ; pl. XIV, fig. 2.
 1931. *Pleuronema crassum* : Kahl, *Urtiere oder Protozoa*, (in : Dahl's *Tierwelt Dtsch.*), Jena, pt. 21, pp. 387-388, fig. 65 (23).

Material.—4 examples : Wellington Square fountain Tank, Calcutta, 9. vi. 1960.

Diagnosis.—Body irregularly egg-shaped ; size small to medium ; peristome long and prominent ; with a prominent undulating membrane on the left border of peristome ; body with long cilia, those at the posterior portion longer than the rest ; with a single contractile vacuole in the posterior half of the body ; macronucleus spherical and lying in anterior half of body ; a micronucleus present close to macronucleus ; size $79 \times 49 \mu$.

Distribution.—Calcutta : As above. Elsewhere : Germany.

Remarks.—Very rare ; found in stagnant water with a little decaying vegetation. The size of our specimens agree with those of Kahl (1931, length 70-120 μ). In one specimen three deeply stained micronuclei-like structures were seen around the macronucleus.

10. *Platycola decumbens* (Ehrenberg)

(Text-fig. 3C)

1830. *Vaginicola decumbens* Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin, p. 41.
 1881. *Platycola decumbens* (Ehrenberg) : Kent, *A Manual of the Infusoria*, London (David Bogue), p. 731, pl. XL, figs. 33 and 34.
 1935. *Platycola decumbens* : Kahl, *Urtiere oder Protozoa* (in : Dahl's *Tierwelt Dtsch.*), Jena, pt. 30, p. 791, fig. 146 (29).

Material.—One example : Manohar Das Thadak (Tank), Calcutta, 16.X.1963.

Diagnosis.—Animalcule *Vorticella*-like ; when fully extended, it projects perpendicular to the attached lorica ; the latter broadly oval, colourless to yellow, decumbent and attached to the substratum entirely on one side. A small collar-like projection ('neck') present at the anterior end of lorica ; size of lorica $105 \times 82 \mu$.

Distribution.—Calcutta : As above (first record from India). Elsewhere : England.

Remarks.—Very rare ; found attached to the submerged twigs ; lorica with two animalcules are also reported but are rare. The lorica of our specimen is smaller than those of Kahl (1935, length 90 μ). Simmons (1891) had reported a species of *Platycola* from Calcutta, but it was not identified correctly.

11. *Pyxicola affinis* Kent

(Text-fig. 3D)

1881. *Pyxicola affinis* Kent, *A Manual of the Infusoria*, London (David Bogue), p. 727, pl. XL, figs. 28 and 29.
 1935. *Pyxicola affinis* : Kahl, *Urtiere oder Protozoa*, (in : Dahl's *Tierwelt Dtsch.*), Jena, pt. 30, p. 787, figs. 146 (1 & 2).

Material.—Several examples : The Indian Museum Tank, Calcutta, 8. x. 1963.

Diagnosis.—Lorica urceolate, slightly curved at anterior end and a little narrowed beneath the aperture end ; lorica colourless to deep brown according to the age ; attached to the substratum by a circular disc formed at the end of short, stumpy stalk which is colourless. Animalcule *Vorticella*-like, single in a lorica ; when fully extended showing a colourless to light brown operculum on the anterolateral surface of a conical protuberance that projects from beneath the peristome border ; size of lorica $76 \times 26\mu$, length of stalk 6-7 μ .

Distribution.—*Calcutta* : As above (first record from India). *Elsewhere* : Cosmopolitan.

Remarks.—The stalk of lorica is small and similar to that of *P. carteri* (Kent), 1880-82 but the even nature of the lorica margin distinguishes it from that species. The stalk of our specimens are smaller than those drawn by earlier authors.

12. *Vaginicola crystallina* Ehrenberg

(Text-fig. 3E)

1830. *Vaginicola crystallina* Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin, p. 41.
 1862. *Vaginicola crystallina* : Mitchell, *Quart. J. Sci.*, (N. S.), London, 2, p. 60.
 1874. *Vaginicola crystallina* : Fromentel, *Etudes sur les Microzoaires ou Infusoires Proprement dits*, Paris, p. 248.
 1935. *Vaginicola crystallina* : Kahl, *Urtiere oder Protozoa* (in : Dahl's *Tierwelt Dtsch.*), Jena, pt. 30, p. 762, fig. 142 (15).

Material.—One example : The Indian Museum Tank, Calcutta, 8.x. 1963.

Diagnosis.—Animalcule elongated and housed in a lorica ; lorica attached to substratum with its posterior end transparent, colourless, vase-like ; lorica with two individuals very common, one of them being invariably shorter ; size of lorica $117 \times 39\mu$.

Distribution.—*Calcutta* : As above (first record from India). *Elsewhere* : Cosmopolitan in freshwater bodies.

Remarks.—Our specimens resemble those drawn by Fromentel (1874). The size is similar to that recorded by Kahl (1935, length 120 μ). The animalcules are colourless, no green granules having been observed. Mitchell (1862) reported a species of *Vaginicola* from Bangalore, but he did not determine the species.

13. *Neobursaridium gigas* Balech

(Text-fig. 3F)

1941. *Neobursaridium gigas* Balech, *Physis*, Buenos Aires, 49, pp. 29-35.1962. *Neobursaridium gigas* : Nilsson, *J. Protozool.*, New York, 9(3), pp. 273-276, figs. 1-5.*Material*.—5 examples : Ponds in Jadavpur, Calcutta, 4. i. 1963.

Diagnosis.—Body large, broadly ovate and purse-shaped ; anterior end truncated, the anterior left side slightly lower and more arched than the right ; ventral surface flattened, dorsal surface convex ; body ciliation uniform and dense with short cilia ; a uniform row of trichocysts present below the ectoplasm ; a layer of oval and spherical brown granules present below the trichocyst layer ; peristome wide and conspicuous, starting from anterior end, then taking a turn to right, there after to the dorsal left, then entering a bulbous portion inside endoplasm and finally ending in a conical "cytopharynx". The conical tube usually pointing straight towards the posterior end but in some cases turning towards one side. Adoral zone of membranellae short and situated on the left side of peristome ; the right side of peristome drawn as a flap ; macronucleus long, dumbbell-shaped, placed in the middle of body parallel to longitudinal axis of body ; anterior half of macronucleus slightly longer than the posterior half ; clear and colourless zone observed around both ends of macronucleus ; micronuclei not observed ; with two contractile vacuoles, each with 6-9 long radiating canals ; the anterior contractile vacuole situated in the anterior one-third of body, the posterior vacuole in the posterior one-third, each vacuole provided with two excretory pores ; body provided with many vacuoles of varied sizes ; bodysize $514 \times 264 \mu$, length of macronucleus 353μ .

Distribution.—*Calcutta* : As above (first record from India and Asia). *Elsewhere* : Argentina (S. America) ; and central Africa.

Remarks.—A rare species found only in ponds with plenty of water hyacinth and decaying vegetation. Superficially resembles *Bursaria truncatella* Müller, in size and in having a truncated anterior end. Seen creeping on the sides of bottles containing the culture medium, rarely seen swimming.

14. *Caenomorpha medusula* Perty

(Text-fig. 3G)

1852. *Caenomorpha medusula* Perty, *Zur Kenntnis kleinster Lebenstformen*, Bern, p. 140.1932. *Caenomorpha medusula* : Kahl, *Urtiere oder Protozoa* (in : *Dahl's Tierwelt Dtsch.*), Jena, pt. 25, p. 430, fig. 71 (30).*Material*.—4 examples : A Tank in Shahid Colony, Calcutta, 5.i.1962.

Diagnosis.—Small, bell-shaped animalcules with a long caudal projection at posterior region. Peristome situated at base of the bell-shaped body ; with long and dense cilia on the posterior margin of the bell-shaped part ; the long cilia in the anterior region in a bunch ; contractile

vacuole single ; macronucleus dumbbell-shaped ; a micronucleus lying just below the connecting strand of the ends of macronucleus ; the animal moving by rotating on its long axis ; size $60 \times 19 \mu$.

Distribution.—*Calcutta* : As above (first record from India). *Elsewhere* : Germany.

Remarks.—These specimens are very similar to *C. medusula* var. *lata* Kahl in shape and disposition of nuclei, but are smaller than Kahl's forms (1932, $150 \times 130 \mu$).

15. *Metopus es* Müller

(Text-fig. 4A)

1786. *Metopus es* Müller, *Animalium Infusoria fluviat. et Marina etc.*, Havniae et Lipsiae, p. 126.

1932. *Metopus es* : Kahl, *Urtiere oder Protozoa* (in : Dahl's *Tierwelt Disch.*), Jena, pt. 25, pp. 416-417, figs. 70 (1-2).

Material.—One example : A Tank in Shahid Colony, Calcutta, 17.ii.1962.

Diagnosis.—Body characteristically sigmoidal in shape ; peristome prominent at the anterior half of the body, runs diagonally from left to right on the ventral side ; contractile vacuole prominent and terminal ; body covered by long cilia arranged in longitudinal row, few longer cilia at posterior end ; macronucleus single, sausage shaped and usually just below the peristome ; micronucleus single and close to the macronucleus ; size $92 \times 26 \mu$.

Distribution.—*Calcutta* : As above. *Elsewhere* : In India marine form recorded from Waltair Coast by Ganapati & Rao (1958).

Remarks.—Very rare forms, usually found moving among the decaying vegetation and very sensitive to disturbance.

15a. *Metopus es* Müller n. var. *minor*

(Text-fig. 4B and Table 1)

Material.—3 examples : The Indian Museum Tank, Calcutta, 29 viii.1961.

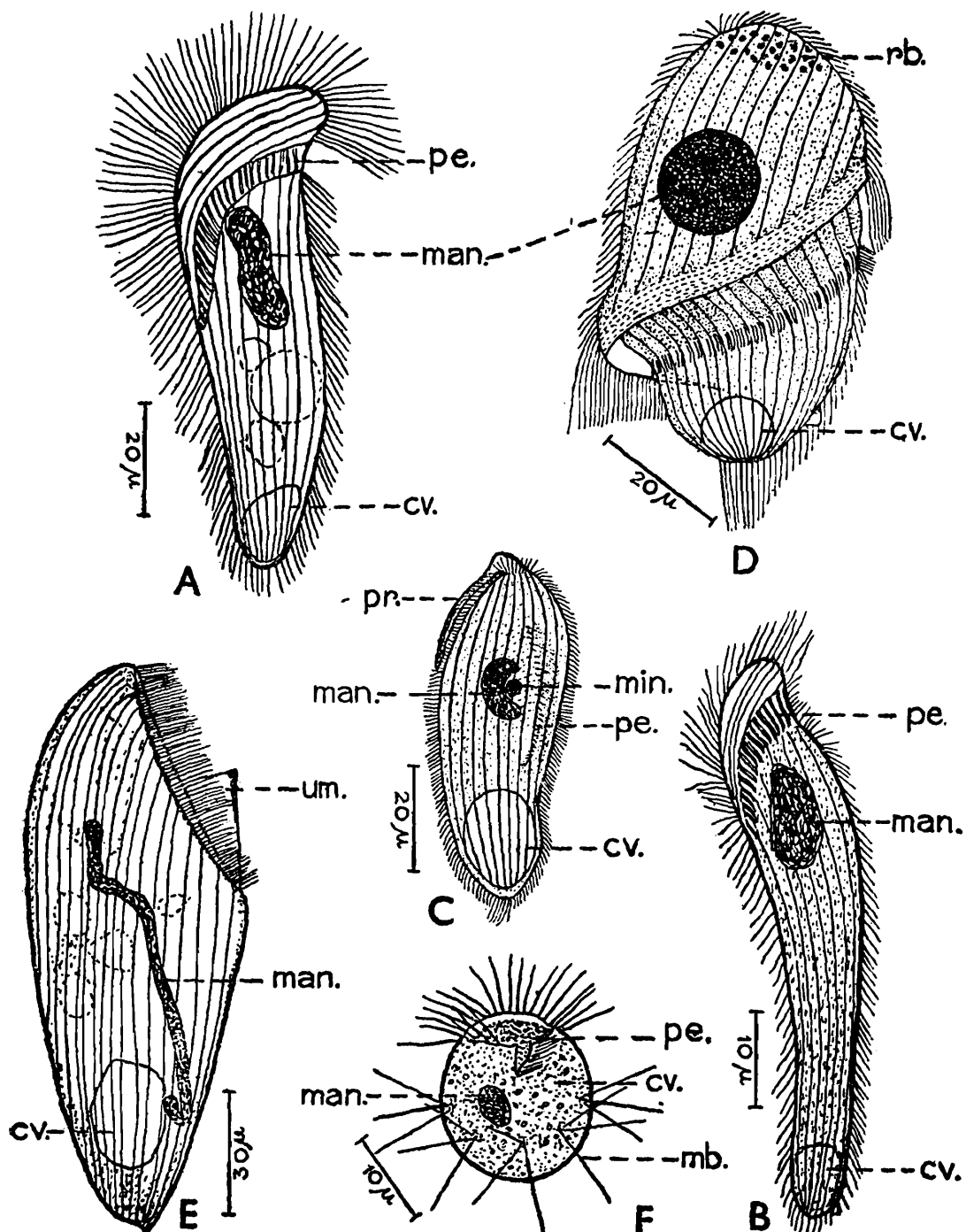
Diagnosis.—Body-shape sigmoidal, four times as long as broad ; narrowing gradually to the posterior end ; body ciliation uniform except at anterior end where a few longer cilia are present ; peristome lying at anterior one-third of body and running diagonally from the left margin to right on ventral side ; macronucleus oval and lying below the peristome ; micronucleus lying close to the macronucleus ; a prominent contractile vacuole present at posterior end ; body size $59 \times 13 \mu$.

Distribution.—*Calcutta* : As above.

Remarks.—This ciliate resembles the nominate form, *Metopus es* Müller, and the two varieties *M. es* var. *rectus* Kahl, (1932) and *M. es* var. *punguis* Kahl, (1927) in having sigmoidal body-shape, the gradual

narrowing of the body towards the posterior end, and a similar peristomial structure. But it differs from these in the absence of granular bodies in its anterior end, as has also been stated in Table 1.

Type-specimens.—The type slides are deposited in the National Zoological Collections at the Zoological Survey of India, Calcutta, as follows :—*Holotype* : One slide, Z. S. I., Reg. No. Pt. 547 (one example). *Paratypes* : Two slides, Z. S. I., Reg. Nos. Pt. 548 and Pt. 549 (one example on each slide).



TEXT-FIG. 4.—Freshwater Ciliates of Calcutta and its environs (lettering as in Text-fig. 2).

(A). *Metopus es es* Müller. (B). *Metopus es* var. *minor*. (C). *Metopus nasutus* Da Cunha. (D). *Metopus spiralis* Smith. (E). *Blepharisma intermedium* Bhandary. (F). *Halteria grandinella* (Müller). For lettering of text-figures, please see p. 22.

TABLE 1.—*Differentiating characters of Metopus es Müller, and its varieties including minor var. nov.*

Characters	<i>M. es</i> <i>es</i> Müller	<i>M. es.</i> var. <i>rectus</i> Kahl	<i>M. es.</i> var. <i>pinguis</i> Kahl	<i>M. es.</i> , n. var., <i>minor</i>
Body-length	92-160 μ	120 μ	150 μ	59 μ
Granular bodies in anterior end	Present	Present	Present	Absent

16. *Metopus nasutus* Da Cunha (Text-fig. 4c)

1915. *Metopus nasutus* Da Cunha, *Brazil Med.*, Rio de Janeiro, p. 129.

1932. *Metopus nasutus*; Kahl, *Urtiere oder Protozoa* (in : Dahl's *Tierwelt Dtsch.*), Jena, pp. 407-408, fig. 69(9).

Material.—One example : A tank in Shahid Colony, Calcutta, 6.ii.1962.

Diagnosis.—Body somewhat fusiform ; body ciliation uniform with long cilia except at the posterior end where 4-5 longer cilia are found ; peristome running only slightly diagonally, more so towards the posterior end, beyond the middle ; a strong undulating membrane on the right side of peristome present ; a prominent antenna-like extension at the anterior end, hanging on one side ; macronucleus single and crescent-shaped ; micronucleus single and placed in notch of macronucleus ; contractile vacuole at the posterior end ; size $68 \times 22 \mu$.

Distribution.—*Calcutta* : As above (first record from India). *Elsewhere* : Brazil (S. America).

Remarks.—Very rare. Our example is much smaller than those of Kahl (1932, length 100-130 μ).

17. *Metopus spiralis* Smith (Text-fig. 4d)

1897. *Metopus spiralis* Smith, *Trans. Amer. micr. Soc.*, Lancaster, 19, p. 62, pl. 1, fig. 13.

1932. *Metopus spiralis* : Kahl, *Urtiere oder Protozoa* (in : Dahl's *Tierwelt Dtsch.*), Jena, pp. 423-424.

1960. *Metopus spiralis* : Nair, *Curr. Sci.*, Bangalore, 29 (11), pp. 435-436, fig. 1.

Material.—(i) 3 examples : A Tank in Sibpur (Howrah Dist., W. Bengal), 7.viii.1959. (ii) 2 examples : A Tank in Shahid Colony, Calcutta, 11.i.1963.

Diagnosis.—The characteristic feature of this species is the location of the spherical macronucleus in the anterior half of the body above the peristome, unlike the species described earlier in this paper. The specimens from Sibpur measure $48-59 \times 25-36 \mu$ and from Shahid Colony, $80 \times 40 \mu$.

Distribution.—Vicinity of *Calcutta* : Nair (1960) ; and also as above. *Elsewhere* : Louisiana (U.S.A.).

Remarks.—The size of specimens varied to a great extent according to the availability of food-material. The length reported by Kahl (1932) is $80-150 \mu$.

18. *Blepharisma intermedium* Bhandary

(Text-fig. 4E)

1962. *Blepharisma intermedium* Bhandary, *J. Protozool.*, New York, 9 (4), p. 437, figs. 1, 1a & 7.

Material.—3 examples : A Tank in Jadavpur, Calcutta, 19.ii.1963.

Diagnosis.—Body flattened, ellipsoidal, both ends narrowed and compressed ; pink coloured ; body ciliation uniform, ciliary meridians slightly spiral ; peristome extending from anterior end to one-third of the body-length, slightly curved to the interior in the middle ; undulating membrane in front of the cytostome ; contractile vacuole at the posterior portion ; macronucleus long and cylindrical with the ends slightly swollen ; micronuclei not observed ; size $210-234 \times 92 \mu$.

Distribution.—*Calcutta* : As above. (first record from W Bengal). *Elsewhere* : India : Bangalore.

Remarks.—Our specimens are medium-sized. Bhandary (1962) gave the length as $200-350 \mu$. The pigmentation is light pink only.

19. *Halteria grandinella* (Müller)

(Text-fig. 4F)

1786. *Trichoda grandinella* Müller, *Animac. Infusoria fluviat. et Marina*, Havniae et Lipsiae, p. 160, pl. XXIII, figs. 1-3.

1841. *Halteria grandinella* (Müller) : Dujardin, *Histoire nat. des Zoophytes Infusoires*, Paris, pp. 415-416.

1951. *Halteria grandinella* : Khajuria, *Rec. Indian Mus.*, Delhi, 48 (2), pp. 58-59.

1962. *Halteria grandinella* : Dingfelder, *Arch. Protistenk.*, Jena, 105 (4), pp. 604-605.

Material.—2 examples : A Tank in Jadavpur, Calcutta, 4.xii.1959.

Diagnosis.—Body globular, anterior border with conspicuous frontal and adoral membranellae ; a small membrane present on right edge of peristome ; an equatorial zone of bristle-bearing grooves, each groove with three long bristles (seen in living condition only) ; contractile vacuole in anterior half of body ; macronucleus oval ; animal moves by jerky movements, length 18μ .

Distribution.—*Calcutta* : As above (first record from W. Bengal).
Elsewhere : India : Varanasi (Uttar Pradesh).

Remarks.—Our specimens are smaller than those of Dingfelder (1962, length 25-43 μ).

V—SUMMARY

Nineteen species and one variety of freshwater ciliates collected from the ponds of Calcutta and its vicinity (Districts of Calcutta and Howrah, West Bengal) are dealt with in the present paper. Of these, 13 species are new records from India (some of these were recorded earlier from Lahore, now in West Pakistan), 4 are new records from West Bengal and one variety, *Metopus* *es* n. var. *minor* (Fam. Gyrocorythidae, Ord. Heterotrichida) is new to science.

A Classified list of the species, as per the classification of Corliss (1961), and a key to their identification are provided.

VI—REFERENCES

- BHANDARY, A.V. 1962. Taxonomy of genus *Blepharisma*, with special reference to *Blepharisma undulans*.—*J. Protozool.*, New York, 9(4), pp. 435-442.
- BHATIA, B.L. 1936. *The Fauna of British India, including Ceylon and Burma, Protozoa : Ciliophora*, xxii+493 pp., London (Taylor & Francis, Ltd.).
- CANTOR, T. 1842. General features of Chusan, with remarks on the Flora and fauna of that Island.—*Ann. Mag. nat. Hist.*, London, 9, pp. 361-370.
- CORLISS, J.O. 1961. *The Ciliated Protozoa*, 310 pp.—Oxford (Pergamon Press).
- DINGFELDER, J.H. 1962. Die Ciliaten vorübergehender Gewässer.—*Arch. Protistenk.*, Jena, 105(4), pp. 509-658.
- DUJARDIN, F. 1841. *Histoire naturelle des Zoophytes Infusoires*, Paris 678, pp. 22 pls.
- FROMENTEL, E. DE. 1874. *Études sur les Microzoaires Ou Infusoires Proprement dits*, pp. viii + 1—364, 30 pls.—Paris.
- GANAPATI, P.N. and RAO, M.V.N. 1958. Systematic survey of marine ciliates from Visakhapatnam.—*Andhra Univ. Mem. in Oceanography*, Waltair, 2, pp. 75-90.
- GHOSH, E. 1918. Studies in Infusoria.—*Rec. Indian Mus.*, Calcutta, 15, pp. 129-134.
- GHOSH, E. 1919. Studies on Infusoria. II.—On two species of *Holophrya*, Ehrenberg.—*Rec. Indian Mus.*, Calcutta, 16, pp. 41-43.
- GHOSH, E. 1920. Infusoria from Bengal.—*Report sci. Convention Indian Ass. Cult. Sci., for 1918*, Calcutta, pp. 144-149.
- GHOSH, E. 1921a. Infusoria from the environment of Calcutta. I.—*Bull. Carmichael med. Coll.*, Calcutta, 2, pp. 6-17.

- GHOSH, E. 1921b. New hypotrichous Infusoria from Calcutta.—*J. R. micr. Soc.*, London, **1921**, pp. 248-250.
- GHOSH, E. 1922. New species of *Vorticella* from Calcutta.—*Bull. Carmichael med. Coll.*, Calcutta, **3**, pp. 8-18, 3 pls.
- GHOSH, E. 1928. Two new ciliates from sewer water.—*J. R. micr. Soc.*, London, **1928**, pp. 382-384.
- GHOSH, E. 1929. Two new Suctoria from sewer water.—*J. R. micr. Soc.*, London, **1929**, pp. 222-223, figs. 1-2.
- KAHL, A. 1930-1935. Urtiere oder Protozoa. I : Wimpertiere oder Ciliata (Infusoria), Eine Bearbeitung der freilebenden und ecto-commensalen Infusorien der Erde, unter Ausschluss der marinen Tintinnidae. In : Dahl, F., *Tierwelt Dtsch.* (pts. 18, 21, 25 & 30), 886 pp., Jena (G. Fischer).
- KHAJURIA, H. 1951. On some free-living Ciliates from Banarās Cantt., U.P.—*Rec. Indian Mus.*, Delhi, **48**(2), pp. 53-59.
- KUDO, R. R. 1960. *Protozoology* (4th ed.). xi+966 pp.,—London (Charles C. Thomas).
- MACKINNON, D.L. and HAWES, R.S.J. 1961. *An Introduction to the study of Protozoa*, xviii+ 506 pp.—Oxford (Clarendon Press).
- MITCHELL, J. 1862. Notes from Madras.—*Quart. J. micr. Sci.*, (N.S.), London, **2**, pp. 60-62.
- NAIR, K.N. 1960. On the occurrence of a heterotrichous ciliate, *Metopus spiralis* Smith, 1897 (Protozoa) in India.—*Curr. Sci.*, Bangalore. **29**(11), pp. 435-436, fig. 1.
- SIMMONS, W J. 1889. Note on a species of *Podophrya* found in Calcutta.—*Amer. mon. micr. J.*, Washington, **10**, p. 145.
- SIMMONS, W J. 1891. Some of the animal and vegetable micro-organisms procurable in the General's Tank, Calcutta.—*Bull. micr. Soc.*, Calcutta, **1**, pp. 1-5.
- STOKES, A.C. 1887. Some new hypotrichous Infusoria from American freshwaters.—*Ann. Mag. nat. Hist.*, London, (5) **20**, pp. 104-114, 1 pl.

LETTERING OF TEXT-FIGS: 2—4

Lettering for Text-figs. 2-4 : *acv.*, anterior contractile vacuole; *arc.*, anterior radiating canals; *azm.*, adoral zone of membranellae; *bg.*, brown granules; *cp.*, caudal projection; *cv.*, contractile vacuole; *cyp.*, cytopharynx; *cz.*, clear zone; *fv.*, food vacuole; *l.*, lorica; *li.*, lip; *man.*, macronucleus; *mb.*, body bristles; *min.*, micronucleus; *mv.*, Müller's vesicles; *op.*, operculum; *pcv.*, posterior contractile vacuole; *pe.*, peristome; *pr.*, proboscis; *prc.*, posterior radiating canal; *rt.*, refractile bodies; *tr.*, trichocysts; *um.*, undulating membrane; *v.*, vacuoles.

STUDIES ON SOME ASPECTS OF AVIAN COCCIDIA (PROTOZOA, SPOROZOA). PART IV OCCURRENCE AND DISTRIBUTION OF COCCIDIAN PARASITES IN INDIAN BIRDS

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(With 2 tables)

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I—INTRODUCTION

The coccidian parasites are not uncommon in vertebrates and their presence is also common in birds. India has a large and varied avifauna, and their coccidian parasites are also equally varied. I have described (1963, 1964, 1965) some of them in my earlier papers. In this paper, only the exogenous states of the coccidian parasites are considered. Besides, details regarding their pathogenicity on the birds parasitized, birds examined for the parasites, their number, locality, etc., are also dealt with.

Earlier workers like Levine and Becker (1933), Becker (1934, 1956), Boughton and Volk (1938), Hardcastle (1943), Chakravarty and Kar (1944, 1947) and Levine (1953) have contributed much in this field. A critical review of the literature was necessary in order to determine the correct taxonomic position of the coccidian parasites. Here an attempt has been made in this direction with particular reference to the coccidian parasites of Indian birds.

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II—MATERIAL AND METHODS

The large majority of birds studied were collected near the vicinity of Calcutta; a few were purchased in the local market and the others shot in the Sundarbans (West Bengal). The purchased birds were stated to have been either caught from different parts of Bengal or imported from other parts of India. For coccidial infections, the faecal matter was examined microscopically. Wherever possible, the birds were directly brought to the laboratory and the faecal matter taken either from the droppings or directly from the rectum. Where it was not possible to bring the birds to the laboratory, small glass vials, with rubber stoppers, containing 2.5 per cent $K_2Cr_2O_7$ solution, were used to bring the faecal samples to the laboratory.

III—OBSERVATIONS

Only the oocysts were observed for the purpose of the present study. No noticeable variations were found in them from their original descriptions. The infection was judged by the presence of oocysts in the faeces. The birds examined in summer showed greater infection than those in winter, the degree of infection being estimated in terms of the number of oocysts discharged with the faeces and the amount of lesions in the intestinal wall. The sites of lesions were mainly in the lower intestine, and the caeca and their junction with the intestine. In no case, the blood was seen either in the lumen of the intestine or mixed with faeces. The cause of seasonal variation in infection remains undetermined.

IV—DISCUSSION

In discussing the relative diagnostic value of sporocysts and sporozoites on the one hand, and of the unsporulated oocysts on the other, Christensen (1938, p. 455) observed, "Measurements of sporocysts and sporozoites have no specific value, since their size depends upon the size of the original sporont and oocyst. In unsporulated oocyst the protoplasmic mass, or a sporont is spherical in shape. At this stage the oocyst is most typical in size, shape, colour and morphology" The writer, after studying the different species of *Coccidia* in the Indian birds mentioned in the paper, has been led to regard Christensen's view as substantially correct. Thus, it becomes evident that the validity of some of the species, which have been described in the past, based mainly on measurement, is open to question.

The birds examined for coccidian parasites and found to contain the latter belong to the orders Anseriformes, Pelicaniformes, Galliformes, Ciconiformes, Charadriiformes, Falconiformes, Gruiformes, Columbiformes, Apodiformes, Psittaciformes, Coraciiformes, Piciformes and Passeriformes. The parasites obtained belong to the genera *Tyzzeria* Allen (1936), *Isospora* Schneider (1881), *Dorisiella* Ray (1930), *Eimeria* Schneider (1875) and *Wenyonella* Hoare (1933).

Only one species of *Tyzzeria* (*T. alleni* Chakravarty & Basu, 1947) was found in one species of bird, *Nettapus coromandelianus* (Gmelin) (Anseriformes). A number of species of *Isospora* Schneider, 1881 were obtained from several species of birds (Piciformes, Psittaciformes, Coraciiformes and Passeriformes). Only two species of *Dorisiella* Ray were reported from Indian birds so far and all the hosts, belong to the Passeriformes. Several species of *Eimeria* Schneider, 1875 were obtained from different birds belonging to the orders Charadriiformes, Galliformes, Columbiformes, Piciformes and Passeriformes. Only one species (*Wenyonella mackinnoni* Misra, 1947) was reported from *Motacilla alba* L. (Passeriformes).

Observing the scattered distribution of Coccidian parasites in Indian birds, both from my observations and those of others (Table 2), it is clear that one species of parasite was found in more than one species of birds, so the host-specificity of the parasites may not be fully established. It might be that carefully conducted cross infection tests alone would satisfactorily solve the question of the precise identity of the different forms of coccidia described, as well as the prevalence of host-specificity amongst them.

V—SUMMARY

For coccidian parasites, a large number of birds were examined, and their pathogenicity on the birds noted. A statement giving complete list of coccidian parasites described so far from Indian birds is also given.

VI—REFERENCES

- BECKER, E. R. 1934. *Coccidia and Coccidiosis of domesticated, game and laboratory animals and of Man*.—Ames (Iowa) ix+147 pp.
- BECKER, E. R. 1956. Catalog of Eimeriidae in genera occurring in vertebrates and not requiring intermediate hosts.—*Iowa St. Coll. J. Sci.*, Ames, **31**, pp. 85-139.
- BOUGHTON, D. C. and VOLK, J. J. 1938. Avian hosts of Eimerian Coccidia.—*Bird-Banding*, Boston, **9**, pp. 139-153.
- CHAKRAVARTY, M. M. and BASU, S. P. 1947. On a new Coccidium, *Tyzzeria alleni* n.sp., from the intestine of the bird Cotton Teal.—*Sci. & Cult.*, Calcutta, **12**, pp. 106-107.
- CHAKRAVARTY, M. M. and KAR, A. B. 1944. A study on the Coccidia of Indian birds. Observations on several species of Coccidia of the subfamilies Cyclosporinae and Eimeriinae.—*Proc. Indian Acad. Sci.*, Bangalore, **20(B)**, pp. 102-114.

- CHAKRAVARTY, M.M. and KAR, A.B. 1947. A study on the Coccidia of Indian birds.—*Proc. roy. Soc. Edinb.*, Edinburgh, **62**(B), pp. 225-233.
- CHRISTENSEN, J.P. 1938. Species differentiation in the Coccidia from the domestic sheep.—*J. Parasit.*, Lancaster, **24**, pp. 453-467.
- HARDCASTLE, A.B. 1943. A check-list and host-index of the species of the protozoan genus *Eimeria*.—*Proc. helm. Soc. Wash.*, Washington, **10**, pp. 35-69.
- KAR, A. B. 1944. Observation on *Eimeria barbata* n. sp. from the Blue-throated Barbet, *Cyanops asiatica* (Lath.).—*Proc. Indian Sci. Congr.*, Calcutta, **31**, pp. 104-105.
- LEVINE, N. D. and BECKER, E. R. 1933. A catalog and host-index of the species of the coccidian genus *Eimeria*.—*Iowa St. Coll. J. Sci.*, Ames, **8**, pp. 83-106.
- LEVINE, N. D. 1953. A review of the Coccidia from the avian orders Galliformes, Anseriformes and Charadriiformes, with descriptions of three new species.—*Amer. Midl. Nat.*, Notre Dame, **49**, pp. 696-716.
- MANDAL, A. K. and CHAKRAVARTY, M. M. 1963. Studies on some aspects of avian Coccidia (Protozoa : Sporozoa). Part I. On a new species of *Dorisiella* from the Indian tree-pie *Crypsirina vagabunda* Latham.—*Proc. zool. Soc.*, Calcutta, **16**, pp. 147-150.
- MANDAL, A. K. and CHAKRAVARTY, M. M. 1964. Studies on some aspects of avian Coccidia (Protozoa : Sporozoa). Part II. Some new species of *Isospora*.—*Proc. zool. Soc.*, Calcutta, **17** (1), pp. 35-45.
- MANDAL, A. K. 1965. Studies on some aspects of avian Coccidia (Protozoa : Sporozoa). Part III. Some new species of *Eimeria*, with a new subspecies of *E. roseoviensis* (Labbé).—*Proc. zool. Soc.*, Calcutta, **18**, pp. 47-57.
- MITRA, A. N. and DAS GUPTA, M. 1937. On a species of *Eimeria* (Coccidia : Sporozoa) from the intestine of a pigeon, *Columba intermedia*.—*Proc. Indian Sci. Congr. Assoc.*, Calcutta, **24**, p. 291.
- MISRA, P. L. 1944. On a new Coccidium, *Wenyonella bahli* n. sp., from the common grey quail, *Coturnix communis* Bonn.—*Proc. nat. Inst. Sci. India*, Calcutta, **10** (2), p. 203.
- MISRA, P. L. 1947. On three Coccidian parasites, *Wenyonella maikinnoni* n. sp., *Eimeria lucknowensis* n. sp. and *Isospora* sp., from the intestine of the wagtail, *Motacilla alba* Linn. (Passeriformes : Motacillidae).—*Proc. Indian Acad. Sci.*, Bangalore, **15**, pp. 75-85.
- RAY, H. N. 1945. On a new Coccidium *Wenyonella gallinae* n. sp., from the gut of the domestic fowl, *Gallus gallus domesticus* Linn.—*Curr. Sci.*, Bangalore, **14**, p. 275.
- RAY, D. K. 1952. On a new coccidium, *Eimeria sphenocercae* n. sp., from *Sphenocercus sphenurus* (Kokla green pigeon).—*J. Parasit.*, Lancaster, **38**, pp. 546-547.

- RAY, D. K., SHIVNANI, G. A., OMEN, M. and BHASKARAN, R. 1952. A study on the Coccidia of some Himalayan birds.—*Proc. zool. Soc., Beng.*, Calcutta, 5, pp. 141-147.
- RAY, H. N. and HIREGAUDAR, L. S. 1959. Coccidia from some birds at Calcutta zoo.—*Bull. Calcutta Sch. trop. Med.*, Calcutta, 7, pp. 111-112.

TABLE 1—Showing the number of birds examined and infection by parasites

Serial No.	Name of the Host	Locality	No. Examined	No. Infected	Name of the Parasite
(1)	(2)	(3)	(4)	(5)	(6)
Order—PELECANIFORMES					
Family—PHALACROCONIDAE					
1.	<i>Phalacrocorax niger</i> (Vieillot)	Suburb of Calcutta	10	Nil	
Order—CICONIIFORMES					
Family—ARDEIDAE					
2.	<i>Ardea cinerea</i> Linnaeus	Ditto	6	„	
3.	<i>Egretta garzetta</i> (Linnaeus)	Ditto	12	„	
4.	<i>Bubulcus ibis</i> (Linnaeus)	Ditto	7	„	
5.	<i>Ardeola grayii</i> (Sykes)	Ditto	5	„	
6.	<i>Nycticorax nycticorax</i> (Linnaeus)	Ditto	6	„	
7.	<i>Ixobrychus cinnamomeus</i> (Gmelin)	Ditto	7	„	
Family—CICONIIDAE					
8.	<i>Leptoptiles dubius</i> (Gmelin)	Sundarbans	4	„	
9.	<i>Anastomus oreitans</i> (Boddaert)	Ditto	3	„	
10.	<i>Xenorhynchus asiaticus</i> (Latham)	Ditto	5	„	

Order—ANSERIFORMES

Family—ANATIDAE

11.	<i>Sarkidiornis melanotos</i> (Pennant)	.	Suburb of Calcutta	.	3	„	
12.	<i>Nettapus coromandelianus</i> (Gmelin)		Ditto		8	3	<i>Tyzzeria alleni</i> Chakravarti & Basu (1947)
13.	<i>Anas crocca</i> Linnaeus		Ditto	.	5	Nil	

Order—FALCONIFORMES

Family—ACCIPITRIDAE

14.	<i>Torgos calves</i> (Scopoli)	.	.	.	.	Ditto	.	4	„
15.	<i>Gyps bengalensis</i> (Gmelin)					Ditto	.	8	„
16.	<i>Haliastur indus</i> (Boddaert)					Ditto	.	5	„
17.	<i>Milvus migrans</i> (Boddaert)					Ditto		6	„

Order—GALLIFORMES

Family—PHASIANIDAE

18.	<i>Pavo cristatus</i> Linnaeus	.	.		Uttar Pradesh	.	4	2	<i>Eimeria pavonis</i> Mandal (1964)
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Order—GRUIFORMES

Family—RALLIDAE

19.	<i>Amaurornis phoenicurus</i> (Pennant)	.	.		Suburb of Calcutta	.	4	Nil	
20.	<i>Gallinula chloropus</i> (Linnaeus)			.	Ditto	.	5	„	
21.	<i>Fulica atra</i> Linnaeus	.	.		Ditto	.	5	„	

TABLE 1—*contd.*

Serial No.	Name of the Host	Locality	No. Examined	No. Infected	Name of the Parasite
(1)	(2)	(3)	(4)	(5)	(6)
Order—CHARADRIIFORMES					
Family—JACANIDAE					
22.	<i>Metopidius indicus</i> (Latham)	Suburb of Calcutta	4	Nil	
23.	<i>Hydrophasianus chirurgus</i> (Scopoli)	Ditto	6	„	
Family CHARADRIIDAE					
24.	<i>Vanellus malabaricus</i> (Boddaert)	Sundarbans	10	4	<i>Eimeria vanelli</i> Mandal (1964)
25.	<i>Pluvialis apricaria</i> Linnaeus .	Ditto	8	4	<i>Eimeria roscoviensis</i> Mandal (1964)
26.	<i>Numenius arquata</i> (Linnaeus) . . .	Ditto	7	4	<i>Eimeria numantii</i> Mandal (1964)
27.	<i>Gallinago gallinago</i> (Linnaeus) . . .	Ditto	10	6	<i>Eimeria gallinagoi</i> Mandal (1964)
28.	<i>Charadrius asiaticus</i> Pallas . . .	Ditto	9	4	<i>Eimeria charadrii</i> Mandal (1964)
Family—ROSTRATULIDAE					
29.	<i>Rostratula benghalensis</i> (Linnaeus) .	Ditto	6	Nil	
Order—COLUMBIFORMES					
Family—COLUMBIDAE					
30.	<i>Streptopelia chinensis</i> (Scopoli) . . .	Suburb of Calcutta	15	„	
31.	<i>Treron phoenicoptera</i> (Latham) .	(Purchased)	7	„	

Order—PSITTACIFORMES

Family—PSITTACIDAE

32.	<i>Psittacula cyanocephala</i> (Linnaeus)	.	Suburb of Calcutta	9	„
33.	<i>Psittacula eupatria</i> (Linnaeus)	.	(Purchased)	6	„
34.	<i>Psittacula krameri</i> (Scopoli)	.	Ditto	5	„

Order—CUCULIFORMES

Family—CUCULIDAE

35.	<i>Clamator jacobinus</i> (Boddaert)	.	Suburb of Calcutta	7	„
36.	<i>Centropus sinensis</i> (Stephens)	.	(Purchased)	5	„
37.	<i>Eudynamys scolopacea</i> (Linnaeus)	.	Suburb of Calcutta	8	„

Order—CORACIIFORMES

Family—CORACIIDAE

38.	<i>Coracias benghalensis</i> (Linnaeus)	.	(Purchased)	6	„
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Family—ALCITINIDAE

39.	<i>Ceryle rudis</i> (Linnaeus)	.	Suburb of Calcutta	8	„
40.	<i>Halcyon smyrnensis</i> (Linnaeus)	.	Ditto	10	„

Order—APODIFORMES

Family—APODIDAE

41.	<i>Apus affinis</i> (J. E. Gray)	.	Ditto	15	„
42.	<i>Cypsiurus parvus</i> (Lichtenstein)	.	Ditto	5	„

TABLE 1—*contd.*

Serial No.	Name of the Host	Locality	No. Examined	No. Infected	Name of the Parasite
(1)	(2)	(3)	(4)	(5)	(6)
Order—PICIFORMES					
Family—PICIDAE					
43.	<i>Dendrocopos mahrattensis</i> (Latham)	Suburb of Calcutta	4	Nil	
44.	<i>Dinopium benghalensis</i> (Linnaeus)	. Ditto	6	..	
Family—CAPITONIDAE					
45.	<i>Megalaima haemacephala</i> (P. L. S. Müller)	Ditto	10	5	<i>Isospora megalaimae</i> Mandal & Chakravarty (1964)
Order—PASSERIFORMES					
Family—HIRUNDINIDAE					
46.	<i>Hirundo rustica</i> Linnaeus	Ditto	25	Nil	
Family—LANIIDAE					
47.	<i>Lanius excubitor</i> Linnaeus .	Ditto	7	..	
48.	<i>Lanius vittatus</i> Valenciennes	Ditto	5	..	

Family—DICRURIDAE

49.	<i>Dicrurus adsimilis</i> (Bechstein)	(Purchased)	5	1	<i>Isospora upupae</i> Chakravarty & Kar (1947)
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Family—STURNIDAE

50.	<i>Sturnus malabaricus</i> (Gmelin)	Suburb of Calcutta	6	3	<i>Isospora sturniae</i> Chakravarty & Kar (1947)
51.	<i>Sturnus pagodarum</i> (Gmelin)	Ditto	5	Nil	
52.	<i>Sturnus contra</i> Linnaeus	Ditto	8	5	<i>Isospora lonchurae</i> Mandal & Chakravarty (1964)
53.	<i>Acridotheres ginginianus</i> (Latham)	Ditto	10	4	<i>Isospora ginginiana</i> Chakravarty & Kar (1944)
54.	<i>Acridotheres tristis</i> (Linnaeus)	Ditto	8	1	<i>Isospora ginginiana tristis</i> Chakravarty & Kar (1944)

Family—CORVIDAE

55.	<i>Crypsirina vagabunda</i> (Latham)	Ditto	17	8	<i>Dorisiella vagabundae</i> Mandal & Chakravarty (1963)
56.	<i>Corvus splendens</i> Vieillot	Ditto	15	9	<i>Isospora bengalensis</i> Mandal & Chakravarty (1964)
57.	<i>Corvus macrorhynchos</i> Wagler	Ditto	5	Nil	

Family—PYCNONOTIDAE

58.	<i>Pycnonotus jocosus</i> (Linnaeus)	Ditto	10	4	<i>Isospora pycnonotae</i> Mandal & Chakravarty (1964)
59.	<i>Pycnonotus cafer</i> (Linnaeus)	Ditto	12	Nil	

TABLE 1—*concl'd.*

Serial No.	Name of the Host	Locality	No. Examined	No. Infected	Name of the Parasite
(1)	(2)	(3)	(4)	(5)	(6)
Family—MUSCICAPIDAE					
60.	<i>Turdoides caudatus</i> (Dumont)	Suburb of Calcutta	8	Nil	
61.	<i>Turdoides striatus</i> (Dumont)	Ditto	10	6	<i>Isospora pycnonotae</i> Mandal & Chakravarty (1964)
62.	<i>Copsychus saularis</i> (Linnaeus)	Ditto	6	1	<i>Isospora lacazei</i> (Labbe, 1893)
63.	<i>Copsychus malabaricus</i> (Soopoli)	Ditto	4	Nil	
64.	<i>Orthotomus suterins</i> (Pennant)	Ditto	3	„	
65.	<i>Erithacus syccicus</i> (Linnaeus)	Ditto	5	„	
Family—MOTACILLIDAE					
66.	<i>Motacilla alba</i> Linnaeus	Ditto	10	3	<i>Wenyonella mackimmoni</i> Misra (1947)
67.	<i>Motacilla citreola</i> Pallas	Ditto	5	Nil	
Family—NECTARINIDAE					
68.	<i>Nectarinia asiatica</i> (Latham)	Ditto	6	„	

Family—PLOCIDAE

69.	<i>Passer domesticus</i> (Linnaeus)	.	.	.	.	.	Ditto	.	10	4	<i>Isospora lacazei</i> (Labbé, 1893)
70.	<i>Ploceus philippinus</i> (Linnaeus)	.	.	.	.	.	Ditto	.	10	Nil	
71.	<i>Lonchura punctulata</i> (Linnaeus)	.	.				Ditto	.	8	3	<i>Isospora lonchurae</i> Mandal & Chakravarty (1964)
72.	<i>Lonchura malacca</i> (Linnaeus)	.	.	.	.	.	Ditto	.	4	1	<i>Isospora muniae</i> Chakravarty & Kar (1944)
73.	<i>Estrilda amandava</i> (Linnaeus)	.				.	Ditto	.	5	2	<i>Dorisiella hareni</i> Chakravarty & Kar (1944)

Family—EMBERIZIDAE

74.	<i>Emberiza bruniceps</i> Brandt.	.	.	.	.	.	Sundarbans		10	4	<i>Isospora emberizae</i> Mandal & Chakravarty (1964)
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TABLE 2.—Statement giving the full list of Coccidian parasites so far obtained from Indian birds indicating the diagnostic characters etc.

Parasite	Oocysts			Sporocysts				Habitat, Host & Locality
	Shape	Measurements (in μ)	Residue	Sporulation time	Shape	Measurements (in μ)	Residue	
1. <i>Isospora munitae</i> Chakravarty & Kar (1944)	Elongate oval	24.7—30.9 $\times$ 14.4—18.5	Absent	48 hrs.	Pyriform	14.4—16.5 $\times$ 10.5	Present	From small intestine of <i>Munia malacca malacca</i> Linn.—Calcutta
2. <i>Isospora ginginiana</i> Chakravarty & Kar (1944)	Rounded	22.0—24.2	„	Not known	„	15.4—17.6 $\times$ 11.0	„	From intestine of <i>Acridotheres ginginianus</i> (Latham)—Calcutta.
3. <i>Isospora temenuchii</i> Chakravarty & Kar (1944)	Subspherical	22.0—24.2 $\times$ 19.8—22.0	„	„	Elongate oval	15.4—17.6 $\times$ 11.0	„	From intestine of <i>Temenuchus pagodarum</i> (Gmelin)—Calcutta.
4. <i>Isospora psittaculæ</i> Chakravarty & Kar (1947)	Oval	28.6—33.0 $\times$ 24.2—28.6	„	48 hrs.	Oval	22.0—26.4 $\times$ 13.2	„	From intestine of (i) <i>Psittacula eupatria nipalensis</i> (Hodge.) (ii) <i>Elathea jocosa emeria</i> —Calcutta.
5. <i>Isospora sturniae</i> Chakravarty & Kar (1947)	Spherical or Subspherical.	22.0—28.6	„	Not known	Pyriform	17.6—19.8 $\times$ 11.0—13.2	„	From intestine of <i>Sturnia malabarica malabarica</i> (Gmelin)—Gaya.
6. <i>Isospora upupæ</i> Chakravarty & Kar (1947)	Spherical	24.2—28.6	„	„	Oval	15.4—19.8 $\times$ 13.3	„	From intestine of (i) <i>Upupa epops orientalis</i> Baker (ii) <i>Dicrurus macrocerus</i> Vieillot—Gaya (Bihar).
7. <i>Isospora zosteropsis</i> Chakravarty & Kar (1947)	Oval	17.6—22.2 $\times$ 13.2—19.8	„	„	„	15.4—17.6 $\times$ 11.0	„	From intestine of (i) <i>Zosterops palpebrosa palpebrosa</i> (Temin. and Schlegel) (ii) <i>Therticryx Zeylanicus caniceps</i> (Frawni)—Calcutta.
<i>Isospora gliginiana varistris</i> Chakravarty & Kar (1947)	Subspherical slightly or oval	24.2—28.0 $\times$ 19.8—24.2	„	„	Pyriform	15.0—17.6 $\times$ 8.8—11.0	„	From intestine of <i>Acridotheres tristis tristis</i> (Linn.)—Calcutta.
9. <i>Isospora lacazei</i> (Labbe), (1893)	Spherical or ovoid	22.6—24.7	„	4 or 5 days	„	16.5—18.5 $\times$ 10.3—12.4	„	From intestine of (i) <i>Ploceus philippinus</i> (Linn.) (ii) <i>Copsuchus saularis saularis</i> (Linn.)—Calcutta.

10. <i>Isospora corviae</i> <i>et al</i> (1952)	Ray	Spherical or subspherical	17.7 × 20.0	Present	36—48 hrs.	„	7.75 × 10.8	„	From intestine of <i>Corvus macrorhynchos</i> inter- medius Adams—Muktes- war (U. P.)
11. <i>Isospora seicercusae</i> <i>et al</i> (1952)	Ray	„	23.28 × 24.8	„	48 hrs.	Pear-shaped	10.31 × 14.21	„	From intestine of <i>Seicercus xanthosclistos</i> (Gray)— Mukteswar (U. P.).
12. <i>Isospora garrulae</i> <i>et al</i> (1952)	Ray	„	19.75 × 20.62	„	24—36 hrs.	Pyriform	13.40 × 8.5	„	From intestine of <i>Garrulax lineatus lineatus</i> (Vigors) —Mukteswar (U. P.).
13. <i>Isospora garrulae</i> <i>et al</i> (1952)	Ray	Oval to subs- spherical	21.20 × 25.0	„	48—72 hrs.	Pear-shaped	16.07 × 9.60	„	From intestine of <i>Garrulus glandarius bispecularis</i> Vigors—Mukteswar (U. P.).
14. <i>Isospora parusae</i> <i>et al</i> (1952)	Ray	„	20.83 × 24.16	„	48 hrs.	Pyriform	15.0 × 10.0	„	From intestine of <i>Parus dichrous</i> Hodgson— Mukteswar (U. P.).
15. <i>Isospora bengalensis</i> ● Mandal & Chakravarty (1964)		Round	18.7—23.3	Absent	Not known	„	15.4 × 7.7	„	From intestine of <i>Corvus splendens</i> Vieillot— Calcutta.
16. <i>Isospora pycnonotusae</i> Mandal & Chakravarty (1964)		Oval	24.2 × 19.8	„	„	„	9.8 × 8.8	„	From intestine of (i) <i>Pycnonotus jocosus</i> (Linn.) (ii) <i>Turdoides striatus</i> (Dumont)— Calcutta.
17. <i>Isospora lonchurae</i> Mandal & Chakravarty (1964)		„	25.3—26.4 × 20.9—23.1	Present	„	„	18.7—20.8 × 11.0—13.2	„	From intestine of (i) <i>Lone- hura punctulata</i> (Linn.) (ii) <i>Sturnus contra</i> L.— Calcutta.
18. <i>Isospora megalaimae</i> Mandal & Chakravarty (1964)		Round	23.2—24.4	Absent	„	„	17.6 × 9.9	„	From intestine of <i>Megala- ima haemacephala</i> (P. L. S. Müller)— Calcutta.
19. <i>Isospora emberizae</i> Mandal & Chakravarty (1964)		Oval	21.0 × 18.7	Present	„	„	19.8 × 15.4	„	From intestine of <i>Emberiza bruniceps</i> Brandt— Calcutta.
20. <i>Tyzzeria alleni</i> Chakra- varty & Basu (1947)		„	14.48—17.3 × 9.63—11.5	Absent	2 days	„	„	„	From intestine of <i>Nettapus coromandelianus</i> (Gmelin) —Bidyadhari spill area (Fisheries)—Calcutta.

TABLE 2--concl'd.

Parasite	Oocysts			Sporulation time	Sporocysts			Habitat, Host & Locality
	Shape	Measurements (in μ)	Residue		Shape	Measurements (in μ)	Residue	
21. <i>Dorisiella hareni</i> Chakravarty & Kar (1944)	Spherical	18.5—22.6	Absent	24 hrs.	Pyriform	14.4—18.5 × 9.3—10.3	Present	From intestine of (i) <i>Munia malacca malacca</i> L. (ii) <i>Amandava amandava</i> (L.). (iii) <i>Munia articapilla rubronigra</i> (Hodgs.) (iv). <i>Uroloncha malabarica</i> (L.). (v) <i>Uroloncha punctulata punctulata</i> (L.)—Calcutta.
22. <i>Dorisiella aethiopsaris</i> Chakravarty & Kar (1947)	Oval or subspherical	33.0—38.8 × 24.2—26.4 28.6—30.8 × 24.2—26.4	„	Not known	Oval	19.8—22.0 × 11.0—13.2	„	From intestine of <i>Aethiopsar fuscus fuscus</i> (Waglar)—Calcutta.
23. <i>Dorisiella vagabundae</i> Mandal & Chakravarty (1964)	Oval	24.0—26.4 × 22.0	Present	„	„	17.6—19.8 × 12.1	„	From intestine of <i>Crypsirina vagabunda</i> (Latham)—Calcutta.
24. <i>Eimeria columbae</i> Mitra & Das Gupta (1937)	Subspherical	16.4 × 14.35	„	„	Ellipsoidal	7.2 × 4.8	„	From intestine of <i>Columba livia intermedia</i> Strickland—Calcutta.
25. <i>Eimeria harbeta</i> Kar (1944)	Oval	22—24 × 19.6—19.8	Absent	„	Oval	19.8	„	From intestine of <i>Cyanops asiatica</i> (Latham) (Loc. ?).
26. <i>Eimeria malaccae</i> Chakravarty & Kar (1944)	Oval or elongate oval	26.8—30.9 × 16.4—18.5	„	„	„	12.4 × 10.3	„	From intestine of <i>Munia malacca malacca</i> L.—Calcutta.
27. <i>Eimeria pfeifferi</i> (Labbe) (1893)	Oval or spherical	19.8—20.9 × 16.5—17.6	„	„	„	11.0—13.2 × 6.6	„	From intestine of <i>Columba livia intermedia</i> Strickland—Calcutta.
28. <i>Eimeria coturnicis</i> Chakravarty & Kar (1947)	Oval	26.4—38.8 × 19.8—26.4	„	„	Pyriform	13.2—17.2 × 8.8—11.0	„	From intestine of <i>Coturnix coturnix coturnix</i> (L.) (Loc. ?).
29. <i>Eimeria lucknowensis</i> Misra (1947)	Ovoid	21.4—24.5 × 17.4—18.8	„	3-4 days	Ovoid	8.5 × 6.0	„	From small intestine of <i>Motacilla alba</i> L.—Lucknow (U. P.).

2 ZSI/67	30.	<i>Eimeria</i> Ra 1952	<i>shenocercae</i>	Kidney-shaped	25.0—17.5 × 16.0—12.5	..	5-6 days	Oval	18.75—17.5 × 13.75—12.5	..	From intestine of <i>Sphenocercus sphenocercus</i> (Gray)—Mukteswar (U. P.) alt, 7500.
	31.	<i>Eimeria</i> & Hiregaudar (1959)	<i>alectoreae</i>	Ray Elliptical	23.6—2.4 × 15.6—15.0	..	Not known	Pea-shaped	8.9.5 × 4.5.6	..	From Calcutta zoo <i>Alectoris gracea</i> (Meisner)—Calcutta.
	32.	<i>Eimeria</i> Ray & Hiregaudar (1959)	<i>gennaeuscaae</i>	Subspherical	21.2—1.5	..	24—36 hrs.	..	7.8 × 4.5	..	From intestine of <i>Gennaeus horsfieldii</i> (L.)—Calcutta.
	33.	<i>Eimeria</i> & Hiregaudar (1959)	<i>bhutanensis</i>	Ray Spherical to subspherical	15.5—16.8 × 14.6—16.6	..	..	..	6.7 × 3.4	..	<i>Polyplectron bicoloratus bakeri</i> Lowe—(ex. Zool. Garden, Calcutta).
	34.	<i>Eimeria</i> Mandal (1965)	<i>gallinagoi</i>	Pyriform	19.8—20.9 × 13.2—14.3	Absent	Not known	Pyriform	5.5 × 7.7	Present	From intestine of <i>Gallinago gallinago</i> (L.)—Sundarbans.
	35.	<i>Eimeria</i> (1965)	<i>pavonis</i>	Mandal Ovoidal	19.8—25.4 × 17.6	..	..	Elliptical	12.1—15.6 × 6.6	..	From intestine of <i>Pavocristatus</i> (L.)—Mau (U. P.).
	36.	<i>Eimeria</i> (1965)	<i>numenii</i>	Mandal Round	20.9—23.1	..	60—70 hrs.	Pyriform	6.6 × 5.5	..	From intestine of <i>Numenius arquata</i> (L.)—Sundarbans.
	37.	<i>Eimeria</i> (1965)	<i>vanelli</i>	Mandal Oval or pyriform	20.9 × 14.3	..	Not known	..	12.1 × 6.6	..	From intestine of <i>Vanellus malabaricus</i> (Boddaert)—Sundarbans.
	38.	<i>Eimeria</i> (1965)	<i>charadrii</i>	Mandal Oval	14.3—17.6 × 11.0—12.0	..	80—90 hrs.	Pyriform	8.8 × 4.6	..	From intestine of <i>Charadrius asiaticus</i> Pallas—Sundarbans.
	39.	<i>Eimeria</i> Mandal (1965)	<i>r. roscoviensis</i>	Pyriform	14.3 × 18.7	Present	72—80 hrs.	..	6.6 × 12.1	..	From intestine of <i>Pivialis apricaria</i> —Sundarbans.
6	40.	<i>Wenyonella</i> (1944)	<i>bahli</i>	Misra Subspherical or ovoidal	16.0—17.5 × 14.6—15.5	Absent	4—5 days	Egg-shaped	6.6 × 1.2	Absent	From intestine of <i>Coturnix coturnix</i> (Gmelin)—Lucknow (U. P.).
	41.	<i>Wenyonella</i> (1945)	<i>gallinae</i>	Ray Oval or egg-shaped	29.48—33.50 × 19.48—22.78	..	4—6 days	Short necked round bottom vials	18.76 × 8.04	Present	From epithelium of terminal part of intestine of <i>Gallus galus domesticus</i> (L.)—Muktiwar (U.P.)
	42.	<i>Wenyonella</i> Misra (1947)	<i>mackinnoni</i>	Spherical or ovoid	19.0—26.2 × 18.0—21.5	Absent	4—6 days	Ovoid	10.2 × 7.4	Absent	From epithelium small intestine of <i>Motari laaba</i> L.—Lucknow (U.P.)

NOTES ON A COLLECTION OF LUCANIDAE (COLEOPTERA) FROM SIKKIM

By

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Zoological Survey of India, Calcutta

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I—INTRODUCTION

This report is based on a small collection of Lucanidae (Coleoptera) collected by my colleague Dr. A. G. K. Menon from Sikkim in 1959.

The collection comprises four genera and eight species. Two species, though suspected to be new, have not been named or described in the present paper for want of sufficient number of examples. The following three species viz., *Cyclommatus albersi* Kraatz, *Dorcus nepalensis* (Hope) and *Calcodes baladeva* (Hope) are being recorded for the first time for Sikkim.

I am grateful to Dr. M. L. Roonwal, Director, Zoological Survey of India, for the permission, necessary facilities, etc., to work out this interesting collection. I am also thankful to my colleague, Shri K. S. Pradhan, for his helpful comments on the paper.

II—SYSTEMATIC ACCOUNT

1. *Lucanus furcifer* Arrow

1949. *Lucanus furcifer* Arrow, *Fauna of Brit. India*.....*Coleoptera, Lamellicornia*, 4, pp. 46-48, pl. iii, fig. 4, London.

Material.—Sikkim : Lachung, 2.vii. 1959, 2♂♂. Length with mandibles 57.0 and 59.5 mm., without mandibles 41.0 and 43.0 mm. respectively.

Remarks.—This species has been previously recorded from the same locality in Sikkim and also from Yunnan. The presence of a large number of serrated teeth on the inner margin of the mandibles indicates that these specimens are not in a fully grown up condition. The larger specimen has a reduced number of serrated teeth. Arrow (*loc. cit.*) has pointed out that larger specimens have the clypeal process comparatively thickened at the end and the same condition has been observed in the specimens before me, but comparatively greater downward curvature of mandibles in the larger specimens as observed by Arrow (*loc. cit.*) is not preceptible in the two specimens.

Rec.-Zool. Surv. India, 63 (1—4), 1971.

2. *Lucanus* sp.

Material.—Sikkim Lachung, 4. vii. 1949, 1♂. Length with mandibles 42.0 mm., without mandibles 32.0 mm.

Remarks.—It is not possible to place the above specimen in any of the known species. It comes near *L. mearesi* Hope in the key to the Indo-Malayan species by Arrow (*loc. cit.*), but detailed examination revealed that it markedly differs from it in the shape of the clypeal process, which is tongue-shaped instead of being triangular and projected anteriorly as in *L. mearesi*. The posterior border of the head is also less rounded in the middle, and the anterior border less prominently straight. It also markedly differs from *L. mearesi* in the absence of the basal mandibular tooth.

3. *Cyclommatus albersi* Kraatz

1894. *Cyclommatus albersi* Kraatz, *Dtsch. ent. Z.*, Berlin, 38, p. 268.

1949. *Cyclommatus albersi* : Arrow, *Fauna of Brit. India*..... *Coleoptera*, *Lamellicornia*, 4, p. 66, pl. v. figs. 9 & 10, London.

Material.—Sikkim : Chungthang, 18. vii. 1959, 1 ♂ Length with mandibles 30.0 mm., without mandibles 22.0 mm.

Remarks.—Previously known from Manipur, Burma and Tonkin, it is now being recorded from Sikkim for the first time. The above specimen is a well-developed male, with distinct longitudinal folds on either side of the head. A closely related species *C. strigiceps* Westwood, also occurs in Sikkim. A dark lateral patch on the pronotum distinguishes this species from *C. strigiceps*. The ventral surface of the specimen is not dark green throughout, only the greater part of the pro- and meso-sternum are dark green in colour. Probably detailed study of a large number of specimens may prove that the two species are really one and the same.

4. *Dorcus ratiocinativus* Westwood

1871. *Dorcus ratiocinativus* Westwood, *Trans. ent. Soc. Lond.*, London, p. 356, pl. viii, fig. 2.

1949. *Dorcus ratiocinativus* : Arrow, *Fauna of Brit. India*..... *Coleoptera*, *Lamellicornia*, 4, pp. 93, 94, pl. ix, fig. 12, London.

Material.—Sikkim : Bichu, 14. vii. 1949, 1 ♂. Length with mandibles 31.0 mm., without mandibles 26.0 mm.

Remarks.—It is already known to occur in Sikkim and Tibet. In the present specimen the scutellum is punctate only in the anterior half : the scutellum may be smooth or punctate as stated by Arrow *loc. cit.* The anterior angles of the pronotum are obliquely truncate as usual, but the truncation is slightly concave in the present specimen.

5. *Dorcus nepalensis* (Hope)

1831. *Lucanus nepalensis* Hope, in Gray's, *Zoological Miscellany*, p. 22.

1949. *Dorcus nepalensis* : Arrow, *Fauna of Brit. India*..... *Coleoptera*, *Lamellicornia*, 4, p. 161, pl. xiii, figs. 1-3, London.

Material.—Sikkim : Lachung, 6. vii. 1959, 1 ♀. Length 44.0 mm., breadth 19.0 mm.

Remarks.—This species has a wide distribution in W. Pakistan (old N. W. Frontier Province and Murree Hills), India (Uttar Pradesh, Panjab, Assam) and Nepal. It is now recorded from Sikkim for the first time.

6. *Dorcus prox. fulvonatus* Parry¹

Material.—Sikkim : Nanga, 2. viii. 1952, 1 ♀. Length 23.5 mm., breadth 9.0 mm.

Remarks.—The above specimen comes near *D. fulvonatus* Parry, but is somewhat larger and has a single orange coloured median and subapical spot on each elytron, as against a curvilinear orange streak near the extremity almost reaching the suture or sometimes continued in a straight line to near the shoulders but more often interrupted in the middle and reappearing behind the shoulder as in *D. fulvonatus*. On the pronotum also there is a single small, median lateral orange spot on each side. The clypeal process is tongue-shaped and not transversely rounded as in *D. fulvonatus*. It, however, agrees with *D. fulvonatus* in having a minute spine on the meso- and meta-tibiae ; such spines are absent in *D. bisignatus* (Parry¹), another closely related species.

7 *Calcodes castanopterus* (Hope)

1831. *Lucanus castanopterus* Hope, in Gray's, *Zoological Miscellany*, p. 22.

1949. *Calcodes castanopterus* : Arrow, *Fauna of Brit. India*....., *Coleoptera, Lamellicornia*, 4, pp.197-199, pl .xxi, figs. 5, 6, London.

Material.—Sikkim : Nanga, 2. viii. 1959, 3♂♂, 1♀. Length of males with mandibles 34.0 and 30.0 mm., of female, 26.0 mm.

Remarks.—This is a widely distributed species and is known from Nepal, Sikkim, India (North Bengal, Assam, Manipur) and Burma. In all the four examples the antennae are with 3-segmented club and there is no tendency towards the 4-segmented club as observed by Arrow (*l.c.*) in some Burmese examples. The specimens are darker than those from Mungphu, E. Himalayas and Shillong present in the collections of the Zoological Survey of India.

8. *Calcodes baladeva* (Hope)

1843: *Odontolabis baladeva* Hope, *Trans. Linn. Soc. Lond. (Zool.)*, London, 9, p. 105.

1949. *Calcodes baladeva* : Arrow, *Fauna of Brit. India*. *Coleoptera, Lamellicornia*, 4, pp. 204-206, pl. xxi, figs. 1-3, London.

Material.—Sikkim : Gangtok, 17. viii. 1959, 1 ♂. Length with mandibles 52.5 mm., without mandibles 49.5 mm.

Remarks.—It is so far known from India (North Bengal, Assam, Manipur, Naga Hills) and Burma. It is now being recorded from

¹ 1863. Parry, *Proc. ent Soc, Lond.*, p. 111.

Sikkim for the first time. The above specimen does not represent the fully grown up condition since it lacks the carina on the dorsal surface of the mandible, and the inner margins of mandibles are serrated.

III—SUMMARY

The small collection of Lucanidae, (Coleoptera) from Sikkim that has been examined by me comprises four genera and eight species. Two of the species, though suspected to be new, are not named or described for want of sufficient number of examples. The species *Cyclommatus albersi* Kraatz, *Dorcus nepalensis* (Hope) and *Calcodes baladeva* (Hope) have been recorded from Sikkim for the first time.

FAUNA OF RAJASTHAN, INDIA.

PART 10. PROTOZOA (NO. 2)

By

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(With 1 Table and 6 Text-figures)

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I—INTRODUCTION

(a) *General*

This is the second of a series of papers on the free-living protozoan fauna of Rajasthan*, and is based on the collections made by the author during the period September-December 1963, from the districts of Ajmer Bikaner, Jaipur, Jodhpur, Pali, Udaipur and the vicinity of the Sambhar Salt Lake (Nagaur and Jaipur districts). Field cultures were prepared to obtain examples of the various species, except in the case of the testacean rhizopods, e.g., species of *Diffugia* Leclerc, *Arcella* Ehrenberg, and *Centropyxis* Stein. The material was subjected to appropriate *intra vitam* staining and was also observed under a phase contrast microscope. In some cases, owing to the scarcity of material, these procedures could be followed only for one or two individuals. For the study of the ciliates, silver-line observations were taken as far as possible. The number of examples mentioned under 'Material' under each species relates to the permanent preparations made but several individuals were also observed and studied in the field, and the final conclusions and identifications arrived at were based on both sets of observations.

* For the first part see Mahajan, *Rec. Zool. Surv. India*, Delhi, 61, (3&4) [1963], 1969, pp. 377—401.

Rec. Zool. Sugv. India, 63 (1—4), 1971.

A total of 34 species belonging to 21 genera, 19 families, 9 orders and 3 classes (Mastigophora, Sarcodina and Ciliata) are included in this paper. Of these, the following three taxa (2 species and one variety), all belonging to the class Ciliata, are new to science :

(A) Subclass Holotricha : Order Gymnostomatida :

1. *Coleps devdaniensis* n. sp. (Fam. Colepidae).

2. *Holophrya bengalensis minor* n. subsp. (Fam. Enchelyidae).

(B) Subclass Spirotricha : Order Hypotrichida :

3. *Oxytricha oblongatus* n. sp. (Fam. Oxytrichidae).

The type-specimens of these new taxa have been deposited in the National Zoological Collections at the Zoological Survey of India, Calcutta.

All the 34 species are recorded for the first time from Rajasthan, and the following 25 of them are first records from India :—

Class MASTIGOPHORA

Order EUGLENOIDINA : 1. *Euglena acus* (probable first record also from India). 2. *Euglena spirogyra minor*. 3. *Entosiphon sulcatum*.

Class SARCODINA

Order AMOEBINA : 4. *Amoeba radiosa*. 5. *Amoeba vespertilio*.

Order TESTACEA : 6. *Arcella vulgaris* (probable first record also from India). 7. *Diffugia lobostoma*. 8. *Diffugia urceolata*. 9. *Diffugia pyriformis*. 10. *Centropyxis aculeata*.

Class CILIATA

Order GYMNOSTOMATIDA : 11. *Coleps hirtus minor*. 12. *Coleps inermis*. 13. *Coleps devdaniensis* n. sp. 14. *Holophrya bengalensis minor* n. subsp. 15. *Hemiophrys procera*. 16. *Nassula ornata*.

Order TRICHOSTOMATIDA : 17. *Colpoda inflata*.

Order HYMENOSTOMATIDA : 18. *Frontonia atra*. 19. *Frontonia complanata*.

Order ODONTOSTOMATIDA : 20. *Saprodinium mimeticum*.

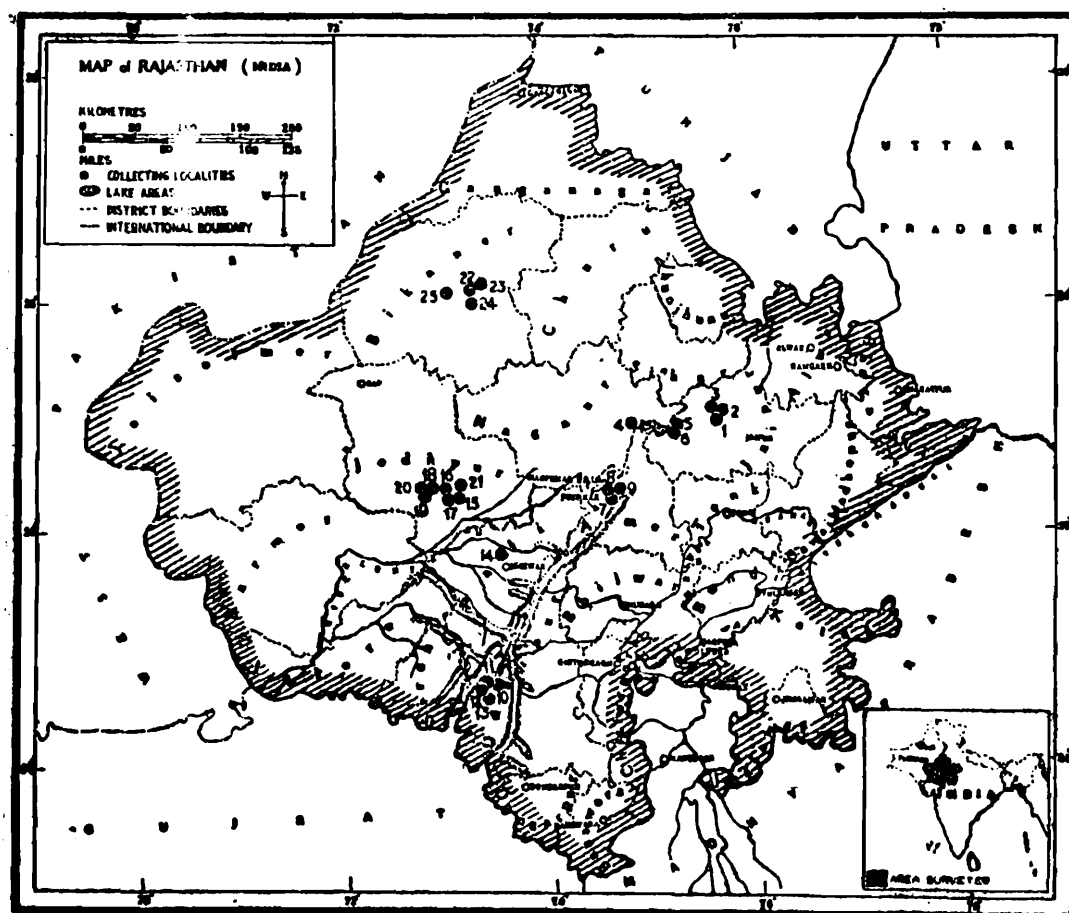
Order HYPOTRICHIDA : 21. *Euplotes plumipes*. 22. *Euplotes inkystans*. 23. *Oxytricha fallax*. 24. *Oxytricha hymenostomata*. 25. *Oxytricha ovalis*. 26. *Oxytricha oblongatus* n. sp.

(b) Abbreviations used

Dist., District.; Ex., Exs., Example, Examples ; Hom., Homonym ; Syns. Svdynvm ; Z. S. I., Zoological Survey of India.

(c) *List of Collecting Stations*

The collecting stations, with their location, etc. are listed in Table 1.



TEXT-FIG. 1.—Map of Rajasthan, showing the collecting localities for freshwater Protozoa. (The number given refers to the serial number of localities in the list of collecting localities in the text).

TABLE 1.—*List of collecting stations for Rajasthan Protozoa dealt with in this paper.*

Collecting Station	Latitude & Longitude (Approximate)	
	Lat. (N)	Long. (E)
(i) <i>Jaipur District</i>		
1. Jaipur	26°55'	75°52'
2. Galta (NE. of Jaipur)	27°00'	75°52'
3. Mansagar (north of Jaipur)	26°58'	75°52'
4. Devdyani (near Sambhar)	26°55'	75°13'
5. Phulera (near Sambhar)	26°52'	75°16'
6. Sambhar Lake	26°54'	75°13'

Collecting Station.	Latitude & Longitude (Approximate)	
	Lat. (N)	Long. (E)
(ii) <i>Ajmer District</i>		
7. Anasagar Lake, Ajmer	26°25'	74°35'
8. Faisagar (ca. 8 Km. NW. of Ajmer)	26°32'	74°37'
9. Pushkar Lake (ca. 15 Km. NW. of Ajmer)	26°32'	74°35'
(iii) <i>Udaipur District</i>		
10. Fatehsagar Lake (near Udaipur)	24°35'	73°35'
11. Sarupsagar (near Udaipur)	24°35'	73°35'
12. & 13. Pichola Lake (near Udaipur)	24°34'	73°40'
(iv) <i>Pali District</i>		
14. Sardar Samand (ca. 55 Km. SE. of Jodhpur)	25°54'	73°25'
(v) <i>Jodhpur District</i>		
15. Jodhpur	26°18'	73°04'
16. Bari Tank (near Jodhpur)	26°60'	72°55'
17. Bijolai (ca. 4 Km., West of Jodhpur)	26°15'	72°50'
18. Lambia & Megulai Nadi (ca. 23 Km., West of Jodhpur)	26°20'	73°00'
19. Khandesar Talab (ca. 35 Km. West of Jodhpur)	26°20'	72°40'
20. Khandia (ca. 35 Km. N. West of Jodhpur)	26°20'	72°40'
21. Nagkund (ca. 10 Km. NE. of Jodhpur)	26°19'	73°02'
(vi) <i>Bikaner District</i>		
22. Bikaner	28°01'	73°22'
23. Devikund (near Bikaner)	27°56'	73°18'
24. Shivbari (ca. 6 Km. SE. of Bikaner)	28°00'	73°23'
25. Gajner (ca. 35 Km. SW. of Bikaner)	27°55'	73°04'

(d) *Acknowledgements*

My thanks are due to the following for the assistance rendered :— To the staff of the Protozoology Section for assistance in the field as well as in the laboratory and the staff of the Desert Regional Station of the Zoological Survey of India at Jodhpur ; to Shri C. L. Mahajan of the Department of Zoology, University of Rajasthan, Jaipur, and to other members of the staff of that department, particularly Dr. P. N. Srivastava, for help and facilities rendered at Jaipur. To the Hindusthan Salt Corporation Ltd., Sambhar Lake, for working facilities afforded from time to time, to Shri Bhim Sen, Principal, M. B. College, Udaipur, for much valuable assistance at Udaipur. I am grateful to Dr. M. L. Roonwal, Director, Zoological Survey of India, for his valuable suggestions and guidance.

II—LIST OF FREE-LIVING PROTOZOA KNOWN FROM RAJASTHAN

In the following list the families, genera and species are numbered serially :

- Class I. **MASTIGOPHORA**
 Order 1. **EUGLENOIDINA**
 Family (i) **EUGLENIDAE**
 Genus 1. *Euglena* Ehrenberg
 1. *Euglena acus* Ehrenberg
 2. *Euglena spirogyra* var. *minor* Lefèvre
 Family (ii) **ANISONEMIDAE**
 Genus 2. *Entosiphon* Stein
 3. *Entosiphon sulcatum* (Dujardin)
 Class II. **SARCODINA**
 Order 1. **AMOEBINA**
 Family (iii) **AMOEBIDAE**
 Genus 3. *Amoeba* Ehrenberg
 4. *Amoeba radiosa* Ehrenberg
 5. *Amoeba vespertilio* Penard
 Order 2. **TESTACEA**
 Family (iv) **ARCELLIDAE**
 Genus 4. *Arcella* Ehrenberg
 6. *Arcella vulgaris* Ehrenberg
 Family (v) **DIFFLUGIIDAE**
 Genus 5. *Diffugia* Leclerc
 7. *Diffugia lobostoma* Leidy
 8. *Diffugia urceolata* Carter
 9. *Diffugia pyriformis* Perty
 Genus 6. *Centropyxis* Stein
 10. *Centropyxis aculeata* (Ehrenberg)
 Class III. **CILIATA**
 Subclass (A) **HOLOTRICHA**
 Order 1. **GYMNOSTOMATIDA**
 Family (vi) **COLEPIDAE**
 Genus 7. *Coleps* Nitzsch
 11. *Coleps hirtus* Müller var. *minor* Kahl
 12. *Coleps inermis* Perty
 13. *Coleps devdaniensis* n. sp.
 Family (vii) **ENCHELYIDAE**
 Genus 8. *Holophrya* Ehrenberg
 14. *Holophrya bengalensis* minor subsp. nov.
 15. *Holophrya simplex* Schewiakoff
 Genus 9. *Lacrymaria* Ehrenberg
 16. *Lacrymaria olor* (Müller)
 Family (viii) **TRACHELIIDAE**
 Genus 10. *Dileptus* Dujardin

17. *Dileptus anser* (Müller)
Family (ix) AMPHILEPTIDAE
Genus 11. *Hemiophrys* Wrzesinowsky
18. *Hemiophrys procera* (Penard)
Family (x) NASSULIDAE
Genus 12. *Nassula* Ehrenberg
19. *Nassula ornata* Ehrenberg
Order 2. TRICHOSTOMATIDA
Family (xi) COLPODIDAE
Genus 13. *Colpoda* Müller
20. *Colpoda inflata* (Stokes)
Order 3. HYMENOSTOMATIDA
Family (xii) PARAMECIIDAE
Genus 14. *Paramecium* Müller
21. *Paramecium bursaria* (Ehrenberg)
Family (xiii) UROCENTRIDAE
Genus 15. *Urocentrum* Nitzsch
22. *Urocentrum turbo* (Müller)
Family (xiv) FRONTONIIDAE
Genus 16. *Frontonia* Ehrenberg
23. *Frontonia atra* (Ehrenberg)
24. *Frontonia complanata* (Wetzel)
Subclass (B) SPIROTRICHA
Order 4. HETEROTRICHIDA
Family (xv) STENTORIDAE
Genus 17. *Stentor* Oken
25. *Stentor coeruleus* Ehrenberg
Family (xvi) SPIROSTOMATIDAE
Genus 18. *Spirostomum* Ehrenberg
26. *Spirostomum ambiguum* Ehrenberg
Order 5. ODONTOSTOMATIDA
Family (xvii) EPALEXELLIDAE
Genus 19. *Saprodinium* Lanterborn
27. *Saprodinium mimeticum* (Penard)
Order 6. HYPOTRICHIDA
Family (xviii) EUPLOTIDAE
Genus 20. *Euplotes* Ehrenberg
28. *Euplotes plumipes* Stokes
29. *Euplotes patella* (Müller)
30. *Euplotes inkystans* Chatton
Family (xix) OXYTRICHIDAE
Genus 21. *Oxytricha* Bory
31. *Oxytricha fallax* Stein
32. *Oxytricha hymenostomata* Stokes
33. *Oxytricha ovalis* Kahl
34. *Oxytricha oblongatus* n. sp.

III—KEY TO GENERA OF FREE-LIVING PROTOZOA KNOWN FROM RAJASTHAN

- 1(7) Permanent locomotory organs (organelle) absent.
- 2(3, 6) Individuals mononucleate ; body in a spherical or flask-shaped monolocular shell formed by reinforcement of sand grains 1. *Diffugia*
- 3(2) Individuals in a hemispherical or dome-shaped shell made up of chitinous membrane. ,
- 4(5) Mouth central 2. *Arcella*
- 5(4) Mouth eccentric ; shell with spines .. 3. *Centropyxis*
- 6(2) Individuals mononucleate, naked, with characteristic locomotory organs called pseudopodia. 4. *Amoeba*
- 7(1) Permanent locomotory organs (organelle) present.
- 8(12) Locomotory organelle long flexible and whip-like (flagella) ; situated anteriorly.
- 9(10, 11) With a single flagellum rooted in a reservoir 5. *Euglena*
- 10(9, 11) With two flagella, both directed forwards 6. *Chilomonas*
- 11(9, 10) With two flagella, one always trails behind during locomotion 7. *Entosiphon*
- 12(8) Locomotory organelle short and generally present all over the body ; sometimes restricted to certain regions.
- 13(50) Individuals free-living (not sessile).
- 14(43) Individuals with no cirri.
- 15(35) Cytostome present on body surface.
- 16(17, 18) Cytostome anterior, at the characteristic apical cone, situated at the tip of a highly contractile neck 8. *Lacrymaria*
- 17(16, 18) Cytostome anterior, lying at tip of an apical cone. Without contractile long neck. Body barrel-shaped, with 2 or 4 characteristic girdles of cilia at various levels . .. 9. *Didinium*
- 18(16, 17) Cytostome anterior, not apical but surrounded by slightly longer cilia. Body barrel-shaped and covered with regularly arranged, perforated cytoplasmic plates 10. *Coleps*
- 19 Cytostome slit-like and situated on a convex surface of a flattened flask-shaped, laterally compressed body at the base of anterior neck-like projection. Cilia present only on right side of the body.
- 20(21) With only one contractile vacuole, situated at posterior end. Cytostome with trichocysts : 11. *Lionotus*

- 21(22) With contractile vacuoles arranged laterally in rows. Posterior portion also drawn out 12. *Hemiophrys*
- 22(19) Cytostome situated on a flattened ventral surface. Dorsal surface convex. Somatic ciliation restricted to ventral surface 13. *Chilodonella*
- 23(24) Cytostome rounded, situated at base of an anteriorly drawn out finger-like process; body oval, and rounded posteriorly 14. *Trachelius*
- 24(23) Cytostome found and at base of a conspicuous neck-like projection. Body lanceolate and drawn out into a tail-like prolongation 15. *Dileptus*
- 25(26) Cytostome at about $\frac{1}{4}$ of the body length towards anterior end, with inconspicuous undulating membrane on right and three membranellae on left. Ciliation uniform. One contractile vacuole present and located centrally 16. *Glaucoma*
- 26(25) Cytostome at left of median line, at about one-fourth of body length. Cilia dense, uniform and in rows, short and conical cytopharynx. One contractile vacuole present and located centrally 17. *Monochilum*
- 27(28) Cytostome at right of median line, in posterior half, with a membrane on both edges forming a pocket. With one caudal cilium. Contractile vacuole single and terminal 18. *Cinetochilum*
- 28(27) Individuals ovoid, with a caudal cilium, peristome near the right side, with a membrane on its right edge which forms a pocket around cytostomal groove. On the left of peristome lies the undulating membrane 19. *Cyclidium*
- 29(31) Pharynx absent.
- 30 Cytostome rounded and anterior. Body uniformly ciliated 20. *Holophrya*
- 31(29) Pharynx present.
- 32 Cytostome round and anterior. Pharynx supported by the characteristic rod apparatus 21. *Nassula*
- 33(34) Cytostome with short, curved pharynx, situated in depression on one side of kidney-shaped body 22. *Colpoda*
- 34(33) Cytostome with well developed pharynx. Body more or less dumb-bell-shaped with a characteristic ciliary girdle and ciliary tail 23. *Urocentrum*
- 35(15) Cytostome not present on body surface but situated within peristome.
- 36(37) Body foot-shaped, with a pair of characteristic contractile vacuoles 24. *Paramecium*

- 37(36) Cytostome having no connection with peristome, though situated therein. Body sole-shaped with contractile vacuole having long radiating canals 25. *Frontonia*
- 38 Body cylindrical, somewhat compressed and extremely contractile. Peristome long, extending down the left side of the ventral surface upto or beyond the middle of the body and continues inward as a short funicular cytopharynx. Excretory (contractile) vacuole terminal, large and with a long dorsal canal. Macronucleus chain form 26. *Spirostomum*
- 39(40) Peristome sickle-shaped. Ciliated slit sunk at right angles to body surface. One or two contractile vacuoles having long radiating canals 27. *Ophryoglena*
- 40(39) Peristome not sunk at right angles to body, but starting from anterior end to middle of body ; curved to right. Body spindle-shaped. Peristome with two membranes on right edge 28. *Cohnilembus*
- 41(42) With conspicuous anterior peristome, slightly spirally diagonal, beginning at anterior end and reaching almost to middle of body. A narrow non-ciliated zone on right of adoral zone. One macronucleus 29. *Metopus*
- 42(41) Peristome wide anteriorly, 'V'-shaped and without non-ciliated zone. A large undulating membrane on right edge and adoral zone on left of peristome, present. Macronucleus moniliform. 30. *Condylostoma*
- 43(14) Individuals with cirri.
- 44(45, 46) Body reniform, inflexible, with two oval macronuclei. Five ventral cirri in two rows 31. *Stylonychia*
- 45(44, 46) Body oblongate or oval, flexible, contractile and with two macronuclei. Eight frontal cirri 32. *Oxytricha*
- 46(44, 45) Body ovoid, inflexible, longitudinally ridged. Nine fronto-ventral cirri, not in rows. Macronucleus ribbon-shaped 33. *Euplotes*
- 47 Body carapaced, rounded triangular in shape and laterally compressed. Anterior end pointed towards ventral surface. Posterior end irregularly truncated and with four anal cirri 34. *Saprodinium*
- 48(49) Body loricated, individuals flask-shaped, flexible and free to move inside lorica. Cytostome at base of proboscis 35. *Chaetospira*
- 49(48) Body not loricated. ..
- 50(13) Individuals sessile, trumpet-shaped and highly contractile, with moniliform macronucleus 36. *Stentor*
- 51(52) Individual sessile with non-contractile stalk. Food-procurement and ingestion with the help of tentacles .. 37. *Sphaerophrya*
- 52(51) Individuals with a short contractile stalk. No suctorial tentacles. Individuals with lorica 38. *Cothurnia*

IV—SYSTEMATIC ACCOUNT

1. *Euglena acus* Ehrenberg

(Text-fig. 2A)

1832. *Euglena acus* Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin, p. 39.1956. *Euglena acus* : Pringsheim, *Nova Acta Leop.*, Leipzig, 18 (125), pp. 47—50, fig. 2.

Material.—2 exs., pond in Megulai Nadi, near Jodhpur (Jodhpur Dist.), 2.xii.63.

Diagnosis.—Spindle-shaped with slight torsion, widest in the middle ; anterior end truncate ; posteriorly narrowing into an almost cylindrical tail-like process devoid of chromatophores. Metaboly weak, limited to general body while the tail portion remaining straight even if bent on one side ; canal opening a little towards one side ; body striation not pronounced but visible with an immersion system ; flagellum about $\frac{1}{4}$ th of the body-length ; nucleus central and cylindrical with hemispherical ends ; size $58.7-75 \times 13\mu$.

Distribution.—RAJASTHAN (first record ; probably first record also from India) : As above. *Elsewhere* : Universal in stagnant waters.

Remarks.—The forms which were designated as type by Pringsheim (1956), possess a flagellum $\frac{1}{3}$ rd of the body-length (vs. $\frac{1}{4}$ th in the present ones). Records in the literature show that the flagellum is less than $\frac{1}{3}$ rd the body-length. Pringsheim gave the size as $104-109 \times 10-22\mu$. The present specimens were much contracted during fixation. The size-range from various authors is : $47-311 \times 4-25\mu$, but Pringsheim (1956) prefers to regard the general range of *Euglena acus* as $75-150\mu \times 7-12\mu$.

In spite of the short flagellum, these animals are lively swimmers; these were not seen to glide. Fixation takes place at the tip of the tail.

2. *Euglena spirogyra* var. *minor* Lefèvre

(Text-fig. 2B)

1932. *Euglena spirogyra* var. *minor* Lefèvre, *Ann Protis.*, Paris, 3, p. 203.

Material.—2 exs., pond in Devikund, Bikaner (Bikaner Dist.), 7.xii.63.

Diagnosis.—Elongated, fusiform, a little twisted ; anterior end slightly narrowed and rounded ; canal opening a little to one side ; posterior end conical, with cylindrical, well-defined, colourless tail-piece. Metaboly by increase in twist ; followed by bending along whole length of the body except the tail portion which remains straight ; flagellum about $\frac{2}{3}$ rds the body-length ; periplast is adorned with quite prominent striation made up of small knobs ; size $42.4-45.6 \times 9.8\mu$.

Distribution.—RAJASTHAN (first record from India) : As above. *Elsewhere* : Universal in stagnant waters.

Remarks.—Lefèvre (1932) had recorded somewhat longer specimens, $45-50 \times 7-9 \mu$.

3. *Entosiphon sulcatum* (Dujardin)

(Text-fig. 2C)

1841. *Anisonema sulcata* Dujardin, *Histoire Naturelle des Zoophytes infusoires* Paris, p. 345, pl. 4, fig. 28.

1878. *Entosiphon sulcatum* (Dujardin): Stein, *Der Organismus der Infusionsthier*, Leipzig, 3, pl. 24, fig. 18 (and explanation).

Material.—2 exs., Mansagar Jaipur (Jaipur Dist.), 21.ix.63.

Diagnosis.—Body oval, flattened, more or less rigid; two flagella both arising from a cytostome, one flagellum trailing; cytopharynx a long conical tubule placed obliquely and covering more than half the body-length; nucleus centro-lateral; size $11.4 \times 13 \mu$.

Distribution.—RAJASTHAN (first record from India) : As above. *Elsewhere* : Universal in stagnant waters with decaying vegetation.

Remarks.—My specimens are small, being nearly half the size of those recorded by earlier authors.

4. *Amoeba radiosa* Ehrenberg

(Text-figs. 2D-G)

1832. *Amoeba radiosa* Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin, p. 39.

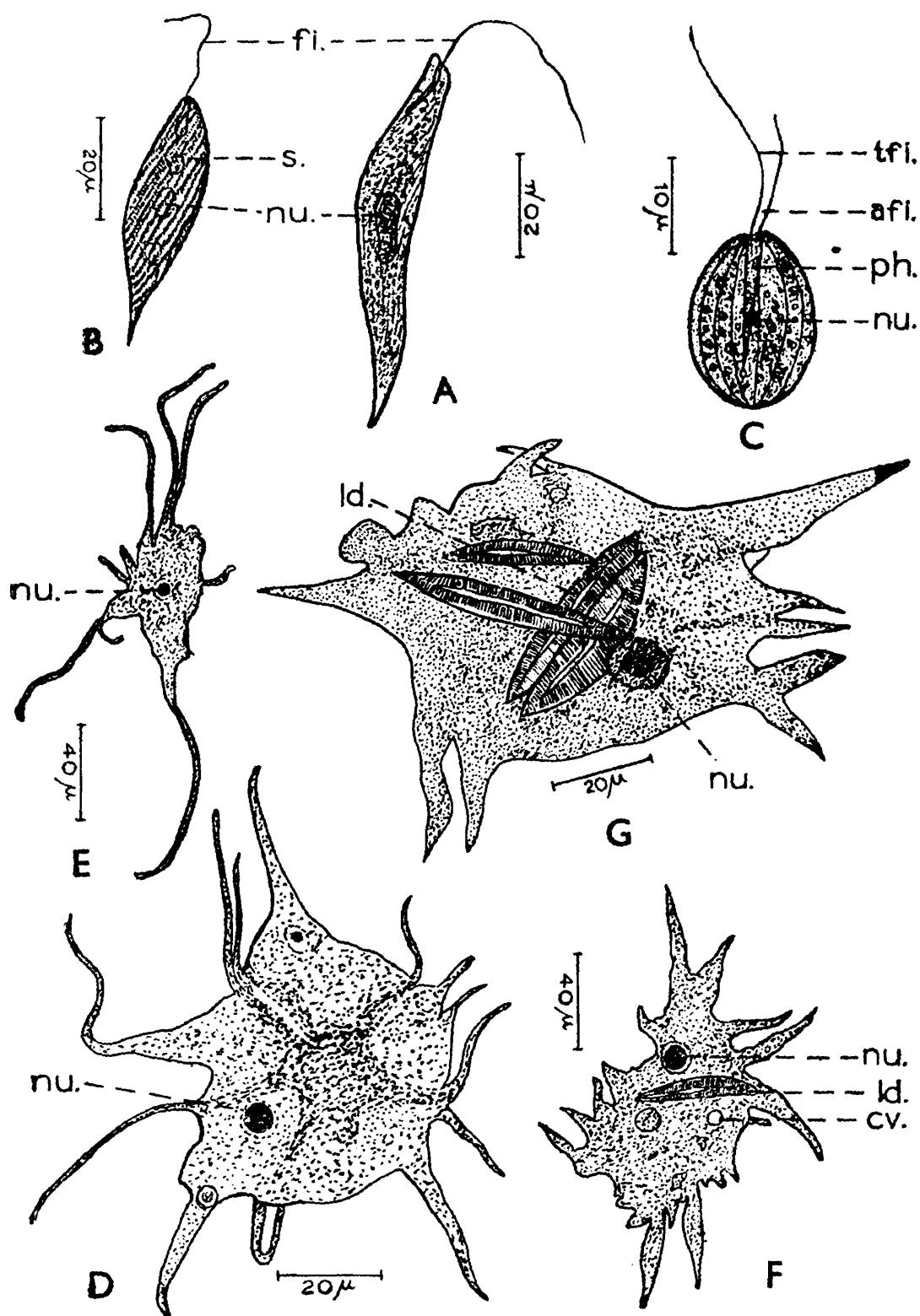
1879. *Amoeba radiosa* : Leidy, *Rep. U. S. geol. Surv.*, Washington, 12, pp. 59—62, pl. 4, figs. 1—18.

Material.—(i) 5 exs., Pushkar Lake near Ajmer (Ajmer Dist.), 27.x.63.
(ii) 2 exs., Sardar Samand (Pali Dist.), 24.xi.63.

Diagnosis.—Small, with many long, slender radiating pseudopodia; when inactive, globular or oval in outline; single nucleus; size $13-45.6 \times 9.7-42 \mu$; length of pseudopodia 42.3μ .

Distribution.—RAJASTHAN (first record from India) : As above. *Elsewhere* : Universal in freshwater bodies.

Remarks.—The specimens observed are of average size, the maximum length of the pseudopodia being $42\ \mu$. Leidy (1879) had recorded $80\ \mu$ long pseudopodia.



TEXT-FIG. 2.—(A) *Euglena acus* Ehrenberg. (B) *Euglena spirogyra* var. *minor* Lefèvre. (C) *Entosiphon sulcatum* (Dujardin). (D-G). *Amoeba radiosa* Ehrenberg.

5. *Amoeba vespertilio* Penard

(Text-fig. 3A)

1902. *Amoeba vespertilio* Penard, *Faune Rhizopodique du Bassin du Léman*, Geneva, 4, p. 92.

Material.—3 exs., Pushkar Lake, near Ajmer (Ajmer Dist.), 27.x.63.

Diagnosis.—Pseudopodia conical, comparatively short, connected at base by web-like expansions of ectoplasm ; single vesicular nucleus ; contractile vacuoles present ; size $32-42 \times 22.8-29 \mu$.

Distribution.—RAJASTHAN : As above (first record from India).

Elsewhere : Universal in freshwater bodies.

Remarks.—My specimens are small, being nearly half the size of the earlier records (60-100 μ). It is a rare species.

6. *Arcella vulgaris* Ehrenberg

(Text-fig. 3B)

1832. *Arcella vulgaris* Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin, p. 90.

1856. *Arcella vulgaris* : Carter, *Ann. Mag. nat. Hist.*, London, (2) 18, p. 247..

Material.—4 exs., Anasagar Lake, Ajmer (Ajmer Dist.), 21.x.63.

Diagnosis.—Height of the test about $\frac{1}{2}$ the diameter ; dome of hemispherical test evenly convex ; aperture circular and central ; test yellowish brown ; protoplasmic body conforming with shape of test but never filling the latter ; lobopodia hyaline ; diameter of test $45.6-92.8 \mu$.

Distribution.—RAJASTHAN : As above (first record ; probably also first record from India). *Elsewhere* : Universal in stagnant waters with vegetation.

Remarks.—The specimens obtained are of medium size (45-93 μ). Leidy (1879) gave the range 48-152 μ .

7. *Diffugia lobostoma* Leidy

(Text-fig. 3C)

1877. *Diffugia lobostoma* Leidy, *Proc. Acad. nat. Sci. Philad.*, Philadelphia, p. 307.

Material.—1 ex., Anasagar Lake, Ajmer (Ajmer Dist.), 18.x.63.

Diagnosis.—Test ovoid ; aperture terminal with 3-6 lobes ; test composed of sand grains ; endoplasm colourless ; size $74.9 \times 58.6 \mu$.

Distribution.—RAJASTHAN (first record from India) : As above.
Elsewhere : Universal in stagnant waters.

Remarks.—My specimen is small. Leidy (1879) recorded the size as $120 \times 100 \mu$. The mouth is trilobed.

8. *Diffugia urceolata* Carter

(Text-fig. 3D)

1864. *Diffugia urceolata* Carter, *Ann. Mag. nat. Hist.*, London, 13, pp. 27 and 37, pl. 1, fig. 7.

Material.—(i) 1 ex., Pichola Lake near Udaipur (Udaipur Dist.), 9.xi.63. (ii) 1 ex., Fatehsagar Lake near Udaipur (Udaipur Dist.), 6.xi.63. (iii) 3 exs., Nagkund, Jodhpur (Jodhpur Dist.), 8.xii.63. (iv) 2 exs., Gajner (Bikaner Dist.), 21.xii.63.

Diagnosis.—Test large, round, with a short neck and a rim around aperture ; mouth large, circular and frequently truncating the neck ; pseudopodia ordinarily 3-6 and of simple digitate type ; size $71.7-120.6 \times 55.4-88 \mu$.

Distribution.—RAJASTHAN : As above (first record from India).
Elsewhere : Universal in stagnant waters.

Remarks.—The test is amphora-form and without spines. In the specimen observed, the mouth is circular. My specimens are small (cf. Leidy's, 1879, measurements, 180-440 μ).

9. *Diffugia pyriformis* Perty

(Text-fig. 3E)

1848. *Diffugia pyriformis* Perty, *Mitt. naturf. Ges., Bern*, p. 168.

Material.—1 ex., Anasagar Lake Ajmer (Ajmer Dist.), 18.x.63.

Diagnosis.—Test pyriform or flask-shaped ; aperture terminal, typically circular ; test composed of angular sand grains ; size $117.3 \times 92 \mu$.

Distribution.—RAJASTHAN : As above (first record from India).
Elsewhere : Universal in stagnant waters.

Remarks.—The test is of medium size (*cf.* Leidy's 1879, specimens, 60—580 $\times$ 40—240 μ). It is a rare species, occurring in the bottom ooze of ponds. The shell is composed of quartz grains.

10. *Centropyxis aculeata* (Ehrenberg)

(Text-fig. 3F)

1832. *Arcella aculeata* Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin, p. 40.

1857. *Centropyxis aculeata* (Ehrenberg): Stein, *S. Bohn. Ges. Wiss.*, Prague, 5 (10), pp. 41—43.

Material.—3 exs., Anasagar Lake, Ajmer (Ajmer Dist.), 18. $\times$ 63.

Diagnosis.—Test circular with the fundus pressed to one side so as to render the mouth eccentric. Fundus of shell obtusely rounded and furnished with 4-6 divergent spines in a single somewhat regular row ; shell made up of yellowish chitinous membrane with variable proportions of thin, membranous plates ; size 124—130 μ .

Distribution.—RAJASTHAN : As above (first record from India)
Elsewhere : Universal in freshwater ponds.

Remarks.—The tests of my specimens are of medium size (*cf.* Leidy's, 1879, specimens, 88—260 μ). Empty tests are usually seen on the bottom ooze of ponds. The spinous processes on the test vary from 4—5 in number.

11. *Coleps hirtus minor* Kahl

(Text-fig. 3G)

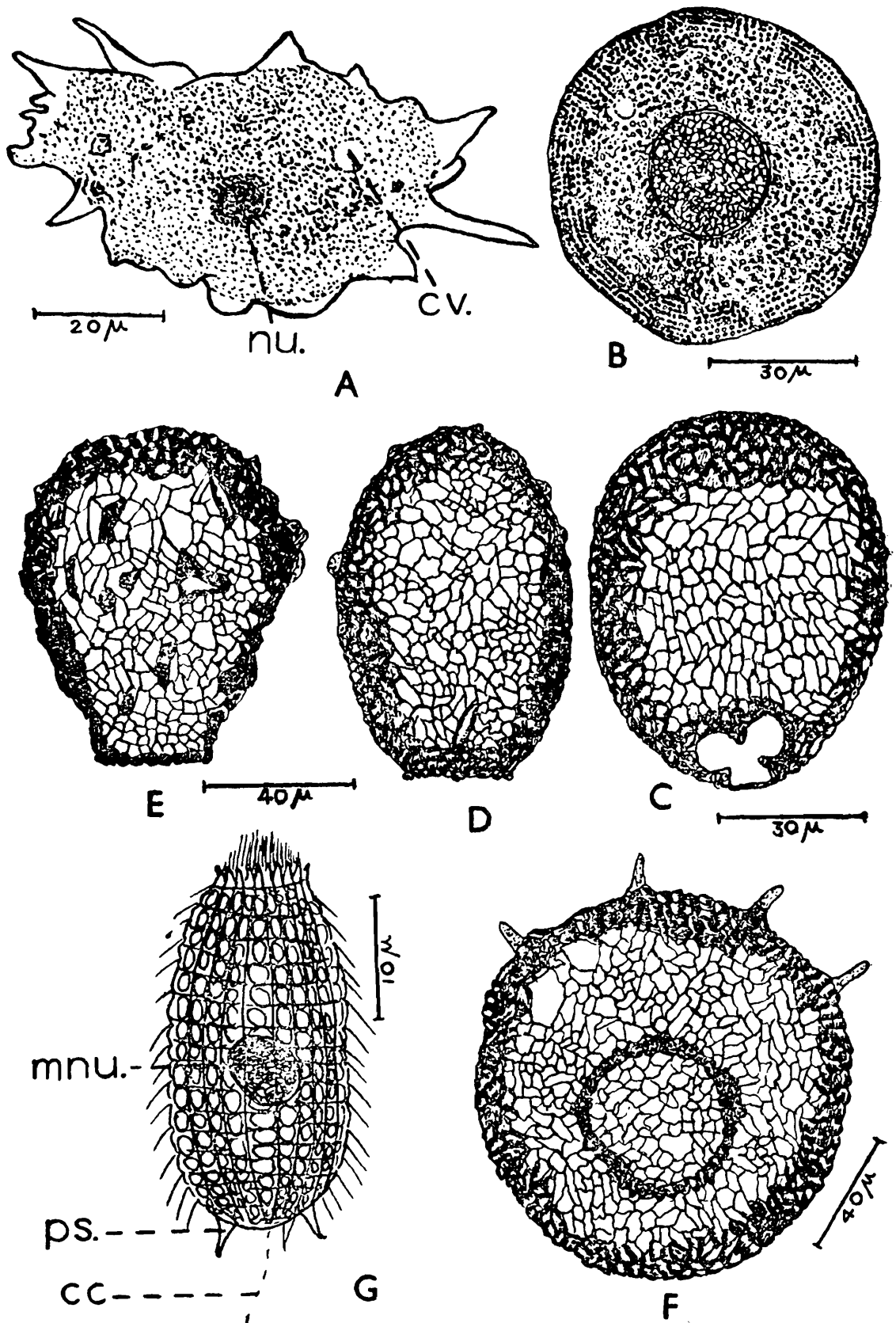
1930. *Coleps hirtus* var. *minor* Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Deutsch.*), Jena, p. 134, pl. 18, fig. 4.

Material.—(i) 1 ex., Galta near Jaipur (Jaipur Dist.), 10.ix.63. (ii) 3 exs., Sardar Samand (Pali Dist.), 24.xi.63.

Diagnosis.—Resembles *Coleps hirtus* in all respects, except being smaller ; size 74.9—84.7 $\times$ 45.6—49 μ .

Distribution.—RAJASTHAN (first record from India) : As above. *Elsewhere* : Universal in freshwater ponds among decaying vegetation.

Remarks.—It is found in lakes and ponds and in shallow waters having decaying vegetation, and is a very voracious eater, commonly feeding on dead Protozoa and rotifers.



TEXT-FIG. 3.—(A) *Amoeba vespertilio* Penard. (B) *Arcella vulgaris* Ehrenberg. (C) *Diffugia lobostoma* (Leidy). (D) *Diffugia urceolata* Carter. (E) *Diffugia pyri-formis* Perty. (F) *Centropyxis aculeata* (Ehrenberg). (G) *Coleps hirtus* var. *minor* Kahl.

12. *Coleps inermis* Perty

(Text-fig. 4A)

1852. *Coleps inermis* Perty, *Zur Kenntniss kleinster Lebensformen*, Bern, pp 57—67.

Material.—3 exs., Galta near Jaipur (Jaipur Dist.), 22.ix.63.

Diagnosis.—Body oval, twice as long as broad ; longitudinal furrows, prominent ; plates quadrangular ; no transverse furrows ; posterior spines absent ; macronucleus single, spherical, central towards one side contractile vacuole terminal ; size $32.6-37.5 \times 16-18 \mu$.

Distribution.—RAJASTHAN : As above (first record from India). *Elsewhere* : Universal in freshwater bodies.

Remarks.—The specimens observed are smaller than those of Perty (1852, 80μ).

13. *Coleps devdaniensis* n.sp.

(Text-fig. 4B)

Material.—3 exs., Devdani Temple tank near Sambhar (Jaipur Dist.), 7.x.63.

Diagnosis.—Body with hemispherical posterior and a conical anterior region, with a prominent girdle separating the two. Longitudinal furrows well pronounced ; transverse furrows not very deep. Body ciliation uniform. Posterior spines absent. Macronucleus single, spherical and sub-central. Size $68.4-78.2 \times 52-55.4 \mu$.

Distribution.—*Rajasthan* : As above.

Comparison.—The new species is separable from the allied ones as follows :

(1) From *C. hirtus* (Müller) : (i) Much broader than long. (ii) Posterior spines absent (vs. present in *hirtus*).

(2) From *C. kenti* Bhatia : (i) Length width ratio 3 : 2 (Vs. 4 : 3 in *kenti*). (ii) Body divided into two halves by a deep transverse furrow (vs. divided into four chief girdles by such furrows). (iii) Body hemispherical posteriorly and conical anteriorly (vs. barrel shaped in *kenti*).

(3) From *C. striatus* Smith : (i) Body proportionately broader and more clearly marked into quadrangular facets (not so in *striatus*).

Type specimens.—*Holotype* : on a slide ; Z. S. I. Reg. No. Pt. 385, Loc. as above. *Paratypes* : two, one on each slide ; Z. S. I. Reg. No. pt. 386 and Pt. 387, Loc. as above.

14. *Holophrya bengalensis* n. subsp. *minor*

(Text-fig. 4C)

Material.—(i) 1 Ex. Phulera, 2.×.63. (ii) 1 Ex., Devdani temple tank, Sambhar, 2.×.63. (both Jaipur Dist.) (iii) 1 Ex., Sarupsagar, Udaipur (Udaipur Dist.), 1.×.1.63.

Diagnosis.—Body cylindrical with uniform ciliation. Cytostome small and anterior. Longitudinal striations very clear. Macronucleus single, oval and situated at one side in the middle of body. Contractile vacuole situated in the posterior quarter towards one side. Size $34.2\text{--}48.9 \times 16\text{--}19.5\ \mu$.

Distribution.—RAJASTHAN : As above (first record from India).

Comparison.—The new variety differs from the nominal one, *H. bengalensis* Ghosh as follows :—

(i) Shape ovoid (vs. fusiform in *bengalensis*). (ii) Size smaller ($34\text{--}49 \times 16\text{--}20\ \mu$) as against $75 \times 37\ \mu$ in *bengalensis*.

Remarks.—Bhatia (1936) described *Holophrya* species as *Holophrya bengalensis*, the description of which is based on the examination of single specimen by Ghosh (1919). Specimens under discussion are smaller in size but the length breadth ratio is almost same as that of the specimen described by Ghosh. The present form is ovoid whereas that of Ghosh is fusiform. In view of the above differences the present material has been considered to belong to a new variety of *Holophrya bengalensis* Ghosh.

Type specimens.—*Holotype* : on a slide ; Z. S. I. Reg. No. Pt. 380, Loc. Phulera (Jaipur Dist.). *Paratypes* : Two, one on each slide ; Devdani Temple tank (Jaipur Dist.) ; Z. S. I. Reg. No. Pt. 381, the other from Sarup Sagar (Udaipur Dist.) ; Z. S. I. Reg. No. Pt. 382.

15. *Holophrya simplex* Schewiakoff

(Text-fig. 4D)

1889. *Holophrya simplex* Schewiakoff, *Bibl. Zool.*, Leipzig, 5, pp. 30—32, pl. 2, fig. 31.

Material.—3 exs., Devdani Temple tank, near Sambhar (Jaipur Dist.), 2.×.63.

Diagnosis.—Body ellipsoid ; ciliation uniform with small, closely-set cilia, in 18—20 longitudinal rows ; cytostome small, terminal and detectable only at time of ingestion ; with trichocysts ; cytopharynx absent ; anus and contractile vacuole posterior ; macronucleus large, spherical, central ; size $22.8\text{--}27 \times 16\text{--}19.5\ \mu$.

Distribution.—RAJASTHAN (first record) : As above. *Elsewhere* : Universal in freshwater ponds.

Remarks.—My specimens are smaller than the ones recorded by Schewiakoff (1889).

16. *Lacrymaria olor* (Müller)

(Text-fig. 4E)

1786. *Vibrio olor* Müller, *Animalc. Infusoria, fluvial. et. marina. etc.*, Hafniae et Lipsiae, p. 75, pl. 10. figs. 12—15.
1832. *Lacrymaria olor* (Müller) : Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin, p. 105.

Material.—(i) 1 ex., Anasagar Lake, Ajmer (Ajmer Dist.), 21.x.63. (ii) 4 exs., Bikaner (Bikaner Dist.) 18.xii.63.

Diagnosis.—Body elongate ; cylindrical posterior portion with a pointed end and a long, highly contractile neck at the other end ; oral cone well-developed ; ciliation uniform and ciliary meridians spiral ; two contractile vacuoles on either ends of cylindrical body-portion. macronucleus consisting of two rounded parts united together ; size $94.5-105 \times 26-31.5 \mu$.

Distribution.—RAJASTHAN: As above (first record). *Elsewhere* Universal in stagnant waters with decaying vegetation.

Remarks.—The length varies considerably according to the state of extension of the neck. It is commonly met with in the surface bacterial films found on top of water samples kept in the laboratory. It is a voracious feeder of bacteria.

17. *Dileptus anser* (Müller)

(Text-fig. 4F)

1786. *Vibrio anser* Müller, *Animalc. Infusoria, fluvial. et. marina, etc.*, Havniae et Lipsiae, pp. 73, 74, pl.10, figs. 7—11.
1841. *Dileptus anser* (Müller) : Dujardin, *Histoire nat. des zoophytes infusoires*, Paris, pp. 407—409, pl. 7, fig. 17.

Material.—(i) 1 ex., Barli Tank near Jodhpur (Jodhpur Dist.), 8.xii.63. (ii) 1 ex., Khandia (Jodhpur Dist.), 8.xii.63. (iii) 2 exs., Lambia (Jodhpur Dist.), 9.xii.63. (iv) 8 exs., Devikund, Bikaner (Bikaner Dist.), 17.xii.63.

Diagnosis.—Body elongate, greyish white; with a tail-like projection at posterior end ; neck elongated, contractile, showing characteristic movements ; very fine cilia all-over body ; cytopharynx funnel-shaped, longitudinally striated, and located at base of neck ; contractile vacuoles many, arranged in a row dorsally ; macronuclei numerous and scattered ; size (semi-contracted) $283.5-341 \times 47-57 \mu$.

Distribution.—RAJASTHAN : As above (first record). *Elsewhere* ; Universal in freshwater bodies with decaying vegetation.

Remarks.—The specimens studied were of medium size, the earlier recorded length being 200—400 μ . The endoplasm was finely granular and the tail drawn out into a distinct, pointed prolongation.

18. *Hemiophrys procera* (Penard)

(Text-fig. 4G)

1922. *Lionotus procerus* Penard, *Etudes sur les Infusoires d'eau douce*, Genève, p. 69, fig. 75.

1931. *Hemiophrys procera* (Penard): Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 21, p. 186, fig. 11.

Material.—(i) 1 ex., Fateh Sagar (Udaipur Dist.), 6.xi.63. (ii) 3 exs., Sardar Samand (Pali Dist.), 24.xi.63. (iii) 1 ex., Khandia (Jodhpur Dist.), 7.xii.63. (iv) 2 exs., Gajner (Bikaner Dist.), 20.xii.63.

Diagnosis.—Flask-shaped, elongate, flattened ; anterior region neck like ; posterior end with a tail-like prolongation ; middle portion broad with a convex dorsal surface and flat ventral side ; two rows of contractile vacuoles ; macronuclei two, oval, situated in middle of the body ; with uniform ciliation all over the body ; size $136.5\text{--}238 \times 36.7\text{--}49 \mu$.

Distribution.—RAJASTHAN : As above (first record from India). *Elsewhere* : Universal in freshwater ponds.

Remarks.—The specimens observed were smaller than the earlier records (600—800 μ).

19. *Nassula ornata* Ehrenberg

(Text-fig. 4H)

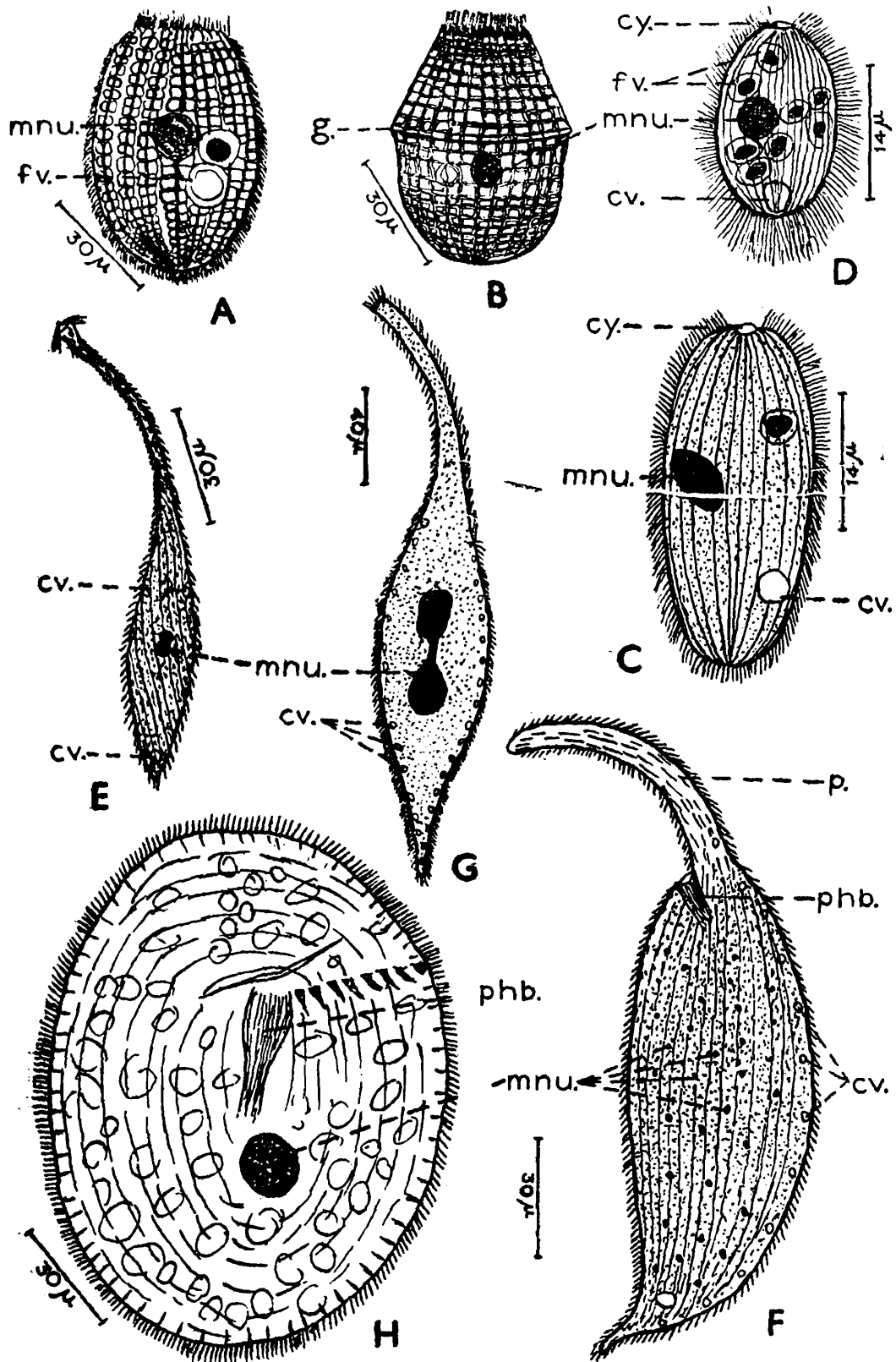
1833. *Nassula ornata* Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin, p. 169, pl. 1, fig 2.

Material.—5 exs., Gajner (Bikaner Dist.), 18.xii.63.

Diagnosis.—Body ovate, twice as long as broad ; brownish green ; with many vesicles ; pharyngeal basket having straight trichites, even undilated tube ; ciliation uniform with fine cilia ; contractile vacuole single, subcentral ; macronucleus single, spherical, usually situated below pharyngeal tube ; size $132\text{--}138.5 \times 88\text{--}94 \mu$.

Distribution.—RAJASTHAN : As above (first record from India). *Elsewhere* : Universal in freshwater ponds.

Remarks.—The specimens observed were smaller than those recorded by previous workers.



TEXT-FIG. 4.—(A) *Coleps inermis* Perty. (B) *Coleps devdaniensis* n. sp. (C) *Holophrya bengalensis* var. *minor* nov. (D) *Holophrya simplex* Schewiakoff. (E) *Lacrymaria olor* (Müller). (F) *Dileptusanter* (Müller). (G) *Hemiofrys procera* (Penard). (H) *Nassula ornata* Ehrenberg.

20. *Colpoda inflata* (Stokes)

(Text-fig. 5A)

1885. *Tilinna inflata* Stokes, *Ann. mag. nat. Hist.*, London, (5), 15 p. 441 fig. 9.

1931. *Colpoda inflata* (Stokes): Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Deutsch.*), Jena, pt. 21, p. 280, fig. 47 (9).

Material.—2 exs., Anasagar Lake, Ajmer (Ajmer Dist.), 21.x.63.

Diagnosis.—Body reniform, compressed ; oral funnel a little anterior to middle of ventral side ; anterior keel with 6—8 indentations ; ciliary meridians 21—24 ; contractile vacuole single, posterior ; macronucleus round, situated in the middle of body ; size $39-40.7 \times 27.7-31 \mu$.

Distribution.—RAJASTHAN : As above (first record from India). *Elsewhere* : Universal in freshwater ponds.

Remarks.—The specimens observed were smaller than those ones recorded by the earlier workers.

21. *Paramecium bursaria* (Ehrenberg)

(Text-fig. 5B)

1831. *Loxodes bursaria* Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin, p. 109.

1836. *Paramecium bursaria* (Ehrenberg) : Focke, *Isis*, Brussels, pp. 786—787.

Material.—(i) 4 exs., Jodhpur (Jodhpur Dist.), 28.xi.63. (ii) 2 exs., Bijolai (Jodhpur Dist.), 9.xii.63. (iii) 2 exs., Shivbari (Bikaner Dist.), 14.xii.63.

Diagnosis.—Body foot-shaped, flat, rounded posteriorly ; green, with abundant zoochlorellae as symbionts ; peristomial groove broad anteriorly, extending obliquely backwards, followed by a cytostome which opens into a distinct cytopharynx ; with two contractile vacuoles with radial canals ; macronucleus oval and massive with a relatively large and compact micronucleus close to it ; size $97.8-130 \times 39-58.6 \mu$.

Distribution.—RAJASTHAN : As above. (first record) *Elsewhere* : Universal in freshwater ponds with green algae.

Remarks.—The specimens observed were of medium size, the length given by earlier workers being 90—306, usually 120—160 μ . The compact micronucleus lies at the notch found in the anterior pole of the macronucleus.

22. *Urocentrum turbo* (Müller)

(Text-fig. 5c)

1786. *Cercaria turbo* Müller, *Animalc. Infusoria, fluviat. et. marina. etc.*, Havniae et Lipsiae, pp. 123—124, pl. 26, figs. 13—16.

1817. *Urocentrum turbo* (Müller) Nitzsch, *Neue. Schrift der naturf. Ges. in Halle*, Halle, 3, p. 3.

Material.—4 exs., Fatehsagar (Udaipur Dist.), 6.xi.63.

Diagnosis.—Body flexible, unevenly cylindrical ; rounded at both ends ; with three ciliary girdles, the anterior widest, the posterior wider with long cilia, the middle narrow with short cilia ; cytostome just below the mid-ciliary girdle ; contractile vacuole posterior, with collecting canals ; macronucleus horse-shoe-shaped with swollen ends, located at posterior end ; size 45.6—50 μ .

Distribution.—RAJASTHAN : As above (first record). *Elsewhere* : Universal in freshwater bodies.

Remarks.—My specimens are rather small. In moving condition, the caudal cilia are very conspicuous.

23. *Frontonia atra* (Ehrenberg)

(Text-figs. 5D. E)

1833. *Ophryoglena atra* Ehrenberg, *Abh. preuss. Akad. wiss.*, Berlin, p. 265, pl. 7, fig. 9.

1931. *Frontonia atra* (Ehrenberg) : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*) Jena, pt. 21., p. 321., figs. 55(8 & 17).

Material.—(i) 1 ex., Devdyani, Sambhar (Jaipur Dist.), 7.× 63. (ii) 2 exs. Phulera, (Jaipur Dist.), 10.×.63. (iii) 1 ex., Anasagar Lakes (Ajmer Dist.), 21.×.63.

Diagnosis.—Body resembling a pin-pong paddle in general, except specimens fully laden with food ; anterior end bluntly rounded, posterior end with a blunt tail like projection. Mouth subterminal, ventral, and at about 1/4th the length of body from the anterior end. Macronucleus single, large and oval. Size 63—89×42—78.8 μ .

Distribution.—RAJASTHAN : As above. (first record from India). *Elsewhere* : Universal in freshwater ponds with decaying vegetation.

Remarks.—*F. atra* is a large freshwater species seen by me in only one collection from a seasonal pond at Phulera and in association with other species of *Frontonia* described elsewhere. Butschli (1889) recognised it as a *F. acuminata* Ehrenberg. Conn (1905) apparently saw the same ciliate in Connecticut, U. S. A., but left it unidentified. Penard (1920) described a species under the name *F. nigricens*, with a

general form, at times, somewhat like a *Stentor* and having a purplish colour. Kahl (1931) recognised a difference in Ehrenburg's *O. acuminata* and *O. atra* and described *O. atra* as *Frontonia atra*. Kahl also thought *F. atra* identical with Burger's (1908), *Paramaecium nigricum*. Unfortunately I could not see the literature concerning this statement. Now from my own study of these forms found at Phulera, and on a study and comparison of the descriptions and drawings given by the above-mentioned authors, I think that all of them belong to the same species. The only apparent difference in Penard's and Kahl's species seems to be the colour which has been reported as purplish for *F. nigricens* Penard whereas Kahl's *F. atra* is black. Regarding size generally this species is quite large as compared to the other species of the genus.

24. *Frontonia complanata* (Wetzel)

(Text-fig. 5F)

1927. *Frontonella complanata* Wetzel, *Arch. Protistenk*, Jena, 60, pp. 130—137, figs. 1—4.

1939. *Frontonia complanata* (Wetzel) : Bullington, *Arch. Protistenk*, Jena, 92, pp. 56—57, pl. 9, fig. 12.

Material.—1 ex., Anasagar, Lake Ajmer (Ajmer Dist.), 21.x.63.

Diagnosis.—Generally broad at both ends but with the posterior end slightly pointed. Possesses a typical *Frontonia* mouth. Contractile vacuole single and sub-central. Macronucleus oval, situated in anterior half of body. Size $105 \times 78.7 \mu$.

Distribution.—RAJASHTAN : As above. (first record from India). *Elsewhere* : Universal in freshwater bodies.

Remarks.—Kahl (1933) described a form *F. arenaria* which might be a synonym of Wetzel's (1927) *F. complanata* as both are of nearly the same size (*F. complanata* $100-120 \mu$, *F. arenaria* $100-130 \mu$), and are very identical in certain other details. My specimens are on an average 100μ in length ($90-120 \mu$) and agree more with those figured by Wetzel.

25. *Stentor coeruleus* Ehrenberg

(Text-fig. 5G)

1830. *Stentor coeruleus* Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin, p. 41.

Material.—(i) 1 ex., Lambia (Jodhpur Dist.), 8.xii.63. (ii) 1 ex., Devikund, Bikaner (Bikaner Dist.), 19.xii.63.

Diagnosis.—Body blue and trumpet-shaped in fully extended condition, with alternative bands of clear and pigmented stripes; clothed with five cilia; peristomial disc slightly convex with membranellae at its margin; macronucleus moniliform; micronucleus many, lying close to macronucleus beads; contractile vacuole lying anteriorly and having a collecting canal; length in fully extended condition c. 1.5 mm

Distribution.—RAJASTHAN : (first record): As above. *Elsewhere* : Universal in stagnant waters.

Remarks.—The specimens are of average length (1.5 mm.) and are coloured bright blue in the fully distended condition. The macronucleus has only seven beads. This is a solitary form.

26. *Spirostomum ambiguum* Ehrenberg

(Text-fig. 5H)

1835. *Spirostomum ambiguum* Ehrenberg, *Abh. preuss. Akad. Wiss.*, Berlin, p. 165.

Material.—(i) 1 ex., Sardar Samand (Pali Dist.), 14.xi.63. (ii) 2 exs., Jodhpur (Jodhpur Dist.), 28.xi.63. (iii) 1 ex., Khandia (Jodhpur Dist.), 7.xii.63.

Diagnosis.—Elongate, thread-like ; covered with rows of short cilia ; highly contractile ; peristome long, extending nearly to 2/3rds of body-length ; peristomial margin with short closely arranged membranelles ; contractile vacuole large, very conspicuous, situated posteriorly and with a long, slender dorsal canal extending from it ; macronucleus moniliform, multimicronucleate ; length of body 1.5-2.0 mm.

Distribution.—RAJASTHAN : As above (first record). *Elsewhere* : Universal in freshwater ponds with decaying vegetation.

Remarks.—In external contours it bears a striking resemblance to *Loxodes* Ehrenberg, 1830 and might readily be mistaken for a member of that genus if casually examined under low magnification. In the genus *Spirostomum* it is nearest to *S. teres* Claparede and Leichmann. The latter species, however, is devoid of the characteristic moniliform nucleus, etc.

27. *Saprodinium mimeticum* (Penard)

(Text-fig. 6A)

1922. *Epalxis mimetica* Penard, *Etudes sur les Infusories d'eau douce*, Genève, p. 161, fig. 157.

1932.- *Saprodinium mimeticum* (Penard) : Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 25, p. 527, fig. 84 (13 and 14).

Material.—(i) 1 ex., Jaipur (Jaipur Dist.), 2.ix.63. (ii) 1 ex., Fatehsagar (Udaipur Dist.), 11.xi.63.

Diagnosis.—Body laterally compressed, dorsal side more convex ; general shape 'rounded triangular' ; anterior end pointed and curved towards posterior end ; posterior end irregularly truncate and with four anal cirri (spines) ; macronucleus oval and dorsal ; contractile vacuole posterior and ventral ; size 21-23 μ .

Distribution.—RAJASTHAN : As above (first record from India). *Elsewhere* : Universal in freshwater bodies with decaying vegetation.

Remarks.—The specimens studied are smaller than the earlier recorded ones (Kahl, 1932).

28. *Euplotes pulmipes* Stokes

(Text-fig. 5I)

1884. *Euplotes pulmipes* Stokes, *Amer. mon. micr. J.*, Washington., 5, p. 229, pl. 12, figs. 7 and 8.

1960. *Euplotes pulmipes* Stokes : Tuffrau, *Hydrobiologia*, Den Haag, 15, pp. 47-50, figs. 31-33, 46(k).

Material.—(i) 3 exs., Anasagar Lake, Ajmer (Ajmer Dist.), 30.x.63. (ii) 2 ex., Fatehsagar (Udaipur Dist.), 11.xi.63. (iii) 2 exs., Gajner (Bikaner Dist.), 20.xii.63.

Diagnosis.—Elongated ellipsoid ; peristome wide and deep. peristomial depression sigmoid ; membranellae forming a sigmoid curve ; end of cytopharynx far to the left and anterior to fifth anal cirrus : from to ventral cirri, 9, transverse cirri 5 and caudals 4 ; macronucleus nearly E-shaped ; micronucleus near flattened anterior corner of macronucleus ; size 89-120.8 μ .

Distribution.—RAJASTHAN : As above (first record from India). *Elsewhere* : Universal in freshwater ponds.

Remarks.—The specimens observed were smaller in size than those recorded earlier by Kahl, (1932 ; 125 μ).

29. *Euplotes patella* (Müller)

(Text-fig. 5G)

1786. *Kerona patella* (?) Müller, *Animalc. Infusoria, fluviat. et marina etc.*, Havniae et Lipsiae, p. 238, pl. 23, figs. 14-17.

1838. *Euplotes patella* (Müller) : Ehrenberg, *Die Infusionsthierchen als vollkommene Organismen*, Leipzig, p. 378, pl. 42, fig. 9.

1936. *Euplotes patella* (Müller) : Bhatia, *Faun. Brit. India*, Ciliophora, p. 386.

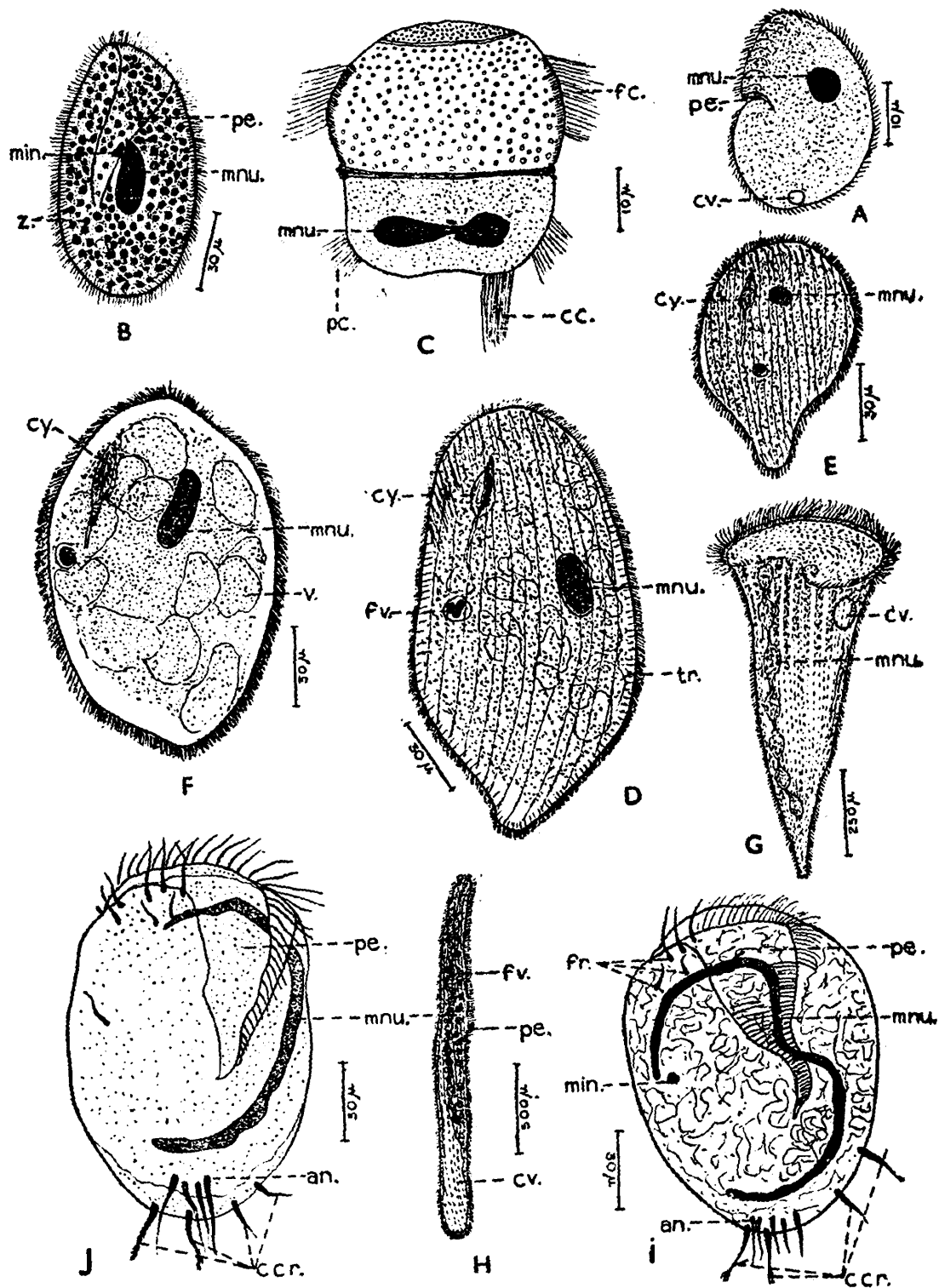
1960. *Euplotes patella* (Müller) : Tuffrau, *Hydrobiologia*, Den Haag, 15, pp. 40-43.

Material.—2 exs., Fatehsagar (Udaipur Dist.), 12.xi.63.

Diagnosis.—Body subcircular to elliptical ; fronto-ventral cirri 9, anals 5, caudals 4 ; aboral surface with six prominent ridges ; posterior end of cytopharynx situated anterior to and to left of the fifth anal cirrus ; macronucleus c-shaped ; with a single micronucleus ; contractile vacuole posterior ; size 124-130 $\times$ 79-85 μ .

Distribution.—RAJASTHAN : As above (first record). *Elsewhere* : Universal in stagnant waters.

Remarks.—My specimens are slightly larger than those of Bhatia (1936) and Tuffrau (1960).



TEXT-FIG. 5.—(A) *Colpoda inflata* (Stokes). (B) *Paramecium bursaria* (Ehrenberg). (C) *Urocentrum turbo* (Müller). (D-E) *Frontonia atra* (Ehrenberg). (F) *Frontonia complanata* (Wetzel). (G) *Stentor coeruleus* Ehrenberg. (H) *Spirostomum ambiguum* Ehrenberg. (I) *Euplotes plumipes* Stokes. (J) *Euplotes patella* (Müller).

30. *Euplotes inkystans* Chatton (?)

(Text-fig. 6B)

1954. *Euplotes inkystans* Chatton, in Faure, Fremiet, Gauchery & Tuffrau, *Bull. biol.*, Paris, **88**, p. 157.

1960. *Euplotes inkystans* : Tuffrau, *Hydrobiologia*, Den Haag, **15**, pp. 50-51, figs. 34, 35 and 46l.

Material.—(i) 8 exs., Sadar Samand (Pali Dist.), 26.xi.63. (ii) 2 exs., Anasagar Lake, Ajmer (Ajmer Dist.), 10.xi.63. (iii) 1 ex., Phulera (Jaipur Dist.), 12.x.63.

Diagnosis.—Body more or less round, fronto-ventral cirri 10, anals 5, caudals 4-5 ; peristome sickle-shaped ; end of cytopharynx turning to left and ending in front of second anal cirrus ; macronucleus, eshaped ; size 39-88 μ .

Distribution.—RAJASTHAN : As above (first record from India). *Elsewhere* : Universal in freshwater ponds among decaying vegetation.

Remarks.—My specimens are of about the same size as those in the earlier records. Regarding the authorship and the date of erection of this species, it may be pointed out that E. Chatton named this species but never published any account of the same. It were Faure-Fremiet, Gauchery and Tuffrau (1954) who came across the slide inscribed as *Euplotes inkystans*, from Chatton's collection, during their studies of some species of genus *Euplotes* (through personal communication, 6 Aug. '64, from Dr. Michel Tuffrau, Paris). The authors, however, giving due credit to Chatton as the author, included an account of this species in their paper (1954), on receiving confirmation from Mme. E. Chatton that the account of that species has since been unpublished.

Diagnosis.—Body ovate, flattened, flexible, rounded and widest posteriorly ; anterior end comparatively tapering ; peristomial field extending to middle of the body ; frontal cirri 8, ventrals 5, anals 5, caudals very short, marginals many ; macronucleus in two parts ; contractile vacuole just below and to the one side of peristomial region ; size 88-98 $\times$ 31-45 μ .

Distribution.—RAJASTHAN : As above (first record from India). *Elsewhere* : Universal in freshwater bodies with decaying vegetation.

Remarks.—My specimens are small, the previous recorded length being 150 μ .

31. *Oxytricha fallax* Stein

(Text-fig. 6C)

1859. *Oxytricha fallax* Stein, *Der Organismus der Infusionsthier*, Leipzig, **1**, p. 189, pl. 12, figs. 12-15.

Material.—(i) 1 ex., Anasagar (Ajmer Dist.), 10.xi.63. (ii) 1 ex., Faisagar (Ajmer Dist.), 10.xi.63. (iii) Several exs., Shivbari (Bikaner Dist.), 20.xii.63.

32. *Oxytricha hymenostomata* Stokes

(Text-fig. 6D)

1887. *Oxytricha hymenostomata* Stokes, *Ann. Mag. nat. Hist.*, London, (5) 2, p. 111, pl. 3, fig. 10.

1932. *Oxytricha hymenostomata* : Kahl, *Urtiere oder Protozoa* (in : Dahl's *Tierwelt Dtsch.*), Jena, pt. 25, p. 603, fig. 113 (27).

Material.—1 ex., Anasagar Lake, Ajmer (Ajmer Dist.), 7.xi.63.

Diagnosis.—Body long, oval ; broadly rounded posteriorly ; anterior and posterior regions more or less equal in width ; peristome extending upto 1/3rd of body-length ; macronucleus in two oval parts ; contractile vacuole situated just below peristome ; size $101 \times 45 \mu$.

Distribution.—RAJASTHAN : As above (first record from India) *Elsewhere* : North America.

Remarks.—This is a very rare species.

33. *Oxytricha ovalis* Kahl

(Text-fig. 6E)

1932. *Oxytricha ovalis* Kahl, *Urtiere oder Protozoa* (in Dahl's *Tierwelt Dtsch.*), Jena, pt. 25, p. 603, fig. 113 (32).

Material.—(i) 1 ex., Phulera (Jaipur Dist.), 24.x.63. (ii) 2 exs., Anasagar Lake, Ajmer (Ajmer Dist.), 9.xi.63. (iii) 2 exs., Faisagar (Ajmer Dist.), 10.xi.63. (iv) 2 exs., Sardar Samand (Pali Dist.), 26.x.63.

Diagnosis.—Body oval ; frontal cirri 9, ventrals 5, anals 5 ; anterior and posterior regions rounded ; peristome extending to about 1/3rd of the body-length ; macronucleus in two parts ; size 78-85 by 45-52 μ .

Distribution.—RAJASTHAN : As above (first record from India). *Elsewhere* : Germany.

Remarks.—My specimens are smaller than those of Kahl (1932, average c. 120 μ).

34. *Oxytricha oblongatus* n. sp.

(Text-fig. 6F)

Material.—2 exs., Sardar Samand (Pali Dist.), 26.xi.63.

Diagnosis.—Body broadly oval and oblong ; sides running parallel for a greater distance than in allied species of the genus ; frontal cirri 9, ventrals 5, anals 5, marginals running uninterrupted at posterior end. Macronucleus in two oval parts. Contractile vacuole situated on one side of peristome. Size 101-114 by 38 μ .

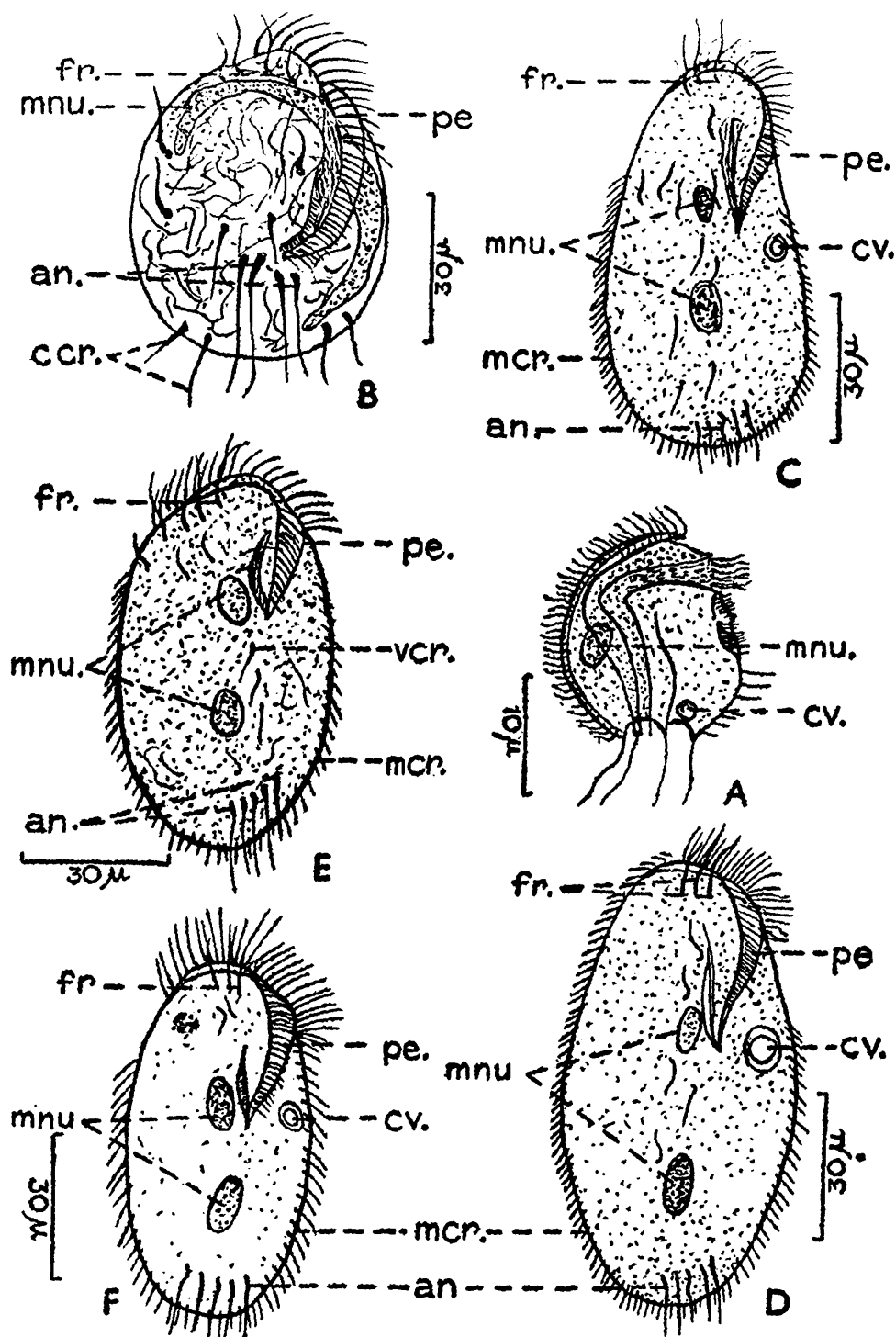
Distribution.—RAJASTHAN : As above.

Comparison.—The new species differs from the allied ones as follows :—

1. From *O. ovalis* Kahl : (i) Body more oblong and posterior by more rounded. (ii) Sides almost parallel (vs. not so in *ovalis*).

2. From *O. hymenostomata* Stokes: (i) Shape oblong, sides almost parallel, both ends rounded (Vs. widest in the middle and narrowing at both ends in *hymenostomatus*).

Type specimens.—*Holotype*: 1 ex., on a slide, Z.S.I. Reg. No. Pt.383, Loc. as above. *Paratype*: 1 ex., on a slide, Z.S.I. Reg. No. Pt. 384, Loc. as above.



TEXT-FIG. 6.—(A) *Saprodinium mimeticum* (Penard). (B) *Euplotes inkystans* Chatton. (C) *Oxytricha fallax* Stein. (D) *Oxytricha hymenostomata* Stokes. (E) *Oxytricha ovalis* Kahl. (F) *Oxytricha oblongatus* n. sp.

V—SUMMARY

1. This paper (the second of the series of papers on the Protozoa of Rajasthan) deals with freshwater Protozoa collected by the author during September—December, 1963 in Rajasthan in the districts of Ajmer, Jaipur, Jodhpur, Bikaner, Pali, Udaipur and the Sambhar Salt Lake area (Nagaur and Jaipur districts).

2. Thirty-four species belonging to 21 genera, 19 families, 9 orders and 3 subclasses (Mastigophora, Sarcodina and Ciliata) are included. Of these, the following three taxa (2 species and one variety) of the class Ciliata are new to science :—

(A) Subcl. Holotricha, Ord. Gymnostomatida.

1 *Coleps devdaniensis* n. sp. (Fam. Colepidae).

2. *Holophrya bengalensis* n. subsp. *minor* : (Fam. Enchelyidae).

(B) Subcl. Spirotricha, Ord. Hypotrichida : (Fam. Oxytrichidae).

3. *Oxytricha oblongatus* n. sp.

3. All the 34 species are recorded for the first time from Rajasthan, and 25 of them are apparently first records from India.

4. Keys for the identification of freshwater protozoan genera known from Rajasthan and brief diagnostic characters of each species are given.

VI—REFERENCES

- BHATIA, B. L. 1936. *The Fauna of British India, including Ceylon and Burma*, Protozoa : Ciliophora, pp. xxii+1-493, II pts.—London (Taylor & Francis Ltd.).
- BURGER, O. 1908. Nuavos estudios sobre Protozoos chilenos del Agua dulce.—*Ann. Univ. chile.*, **122**, pp. 137-204.
- BÜTSCHLI, O. 1889. Protozoa. Abt. III. Infusoria und System der Radiolaria. (In : Bronn, H. G. *Klassen und Ordnungen des Thiers-Reichs*), **1**, pp. 1585-2035, Leipzig (C. F. Winter).
- CONN, H. W. 1905. A preliminary report on the Protozoa of the freshwaters of Connecticut.—*Bull. Conn. geol. nat. Hist. Surv.*, Hartford, No. 2, pp. 5-69.
- FAURE-FREMIET, E., GAUCHERY, M. AND TUFFRAU, M. 1954. Les processus d'enkystement chez *Euplotes muscicola* Kahl.—*Bull. biol.*, Paris, **88**, pp. 154-167.
- GHOSH, E. 1919. Studies on Infusoria.—*Rec. Indian Mus.*, Calcutta, **16**, pp. 41-43, fig. 1.
- KAHL, A. 1930-35. Urtiere oder Protozoa. *Tierwelt Deutsch.*—Teil, **18**, pp. iv+180 (1930), **21**, pp. 181-398 (1931), **25**, pp. 399-650 (1932); **30**, pp. 651-886 (1935), Jena (G. Fischer).

- LEFÈVRE, M. 1932. Sur la structure de la membrane des Euglènes du group *Spirogyra*.—*C. R. Acad. Sci.*, Paris, **195**, pp. 1308-9.
- LEIDY, J. 1879. Freshwater Rhizopods of North America, *Rep. U. S. geol. Surv.*, Washington, **12**, pp. 1-324.
- PENARD, E. 1920. Études sur les infusoires tentaculifères.—*Mem. Soc. Phys.*, Geneve, **39**, pp. 131-229.
- PERTY, M. 1849. Ueber verticale Verleeritum microscopischer Lebensformen. —*Mitt. nat. Ges.*, Bern, **1**, pp. 17-45.
- PERTY, M. 1852. *Zur Kenntniss kleinster, Lebensformen nach Bau, Funktionen. Systematik, mit Specialerzeichniss in der Schweiz beobachteten.* Jent u. Reinert, Bern, pp. 228.
- PRINGSHEIM, E. G. 1956. Contributions towards a Monograph of the genus *Euglena*.—*Nova Acta Leopoldina*, Leipzig, **18**, pp. 1-168.
- SCHEWIAKOFF, W. 1889. Beiträge zur Kenntniss der holotrichen Ciliaten. *Biblioth. Zoology.* (Leuckart u. Chun) **5**, pp. 1-77.
- TUFFRAU, M. 1960. Révision du genre *Euplotes* fondée sur la comparaison des structures superficielles.—*Hydrobiologia*, Hague, **15**, pp. 1-77.
- WETZEL, A. 1927. Über zwei noch unbekannte holotriche *en* Ciliaten *Frontoniella Complanata* nov. gen., nov. spec. und *Spathidi caudalum* n. sp.—*Arch. Protistenk.*, Jena, **60**, pp. 130-141, 7 figs.

VII—LETTERING USED IN TEXT-FIGURES

afl., anterior flagellum ; *an.*, anal cirri ; *cc.*, caudal cilium ; *cer.*, caudal cirri ; *cv.*, contractile vacuole ; *cy.*, cytostome. *phb.*, pharyngeal basket, *fl.*, flagellum ; *fr.*, frontal cirri ; *g.*, girdle ; *fv.*, food vacuole ; *mar.*, marginal cirri ; *min.*, micronucleus ; *mn.*, macronucleus ; *nu.*, nucleus ; *pe.*, peristome ; *ph.*, pharynx ; *ps.*, posterior spines ; *s.*, striation ; *tfl.*, trailing flagellum ; *tr.*, trichocysts.

THE REPTILE FAUNA OF THE NAGARJUNASAGAR DAM AREA (ANDHRA PRADESH, INDIA)

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(With 1 Table and 1 Text-figure)

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I—INTRODUCTION

(a) *General*

The Zoological Survey of India conducted two faunistic surveys, in the years 1962 and 1963, of Nagarjunasagar Project area, located in the districts of Guntur and Nalgonda in Andhra Pradesh. These areas will get submerged by stages with the progress in the construction of Nagarjunasagar Dam. The project covers a large area comprising principally the Nagarjunakonda Valley and its vicinity in the Guntur District, and the following areas in the Nalgonda District : Vijaypuri North, Vijaypuri South and some portions of the Deverkonda taluq.

(b) *Physical features*

The Guntur and Nalgonda Districts are situated between latitudes, 15°—18° N. and longitudes 79°—81° E. They consist of stony uplands, low ranges of rocky structures and level plains of black soil. The eastern portion is made up of the alluvial delta of the Krishna river. The area comprises some of the richest rice belts of southern India. The Krishna river flows almost across the middle of these districts. The main tributary of this river here is the Gundlakamma. Geologically, the districts

contain thin bedded deposits of mica and chloritic schists with quartzites, granitoid gneisses, dioritic dykes, granite, felsite and quartz veins.

Both the districts contain dense evergreen forests and, in the higher elevations, a subalpine flora consisting of orchids and dwarf and large flowering species. The lower hills of the eastern side of the Guntur District has a mixture of evergreens and deciduous plants of a marked xerophytic nature.

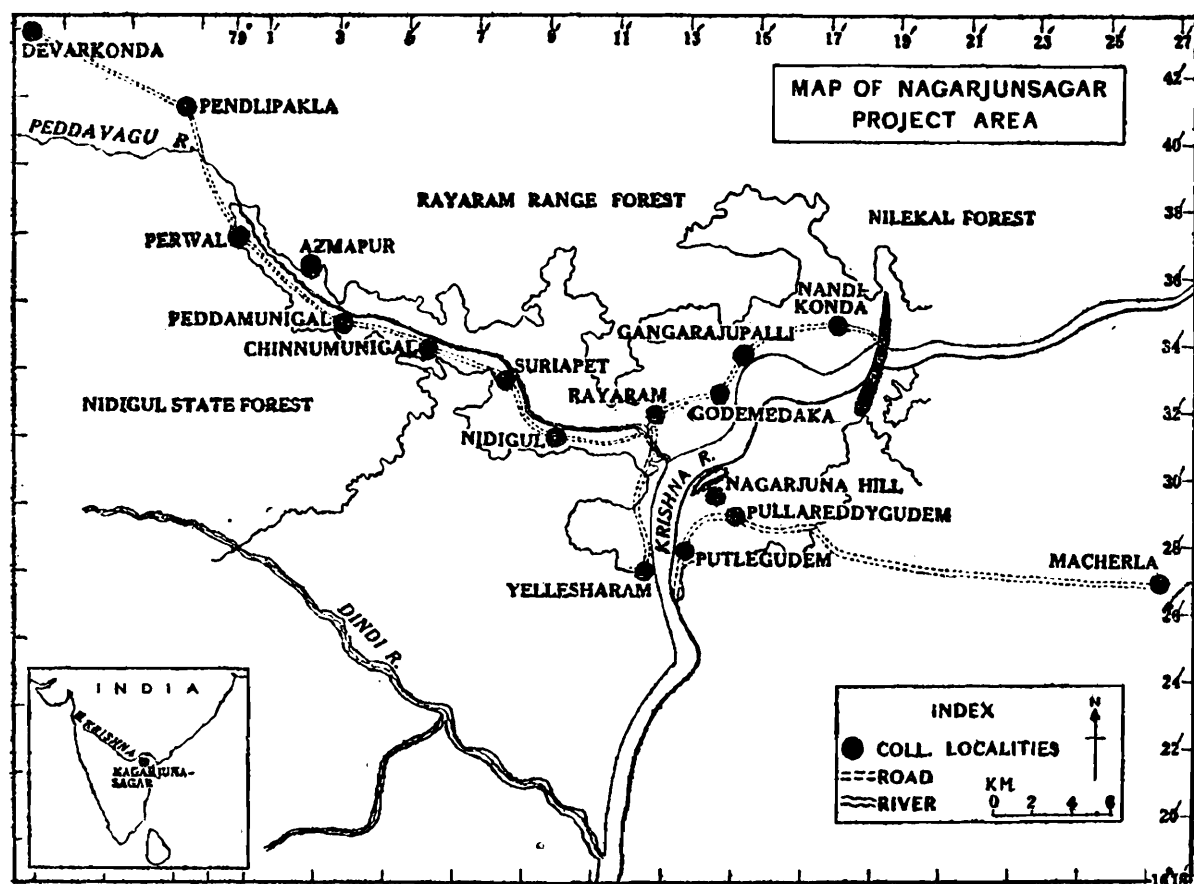
The climate is hot and dry during March to October. The annual temperature usually varies between 18° — 46° C. The rainfall, due to the south-west and the north-east monsoon, is heavy, certain areas getting as much as 250 cms. per year.

(c) Abbreviations used

Alt., altitude above mean sea-level ; *Coll.*, collected by, collection ; *Ex.*, *Exs.*, example(s) ; *Z.S.I.*, Zoological Survey of India, Calcutta.

(d) Acknowledgements

I am thankful to Dr. M. L. Roonwal, the Director, Zoological Survey of India, for advice and helpful suggestions, and to Shri Bhola Nath and Sri I. Maligi for diligently making the collections under report.



TEXT-FIG. 1.—Map showing collecting localities in Nagarjunsagar Project Area (Andhra Pradesh).

II—LIST OF COLLECTING STATIONS

(Text-fig. 1 and Table 1)

A list of the 22 collecting localities is given in Table 1, together with dates of collection, etc.

III—LIST OF SPECIES

The collections reported upon here consist of 353 examples comprising 34 species (2 turtles, 285 lizards and 66 snakes) belonging to 24 genera and 11 families, as follows :—

Order I. TESTUDINES

Family 1 TRIONYCHIDAE

1. *Trionyx gangeticus* Cuvier
2. *T. leithi* Gray

Order II. SQUAMATA

Suborder (i) SAURIA

Family 1 GEKKONIDAE

3. *Hemidactylus brooki* Gray
4. *H. reticulatus* Beddome
5. *H. giganteus* Stoliczka
6. *H. triedrus* (Daudin)

Family 2. AGAMIDAE

7. *Sitana ponticeriana* Cuvier
8. *Calotes versicolor* (Daudin)
9. *Psammophilus dorsalis* (Gray)
10. *P. blanfordianus* (Stoliczka)

Family 3. SCINCIDAE

11. *Mabuya carinata* (Schneider)
12. *M. nagarjuni* Sharma
13. *Riopa punctata* (Gmelin)
14. *R. ashwamedhi* Sharma

Family 4. IACERTIDAE

15. *Cabrita leschenaulti* (Milne-Edwards)
16. *C. jerdoni* Beddome
17. *Ophisops jerdoni* Blyth

Family 5. VARANIDAE

18. *Varanus monitor* (L.)

Suborder (ii) SERPENTES

Family 6. TYPHLOPIDAE

19. *Typhlops braminus* (Daudin)
20. *T. acutus* (Duméril & Bibron)

Family 7. BOIDAE

21. *Eryx conicus* (Schneider)
22. *E. johni johni* (Russell)

Family 8. COLUBRIDAE

23. *Elaphe helena* (Daudin)
24. *Ptyas mucosus* (L.)
25. *Coluber prox. gracilis* (Günther)
26. *Oligodon taeniolatus* (Jerdon)
27. *Natrix piscator* (Schneider)
28. *Boiga trigonata* (Schneider)
29. *Dryophis nasutus* (Lacépède)

Family 9. ELAPIDAE

30. *Bungarus caeruleus* (Schneider)
31. *Callophis melanurus* (Shaw)
32. *Naja naja naja* (L.)

Family 10. VIPERIDAE

33. *Vipera russelli russelli* (Shaw)
34. *Echis carinatus* (Schneider)

IV—SYSTEMATIC ACCOUNT

(a) General

The following is a brief systematic account of the reptiles obtained from the Nagarjunasagar Dam area. For other details regarding the species, reference may be made to publications by Smith (1931, 1935 and 1943). For each species, details of the material collected, some important measurements and the geographical distribution are given. Under measurements, the "Total Length" means the length from snout to tip of tail, and the "Standard Length" indicates the length from snout to vent; in both cases the specimen is kept flat and the straight-line measurement (not along curvatures) is taken. Where necessary, taxonomic and ecological notes are given under each species.

(b) *Account of species*

Order I. TESTUDINES

1. *Trionyx gangeticus* Cuvier

(The Ganges Soft-shelled Turtle)

Material.—One juvenile ex., *Guntur Dist.* : Pullareddygudem village 2.ix.62, (coll. *B. Nath* and *I. N. Maligi*).

Measurement.—Length of dorsal disc, 57 mm.

Distribution.—*Nagarjunasagar area* : As above (first record from the area). Previously the known southern limits of its distribution was upto the Mahanadi and its tributaries ; it is being recorded as now extending to Krishna river. *Elsewhere* : The Indus, Ganges, Mahanadi and their tributaries. Also from the erstwhile North-West Frontier Province of West Pakistan ; Sind (Karachi) and from Nepal.

2. *Trionyx leithi* Gray

(The Soft-shelled Turtle)

Material.—One ex., *Guntur Dist.* : Peddavagu River, 20.x. 63, (coll. *B. Nath*).

Measurement.—Length of dorsal disc, 129 mm.

Distribution.—*Nagarjunasagar area* : As above. *Elsewhere* : India The Ganges and rivers of peninsular India as far south as Madras

Order II. SQUAMATA

Suborder (i) SAURIA

3. *Hemidactylus brooki* Gray

(The House Lizard)

Material—12 exs., as follows :—*Guntur Dist.* : Nagarjuna Hill, 28.vii.62, coll. *B. Nath* ; Ashwamedh site, 30.vii.62 ; Putlegudem village, 6.xi.63. *Nalgonda Dist.* : Tiger Valley, 4.viii.62. Deyerkonda town, 14.viii.62, under stones in rocky area ; Nandikonda Valley, 7.x.63 ; (all coll. *B. Nath* and *I. N. Maligi*). Madhavram village, 11.x.63, (coll. *B. Nath*).

Measurements.—Total length, 93-105 mm. ; Standard length, 40-55 mm.

Distribution.—*Nagarjunasagar area* : As above. *Elsewhere* : Whole of India.

Remarks.—In all cases the lizards were collected from rocky areas, under stones or from crevices in rocks having xerophytic vegetation. Five specimens from Nidigul and Nandikonda villages are milky white, with dark brown spots on the dorsum and the sides. (In contrast, specimens from other parts of India are brownish with dark brown spots). Two specimens from Nidigul also vary as follows from other Indian examples : upper labials 11 (vs. 8-10 in other examples) ; postmentals 3 pairs (vs. 2 pairs) ; lamellae under 1st toe 4-5 (vs. 5-6), those under 4th toe 6 (vs. 7-10).

4. *Hemidactylus reticulatus* Beddome

(The Rock Gecko)

Material.—62 exs., as follows :—*Guntur Dist.* : Ashwamedh site, 30.vii.62 ; Eddenmotu and Fringimotu Hills, 2, 3, 6, 8.ix.62 ; 30.ix.63 ; 7, 8, 9, 15.xi.63 ; Macherla town, 14-16.ix.62. *Nalgonda Dist.* : Nandikonda Valley, 8, 11.viii.62 ; Deverkonda town, 14.viii.62 ; Vijaypuri South, 26.viii.62 (all coll. *B. Nath* and *I. N. Maligi*) ; Madhavram village, 3, 10.x.63 ; Suryaraopet village, 14.x.63 ; Nidigul village ; 22.x.63, Yelleshwaram village, 1, 3, xi.63. (all coll. *B. Nath*) :

Measurements.—Total length, 52-83 mm. ; Standard length, 221-246 mm.

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : S. India (Mysore and Madras States).

Remarks.—All the specimens were collected from rocky areas either under stones or from crevices in rocks.

5. *Hemidactylus giganteus* Stoliczka

(The Giant Tree Gecko)

Material.—2 exs. as follows :—*Guntur Dist.* : Nagarjuna Hill (bank of R. Krishna), 1.x.63 ; Siddelder Hill, 11.xi.63. (coll. *B. Nath*).

Measurements.—Total length, 192-207 mm. ; Standard length, 110-115 mm.

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : Andhra Pradesh.

Remarks.—Both examples were collected from trees in hilly area.

6. *Hemidactylus triedrus* (Daudin)

(The Daudin's Hemidactylus Lizard)

Material.—One ex., *Nalgonda Dist.* : Vijaypuri North, 31.vii.62, (coll. *B. Nath* and *I. N. Maligi*).

Measurements.—Total length, 130 mm. ; Standard length, 65 mm.

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : India : States of Maharashtra, Rajasthan, Madhya Pradesh, Madras, Mysore and Kerala.

Remarks.—This example differs from other Indian specimens as follows :—Upper and lower labials deeply spotted with black (vs. not so spotted) ; with 3 pairs of postmentals (vs. 2 pairs).

7. *Sitana ponticeriana* Cuvier

(The Sargota Lizard)

Material.—77 exs., as follows :—*Guntur Dist.*: Pullareddygudem village, July-September, 1962 ; Eddenmotu Hills and Fringimotu, 2-9.ix.62. Macherla town, 13-16.ix.62. *Nalgonda Dist.*: Deverkonda town, 14.viii.62 ; Nandikonda Valley, 7-11.viii.62 ; Vijaypuri South, 22-28.viii.62 ; (all coll. *B. Nath* and *I. N. Maligi*) ; Ethipotla Fall, 25.viii.62 ; Madhavram village, 11.x.63 ; Rayaram village, 18.x.63 ; Nidigul village, 23.x.63 (all coll. *B. Nath*).

Measurements.—Total length, 42-230 mm. ; Standard length, 15-65 mm.

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : Whole of India, excluding Bengal east of the Ganges.

Remarks.—Many specimens are brilliantly coloured with blue, bluish gray, deep blue-black, pink and red.

8. *Calotes versicolor* (Daudin)

(The Blood-sucker)

Material.—49 exs., as follows :—*Guntur Dist.* : Pullareddygudem village, July-September and November, 1963 ; Macherla town, 14.ix.62. *Nalgonda Dist.*: Tiger Valley, 4.viii.62 ; 5.x.63 ; Deverkonda town, 14.viii.62 ; Vijaypuri South, 22.viii.62, (all coll. *B. Nath* and *I. N. Maligi*) ; Azampur village, 16.viii.62 ; Rayaram village, 19.x.63 ; Surya-raopet village, 14.x.63 ; Madhavram village, 13.x.63 ; Nidigul village, 22.x.63 ; Yelleshwaram village, 4.xi.63 (all coll. *B. Nath*) ; Nandikonda Valley, 8.x.63 (all coll. *B. Nath* and *I. N. Maligi*).

Measurements.—Total length, 224-395 mm. ; Standard length, 56-120 mm.

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : Whole of India.

9. *Psammophilus dorsalis* (Gray)(Gray's *Psammophilus* Lizard)

Material.—One ex., *Nalgonda Dist.* : Vijaypuri South, 22.viii.62 ; (coll. *B. Nath*, and *I. N. Maligi*).

Measurements.—Total length, 293 mm. ; Standard length, 103 mm.

Distribution.—*Nagarjunasagar* area : As above (first record from the area). *Elsewhere* : India south of about lat. 16°N.

10. *Psammophilus blanfordanus* (Stoliczka)(Stoliczka's *Psammophilus* Lizard)

Material.—Two exs., *Guntur Dist.* : Nagarjuna Hill, 29.ix.63 (coll. *B. Nath*).

Measurements.—Total length, 162-181 mm., Standard length, 59-85 mm.

Distribution.—*Nagarjunasagar* area : As above (first record from the area). *Elsewhere* : Several parts of India : Bihar (Chotanagpur, Parasnath Hills), Orissa, Madhya Pradesh, Andhra Pradesh (Godavari Dist.), Madras (Eastern Ghats) and Kerala (Travancore).

11. *Mabuya carinata* (Schneider)

(The Brahmini Lizard)

Material.—7 exs., as follows :—*Guntur Dist.* : Pullareddygudem village, 29.vii.62 ; 15.xi.63 ; Eddenmotu Hill, 5.7.ix.62. *Nalgonda Dist.* : Vijaypuri South, 23,24.viii.62, (all coll. *B. Nath* and *I. N. Maligi*) ; Pindlipakula village, 18.viii.62 (coll. *B. Nath*).

Measurements.—Total length, 133-172 mm.; Standard length, 21-73 mm.

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : Peninsular India.

12. *Mabuya nagarjuni* Sharma

(The Nagarjuni Lizard)

Material.—4 exs., *Nalgonda Dist.* : Vijaypuri South, 23,28.viii.62 (all coll. *B. Nath* and *I. N. Maligi*).

Brief Diagnosis : This species closely resembles *M. beddomi* Jerdon from South India but is separable as follows :

(i) Supranasals not in contact with one another, being separated by the frontonasal (*vs.* in contact).

(ii) Frontonasal square in shape (*vs.* broader than long).

(iii) Prefrontals not in contact with one another (*vs.* in contact).

(iv) Three pairs of nuchals (*vs.* single pair).

(v) Postnasal present (*vs.* absent).

(vi) Dorsal scales with 5—7 keels (*vs.* 3—5).

(vii) With 16—22 lamellae beneath fourth toe (*vs.* 12—15).

Measurements.—Total length, 120 mm.; Standard length, 51 mm.

Distribution.—*Nagarjunasagar* area : As above.

13. *Riopa punctata* (Gmelin)

(Gmelin's Riopa Lizard)

Material.—4 exs., as follows :—*Guntur Dist.* : Eddenmotu Hill, 3.ix.62 ; Macherla town, 13.ix.62. *Nalgonda Dist.* : Nandikerda Valley, 9.viii.62. (all coll. *B. Nath* and *I. N. Maligi*).

Measurements.—Total length, 47-92 mm.; Standard length, 25-58 mm.

14. Riopa ashwamedhi Sharma

(The Ashwamedhi Lizard)

Material.—7 exs., as follows :—*Guntur Dist.* : Pullareddygudem, 30.vii.62. ; Eddenmotu and Fringimotu Hills, 1.ix.62 ; Macherla town, 15.ix.62. *Nalgonda Dist.* : Vijaypuri North, 8.vii.62, Vijaypuri South, 22 and 23.viii.62 (all coll. *B. Nath* and *I.N. Maligi*).

Brief Diagnosis : This species closely resembles *R. punctata* (Gmelin) from India, but is separable as follows :

(i) Distance between axilla and groin $1\frac{1}{2}$ times the distance between tip of snout and fore-limb (vs. $2-2\frac{3}{4}$ times).

(ii) Lower eyelids scaly, central scales of the lid much enlarged and thin (vs. with an undivided semitransparent disc).

(iii) Frontal scale shorter than fronto-parietals and interparietal together (vs. longer).

(iv) Scales bordering outer margins of parietals equal (vs. temporal-scale bordering the outer margins of parietals enlarged).

(v) Ear opening with 3 or 4 minute lobules on anterior margin (vs. 1 or 2).

(vi) With 28—32 scales round the body (vs. 24—28 ; 45—60 scales down the middle of back (vs. 62—76).

(vii) With 13—15 lamellae under fourth toe (vs. 11—14).

Measurements.—Total length, 52-91 mm.; Standard length, 20-32 mm.

Distribution.—*Nagarjunasagar* area : As above.

15. Cabrita leschenaulti (Milne-Edwards)

(Edwards' Cabrita Lizard)

Material.—4 exs., *Guntur Dist.*, as follows :—Pullareddygudem village, 28.vii.62 (coll. *B. Nath* and *I. N. Maligi*) ; Nagarjuna Hill, 2.x.63. (coll. *B. Nath*).

Measurements.—Total length, 129-150 mm.; Standard length, 41-45 mm.

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : Peninsular India.

16. *Cabrita jerdoni* Beddome(Beddome's *Cabrita* Lizard)

Material.—10 exs., *Nalgonda Dist.* Vijaypuri South, 23-29.viii.62, (coll. *B. Nath* and *I. N. Maligi*).

Measurements.—Total length, 109-147 mm.; Standard length, 35-42 mm.

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : Northern and Central India.

17 *Ophisops jerdoni* Blyth(The Golden Striped Lizard or Blyth's *Ophisops* Lizard)

Material.—40 exs., as follows :—*Guntur Dist.* : Pullareddygudem village, 27.vii—9.ix.62 ; Eddenmotu Hill, 3-5.ix.62 ; Nagarjuna Hill, 28.vii.62 ; 28.ix.63 ; Macherla town, 13.ix.62, *Nalgonda Dist.* : Tiger valley, 3-7.viii.62, Nandikonda Valley, 7-9.viii.62 ; Deverkonda town, 14.viii.62 ; Vijaypuri South, 22.viii.62 (all coll. *B. Nath* and *I. N. Maligi*).

Measurements.—Total length, 76-135 mm.; Standard length, 33-40 mm.

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : Northern and Central India.

Remarks.—In many examples a small basioccipital scale is present.

18. *Varanus monitor* (L.)

(The Common Monitor Lizard.)

Material.—3 exs., as follows :—*Guntur Dist.* : Nagarjuna Hill, 2.ix.62 (coll. *B. Nath*), Pullareddygudem village, 6, 7.ix.63, (coll. *B. Nath* and *I. N. Maligi*).

Measurements.—Standard length, 163-288 mm.; (Tail broken in all specimens.)

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : Whole of India.

Sub-Order (ii) *SERPENTES*19. *Typhlops braminus* (Daudin)

(The Common Blind Snake.)

Material.—35 exs., coll. as follows :—*Guntur Dist.* : Nagarjuna Hill, 5 and 28.vii.62 (coll. *B. Nath*) ; Pullareddygudem village, 27.vii—14.xi.63 ; Eddenmotu and Fringimotu Hills, 2-8.ix.62 ; Macherla town 12.ix.62. *Nalgonda Dist.* : Nandikonda Valley, 7-11.viii.62 (all coll. *B. Nath* and *I. N. Maligi*) ; Madhavram village, 10.x.63 ; Yelleswharam village, 2.xi.63 (coll. *B. Nath*).

Measurements.—Total length, 128-133 mm.; Standard length, 125-130 mm.

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : Whole of India.

20. Typhlops acutus (Dumiril and Bibron)

(The Beaked Blind Snake.)

Material.—One ex., *Guntur Dist.* : Nagarjuna Hill, 9.ix.62 (coll. *B. Nath*).

Measurements.—Total length, 345 mm.; Standard length, 342 mm.

Distribution.—*Nagarjunasagar* area : As above. (first record from the area. *Elsewhere* : Following parts of India : South Rajasthan, Gujarat (Baroda), West Bengal (Calcutta). The known distribution thus appears to be very patchy.

21 Eryx conicus (Schneider)

(The Russell's Sand Boa)

Material.—One ex., *Nalgonda Dist.* : Tiger Valley, 5.viii.62. (coll. *B. Nath* and *I. N. Maligi*).

Measurements.—Total length, 380 mm.; Standard length, 345 mm.

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : Whole of India.

22. Eryx johni johni (Russell)

(John's Sand Boa)

Material.—2 exs., as follows :—*Guntur Dist.* : Nagarjuna Hill, 27.vii.62, (coll. *B. Nath*); Eddenmotu Hill, 3.ix.62, (coll. *B. Nath* and *I. N. Maligi*).

Measurements.—Total length, 325-770 mm.; Standard length, 270-680 mm.

Distribution.—*Nagarjunasagar* area : As above. (First record from the area). *Elsewhere* : India : Rajasthan, U.P., Punjab.

23. Elaphe helena (Daudin)

(The Trinket Snake)

Material.—One ex., *Guntur Dist.* : Eddermotu Hill, 3.ix.62. (coll. *B. Nath* and *I. N. Maligi*).

Measurements.—Total length, 835 mm. ; Standard length, 640 mm.

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : India : Maharashtra, Peninsular India, U. P. (Almora Dist.), W Bengal (Jalpaiguri Dist.), Assam.

24. Ptyas mucosus (L.)

(The Dhaman or Rat Snake)

Material.—4 exs. as follows :—*Guntur Dist.* : Pullareddygudem village, 14.ix.63, 9.xi.63. *Nalgonda Dist.* : Tiger Valley, 3.x.63, (coll. *B. Nath* and *I. N. Maligi*) ; Nidigul village, 23.x.63, (coll. *B. Nath*).

Measurements.—Total length, 1845-1875 mm.; standard length, 1290-1335 mm.

Distribution.—*Nagarjunasagar* area : As above *Elsewhere* : Whole of India.

25. *Coluber prox. gracilis* (Günther)

Material.—3 exs., *Guntur Dist.*: Nagarjuna Hill, 27.vii.62 and 4 and 9.ix.62, (coll. *B. Nath*.)

Measurements.—Total length, 760-1220 mm.; Standard length, 550-910 mm.

Distribution.—*Nagarjunasagar area* : As above (first record from the area).

Distribution (of *Coluber gracilis*).—India, as follows : Neighbourhood of Bombay ; Madhya Pradesh (Asirgarh). A rare species.

Remarks.—Though these specimens appear to agree with *Coluber gracilis* in colour and many details, due to the difference in many major characters, I hesitate to regard them as that species fully. They differ from *C. gracilis* as follows :—Rostral two times wider than high (vs. as broad as high in *C. gracilis*) ; internasals shorter than prefrontals (vs. of equal length) ; scales round the middle of body in 19 rows (vs. in 21 rows) ; ventral scales 201-213 (vs. 206-222) ; subcaudal scales 109-121 (vs. 118-127).

26. *Oligodon taeniolatus* (Jerdon)

(Jerdon's Oligodon Snake.)

Material.—4 exs., *Guntur Dist.* : Pullareddygudem village, 28.vii.62, and 6 and 11.xi.63 ; (All coll. *B. Nath* and *I. N. Maligi*).

Measurements.—Total length, 357-525 mm.; Standard length, 300-450 mm.

Distribution.—*Nagarjunasagar area* : As above. *Elsewhere* : Peninsular India.

27. *Natrix piscator* (Schneider)

(The Checkered Keelback.)

Material.—5 exs., as follows :—*Guntur Dist.* : Pullareddygudem village, 1.x.63, 9.xi.63. *Nalgonda Dist.*: Tiger Valley, 6.viii.62, (coll. *B. Nath* and *I. N. Maligi*); *Rayaram village*, 18.x.63, (coll. *B. Nath*).

Measurements.—Total length, 625-1095 mm.; standard length, 445-835 mm.

Distribution.—*Nagarjunasagar area* : As above. *Elsewhere* : Whole of India.

28. *Roiga trigonata**(Schneider)

(The Indian Gamma)

Material.—2 exs., as follows :—*Guntur Dist.*: Pullareddygudem village, 13.xi.63, (coll. *B. Nath* and *I. N. Maligi*); *Nalgonda Dist.* : Madhavram village, 10.x.63. (Coll. *B. Nath*).

Measurements.—Total length, 555-580 mm.; Standard length, 450-470 mm.

Distribution.—*Nagarjunasagar area* : As above. *Elsewhere* : Whole of Peninsular India ; and W & E. Himalayas.

29. *Dryophis nasutus* (Lacépède)

(The Common Green Whip Snake)

Material.—one ex., *Nalgonda Dist.*, on way to Hyderabad. 20. iii.62. (coll. *B. Nath*.)

Measurements.—Total length. 951 mm.; Standard length. 605 mm.

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : India ; Peninsular India ; Bengal.

30. *Bungarus caeruleus* (Schneider)

(The Common Indian Krait)

Material.—2 exs., *Nalgonda Dist.* : Nandikonda Valley, 7.x.63 and 7.xi.63, (coll. *B. Nath* and *I. N. Maligi*).

Measurements.—Total length, 725-890 mm.; Standard length, 630-760 mm.

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : India : South to Andhra Pradesh, as follows :—Eastern Rajasthan, U.P., E. Punjab, Madhya Pradesh, Orissa, Andhra Pradesh.

31. *Callophis melanurus* (Shaw)

(The Slender Coral Snake)

Material.—One ex., *Nalgonda Dist.* : Nandikonda Valley, 6.xi.63, (coll. *B. Nath* and *I. N. Maligi*).

Measurements.—Total length, 323 mm.; Standard length, 300 mm.

Distribution.—*Nagarjunasagar* area : As above. (First record from the area). *Elsewhere* : Peninsular India (Maharashtra. Kerala) ; and Bengal.

32. *Naja naja naja* (L.)

(The Indian Cobra)

Material.—One ex., *Guntur Dist.*: Pullareddygudem village, 1.x.63, (coll. *B. Nath* and *I. N. Maligi*).

Measurements.—Total length. 1190 mm.; Standard length. 975 mm.

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : Whole of India.

33. *Vipera russelli russelii* (Shaw)

(Russell's Viper)

Material.—One ex., (damaged), *Guntur Dist.*: Eddenmotu Hill, 4.ix.62, (coll. *B. Nath* and *I. N. Maligi*).

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : Whole of India.

34. *Echis carinatus* (Schneider)

(The Saw-scaled Viper or Phoorsa.)

Material.—4 exs., *Guntur Dist.*: as follows :—Eddenmotu and Fringimotu Hills, 3 and 8.ix.62. *Nalgonda Dist.*: Nandikonda Vailey, 8.viii.62.(coll. *B. Nath* and *I. N. Maligi*).

Measurements.—Total length, 122-352 mm.; Standard length, 110-312 mm.

Distribution.—*Nagarjunasagar* area : As above. *Elsewhere* : India south of the Ganges, except Bengal.

V.—FIELD KEYS FOR THE IDENTIFICATION OF SAURIA (LIZARDS, ETC.)
FROM NAGARJUNASAGAR DAM AREA

Keys to families of SAURIA

- 1(2). Tongue broad and short, covered with villose papillae ; skin soft, with granules ; top of head with asymmetrical shields ; eyes devoid of movable lids GEKKONIDAE
- 2(3). Tongue broad and short, smooth or covered with villose papillae ; no symmetrical shields on top of head ; eyes with movable eyelids AGAMIDAE
- 3(4). Tongue covered with imbricate, scale-like papillae ; body covered with cycloid, imbricate scales ; head with symmetrical shields above ; no femoral or preanal pores SCINCIDAE
- 4(5). Tongue covered with imbricate papillae, forked anteriorly ; dorsal scales much differentiated from those on belly ; head with symmetrical shields above ; femoral pores present LACERTIDAE
5. Tongue smooth, very long and slender, bifid, retractile into a sheath at the base ; back covered with rounded scales ; top of head with small scales VARANIDAE

(a) *Keys to species of family GEKKONIDAE*

- 1(2). Dorsum with dark cross bars ; 7-10 lamellae under fourth toe *Hemidactylus triedrus* (Daudin)
- 2(1). Dorsum with dark spots ; 8-10 lamellae under fourth toe *Hemidactylus brooki* Gray
- 3(4). Size small ; snout rounded ; dorsum brown, with dark reticulations *Hemidactylus reticulatus* Beddome
- 4(3). Size very large ; snout obtusely pointed ; dorsum with large cross bars *Hemidactylus giganteus* Stoliczka

(b) *Keys to species of family AGAMIDAE*

- 1(2). Dorsal crest not present ; toes 4 in number *Sitana ponticeriana* Cuvier
- 2(1) Dorsal crest present ; toes 5 in number *Calotes versicolor* (Daudin)
- 3(4). 115-150 scales round the middle of body *Psammophilus dorsalis* (Gray)
- 4(3). 80-100 scales round the middle of body *Psammophilus blanfordanus* (Stoliczka).

(c) *Keys to species of family SCINCIDAE*

- 1(2). Dorsal scales with 3-5 keels ; lamellae 14-19 under fourth toe ; one pair of nuchals. *Mabuya carinata* (Schneider)
- 2(1). Dorsal scales with 5-7 keels ; 16-22 lamellae under fourth toe ; three pairs of nuchals. *Mabuya nagarjuni* Sharma
- 3(4). Body greatly elongate ; 24-28 scales round the middle of the body ; lower eyelid with an undivided semitransparent disc ; 11-14 lamellae under fourth toe *Riopa punctata* (Gmelin)
- 4(3). Body less elongate ; 28-32 scales round the middle of body ; lower eyelids scaly 13-15 lamellae under fourth toe *Riopa ashwamedhi* Sharma

- (d) *Keys to species of family LACERTIDAE*

- 1(2). Anterior labials ridged ; occipital scale present ; 42-50 scales round the middle of body . *Cabrita leschenaulti* (M. Edwards)
- 2(1). Anterior labials not ridged ; occipital scale absent ; 26-30 scales round the middle of body . *Cabrita jerdoni* Beddome
3. Lower eyelid fused with the upper ; 28-35 scales round the middle of body . *Ophisops jerdoni* Blyth

(e) *Family VARANIDAE*

The single species, *Varanus monitor* (L.) has the following characters : —

Abdominal scales quadrangular, arranged in 90-110 transverse rows ; tail long, compressed, with a low double-toothed crest above.

VI—SUMMARY

1 This is the first comprehensive study of the reptile fauna of the Nagarjunasagar Dam Project Area (Guntur and Nalgonda Districts, Andhra Pradesh), and is based on the considerable collections made by field parties of the Zoological Survey of India during the years 1962 and 1963.

2. A total of 34 species belonging to 24 genera of 11 families are recorded here, as follows :—Two species of the order Testudines, and 32 of the order Squamata, thus : 16 of suborder Sauria (4 Gekkonidae, 4 Agamidae, 4 Scincidae, 3 Lacertidae, 1 Varanidae) and 16 of suborder Serpentes.

3. Two species of Scincidae, namely, *Mabuya nagarjuni* and *Riopa ashwamedhi*, were described by the author recently (Sharma, 1969) elsewhere based on this material.

4. The following species are recorded for the first time from the Nagarjunasagar area :—

Order TESTUDINES : *Trionyx gangeticus* Cuvier :

Order SQUAMATA :

Suborder SAURIA : *Psammophilus dorsalis* (Gray), *P. blanfordanus* (Stoliczka).

Suborder SERPENTES : *Typhlops acutus* (Duméril Bibron), *Eryx johni* (Russell), *Coluber prox. gracilis* (Günther), *Callophis melanurus* (Shaw).

VII—REFERENCES

SHARMA, R. C. 1969. Two new lizards of the genera *Mabuya* Fitzinger and *Riopa* Gray (Scincidae) from India—*Bull. syst. Zool.*, Calcutta, 1(2), 71-75.

SMITH, M.A. 1931. *Fauna Brit. India, Reptilia and Amphibia*. 1 *Loricata, Testudines*, xxviii+185 pp., 2 pls. 1 map. London (Taylor & Francis, Ltd.).

SMITH, M.A. 1935. *Fauna Brit. India*. 2. *Sauria*, xiii+440 pp. pl., 2 maps. London (Taylor & Francis, Ltd.).

SMITH, M.A. 1943. *Fauna Brit. India* 3. *Serpentes*, xii+583 pp. 1 map.—London (Taylor & Francis Ltd.).

TABLE 1.—List of collecting localities for reptiles in the Guntur and Nalgonda districts, Andhra Pradesh, during 1962 and 1963.

BN., Shri Bhola Nath ; IM., Shri I. N. Maligi.

1. GUNTUR DISTRICT

Collecting Station	Altitude (above mean sealevel) (in feet)	Approx. Latitude (N.)	Approx. Longitude (E.)	Name of Collector and date of Collection
1	2	3	4	5
1. Ashwamedh site, ca. 5 Km. S.W. of Pullareddy-gudem village.	340'	16°31'	79°41'	BN & IM (29-30. vii.62).
2. Eddenmotu and Fringimotu Hills ca. 4 Km. S. of Pullareddy-gudem village.	300-1000'	16°30'	79°14'	BN & IM (2-8. ix. 62 ; 3-6, 8,30. ix. 7-9, 15.xi.63).
3. Macherla town and vicinity.	..	16°30'	79°27'	BN & IM (12-16.ix. 62).
4. Nagarjuna Hill, ca. 4Km. N. W. of Pullareddy-gudem village.	350'	16°31'	79°14'	BN (5, 27-28.viii. ; 4,9.ix.62 ; 28,29. ix ; 1-2.x.63).
5. Peddavagu river, ca. 29 Km. N. W. of Macherla town.	360'	16°33'	79°12'	BN (20.x.63).
6. Pullareddy-gudem village and vicinity, ca. 23 Km. N. W. of Macherla town.	350'	16°31'	79°14'	BN & IM (25-30. vii ; 1-2,22-23, 26-27. viii ; 2-4, 7-9, 28-29.ix.62 ; 6,7,14.ix ; 1.x ; 6, 9,11,13-15. xi. 63).
7. Putlegudem village, ca. 6 Km. S. of Pullareddy-gudem village.	360'	16°29'	79°14'	BN & IM (31.vii. 62 ; 6.xi.63).
8. Siddelder Hill, ca. 4 Km. N. E. of Pullareddy-gudem village.	310-650'	16°31'	79°15'	BN (11.xi.63).

2. NALGONDA DISTRICT

Collecting Station	Altitude (above mean sea level) (in feet)	Approx. Latitude (N.)	Approx. Longitude (E.)	Name of Collector and date of Collection
9. Azmapur village, <i>ca.</i> 27 Km. E. of Deverkonda town.	450'	16°42'	79°56'	BN (16.viii.62).
10. Deverkonda town and vicinity, <i>ca.</i> 54 Km. W. of Vijaypuri North.	540'	16°43'	78°58'	BN & IM (14.vii.62).
11. Ethiopotla Fall, <i>ca.</i> 12 Km. S. E. of Vijaypuri South.		16°32'	79°25'	BN (25.viii.62).
12. Madhavram village, <i>ca.</i> 50 Km. N. E. of Nagarjunasagar Dam.	510'	16°33'	79°08'	BN (3,10-11, 13.x.63).
13. Nandikonda Valley, <i>ca.</i> 10 Km. N. W. of Nagarjunasagar Dam.	250'	16°34'	79°17'	BN & IM (1,7-9, 11.viii.62 ; 4,7-8, x ; 6-7.xi.63).
14. Nidigul village, <i>ca.</i> 12 Km. N. E. of Nagarjunasagar Dam.	520'	16°33'	79°10'	BN (22-23, 25.x.63).
15. On way to Hyderabad, <i>ca.</i> 40 Km. N. W. of Deverkonda town.			..	BN (20.viii.92).
16. Pindlipakula village, <i>ca.</i> 16 Km. E. of Deverkonda town.	490'	16°43'	79°55'	BN (18.viii.62).
17. Rayaram village, <i>ca.</i> 7 Km. N. W. of Pullareddygudem village	360'	16°33'	79°12'	BN (18-19.x.63).
18. Suryaraopet village, <i>ca.</i> 8 Km. W. of Madhavram village.	470'	16°35'	79°08'	BN (14.x.63).
19. Tiger Valley, <i>ca.</i> 3 Km. E. of Nagarjunasagar Dam.	500'	16°34'	79°18'	BN & IM (3-7.viii.62 ; 3,5.x.63).
20. Vijaypuri North, <i>ca.</i> 5 Km. N. of Nagarjunasagar Dam.	500'	16°34'	79°17'	BN & IM (3,7-8, 31.vii.62).
21. Vijaypuri South, <i>ca.</i> 4 Km. S. of Nagarjunasagar Dam.	500'	16°35'	79°18'	BN & IM (22-24, 26-29.viii.62).
22. Yelleshwaram village, <i>ca.</i> 12 Km. S. W. of Nidigul village.	390'	16°28'	79°12'	BN (1-4.xi.63).

FAUNA OF RAJASTHAN, INDIA, PART II

CRUSTACEA : CLADOCERA

By

S. BISWAS

Zoological Survey of India, Calcutta

(With 2 Tables and 14 Text-figures)

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I—INTRODUCTION

(1) *General*

The present work is mostly devoted to the Cladocera collections from Rajasthan made by the Zoological Survey of India parties during the years 1957-61.

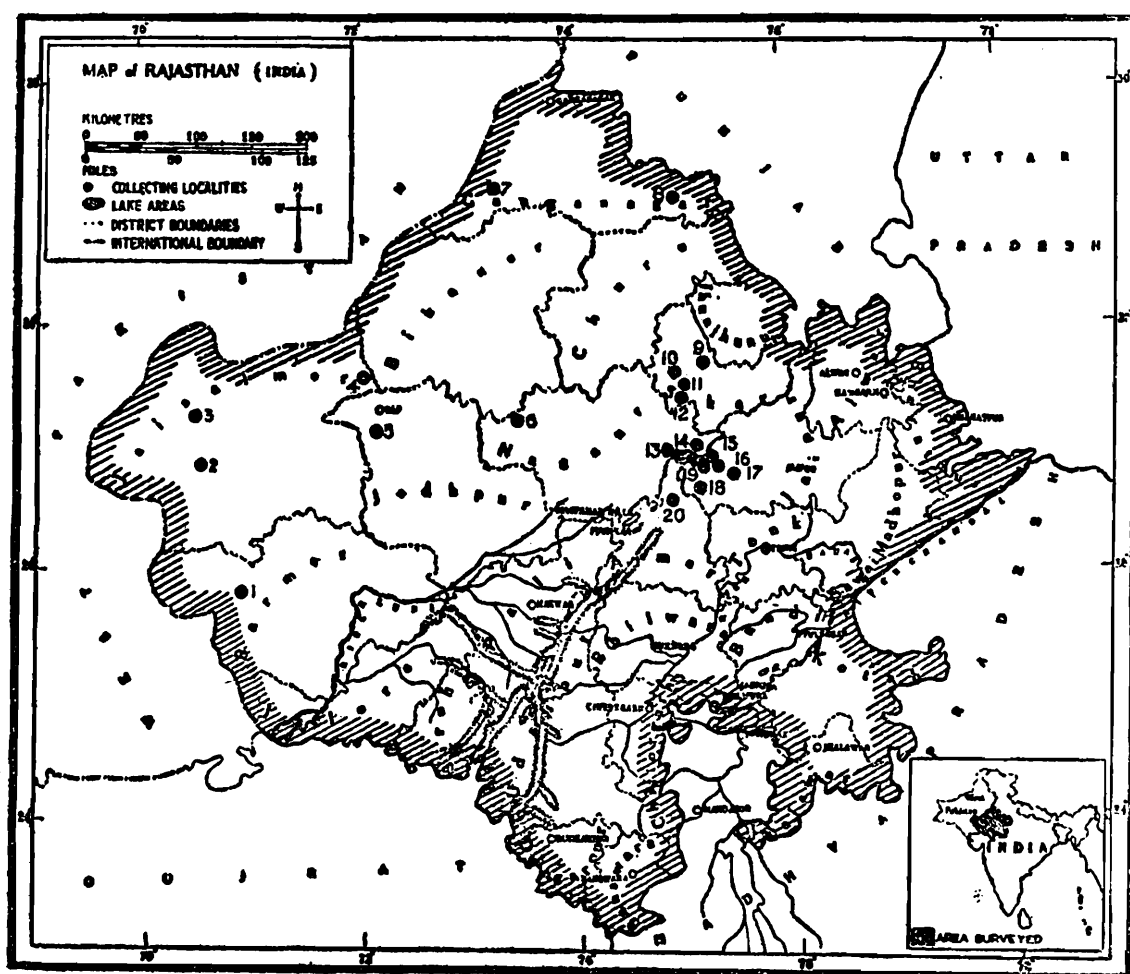
Our earlier knowledge on the Cladocera fauna of Rajasthan was almost scanty, and even of India as a whole, meagre. After the papers of Gurney (1906, 1907), Brehm (1936, 1950, 1953) and Sewell (1935), there are no important works worth mentioning. Gurney's work is mostly concerned with Lower Bengal and Chota Nagpur. Brehm recorded some Cladocera from different parts of India, viz., Kashmir, Punjab, Saurashtra, etc., and Sewell's work is confined to the Cladocera of Bengal only. Recently, I have described two species from Rajasthan, viz., *Latona tiwarii* Biswas (1964) and *Chydorus brehmi* Biswas (1965).

This report is based on the collections made mostly from the Sambhar Lake Survey (November, 1957 to January, 1959) and two Rajasthan Desert Surveys undertaken by Dr. B. Biswas and Western Rajasthan

Survey by Dr. K. K. Tiwari and myself (1957-58). Freshwater collections were also made in Jaipur and Nagaur Districts during the Sambhar Lake Survey. Dr. Tiwari's collections were made mainly from the Barmer, Jaisalmer and Jodhpur Districts, while those by Dr. Biswas come from the districts of Bikaner, Ganganagar, Jaipur, Nagaur and Sikar.

On the basis of the ecological characteristics, the collections from Rajasthan, can be broadly divided into the freshwater and the brackish-water collections. The former were obtained from tanks, ditches, canals, reservoirs, etc., and the latter mostly from the Sambhar Lake. In the rainy season, or just after that, the water of the Sambhar Lake approaches freshwater conditions and therefore, some freshwater species also make their appearance in that Lake. For a general account of Rajasthan, Part 1 of this series (Roonwal, 1967) may be consulted.

All the species, except *Daphnia carinata* King, recorded in this paper are new records for Rajasthan though some of them have been recorded by the above mentioned earlier authors from other parts of India. Out of the 45 species and varieties recorded here from Rajasthan, 26 are new to India.



TEXT-FIG. 1.—Map of Rajasthan, showing collecting localities for Cladocera (Crustacea)

1. Bhap tank (Barmer Dist.). 2. Gadisar. 3. Biprasar. 4. Nokh (Jaisalmer Dist.). 5. Phalodi. 6. Gurha (Jodhpur Dist.). 7. Suratgarh. 8. Diplana (Ganganagar Dist.). 9. Gunjara. 10. Molasi. 11. Puranchhoti. 12. Kanwarapura (Sikar Dist.). 13. Nawa or Kuchaman Road. 14. Gudha (Nagaur Dist.). 15. Sambhar Lake Town. 16. Phulera. 17. Asalpura Bund. 18. Dudu. 19. Julga Lake (Jaipur Dist.). 20. Anasagar (Ajmer Dist.).

(2) *List of the Collections Examined*

(Table 1)

The Collections examined are given in Table 1 below.

TABLE 1.—List of surveys from which the material for Rajasthan Cladocera was studied.

<i>Name of the Survey</i>	<i>Year</i>	<i>Leader of Survey Party</i>	<i>Districts surveyed</i>
1. Sambhar Lake Survey	Nov., 1957 to Jan., 1959	A. K. Mukherjee & S. Biswas	Jaipur & Nagaur
2. Rajasthan Survey	Desert { 1956 1957-58 1960-61	Dr. B. Biswas ,, ,,	Nagaur, Bali, Ajmer, Bikaner, Jaipur, Jodhpur, Bikaner, Churu, Ganganagar. Jaisalmer, Nagaur & Sikar
3. Western Rajasthan Survey	1957-58	Dr. K. K. Tiwari	Barmer, Jaisalmer & Jodhpur
4. Ajmer Collection	1961	Dr. Tej Singh	Ajmer
5. Rajasthan Survey	1963	K. K. Mahajan	Jaipur

(3) *Acknowledgements*

I am very thankful to the Director, Zoological Survey of India, Calcutta, for providing me with the facilities to work out these collections. It would have been impossible for me to write up this report without his help and guidance. I am also thankful to Dr. K. K. Tiwari for his help.

II—LIST OF COLLECTING LOCALITIES

(Table 2)

Cladocera were collected from a total of 22 collecting stations, distributed over 8 districts of Rajasthan (Table 2).

TABLE 2.—List of the Main Collecting Stations for Cladocera of Rajasthan.

Abbreviation : AKM, A. K. Mukherjee; BB, Dr. B. Biswas; KKM, K. K. Mahajan; KKT, Dr. K. K. Tiwari; SB, S. Biswas; TS, Dr. Tej Singh; *Sta.*, Collecting Station.

<i>Serial No.</i>	<i>Collecting Station</i>	<i>Approx. Latitude (N)</i>	<i>Approx. Longitude (E)</i>	<i>Name of collector & year of collection</i>
(1)	(2)	(3)	(4)	(5)
1. Ajmer District				
1.	Anasagar Lake, Ajmer	26°25'	74°35'	TS (1961)
2. Barmer District				
2.	Bhap Tank, ca. 18 km. NE. of Barmer	25°51'	71°26'	KKT & SB (1957—58)
3. Ganganagar District				
3.	Diplana, 13 km. E. of Nohar	29°11'	74°53'	BB (1960)
4.	Suratgarh, Sta. 23	29°19'	73°54'	BB (1960)
4. Jaipur District				
5.	Julga Lake ca. 21 km. SW. of Gudna	26°	75°	SB (1958—59)
6.	Narayana Village	26°45'	75°10'	SB (1958—59)
7.	Dudu	26°40'	75°10'	SB (1958—59)
8.	Sambhar Lake	26°54'	75°13'	AKM (1958)
9.	Devdyani (temple tank near Sambhar)	26°55'	75°13'	SB (1958—59)
10.	Asalpura Bund	..	..	SB (1958—59)
11.	Phulera	26°52'	75°16'	SB (1958—59) KKM (1963)

(Table 2)—*contd.*

<i>Serial No.</i>	<i>Collecting Station</i>	<i>Approx. Latitude (N)</i>	<i>Approx. Longitude (E)</i>	<i>Name of collector & year of collection</i>
(1)	(2)	(3)	(4)	(5)
5. Jaisalmer District				
12.	Gadisar, Jaisalmer	26°55'	70°57'	KKT & SB (1957—58)
13.	Geodiasar (<i>ca.</i> 24 km. S. of Ramgarh)	27°16'	70°32'	KKT & SB (1957—58)
14.	Biprasar (<i>ca.</i> 80 km. S. of Ramgarh)	27°18'	70°30'	KKT & SB (1957—58)
15.	Nokh Village	27°33'	72°15'	BB (1960)
6. Jodhpur District				
16.	Phalodi	27°09'	72°24'	KKT & SB 1957—58)
7. Nagaur District				
17.	Gudha (on Sambhar Lake)	26°55'	75°25'	BB (1956—57) SB (1958—59) AKM (1957—58)
18.	Nawa (on Sambhar Lake)	27°00'	75°00'	SB (1958—59)
19.	Kuchaman Road (close to Nawa)	27°00'	75°00'	SB (1958—59)
20.	Gurha (<i>ca.</i> 26 km. W. of Nagaur)	27°13'	73°29'	BB (1960)
8. Sikar District				
21.	Molasi (16 km. W. of Sikar)	27°36'	75°00'	BB (1960)
22.	3 km. W. of Gunjara	27°40'	75°16'	BB (1960)
23.	1.62 km. E. of Kanwarpura	27°36'	75°05'	BB (1960)
24.	1 Puran Chhoti (15 km. SSW. of Sikar)	27°31'	75°05'	BB (1960)

III—LIST OF SPECIES OF CLADOCERA KNOWN FROM RAJASTHAN

A total of 45 species and varieties of Cladocera are known from Rajasthan and are listed below ; they belong to four families, *viz.*, Sididae, Daphnidae, Macrothricidae and Chydoridae.

Class CRUSTACEA

Superorder DIPLOSTRACA

Order I. CLADOCERA

Suborder (A) EUCLADOCERA

Superfamily (a) SIDOIDEA

Family (1) SIDIDAE

1. *Latona tiwarii* Biswas
2. *Diaphanosoma excisum* Sars
3. *D. excisum* Sars var. *stingelini* Jenkin
4. *D. excisum* Sars var. *longiremis* Ekman
5. *D. sarsii* Richard
6. *Latonopsis occidentalis* Birge
7. *L. australis* Sars
8. *Pseudosida szalay* Daday

Superfamily (b) CHYDOROIDEA

Family (2) DAPHNIDAE

9. *Daphnia lumholtzi* Sars
10. *D. carinata* King
11. *D. hyalina* Leydig
12. *Simocephalus australiensis* (Dana)
13. *S. elizabethae* (King)
14. *S. vetulus* (O.F. Müller)
15. *S. latirostris* Stingelin
16. *Scapholeberis kingi* Sars
17. *Ceriodaphnia rigaudi* Richard
18. *C. reticulata* (Jurine) var. *kurzii* Stingelin
19. *C. reticulata* (Jurine) var. *serrata* Sars
20. *C. laticaudata* P. E. Müller
21. *Moina dubia* Guerne & Richard
22. *M. brachiata* (Jurine)
23. *M. rectirostris* (Leydig)
24. *Monia banffy* Daday
25. *M. macrocopa* (Straus)

Family (3) MACROTHRICIDAE

26. *Streblocerus serricaudatus* (Fischer)
27. *Macrothrix spinosa* King
28. *M. triserialis* Brady
29. *M. chevreuxi* Guerne & Richard
30. *Gurneyella odiosa* (Gurney)
31. *Ilyocryptus halyi* rady

Family (4) CHYDORIDAE

32. *Leydigia laevis* Gurney
33. *L. acanthocercoides* (Fischer)

34. *Alona rectangularis* Sars
35. *A. bukobensis* Welthner
36. *A. intermedia* Sars var. *minor* Stingelin
37. *A. cambouei* Guerne & Richard
38. *A. glabra* Sars
39. *Pleuroxus aduncus* (Jurine)
40. *Dunhevedia crassa* King
41. *Chydorus robustus* Stingelin
42. *C. denticulatus* Henry
43. *C. reticulatus* Daday
44. *C. ventricosus* Daday
45. *C. brehmi* Biswas

IV—KEY TO THE SPECIES OF RAJASTHAN CLADOCERA

- 1(112). Body and feet covered by a bivalve shell. Feet in general foliaceous, not plainly jointed Suborder (A) *EUCLADOCERA*
- 2(21). Six pairs of feet, all similar except the last ; all foliaceous Superfamily (a) *SIDOIDEA*
- 3(20). Shell of ordinary type. Antennae biramus in female ; rami flattened, the dorsal with numerous setae both lateral and terminal Fam. (i) *SIDIDAE*
- 4(5). Dorsal ramus of antenna 3-jointed Genus (1) *Sida* Straus
 - Rostrum present 1. *Sida crystallina** (O. F. Müller)
- 5(4). Dorsal ramus of antenna 2-jointed.
- 6(7). With foliaceous appendix from the ventral side of head Genus (2) *Latona* Straus
 - Without lateral expansion of antenna 2. *Latona tiwarit* Biswas
- 7(6). Without foliaceous appendix.
- 8(15). Without spines on postabdomen Genus (3) *Diaphanosoma* Fischer
- 9(14). Shell duplicator narrow.
- 10(13). Reflex antenna not exceeding posterior margin of shell.
- 11(12). Reflex antenna not more than one-third of body-length 3. *Diaphanosoma excisum* Sars
- 12(11). Reflex antenna nearly reaches posterior border of shell 4. *Diaphanosoma excisum* var. *stingelini* Jenkin

*Not recorded from Rajasthan. Found in Assam only.

- 13(10). Reflex antenna exceeding posterior margin of shell 5. *Diaphanosoma excisum* var. *longiremis* Ekman
- 14(9). Shell duplicator broad, more than 10 spines on margin of shell 6. *Diaphanosoma sarsii* Richard
- 15(8). Spines on postabdomen.
- 16(19). Eyes dorsal, far from insertion of antennule and optic ganglion. Without rostrum . . . Genus (4) *Latonopsis* Sars
- 17(18). With fornix ; antennule longer than anterior margin of head . . . 7. *Latonopsis occidentalis* Birge
- 18(17). Without fornix ; antennule shorter than anterior margin of head . . . 8. *Latonopsis australis* Sars
- 19(16). Eye ventral or in middle of head ; rostrum present . . . Genus (5) *Pseudosida* Herrick
- A median projection present on dorsal side near apex of postabdomen . . . 9. *Pseudosida szalayi* Daday
- 20(3). Body enclosed in a gelatinous mantle. Antennae simple in female ; cylindrical with 3 terminal setae . . . Fam. (ii) HOLOPEDIDAE
- 21(2). Five or six pairs of feet ; first and second pairs more or less prehensile, others foliaceous Superfamily (b) CHYDOROIDEA
- 22(80). Antennules attached to ventral side of head and not covered by fornices.
- 23(62,63). Antennules of female usually small, sometimes rudimentary ; if large, never inserted at anterior end of ventral surface of head. Dorsal ramus of antenna 4-jointed, ventral 3-jointed. Intestine simple, with 2 hepatic caeca Fam. (iii) DAPHNIDAE
- 24(42). Rostrum present.
- 25(32). No cervical sinus. Valves with polygonal, usually rhomboidal, marking and with posterior spines. Crest on dorsal side of head Genus (6) *Daphnia* O. F. Müller
- 26(29). Claws with pecten.
- 27(28). Head helmeted and often produced into spine 10. *Daphnia lumholtzi* Sars
- 28(27). Head not helmeted. Rostrum and antennule *pulex*-like but front not sinuate. Head carinated. Postabdomen tapered and not sinuate. 11. *Daphnia carinata* King
- 9(26). Claws without pecten.

- 30(31). Adult with no crest or at most rudimentary crest on head; rostrum of characteristic form; shell reticulation more or less well marked 12. *Daphnia longispina* (O. F. Müller)
- 31(30). Adult with definite crest; rostrum not like *longispina*; reticulation less marked 13. *Daphnia hyalina* Leydig
- 32(25). Cervical sinus present. No crest.
- 33(40). Valves transversely striated. Postabdomen broad, with indentation in which anus opens Genus (7). *Simocephalus* Schoedler
- 34(39). Vertex rounded, smooth. No posterior spine.
- 35(36). Ocellus punctiform. Posterior prominence obtuse 14. *Simocephalus australiensis* (Dana)
- 36(35). Ocellus elongated.
- 37(38). Body nearly symmetrical. Posterior prominence not very prominent 15. *Simocephalus vetulus* (O. F. Müller)
- 38(37). Body not symmetrical. Posterior prominence very prominent 16. *Simocephalus elizabethae* (King)
- 39(34). Vertex angulate. Blunt posterior spine or prominence present 17. *Simocephalus latirostris* Stinelin
- 40(33). Valves obscurely reticulated and with some striae. Posterior and ventral margin straight, the latter extended into a spine Genus (8) *Scapholeberis* Schoedler
- 41(40). Colour usually dark. Infrapostalar angle with a spine, often long 18. *Scapholeberis kingi* Sars
- 42(24). Rostrum absent; cervical sinus present.
- 43(50). Head small and depressed. Antennules small. Valves oval and rounded. No postalar extension of postabdomen. Genus (9) *Ceriodaphnia* Dana
- 44(49). Postabdomen of ordinary form.
- 45(46). Head with a short spine or horn in front of antennule 19. *Ceriodaphnia rigaudi* Richard
- 46(45). Head without spine. Claws pectinate 20. *Ceriodaphnia reticulata* (Jurine)
- 47(A). Shell not reticulated; fornix rounded 21. *Ceriodaphnia reticulata* var. *kurzi* Stingelin
- 48(B). Shell reticulated; fornix extended 22. *Ceriodaphnia reticulata* var. *serrata* Sars
- 49(44). Postabdomen very broad, obliquely truncate 23. *Ceriodaphnia laticaudata* P. E. Müller

- 50(43). Head large and usually extended. Antennules large and freely movable. Postabdomen with postanal extension.
- 51(50). Body thick and large. Valves somewhat rhomboidal, not wholly covering the body. Fornix small. Ocellus absent. Abdominal processes represented by horse-shoeshaped fold Genus (10) *Moina* Baird
- 52(60). Postabdominal end-claw with pecten.
- 53(53). Postanal spine 8 or more. Animal large.
- 55(57). Two ehippial eggs.
56. Supraocular depression present. Antennules of male with sense seta in the middle. Anal spines without seta 25. *Moina brachiata* (Jurine)
- 57(55). One ehippial egg.
- 58(59). Valves smooth. Ehippium reticulated around edges, smooth in middle. Antennules of male with sense seta near middle. 26. *Moina rectirostris* (Leydig)
- 59(58). Valves with striae. Ehippium reticulated all over. Antennules of male with sense seta nearer to base 27. *Moina banffy* Daday
- 60(52). End-claw without pecten.
61. No supraocular depression 28. *Moina macrocopa* (Straus)
- 62(23,63). Six pairs of feet. Antennules of female large, fixed. Intestine simple, no caeca Fam. (iv) BOSMINIDAE
- 63(62). Antennules of female freely movable, usually inserted at anterior end of ventral surface of head. Rami of antennae 3 and 4-jointed. Intestine simple or convoluted; hepatic caeca usually wanting; 5 or 6 pairs of feet.
- 64(67). Intestine convoluted Fam. (v) MACROTHRICIDAE
- 65(77). Antennary setae $\frac{0-0-1-3}{1-1-3}$ Animal small and spherical Genus (11) *Streblocerus* Sars
66. Dorsal margin of valves smooth 29. *Streblocerus serri-caudatus* (Fischer)
- 67(64). Intestine simple.
- 68(75). Anus not guarded by a pair of flaps.
69. Antennary setae $\frac{0-0-1-3}{1-1-3}$ basal seta of 3-jointed ramus, stout and stiff Genus (12) *Macrothrix* Baird
- 70(72). Antennules enlarged near distal end.
71. Postabdomen bilobed Squamous marking on shell 30. *Macrothrix spinosa* King

- 72(70). Antennules not enlarged near distal end.
- 73(74). Dorsal appendages of lip-plate bilobed and hairy
- 74(73). Dorsal appendages of lip-plate not bilobed and not hairy
- 75(68). Anus guarded by a pair of flap-like structures
76. Body outline oval. Postabdominal sides covered with numerous setae groups. Anal declivity 3-pointed. Antennules always with 3 spines
- 77(65). Antennary setae $\frac{0-0-0-3}{1-1-3}$
78. Vertex of head forming sharp angle in front of insertion of antennules. Dorsal crest of the valves absent or small. Postabdomen very large, with numerous long spines
79. Antennae less massive and long. Preanal spine 6-7 in number. Front angulate
- 80(22). Fornices extended so as to cover antennules in whole or in part and united with rostrum into a beak, projecting ventrally in front of antennules.
81. Anus on dorsal side of postabdomen, with the postanal portion bearing denticles. Without hepatic caeca. Two summer eggs; one ephippial egg. Male with strong hook on first leg
- 82(98). Posterior margin of valves not greatly less than maximum height.
- 83(85). Postabdomen with marginal and lateral denticles.
- 84(88). Postabdomen relatively long and narrow; marginal denticles numerous, longer distally. Basal spine stout and long.
- 85(83). Postabdomen with numerous clusters of large spines
- 86(87). Valves without marking
- 87(86). Valves striated longitudinally
- 88(84). Postabdomen not noticeably narrow; distal denticles not conspicuously larger. Basal spine small.
89. Valves with longitudinal striae
- 90(95). Infrapostcal angle of postabdomen rounded.
- 91(97). Lateral fascicles long, extending beyond dorsal margin.
- 92(93). Postabdomen not broadened towards apex
- 93(92). Postabdomen broader towards the apex. Shell with longitudinal striae
4. Shell plain
31. *Macrothrix chevreuxi* Guerne & Richard
32. *Macrothrix triserialis* Brady
- Genus (13) *Gurneyella* Brehm
33. *Gurneyella odiosa* (Gurney)
- Genus 14. *Ilyocryptus* Sars
34. *Ilyocryptus halyi* Brady
- Fam. (vi) CHYDORIDAE
- Subfamily (a) CHYDORINAE
- Genus (15) *Leydigia* Kurn
35. *Leydigia laevis* Gurney
36. *Leydigia acanthocercoides* (Fischer)
- Genus (16) *Alona* Baird
37. *Alona rectangula* Sars
38. *Alona bukobensis* Welthner
39. *Alona intermedia* Sars
40. *Alona intermedia* var. *minor* Stingelin

- 95(90). Infraposteal angle of postabdomen not rounded.
- 96(97). Lateral fascicle extending beyond dorsal margin 41. *Alona cambouei* Guerne & Richard
- 97(96). Lateral fascicle not extending beyond dorsal margin 42. *Alona glabra* Sars
- 98(82). Posterior margin of valves considerably less than maximum height.
- 99(104). Body elongated, form not spherical.
- 100(102). Rostrum long . . . Genus (17) *Pleuroxus* Baird
101. Angle of postabdomen rounded. Row of marginal denticles equal to anal emargination. 43. *Pleuroxus aduncus* (Jurine)
- 102(100). Rostrum short . . . Genus (18) *Dunhevedia* King
103. Body short and high, dorsal margin much arched 44. *Dunhevedia crassa* Kin
- 104(99). Body spherical and broadly ellipsoidal. Postabdomen ordinarily short, with prominent preanal angle . Genus (19) *Chydorus* Leach
- 105(106). Shape of body arched prominently, hinder part drawn outward, posterior margin straight. 45. *Chydorus ventricosus* Daday
- 106(105). Shape of body normal.
- 107(108). Dorsal edge of valve with "chitin schlub" or tubercles . . . 46. *Chydorus robustus* Stingelin
- 108(107). Edge of valve normal-shaped..
- 109(110). Shape of lip-plate obtuse . . . 47. *Chydorus denticulatus* Henry
- 110(109, 111). Shape of lip-plate acuminate 48. *Chydorus reticulatus* Daday
- 111(110). Shape of lip-plate button or nipple-shaped. 49. *Chydorus brehmi* Biswas
- 112(1). Body and feet not covered by shell. Feet subcylindrical; six pairs of feet cylindrical, first pair long, without branchial appendages. Suborder(B) *HOPLOPODA*

V—SYSTEMATIC ACCOUNT

Family (1) SIDIDAE

1. *Latona tiwarii* Biswas

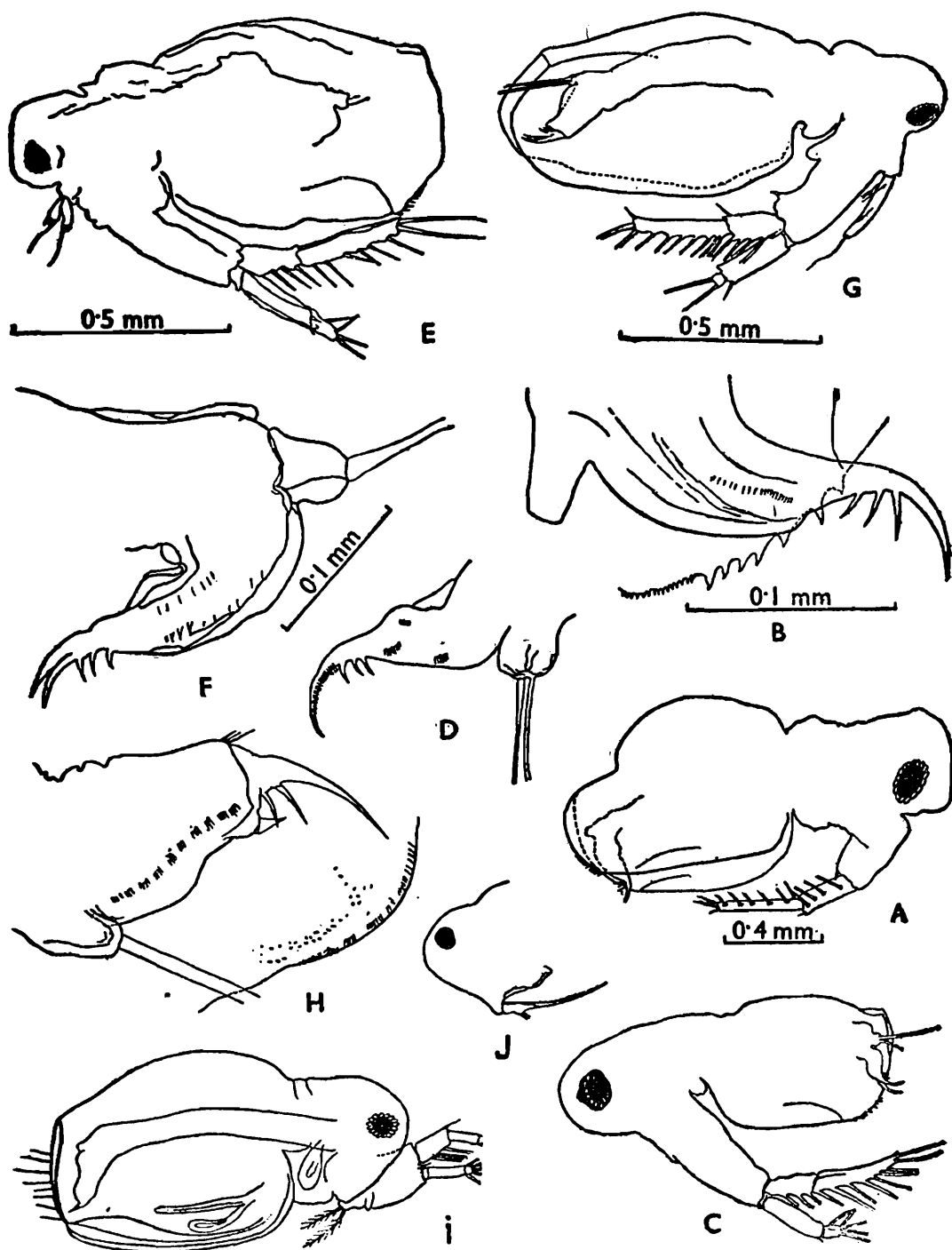
1964. *Latona tiwarii* Biswas, *Proc. zool. Soc.*, Calcutta, 17(2), pp. 140-152, figs. 1 & 2.

Material.—Nagaur Dist. : 4 exs., a ditch adjacent to main lake, Gudha, on Sambhar Lake, 17.ix.58. Jaisalmer Dist. : 15 exs., Nokh, 27.viii.60, (All Coll. B. Biswas).

Measurement.—Length 1.50 mm.

Distribution.—Rajasthan : As above (first record from the area and for India).

Remarks.—The present species can be separated from the other two species of the genus, *L. setifer* (O. F. Müller) and *L. parviremis* Birge by the absence of antennary expansion and presence of spinules on the end-claw of the postabdomen.



TEXT-FIG. 2.—Cladocera from Rajasthan

(A) *Diaphanosoma excisum* Sars, ♀, in lateral view. (B) Same, post-abdomen lying below inferoposteal corner of carapace. (C) *Diaphanosoma excisum* Sars var. *stingelini* Jenkin, ♀, in lateral view. (D) Same, postabdomen. (E) *Diaphanosoma sarsii* Richard, ♀, in lateral view. (F) Same, postabdomen. (G) *Pseudosida Szalay* Daday, ♀, lateral view. (H) Same, postabdomen. (I) *Latonopsis occidentalis* Birge, ♀, lateral view. (J) Same, ♂, anterior part.

Magnifications : (A), (I), to same scale. (E), (C), to same scale. (G), (H), (J), to same scale.

2. *Diaphanosoma excisum* Sars

(Text-figs. 2A, B)

1885. *Diaphanosoma excisum* Sars, *Forh. vid. Selsk.*, Christiania, No. 8, pp. 13-18, pl. 2, figs. 1-3.

1895. *Diaphanosoma excisum* : Richard, *Ann. Sci. nat.*, Paris, 18, pp. 367-369, pl. 16, fig. 9.

Material.—Jaipur Dist. : 2 exs., Julga Lake, 21 km. S.W. of Gudha, 24.xi.58, (Coll. S. Biswas).

Measurement.—Length 1.12 mm.

Distribution.—Rajasthan : As above (first record from the area and from India). Elsewhere : Australia.

Remarks.—This species can be easily recognised from allied species by its shorter antennae and the absence of hairs on the sides of postabdomen ; the body is more robust and the supero-posteal angles are markedly deflected.

3. *Diaphanosoma excisum* Sars var. *stingelini* Jenkin

(Text-figs. 2C, D)

1904. *Diaphanosoma excisum* var., *Stingelin*, *Zool. Jb. (Syst.)*, Jena, 21, p. 50, pl. 8, figs. 19, 20.

1934. *Diaphanosoma excisum* var. *stingelini* Jenkin, *Ann. Mag. nat. Hist.*, London, (10) 13, pp. 140-143, figs. 1, 1a.

Material.—Jaipur Dist. : 1 ex., Kalo Talao, Narayana, 1.xi.58 ; 20 exs., Julga Lake, 21 km. S.W., of Gudha, 24.xi.58, (All Coll. S. Biswas).

Measurement.—Length 1.01 mm.

Distribution.—Rajasthan : As above (first record from the area and from India). Elsewhere : Sumatra and Africa (Egypt and Uganda).

Remarks.—The variety differs from var. *longiremis* Ekman (see infra) in having a shorter antenna which never exceeds in length the posterior border of the carapace.

4. *Diaphanosoma excisum* Sars var. *longiremis* Ekman

1904. *Diaphanosoma excisum* var. *longiremis* Ekman, *Jagerskiold Exped.*, Uppsala, 26, (i)(8), pp. 1-2, figs. 2, 3.

1935. *Diaphanosoma excisum* var. *longiremis* : Sewell, *Int. Revue. ges. Hydr. U. Hydr.*, Leipzig, 31 (3-4), p. 210.

Material.—Ajmer Dist. : 15 exs., Anasagar Lake near Ajmer, 20.xi.61, (Coll. Tej Singh). Jaipur Dist. : 8 exs., Dudu Talao, Dudu, 8.i.59, (Coll. S. Biswas).

Measurement.—Length 0.90 mm.

Distribution.—*Rajasthan* : As above (first record from the area). *Elsewhere* : West Bengal (India). Also Sumatra and Africa (Sudan, Egypt).

Remarks.—This variety agrees with var. *stingelini* Jenkin in the presence of hairs at the sides of the postabdomen and with the type in the number of setae on the carapace border, but differs from both in the greater length of the antennae which surpass the posterior border of the carapace.

5. *Diaphanosoma sarsii* Richard

(Text-figs. 2E, F)

1895. *Diaphanosoma sarsii* Richard, *Ann. Sci. nat.*, Paris, (7) 18, pp. 365-367, pl. 15, figs. 1 and 8.

1901. *Diaphanosoma sarsii* : Sars, *Arch. Math. Naturu.*, Christiania, 25, pp. 10-13, pl. 2, figs. 1-10.

Material.—*Jaipur Dist.* : 1 ex., canal water, Dhobola Talao, Narayana, 29.x.58. (Coll. S. Biswas). 12 exs., Narayana Talao, Narayana, 2.xi.58, (Coll. S. Biswas). *Ganganagar Dist.* : 2 exs., Suratgarh, Sta. 23, 9.x.60, (Coll. B. Biswas).

Measurement.—Length 1.17 mm.

Distribution.—*Rajasthan* : As above (first record). *Elsewhere* : India : Chota Nagpur. Also from Ceylon, S.E. Asia (Sumatra, Java, Celebes, Singapore and Bangkok), Africa and S. America.

Remarks.—The species differs from the nearest one, *D. excisum* Sars and its varieties, mainly by the greater breadth of the shell-duplicator and more spines at its inferoposteal corner.

6. *Latonopsis occidentalis* Birge

(Text-figs. 2I, J)

1892. *Latonopsis occidentalis* Birge, *Trans. Wis. Acad.*, Madison, 8, pp. 383-388, pl. 13, figs. 1-5.

1895. *Latonopsis occidentalis* : Richard, *Ann. Sci. nat. (Zool.)*, Paris, (7) 18, pp. 380, 381, pl. 16, fig. 12.

Material.—*Jaipur Dist.* : 3♂♂, 2♀♀, Pumping enclosure, Gudha kyār, Sambhar Lake, 11.x.58. 11 exs., from a cemented tank, Gudha kyār, 5.ix.58, (All Coll. S. Biswas).

Measurements.—Length ♀ 0.78, ♂ 0.65 mm.

Distribution.—*Rajasthan* : As above (first record from the area and from India). *Elsewhere* : North and South America.

Remarks.—The distinguishing characters by which this species differs from *L. australis* Sars are : a small and bilobed fornix ; and the antennule longer than the ventral margin of head.

7. *Latonopsis australis* Sars

(Text-figs. 8A-C)

1888. *Latonopsis australis* Sars, *Forh. vid. Selsk.*, Christiania, No. 7, p. 6-15, pl. 1, figs. 1-6.

1895. *Latonopsis australis* : Richard, *Ann. Sci. nat. (Zool.)*, Paris, (7) 18, pp. 378-380, pl. 16, figs. 11, 13 and 20.

Material.—*Jaipur Dist.* : 15 exs., from a cemented tank at Gudha kyār, Sambhar Lake, 15.x.58, (Coll. S. Biswas).

Measurement.—Length 1.42 mm.

Distribution.—*Rajasthan* : As above (first record from the area and from India). *Elsewhere* : Australia and Europe (Yugoslavia).

Remarks.—The present species is distinguished from closely allied species by its antennule being shorter than the ventral margin of head and the absence of the fornix.

8. *Pseudosida szalayi* Daday

(Text-fig. 2G-H)

1898. *Pseudosida szalayi* Daday, *Termes. Füzetek.*, Budapest, 21, pp. 64-66, figs. 33a-d.

1904. *Pseudosida szalayi* : Stingelin, *Zool. Jb. (Syst.)*, Jena, 21, pp. 327-370, pl. 11, figs. 1 and 2.

Material.—*Jaipur Dist.* : 1 ex., canal water of Dhobola Talao, Sta. Narayana, 29.x.58, (Coll. S. Biswas).

Measurement.—Length 1.17 mm.

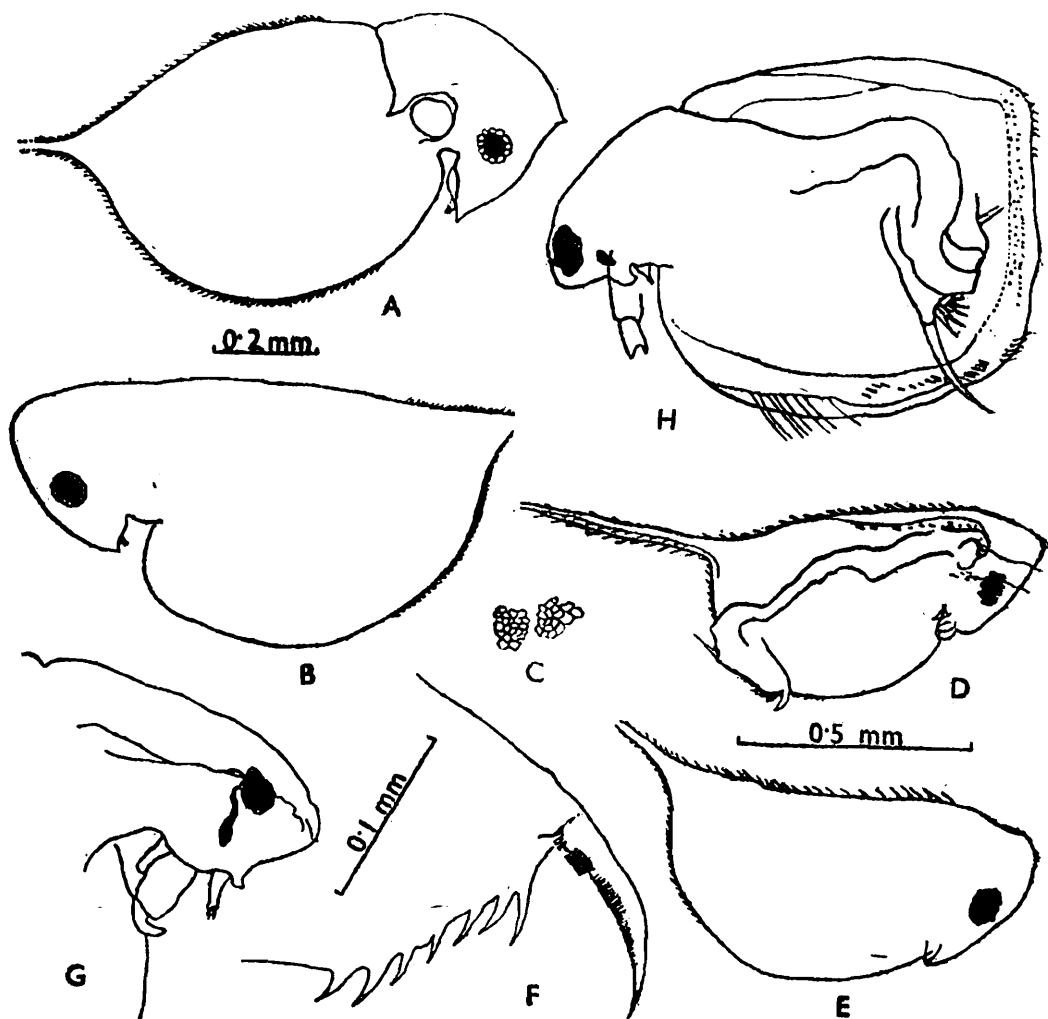
Distribution.—*Rajasthan* : As above (first record from the area). *Elsewhere* : India : South India. Also from Ceylon, Thailand and Sumatra.

Remarks.—The characteristic of this species is a median projection on the dorsal side near the apex of the postabdomen.

Family (2) DAPHNIDAE

9. *Daphnia lumholtzi* Sars

(Text-figs. 3A & 4C, D)

1885. *Daphnia lumholtzi* Sars, ♀. *Selsk. Forh.*, Christiania, No. 8 pp. 19-26, pl. 1, figs. 1-10, pls. 3 & 4.1950. *Daphnia lumholtzi* : Brehm, *Rec. Indian Mus.*, Delhi, 48, pp. 19-21 figs. a-e.

TEXT-FIG. 3.—Cladocera from Rajasthan

(A) *Daphnia lumholtzi* Sars, ♀, lateral view. (B) *Daphnia hyalina* Leydig, ♀, lateral view. (C) Same, reticulation on carapace. (D) *Daphnia carinata* King-Young ♀. (E) Same, ♀ adult. (F) Same, end part of postabdomen. (G) *Simocephalus elizabethae* (King), ♀, anterior part. (H) *Simocephalus australiensis* (Dana) ♀, lateral view.

Magnifications : (A), (B), (C), to same scale. (D), (E), (G), (H), to same scale.

Material.—Ajmer Dist. : 4 exs., Anasagar Lake, Ajmer, 20.xi.61, (Coll. Tej. Singh). Jaipur Dist. : 4 exs., Balanadi, Dudu, 6.i.59, (Coll. S. Biswas).

Measurement.—Length 1.75 mm.

Distribution.—*Rajasthan* : As above (first record from the area). *Elsewhere* : India : Uttar Pradesh, Bengal, Madras and Andhra Pradesh. Also W. Pakistan (W Punjab), Ceylon, Palestine, Syria, Egypt and Australia.

Remarks.—The important characters of this species are : long head-spine, well-developed and peculiar fornix, and long, distinct, marginal denticles of the valves.

10. *Daphnia carinata* King

(Text-figs. 3D & E)

1853. *Daphnia carinata* King, *Pap. and Proc. R. Soc. van Diemen Land*, Hover Town, 2, (2), p. 246, pl. I & VIA.

1896. *Daphnia carinata*, Sars, *Arch. Math. Natur. Vid.*, Christiania, 18 (3), pp. 5, 6, pl. 1, figs. 1-4.

1950. *Daphnia carinata*, Brehm, *Rec. Indian Mus.*, Delhi, 48 (1), pp. 21-23, text-figs. 5a-d, 6a-d.

Material.—Ganganagar Dist. : ca. 50 exs., Suatgarh, 7.x.60 ; many exs., Diplana, 13 km. E. of Nohar, 13.x.60, (Coll. B. Biswas). Jodhpur Dist. : Many exs., Ranisar, Phalodi-xii.57, (Coll. K. K. Tiwari & S. Biswas). Jaipur Dist. : ca. 100 exs., a ditch at Barbarya, Narayana, 1.xii.59 ; ca. 70 exs., Dudu Talao, Dudu, 8.i.59, (Coll. S. Biswas) ; 20 exs. Narainsar, ca. 6 km. on Phulera Road, 6.x.63, (Coll. K. K. Mahajan). Jaisalmer Dist. : 50 exs., Nokh, 26/27.viii.60 (Coll. B. Biswas) ; 30 exs. Geodeasar 24 km. S. of Ramgarh, 17.i.58, (Coll. K. K. Tiwari & S. Biswas). Nagaur Dist. : Many exs., Gurha, 3.ix.60, (Coll. B. Biswas). Sikar Dist. : Many exs., a tank 3 km. E. of Gunjara, 10.xi.60 ; many exs., 2 km. W. of Kanwarpura, 8.xii.60 ; many exs., Puran Chhoti, 9.xi.60, (All Coll. B. Biswas).

Measurements.—Length, 0.78 mm. (young) ; 1.75 mm. (adult).

Distribution.—Rajasthan : Previous record from Nagaur. Present records as mentioned above. Elsewhere : India : Punjab, Uttar Pradesh, Gujarat and Mysore. Also Ceylon and Australia.

Remarks.—Wagler (1926) synonymised the American species *D. similis* Claus with the present species, but Brooks (1956) considered these to be separate species on the character of the dorsal ridge of carapace which expands in *D. similis* in a plane at right angles to the plane of symmetry. The species is widely distributed in Rajasthan.

11. *Daphnia hyalina* Leydig

(Text-figs. 3B-C, 4A & B)

1860. *Daphnia hyalina* Leydig, *Natur. de Daphniden*. Tübingen, pp. 151-153, pl. I, figs. 8-10.

1909. *Daphnia longispina hyalina* forma *typica* Keilhack, *Phyllopoda* in Brauer's ["*Suss. Deut.*"], Jena, 10, p. 28, figs. 53 & 55.

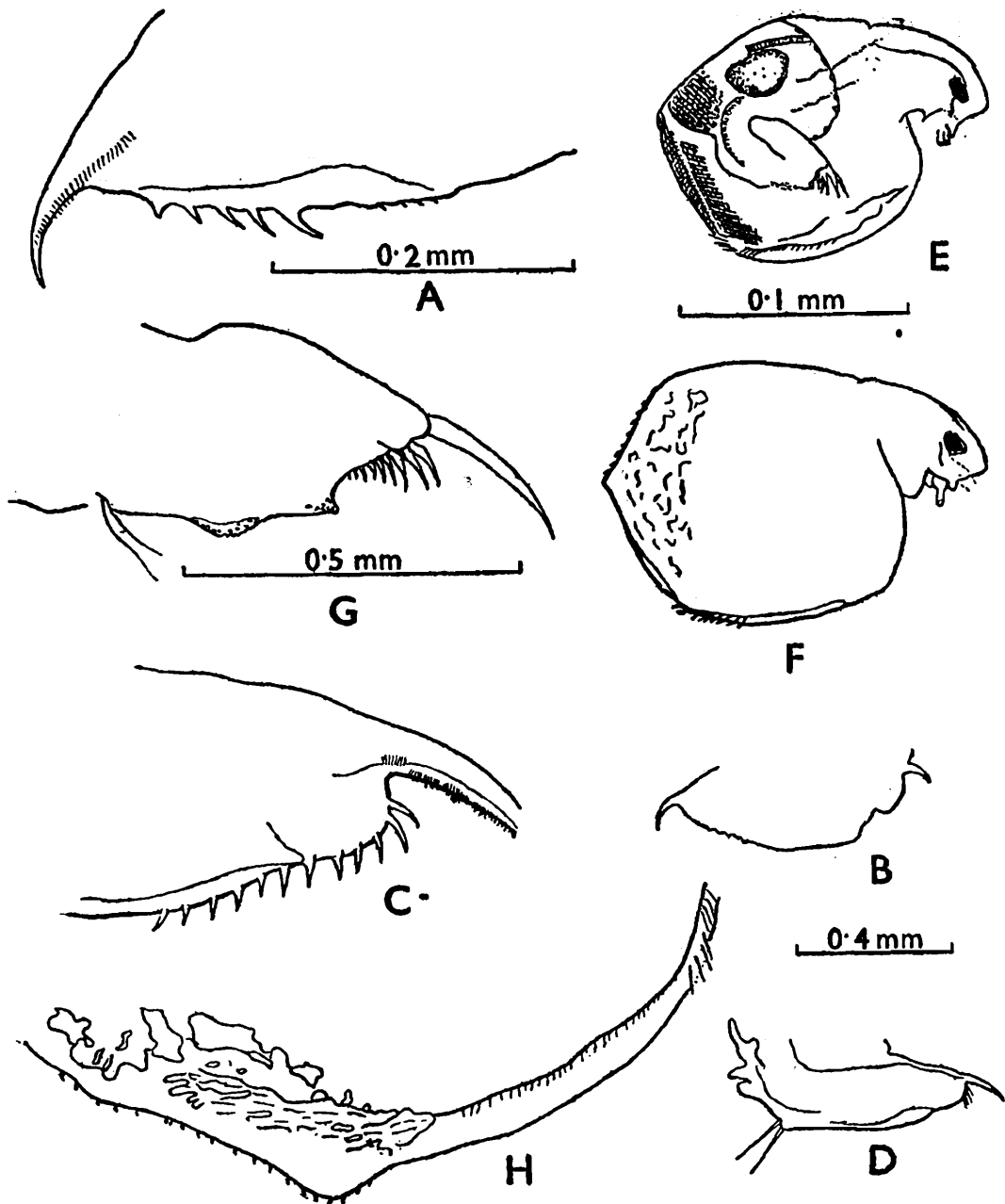
1918. *Daphnia longispina* var. *hyalina* : Birge, In *Freshwater Biol.*, New York, p. 697, figs. 10.70 & 10.71.

Material.—Jaipur Dist. : 2 exs., Balanadi, Dudu, 6.i.59, (Coll. S. Biswas). Jaisalmer Dist. : 1 ex., Geodiasar, Sta. 4, 7.i.58 : Coll. K. K. Tiwari & S. Biswas).

Measurement.—Length 1.75 mm.

Distribution.—Rajasthan : As above (first record from the area and from India). Elsewhere : Pakistan, Asia and N. America.

Remarks.—This is a variable species. Usually three varieties, *hyalina typica locustris* Sars and *galeata* Sars, are recognised. Variety *galeata* is identified by its pointed or angulate head and var. *hyalina* by its rounded head in which the ventral margin is straight or convex. In variety *locustris* the ventral head margin is distinctly concave and shell reticulation prominent. The present species differs from its nearest species, *D. longispina* Müller, in the shape of the rostrum and developed head-crest. *D. longispina* has been recorded by Brehm (1950) and Brehm & Weltereck (1939) from N. E. Himalaya.



TEXT-FIG. 4.—Cladocera from Rajasthan

(A) *Daphnia hyalina* Leydig, ♀, end part of postabdomen. (B) Same, postabdomen. (C) *Daphnia lumholtzi* Sars, ♀, end part of postabdomen. (D) Same, postabdomen. (E) *Simocephalus vetulus* (Müller), ♀, lateral view. (F) *Simocephalus elizabethae* (King), ♀, lateral view. (G) Same, postabdomen. (H) Same, posterior part of body.

Magnifications : (A), (C), to same scale. (B), (D), to same scale. (E), (F), to same scale. (G), (H), to same scale.

12. *Simocephalus australiensis* (Dana)

(Text-figs. 3H & 5A)

1853. *Daphnia australiensis* Dana, Report U.S. Explo. Expd., Crustacea, II, 14, p. 127, pl. 89, figs. 4a-e.
 1822. *Simocephalus australiensis* : Henry, Proc. Linn. Soc. N.S.W., Sydney, 42, p. 31, pl. 5, figs. 1-1c.

Material.—Jodhpur Dist. : 1 ex., Shivsar, Phalodi, 16.xii.57, Jaisalmer Dist. : 2 exs., Geodiasar, Ramgarh, 28.xii.57, (Coll. K. K. Tiwari & S. Biswas).

Measurement.—Length 1.13 mm.

Distribution.—Rajasthan : As above (first record from the area and from India). Elsewhere : Australia and South Africa.

Remarks.—This species is usually confused with *S. vetulus* (O. F. Müller) but can be separated from the latter by its rounded or rhomboidal ocellus, the general shape of the body and the upturned rostrum. The characteristic shell marking of *vetulus* is also lacking here.

13. *Simocephalus elizabethae* (King)

(Text-figs. 3G and 4H, G)

1852. *Daphnia elizabethae* King, Pap. and Proc. R. Soc. Van Diemen Land., Hobart Town, 2 (2), pp. 243-253.
 1888. *Simocephalus elizabethae* : Sars, Forth. Vidensk Selsk., Christiania, No. 7, pp. 22-25, pl. 2, figs. 6-7.
 1935. *Simocephalus elizabethae* : Sowell, Int. Rev. Ges. Hydr. u. Hydr., Leipzig, 31 (3-4), pp. 210, 211.

Material.—Jaipur Dist. : 30 exs., Devdani temple tank, Sambhar town, 13.xi.58. 7 exs., Dhobola Talao, Narayana, 31.x.58. 15 exs., Narayana Talao, Narayana, 2.xi.58. (Coll. S. Biswas.) 1 ex., Sambhar Lake, 17.vii.58, (Coll. A. K. Mukherjee).

Measurement.—Length 1.90 mm.

Distribution.—Rajasthan : As above (first record from the area). Elsewhere : India : W. Bengal, Madhya Pradesh (Chota Nagpur). Also Ceylon, Thailand, Sumatra, Java and Australia.

Remarks.—The species differs from *S. vetulus* (O. F. Müller) in the shape of its posterior border of the carapace only and for this reason it has been synonymised with it by some authors.

The present specimens are larger than *vetulus* and there is no ovigerous female specimen of the shape of *elizabethae* bearing an ephippium.

14. *Simocephalus vetulus* (O. F. Müller)

(Text-figs. 4C and 6A)

1776. *Daphne vetula* O.F. Müller, *Zool. Daniae Prodrromus seu Animalium Norvegiae, etc.*, Havniae, p. 199, No. 2399.
1850. *Daphnia vetula* : Baird, *Natural Hist. Brit. Entom., Ray. Soc.*, London, pp. 95, 96, pl. 10, fig. 1.
1853. *Daphnia sima* O. F. Müller, Lilljeborg, *Cladocera, Ostracoda et Copepoda in Scania occur.*, Lund, pp. 42-44, pl. III, figs. 2-4-(Synonymised by Baird, 1850).

Material.—*Jaipur Dist.* : 12 exs., Asalpura Bund, Phulera, 5.xii.58. 20 exs., Balanadi, Dudu, 6.i.59. 1 ex., Julga Lake, 21 km. S. W. of Gudha, 24.xi.58. 4 exs., Dudu Talao, Dudu, 8.i.59. 50 exs., Dho-bola Talao, Narayana, 31.x.58, 5 exs., Kalo Talao, Narayana, 1.xi.58. 1 ex., Narayana Talao, Narayana, 3.xi.58 (Coll. S. Biswas). 20 exs. Sambhar Lake (Main), 17.vii.58 (Coll. A. K. Mukherjee). *Jaisalmer Dist.* : 1 ex., Geodiasar, Jaisalmer, 28.xii.57. (Coll. K. K. Tiwari & S. Biswas).

Measurement.—Length 1.30 mm.

Distribution.—*Rajasthan* : As above (first record from the area). *Elsewhere* : India : Northern U.P., Kashmir and Punjab. Also Europe (England, Switzerland, Turkey, Russia) and N. and S. America.

Remarks.—It is one of the commonest species of Rajasthan and is usually found in weedy pools. Important characters for its identification are : Frons rounded, ocellus elongate carapace markings as oblique-parallel lines and usually without carapace-spine.

15. *Simocephalus latirostris* Stingelin

(Text-figs. 6B-D)

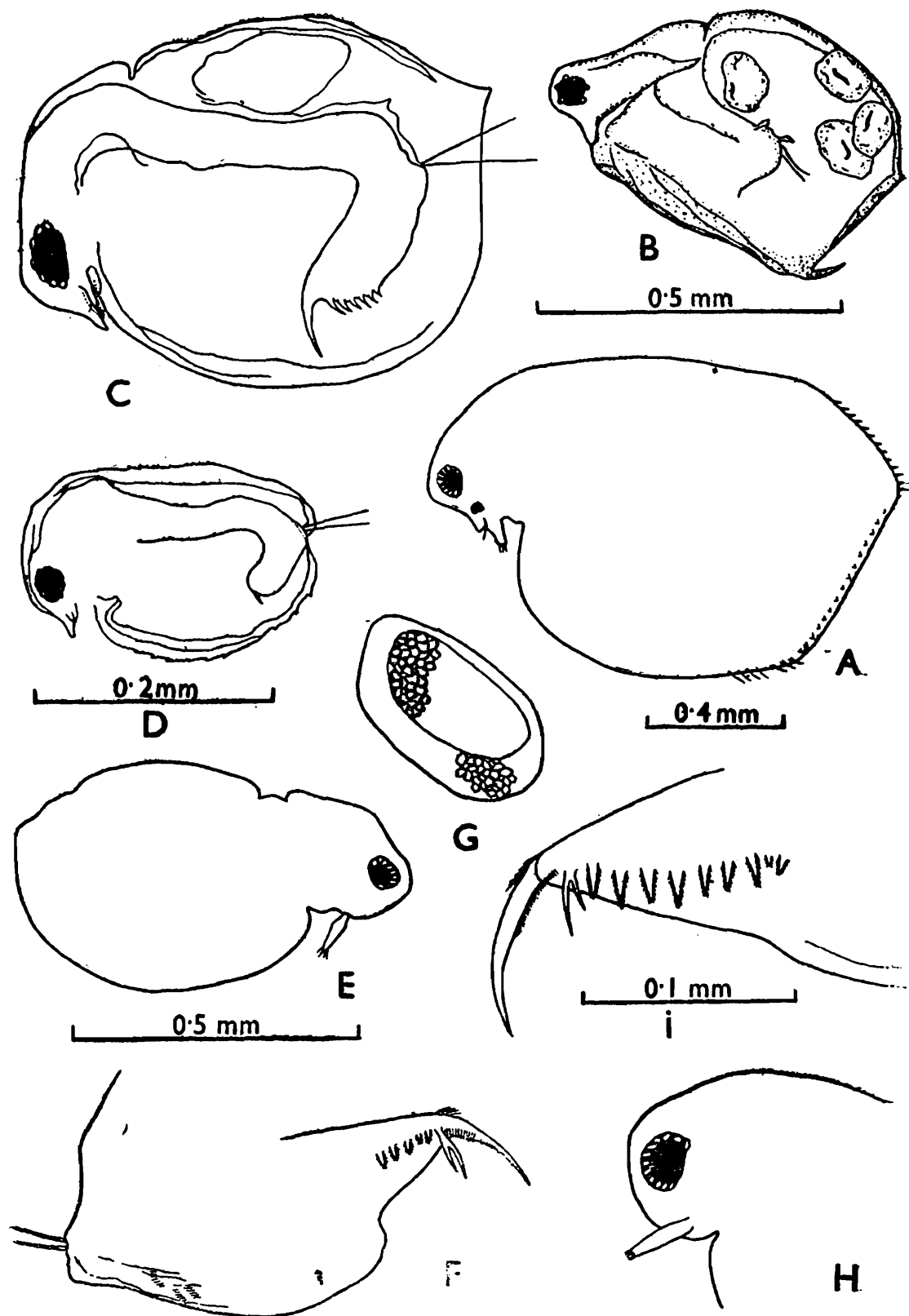
1906. *Simocephalus latirostris* Stingelin, *Ann. Biol. Lacustre*, Brussels, 14, pp. 187-189, figs. 5-7.

Material.—*Jaipur Dist.* : 1 ex., Julga Lake, 21 km. S.W. of Gudha, 24.xi.58 (Coll. S. Biswas).

Measurement.—Length 2 mm.

Distribution.—*Rajasthan* : As above (first record from the area and from India). *Elsewhere* : Paraguay (S. America).

Remarks.—The species is allied to *S. serrulatus* (Koch), but differs in its larger size, peculiar long rostrum, polygonal markings on shell, dorsal bulge of head, and the character of the postabdomen.



TEXT-FIG. 5.—Cladocera from Rajasthan

(A) *Simocephalus australiensis* (Dana), ♀, lateral view. (B) *Scapholeberis kingi* Sars, ♀, lateral view. (C) *Ceriodaphnia rigaudi* Richard, ♀, lateral view. (D) Same, juveniles. (E) *Moina dubia* Guerne & Richard, ♀, lateral view. (F) Same, postabdomen. (G) Same, ephippium. (H) *Moina macrocopa* (Straus), ♀, lateral view. (I) Same, postabdomen.

Magnifications : (C), (D), to same scale. (E), (G), (H), to same scale. (F), (I), to same scale.

16. *Scapholeberis kingi* Sars

(Text-fig. 5b)

1903. *Scapholeberis kingi* Sars, *Archiv. Math. Natur.*, Christiania, **25**, pp. 8-10, pl. 1, figs. 2a-c.

1916. *Scapholeberis kingi* : Sars, *Ann. S. Afr. Mus.*, Capetown, **15**, pp. 314, 315, pl. 32, fig. 3b.

Material.—Jaipur Dist. : 5 exs., Asalpura Burd, Phulera, 5.xii.58, (Coll. S. Biswas).

Measurement.—Length 1.01 mm.

Distribution.—Rajasthan : As above (first record from the area). Elsewhere : India : W Bengal. Also Thailand, Sumatra, Australia, Africa and N. America.

Remarks.—According to Gurney (1906), excepting for its small size the species is inseparable from *S. mucronata* (O. F. Müller). The other nearest species, *S. aurita* (Fischer), can be separated by its whitish or greenish colour which is never dark or black as in the present species.

17. *Ceriodaphnia rigaudi* Richard

(Text-figs. 5C & D)

1894. *Ceriodaphnia rigaudi* Richard, *Bull. Soc. Zool. France*, Paris, **7**, pp. 239-241.

1916. *Ceriodaphnia rigaudi* : Sars, *Ann. S. Afr. Mus.*, Cape Town, **15**, p. 319, pl. 34, figs. 3, 3a, b.

1935. *Ceriodaphnia rigaudi* : Sewell, *Int. Rev. ges. Hydr. u. Hydr.*, Leipzig, **31**, (3 & 4), pp. 211-212.

Material.—Ajmer Dist. : 5 exs., Anasagar Lake, Ajmer, 20.xi.61, (Coll. Tej Singh). Jaipur Dist. : 2 exs., water-pools, 3 km. W of Phulera, 4.xii.58, 15 exs., Dudu Talao, Dudu, near Rest House, 8.i.58. Julga Lake 21 km. S. W. of Gudha, 24.xi.58. Nagaur Dist. : 10 exs., a ditch adjacent to Sambhar Lake, Gudha, 17.xi.58. 4 exs. Julga Lake 22-50 Km. S. W. of Gudha, 24. xi. 58. 5 exs., Bala Talao, ca. 5 km. S. E. of Julga Lake, 24.xi.58. 2 exs., Narayana Talao, Narayana, 2.xi.58. 4 exs., Kalo Talao, Narayana, 6.xi.58, (Coll. S. Biswas). ca. 50 exs., Narinsar, 6 km. on Phulera Road, 6.x.63, (Coll. K. K. Mahajan). Barmer Dist. : 5 exs., Bhap tank, ca. 11 km. from Barmer town, 25.i.58, (Coll. K. K. Tiwari & S. Biswas).

Measurement.—Length 0.35 mm.

Distribution.—Rajasthan : As above (first record from the area). Elsewhere : India : W Bengal, Bihar, Andhra, Mysore, Madhya Pradesh and Gujarat. Also S. E. Asia, Japan, Palestine, Egypt, S. Africa and N. and S. America.

Remarks.—This species is widely distributed in Rajasthan as well in India as a whole. It is distinctive due to a short spine or horn on its head in front of the antennules.

18. *Ceriodaphnia reticulata* (Jurine) var. *kurzii* Stingelin

(Text-fig. 6F)

1895. *Ceriodaphnia kurzii* Stingelin, *Rev. suisse Zool.*, Geneva, 3, pp. 214-215, pl. 6, fig. 15 ; & pl. 6, fig. 18.
1908. *Ceriodaphnia reticulata* (Jurine) var. *kurzii*, Stingelin, *Cat. Phyllopods Mus. d'Hist. Nat. Geneve*, Geneva, pp. 50, 51. (*kurzii* considered as variety of *reticulata*).

Material.—*Jaipur Dist.* : Many exs., Devdyani temple tank near Sambhar town, 13.xi.58. *Nagaur Dist.* : 1 ex., Sambhar Lake, Sta. 6, Gudha, 10.xi.58, (Coll. S. Biswas).

Measurement.—Length 0.38 mm.

Distribution.—*Rajasthan* : As above (first record from the area and from India). *Elsewhere* : Europe and England.

Remarks.—This variety differs from the typical form, *C. reticulata* (Jurine), in having a plain shell without marking and the fornix more or less plain, not prominently rounded.

19. *Ceriodaphnia reticulata* (Jurine) var. *serrata* Sars

(Text-fig. 9E-G)

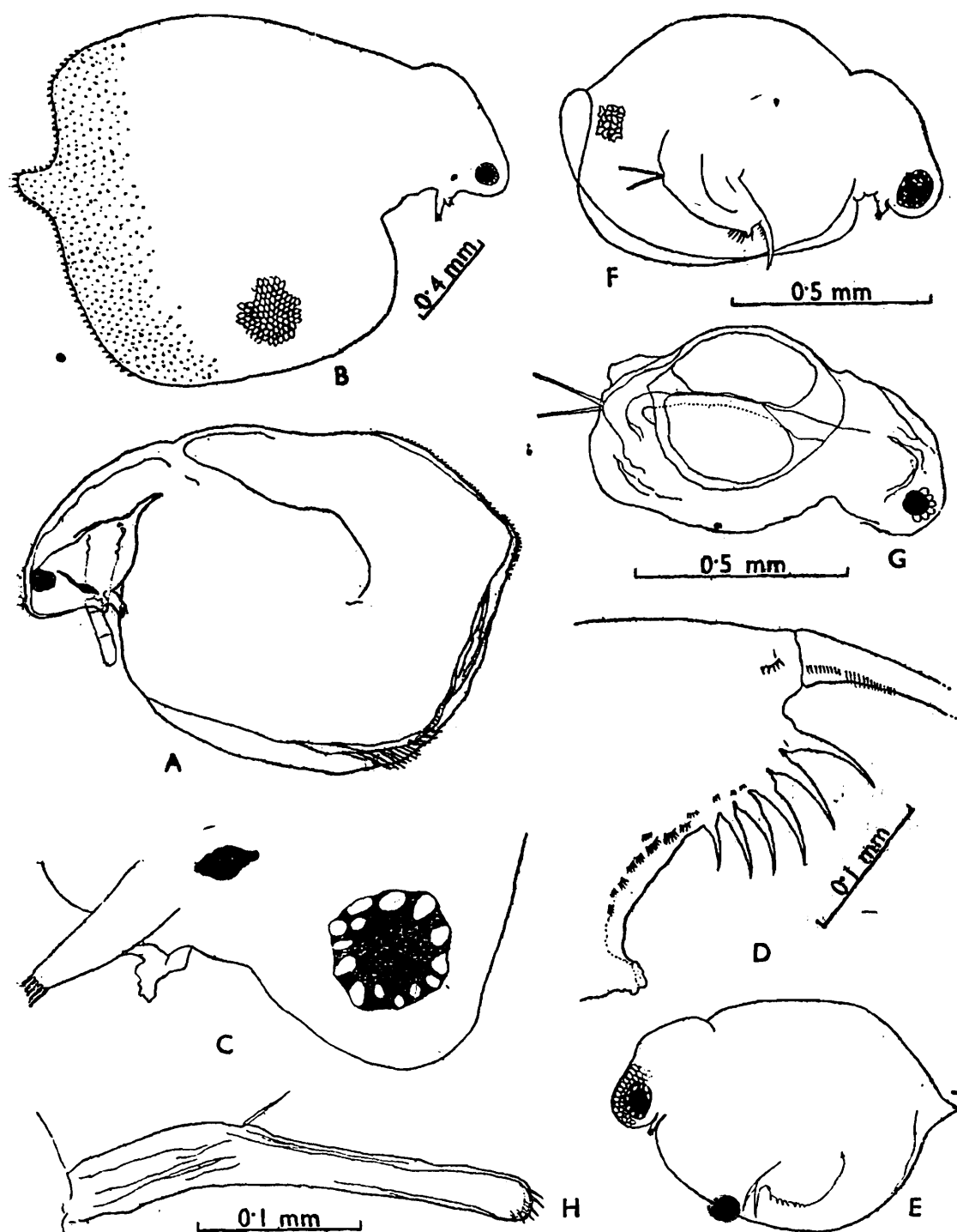
1890. *Ceriodaphnia reticulata* var. *serrata* Sars, *Forh. vid. Selsk.*, Christiania, No. 1, p. 37.
1962. *Ceriodaphnia reticulata* var. *serrata* : Srámek-Haüsek, *Fauna C.S.S.R.*, Prague, 16, pp. 232-233, figs. 82 A-F.

Material.—*Nagaur Dist.* : 1 ex., cemented tank in Gudha *kyār*, Gudha, 15.x.58, (Coll. S. Biswas). *Jaipur Dist.* : Many exs., Narinsar, ca. 6 km. on Phulera Road, 6.x.63, (Coll. K. K. Mahajan).

Measurement.—Length 0.40 mm.

Distribution.—*Rajasthan* : As above (first record from the area and from India). *Elsewhere* : Europe.

Remarks.—This variety differs from the typical form as well as var. *kurzii* in having extended fornices ; the body is prominently reticulate.



TEXT-FIG. 6.—Cladocera from Rajasthan

(A) *Simocephalus vetulus* (O. F. Müller), ♀, lateral view. (B) *Simocephalus latirostris* Stingelin, ♀, lateral view. (C) Same, anterior part. (D) Same, posterior part of postabdomen, magnified. (E) *Ceriodaphnia laticaudata* P. E. Müller, ♀, lateral view. (F) *Ceriodaphnia reticulata* var. *kurzii* Stingelin, ♀, lateral view. (G) *Moina dubia* Guerne & Richard, ♀, lateral view. (H) Same, ♂, antennule.

Magnifications : (A), (G), to same scale. (C), (D), to same scale. (E), (F), to same scale.

20. *Ceriodaphnia laticaudata* P. E. Müller

(Text-fig. 6C)

1867. *Ceriodaphnia laticaudata* P.E. Müller, *Nat. Tidskr.*, (3) 5, p. 130, pl. 1, fig. 19.
 1959. *Ceriodaphnia laticaudata* : Brooks, *Freshwater Biology*, New York, p. 620, fig. 27.92.
 1962. *Ceriodaphnia laticaudata* : Husek, *Fauna C.S.S.R.*, Prague, 16, pp. 241-242, figs. 87 A-K.

Material.—Jaipur Dist.: 1 ex., canal water of Dhobola Talao, Narayana, 9.x.59, (Coll. S. Biswas).

Measurement.—Length 0.91 mm.

Distribution.—Rajasthan : As above (first record from the area).
Elsewhere : India : Poona (Maharashtra) and Simla Hills. Also Turkestan, Europe, Africa, Madagascar and Australia.

Remarks.—The present specimen has seven anal spines on the post-abdomen ; the shape of the postabdomen is characteristic of the species.

21. *Moina dubia* Guerne & Richard

(Text-figs. 5E—G and 6G, H)

1892. *Moina dubia* Guerne & Richard, *Mem. Soc. Zool. France*, Paris, 5, pp. 527-530, figs. 1 and 2.

1935. *Moina dubia* : Sewell, *Int. Rev. ges. Hydrob. u. Hydrogr.*, Leipzig—(1) 3, pp. 213-216, figs. 1 and 2.

1953. *Moina dubia* : Brehm, *Osterr. Zool. Z.*, Vienna, (4) 3, pp. 334-336.

Material.—Jaipur Dist. : 4 exs., Bala Talao, ca. 5 km. S. E. of Julga Lake, 24.ii.58. 20 exs., Julga Lake, 21 km. S. W. of Gudha, 24.ii.58. 2 exs., water-pools, 3 km. W. of Phulera, 4.xii.58. Nagaur Dist. : 10 exs., cemented tank in Gudha kyār, Gudha, 4.x.58. 5 exs., rain-water pools by side of railway bund, Gudha, 19.ix.58, (Coll. S. Biswas).

Measurement.—Length 0.65 mm.

Distribution.—Rajasthan : As above (first record from the area).
Elsewhere : India : W. Bengal, Bihar and S. India. Also Java, Australia, Africa (Sahara, Uganda, Congo, Transvaal and Kenya) and Europe.

Remarks.—Sewell (1935) did not distinguish the present species from *M. rectirostris* (Leydig). According to Brehm (1953), the characters, viz., the proximal part of ventral margin of valves with strong spines, the distal part with groups of spinules, the proportion 1 : 2 of the reduced distal part to the broad proximal part of the postabdomen, absence of accessory ridge on end-claw and the head depression at an angle of 70°, are important enough for the separation of this species. In the opinion of Hausek (1962) it is synonymous with *M. micrura* Kurz.

22. *Moina brachiata* (Jurine)

(Text-figs. 8D, E)

1820. *Monocles brachiatus* Jurine, *Historie Monocles Genève, Geneva & Paris*, p. 131, pl. 12, figs. 1, 2.

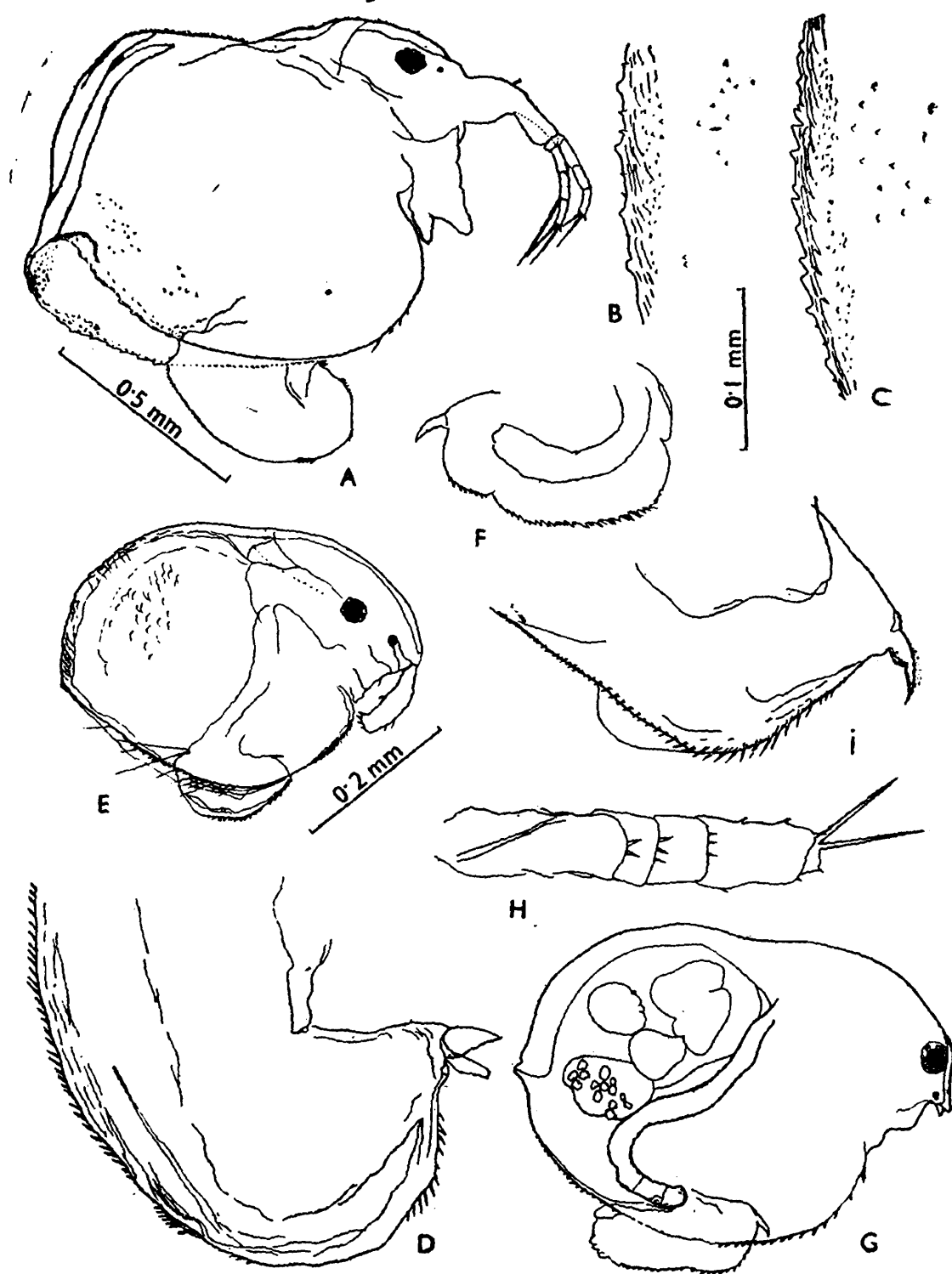
1850. *Moina brachiata* : Baird *Natural History Brit. Entom.*, Ray Soc., London, 102, pl. IX, figs. 1, 2.

Material.—Jaipur Dist. : 15 exs., water-pools, ca. 3 km. W. of Phulera, 4.xii.58, Nagaur Dist. : 6 exs., Gudha Talao, 1.60 km. N. W. of Gudha village, 22.x.58, (Coll. S. Biswas).

Measurement.—Length 0.78 mm.

Distribution.—*Rajasthan* : As above (first record for the area, and from India). *Elsewhere* : W Pakistan, Europe, Africa and N. America.

Remarks.—The present species is difficult to identify without the ephippium-bearing females or males in the collection. But the character of anal spine being without ciliation can be taken into consideration in distinguishing parthenogenetic females from other allied species, i.e., *M. rectirostris* (Leydig) or *M. dubia* Guerne & Richard.



TEXT-FIG. 7.—Cladocera from Rajasthan

(A) *Macrothrix triserialis* Brady, ♀, lateral view. (B) and (C), Same, upper and lower ventro-posterior margin of valves respectively. (D) Same, postabdomen. (E) *Macrothrix spinosa* King, ♀, lateral view. (F) Same, postabdomen. (G) *Gurnevella odiosa* (Gurney), ♀, lateral view. (H) Same, antennule. (I) Same, postabdomen.

Magnifications : (A), (G), to same scale. (B), (C), (D), (F), (H), (I), to same scale.

23. *Moina rectirostris* (Leydig)

(Text-figs. 9A-D)

1860. *Daphnia rectirostris* Leydig, *Naturg. Daphiden*, Tübingen, p. 174, pl. 10, figs. 76, 77.
1959. *Moina rectirostris* (Leydig) Brooks, *Freshwater Biology*, New York, p. 623, figs. 27, 50a.
1962. *Moina rectirostris* : Sra'mek-Hausek, *Fauna C.S.S.R.*, Prague, 16, pp. 247-248, figs. 89 A-D.

Material.—*Ganganagar Dist.* : Many exs., 18 km. N.W. of Nohar 16.x.60, (Coll. B. Biswas). *Nagaur Dist.* : Many exs., Gudha, Sambhar Lake, 21.xi.58. Many exs., Nawa on Sambhar Lake, 16 & 25.ix.58, (Coll. S. Biswas).

Measurement.—Length 0.38 mm.

Distribution.—*Rajasthan* : As above (first record from the area). *Elsewhere* : India : Kashmir. Also widespread in palaearctic, nearctic and ethiopian regions.

Remarks.—The present species is close to *M. dubia* Guerne & Richard, and *M. micrura* Kurz, but can be separated by having 9-15 anal spines, a reticulated ephippium and the male antennule having 5 end-spines.

24. *Moina banffy* Daday

(Text-figs. 10A-E)

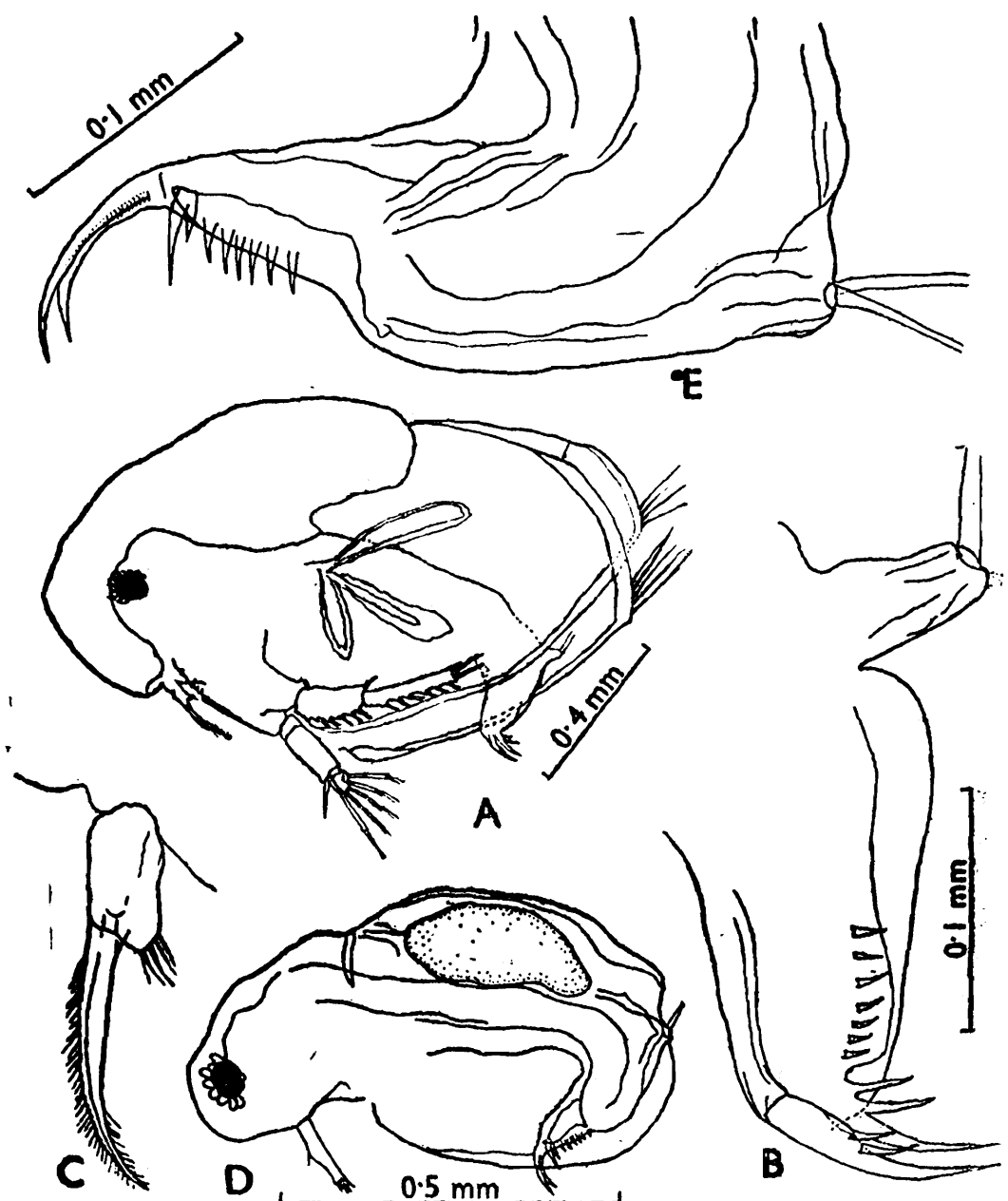
1888. *Moina banffy* Daday, *Term. tud. Tars.*, Budapest, pp. 1-128.
1903. *Moina banffy* : Scourfield, *J. Quckett micr. clube*, London, 8 (2), No. 52, pp. 437-438, pl. 24, figs. 5-8.

Material.—*Jaipur Dist.* : 15 exs., water-pools, 3 km. W of Phulera, 11.xii.58. *Nagaur Dist.* : 10 exs., adjacent to Sambhar Lake, Gudha, 17.x.58, (Coll. S. Biswas). Many exs., New kyar, Sambhar Lake, 22.xi.58, (Coll. B. Biswas).

Measurement.—Length 0.94—1.10 mm.

Distribution.—*Rajasthan* : As above (first record from the area and from India). *Elsewhere* : Europe (Hungary and England).

Remarks.—Important characters of this species are : Head without depression and more or less hairy ; shell-marking as in *Simocephalus* ; antennule covered with scale-like markings and hairy. It is close to *M. belli* Gurney, but is separable by the posterior part of the shell being drawn out into a spine.



TEXT-FIG. 8.—Cladocera from Rajasthan

(A) *Latonopsis australis* Sars, ♀, lateral view. (B) Same, postabdomen. (C) Same ♂, antennule. (D) *Moina brachiata* (Jurine), ♀, lateral view. (E) Same, postabdomen.

Magnifications : (B), (C), to same scale.

25. *Moina macrocopa* (Straus)

(Text-figs. 5H, I)

1820. *Daphnia macrocopus* Straus, *Mem. Mus. Hist. nat.*, Paris, 5, p. 161.

1916. *Moina macrocopa* (Straus) Sars, *Ann. S. Afr. Mus.*, Cape Town, 15, p. 320, pl. 35, figs. 1, 10.

Material.—Ganganagar Dist. : 1 ex., Diplana, E. of Nohar 13.x.60, (Coll. B. Biswas).

Measurement.—Length 0.97 mm.

Distribution.—Rajasthan : As above (first record from the area and from India). Elsewhere : Central Asia, Japan, Africa, Europe and N. America.

Remarks.—Due to the absence of ephippium-bearing males and females in the collection, the identification of the specimen is a little uncertain. However, the absence of supraocular depression and the pectination on the end-claw suggest assignment as above.

Family (3) MACROTHRICIDAE

26. *Streblocerus serricaudatus* (Fischer)

(Text-figs. 13A, B)

1849. *Daphnia serricaudatus* Fischer, *Bull. Soc. imp. Nat. Moscow*, 22 (38), p. 46, pl. 4, figs. 2-8.

1959. *Streblocerus serricaudatus* (Fischer) Brooks, *Freshwater biology*, New York, p. 627, figs. 27, 58, 27.59.

Material.—Jaipur Dist. : 1 ex., Asalpura Bund, Phūlera, 5.xii.58, (Coll. S. Biswas).

Measurement.—Length 0.91 mm.

Distribution.—Rajasthan : As above (first record from the area and from India). Elsewhere : Europe and N. America.

Remarks.—Unfortunately at the time of preparing the specimen for examination, the antennule and the postabdomen were lost. The specimen agrees with the description of *S. serricaudatus*.

27. *Macrothrix spinosa* King

(Text-figs. 7E, F)

1852. *Macrothrix spinosa* King, *Pap. Proc. Roy. Soc. Van Diemen Land*, Hove Town, 2 (2), pp. 25-26, pl. 6E.

1888. *Macrothrix spinosa* : Sars, *Forh. vid. Selsk.*, Christiania, No. 7, pp. 25-32, pl. 3, figs. 1-6.

1933. *Macrothrix spinosa* : Brehm, *Arch. Hydrobiol.*, Stuttgart, 11, pp. 695-698.

Material.—Jaipur Dist. : 2 exs., Asalpura Bund, Phulera, 5.xii.58 ; (Coll. S. Biswas) Jaisalmer Dist. : 4 exs., Gadisar, Jaisalmer, 28.xi.57 ; 1 ex., Biprasar, Ramghar, 4.i.58 ; 2 exs., Geodeasar, Ramghar, Sta. 4, 4 & 7.i.58, (Coll. K. K. Tiwari & S. Biswas). Nagaur Dist. : 2 exs. rainwater pools near Nawa *kyār*, 28.ix.58. 4 exs., water-pools adjacent to Sambhar Lake, Gudha, 17.ix.58, (Coll. S. Biswas).

Measurement.—Length 0.45 mm.

Distribution.—Rajasthan : As above (first record from the area and from India). Elsewhere : Malaysia (Singapore), Thailand, Sumatra, Java, Australia, Africa and S. America.

Remarks.—The species is close to *M. hirsuticornis* Norman & Brady and *M. laticornis* (Jurine), but is easily distinguished from the former by its squamose marking on the shell and from the latter in its bilobed postabdomen.

28. *Macrothrix triserialis* Brady

(Text-figs. 7A-D)

1886. *Macrothrix triserialis* Brady, *J. Linn. Soc. Lond. (Zool.)*, London, 19, p. 295, pl. 47, figs. 16-20.

1907. *Macrothrix triserialis*: Gurney, *Rec. Indian Mus.*, Calcutta, 1, p. 25, pl. 2, figs. 21, 21a.

Material.—Jaisalmer Dist. : 1 ex., Sta. 4, Biprasar, Ramgarh, 4.i.58, (Coll. K. K. Tiwari & S. Biswas).

Measurement.—Length 1.19 mm.

Distribution.—Rajasthan : As above (first record from the area) : Elsewhere : India : Madhya Pradesh and Ceylon.

Remarks.—The species is separated from the *M. chevreuxi* Guerne & Richard by the shape of its body and the shape and arrangement of teeth on the postero-ventral margin of carapace and its lip-plate.

29. *Macrothrix chevreuxi* Guerne & Richard

1892. *Macrothrix chevreuxi* Guerne & Richard, *Mem. Soc. Zool. France*, Paris, 5, pp. 530-33, figs. 3-6.

1910. *Macrothrix chevreuxi*: Daday, *Zoologica*, Stuttgart, 23 (5-9), p. 139, pl. 7, fig. 27.

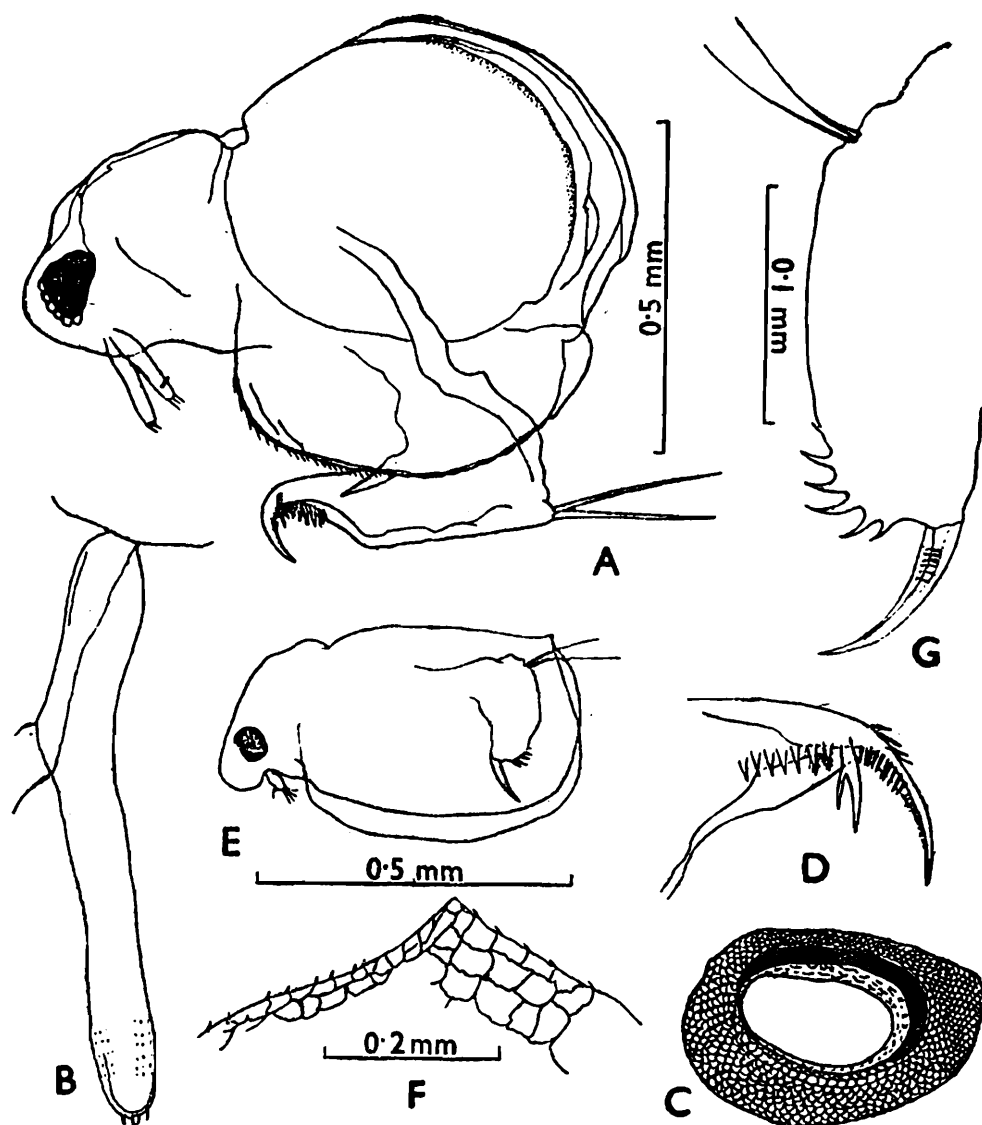
1934. *Macrothrix chevreuxi*: Jenkin, *Ann. Mag. nat. Hist.*, London, (10) 13, pp. 281-283, figs. 13, 13a.

Material.—Nagaur Dist. : 3 exs., rainwater pools near Nawa kyār, 28.ix.58. 1 ex., Kuchaman Road, 5.ix.58. 5 exs., adjacent to Sam-bhar lake, Gudha, 17.x.58, (Coll. S. Biswas).

Measurement.—Length 1.01 mm.

Distribution.—Rajasthan : As above (first record from the area and from India). Elsewhere : Africa and S. America.

Remarks.—The present species has often been treated as a variety of *M. triserialis* Brady, but can be separated from the latter by the transverse line of sculpturing joining irregularly on the carapace, greater length of the antennules which are almost of equal width throughout, and by the less heavy armature of the postabdomen. The shape of lip-plate is also important in differentiating this species.



TEXT-FIG. 9.—Cladocera from Rajasthan

(A) *Moina rectirostris* (Leydig), ♀, lateral view. (B) Same, ♂, antennule. (C) Same, ♀, ehippium. (D) Same, ♀, postabdomen. (E) *Ceriodaphnia reticulata* var. *serrata* Sars, ♀, lateral view. (F) Same, posterior part, enlarged. (G) Same, postabdomen.

Magnifications : (A), (C), to same scale. (B), (D), (G) to same scale.

30. *Gurneyella odiosa* (Gurney)

(Text-figs. 7 G-I)

1907. *Macrothrix tenuicornis* Gurney, *Rec. Indian Mus.*, Calcutta, 1 (2) p. 25, pl. I, figs. 1, 2 ; and pl. I2, fig. 22 (specific name preoccupied).

1907. *Macrothrix odiosa* : Gurney, *Rec. Indian Mus.*, Calcutta, 1 (2), p. 175.

Material.—*Jaisalmer Dist.* : 8 exs., Biprasar tank, Ramgarh, Sta. 4, 4.i.58. 15 exs., Gadisar, Jaisalmer, ca. 19 km. from Ramgarh, 7.i.58, (Coll. K. K. Tiwari & S. Biswas). *Nagaur Dist.* : 1 ex., rainwater pools near Nawa *kyār*, 13.ix.58, (Coll. S. Biswas).

Measurement.—Length 1 mm.

Distribution.—*Rajasthan* : As above (first record from the area), *Elsewhere* : India : Madhya Pradesh.

Remarks.—Brehm (1930, 1933) assigned to the present genus those species of the *Macrothrix* in which the anus is guarded by a pair of peculiar flaps. The same character was also noticed by Gurney in this species.

31. *Ilyocryptus halyi* Brady

(Text-figs. 12 B-D)

1886. *Ilyocryptus halyi* Brady, *J. Linn. Soc. Lond. (Zool.)*, London, 19, pp. 294, 295, pl. 37, figs. 6-9.

1888. *Ilyocryptus longiremis* Sars, *Forh. vid. Selsk.*, Christiania, No. 7, pp. 32-41, pl. 4 (synonymised by Brady, 1898) *Termes. Füz.*, 21, pp. 48-50).

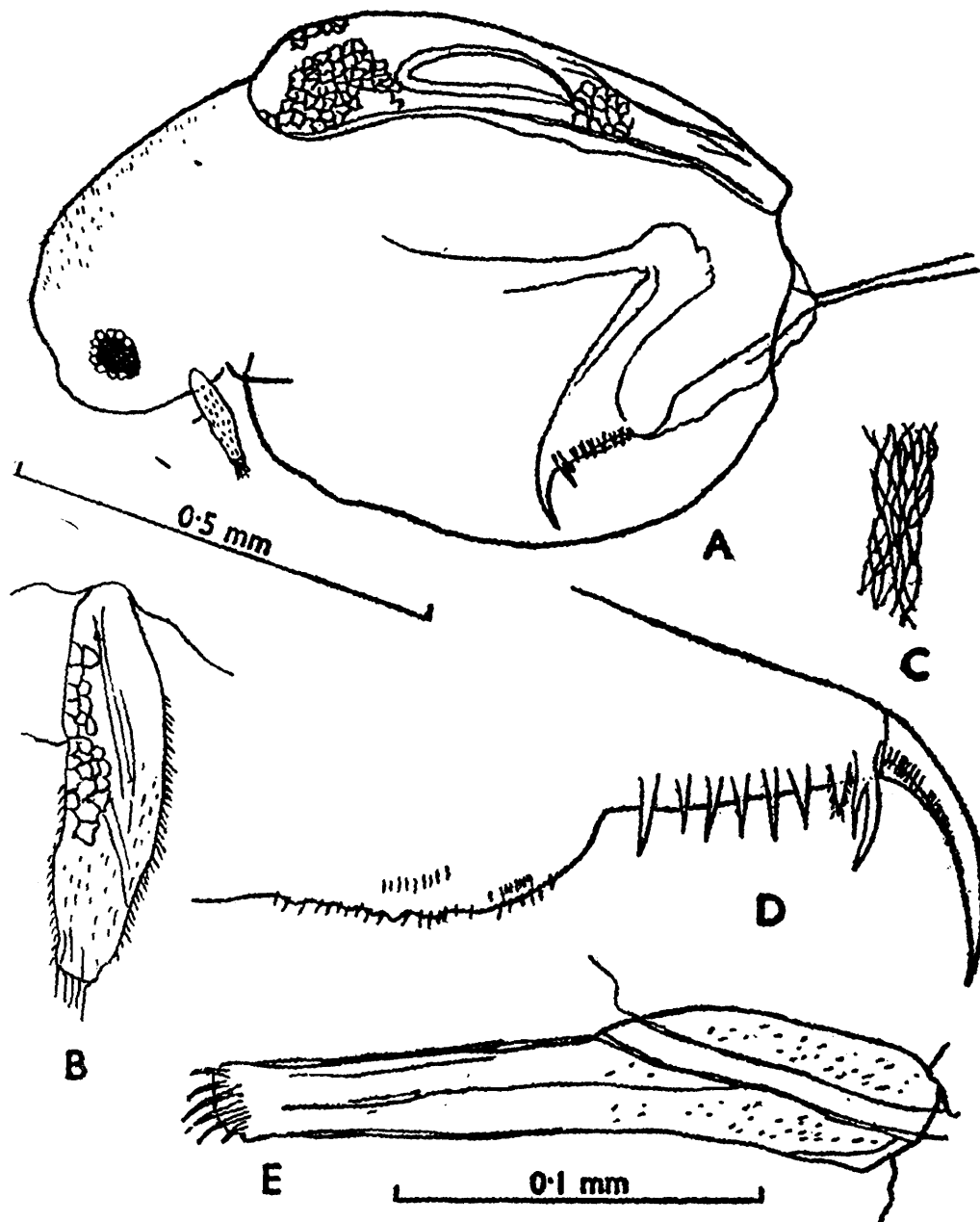
1898. *Ilyocryptus halyi* : Daday, *Termes Fuzetek.*, Budapest, Suppl. to vol. 21, pp. 48-50, figs. 23 a-d.

Material.—*Jaipur Dist.* : 1 ex., canal water of Dhobola Talao, Narayana, 20.x.58. 1 ex., Devdyani temple tank, Sambhar town 13.xi.58. 2 ex., Julga Lake, 21 km. W. of Gudha, 24.xi.58, (Coll. S. Biswas).

Measurement.—Length 0.65 mm.

Distribution.—*Rajasthan* : As above (first record from the area). *Elsewhere* : India : W Bengal. Also Australia, Malaysia (Singapore), Indonesia (Sumatra, Java, Celebes), Africa and N. and S. America.

Remarks.—*I. halyi* differs from its nearest ally, *I. sordidus* (Lievén), by its less massive and longer antennae, lesser number of preanal spines (9-10) and angulate front; and from *I. spinnifer* Herrick in having more preanal spines and shorter antennae. Sometimes *spinnifer* is considered synonymous with the present species.



TEXT-FIG. 10.—Cladocera from Rajasthan

(A) *Moina banffy* Daday, ♀, lateral view. (B) Same, antennule. (C) Same marking on shell. (D) Same, postabdomen. (E) Same, ♂, antennule.

Magnifications : (b)-(e), to same scale.

Family (4) CHYDORIDAE

32. *Leydigia laevis* Gurney

(Text-fig. 12 L)

1927. *Leydigia laevis* Gurney, *Proc. zool. Soc., Lond.*, London, 1, pp. 73-75, text+figs. 9 A-C.

Material.—*Nagaur Dist.* : 1 ex., water pools adjacent to Sambhar Lake, Gudha, 17.i.58, (Coll. S. Biswas).

Measurement.—Length 0.92 mm.

Distribution.—*Rajasthan* : As above (first record from the area and from India). *Elsewhere* : Australia.

Remarks.—Specimens of this species have no striation on the shell, no basal spine on the end claw and a triangular ocellus which is scarcely larger than the eye.

33. *Leydigia acanthocercoides* (Fischer)

(Text-fig. 12 F)

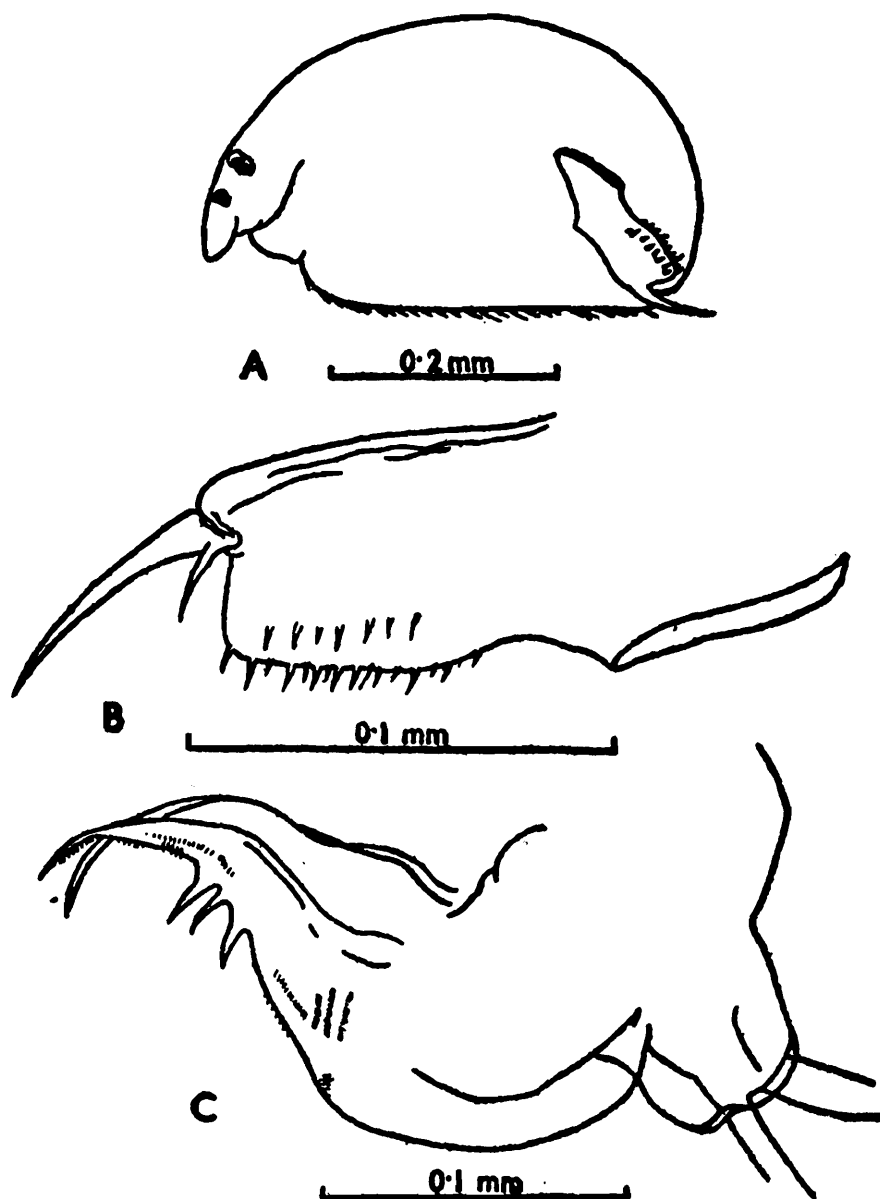
1884. *Lynceus acanthocercoides* Fischer, *Bull. Soc. nat. Moscou*, Moscow, 27, p. 431, pl. 3, figs. 21-23.
1905. *Leydigia acanthocercoides* : Daday, *Zoologica*, Stuttgart, 18, p. 185, pl. 11 fig. 19.
1959. *Leydigia acanthocercoides* : Brooks, *Freshwater Biology*, New York, p. 640, figs. 27, 56.

Material.—*Jaipur Dist.* : 2 exs., Dudu Talao, Dudu, 8.i.58. 2 exs., Julga Lake, ca. 21 km. S.W. of Gudha, (Coll. S. Biswas). *Ganganagar Dist.* : 3 exs., Suratgarh, 9.x.60, (Coll. B. Biswas). *Nagaur Dist.* : 18 exs., a ditch adjacent to Sambhar Lake, Gudha, 6 & 17.xi.58, (Coll. S. Biswas).

Measurement.—Length 0.49 mm.

Distribution.—*Rajasthan* : As above (first record from the area) *Elsewhere* : India : W. Bengal. Also S. E. Asia and N. America.

Remarks.—Three characters, viz., the longitudinally striated valves, the keel of labrum with long cilia and the claw without basal spine, are important for recognizing this species.



TEXT-FIG. 11.—Cladocera from Rajasthan

(A) *Alona giabra* Sars, ♀, lateral view. (B) Same, postabdomen. (C) *Diaphanosoma excisum* var. *stingelini* Jenkin, ♀, postabdomen.

34. *Alona rectangula* Sars

(Text-figs. 13 C, D, H & 14 E, F)

1862. *Alona rectangula* Sars, Forh. *vid. Selsk.*, Christiania, p. 160.

1959. *Alona rectangula*: Brooks, *Freshwater Biology*, New York, p. 643, figs. 27, 59 e, f.

1962. *Alona rectangula*: Hausek, *Fauna C.S.S.R.*, Prague, 16, pp. 345-347, figs. 128 A.K.

Material.—Jaipur Dist.: 1 ex., Asalpura Bund, 5.xii.58., 1 ex., Julga Lake, ca. 21 km. S. W. of Gudha, 8.i.58, (Coll. S. Biswas).

Measurement.—Length 0.39 mm.

Distribution.—*Rajasthan* : As above (first record from the area). *Elsewhere* : India : W. Bengal, Kashmir (Ladakh). Also Europe and N. America.

Remarks.—Four varieties have been recognised by different authors due to the variations of shell-sculpturing and differences in the post-abdomen. But two main characters, viz., the lateral fascicles long, extending beyond dorsal margin of postabdomen and not being broad toward its apex, distinguish the present species.

35. *Alona bukobensis* Welthner

(Text-figs. 13E-G)

1897. *Alona bukobensis* Welthner, *Die Cladocera Ost. Africa*, Berlin, p. 9, pls. 1 & 2, figs. 16—18.
 1904. *Chydorus bukobensis* : Ekman, *Jagerskold's Swedish Expd.*, Uppsala, 26, pp. 10—14, figs. 5—10.
 1916. *Alona bukobensis* : Sars, *Ann. S. Afr. Mus.*, Cape Town, 15, pp. 336—537, pl. 40, figs. 3, 3a.

Material.—*Jaipur Dist.* : 1 ex., Asalpura Bund, 5. xii. 58. 2 exs., *Julga Lake*, c. 23 km. SW of Gudha, 24. xi. 58, (Coll. S. Biswas).

Measurement.—Length 0.40 mm.

Distribution.—*Rajasthan* : As above (first record from the area and from India). *Elsewhere* : E. and N. Africa (Egypt and Sudan).

Remarks.—These specimens have been referred to the present species due to the marginal denticles of post-abdomen being small and the sub-marginal fascicles well marked. In other characters the specimens resemble *A. rectangula* Sars.

36. *Alona intermedia* Sars var. *minor* Stingelin

(Text-fig. 12H)

1904. *Alona intermedia* Sars var. *minor* Stingelin, *Zool. Jb. (Syst.)* Jena, 21, p. 351, pl. 12, fig. 22.

Material.—*Jaisalmer Dist.* : 1 ex., Biprasar, Ramgarh, 4.i.58, (Coll. K. K. Tiwari & S. Biswas).

Measurement.—Length 0.48 mm.

Distribution.—*Rajasthan* : As above (first record from the area and from India). *Elsewhere*. : S. E. Asia (Indochina).

Remarks.—The present specimen differs from *A. intermedia* Sars mainly in the absence of longitudinal striae on the shell and in having a ciliated end-claw.

37. *Alona cambouei* Guerne & Richard

(Text-fig. 12I).

1893. *Alona cambouei* Guerne & Richard, *Mem. Soc. Zool. France*, Paris, 6, pp. 242-244, figs. 10 & 11.
 1897. *Alona cambouei*: Richard, *Mem. Soc. Zool. France*, Paris, 10, pp. 289-290, figs. 42 & 43.
 1922. *Alona cambouei*: Henry, *Proc. Linn. Soc. N.S.W.*, Sydney, 47, p. 42, pl. 8, fig. 5.

Material.—Jaipur Dist. : 1 ex., Asalpura Bund, 5. xii. 58, (Coll. S. Biswas.)

Measurement.—Length 0.45 mm.

Distribution.—*Rajasthan* : As above (first record from the area). *Elsewhere* : India : W Bengal. Also Palestine, E. and S. E. Africa, Madagascar, Australia, New Zealand and S. America.

Remarks.—The important characters by which the present specimen has been assigned to this species are the presence of fascicles which are long and extend beyond the margin and the shape of postabdomen.

38. *Alona glabra* Sars

(Text-figs. 11 A, B)

1901. *Alona glabra* Sars, *Archiv. Math. Nature*, Christiania, 23(1), pp. 55-56, pl. 9, figs. 6 & 6a.
 1933. *Alona glabra*: Brehm, *Archiv. Hydrobiol.*, Vienna Suppl., 11, pp. 725-726, fig. 31.

Material.—Jaipur Dist. : 1 ex., Asalpura Bund, 5. xii. 58, (Coll. S. Biswas.)

Measurement.—Length 0.40 mm.

Distribution.—*Rajasthan* : As above (first record from the area and from India). *Elsewhere* : Java and S. America.

Remarks.—This species is grouped in the *cambouei*-group in which posterior end of postabdomen is straight or concave, but due to this being overlooked, it is sometimes confused with *A. laevis* Sars which belongs to the *pulchra*-group.

39. *Pleuroxus aduncus* (Jurine)

(Text-figs. 14 C, D).

1820. *Monoculus aduncus* Jurine, *Histoire des Monocles de Genève*, Geneva & Paris, p. 152, pl. 18, figs. 8 & 9.
 1909. *Pleuroxus aduncus* (Jurine): Keilhack, *Süsswasserfauna Deutsch.* (Brauer), Jena, 10, p. 98, figs. 237 & 238.
 1959. *Pleuroxus aduncus*: Brooks, *Freshwater Biology*, New York, p. 648, figs. 27, 103.

Material.—Jaipur Dist. : 2 exs., Asalpura Bund, 5. xii. 58, (Coll. S. Biswas.)

Measurement.—Length 0.52 mm.

Distribution.—*Rajasthan* : As above (first record from the area and from India). *Elsewhere* : W. Pakistan (Brehm, 1950, Punjab), Central Asia, Europe and N. and S. America.

40. *Dunhevedia crassa* King

(Text-fig. 12A).

1853. *Dunhevedia crassa* King, *Pap. & Proc. Roy. Soc. van Diemens Land*, Hovort Town, 2, p. 261.
 1904. *Dunhevedia crassa* : Stingelin, *Zool. Jb. (Syst.)*, Jena, 21, p. 357, pl. 13, figs. 30, 31.
 1916. *Dunhevedia crassa* : Sars, *Ann. S. Afr. Mus.*, Cape Town, 15, pp. 343-344, pl. 41, figs. 3, 3a.

Material.—Jaipur Dist. : 1 ex., Asalpura Bund, 5. xii. 58, (Coll. S. Biswas).

Measurement.—Length 0.57 mm.

Distribution.—*Rajasthan* : As above (first record from the area). *Elsewhere* : India : S. India and W. Bengal. Also widespread : Asia, Australia, Africa, Europe and N. and S. America.

Remarks.—The present species differs from *D. serrata* Daday, of Ceylon, in the shape of the body. In the former the body is short and high with the dorsal margin much arched and in the latter more elongate and with less arched dorsal edge.

41. *Chydorus robustus* Stingelin

(Text-fig. 12E).

1904. *Chydorus robustus* Stingelin, *Zool. Jb. (Syst.)* Jena, 21, pp. 360-361, pl. 13, figs. 35-38.
 1933. *Chydorus robustus* : Brehm, *Archv. Hydrobiol.*, Stuttgart, 11, pp. 756-757, figs. 42-44.

Material.—Jaipur Dist. : 1 ex., Dudu Talao, Dudu, 8. i. 58, (Coll. S. Biswas).

Measurement.—Length 0.39 mm.

Distribution.—*Rajasthan* : As above (first record from the area). *Elsewhere* : India : Lake Povai. Also Sumatra and Java.

Remarks.—This species is easily distinguished from other species of *Chydorus* by the presence of "Chitinschlob" or chitinous tubercles at the dorsal edge.

42. *Chydorus denticulatus* Henry

(Text-figs. 13J & 14 A, B)

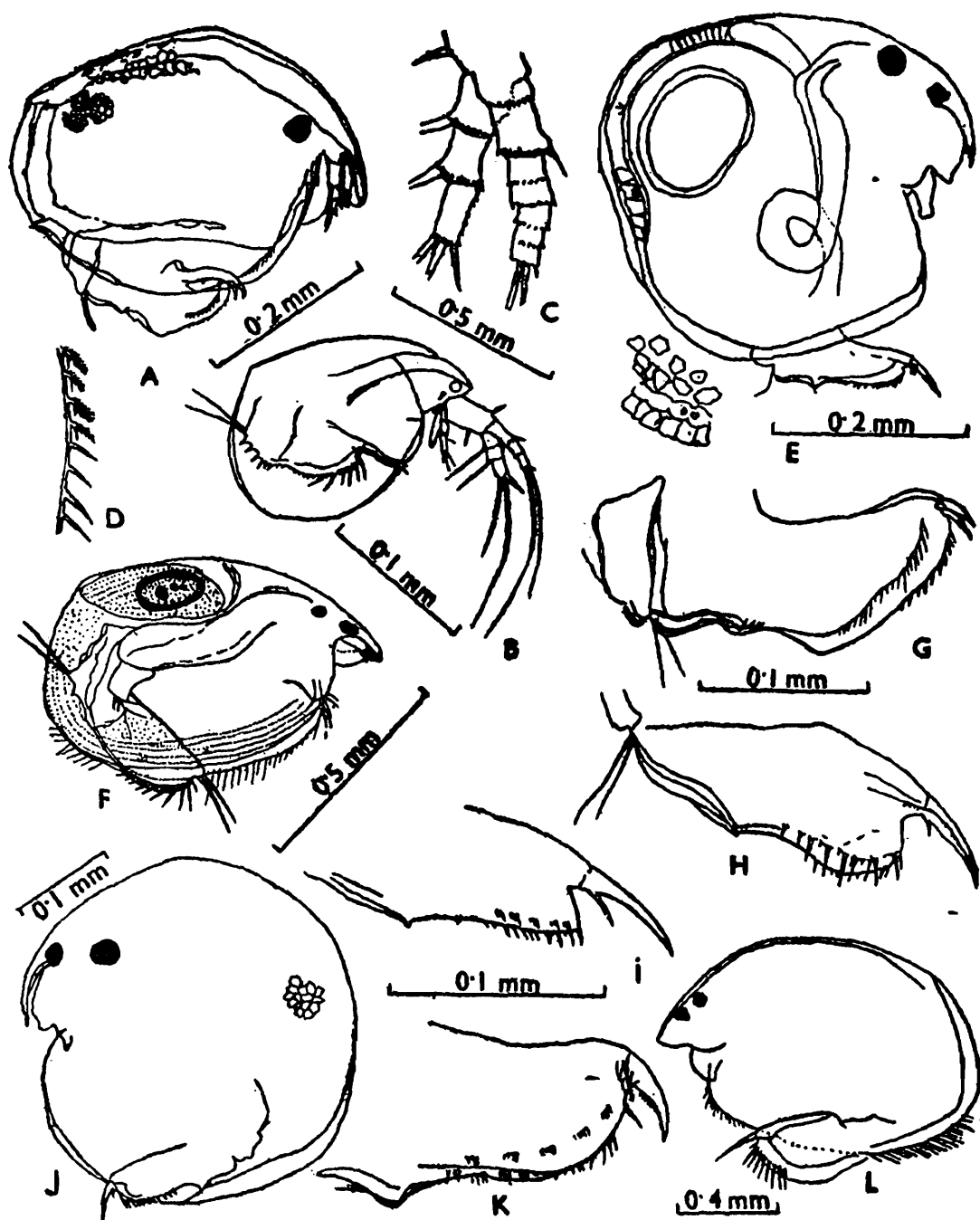
1918. *Chydorus denticulatus* Henry, *J. roy. Soc. N.S.W.*, Sydney, 52, pp. 480-481, pl. 42, figs. 15, 16.
 1927. *Chydorus denticulatus* : Gurney, *Proc. zool. Soc., Lond.*, London, pp. 76, 77, text-figs. 11A, B.

Material.—Jaipur Dist. : 2 exs., Dudu Talao, Dudu, 8. i. 59, (Coll. S. Biswas).

Measurements.—Length 0.45 and 0.35 mm.

Distribution.—*Rajasthan* : As above (first record from the area and from India). *Elsewhere* : Australia.

Remarks.—One example clearly shows reticular marking on the rapace as described by Gurney, the other one is like the type-specimen of Henry, without any marking.



TEXT-FIG. 12.—Cladocera from Rajasthan

(A) *Dunhevedia crassa* King, ♀, lateral view. (B) *Ilyocryptus halyi* Brady, lateral view. (C) Same, antennule. (D) Same, spines on posterior margin of shell. (E) *Chydorus robustus* Stingelin, ♀, lateral view. (Enlarged marking on shell shown separately.) (F) *Leydigia acanthocercoides* (Fischer), ♀, lateral view. (G) *Dunhevedia crassa* King, ♀, postabdomen. (H) *Alona intermedia* var. *minor* Stingelin, ♀, postabdomen. (I) *Alona cambouei* Guerne & Richard, ♀, postabdomen. (J) *Chydorus reticulatus* Daday, ♀, lateral view. (K) *Chydorus ventricosus* Daday, ♀, postabdomen, mounted on slide. (L) *Leydigia laevis* Gurney, ♀, lateral view.

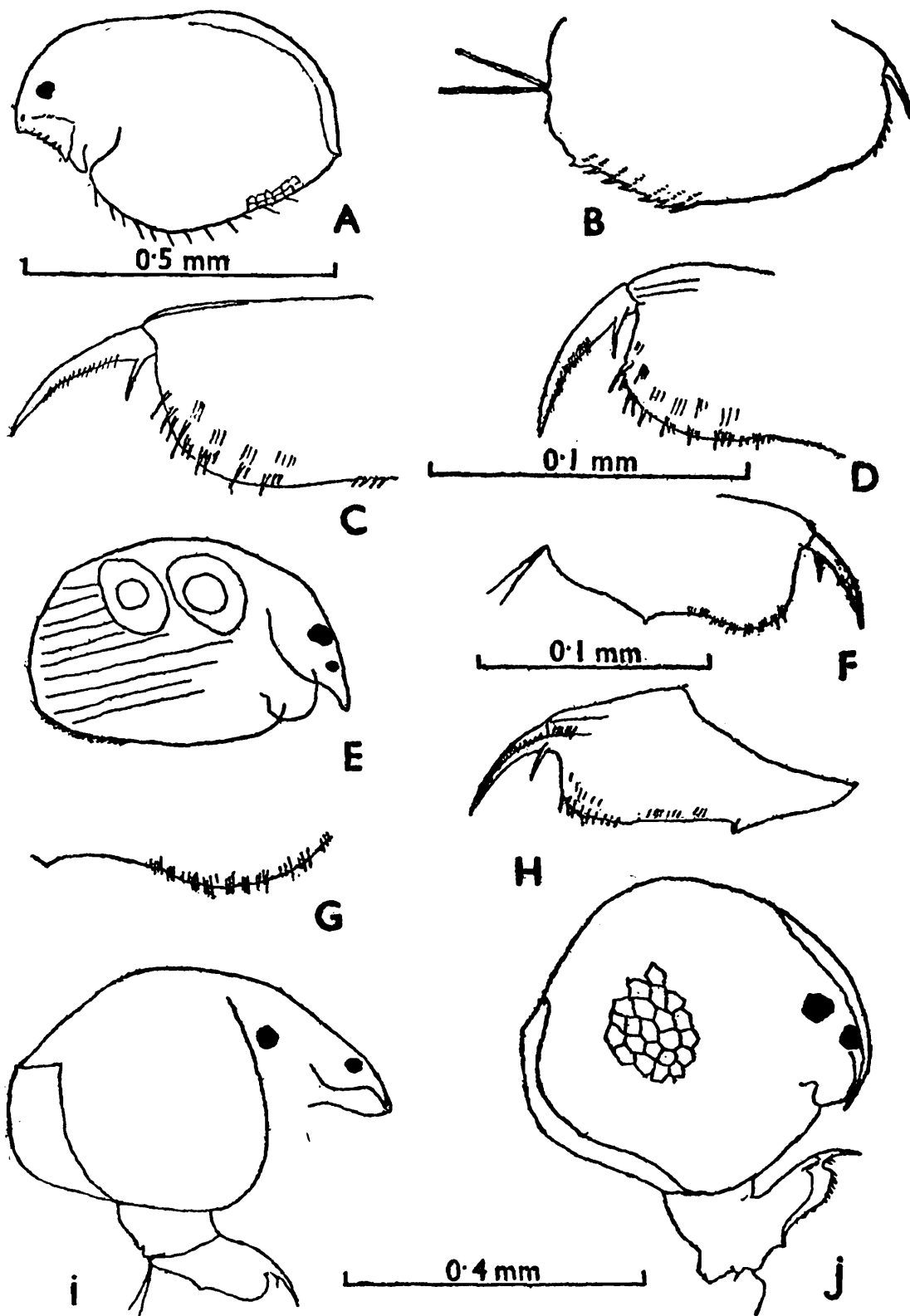
Magnifications : (C), (D), to same scale. (H), (I), to same scale.

43. *Chydorus reticulatus* Daday

(Text-fig. 12J)

1898. *Chydorus reticulatus* Daday, *Termes. Fuzetek.* Budapest, 21, (suppl.), pp. 27-28, figs. 9a-d.
1898. *Chydorus sphaericus* author var. *parvus* Daday, *Termes Fuzetek.* Budapest, 21 (suppl.), pp. 26-27, figs. 8a-c (synonymised by Brehm, 1933).
1916. *Chydorus parvus* : Gurney, *Proc. zool. Soc Lond.* London, 1, p. 336, pl. 1, figs. 2, 3.

Material.—Jaipur Dist. : 1 ex., Julga Lake, ca. 21 km. S.W. of Gudha, 24. xi. 58, (Coll. S. Biswas).



TEXT-FIG. 13.—Cladocera from Rajasthan

(A) *Streblocerus serricaudatus* (Fischer), ♀, lateral view. (B) Same, postabdomen. (C) and (D) *Alona rectangulara* Sars, ♀, postabdomen. (E) *Alona bukobensis* Welthner, ♀, lateral view. (F) and (G) Same, postabdomen. (H) *Alona rectangulara* Sars, ♀, postabdomen of another specimen. (I) *Alona intermedia* var. *minor* Stingelin, ♀, lateral view (distorted). (J) *Chydorus denticulatus* Henry, ♀, lateral view.

Magnifications : (C), (D), to same scale. (B), (F), (G), (H), to same scale. (E), (I), (J), to same scale.

Measurement :—Length 0.27 mm.

Distribution :—*Rajasthan*: As above (first record from the area and from India). *Elsewhere* : Ceylon.

Remarks .—The species *sphaericus* var. *parvus* Daday is synonymus with *C. reticulatus* Daday. *C. reticulatus* can be easily distinguished from *C. sphaericus* by the shape of the upper portion of the lip and its postabdomen. The sculpture on the shell noted by Daday is also clear in the specimen.

44. *Chydorus ventricosus* Daday

(Text-fig. 12K)

1895. *Chydorus ventricosus* Daday, *Termes Fuzetek*, Budapest, 21 (suppl.), pp. 28-29, fig. 10.

1910. *Chydorus ventricosus* : Daday, *Zoologica*, Stuttgart, 51, p. 121, pl. 6, figs. 1-4,

Material.—*Jaipur Dist.* : 1 ex. Dudu Talao, Dudu, 8, i. 59, (Coll. S. Biswas).

Measurement.—Length 0.82 mm. -

Distribution.—*Rajasthan* : As above (first record from the area and from India). *Elsewhere* : Ceylon, Africa and S. America (Paraguay).

Remarks.—Daday described the shell sculpture of the species as punctate and indistinctly marked with hexagonal markings. But in the present specimen it is no doubt punctate, and this, under a high magnification, is seen to be spiny but no hexagonal marking is visible. The postabdomen agrees more with Daday's 1910 figure of the African specimen than with the type.

45. *Chydorus brehmi* Biswas

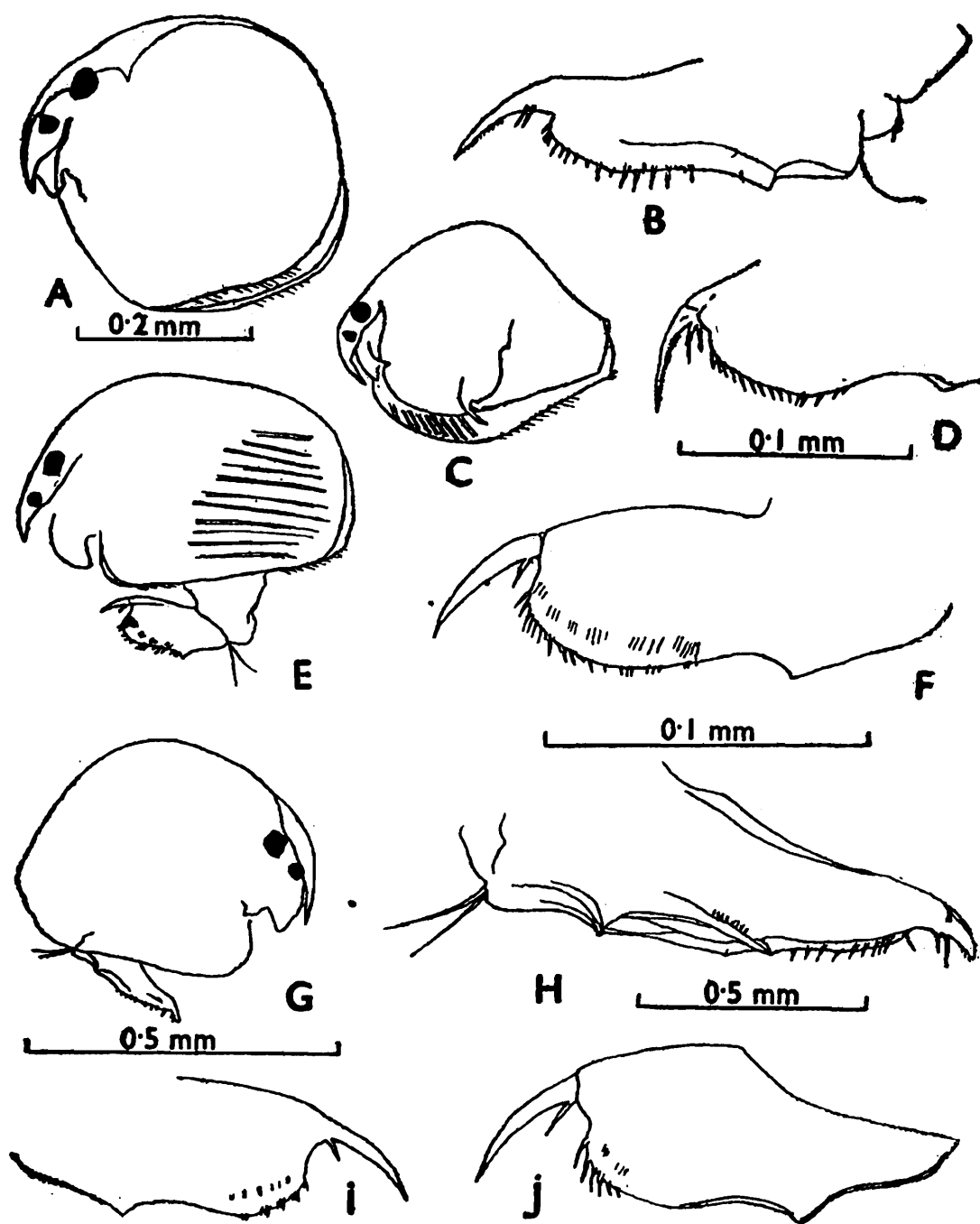
1965. *Chydorus brehmi* Biswas, *Crustaceana*, Leiden, 11(2), pp. 113-114.

Material.—*Jaipur Dist.* : 2 exs. (types,) Dudu Talao, Dudu, 8.i. 59, (Coll. S. Biswas).

Measurement.—Length 0.57, 0.59 mm.

Distribution.—*Rajasthan* : As above (first record from the area).
Elsewhere : India : Nilgiri Hills.

Remarks.—Brehm (1936) doubtfully mentioned a specimen from the Nilgiri Hills.



TEXT-FIG. 14.—Cladocera from Rajasthan

(A) *Chydorus denticulatus* Henry, ♀, lateral view. (B) Same, postabdomen.
 (C) *Pleuroxus aduncus* (Jurine), ♀, lateral view. (D) Same, postabdomen. (E) *Alona rectangula* Sars, ♀, lateral view. (F) Same, postabdomen of another specimen.
 (G) *Chydorus ventricosus* Daday, ♀, lateral view. (H) Same, postabdomen. (I) and (J) *Alona rectangula* Sars, ♀, postabdomen of two other specimens.

Magnifications : (A), (E), to same scale. (C), (G), to same scale. (B), (H) to same scale. (F), (I), (J), to same scale.

VI—NOTE ON ZOOGEOGRAPHY OF RAJASTHAN CLADOCERA

With the present scanty knowledge a comparative study of the Cladoceran fauna of the various parts of India is not possible. The more important papers on the Cladocera of the Indian Region are those of Biswas (1964) on Daphnidae from Simla Hills, Arora (1931) on the Entomostraca of Lahore, Daday (1908) on Tibet, Brehm & Waltereck (1939) and Brehm (1936) on Tibet and N. Himalaya, and Apstein (1907), Bar 1924, Gurney (1907, 1916), Daday (1898) and Brady (1886) on Ceylon. Unfortunately little or nothing is so far known about the Entomostraca of Burma.

Due to the world-wide distribution of the Cladocera there is not much zoogeographical limitation of their distribution as is usually found in certain other groups of animals. Sometimes a species may be unexpectedly discovered in a region though it might have been regarded as characteristic of a region or another rather remote. Examples of this type of discontinuous distribution are *Latonopsis occidentalis*, *L. australis* and *Simocephalus latirostris* which are known to occur only in N. America, S. Australia, and America, respectively, but have, as mentioned in the present work been found to occur in Rajasthan, India. Recently, Harding and Petkovaski (1963) have recorded the occurrence of *Latonopsis australis* from Yugoslavia also.

Regarding the zoogeographical distribution of the Rajasthan Cladocera, it generally appears to have greater affinities with the South-East Asian, Australian and African fauna, than with the Palaearctic fauna.

VII—SUMMARY

The collections on which the present work is based were made during the surveys carried out mainly by parties of the Zoological Survey of India during the period 1957—1963 in the western, northern and central parts of Rajasthan. Collections from the eastern and southern parts are wanting.

2. To study the Cladocera fauna of the Sambhar Salt Lake region, field collections from different localities were cultured in a cemented tank, and four species namely, *Latonopsis occidentalis* Birge, *Latonopsis australis* Sars, *Moina dubia* Guerne & Richard and *Ceriodaphnia reticulata* var. *serrata* Sars, were found to occur.

3. Out of 45 species and varieties recorded here from Rajasthan, all excepting three, namely, *Daphnia carinata* King, *Latona tiwarii* Biswas and *Chydorus brehmi* Biswas, are new records from Rajasthan (and several from India), and the last two species have only recently been described by me (Biswas 1964, 1965).

4. Two ecological niches, saline and freshwater were met with namely the Sambhar Lake proper where water salinity is often high varying from 0°—3°B.E., and the freshwater sources. No species was exclusively found to inhabit the Sambhar Lake. The reason probably is that due to the addition of rain-water in the Lake, the salinity is very low in the rainy season (July to September) and during this period some freshwater fauna makes its appearance but it disappears with the increase of salinity before December.

5. Regarding the zoogeographical distribution of the Rajasthan Cladocera, it appears that it has greater affinity with South-East Asian, Australian and African fauna than with the Palaearctic.

VIII—REFERENCES

- ARORA, G. L. 1931. Fauna of Lahore. 2. Entomostraca (waterfleas) of Lahore.—*Bull. Dep. Zool. Panjab Univ.*, Lahore, 1, pp. 62–100.
- APSTEIN, C. 1907. Das Plankton Colombo See auf Ceylon.—*Zool. Jb.*, (Syst.), Jena, 25, pp. 217–220.
- BAR, G. 1924. Ueber Cladoceran von der Insel Ceylon.—*Jena. Z. Naturw.*, Jena, 60, pp. 81–126.
- BISWAS, S. 1964. Five species of Daphnidae (Crustacea ; Cladocera) from Simla Hills, in India, with a new record of *Alona costata* Sars from NEFA.—*J. zool. Soc. India*, Calcutta, 16(1&2), pp. 92–98.
- BISWAS, S. 1964. A new species of the Cladoceran genus *Latona* Straus, 1820 [Crustacea : Cladocera : Sididae] from Rajasthan, India.—*Proc. zool. Soc.*, Calcutta, 17, pp. 149–152.
- BISWAS, S. 1965. A new species of the genus *Chydorus* Leach, 1843 (Crustacea : Cladocera : Chyderidae) from Rajasthan, India.—*Crustaceana*, Leiden, 11(2), pp. 113–114.
- BRADY, G. 1886. Notes on Entomostraca collected by Mr. A. Haly in Ceylon.—*J. Linn. Soc.*, London, 19, pp. 293–317.

- BREHM, V. 1914. Cladoceren and Ostrakoden aus Baluchistan.—*Zool. Anz.*, Leipzig, 43, pp. 511-512.
- BREHM, V. 1930. Notizen zur Cladoceren fauna Madagascars.—*Arch. Hydrobiol.*, Stuttgart, 21, pp. 679-686.
- BREHM, V. 1933. Die Cladoceren der Deutschen Limnologischen Sunda Expedition.—*Arch. Hydrobiol.*, Stuttgart, 11, pp. 331-763.
- BREHM, V. 1936a. Notizen zur Cladoceren Fauna Madagascars.—*Arch. Hydrobiol.*, Stuttgart, 21, pp. 679-686.
- BREHM, V. 1936b. Report on Cladocera (Yale North India Expedition).—*Mem. Conn. Acad. Arts. Sci.*, New Haven, 10, pp. 293-297.
- BREHM, V. 1950. Contributions to the freshwater fauna of India. Part II.—*Rec. Indian Mus.*, Calcutta, 48, pp. 9-28.
- BREHM, V. 1953. Indische Diaptomiden, Pseudodiaptomiden and Cladoceren.—*Ost. Zool. Z.*, Wien, 3, pp. 241-345.
- BREHM, V. and WALTERECK, R. 1939. Die Daphniden der Yale North Indian Expedition.—*Inst. Rev. Hydrobiol.*, Leipzig, 38, pp. 1-19.
- BROOKS, J. L. 1956. The systematics of North American Daphnia.—*Mem. Conn. Acad. Arts. Sci.*, New Haven, 13, pp. 1-180.
- DADAY, E. VON. 1908 Entomostraca et Hydrachnidae Tibet.—*Rec. Indian Mus.*, Calcutta, 2, pp. 327-330.
- GURNEY, R. 1906. On some freshwater Entomostraca in the collection of the Indian Museum, Calcutta.—*J. Asiat. Soc. Beng.* (N. S.), Calcutta, 2 (7), pp. 273-281.
- GURNEY, R. 1907. Further notes Indian freshwater Entomostraca.—*Rec. Indian Mus.*, Calcutta, -1, pp. 21-33.
- HARDING, J. P. and PETROVOSKI, T. 1963. *Latonopsis australis* Sars (Cladocera) in Jugoslavia, with notes on its synonymy and distribution.—*Crustaceana*, Leiden, 6 (1), pp. 1-4.
- KEILHACK, L. 1909. Süßwasserfauna Deutschlands, Heft. 10, pp. 112. (edited by Dr. Brauer), Jena.

- ROONWAL, M. L. 1967. Fauna of Rajasthan, India. Part I. General introduction, with a list of collecting localities and a bibliography of Rajasthan Zoology.—*Rec. zool. Surv. India*, Delhi, 61 (3&4), pp. 291–375.
- SEWELL, R. B. S., 1935. Studies on the bionomics of freshwaters of India II.—*Int. Revue. Ges. Hydrobiol. Hydrogr.*, Leipzig, 31 (3 & 4), pp. 203–238.
- SRÁMEK-HAUŠEK, R. S. 1962. Fauna CSSR.—Branchiopoda, 16, pp. 465.—(Ceskoslovenske akademik ved) Praha.
- WAGLER, E. 1926. Die Systematik und geographische Verbreitung des Genus *Daphnia*—*Arch. Hydrobiol.*, Stuttgart, 30, pp. 505–556.

**A NEW GEOPHILID CENTIPEDE *HIMANTARIUM*
SAMUELRAJI SP. N. FROM SOUTH INDIA**

By

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(With 1 Text-figure)

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I—INTRODUCTION

Through the kindness of Professor J. Samuelraj, of the department of Zoology, Alagappa College, I have been able to collect and examine centipedes of a species of the genus *Himantarium* Koch (1847) from the Solayandar Koil Forest region. This species differs from the two other known species of the genus, viz., *H. gabrielis* Koch (1847) and *H. rugulosum* Koch (1863) in certain structural characters and also in its peculiar coiling behaviour. It is described here as a new species.

II—SYSTEMATIC ACCOUNT

Class **CHILOPODA**

Order **GEOPHILOMORPHA**

Tribe **HIMANTARIINI**

Family **HIMANTARIIDAE**

Genus ***Himantarium* Koch (1847)**

Himantarium samuelraji* sp. n.

Material.—15 specimens, Solayandar Koil Forest region (Madras State), South India, ca. 9°25' N. Lat., 78°55' E. Long., Coll. *Sundara Rajulu*, 16.vii.1963; found in soft mud, under stones, and in organic debris.

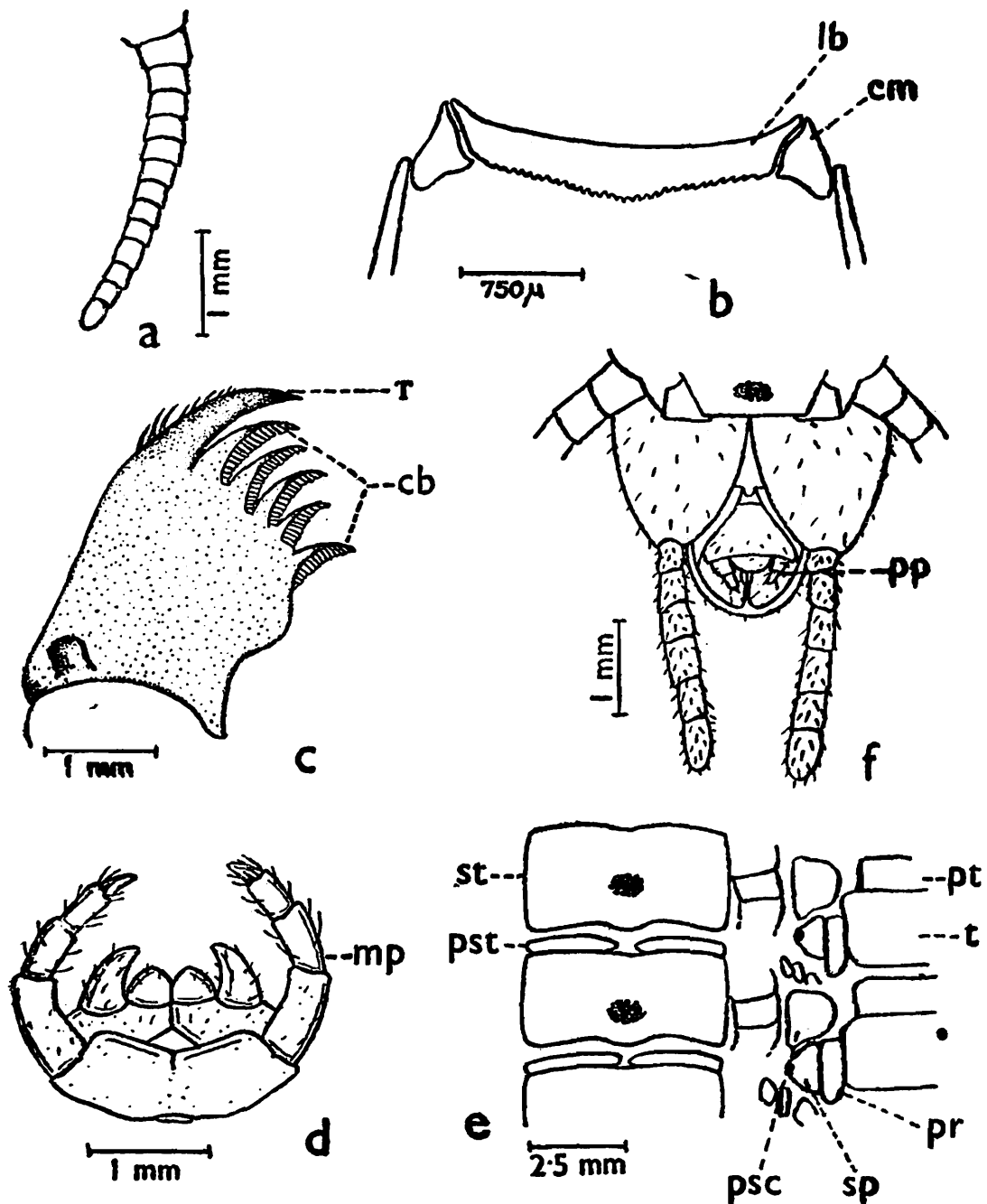
Body blood-red in colour; anterior and posterior regions narrow. Total length (excluding antennae) 23 to 25 cms., width, 0.5 to 0.7 cm.

Head very narrow and conical. Eyes and ocelli absent. Antennae short and stumpy, 3 mm. long, thicker at the proximal end (Text-fig. 1a) and thinner at the distal end; 13-segmented. Labrum long; mostly of uniform width throughout (Text-fig. 1b), slightly arched below, free margin denticulated. Mandible with one long tooth, sharp and hook-like, the tip of the hook bent inwards; five short combs follow-

*Named after Professor J. Samuelraj.

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ing the tooth (Text-fig. 1c). II Maxilla small with a pair of long, slender and 4-segmented palp (Text-fig. 1d) ; the palps of both the sides form a 'V'



TEXT-FIG. 1—*Himantarium samuelraji* sp. n. (a) Right antenna. (b) Labrum. (c) Right mandible. (d) II Maxilla. (e) Sclerites of 19th and 20th segments. (f) Male genitalia, ventral view.

cb., combs ; *cm.*, comandibularis ; *lb.*, labrum ; *mp.*, maxillary palps ; *pp.*, palpifers ; *pr.*, paratergite ; *psc.*, parascutellum ; *pst.*, presternites ; *pt.*, pretergite ; *sp.*, stigmopleurite ; *st.*, sternite ; *t.*, tergite ; *T.*, tooth of the mandible.

Trunk 133 segmented. Tergites twice as wide as the breadth (Text-fig. 1e) ; pretergite approximately half the size as the tergite ; paratergite small, roughly conical, closely opposed to the stigmopleurite. Sternite approximately $1\frac{1}{2}$ times wider than the tergite ; sternal spinules grouped as an oval spot. Presternites represented by a pair of linear plates opposed to the anterior border of the sternite (Text-fig. 1e).

Genitalia ♂ : Penis short with a pair of double segmented palpifers ; all enclosed inside the dorsal plate (Text-fig. 1f.) ; Female : Unknown.

Type specimens.—*Holotype*.—Male, from Solayandar Koil Forest region (Madras State), 16.vii.1963, (Coll. *Sundara Rajulu*). Deposited in the National Collections, Zoological Survey of India, Calcutta. (Reg. No. 3092/18, in spirit in a vial).

Paratypes.—With same data as the holotype. Deposited as follows : (i) one example, in the collections of the Zoological Survey of India (Reg. No. 3093/18, in spirit in a vial) ; (ii) one example with Prof. J. Samuelraj, Department of Zoology, Alagappa College, Karaikudi ; (iii) one example with the Natural Science Museum, Thiagarajar College, Madurai ; (iv) the remainder with the author.

Type locality and geographical distribution.—INDIA : Solayandar Koil Forest region, Madras State.

Comparison.—*Himantarium samuelraji* sp. n. is similar to *H. gabrielis* Koch, but is distinguishable by the following features : (i) Antenna very short, with 13 segments ; (ii) labrum long and uniform in width ; (iii) mandible with a long hook-like curved tooth and five small combs ; and (iv) second maxilla small with a pair of slender and long palps.

In *H. gabrielis* Koch the antennae are long, with 15 to 16 segments ; the labrum is short, with a very narrow middle region connecting the two wider lateral wings ; mandibles with a short and denticulated tooth and with four combs ; and finally the second maxilla large, with a pair of very corpulent conical palps (*vide* Koch, 1847).

A peculiarity noted in the behaviour of *H. samuelraji* is that, when disturbed, it coils its body into an irregular twist and remains inactive much similar to a millipede. Such a behaviour is unknown in any centipede.

III—SUMMARY

1. A new species of Geophilomorpha, *Himantarium samuelraji* is described from South India (Type locality : Solayandar Koil Forest region, Madras State).

2. It is closely allied to *H. gabrielis* in the number and nature of the sclerites on the trunk segments and the structure of the male genitalia ; but differs in the shape of the labrum, the number of segments in the antenna, the number of combs in the mandible, and structure of mandibular teeth and maxillary palps.

IV—ACKNOWLEDGEMENTS

Thanks are due to the Principal, Dr. A. Chidambaranathan Chettiar, for taking interest in this work. I am grateful to my colleagues Messrs. R. S. P. Radha and K. R. Krishnan, for their help during the collection of specimens.

V—REFERENCES

- KOCH, C. L. 1847. System der Myriapoden. Koch-Panzer.—*Krit. Revis.*, Regensburg., 3, p. 438.
- KOCH, C. L. 1870. Die Myriapoden.—*Naturh. Tidsskr.*, Halle., 7, p. 35.
- SILVESTRI, F. 1919. Contributions to the knowledge of the Chilopoda. Geophilomorpha of India.—*Rec. Indian Mus.*, Calcutta, 16, p. 93.

ON SOME INDIAN ARAEOPIDAE (=DELPHACIDAE) (FULGOROIDEA, HOMOPTERA)

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(With 14 Text-figures)

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I—INTRODUCTION

We owe our knowledge on Indian Araeopidae to the pioneer works of Distant (1906 *et seq.*) and Muir (1921, 1922). As was perhaps customary at that time, the former, who examined majority of the species of these insects from our country, has made little use of male genitalia in his systematic descriptions. Further, he seems to have ignored the nature of the spur, which is also an important character for a study of the taxonomy of araeopids. Muir (1915), therefore, expressed serious doubts regarding the validity of Distant's genera, which he was unable to examine in constructing keys to the genera.

Araeopidae is one of the most neglected families of insects from India. Although 1114 species, belonging to 137 genera are listed all over the world by Metcalf in 1943, only 30 species, under 19 genera, are so far reported from our country. From the fact that 38 species have been recorded under 18 genera from Ceylon, with its very limited geographical boundaries and climatic limits, the vast richness of araeopid fauna awaiting discovery is easily conceivable. There is thus an urgent need for careful taxonomic revision. The present paper aims at fulfilling this objective. The type-localities have been quoted in verbatim from the original description, since the types were not available to the author for study.

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II—MATERIAL AND METHODS

The insects were collected from Rajasthan, Delhi, Uttar Pradesh, Orissa, Maharashtra, Madras and Kerala. They were caught in light traps and in electric light domes. The latter method is quite useful, as these insects gather in abundance in the domes.

Dissections of the male genitalia were made under stereoscopic binocular microscope as illustrated by Giffard (1921). All the diagrams were drawn with the help of camera lucida. The length of the insect is intended to indicate the distance from the vertex to the tip of tegmina.

III—SYSTEMATIC ACCOUNT

Subfamily *Araeopinae* (= *Delphacinae*)

Tribe I. Tropidocephalini

1. *Tropidocephala signata* (Distant)

(Text-fig. 1)

1912. *Orchesma signata* Distant, *Ann. Mag. nat. Hist.*, London, (8) 9, pp. 192—193. (Type-locality: Peradeniya, Ceylon.)

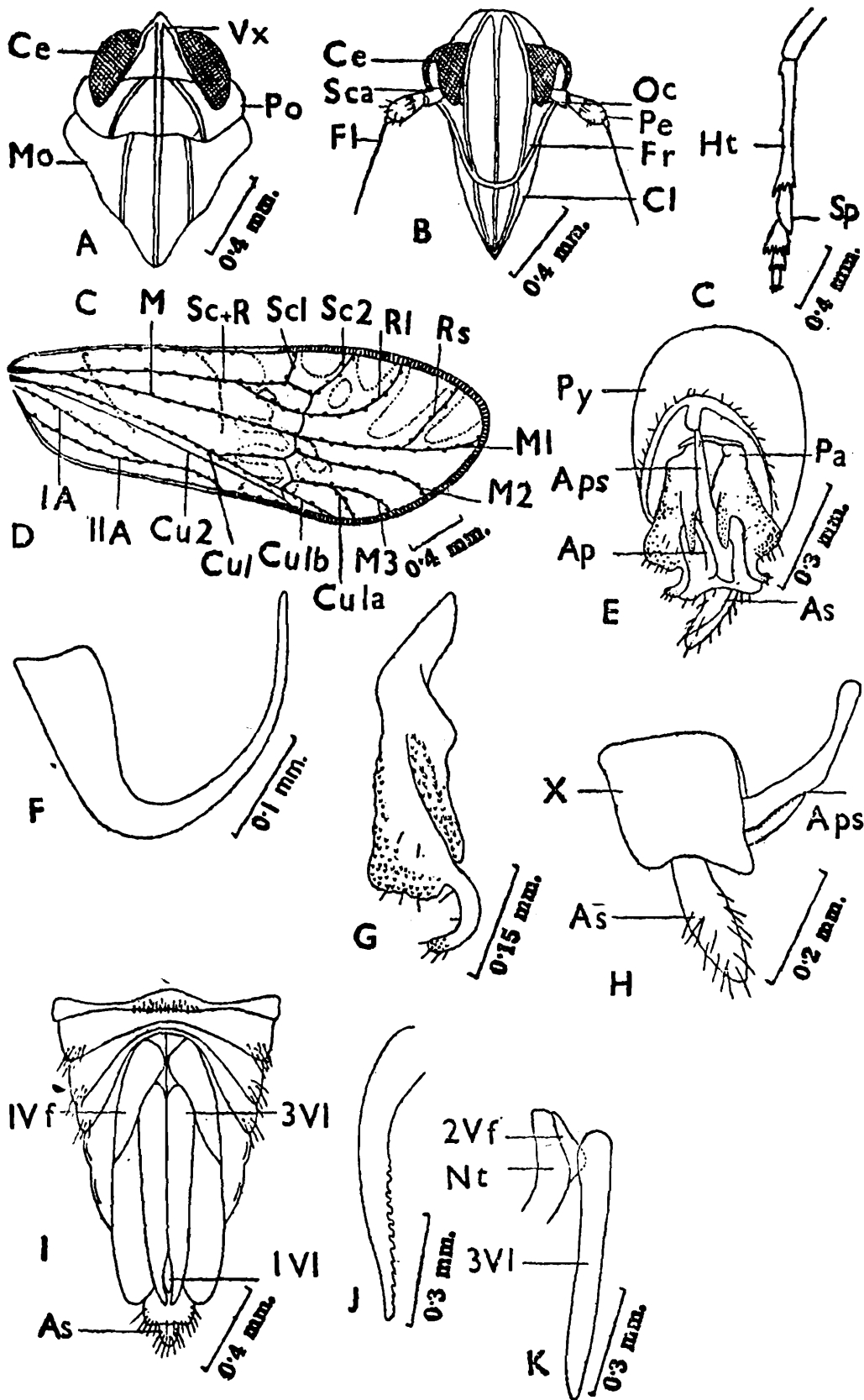
Material.—3 exs., Coimbatore, Agriculture College campus,—. xii. 1958. (Coll. M. G. R. Menon).

Length : *male* 3.2—3.8mm.; *female* 3.8—4.4 mm.

Vertex, pronotum and mesonotum ochraceous ; their carinae pale, with narrow margins on either side ; face testaceous red, the median carina pale and the lateral carinae pale ochraceous-brown. Antenna ochraceous, with a castaneous ring near the middle of the pedicel. Tegmen shining pale brown, with the space in between hyaline, an irregular castaneous patch near the middle, provided with profuse macrotrichiae on and adjacent to the veins. Dorsal side and ventrolateral margins of abdomen testaceous red ; rest of abdomen, ventral side of thorax, legs and ventral side of head, excluding the face, ochraceous. Spur cultrate, with the inner surface concave and without teeth. Spines on the hind margin of tarsomere seven, similar to those in other members of *Araeopinae*. Antenna short ; scape annular, only half the length of pedicel ; the latter with profuse hair growth, the hair on the castaneous ring of pedicel long and matching in colour. Vertex turbinate—triangular, with curved lateral sides. The lateral carinae of frons arcuate, mediolongitudinal carina not furcate ; vertex, pro- and mesonota tricarinate, carinae reaching the hind margin.

Genitalia complicated ; ventromedian margin of pygofer slightly produced posteriorly, anal angles short and extending only upto the proximal part of the tenth segment ; diaphragm without armature ; aedeagus periandrum tubular, curved semi-circularly, swollen at the base but gradually narrowed to the tip, projects out through a ring formed by the union of anal processes ; paramere with a basal prong bearing another curved projection at the distal end of the inner margin, outer margin wavy, outer surface with a number of small projections ; after the formation of the ring the fused anal processes continue anteriorly as a single, ventrally grooved structure, the periandrum rests in this groove. Ovipositor

extends posteriorly upto the hind margin of the ninth abdominal segment; no distinct subgenital plate; first valvifer broad basally; second valvulae serrate for more than half of their length, serrations large.



TEXT-FIG. 1—*Tropidocephala signata* (Distant)

(A) Dorsal view of head, pronotum and mesonotum. (B) Cephalic view of head. (C) Distal region of hind leg. (D) Tegmen. (E) Ventrolateral view of pygofer. (F) Aedeagus perianth. (G) Lateral view of paramere. (H) Lateral view of tenth and eleventh male abdominal segments. (I) Ventral view of female abdomen. (J) Lateral view of second valvula. (K) Lateral view of third valvula.

2. *Purohita cervina* (Distant)

(Text-fig. 2)

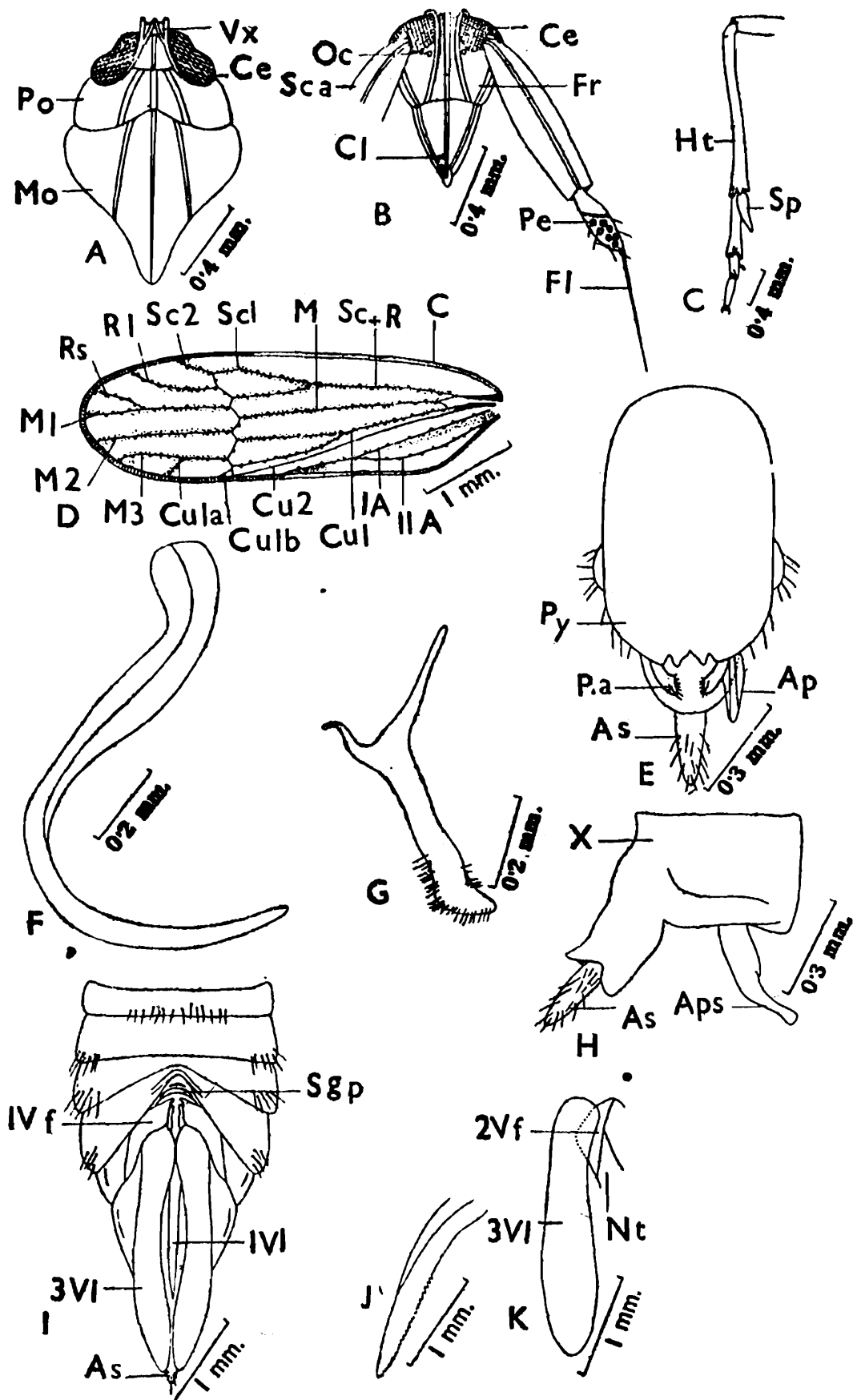
1906. *Purohita cervina* Distant, *Fauna Brit. India*, Rhynchota, 3, pp. 470—471, fig. 257. (Type-locality : Ceylon.)

Material.—(i) 2 exs., Calicut, Medical College campus, 18—21. ix. 1961. (Coll. A. N. A. Johny). (ii) 6 exs., Coimbatore, Agriculture College campus, xii. 1958. (Coll. M. G. R. Menon).

Length : male 5.5—6.1 mm. ; female 6.7—7.3 mm.

Ochraceous or pale ochraceous-brown, lateral margins of vertex pale castaneous frons with a pale castaneous transverse mark near the lower part of the eyes ; clypeus pale ochraceous-brown ; lateral areas of pronotum a little darker than the middle region. Antennae ochraceous, sprinkled with testaceous. Tegmina subhyaline, along the veins brownish-ochraceous, with profuse macrotrichiae. Spur cultrate, with the inner surface concave and without teeth along the hind margin. The hind margin of first tarsomere with only six spines instead of seven as found in other Araeopinae. Scape much larger than the pedicel ; the former foliaceous and triangular in cross section, while the latter foliaceous only. Vertex longer than broad. Lateral carinae of pronotum, vertex and frons form deep keels, mediolongitudinal carina of frons unbranched ; pro- and mesonota tricarinate, all reach the hind margin.

Genitalia complicated ; pygofer elongated, medially constricted, anal angles short reaching upto the base of the tenth abdominal segment, ventromedian margin considerably produced posteriorly forming a cover over the aedeagus and parameres and having one median wide and two lateral incisions, thus forming two small conical projections ; diaphragm without armature ; aedeagus periantrum sickle-shaped, subcylindrical, basally swollen, with a ridge at its lateral side throughout its length, projecting through a ring formed by the fusion of anal processes ; parameres small, laterally flattened with a swollen bifurcated base and swollen inner margin ; the fused tenth and eleventh segments long, bearing a long anal style ; anal processes fuse to form a ring which continue distally as a single structure. Ovipositor extends upto the middle of the anal style ; subgenital plate small and transversely elongated ; first valvifer with a small proximal projection ; second valvulae serrate for more than half of their length ; third valvula highly developed.

TEXT-FIG. 2—*Purohita cervina* (Distant)

(A) Dorsal view of head, pronotum and mesonotum. (B) Cephalic view of head. (C) Distal region of hind leg. (D) Tegmen. (E) Ventral view of pygofer. (F) Aedeagus perianthrum. (G) Lateral view of paramere. (H) Lateral view of tenth and eleventh male abdominal segments. (I) Ventral view of female abdomen. (J) Ventro-lateral view of second valvula. (K) Lateral view of third valvula.

Tribe II. Araeopini (=Delphacini)

3. *Perkinsiella insignis* (Distant)

(Text-fig. 3)

1912. *Pundaluoya insignis* Distant, *Ann. Mag. nat. Hist.*, London, (8) 9, p. 190. (Type-locality : Bengal. Pusa. Balighai, near Puri, Orissa. Bassein Fort, Bombay).

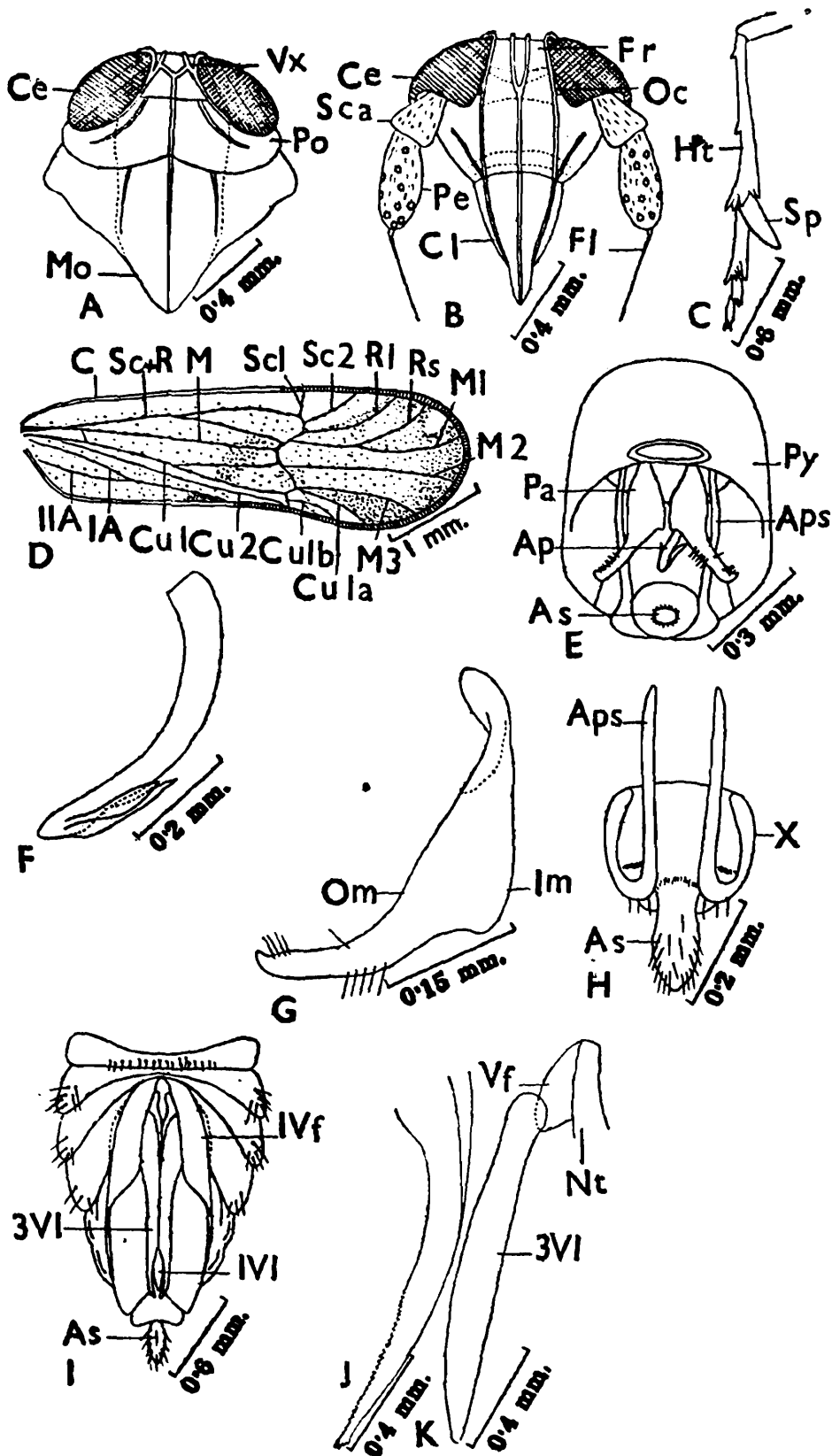
Material.—(i) 3 exs., Calicut, Medical College campus, 18—21. ix. 1961. (Coll. A. N. A. Johnny). (ii) 6 exs., Coimbatore, Agriculture College campus, xii. 1958. (Coll. M. G. R. Menon).

Length : *male* 4.5—5.0 mm. ; *female* 5.3—5.8 mm.

Creamy or ochraceous-white in the mediolongitudinal area from the vertex to the posterior end of mesonotum (Fig. A, marked in dashes) ; remaining part of pro- and mesonota black or castaneous. Tegmen with a creamy-white posteroproximal border, as if extending from the mesonotum and terminating a little in front of the region where the Y-vein joins the outer border, subhyaline, major part shaded black, castaneous or brown and even rarely pale brown. Abdomen dorsally black, castaneous or brown with ochraceous marks ; ventral side of head (Fig. B, the area of ochraceous colour marked in dashes), thorax and abdomen follow the same colour pattern, except for the mesothorax being completely ochraceous ; ochraceous patches of abdomen varying. Males invariably darker than females. Spur foliaceous with a large number of teeth (35-45). Scape a little longer than half the length of pedicel ; both flattened ; the former nearly triangular. Vertex a little wider than long. Mediolongitudinal carina of frons furcate near the lower margin of eyes ; pronotum tricarinate, the lateral carinae divergently curved posteriorly and not reaching the hind margin ; mesonotum also tricarinate, the lateral carinae stop a little in front of the posterior border.

Pygofer wider in the middle of the opening, the opening broader than long, anal angles rather angular, the ventromedian margin projected into a plate-like structure with each apical corner drawn out into a short, flat spine ; diaphragm without armature ; aedeagus periandrum tubular, arched, ornamented with two large spines at the posteroventral margin, spines directed posterolaterally, one on either side and of unequal length ; parameres broad in middle and divergently curved posterior to the swelling, the outer margin of the posterolateral angle pointedly produced laterally, the outer margin wavy towards the distal region ; the anal processes highly developed and extend slightly into the ventral margin of the opening of pygofer, they arise basally wide apart and uniformly

thickened throughout their length. Ovipositor stops a little short of the ninth abdominal segment ; no distinct subgenital plate ; first valvife pointed basally ; second valvulae serrate for less than half of their length.



TEXT-FIG. 3—*Perkinsiella insignis* (Distant)

(A) Dorsal view of head, pronotum and mesonotum. (B) Cephalic view of head. (C) Distal region of hind leg. (D) Tegmen. (E) Ventral view of pygofer. (F) Aedeagus perianthium. (G) Ventral view of paramere. (H) Ventral view of tenth and eleventh male abdominal segments. (I) Ventral view of female abdomen. (J) Ventro-lateral view of second valvulae. (K) Lateral view of third valvula.

4. *Perkinsiella sinensis* (Kirkaldy)

(Text-fig. 4)

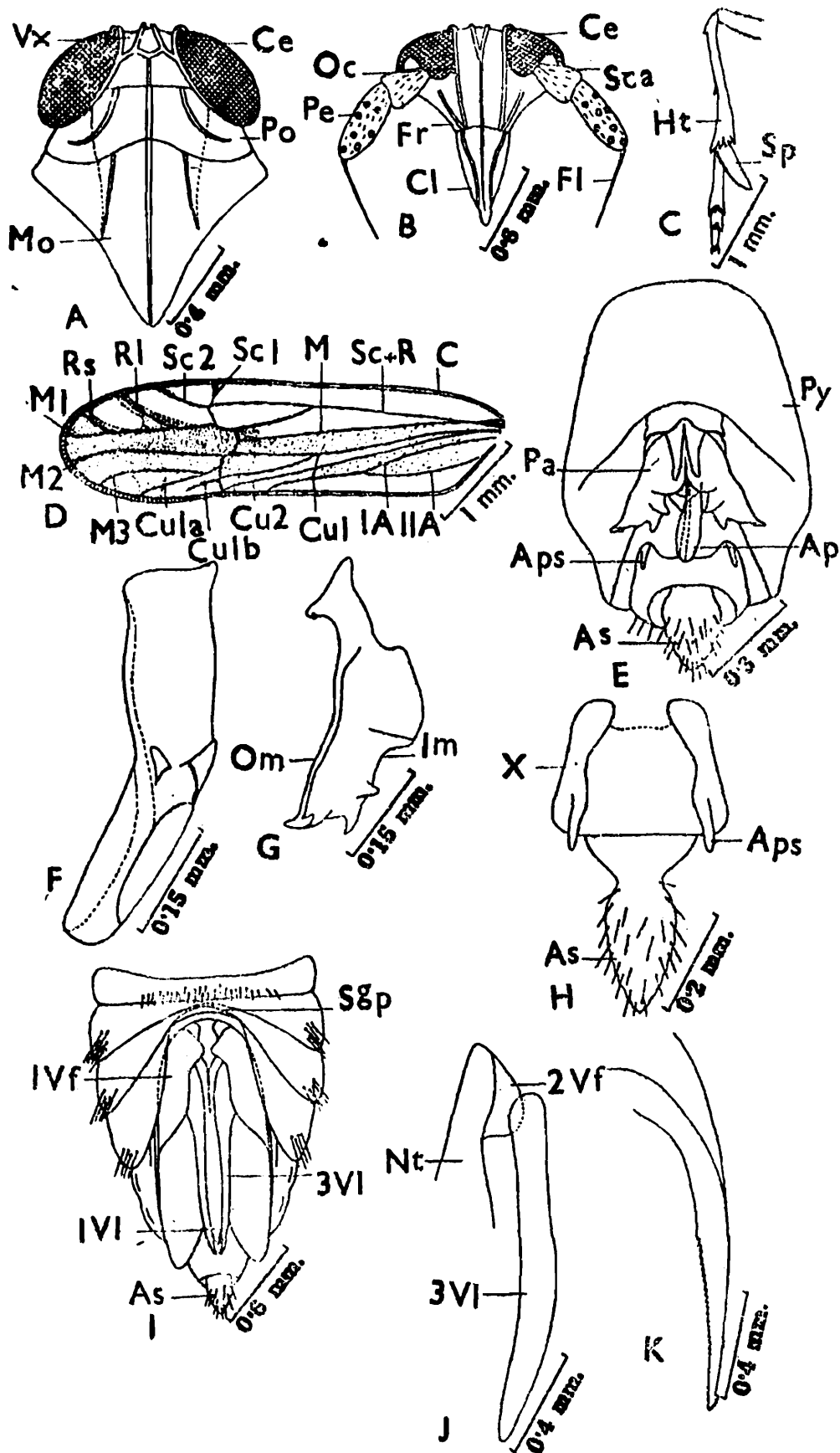
1907. *Perkinsiella sinensis* Kirkaldy, *Bull. Hawaii Sug. Ass. ent. Se.*, Honolulu, 3, p. 138, pl. 12, figs. 14 & 15. (Type-locality : China).

Material.—15 exs., Coimbatore, Agriculture College campus, xii 1958. (Coll. M. G. R. Menon).

Length : *male* 4.5—5.0 mm.; *female* 5.3—5.8 mm.

The pattern of colouration essentially the same as in *Perkinsiella insignis*, but always lighter ; castaneous, brown or pale brown with dominant ochraceous markings. Occasionally, the female specimens almost wholly ochraceous. Spur foliaceous, with a large number of teeth (35—45). Scape a little longer than half the length of pedicel ; both of them flattened ; the basal one nearly triangular. Vertex wider than long. Carination similar to that of *Perkinsiella insignis*.

Pygofer wider towards the middle of opening ; opening broader than long, anal angles angular covering the tenth abdominal segment, ventromedian, margin produced into two large divergently curved spines ; diaphragm without armature ; aedeagus periantrum stout, subtubular with a thick ridge along the ventromedian line, constricted twice, one immediately after the base and another towards the middle, curved (about 45°) ventrally after the second constriction, decorated with two small, unequal, triangular, anterolaterally directed spines ; parameres swollen medially and appose each other, distal to this they diverge, terminally end in two projections, the inner one spine-like and the outer double headed, basal to these each bearing a third, ventrally directed projection near the inner margin, outer margin of the paramere wavy ; anal processes small, directed posteriorly and well apart basally. Ovipositor stops a little short of the hind margin of the ninth abdominal segment ; subgenital plate narrow and transversely elongated ; first valvifer broad basally ; second valvulae serrate for more than half their length.

TEXT-FIG. 4—*Perkinsiella sinensis* (Kirkaldy)

(A) Dorsal view of head, pronotum and mesonotum. (B) Cephalic view of head. (C) Distal region of hind leg. (D) Tegmen. (E) Ventral view of pygofer. (F) Aedeagus perianthium. (G) Ventral view of paramere. (H) Ventral view of tenth and eleventh male abdominal segments. (I) Ventral view of female abdomen. (J) Lateral view of third valvula. (K) Ventrolateral view of second valvulae.

5. *Phyllodinus pulchellus* (Distant)

(Text-fig. 5)

1912. *Pundaluoya pulchella* Distant, *Ann. Mag. nat. Hist.*, London, (8)9, p.190.
 (Type-locality: Peradeniya and Trincomalee, Ceylon. Bengal. Pusa. Chapra, Bihar. Tenmalai, W. Ghats. Bassein Fort, Bombay).

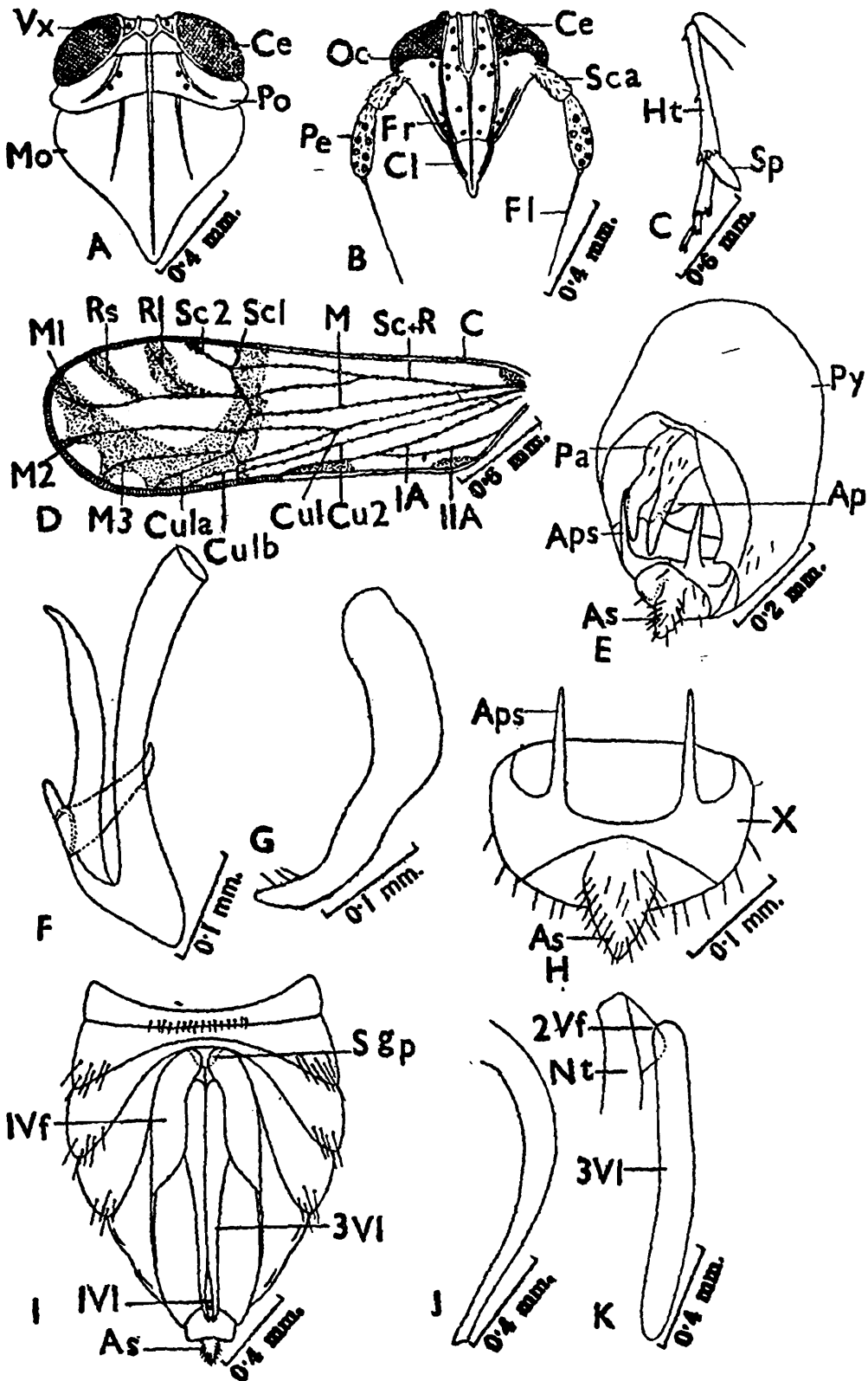
Material.—(i) 7 exs., Coimbatore, Agriculture College campus, xii. 1958. (Coll. M. G. R. Menon). (ii) 2 exs., Poona, University campus, 10. iii. 1960. (Coll. Joseph).

Length : male 3.5—4.0 mm.; female 4.3—4.8 mm.

Black with ochraceous marks. Vertex ochraceous suffused with black; pronotum, vertex and frons speckled with ochraceous (Figs. 5A,B); pro- and mesonota black, carinae ochraceous; a transverse ochraceous band on the ventral side passing from one side of thorax to another across the head at the junction of frons and clypeus. Sometimes the head, pro- and mesonota castaneous instead of black. Scape black, pedicel ochraceous-brown. Legs ochraceous or castaneous with black streaks. Tegmen hyaline with fuscous marks, veins thickly speckled with fuscous at the base of macrotrichiae, (Cu2) also provided with macrotrichiae. Spur foliaceous with a large number of small teeth (25—30). Anterior and intermediate femora and tibiae foliaceous. Antenna long; scape longer than half the length of pedicel. Vertex wider than long, head as broad as pronotum. The median carina of frons furcate near the middle; pro- and mesonota tricarinate, the lateral pronotal carinae divergently curved under the eyes, not reaching the posterior margin, the lateral carinae of mesonotum stop a little in front of the hind margin.

Pygofer rather globular, the opening longer than broad, anal emargination angular and covers only the basal half of the tenth segment, the ventromedian margin slightly produced into a lip-like projection; the diaphragm without armature, but its dorsomedian margin a little more thickly sclerotised than the remaining part; aedeagus periantrum tubular, narrow towards the middle from both the sides and ventrally curved, distally much swollen and the dorsal margin decorated with two large unequal spines and a small projection, of these one spine very large, curved and recurved and directed anterolaterally extending three-fourths the length of periantrum, the other spine comparatively small and slightly curved; the parameres subcylindrical, swollen and almost parallel to each other, basally much swollen and constricted towards the middle; the combined tenth and eleventh segments large with

the base of anal processes apart, anal processes narrow and pointed. The ovipositor stops a little in front of the hind margin of the ninth segment ; the subgenital plate conical ; the first valvifer broad basally ; the second valvulae serrate for lesser than half of their length.



TEXT-FIG. 5—*Phyllodinus pulchellus* (Distant)

(A) Dorsal view of head, pronotum and mesonotum. (B) Cephalic view of head. (C) Distal region of hind leg. (D) Tegmen. (E) Ventrolateral view of pygofer. (F) Aedeagus periandrum. (G) Ventrolateral view of paramere. (H) Ventral view of tenth and eleventh male abdominal segments. (I) Ventral view of female abdomen. (J) Lateral view of second valvulae. (K) Lateral view of third valvula.

6. *Phyllodinus sauteri* (Muir)

(Text-fig. 6)

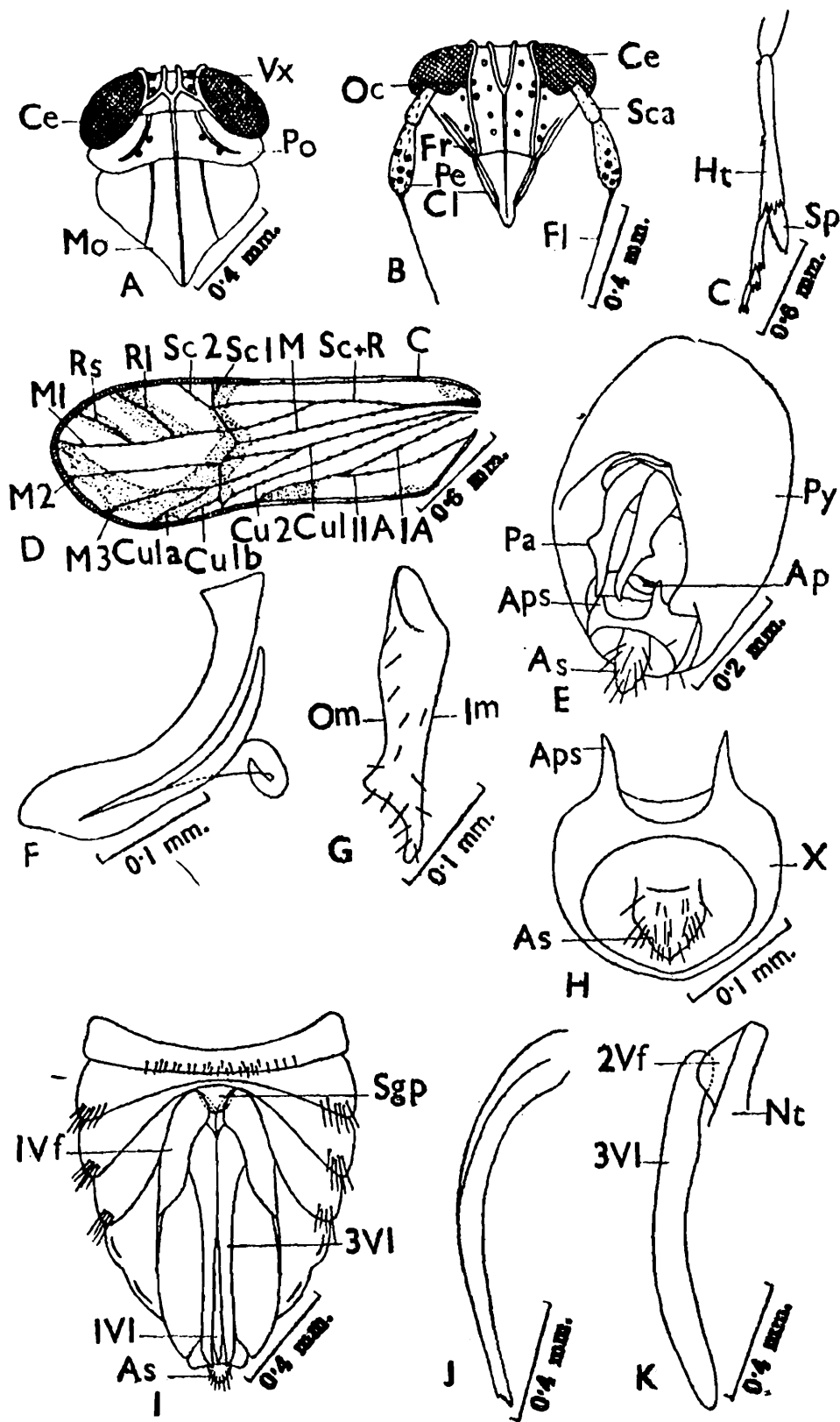
1917. *Phyllodinus sauteri* Muir, *Proc. Hawaii. ent. Soc.*, Honolulu, 3 (4), pp. 319—320, pl. 5, figs. 25, 25a. (Type-locality : Dainakko Formosa).

Material.—6 exs., Calicut, Medical College campus 18—21.ix. 1961. (Coll. A. N. A. Johnny).

Length : male 2.9—3.3 mm.; female 3.1—3.5 mm.

Colouration similar to that of *Phyllodinus pulchellus*. Spur foliaceous with a number of teeth (19—25). Anterior and intermediate femora and tibiae foliaceous. Antenna long; scape longer than half the length of pedicel. Vertex wider than long, head as broad as pronotum. Carination similar to that of *Phyllodinus pulchellus* except for the lateral mesonotal carinae which reach the hind border.

Pygofer rather globular, opening longer than broad, the anal emargination short and extends only upto the base of the tenth segment, the ventromedian margin produced into a lip-like projection, more conspicuous than *Phyllodinus pulchellus*; the diaphragm without armature, its dorsomedian margin thickly sclerotised than the remaining part; the aedeagus perianth tubular, arched ventrally but wider at both ends, a large bifurcated spine at the posteroventral margin, one of the bifurcations runs parallel to the perianth proximally and extends more than three-fourths the length of the tube, the other curved and recurved and directed externally; parameres small with swollen bases; parallel to each other, each with an outer prong distally and tapering posteriorly; fused tenth and eleventh segments large, anal processes short and conical. Ovipositor extends upto the posterior end of the tenth abdominal segment or a little beyond that; subgenital plate broader than *Phyllodinus pulchellus*; the first valvifer broad basally; the extension of the serration of the second valvulae similar to that of *Phyllodinus pulchellus*.

TEXT-FIG. 6.—*Phyllodinus sauteri* (Muir)

(A) Dorsal view of head, pronotum and mesonotum. (B) Cephalic view of head. (C) Distal region of hind leg. (D) Tegmen. (E) Ventrolateral view of pygofer. (F) Aedeagus periandrum. (G) Ventral view of paramere. (H) Ventral view of tenth and eleventh male abdominal segments. (I) Ventral view of female abdomen. (J) Ventrolateral view of second valvulae. (K) Lateral view of third valvulae.

7. *Peregrinus maidis* (Ashmead)

1890. *Delphax maidis* Ashmead, *Psyche, Camb., Mass., Mass*, 5, pp. 321—324. (Type-locality : Florida).

For figures refer Mathur & Joseph (1961 *a, b*) and Joseph (1961*b*).

Material.—(i) 2 exs., Trivandrum, Agriculture College campus, 8. x. 1960 ; (ii) 11 exs., Trichur District, Valapad, 15—22. v. 1960; (iii) 3 exs., Trichur District, Ollur, 23.v. 1960 ; (All Coll. *Joseph*). (iv) 5 exs., Calicut, Medical College campus, 18—21. ix. 1961 ; (Coll. *A.N.A. Johnny*). (v) 157 exs., Coimbatore, Agriculture College campus, xii. 1958 ; (Coll. *M. G. R. Menon*). (vi) 7 exs., Poona, University campus, 7—10. iii. 1960 ; (vii) 3 exs., Agra, Balwant Rajput College campus, 26. vii. to 4. ix. 1962; (viii) 5 exs., Delhi, Indian Agricultural Research Institute campus, 12.x. 1960; (All Coll. *Joseph*).

Length : *male* 3.5—3.9 mm. ; *female* 4.3—4.7 mm.

Vertex pro- and mesonota ochraceous ; their carinae pale, the area between median and lateral carinae with testaceous fasciae ; the lateral margins of pro- and mesonota piceous or castaneous ; ventrally head piceous. Antennae ochraceous, with the distal part of the scape and basal and terminal parts of pedicel piceous or piceous-brown. Tegmen hyaline with castaneous patches distally. Ventrally pro- and mesothorax with castaneous marks, femur and distal part of fore and middle legs, occasionally the hind leg too, piceous, remaining part ochraceous ; metatergum and the anterior two or three terga of abdomen ochraceous with castaneous or dark marks ; remaining part of abdomen castaneous or black with posterior margin, dorsomedian margin and lateral sides of segments ochraceous. Generally female lighter coloured, ninth segment and ovipositor ochraceous to a greater extent. Spur foliaceous with a number of teeth (19—24). Antenna long ; pedicel longer than scape. [Refer foot-note, Mathur & Joseph (1961*a* p.5)]. Vertex wider than long, base wider than apex. Median carina of frons furcate towards the base ; a thin mediolongitudinal carina on vertex ; pro- and mesonota tricarinate, all the carinae reach the hind margin, the lateral carinae converge posteriorly.

Pygofer globular, opening longer than broad, anal angles short, acute and cover only the base of the tenth segment ; diaphragm without armature ; aedeagus periandrium tubular, elongated, arched medially, narrow and gradually enlarging towards the base, it bears

five or six basally directed spines at the distal region, of these the distal one longest and sometimes branches basally, the remaining ones small and gradually reduced in length from the second to the last ; parameres small, sickle-shaped, abruptly narrow basally behind the diaphragm and with three distal projections, the distal one largest, anal processes absent. Ovipositor extends upto the tenth segment ; subgenital plate small and conical ; first valvifer project internally towards the middle ; second valvulae serrate for two-thirds of their length.

8. *Sardia rostrata* (Melichar)

(Text-fig. 7A-C)

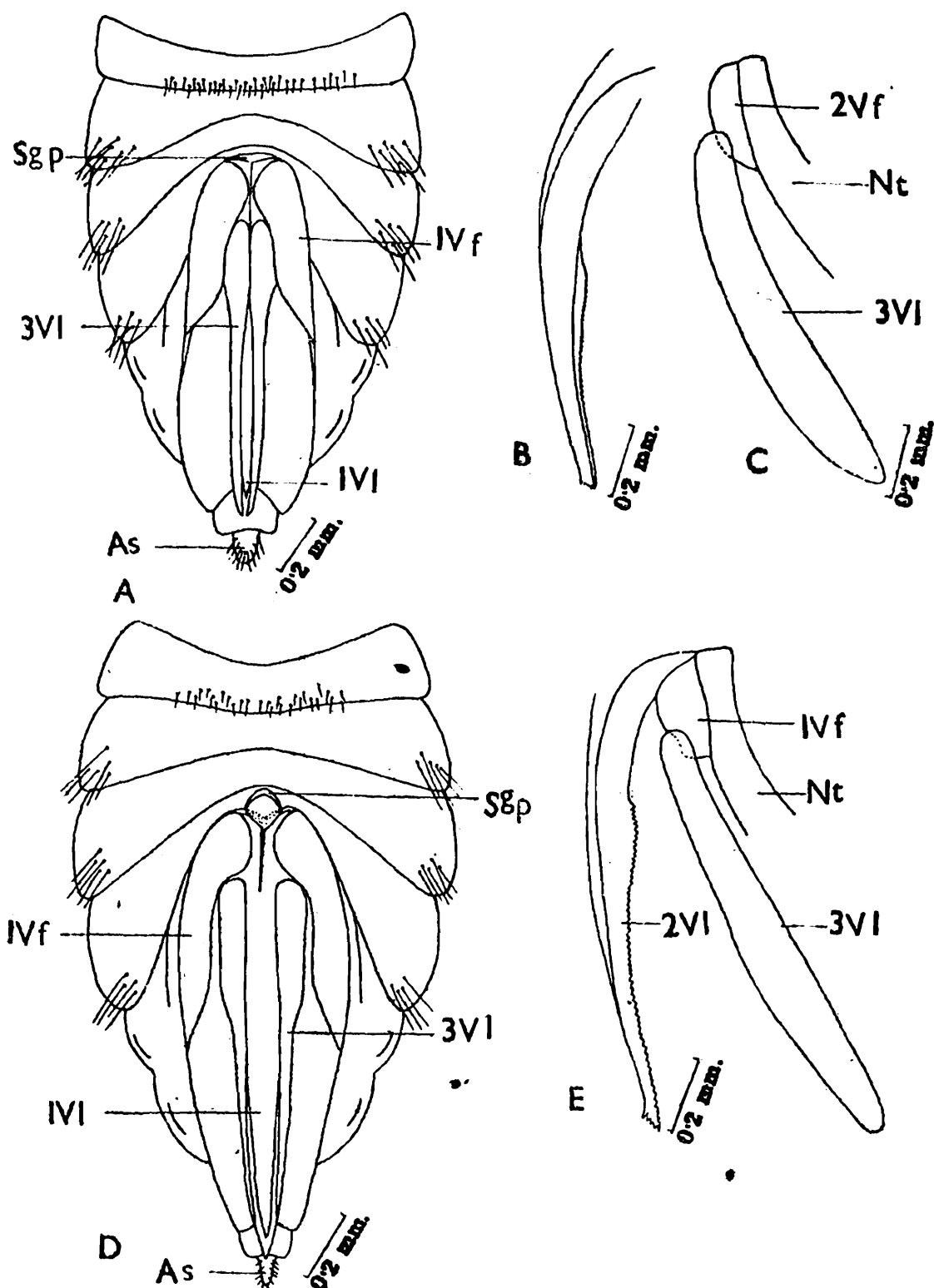
1903. *Sardia rostrata* Melichar, *Homoptera Fauna Ceylon*, pp. 96—97, pl. 2, fig. 4. (Type-locality : Henaratgoda, Ceylon).

Material.—(i) 2 exs., Trivandrum, Agriculture College campus, 8. x. 1960 ; (ii) 1 ex., Kaladi, Church campus, 26. v. 1960 ; (iii) 8 exs., Trichur District, Valapad, 15—22. v. 1960 ; (iv) 1 ex., Trichur District, Ollur, 25. v. 1960 ; (All Coll. *Joseph*). (v) 5 exs., Calicut, Medical College campus, 18-21. ix. 1961 ; (Coll. *A. N. A. Johnny*). (vi) 53 exs., Coimbatore, Agriculture College campus, xii. 1958 ; (Coll. *M. G. R. Menon*). (vii) 4 exs., Poona, University campus, 7—10. iii. 1960 ; (viii) 2 exs., Ajmer, Government College campus, 10. viii. 1960 ; (ix) 5 exs., Abu Road., near Railway Station, 26. ix. 1959 ; (x) 2 exs., Mount Abu, 27. ix. 1959 ; (xi) 1 ex., Agra, Balwant Rajput College campus, 25. iii. 1960 ; (xii) 7 exs., Agra, Balwant Rajput College campus, 15. viii. to 9. ix. 1962 ; (xiii) 2 exs., Delhi, Indian Agricultural Research Institute campus, 12. x. 1960 ; (All Coll. *Joseph*). (xiv) 1 ex., Cuttack, Medical College campus, 13. viii. 1961 ; (Coll. *C. V. J. Varghese*).

For figures and description of males refer Joseph (1961a).

The specimens from Kerala darker than from other areas.

The ovipositor extends posteriorly a little beyond the ninth abdominal segment ; subgenital plate narrow and transversely elongated ; first valvifer broad basally ; second valvulae serrate nearly half of their length, serrations minute, innumerable and located on a well developed ridge.



TEXT-FIG. 7 (A-C). *Sardia rostrata* Melichar ; (D, E) *Liburnia furcifera* (Horvath)

(A) Ventral view of female abdomen. (B) Ventrolateral view of second valvulae. (C) Lateral view of third valvula. (D) Ventral view of female abdomen. (E) Ventrolateral view of second valvulae and lateral view of third valvula.

9. *Liburnia furcifera* (Horvath)

(Text-fig. 7, D & E)

1899. *Delphax furcifer* Horvath, *Természetr. Fiiz*, Budapest, 22, p. 372, fig. 1
(Type-locality : Yesso, Japan).

For figures of male refer Mathur & Joseph (1961c).

Material.—(i) 2 exs., Trivandrum, Agriculture College campus, 8. x. 1960 ; (ii) 2 exs., Kaladi, Church campus. 26. v. 1960 ; (iii) 11 exs.,

Trichur District, Valapad, 15—22. v. 1960 ; (iv) 1 ex., Trichur District, Ollur, 24. v. 1960 ; (All Coll. *Joseph*). (v) 36 exs., Coimbatore, Agriculture College campus, xii. 1958; (Coll. *M. G. R. Menon*). (vi) 1 ex., Poona, University campus, 7. iii. 1960 ; (vii) 55 exs., Ajmer, Government College campus, 20. vii. to 16. ix. 1959; (viii) 70 exs., Ajmer, Government College campus, 12. viii. to 15. ix. 1961 ; (ix) 6 exs., Abu Road, near Railway Station, 26. ix. 1966 ; (x) 17 exs., Jaipur, near Railway Station, 29. ix. to 2. x. 1966 ; (xi) 1 ex., Pilani, Birla College campus, 10. vii. 1961 ; (xii) 3 exs., Agra, Balwant Rajput College campus, 25. iii. 1960 ; (xiii) 34 exs., Agra, Balwant Rajput College campus, 15. vii. to 21. ix. 1962 ; (xiv) 9 exs., Delhi, Indian Agricultural Research Institute campus, 12. x. 1960 ; (All Coll. *Joseph*). (xv) 3 exs., Cuttack, Medical College campus 13. vii. 1961; (Coll. *C. V. J. Varghese*).

Length: *male* 2.7—3.2 mm. ; *female* 3.7—4.2 mm.

In profile almost wholly ochraceous dorsally. A creamy-white medio longitudinal area from the transverse carina of head to hind border of mesonotum ; external to this the mesonotum black. Tegmina subhyaline, tinted with brownish-ochraceous at the posterior half which becomes a little darker apically and also beneath the fused first and second anal veins. Antennae, carinae of frons, clypeus and legs ochraceous. Body beneath dark brown with ochraceous marks in male, in female almost wholly ochraceous. Spur foliaceous with a large number of teeth (25—30). Scape almost equal in length to the pedicel. Vertex longer than broad, apex narrower than base. Vertex with a mediolongitudinal carina behind the transverse carina, the latter carina dividing the posterior region of vertex into two pentagonal areas ; pro- and mesonototricarinate, the lateral carinae of pronotum divergingly curved posteriorly and fade away before reaching the hind border.

Pygofer rather elongated, opening longer than broad, the ventro-median margin produced a little posteriorly, the anal angles rather pointed ; armature of diaphragm U-shaped and thickly sclerotised ; aedeagus periantrum tubular, basally enlarged, two rows of anteriorly directed spines meeting basally, one row starting from the external opening while the other well posterior to it, the spines gradually decrease in size posteriorly ; the paramere of peculiar scapula-like shape, somewhat circular at the base, abruptly bulged in middle, prominently internally, distally bifid ; the anal processes divergingly curved, bases well apart. The ovipositor extends upto the base of anal style ; subgenital plate small, lightly sclerotised and conical ; the first valvifer basally broad, inner margin incurved medially ; second valvulae serrate for three-fourths of their length.

10. *Liburnia pallescens* (Distant)

(Text-fig. 8)

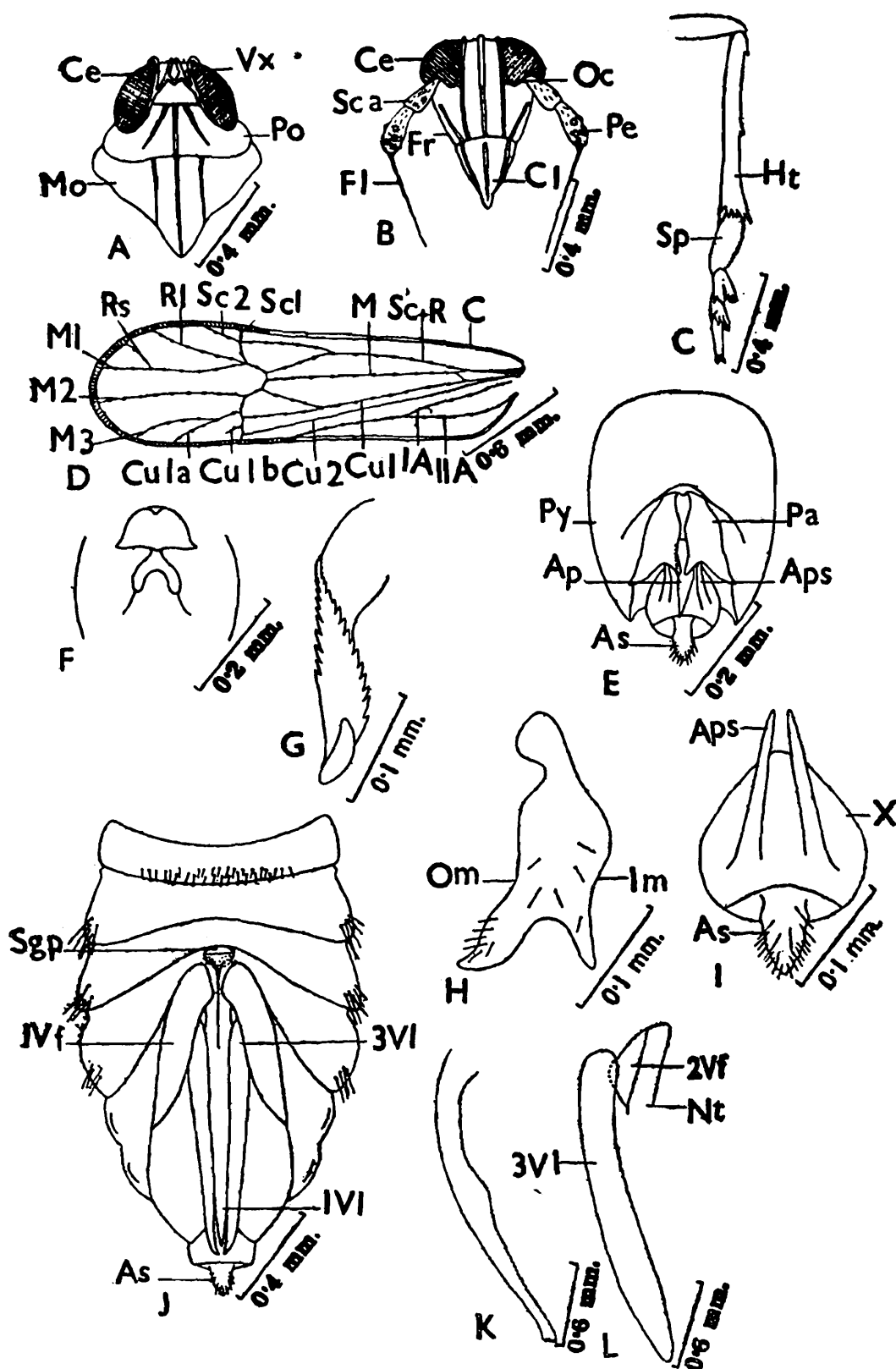
1912. *Sogata pallescens* Distant, *Ann. Mag. nat. Hist.*, London, (8) 9, p. 190.
(Type-locality : Galle, Ceylon. Chapra, between Bopore and Rampore Haut, Bihar, Calcutta).

Material.—(i) 1 ex., Trivandrum, Agriculture College campus, 8. x. 1960 ; (ii) 2 exs., Kaladi, Church campus, 26. v. 1960 ; (iii) 5 exs., Trichur District, Valapad, 15—18. v. 1960 ; (All Coll. *Joseph*) ; (iv) 4 exs., Calicut, Medical College campus, 18—21. ix. 1961 ; (Coll. *A. N. A. Johnny.*) (v) 63 exs., Coimbatore, Agriculture College campus,—xii. 1958 ; (Coll. *M. G. R. Menon.*) (vi) 6 exs., Poona, University campus, 7—10. iii. 1960 ; (vii) 31 exs., Ajmer, Government College campus, 20. viii. to 16. ix. 1959 ; (viii) 58 exs., Ajmer, Government College campus, 12. viii. to 15. ix. 1961 ; (ix) 1 ex., Abu Road, near Railway Station, 26. ix. 1959 ; (x) 1 ex., Mount Abu, 27. ix. 1959 ; (xi) 16 exs., Jaipur, near Railway Station, 29. ix. to 2. x. 1959 ; (xii) 2 exs., Pilani, Birla College campus, 10. vii. 1961 ; (xiii) 4 exs., Agra, Balwant Rajput College campus, 25. iii. 1960 ; (xiv) 29 exs., Agra, Balwant Rajput College campus, 18. viii. to 21. ix. 1962 ; (xv) 4 exs., Delhi, Indian Agricultural Research Institute campus, 12. x. 1960 ; (All Coll. *Joseph*). (xvi) 2 exs., Cuttack, Medical College campus, 13. viii. 1961 ; (Coll. *C. V. J. Varghese*).

Length : *male* 3.0—3.5 mm. ; *female* 3.7—4.3 mm.

In profile ochraceous. A creamy-white mediolongitudinal area extending from the transverse carina of vertex to the hind margin of mesonotum included in the lateral carinae of pro- and mesonota ; external to this to a greater extent the mesonotum testaceous, castaneous or black. Tegmen subhyaline (Fig. d) with or without pale infumation at the posterodistal region. Antennae ochraceous. Abdomen and ventrally the thorax and head ochraceous, or testaceous or castaneous or black with ochraceous marks. Spur foliaceous with a number of teeth (14—20). Scape nearly equal in length to that of pedicel. Vertex a little longer than broad. The lateral carinae of frons nearly parallel ; no mediolongitudinal carina on vertex posterior to the transverse carina ; pro- and mesonota tricarinate, the lateral carinae of pronotum not reaching the hind margin and divergingly curved.

Pygofer large basally, the opening longer than broad, anal angles rather pointed and cover the tenth abdominal segment, the ventromedian margin produced a little posteriorly ; armature of diaphragm U-shaped, thickly sclerotised and projecting ; aedeagus periandrum tubular, basally swollen followed by a curve, two rows of anteriorly directed spines meeting basally, one row from the external opening while the other well posterior to it, the spines become gradually reduced in size from the distal to the proximal part ; parameres twice constricted, the posterior margin behind the basal constriction rather circular in outline, the distal margin asymmetrically divided into two by a deep notch, the outer one large and directed externally, the inner one small and straight ; the anal processes small and pointed, their bases well apart. Ovipositor extends upto the distal part of the tenth abdominal segment ; the second valvulae serrate or a little more than half of their length ; subgenital plate and first valvifer similar to those of *Liburnia furcifera* (Horvath).

TEXT-FIG. 8.—*Liburnia pallescens* (Distant)

(A) Dorsal view of head, pronotum and mesonotum. (B) Cephalic view of head. (C) Distal region of hind leg. (D) Tegmen. (E) Ventral view of pygofer. (F) Armature of diaphragm. (G) Aedeagus periantrum. (H) Ventral view of paramere. (I) Ventral view of tenth and eleventh male abdominal segments. (J) Ventral view of female abdomen. (K) Lateral view of second valvulae. (L) Lateral view of third valvula.

Muir (1919) synonymises *Liburnia pallescens* with *Liburnia furcifera* which has been followed by later workers. I do not agree with Muir, since I observe the following differences :—

	<i>L. furcifera</i>	<i>L. pallescens</i>
1. Colouration	dark	pale
2. Mediolongitudinal carina of vertex posterior to the transverse carina	distinct	obsolete
3. Number of spur teeth	25 to 30	14 to 20
4. Paramere	distal border only a little incurved	asymmetrically divided into two by a deep notch
5. Anal processes	short, divergingly curved	long, straight
6. Ovipositor	extends up to the base of anal style	extends only upto the distal part of the tenth segment
7. Second valvulae	serrate for three-fourths of their distance	only for a little more than half of their length

I should retain *Liburnia pallescens* as a distinct species, as originally done by Distant (1912).

11. *Liburnia pusana* (Distant)

(Text-fig. 9)

1912. *Sogata pusana* Distant, *Ann. Mag. nat. Hist.*, London, (8) 9, p. 191.
(Type-locality : Bengal. Pusa. Calcutta. Berhampur and Murshidabad District, Bengal.)

Material.—(i) 1 ex., Trivandrum, Agriculture College campus, 8. x. 1960 ; (ii) 1 ex., Kaladi, Church campus, 26.v. 1960 ; (iii) 3 exs., Trichur District, Valapad, 15—22.v. 1960 ; (All Coll. *Joseph*). (iv) 1 ex., Calicut, Medical College campus, 20. ix. 1961 ; (Coll. *A. N. A. Johnny*). (v) 25 exs., Coimbatore, Agriculture College campus,—. xii. 1958. (Coll. *M. G. R. Menon*). (vi) 2 exs., Poona, University campus, 10. iii. 1960 ; (vii) 6 exs., Ajmer, Government College campus, 20.vii. to 11. ix. 1959 ; (viii) 4 exs., Ajmer, Government College campus, 12. viii. to 5. i x. 1961 ; ix) 2 exs., Abu Road, near Railway Station, 26. ix. 1959 ; (x) 1 ex., Mount

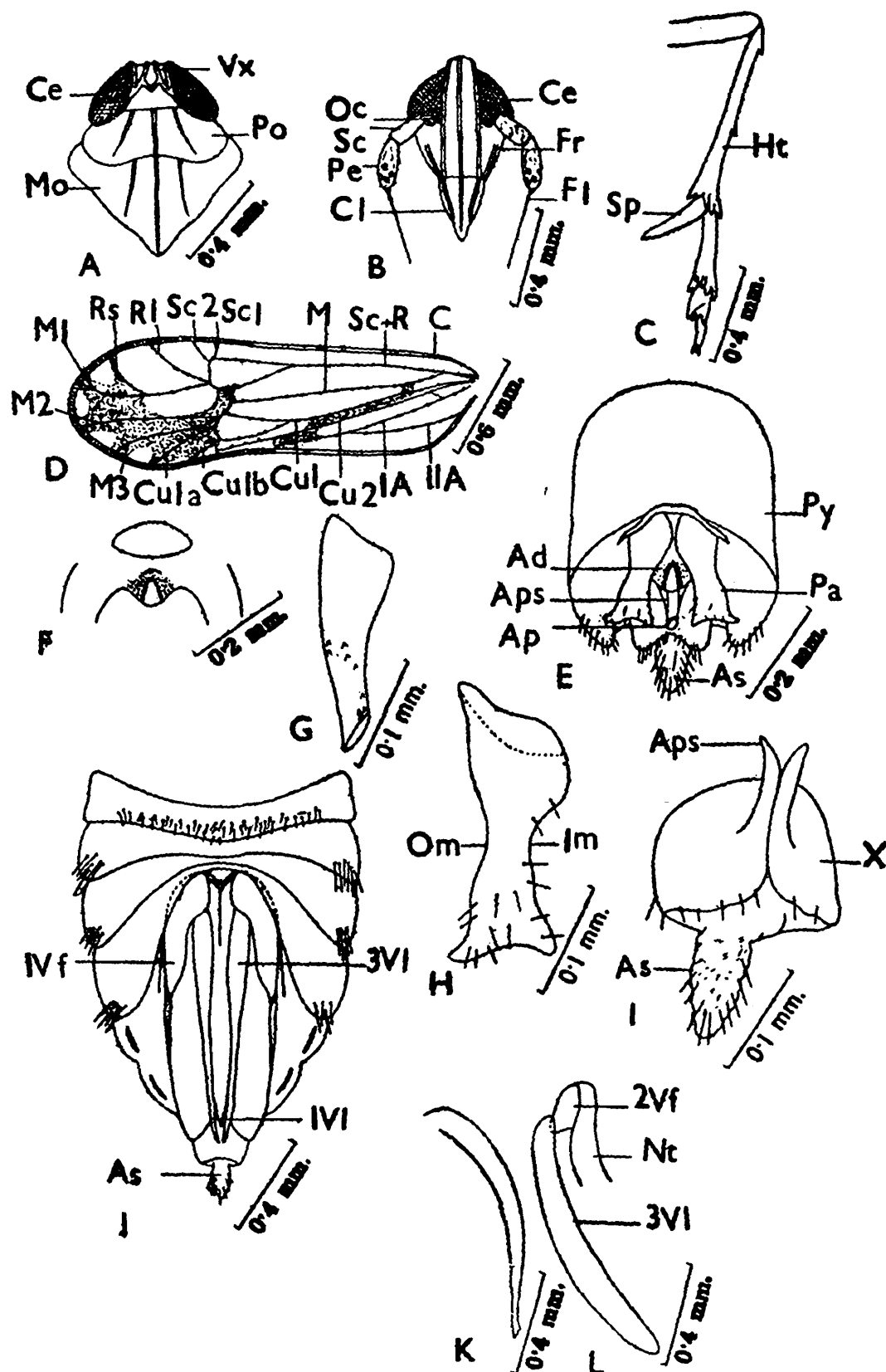
Aba, 27.ix. 1959; (xi) 1 ex., Pilani, Birla College campus, 10.vii. 1961; (xii) 1 ex., Agra, Balwant Rajput College campus, 25.iii. 1960 ; (xiii) 10 exs., Agra, Balwant Rajput College campus, 15.viii. to 21.ix. 1962 ; (xiv) 1 ex., Delhi, Indian Agricultural Research Institute campus, 12.x. 1960 ; (All Coll. *Joseph*).

Length : *male* 3.3—3.8 mm. ; *female* 3.5—4.0 mm.

Posterior to the transverse carina of vertex and the mediolongitudinal area of thoracic nota creamy or creamy-white with ochraceous tinge ; the said area of thorax bordered by piceous margin with ochraceous lateral areas. Tegmen subhyaline with brown or dark brown marks, the posterior margin white for one-third distance from the proximal border. Antennae, frontal carinae, metathorax and legs ochraceous, the metathorax with castaneous marks. Frons, pro- and mesonota and abdomen black or castaneous with ochraceous marks. Female lighter coloured ; generally ochraceous abdomen with castaneous marks. Spur foliaceous, with a large number of teeth (22—27). Scape almost equal in length to that of pedicel. Vertex a little longer than wide. The lateral carinae of frons almost straight ; no mediolongitudinal carina on vertex behind the transverse carina ; pro- and mesonota tricarinate, the lateral pronotal carinae divergently curved and stop a little in front of the posterior border.

Pygofer a little broader distally, the opening broader than long, anal angles rather rounded covering almost the tenth segment ; armature of diaphragm with numerous small projections arranged in an inverted V-form, the projections at the posterior margin large ; aedeagus periantrum tubular, base swollen followed by a curve, decorated with basally directed small spines whose number varies with the specimens, a few spines crowded near the external opening followed by two small rows of spines ; paramere medially constricted, distally with two projections ; anal processes short, bases appose each other, divergently curved distally. Ovipositor extends upto the middle of the tenth abdominal segment ; subgenital plate indistinct ; first valvifer similar to that

of *Liburnia furcifera*, though shorter ; second valvulae serrate for more than half of their length.



TEXT-FIG. 9.—*Liburnia pusana* (Distant)

(A) Dorsal view of head, pronotum and mesonotum. (B) Cephalic view of head. (C) Distal region of hind leg. (D) Tegmen. (E) Ventral view of pygofer. (F) Armature of diaphragm. (G) Aedeagus periantrum. (H) Ventral view of paramere. (I) Ventral view of tenth and eleventh abdominal segments. (J) Ventral view of female abdomen. (K) Lateral view of second valvulae. (L) Lateral view of third valvula.

12. *Dicranotropis cognata* Muir

(Text-fig. 10)

1917. *Dicranotropis cognata* Muir, *Proc. Hawail. ent. Soc.*, Honolulu, 3(4), pp. 319—320, pl. 5, figs. 25, 25a. (*Type-locality* : Daimakko, Formosa).

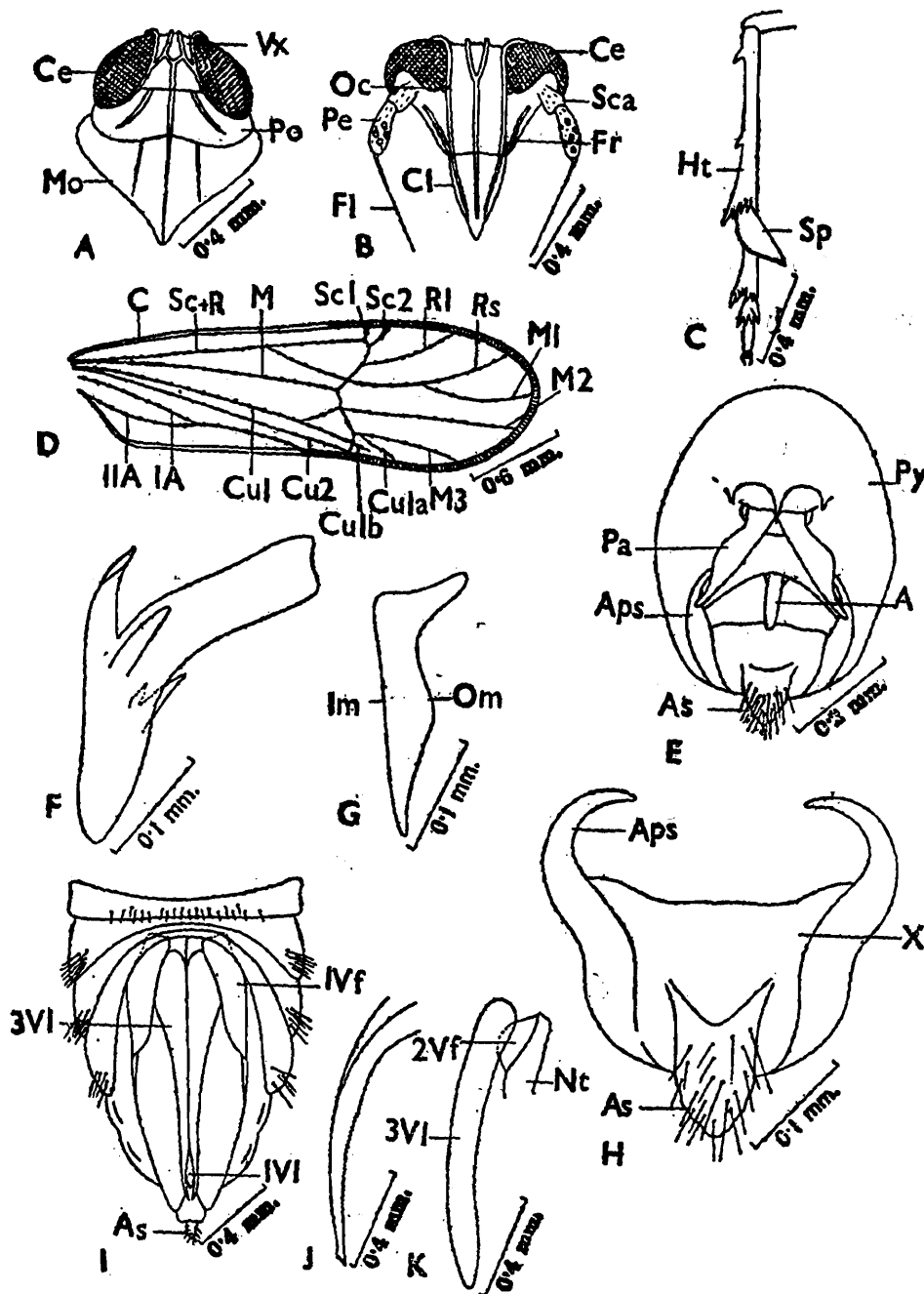
Material.—5 exs., Calicut, Medical College campus, 18—21. ix. 1961. (Coll. A. N. A. Johnny).

Length : *male* 3.0—3.3 mm. ; *female* 3.4—3.7 mm.

Vertex, pro- and mesonota ochraceous ; the area between the median and longitudinal carinae testaceous, carinae pale ; ventral side of head pale ochraceous-brown with ochraceous speckles in between the median and lateral carinae of frons. Antenna ochraceous. Ventral side of thorax and legs ochraceous, a castaneous speckle just above the coxae one on either side of metathorax. Tegmen subhyaline, its distal veins chocolate-brown. Abdomen dorsally ochraceous-brown with ochraceous markings ; ventral side ochraceous with ochraceous-brown marks, the latter colour dominant in male and the pygofer castaneous. Spur foliaceous with a large number of teeth (28—35). Pedicel nearly one and a half times the length of scape. Length of vertex nearly equal to the width at its base. The median carina of frons furcate at the lower margin of eyes ; pro- and mesonota tricarinate, the lateral carinae of pronotum divergingly curved and not reaching the hind border.

Pygofer swollen about the middle, opening longer than broad, the ventromedian margin bears three outgrowths, one median pointed spine-like projection and two small, lateral, ventrally curved outgrowths; diaphragm without armature; aedeagus periandrum arcuate, cylindrical and ornamented with four spines, one of them dorsal, large, directed anterodorsally and twisted towards the distal end, the remaining three lateral in position and directed anterodorsally, two of them in one cluster and the other independent, those in cluster small and subequal; each paramere enlarged basally, swollen at the outer margin near the middle and pointed distally ; the fused tenth and eleventh segment

large with a well developed anal style, the anal processes well apart, basally large, curved and recurved. Ovipositor terminates a little anterior to the hind margin of ninth segment; subgenital plate indistinct; first valvifer broad basally; second valvulae serrate for more than half of their length.



TEXT-FIG. 10.—*Dicranotropis cognata* Muir

(A) Dorsal view of head, pronotum and mesonotum. (B) Cephalic view of head. (C) Distal region of hind leg. (D) Tegmen. (E) Ventral view of pygofer. (F) Aedeagus periandrum. (G) Ventral view of paramere. (H) Ventral view of tenth and eleventh male abdominal segments. (I) Ventral view of female abdomen. (J) Ventrolateral view of second valvulae. (K) Lateral view of third valvula.

13. *Sogata rhodesi* Muir

(Text-fig. 11)

1929. *Sogata rhodesi* Muir, *Ann. Mag. nat. Hist.*, London, (10) 4, pp. 208—209, figs. 28—30. (Type-locality : Eshowe, Zululand).

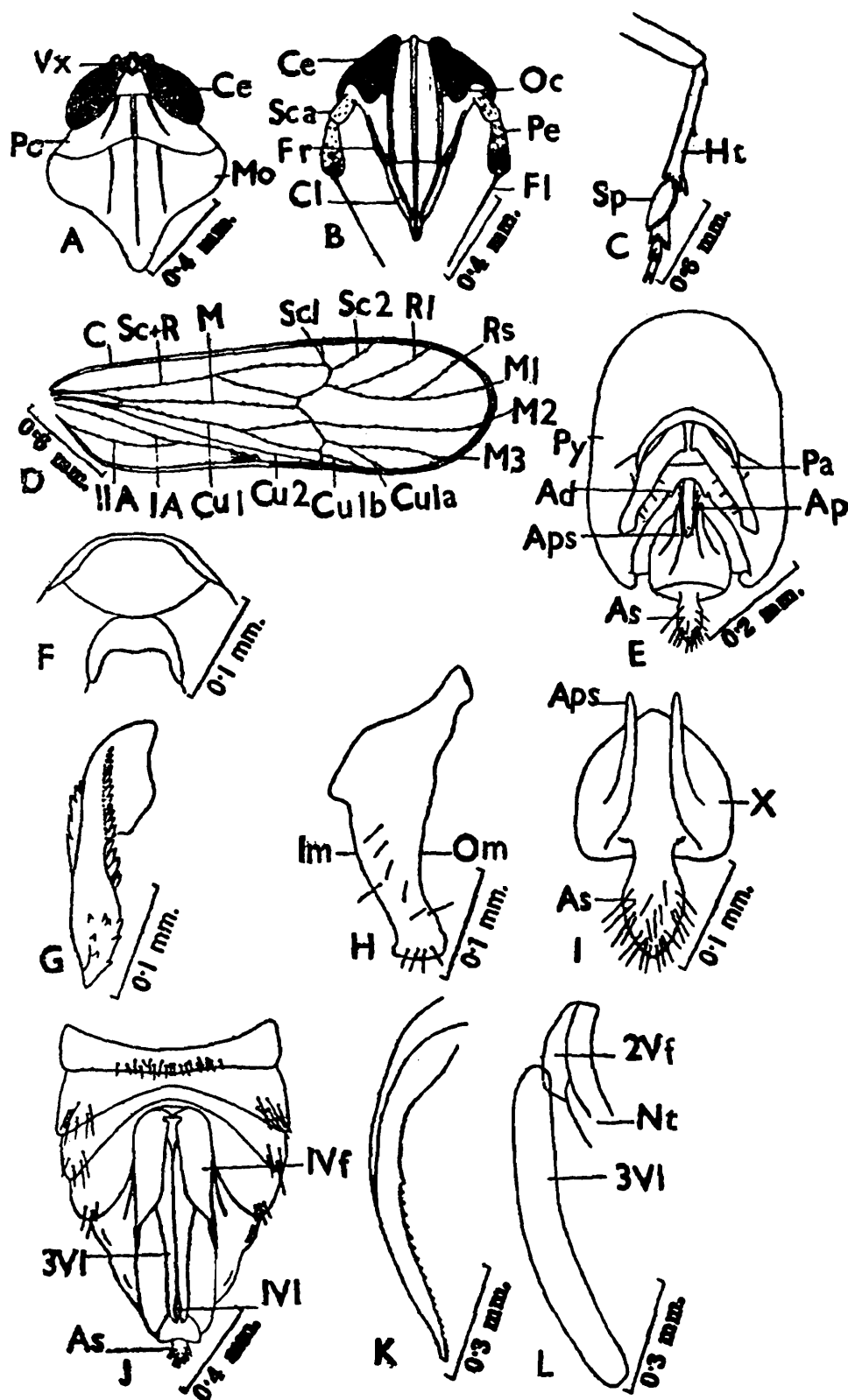
Material.—(i) 4 exs., Trivandrum, Agriculture College campus, 5—8.x.1960 ; (Coll. A. V. Joseph). (ii) 2 exs., Calicut, Medical College campus, 18—21.ix.1961 ; (Coll. A. N. A. Johny). (iii) 1 ex., Poona, University campus, 9.iii.1960 ; (Coll. Joseph).

Length : *male* 2.8—3.3mm.; *female* 3.1—3.6 mm.

Vertex, pro- and mesonota ochraceous ; ventrally the head black with its lateral margins and labrum ochraceous, carinae ochraceous. Antenna ochraceous with a castaneous ring at the distal margin of scape. Tegmen subhyaline, the distal veins pale brown with a castaneous speckle at the region where the 'Y' vein joins the anal margin. Ventral side of pro- and mesothorax ochraceous, legs castaneous, their coxae and trochanters with castaneous streaks or with castaneous pale enfumation. In males the abdomen black, the medioventral area, the ventrolateral margins and the posterior border of each segment ochraceous. The females invariably lighter coloured, ochraceous with castaneous or pale brown marks whose extent varies with the specimens. Spur foliaceous with about twenty teeth. The first tarsomere of the hind leg longer than other two together. Pedicel more than one and a half times the length of scape. Vertex longer than wide. The frontal carina furcate at its very base ; no mediolongitudinal carina on the vertex behind the transverse carina ; pro- and mesonota tricarinate, the lateral carinae of the former diverging and disappear a little in front of the hind border, the mesonotal carinae not reaching the hind border.

The opening of pygofer as broad as long, anal angles well produced, rounded and curved inwards to cover the tenth segment ; the diaphragm with an inverted U-shaped highly sclerotised thickening as its armature ; the aedeagus periandrium subtubular, laterally compressed and decorated with a few scattered, small spines distally, one row of five or six spines ventrally and another long, oblique row of a large number of spines opposite to the first row on a flange ; the paramere of peculiar shape with a projection at the basal angle, another small at the distal end towards the inner margin ; anal processes medium sized, flattened, apart basally and nearly straight, the anal style well developed. The ovipositor extends upto the posterior margin of the ninth abdominal

segment; subgenital plate indistinct; the first valvifer with a small hook-like projection at the antero-inner margin; the second valvulae serrate for more than half of their length, the serrations large and basally apart.



TEXT-FIG. 11.—*Sogata rhodesi* Muir

(A) Dorsal view of head, pronotum and mesonotum. (B) Cephalic view of head. (C) Distal region of hind leg. (D) Tegmen. (E) Ventral view of pygofer. (F) Armature of diaphragm. (G) Aedeagus perianth. (H) Ventral view of paramere. (I) Ventral view of tenth and eleventh male abdominal segments. (J) Ventral view of female abdomen. (K) Ventrolateral view of second valvulae. (L) Lateral view of third valvula.

14. *Nilaparvata lugens* (Stål)

(Text-fig. 12)

1854. *Delphax lugens* Stål, *Ofvers. Vetensk Akad. Forh.*, Stockholm, 11, p. 246. (Type-locality : Java).

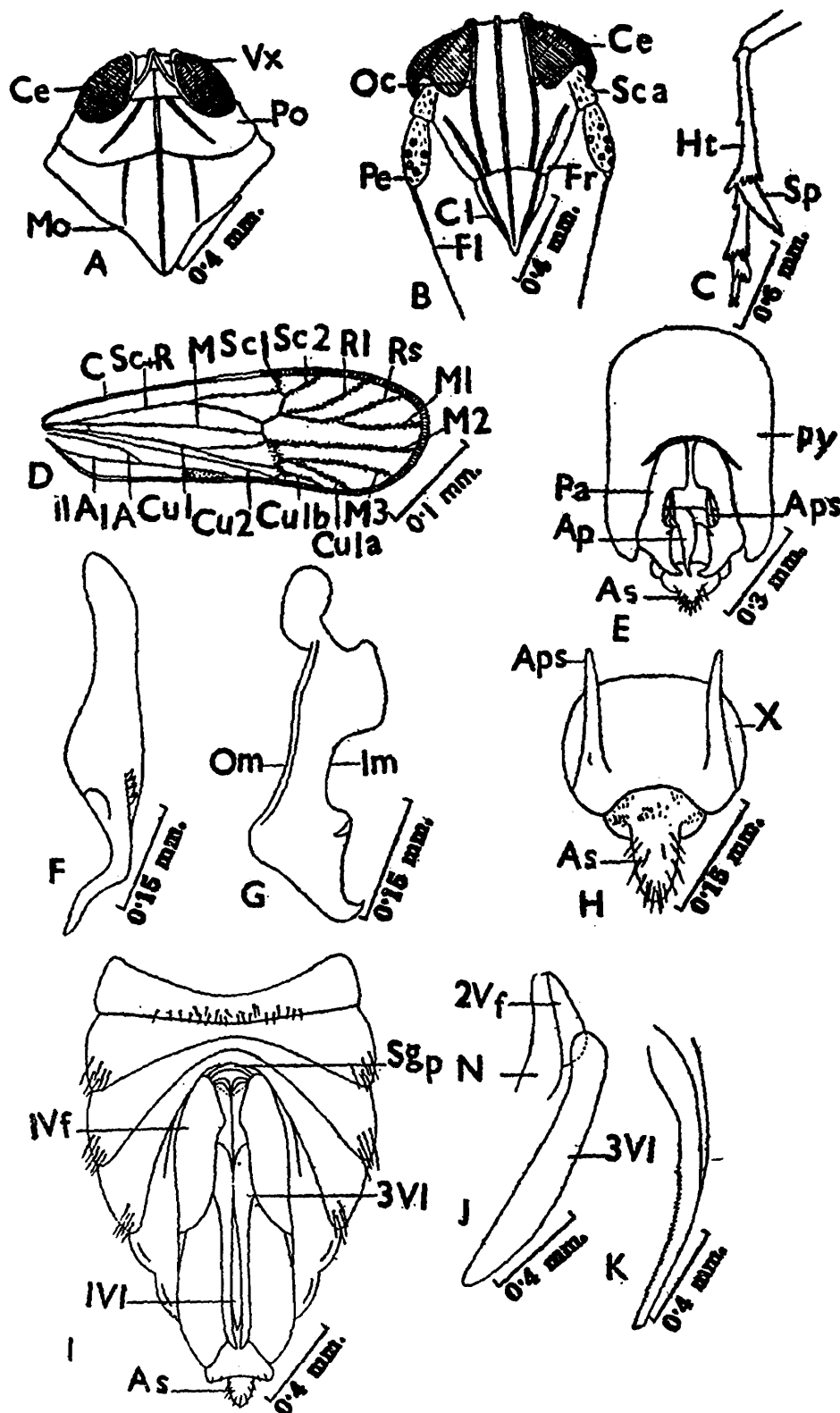
Material.—(i) 1 ex., Trivandrum, Agriculture College campus, 5—8.x.1960 ; (Coll. A. V. Joseph). (ii) 3 exs., Kaladi, Church campus, 26.v.1960 ; (iii) 23 exs., Trichur District, Valapad, 15—22.v.1960 ; (iv) 3 exs., Trichur District, Ollur, 24.v.1960 ; (A11 Coll. Joseph). (v) 5 exs., Calicut, Medical College campus, 18—21.ix.1961 ; (Coll. A.N.A. Johny). (vi) 90 exs., Coimbatore, Agriculture College campus,—xii. 1958 ; (Coll. M. G. R. Menon). (vii) 16 exs., Poona, University campus, 7—10.iii.1960 ; (Coll. Joseph). (viii) 4 exs., Ajmer, Government College campus, 3—5.ix.1961 ; (Coll. Joseph).

Length : *male* 3.5—4.0 mm. ; *female* 4.3—4.8 mm.

Almost wholly ochraceous or pale ochraceous. Vertex and mesonotum rather light brown ; in many cases, especially in males, the mesonotum, pronotum and head brown, in such cases the abdomen either follows the same colouration with ochraceous markings or piceous or black with ochraceous marks. Antenna ochraceous. Tegmen subhyaline with a small dark-brown enfumation at the region where the combined anal vein joins the border, the distal veins as well as their borders brown. Spur foliaceous with a large number of teeth (21—31). The first tarsomere of the hind leg provided with one to four small spines. Scape longer than half the length of pedicel. Vertex almost as wide as long. Mediolongitudinal carinae of vertex meeting at the base of frons ; the pro- and mesonota tricarinate, the pronotal carinae divergingly curved posteriorly and stop a little in front of the hind border.

Pygofer elongated, distal margin wider, opening longer than broad, anal angles rounded and cover the tenth abdominal segment ; diaphragm without armature ; aedeagus periantrum tubular, curved and recurved distally, extending posteriorly to a considerable distance after the external opening, a shallow constriction towards the base, the external opening located at its lateral side and ornamented with four anterolaterally directed spines adjacent to the external opening, distal to the opening much narrowed ; paramere convergingly curved, constricted medially and distally, posterior to the distal constriction triangular with the distal angle produced into a curved spine, at the base of the triangle towards the inner side a small pointed outgrowth directed ventrally, proximal to the constriction it projects internally ; the anal processes straight, well apart

basally. Ovipositor stops posteriorly a little short of the ninth abdominal segment; subgenital plate for the major part hidden; first valvifer conical basally; second valvulae serrate for a little more than half of their length.



TEXT-FIG. 12.—*Nilaparvata lugens* (Stål)

(A) Dorsal view of head, pronotum and mesonotum. (B) Cephalic view of head. (C) Distal region of hind leg. (D) Tegmen. (E) Ventral view of pygofer. (F) Aedeagus periandrum. (G) Ventral view of paramere. (H) Ventral view of tenth and eleventh male abdominal segments. (I) Ventral view of female abdomen. (J) Lateral view of third valvula. (K) Ventrolateral view of second valvulae.

15. *Delphacodes propinqua* Fieber

(Text-fig. 13)

1866. *Delphacodes propinqua* Fieber, *Verh. Zool.-bot. Ges. Wien.*, Vienna, 16, p. 525, pl. 8, fig. 24. (Type-locality : Trieste, Europe. Malaga, Spain).

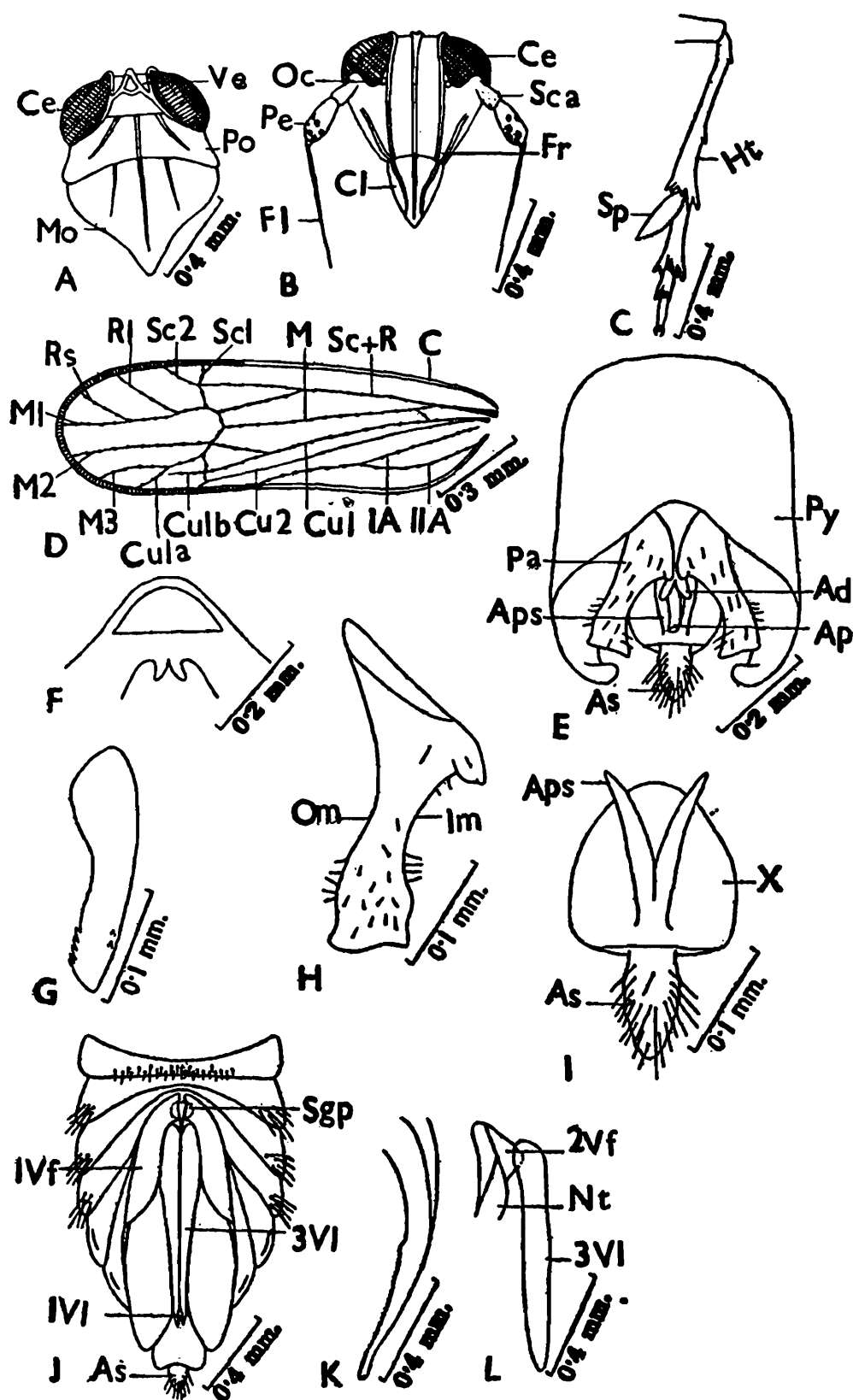
Material.—(i) 4 exs., Trivandrum, Agriculture College campus, 8.x.1960 ; (ii) 2 exs., Kaladi, Church campus, 26.v.1960 ; (Coll. *Joseph*). (iii) 5 exs., Calicut, Medical College campus, 18—21.ix.1961 ; (Coll. *A. N. A. Johnny*). (iv) 48 exs., Coimbatore, Agriculture College campus, —.xii. 1958 ; (Coll. *M. G. R. Menon*). (v) 2 exs., Poona, University campus, 9.iii.1960 ; (vi) 25 exs., Ajmer, Government College campus, 20.viii. to 16.ix.1959 ; (vii) 61 exs., Ajmer, Government College campus, 12. viii. to 15.ix.1961 ; (viii) 2 exs., Abu Road, near Railway Station, 26.ix.1959 ; (ix) 1 ex., Mount Abu, 27.ix.1959 ; (x) 13 exs., Jaipur, near Railway Station, 29.ix. to 2.x.1959 ; (xi) 1 ex., Pilani, Birla College campus, 10.vii. 1961 ; (xii) 1 ex., Agra, Balwant Rajput College campus, 25.iii. 1960 ; (xiii) 29 exs., Agra, Balwant Rajput College campus, 20.viii. to 21.ix. 1962 ; (xiv) 4 exs., Delhi, Indian Agricultural Research Institute campus, 12.x.1960 ; (All Coll. *Joseph*). (xv) 3 exs., Cuttack, Medical College campus, 13.viii. 1961 ; (Coll. *C. V. J. Varghese*).

Length : *male* 2.9—3.3 mm. ; *female* 3.4—3.8 mm.

Colouration much varies. Vertex, pronotum and mesonotum ochraceous, their carinae pale ; ventral side of head either black or castaneous with ochraceous carinae ; the carinae of frons narrowly margined on either side with castaneous except the external border of the outer carinae. Ventral side of mesothorax chocolate brown, castaneous or black with ochraceous marks ; in metathorax *vice versa*. Legs wholly ochraceous or ochraceous with brown streaks ; generally the hindtrochanter fuscous or castaneous. Tegmina subhyaline, their veins pale brown. Abdomen of male black, castaneous or chocolate brown and ventrolateral sides white. In females almost wholly ochraceous with chocolate-brown or fuscous marks. Spur foliaceous with a number of teeth (16—25). Pedicel considerably longer than scape. Vertex as wide as long. Median carina of frons furcate at its base ; mediolongitudinal carina posterior to the transverse carina of vertex absent ; pro- and mesonota tricarinate, the lateral carinae of pronota divergingly curved and not reaching the hind margin.

Opening of pygofer broader than long, anal angles highly developed, projected well above the tenth segment and curved internally to form partly a roof over the parameres ; diaphragm with a pair of well developed, horn-like outwardly directed projections as armature ; aedeagus periandrium small, tubular, pistol-shaped and decorated with two rows of basally directed spines towards the distal part, one row at the distal side having five to six spines and the other slightly lateral to the dorsal side with two to three spines ; paramere swollen for three-fourth distance from the base while the remaining part flat, narrow towards the middle, at the basal angle the paramere gives a small projection and distally it terminates in two small lateral projections ; anal style well developed, anal processes divergingly curved distally and basally appose each other.

Ovipositor stops a little anterior to the hind end of the ninth abdominal segment ; subgenital plate small and hidden by the first valvifers, the latter broader proximally ; second valvulae serrate for more than half of their length.



TEXT-FIG. 13.—*Delphacodes propinqua* Fieber

(A) Dorsal view of head, pronotum and mesonotum. (B) Cephalic view of head. (C) Distal region of hind leg. (D) Tegmen. (E) Ventral view of pygofer. (F) Armature of diaphragm. (G) Aedeagus periandrum. (H) Ventral view of paramere. (I) Ventral view of tenth and eleventh male abdominal segments. (J) Ventral view of female abdomen. (K) Ventrolateral view of second valvulae. (L) Lateral view of third valvula.

16. *Delphacodes crawfordi* Muir & Giffard

(Text-fig. 14)

1924. *Delphacodes crawfordi* Muir & Giffard, *Bull. Hawaii. Sug. Asst., ent. Sec.*, Honolulu, No. 15, p. 34, pl. 3, fig. 29 and pl. 5, fig. 97a (Type-locality : Mexico).

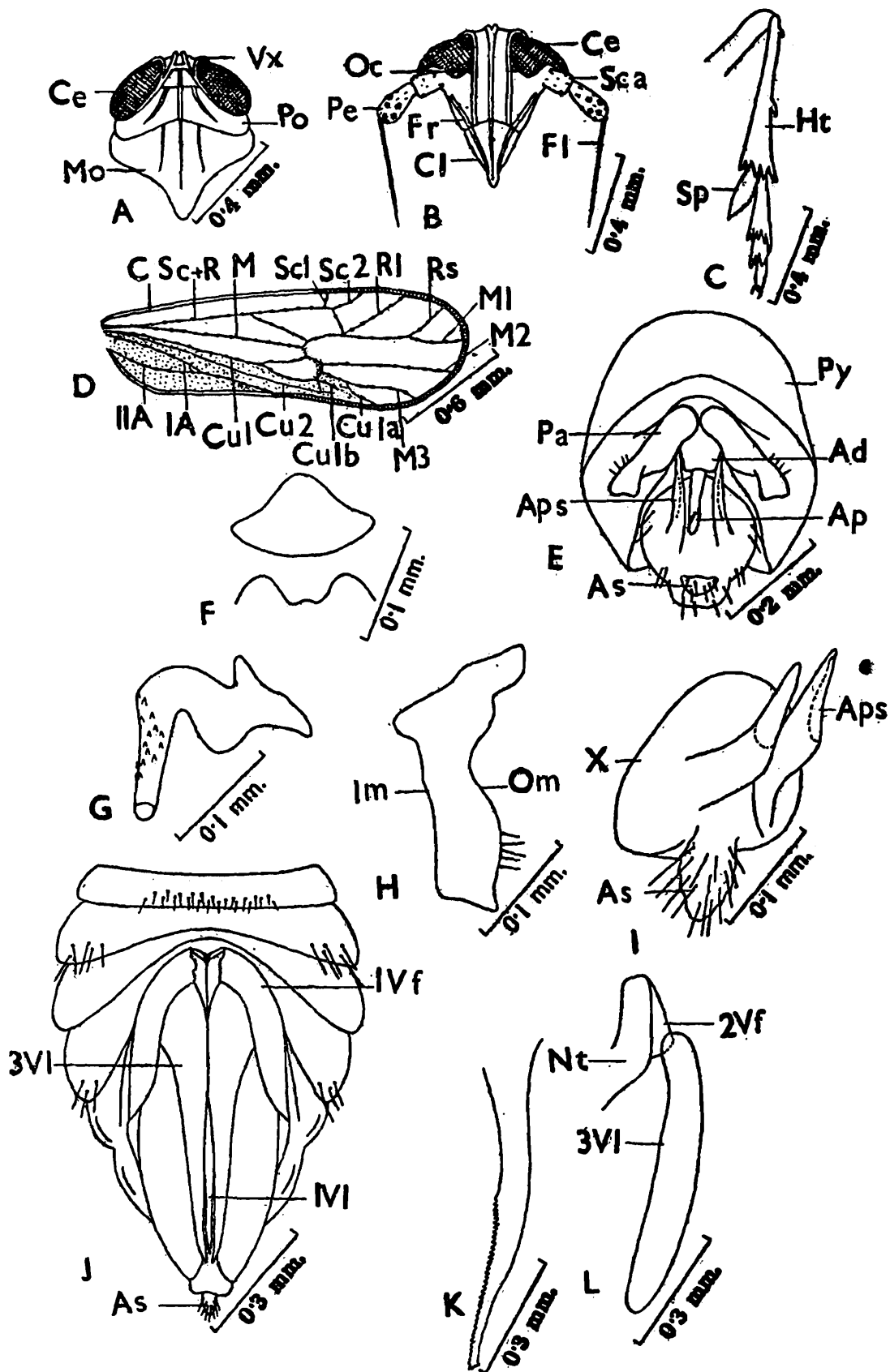
Material.—(i) 2 exs., Trivandrum, Agriculture College campus, 8.x.1960 ; (ii) 5 exs., Poona, University campus, 7—10. iii.1960 ; (All Coll. *Joseph*).

Length : *male* 2.4—2.7 mm. ; *female* 2.6—3.0 mm.

Vertex and pronotum ochraceous ; mesonotum black with ochraceous posterior margin ; in female the area between the lateral and median carinae also ochraceous. Ventrally the head black, the carinae ochraceous with a thin black line medially. Scape black, pedicel ochraceous. Tegmen subhyaline and speckled with a castaneous mark at the region where the combined anal vein joins the anal margin, with or without pale enfumation posterior to (Cu_1). Ventral side of pro- and mesothorax black or castaneous with ochraceous marks and *vice versa* in metathorax. Legs ochraceous with castaneous or black streaks. Abdomen black with an ochraceous red area at the anterolateral region, the lateral areas and the hind margin of the segments ochraceous. Females lighter coloured. Spur foliaceous, almost as long as the first tarsomere ; sixteen teeth generally, the number varies from fourteen to eighteen. Scape almost as broad as long ; pedicel twice the length of scape. Vertex as wide as long. Median carina of frons furcate at its base ; medio-longitudinal carina of vertex posterior to the transverse carina faint ; pro- and mesonota tricarinate, the lateral carinae of former diverging and stop before reaching the hind border.

Opening of pygofer broader than long, anal angles rather rounded and cover the tenth segment ; diaphragm with a small projection as armature, the latter almost as broad as long, distal margin incurved ; aedeagus periandrum laterally compressed for the proximal one-third, apical two-thirds, strongly curved and tubular, distal part ornamented with a number of small spines at its ventral and ventrolateral sides ; paramere swollen at the middle towards the internal side, diverge posteriorly, basal angle small and rounded, in ventral view concave internally and convex externally towards the distal part ; anal processes laterally flattened, long and extend upto the base of diaphragm, their bases moderately wide apart, in front view slightly sinuate, curiously enough they open externally at their lateral sides a little away from the middle. Ovipositor stops a little in front of the posterior end of the ninth abdo-

minal segment ; first valvifer broad proximally ; subgenital plate indistinct ; second valvulae serrate for more than half of their length.



TEXT-FIG. 14.—*Delphacodes crawfordi* Muir & Giffard

(A) Dorsal view of head, pronotum and mesonotum. (B) Cephalic view of head. (C) Distal region of hind leg. (D) Tegmen. (E) Ventral view of pygofer. (F) Armature of diaphragm. (G) Aedeagus periandrum. (H) Ventral view of paramere. (I) Ventrolateral view of tenth and eleventh male abdominal segments. (J) Ventral view of female abdomen. (K) Lateral view of second valvulae. (L) Lateral view of third valvula.

IV—SUMMARY

It is a preliminary survey of araeopids from various parts of India and 16 species under 11 genera have been described. 4 species, namely, *Sogata rhodesi* Muir, *Delphacodes crawfordi* Muir & Giffard, *Phyllodinus sauteri* Muir and *Dicranotropis cognata* Muir are reported for the first time from India.

V—ACKNOWLEDGEMENTS

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VI—REFERENCES

- DISTANT, W. L. 1906. *Fauna of British India*, Rhynchota, 3, pp. 1—503 London (Taylor & Francis).
- DISTANT, W. L. 1916. *Fauna of British India*, Rhynchota, 6, pp. 1—248. London (Taylor & Francis).
- GIFFARD, W. M. 1921. The systematic value of male genitalia of Delphacidae (Homoptera).—*Ann. ent. Soc. Amer.*, Columbus, 46 (7), pp. 135—140.
- JOSEPH, A. N. T. 1961a. Taxonomic notes on *Sardia rostrata* Melichar Homoptera, Fulgoroidea, Delphacidae (=Araeopidae).—*J. Bombay nat. Hist. Soc.*, Bombay, 58, pp. 48—52.
- JOSEPH, A. N. T. 1961b. Studies on the external morphology of *Peregrinus maidis* (Ashmead) (Homoptera, Fulgoroidea, Araeopidae=Delphacidae). Part III, Abdomen.—*J. Anim. Morph. Physiol.*, Baroda, 8 (2), pp. 93—99.
- MATHUR, P. N. & JOSEPH, A. N. T. 1961a. Studies on the external morphology of *Peregrinus maidis* (Ashmead) (Homoptera, Fulgoroidea, Araeopidae=Delphacidae). Part I, Head capsule and mouth parts.—*J. Anim. Morph. Physiol.*, Baroda, 8 (1), pp. 1—10.
- MATHUR, P. N. & JOSEPH, A. N. T. 1961b. Studies on the external morphology of *Peregrinus maidis* (Ashmead) (Homoptera, Fulgoroidea, Araeopidae=Delphacidae). Part II, Thorax.—*J. Anim. Morph. Physiol.*, Baroda, 8 (2), pp. 81—92.
- MATHUR, P. N. & JOSEPH, A. N. T. 1961c. Observations on the external morphology of *Liburnia furcifera* (Horvath) (Homoptera, Fulgoroidea, Araeopidae).—*Proc. Indian Acad. Sci.*, Bangalore, 53 (5), pp. Sec. B, pp. 263—273.
- METCALF, Z. P. 1943. *General Catalogue of Hemiptera*, Fasc. IV, Part 3, Delphacidae, 1—552. (Smith College, Northampton, Mass., U.S.A.).
- MUIR, F. 1915. A contribution towards the taxonomy of Delphacidae.—*Canad. Ent.*, Ontario, 47, pp. 208—212, 261—271, 296—302 and 317—320.

- MUIR, F. 1919. Notes on the Delphacidae in the British Museum.—*Canad. Ent., Ontario*, **51**, pp. 6—8.
- MUIR, F. 1921. On some Delphacidae from South India. *Proc. Hawaii. ent. Soc.*, Honolulu, **4**, pp. 480—486.
- MUIR, F. 1922. New Indian Homoptera.—*Rec. Indian Mus.*, Calcutta, **24**, pp. 343—355.

VII—ABBREVIATIONS USED IN TEXT—FIGURES

<i>A.</i> , first anal.	<i>Oc.</i> , ocellus.
<i>IIA.</i> , second anal.	<i>Om.</i> , outer margin of paramere.
<i>A; Ap.</i> , aedeagus perianthrum.	<i>Pa.</i> , paramere.
<i>Aps.</i> , anal processes.	<i>Pe.</i> , pedicel.
<i>As.</i> , anal style.	<i>Po.</i> , pronotum.
<i>C.</i> , cost:	<i>Py.</i> , pygofer.
<i>Ce.</i> , compound eye.	<i>Rl.</i> , radial one.
<i>Cl.</i> , clypeus.	<i>Rs.</i> , radial sector.
<i>Cul.</i> , cubitus one.	<i>Sca.; Sc.</i> , scape.
<i>Cula.</i> , first branch of cubitus one.	<i>Sc1.</i> , first branch of subcosta
<i>Culb.</i> , second branch of cubitus one.	<i>Sc2.</i> , second branch of subcosta.
<i>Cu2.</i> , cubitus two.	<i>Sc+R.</i> , subcosta plus radius.
<i>Fl.</i> , flagellum.	<i>Sgp.</i> , subgenital plate.
<i>Fr.</i> , frons.	<i>Sp.</i> , spur.
<i>Ht.</i> , tibia.	<i>IVf.</i> , first valvifer.
<i>Im.</i> , inner margin of paramere.	<i>2Vf.</i> , second valvifer.
<i>M.</i> , media.	<i>1Vl.</i> , first valvula.
<i>M1.</i> , first branch of media.	<i>2Vl.</i> , second valvula.
<i>M2.</i> , second branch of media.	<i>3Vl.</i> , third valvula.
<i>M3.</i> , third branch of media.	<i>Vx.; Vs.</i> , vertex.
<i>Mo.</i> , mesonotum.	<i>X.</i> , tenth abdominal segment.
<i>Nt.</i> , ninth tergum.	

STUDIES ON THE INDIAN ISOPODS PT. 2 NOTES ON THE ONISCID COLLECTION FROM THE KAMENG DIVISION OF NEFA

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(With one text-figure)

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I—INTRODUCTION

The material reported here deals with terrestrial Isopods collected in 1961 by Dr. K. C. Jayaramakrishnan in the Kameng Division, North-Eastern Frontier Agency. Although small in number, the collection includes fascinating forms. It consists of four species belonging to four genera viz., *Porcellio* Latreille, *Philoscia* Latreille, *Porcellionides* Miers and *Cubaris* Brandt and two families. Of the family Oniscidae, *Porcellio* and *Philoscia* were collected at elevations of 1982 and 2012 metres and *Porcellionides* was collected from 593 metres. The Armadillidae is represented by a single species viz., *Cubaris marmoratus* Collinge in the collection. This was also collected from an elevation of 1982 metres.

II—SYSTEMATIC ACCOUNT

TRIBE ONISCOIDEA

FAMILY ONISCIDAE

1. *Porcellio assamensis* Chopra

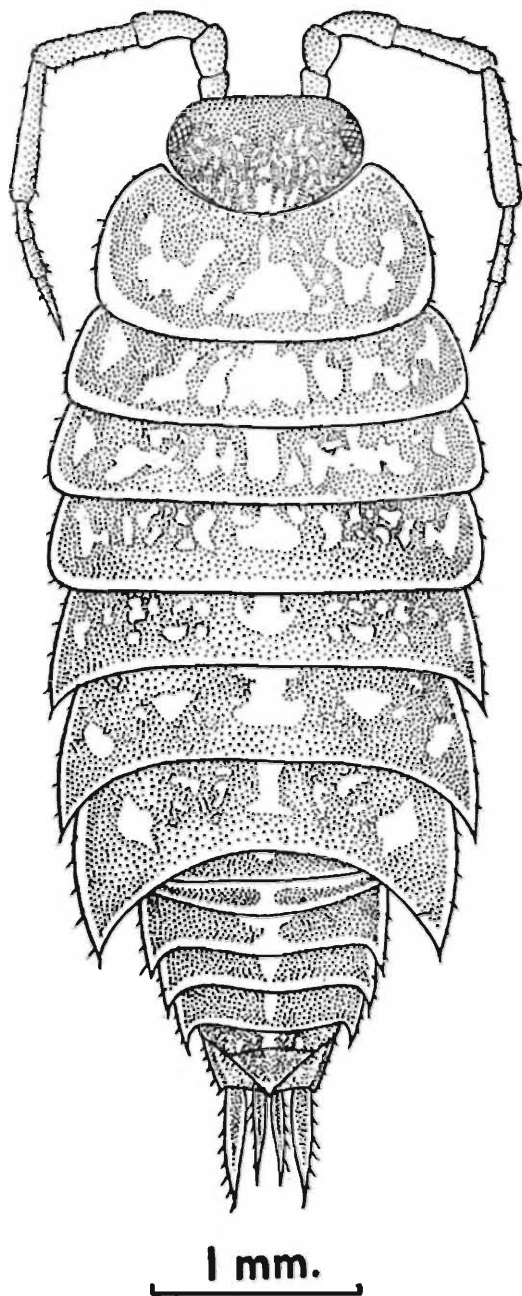
1924. *Porcellio assamensis* Chopra, *Rec. Indian Mus.*, 26(1), p. 51, text-figs. 1 & 2.

Rec. Zool. Surv. India. 63 (1-4), 1971.

(181)

Ten specimens of this somewhat rare species were collected from below the stones above the confluence of Milan Kang with R. Digien, alt. ca. 1982 m., 20.iv.1961.

Porcellio assamensis was first described by Chopra in 1924 from Siju Cave, Garo Hills in Assam. Subsequently, for about three decades, there have been no records of this species. Needless to say, its record now for the first time from the Kameng Division of NEFA is of special interest from the point of view of its distribution.



TEXT-FIG. 1.—*Philoscia muscorum* (Scopoli)—Dorsal view.

2. *Philoscia muscorum* (Scopoli)

(Text-figure 1)

- 1863. *Oniscus muscorum* Scopoli, *Entomologia Carniolica*, p. 415.
- 1885. *Philoscia muscorum* (Scopoli) : Budde Lund, *Crust. Isopoda Terrestria*, p. 207.
- 1889. *Philoscia muscorum* (Scopoli) : Sars, *An account of the Crustacea of Norway*, 2, p. 173, pl. 76, fig. 1.

The genus *Philoscia* differs from *Porcellio* in having a three-segmented antennal flagellum and in the absence of lateral and central lobe on the head. Only three species of this genus have so far been recorded from India. Collinge (1915) described *P. tenuissima* from Madras. Budde Lund (1894) and Chopra (1924) described two cave forms namely, *P. coeca* and *P. dobakholi* from the Moulmein cave in Burma and Siju cave in Assam respectively. In addition, there are two other records of this genus from N. E. Assam and Abor Country by Collinge (*loc. cit.*) who did not give them any specific names.

This species is represented by two specimens collected from below stones, about 1.6 km. north-west of Shergaon, alt. 2012 m., 7.v.1961.

Philoscia muscorum has a fairly wide range of distribution over Europe and Africa, being known from Britain, Denmark, Germany, Poland, Austria, France, Spain, Italy and Algeria. So far, as I am aware, this species has not been recorded from India. Therefore, its occurrence now reported for the first time from the Kameng Division of NEFA is, indeed, very significant.

3. *Porcellionides pruinosus* (Brandt)

1833. *Porcellio pruinosus* Brandt, *Conspectus Crust. Oniscodorum*, p. 19.

1879. *Metoponorthus pruinosus* (Brandt) : Budde Lund, *Prospectus Isopoda terrestrium*, p. 4.

1911. *Porcellionides pruinosus* (Brandt) : Stebbing, *Rec. Indian Mus.*, 6(4), p. 189.

There are three specimens of this species in the present collection. They are collected from below stones and rotting wood in the jungle on way to Kalaktang, alt. 610 m., 10.iii.1961.

This species is considered to be rather cosmopolitan since its distribution extends from greater part of Europe, North Africa, North and South America and Sumatra (South-East Asia). However, in India Stebbing (1911) reported this species from Kurseong (1524 m.) from the Eastern Himalayas. Subsequently Collinge (1914) recorded from Rotung, Abor Country ; Kobo and Sadiya in the North Eastern Assam. It is now reported for the first time from the Kameng Division of the NEFA region.

Family : ARMADILLIDAE

4. *Cubaris marmoratus* Collinge

1916. *Cubaris marmoratus* Collinge, *Rec. Indian Mus.*, 8(9), p. 545, pl. 1, figs. 1—8.

A fairly large number of specimens referable to this species are represented in the collection. They were collected from below stones above the confluence of Milan Kang with Digien river, alt. 1982 m., 20.iv.1961.

Collinge (1916) described this species from specimens collected from under bark at Kobo, Abor Country. The species is characterized by the presence of small and narrow lobes of the maxillipede and by the shape of uropoda. Since then, the species has not been reported from India, this being the first record from Kameng Division, in NEFA.

III—SUMMARY

This short paper deals with terrestrial Isopods from the Kameng Division of North-Eastern Frontier Agency. The material consists of four species pertaining to two families viz., Oniscidae and Armadillidae. While *Philoscia muscorum* (Scopoli) is recorded for the first time from India, the other three species are reported for the first time from this region.

IV—REFERENCES

- BUDDE-LUND, G. 1894. Viaggio di Leonardo Fea in Birmaniae Regioni vicine. LXIV. Isopodi Terrestri.—*Ann. Mus. Civ. Stor. nat. Genova*, (2) 14, pp. 602-612.
- CHOPRA, B. N. 1924. Isopoda of the Siju Cave, Garo Hills, Assam.—*Rec. Indian Mus.*, Calcutta, 26(1), p. 51, text-fig. 1 & 2.
- COLLINGS, W. E. 1914. Terrestrial Isopoda.—*Rec. Indian Mus.*, Calcutta, 8 (6), pp. 465-469, pls. 31-33.
- COLLINGS, W. E. 1915. Contributions to a knowledge of the Terrestrial Isopoda of India. Pt. 1. On a collection from the Madras Province and Southern India.—*Rec. Indian Mus.*, Calcutta, 11(2), pp. 143-151, pls. iv to xii.
- COLLINGS, W. E. 1916. Terrestrial Isopoda II.—*Rec. Indian Mus.*, Calcutta, 8(9), pp. 543-545.
- STEBBING, T. R. R. 1911. Indian Isopods.—*Rec. Indian Mus.*, Calcutta, 6(4), pp. 179-191.

CONTRIBUTIONS TO THE STUDY OF BAGRID FISHES.
4. NOMENCLATURAL STATUS AND SYSTEMATIC POSI-
TION OF THE FISHES OF THE SUBGENUS *OSTEOBAG-*
RUS JAYARAM (SILUROIDEA : BAGRIDAE)

By

K. C. JAYARAM

Zoological Survey of India, Calcutta

(With five Text-figures)

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I—INTRODUCTION

In my revision of the genus *Mystus* Scopoli (Jayaram, 1955), I proposed *Osteobagrus* as a new subgenus, with *Pimelodus aor* Hamilton as the type-species. The subgenus included the species of *Mystus* in which there is a distinct interneural shield between the basal bone of the dorsal fin and the occipital process, and the air-bladder is elongated posteriorly, with a longitudinal complete septum *in situ* separating the two lateral chambers. Other species referred to this subgenus were : *Bagrus lamarii* Valenciennes (= *Mystus seenghala* (Sykes)) and *Bagrus leucophasis* Blyth (= *Mystus leucophasis* (Blyth)).

Recently Misra (1962) used the name *Aorichthys* Wu in place of *Osteobagrus*. Sarkar (1964) believed that in all the species of *Mystus*, the interneural shield is present and that "the creation of the two subgenera, *Mystus* and *Osteobagrus* " was "premature " This paper examines these nomenclatural and systematic problems.
Rec. Zool. Swv.India, 63 (1-4), 1971.

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II—NOMENCLATURAL STATUS

Wu (1939) proposed the name *Aorichthys* as a substitute for *Aoria* Jordan, 1919 (= *Macrones* Duméril, 1856), which is preoccupied in Insecta (Coleoptera). *Aorichthys* shares the same type-species with *Aoria* viz., *Bagrus lamariei* Valenciennes (= *Mystus seenghala* (Sykes)). When I proposed *Osteobagrus* with *Pimelodus aor* Hamilton (= *Mystus aor* (Hamilton)) as the type-species, *Aorichthys* Wu with a different type species (*Bagrus lamariei* Valenciennes) was not considered to be applicable. On the authority of the Nomenclatural Committee of the American Society of Ichthyologists and Herpetologists, it now turns out that placing *Pimelodus aor* and *Bagrus lamariei* in the same subgenus, involves also the use of the older subgeneric name *Aorichthys* Wu, 1939 for both the species. *Aorichthys* Wu should therefore replace *Osteobagrus* Jayaram. It is also pertinent to point out that the name *Sperata* Holly (1939), proposed as a substitute name for *Aoria* Jordan, though earlier than *Aorichthys*, cannot however replace *Osteobagrus*, since the type-species of *Sperata*, *Mystus vittatus* (Bloch), does not come under the new subgenus.

III—SYSTEMATIC POSITION

On the basis of studies of the skeletons of "some species of the subgenus *Mystus* and both the species of the subgenus *Osteobagrus*" Sarkar (1964) stated that "in *all* the species of the two subgenera inter-neural shield is present" (*italics mine*). "Only in the subgenus *Mystus* it is covered by a skin which is naked in *Osteobagrus* subgenus"

The occipital process in siluroid genera is an important bone and its presence is easily discernible even externally without any extensive preparation of the skull. When the bone is covered by skin with hardened mucus, as in the case of *Mystus montanus* (Jerdon), *Mystus punctatus* (Jerdon), *Mystus malabaricus* (Jerdon), a little peeling of the skin covering the bone, clearly indicates its relative length, size and shape. The occipital process is a posterior elongation of the supraoccipital bone. It varies in its length considerably and this character has been much adopted as of specific value (Smith, 1945, Ahmad, 1951, Jayaram, 1955). In the genus *Mystus*, there are two groups of species : in one the occipital process is long and meets the basal bone of the dorsal fin and in the other the occipital process is short and does not meet the basal bone of the dorsal fin. These two groups of species are given in the following list. It includes all the valid species of the genus *Mystus* so far known from its entire range of distribution. Some of the Indian species of the two groups are illustrated in Text-figs. 1 to 4.

Group A. Occipital process meeting the basal bone of dorsal fin.

Subgenus* <i>Mystus</i>	
*1. <i>argentivittatus</i> (Regan)	12. <i>nigriceps</i> (Valenciennes)
2. <i>armatus</i> (Day)	13. <i>oculatus</i> (Valenciennes)
3. <i>bleekeri</i> (Day)	*14. <i>peguensis</i> (Boulenger)
4. <i>cavasius</i> (Hamilton)	*15. <i>pelusius colvilli</i> (Günther)
5. <i>gulio</i> (Hamilton)	*16. <i>pelusius pelusius</i> (Solander)
*6. <i>johorensis</i> Herre	*17. <i>pluriradiatus</i> (Vaillant)
7. <i>leucophasis</i> (Blyth)	18. <i>pulcher</i> (Chaudhuri)
8. <i>micracanthus</i> (Bleeker)	*19. <i>rufescens</i> (Vinciguerra)
9. <i>montanus dibrugarensis</i> (Chaudhuri)	*20. <i>sabanus</i> Inger & Chin
10. <i>montanus montanus</i> (Jerdon)	21. <i>tengara</i> (Hamilton)
11. <i>nemurus</i> (Valenciennes)	22. <i>vittatus horai</i> Jayaram
	23. <i>vittatus vittatus</i> (Bloch)
	*24. <i>wolffii</i> (Bleeker)

NOTE.—*No specimens of these species have been seen by me.

Group B. Occipital process not meeting the basal bone of the dorsal fin.

Subgenus *Mystus*

- *25. *ameniiyae* (Kimura)
- *26. *chinensis* (Steind.)
- *27. *elongatus* (Günther)
- 28. *keletius* (Valenciennes)
- 29. *malabaricus* (Jerdon)
- *30. *maydelli* Rossel
- 31. *menoda menoda* (Hamilton)
- 32. *menoda microphthalmus* (Day)
- 33. *menoda trachacanthus* (Valenciennes)

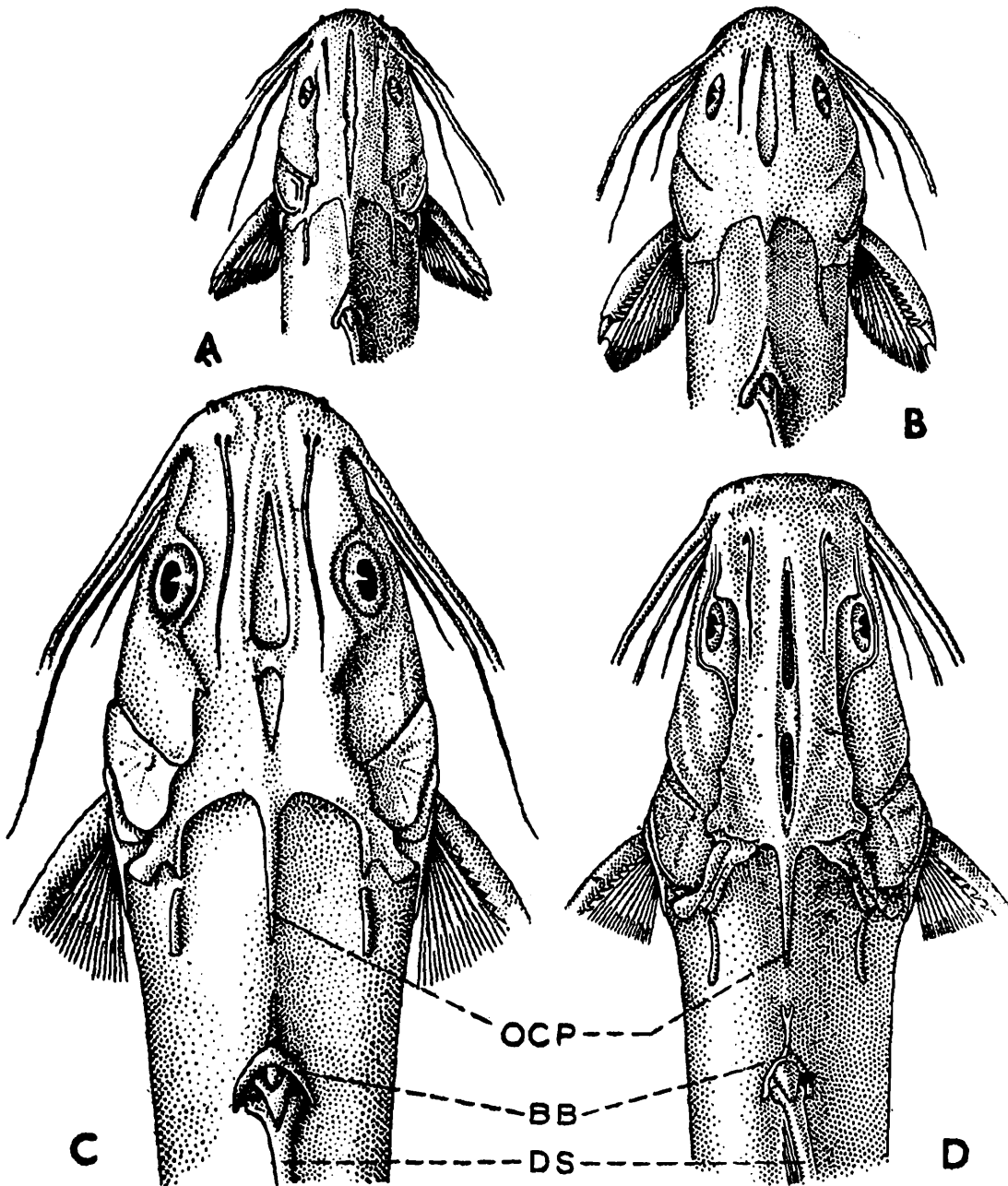
- *34. *pahangensis* Herre
- 35. *planiceps* (Valenciennes)
- 36. *punctatus* (Jerdon)
- *37. *wyckii* (Valenciennes)

Subgenus *Aorichthys*

- 38. *qor* (Hamilton)
- 39. *seenghala* (Sykes)

Unidentifiable Species

- *40. *sinensis* (Bleeker)

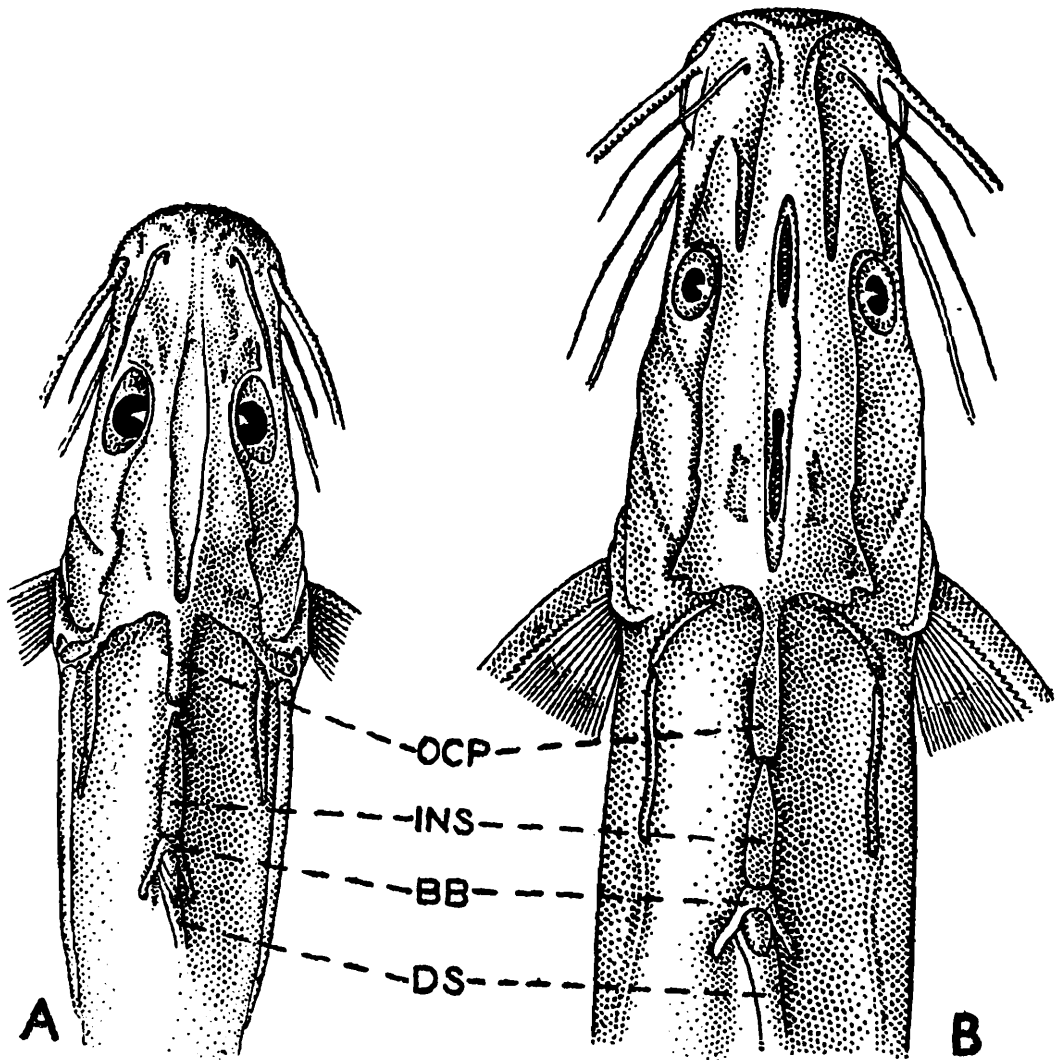


TEXT-FIG. 1.—Head and anterior portion of body of a few species of *Mystus* in which the occipital process is not meeting the basal bone of the dorsal fin.

(A). *Mystus (Mystus) menoda* (Hamilton). (B). *Mystus (Mystus) malabaricus* (Jerdon). (C). *Mystus (Mystus) punctatus* (Jerdon). (D). *Mystus (Mystus) microphthalmus* (Day). (A, B, after Jayaram, 1955).

NOTE.—*No specimens of these species have been seen by me.

It will be seen from the text-figures that there is a clear interspace without any intervening bone in between the posteriormost tip of the occipital process and the anteriormost end of the basal bone of the dorsal fin in the case of the species of group B (Text-fig. 1). In the case of the

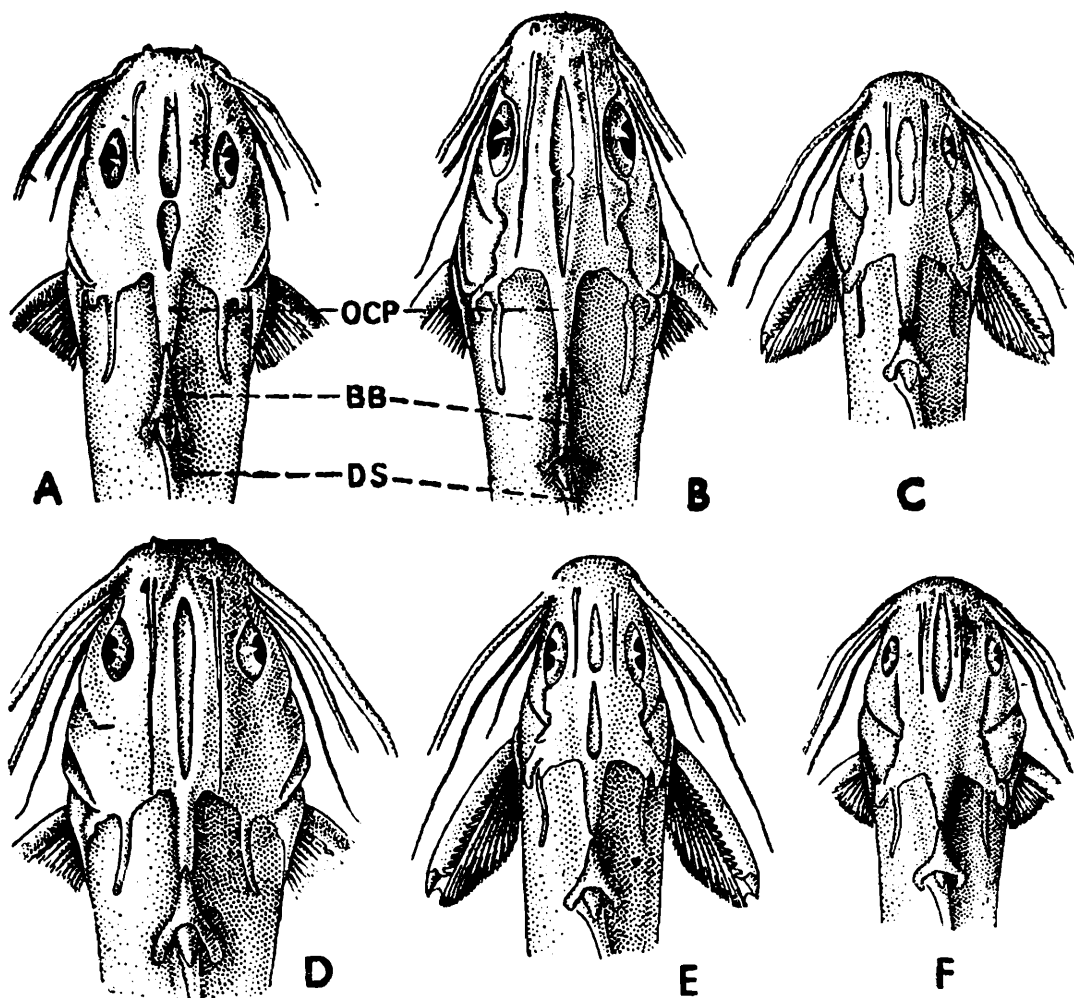


TEXT-FIG. 2.—Head and anterior portion of body of the two species of *Aorichthys* showing the interneural shield.

(A). *Mystus (Aorichthys) seenghala* (Sykes) (After Jayaram, 1955). (B). *Mystus (Aorichthys) aor* (Hamilton).

two species of *Aorichthys*, the occipital process meets only the interneural shield and not the basal bone of the dorsal fin (Text-fig.-2). In the case of the species of group A, though the length of the occipital process is varying, it always meets the basal bone of the dorsal fin (Textfigs. 3, 4).

For a proper understanding of the inter-relationship of the occipital process, the interneural shield and the so called “basal bone of the dorsal fin” it is necessary to know in detail the skeletal elements constituting these bones. These are described below.



TEXT-FIG. 3.—Head and anterior portion of body of a few species of *Mystus* in which the occipital process is meeting the basal bone of the dorsal fin.

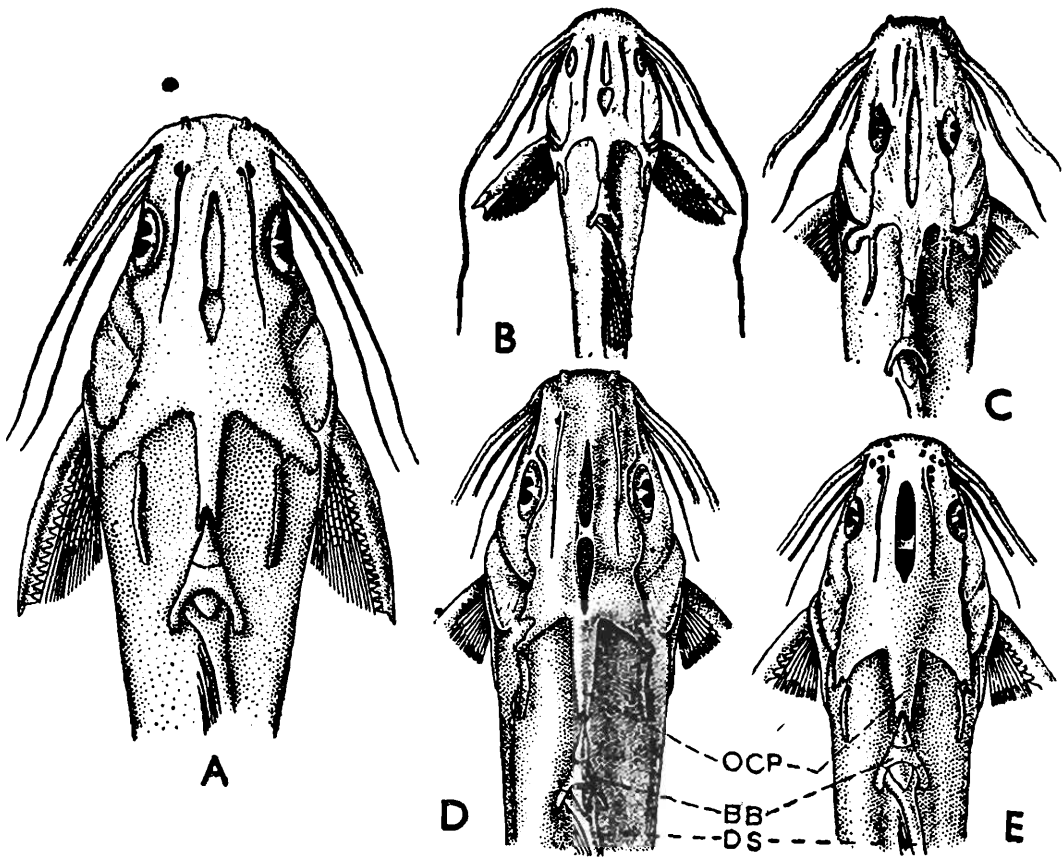
(A). *Mystus (Mystus) bleekeri* (Day). (B). *Mystus (Mystus) cavasius* (Hamilton). (C). *Mystus (Mystus) vittatus* (Bloch). (D). *Mystus (Mystus) armatus* (Day). (E) *Mystus (Mystus) oculatus* (Valenciennes). (F). *Mystus (Mystus) gulio* (Hamilton). (All figures after Jayaram, 1955).

1. Skeletal elements of the dorsal fin

The dorsal fin in *Mystus* is composed of one spine and 7 or 8 rays. The spine is considered to be the third dermatrich whereas the rays are considered as representing the different lepidotrichia. The latter are jointed and branched and rest on nodule-like radial bones. The last two lepidotrichia have one radial bone between them.

The dorsal spine rests on a plate formed by the second and third interneural bones, and has three condyles at its base for articulation. Posteriorly the second interneural is produced into a short, triangular prism-like process on which the second lepidotrich moves. The median condyle of the dorsal spine articulates on the posterior side of this

prism-like process. The second lepidotrich itself is in the form of a short, triangular spine closely fitting the dorsal spine. On either side of the dorsal spine there are four holes for the passage of muscles which facilitate movement of the spine.



TEXT-FIG. 4.—Head and anterior portion of body of a few species of *Mystus* in which the occipital process is meeting the basal bone of the dorsal fin.

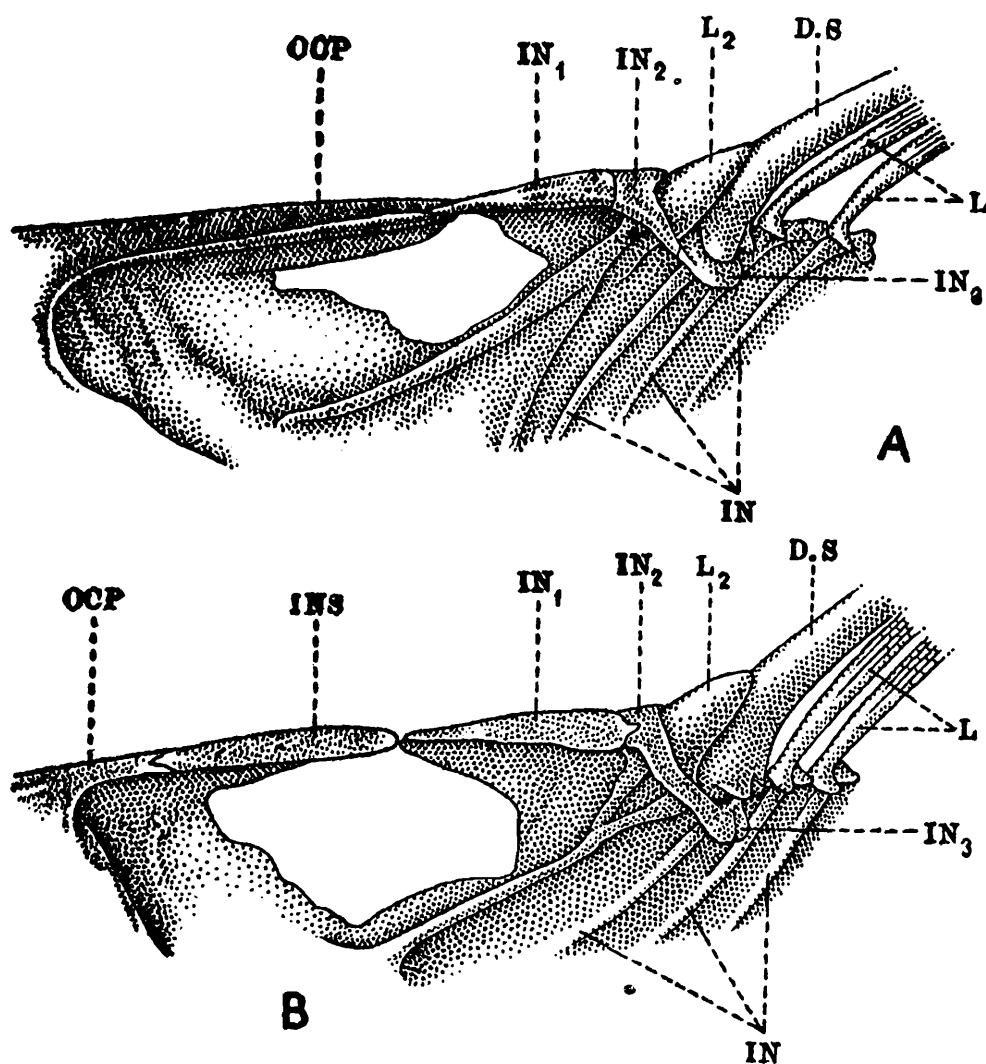
(A). *Mystus* (*Mystus*) *montanus* (Jerdon). (B). *Mystus* (*Mystus*) *vittatus horai* Jayaram. (C). *Mystus* (*Mystus*) *leucophasis* (Blyth). (D). *Mystus* (*Mystus*) *tengara* (Hamilton). (E). *Mystus* (*Mystus*) *pulcher* (Chaudhuri). (After Jayaram 1955).

2. Skeletal elements of the “basal bone of the dorsal fin”

The term “basal bone of the dorsal fin” (Day, 1877, Jayaram, 1955) is synonymous with “predorsal plate” (Günther, 1873), “bouchir dee 1' interspineux ” (Regan, 1905), “bony plate ” (Chaudhuri, 1911) etc. It is composed of three bony plates, formed by the distally flattened first three interneurals. These bony plates are different in shape and size in the two subgenera of *Mystus*.

In the subgenus *Mystus*, the first interneural (IN₁, Text-fig. 5A) is small, triangular and sharply pointed anteriorly. It fits into and under the bifurcated posterior tip of the supraoccipital process in the species

of group A (occipital process meeting the basal bone of the dorsal fin). In species of group B (occipital process not meeting the basal bone of the dorsal fin) this remains extended in the intervening space. The second



TEXT-FIG. 5.—Skeletal elements constituting the basal bone of the dorsal fin in the two subgenera of *Mystus*.

(A). Subgenus *Mystus*. (B). Subgenus *Aorichthys*.

interneural (IN₂, Text-fig. 5A) is slightly semilunar and curved laterally on either side at the base of the dorsal spine. It has already been stated that posteriorly the second interneurals extend into a prism-like process providing articulation for the second lepidotrich. The third interneural is a reduced plate (IN₃, Text-fig. 5A) and is in the form of a pyramid turned on its side. Ventrally the third interneural provides on either side a facet for the articulation of the two lateral condyles of the dorsal spine.

In the subgenus *Aorichthys*, the first interneural is much enlarged, resembling the interneural shield (IN₁, Text-fig. 5B). Further, unlike in *Mystus* the first interneural meets anteriorly the interneural shield, which is larger in size and which is completely fused with the occipital process. This fusion turns the occipital process into a "thumb-like process" (Ahmad, 1951). The occipital process itself is a short bone in this subgenus. The size of the interneural shield varies with age of the fish. In some large examples this bone is rather wide (Day, 1877, p. 454).

The second interneural is similar to the pattern found in the subgenus *Mystus* and provides posteriorly a prism-like process for the articulation of the short triangular second lepidotrich. The third interneural is much reduced and is in the form of a heel-like process, into which the second interneural is fused laterally and ventrally (IN₃, Text-fig. 5B).

It is seen from the foregoing account, that the interneural shield is a distinct feature only in the subgenus *Aorichthys*. It seems therefore that Sarkar (1964) has confused the interneural shield with the first interneural bone. This has led to the erroneous conclusion that in all the species of *Mystus*, the interneural shield is present.

3. Modifications of the air-bladder

In the diagnostic characters of the subgenus *Aorichthys*, the relative length of the air-bladder and its internal structure were also considered. From my examination of a large series of specimens of *aor*, and *seenghala*, both in the field and in the laboratory, I find that the posterior elongation of the air-bladder and the internal division of the bladder into two non-communicating lateral chambers vary considerably. In specimens which are long and lean, the air-bladder is slightly elongated posteriorly, but in specimens which are deep and short, the posterior elongation of the air-bladder is insignificant. In a series of papers Nair (1937, 1938) has shown that the internal structure and shape of the air-bladder in siluroids undergo modifications to a great extent, and this seems to be applicable to the fishes of the genus *Mystus* also. As such, not much importance can be attached to the shape and structure of the air-bladder in *Aorichthys*, which is, however, easily and sufficiently distinguishable by the character of the interneural shield alone.

4. Species to be included under *Aorichthys*

Bagrus leucophasis Blyth has so far been considered as belonging to this subgenus. The inclusion of this species under *Aorichthys* was due to the statement by Day (1877, p. 449) that the occipital process in this species is "twice as long as wide at its base whilst between it and the basal bone of the dorsal fin is a pyriform bone about twice as long as wide". I have now re-examined the specimen in the Zoological Survey of India and find that there is no separate pyriform bone, as described by Day, resembling the interneural shield of *aor* or *seenghala*. The bone is only the first interneural, which is enlarged in this species. In his original description of the species, Blyth (1860) also makes no mention of such a bone, but has simply described the occipital process "as in *B. gulio*, (B. H.)". In view of the above it is necessary to exclude *B. leucophasis* from *Aorichthys* and include it under the subgenus *Mystus*.

IV—ACKNOWLEDEMENTS

I am much indebted to Mr. W. I. Follett of the California Academy of Sciences, San Francisco (U. S. A.) for his constructive suggestions in regard to the nomenclatural details of the subgeneric name. I am thankful to the Director, Zoological Survey of India, Calcutta for facilities.

V—SUMMARY

This paper discusses the nomenclatural and systematic status of the subgenus *Osteobagrus* Jayaram. Since the type-species of *Aorichthys* Wu viz., *Bagrus lamarii* Valenciennes and the type-species of *Osteobagrus* Jayaram viz., *Pimelodus aor* Hamilton are congeneric, the earlier name proposed as a substitute in the synonymy of the nominal genus should replace the latter name. Accordingly, *Aorichthys* Wu replaces *Osteobagrus* Jayaram, but in a different sense. The views of certain authors like Sarkar (1964) that all the species of *Mystus* possess an interneural shield are based on their mistaken identification of the first interneural bone in these fishes. The various skeletal elements of the dorsal fin, basal bone of the dorsal fin and the interneural shield are described in detail. A list of all the known valid species of the genus is also given, alphabetically arranged in two groups depending upon whether they meet the basal bone of the dorsal fin or not. Some species of both the groups are illustrated.

VI—REFERENCES

- AHMAD, R. U. 1951. Preliminary notes on specific differences in the cranial morphology of *Macrones aor* (Ham. Buch) and *Macrones seenghala* (Sykes).—*Univ. Allahabad Stud.*, Allahabad, pp 51-55, 1 pl.
- BLYTH, E. 1860. Report on some fishes received chiefly from the Sittang river and its tributary streams, Tenasserim provinces.—*J. Asiat. Soc.*, Calcutta, 29, pp. 138-174.
- CHAUDHURI, B. L. 1911. Contributions to the fauna of Yunnan. Part II, Fishes.—*Rec. Indian Mus.*, Calcutta, 6, pp. 13-24, 1 pl.
- DAY, F. 1877. The fishes of India : being a natural history of the fishes known to inhabit the seas and fresh waters of India, Burma and Ceylon.—London, xx+778 pp., 198 pls.
- DUMÉRIL, A. M. C. 1856. Ichthyologie generales sur les classifications on histoire naturelle et express commeure du plan de l'ichthyologie analytique a la de tableaux synoptiques.—*Mem. Acad. Sci.*, Paris, 28, pp. 1-511.
- GÜNTHER, A. 1873. Report on a collection of fishes from China.—*Ann. Mag. nat. Hist.*, London, (4) 12, pp. 239-250.
- HOLLY, M. 1939. Zur nomenklatur des Siluriden Gattung *Macrones* C. Duméril.—*Zool. Anz.*, Leipzig, 125, p. 143.
- JAYARAM, K. C. 1955. Siluroid fishes of India, Burma and Ceylon. XIV. Fishes of the genus *Mystus* Scopoli.—*Rec. Indian Mus.*, Delhi, 51 (4) [1954], pp. 527-558, 1 pl.
- JORDAN, D. S. 1919. New genera of fishes.—*Proc. Acad. nat. Sci. Philad.*, Philadelphia, 70, pp. 341-344.
- MISRA, K. S. 1962. An aid to the identification of the common commercial fishes of India and Pakistan.—*Rec. Indian Mus.*, Delhi, 57 (1-4) [1959], pp. 1-320.
- NAIR, K. K. 1937. Changes in the internal structure of the air-bladder of *Pangasius pangasius* (Ham.) during growth.—*Rec. Indian Mus.*, Calcutta, 39, pp. 117-124.

- NAIR, K. K. 1938. Changes in the internal structure of the air-bladder of *Silonia silondia* (Ham.) during growth.—*Rec. Indian Mus.*, Calcutta, 40, pp. 5-12.
- NAIR, K. K. 1938. Changes in the internal structure of the air-bladder of *Eutropiichthys vacha* (Ham.), *Clupiscma garua* (Ham.) and *Ailia coila* (Ham.) during growth.—*Rec. Indian Mus.*, Calcutta, 40, pp. 183-188.
- REGAN, C. T. 1905. Description di six poissons nouveaux faisant parti de la collection du Musee d' histoire naturelle de Geneva.—*Rev. suisse Zool.*, Geneva, 13, pp. 390-393, 2 pls.
- SARKAR, H. L. 1964. On the nomenclatural status of the two subgenera *Mystus* and *Osteobagrus* of the genus *Mystus* Scopoli.—*Proc. Indian Sci. Congr.*, Calcutta, 51st & 52nd Session, part 3, p. 495.
- SMITH, H. M. 1945. The freshwater fishes of Siam or Thailand.—*U. S. nat. Mus. Bull.*, Washington, No. 188, xi+622 pp., 9 pls.
- WU, H. W. 1939. On the fishes of Li-kiang.—*Sinensia*, Nanking, 10, pp. 92-142.

ABBREVIATIONS USED IN TEXT-FIGURES

BB	..	..	.	Basal bone of the dorsal fin
DS	..	..	..	Dorsal spine
IN	..	..	.	Interneurals
IN ₁	..	..	..	First interneural bone
IN ₂	..	..	..	Second Interneural bone
IN ₃	..	..	.	Third interneural bone
INS	..	..	..	Interneural shield
L	..	..	..	Lepidotrichia
L ₁	..	..	..	Second lepidotrich
OCP	..	..	..	Occipital process

TAXONOMY OF FISHES OF THE GENUS *SCHIZOTHORAX* HECKEL* WITH THE DESCRIPTION OF A NEW SPECIES FROM KUMAON HIMALAYAS

By

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Zoological Survey of India, Calcutta

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I—INTRODUCTION

Recently, while studying the fish fauna of the Himalayas, considerable difficulty was experienced in identifying the various species of *Schizothorax* Heckel namely, *S. plagiostomus* Heckel, *S. richardsonii* (Gray) and *S. molesworthii* Chaudhuri and defining their respective limits of distribution. This led me to a thorough examination of the entire material of *Schizothorax* in the collection of the Zoological Survey of India. A careful morphometric and biometric study of the various closely related populations of *Schizothorax* occurring in the different drainages of the Himalayas including Afghanistan was undertaken. As a result of this study it has been possible to conclude that there are only two valid species of *Schizothorax*, including the new species, described under the name *S. kumaonensis* in this paper.

**Schizothorax plagiostomus* Heckel, characterised by a suctorial mouth is the type-species of *Schizothorax* Heckel and McClelland's *Oreinus* with *O. guttatus*, also characterised by a suctorial mouth is synonymous with *Schizothorax* Heckel. Thus the generic name *Schizothorax* should be strictly applied to only species with a suctorial mouth and all other species of the Schizothoracinae without a suctorial mouth like *S. esocinus* Heckel should be placed under *Schizothoracichthys* Misra (vide, *Rec. Indian Mus.*, 57, p. 48, 1959).

Ree. Zool. Surv. India, 63 (1-4), 1971.

II—REVIEW OF LITERATURE

Gray(1832) gave the illustration of his *Cyprinus richardsonii* without any description. No type was deposited nor any mention of the type-locality made. However, from the illustration it will be obvious that (1) the length of the head in *richardsonii* is about 4.5 times in standard length, (2) the dorsal commences slightly in advance of the root of the ventral and (3) the dorsal origin is somewhat nearer the tip of snout than the base of the caudal fin.

Heckel (1838) in his "*Fische Aus Caschmir*" described ten species of *Schizothorax* of which only two species namely, *S. plagiostomus* and *S. sinuatus* are characterised by a suctorial mouth and hence considered as *Schizothorax* sensu stricto (*vide* Misra, *loc. cit.*). From the comparison of his description of the species it would appear that Heckel distinguished the two species by the following characters :

S. plagiostomus Heckel

S. sinuatus Heckel

Dorsal serrated spine weak

Dorsal serrated spine strong.

Snout covered with tubercles

Snout smooth.

McClelland (1839) in his monograph on Indian Cyprinidae gave brief descriptions of his two new species of *Oreinus*, *O. guttatus* and *O. maculatus*. *O. guttatus* was characterised as follows : "Head covered with thick integument, branchial apertures small, side and fins irregularly marked with brown spots, scales minute" McClelland's second species, *O. maculatus* was characterised as "Mouth situated on the lower surface of the head, small shapeless spots irregularly distributed over the body but not on the fins, scales minute." In the same work McClelland gave a very brief description of *O. richardsonii* Gray. He characterised it thus : "About eleven rays in the dorsal and nine in the anal, back, speckled with minute dots"

In his account of the fishes of Afghanistan in Griffith's collection McClelland (1842) recorded specimens of the genus *Oreinus* from the head of the Ali Musjid stream (Khyber Pass), Kabur River, Gandamak, Pashat and Girdun Dewar. The specimens from Helmand river (Girdun Dewar) were referred to *O. plagiostomus* Heckel, while those of Pashat (Kunar River) were described as *O. griffithii*. The young specimens collected from Kabul River, Ali Musjid stream and Gandamak were referred to *O. maculatus*. *O. griffithii* was characterised by McClelland as follows : "The breadth of the mouth is equal to half the length of head, and of the interval from the extremity of the snout to the commencement of the pectorals. Dorsal spine large, vertical scales at the anal obsolete, posterior margin of the operculum round, snout smooth in D, 4/8 : P. 20 : V II. A 1/6.C.19. The intestines are six length of the body, and contain a brownish pulp. The species although perfectly distinct, differs but little in appearance from *Oreinus plagiostomus*" *S. plagiostomus*, *S. sinuatus*, *Oreinus richardsonii* and *O. maculatus* are again briefly described by Valenciennes (1842).

Heckel (1844) published *Fische Kaschmir's* in Von Huegel's *Kaschmir und Das Reich Der Seik* and gave descriptions of *Schizothorax plagios-tomus* and *S. sinuatus*.

Günther (1861) recorded *O. maculatus* and described *O. hodgsoni* in the collections of B. H. Hodgson from Nepal. He characterised *hodgsoni* as follows : "The height of the body is one-fifth of the total length (the caudal fin not included), the length of the head one-fourth. Scales very small. The dorsal fin is short and elevated, rather higher than the body below ; the second spine is very short, serrated posteriorly. The origin of the dorsal fin is exactly on the middle between the extremity of the snout and the base of the caudal fin".

In Günther's (1868) catalogue, all his Nepalese specimens (one stuffed 18" long, one adult female 9" long and a young specimen, all presented by B. H. Hodgson) and one specimen from Kumaon presented by Capt. Strackey were referred to *O. richardsonii*. *O. plagios-tomus* was characterised by Günther on Afghanistan specimens (one stuffed adult from Jallalabad and skins of one adult and one half-grown from Helmand River) while *O. sinuatus* was characterised on Punjab and Kashmir specimens. McClelland's young specimen of *O. maculatus* from Gandamuck (Afghanistan) was referred to *O. sinuatus*. *O. griffithii* and *O. guttatus* were not described at all in the catalogue but were referred to in a footnote as doubtful species. From Günther's description of *O. plagios-tomus*, *O. sinuatus* and *O. richardsonii* the three species appear to have been separated by means of the following characters :—

<i>O. plagios-tomus</i>	<i>O. sinuatus</i>	<i>O. richardsonii</i>
Head-length $1/5$ of total length.	Head-length $1/5$ of total length.	Head-length $1/6$ of total length.
Dorsal fin originates mid-way between tip of snout and caudal-root, advance of root of ventral.	Dorsal fin originates nearer root of caudal, opposite to root of ventral.	Dorsal fin originates mid-way or slightly nearer snout than caudal-root, advance of the root of ventral.
Dorsal osseous ray strong, serrature feeble.	Dorsal osseous ray moderately strong, serrature well developed.	Dorsal osseous ray strong, serrature developed.
Anal fin narrow and deep	Anal fin narrow and deep.	Anal fin very narrow and deep.
Anal scales well developed, large as broad as orbit.	Anal scales moderately developed, large, half as broad as orbit.	Anal scales well developed, as large as orbit.

Day (1878) in the Fishes of India described *O. plagios-tomus*, *O. sinuatus* and *O. richardsonii*. Referring to *O. griffithii* under the description of *O. plagios-tomus* he remarked that *O. griffithii* "is said to differ but little from the above". From a comparison of his descriptions in

the *Fauna of British India* (1889) it will be seen that Day distinguished the three species by the following characters :

<i>O. plagiostomus</i>	<i>O. sinuatus</i>	<i>O. richardsonii</i>
D. 10,11 $\frac{2-3}{8}$, P. 17	D. 3-4/8, P. 17, V. 10.	D. 11 (3/8), P. 17, V. 10.
V. 11, A. 7.(2)/5, C.19, L. 1, 110, L. tr. 170.	A. 2-3/5, C. 19, L. 1, 105 Ver. 24/23.	A. 7. (2/5), C. 19, 1.1. 98-100, L. tr. 140.
Head-length $5\frac{1}{2}$ -6 in total length	Head-length $5\frac{1}{2}$ -6 in total length.	Head-length 4-6 in total length.
Dorsal commences in advance of ventrals and mid-way between snout and root of caudal.	Dorsal commences a little before ventrals and slightly nearer snout than root of caudal.	Dorsal commences slightly before ventral and mid-way between snout and root of caudal.
Anal scales about as large as orbit	Anal scales $\frac{1}{2}$ as large as orbit.	Anal scale $\frac{2}{3}$ as large as orbit.
Colour uniform	Black spots on body	Colour uniform.

Regan (1907) reported on a collection of fish from Nepal and described a new species under the genus *Diptychus*, *D. annandalei*, basing his description on three young (70 mm. total length) specimens. He also reported *O. richardsonii* from the same collection.

Chaudhuri (1913) described a new species, *O. molesworthii* basing his meagre description on a single specimen from Yombung at an altitude of 1,100 feet in the Abor Hills.

Hora (1921) referred to a single specimen from eastern Himalayas below Darjeeling to *O. molesworthii*.

Mukherji (1936) referred Regan's new species of the genus *Diptychus*, *D. annandalei* to *Schizothorax*.

In his ichthyology of Afghanistan Hora (1933) recorded *Oreinus sinuatus* var. *griffithii* McClelland from the Paghman river and considered it in all respects similar to *griffithii* collected by Dr. B. N. Chopra from the Chitral River.

Hora (1934) in his account of "Fishes of Chitral" referred specimens obtained from the Kunar River (or Chitral River), the type locality of *O. griffithii* to *O. sinuatus* var. *griffithii* McClelland, and remarked *O. griffithii* very closely resembles *O. sinuatus* in its general facies, but differs in having somewhat finer serrations in the dorsal spine, in the shorter length of the spine and in the fact that all the fins, especially the anal are shorter. The vertical anal scales are obsolete in *O. griffithii*, with the exception of the two specimens mentioned above, whereas in *O. sinuatus* the scales, though small, are fairly well-marked and distinct. In view of these differences it seems desirable to treat *O. griffithii* as a distinct form, for the time being at least, and at the same time to express its close affinity to *O. sinuatus*. For these reasons, I have regarded *griffithii* as a variety of *sinuatus*"

Hora & Mukherjee (1935) extended the range of *O. molesworthii* to the Chindwin drainage system in the Naga Hills. In the same year Hora (1935) reported on a further collection of fish from Afghanistan made by Sir Richard Maconachie, Major A. E. Farwell and Capt. E. W. Fletcher

from all the major river systems of Afghanistan namely, the Kabul, the Helmand and the Oxus. From the Kabul system Hora reported a single specimen of *O. sinuatus griffithii*.

Hora (1937) reported *O. richardsonii* from Soondrijal Hills above Kathmandu and *Diptychus anandalei* from Pharping in Katmandu Valley.

Shaw and Shebbeare (1938) in their account of fishes of northern Bengal described *Oreinus molesworthii* and characterised it as follows :

"Length of head 6, of caudal $6\frac{3}{4}$, height of body 5 in total length. Scales very small and not very evident, those immediately behind the gill opening and below the lateral line rudimentary. Vent and base of anal in a sheath formed of enlarged, imbricate scales"

Nichols (1943) in his account of "The freshwater fishes of China" considered four species, *S. molesworthi* (Chaudhuri) *S. preneni* (Tchang). *S. sinensis* Herzenstein and *S. grahmi* (Regan) under the subgenus *Schizophyge* characterised by a horny lower jaw.

Misra (1949) showed that Heckel's species *Schizothorax plagios tomus* and *S. sinuatus* were based on male and female specimens respectively of the same species and relegated *O. sinuatus* to the synonymy of *O. plagios tomus*.

De Witt (1956) in his contribution to the ichthyology of Nepal referred a single specimen of 87.9 mm. to *Schizothorax* sp. and remarked that "it is close to, if not the same as the fish described as *Diptychus annandalei* by Regan" He identified thirteen other specimens ranging from 48.4 to 157.5 mm. in total length as *O. richardsonii* reproducing Gray's original illustration of the species.

From a close scrutiny of the descriptions and notes relating to the various species given above it would become abundantly clear that the characters used by the various workers in segregating the species were highly variable and not dependable for their identification. In order, therefore, to ascertain whether there is any significant difference in the various closely related populations of *Schizothorax* the morphometric characters of the samples of *Schizothorax* from the different drainages in the collections of Zoological Survey of India were studied and their range of variations biometrically analysed.

III—MORPHOMETRIC CHARACTERS STUDIED

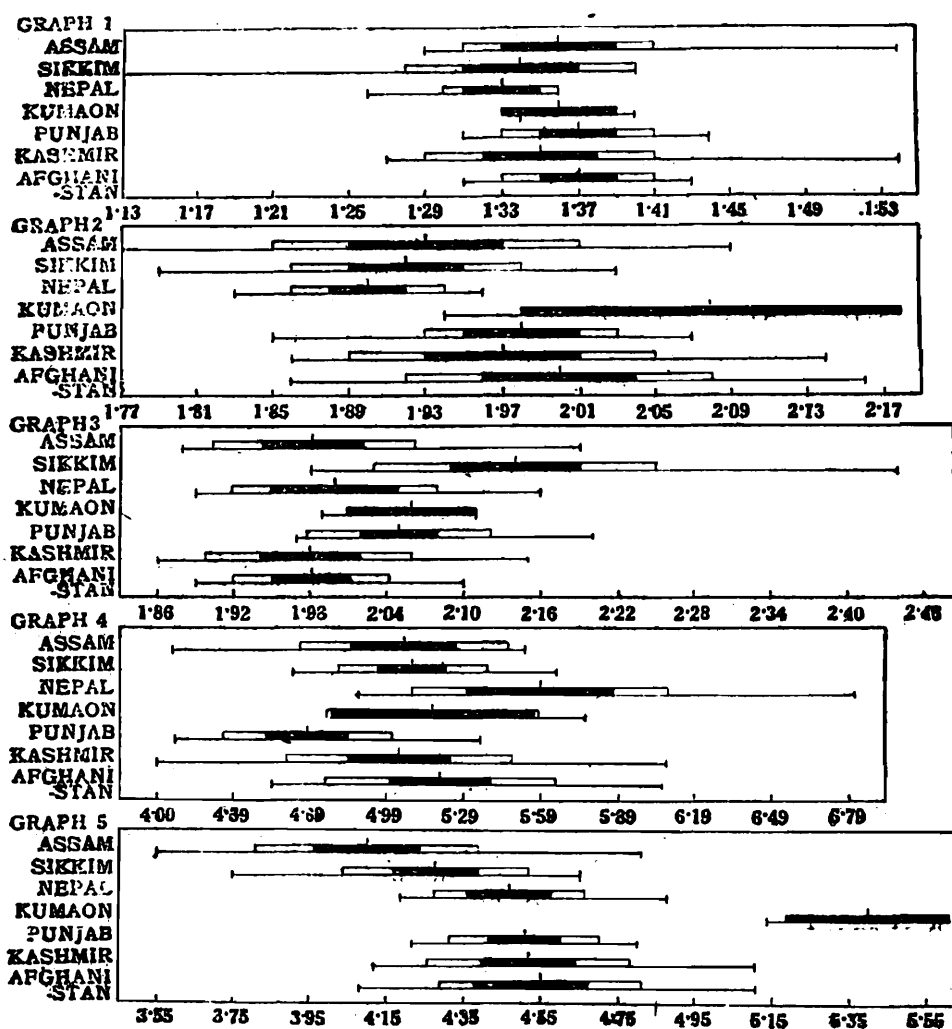
The following morphometric characters of the samples of the different populations occurring in the various drainages of the Himalayas including Afghanistan were studied :

1. Length of head	in standard length.
2. Depth of body	in standard length.
3. Distance between snout and origin of dorsal fin	in standard length.
4. Distance between snout and origin of pelvic fin	in standard length.
5. Distance between snout and origin of anal fin	in standard length.
6. Length of snout	in length of head.
7. Width of head	in length of head.
8. Height of head	in length of head.
9. Diameter of eye	in length of head.
10. Inter-orbital width	in length of head.
11. Length of pectoral fin	in length of head.
12. Length of caudal peduncle	in length of head.
13. Length of pelvic fin	in length of head.
14. Length of anal fin	in length of head.

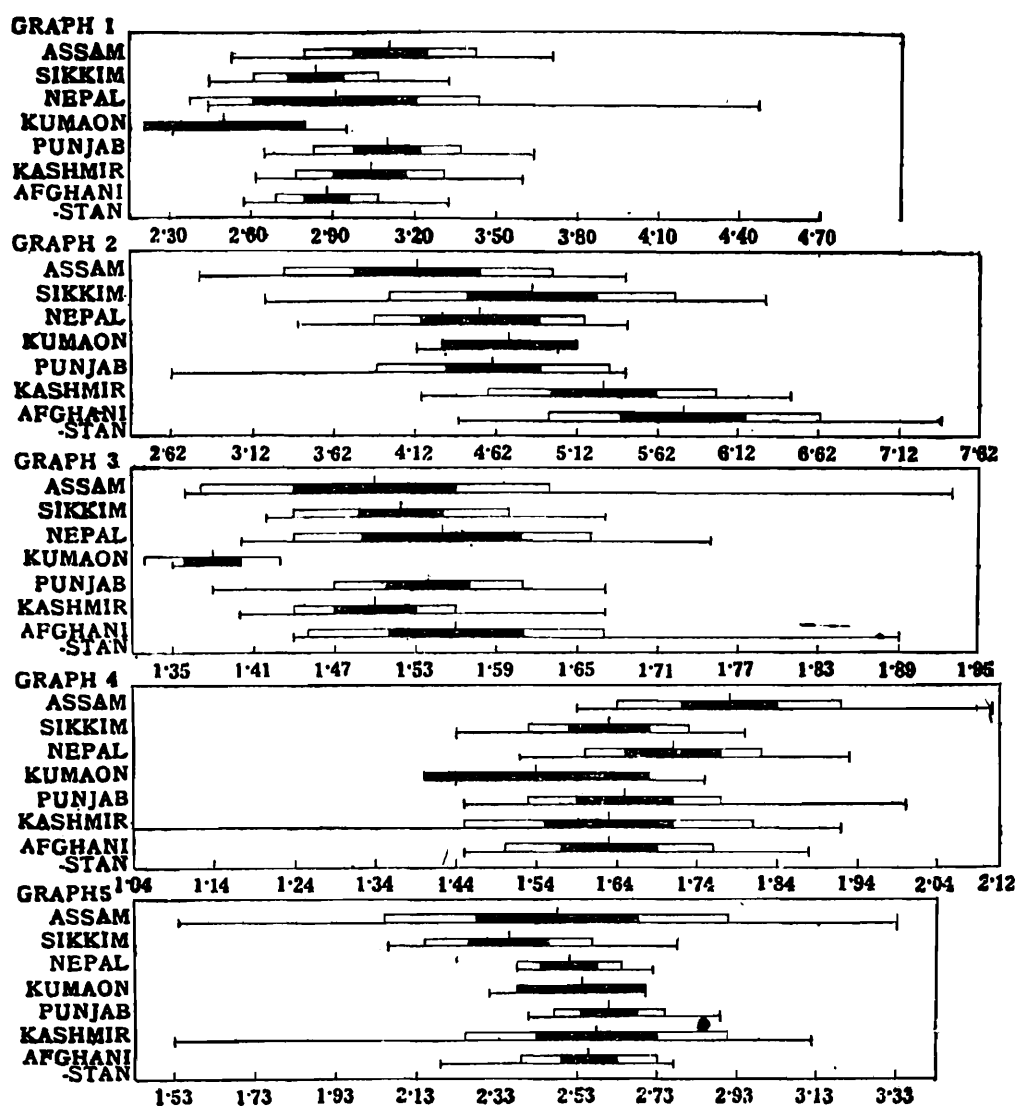
15. Height of dorsal fin . . . in length of head.
 16. Breadth of mouth . . . in width of head.
 17. Distance between pelvic and anal fin . . . in distance between pelvic and base of caudal.
 18. Length of pelvic fin . . . in distance between pelvic origin and anal fin.
 19. Height of caudal peduncle . . . in length of caudal peduncle.
 20. Scales along lateral line.

IV—BIOMETRIC COMPARISON OF POPULATIONS

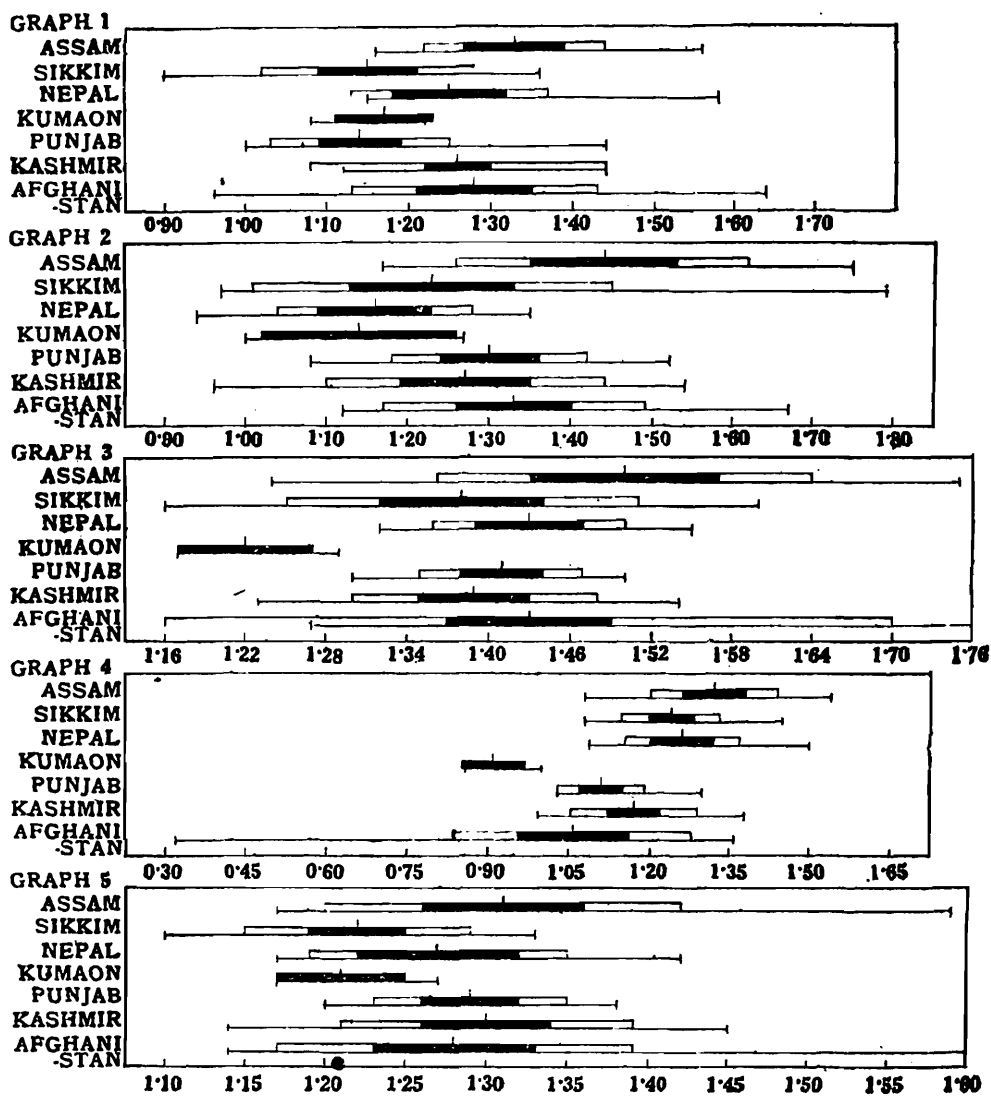
For a correct taxonomic assessment of the samples the range, mean, standard deviation and standard error, were calculated for all the twenty characters enumerated and this data are presented below in graph form (*vide*, Text-figs. 1-4). For each sample diagram shows (1) the total range of variation of the particular character by the horizontal line, (2) the mean, by the simple streak projecting upwards in the middle of it, (3) two standard errors of the mean on either side of the mean by the blackened area of each bar and (4) one standard deviation on either side of the mean by one half of each black bar plus the white bar at either end. The overlap or divergence of the standard deviations of the characters studied has been taken to determine the status of the populations (*vide*, Hubbs and Perlmutter, 1942; Hubbs and Hubbs, 1953; Menon, 1964).



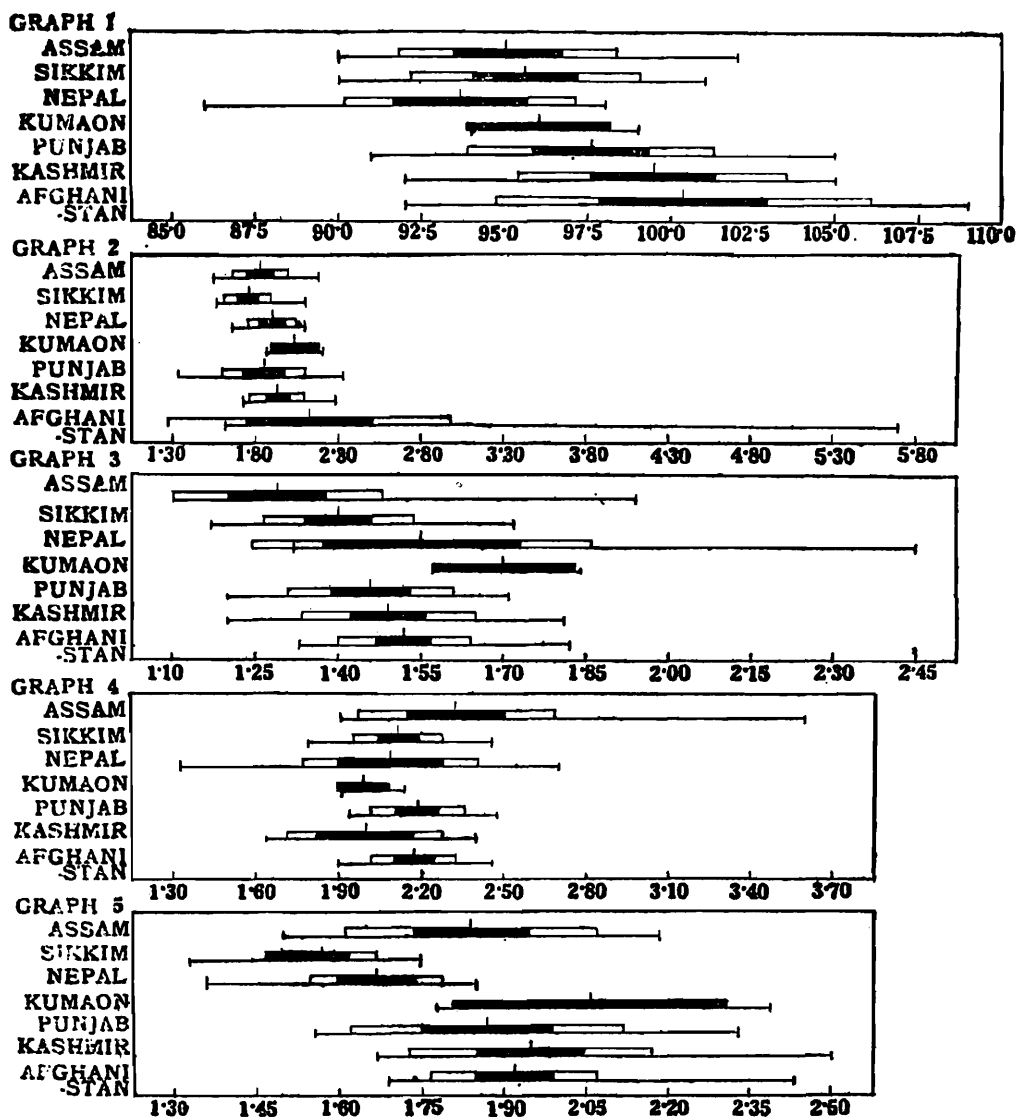
TEXT-FIG. 1. Variations in the different populations of *Schizothroax*. Graph 1. Distance between snout and origin of anal fin in standard length. Graph 2. Distance between snout and origin of pelvic fin in standard length. Graph 3. Distance between snout and origin of dorsal fin in standard length. Graph 4. Depth of body in standard length. Graph 5. Length of head in standard length.



TEXT-FIG. 2. Variations in the different populations of *Schizothorax*. Graph 1. Inter-orbital width in length of head. Graph 2. Diameter of eye in length of head. Graph 3. Height of head in length of head. Graph 4. Width of head in length of head. Graph 5. Length of snout in length of head.



TEXT-FIG. 3. Variations in the different populations of *Schizothorax*. Graph 1. Height of dorsal fin in length of head. Graph 2. Length of anal fin in length of head. Graph 3. Length of pelvic fin in length of head. Graph 4. Length of caudal peduncle in length of head. Graph 5. Length of pectoral fin in length of head.



TEXT-FIG. 4. Variations in the different populations of *Schizothorax*. Graph 1. Scales along lateral line. Graph 2. Height of caudal peduncle in length of caudal peduncle. Graph 3. Length of pelvic fin in distance between origin of pelvic and anal fins. Graph 4. Distance between pelvic and anal fin in distance between pelvic and base of caudal. Graph 5. Breadth of mouth in width of mouth.

From the inter-gradation of characters as shown in the graphs (Text figs. 1-4) it is evident that the various populations studied except that of the Kumaon population are identical. The Kumaon population differs from the rest in the character of its head length. This character is considered of great taxonomic significance and the divergence shown in the character (*vide*, Text-fig. 1, Graph 5) by the Kumaon population necessitates its being segregated as a distinct species, the rest of the populations being treated as belonging to the same species.

V—SYSTEMATIC ACCOUNT*

Schizothorax richardsonii (Gray)

Cyprinus richardsonii Gray, *Ill. Indian Zool.*, pt. 10, pl. 14, fig. 2. 1832.—*Schizothorax plagiostomus* Heckel *Fisch. Caschmir*, p. 16, pl. 1838.—Heckel, *Fische Kaschmir* in Hugel's *Reich*, p. 357; 1844, text-fig.

*I have not examined any material from China and hence the systematic position of *S. molesworthi* (Chaudhuri), *S. prenanti* (Tchang), *S. sinensis* Herzenstein and *S. arakani* (Regan), all characterised by horny lower jaw and known from China, has not been ascertained.

- Oreinus richardsonii* McClelland, *Asiatic Res.*, pp. 273, 335. 1839.—Valenciennes (in : Cuvier and Valenciennes), *Hist. Nat. Poiss.*, 16, p. 227, 1842. Günther, (in part).—*Cat. Fish. Brit. Mus.*, 7, p. 161, 1868. Day, *Fish. India*, p. 530, pl. 125, fig. 4, 1878. Day, *Faun. Brit. India Fish.*, 1, p. 250. 1889.—Regan, *Rec. Indian Mus* 1, p. 157, 1907.—Chaudhuri, *Rec. Indian Mus.*, 8, 247, 1913—Hora, *Rec. Indian Mus.*, 39, pl. 44, 1937. de Witt., *Stanford ichthyol. Bull.*, 7, (4), p. 67, fig. 3, 1960.
- Schizothorax sinuatus* Heckel, *Fische Caschmir*, p. 21, pl. 2, 1838.—Heckel, *Fische Kaschmir* in Hugel's *Reich*, p. 359, text-fig. 2, 1844.—*Oreinus guttatus* McClelland, *Asiatic Res.*, pp. 283, 344, pl. 39, fig. 1, 1839.
- Oreinus plagiosomus*. McClelland, *Calcutta J. Nat. Hist.*, 2, p. 580, 1842.—Günther, *Cat. Fish. Brit. Mus.*, 7, p. 160. 1868.—Day, *Fish. India*, p. 530. 1878.—Day, *Faun. Brit. India Fish.*, 1, p. 250, 1889.—Mukherjee, *Mem. Conn. Acad.*, 10, Art. 18, p. 348, 1936—Misra, *J. zool. Soc. India*, 1 (1), p. 39-40, 1949.
- Oreinus sinuatus* Günther, *Cat. Fish. Brit. Mus.*, 7, p. 161, 1868.—Day, *Fish. India*, 7, 529, pl. 124, fig. 4, 1878.—Day, *Faun. Brit. India Fish.*, 1, p. 248, fig. 88, 1889.—Mukherjee, *Mem. Conn. Acad.* 10, Art. 18, p. 348, 1936.
- Oreinus maculatus* McClelland, *Asiatic Res.*, 19, pp. 274, pl. 57, fig. 6, 1839.—McClelland *Calcutta J. nat. Hist.*, 2, p. 580, 1842.—Günther, *Proc. zool. Soc. Lond.*, p. 224, 1861.
- Diptychus annandalei* Regan, *Rec. Indian Mus.*, 1, p. 157. 1907.
- Oreinus molesworthii* Chaudhuri.—*Rec. Indian Mus.*, 8, pp. 247, 248, pl. 7, fig. 2, 2a, 2b, 1913.—Hora, *Rec. Indian Mus.*, 22, p. 734, 1921.—Hora, *Rec. Indian Mus.*, 37, p. 391, 1935.—Shaw and Shebbeare, *J. Asiat. Soc. Beng.*, 3, p. 17, fig. 9, 1937.
- Specimens examined*.—INDIA : 18, 65.0 to 170.0 mm., from Dupla Ko, N.E.F.A., K. C. Jayaram, 6.v. 1961 ; 1, 100.0 mm., N.E.F.A., S. Biswas, 25.vii. 1961, 4, 55.0 to 60.0 mm., Norgam River below Birtrelling Village, N.E.F.A., K.C. Jayaram, 16. v. 1961 ; 1, 210.0 mm. Yembung, Abor Country, Assam. S. W. Kemp, 1912 ; 2, 96.0 to 147.0 mm., Assam, purchased from F. Day ; 6, 50.0 to 234.0 mm., Palampur Kangra Dist., Punjab. S.L. Hora, 8.vi. 1926 ; 13, 70.0 to 234.0 mm. Chamba, Punjab (3000 ft.), D. Bagchi, v. 1927 ; 1, 250.0 mm., Dal Lake between Nasim Bagh Ghat and Sonalanka, Coll. *Kashmir Valley Survey* 1954 ; 4, 96.0 to 280.0 mm., Coll. *Kashmir ; Valle. Survey* 2 215.0 to 250.0 mm., Junction of Yelbal stream with Dal Lake, Coll. *Kashmir Valley Survey* 1954 ; 5, 117.0 to 193.0 mm., Rishikhola, Rishi W. Sikkim, A.G.K. Menon, 15. iv. 1959 ; 21, 175.0 to 240.0 Denton, 5000 ft. W. Sikkim, A.G.K. Menon, 4. iv. 1959 ; 1, 236.0 mm., Rorathong, Sikkim ; 9, 165.0 to 245.0 mm., Rorathong Sikkim, S. L. Hora, 17 xii. 1938 ; 8, 163.0 to 218.0 mm., Rhanikkhola, Gangtok, Sikkim. 15.viii. 1955 ; 4, 185.0 to 270.0 mm., Rhanikhola, Ranipool, near Gangtok, A. G. K. Menon, 15. viii. 1959 ; 6, 76.0 to 190.0 mm., Samdong, 3 miles down Chakung, W. Sikkim, A.G.K. Menon, 30. iii. 1957 ; 7, 135.0 to 205.0 mm., Dikchukhola, at the confluence of Dikchukhola with Tista, W. Sikkim, A.G.K. Menon, 14.viii. 1959 ; 9, 8.0 to 165.0 mm., Mangon, N. Sikkim, A.G.K. Menon, viii. 1959 ; 24, 13.0 to 156.0 mm., 1½ miles. W. of

Pechrek, W. Sikkim, *A.G.K. Menon*, 3. iv. 1959. NEPAL : 5, 135.0 to 195.0 mm. Kulikhani River, Kulikhani, Purchased from *Dr. Day*, 1. iv, 1947 : 6, 90.0 to 201.0 mm., Fanamati River at Marku, 24. v. 1947. AFGHANISTAN : 44, 130.0 to 220.0 mm., Farakhellum, *S. Akhter Ali*, 14. xii. 1937 ; 27, 127.0 to 237.0 mm., Helmund River, *S. Akhter Ali*, 14. xii. 1937 ; 8, 21.5 to 40.0 mm., Mastuj River between Koghâzi and Mastuj, *B.N. Chopra*, 1, 190.0 mm., Khinam, Andrat River near village Doshi, *S. Akhter Ali* 28, vi, 1940 ; 1, 238.0 mm., near Gulbagh bridge Kabul River, *S. Akhter Ali*, 28. vi. 1940 ; 210.0 mm., Upper Kagan Range, 1, 280.0 mm., pallarga, Chitral, *B. N. Chopra* ; 1, 172.0 mm. Chitral, *B. N. Chopra* ; 13, 120.0 to 225.0 mm., Chitral, Afghanistan, *B.N. Chopra*.

Diagnosis.—A *Schizothoracine* with suctorial mouth and attaining a length of about 2ft. (600.0 mm.) in length. There are about 97 scales in lateral line. The length of head 4.4 in standard length.

Description.—Depth of body 4.76 (4.12 to 6.18) in standard length, length of head 4.46 (4.05—5.05). Width of head 1.61 (1.41—1.85) in length of head, height of head 1.47 (1.03—1.71). Pupil of eye little in front of middle of length of head, 2.47 (1.86—3.69) in length of snout and 2.20 (1.45—2.81) in inter-orbital width. The inter-orbital space is broad and flat. Snout tuberculated in adult males, smooth in females and young. Mouth inferior, transverse and slightly arched, the width is somewhat greater than half width of head. Two pairs of small barbels. 97 (86—110) scales in lateral line. Dorsal $3/8$; the dorsal spine long and serrated ; its height 1.07 in body depth. Origin of dorsal over 30th to 32nd scale of lateral line, distance between its anterior origin and tip of snout 1.95 (1.62—2.34) in standard length. Pectorals shorter than head, its length 1.21 (1.10—1.33) in length of head. Length of pelvics 1.31 (1.21—1.44) in head, its origin directly below dorsal origin or slightly behind. Pre-pelvic distance 1.93 (1.79—2.22) in standard length. Anal $3/5$; origin of anal at 65th to 68th scale of lateral line. Pre-anal distance 1.35 (1.24—1.90) in standard length. Length of caudal peduncle 1.05 (0.88—1.32) in length of head, width 1.86 (1.54—2.15) in its own length.

Colouration.—In alcohol, uniform silvery or with black spots.

Distribution.—Assam and Eastern Himalayas through Bhutan, Sikkim and Nepal to Punjab, Kashmir and Afghanistan.

Schizothorax kumaonensis sp. nov.

Specimens examined.—3, 172.0 to 189.0 mm. in total length, Naini Tal, Uttar Pradesh, Coll. *Capt. R. E. Lloyd* ; 1, 185.0 mm., Himalayas, purchased from F. Day.

Diagnosis.—A *Schizothoracine* with suctorial mouth and attaining a length of 185.0 mm. in length. There are 97 to 98 scales in lateral line. The length of head 5.4 in standard length.

Description.—Depth of body 5.17 (4.85—5.76) in standard length, length of head 5.40 (5.14—5.57). Width of head 1.54 (1.44—1.75) in length of head, height of head 1.38 (1.35—1.40). Pupil of eye little in front of middle of length of head, 1.82 (1.60—2.17) in length of snout and 1.85 (1.58—2.17) in inter-orbital width. The inter-orbital space broad and flat. Snout smooth. Mouth inferior, transverse and

slightly arched, the width is greater than half width of head. Two pairs of small barbels. 96 (94-99) scales in lateral line. Dorsal $3/8$; the dorsal spine long and serrated, its height 1.22 (1.09—1.32) in body depth. Origin of dorsal over 36—37 scale of lateral line, distance between its anterior origin and tip of snout 2.06 (1.99—2.11) in standard length. Pectorals shorter than head; its length 1.21 (1.17—1.27) in length of head. Length of pelvics 1.22 (1.17—1.29) in head, its origin directly below dorsal origin. Pre-pelvic distance 2.08 (1.94—2.15) in standard length. Anal $3/5$. Origin of anal at 66—70 scale of lateral line. Pre-anal distance 1.36 (1.34—1.40) in standard length. Length of caudal peduncle 0.91 (0.86—1.0) in length of head, width 2.04 (1.87—2.21) in its own length.

Colouration.—In alcohol, uniform silvery.

Type specimens.—Deposited in the National Collections, Zoological Survey of India, Calcutta.

Holotype.—Reg. No. F. $\frac{2712}{1}$, 187.0 mm. in total length, Coll. Capt. R. E. Lloyd.

Type Locality.—Naini Tal, Uttar Pradesh, India,

Paratypes.—Reg. Nos. F. $\frac{2714}{1}$ & F. $\frac{2715}{1}$, 2 specimens, 172.0 & 173.0 mm. in total length, taken along with the holotype and bearing the same data as the holotype. Reg. No. 2755, 1 specimen, 185.0 mm., Himalayas, purchased from F. Day.

Relationship.—*Schizothorax kumaonensis* is quite close to *S. richardsonii*: it can be easily distinguished by its shorter head, the length of head being more than five times in standard length, whereas in *richardsonii* it is lower than five times (*vide*, Text-fig. 1, graph 5).

VI—SUMMARY

The literature relating to the systematics of the various species of *Schizothorax* is reviewed. The morphometric data of the various samples of *Schizothorax* from the Himalayas, Kashmir and Afghanistan present in the collections of the Zoological Survey of India is biometrically analysed and the results show that there are only two distinct species, *S. richardsonii* (Gray) and *S. kumaonensis* sp. n., full descriptions of which are given.

VII—REFERENCES

- CHAUDHURI, B. J. 1913. Zoological results of the Abor Expedition, 1911-1912, 18. Fish.—*Rec. Indian Mus.*, Calcutta, 8, pp. 243-257, 3 pls.
- DAY, F. 1876-78. *Fishes of India*, XX+778 pp., 198 pls.—London (Taylor & Francis).
- DAY, F. 1889. *Fauna of British India, including Ceylon and Burma*. Fishes, 1, xvii+548 pp., 164 figs.—London (Taylor & Francis).
- DE WITT, H. 1956. A contribution to the ichthyology of Nepal—*Stanford Ichthyol. Bull.*, Stanford, 7 (1) pp. 63-88.

- GRAY, J. E. 1830-35. Illustrations of Indian Zoology, 202 pls.—London (Tevuttel).
- GÜNTHER, A. 1861. List of cold-blooded vertebrata collected by B. H. Hodgson, Esqr., in Nepal.—*Proc. zool. Soc. Lond.*, London, pp. 213-227
- GÜNTHER, A. 1868. *Catalogue of fishes in the British Museum*, London, 7, xx+512 pp.
- HECKEL, J. J. 1838. *Fische aus Caschmir*, X+112 pp., 13 pls.—Wien (Gedruckt Bei Den P.P. Mechitaristen).
- HECKEL, J. J. 1844. Fische Kaschmir's in Von Hugel's.—*Kaschmir und das Reich der Siek*, Bd. 4, abth. 2, pp. 351-384. (Original not seen).
- HORA, S. L. 1921. On some new or rare species of fish from Eastern Himalayas.—*Rec. Indian Mus.*, Calcutta, 22, pp. 731-744, 1 pl.
- HORA, S. L. 1933. Fishes of Afghanistan.—*J. Bombay nat. Hist. Soc.*, Bombay, 36, pp. 688-706.
- HORA, S. L. 1934. The fishes of Chitral.—*Rec. Indian Mus.*, Calcutta, 36, pp. 279-319.
- HORA, S. L. 1935. On a collection of fish from Afghanistan.—*J. Bombay nat. Hist. Soc.*, Bombay, 37, pp. 784-802.
- HORA, S. L. 1937. Notes on fishes in the Indian Museum. XXIX. On a collection of fish from Nepal.—*Rec. Indian Mus.*, Calcutta, 39, pp. 43-46.
- HORA, S. L. & MUKHERJI, D. D. 1935. Fish of the Naga Hills, Assam.—*Rec. Indian Mus.*, Calcutta, 37, pp. 381-404.
- HUBBS, C. L. & HUBBS, C. 1953. An improved graphical analysis.—*Syst. Zool.*, Washington, 2 (2), pp. 49-56.
- HUBBS, C. L. & PERLMUTTER, A. 1942. Biometric comparison of several samples with particular reference to racial investigations.—*Amer. Nat.*, Lancaster, 76, pp. 582-592.
- MCCLELLAND, J. 1839. Indian Cyprinidae.—*Asiatic Res.*, Calcutta, 19 (2), pp. 217-471
- MCCLELLAND, J. 1842. Afghan collection of fishes. *Calcutta J. nat. Hist.*, Calcutta, 2, pp. 575-589.
- MENON, A. G. K. 1964. Monograph of the Cyprinid fishes of the genus *Garra* Hamilton.—*Mem. Indian Mus.*, Delhi, 14 (4), pp. 173-260, 6 pls.
- MISRA, K. S. 1949. A note on the systematic position of two cyprinid fishes of the genus *Oreinus* McClelland from Kashmir.—*J. zool. Soc. India*, Calcutta, 1 (3), pp. 39-40.
- MUKHERJI, D. D. 1936. Yale North India Expedition. Article 18. Report on fishes. Part 2. Sisoridae and Cyprinidae.—*Mem. Conn. Acad. Arts. Sci.*, New Haven, 10, pp. 323-359.
- NICHOLS, J. T. 1943. The freshwater fishes of China, *Natural History of Central Asia*, 9, xxxvi+322 pp., 10 pls.—New York (American Museum of Natural History).

PLATE 1

***Schizothorax richardsonii* and *S. kumaonensis*.**

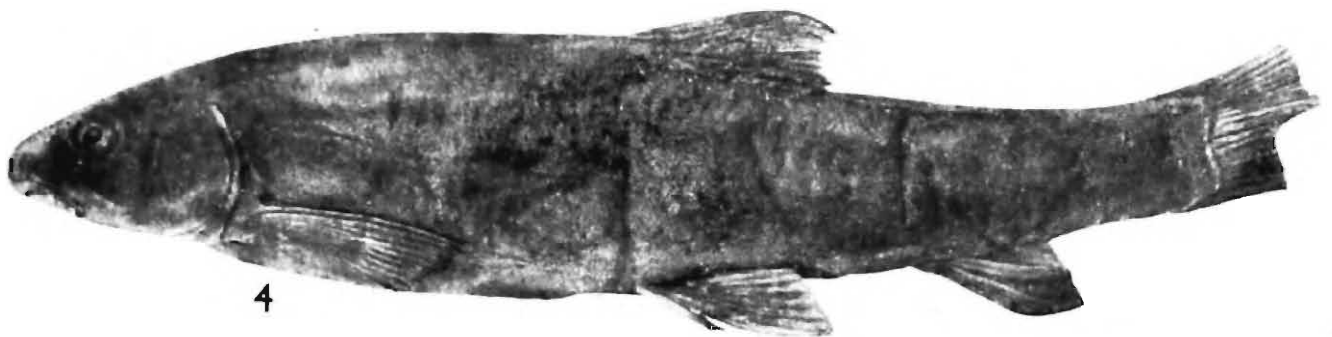
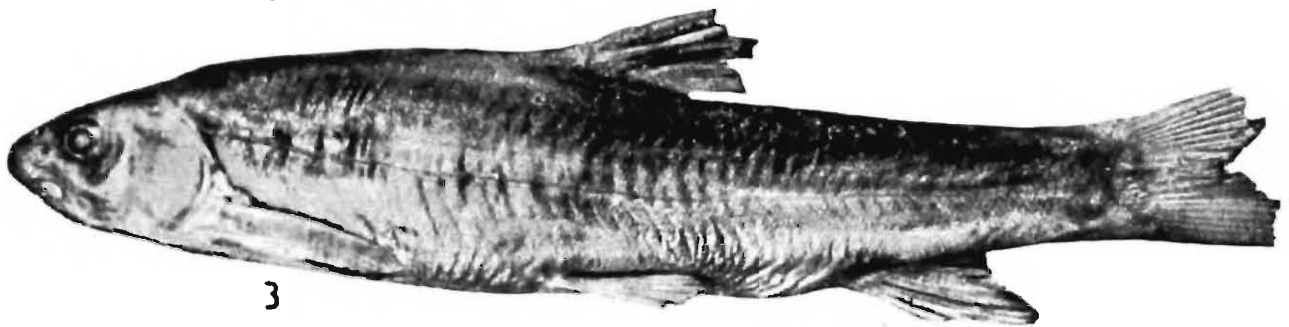
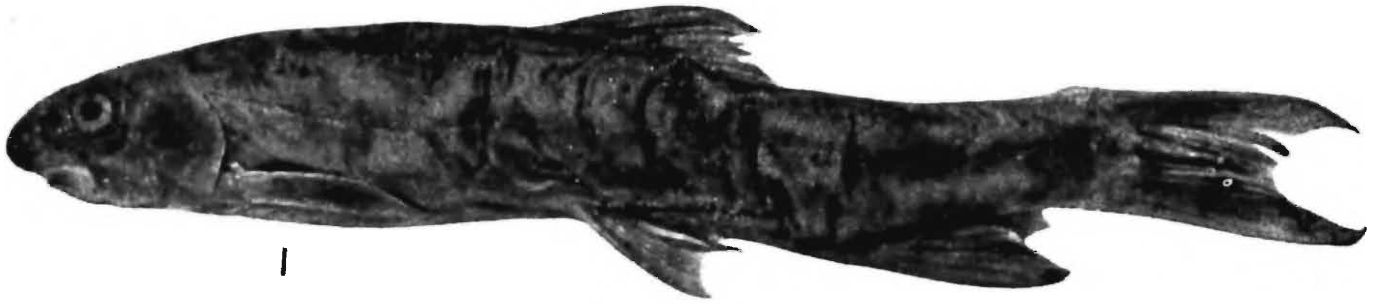
Fig. 1. *S. richardsonii* from Nepal, (same size).

Fig. 2. *S. richardsonii* from Gangtok, Sikkim, (Same size).

Fig. 3. *S. kumaonensis* from Nainital, U. P.

(Holotype, same size)

Fig. 4. *S. richardsonii* from Kashmir (same size).



TWO NEW TERMITES OF GENUS *ANGULITERMES* SJOSTEDT (ISOPTERA : TERMITIDAE) FROM INDIA, WITH A KEY TO SPECIES OF INDIAN REGION

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(With 5 Text-figures and 2 Tables)

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I—INTRODUCTION

Ahmad (1955) reported the occurrence of the genus *Angulitermes* Sjöstedt (Termitidae : Termitinae) from the Indian Region, including here the species *dehraensis* (Gardner) (India and West Pakistan) and his own *hussaini* (West Pakistan). The former was originally described as a species of the genus *Mirotermes* Wasmann and was catalogued by Snyder (1949) under the genus *Termes* Linnaeus. In 1958, Ahmad included in *Angulitermes* three species from the Indian Region, namely *dehraensis* (Gardner), *hussaini* Ahmad and *obtusus* (Holmgren and Holmgren). Harris (1962), in his work on the African members of the genus *Angulitermes*, also listed these three species under that genus.

Angulitermes fletcheri (Holmgren and Holmgren), also first described as a species of *Mirotermes*, and considered by Snyder (1949) and Ahmad (1958) to be a species of genus *Termes* Linn., has recently been referred to *Angulitermes* by Mathur and Sen-Sarma (1961) and by Krishna (1965). The other two species, namely, *lighti* Snyder and Emerson and *marjoriae* (Snyder), both originally described as *Mirotermes* species from this region, are still referred to genus *Termes*.

Besides these four species of *Angulitermes*, namely, *dehraensis*, *fletcheri*, *hussaini* and *obtusus*, four more have recently been described from the Indian Region. These latter are : *acutus* Mathur and Sen-Sarma (1961), *akhorisainensis* Chatterjee and Thakur (1964), and *paanensis* and *resimus*, the last two by Krishna (1965).

In this paper, we have described two more new species from India (District Udhampur, Jammu and Kashmir State), thus making a total of

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ten from the Indian Region as follows, and also provided an identification key, based on soldier characters, for these ten species.

- acutus* Mathur & Sen-Sarma.—India.
- akhorisainensis* Chatterjee and Thakur.—India.
- dehraensis* (Gardner).—India and West Pakistan.
- fletcheri* (Holmgren and Holmgren).—India.
- hussaini* Ahmad.—West Pakistan.
- kashmirensis* sp. n.—India.
- obtus* (Holmgren and Holmgren).—India.
- paanensis* Krishna.—Burma.
- resimus* Krishna.—Burma.
- tilaki* sp. n.—India.

II—DESCRIPTION OF NEW SPECIES

1. *Angulitermes kashmirensis* sp. n.

(Text-figs. 1 and 2 ; and Tables 1 and 2)

(a) *Material*

Two vials, in spirit, both from District Udhampur, Jammu and Kashmir State, India, *Raj Tilak* coll., 1964, and present in the collections of the Zoological Survey of India, Calcutta : (i) A vial, with a soldier and several workers (mixed with *Microtermes obesi* Holmgren), Z.S.I. Coll. Station No. 39, c. 10 km. east of Chineni near confluence of River Tawi and Binisangh Nullah (stream), altitude c. 1122 m. (3700 ft.) above mean sea-level, 28.ix.1964 (Field No. T39/28.9.64). (ii) A vial in spirit, with a soldier and several workers (mixed with soldiers and workers of *Odontoitermes obesus* Rambur), Z. S. I. Coll. Station No. 45, 12 km. west of Chineni near confluence of River Tawi and Samroli Nullah (stream), altitude c. 940 m. (3100 ft.) above mean sea-level, 2.x.1964 (Field Coll. No. T45/2.10.64).

(b) *Description*

1 IMAGO—

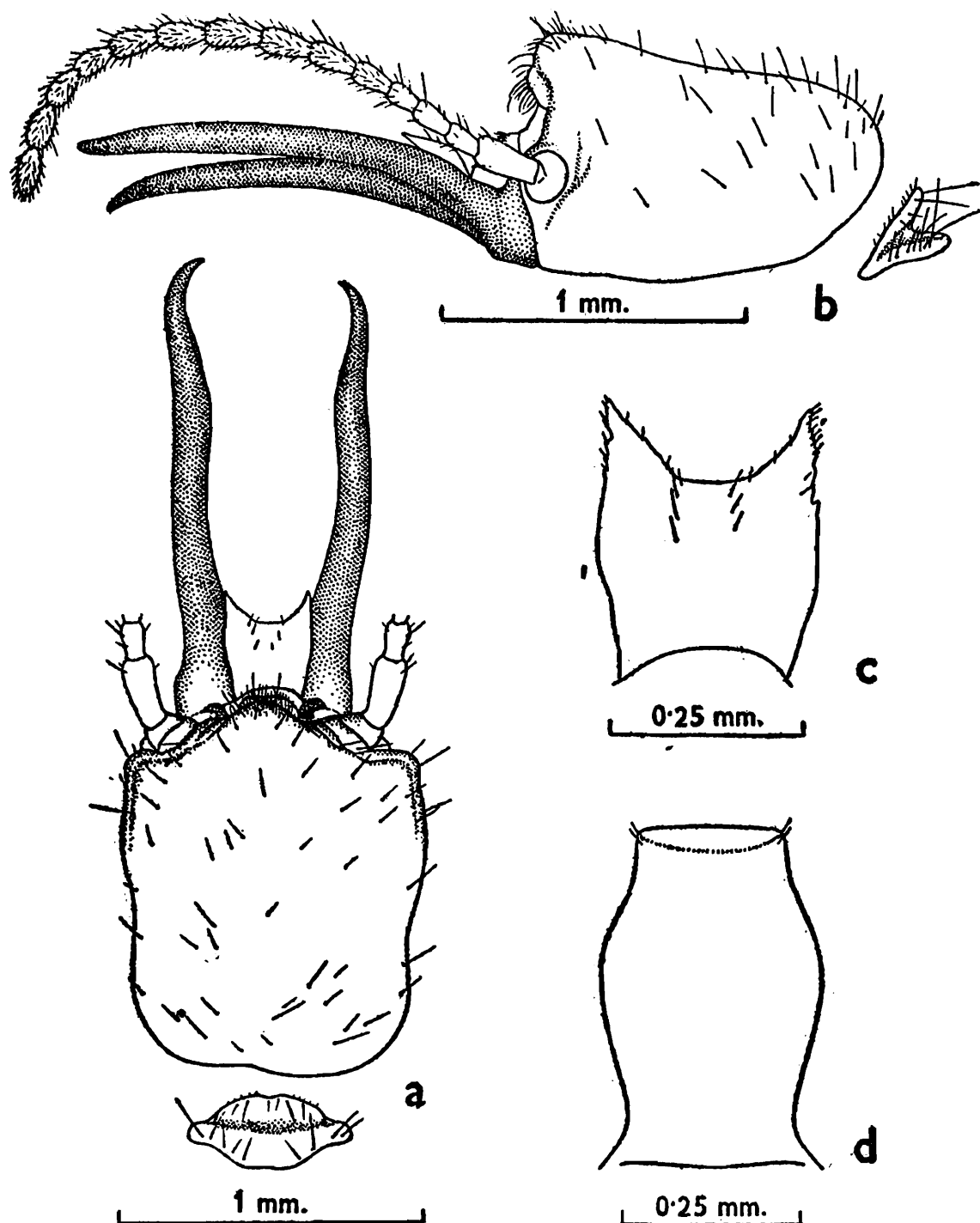
Unknown.

2. SOLDIER (Text-fig. 1 ; and Table 1)—

General : Head-capsule pale yellow to light orange yellow ; antennae, body and legs paler. Head-capsule moderately, and frontal projection, fontanelle and body fairly densely, pilose. Total body-length including mandibles c. 5.2 mm.

Head : Head-capsule subrectangular (length to base of mandibles 1.20—1.30 ; maximum width 1.00 mm.) ; broadest at about anterior one-third, whence the sides gradually narrowing behind and somewhat incurved a little posterior to middle ; posterior margin weakly rounded (slightly invaginated in holotype, Text-fig. 1a) ; frontal projection broadly projected in front and slightly indented medially at anterior margin. **Fontanelle** : Lying below the frontal projection and hairy. **Eyes and ocelli** : Absent. **Antennae** : With 14 segments ; segments 1 and 2 sparsely, and the remainder fairly densely, pilose ; segment 1 longest, cylindrical ; 2 about half of 1 ; 3 slightly longer than 2 and club-shaped ; 4 subequal to 2 ; 5-8 club-shaped and increasing in length in that order ; 9 to the

penultimate one subequal to or shorter than 8 ; the last ovate and a little longer than the penultimate one. *Clypeus* : Postclypeus weakly swollen and pilose. Anteclypeus apilose. *Labrum* : Subrectangular, longer than wide (index Width/Length 0.85-0.88) ; sides weakly narrowed behind and minutely wavy in the region of the horn-like antero-lateral projections ; anterior margin deeply incurved medially. *Mandibles* : Long, slender, rod-like, slightly wavy, and of the snapping-type ; pointed and weakly incurved at distal tips ; longer than head-length to base of mandible (index Left mandible length/Head-length to base of mandibles 1.14-1.23). *Postmentum* : Short and club-shaped, widest a little above the middle ; waist lying near posterior margin ; anterior margin sub-straight.



TEXT-FIG. 1.—*Angulitermes kashmirensis* sp. n. Holotype soldier. (a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c) Labrum, in dorsal view. (d) Postmentum, in ventral view.

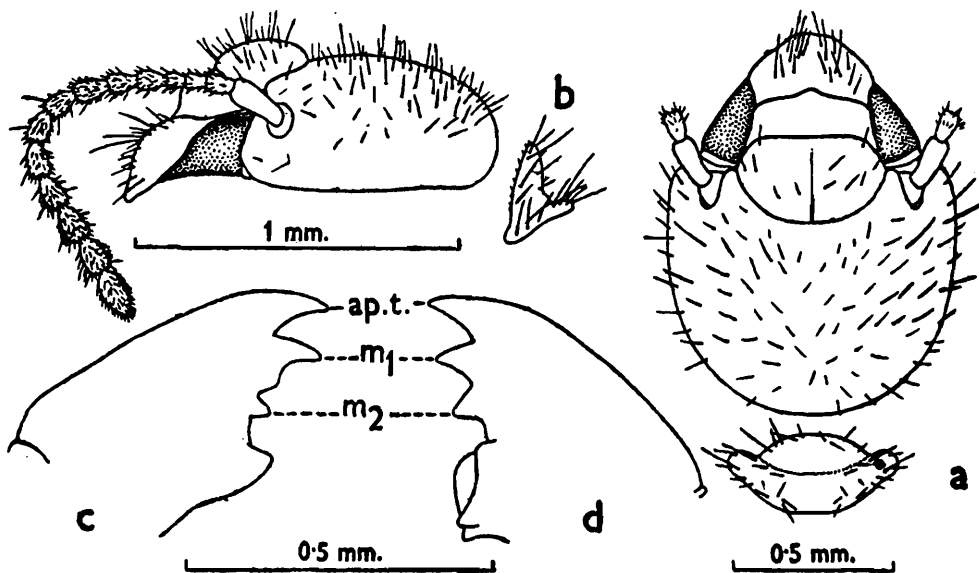
Thorax : Pronotum : Strongly saddle-shaped ; broader than long and much narrower than head-capsule (maximum length 0.20 ; maximum width 0.47-0.50 mm.) ; anterior margin weakly notched medially. **Mesonotum :** Suboval ; almost as wide as pronotum ; posterior margin weakly convex. **Metanotum :** Also suboval ; wider than pronotum ; posterior margin weakly convex. **Legs :** Thin, short and pilose ; hind-legs longest, middle-legs shortest ; apical tibial spur formula 3 : 2 : 2 ; dorsal spur on fore-tibia shorter than the ventral ones. Tarsi 4-segmented.

Abdomen : Oblong, fairly densely pilose. Cerci short, 2-segmented and hairy ; c. 0.07 mm. long. Styli absent.

3. WORKER (Text-fig. 2 ; and Table 2)—

General : Head-capsule pale yellow ; antennae, legs and thorax whitish with a yellow tinge ; abdomen appearing dark grey because of intestinal contents showing through the semi-transparent tergites and sternites ; head and body fairly densely pilose. Total body-length c. 3.9-4.5 mm.

Head : Oval, broader than long (length to base of mandibles 0.73-0.80 ; maximum width 0.87-0.90 mm.) ; posterior margin rounded. Fontanelle indistinct. Eyes and ocelli absent. Antennae with 14-segments ; segments 1 and 2 sparsely, and the remainder fairly densely, pilose ; segment 1 longest, cylindrical, narrower proximally ; 2 also cylindrical, longer than half of 1 ; 3 shorter than 2 ; 4 shortest ; 5-9 gradually increasing in length and club-shaped ; 10-13 subequal and club-shaped ; the last longer than the penultimate one and tapering in front. Postclypeus swollen and pilose ; anterior margin substraight ; posterior margin round ; divided into two halves by a thin, median, longitudinal line. Anteclypeus translucent hyaline, apilose, projected in front medially. Labrum broadly tongue-shaped ; broader than long. Mandibles of typical *Angulitermes*-type.



TEXT-FIG. 2.—*Angulitermes kashmirensis* sp. n. Morphotype worker.

(a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c), (d) Left and right mandibles respectively, in dorsal view.

ap. t., apical tooth of mandibles ; m_1 , m_2 , 1st and 2nd marginal teeth of mandibles.

Thorax : Pronotum strongly saddle-shaped ; broader than long, anterior and posterior margins not notched. Meso and metanota oval ; the former as wide as, and the latter wider than, the pronotum ; posterior margin of both convex and not notched. **Legs** : As in soldier.

Abdomen : Oblong, fairly densely pilose. Cerci 2-jointed, short, c. 0.07 mm. long. Styli absent.

(c) *Type-Specimens*

Holotype : A soldier (Z.S.I. Reg. No. 5038/H8) ; from "Material (i)" above ; deposited in National Zoological Collections, Zoological Survey of India, Calcutta. **Morphotype** : A worker (Z.S.I. Reg. No. 5039/H8) ; from "Material (i)" above ; deposited as above. **Paratype** (soldier) and **paramorphotypes** (workers) : (i) A soldier and several workers from "Material (ii)" above, deposited in Z.S.I. (ii) 20 workers from holotype lot, in Z.S.I. (iii) Two workers, from holotype lot, in Entomological Collections, Forest Research Institute, Dehra Dun. (iv) Two workers, also from holotype lot, with Prof. Alfred E. Emerson, U.S.A.

(d) *Type-Locality and Distribution*

Type-locality : About 10 km. east of Chineni, near confluence of River Tawi and Binisangh Nullah (stream), alt. c. 1122 metres, District Udhampur (Jammu and Kashmir State, India). **Distribution** : District Udhampur (*vide* "Material" above).

(e) *Comparisons*

The soldier of *A. kashmirensis* is closest to that of *A. akhorisainensis*, Chatterjee and Thakur, and is separable from the latter as follows :—

(i) Head shorter (length to base of mandibles 1.20-1.30 vs. 1.35-1.40 mm.). (ii) Mandibles longer in comparison to head-length (index Left mandible-length/Head-length to base of mandibles 1.14-1.23 vs. 1.00-1.04). (iii) Labrum shallowly incurved anteriorly vs. deeply so (index Median length/Maximum length 0.72-0.75 vs. 0.68) ; and broader (index Maximum width/Maximum length 0.85-0.88 vs. 0.80). (iv) Frontal projection slightly notched at anterior margin (vs. not notched).

The soldier is also close to that of *A. dehraensis*, but is separable in having a shorter frontal projection (length of projection 0.10 vs. 0.13-0.17 mm.).

From *A. tilaki* sp. n. (*vide* below), the other species from the area, the soldier is separable in having a larger head (head-length to base of mandibles 1.20-1.30 vs. 1.13-1.20 mm.), and longer mandibles both absolutely and in comparison with head-length (length of mandibles 1.43-1.47 vs. 1.27 mm.; index Left mandible length/Head-length to base of mandible 1.14-1.23 vs. 1.06-1.12). Third segment of antenna longer (vs. shorter) than 2. The workers are very similar except that the post-clypeus is shorter in comparison with width (index Length/Width 0.50 vs. 0.57-0.58).

2. *Angulitermes tilaki* sp. n.

(Text-figs. 3-5 ; and Tables 1 and 2)

(a) *Material*

A vial, in spirit, with 2 soldiers and several workers, Z.S.I. Coll. Station No. 38, c. one km. west of Chineni near confluence of River Tawi and Motor Shed Nullah (stream), District Udhampur (Jammu

and Kashmir State, India), altitude c. 1090 m. (3600 ft.) above mean sea-level, *Raj Tilak* coll., 27.ix.1964 (Field Coll. No. T38/27.9.64).

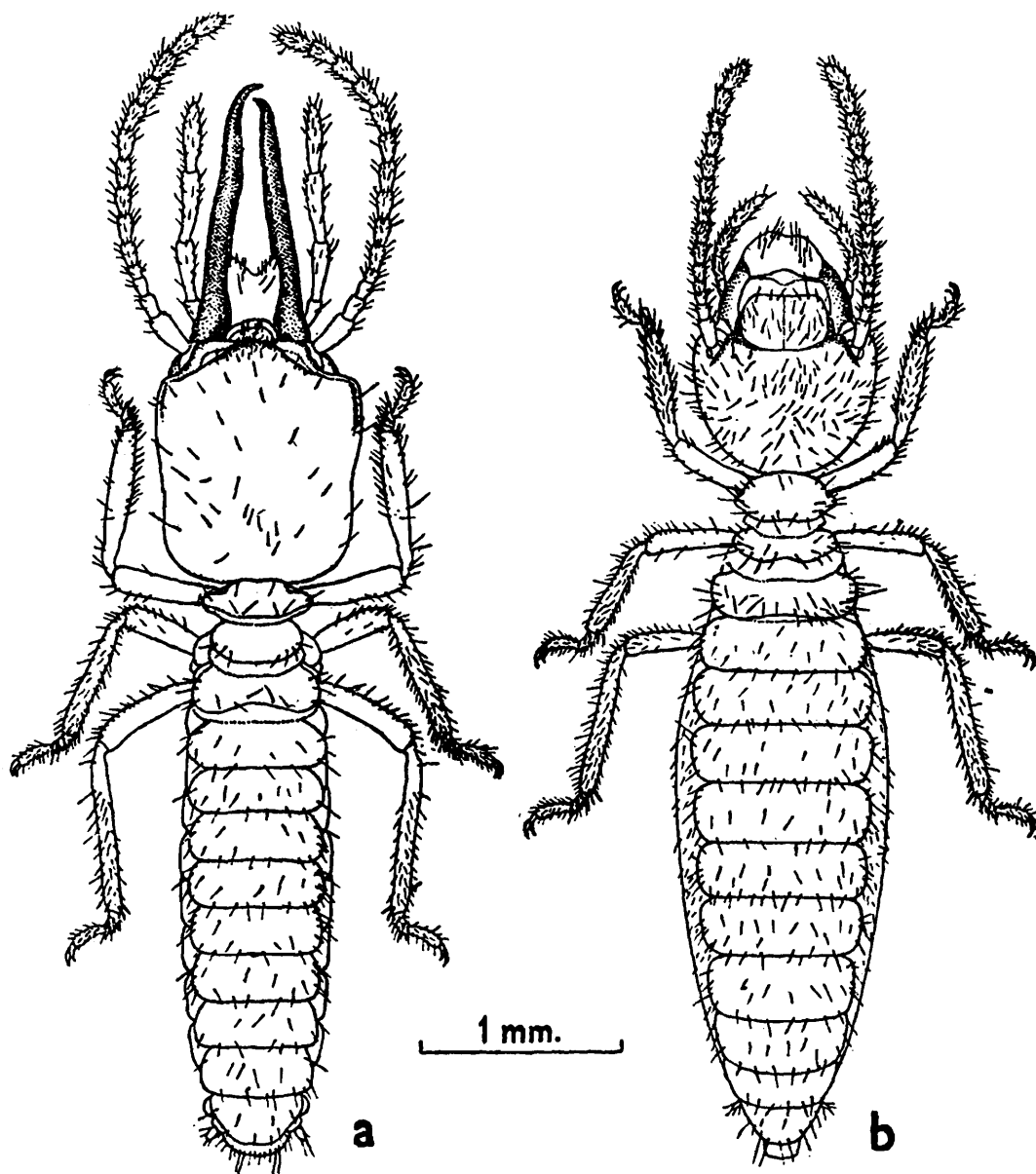
(b) *Description*

1. IMAGO—

Unknown.

2. SOLDIER (Text-figs. 3 and 4 ; and Table 1)—

General : Head-capsule pale yellow ; antennae labrum, legs and body whitish ; mandibles dark brown. Head and body fairly pilose. Total body-length with mandibles, c. 4.6-4.9 mm.

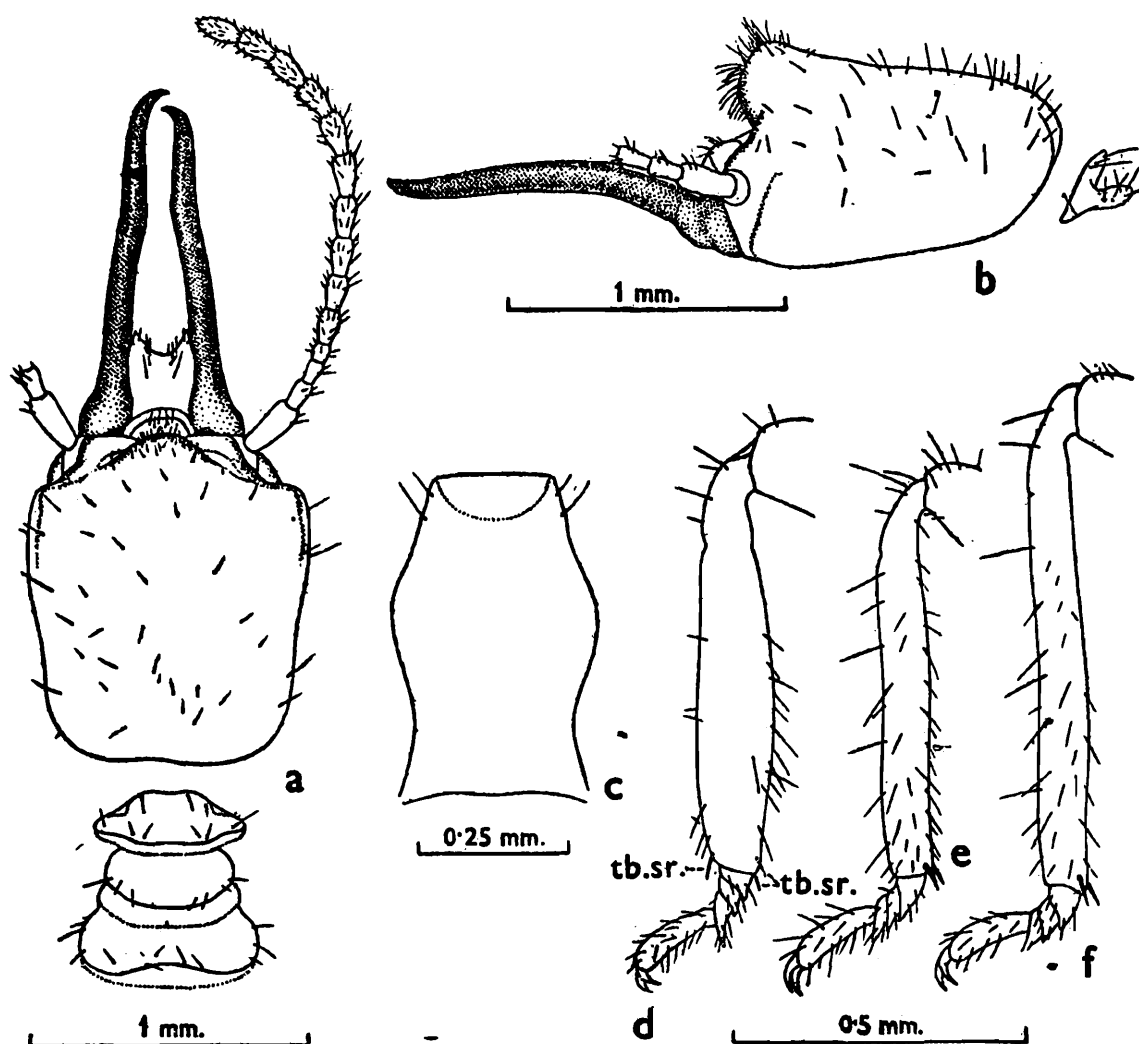


TEXT-FIG. 3.—*Angulitermes tilaki* sp. n.

(a) Soldier, in dorsal view. (b) Worker, in dorsal view.

Head : Head-capsule subrectangular, broader anteriorly, longer than wide (length to base of mandibles 1.13-1.20 ; maximum width 0.97-1.00 mm.) ; sides weakly incurved a little behind the middle ; posterior margin weakly rounded ; frontal projection broadly round and projected in front, not reaching up to base of mandibles ; head moderately pilose. *Fontanelle* : Lying below the frontal projection. *Eyes and ocelli* : Absent. *Antennae* : With 14-segments ; segments 1

and 2 weakly, and the remainder fairly densely, pilose ; segment 1 longest cylindrical, slightly wider apically ; 2 also cylindrical and about half of 1 ; 3 shorter than 2 ; 4 shortest ; 5 to 9 long, club-shaped and gradually increasing in length in that order ; 10-13 also long and club-shaped but gradually decreasing in length ; the last ovate and subequal to the penultimate one. *Clypeus* : Somewhat swollen ; divided into an ante and a postclypeus and clearly demarcated from frons. Postclypeus of same colour as head-capsule, pilose ; anteriorly rounded ; posterior margin weakly convex. Anteclypeus translucent white, apilose ; anterior margin round. *Labrum* : Subrectangular, longer than wide (Index Width/Length 0.80-0.88) ; sides weakly narrowed posteriorly ; anterior margin deeply incurved medially and with sharply pointed, lateral, horn-like projections ; index Median length/Maximum length 0.75-0.79. *Mandibles* : Long, slender, slightly wavy, rod-like and of the snapping-type, with pointed incurved distal tips ; slightly longer than head-length to base of mandibles (index Left mandible length/Head-length to base of mandibles 1.06-1.12). *Postmentum* : Short and club-shaped ; broadest a little above, and incurved a little behind, the middle ; anteriorly translucent and hyaline ; anterior margin substraight, with a pair of short hairs on either side ; posterior margin weakly incurved.



TEXT-FIG. 4.—*Angulitermes tilaki* sp. n. Holotype soldier.

(a) Head and thorax, in dorsal view. (b) Ditto, in side view. (c) Postmentum in ventral view. (d)-(f) Fore-, middle-and hind-legs respectively, in dorsal view, Only tibia and tarsi shown.

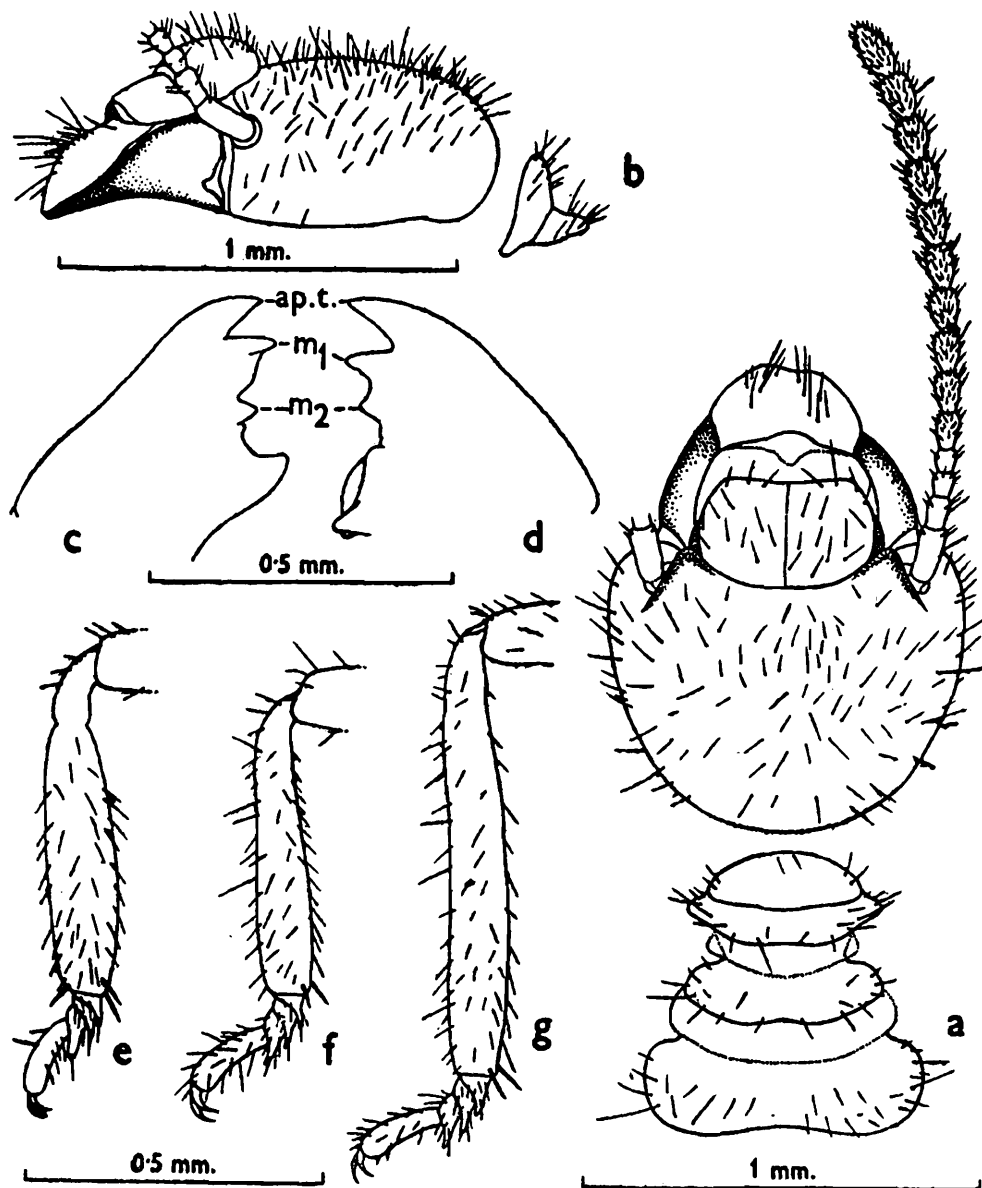
tb. sr., apical tibial spur,

Thorax : Pronotum : Strongly saddle-shaped ; broader than long and much narrower than head-width (maximum length 0.17 ; maximum, width 0.50 mm.); anterior lobe greatly upturned ; anterior margin round, weakly incurved medially. **Mesonotum :** Suboval, posteriorly rounded ; as wide as pronotum. **Metanotum :** A little broader than pronotum ; posterior margin strongly incurved medially. **Legs :** Thin and pilose ; hind-legs longest ; middle-legs shortest ; fore-tibiae weakly swollen ; apical tibial spur formula 3 : 2 : 2 ; dorsal spur on fore-tibia longer than ventral ones. Tarsi 4-segmented.

Abdomen : Oblong, pilose. Cerci 2-jointed ; c. 0.10 mm. long. Styli absent.

3. WORKER (Text-figs. 3 and 5 ; Table 2)—

General : Head-capsule pale yellow ; antennae, labrum, legs and thorax whitish ; abdominal tergites and sternites semi-transparent, but



TEXT-FIG. 5.—*Angulitermes tilaki* sp. n. Morphotype worker.

(a) Head and thorax, in dorsal view. (b) Head and pronotum, in side view. (c), (d), Left and right mandibles respectively, in dorsal view. (e)-(g) Fore-middle-and hind-legs respectively, in dorsal view. Only tibia and tarsi shown.

ap. t., apical tooth of mandibles ; m_1 , m_2 , 1st and 2nd marginal teeth of mandible ; tb. sr., apical tibial spurs.

abdomen appearing greyish due to intestinal contents showing through. Head and body fairly densely pilose. Total body-length *c.* 4.4-4.9 mm.

Head : Oval, longer than broad ; head-capsule subcircular, broader than long ; posterior margin round. Fontanelle indistinct. Eyes and ocelli absent. Antennae with 14-segments ; segment 1 longest, cylindrical ; 2 cylindrical, longer than half of 1 ; 3 shorter than 2 ; 4 shortest ; 5-8 club-shaped and gradually increasing in length in that order ; 9 to the penultimate one subequal ; the last ovate, tapering in front and longer than the penultimate one. Postclypeus large, swollen, pilose and divided into right and left halves by a dark median longitudinal line ; anterior margin weakly concave. Anteclypeus translucent, apilose ; anteriorly projected in front medially. Labrum broadly tongue-shaped ; pilose near anterior margin and on body. Mandibles of typically *Angulitermes*-type.

Thorax : Pronotum saddle-shaped ; anterior lobe greatly upturned ; anterior margin rounded, not notched medially ; posterior margin weakly convex, with or without a median incurving. Mesonotum oval, as wide as pronotum ; posterior margin convex, incurved medially. Metanotum wider than pronotum ; posterior margin convex with a broad median incurving. Legs as in soldier.

Abdomen : Oblong, hairy. Cerci 2-jointed, short, *c.* 0.07 mm. long. Styli absent.

(c) *Type specimens*

Holotype : A soldier (Z.S.I. Reg. No. 5042/H8.). Deposited in National Zoological Collections, Zoological Survey of India, Calcutta.

Morphotype : A worker (Z.S.I. Reg. No. 5043/H8), deposited as above.

Paratype (soldier) and *paramorphotypes* (workers) : (i) A paratype soldier and 20 paramorphotype workers, in Zoological Survey of India. (ii) Two paramorphotype workers in Entomological Collections, Forest Research Institute, Dehra Dun. (iii) Two paramorphotype workers with Prof. Alfred E. Emerson, U.S.A.

(d) *Type-Locality and Distribution*

Type-locality : Approximately one km. west of Chineni near confluence of River Tawi and Motor Shed Nullah (stream), District Ud'hampur (Jammu and Kashmir State, India). Known only from the type-locality.

(e) *Comparisons*

The soldier of *Angulitermes tilaki* is close to that of *A. obtusus* Holmgren and Holmgren in size but is separable as follows :—(i) Head-capsule wider in front and narrower behind (*vs.* uniformly wide). (ii) Frontal projection with a round apex and rounded anteriorly (*vs.* with an acute apex and sharply declining anteriorly). (iii) Head-capsule wider both absolutely and in comparison with head-length (maximum width 0.97-1.00 *vs.* 0.90-0.93 mm. ; index Width /Length to side base of mandibles 0.83-0.85 *vs.* 0.78-0.80).

For differences from *A. kashmirensis*, see above under that species.

III—KEY TO *ANGULITERMES* OF INDIAN REGION BASED ON SOLDIERS

Note : The types of all species except *hussaini*, *paanensis* and *resimus* have been examined by us.

- 1(2). Frontal projection of head relatively long (length c. 0.23 mm.) and subconical
 1. *A. fletcheri* Holmgren & Holmgren
- 2(1). Frontal projection of head short (length c. 0.10—0.17 mm.) and blunt.
- 3(6). Smaller species : Head-length to side base of mandibles c. 0.87—1.00 mm. ; maximum head-width c. 0.80—0.84 mm.
 - 4(5). Head wider anteriorly and sparsely hairy. Frontal projection narrower and indented medially at anterior margin. Third antennal segment longer than second
 2. *A. hussaini* Ahmad
 - 5(4). Head wider posteriorly and fairly densely hairy. Frontal projection broader and even at anterior margin. Third antennal segment subequal to second
 3. *A. paanensis* Krishna
- 6(3). Larger species : Head-length to side base of mandibles over 1 mm. (c. 1.13—1.40 mm.) ; maximum head-width c. 0.90—1.05 mm.
 - 7(8). Labrum broader (index Maximum Width/Maximum length 0.97), and strongly narrowed posteriorly ; anterior margin broadly and shallowly concave
 4. *A. acutus* Mathur & Sen-Sarma
 - 8(7). Labrum narrower (index Maximum width/Maximum length 0.66—0.88), and weakly narrowed posteriorly ; anterior margin narrowly and deeply concave.
- 9(12). Mandibles shorter (c. 1.27—1.30 mm. long).
- 10(11). Head-capsule uniformly wide ; frontal projection with an acute apex and sharply truncated in front
 5. *A. obtusus* Holmgren & Holmgren
- 11(10). Head-capsule wide in front and narrowed posteriorly ; frontal projection with a round apex and roundly truncated in front
 6. *A. tilaki* sp. n.
- 12(9). Mandibles longer (c. 1.34—1.47 mm. long).
- 13(16). Frontal projection of head longer ; length of head to frontal projection slightly more than its length to side base of mandibles.
- 14(15). Head fairly pilose ; frontal projection rounded and not turned upwards apically
 7. *A. dehraensis* (Gardner)
- 15(14). Head sparsely pilose, with only a few bristles ; frontal projection conical and turned upwards apically
 8. *A. resimus* Krishna
- 16(13). Frontal projection of head shorter (c. 0.1 mm. long) ; length of head to frontal projection slightly less than its length to side base of mandibles (index Head-length upto frontal projection/Head-length to side base of mandibles 0.97—0.98).

17(18). Head shorter (head-length to side base of mandibles c. 1.20—1.50 mm.). Mandibles longer compared to head-length (index Left mandible-length/Head-length to side base of mandibles 1.14—1.23). Labrum shallowly incurved at anterior margin (index Median length/Maximum length 0.72—0.75) and broader (index Maximum width/Maximum length 0.85—0.88) 9. *A. kashmirensis* sp.n.

18(17). Head longer (head-length to side base of mandibles 1.35—1.40 mm.). Mandibles shorter compared to head-length (index Left mandible-length/Head-length to side base of mandibles 1.0—1.04). Labrum deeply incurved at anterior margin (index Median length/Maximum length 0.68) and narrower (index Maximum width/Maximum length 0.80) 10. *A. akhorisainensis*
Chatterjee and Thakur

IV—SUMMARY

1. Ten species of genus *Angulitermes* Sjöstedt are now known from the Indian Region (8 already known and 2 described as new here).

2. The two new species are : *A. kashmirensis* and *A. tilaki*. They are described from soldier and worker castes, from Udhampur District, Jammu and Kashmir State, India.

3. A key, based on soldier characters, is provided for the identification of the ten species.

V—REFERENCES

- AHMAD, M. 1955. Termites of West Pakistan.—*Biologia*, Lahore, 1 (2), pp. 202-264.
- AHMAD, M. 1958. Key to the Indomalayan termites.—*Biologia*, Lahore, 4 (1&2), pp. 33-198+i-xii.
- CHATTERJEE, P. N. AND THAKUR, M. L. 1964. A new species of *Angulitermes* from North India (Isoptera : Termitidae : Termitinae).—*J. Bombay nat. Hist. Soc.*, Bombay, 61 (2), pp. 348-353, 3 pls.
- HARRIS, W. V. 1962. Termites of genus *Angulitermes* in Africa (Isoptera, Termitidae).—*Ann. Mag. nat. Hist.*, London, (13) 5, pp. 311-318.
- HOLMGREN, K. AND HOLMGREN, N. 1917. Report on a collection of termites from India.—*Mem. Dept. Agric. India (Ent.)*, Calcutta, 5 (3), pp. 137-171.
- KRISHNA, K. 1965. Termites (Isoptera) of Burma.—*Amer. Mus. Novit.*, New York, No. 2210, pp. 1-34.
- MATHUR, R. N. AND SEN-SARMA, P. K. 1961. A new species of *Angulitermes* from South India (Insecta : Isoptera : Termitidae : Termitinae) —*Ann. Mag. nat. Hist.*, London, (13) 3, pp. 401-406.
- SNYDER, T. E. 1949. Catalog of the termites (Isoptera) of the world.—*Smiths. misc. Coll.*, Washington, 112, 490 pp.

TABLE 1.—Measurements (in mm.) etc., of soldiers of *Angulitermes kashmirensis* and *A. tilaki* spp. n.

Body-parts	<i>A. kashmirensis</i>		<i>A. tilaki</i>	
	Range (2 exs.)	Holotype	Range (2 exs.)	Holotype
1. Total body-length (including mandibles but excluding antennae), c.	5.20	5.20	4.6—4.9	4.6
2. Length of head to lateral base of mandibles	1.20—1.30	1.20	1.13—1.20	1.20
3. Length of head upto frontal projection	1.17—1.27	1.17	1.10—1.17	1.17
4. Length of head upto fontanelle	1.07—1.20	1.07	1.00—1.07	1.07
5. Maximum width of head	1.00	1.00	0.97—1.00	1.00
6. Maximum height of head	0.70—0.77	0.70	0.70	0.70
7. Head Index I (Width/Length to side base of mandibles)	0.77—0.83	0.83	0.83—0.85	0.83
8. Head Index II (Height/Length to side base of mandibles)	0.58—0.59	0.58	0.58—0.62	0.58
9. Head Index III (Height/Width)	0.70—0.77	0.70	0.70—0.72	0.70
10. Head Index IV (Length upto frontal projection/Length to side base of mandibles)	0.975—0.977	0.975	0.973—0.975	0.975
11. Fontanelle-Head Index (Length upto fontanelle/Length to side base of mandibles)	0.89—0.92	0.89	0.88—0.89	0.89
12. Length of frontal projection of head	0.10	0.10	0.10	0.10
13. Maximum length of labrum	0.30—0.33	0.33	0.28—0.31	0.31
14. Maximum length of labrum upto middle of anterior margin	0.22—0.25	0.25	0.20—0.25	0.25
15. Maximum width of labrum	0.27—0.28	0.28	0.25	0.25
16. Labrum Index I (Length upto middle of anterior margin/Maximum length)	0.72—0.75	0.75	0.75—0.79	0.79
17. Labrum Index II (Maximum width/Maximum length)	0.85—0.88	0.85	0.80—0.88	0.80

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18. Length of mandibles (from upper base of condyle to tip) :

(a) Left Mandible	.	.	.	.	.	.	.	.	.	.	1.47	1.47	1.27	1.27
(b) Right Mandible	.	.	.	.	.	.	.	.	.	.	1.43—1.47	1.47	1.27	1.27
19. Head-Mandibular length Index (Left mandible length/Head-length to side base of mandibles)	.	.	.	.	.	.	.	.	.	.	1.14—1.23	1.23	1.06—1.12	1.06
20. Minimum median length of postmentum	.	.	.	.	.	.	.	.	.	.	0.47	0.47	0.47—0.50	0.50
21. Maximum width of postmentum	.	.	.	.	.	.	.	.	.	.	0.31—0.33	0.31	0.33	0.33
22. Width of postmentum at waist	.	.	.	.	.	.	.	.	.	.	0.23—0.27	0.23	0.27	0.27
23. Postmentum contraction Index	.	.	.	.	.	.	.	.	.	.	0.74—0.82	0.74	0.82	0.82
24. Maximum length of pronotum	.	.	.	.	.	.	.	.	.	.	0.20	0.20	0.17	0.17
25. Maximum width of pronotum	.	.	.	.	.	.	.	.	.	.	0.47—0.50	0.47	0.50	0.50

TABLE 2.—Measurements (in mm.) of workers of *A. kashmirensis* and *A. tilaki* spp. n.

Body-parts	<i>A. kashmirensis</i> (5 exs.)	<i>A. tilaki</i> (5 exs.)
1. Total body-length (excluding antennae), c.	3.90—4.50	4.4 —4.9
2. Length of head to tip of labrum	1.10—1.17	1.10—1.17
3. Length of head to lateral base of mandibles	0.73—0.80	0.73—0.80
4. Maximum width of head	0.87—0.90	0.87—0.90
5. Maximum height of head	0.40—0.43	0.37—0.40
6. Maximum length of postclypeus	0.23—0.25	0.25—0.27
7. Maximum width of postclypeus	0.47—0.50	0.43—0.47
8. Maximum length of labrum	0.30—0.33	0.30—0.33
9. Maximum width of labrum	0.40—0.43	0.40—0.43
10. Maximum length of pronotum	0.20—0.23	0.20
11. Maximum width of pronotum	0.47—0.50	0.50

THE IMAGO OF TERMITE *NASUTITERMES INDICOLA* (HOLMGREN AND HOLMGREN) (ISOPTERA : TERMITIDAE) AND THE NESTING HABITS OF THE SPECIES

By

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(With 3 Plates, 1 Text-figure and 1 Table)

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I—INTRODUCTION

Nasutitermes indicola (Holmgren, K. and Holmgren, N., 1917) (Isoptera : Termitidae : Nasutitermitinae) was described from soldiers and workers from Mercara, Coorg (Mysore State), and the Anamalai Hills (South India). Prasad and Sen-Sarma (1959), in their recent revision of Indian *Nasutitermes* Banks, recorded the species from Mysore also and designated the Anamalai Hills as the type-locality.

During a survey of termites of South India in November, 1962 the author made an extensive collection of the above species in the Mercara Reserve Forest, about 2 km. from Mercara on the road to Mysore, from a large number of carton nests constructed by the species, and also made some observations on its nesting habits. The collections generally comprised of soldiers and workers and, in a few cases, of the king and queen ; nymphs of both workers and adults were also obtained.

Rec. zool. Surv. India, 63, (1-4), 1971.

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Holmgren and Holmgren (1917) recorded that their material came from Mercara "from globular nest built around a branch" ; and from the Anamalai Hills from "Nest in tree" and "Nest in dead stump." No other data on the biology and the nests of the species are available in the literature.

In this paper the hitherto unknown imago caste of the species is described from four queens and a king. The nest is described in detail and some field notes on the biology and nesting habits are given.

II—*Nasutitermes indicola* (Holmgren and Holmgren)

1917. *Nasutitermes indicola* Holmgren and Holmgren, *Mem. Dept. Agric. India. (Ent.)* Calcutta, 5 (3), p. 161.
 1959. *Nasutitermes indicola*, Prashad and Sen-Sarma, *Revision of Nasutitermes Banks : from Indian Region*, Delhi, pp. 35-39.

(i) Material

All from Mercara Reserve Forest, Mercara (Coorg, Mysore State, India). O. B. Chhotani coll., 20th Nov., 1962, as follows :—(i) Three vials, Nos. 01/, 010/ and 021/20-11-62, each with a queen and several soldiers, workers, nymphs and eggs. (ii) A vial, No. 03/20-11-62, with a king, a queen and several soldiers, workers, nymphs and eggs. (iii) A vial, No. 016/20-11-62, with several soldiers and workers only. All ex. "carton nests on tree." (iv) Three vials with several soldiers and workers as follows : No. 09/20-11-62, ex. "galleries on the stem of 'chedle' tree ; the galleries leading to a carton nest on the tree" ; No. 020/20-11-62, ex. "at base of a dead tree" ; and No. 024/20-11-62, ex. "galleries over an unknown tree." (v) A vial with several soldiers, workers and nymphs ex. "under stone."

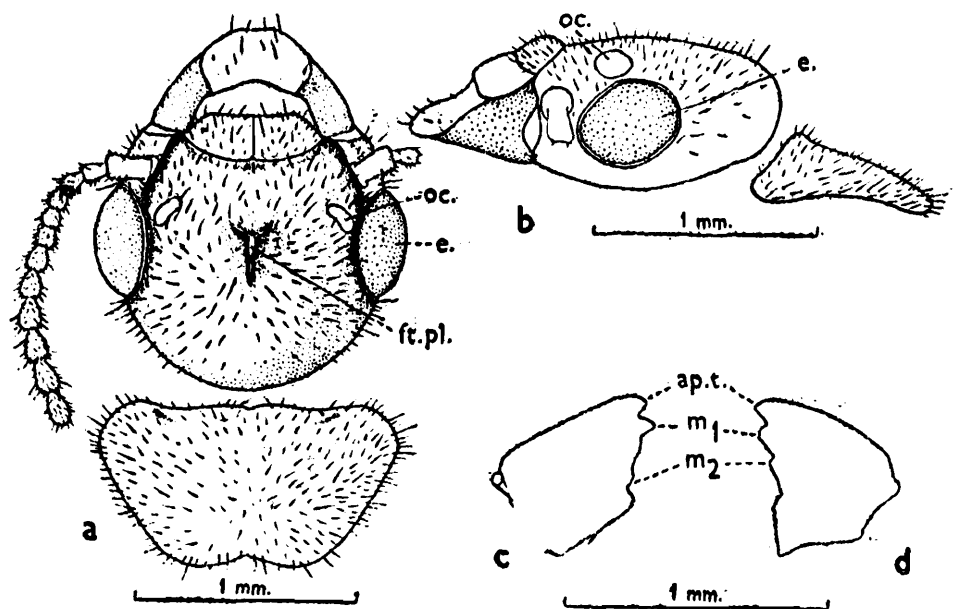
(ii) Description of imago

The hitherto unknown imago caste of *Nasutitermes indicola* is described below.

1 PHYSOGASTRIC QUEEN (Pl. 2, Fig. 1 ; Text-fig. 1 ; and Table 1).—

General : Head-capsule dark castaneous brown ; postclypeus, labrum, antennae and thorax yellowish brown ; mandibles brown with dark brown toothed margins ; wing-scale and abdominal tergites dark brown ; sternites pale brown, somewhat darker at sides ; rest of a domen whitish. Head-capsule, pronotum, wing-scales, legs and

abdominal tergites and sternites fairly densely pilose. Total body-length, without antennae c. 22.00—28.20 mm.



TEXT-FIG. 1.—*Nasutitermes indicola* (Holmgren and Holmgren). Imago (physogastric queen). From Mercara Reserve Forest, Mercara, O. B. Chhotani coll., 20th November, 1962 (No. 021/20-11-62).

(a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c) Left mandible. (d) Right mandible.

ap.t., apical tooth of mandibles; e., eye; ft. pl., fontanelle plate; m_1 and m_2 , 1st and 2nd marginal teeth of mandibles respectively; oc., ocellus.

Head: Oval, length to tip of labrum 1.63—1.70 mm.; head capsule subcircular; broader than its length to base of mandibles (maximum width with eyes 1.40—1.47; length to side base of mandibles 1.10—1.17 mm.); posterior margin round; epicranial sutures faint. **Fontanelle plate:** whitish, elongate and narrow, c. 0.10—0.13 mm. long; situated a little above middle of head dorsum. **Eyes:** Two large, oval, black, faceted eyes, one on either side. **Ocelli:** Two lateral, oval, translucent ocelli, one on either side, situated in between and close to eyes; each separated from the antenna of its side by its long diameter. **Antennae:** Incomplete in all specimens (maximum of 12 segments present); proximal segments sparsely, and distal ones fairly densely, pilose; segment 1 longest, cylindrical; 2 about half of 1 and cylindrical; 3 subequal to, or slightly longer than, 2; 4 subequal to 5; segment 5 onwards club-shaped and gradually increasing in length. **Clypeus:** Divided into an ante- and a postclypeus. Anteclypeus translucent white, apilose; medially somewhat projected in front. Postclypeus pilose; divided into right and left halves by a dark median line; length about one-third the width. **Labrum:** Broadly tongue-shaped; broader than long; pilose near anterior margin and on body medially. **Mandibles:** Each mandible with an apical and two marginal teeth. **Left mandible:** with apical tooth finger-like and broad; 1st marginal slightly longer than apical and with a long posterior margin; 2nd marginal short and without a notch at its anterior base. **Right mandible:** Apical tooth a little longer and narrower than the apical of left mandible; 1st marginal subequal to apical, with posterior margin

a little longer than anterior ; 2nd short, with a long posterior margin ; molar plate weakly undulating at inner margin and longer than posterior margin of 2nd marginal.

Thorax : Pronotum : Broader than long ; narrower than head with eyes (maximum length 0.70—0.80 ; maximum width 1.33 mm.) ; anterior margin slightly wavy with a weak median notch ; sides narrowing posteriorly ; posterior margin convex with a deep median notch. *Mesonotum and metanotum* : With a deep, angular median notch at hind margin. *Wing-scales* : Triangular ; forewing scales longer than hindwing scales and not covering the latter. *Legs* : Long, thin and hairy ; apical tibial spurs two on each leg ; tibial spur formula 2 : 2 : 2. Tarsi 4-jointed.

Abdomen : Oblong ; greatly enlarged, c. 18.5-24.0 mm. long and ; 8.0 mm. wide ; tergites and sternite pilose. Cerci 2-jointed and pilose c. 0.13 mm. long. Styli absent.

2. MALE (KING) (Pl. 2, Fig. 2).—

Like queen, except that head and pronotum are slightly wider and the abdomen is small and normal (not physogastric). Total body-length without wings c. 8.5 mm.

(iii) Brief description of other castes

The soldier and worker castes have recently been described in some detail by Prashad and Sen-Sarma (1959). I, therefore, give below only a brief description and measurements of these castes and of the nymphs of workers and adults.

1. SOLDIER (Pl. 2, Fig. 3).—

Head-capsule brown ; rostrum dark brown ; antennae, legs and body pale brown. Head without rostrum pear-shaped ; rostrum long and cylindrical ; antennae 12-segmented ; segment 3 slightly longer than 2 ; mandibles vestigial, each with a short spine-like process. Pronotum strongly saddle-shaped ; legs long and thin ; apical tibial spur formula 2 : 2 : 2.

Measurements of soldiers (10 examples) :

	Range (mm.)
1. Total body-length (without antennae), c.	3.4 — 4.5
2. Length of head with rostrum	1.60—1.67
3. Length of head without rostrum	0.87—0.90
4. Maximum width of head	0.83—0.90
5. Length of rostrum	0.63—0.70
6. Maximum width of pronotum	0.47—0.50

2. WORKER (Pl. 12, Figs. 4 and 5).—

Dimorphic. Head-capsule brown ; antennae, labrum and legs pale yellow ; tergites and sternites transparent. Head subcircular ; antennae 13-segmented ; mandibles of the *Nasutitermes*-type, each with an apical and two marginal teeth. Pronotum strongly saddle-shaped. Legs as in soldier

Measurements of workers (in mm.) :

	Worker major (5 exs.)	Worker minor (6 exs.)
1. Total body-length (without antennae), c.	4.3 —4.9	3.7 —3.9
2. Length of head to tip of labrum	1.20—1.33	1.00—1.07
3. Length of head to side base of mandibles	0.97—1.00	0.80—0.83
4. Maximum width of head	1.07—1.10	0.83—0.90
5. Maximum width of pronotum	0.50—0.53	0.45—0.50

3. EGGS AND NYMPHS (Pl. 2, Figs. 6-8).—

Eggs small, oval, c. 0.60—0.70 mm. long. Nymphs of workers small, whitish, c. 1.5—4.0 mm. long. Nymphs of imago whitish ; longer c. 4.0—6.0 mm. long ; older nymph with brownish wing-pads.

III—NESTING HABITS AND NESTS

(Pls. 3 and 4)

(i) *Nesting habits and ecological habitat*

Nasutitermes indicola is arboreal in its nesting habits and builds carton nests on, and in between, the branches and on main trunks of trees. In the Mercara Reserve Forest, the species was found making nests on *Syzygium cuminis* (Linn.) Skeels (= *Eugenia jambolana* Lam.), *Croton oblongifolius* Roxb. and *Eucalytus* sp. ; also on “chedle”, “thadali” (local names) trees and many other plants in the vicinity. The height at which the nests were found was 2 to 10 meters from ground-level. Long, thin and narrow covered runways or galleries generally connect these nests with the soil below ; through these galleries the soldiers and workers go out foraging. Small communities of soldiers and workers (and also nymphs in one case) were found under stones and at the base of trees.

The Mercara Reserve Forest, where the nests were found in abundance, is about 2 km. from Mercara town on the road to Mysore. The plateau of Mercara (c. 1,200 m. or 4,000 ft. above sea-level) is crossed in all directions by minor hills and ridges ; on the west it is bounded by the Western Ghats. The temperature of the region is moderate throughout the year (average daily mean 65° F. in winter and 70° F. in summer). The relative humidity varies from c. 48-87 per cent ; it is lowest in December and highest in September, i.e. just after the rains. The rainfall is fairly heavy, the yearly average being about 300 cm. These ecological conditions seem to be very favourable for the species.

(ii) Nest-structure

The carton nests are globular to oval in shape, with the long diameter c. 15-45 cm. They are dark brown mottled with black, and are made up of vegetable matter. The outer wall is thin, rough and very brittle and breaks with a little pressure or touch. Inside the outer wall the structure is rough, honeycombed and hard. The honeycomb cavities extend to the interior into long, narrow, flat, horizontal galleries or chambers which, in the outer region of the nest, are larger and longer and are mottled with black. The galleries are interconnected by small, round or flat holes and are supported by small supporting constructions in between.

The royal chamber (Pl. 4, Figs. 3 and 4) lies approximately in the middle of the nest (Pl. 3, Fig. 2 ; and pl. 4, figs. 3 and 4) and is larger than other chambers, being c. 25 mm. long, 12 mm. wide and 7 mm. high. It is spindle-shaped and there are a few round or flat holes on its sides which communicate with the outer galleries.

IV—SUMMARY

1 The hitherto unknown imago caste of *Nasutitermes indicola* (Holmg. & Holmg.) is described here for the first time from four physogastric queens and a king. The collections were obtained from carton nests at Mercara (Coorg, Mysore State, India), which is one of the localities from where the species was originally described.

2. The other castes (namely the soldier and the worker) and the eggs and nymphs are briefly described.

3. The nesting habits and the carton nests of the species are described.

V—ACKNOWLEDGEMENTS

The author is thankful to Dr. A. P. Kapur, Director, Zoological Survey of India, for his encouragement and interest and to Dr. M. L. Roonwal for very kindly going through the manuscript.

VI—REFERENCES

- HOLMGREN, K. AND HOLMGREN, N. 1917. Report on a collection of termites from India.—*Mem. Dept. Agric. India (Ent.)*, Calcutta, 5 (3), pp. 137-171.
- PRASHAD, B. AND SEN-SARMA, P. K. 1959. *Revision of the Termite Genus Nasutitermes Banks (Isoptera : Termitidae : Nasutitermitinae) from the Indian Region*. 66 pp.—Delhi (Govt. of India Publ.).

TABLE 1.—Measurements (in mm.) of *Nasutitermes indicola* (Holmg. and Holmg.). Imago (king and physogastric queen).

Body-parts	Physogastric queen (3 exs.)	King (1 ex.)
1. Total body-length <i>without</i> wings, (excluding antennae), <i>c.</i>	22.00—28.20	8.50
2. Length of head to tip of labrum	1.63— 1.70	1.57
3. Length of head to lateral base of mandibles	1.10— 1.17	1.10
4. Maximum width of head (with eyes)	1.40— 1.47	1.50
5. Maximum height of head . . .	0.60	0.63
6. Length of fontanelle plate . . .	0.10— 0.13	0.15
7. Maximum length of postclypeus .	0.20— 0.21	0.20
8. Maximum width of postclypeus .	0.57—0.58	0.57
9. Maximum length of labrum . . .	0.37—0.47	0.43
10. Maximum width of labrum .	0.50	0.50
11. Maximum diameter of compound eye (with ocular sclerite) . . .	0.47— 0.50	0.50
12. Maximum diameter of lateral ocellus . .	0.15— 0.17	0.16
13. Minimum diameter of lateral ocellus . . .	0.13— 0.15	0.13
14. Minimum eye-ocellus distance . .	0.03	0.03
15. Minimum eye-antennal distance .	0.03— 0.05	0.03
16. Minimum ocellus-antennal distance	0.16—0.17	0.15
17. Maximum length of pronotum . .	0.70— 0.80	0.80
18. Maximum width of pronotum	1.33	1.40
19. Length of forewing scale . . .	0.80— 0.83	0.80
20. Length of hindwing scale . .	0.63— 0.67	0.67

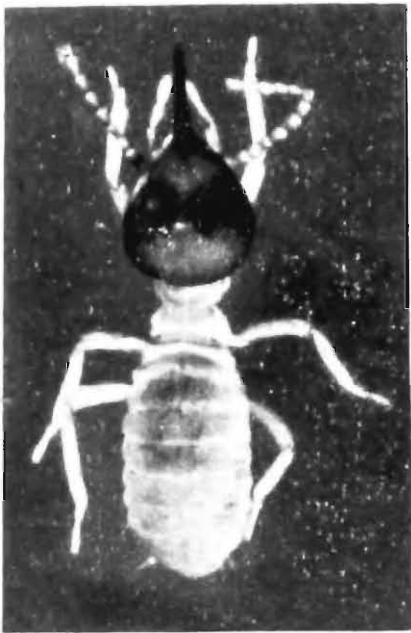
PLATE 2

Nasutitermes indicola (Holmgren and Holmgren). Photographs of various castes. Material from Mercara, Coorg (Mysore State, India), O. B. Chhotani coll., 20th November, 1962.

1. Physogastric queen. 2. King. 3. Soldier. 4. Major worker. 5. Minor worker. 6. Eggs. 7. and 8. Nymphs of workers and adults respectively, at different stages of development.



4

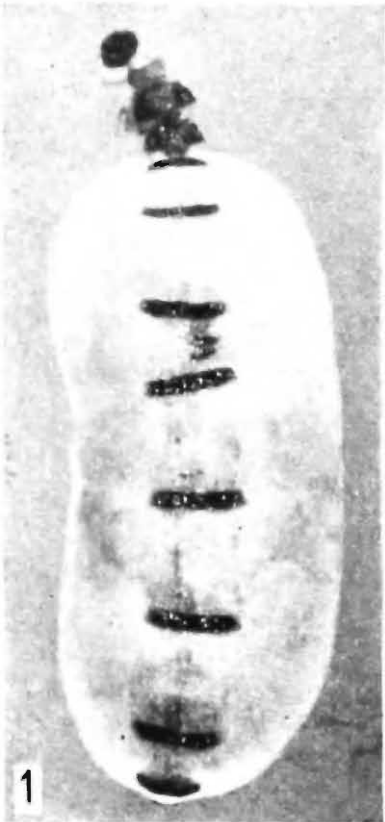


3

3 mm



5



1

10 mm



8

5 mm



6

2 mm



2



7



5 mm



PLATE 3

Nasutitermes indicola (Holmgren and Holmgren). Carton nests from Mercara Reserve Forest, Mercara (Coorg, Mysore State).

1. A carton nest on a tree (*Photo O.B C.*). 2. Several carton nests of various sizes.

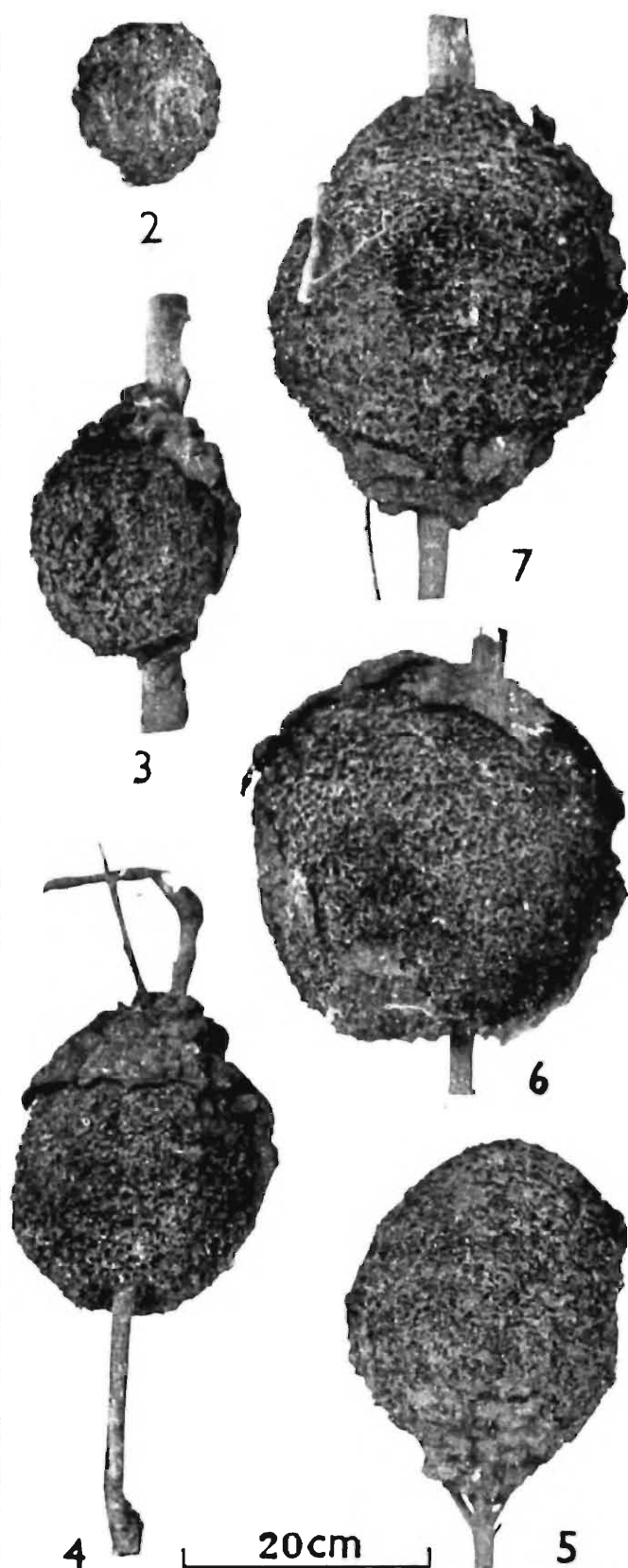
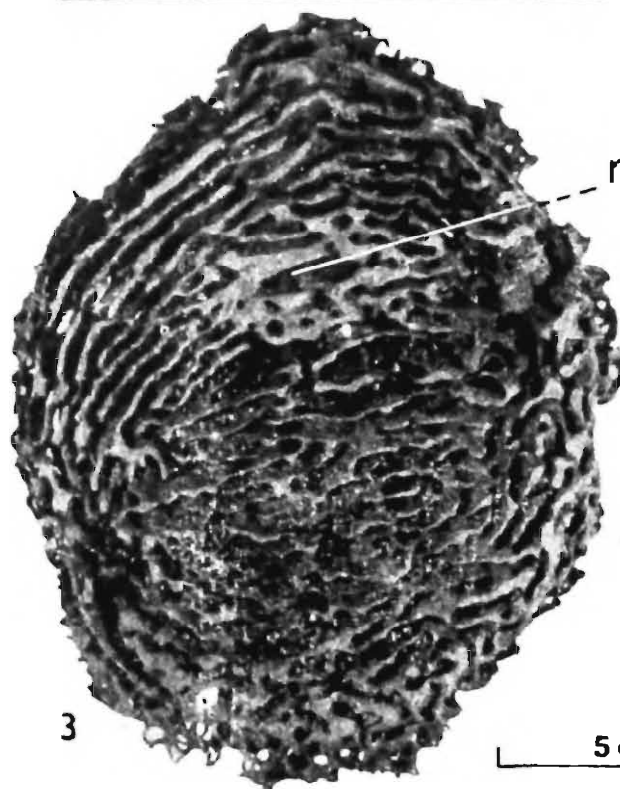
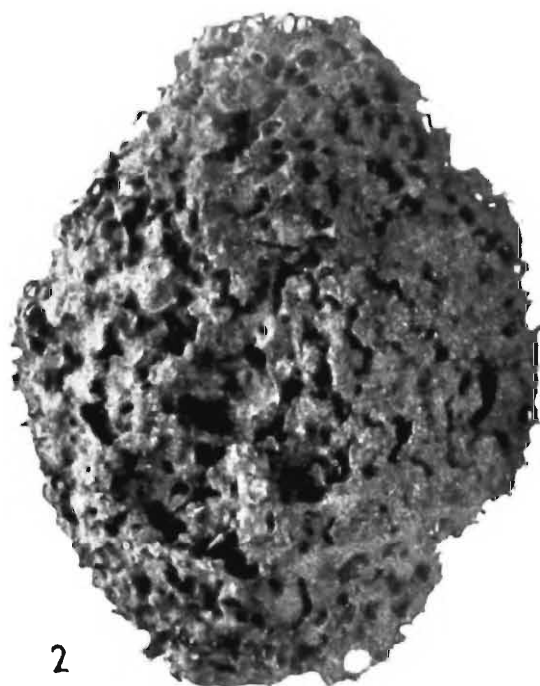


PLATE 4

Nasutitermes indicola (Holmgren and Holmgren). Carton nests from Mercara Reserve Forest, Mercara (Coorg, Mysore State).

1. Carton nest with outer wall intact. 2. Same nest as shown in Pl. 3, Fig. 2, enlarged. (Outer wall removed to show the inside honeycomb structure.) 3 and 4. Ditto, in section, showing royal chamber in middle and galleries inside.

r.c., royal chamber.



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The title should include the Phylum and Class where necessary and invariably the Order and Family of the animals dealt with. Generic and specific names of animals, which should be underlined, must be given in full at least once on their first citation in the paper according to the International Code of Zoological Nomenclature adopted at the 15th International Congress of Zoology, 1961 and include the name(s) of author(s) in full, the only exceptions being according to the Code, those of Linnaeus and Fabricius which may be suitably abbreviated. Systematic papers should conform to the Rules of the Code and to its recommendations also, as far as possible.

The Metric system should be used for measures and weights; measures in other systems may, if desired, be given in brackets. Temperatures should be given in Degrees Centigrade, with, if desired, the Fahrenheit reading in brackets.

REFERENCES.—References must be listed at the end of the articles as follows: Name and initial(s) of author(s), year of publication, further distinguished by the addition of small letters *a, b, c*, to the year where more than one paper published by the same author(s) in the same year is cited; exact and full title of paper; abbreviated title of journals as given in the World List of Scientific Periodicals (London); place of publication: volume numbers in Arabic figures, preceded, within brackets, by series number, if any, and followed, within brackets, by part or number of the issue; the first and last pages; the number of plates, etc., thus:

ANNANDALE, N. 1909. Report on a small collection of sponges from Travancore.—*Rec. Indian Mus.*, Calcutta, 3, pp. 101–104, 2 pls.

WIGGLESWORTH, V. B. 1950. *The Principles of Insect Physiology* (4th ed.), viii+544 pp.—London (Methuen & Co.).