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CONTENTS

	Page
ROONWAL, M. L.—The late Dr. Sunder Lal Hora (1896-1955) : An appreciation, together with a complete list of his scientific writings	107
MENON, M. A. S.—On a third collection of fish from Iraq . . .	139
KAPUR, A. P. and VAZIRANI, T. G.—The identity and geographical distribution of the Indian species of the genus <i>Dysdercus</i> Boisduval (Hemiptera : Pyrrhocoridae) . . .	159
RAO, S. N.—Studies on gall midges (Itonididae = Cecidomyiidae : Diptera, Insecta) from India. — IX	177
MEHRA, H. R.—Studies on the family Cyathocotylidae Poche. Part 3. Subfamily Muhlingininae Mehra, 1950, with description of <i>Muhlingina lutrai</i> Mehra, 1950 . . .	195
KUSHWAHA, K. S.—External morphology of the termite, <i>Odontotermes obesus</i> (Rambur) (Isoptera : Termitidae). Part I. Soldier	209
KUSHWAHA, K. S.—External morphology of the termite, <i>Odontotermes obesus</i> (Rambur) (Isoptera : Termitidae). Part 2. Alate and Worker . . .	229

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34, Chittaranjan Avenue,

CALCUTTA-12.

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THE LATE DR. SUNDER LAL HORA (1896-1955): AN APPRECIATION, TOGETHER WITH A COMPLETE LIST OF HIS SCIENTIFIC WRITINGS

By

M. L. ROONWAL

*Director, Zoological Survey of India,
Calcutta*

(With a photograph)

Dr. Sunder Lal Hora died in his sixtieth year while in active service as the Director, Zoological Survey of India. On the 6th December, 1955, while presiding over a meeting of the Asiatic Society of Bengal in Calcutta, and in which he read a paper on the significance of *mahi-maratib*, a fish-ensignia of the Moghul times, he was seized with an attack of coronary thrombosis, his second in the last three years, and passed away peacefully on the 8th December.

Hora was born on the 22nd May, 1896, as the son of the late Lala Gobind Sahay Hora, at Hafizabad in the West Punjab (now in Pakistan). He had his early education at the Sain Das Anglo-Sanskrit School at Jullunder where he showed interest in science subjects. At the wish of his father for technical education, young Hora studied biology in the Intermediate course with a view to join the medical profession. He showed proficiency in Chemistry, Physics and Botany, but not in Zoology. In the first college examination he got very low marks in Zoology which hurt his feelings and created in him a determination to master the subject so that in later years he became one of the best known Indian zoologists. For his high marks in Zoology and Botany in his B.Sc., which he took in 1917 from the Government College, Lahore, he was awarded a cash prize. In 1919 he took his M.Sc. degree from the same college and in the same year he joined the Zoological Survey of India as a Research Scholar. Almost his entire service career was spent in that department which, in 1921, he joined as regular member of the gazetted staff (Assistant Superintendent), a post which he held until 1942. During the years 1942-47 he was seconded on deputation to the Bengal Government as the Director of Fisheries. He came back to the Zoological Survey of India in May, 1947, as its Director which post he held until his death in December, 1955.

While in service, Hora obtained on the basis of his researches, the D.Sc. degrees of the Punjab University in 1921 and of the Edinburgh University in Scotland in 1928, his theses being on the ecology of torrential fishes.

In the Zoological Survey of India, Hora was in charge of the collection of fishes, and his main contributions to science were on the taxonomy and

e ology of oriental fishes. He was a prolific and indefatigable writer and wrote during his life-time about 425 papers, not a few of them being monographic in nature. Hora's interests were not confined to the taxonomy and ecology of fishes. He wrote extensively, especially in his later years, on a variety of topics such as zoogeography, physiology, evolution, bionomics, etc., but always with fishes as the motif. While his earlier papers up to about 1935 were mostly technical, his later papers were often semi-popular. Early in life he developed an interest in the role of fishes in ancient Indian culture and wrote extensively on the subject. Perhaps his best contributions to science were his early papers on the evolution and adaptation of the fishes living in torrential streams in the hills of India and on the taxonomy of certain families of oriental fishes. In these works he was inspired by the example of Dr. Nelson Annandale, then Director, Zoological Survey of India, and he was also ably assisted throughout, first by his assistant Shri D. D. Mukherjee and later by his assistant Dr. K. S. Misra who subsequently succeeded him as Officer-in-Charge of the Fish Section.

Many honours came to him in recognition of his scientific work. In 1936, the Government of India conferred on him the title of Rai Bahadur. He was awarded the following medals by the learned societies and other bodies :—

1. The *MacLagan Gold Medal and Purse* of the University of Punjab in 1919. (For standing first in all science subjects in the M.Sc. examination.)
2. The *Joy Gobind Law Memorial Medal* of the Asiatic Society of Bengal in 1944. (For conspicuously important contributions to zoology in Asia.)
3. The *Jawaharlal Nehru Medal* of the National Geographical Society of India in 1951. (For outstanding zoogeographical researches.)
4. The *Sir Dorabji Tata Memorial Medal* of the Zoological Society of India in 1951. (For conspicuously important contributions to zoology.)

Several societies, institutions and international organizations all over the world honoured him and elected him as their honorary member, or fellow, etc., as follows : —

1. Honorary Member of the American Society of Ichthyologists and Herpetologists : 1946.
2. Honorary Director, Central Inland Fisheries Research Station, Barrackpore (Calcutta) : 1947.
3. Honorary Professor, Scientific Institutes, Netherlands : 1948. (For contributions to tropical zoology.)
4. Honorary Visitor to the Royal Institute of Science, Bombay : 1948-1951.
5. Senior Fellow and Member of Council and various Committees of the Asiatic Society of Bengal, Calcutta.

6. Foundation Fellow, Member of Council and of various Committees and Editor of Publications (for several years) of the National Institute of Sciences of India, and its President for 1951 and 1952.
7. Member of Council and of various Committees of the Indian Science Congress Association and President of the 41st Session (1953-54) of that body.
8. Fellow of the National Geographical Society of India.
9. Fellow of the Indian Ecological Society of India and its President for 1948 and 1949.
10. Fellow of the Zoological Society of India, and its President from 1948 to 1951.
11. Member of the Executive and Advisory Committees of the Bombay Natural History Society.
12. Foreign Secretary of the Helminthological Society of India.
13. Member of the Technical Advisory Board of the Calcutta Corporation's Waterworks (1936-39).
14. Member of the Oceanographic Committee of the Central Board of Geophysics (India).
15. Correspondent in India of the International Association of Oceanography.
16. Member of the Institute of Biology, London (1950).
17. Fisheries and Wildlife Adviser to the Damodar Valley Corporation (India).
Consultant for Tropical Fish Culture to the Food and Agricultural Organization of the United Nations.
19. Member of the UNESCO Panel of Experts on Human Ecology and Arid Zone.
20. Member of Editorial Boards of the following journals :
(i) *Evolution* (U.S.A.) (ii) *Copeia* (U.S.A.). (iii) *Current Science* (Bangalore). (iv) *Science and Culture* (Calcutta). (v) *Everyday Science* (Ambala).

Hora attended the following international scientific conferences as one of the representatives of India :—

1. Royal Empire Scientific Conference and the British Commonwealth Scientific Conference. At London in 1946.
2. Food and Agricultural Organization (of U. N.) Fisheries Conference. At Baguio (the Philippines) in 1948.
3. United Nations Scientific Conference on the Conservation and Utilization of Resources. At Lake Success (U.S.A.) in 1949.
4. Jubilee Meeting of the Australian and New Zealand Association for Advancement of Science. At Brisbane (Australia) in 1951.
5. Leader of Indian Delegation to the Third Meeting of the Indo-Pacific Fisheries Council. At Madras in 1951.

6. Chairman of the *Hilsa* Sub-Committee of the Indo-Pacific Fisheries Council. At Calcutta in 1952.
- 7 Annual Meeting of the British Association for Advancement of Science. At Liverpool (United Kingdom) in 1953.
8. Second Congress of the Pan-Indian Ocean Science Association. At Perth (Australia) in 1954.

From 1952-55 Hora was the Honorary Secretary-General of the Indian Board for Wild Life (Ministry of Agriculture) and did yeoman service to the organization of that Board in the years of its infancy.

Hora was gentle and loving by nature. Hard, conscientious work and persistence were perhaps his most outstanding characteristics. Once his interest was created in a scientific problem, the affairs of a scientific society or whatever it might be, he considered no trouble too much and no work too unimportant for that cause. His hobby was hard work and harder work. To the assistants and students who worked under him he was kind and considerate and always free with encouragement. To his enemies he was never forgiving, but he had great adaptability when the occasion demanded and he was thus a great success in the numerous scientific societies whose offices he held.

He is survived by his wife, a son and two daughters to all of whom we tender our sympathies.

A number of appreciative notices and obituaries on the late Dr. Hora have already appeared and the reader will find interesting material in them. Such notices as have come to my attention are listed below :—

List of obituaries and other publications concerning Dr. S. L. Hora.

- Anonymous. 1951. *Bibliography of the Publications of Sunder Lal Hora*. Published in commemoration of the Silver Jubilee of Dr. S. L. Hora's first contribution to Science. ix+57 pp., and 1 frontispiece portrait.—Calcutta.
- Anonymous. 1956. Dr. S. L. Hora (1896-1955). Obituary.—*J. sci. industr. Res.*, New Delhi, **15A**(1), p. 23.
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Seshachar, B. R. 1956. Dr. S. L. Hora.—*Curr. Sci.*, Bangalore, **25**(2), p. 46.

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A fully indexed list of his publications was issued in a booklet in 1951 by his admirers and friends "in commemoration of the Silver Jubilee of Dr. S. L. Hora's first contribution to Science" A complete list of his publications, including a few which appeared posthumously, is given below in a chronological order ; two or three of his papers are still believed to be in the press.

ACKNOWLEDGMENTS

In the preparation of this obituary notice and the bibliography I have received much help from my assistants Shri Kedar Nath Bagchi and Shri K. C. Jayaramakrishnan to both of whom my thanks are due for their able assistance.

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3. ———, 1920c. A short note on the structure of the compound limb bones of *Rana*.—*Rec. Indian Mus.*, Calcutta, **19**(4), pp. 183-184.
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5. ———, 1921b. Notes on fishes in the Indian Museum. II. On a new species of *Nemachilus* from the Nilgiri Hills.—*Rec. Indian Mus.*, Calcutta, **22**(1), pp. 19-21.
6. ———, 1921c. Notes on the occasional absence of the paired fins in freshwater fishes, with some observations on the two Apodal genera *Channa* Gronov., and *Apua* Blyth.—*Rec. Indian Mus.*, Calcutta, **22**(1), pp. 27-32.
7. ———, 1921d. Fish and Fisheries of Manipur with some observations on those of the Naga Hills.—*Rec. Indian Mus.*, Calcutta, **22**(3), pp. 165-214, 4 pls.
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PLATE 1

Photograph of the late Dr. S. L. Hora.



The late Dr. S. L. Hora
1896 -1955

ON A THIRD COLLECTION OF FISH FROM IRAQ

By

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(With 2 Text-figures and 1 Plate)

CONTENTS

	PAGE
I—Introduction	139
II—Systematic Account .. .	141
III—Key for the identification of the Iraq fishes so far received for determination	151
IV—Summary .. .	157
V—References :.	157

I—INTRODUCTION

Our recent knowledge about the ichthyfauna of Iraq is derived mainly from the papers of Hora and Misra (1943) and Misra (1947). Reporting on the two previous collections received by the Zoological Survey of India in the years 1941 and 1943 from Mr. Dimitry D. Belayew, Specialist in Fisheries, Directorate General of Agriculture, Baghdad, these authors recorded 13 and 19 species respectively, of which 2 were new.

During the years 1950, 1953 and 1954 three lots of fishes were receiver by the Zoological Survey of India from the Directorate General of Agriculture, Baghdad, for determination. These were accompanied by photographs of 30 species and a list of the Arabic names of most of them. These fishes, collected from the Persian Gulf and from the Hors and Rivers Shatt-al-Arab, the Tigris and the Euphrates, are reported in the present paper.

I am grateful to Dr. M. L. Roonwal, Director and Dr. K. S. Misra, Assistant Superintendent, for going through the manuscript of this paper. The drawings were done by Sri R. C. Bagchi, Artist.

The following 41 species¹ are represented in the collection under report :

- | | |
|--|--|
| <p>Class ELASMOBRANCHII
 Subclass SELACHII
 Order EUSELACHII
 Family GALEIDAE
 1. <i>Carcharhinus menisorrh</i> (M. H.)
 Class PISCES
 Subclass ACTINOPTERI
 Order ISOSPONDYLI
 Family CHIROCENTRIDAE
 2. <i>Chirocentrus dorab</i> (Forsk.)
 Family CLUPEIDAE
 3. <i>Hilsa ilisha</i> (Ham.)
 Family DOBOSOMIDAE
 4. <i>Nematalosa nasus</i> (Bl.)
 Family ENGRAULIDAE
 5. <i>Thrissocles malabaricus</i> (Bl.)
 Order OPISTHOMI
 Family MASTACEMBELIDAE
 6. <i>Mastacembelus haleppensis</i> (Bl. Schn.)
 Order EVANTOGNATHI
 Family CYPRINIDAE
 7. <i>Barbus esocinus</i> (Hckl.)
 8. <i>Barbus kersin</i> Hckl.
 9. <i>Barbus subquincunciatus</i> Gthr.
 10. <i>Barbus xanthopterus</i> (Hckl.)
 11. <i>Barbus belayewi</i> sp. nov.
 12. <i>Puntius luteus</i> (Hckl.)
 13. <i>Varicorhinus trutta</i> (Hckl.)
 Order NEMATOGNATHI
 Family TACHYSURIDAE (=Ariidae)
 14. <i>Tachysurus thalassinus</i> (Rupp.)
 Order INIOMI
 Family SYNOdontIDAE
 15. <i>Saurida tumbil</i> (Bl.)
 Order CYPRINODONTES
 Family CYPRINODONTIDAE
 16. <i>Aphanius dispar</i> (Rupp.)
 Order HETEROSOMATA
 Family BOTHIDAE
 17. <i>Pseudorhombus arsius</i> (Ham.)
 Family CYNOGLOSSIDAE
 18. <i>Cynoglossus sealarki</i> Reg.
 Order PERCOMORPHI
 Family SPHYRAENIDAE
 19. <i>Sphyraena obtusata</i> V</p> | <p>Family SCOMBRIDAE
 20. <i>Scomberomorus commersoni</i> (Lac.)
 Family TRICHIURIDAE
 21. <i>Trichiurus haumela</i> (Forsk.)
 Family STROMATEIDAE
 (= Pampidae)
 22. <i>Apolectus niger</i> (Bl.)
 Family CARANGIDAE
 23. <i>Alectis indicus</i> (Rupp.)
 24. <i>Atule kalla</i> (C. V.)
 25. <i>Atule mate</i> (C. V.)
 26. <i>Caranx malabaricus</i> (Bl. Schn.)
 27. <i>Scomberoides lysan</i> (Forsk.)
 Family RAACHYCENTRIDAE
 28. <i>Rachycentron canadus</i> (L.)
 Family EPINEPHELIDAE
 29. <i>Epinephelus stoliczkae</i> (Day)
 Family LUTIANIDAE
 30. <i>Lutianus fulvus</i> (Bl. Schn.)
 Family THERAPONIDAE
 31. <i>Therapon theraps</i> C. V.
 Family NEMIPTERIDAE
 32. <i>Nemipterus bleekeri</i> (Day)
 Family GERRIDAE
 33. <i>Gerres filamentosus</i> C.
 Family SCIAENIDAE
 34. <i>Johnius osseus</i> (Day)
 35. <i>Pseudosciaena aeneus</i> (Bl.)
 Family EPHIPPIDAE
 36. <i>Ephippus orbis</i> (Bl.)
 Family DREPANIDAE
 37. <i>Drepane punctata</i> C. V.
 Order CATAPHRACTI
 Family DACTYLOPTERIDAE
 38. <i>Dactyloptena orientalis</i> (C. V.)
 Order GOBIOIDEA
 Family PERIOPHTHALMIDAE
 39. <i>Boleophthalmus dentatus</i> C. V.
 Order PLECTOGNATHI
 Family TRIACANTHIDAE
 40. <i>Triacanthus brevirostris</i> Schgl.
 Family TETRAODONTIDAE
 41. <i>Lagocephalus lunaris</i> (Bl. Schn.)</p> |
|--|--|

¹Classified after Jordan (1923).

II—SYSTEMATIC ACCOUNT

The Arabic name of the species is mentioned in italics alongside the scientific name.

1. **Carcharhinus menisorrah** (M. H.) : *Kossetch*

1841. *Carcharias* (*Prionodon*) *menisorrah* Muller and Henle, *Syst. Besch.* *Plagiostomen*, p. 46, pls. 17, 19, fig. 7. (Type-locality : Java.)

A single specimen from the Persian Gulf ; total length 547 mm.

2. **Chirocentrus dorab** (Forsk.) : *Hoff*

1775. *Clupea dorab* Forskal, *Descript. Animal.*, pp. xiii ; 7. (Type-locality : Djedda, Red Sea.)

A single specimen from the Persian Gulf ; total length 522 mm.

3. **Hilsa ilisha** (Ham.) : *Sbour*

1822. *Clupanodon ilisha* Hamilton, *Fish. Ganges*, pp. 243, 382, pl. 19, fig. 73. (Type-locality : Ganges estuaries.)

A single specimen from Habanian ; total length 238.5 mm.

4. **Nematalosa nasus** (Bl.) : *Yaffoud*

1795. *Clupea nasus* Bloch, *Naturl. ausland. Fische*, 9, p. 116, pl. 339 fig. 1. (Type-locality : Malabar.)

Two specimens from the Hor-el-Hammar Lake ; total length 197 and 183 mm.

5. **Thrissocles malabaricus** (Bl.) : *Siha demer*

1795. *Clupea malabaricus* Bloch, *Naturl. ausland. Fische*, 9, p. 115, pl. 432. (Type-locality : Tranquebar.)

Two specimens from the Persian Gulf ; total length 225 and 245 mm.

6. **Mastacembelus haleppensis** (Bl. Schn.) : *Saebouh Abou Siyan*

1801. *Rhynchobdella haleppensis* Bloch & Schneider, *Syst. Ichthyol.*, p. 480. (Type-locality : Aleppo.)

Two specimens from the Tigris ; total length 197 and 423 mm.

Hora and Misra (1943), in their specimen of 495 mm. total length found " the dorsal and anal fins somewhat shorter (D. XXXI-73 ; A. III-73)" and the pectoral fins "stumpy" being "either deformed or diseased" In the two specimens under report the dorsal and anal fins are a little longer (D. XXXIII-85 ; A. III-85) and the pectoral fins normally developed.

7 **Barbus esocinus** (Heckel) : *Biz*

1841. *Luciobarbus esocinus* Heckel, in Russegger's *Reise in Europa, Asien und Africa*, 1, p. 1054, pl. 4, fig. 2. (Type-locality : River Tigris, near Mossul.)

Single specimen from the Tigris ; total length 390 mm.

8. *Barbus kersin* Heckel ; *Shissan*

(Pl. 2, fig. 2 & Text-fig. 1 c-f)

1841. *Barbus kersin* Heckel, in Russegger's *Reise in Europa, Asien und Africa*, 1, p. 1049 and 2, p. 211, pl. 14, fig. 2. (Type-locality : Aleppo.)

D. $3\frac{4}{8}$; A. $3\frac{5}{5}$; P. $1\frac{1}{17}$; V. $1\frac{1}{8}$; L. 1.53-58; L. tr. $10\frac{7}{7}$; C. 21.

Three specimens from the Tigris ; total length 367, 451, and 701 mm. In the largest example length of the head and depth of body 4.0 times in standard length ; lateral line scales 56 on the left side and 55 on the right side ; lips very thick, broad, continuous at the angles of the jaw with the transverse fold of the lower lip interrupted in the middle. In the two smaller specimens head length 4.50 times and depth of the body 3.25 to 3.75 times in standard length ; lateral line scales 58 in the example measuring 451 mm. in total length ; in the other one of 367 mm. in total length 53 scales on the right side and 57 on the left side ; lips only moderately thick in these two examples.

9. *Barbus subquincunciatus* Gthr. : *Abou Khazzama*

(Pl. 2, fig. 1 & Text-fig. 1, a, b)

1868. *Barbus subquincunciatus* Gunther, *Cat. Fish Brit. Mus.*, 7. p. 86. (Type-locality : Mesopotamia ?.)

Single specimen from Baghdad ; total length 338 mm. The species is redescribed here with a view to amplify Gunther's (1868) account, which was based on a " skin 15 inches long"

D. $3\frac{8}{8}$; A. $3\frac{5}{5}$; P. $1\frac{1}{13}$; V. $1\frac{1}{7}$; L. 1.82-85; L. tr. $17\frac{11}{11-12}$; C. 19.

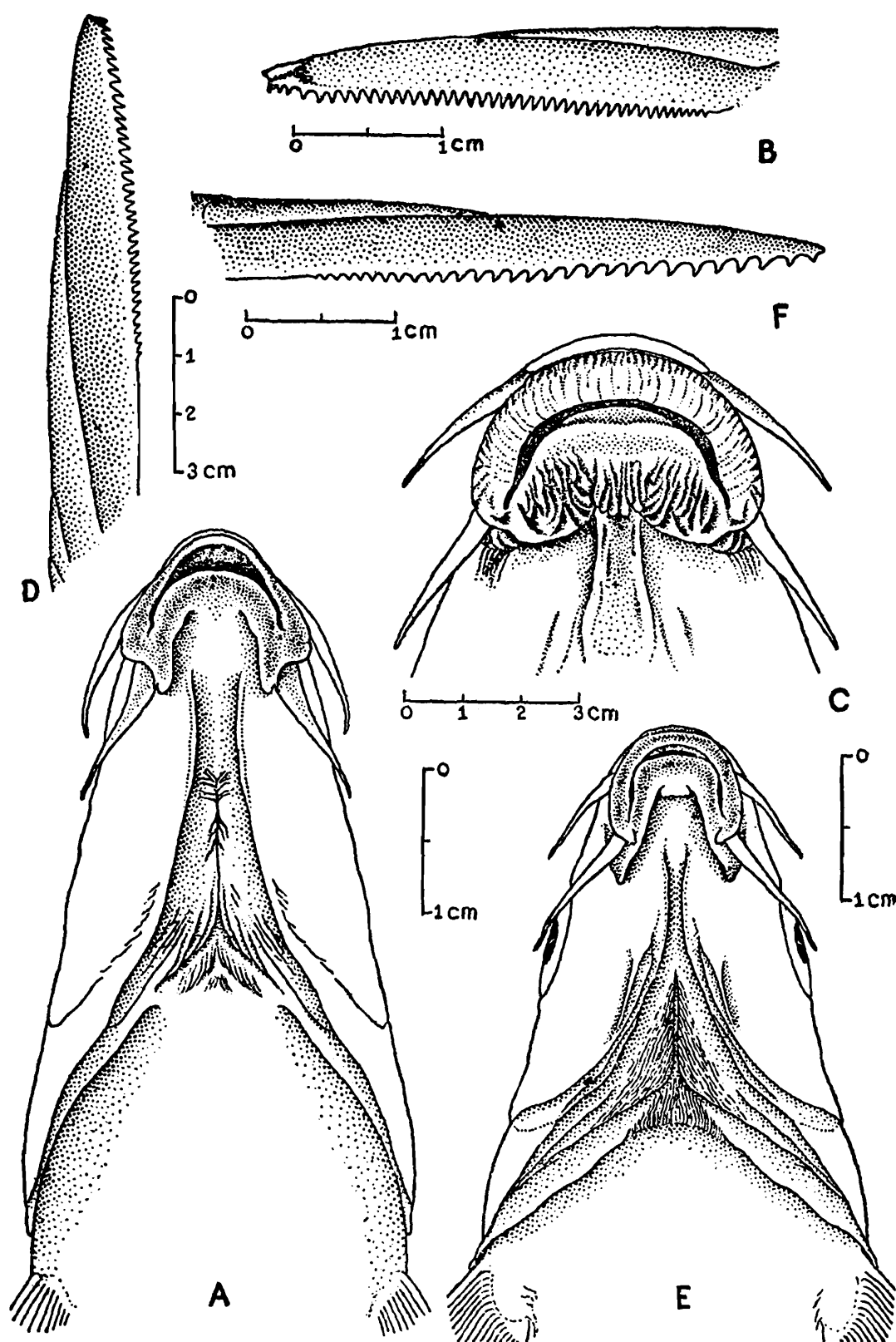
Body elongate, rather compressed ; dorsal profile more elevated anteriorly than the ventral profile. Snout produced and acute ; eye in the middle of the head length. Barbels four, about 2 eye-diameters in length. Mouth inferior, gape about half of the snout length. Lips somewhat fleshy and continuous at the angles of the jaw ; upper lip thinner than the lower ; lower lip with an interrupted fold in the middle.

Length of head nearly equals depth of body ; 5.03 times in total length and 4.16 times in standard length. Depth of body 5.17 times in total length and 4.28 times in standard length. Diameter of eye 5.92 times in length of head, 2.46 times in length of snout and 1.84 times in interorbital width. Least height of caudal peduncle 1.90 times in its length.

Scales moderate ; 83 scales on left side and 85 on right, in longitudinal series along lateral line ; 17 on either side in transverse series. Between lateral line and base of dorsal fin, and 12 on left side and 11 on right, between lateral line and pelvic base.

Dorsal origin slightly behind pelvic origin and nearer to base of caudal than to end of snout. Last dorsal spine very strong, bony and serrated ; its length 1.11 times in length of head and depth of body. Pectorals

and pelvics shorter than head and separated by a considerable distance. Anal fin short, twice as high as long. Caudal deeply forked.



TEXT-FIG. 1.—(a) and (b). *Barbus subquincunciatus* Gthr.; (c)—(f). *Barbus kersin* Hekl.

(a). Ventral view of the head of *Barbus subquincunciatus* Gthr. (b). Serrated dorsal spine of the same. (c). Ventral view of the anterior part of the head of *Barbus kersin* Hekl., measuring 701 mm. in total length. (d). Serrated dorsal spine of the same. (e). Ventral view of the head of *Barbus kersin* Hekl., measuring 367 mm. in total length. (f). Serrated dorsal spine of the same.

Colour in spirit pale brownish ; back, sides, head, snout and fins with irregularly arranged black spots, each as large, or half as large as eye.

Measurements in millimetres, and scale counts of Barbus subquincunciatus Gthr.

Total length	..	..	..	..	..	..	388.0
Standard length	..	..	..	..	..	..	321.0
Length of head	..	..	..	..	..	..	77.0
Width of head	..	..	..	..	..	..	40.0
Height of head	..	..	..	..	..	..	49.0
Diameter of eye	..	..	..	..	..	..	13.0
Length of snout					..		32.0
Interorbital width		..	..	..		..	24.0
Depth of body	..	..	..	..	..	..	75.0
Width of body			..		..	..	48.0
Length of third dorsal spine	..						67.0
Length of dorsal fin	..	..					79.0
Length of pectoral fin	..	..		..	..	..	62.0
Length of pelvic fin	..	..	..				56.0
Length of anal fin	..	..	..	..	..	..	59.0
Length of caudal peduncle	..	..	..	..	..	..	61.0
Least height of caudal peduncle				..		..	32.0
No. of scales along lateral line		..	..	..	..	..	82.85
No. of scales between L. l. and base of dorsal, and between L. l. and base of pelvics	..						17/12 : 17/11

10. *Barbus xanthopterus* (Heckel) : Gattan or Nobbash

1841. *Luciobarbus xanthopterus* Heckel, in Russegger's *Reise in Europa, Asien und Africa*, 1, p. 1053, pl. iv, fig. 1. (Type-locality : Tigris near Mossol.)

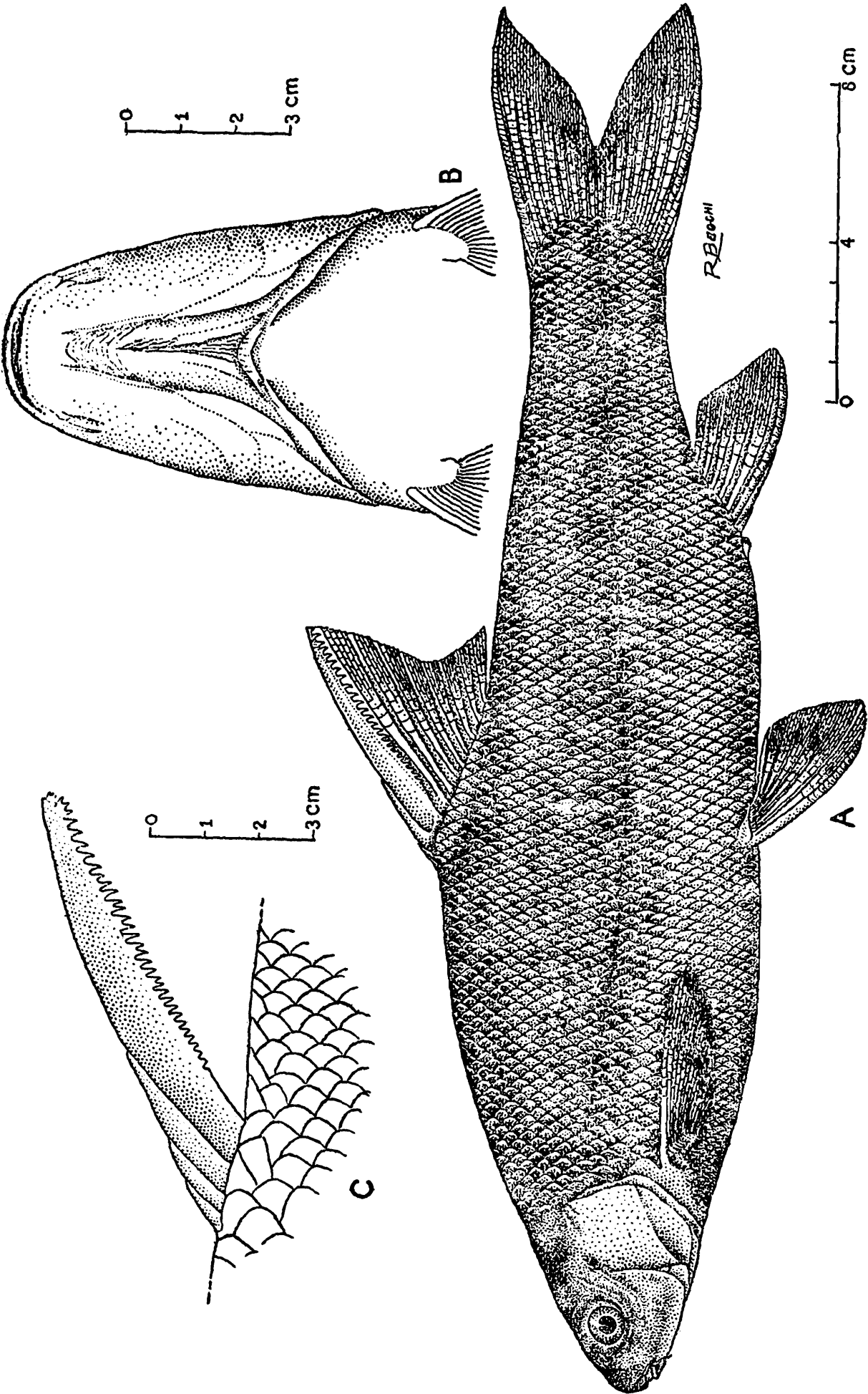
Single specimen 404 mm. total length.

11. *Barbus belayewi*¹, sp. nov. : Bartin : Tin or Tomoxeni
(Text-fig. 2)

D. 3-4/8 ; A. 3/5 ; P. 1/14 ; V. 1/6 ; L. 1. 77-81 ; L. tr. 14-16/12-13, C.20.

Body moderately elongate ; dorsal and ventral profiles more or less equally convex. Snout rather short and obtuse, eye almost in anterior

¹Named after Mr. D. D. Belayew of the Directorate General of Agriculture, Baghdad, Iraq, through whose courtesy the material under report was obtained.



TEXT-FIG. 2.—*Barbus belayewi*, sp. nov.
(a). Lateral view of the holotype. (b). Ventral view of the head of the paratype. Serrated dorsal spine of the paratype.

one-third of head length, about an eye-diameter away from end of snout. Barbels two, nearly an eye-diameter in length. Mouth inferior, somewhat transverse; its width almost equal to length of snout. Lips very thin.

Length of head a little greater than half depth of body, 6.13 to 6.40 times in total length and 5.18 to 5.22 times in standard length.

Depth of body 4.05 to 4.34 times in total length and 3.45 to 3.51 times in standard length. Eye from 5.00 to 5.28 times in length of head, 1.27 to 1.57 times in length of snout and 2.09 to 2.35 times in interorbital width. Least height of caudal peduncle 1.16 to 1.38 times in length of caudal peduncle.

Scales moderate; 77-81 in the longitudinal series along lateral line; 14-16 in transverse series between lateral line and base of dorsal fin, and 12-13 between lateral line and base of pelvic fin.

Origin of dorsal fin slightly in advance of origin of pelvic fins, nearer to end of snout than to base of caudal fin. Last dorsal spine very strong, bony, serrated; its length 1.20 times in depth of body, slightly longer than head length. Pectoral and pelvic fins nearly as long as head, widely separated. Anal fin about twice as high as long. Caudal fin rather deeply forked.

Colour; in spirit, uniform pale brown, with fins somewhat deeply tainted.

Holotype.—Regd. No. F. 1046/2, in the Zoological Survey of India, Calcutta.

Paratype.—Regd. No. F. 1047/2, in the Zoological Survey of India, Calcutta.

Type-locality.—Tigris, Baghdad, Iraq.

Barbus belayewi, sp. nov., is closely related to *Barbus plebejus* C. V. from Italy and Dalmatia; but the two can be distinguished by the following table of characters:

<i>Barbus belayewi</i>	<i>Barbus plebejus</i>
1. Lateral line scales in the longitudinal series 77-81.	1. Lateral line scales in the longitudinal series 66-75.
2. Scales in the transverse series between the lateral line and the base of pelvic fin 14-16.	2. Scales in the transverse series between the lateral line and the base of pelvic fin 8-9.
3. Snout short, obtuse.	3. Snout moderately produced.
4. Dorsal spine very strong, bony, deeply serrated.	4. Dorsal spine moderately strong, finely serrated.

Measurements in millimetres, and scale counts of Barbus belayewi, sp. nov.

						Holotype	Paratype
Total length	..	..	.	..	..	352.0	354.0
Standard length	..	..		..	..	285.0	387.0
Length of head		..	..	..	..	55.0	74.0
Width of head		..	..			40.0	51.0
Height of head		..	..			49.0	62.0
Diameter of eye		..			..	11.0	14.0
Length of snout		..		..	..	14.0	22.0
Interorbital width	..	..	..			23.0	33.0
Depth of body				..	..	81.0	112.0
Width of body			..	..	..	39.0	62.0
Length of last dorsal spine				..		67.0	89.0
Length of dorsal fin			..			72.0	96.0
Length of pectoral fin	..	..	..			53.0	65.0
Length of pelvic fin					..	47.0	56.0
Length of anal fin		..			..	50.0	66.0
Length of caudal peduncle	..			..	..	47.0	56.0
Least height of caudal peduncle	..	..	..			24.0	48.0
No. of scales along lateral line	..	..	..			81.79	78.77
No. of scales between L.l. and base of dorsal, and between L. l. and base of pelvics				..		16/13 : 15/12	14/12

12. *Puntius luteus* (Heckel)*Binni Hamour ; Binni Hamri or Binni or Shifatha*1841. *Systomus luteus* Heckel, in Russegger's *Reisen in Europa, Aien und Africa*, 1, p. 1016, pl. 6, fig. 1. (Type-locality : Orontes and Tigris.)

Two specimens from the Tigris ; total length 152 and 302 mm.

13. *Varicorhinus trutta* (Heckel)1841. *Scaphiodon trutta* Heckel, in Russegger's *Reisen in Europa, Asien und Africa*, 1, p. 1056, pl. 4, fig. 3. (Type-locality : Syria.)

D. 3/8 ; A. 1/7 ; P. 1/16 ; V 1/7 ; L. 1. 77-84 ; L. tr. 17/12 ; C. 21.

Two specimens from the Tigris ; total length 263 and 301 mm. Length of head about 6.6 times in depth of body, 5 times in standard length. Dorsal fin slightly higher than depth of body ; dorsal spine strong, bony, deeply serrated, nearly as long as depth of body. Scales 80-84 in the longitudinal series along lateral line ; 17 in transverse series between lateral line and base of dorsal fin ; 12 between lateral line and base of pelvic fin. Two barbels.

14. **Tachysurus thalassinus** (Rupp.) : *Tchim*

1835. *Bagrus thalassinus* Ruppell, *Neue Wirbelt. Fische*, p. 75, fig. 2.
(Type-locality : Massaua, Red Sea.)

Three specimens from the Hor-el-Hammar Lake ; total length 396, 438 and 508 mm. As noted by Misra (1947) they differ from the *forma typica* in having a rather, pointed snout, shorter maxillary, outer and inner mandibular barbels and in the presence of granulations on the snout.

15. **Saurida tumbil** (Bl.)

1795. *Salmo tumbil*, Bloch, *Nat. ausland Fische*, 9, p. 112, pl. 430. (Type-locality : not known.)

Single specimen from the Persian Gulf ; total length 391 mm.

16. **Aphanius dispar** (Rupp.)

1828. *Lebias dispar* Ruppell, *Atl. Fische*, p. 66, pl. 18, figs. 1, 2. (Type-locality : Abyssinia.)

Single specimen from Lake Bahroul Melch ; total length 69 mm.

17. **Pseudorhombus arsius** (Ham.) : *Mislak Malbahr*

1822. *Pleuronectes arsius* Hamilton, *Fish. Ganges*, p. 128. (Type-locality : estuaries of Ganges.)

Single specimen from the Persian Gulf ; total length 224 mm.

18. **Cynoglossus sealarki** Regan : *Lessanet Tor*

1908. *Cynoglossus sealarki* Regan, *Trans. Linn. Soc. (Zool.)*, 12, p. 235, pl. 26, fig. 1. (Type-locality : Saya de Malha Bank, over 123 fms.)

Single specimen from the Persian Gulf ; total length 215 mm.

19. **Sphyaena obtusata** C. V.

1803. *Sphyaena obtusata* Cuvier and Valenciennes, *Hist. Nat. Poissons*, 3, p. 324, pl. 10, fig. 2. (Type-locality : Pondicherry.)

Single specimen from the Persian Gulf ; total length 228 mm.

20. **Scomberomorus commersoni** (Lac.) : *Habbat*

1800. *Scomber commersoni*, Lacepede, *Hist. Nat. Poissons*, 2, pp. 598, 600, pl. 20, fig. 1. (Type-locality : not known.)

Single specimen from the Persian Gulf : total length 270 mm.

21. **Trichiurus haumela** (Forsk.)

1775. *Clupea haumela* Forskal, *Descript. Animal.*, p. 72. (Type-locality : Mocha, Red Sea.)

Single specimen from the Persian Gulf ; total length 690 mm.

22. **Apolectus niger** (Bl.) : *Halfai*

1795. *Stromateus niger* Bloch, *Nat. ausland. Fische*, 9, p. 93, pl. 422. (Type-locality : "Malaisch" = Malaya.)

Two specimens from the Persian Gulf ; total length 392 and 484 mm.

23. *Alectis indicus* (Rupp.)

1828. *Scyris indicus* Ruppell, *Atlas, Fische Rothen Meeres*, p. 128, pl. 33, fig. 33, fig. 1. (Type-locality : Djedda, Red Sea.)

Single specimen from the Persian Gulf ; total length 182 mm.

24 *Atule kalla* (C. V.) : *Hamam*

1831. *Caranx kalla* Cuvier and Valenciennes, *Hist. Nat. Poissons*, 9, p. 37. (Type-locality : Pondicherry.)

Single specimen from the Persian Gulf ; total length 134 mm.

25. *Atule mate* (C.V.)

1833. *Caranx mate* Cuvier and Valenciennes, *Hist. Nat. Poissons*, 9, p. 54. (Type-locality : Pondicherry.)

Single specimen from the Persian Gulf ; total length 267 mm.

26. *Caranx malabaricus* (Bl. Schn.)

1801. *Scomber malabaricus* Bloch and Schneider, *Syst. Ichth.*, p. 31. (Type-locality : Tranquebar.)

Single specimen from the Persian Gulf ; total length 223 mm.

27. *Scomberoides lysan* (Forsk.) : *Zila*

1775. *Scomber lysan* Forskal, *Descript. Animal.*, p. 54. (Type-locality : Djedda.)

Single specimen from the Persian Gulf ; total length 344 mm.

28. *Rachycentron canadus* (L.)

1766. *Gasterosteus canadus* Linnaeus, *Syst. Nat.*, ed. 12, p. 491. (Type-locality : Carolinas.)

Single specimen from the Persian Gulf ; total length 483 mm.

29. *Epinephelus stoliczkae* (Day) : *Hamour*

1878. *Serranus stoliczkae* Day, *Fish. India*, p. 11, pl. 1, fig. 3. (Type-locality : Coast of Sind.)

Two specimens from the Persian Gulf ; total length 237 and 476 mm.

30. *Lutianus fulvus* (Bl. Schn.)

1801. *Holocentrus fulvus*, Bloch and Schneider, *Syst. Ichth.*, p. 318. (Type-locality : Tahiti.)

Single specimen from the Persian Gulf ; total length 244 mm.

31. *Therapon theraps* C. V.

1829. *Therapon theraps* Cuvier and Valenciennes, *Hist. Nat. Poissons*, 3, p. 129, pl. 53. (Type-locality : Java.)

Single specimen from the Persian Gulf ; total length 153 mm.

32. *Nemipterus bleekeri* (Day)

1878. *Synagris bleekeri* Day, *Fish. India*, p. 92, pl. 24, fig. 1. (Type-locality : Madras.)

Single specimen from the Persian Gulf : total length 195 mm.

33. *Gerres filamentosus* C.

1829. *Gerres filamentosus* Cuvier, *Regne Animal.*, 2, ed. 2, p. 188. (Type-locality : Vizagapatam ; on *Wodowaha* Russell.)

Single specimen from the Persian Gulf ; total length 158 mm.

34. *Johnius osseus* (Day) : *Shmay*

1878. *Sciaena osseus* Day, *Fish. India*, p. 193, pl. 46, fig. 3. (Type-locality : Malabar coast.)

Single specimen from the Persian Gulf ; total length 401 mm.

35. *Pseudosciaena aneus* (Bl.)

1793. *Johnius aneus* Bloch, *Naturg. ausland Fische*, 7, p. 135, pl. 257. (Type-locality : Malabar.)

Single specimen from the Persian Gulf ; total length 196 mm.

36. *Ephippus orbis* (Bl.)

1788. *Chaetodon orbis* Bloch, *Ichthyologie*, 6, p. 59, pl. 202, fig. 2. (Type-locality : East Indies.)

Single specimen from the Persian Gulf ; total length 162 mm.

37. *Drepane punctata* C. V : *Mysht el Gavvi*

1831. *Drepane punctata* Cuvier and Valenciennes, *Hist. Nat. Poissons*, 7, p. 99 (132), pl. 179. (Type-locality : Malabar.)

Three specimens from the Persian Gulf ; total length 158, 181 and 192 mm.

38. *Dactyloptena orientalis* (C. V.)

1829. *Dactylopterus orientalis* Cuvier and Valenciennes, *Hist. Nat. Poissons*, 4, p. 98 (134), pl. 76. (Type-locality : Mauritius.)

Single specimen from the Persian Gulf ; total length 130 mm.

39. *Boleophthalmus dentatus* C. V. : *Triton*

1837. *Boleophthalmus dentatus* Cuvier and Valenciennes, *Hist. Nat. Poissons*, 12, p. 208, pl. 355. (Type-locality : Bombay.)

Single specimen from Shatt-al-Arab ; total length 175 mm.

40. *Triacanthus brevirostris* Schlegel : *Tchelb Mal Daon*

1842. *Triacanthus brevirostris* Schlegel, *Faun. Japonica, Pisces*, p. 294, pl. 129, fig. 2. (Type-locality : Nagasaki.)

Three specimens from the Persian Gulf ; total length 193, 205 and 213 mm.

41. *Lagocephalus lunaris* (Bl. Schn.) : *Farial*

1801. *Tetrodon lunaris* Bloch and Schneider, *Syst. Ichth.*, p. 505. (Type-locality : Malabar.)

Single specimen from the Persian Gulf ; total length 113 mm.

III—KEY FOR THE IDENTIFICATION OF THE IRAQ FISHES SO FAR RECEIVED IN THE ZOOLOGICAL SURVEY OF INDIA FOR DETERMINATION¹

1. Gill-slits covered by gill-cover : body without placoid scales 2.
 Gill-slits naked, without gill-cover : body with placoid scales Fam. Galeidae
 [*Carcharhinus menisorrah* (M.H.)].
2. Body symmetrical : eyes on either side of head 3.
 Body asymmetrical : eyes on one side of head . 41.
3. With long, 4-8 barbels : body totally naked 4.
 Without barbels (except in some Cyprinids where barbels are short) : body scaly (except in Trichiuridae in which scales are absent) or scales rudimentary (as in Chirocentridae and Scombridae) or body armoured (as in Triacanthidae, Tetraodontidae and Dactylopteridae) 6.
4. Anal fin very long (about 80 rays) : barbels four : adipose dorsal absent Fam. Siluridae
 [*Silurus triostegus* (Heckl.)].
 Anal fin short (15-20 rays) : barbels six or eight : adipose dorsal present 5.
5. Barbels six : posterior nostrils with a valve Fam. Tachysuridae (= Aritidae)
 [*Tachysurus thalassinus* (Rupp.)].
 Barbels eight : posterior nostrils without a valve Fam. Bagridae
 [*Mystus haleppensis colvillii* (Gthr.)].
6. Pelvic fins united together and disc-like Fam. Periophthalmidae, (a)-(b).
 (a). Dorsal fins connected by membrane at their bases *Boleophthalmus dentatus* C.V.
 (b). Dorsal fins not connected by membrane at their bases *Boleophthalmus dussumieri* C.V.
 Pelvic fins separate and not disc-like, or absent or reduced or as spines 7.
7. Both the jaws very much produced and bill-like Fam. Belonidae
 [*Strongylura strongylura* (v. Hass.)].
 Both the jaws normal, neither produced nor bill-like 8.
8. Body very elongate, eel-like or cutlass-like 9.
 Body neither very elongate, eel-like or cutlass-like .. 11.

¹ This artificial key is applicable mainly to the species dealt with in this paper.

9. Body eel-like, cylindrical : with 30-33 stumpy dorsal spines
 Body cutlass-like, laterally compressed : without any stumpy dorsal spines
 10. Snout pointed : tail tapering to a point : dorsal fin very long
 Snout not pointed : tail forked ; dorsal fin short
 11. Head cuirassed and bony : pectoral fins long and wing-like ..
 Head neither cuirassed nor bony : pectoral fins neither long nor wing-like ..
 12. Head broad, depressed and armed with spines
 Head neither broad nor depressed nor armed with spines. 13.
 13. Adipose dorsal fin present ..
 Adipose dorsal fin absent 14.
 14. Two detached pre-anal spines .. Fam. Carangidae, (a)-(d).
 (a). Lateral line armed with scutes (b).
 Lateral line not armed with scutes .. *Scomberoides lysan* (Forsk.).
 (b). Dorsal spines reduced and not connected by membrane .. *Alectis indicus* (Rupp.).
 Dorsal spines well developed and connected by membrane (c).
 (c). Eyes without adipose lids : anterior part of soft dorsal and anal fins elevated : breast scaleless .. *Caranx malabaricus* (Bl. Schn.).
 Eyes with adipose lids : anterior part of soft dorsal and anal fins not much elevated : breast scaly .. (d).
 (d). Dorsal and ventral profiles equally convex : last dorsal and anal ray detached or finlet-like .. *Atule mate* (C. V.).
 Ventral profile more convex than the dorsal profile : last dorsal and anal ray not detached or finlet-like *Atule kalla* (C. V.).
 No detached pre-anal spines .. 15.
 15. Finlets (9-10) behind the dorsal and anal fins : caudal lobes keeled ..
 No finlets behind dorsal and anal fins : caudal lobes not keeled 16.
- Fam. Mastacembelidae
 [*Mastacembelus haleppensis* (Bl. Schn.)].
10.
 Fam. Trichiuridae
 [*Trichiurus haumela* (Forsk.)].
- Fam. Chirocentridae
 [*Chirocentrus dorab* (Forsk.)].
- Fam. Dactylopteridae
 [*Dactyloptena orientalis* (C. V.)].
12.
 Fam. Platycephalidae
 [*Platycephalus indicus* (L.)].
- Fam. Synodontidae
 [*Saurida tumbil* (Bl.)].
14.
 Fam. Carangidae, (a)-(d).
- (b).
Scomberoides lysan (Forsk.).
- Alectis indicus* (Rupp.).
- (c).
Caranx malabaricus (Bl. Schn.).
- (d).
Atule mate (C. V.).
- Atule kalla* (C. V.).
15.
 Fam. Scombridae
 [*Scomberomorus commersoni* (Lac.)].

16. Dorsal and anal fins elevated anteriorly : pelvic fins
absent (in the adult) .. Fam. Stromateidae, (a)-(b).
(a). Last portion of lateral line keeled *Aplocheilichthys niger* (Bl.).
Last portion of lateral line not keeled .. (b).
(b). Free spines before dorsal and anal fins : lower
caudal lobe longer .. *Chondroplites chinensis*
(Euphr.).
No free spines before dorsal and anal fins :
caudal lobes of about equal length .. *Pampus argenteus* (Bl.).
Dorsal and anal fins not elevated anteriorly : pelvic
fins present 17.
17. Single dorsal fin or no distinct spinous and soft parts in
the dorsal fin .. 18.
Two dorsal fins or distinct spinous and soft parts in
the dorsal fin 23.
18. Abdomen keeled and serrated .. 19.
Abdomen neither keeled nor serrated 21.
19. Last dorsal ray prolonged into a filament Fam. Dorosomidae
[*Nematalosa nasus* (Bl.)].
Last dorsal ray not prolonged into a filament 20.
20. Upper jaw prominent, projecting over lower jaw :
maxillaries much elongated .. Fam. Engraulidae, (a)-(b).
(a). Height of body $3\frac{1}{4}$ times in total length : lower
gill-rakers 21-25 *Thrissoctes malabaricus* (Bl.).
(b). Height of body $4\frac{1}{4}$ to $4\frac{1}{2}$ times in total length :
lower gill-rakers 11 *Thrisoetes purava* (Ham.).
Upper jaw neither prominent nor projecting over
lower jaw : maxillaries not elongated .. Fam. Clupeidae, (a)-(b).
(a). Upper jaw with a distinct median notch :
anal rays 18-22 *Hilsa ilisha* (Ham.).
(b). Upper jaw without a distinct median notch :
anal rays 46-50 .. *Ilisha filigera* (C. V.).
21. Dorsal fin in the posterior half of body and spineless 22.
Dorsal fin not in the posterior half of body and often
with a spine Fam. Cyprinidae, (a)-(k).
(a). Anal fin short, with 8 rays : dorsal fin opposite
to pelvics : abdomen not compressed behind
pelvics (b).
Anal fin long, with 13-19 rays ; dorsal fin
behind pelvics : abdomen compressed behind
pelvics (j).
(b). Mouth transverse : anterior edge of jaw sharp
and covered with a horny, brown layer *Varicorhinus trutta* (Hckl.).
Mouth arched : anterior edge of jaw neither
sharp nor covered with a horny, brown layer .. (c).

- (c). Lateral line scales 28-38 : dorsal spine smooth (d).
 Lateral line scales 53-85 : dorsal spine serrated .. (f).
- (d). Lateral line scales 28-31 : lower labial fold interrupted (e).
 Lateral line scales 38 : lower labial fold continuous .. *Tor grypupus* (Hckl.).
- (e). Barbels present : $2\frac{1}{2}$ rows of scales between the lateral line and the base of pelvic fin : L. l. scales 28 *Puntius luteus* (Hckl.).
 No barbels : $3\frac{1}{2}$ rows of scales between the lateral line and the base of pelvic fin : L. l. scales 28-31 .. *Puntius sharpeyi* (Gthr.).
- (f). Lateral line scales 53-60 .. (g).
 Lateral line scales 76-85 (h).
- (g). Snout acute : lateral line scales 60 *Barbus xanthopterus* (Hckl.).
 Snout obtuse : lateral line scales 53-58 .. *Barbus kersin* Hckl.
- (h). Lateral transverse scales 14-17/11-13 : L. l. scales 77-85 .. (i).
 Lateral transverse scales 12/7-8 : L. l. scales 76-78 .. *Barbus esocinus* Hckl.
- (i). **Snout produced, acute : eyes in the middle of the length of head : back and sides with black spots : L.l. scales 82-85** *Barbus subquincunciatus* Gthr.
 Snout short, obtuse : eye in the anterior-third of the length of head : back and sides not spotted : L.l. scales 77-81 .. *Barbus belayewi*, sp. nov.
- (j). Both the jaws equal : L.l. scales 50 *Abramis caeruleus* (Hckl.).
 Lower jaw longer, projecting beyond the upper : L.l. scales 70-96 .. (k).
- (k). Lateral line scales 96 : L. tr. scales 18/10 *Aspius vorax* Hckl.
 Lateral line scales 70-72 : L.tr. scales 11/7 *Alburnus scheitan* Hckl.
22. Pelvic fins present : body covered with scales Fam. Cyprinodontidae
 [*Aphanius dispar* (Rupp.)].
 Pelvic fins absent : body covered with dermal spines .. Fam. Tetraodontidae
 [*Lagocephalus lunaris* (Bl. Schn.)].
23. Body fusiform : first dorsal fin reduced to a few (8) stumpy spines Fam. Rachycentridae
 [*Rachycentron c a n a d u s* (L.)].
 Body not fusiform : first dorsal fin not reduced to stumpy spines 24.
24. Spinous dorsal widely separated from the soft dorsal .. 25.
 Spinous dorsal continuous with the soft dorsal 29.
25. With 2 strong pelvic spines : without pelvic fins .. Fam. Triacanthidae
 [*Triacanthus brevirostris* Schgl.]

- Without pelvic spines : with pelvic fins .. 26.
26. Pectoral fin with (4-7) free, elongated rays at its base Fam. Polynemidae
[*Eleutheronema tetradactylum* (Shaw)].
- Pectoral fin without any free, elongated rays at its base 27.
27. Soft dorsal (9-10 rays) and anal (9-12 rays) fins short : spinous dorsal with 4-5 spines .. 28.
- Soft dorsal (21-24) and anal (23-24) fins long : spinous dorsal with 10-11 spines Fam. Sillaginidae
[*Sillago sihama* (Forsk.)].
28. Cleft of mouth very deep : teeth in jaws large and cutting : 5 weak dorsal spines Fam. Sphyraenidae
[*Sphyraena obtusata* V.].
- Cleft of mouth narrow: teeth in jaws small, or absent and not cutting : 4 strong dorsal spines Fam. Mugilidae, (a)-(b).
- (a). Lateral line scales 46-49 : L. tr. scales 15-16 .. *Mugil (Liza) abu* (Hckl.)¹
(= *Mugil (Liza) hishni* Misra).
- (b). Lateral line scales 26-28 : L. tr. scales 10 *Mugil (Liza) oligolepis* (Blkr.).
29. Anal spines 1 or 2 : muciferous system on head well developed 30.
- Anal spines 3 : muciferous system on head not well developed 31.
30. Lower jaw more prominent than the upper jaw : canine teeth present Fam. Otolithidae
[*Otolithes ruber* (Bl. Schn.)].
- Lower jaw not more prominent than the upper jaw : no true canine teeth .. Fam. Sciaenidae, (a)-(c).
- (a) Mouth terminal ; gape of mouth oblique : snout pointed : upper jaw not overhanging the lower jaw .. (b).
- Mouth inferior ; gape of mouth rather horizontal : snout more or less obtuse : upper jaw overhanging the lower jaw (c).
- (b) Lateral transverse scales 8/14 *Pseudosciaena sinu* (C.V.).
- Lateral transverse scales 8-9/18 .. *Pseudosciaena aneus* (Bl.).
- (c) Eye diameter $3\frac{1}{2}$ to $3\frac{3}{4}$ of the length of head : 2nd anal spine $2\frac{1}{2}$ in the length of head *Johnius belengeri* (C. V.).
- Eye diameter $1\frac{1}{5}$ of the length of head : 2nd anal spine $\frac{1}{2}$ as long as head *Johnius osseus* (Day).
31. Body abruptly elevated from the snout end end very much compressed .. 32.

¹ Dr. K. S. Miera is now of the opinion that *Mugil (Liza) hishni* is synonymous with *Mugil (Liza) abu* (Hckl.).

- Body neither abruptly elevated from the snout end
nor very much compressed . 33.
32. Some of the anterior dorsal spines flexible and elongated : pectoral fins short .. Fam. Ephippidae
[*Ephippus orbis* (Bl.)].
- None of the dorsal spines flexible or elongated :
pectoral fins long and falciform Fam. Drepanidae
[*Drepane punctata* (L.)].
33. A median longitudinal groove behind the chin Fam. Pomadasyidae
[*Pomadasys argyreus*
(C. V.)].
- No median longitudinal groove behind the chin .. 34.
34. Mouth very protractile : second dorsal spine very
much prolonged .. Fam. Gerridae
[*Gerres filamentosus* C.].
- Mouth not very protractile : second dorsal spine not
prolonged 35.
35. Dorsal and anal spines weak .. . Fam. Nemipteridae
[*Nemipterus bleekeri* (Day)].
- Dorsal and anal spines strong 36.
36. Teeth in jaws molariform .. 37.
- Teeth in jaws not molariform .. . 38.
37. Dorsal profile abruptly arched Fam. Sparidae
[*Acanthopagrus berda*
(Forsk.)].
- Dorsal profile gradiently arched Fam. Denticidae
[*Petrus belayewi* Misra].
38. Opercle with prominent spines : preopercle not
notched 39.
- Opercle without prominent spines ; preopercle
notched Fam. Lutianidae
[*Lutianus fulvus*
(Bl. Schn.)].
39. Dorsal fin notched : maxila not extending to hind
border of eye Fam. Theraponidae
[*Therapon theraps* C.].
- Dorsal fin not notched : maxilla extending to hind
border of eye Fam. Epinephelidae
[*Epinepheles stoliczkae*
(Day)].
40. Preopercular margin free, not hidden by the skin and
scales of the head : lower jaw more prominent
than the upper jaw Fam. Bothidae
[*Pseudorhombus arsius*
(Ham.)].
- Preopercular margin not free, hidden by the skin
and scales of the head : lower jaw prominent .. 41.
41. Vertical fins confluent: eyes on left side Fam. Cynoglossidae
[*Cynoglossus sealarki*
Regan].
- Vertical fins not confluent : eyes on right side .. Fam. Soleidae
[*Synaptura orientalis* (M.
Schn.)].

IV—SUMMARY

1. The present paper is a report on the third collection of Iraq fishes—freshwater and marine—received in the Zoological Survey of India, for determination, from the Directorate General of Agriculture, Baghdad.

2. The collection representing 41 species, 36 genera and 30 families, is of considerable interest inasmuch as a few of the freshwater species had been obtained from their respective type-localities and as one of them, *Barbus belayewi*, sp. nov., has proved to be new.

3. Further, opportunity has also been taken to amplify the earlier descriptions of two of Heckel's and one of Günther's species on the basis of the topotype specimens in the material under report.

4. Finally, an artificial key for the identification of the freshwater and marine fishes so far received in the Zoological Survey of India for determination from the Directorate General of Agriculture, Baghdad, is also added at the end of the paper.

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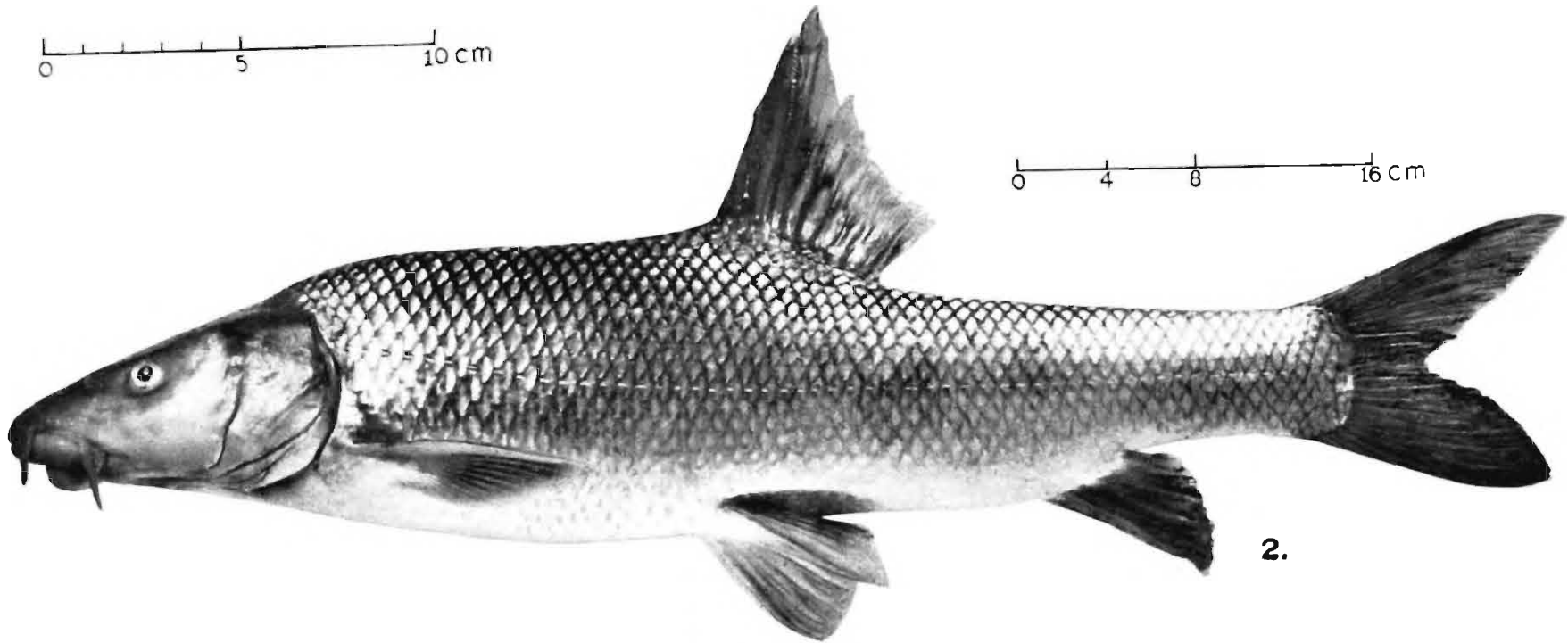
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EXPLANATION OF PLATE 2

- FIG. 1. Photograph of the lateral view of *Barbus subquincunciatus* Gthr., measuring 338 mm. in total length.
- FIG. 2. Photograph of the lateral view of *Barbus kersin* Hckl., measuring 701 mm. in total length.



0 5 10 cm



0 4 8 16 cm

Lateral views of (1) *Barbus subquincunciatus* Gthr. and (2) *Barbus kersin* Hckl.

THE IDENTITY AND GEOGRAPHICAL DISTRIBUTION OF THE
INDIAN SPECIES OF THE GENUS *DYSDERCUS* BOISDUVAL
(HEMIPTERA : PYRRHOCORIDAE)

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(With 5 Text-figures and 1 Map)

	CONTENTS	PAGE
I—Introduction		159
II—Key to the Indian species of <i>Dysdercus</i>		160
III—Systematic Account		161
1. <i>Dysdercus koenigii</i> (Fabricius)		161
2. <i>D. evanescens</i> Distant		164
3. <i>D. olivaceus</i> (Fabricius)		166
4. <i>D. similis</i> Freeman		168
5. <i>D. poecilus</i> (Herrich-Schaffer)		168
6. <i>D. cingulatus</i> (Fabricius)		169
7. <i>D. mesiostigma</i> Distant		170
8. <i>D. decussatus</i> Boisduval		171
IV—Geographical Distribution		172
V—Summary		174
VI—References		174

I—INTRODUCTION

Several species of the genus *Dysdercus* Boisduval are well known for their association with cotton crop in many parts of the world. On account of this association as well as for the generally red colour of the body, these bugs have been called the Red Cotton Bugs. There are some eight species of the genus recorded from India but only one of these is

well known, being widely distributed in the country and, at times, occurring in very large numbers on cotton plants. The species commonly known as *Dysdercus cingulatus* (Fabr.) in India should, as recently shown by Freeman (1947), be called *Dysdercus koenigii* (Fabr.). The type-locality of the former is Australia and of the latter is Tranquebar, South India. As observed by Freeman, while *D. cingulatus* is widely distributed from Assam eastwards to the Pacific Islands, China and Australia, *D. koenigii* occurs in Ceylon, throughout India and in Burma. The only area of common occurrence between these two species, therefore, lies in Assam eastwards and except for the material coming from there, the two species could be easily distinguished on geographical basis. Freeman was able to examine some 50 examples of *D. koenigii* from India, Ceylon and Burma and some 20 of *D. cingulatus* from the same countries. Since he has made a very significant observation on the identity and geographical distribution of these species and since at least one of the species is of economic importance in India, it was thought desirable to examine, revise and rearrange the large collection of the genus *Dysdercus* deposited in the Indian Museum (Zoological Survey of India). It was also hoped that this collection would add to our knowledge of the geographical distribution of the species in India. In this connection use was also made of the named and un-named collections of the genus, with the Bombay Natural History Society, the Indian Agricultural Research Institute, New Delhi, and the Forest Research Institute, Dehra Dun, indicated in the paper as B.N.H.S., I.A.R.I. and F.R.I., respectively. Our sincere thanks are due to the authorities concerned for the loan of the material.

Since it appeared that even after several years of the publication of Freeman's paper, the name *D. cingulatus* is being applied in certain quarters to what is referable to *D. koenigii* and since the economic status of certain other Indian species was not adequately known, we have given in this paper diagnostic characters as well as a key to all the Indian species for purposes of easy identification. Further collecting would also be of great interest for a study of their geographical distribution which has been reviewed at the end of the paper.

II—KEY TO THE INDIAN SPECIES OF *Dysdercus*

1. Corial markings always in the form of black spots or transverse lines, except in some varieties of *D. poecilus* in which they are lacking; scutellum never punctured or pubescent; second conjunctiva appendage of male simple

2

Corial markings never in the form of black spots or transverse lines, often absent; scutellum basally with strong, sparse punctures or scutellum and prothoracic fold finely pubescent; second conjunctiva appendage forked

7

2. Corial spots touching or nearly touching inner margin (Text-fig. 2b); if spots absent, the first (true) ventral abdominal segment also without white fascia. (India, S. E. Asia)

poecilus (H. & S.)

Corial spots placed centrally, never absent; white fascia on the abdomen always present on the first ventral segment

3

3. Hemelytra with the membrane pale; corial spots very small for the size of the insect (Text-fig. 2a). (India, Burma, Indo-China) *evanescens* Dist.
- Hemelytra with the membrane black; corial spots not very small 4
4. Thorax much narrowed anteriorly (Text-fig. 1d); white ventral abdominal fasciae usually bifid 5
- Throax moderately narrowed anteriorly; white abdominal fasciae never bifid 6
5. White abdominal fasciae varying from slightly to strongly bifid; vertical processes of the ninth segment broad (Text-fig. 4h). (S. India and Ceylon) . . . *olivaceus* Fabr.)
- White abdominal fasciae usually not bifid sometimes very slightly bifid, never strongly so; vertical processes (Text-fig. 4c) narrower. (S. India, Ceylon) *similis* Freeman
6. Femora red, only very occasionally dark; parameres (Text-fig. 3d) double crest type apically; spermathecal duct short, accessory gland narrow, long, much coiled (Text-fig. 5b). (Throughout India, Burma & Ceylon) *koenigii* (Fabr.)
- Femora usually at least apically dark; parameres single crested (Text-fig. 3a) spermathecal duct long, accessory gland wider and relatively short with a simple coil near the apex. (Assam, Burma, S. E. Asia & Australia) *cingulatus* (Fabr.)
7. Hemelytral membrane pale with black spot basally across the anal angle; prothoracic fold and scutellum finely pubescent. (China, S. E. Asia & Ceylon) *mesiostigma* Dist.
- Hemelytral membrane uniformly black, without pubescence on the dorsal surface. (Ceylon, Sikkim, Andaman Is., S.-E. Asia, Queensland, etc.). *decussatus* Boisd.

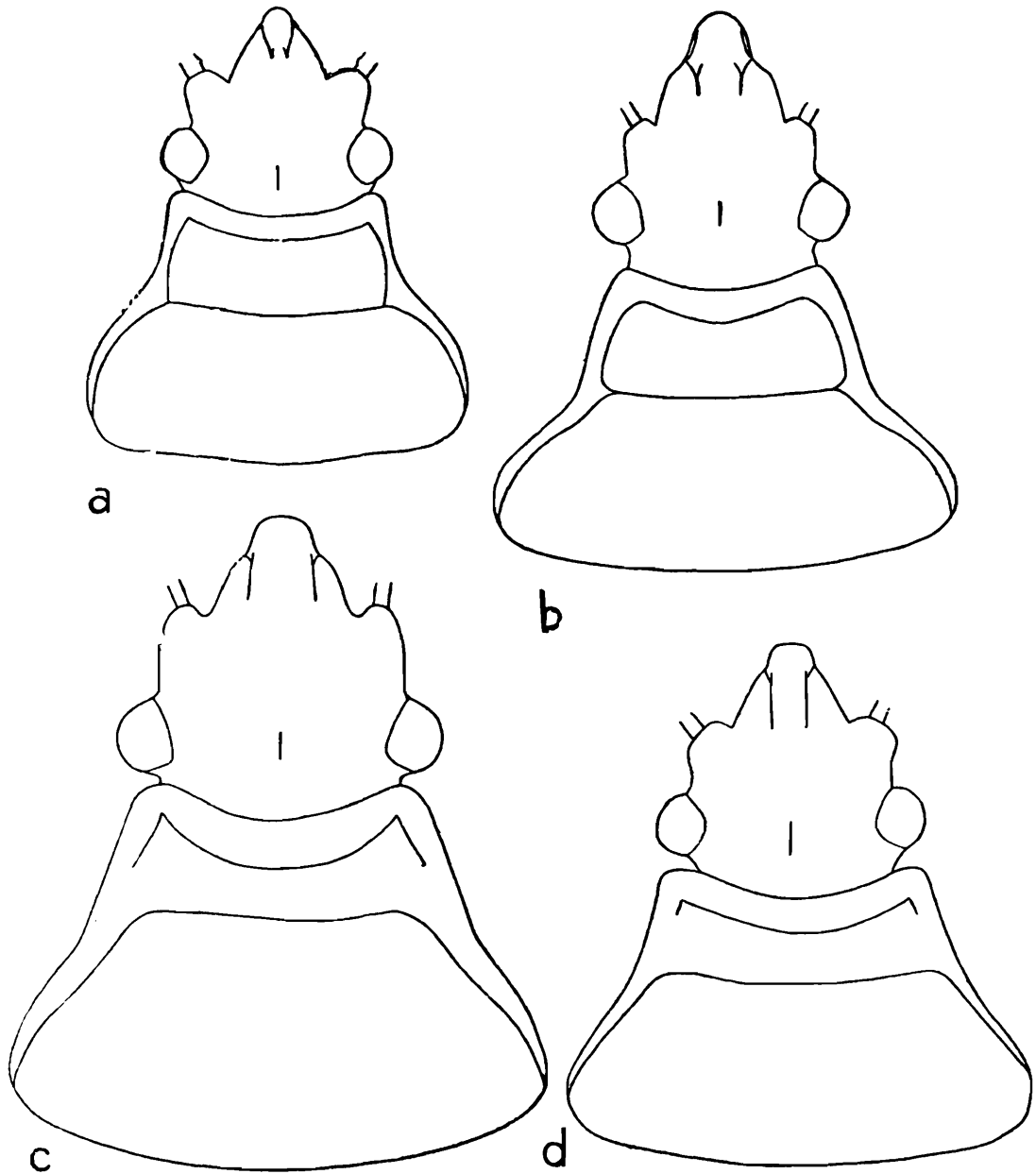
III.—SYSTEMATIC ACCOUNT

1. *Dysdercus koenigii* (Fabricius)

1774. *Cimex koenigii* Fabricius, *Systema Entomologia*, p. 720.
1794. *Lygaeus koenigii* Fabricius, *Entomologia Systematica*, 4, p. 155.
1833. *Astemma koenigii*, Laporte, *Mag. Zool.*, 2, No. 52-55, p. 37.
1834. *Pyrrhocoris koenigii*, Hahn, *Die Wanzenartigen Insekten*, 2, p. 12.
1843. *Dysdercus koenigii*, Amyot and Serville, *Histoire naturelle des Insectes. Hemipteres*, p. 272.
1866. *Dysdercus supersticiosus*, Stål, *Hemiptera Africana*, 3, p. 15. (in part)
1904. *Dysdercus cingulatus*, Distant, *Fauna Brit. India*, Rhynchota, 2, p. 118. (in part).
1909. *Dysdercus micropygus*, Eredidin, *Ann. Soc. ent. Belg.*, 35, p. 99.
1910. *Dysdercus cingulatus*, Distant, *Fauna Brit. India*, Rhynchota, 5, p. 100 (in part).
1947. *Dysdercus koenigii*, Freeman, *Trans. R. ent. Soc. Lond.*, 98, pp. 400-401.

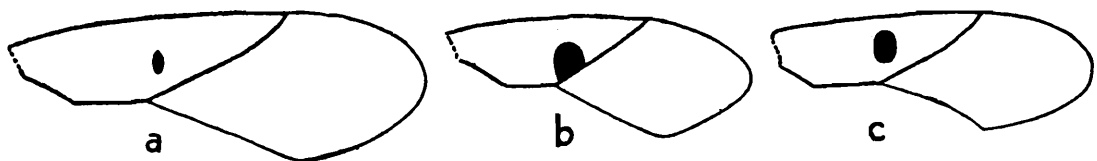
Diagnostic characters.—Prothorax only moderately narrowed anteriorly (Text-fig. 1c), crescentic collar white, anterior angles and lateral

margins red, pronotal disc and posterior margin variable in colour, yellowish or reddish. Corium with centrally placed, oval, black spot (Text-fig. 2c), variable in size but never touching either margin ;



TEXT-FIG. 1.—Head and prothorax of : (a). *Dysdercus poecilus*. (b). *D. decussatus*. (c). *D. koenigii*. (d). *D. olivaceus*.

membrane black. White abdominal fasciae on segments 1-6 rather narrow, usually less than half the width of the segment. Male genitalia with parameres (Text-fig. 3d) double crested apically, somewhat variable ;



TEXT-FIG. 2.—Hemelytron of : (a). *Dysdercus evanescens*. (b). *D. poecilus*. (c). *D. koenigii*.

vertical processes (Text-fig. 4a), gradually narrowed anteriorly and separated along about half the length of the processes ; second conjunctiva apendages simple. Spermathecal duct very short, accessory gland

moderately wide and much coiled (Text-fig. 5b). Length 11.0–15.5mm.; breadth 2.5–5.0mm.

Material examined.—189 examples from the following localities :—

INDIA : MADRAS : Shevaroy Hills, 4500 ft., Yercaud, 6.III.1932, 1 ex. (*Narayana*) (I.A.R.I.).

MYSORE : Bangalore, 3000 ft., 12.X.1910, 1♀ (*N. Annandale*); 1♂, 7♀ (*M. Cameron*).

MADHYA PRADESH : Jubbulpore, 3.VI.1922, 2♂, 2♀ (*S. Ribeiro*).

BOMBAY : Poona 29.II.1924, 1♀ (*V. S. Laperson*) (B.N.H.S.). *Andheri*, Salsette, 28.IV.1908, 1♀ (B.N.H.).

PANJAB : Rawalpindi, VI—VII. 1917, 1♀ (*R.A. Hodgart*); 16.VII.1944, 7 ex. (*B.M. Bhatia*) (F.R.I.). Karar, East Rawalpindi, 22. III. 1931, 1 ex. (*B.M. Bhatia*) (F.R.I.). Khewra Salt Range, IX-X. 1930, 1♀ (*H.S. Pruthi*). Kalar Kahar Salt Range, 10-21.X. 1930, 31♂, 40♀ (S. L. Hora and H. S. Pruthi).

P.E.P.S.U. : Pinjaro (Patiala State), base of Simla Hills, 17.VII.1911, 1♂ (*Mus. Collr.*).

HIMACHAL PRADESH : Dharampur, 5000 ft., Simla Hills, 6-8.V.1907, 1♂ (*N. Annandale*). Phagu, 9000 ft., Simla Hills, 14-15. V. 1909, 1 ♀ (*N. Annandale*).

UTTAR PRADESH : Meerut, 1 ♂, 2 ♀; 13.19.VI. 1905, 1 ♀ (*E. Brunetti*). Almora, Kumaon, 5500 ft., XII. 1911, 1♀ (*C. Paiva*). Dehra Dun, 2♀; 19.V.1947, 1♀ X-XI.1938, 3 ex. (*B. N. Chatterjee*) (F.R.I.); 16. V. 1928, 1 ex. (*P. L. N.*; *F. Z. Colln.*) (F.R.I.); 7.IX.1929, 1 ex. (*G. D. Pant*) (F.R.I.); 30. X. 1937, 1 ex. (*G. D. Bhasin*) (F.R.I.); 12. XII. 1939, 1 ex. (*S. L. Mark*) (F.R.I.); III. 1930, 1 ex. (*B. M. Bhatia*) (I.A.R.I.); New Forest, Dehra Dun, 4. XI. 1938, 11 ex. (*ex Dalbergia sissoo*. Ent. Survey) (F.R.I.). Anwarganj, Kanpur dist., 1-13. X. 1911, 1♀ (*J.W.C.*). Between Amausi and Harawni, 25-26. X. 1911, 1♂ (*J. W. C.*). Sahelwa, Bahraich dist., 12. III. 1909, 1♂. Shahzadpur, Allahabad, 22. V. 1908, 1♂ (*Mus. Collr.*). Banaras, 30. VII. 1947, 1♂; 10. VI. 1947, 1♀ (*T. N. and V. N.*). BIHAR : Pusa, 26-30. VIII. 1925, 1♂ (*H. S. Pruthi*); 12. V. 1932, 1 ex. (*C. K. Samuel*) (I.A.R.I.). Olo Anqua, Singbhum dist., 13. II. 1955, 7♂, 7♀ (*A. P. Kapur*). Chiria, Singbhum dist., 18. II. 1955, 3♂ (*A. P. Kapur*). Manoharpur, Singbhum dist., 2. II. 1954, 1♀, 3♂, (*A. P. Kapur*) from vegetable garden. BENGAL : Darjeeling, 29. V. 1917, 1♀ (*E. Brunetti*). Siliguri, 29.VI. 1906, 1♀. Calcutta, 1♀; 1. 21. V. 1909 1♀; 13. II. 1904, 1♀, 1♂, (*E. Brunetti*); 6. XII. 1925, 1♀ (*R. B. S. Sewell*); 1930, 2♀; 1929, 1♂ (*S. Ribeiro*); V. 1949, 1♂, 1♀ (*G. K. Manna*). Chennia, 24-Parganas, Sunderbans, 11. XI. 1909, 1♂ (*J. T. Jenkins*). Basanti F. S., 24-Parganas, Sunderbans, 16. XI. 1909, 1♀ (*J. T. Jenkins*). Kankandigee, 24 Parganas, Sunderbans, 18. XI.1909, 2♂, 3♀ (*J. T. Jenkins*). ORISSA : Barkul, 1-3.VIII.1914, 1♀ (*F. H. Gravely*). ASSAM : Silonibar, North Lakhimpur, 15-30. VI. 1911, 1♀ (*S. Stevens*).; Gauhati, 25 VI.—4. V. 1919, 1 ex. (*T. B. Fletcher*) (I.A.R.I.).

NEPAL : Maho, 17. III. 1909, 1 ex. Tiruani, 25. XII. 1909, 2♂, 4♀ (*B. Warren*); Butal, 12. XI. 1908, 2♂ (*Mus. Collr.*).

Distribution.—Ceylon, India (type-locality : Tranquebar), West Pakistan and Burma. Distant (1904, 1910) has not reported this species name from India. Breddin (1909) described *D. micropygus* from Ceylon. Freeman (1947) has mentioned the following localities from India and West Pakistan—Mysore : Bangalore ; Bombay ; Rajputana ; Suajgarh ; Punjab : Multan ; Uttar Pradesh (United Provinces) : Merut, Kumaon, Agra, Dehra Dun ; Bihar ; Bengal : Darjeeling, Calcutta. Burma : Shw-egyin, N. Pegu. Ceylon : Galle, Tala, Trincomalee. The species is recorded here for the first time from Assam, Nepal and Orissa.

Remarks.—As stated in the introduction, this species has been more often than not confused with *D. cingulatus* in India and Pakistan. The two species may overlap in N. E. India and Burma only. The species are very variable in external characters and coloration but can be distinguished from each other by the following characters :—

D. koenigii

D. cingulatus

i. Usually clear red femora.

Usually dark femora, at least apically black.

ii. Size 11.0—15.5 mm.

Size 12.0—18.0 mm

D. koenigii

- iii. Male genitalia with parameres of double crest type apically.
- v. Vertical processes of the ninth segment in male moderately broad, gradually and slightly narrowed apically, and separated for about half the length of processes.
- v. Spermathecal duct short, accessory gland narrow and much coiled at the apex.
- vi. Distributed in India, Burma and Ceylon.

D. cingulatus

- Male genitalia with parameres of single crest type ; hooked.
- Vertical processes of the ninth segment in male broad, closely oppressed, narrowed at the apex.
- Spermathecal duct long, accessory gland broad and less coiled.
- Distributed mainly in S. E. Asia and Australia, overlapping with *koenigii* in N. E. India and Burma.

2. *Dysdercus evanescens* Distant

- 1902. *Dysdercus evanescens* Distant, *Ann. Mag. nat. Hist.* (7) **9**, p. 43.
- 1902. *Astemma evanescens*, Kirkaldy and Edwards, *Wien. ent. Ztg.*, **21**, p. 172.
- 1904. *Dysdercus evanescens*, Distant, *Fauna Brit. India*, Rhynchota, **2**, p. 120.
- 1947. *Dysdercus evanescens*, Freeman, *Trans. R. ent. Soc. Lond.*, **98**, p. 402.

Diagnostic characters.—Pronotal collar either white or concolorous (in darker forms) with the pronotum ; pronotal disc, anterior angles and posterior margin concolorous, varying from light greyish-ochraceous to deep red. Corium with small transverse spot, centrally placed, much smaller for the size of the insect (Text-fig. 2a) ; membrane pale. Male genitalia with the parameres (Text-fig. 3b) double crested apically ; the vertical processes (Text-fig. 4b) broad, separated along about half the length of the processes and rounded apically. Spermathecal duct (Text-fig. 5a) short, as in *koenigii*, but the accessory gland broader and less coiled. *Length* 15.0–19.5 mm., *breadth* 5.0–6.5 mm.

Material examined.—35 examples from the following localities :—

INDIA : UTTAR PRADESH : Banaras, 2.V.1945, 2♀ (*T.B. Sinha*), under cotton and 'gular' (*Ficus racemosa* Linn.) trees. Bhimtal, 4500 ft., Kumaon, 22-27.IX.1906, 1♂ (*N. Annandale*). PUNJAB : Above Kufri, Simla hills, 8000 ft., 20-30. IX.1921, 1♀ (*S. W. Kemp*). BENGAL : Kurseong, 1♀ ; 21.VI.1910, 1♀ (*N. Annandale*). Darjiling, 8.VI.1917, 1♂, 1♀ (*E. Brunetti*), 12.V.1928. 1 ex. (*Bose*) (I.A.R.I.) ; 1 ex. (*Carmichael*) (I.A.R.I.). Pashok, 26. V.-14. VI. 1916, 3♀ (*F.H. Gravely*) ; 23.11-11. V. 1915, 2♀, 2♀ (*F.H. Gravely*). Kalimpong, 24.IV-10. V.1915, 2♂, 4♀ (*F. H. Gravely*). Calcutta, 14. VI.1950, 1♀ (*A.P. Kapur*). Dist. Purneah, 1♂, 5♀.

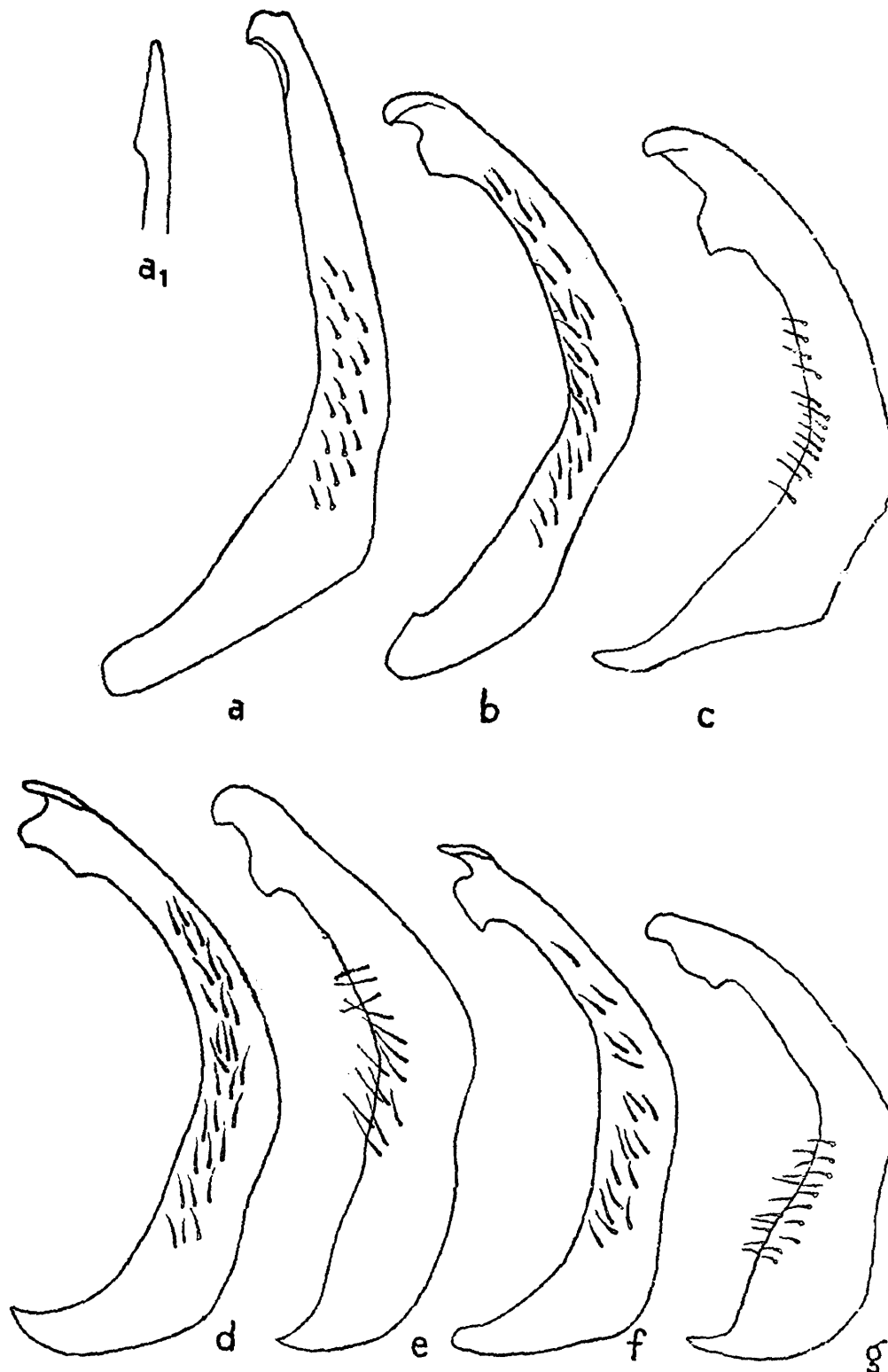
SIKKIM : Sikkim, 1♀

NEPAL : Chitlong, 1♀. Above Nah, 15500 ft., 15.V. 1955, 1♀ (*B. Biswas*).

BURMA : Saden, Myitkyina dist. V.1911, 1♀ (*E. Colenso*). Misty Hollow, W. side of Dawna hills, 2200 ft., 22-30.XI. 1911, 1♂ (*F.H. Gravely*).

Distribution.—India, Sikkim, Burma, Indo-China. Distant (1904) recorded this species from Assam and Burma. Freeman (1947) further recorded it from Indo-China, Sikkim, Kumaon Hills (U.P.) and N. Konkan (Bombay State). It is here recorded for the first time from two places in Nepal, namely, Chitlong and above Nah, at 15,500 ft. The high altitude from which the latter specimen has been collected may perhaps be the highest altitudinal record of the occurrence of the genus. As the species is generally found in mountainous tracts the present record from Banaras is also of interest since the latter is situated in the Indo-Gangetic plain.

Remarks.—This species has many distinctive characters and can be easily distinguished from other species by its large size, the pale hemelytral membrane, and by having a corial spot which is small for the size of the insect. It may also be mentioned that the specimens from Banaras were

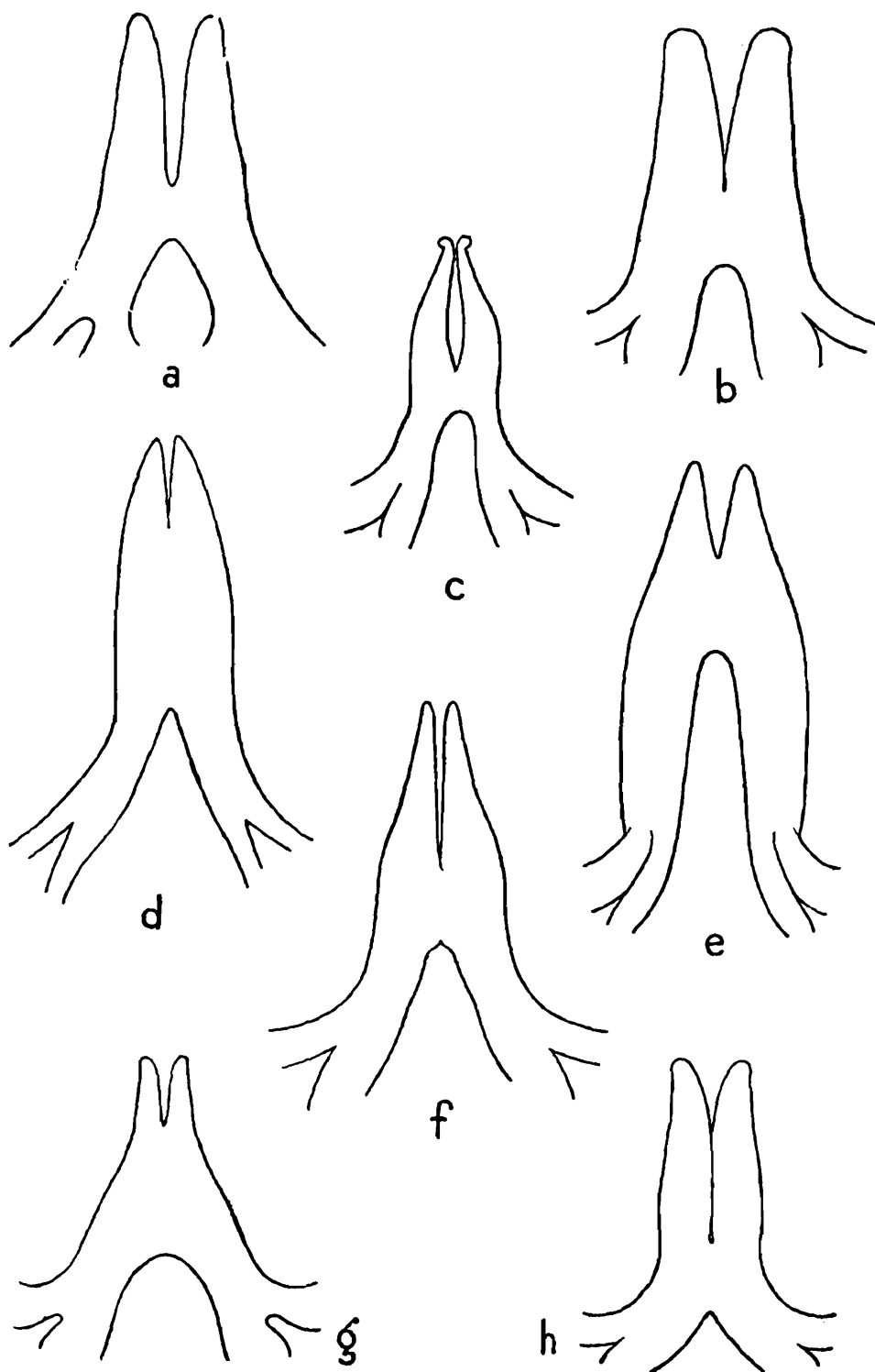


TEXT-FIG. 3.—Lateral view of right parameres of: (a). *Dysdercus cingulatus*. (a₁). *D. cingulatus*, front view. (b). *D. evanescens*. (c). *D. olivaceus*. (d). *D. koenigii*. (e). *D. mesiostigma*. (f). *D. poecilus*. (g). *D. decussatus*.

collected from underneath cotton plants and gular (*F. racemosa*) tree although the economic status of this species in relation to the forms remains unknown.

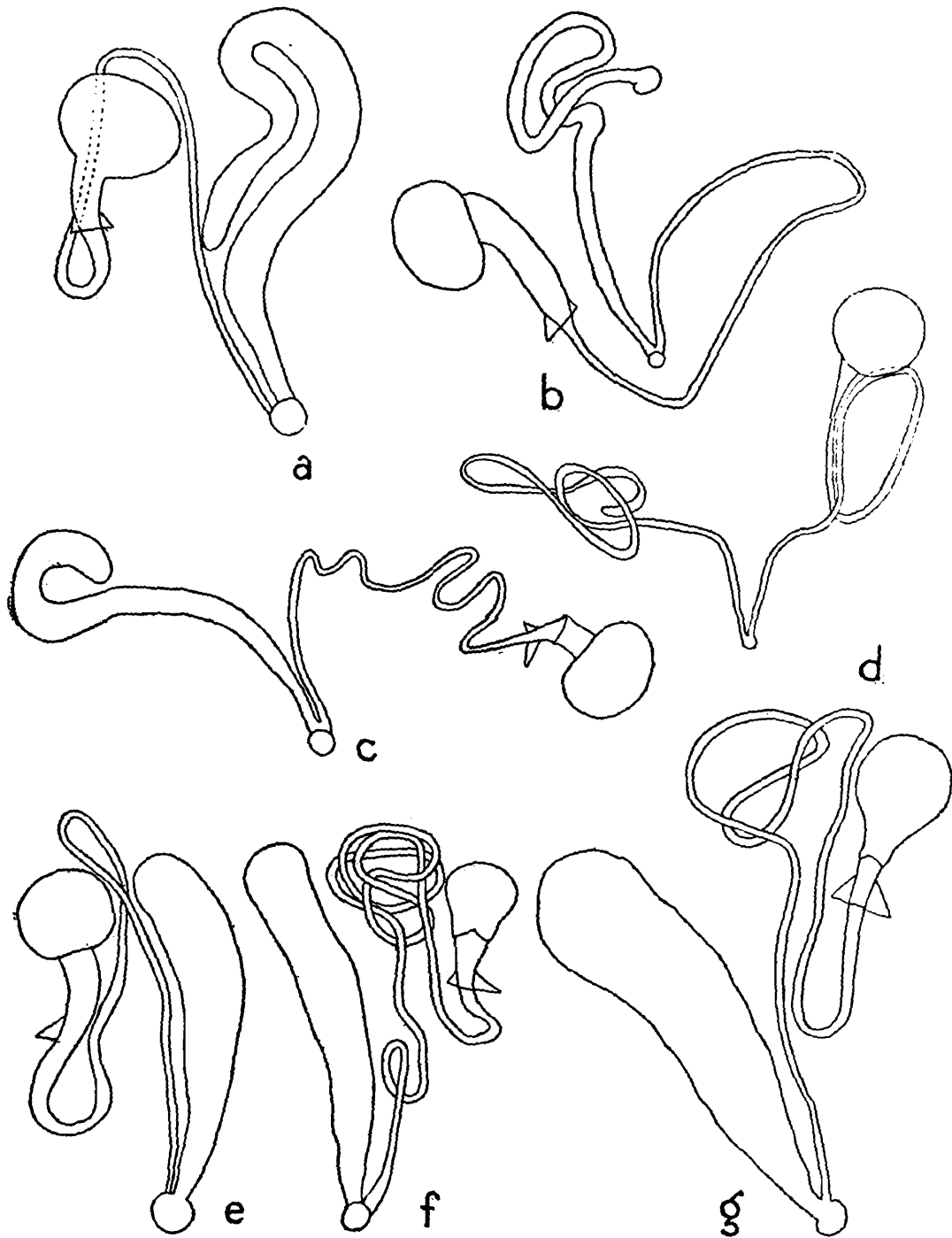
3. *Dysdercus olivaceus* (Fabricius)

1798. *Lygaeus olivaceus* Fabricius, *Entomologia Systematica* 4, *Supplementum*, p. 540.
 1868. *Dysdercus olivaceus*, Stål, *K. svenska Vetensk Akad. Handl.*, 7, p. 84.
 1904. *Dysdercus olivaceus*, Distant, *Fauna Brit. India*, Rhynchota, 2, p. 119.
 1904. *Dysdercus cingulatus*, Distant, *ibid.*, 2, p. 119 (in part).
 1909. *Dysdercus luteolus* Breddin, *Ann. Soc. ent. Belg.*, 53, p. 300.
 1910. *Dysdercus cingulatus*, Distant, *ibid.*, 5, p. 100 (in part).
 1947. *Dysdercus olivaceus*, Freeman, *Trans. R. ent. Soc. Lond.*, 98, pp. 403-404.



TEXT FIG. 4.—Posterior view of the vertical processes of the ninth abdominal segment of male of : (a). *Dysdercus koenigii*. (b). *D. evanescens*. (c). *D. similis*. (d). *D. cingulatus*. (e). *D. mesiostigma*. (f). *D. poecilus*. (g). *D. decussatus*. (h). *D. Olivaceus*.

Diagnostic characters.—Prothorax (Text-fig. 1d) narrow anteriorly ; pronotal collar white ; disc and posterior margin pale dull yellow ; lateral margins pale or reddish. Corium with the centrally placed black spot, usually rounded but variable in size, never touching either margin. The white abdominal fasciae (on segments 2-3 and sometimes 4-5, forked). Male genitalia with the parameres (Text-fig. 3c) of double crest type ;



TEXT-FIG. 5.—Spermatheca and accessory gland of : (a). *Dysdercus evanescens*. (b). *D. koenigii*. (c). *D. cingulatus*. (d). *D. olivaceus*. (e). *D. poecilus*. (f). *D. decussatus*. (g). *D. mesiostigma*.

vertical processes (Text-fig. 4h) moderately broad, bluntly pointed and a little bent apically on the outer side. Second conjunctiva appendages simple. Spermathecal duct (Text-fig. 5d) narrow, long, a little longer than in *koenigii* ; the accessory gland is narrow and much coiled. Length 11.0-15.5 mm., breadth 4.0-5.5 mm.

Material examined.—16 examples from the following localities :—

INDIA : MADRAS : Tope, foot of Palni Hills, 2♂, 2♀ (S. W. Kemp). COCHIN : Parambikulam, 10-15.IX.1914, 2♂, 4♀ (F. H. Gravelly).

CEYLON : Peradeniya, 18.V.1910, 5♂, 1♀.

Distribution.—South India (type-locality : India) and Ceylon. Distant (1904) gave its distribution as “Indie orientalis” Freeman (1947) recorded it from S. India and Ceylon which are also the areas from where our material comes.

Remarks.—All the specimens except those from Tope have the white abdominal fasciae strongly forked. This character of the fasciae is, however, variable. In the examples from Tope, the forked shape of the abdominal fasciae though not so well marked is never quite absent. By the forked shape of the fasciae this species can be distinguished from the allied species *Dysdercus similis* in which the fasciae are simple. For some of the specimens of *D. similis* which may somewhat approach the forked condition of fasciae as in *olivaceus*, the structure of the male genitalia alone affords the reliable distinguishing character. Cumman (1931) has doubtfully recorded this species from Indo-China, on cotton.

4. *Dysdercus similis* Freeman

1947. *Dysdercus similis* Freeman, *Trans. R. ent. Soc. Lond.*, **98**, p. 404.

Diagnostic characters.—Prothorax much narrowed anteriorly as in *olivaceus*, corium also as in *olivaceus*. White abdominal fasciae often simple and narrow or may be pointed anteriorly but never truly bifid. Male genitalia distinctly different from *olivaceus*, parameres of double crest type, vertical processes (Text-fig. 4c) very much narrowed anteriorly and close together at the apex though separated in the middle; second conjunctiva appendages simple. *Length* 8.0-15.0 mm., *breadth* 2.5-5.0 mm.

Remarks.—Unfortunately it has not been possible to examine any specimen of this species which has been recently described by Freeman (1947) from Wayalar, South India, and whose distribution extends southwards to Ceylon. As stated earlier the species is allied to *D. olivaceus*, being similar to it in the anteriorly much narrowed prothorax, in general colouration, spots on the corium, etc. The differences in the character of the abdominal fasciae have already been referred to under *olivaceus*. The two species may be separated by the shape of vertical processes which are here much narrower and closer together at the apex (Text-fig. 4c) than is the case in *olivaceus*.

5. *Dysdercus poecilus* (Herrich-Schaffer)

1844. *Pyrrhocoris poecilus* Herrich-Schaffer, *Wanzenartigen Insekten*, **7**, p. 17.

1853. *Dysdercus poecilus*, Herrich-Schaffer, *ibid.*, **9**, p. 177.

1901. *Dysdercus poecilus* var. *semifuscus* Breddin, *Wien. ent. Ztg.*, **20**, p. 85.

1901. *Dysdercus poecilus* var. *simplex* Breddin (nec. Walker), *ibid.*, **23**, p. 85.

1927. *Dysdercus poecilus* var. *semifuscus*, Taeuber, *Konowia*, **6**, pp. 193-195.

1929. *Dysdercus vacillans* Hussey, *General Catalogue of the Hemiptera*, **3**, p. 99 (nom. nov. for *D. poecilus* var. *simplex* Breddin).

1947. *Dysdercus poecilus*, Freeman, *Trans. R. ent. Soc. Lond.*, **98**, pp. 405-406.

Diagnostic characters.—Pronotum with white colour of the crescentic collar extending to the lateral margins ; pronotal disc and posterior margin red or orange. Corium with roundish spot (Text-fig. 2b) touching the inner margin only. In the forms without corial spots, the white fasciae on the (true) first abdominal segment present. Male genitalia with parameres (Text-fig. 3b) of double crested type, vertical processes (Text-fig. 4f) much narrowed towards the apices. Spermathecal duct (Text-fig. 5e) as in *cingulatus*, accessory gland sufficiently broad, small and not coiled. Length 8.5-13.0 mm., breadth 2.5-4.5 mm.

Material examined.—7 examples from the following localities :—

INDIA : BENGAL : Darjiling, 26.X.1955, 2♀ (G. K. Manna). ASSAM : Assam-Bhutan Frontier, 26.XI.1910, 2♂ (S. W. Kemp) ; Mangaldai Dist., 16.X. 1910, 1♂, 1♀ (S. W. Kemp) ; Sylhet, 12.X.1930, 1♀ (M. Bose) (F.R.I.).

Distribution.—Sikkim, India (Assam and N. Bengal), Burma, Siam, Indo-China, China (Hainan, Hongkong), Formosa, Malay States, Sumatra, Borneo, Java (type-locality : Java), Philippine Is. and Sulu Is. Distant (1904, 1910) does not record this species from India, Burma or Ceylon. Freeman (1946) has recorded this species from Sikkim ; Naga Hilla, Khasia Hills, N. Lakhimpur in Assam, and from Bhamo in Burma.

Remarks.—On account of their general similarity in appearance, *D. poecilus* is likely to be confused with *D. koenigii* and *D. cingulatus*. It is, however, smaller than *D. cingulatus*. Invariably it may be separated by the white colour of the prothoracic collar extending to the lateral margins. A few specimens of *D. cingulatus* also slightly approach this condition but these could be distinguished further by the corial spot, which, when present, touches the inner margin and by the absence of a clear, white fascia on the first abdominal segment. Otaness and Butac (1939) record this species as a pest of minor importance on cotton. In view of its economic importance, it might be useful to keep a watch on it in the area of its occurrence in India.

6. *Dysdercus cingulatus* (Fabricius)

1775. *Cimex cingulatus* Fabricius, *Systema Entomologia*, p. 719.

1794. *Lygaeus cingulatus*, Fabricius, *Entomologia Systematica*, 4, p. 153.

1835. *Pyrrhocoris koenigii*, Burmeister, *Handbuch der Entomologie*, 2, p. 285.

1840. *Astemma koenigii*, Blanchard, *Histoire Naturelle des Animaux articulés*, 3, p. 128.

1853. *Dysdercus cingulatus*, Herrich-Schäffer, *Die Wanzenartigen Insekten*, 9, p. 177.

1904. *Dysdercus cingulatus*, Distant, *Fauna Brit. India*, Rhynchota, 2, p. 118 (in part).

1909. *Dysdercus megalopygus* Breddin, *Ann. Soc. ent. Belg.*, 53, p. 300.

1910. *Dysdercus cingulatus*, Distant, *ibid.*, 5, p. 100 (in part).

1929. *Dysdercus megalopygus* var. *ornatus* Hussey, *General Catalogue of the Hemiptera*, 3, p. 94.

1947. *Dysdercus cingulatus*, Freeman, *Trans. R. ent. Soc. Lond.*, 98, pp. 409-411.

Diagnostic characters.—Prothorax as in *koenigii*, with the collar white, white colour of the collar, however, rarely extending on to the lateral angles, disc and posterior margin usually orange. Corium concolorous with the disc of pronotum ; the spot black, usually slightly oval, centrally placed, usually fairly large, sometimes much reduced ; membrane

black. White abdominal fasciae on segments 1-6 always present though variable in size, the fasciae on segments 2-4 often quite narrow, sometimes broadened laterally to half or more of the width of segment. Male genitalia with parameres hooked (Text-fig. 3a, 3a1), single crested, characteristic and constant for the species; vertical processes (Text-fig. 4d) broad basally and narrowed apically, closely oppressed and separated only at the apex. Spermathecal duct (Text-fig. 5c) long (longer than in *koenigii*), accessory gland moderately broad and coiled at the apex in the form of a question mark. Length 12.0-18.0 mm., breadth 3.5-5.5 mm.

Material examined.—29 examples from the following localities :—

INDIA : ASSAM : Mazbat, Mangaldai dist., 11-15.X.1910, 1♂ : 1♀ (*S. W. Kemp*). Shillong, 5♂, 3♀. Sylhet, 1♀ (*M. Bose*) (*F. R. I.*).

BURMA : Tenasserim, 1♂. Hopin, Myitkyina dist., 12-13.X. 1926, 1♂ (*B. N. Chopra*). Tavoy, 1♀.

SUMATRA : Batavia, 17.VI.1906, 1♂ (*F. Brunetti*).

BORNEO : Sibuloh, Sarawak, 2. VII.1910, 6♂, 6♀ (*Beebe*).

PHILIPPINES : Manila, 10-16.III.1906, 2♀ (*E. Brunetti*).

Distribution.—India (Assam), East Pakistan (Chittagong), Burma, Siam, Indo-China, Hainan, Formosa, Canton, Malaya States, Sumatra, Borneo, Philippine Is., Celebes, Moluccas, Tenimber, New Guinea, New Ireland, Solomon Is., Australia (type-locality : Australia).

Remarks.—In literature on the Indian species of *Dysdercus* the name *D. cingulatus* has been most commonly employed for over half a century *vide* Atkinson (1888), Cotes (1888, 1891, 1892, 1896), Stebbing (1903), Lefroy (1909), Misra (1920, 1923), Pruthi (1922), Singh (1923), Fletcher (1930), Mehta (1930), Ayyar (1936), Beeson (1941), Banerjee and Basu (1955). The material seems actually to have belonged to *D. koenigii*, which is the most widely distributed species in India and the type-locality of which is Tranquebar, South India. The type-locality of *D. cingulatus* is Australia. As revealed by the studies of Freeman (1947) and confirmed by the present observations based on extensive material of the genus, *D. cingulatus* is, as far as known, confined to N. E. India (Assam) and East Pakistan (Chittagong), although it is widely distributed in the Australasian Region (*vide* map on p. 173) and causes serious damage to cotton. The characters distinguishing this species from *D. koenigii* have already been dealt with (p. 163). Since the latter species is more common in India and is invariably used in class-room dissections in agricultural colleges and elsewhere, and has also been employed recently for testing the efficacy of insecticides (Banerjee and Basu, 1955), it is only proper that the correct name, *D. koenigii*, is employed for it.

7. *Dysdercus mesiostigma* Distant

1888. *Dysdercus mesiostigma* Distant, *Trans. ent. Soc. Lond.*, p. 484.

1902. *Astemma mesiostigma*, Kirkaldy and Edwards, *Wien. ent. Ztg.*, 21, p.172.

1904. *Dysdercus mesiostigma*, Distant, *Fauna Brit. India*, Rhynchota, 2, p. 120.

1947. *Dysdercus mesiostigma*, Freeman, *Trans. R. ent. Soc. Lond.*, 98, pp. 415-416.

Diagnostic characters.—Prothorax moderately and finely punctured ; prothoracic fold and scutellum closely and finely pubescent ; the remaining of the dorsal surface sparsely pubescent. Corium without any dark spots or markings ; membrane pale with black basal spot. Rostrum very long, reaching at least the base of the fifth and apex of the sixth abdominal segment. Male genitalia with second conjunctiva appendages forked ; parameres (Text-fig. 3e) intermediate between *koenigii* and *decussatus* ; vertical processes (Text-fig. 4e) broad, rather pointed and slightly separated apically. Spermathecal duct (Text-fig. 5g) long, but shorter than that of *D. decussatus*, accessory gland very broad and uncoiled. Length 17.0-24.0 mm., breadth 5.5-7.5 mm.

Distribution.—Distant (1904) recorded this species from Ceylon and New Guinea. Freeman (1947) mentions the following localities : Ceylon, China, Malay States, Borneo (Sarawak), Saalayar Is., Amboina, New Guinea (Type-locality), Solomon Is. and Leti Is.

Remarks.—The species is characterised by the pubescence on the dorsal surface and may be further recognized by the absence of any markings on the corium, and by the pale membrane with a black basal spot. This species comes close to *D. decussatus* in respect of the second conjunctiva appendages of the aedeagus being forked, but can be easily distinguished by the presence of pubescence on the dorsal surface and by very long rostrum which reaches at least the base of the fifth abdominal segment.

8. *Dysdercus decussatus* Boisduval

- 1835. *Dysdercus decussatus* Boisduval, *Voyage de l' Astrolabe etc. Paris*, p. 640.
- 1855. *Lygaeus fabricii* Montrouzier, *Ann. Soc. Agric. Lyon*, (2) 7, p. 106.
- 1855. *Lygaeus cruciatus* Montrouzier, *ibid.*, (2) 7, p. 106.
- 1870. *Dysdercus decussatus* Stal, *K. svenska Vetensk Akad. Handl.*, 9, p. 124.
- 1870. *Dysdercus crucifer* Stal, *ibid.*, 9, 118.
- 1873. *Dindymus simplex* Walker, *Catalogue of the specimens of Heteropterous Hemiptera in the collection of British Museum, London*, 6, p. 6.
- 1888. *Dysdercus papuensis* Distant, *Trans. ent. Soc. Lond.*, p. 484.
- 1901. *Dysdercus decorus* Breddin, *Abh. naturf. Ges. Halle*, 24, pp. 19, 82.
- 1927. *Dysdercus simon* Taeuber, *Konowia*, 6, pp. 190, 195.
- 1931. *Dysdercus jacobsoni* Blöte, *Zool. Meded.*, 14, p. 121.
- 1932. *Dysdercus sumatranus* Schmidt, *Wien. ent. Ztg.*, 49, p. 263.
- 1932. *Dysdercus sauteri* Schmidt, *ibid.*, 49, pp. 263-264.
- 1947. *Dysdercus decussatus* Freeman, *Trans. R. ent. Soc. Lond.*, 98, pp. 417-419.

Diagnostic characters.—Prothorax with lateral margins strongly sinuate (Text-fig. 1 b), anterior margin less than half as wide as posterior margin. Corium without any transverse markings, variable in colour, in *decussatus* proper it is black, while var. *simplex* Walker is characterised by red colour with a clear white cross. Examples with intermediate colouration are also stated to be present. The species is also characterised by the anterior femora being provided with spines along the ventral surface in addition to the subapical group of spines which are of common occurrence in other species also. Male genitalia with the second conjunctiva appendages forked ; the parameres (Text-fig.

3g) apically double crested but without transverse fold. Spermathecal duct very long (longest among the Indian species), accessory gland broad and uncoiled. *Length* 11.0-15.5 mm., *breadth* 3.0-5.5 mm.

Material examined.—2 examples from the following locality :—

INDIA : NICOBAR ISLANDS, 2 ♂♂ (no further data).

Distribution.—Distant (1904) recorded this species from Nicobar Islands under the name *Dysdercus simplex* Walker which was synonymised with *decussatus* by Freeman (1947), who mentions it from the following localities : Ceylon ; Sikkim ; Nicobar and Andaman Is., Malay Peninsula, Sumatra, Borneo, China, Formosa, Celebes, Moluccas, New Guinea, Bismarck Archipelago, Solomon Is. (type-locality : Carteret Is., Solomon Is.), New Hebrides, Queensland, Philippine Is.

Remarks.—This is one of the most variable species in regard to colour pattern of the dorsal surface. In the past, many names have been based on differences in the colour pattern. Freeman (1947) has stated that all these names based on coloration are linked by intermediates and he was thus able to state the synonymy mentioned above. The two specimens mentioned here belong to the variety *simplex* Walker. This is also a predominantly Austro-Malayan species like *mesio stigma*.

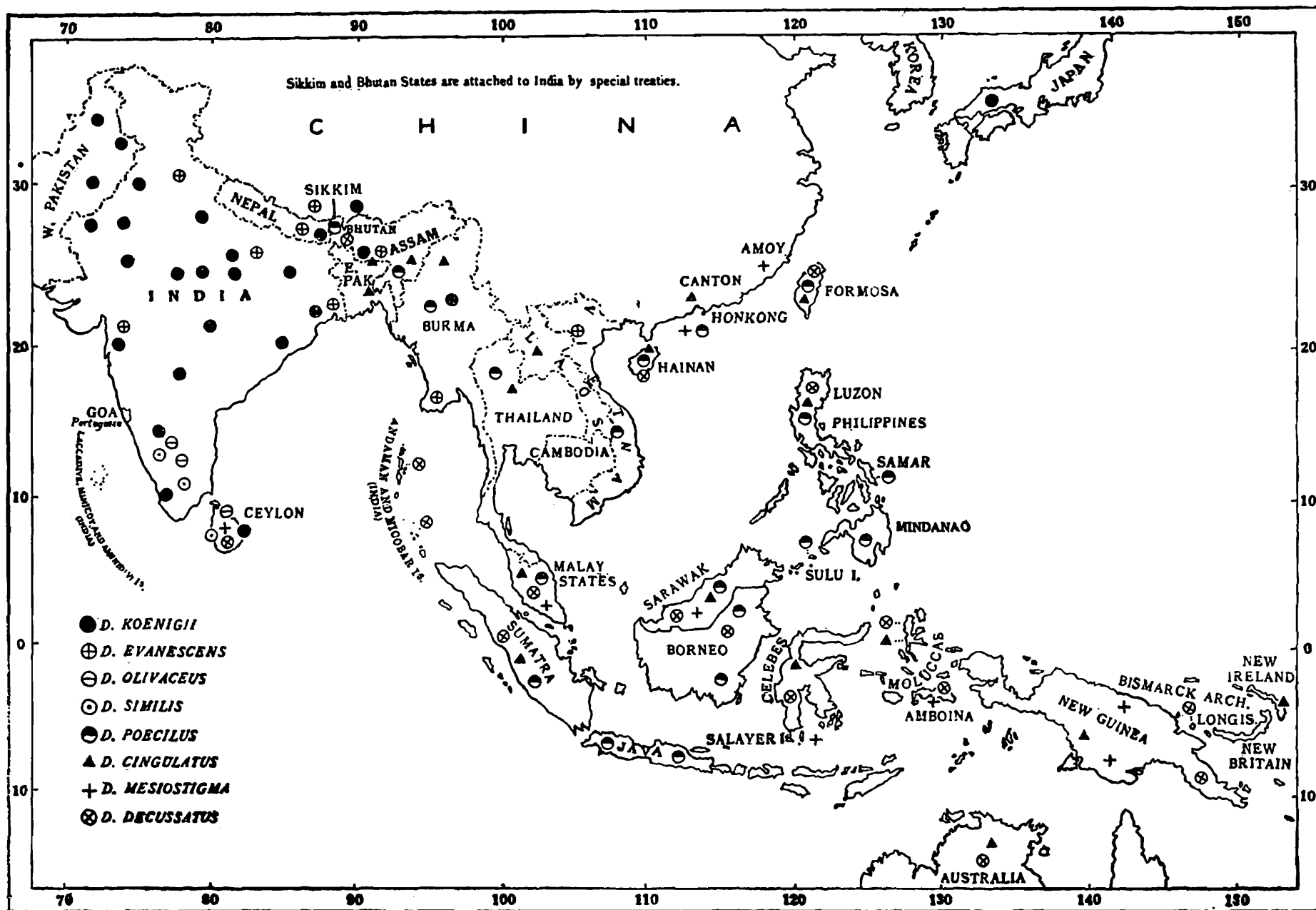
IV—GEOGRAPHICAL DISTRIBUTION

The genus *Dysdercus* Boisduval has world wide distribution. Recent revision of the old world species of the genus shows that the species fall into two rather distinct groups occurring in the Aethiopian and the Oriental-Australian regions.* While in the latter there are a number of widely distributed species, certain other species are endemic in a few zoogeographical subregions. Out of the eight species of the genus (see map) that have been dealt with in this paper, three species viz., *D. koenigii*, *D. olivaceus* and *D. similis* are confined to the limits of India, Burma and Ceylon. Of these, *D. olivaceus* and *D. similis* occur in the Ceylonese subregion, while *D. koenigii* is widely distributed in the Indian subregion, though at the same time it extends to the Ceylonese subregion and to Assam and Burma in the Indo-Chinese subregion.

D. evanescens is distributed in the Indian and Indo-Chinese subregions, having been recorded from Simla Hills, North and North-East India, Kumaon, Bombay, Burma (Rangoon) and Indo-China (Tongking).

Out of the remaining four species, *D. cingulatus*, *D. mesio stigma* and *D. decussatus* are predominantly Indo-Malayan and Austro-Malayan in distribution. *D. cingulatus* is the most widely distributed species, extending to Assam and Chittagong in the west ; to Canton, Formosa and Japan in the north and to Australian and New Zealand subregions in the south-east. It is an important pest of cotton in these regions and does not extend to the Indian and Ceylonese subregions of the Oriental region. *D. decussatus* is nearly as widely distributed as *D. cingulatus*. The western limits of its distribution are Assam in India,

*The zoogeographical divisions followed here are those given in Bartholomew, Eagle Clarke, Grinshaw's Atlas of Zoogeography, *Physical Atlas*, Vol. 5, 1911.

Map, showing the Geographical distribution of the Indian species of *Dysdercus*.

Ceylon and the Andaman and Nicobar Islands. In the North it is reported from Formosa and in the south-east it occurs in the Australian and New Zealand subregions of the Australian region. This is the only species *Dysdercus* so far reported from the Andaman and Nicobar Island.

D. mesiostigma has its northern known limit up to Amoy and Hong-kong, and though it is not reported from Assam, Burma, Siam and Indo-China, it is recorded from Ceylon, the south-eastern limits of its distribution are almost the same as those of *cingulatus* and *decussatus* except that it is absent from Australia.

D. poecilus is predominantly Indo-Malayan in distribution. It does not occur in the Indian or the Ceylonese subregions and its western limit is up to Assam and Sikkim which lie in the Indo-Chinese subregion. Its northern limit is up to Honkong and Formosa and in the south it is not distributed beyond Java, Borneo and the Philippine Islands.

V—SUMMARY

The paper deals with all the eight Indian species of the genus *Dysdercus*, namely, *D. koenigii*, (Fabr.), *D. evanescens* Dist. *D. olivaceus* (Fabr.), *D. similis* Freeman, *D. poecilus* (H. & S.), *D. cingulatus* (Fabr.), *D. mesiostigma* Dist and *D. decussatus* Boisd. A key for the identification of the species is given. Besides enumerating the large collections examined from various museums and Institutions in India, diagnostic characters and notes on the distribution of each species are also added. *D. koenigii* is the most common Indian species while *D. cingulatus* is distributed in India from Assam eastwards to the Pacific Is., China and Australia. *D. koenigii*, as recognised in the paper, is recorded for the first time from Assam and Nepal. *D. evanescens*, also recorded for the first time from Nepal, was collected at an altitude of 15,500 ft.

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STUDIES ON GALL MIDGES (ITONIDIDAE = CECIDOMYIIDAE : DIPTERA, INSECTA) FROM INDIA.—IX

By

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(With 8 Text-figures)

CONTENTS

	PAGE.
I—Introduction	177
II—Systematics	177
III—Summary	193

I—INTRODUCTION

This paper contains descriptions of nine new species of gall midges. the type slides of which are in the collections of the Zoological Survey of India, Calcutta. I am grateful to Prof. M. S. Mani for guidance and constant encouragement. I am also indebted to the National Institute of Sciences of India for the grant of a research fellowship.

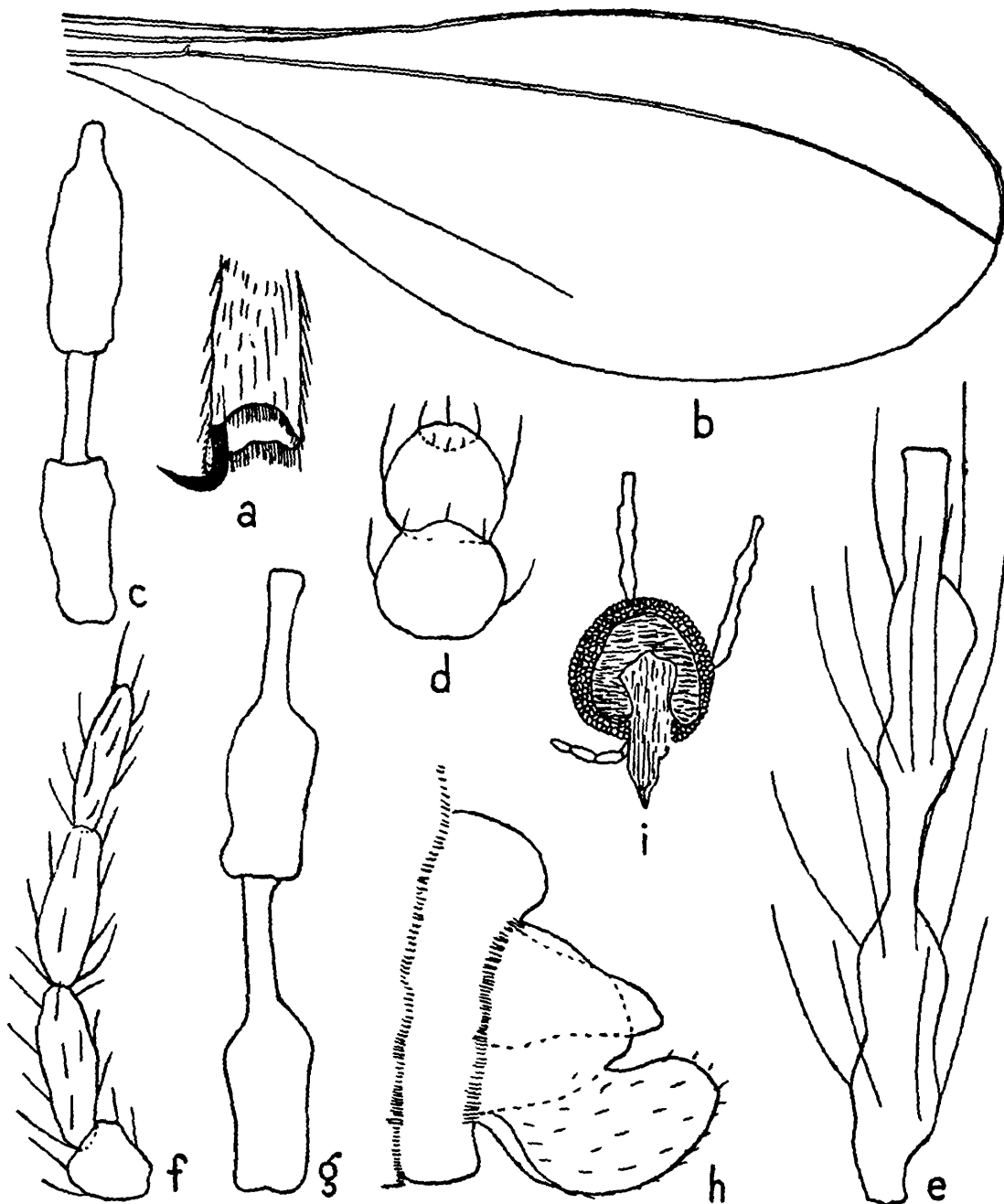
II—SYSTEMATICS

Subfamily *HETEROPEZINAE*

1. *Johnsonomyia indica*, sp. nov.

♀ Length 1.4 mm. Body light brown. Eyes (Text-fig. 1*i*) confluent above. Trophi (Text-fig. 1*i*) produced. Antenna pale brown, longer than body, with fourteen segments, flagellate segments cylindrical, gradually becoming reduced, enlargements slightly constricted in the middle, with long apical stems and with two whorls of long setae; first segment (Text-fig. 1*d*) nearly globose, pale brown, broader than long, length seven-ninths the width; second segment (Text-fig. 1*d*) longer than the first, nearly globose, length a little greater than the width; third segment (Text-fig. 1*e*) fused with the fourth, longer than both the first two segments combined, with a very short basal stem, enlargement cylindrical but for a slight constriction in the middle, apical portion of the enlargement slightly broader than the basal portion, enlargement nearly two-thirds the length of the segment and three and one-third times as long as the maximum thickness, stem nearly half the length of the enlargement, one-third the length of the segment and thrice as long as thick; fourth segment (Text-fig. 1*e*) shorter than the third, enlargement five-eighths the length of the segment and two and a half times as long as the maximum thickness, stem nearly

one-third the length of the segment, length nearly three and a half times the median thickness ; segments nine and ten as in figure 1g ; thirteenth segment (Text-fig. 1c) cylindrical, longer than the terminal, enlargement not constricted in the middle, as is the case in the basal segment, length two and two-fifths the thickness, stem slender, seven-twelfths the length of the enlargement and nearly five and a half times as long as thick ; terminal segment (Text-fig. 1c) with a small knob, enlargement slightly longer than that of the penultimate segment,



TEXT-FIG. 1.—*Johnsonomyia indica*, sp. nov.

(a). Claw. (b). Wing. (c). Terminal two antennal segments. (d). First two antennal segments. (e). Third and fourth antennal segments. (f). Palpi. (g). Ninth and tenth antennal segments. (h). Ovipositor. (i). Head.

cylindrical, without a constriction, length nearly thrice the thickness, knob one-third the length of the enlargement. Palpi (Text-fig. 1f) quadri-articulate, very sparsely setose, pale yellow, first segment shortest of all, nearly globose, length one and one-fourth the maximum thickness at the apical third ; second segment a little over twice the length of the

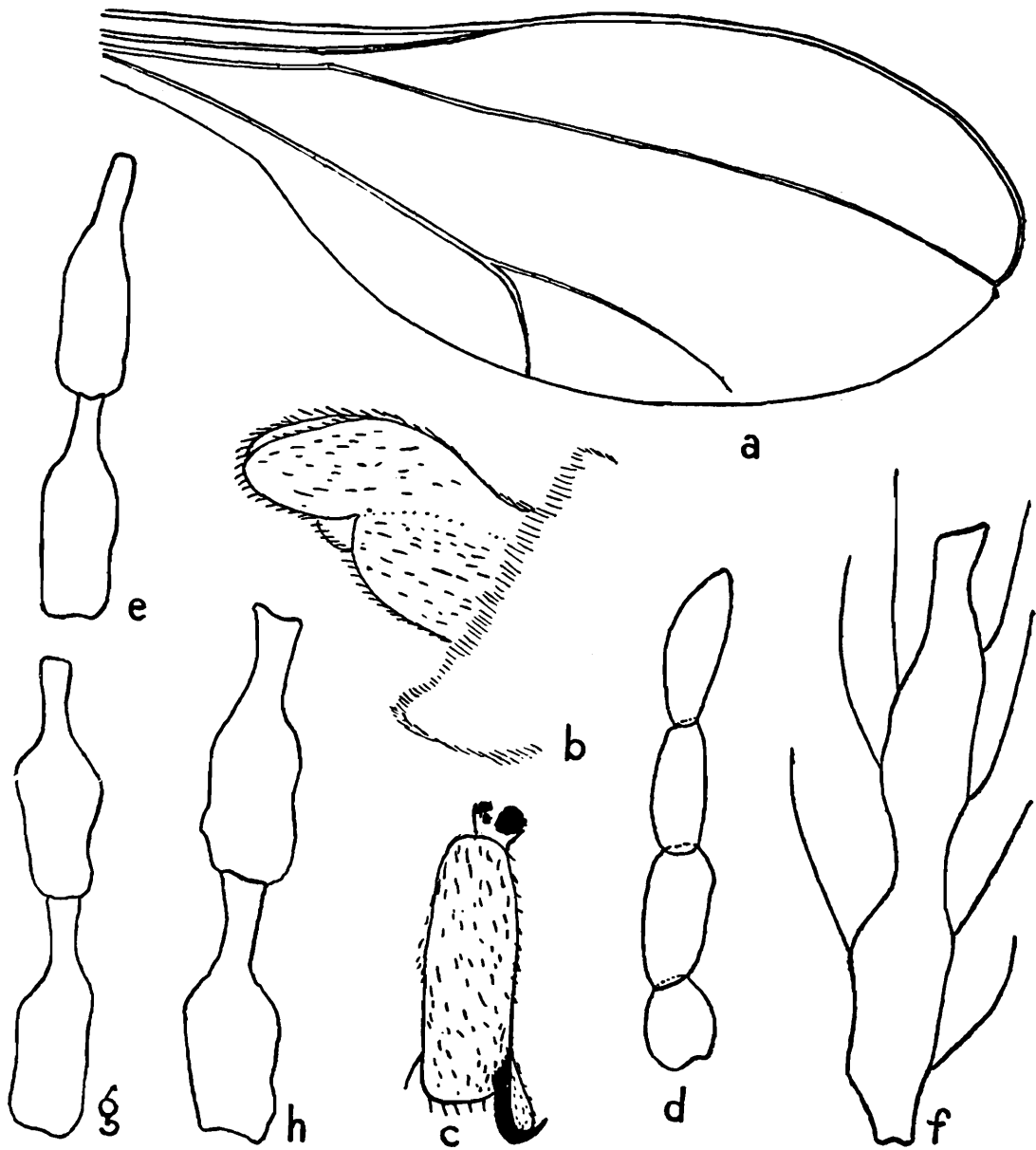
first, nearly cylindrical, slightly narrowed towards the apex, length two and three-fourths the maximum thickness ; third segment very slightly shorter than the second, elongate oval, length two and one-fourth times the maximum thickness ; fourth segment cylindrical, slightly shorter and slender than the third segment, length three and two-thirds the maximum thickness in the middle. Mesonotum yellowish-brown ; scutellum and postscutellum lighter. Halteres pale yellow. Abdomen yellowish brown. Wing (Text-fig. 1*b*) hyaline, length two and one-third the width, with three long veins, costa interrupted at its union with vein R_5 , vein R_s distinct but faint, at nearly right angles to vein R_1 , vein R_5 slightly curved and reaching the wing margin well beyond the apex, vein M_4-m-Cu simple. Legs long, pale brown, moderately hairy, metatarsus slightly shorter than the fifth tarsal segment. Claw (Text-fig. 1*a*) simple, curved at right angles. Empodium half the length of claw. Ovipositor (Text-fig. 1*h*) slightly exserted, terminal lobes oval.

Holotype : 1 ♀ on slide labelled " At light, Aizaz Manzil, Agra, S. N. Rao Coll., 10-9-1950 "

2. *Haplusia elliptica*, sp. nov.

♀ Length 1.2 mm. Body yellowish-black. Eyes confluent above. Antenna pale brown, slightly shorter than body, with fourteen segments, flagellate segments cylindrical, gradually becoming reduced, slightly constricted in the middle, with long apical stems and with two whorls of long setae ; first segment not visible in the preparation ; second segment globose, whitish-yellow, length nearly equal to the width ; third segment (Text-fig. 2*f*) confluent with the fourth and very slightly longer than the latter, with a very small basal stem, enlargement slightly narrower in the middle than at the apices, two-thirds the length of the segment and two and two-thirds as long as thick, apical portion of the enlargement slightly broader than the basal portion, stem nearly one-fourth the length of the segment, two and a half times as long as thick ; fourth segment (Text-fig. 2*f*) very slightly shorter than the third, enlargement slightly narrowed in the middle, apical portion very slightly broader than the basal portion, rest of the details as those of the preceding segment ; sixth segment shorter than the fourth, enlargement nearly cylindrical, basal and apical portions of the enlargement nearly of the same thickness, length nearly two-thirds the segment and twice as long as thick, stem less than half the length of the segment and three and a half times as long as thick ; seventh and eighth segments as in figure 2*h* ; ninth segment slightly shorter than the sixth, enlargement nearly cylindrical, length nearly twice the thickness, stem nearly half the length of the enlargement and twice as long as thick ; eleventh segment (Text-fig. 2*g*) nearly similar in all proportions to the ninth segment ; twelfth segment as in figure 2*g* ; penultimate segment (Text-fig. 2*e*) shorter than the terminal segment, enlargement nearly cylindrical, length twice the thickness with a stem of nearly half the length of the enlargement ; terminal segment (Text-fig. 2*e*) with a knob of nearly one-third the length of the segment, longer than the penultimate, enlargement nearly cylindrical, length nearly thrice the thickness, length

of knob thrice its own thickness. Palpi (Text-fig. 2*d*) short, pale yellow, quadriarticulate, moderately hairy, first segment shortest, nearly globose, length a little over maximum thickness; second segment longer than the first, nearly twice as long as the first and also twice as long as thick; third segment nearly equal to the second but slender, length two and one-third the maximum thickness; fourth segment longest of all. Mesonotum yellowish-brown; scutellum and postscutellum lighter. Abdomen yellowish black. Halteres pale yellow. Wing (Text-fig. 2*a*) hyaline, length nearly two and two-thirds the width, vein *Rs* faint, costa interrupted at



TEXT-FIG. 2.—*Haplusia elliptica*, sp. nov.

(a). Wing. (b). Ovipositor. (c). Claw. (d). Palpi. (e). Terminal two antennal segments. (f). Third and fourth antennal segments. (g). Eleventh and twelfth antennal segments. (h). Seventh and eighth antennal segments.

its union with vein *R*₅, the latter reaching the margin well beyond the apex, vein *M*₄-*m-Cu* forked. Legs long, whitish-yellow, moderately hairy, metatarsus slightly shorter than the terminal tarsal segment. Claw (Text-fig. 2*c*) simple, bent at right angles. Empodium nearly equal to the claw. Ovipositor (Text-fig. 2*b*) moderately hairy, exserted, lamellae elliptic.

Holotype : 1 ♀ dissected and mounted on slide labelled "At light, Research Laboratory, St. John's College, Agra. S. N. Rao Coll., 10-9-1949"

This species closely resembles *H. longipalpia* Rao¹ and its position along with other Indian species is shown in the following key :

Key to species

1. Palpi short ; flagellate antennal segments with short stems ; third and fourth antennal segments equal in length . *brevipalpia* Rao
- Palpi long ; flagellate antennal segments with long stems 2
2. Third antennal segment shorter than the fourth ; empodium shorter than claw *longipalpia* Rao
- Third antennal segment longer than the fourth ; empodium nearly as long as the claw ; ovipositor lobes elliptic *elliptica*, sp. nov.

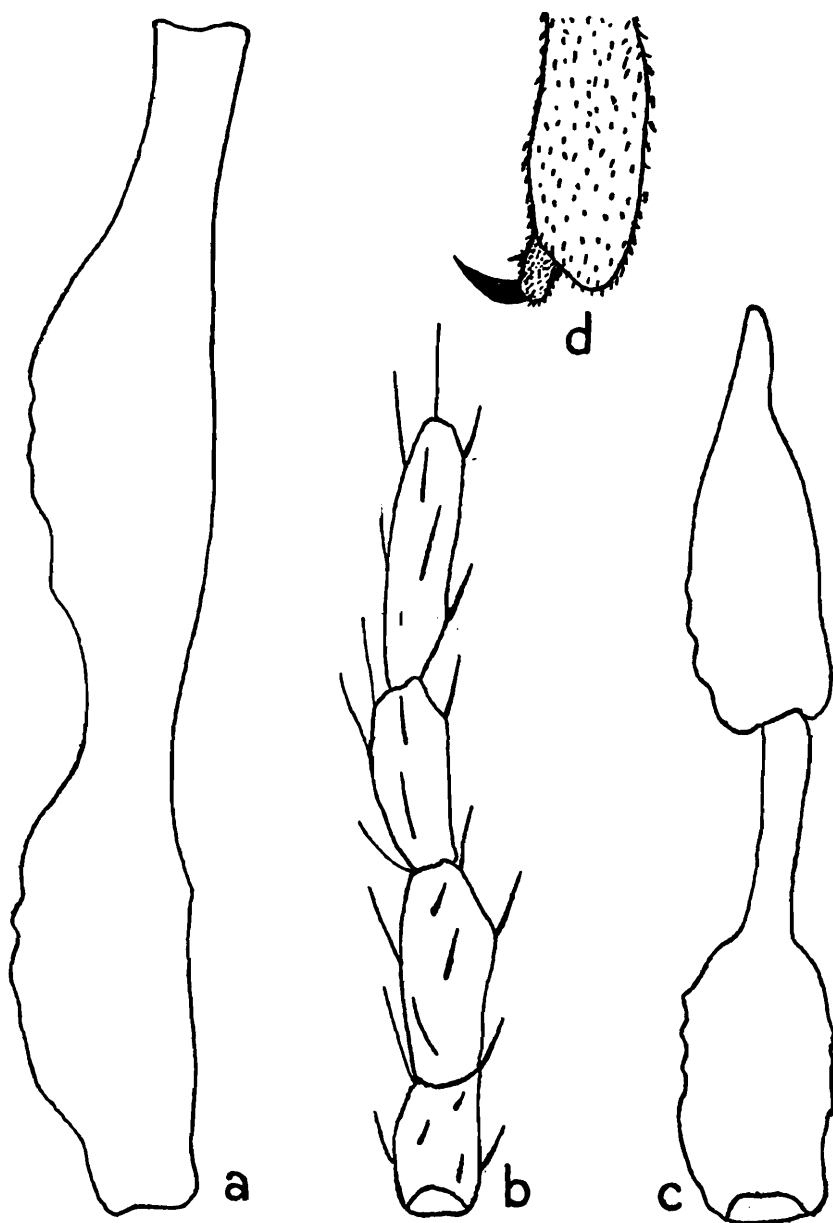
3. *Neohaplusia inaequipalpis*, sp. nov.

♀ Length 1.4 mm. Body brown to yellowish-brown. Eyes confluent above. Antenna light brown, longer than body, with fifteen segments ; flagellate segments cylindrical with apical stems ; first and second segments not clear in the preparation ; third segment (Text-fig. 3a) confluent with and equal in length to the fourth, with a very short basal stem, basal portion of enlargement slightly narrower than the apical portion, length nearly two-thirds the segment and two and one-third times the maximum thickness, stem nearly half the length of the enlargement and twice as long as thick ; fourth segment (Text-fig. 3a) similar in all essential details to the third ; penultimate segment (Text-fig. 3c) slightly longer than the terminal, enlargement nearly half the length of the segment and twice as long as thick, stem nearly half the length of the segment and as long as the enlargement, length five times the thickness ; terminal segment (Text-fig. 3c) with a knob of nearly half the length of the segment, enlargement two and one-third times as long as thick, knob nearly thrice as long as thick. Palpi (Text-fig. 3b) long, quadriarticulate, pale yellow, sparsely setose, first segment cylindrical, shortest of all, length one and a half times the thickness, second segment twice the length of the first and two and a half times its own thickness, nearly cylindrical, third segment shorter than the second, length two and one-third the thickness, fourth segment longest of all, cylindrical, length nearly four times the thickness. Mesonotum dark brown ; scutellum and postscutellum lighter. Abdomen yellowish-brown. Wing hyaline, two and a half times as long as broad, vein *Rs* distinct, costa interrupted at its union with vein *R*₅, the latter slightly curved and joining the wing margin beyond the apex, vein *M*_{4-m-Cu} forked. Halteres pale yellow. Legs long, hairy, metatarsus one and one-third the length of the fifth tarsal segment, second tarsal segment longest of all. Claw (Text-fig. 3d) bifid basally, empodium one-third the length of the claw. Ovipositor triarticulate, slightly exserted.

¹ Rao, S. N., *Indian J. Ent.*, New Delhi, **11**, p. 112 (1949).

Holotype : 1 ♀ on slide labelled " At light, Aizaz Manzil, S. N. Rao Coll., Agra, 27-9-1949 "

This species closely resembles *Neohaplusia neohaplusia* Rao¹, but is easily separated by the differences in the antennal and palpal segments and empodium being only one-third the length of the claw. The relation of this species with other known species is shown in the following key :



TEXT-FIG. 3.—*Neohaplusia inaequipalpis*, sp. nov.

(a). Third and fourth antennal segments. (b). Palpi. (c). Terminal two antennal segments. (d). Claw.

Key to species

- | | |
|---|---------------------------------|
| 1. Antenna less than the length of the body | 2 |
| Antenna greater than the length of the body, third and fourth antennal segments equal to each other in length ; terminal palpal segment longer than the third ; metatarsus longer than the fifth tarsal segment | |
| | <i>inaequipalpis</i> , sp. nov. |
| 2. Antenna slightly more than half the length of the body ; third antennal segment slightly shorter than the fourth ; terminal two palpal segments equal in length ; metatarsus equal to the fifth tarsal segment ; empodium three-fourths the claw | |
| | <i>agraensis</i> Rao |

¹ Rao, S. N., *Indian J. Ent.*, New Delhi, 11, p. 114 (1949).

Antenna half the length of the body ; third antennal segment longer than the fourth ; terminal palpal segment shorter and slenderer than the penultimate ; metatarsus half the length of the fifth tarsal segment ; empodium shorter than claw

neohaplusia Rao

Subfamily *ITONIDINAE*

Tribe Lasiopterini

4. *Lasioptera orientalis*, sp. nov.

♀ Length 1.2 mm. Body yellow. Eyes confluent above. Antenna yellowish-brown, nearly as long as the body, with sixteen sessile and cylindrical segments, flagellate antennal segments gradually becoming reduced, with scattered hairs ; first segment yellow, obconical, length slightly less than the maximum width at the apical three-fourths ; second segment yellow, broader than long, maximum width one and one-fourth the length ; third segment confluent with the fourth, with a very short basal stem, length of the enlargement nearly one and one-third the thickness ; fourth segment nearly as long as the third, enlargement a little less than one and a half times the thickness ; penultimate segment equal to terminal, nearly globose, length a little more than the thickness ; terminal segment similar in all essential details to the penultimate but slightly slender. Palpi quadriarticulate, long, pale yellow, moderately hairy, first segment nearly oval, shortest of all, length nearly equal to the maximum thickness ; second segment two and one-fourth times the length of the first, nearly cylindrical, wider at base than at apex, length three and one-eighth times the maximum thickness ; third segment longer but slenderer than the second, cylindrical, ends slightly tapering, length nearly three times the maximum thickness ; terminal segment similar in all essential details to the third but slightly slender. Mesonotum brown ; scutellum and postscutellum lighter. Halteres pale yellow. Wings hyaline, length two and one-third times the width, costa slightly scaled and interrupted at its union with vein R_5 , the latter not reaching the tip of the wing but ending in the distal third, vein M_4-m-Cu forked. Legs long, hairy, pale yellow, metatarsus shorter than the terminal tarsal segment. Claw bifid, slender, evenly curved, empodium nearly half the length of the claw. Ovipositor exerted.

Holotype : 1 ♀ on slide labelled " At light, Bishop French Hostel, S. N. Rao Coll., Agra, June 1949 "

This species closely resembles *Lasioptera indica* Rao¹, but is easily distinguished from it in the antenna being equal to the length of the body, in the different proportions of the palpal and antennal segments and in the differences in the wing. The relationship of this species with other Indian species is shown in the appended key :

Key to species

- | | |
|--|---|
| 1. Abdomen brown or black ; antennal segments eighteen or more | 2 |
| Abdomen not as above ; antennal segments less than eighteen | 5 |

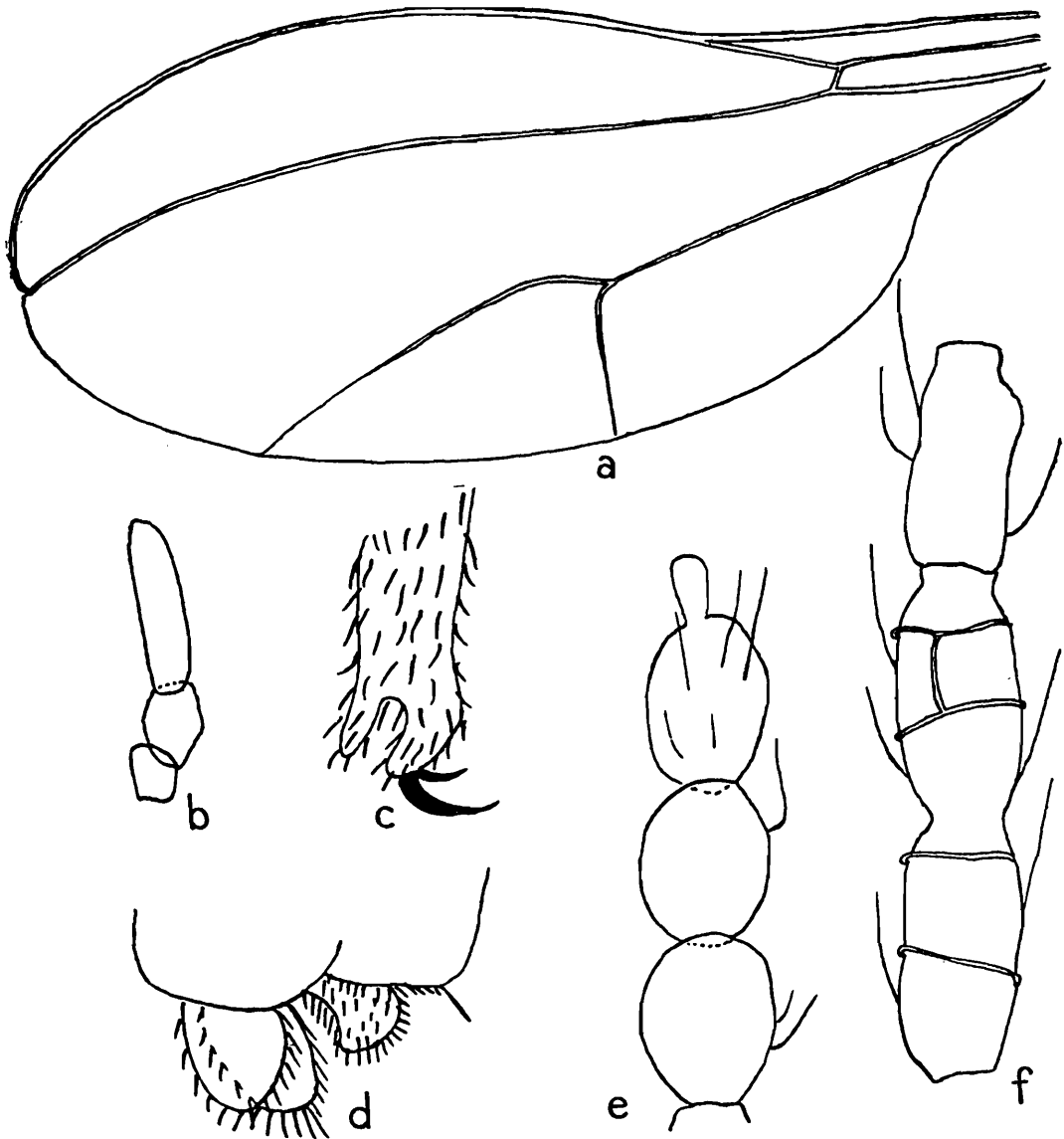
¹Rao S. N., *Proc. R. ent. Soc. Lond.*, London, **21**, p. 50 (1952).

2. Abdominal segments narrowly margined posteriorly, antenna extending to the base of the abdomen, empodium a little shorter than claw; ovipositor about three-fourths the length of the abdomen *eriochloa* Felt
- Abdomen not as above, dorsally with silvery-white submedian lines 3
- 3 Antenna with twenty-four segments in ♀ and extending to near the base of the abdomen, ovipositor nearly equal to the length of the body *falcata* Felt
- Antenna with less than twenty-four segments 4
4. Antenna with eighteen segments in ♀, ovipositor as long as the abdomen, terminal two palpal segments unequal *fluitans* Felt
- Antenna with twenty segments . *bryoniae* Felt
5. Terminal two palpal segments equal in length . 6
- Terminal two palpal segments unequal in length 7
6. Antenna less than half the length of the body . *indica* Rao
- Antenna as long as the body . *orientalis*, sp. nov.
7. Antenna with ten and possibly fifteen segments, empodium as long as the claw *paniculi* Felt
- Antenna with sixteen segments, empodium about the length of the claw *asystasiae* Nayar

5. *Bryocrypta deepica*, sp. nov.

♀ Length 1.35 mm. Body light brown to brownish-yellow. Antenna yellowish-brown, a little over half the length of the body, with fifteen segments; first segment (scape) short, widest at apex, width at apex equal to the length; second segment (pedicel) short, subcylindrical, slightly broader than long, wider at the basal one-third; third segment (Text-fig. 4f) confluent with the fourth, cylindrical, moderately setose, twice the length of the first segment, twice as long as thick, slightly wider at the distal end, apical stem very short; fourth segment (Text-fig. 4f) equal to the third; fifth segment (Text-fig. 4f) slightly shorter than the fourth, length one and a half times the thickness, with a stem of one-fifth the length of the enlargement; sixth segment equal to the fifth; eighth segment similar to the sixth; eleventh segment five-sevenths the length of the third, nearly oval, without stem; terminal segment (Text-fig. 4e) longer than the eleventh and with an apical knob of one-fifth the length of the enlargement. Trophi prominent. Palpi (Text-fig. 4b) triarticulate, long, moderately setose, first segment wider at apex, narrow basally, one and a half times as long as broad; second segment one and a half times the length of the first and two and a half times as long as broad, cylindrical; third segment cylindrical, longest of all, more than one and a half times the length of the second and four times as long as broad. Mesonotum brown, scutellum, postscutellum and abdomen lighter. Wing (Text-fig. 4a) hyaline, normal, two and a half

times as long as broad, with three long veins, vein R_s distinctly at an angle with vein R_1 , vein R_5 reaching the apex of wing and interrupting the costa at its union, vein M_4-m-Cu forked. Halteres light brown. Legs pale yellow, long moderately hairy, metatarsus short, slightly shorter than the fifth tarsal segment; second tarsal segment the longest, slightly shorter than the rest of the segments combined. Claw (Text-fig. 4c) dentate on all legs, bent at right angles, pale yellow. Empodium much shorter than claw. Ovipositor (Text-fig. 4d) slightly exserted, dorsal lobe broad, ventral lamellae small and narrow.



TEXT-FIG. 4.—*Bryocrypta deepica*, sp. nov.

(a). Wing. (b). Palpi. (c). Claw. (d). Ovipositor. (e). Terminal three antennal segments. (f). Third, fourth and fifth antennal segments.

Holotype: 1 ♀ on slide labelled "At light, Hewett park, M.S. Mani Coll., Agra, August, 1947"

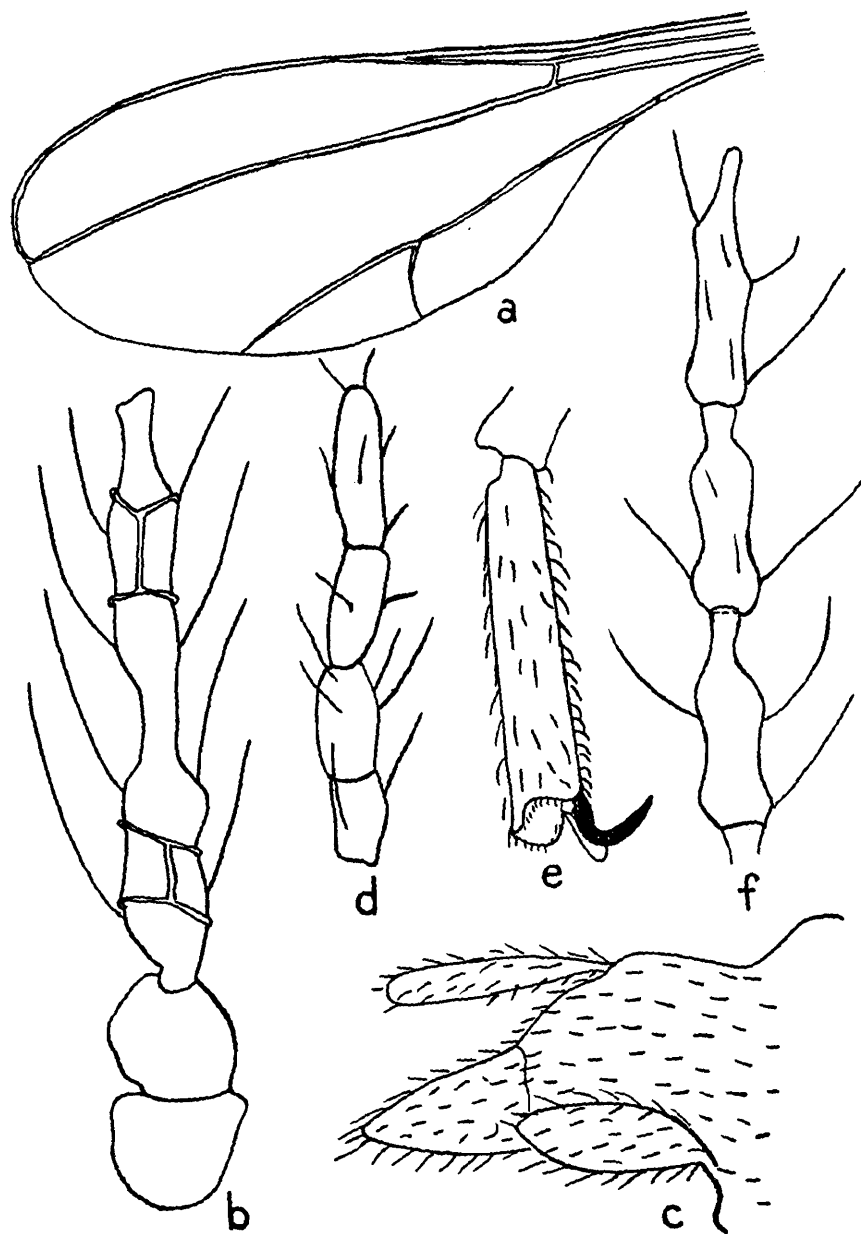
This species differs from the only known species, *B. dubia* Kieffer¹, in the length of the second palpal segment being two and a half times its own thickness and less than the length of the other two segments combined, in the flagellate segments being cylindrical and with short

¹Kieffer, J. J., *Berl. ent. Z.*, Berlin, **41**, p. 8 (1896).

stems, in the slightly exserted ovipositor and in the claw being longer than the empodium.

6. *Liebeliola dehradunensis*, sp. nov.

♀ Length 4.0 mm. Body brown. Antenna light brown, longer than body, with fourteen segments, flagellate segments nearly cylindrical, gradually becoming narrowed towards the apex, slightly constricted in the middle, with long stems and with two whorls of long setae and two whorls of closely attached circumfila; first segment (Text-fig. 5b),



TEXT-FIG. 5.—*Liebeliola dehradunensis*, sp. nov.

(a). Wing. (b). First four antennal segments. (c). Ovipositor. (d). Palpi. (e). Claw. (f). Terminal three antennal segments.

short, slightly wider at apex than at base, width at apex a little over its own length; second segment (Text-fig. 5b) as long as first, broadest in middle, length equal to the maximum width; third segment (Text-fig. 5b) cylindrical, very slightly longer than and confluent with fourth segment, much longer than the first two segments combined, enlargement slightly constricted in middle, nearly twice as long as thick, with a stem twice as long as its own thickness and measuring nearly one-third the

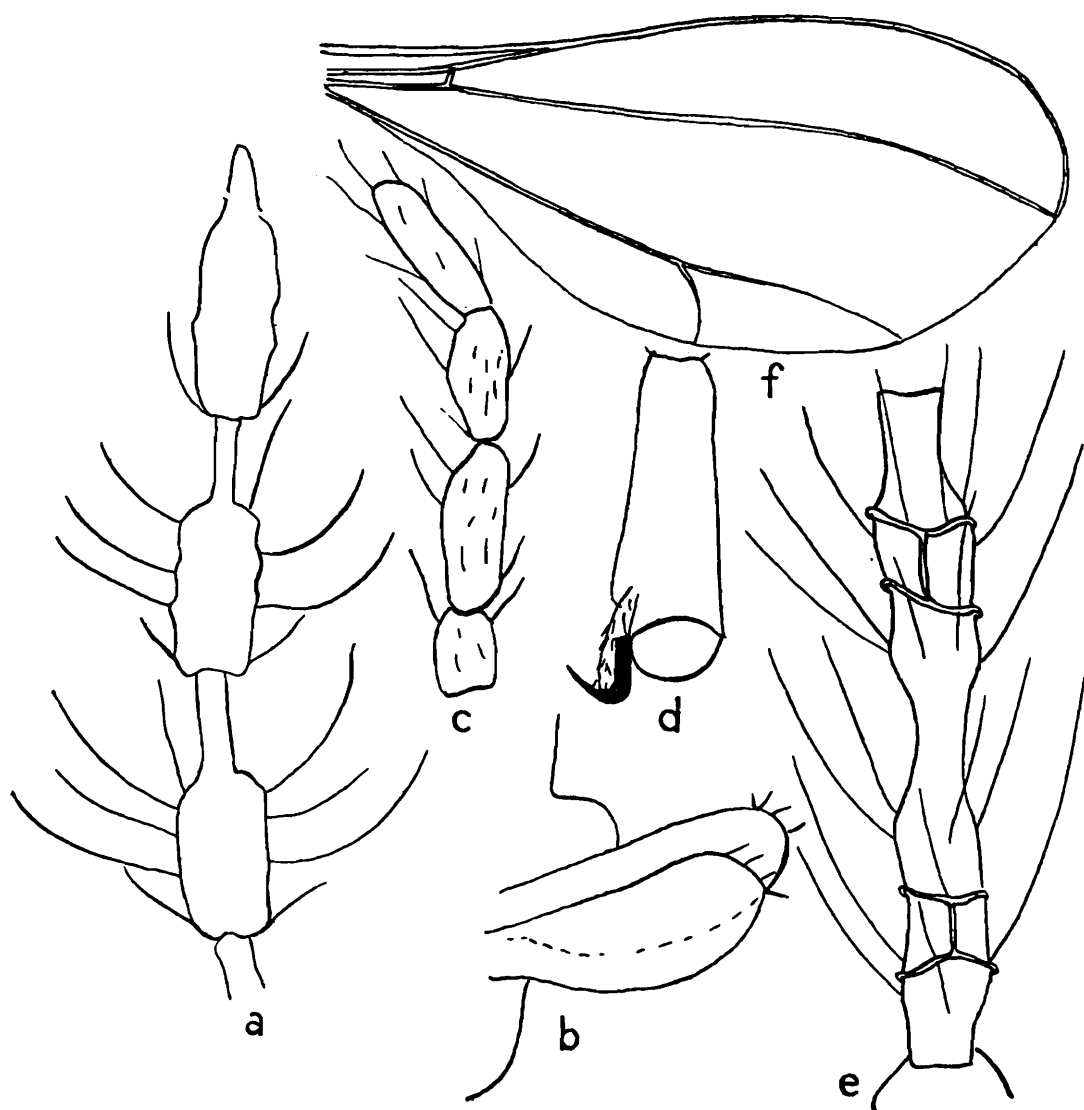
length of enlargement ; fourth segment (Text-fig. 5b) similar in all essential details to the third segment but very slightly slenderer than the latter ; sixth segment shorter than the fourth, enlargement very slightly constricted in middle, twice as long as thick, with a stem a little over half the length of the enlargement and two and a half times its own thickness ; eighth segment slightly slender but as long as the sixth, enlargement very slightly constricted in middle, two and one-fourth times as long as broad, stem a little longer than half the length of enlargement and nearly thrice as long as thick ; penultimate segment (Text-fig. 5f) much shorter and slenderer than eighth segment, length of enlargement a little less than thrice its own thickness, stem one-third the length of the enlargement and thrice as long as thick ; terminal segment (Text-fig. 5f) longer than the penultimate, enlargement slender but longer than that of the penultimate, four times as long as thick, with an apical knob of one-fourth the length of enlargement and thrice its own thickness. Palpi (Text-fig. 5d) quadri-articulate, long, moderately hairy, pale brown, first segment nearly cylindrical, length one and two-thirds the width in the middle, second segment widest at the apical three-fourths, length one and one-sixth the length of the first and a little less than the maximum width, third segment longer than second, wider at apex than at base, length two and one-third the maximum width, terminal segment longest of all the segments, cylindrical, length three and a half times the maximum width. Mesonotum dark brown, scutellum and postscutellum brown. Abdomen pale brown. Halteres pale yellow. Wing (Text-fig. 5a) hyaline, nearly twice as long as broad, with three long veins, vein R_s distinct, at right angles, vein R_5 slightly curved and reaching the wing margin a little beyond the apex, vein M_4-m-Cu forked. Legs pale yellow, long, thickly hairy, metatarsus nearly one-sixth the length of the second tarsal segment and also slightly shorter than the terminal tarsal segment, second tarsal segment longer than the rest of the segments combined. Claw (Text-fig. 5e) slender, simple, dark brown, bent at right angles ; empodium nearly half the length of the claw. Ovipositor (Text-fig. 5c) slightly exserted, dorsal lamellae elliptic, small.

Holotype : 1 ♀ on slide labelled "On wing, Officer's Rest House, S. N. Rao Coll., Dehra Dun, 7-7-1950"

7. *Liebeliola diurni*, sp. nov.

♀ Length 4.5 mm. Body brown. Antenna light brown, nearly equal to the length of the body, with fourteen segments, flagellate segments cylindrical, distal segments gradually becoming narrowed, enlargements slightly constricted in the middle, with long stems and two whorls of setae and two whorls of circumfila ; first and second segments not visible in the preparation, third segment (Text-fig. 6e) cylindrical, longer than but confluent with the fourth segment, enlargement very slightly constricted in the middle, thrice as long as thick, with the stem a little over twice as long as thick and one-third the length of the enlargement ; fourth segment (Text-fig. 6e) shorter than the third segment, enlargement a little over twice as long as thick, stem a little less than half the length of the enlargement and nearly twice as long as thick ; sixth segment shorter

than the fourth, enlargement very slightly constricted in the middle, length a little less than twice the thickness, stem two-thirds the length of the enlargement and nearly thrice as long as thick; eighth segment similar in all essential details to the sixth; penultimate segment (Text-fig. 6a) shorter than the eighth segment, length of enlargement a little over twice its own thickness, stem nearly four times as long as thick and half the length of the enlargement; terminal segment (Text-fig. 6a) longer than the penultimate segment, enlargement thrice as long as thick, with an apical knob measuring two-sevenths the length of the enlargement and two and a half times as long as thick. Trophi not very prominent. Palpi (Text-fig. 6c) pale yellow, quadriarticulate, long, moderately



TEXT-FIG. 6.—*Liebeliola diurni*, sp. nov.

(a). Terminal three antennal segments. (b). Ovipositor. (c). Palpi. (d). Claw. (e). Third and fourth antennal segments. (f). Wing.

setose, first segment nearly cylindrical, length one and one-fourth the thickness, second segment twice as long as the first, cylindrical, two and a half times as long as thick, third segment shorter than the second, widest at the apical three-fourths, length two and a half times the thickness, terminal segment longest of all, nearly cylindrical, length three and one-fourth times the thickness. Mesonotum brown. Scutellum brown. Abdomen yellowish-black. Wing (Text-fig. 6f) hyaline, length twice the breadth, with three long veins, vein *Rs* distinctly at an angle, vein

R_5 slightly curved and reaching the margin of wing beyond its apex, vein M_4-m-Cu forked. Legs yellowish-brown, thickly hairy, metatarsus one-sixth the second tarsal segment and nearly equal to the terminal tarsal segment, second tarsal segment nearly equal to the rest of the segments combined. Claw (Text-fig. 6d) simple, slender, dark brown, bent nearly at right angles, empodium half the length of the claw. Ovipositor (Text-fig. 6b) slightly exserted, small, lamellae elliptic.

Holotype : 1 ♀ on slide labelled "On wing, Zoology Laboratory, St. John's College, Agra, S. N. Rao Coll., 18-7-1950"

This species differs from *L. dehradunensis* Rao in the legs, palpi, antenna and ovipositor and its place is as shown in the following key :

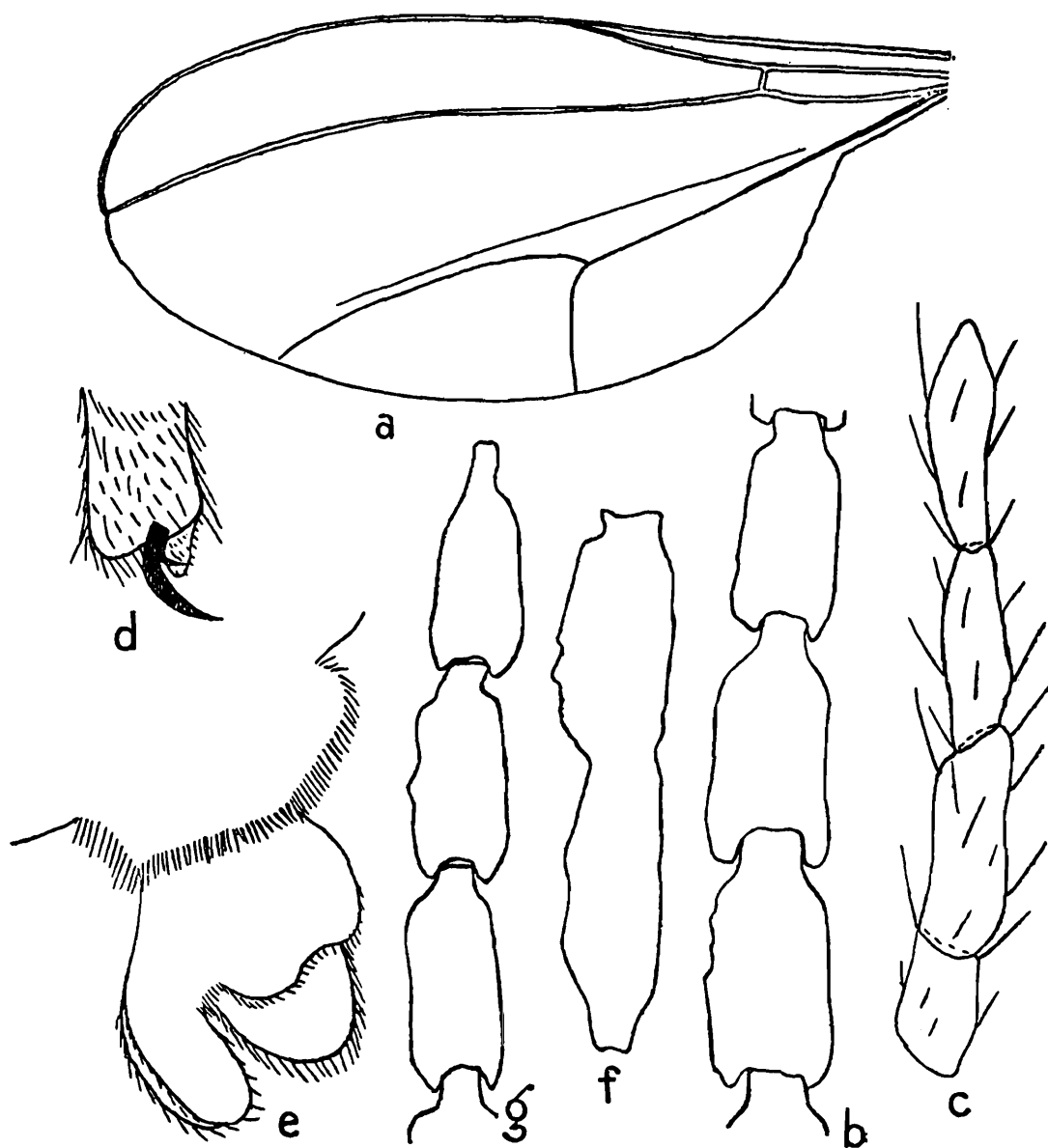
Key to species

1. Third antennal segment twice as long as the fourth and four to five times as long as thick ; stems of the antennal segments twice as long as thick *prosopidis* K. & J.
- Not as above 2
2. Second palpal segment longer than the first but shorter than the third and less than twice its own thickness. *dehradunensis*, sp. nov.
- Second palpal segment longer than both the first and third segments and two and a half times as long as thick *diurni*, sp. nov.

8. *Vanchidiplosis brevipalpi*, sp. nov.

♀ Length 0.9 mm. Body brown. Eyes confluent above. Trophi slightly produced. Antenna light-brown, half the length of the body, with fifteen segments, flagellate segments gradually becoming reduced and cylindrical, with two whorls of closely attached circumfila and scattered setae with very short apical stems; first and second segments not visible in the preparation ; third segment (Text-fig. 7f) confluent with the fourth, appearing as one single segment but for a slight constriction in the middle, with a very short stem at base, enlargement slightly narrower than that of the fourth segment, length of enlargement a little over two and a half times its own thickness ; fourth segment (Text-fig. 7f) little shorter than the third, with a very short neck, length of enlargement two and one-third times its own thickness ; eighth segment (Text-fig. 7b) with a small apical stem, enlargement nearly twice as long as thick, stem very short, one-seventh the length of the segment and length nearly one-fourth the thickness of the enlargement and three-fifths its own thickness ; thirteenth segment (Text-fig. 7g) cylindrical, enlargement twice as long as thick, with a stem one-fifth the length of the enlargement, broader than long, length one-twelfth its own thickness ; penultimate segment (Text-fig. 7g) cylindrical, enlargement very slightly longer than that of the preceding segment, length very little over twice the thickness, stem shorter than that of the preceding segment, broader than long ; terminal segment (Text-fig. 7g) with a small knob of nearly one-third the length of the segment and twice as long as thick. Palpi (Text-fig. 7c) short, blackish-brown, with scanty hairs, first segment cylindrical, broadest at the apical three-fourths, length a little over one

and one-fourth times the maximum thickness ; second segment cylindrical, very slightly shorter than twice the length of the first and also a little less than thrice its own thickness ; third segment cylindrical, ends tapering, very slightly shorter than the second, length thrice its own thickness ; fourth segment cylindrical, ends tapering, longest of all, length four and a half times its own thickness. Mesonotum blackish-brown, scutellum and postscutellum brown. Halteres pale brown. Abdomen brown. Wing (Text-fig. 7a) hyaline, length nearly two and three-eighth the width, with four long veins, costa interrupted at its union with vein R_5 , vein R_s



TEXT-FIG. 7.—*Vanchidiplosis brexipalpi*, sp. nov

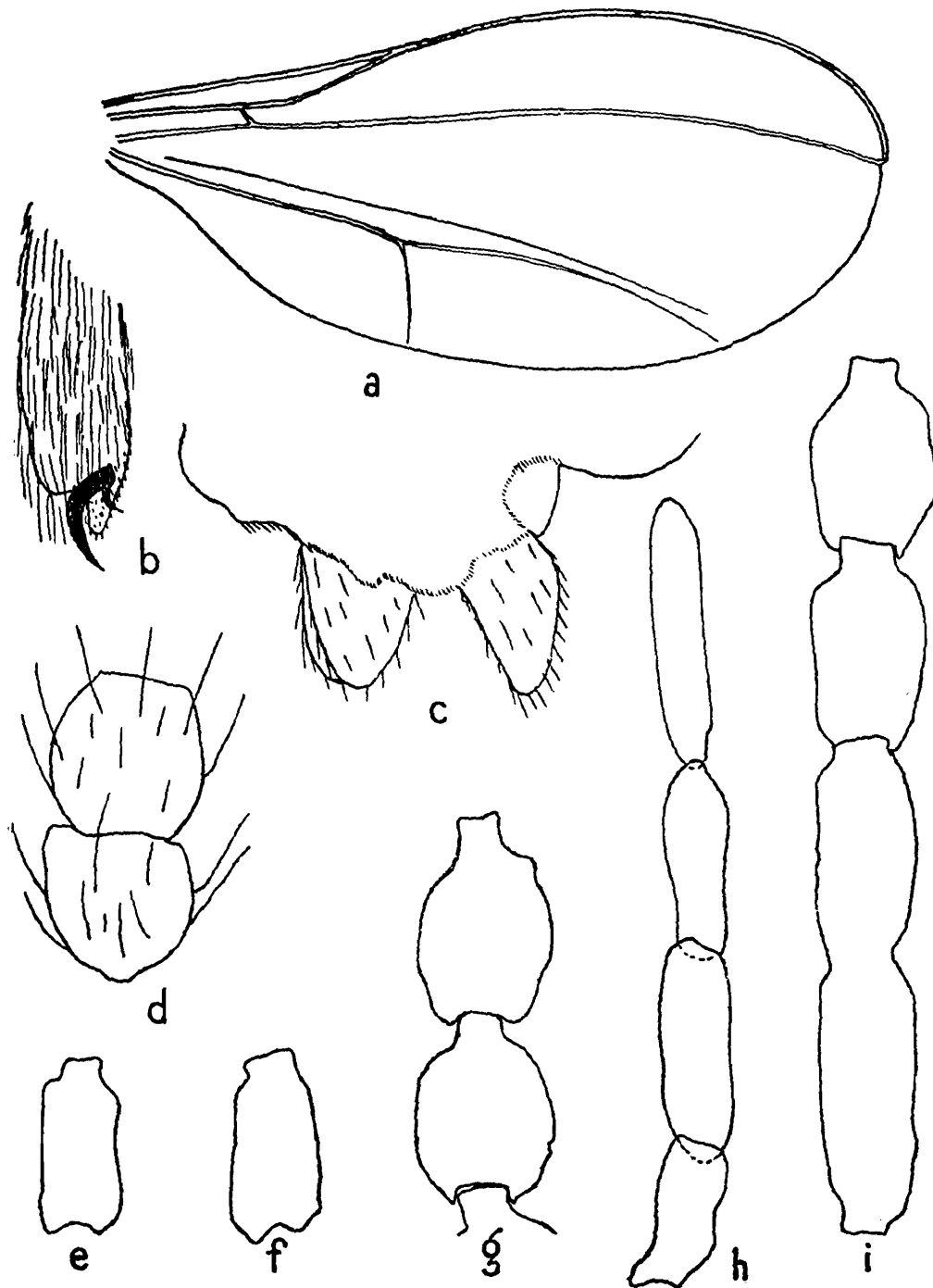
(a). Wing. (b). Sixth, seventh and eighth antennal segments. (c). Palpi. (d). Claw. (e). Ovipositor. (f). Third and fourth antennal segments. (g). Thirteenth, fourteenth and fifteenth antennal segments.

distinctly at right angles, vein R_5 reaching the margin of wing well beyond the apex, vein M obsolete both apically and distally, vein M_4-m-Cu forked. Legs long, hairy, brown, metatarsus shorter than the terminal tarsal segment. Claw (Text-fig. 7d) dark brown, bifid basally, evenly curved, empodium a little less than half the length of claw. Ovipositor (Text-fig. 7e) slightly exserted with elongate oval lobes.

Holotype : 1 ♀ dissected and mounted on slide labelled "On wing, at light, Aizaz Manzil, Agra, S. N. Rao Coll., 29-9-1950"

9. *Vanchidiplosis longipalpi*, sp. nov.

♀ Length 1.1 mm. Body yellowish-brown. Eyes confluent above. Trophi very slightly produced. Antenna light brown, a little less than half the length of body, with fifteen segments, flagellate segments gradually becoming reduced, cylindrical, (some segments are nearly globose),



TEXT-FIG. 8.—*Vanchidiplosis longipalpi*, sp. nov.

(a). Wing. (b). Claw. (c). Ovipositor. (d). First two antennal segments. (e). Twelfth antennal segment. (f). Ninth antennal segment. (g). Seventh and eighth antennal segments. (h). Palpi. (i). Third, fourth, fifth and sixth antennal segments.

with two whorls of closely attached circumfila and with hairs irregularly placed in two whorls, with very short apical stems, first and second segments as in Text-figure 8d; third segment (Text-fig. 8i) confluent with fourth, with a very small stem at base, slightly longer than fourth segment, enlargement two and a half times as long as thick; fourth segment

shorter than the third, appearing as though it is only one single segment with a small constriction in the middle, enlargement two and three-fifths as long as thick, length of stem two-thirds its own thickness; seventh segment as in Text-figure 8g; eighth segment (Text-fig. 8g) nearly globose, enlargement two and one-fourth times as long as thick, with a stem one-sixth the length of the enlargement and one-third its own thickness; ninth segment as in Text-figure 8f; twelfth segment as in Text-figure 8e; thirteenth segment partly shrunk, nearly globose, enlargement twice as long as thick, with a stem one-tenth the length of the enlargement and half as long as thick; penultimate segment partly shrunk, nearly globose, enlargement thrice as long as thick, with a stem which is broader than long; terminal segment as long as the penultimate, with a knob of two-fifths the enlargement, and four times as long as thick. Palpi (Text-fig. 8h) long, brown, quadriarticulate, with scattered hairs, first segment shortest of all, nearly cylindrical, length one and two-fifths the maximum thickness, at the apical three-fourths; second segment cylindrical, a little less than twice the length of the first and nearly thrice as long as thick; third segment nearly as long as the second, slender, nearly cylindrical, with the ends tapering, length four times the maximum thickness at the apical third; fourth segment longest of all, length nearly five times its own thickness. Mesonotum brown, scutellum and postscutellum lighter. Halteres pale yellow. Abdomen yellow. Wing (Text-fig. 8a) hyaline, two and three-eighths as long as broad, with four long veins and the veins moderately scaled, costa interrupted at its union with vein R_5 , vein R_s distinct and nearly at right angles to vein R_1 , vein R_5 slightly curved and reaching the wing margin well beyond the apex, vein M obsolete at the ends, vein M_4-m-Cu forked. Legs long, hairy, yellowish-brown, metatarsus three-fourths the terminal tarsal segment. Claw (Text-fig. 8b) brown, evenly curved, bifid basally, empodium half the length of the claw. Ovipositor (Text-fig. 8c) slightly exerted with broadly oval lobes.

Holotype: 1 ♀ dissected and mounted on slide labelled "At light, Hewett Park, M. S. Mani Coll., Agra, August 1947"

This species is distinguished from *V brevipalpi* Rao in the differences in the antennal segments, the antenna measuring less than half the length of the body, the third antennal segment being longer than the fourth, the second and third palpal segments being equal in length, and in the claw being twice the empodium. Its relationship with other species is shown in the following key:

Key to species

1. Terminal palpal segment spatulate, longer than the third; empodium nearly equal to claw; lobes of ovipositor oval vanchi Nayar
- Terminal palpal segment cylindrical; empodium half or one-fourth the length of claw 2
2. Terminal palpal segment nearly equal to the third; empodium half the length of claw; lobes of ovipositor triangular agraensis Rao

Terminal palpal segment longer than the third ; lobes
of ovipositor oval

3

3. Antenna half the length of body ; third and fourth
antennal segments equal ; second palpal segment
shorter than the fourth ; empodium less than half
the length of claw

brevipalpi, sp. nov.

Antenna less than half the length of body ; third
antennal segment longer than the fourth ; emp-
odium half the length of claw

longipalpi, sp. nov.

III—SUMMARY

The paper contains descriptions of nine new species of gall midges from India, namely, *Johnsonomyia indica*, *Haplusia elliptica*, *Neohaplusia inaequipalpis*, *Lasioptera orientalis*, *Bryocrypta deepica*, *Liebeliola dehradunensis*, *L. diurni*, *Vanchidiplosis brevipalpi* and *V. longipalpi*. It also contains keys to the known Indian species of the genera *Haplusia*, *Neohaplusia*, *Lasioptera*, *Bryocrypta*, *Liebeliola* and *Vanchidiplosis*.

STUDIES ON THE FAMILY CYATHOCOTYLIDAE POCHE.
PART 3. SUBFAMILY MUHLINGININAE MEHRA, 1950, WITH
DESCRIPTION OF *MUHLINGINA LUTRAI* MEHRA, 1950

By

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(With 1 Table and 6 Text-figures)

CONTENTS

	PAGE
I—Introduction	195
II—Morphology of <i>Muhlingina lutrai</i> Mehra	196
III—Systematic Position and Phylogeny of Genus <i>Muhlingina</i> Mehra	205
IV—Summary	207
V—References	298

I—INTRODUCTION

In 1950 (Mehra, 1950) I created the genus *Muhlingina*, with *Muhlingina lutrai* sp. nov. as the generic type for a number of specimens collected from the intestine of the common Indian otter, *Lutra vulgaris*, in June, 1913, and placed at my disposal by the Zoological Survey of India in 1948 for description. A full account of the species was, however, delayed till now.

The genus *Muhlingina* is remarkable in having a small anterior part of the body modified into the form of a beaker surrounding a cavity of the ventral surface around the characteristic sucker-like anterior part of the holdfast organ opening to the exterior by an anteriorly directed ventral funnel-shaped opening, whereas the much larger hind-body has remained a solid, compact part with the narrow chink-like cavity of the glandular parenchymatous holdfast organ penetrating through it almost to a little in front of the hinder end.

In the family Cyathocotylidae is included another remarkable genus, *Braunina* Heider, 1900, for which Wolf (1903) created the subfamily Brauniniinae and for which Bosma (1931) created the family Brauninidae, in which cup-shaped fore-body is of much larger size and is also formed by a great development and subsequent fusion of the margins of the ventral folds surrounding the deep ventral concavity with the anteriorly directed opening and enormously developed, ventrally projecting holdfast organ in it. The hind-body in *Braunina* is reduced to a short terminal cylindrical or truncated appendix. The holdfast organ in this genus is altogether of a different shape and structure from that of *Mu-*

hlingina. It is solid, massive, without a cavity and protrudes as a large heart-shaped structure in the cavity of the fore-body which is consequently narrowed. The two genera, namely, *Muhlingina* and *Braunina*, though they have a cup-shaped fore-body, thus differ much in the shape of the entire body, size and shape of the fore-body and the hind-body and in the structure of the holdfast organ. It is obvious that their common resemblance in having a cup-shaped fore-body has been brought about by convergent evolution along two different lines of ancestry possibly on account of similar habitat in aquatic mammalian hosts for effective attachment and functioning of the secretions of the glandular holdfast organ. A fundamental similarity in the totality of their organisation, all the same, signifies their close relationship as being members of the same family Cyathocotylidae.

II—MORPHOLOGY OF *Muhlingina lutrai* MEHRA

Muhlingina lutrai Mehra, 1950

Host : *Lutra vulgaris* (the common otter, Indian race).

Location : Intestines.

Locality : ?

Donor : Zoological Gardens, Calcutta.

Zoological Survey of India Registered No. ZEV 5970/7.

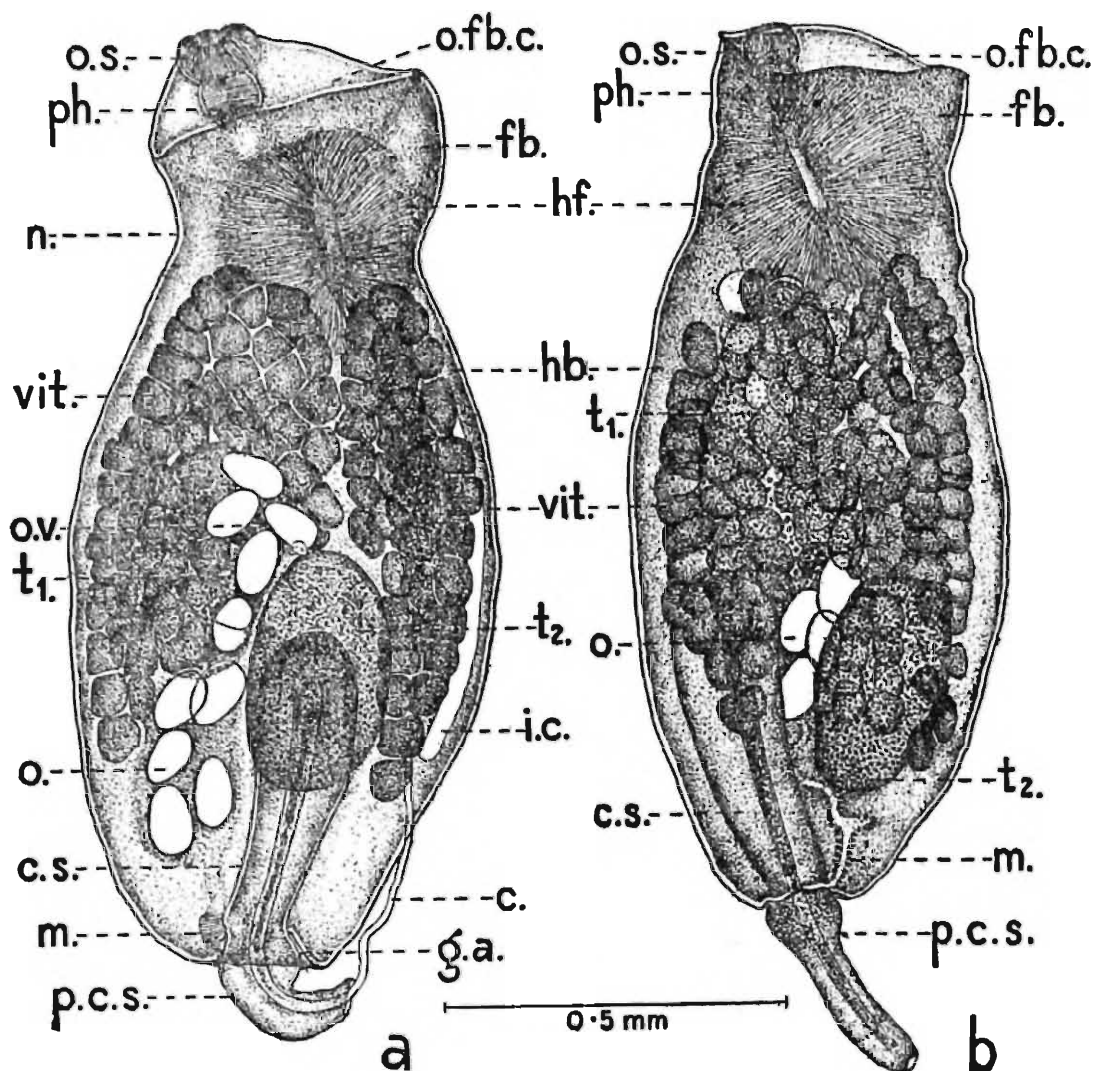
Number of specimens : Reported many, about 2 dozen.

A large number of specimens, about two dozen, were collected from the intestines of the common Indian otter *Lutra vulgaris* in June, 1913, which had died in the Zoological Gardens, Calcutta. A preliminary account of these specimens was given by me in 1950.

Muhlingina lutrai is a small cyathocotylid measuring 1.13-1.57 mm. in length and 0.51-0.72 mm. in maximum breadth, which lies a little behind the middle, with an average measurement of 1.36 by 0.58 mm. with broad anterior and narrow posterior ends of 0.144-0.399 and 0.136-0.187 mm. breadth. The body is somewhat vase-shaped, wide-mouthed, bottle-shaped or jar-shaped, with a more or less distinct neck region (Text-figs. 1-3) dividing it into a small cup or beaker-shaped anterior region or fore-body of 0.28-0.47 mm. length (average 0.37) and 0.32-0.476 mm. breadth, and a large posterior compact region, the hind-body of 0.86-1.156 mm. length (average 0.99). The neck region of 0.32-0.416 mm. breadth is separated usually from the hind-body by a constriction. The fore-body has a large cavity with a broad funnel-shaped opening of 0.187-0.27 mm. breadth situated ventrally a little behind the dorsally projecting anterior end containing the oral sucker and pharynx.

The almost spherical cup-shaped holdfast organ, with a fairly wide cavity, situated on the ventral surface of the fore-body opens into the cavity of the latter by a fairly large opening. The holdfast organ is enormously developed, extending almost in the entire hind-body except the posterior end. Its cavity in the hind-body is mostly reduced to a narrow chink or slit, while in the fore-body, where it opens to the exterior

into the form of a fairly large outer suctorial cup-like structure with a wide cavity having disc-shaped margin usually projecting in the form of two eversible flaps or lobes (Text-figs. 1, 2, 4 & 5), it lies on the ventral surface enclosed in the cavity of the fore-body formed by extensions of the ventral margins of the bodywall and their subsequent fusion around the ventral concavity of the ancestor. Its sucker-like part opening in the fore-body measures 0.27-0.3 mm. in diameter (Table 1). Its secretion formed and accumulated in the large glandular parenchymatous vacuoles

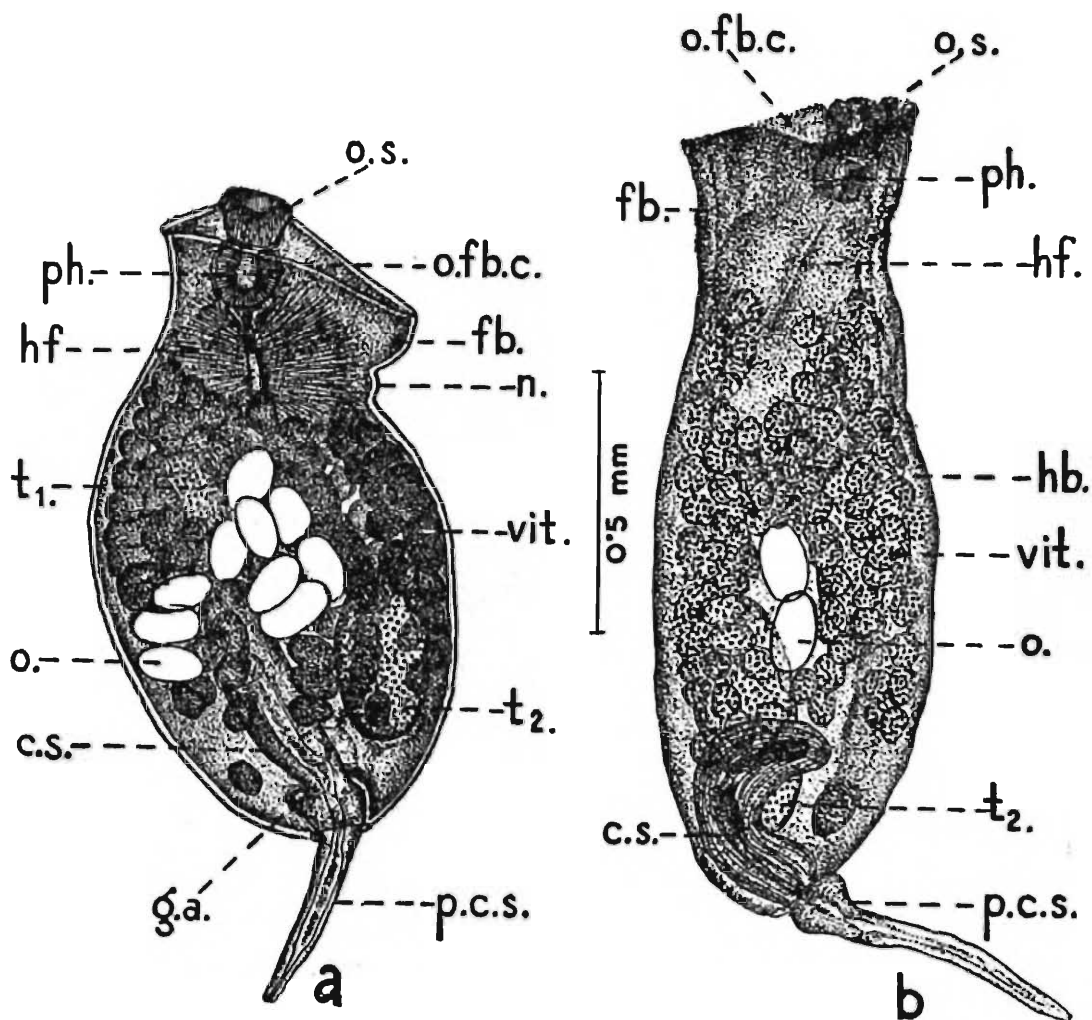


TEXT-FIG. 1.—*Muhlingina lutrai* Mehra. (a) and (b). Ventral views.

c., cirrus; c.s., cirrus sac; fb., fore-body; g.a., genital atrium; hb., hind-body; hf., holdfast organ; i.c., intestinal caecum; m., metraterm; n., neck region; o., ovum; o. fb. c., opening of fore-body cavity; o.s., oral sucker; ov., ovary; p. c. s., protrusible part of cirrus sac; ph., pharynx; t₁, anterior testis; t₂, posterior testis; vit., vitelline follicles.

flows into the cavity of the holdfast organ, and from there it is finally discharged through the sucker-shaped outlet into the cavity of the fore-body. The fibrous walls of concentrically arranged fibres around the sucker-shaped part are mostly parenchymatous, simulating muscular appearance. A thin cuticle lines the cavity of the holdfast organ. It is in continuation of the cuticle lining the cavity of the fore-body and the bodywall outside. It is the parenchymatous fibrous wall formed as the result of aggregation and concentration of concentrically arranged fibres separating the large vacuoles of the glandular parenchyma outside

the thin longitudinal layer and cuticle lining the cavity of the holdfast organ that forms the wall of the suckorial cup of the latter on the ventral surface of the fore-body. This fibrillar parenchymatous wall in and near the disc-shaped margin surrounding the opening gives the appearance of a musculature, and is produced into two folds, one dorsal and the other ventral, the former being anterior. The ventral fold is larger and may be subdivided into two small lobes. The opening of the holdfast organ surrounded by these flaps, which form the disc-shaped margin of the cup, is funnel-shaped, measuring 0.0093-0.013 mm. in diameter, and gradually narrows posteriorly till it becomes a narrow chink-like canal



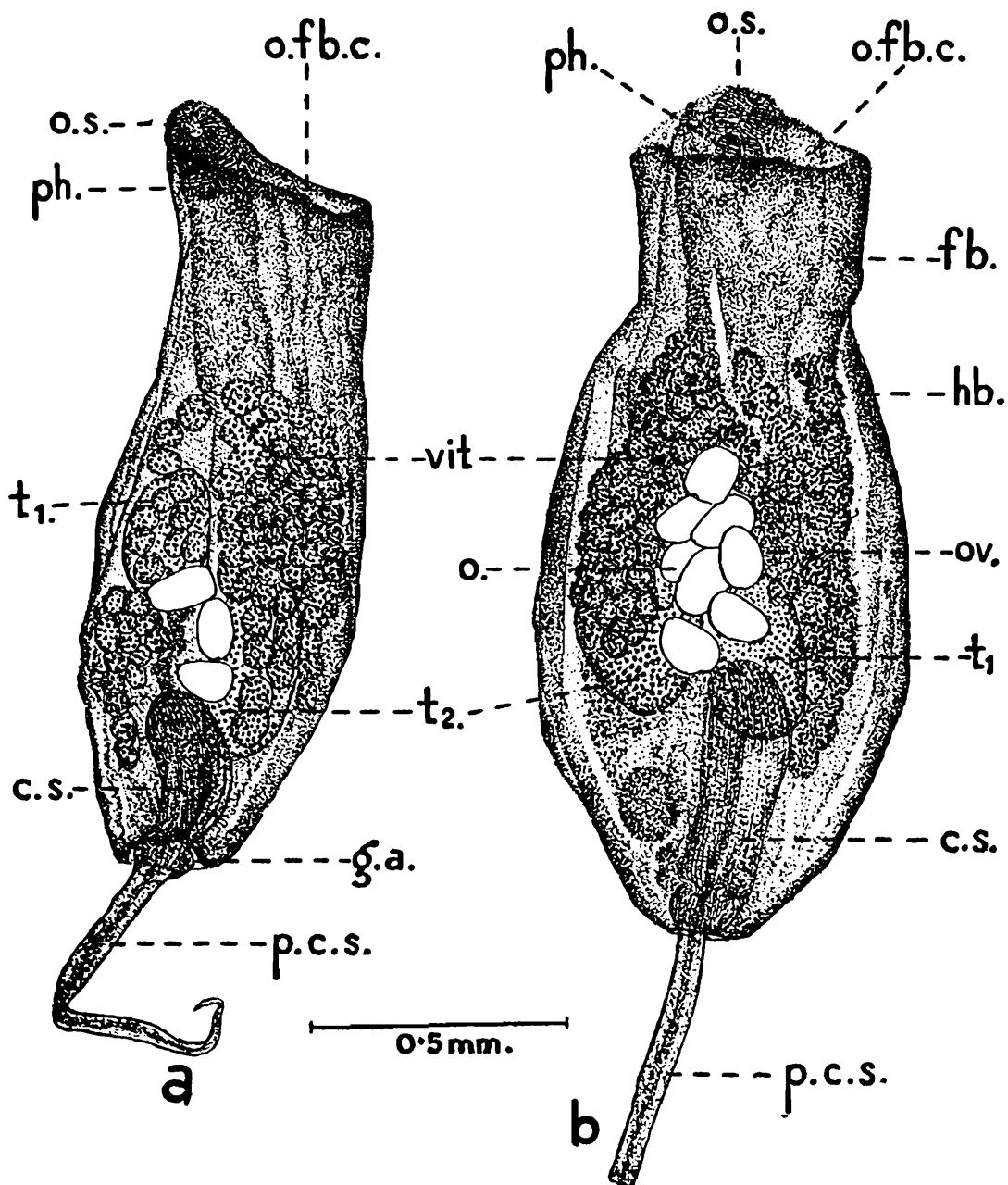
TEXT-FIG. 2.—*Muhlingina lutrai* Mehra. (a). Ventral view. (b). Dorsal view. c.s., cirrus sac; fb., fore-body; g.a., genital atrium; hb., hind-body; hf., holdfast organ; n., neck region; o., ovum; o.fb.c., opening of fore-body cavity; o.s., oral sucker; p.c.s., protrusible part of cirrus sac; ph., pharynx; t_1 , anterior testis; t_2 , posterior testis; vit., vitelline follicles.

of 0.0056-0.0037 mm. diameter running through the length of the hind-body much nearer the ventral surface in its middle and posterior part, with the uterus and gonads lying above it. In the anterior part of the hind-body behind the intestinal bifurcation it lies more dorsally.

The holdfast or adhesive organ thus conforms to the description given by me in the diagnosis of the family Cyathocotylidae in 1947. It is "simple in structure, mostly glandular and parenchymatous, and slightly muscular with a central cavity".

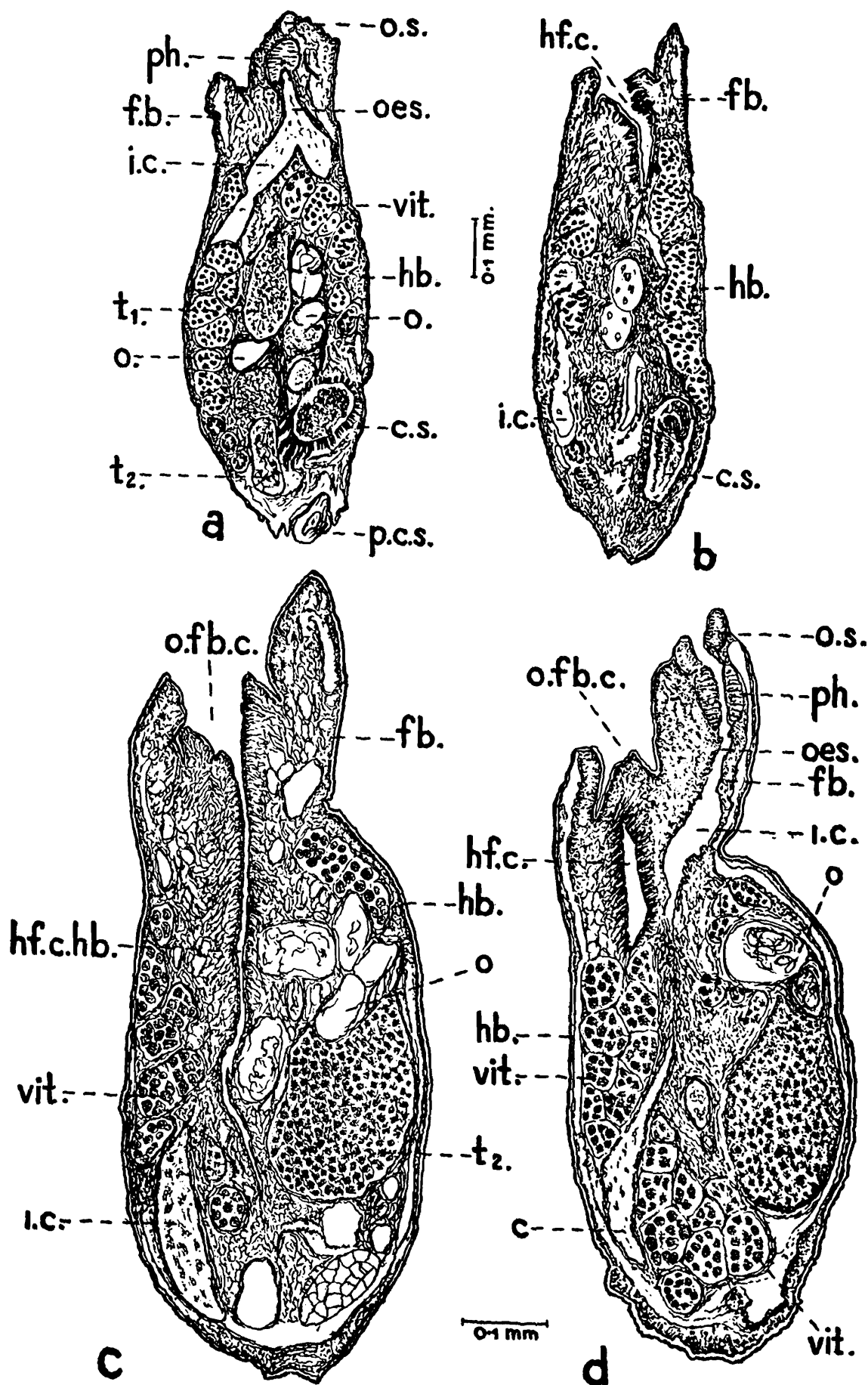
The thin body wall is without spines, and covered with a thin cuticle. The ventral sucker is absent.

The oral sucker and pharynx are well developed. They lie at the anterior end of the dorsally projecting anterior part of the body in front of the ventrally situated opening of the cavity of the fore-body. The oral sucker with its opening is terminal, measuring 0.093×0.093 – 0.17 mm. in size. A short prepharynx though not visible in entire mounts is present. The spherical pharynx has thick muscular walls and is almost equal to the oral sucker, measuring 0.09 – 0.115 mm. in diameter. Its lumen, 0.02 mm. in diameter, is a little broader in the less muscular



TEXT-FIG. 3.—*Muhlingina lutrai* Mehra. (a). Lateral view. (b). Dorsal view. c.s., cirrus sac; fb., fore-body; g.a., genital atrium; hb., hind-body; o., ovum; o.fb.c., opening of fore-body cavity; o.s., oral sucker; ov., ovary; p. c. s., protrusible part of cirrus sac; ph., pharynx; t₁, anterior testis; t₂, posterior testis; vit., vitelline follicles.

posterior one-fourth part, whereas anteriorly it is narrower, measuring 0.0075 mm. in diameter. A short oesophagus of 0.084 mm. length, usually not seen in entire mounts, is present. It gradually increases in breadth towards the intestinal bifurcation, measuring 0.0476 mm. near the latter and 0.02 mm. near the pharynx in breadth. The intestinal bifurcation is 0.112 mm. broad. The intestinal caeca, which are

TEXT-FIG. 4.—*Muhlingina lutrai* Mehra.

(a) and (b). Horizontal-longitudinal sections. (c) and (d). Horizontal-longitudinal sections of another specimen.

c., cirrus; c.s., cirrus sac; fb., fore-body; hb., hind-body; hf.c., holdfast organ cavity in fore-body; hf.c.hb., holdfast organ cavity in hind-body; i.c., intestinal caecum; o., ovum; o.f.b.c., opening of fore-body cavity; o.s., oral sucker; oes., oesophagus; p.c.s., protrusible part of cirrus sac; ph., pharynx; t₁, anterior testis; t₂, posterior testis; vit., vitelline follicles.

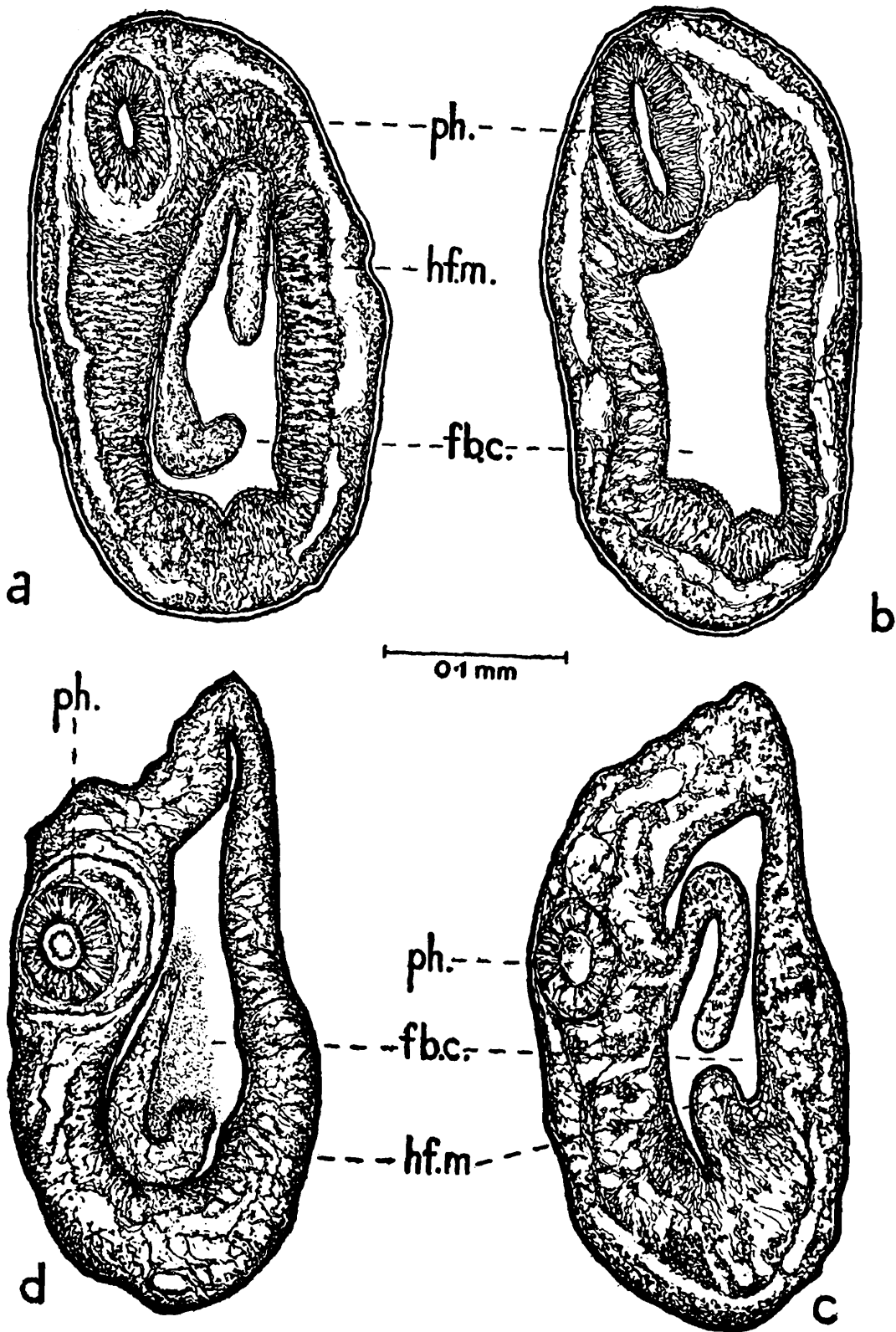
broader near the intestinal bifurcation, terminate a little distance in front of the hinder end of the body at about the level of the posterior end of the posterior testis.

TABLE 1.—*Dimensions in mm. of specimens of Muhlingina lutrai Mehra.*

Specimen	Length of body	Length of fore-body	Length of hind-body	Breadth near ant. end	Maximum breadth of body just behind middle	Breadth in neck region
(1)	1.19	0.29	0.9	0.144	0.55	0.32
(2)	1.23	0.297	0.935	0.39	0.578	0.357
(3)	1.4	0.467	0.935	0.399	0.51	Neck indistinct. 0.357
(4)	1.58	0.425	1.156	0.416	0.7225	0.416
(5)	1.53	0.3825	1.1475	0.399	0.535	0.357
(6)	1.57	0.442	1.1305	0.255	0.578	0.382
(7)	1.317	0.382	0.935	Anterior part with o. s. and pharynx separated.	0.535	0.38
(8)	1.394	0.34	1.054	0.34	0.569	0.38
(9)	1.13	0.28	0.85	0.33	0.595	0.323
(10)	1.28	0.425	0.857	0.39	0.646	0.38

Specimen	Max. Breadth of fore-body	Breadth of opening of fore-body cavity	Breadth at hinder end	Size of oral sucker	Size of pharynx	Approximate diameter of holdfast organ
(1)	0.32	0.289	0.144	0.065 × 0.1028	0.09 × 0.09	0.27
(2)	0.4	0.26	0.1589	0.0748 × 0.1028	0.0935 × 0.097	0.28
(3)	0.38	0.255	0.187	0.066 × 0.1028	0.1028 × 0.1028	0.272
(4)	0.476	0.255	0.1496	0.0748 × 0.0748	0.0935 × 0.0935	0.297
(5)	0.3825	0.2125	0.136	0.093 × 0.17	0.1 × 0.1	0.2975
(6)	0.425	0.215	0.144	0.084 × 0.13	0.0935 × 0.0935	0.2975
(7)	0.425	0.215	0.17	0.0673 × 0.0935	0.112 × 0.099	0.29
(8)	0.391	0.255	0.175	0.0748 × 0.0935	0.1028 × 0.1028	0.297
(9)	0.33	0.187	0.17	0.065 × 0.075	0.11 × 0.11	0.299
(10)	0.467	0.27	0.144	0.076 × 0.102	0.11 × 0.11	0.297

All the genital organs lie in the hind-body. The two testes are obliquely situated closely in front of one another, the posterior part of anterior testis being opposite and overlapping the anterior part of



TEXT-FIG. 5.—*Muhlingina lutrai* Mehra.

(a) and (b). Transverse sections of forebody, showing fore-body cavity and suckler-like margin of the opening of holdfast organ. (c) and (d). Transverse sections of fore-body of another specimen, showing fore-body cavity and suckler-like margin of the opening of holdfast organ.

fb.c., fore-body cavity; hf.m., holdfast organ margin; ph., pharynx.

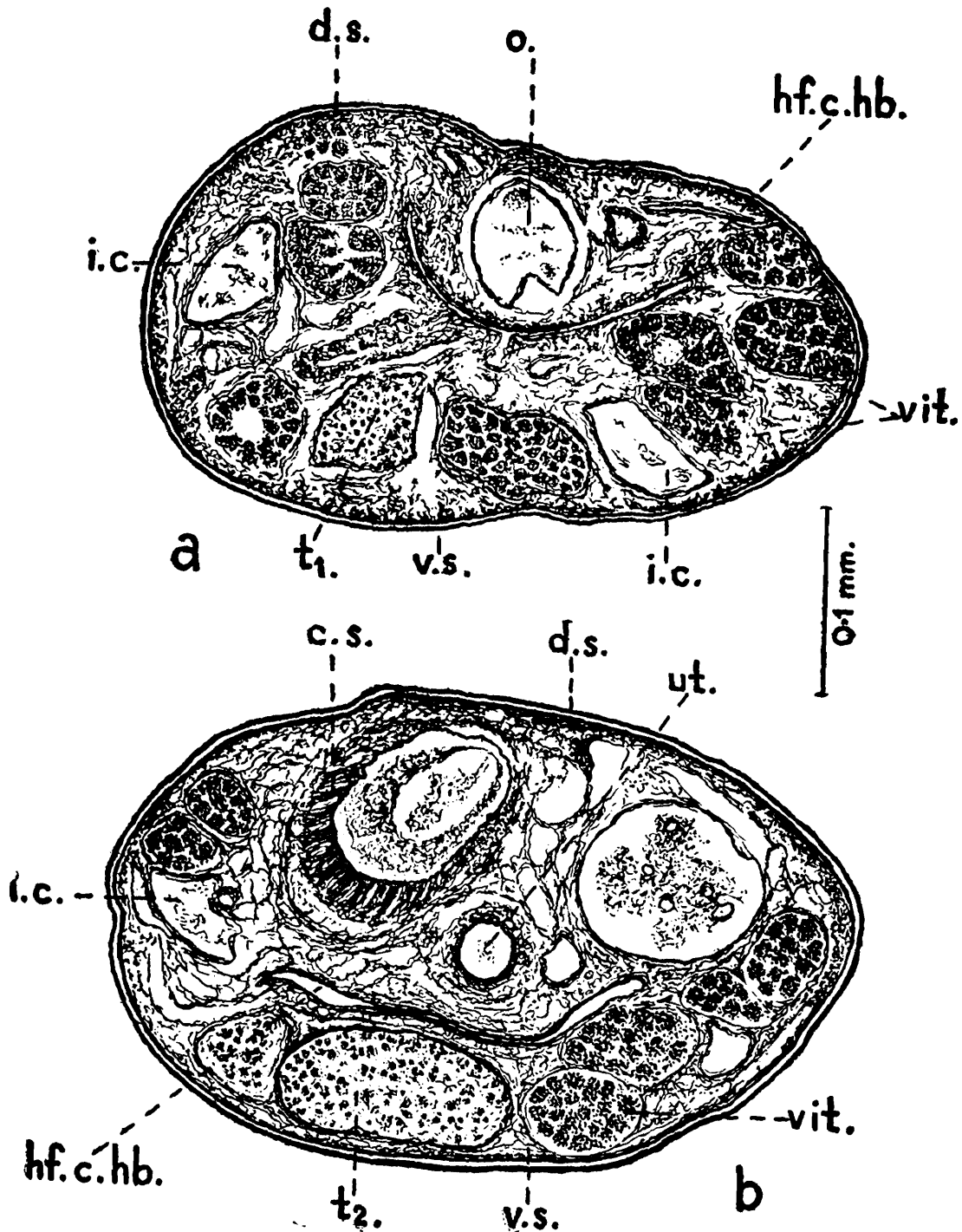
posterior testis. They are oval or somewhat spherical and entire. The anterior testis lies in the anterior part of the hind-body just behind the neck region, a little behind the intestinal bifurcation, about 0.137 mm.

distance behind it, mostly covered by vitelline follicles and ova, closely in front of and in the same line with the posteriorly situated cirrus sac, sometimes overlapping dorsally its basal part, measuring $0.187-0.34 \times 0.21$ mm. in size. It covers the ovary ventrally in its anterior part and extends posteriorly into the region of the posterior testis and basal part of the cirrus sac. The posterior testis lies in the posterior part of the hind-body a little in front of the hinder end, 0.17 mm. distance in front of it opposite to the cirrus sac, covered dorsally in its anterior half by the dorsally situated basal or proximal part of the latter. It is larger than the anterior testis and measures $0.255-0.31 \times 0.12-0.187$ mm. in size. The cirrus sac is large with thick muscular walls composed of an outer prominent thick layer of longitudinal muscle fibres and an inner thin layer of circular muscle fibres. It lies dorsally, usually obliquely, with its basal end approaching the dorsal surface closely behind or overlapping the posterior end of anterior testis and the terminal end median and ventral. It sometimes occupies almost a median position throughout its length, usually occupying a great part of hind-body; in a few specimens it extends as far forwards as the anterior end of the latter much in front of the middle of the entire body; in some specimens it is confined only to the posterior half of hind-body. Its size and shape vary much due to the state of its contraction. It measures $0.39-0.85$ mm. in length, with a maximum breadth of $0.127-0.168$ mm. near the basal end. It may be slightly or very deeply curved on its inner side, assuming a semilunar or rarely an almost semicircular shape. In a few specimens it is slightly concave dorsally and convex ventrally, or almost straight. The terminal or distal part of the cirrus sac which is usually found protruded out of the genital opening consists of a small proximal bulb of 0.112×0.116 mm. size and a much longer narrower tubular part of $0.22-0.3$ mm. length and 0.042 mm. breadth at its proximal end. In one specimen a long very narrow cirrus was found everted out of the narrow distal protruded part of the cirrus sac (Text-fig. 1a). In some specimens the proximal bulb of the protrusible part of the cirrus sac is not found protruded, but it lies within the genital atrium or even further inside the body. It appears that this part marks the limit for protrusion of the length of the terminal region of the cirrus sac. The vesicula seminalis filled with sperms is fairly large and lies somewhat coiled in the basal part of the cirrus sac. The long narrower pars prostatica surrounded by prostate gland cells, and the long narrow cirrus occupy the greater part of its length. A great part of the latter lies usually enclosed in the protruded part of the cirrus sac.

The ovary is almost spherical and measures $0.08-0.14$ mm. in diameter. It lies in the anterior part of the hind-body near the dorsal surface, above the anterior testis closely in front of the proximal end of the cirrus sac, with its posterior end sometimes overlapped by the latter dorsally. It was not possible to see the ovary in entire mounts as it is covered ventrally and laterally by the anterior testis, the large vitelline follicles and the uterine ova. Its correct position has been determined by study of serial transverse sections. While the testes of *Braunina* differ from those of *Muhlingina* in shape and position, in being strongly lobed and lying parallel opposite to one another, the ovary is similar in shape and lies

dorsal to the anterior testis. In *Braunina* the ovary lies dorsally to the right testis, as both the testes lie opposite to each other at the same level, in the large voluminous compact holdfast organ along with uterine convolutions, vitelline follicles and intestinal caeca.

The oviduct arises from the inner margin of the ovary at about the middle of its length. Soon after its origin it forms a short loop and continues its course forward to pass into the ootype which is surrounded by the inconspicuous shell-gland mass and lies median between the



TEXT-FIG. 6.—*Muhlingina lutrai* Mehra

(a) and (b). Transverse sections of hindbody.

c. s., cirrus sac; d. s., dorsal surface; hf. c. hb., holdfast organ cavity in hindbody; i. c., intestinal caecum; o., ovum; t_1 , anterior testis; t_2 , posterior testis; ut., uterus; vit., vitelline follicles; v. s., ventral surface.

inner margin of the ovary and that of the anterior testis at about the level of one-third length of the latter, a little above the narrow cavity of the holdfast organ. It is there joined by the rather inconspicuous

vitelline reservoir. A short narrow Laurer's canal arises from the ootype and opens to the exterior on the dorsal surface in the median line in a slight depression of the bodywall just in front of the ovary. The receptaculum seminis is absent. The uterus arising from the ootype passes a little forward and makes a loop to take a downward course. It lies dorsally in front of the middle of the posterior testis, mostly almost median in the hind-body in between the vitelline follicles which contain a few large, yellow, thick-shelled operculated ova, 1-15 in number and of $0.1234-0.1533 \times 0.0748-0.0972$ mm. size. The initial part of the uterus is filled with sperms and forms the receptaculum seminis uterinum. The metraterm is well developed and has strongly muscular walls composed of a fairly thick layer of circular muscle fibres. It lies at the hinder end of the body ventrally to the cirrus sac and dorsally to the hinder part of the posterior testis curving strongly and forming one or two coils and becoming wider near its terminal end before it opens ventrally in the genital atrium near the genital opening. The genital atrium is a large deep terminal chamber of $0.112-0.12$ mm. breadth and $0.06-0.1028$ mm. depth at the hinder end. In some specimens the proximal bulbed, protrusible part of the cirrus sac fills it completely with the distal narrow part protruding outside. The terminal genital opening measures $0.056-0.17$ mm. in diameter.

The vitellaria are composed of large vitelline follicles and are mostly situated ventrally in the hind-body. They commence a little behind the intestinal bifurcation, about 0.028 mm. distance behind it, from just behind the opening of the holdfast organ in the neck region and extend to about the level of posterior end of the posterior testis, i.e., a little distance ($0.09-0.17$ mm.) in front of the hinder end of the body. They are united mesially from their commencement and broadened in a fan-shaped manner on the ventral surface of the hind-body for a little more than half of their length to a little in front of the posterior testis, where they are separated to occupy a lateral position for about 0.3 mm. of their posterior length. The transverse vitelline ducts arise at about the middle of their length in the region of the ovary between the latter and the anterior testis, and unite in the median plane to form the vitelline reservoir.

The excretory system could not be studied in entire mounts. The study of sections, however, revealed the presence of a subcutaneous excretory capillary system underneath the bodywall and extending anteriorly to the pharynx. The minute excretory opening is situated postero-subterminally on the dorsal side a little in front of the hinder end behind the posterior testis. It leads into a short, somewhat globular or V-shaped excretory vesicle, from which a pair of main excretory canals arise, one on each side from each corner, and probably extend anteriorly as far as the pharynx.

III—SYSTEMATIC POSITION AND PHYLOGENY OF GENUS

Muhlingina MEHRA

The systematic position and relationships of *Muhlingina* Mehra with *Braunina* Heider, 1900, were discussed briefly by me in 1950. *Muhlingina* belongs, without any doubt, to the family Cyathocotylidae

Poche, 1925, according to the diagnosis of the family given by me in 1947. This genus has the body indistinctly divided into a small fore-body and a large hind-body. The fore-body has been modified into a cup-shaped or beaker-shaped form on account of the fusion of the ventral folds in the median line surrounding the deep ventral concavity around the externally opening anterior part of the holdfast organ. The somewhat funnel-shaped opening of the cavity of the fore-body lies a little behind the anterior end just behind or at about the level of the dorsally situated pharynx. The presence and structure of the large cirrus sac which extends anteriorly to the middle or even further forwards, the oblique position of the testes behind and near one another, the vitellaria composed of large follicles situated laterally to the holdfast organ and united anteriorly in the hind-body, the presence of a muscular metraterm, the absence of receptaculum seminis and the presence of receptaculum seminis uterinum, the well developed genital atrium with a terminal genital opening at the posterior end, justify the inclusion of this genus definitely in the family Cyathocotyliidae. The holdfast organ is simple, mostly parenchymatous and slightly muscular with a central cavity which is large anteriorly in the fore-body and gradually narrows into a chink-like, tubular cavity extending posteriorly to a little in front of the hinder end. It has, however, undergone some modification in structure as compared with the members of the subfamily Cyathocotylinae, though it retains essentially the same morphological features. The extensive massive holdfast organ of the subfamily Brauniniinae Wolf, 1903, is a solid compact mass without a cavity. It also projects out in the cavity of the cup-shaped fore-body which is consequently considerably narrowed. It contains all the vitelline follicles, ovary, both testes, uterine convolutions and intestinal caeca throughout their length. In the subfamily Muhlinginiinae though it is extensive and occupies almost the whole body behind the pharynx, it is characterised by having a cavity throughout its length, which opens to the exterior in the cavity of the fore-body as mentioned already by its sucker-like anterior part. The genital organs, *i.e.*, testes, ovary, cirrus sac and vitelline follicles, as well as the intestinal caeca lie outside its cavity and also its glandular parenchymatous walls. So its extensive development and growth have taken place differently in the two subfamilies. It appears that the Cyathocotyloid ancestor of the Muhlinginiinae belonged to the subfamily Cyathocotylinae in which only the small anterior part of the body became modified into the cup-shaped form enclosing the deep concavity of the ventral surface of that region surrounding the externally opening part of the holdfast organ, whereas the remaining part remained as such and the posterior part of the holdfast organ continuing in this region—the hind-body became narrowed with its cavity reduced to a narrow chink. I am in favour of the view expressed by Szidat (1936) about the evolution of the subfamily Brauniniinae from an ancestor which resembled and was closely related to the genus *Prosostephanus* Lutz, 1935.

The striking features of resemblance between the Muhlinginiinae and Brauniniinae besides the similarity of the cup-shaped body are : (1) Complete disappearance of ventral sucker ; (2) large size of the pharynx ; (3) great size of the cirrus sac ; (4) large size of the ova, 0.16-0.17 mm. in

length and 0.1 mm. in breadth in *Braunina*, 0.1234-0.1533 mm. in length and 0.07-0.0972 mm. in breadth in *Muhlingina*; and (5) hosts being aquatic mammals. The two subfamilies, however, differ remarkably in the following respects:—(a) the structure and form of holdfast organ; (b) shape of the entire body, and relative size and shape of the fore-body and hind-body; (c) absence of oral sucker in Braunininae; (d) position of the testes parallel to each other and their strongly lobed form in Braunininae; (e) ovary situated dorsally to right testis in Braunininae and dorsally to anterior testis in Muhlingininae; (f) uterus much convoluted containing numerous ova in Braunininae in contrast to small uterus containing a few ova (1-15 in Muhlingininae); and (g) hosts marine Dephidae of the Adriatic Sea for Braunininae and the freshwater Indian Carnivora (Mustelidae, the otter, *Lutra vulgaris*) for Muhlingininae.

As discussed previously by me (1950), I have followed Szidat (1936) in dropping the family Brauninidae Bosma, 1931 and maintaining the subfamily Braunininae Wolf, 1903, under the family Cyathocotylidae. The family diagnosis of the Braunimidae as given by me in 1947 should be considered to apply to it as the subfamily.

Subfamily MUHLINGININAE Mehra, 1950

Subfamily diagnosis.—Body indistinctly divided into small cup-shaped fore-body and a large compact hind-body. Opening of the fore-body cavity large, anterior, ventral, close to or just behind pharynx. Holdfast organ with fairly large cavity with externally opening sucker-like part in fore-body and extending through hind-body to a little distance in front of hinder end with narrow chink-like tubular cavity, mostly parenchymatous and glandular, slightly muscular. Ventral sucker absent. Oral sucker and pharynx present; intestinal caeca outside holdfast organ ending a little distance in front of hinder end. Genital organs in hind-body. Testes entire, oblique, close behind one another, outside holdfast organ. Ovary dorsal to anterior testis, outside holdfast organ; receptaculum seminis absent; receptaculum seminis uterinum present. Cirrus sac large, thick and muscular. Uterus small, outside holdfast organ; muscular metraterm well developed. Ova a few, large, oval, 1-15 in number. Habitat in intestines of freshwater Mustelidae (the otter, *Lutra vulgaris*).

Type genus.—*Muhlingina* Mehra, 1950, with a single species, *Muhlingina lutrai* Mehra, 1950.

Generic diagnosis of the genus Muhlingina Mehra.—The same as for the subfamily.

IV—SUMMARY

1. A detailed account of the morphology of *Muhlingina lutrai* Mehra, 1950 is given.

2. The systematic position and phylogeny of the genus *Muhlingina* Mehra, 1950 are discussed, and a fuller diagnosis of the subfamily Muhlingininae Mehra, 1950 is provided.

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EXTERNAL MORPHOLOGY OF THE TERMITE, *ODONTOTERMES OBESUS* (RAMBUR) (ISOPTERA : TERMITIDAE). PART
1. SOLDIER

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(With 2 Tables and 5 Text-figures)

CONTENTS

	PAGE
I—Introduction	209
II—Material and Methods .. .	210
III—Head	210
(a) General	210
(b) Sutures of the cranium .. .	211
(c) Areas of the cranium .. .	212
(d) Tentorium	215
(e) Head-appendages	216
IV—Cervix	221
V—Thorax	221
VI—Abdomen	224
VII—Summary	226
VIII—References	226

I—INTRODUCTION

The detailed morphology of none of the Indian species of termites, with the exception of the primitive species, *Archotermopsis wroughtone* (Imms, 1919), has been worked out. Some work on *Odontotermes rede-manni* has been done by Mukerji and co-workers (1940-49), but they studied only a few special organs, such as the exudate organs, the anatomy of the alimentary system, etc. Holmgren (1909) in his systematic works has touched upon briefly on some aspects of the morphology of some oriental termites, but not *Odontotermes obesus* (Rambur). Some work on the ecology of this species has been done presently by Gupta (1953a, b) and by Roonwal & Gupta (1952).

To fill this gap in our knowledge, the morphology of one of the higher oriental termites, namely, *Odontotermes (Odontotermes) obesus* (Rambur)

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(Isoptera, family Termitidae) was taken up for study. In Part 1, the morphology of the soldier caste is presented; that of the workers and alates will follow in the subsequent parts.

Acknowledgments.—My sincere thanks are due to Dr. M. L. Roonwal, Chief Research Officer (Forest Entomologist), Forest Research Institute, Dehra Dun, for his care and guidance during the progress of the work. I am also thankful to the Principal, S. K. N. Agricultural Institute, Jobner, for kindly permitting me to carry on this work and to Shri Balwant Singh, Research Assistant (I), Dehra Dun, and my colleague Shri B. K. Kaul for kind suggestions.

II—MATERIAL AND METHODS

The material for study of the soldiers of *Odontotermes obesus* was collected around Dehra Dun (U. P.), ca. 2,000 ft. above sea-level, from earthen mounds which this species builds. Specimens were dissected and permanent mounts made on slides.

III—HEAD

(a) General

The general colour of the head is shining pale cadmium yellow. The postclypeus is pale yellowish brown and the anteclypeus yellowish white; the labrum is pale brown ochre, darker in the middle than at the borders. The proximal one-third of the mandibles is darker than the labrum; distally it deepens to dark tan and finally becomes shining black at the distal tips. The maxillary palpi are pale clay-yellow, becoming yellowish white at the joints. The antennae are pale clay-yellow basally, gradually changing to pale brown, van Dyke brown and Roman sepia distally; the areas between the joints are paler.

The head (Text-figs. 1d-f) is of the prognathous type, *i.e.*, with its long axis horizontal, though slightly inclined ventrally, and with the mouth-parts directed forwards. It is oval, heavily chitinated and sparsely haired, and has its facial area turned upwards. It is bilaterally symmetrical except for the mandibles.

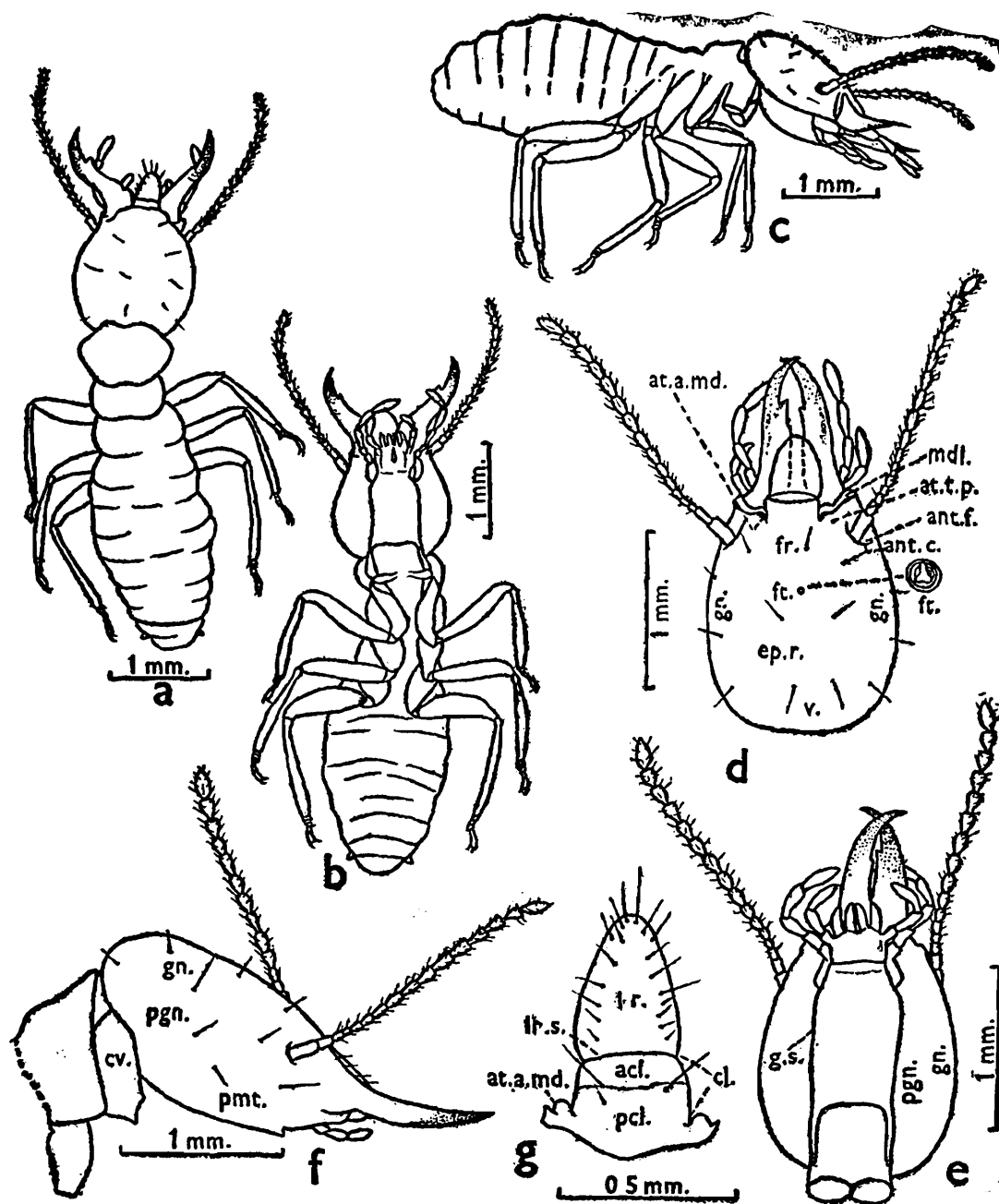
The cranium or the main head-capsule is dorso-ventrally flattened, with its sub-parallel lateral margins rounding into broadly rounded postero-lateral angles. The posterior margin is slightly overlapped by the sellate (saddle-shaped) pronotum. The cranium is supported internally by the tentorium (*vide infra*).

The mouth-parts are of the orthopteroid or mandibulate type and are directed forwards. The labrum overlies the rest of the gnathal appendages which consist of the paired mandibles and maxillae, and an elongate, median labium; the last named, together with the post-genae on either side, form the floor of the cranium. The hypopharynx is located on the prementum; the epipharynx is absent.

The compound eyes and ocelli, which are usually well developed in the more primitive termites, are absent here. The antennae take their origin within the antennal foveolae on the dorsal aspect of the cranium just above the base of the mandibles.

(b) *Sutures of the cranium*

The principal sutures of the cranium are the following :—(i) The labral suture dorsally ; and (ii) the gular, (iii) the postoccipital, and (iv) the labial suture ventrally. They are described below in detail.



TEXT-FIG. 1.—*Odontotermes obesus* (Rambur), soldier caste.

(a). Whole body, in dorsal view. (b). Whole body, in ventral view. (c). Whole body, in lateral view. (d). Head of soldier, in dorsal view. (Fontanelle (ft.) magnified separately). (e). Head of soldier, in ventral view. (f). Head of soldier, in lateral view. (g). Dorsal view of labrum and clypeus.

acl., anteclypeus ; *ant. c.*, antennal carina ; *ant. f.*, antennal foveola ; *at. a. md.*, anterior articulation of mandible ; *at. t. p.*, anterior tentorial pit ; *cl.*, clypeus ; *cv.*, cervix ; *ep. r.*, epicranial region ; *fr.*, frons ; *ft.*, fontanelle ; *gn.*, gena ; *g.s.*, gular suture ; *lr.*, labrum ; *lr. s.*, labral suture ; *mdl.*, mandibularia ; *pcl.*, postclypeus ; *pgn.*, postgenae ; *pmt.*, postmentum ; *v.*, vertex.

The *labral suture* (Text-fig. 1g, *lr.s.*) is a transverse suture which separates the anteclypeus from the labrum. It provides mobility to the labrum in the vertical plane. There is no distinct clypeal suture but a transverse line divides the clypeus transversely into a distal hyaline

anteclypeus (Text-fig. 1g, *acl.*) and a proximal sclerotized postclypeus (*pcl.*).

The epistomal suture (of Snodgrass, 1935) (or clypeo-frontal suture of Fuller, 1915; and Light, 1921), of other termites, which separates the frons from the clypeus is also suppressed here. Similarly, the frontal suture of Snodgrass, 1935 (or transverse suture of Light, 1921), which in other termites forms the arms of the inverted Y-suture separating the epicranium from the frons, is also not present here. In *Archotermopsis* (Imms, 1919) a V-shaped suture separates the epicranial plates from the frons. According to Imms (1948, p. 266) in termites "the median and V-shaped epicranial sutures are frequently evident although extremely variable in their degree of development" The coronal or metopic suture (of Snodgrass, 1935; frontal suture of Light, 1921; the stem of Y-suture of some authors), which divides the epicranium medially and longitudinally into two equal halves, is also suppressed here. Light (1921) has stated that the frontal, transverse and clypeo-frontal sutures are absent or imperfect in most termite soldiers, while the clypeal suture is absent in some forms.

Ventrally, the *gular sutures* (Text-fig. 2, *g.s.*) run longitudinally, separating the lengthened proximal plate of the labium (called postmentum) from the postgenae. It is formed by the forwardly extended ventral or anterior ends of the postoccipital suture.

The *postoccipital suture* (Text-fig. 2, *poct.s.*) lies ventro-posteriorly on the cranium surrounding the occipital foramen posteriorly and laterally. It runs more or less parallel to the margins of the occipital foramen.

The *labial suture* (Text-fig. 3c, *lb.s.*) is a transverse suture separating the prementum from the postmentum.

(c) *Areas of the cranium*

Since the coronal, frontal and epistomal sutures are suppressed the limits of the principal cranial areas have become obscured. For the sake of clarity, the areas are, however, discussed as such and denoted in the figures to mark their positions. The principal areas are the following:—(i) *Dorsal*: the vertex, epicranial region, frons, clypeus, genae, and the trochantin of mandible or mandibularia. (ii) *Ventral*: the occiput, postocciput, postgenae and the postmentum. The postmentum will be discussed under head-appendages, since it forms a part of the labium; the other cranial areas are described below.

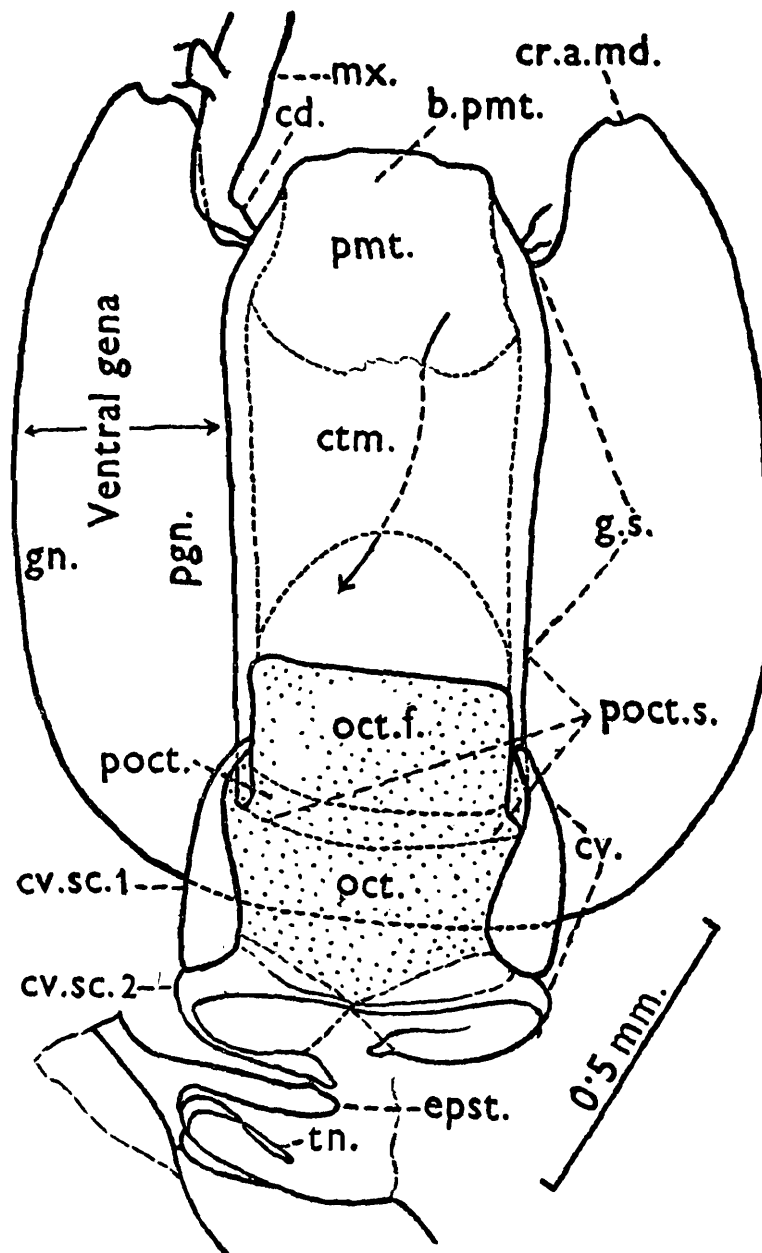
The *vertex* (Text-fig. 1d, *v.*) appears as a somewhat flatly arched surface and forms the posteriormost part of the epicranial region.

The *epicranial region* (Text-fig. 1d, *epr.*) forms the dorso-posterior part of the cranium, occupying nearly the entire proximal half of the head above the frons. It corresponds to the "vertex" of Fuller (1915). As already stated, the inverted Y-shaped epicranial suture dividing it into two epicranial plates and separating it from the frons is absent.

The *frons* (Text-fig. 1d, *fr.*) (or "Transversalband" of Holmgren, 1909) lies anterior to and adjoining the epicranial region. The frontal sutures bounding it posteriorly and the epistomal suture bounding it

anteriorly in the primitive termites are not found here. According to Light (1921), it is "not at all or imperfectly defined in most soldiers"

A minute, more or less Y-shaped gland-orifice of the cranium, called *fontanelle* (Text-fig. 1*d*, *ft.*), is clearly visible under a high magnification. It is located medially, approximately at the point where the frons and the epicranial region are supposed to meet, and is surrounded by a



TEXT-FIG. 2.—*Odontotermes obesus* (Rambur), soldier caste.

Ventral view of cranium (minus the head-appendages) with the cervix, etc., showing various cranial areas and sutures.

b. pmt., blade of postmentum; *cd.*, cardo; *cr. a. md.*, cranial articulation of mandible; *ctm.*, corporotentorium; *cv.*, cervix; *cv. sc. 1*, cervical sclerite 1; *cv.sc.2*, cervical sclerite 2; *epst.*, episternum; *gn.*, gena; *g.s.*, gular suture; *mx.*, maxilla; *oct.f.*, occipital foramen; *oct.*, occiput; *pgn.*, postgena; *pmt.*, postmentum; *poct.*, post-occiput; *poct.s.*, postoccipital suture; *tn.*, trochantin of leg.

deeply staining circular band. According to Fuller (1915), it is present in soldiers of certain termites where the Y-suture is obsolete. The fontanelle is present in most of the genera except *Archotermopsis*, *Hodotermes* (*Anacanthotermes*), *Kalotermes*, *Neotermes*, *Glyptotermes* and *Cryptotermes* (vide Snyder, 1934).

The *clypeus* (Text-fig. 1g, *cl.*) is a transverse sclerite lying anteriorly to the frons. There is no sutural demarcation within it, but a distinct transverse line divides it into a pale, hyaline, membranous *anteclypeus* (*acl.*) and a dark sclerotized *postclypeus* (*pcl.*) which usually bears two prominent bristles, one at each disto-lateral angle. At the outer basal angles of the postclypeus there lies, on either side, a small condyle produced forward; this is the *anterior articulation of mandible* (Text-fig. 1g, *at.a.md.*). The fusion of the *anterior tentorial arms* (*at.t.a.*) with the cranial wall commences dorsally, close to the point of the anterior articulation of the mandible, and is visible as a dark spot on each side. It is faintly depressed and marks the position of the *anterior tentorial pits* (Text-fig. 1d, *at.t.p.*). The anteclypeus sometimes gets partially folded below the postclypeus.

In most termite soldiers where both the frontal and the epistomal sutures are obscured, the region of the frons and the clypeus is together designated as the *frontal area* (Fuller, 1915). According to that author, the term "frons" should be used only in those cases where the Y-suture is demarcated either fully or partially.

The lateral areas of the cranium from the anterior cranial margin or cephalic extremity to and including the vertex are called the *genae* (Text-figs. 1d-f, *gn.*), on which are located the *antennal foveolae* together with the prominent *antennal carinae*. Since there is no sutural demarcation, the genae become confluent with the epicranial region on either side. On either side between the basal margin of mandible and the anterior margin of the genae there is a transverse narrow but distinct area dorsally; this is the *mandibularia* (Text-fig. 1d, *mdl.*) (or *trochantin of mandible* of Fuller, 1915).

The *occiput* (Text-fig. 2, *oct.*) is an area on the ventral surface (although some authors regard it as situated on the top of the head in other insects). It becomes confluent with the ventral genae (*vide infra*) anteriorly on either sides of the occipital foramen. Fuller (1915) regards it as "forming the convex caudal extremity of the head"

The *postocciput* (Text-fig. 2, *poct.*) is a narrow rim separated from the occiput by the postoccipital suture to which it runs parallel; it is attached to the cervical or neck membrane. The elongated anterior cervical sclerites are articulated on this region postero-laterally.

The ventral regions on either side of the gula or postmentum are called the *ventral genae* (Text-fig. 2) (*vide* Fuller, 1915). They are composed partly of the genae continued from the dorsal side and the whole of the postgenae (Text-fig. 2, *pgn.*) which lie adjacent to the gula and separated from the latter by the gular sutures on both sides. There is on suture separating the genae from the postgenae. In certain species, specially in the genus *Hodotermes*, the postgenae are well demarcated from the genae, but in most other species the suture is either lost or only slightly indicated (Fuller, 1915).

(d) *Tentorium*

The tentorium (Text-fig. 3*i*) is a stout, endoskeletal, chitinous framework giving rigidity to the cranium and strength to the anterior articulations of the mandibles (*at.a.md.*). It also supports the brain and provides attachment for certain cephalic muscles.

The tentorium is composed of a corporotentorium or tentorial body and two pairs of tentorial arms, the anterior and the posterior arms. A pair of dorsal arms (extension of anterior arms) as is found in the cockroach *Periplaneta orientalis* (Orthoptera, Blattidae) and other insects, is absent in *O. obesus*.

The *corporotentorium* (*ctm.*) is a broad median structure. Medially at its anterior border, is present a conspicuous broad *tentorial foramen* (*t.f.*). The anterior margins of the corporotentorium on either side of the foramen are deeply incurved. Posteriorly its margin is considerably incurved, being much pushed in as compared to the posterior margin of the postmentum (Text-fig. 2). The two antero-lateral angles of the corporotentorium are produced forwards and fuse at the points where the cardines of the first maxillae articulate. Similarly, the postero-lateral angles are produced posteriorly, overlying the postero-lateral angles of the postmentum, and become confluent with the post-occipital region at the lateral margins of the occipital foramen.

The *tentorial arms* are the cuticular invaginations of the cranium, uniting internally at the anterior and posterior regions of the tentorial body.

The stout *anterior tentorial arms* (*at.t.a.*) form the most powerful chitinous portions of the tentorium, and are slightly twisted on themselves in order to provide more rigidity. They arise from the faintly demarcated anterior tentorial pits close to the points of the anterior articulation of mandibles. The two arms are inclined at an acute angle with each other and are bound together transversely by means of a *broad strip* (*b.s.*) which forms the anterior border of the tentorial foramen. The arms are further fused with the tentorial body at the lateral margins of the tentorial foramen.

The *posterior tentorial arms* (*p.t.a.*) and the *posterior tentorial pits* (*p.t.p.*) are of considerable interest. We note that the lengthened head is equipped with an endoskeleton rightly suited to provide due rigidity to it. Thus, the posterior tentorial arms are much lengthened. They take their origin from the posterior tentorial pits which are greatly lengthened grooves (gular sutures) extending throughout the lateral margins of the postmentum. Consequently, the edges of the posterior tentorial arms are fused laterally with the margins of the postmentum. They have attained excessive development and, together with the tentorial body, go to compose a slightly arched *tentorial bridge*. The latter forms a roof over the postmentum. The chitinous tunnel is thus formed by the tentorial bridge above and the postmentum below.

(e) *Head-appendages*

The head-appendages consist of the medially placed labrum, hypopharynx and labium, and the paired antennae, mandibles and maxillae.

The *labrum* (Text-fig. 1g, *lr.*) is a flat preoral sclerite movably attached to the anteclypeus from which it is separated by the labral or clypeo-labral suture. The latter provides mobility to the labrum in a vertical plane, and the labrum thus functions as one of the gnathal appendages. It overlies the basal portion of the mandibles.

The labral setae show an interesting, more or less bilaterally symmetrical arrangement. This arrangement is sometimes varied due to the absence of the corresponding setae on one side or the other or both. Usually there are 9-12 setae on either side.

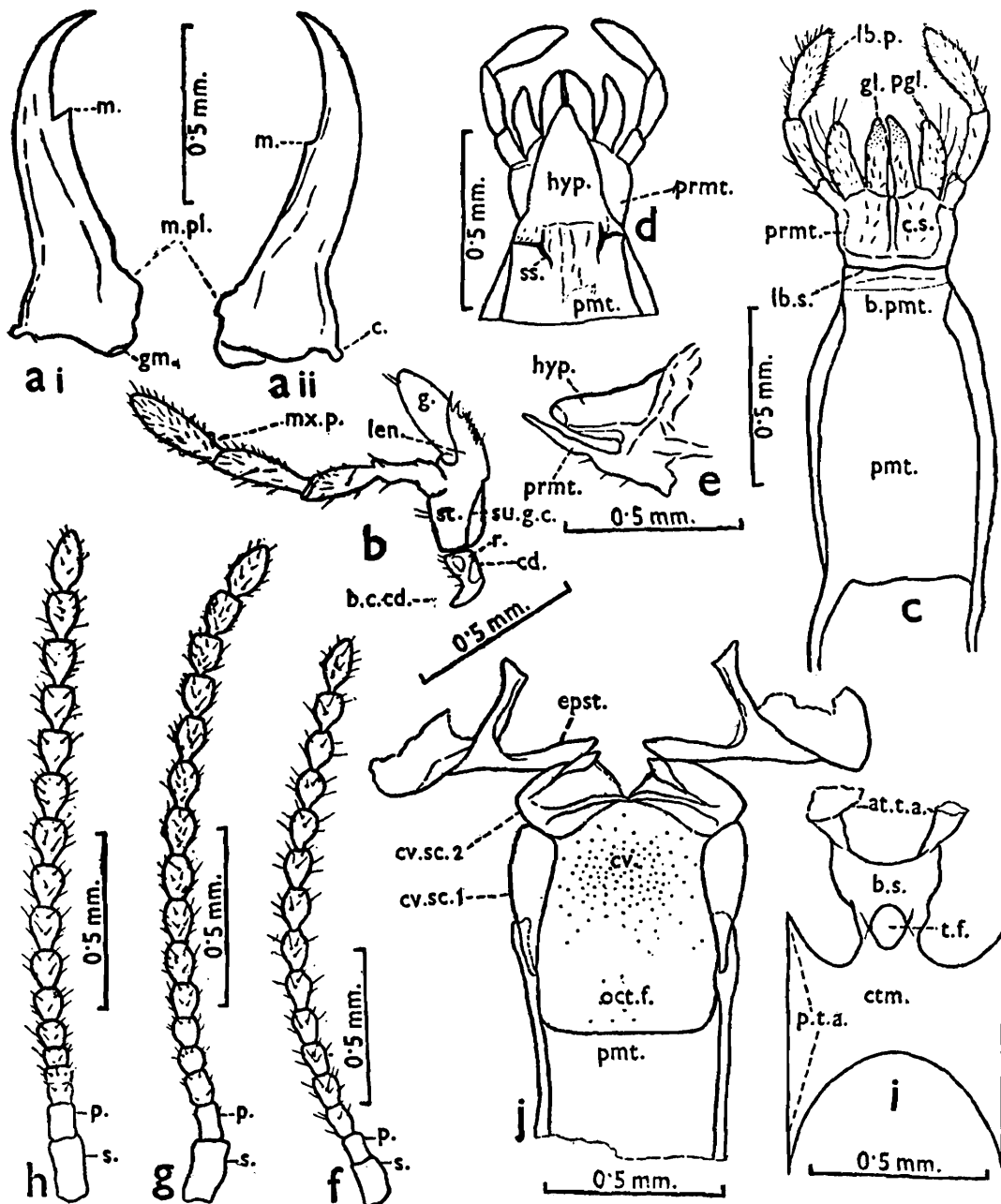
The *hypopharynx* (Text-figs. 3d, e, *hyp.*) is located in the intergnathal space or preoral cavity, with its aboral wall reflected into the adoral wall of the labium at the base of the prementum. It consists only of the *lingua* which, according to Snodgrass (1935), forms in the more generalised insects the median part of the hypopharynx where superlinguae are present as its lateral lobes. In dorsal view the hypopharynx appears more or less cone-shaped, while in lateral view its dorsal margin is more slanting than the ventral. Medially it appears to be traversed by a fine canal which may be the salivary duct, but this point is not quite clear. The adoral area of the hypopharynx at its base is flanked on each side by a sclerite, constituting the *suspensoria* (*ss.*) of the hypopharynx.

The *labium* (Text-fig. 3c, *lb.*) is composed of two primary regions, *viz.*, a proximal rigid postmentum (also called gula, Snodgrass, 1935) and a movable prementum; separating the two is the labial suture. The prementum carries additional movable terminal lobes, namely, the labial palpi laterally and the ligula (consisting of the glossae and the paraglossae) distally.

The *postmentum* (*pmt.*) is a somewhat longitudinally concave, much elongated and subquadrangular sclerite lying between the long postgenal regions of the cranium. It forms the mid-ventral floor of the head with its basal margin deeply invaginated or concave and lying transversely in front of the *occipital foramen* (Text-fig. 2, *oct.f.*). The postero-lateral arms extend much posteriorly along the margin of the occipital foramen, thus circumscribing it antero-laterally. The lateral margins are parallel to each other but converge anteriorly as they separate from the postgenae. The resulting narrow distal region has been called the *blade of postmentum* (*b.pmt.*) by Fuller (1915). *Odonotermes obesus* resembles *Archotermopsis* (Imms, 1919) in having no separate gula as is the case in other insects. The postoccipital suture, as is present in *Termopsis* (Snodgrass, 1935), is very marked in the present species.

The *prementum* (*prmt.*) is a transverse structure divided by a median longitudinal fold into two halves, each having a sub-rectangular *chitinised sclerite* (*cs.*) embedded in its hyaline membrane. Laterally this hyaline membrane is folded dorsally and its margins are chitinized, leaving a

gap in between over which lies the hypopharynx. The palpigers are indistinct. Each lateral half bears distally the inner hyaline *glossae* (*gl.*) bearing microscopic hairs and the outer *paraglossae* (*pgl.*) having, in addition, long hairs. They are similar in size, bluntly pointed and



TEXT-FIG. 3.—*Odontotermes obesus* (Rambur), soldier caste.

(a i, a ii). Left and right mandibles respectively. (b). Maxilla. (c). Labium, in dorsal view. (d). Hypopharynx, in dorsal view, showing its attachment with the labium. (e). Hypopharynx, in lateral view, showing its attachment with the prementum. (f, g, h). Right antennae with 15, 16 and 17 segments respectively. (i). Tentorium. (j). Cervix, showing its attachment with the postmentum and the prothoracic episternum.

at.t.a., anterior tentorial arm; *b.c.cd.*, basal condyle of cardo; *b.s.*, broad strip; *c.*, condyle; *cd.*, cardo; *ctm.*, corporotentorium; *cv.*, cervix; *cv.sc.1*, cervical sclerite 1; *cv.sc.2*, cervical sclerite 2; *epst.*, episternum; *g.*, galea; *gm.*, ginglymus; *hyp.*, hypopharynx; *len.*, lacinia; *m.*, marginal tooth of mandible; *m.pl.*, molar plate of mandible; *mx.p.*, maxillary palp; *occ.f.*, occipital foramen; *p.*, pedicel; *pmt.*, postmentum; *prmt.*, prementum; *p.t.a.*, posterior tentorial arm; *r.*, ridge; *s.*, scape; *ss.*, suspensorium; *st.*, stipes; *su.g.*, sutural groove; *t.f.*, tentorial foramen,

separated from the prementum by distinct transverse sutures and are collectively called the *ligula*.

The segments of the 3-segmented *labial palpi* (*lb.p.*) vary in length from the basal segment onward in the following proportion: 1:2:2. The ultimate segment is the thickest and is densely haired and bluntly pointed.

The *antennae* (Text-fig. 3 *f-h*, *ant.*) are moniliform and located dorso-laterally on the head at the anterior end of the genae above the trochantin of the mandibles. They are about $1\frac{1}{2}$ times as long as the width of the head, and arise from a shallow trough called the *antennal foveolae* (*ant.f.*) or *antennal fossae*. The rim of each foveola is strengthened by a prominent ridge, the *antennal carina* (*ant.c.*).

TABLE 1.—*Variation in the number of antennal segments in Odontotermes obesus (Rambur), soldier caste, collected from different mounds near Dehra Dun, during July 1954.*

Locality and date of collection	Total Number of segments No.	NUMBER OF INDIVIDUALS (ALSO %)					
		Number of segments in left antenna			Number of segments in right antenna		
		15	16	17	15	16	17
1. Near Chemistry Department, New Forest, Dehra Dun. 18. vii. 1954.	100	0	58	42	0	58	42
2. Compartment 13, near Dy. Ran- ger's Quarter, New Forest, Dehra Dun. 18. vii. 1954.	100	1	58	41	1	60	39
3. On boundary between Demonstra- tion Area and Power House, New Forest, Dehra Dun. 18. vii. 1954.	100	0	67	33	0	64	36
4. Compartment 17, Demonstra- tion Area, New Forest, Dehra Dun. 18. vii. 54.	100	3	75	22	0	81	19
5. Jhajra Forest, Malhan Range, Kolhuwara, Jhore-ki-ghati. 27. vii. 1954.	100	0	5	95	0	6	94
6. Jhajra Forest, near Dak Bunga- low. 27. vii. 1954.	100	0	44	56	0	43	57

The number of antennal segments (Table 1) varies from 15 (rarely) to a maximum of 17, the number frequently varying in the same individual. The extra segment in the 17-segmented individuals arises by a division of the segment III (from the base) into two (when derived from the 16-segmented forms) or by a division of both segments III and IV (when derived from the 15-segmented forms). These segments, when involved in division, attain a length equal to that of the scape. The *scape* (*s.*) is the largest segment, is double the length of the pedicel

TABLE 2.—Proportions of symmetrical and asymmetrical individuals as regards the number of antennal segments in *Odontotermes obesus* (Rambur), soldier caste.

Locality and date of collection	Total No.	% of individuals showing symmetry.				% of individuals showing asymmetry.				Difference in number of segments in asymmetrical individuals.
		15-segmented.	16-segmented.	17-segmented.	Total No.	No. of individuals having more segments in left antenna, i.e., 17.	No. of individuals having more segments in right antenna, i.e., 17.	No. of individuals having more segments in right antenna, i.e., 16.	Total No.	
1. Near Chemistry Department, New Forest, Dehra Dun. 18. vii. 1954.	100	0	43	27	70	15	15	0	30	1
2. Compartment 13, near Dy. Ranger's Quarter, New Forest, Dehra Dun. 18. vii. 1954.	100	1	49	30	80	11	9	0	20	1
3. On boundary between Demonstration Area and Power House, New Forest, Dehra Dun. 18. vii. 1954.	100	0	56	25	81	8	11	0	19	1
Compartment 17, Demonstration Area, New Forest, Dehra Dun. 13. vii. 1954.	100	0	66	10	76	12	9	3	24	1
5. Jhajra Forest, Malhan Range, Kolhuwara, Jhore-ki-ghati. 27. vii. 1954.	100	0	0	89	89	6	5	0	11	1
6. Jhajra Forest, near Dak Bungalow. 27. vii. 1954.	100	0	34	47	81	9	10	0	19	1

and has no bristles. The *pedicel* (*p.*) has very few bristles present distally. Each segment of the flagellum has a whorl of subequal bristles and is somewhat flask-shaped, except for the apical segment which is globular, bluntly pointed and measures about as long as the scape.

A careful count was made of the number of antennal segments of about 600 individuals collected at New Forest and Jhajra Forest near Dehra Dun (Table 1). Six samples of 100 individuals each were taken, each sample being from a separate mound, *i.e.*, from a separate colony. In four samples of 100 individuals each from the New Forest area, the percentage of 16-segmented individuals varied from 58 to 81 (there being little difference between the right and left antennae); the remainder were mostly 17-segmented (19-42 per cent.) and 15-segmented (1-3 per cent.). In the two samples from the Jhajra Forest, this condition was more or less reversed, in favour of the 17-segmented forms (56-95 per cent.), the remainder being 16-segmented. Bilateral symmetry (Table 2) in the right and left antennae is more frequent (76-89 per cent.) than asymmetry (11-30 per cent.). In the asymmetrical individuals, the difference in the number of segments in the right and left antennae of an individual is always one.

The *mandibles* (Text-fig. 3*ai*, *aii*, *md.*) are partly concealed proximally by the labrum on the dorsal side and the labium on the ventral. Dorsally, their basal margins bound the trochantin of the mandible at its anterior margin on either side. In 50 specimens examined with their mandibles closed, 48 had the left mandible overlying the right; in the remaining 2 the reverse condition occurred.

Each mandible is articulated with the cranium antero-laterally, moving inwards and outwards in a transverse plane, and crossing each other at their distal ends. They have thus the transverse movements of abduction and adduction. Each is hinged by means of a *condyle* (*c.*) and a *ginglymus* (*gm.*). The condyle is a rounded head at the base of the mandible in the ventro-lateral position and fits into a socket called the *cranial articulation of mandible* (Text-fig. 2, *cr.a.md.*) at the distal end of the gena or postgena. The ginglymus, on the other hand, is a cup-shaped cavity at the base of each mandible and articulates with a convex process termed the *anterior articulation of mandible* (Text-fig. 1*d*, *at.a.md.*) located at the posterior outer angles of the postclypeus.

Each mandible measures about 0.93-1.02 (mostly *ca.* 0.99) mm. long. The two mandibles are asymmetrical, flattened and upturned apically; they are thickened basally and incurved like the legs of a pair of callipers. The left one (Text-fig. 3*ai*) is armed with a prominent, cone-shaped and bluntly pointed marginal tooth (*m.*) on the edge, at one-third the length of the mandible from apex. The tooth is feebly developed in the right one (Text-fig. 3*aii*). The basal margins are uneven, forming the *molar plate of mandible* or *pars molaris* (*m.pl.*) for mastication.

The *maxillae* (Text-fig. 3*b*, *mx.*) are well developed and composed proximally of a cardo, and distally of a stipes carrying the large inner and outer terminal lobes at its distal end. They lie on the ventral surface of the cranium below the mandibles, and thus partly forming

together with the labium, the floor of the oral cavity. They are articulated laterally at the narrow distal end of the postmentum or blade of gula where the gular sutures end in the angle where the postgenae become free from the postmentum. They are also articulated to the cranium by means of the basal condyle which forms the proximal end of the cardo.

The *cardo* (*cd.*) is broad distally and narrow proximally, and ends in an outwardly projected, nose-like *basal condyle* (*b.c.cd.*) bent at an obtuse angle. A few minute hairs are borne by it laterally. Internally it is supported by a network of prominent *ridges* (*r.*). It is a considerably shorter and narrower sclerite than the stipes and is movably hinged on the latter.

The *stipes* (*st.*) is an elongated sclerite, broad distally with a *sutural groove* (*su.g.*) on the inner margin, which forms internally a submarginal ridge for the attachment of muscles. The sclerite inner to this groove is *parastipes* or *subgalea*. Distally it bears the inner lacinia, the outer galea, and a 5-segmented maxillary palp laterally, below which there is a pair of conspicuous bristles.

The *lacinia* (*lcn.*) is chitinous, apically bi-dentate and partially overlying the galea; its inner margin is fringed with thick bristles. The *galea* (*g.*) is a soft leaf-like, hyaline structure with a pair of conspicuous hairs apically on the outer margin.

The segments of the 5-segmented *maxillary palpi* (*mx.p.*) are mutually related in length in the following proportion, starting from the basal or first segment: 5 : 6 : 13 : 14 : 16. The basal segment is the thickest and without bristles, while the remaining ones possess bristles.

IV—CERVIX

(Text-figs. 1f, 2, and 3j, *cv.*)

The cervix or neck is a narrow region concealed by the overlapping saddle-shaped pronotum (Text-fig. 1f, *cv.*). It consists of a flexible and transparent membrane supported by two pairs (anterior and posterior) of lateral *cervical sclerites* or plates hinged on to each other. The sclerites of the anterior pair (*cv.sc.1*) are elongated and have a forwardly tapering process articulating movably with the postero-lateral arms of the postmentum at the lateral margins of the occipital foramen. They thus form the fulcral points for the movements of the head. The sclerites of the posterior pair (*cv.sc.2*), on the other hand, are hollowed internally and convex ventrally, and articulate with those of the preceding pair at their anterior border, while their posterior border articulates with the prothoracic episternum of their respective sides. The feebly developed dorsal and ventral cervical sclerites noticed by Imms (1919) in *Archotermopsis wroughtoni* are not found in *Odontotermes obesus*.

V—THORAX

(Text-figs. 4a, c, and 5a)

(a) *The Main Body*

The thorax is composed of three segments, the pro-, meso- and meta-thorax from before backwards. The dorsal *tergites* are well developed

and strongly chitinised, while the ventral *sternites* are feebly developed. The *pronotum* (*pnt.*) or the prothoracic tergum is the most conspicuous and strongly chitinised of the three terga. It is sellate (saddle-shaped), nearly as broad as long, and bears prominent setae at its anterior and posterior margins. Its anterior rim, which is slightly raised, overlaps the cranium a little, while its antero-lateral margins are drawn somewhat downward. The pronotum thus presents a slightly hood-like lobe with the dorsal surface slightly arched.

The *mesonotum* (*mst.*) and *metanotum* (*mtt.*) are subequal and, unlike the pronotum, do not form prominent shields; they are a little wider than long and bear setae on their posterior halves.

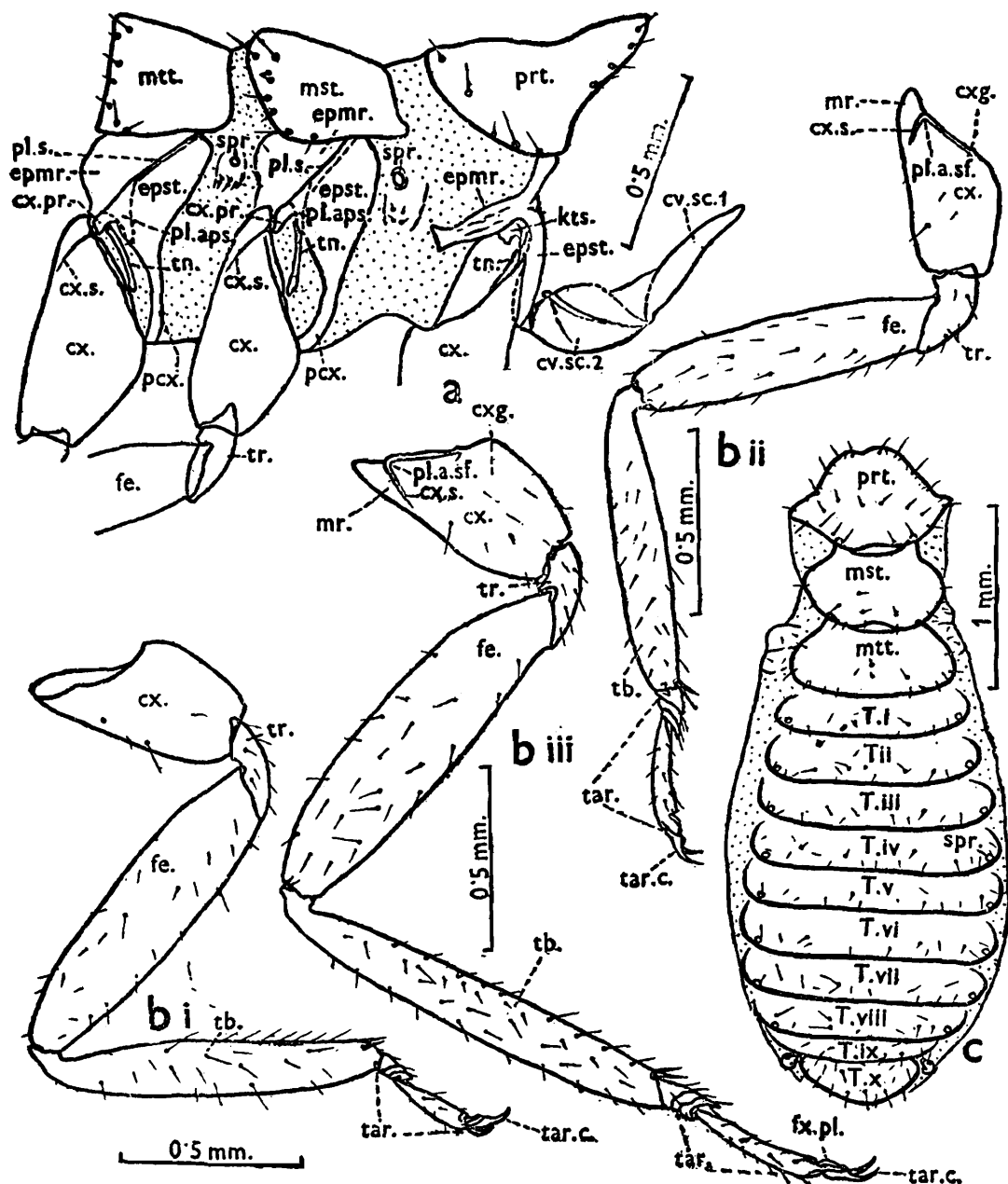
There are two pairs of laterally situated thoracic *spiracles* (*spr.*) in the pleural region, a pair each on the meso- and metathorax. The mesothoracic spiracles are more conspicuous, slightly displaced anteriorly, and lie near the posterior margin of the prothorax. The metathoracic spiracles similarly lie near the posterior margin of the mesothorax.

The *pleura* of the meso- and metathorax resemble each other but differ markedly from that of the prothorax. Each pleuron of the meso- and metathorax is divided by the *pleural suture* (*pl.s.*) into two oblique, subtriangular sclerites lying above the coxa and forming the presutural *episternum* (*epst.*), and the postsutural *epimeron* (*epmr.*). In addition, there is a slender sclerite, the *trochantin* (*tn.*), pointing ventrally and articulating with its ventral extremity at the anterior margin of the coxa. Anterior to the trochantin the episternum extends ventrally to merge with the sternum and is here known as the *precoxal bridge* or *precoxale* (*pcx.*). A similar extension of the epimeron, forming the *postcoxal bridge* or *postcoxale*, is indistinct in the soldier. The pleural suture arises from the *coxal process* or *coxal articulation* (*cx.p.*) of the pleuron and runs upwards obliquely to form an anterior proclivity. The suture is formed by a shallow invagination of the pleuron and forms internally a ridge, the *internal pleural ridge*, which provides strength to the pleuron. From this ridge arises an apodemal arm, called the *pleural apophysis* (*pl. aps.*), projecting downwards and inwards. The corresponding sternal apophysis, which is usually associated with it in other insects, is not distinctly marked here.

The pleuron of the prothorax has, in addition to the episternum and the epimeron, a reduced and curved arm-like process which articulates with the trochantin and is closely associated with the episternum. It has been called *katepisternum* (*kts.*) by Fuller (1924) in winged termites. The prothoracic episternum differs markedly from that of the succeeding segments in being an elongated, stout, highly chitinised and rod-like structure hanging downwards from the pronotum. It thus forms a sort of rigid collar-band providing attachment to the cervical sclerites ventrally. The epimeron is attached at the base of the episternum below the pronotum and projects more or less posteriorly.

The *sternum* (*S.1, S.2, S.3*) is present in all the three segments *i.e.*, pro-, meso- and metathorax ventrally between the two coxae. The

prothoracic sternum is more or less oval and much less chitinised, whereas the meso- and metathoracic sternum is transverse and narrow sclerite connected with the episternum by the precoxal bridge. Besides, there are intersegmental sclerites or intersternites commonly termed as *spinasterna*. The *spinasterna* (*spn.1*) between the prothorax and



TEXT-FIG. 4.—*Odontotermes obesus* (Rambur), soldier caste.

(a). Lateral view of thorax, showing the arrangement of pleural sclerites and articulation of coxae. (b i, b ii, b iii). Fore, middle and hind-legs respectively of the right side. (c). Dorsal view of thoracic and abdominal tergites.

cv.sc.1, cervical sclerite 1; cv.sc.2, cervical sclerite 2; cx., coxa; cx.pr., coxal process; cx.s., coxal suture; epmr., epimeron; epst., episternum; fe., femur; fx.p., flexor plate; kts., katepisternum; mr., meron; mst., mesonotum; mtt., metanotum; pl.aps., pleural apophysis; pl.a.sf., pleural articular surface; pl.s., pleural suture; pcx., precoxale; prt., pronotum; spr., spiracle; T.i.-T.x., terga 1 to 10, tb., tibia; tn., trochantin of leg; tar.c., tarsal claws; tr., trochanter.

mesothorax is represented only as a median, elongated, forwardly pointing apodemal process or spine, whereas the *spinasterna* (*spn.2*) between the mesothorax and metathorax is united with mesothoracic sternum with a usual median spine pointing forwards.

(b) *The legs*

(Text-figs. 4bi, ii, iii)

The legs bear fine hairs which are especially dense on the tibiae. The pro- and mesothoracic legs are subequal, the metathoracic legs being larger. The most proximal leg segment or *coxa* (*cx.*) is a relatively small, thick segment articulated with the pleuron. The articular joint is surrounded by the episternum and epimeron anteriorly and dorsally. The coxa, which is truncate, cone-shaped, somewhat cylindrical and with outer surface projecting upwards, is separated proximally from the body by a distinct suture. It articulates with the ventral extremity of the trochantin at the anterior margin of the latter. Slightly above this articulation it bears another articular facet, the *pleural articular surface* (*pl.a.sf.*) (Snodgrass, 1935), which articulates with the *coxal process* (*cx.pr.*) of the pleuron. At its distal end the coxa is articulated with the trochanter at two articular points. The coxa of the mid- and hind-legs is divided obliquely into two by an inflexion of its wall called the *coxal suture* (*cx.s.*) which falls in line with the *pleural suture* (*pl. s.*). That portion which is in line with the episternum is most probably the *coxa genuina* (*cx.g.*), and the portion in line with the epimeron is the *meron* (*mr.*).

The *trochanter* (*tr.*) is a small segment of the leg with its distal end obliquely truncated. It is hinged proximally to the coxa, and is rigidly fixed to the femur distally. The *femur* (*fr.*) is the stoutest segment and is slightly narrowed at the ends. The *tibia* (*tb.*) is slender and has its proximal end constricted and slightly bent towards the femur so as to be flexed closely underneath the latter. It provides a condylic hinge to the femur. The tibiae of the fore- and middle-legs are nearly equal in length to the corresponding femora, while that of the hind-leg equals in length the combined femur and trochanter. Each tibia carries a pair of tibial spurs near its distal extremity.

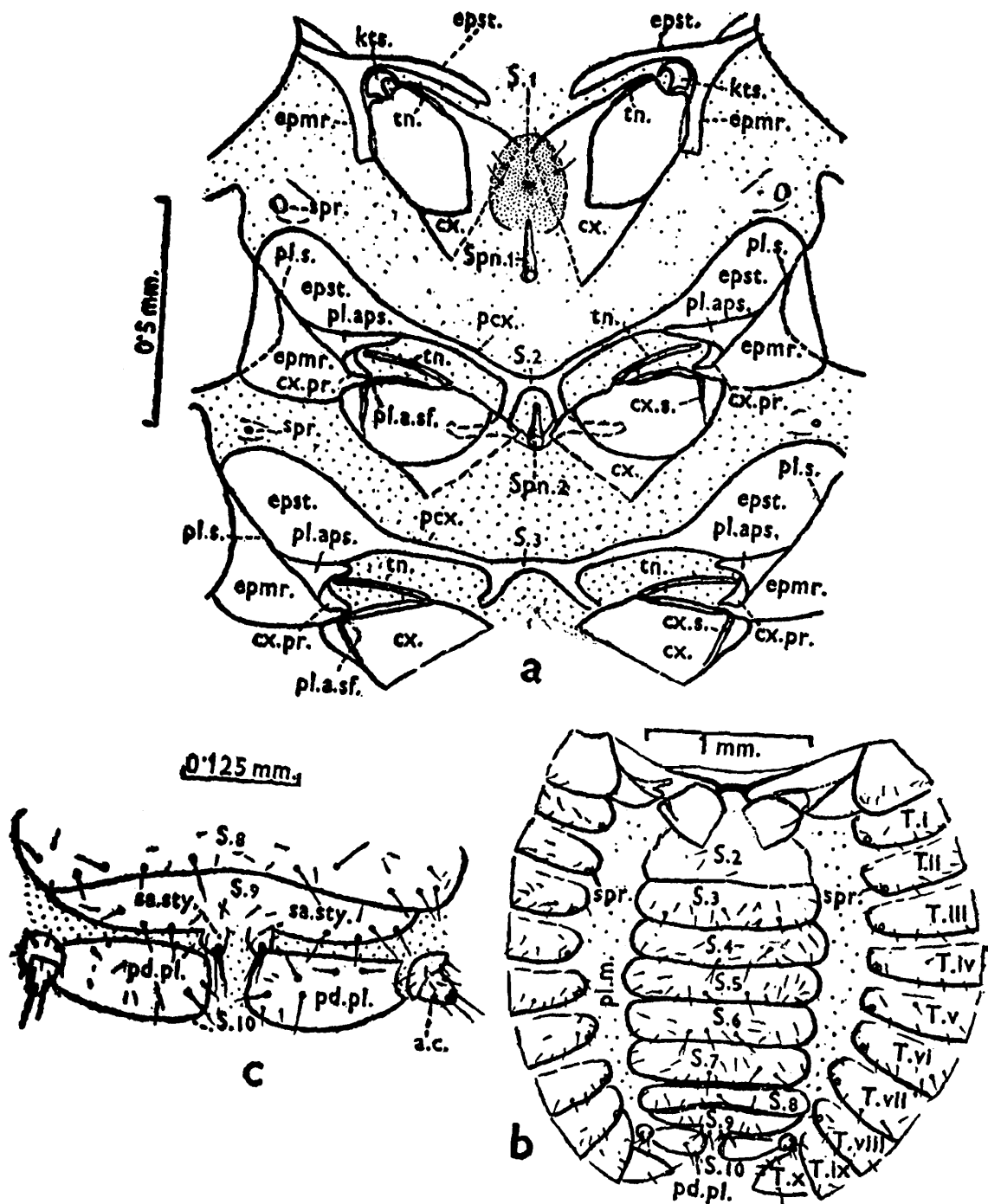
The *tarsi* (*tar.*) in all the 3 legs are 4-jointed. The basal segment or *basitarsus* is subtriangular and is larger than the next two segments. The distal segment or *distitarsus* is the longest and has a relatively narrow proximal end; it bears a pair of *claws* (*tar. c.*) which are articulated with the distitarsus by means of a small distal process of the latter. A small sclerite situated ventrally between the claws may possibly represent the *flexor plate* (*fx. pl.*). The terminal region of the leg, including the claws and the flexor plate, may be referred to as the *pretarsus*. The empodium is absent here.

VI—ABDOMEN

(Text-figs. 4c. and 5b, c)

The abdomen is 10-segmented and differs from the head and thorax in the simplicity of its structure. Anteriorly, it broadly adjoins the thorax. There are 10 distinct *tergites* (*Ti -Tx*) of which the first eight

bear a pair of *spiracles* (*spr.*) each at their lateral margins. The 5th and 6th tergites are the largest; the posterior ones undergo a gradual reduction in size. Within each segment the dorsal or *tergal* sclerites and ventral or *sternal* sclerites are separated laterally by the *pleural*



TEXT-FIG. 5.—*Odontotermes obesus* (Rambur), soldier caste.

(a). Thorax, showing the different ventral and lateral sclerites and the attachment of the coxae. (b). Abdominal sternites, in ventral view, with the tergites out medially in longitudinal axis and spread on either side. (c). The 8th, 9th and 10th (podical plates) abdominal sternites.

a c., anal cercus; *cx.*, coxa; *cx. pr.*, coxal process; *cx. s.*, coxal suture; *epmr.*, epimeron; *epst.*, episternum; *kts.*, katapisternum; *pd. pl.*, podical plate; *pl. aps.*, pleural apophysis; *pl. a. sf.*, pleural articular surface; *pl. m.*, pleural membrane; *pl. s.*, pleural suture; *pcx.*, precoxale; *s1-s10*, sterna 1-10; *sa. sty.* sub-anal style; *spr.*, spiracle; *Ti-Tx*, terga 1 to 10; *tn.*, trochantin of leg.

membrane (*pl. m.*). The sclerites bear spines of various sizes all over, which are densely distributed at random but the narrow anterior margins are relatively less spinose. Each tergum slightly overlies the one

following it. The apical or tenth tergum is somewhat triangular, is relatively more arched dorsally and has its apex broadly rounded posteriorly.

All the abdominal segments except the first have a corresponding sternite, the first sternum being atrophied. The eighth and ninth sternites are narrower than the rest. The last or tenth sternum is represented by a pair of *podical plates* (*pd. pl.*).

The ninth sternum carries a pair of small, unjointed, setose, somewhat nipple-shaped *sub-anal styles* (*sa. sty.*) at its posterior margin. The two styles lie close to each other on either side of the mid-ventral line. Arising from the pleuro-ventral region, adjacent to the outer lateral margins of the podical plates, there is on either side a setose process called the *anal cercus* (*a. c.*).

It is not possible to distinguish the sexes in the soldier caste.

VII—SUMMARY

1. The external morphology of the soldier caste of *Odontotermes obesus* (Rambur) was studied from material collected around Dehra Dun.

2. The antennal segments vary from 15 (rarely) to 17, the usual number being either 16 or 17. The number may vary in the same individual.

3. The labrum shows a more or less bilaterally symmetrical arrangement of the setae whose number varies from 9-12 on either side.

4. The hypopharynx consists only of the lingua.

5. The meso- and metathoracic segments possess a pair of spiracles each.

6. The pleuron in the meso- and metathoracic segments differs from that of the prothoracic segment in the arrangement of the sclerites.

7. All the abdominal segments except the first have a corresponding sternite. The first sternite is atrophied.

8. A pair of podical plates represent the tenth sternum.

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EXTERNAL MORPHOLOGY OF THE TERMITE, *ODONTO
TERMES OBESUS* (RAMBUR) (ISOPTERA : TERMITIDAE).
PART 2. ALATE AND WORKER

By

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(With 1 Table and 12 Text-figures)

CONTENTS

	PAGE
I—Introduction	229
II—Material and Methods	230
III—Morphology of the Alate	230
1. Head	230
2. Cervix	235
3. Thorax	235
4. Abdomen	241
IV—Morphology of the Workers	244
1. Head	244
2. Thorax and abdomen	248
V—Summary	249
VI—References	250

I—INTRODUCTION

In Part 1 of this series (Kushwaha, 1955, 1960), the external morphology of the soldier caste was described. In the present part, an account of the external morphology of the alates and the worker caste is presented. On the whole, except in body-size, the workers distinctly resemble the alates in the configuration of the head ; and the soldiers rather than the alates in the configuration of the thorax and abdomen. Where the alates and workers do not differ materially from the soldier caste already described, this fact is mentioned and a detailed description avoided.

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II—MATERIAL AND METHODS

The material for study of the workers and alates was collected from mounds in the areas of New Forest and Jhajra Forest near Dehra Dun (U. P.), *ca.* 2,000 ft. above sea-level. For permanent mounts, specimens were treated with a hot 1 per cent. water solution of KOH for a few minutes, left over-night in the cold solution, and then dissected, suitably washed, stained and mounted in canada balsam.

III—MORPHOLOGY OF THE ALATE

1. Head

(a) *General.*—The flexible and translucent cuticle of the head is much more chitinized in alates than in soldiers and workers. The general dorsal colour of the head is dark brown or fuscous approaching black. Anterior to the clypeo-frontal suture (and including the ocelli which are present posterior to it) the colour changes to pale cadmium yellow. The compound eyes and the mandibular teeth are almost black. Ventrally, the head is paler.

The head (Text-fig. 1*d-f*) is more or less rounded and hypognathous. The long axis of the head is inclined almost vertically. The mouth-parts are directed downwards and the facial area forwards. There is bilateral symmetry except for the mandibles which present asymmetry in respect of their teeth. The cranium is antero-posteriorly flattened, when considering the apical direction, with the proximal half hemispherical and gradually narrowed anteriorly. Internally it is supported by an endoskeletal structure, the tentorium (*vide infra*).

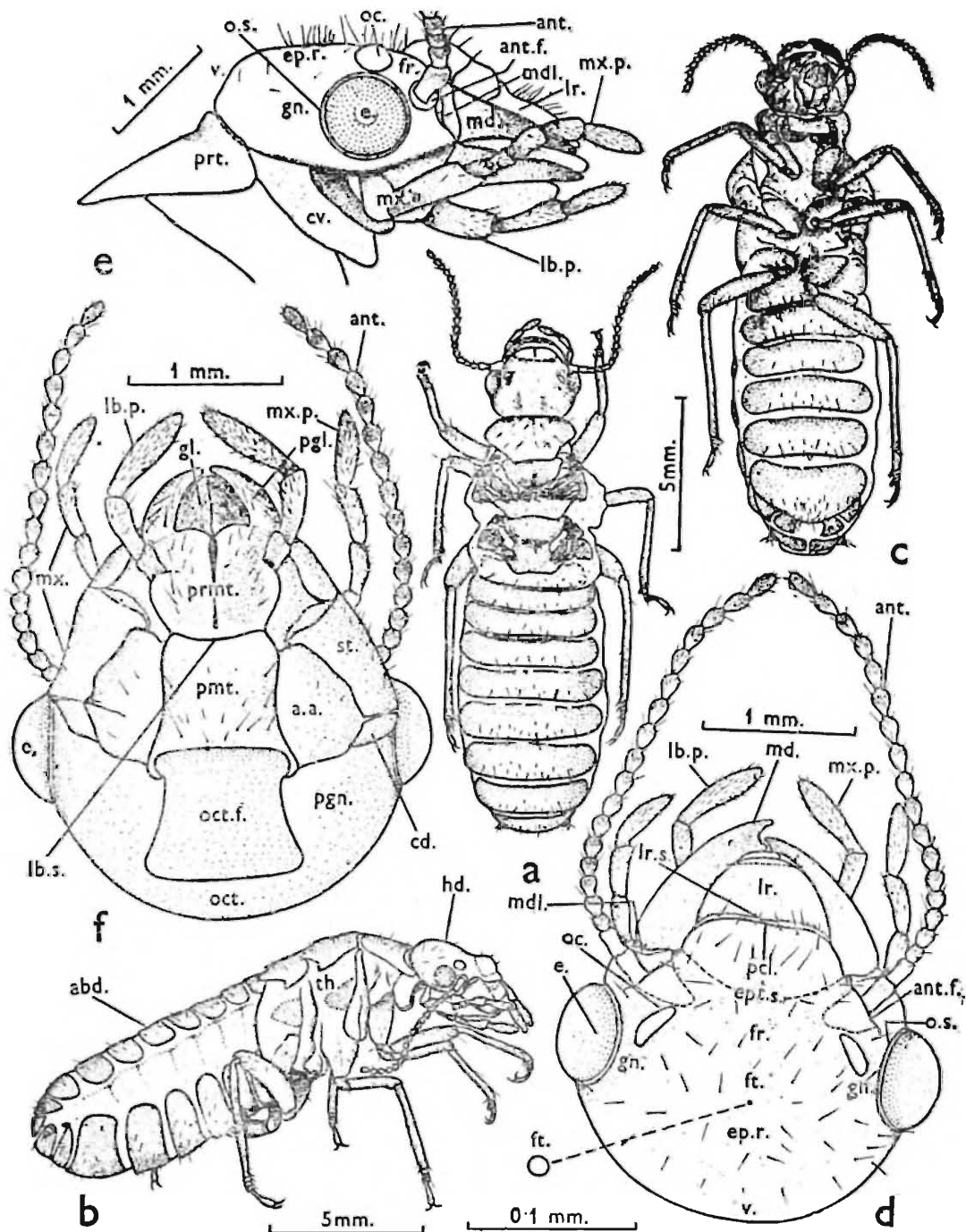
The mouth-parts are of the mandibulate type, directed downwards and are located in their same relative positions as in the soldier. The chief difference from the soldier is that the mandibles and the postmentum are not so much elongated in the alates.

The paired compound eyes (Text-fig. 1*d-f*) and the ocelli (Text-fig. 1*d-f*) are well developed and located laterally and symmetrically on the cranium just above the antennal foveolae. The cornea of the compound eyes is, as usual, divided into numerous hexagonal facets. The two lateral ocelli are reniform and lie inner to the compound eyes. There is no median ocellus. The antennae originate within the antennal foveolae just above the base of the mandibles.

(b) *Sutures of the cranium* (Text-figs. 1*d-f* and 3).—The principal sutures of the cranium are: (i) the labral (*lr. s.*); (ii) the *epistomal* or

clypeo-frontal (*ept. s.*) ; and (iii) the *ocular* (*o.s.*) sutures dorsally ; and iv) the *postoccipital* (*poct. s.*) and (v) the *labial* (*lb. s.*) sutures ventrally.

The clypeo-frontal or epistomal suture, together with a prominent^t median longitudinal fold on the clypeus present in the alates, is suppressed in the soldiers. On the other hand, the gular suture,



TEXT-FIG. 1.—*Odontotermes obesus* (Rambur), alate caste.

(a). Whole body, dorsal view. (b). Same, lateral view. (c). Same, ventral view. (d). Head, dorsal view (Fontanelle, *ft.*, magnified separately). (e). Head, lateral view. (f). Head, ventral view.

a.a., an articulating area ; *abd.*, abdomen ; *ant.*, antenna ; *ant. f.*, antennal foveola ; *cd.*, cardo ; *cv.*, cervix ; *e.*, eye ; *ep. r.*, epicranial region ; *ept. s.*, epistomal suture ; *fr.*, frons ; *ft.*, fontanelle ; *gl.*, glossa ; *gn.*, gena ; *hd.*, head ; *lb. p.*, labial palp ; *lr.*, labrum ; *lr. s.*, labral suture ; *md.*, mandible ; *mdl.*, mandibularia (or trochantin of mandible) ; *mx.*, maxilla ; *mx. p.*, maxillary palp ; *oc.*, ocellus ; *oct.*, occiput ; *oct. f.*, occipital foramen ; *o.s.*, ocular suture ; *pcl.*, postclypeus ; *pgl.*, paraglossa ; *pgn.*, postgena ; *pmt.*, postmentum ; *prmt.*, prementum ; *prt.*, pronotum ; *st.*, stipes ; *th.*, thorax ; *v.*, vertex.

characteristic of the heads of some prognathous insects and which is also present in the soldiers here, is suppressed in the alates.

(c) *Arcas of the cranium* (Text-figs. 1d-f and 3).—All the cranial areas discussed in the soldier caste are present in the alates in the same relative positions. The chief differences from that of the soldier are as follows:—

- (i) The epicranial region is less extensive than in the soldier.
- (ii) The frons is separated from the clypeus by the clypeo-frontal or epistomal suture.
- (iii) The fontanelle is circular and very distinct in the alates, being visible even under a low magnification, and is situated approximately in the middle of an imaginary line joining the upper margins of the two compound eyes.
- (iv) The postocciput region is more conspicuous here than in the soldier.
- (v) Unlike as in the soldier, the postmentum is greatly displaced anteriorly and is set apart from the postgenae. There intervenes an area between the cardo and stipes of the maxilla and the postmentum of the labium on either side. This area may be designated as an *articulating area* (a.a.) and has been shown as such by Imms (1948) also in the larva of *Embaphion* sp. (Coleoptera: Tenebrionidae).

(d) *Tentorium* (Text-figs. 2a and 3).—As in the soldier, the tentorium supports the cranium, its inner contents and the *anterior articulation of the mandibles* (Text-fig. 2b, *at.a.md.*). The corporotentorium (*ctm.*), however, is here considerably shortened, and forms a narrow, transverse band in conformity with the cranial length.

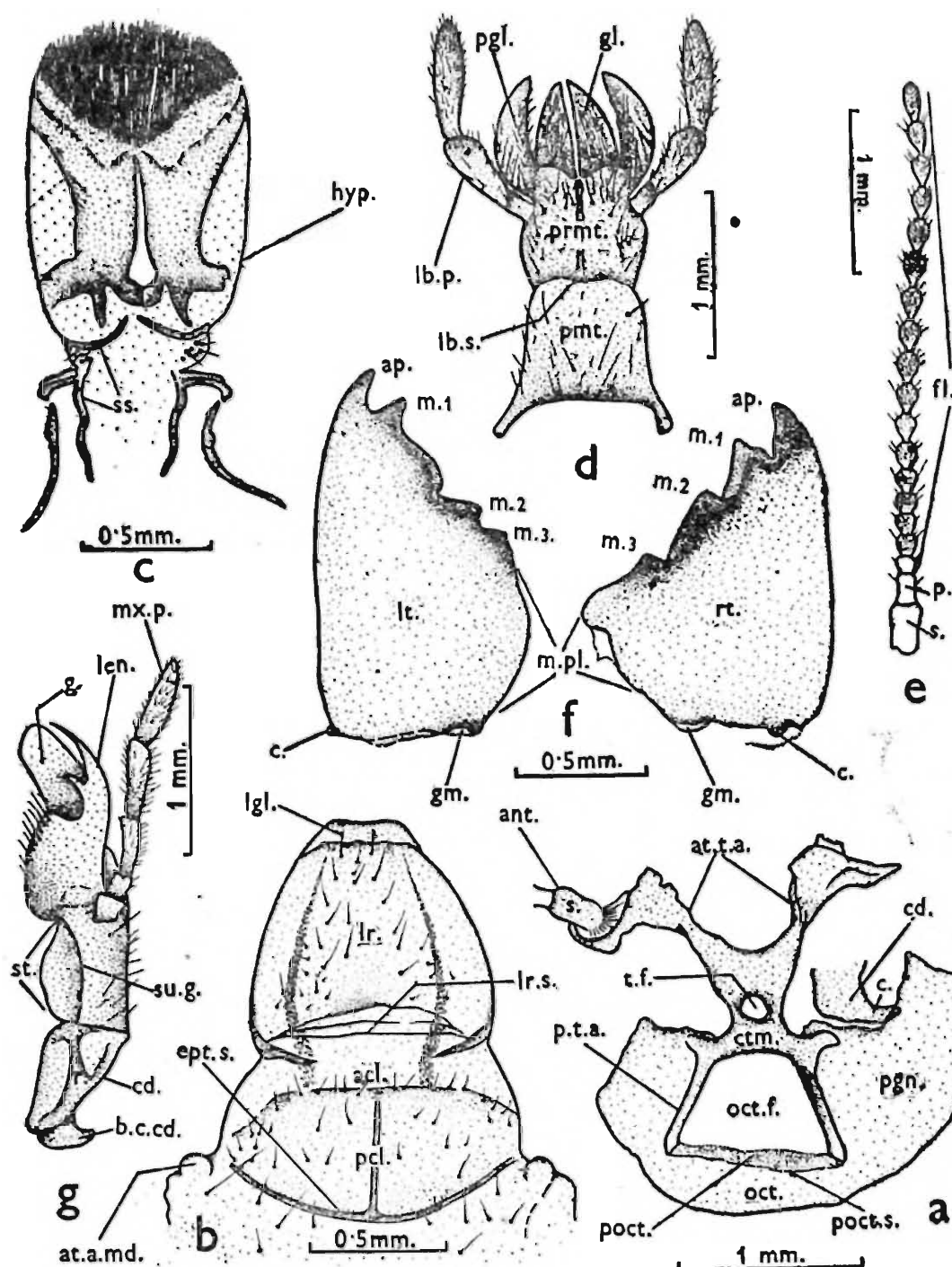
The *anterior tentorial arms* (*at.t.a.*) are as in the soldier, and the *tentorial foramen* (*t.f.*) is of about the same size when the relative size of the tentorium is taken into account.

The *corporotentorium* extends laterally and ends in stumpy processes which become confluent with the postgenae and overlie the postero-lateral angles of the postmentum, near the points where the cardines of the first maxillae articulate. The posterior margin of the corporotentorium is concave and the posterior arms are prolonged posteriorly, bounding the occipital foramen anteriorly and laterally. In the soldier, on the other hand, the posterior arms are fused with the postero-lateral angles of the postmentum at the lateral margins and do not extend much beyond the anterior margin of the occipital foramen.

(e) *Head-appendages*.—All the head-appendages found in the soldier also occur in the alates in the same relative position. The shape of the mandibles, labium and antennae, however, differ strikingly from that in the soldiers.

The *labrum* (Text-fig. 2b, *lr.*) is a broad, flat lobe gradually narrowing distally to end in a hyaline tip known as *lingula* (*lgl.*). Basally, at the lateral margins on the labral suture (*lr.s.*), lies a narrow subtriangular chitinized sclerite, the *torma* (indicated in the figure as dark shaded area). There is a membranous fold ventrally, called *palatum* (Cook, 1944), showing numerous microscopic processes densely distributed in a narrow longitudinal area on either side. The setae are arranged in a more or less orderly manner, in rows converging distally.

The *hypopharynx* (Text-fig. 2c, *hyp.*) is located in the same relative position as in the soldier, but differs in the fact that the free distal portion is broad and densely fringed with fine hair-like or ciliary structures.

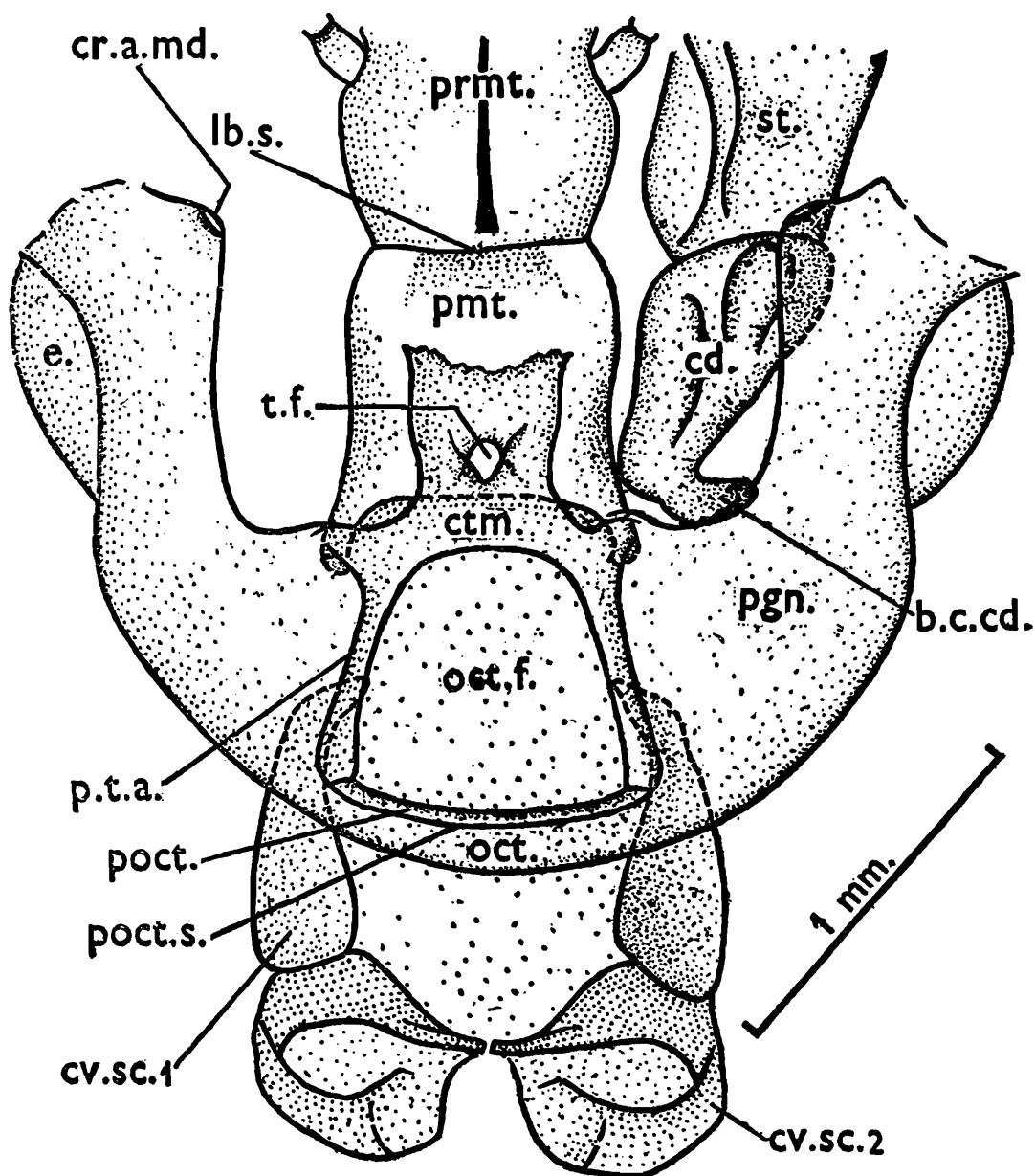


TEXT-FIG. 2.—*Odontotermes obesus* (Rambur), alate caste.

(a). Tentorium with ventral wall of cranium (without head-appendages). (b). Dorsal view of labrum and clypeus. (c). Hypopharynx. (d). Labium, ventral view. (e). Right antenna. (f). Left and right mandibles. (g). Maxilla.

acl., anteclypeus; *ant.*, antenna; *ap.*, apical tooth of mandible; *at. a. md.*, anterior articulation of mandible; *at. t. a.*, anterior tentorial arm; *b.c.cd.*, basal condyle of cardo; *c.*, condyle of mandible; *cd.*, cardo; *ctm.*, corporotentorium; *ept.s.*, epistomal suture; *fl.*, flagellum; *g.*, galea; *gl.*, glossa; *gm.*, ginglymus; *hyp.*, hypopharynx; *lb.p.*, labial palp; *lb.s.*, labial suture; *len.*, lacinia; *lgl.*, lingula (hyaline tip of labrum); *lr.*, labrum; *lr.s.*, labral suture; *lt.*, left; *m.1.*, *m.2.*, *m.3.*, marginal teeth of mandible; *m.pl.*, molar plate of mandible (or molar lobe, mola, pars molaris); *mx. p.*, maxillary palp; *oct.*, occiput; *oct.f.*, occipital foramen; *p.*, pedicel; *pcl.*, postclypeus; *pgn.*, postgena; *pmt.*, postmentum; *p.oct.*, postocciput; *p.oct.s.*, postoccipital suture; *prmt.*, prementum; *rt.*, right; *s.*, scape; *st.*, stipes; *su.g.*, sutural groove of stipes; *t.f.*, tentorial foramen.

Laterally, it is supported by conspicuous chitinized areas in addition to other rod-like basal *suspensorial sclerites* or apodemes (ss.) as in the soldier. The *salivary duct* opens below the hypopharynx.



TEXT-FIG. 3.—*Odontotermes obesus* (Rambur), alate caste.

Ventral wall of cranium, showing points of attachment of the tentorium, labium, maxilla and cervix (complete).

b.c.cd., basal condyle of cardo; cd., cardo; cr.a.md., cranial articulation of mandible; ctm., corporotentorium; cv.sc.1, first cervical sclerite; cv.sc.2, second cervical sclerite; e., eye; lb.s., labial suture; oct., occiput; oct.f., occipital foramen; pgn., postgena; pmt., postmentum; poct., postocciput; poct.s., postoccipital suture; prmt., prementum; st., stipes; t.f., tentorial foramen.

The *labium* shows two regions, viz., a proximal *postmentum* and a distal *prementum* (Text-fig. 2d.) The *postmentum* is a more or less trapezoidal sclerite. It is much reduced than in the soldier, the reduction in size being in conformity with the reduction in the length of the cranium. Its postero-lateral angles point backwards and somewhat outwards. The *postmentum* does not lie directly below the corporotentorium due to the forward displacement of the former. The slightly arched, concave posterior transverse margin leans forward in front of the

anterior margin of the tentorial body, but the postero-lateral angles join the postgenae immediately below the stumpy processes of the corporo-tentorium. The *prementum* is as in the soldier, but the median longitudinal fold dividing the prementum into two halves is more pronounced. In the *ligula*, the glossae and paraglossae are more or less separately marked from the prementum by a transverse suture. The segments of the labial palpi, starting from the proximal one, vary in the following proportions : 5 : 13 : 20. In other respects the alates resemble the soldier.

The *antennae* (Text-fig. 2e) are moderately pilose and bristled. The main difference from the soldier caste lies in the number of segments, which is 19 in alates. The basal segment or *scape* (s.) is the thickest segment and is subequal to or smaller than segments 2+3. The second segment or *pedicel* (p.) is about twice as long as the third segment. The apical segment is oval and is smaller than the scape but subequal to the pedicel.

The *mandibles* (Text-fig. 2f) are adapted for crushing the food and are, therefore, very different from that of the soldier where they serve only the defence. The alate mandibles are broad, flat, subtriangular, with nearly straight margins, and the inner margins bear several blunt teeth. The mandibles are hinged by the condyle and the ginglymus. The mandibular length (from the basal condyle to the tip of the apical tooth) varies from 1.21—1.43 mm. In the left mandible (*lt.*) there are two large teeth near the apex, viz., the apical tooth (*ap.*) and the first tooth (*m.1.*), followed by two smaller teeth (*m.2.* and *m.3.*) adjacent to the *molar plate* or *pars molaris* (*m. pl.*). The right mandible (*rt.*) possesses four large teeth (*ap.*, *m.1.*, *m.2.*, and *m.3.*); the molar plate (*m. pl.*) is uneven and convex.

The *maxillae* (Text-fig. 2g) are as in the soldier but differ in size and in the point of attachment with the cranium. In the soldier they are articulated at the blade of gula in the angle where the postgenae become free from the postmentum, whereas in the alates, the cardines (Text-fig. 3, *cd.*) articulate where the postero-lateral angles of the postmentum join the postgenae. The 5 segments of the *maxillary palpi* are mutually related in length in the following proportion, starting from the proximal segment : 9 : 10 : 22 : 26 : 31.

2. Cervix

(Text-figs. 3 and 5a)

The cervix closely resembles that of the soldier in respect of their sclerites (*cv. sc. 1* and *cv. sc. 2*), their structure and attachment.

3. Thorax

(Text-figs. 4 ; 5b, c, and 6a, b)

(a) *The main body of thorax.*—The thorax is divided into two portions, viz., an anterior prothoracic part and a posterior, wing-bearing, meso-metathoracic part termed *pterothorax* by Snodgrass (1935). The two wing-bearing segments of the pterothorax are subequal but differ

from the prothorax structurally in respect of the terga, pleura and sterna. These modifications, as in other Pterygote insects, are adaptations for the movement of the wings:

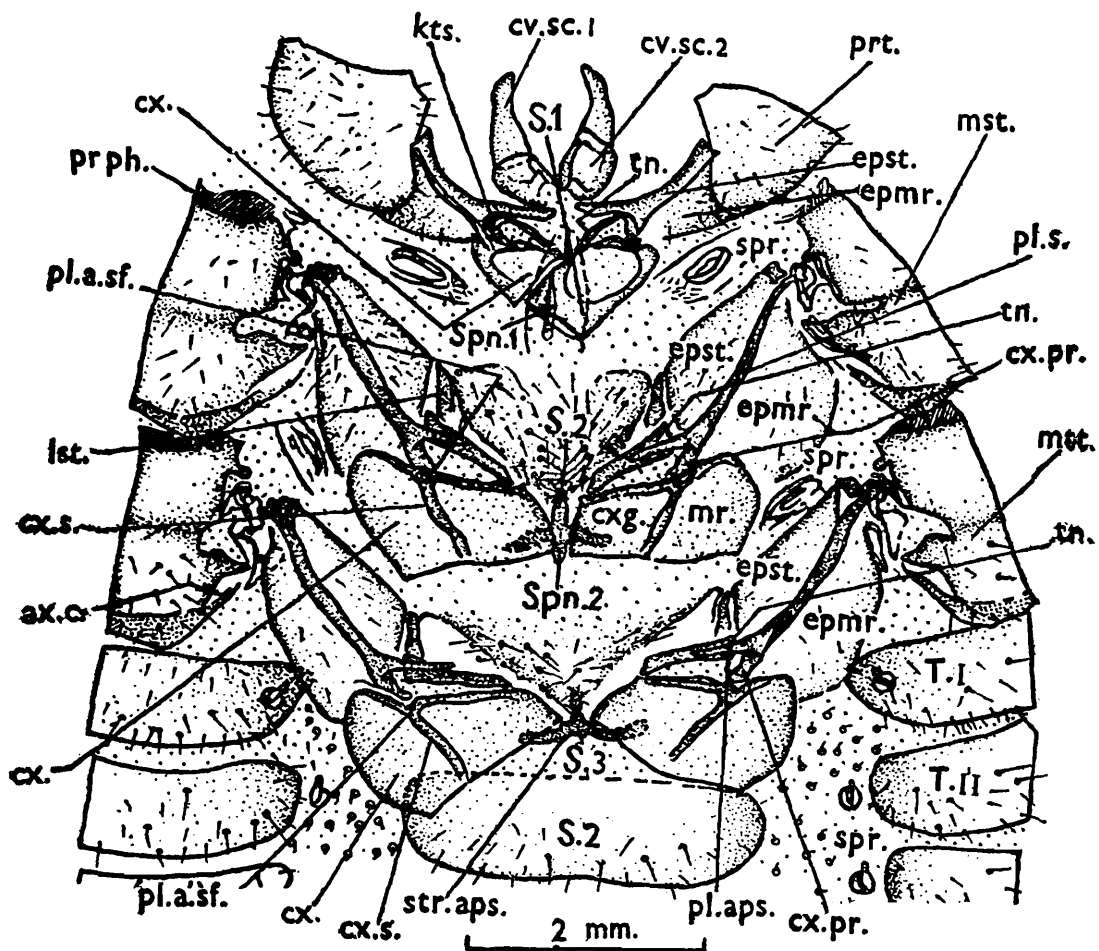
The *pronotum* is the more indurated and pigmented of the three thoracic tergites. It is nonsellate, flat, trapezoid, with the anterior margin wider than the posterior and the antero-lateral corners rounded. It is nearly twice as broad as long and is moderately bristled. It is somewhat notched medially at its anterior margin and mildly incurvated medially at its posterior margin. The dorsal field or profile is straight or slightly arched, but has no anterior hood-like structure or lobe as is present in the soldier. The anterior margin is nearly entire, reduplicated or folded, and is continuous with the neck-membrane and the pleural-membrane. There are no anterior or posterior notal ridges or prephragma.

The *mesonotum* (*mst.*) and *metanotum* (*mtt.*) are nearly alike, and differ greatly from the pronotum. Each of the former is characteristically divisible medially and transversely at its narrowest point into two pigmented regions—an anterior narrower region or *scutum* (*sct.*) and a posterior, wider region or *scutellum* (*scl.*). The scutum is bounded at its anterior margin by the *anterior notal ridge* (*a. n. r.*) which protrudes laterally as a stumpy *anterior notal wing process* (*a.n.p.*). Antero-ventrally the notal ridge is produced into the bilobed *prephragma* (*prph.*). The scutellum stretches antero-laterally into an angular, *posterior notal wing process* (*p.n.p.*) on either side. It slightly tapers caudally, and its hind margin is weakly incurved and folded ventrally so as to form a marginal cord-like rim called the *axillary cord* (*ax. c.*). Thus, the axillary cord arises ventrally from the postero-lateral angles of the pterothoracic notum and continues laterally to the wings to strengthen the inner or anal margin of each wing basally.

There are two pairs of conspicuous thoracic *spiracles* (*spr.*), each pair situated in the pleural region of the meso- and metathoracic segments. Their oblique, slit-like openings are guarded externally by two strongly chitinized, deeply staining lips.

The pleural membrane is uniformly clothed with fine, minute hairs, each of which arises from the centre of a circular, deeply staining area. The pterothoracic pleura differ markedly from that of the prothoracic region in that the pleural sclerotization of the latter lacks the alar elements which are characteristic of the former. In the pterothorax the well developed pleural sclerotization is, as usual, divided by the pleural suture into an *episternum* (*epst.*) and an *epimeron* (*epmr.*). Both the internal *pleural ridge* and the *pleural suture* (*pl. s.*) reinforcing the pleuron above the coxa extend from the *coxal process* (*cx.p.*) upwards into the *pleural wing process* (*w.p.*). The *pleural apophysis* (*pl. aps.*) projects downwards and inwards, as in the soldier. The corresponding *sternal apophysis* (*str. aps.*) associated with it is also very distinct here. The position and the structure of the episternum in all the three thoracic segments is nearly the same as in the soldier, except in size. The prothoracic episternum is a rigid, rod-like collar-band hanging downwards from the pronotum. The episternum in the meso- and metathoracic segments of

the soldier extend ventrally anterior to the coxa forming the precoxal bridge or precoxale, whereas in the alates the precoxal region forms a distinct sclerite separated from and lying in between the episternum, the trochantin and the sternum. This is a small, somewhat triangular sclerite called the *laterosternite* (*lst.*). The prothorax lacks this sclerite. According to Fuller (1924), the laterosternite was described as "pre-sternum" by Snodgrass (1909) and as "epimeral sternite" by Holmgren (1909). Fuller himself (1924) had borrowed the term from Crampton (1914) who had stated that it is present in both the pterothoracic segments of the termites only.



TEXT-FIG. 4.—*Odontotermes obesus* (Rambur), alate caste.

Thorax, showing the various ventral and lateral sclerites and the attachment of the coxae, together with the tergites cut medially along the longitudinal axis and spread out flat on either side.

ax.c., axillary cord ; cv. sc.1, first cervical sclerite ; cv.sc.2, second cervical sclerite ; cx., coxa ; cx.g., coxa genuina ; cx.pr., coxal process ; cx.s., coxal suture ; epmr., epimeron ; epst., episternum ; lst., latero-sternite ; mr., meron ; mst., mesonotum ; mlt., metanotum ; pl. aps., pleural apophysis ; pl. a. sf., pleural articular surface ; pl.s., pleural suture ; prph., prephragma ; prt., pronotum ; S₁-S₃, sterna 1-3 ; spr., spiracle ; str. aps., sternal apophysis ; T.I., T.II, terga first and second ; tn., trochantin of leg.

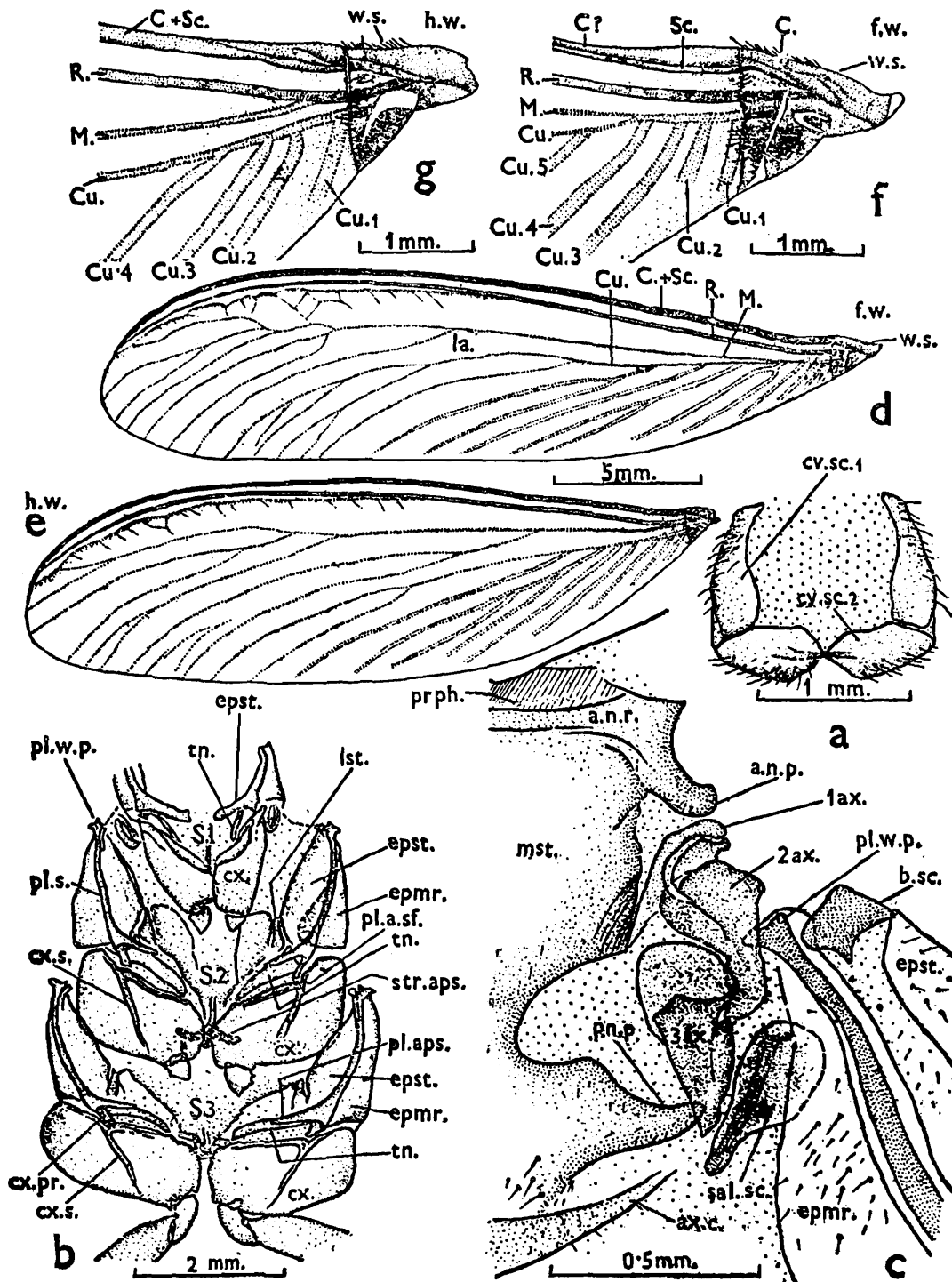
In the pterothorax, the *epimeron* (*epmr.*) occupies the same post-sutural position (adjacent to the episternum) as in the soldier, but the prothoracic epimeron in the present caste is a smaller sclerite than those of the pterothorax. In the soldier the prothoracic epimeron was described as a posteriorly directed, narrow sclerite attached at the base of the episternum below the pronotum.

The *trochantin* (*tn.*) of the pterothoracic segments is well developed, broad, elongated and triangular, with its tapering ventral end bluntly rounded to form the *trochantinal articulation of the coxa*. The trochantin of the prothorax, however, is narrower and more slender. Another prothoracic pleural sclerite known as the *katepisternum* (*kts.*) is present as a curved, arm-like process occupying the same position as in the soldier; it articulates with the trochantin and is associated closely with the proepisternum.

The *thoracic sternum* (*S. 1, S. 2, S. 3*) located in between the coxae is also designated as "eusternum" by Snodgrass (1935). In the alates, the prosternum (*S. 1*) is represented, as in the soldier, by an elongated or more or less oval sclerite. The sternum in both meso- and metathorax, i.e., the pterothoracic sternum, show no sclerotic continuity and get gradually desclerotised anteriorly. It is, therefore, difficult to distinguish their boundaries anteriorly. Each of the pterothoracic sterna bears posteriorly the paired *furcal arms* or *sternal apophysis* (*str. aps.*) arising from a common stalk. The two divergent prongs of this Y-shaped endosternal apodeme or furca are closely associated with the pleural apophysis on either side. The corresponding intersternites known as *spinasterna* (*Spn. 1, Spn. 2*) as described in soldier caste are also present here. The *spinasterna* (*Spn. 1*) between prothorax and mesothorax is similarly represented only by a free spine, and the *spinasterna* (*Spn. 2*) between mesothorax and metathorax being similarly united with the mesothoracic sterna and bearing a comparatively reduced spine pointing backwards.

(b) *The legs* (Text-fig. 7, *ai, aii, aiii*).—The three pairs of thoracic legs are subequal and similar in their component parts. They resemble more or less those of the soldier in the general shape of their segments, in the articulating joints and in their attachment with the thorax, but differ in size. All parts of the legs bear fine hairs which are especially dense on the tibiae. The *coxae* (*cx.*) of the pterothoracic legs are very broad. The coxae of all the legs show articular surfaces for the trochantin and for the coxal process of the pleuron. Only the meso- and metathoracic coxae are separately marked into the *meron* (*mr.*) and the *coxa genuina* (*cxg.*) by the deeply inflected *coxal suture* (*cx. s.*), and the two subdivisions occupy the same relative positions as in the soldier. The *trochanter* (*tr.*) is obliquely truncated distally. The *femur* (*fe.*) is short and the *tibia* (*tb.*) long and comparatively slender; the latter is armed with a pair of robust terminal tibial spurs. Of the 4-jointed tarsi, the most distal one or *distitarsus* is the longest and bears a pair of claws together with a proximal plate which is probably the *flexor plate*.

(c) *The wings and their basal sclerites* (Text-figs. 5c-g and 6b, c).—The two pairs of wings are characterized by their similarity in size, form and venation, and also in the fact that they are shed soon after the nuptial flight. There is a conspicuous *humeral or basal suture* (*h. s.*) along which the wing is shed. The proximal part, which is permanently retained, is termed the *wing-stump* or *scale* (*w. s.*), while the part which is shed is termed the *lamina* (*la.*). Since the scale is more chitinized, the basal arrangement of venation is rather indistinct.

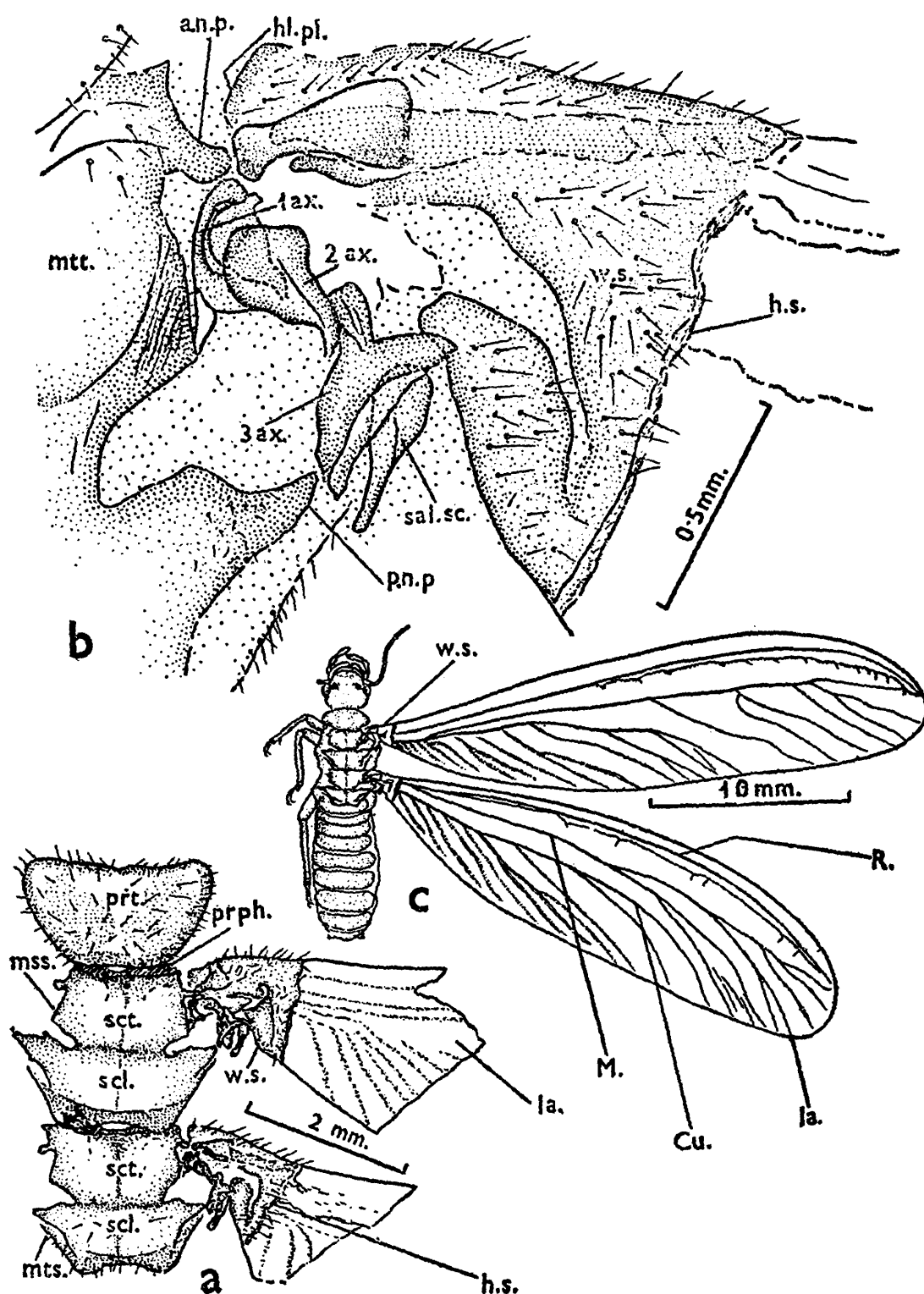


TEXT-FIG. 5.—*Odontotermes obesus* (Rambur), alate caste.

(a). Cervix in ventral view. (b). Thorax, showing the various ventral and lateral sclerites and the attachment of the coxae. (c). Part of pterothoracic tergite, in dorsal view with alar articular sclerites, epipleural sclerites and parts of epimeron and episternum. (d). Left fore-wing. (e). Left hind-wing. (f). Wing scale and part of lamina of the fore-wing. (g). Wing scale and part of lamina of the hind-wing.

a.n.p., anterior notal process ; *a.n.r.*, anterior notal ridge ; *1ax.*, *2ax.*, *3ax.*, first, second and third axillary ; *ax.c.*, axillary cord ; *b.sc.*, basalar sclerite ; *C.*, costal vein ; *C+Sc.*, costal+subcostal vein ; *Cu.*, cubital vein of wing ; *Cu. 1-5*, branches 1-5 of cubital vein ; *cv.sc.1*, first cervical sclerite ; *cv.sc.2*, second cervical sclerite ; *cx.*, coxa ; *cx.pr.*, coxal process ; *cx.s.*, coxal suture ; *epmr.*, epimeron ; *epst.*, episternum ; *f.w.*, fore-wing ; *h.w.*, hind-wing ; *la.*, lamina ; *lst.*, latero-sternite ; *M.*, medial vein of wing ; *pl.aps.*, pleural apophysis ; *pl.a.sf.*, pleural articular surface ; *pl.s.*, pleural suture ; *pl.w.p.*, pleural wing process ; *p.n.p.*, posterior notal wing process ; *R.*, radius vein of wing ; *S.1-3.*, sterna 1-3 ; *sal.sc.*, subalar sclerites ; *Sc.*, subcostal vein ; *str.aps.*, sternal apophysis ; *w.s.*, wing scale.

Each of the fore-and hind-wings is hinged, as usual, to the *anterior notal process* (*a. n. p.*) and the *posterior notal process* (*p. n. p.*) of the respective pterothoracic notum. They also articulate ventrally with the



TEXT-FIG. 6.—*Odontotermes obesus* (Rambur), alate caste.

(a). Thoracic tergites with part of the wings attached. (b). Part of the pterothoracic tergite in dorsal view with alar articular sclerites and wing-scale. (c). Whole body, in dorsal view, with wings of right side stretched out.

a.n.p., anterior notal process; *1ax.*, *2ax.*, *3ax.*, first, second and third axillary; *Cu.*, cubital vein of wing; *hl.pl.*, humeral plate; *h.s.*, humeral suture; *la.*, lamina; *M.*, medial vein of wing; *mss.*, mesosternum; *mts.*, metasternum; *mtt.*, metanotum; *p.n.p.*, posterior notal wing process; *prph.*, prephragma; *prt.*, pronotum; *sal.sc.*, subalar sclerites; *scl.*, scutellum; *sct.*, scutum; *w.s.*, wing scale.

pleural wing process (*pl. w. p.*). As already described, the *axillary cord* supports the posterior margin of each wing at its base.

Situated around the wing-base are the *basal articular sclerites* consisting of three *axillaries* or *pteralia* which participate in the complex joint which articulates the wing with the thorax. The *first axillary* (1 *ax.*) forms the anterior hinge-plate with its anteriorly produced, slender, curved neck and rounded head supported on the anterior notal wing process. Posteriorly it is articulated with the lateral margin of the scutum, and its main body articulates laterally with the second axillary. The *second axillary* (2 *ax.*) is slightly curved and is obliquely hinged to the curved neck of the first axillary to form the pivotal sclerite which rests upon the fulcral wing-process ventrally. The *third axillary* (3 *ax.*) is the posterior hinge-plate and articulates anteriorly with the second axillary and posteriorly with the posterior notal wing-process. It is somewhat Y-shaped, with a bicuspid tip which is pivoted upon the posterior notal process. It provides insertion to the flexor muscle which produces flexion of the wing.

In addition to the above, there is another sclerite associated with the anterior margin of the wing proximally. Most probably it represents the *humeral plate* (*hl. pl.*).

The *epipleural sclerites* are also located below the wing bases. Since they are closely associated with the wings, they are referred to here. Two of them are present, one on each side of the pleural wing process. The *anterior* or *basalar sclerite* (*b. sc.*) is somewhat quadrangular and lies above the episternum, while the *posterior* or *subalar sclerite* (*sal. sc.*) lies slightly behind the pleural wing process above the epimeron.

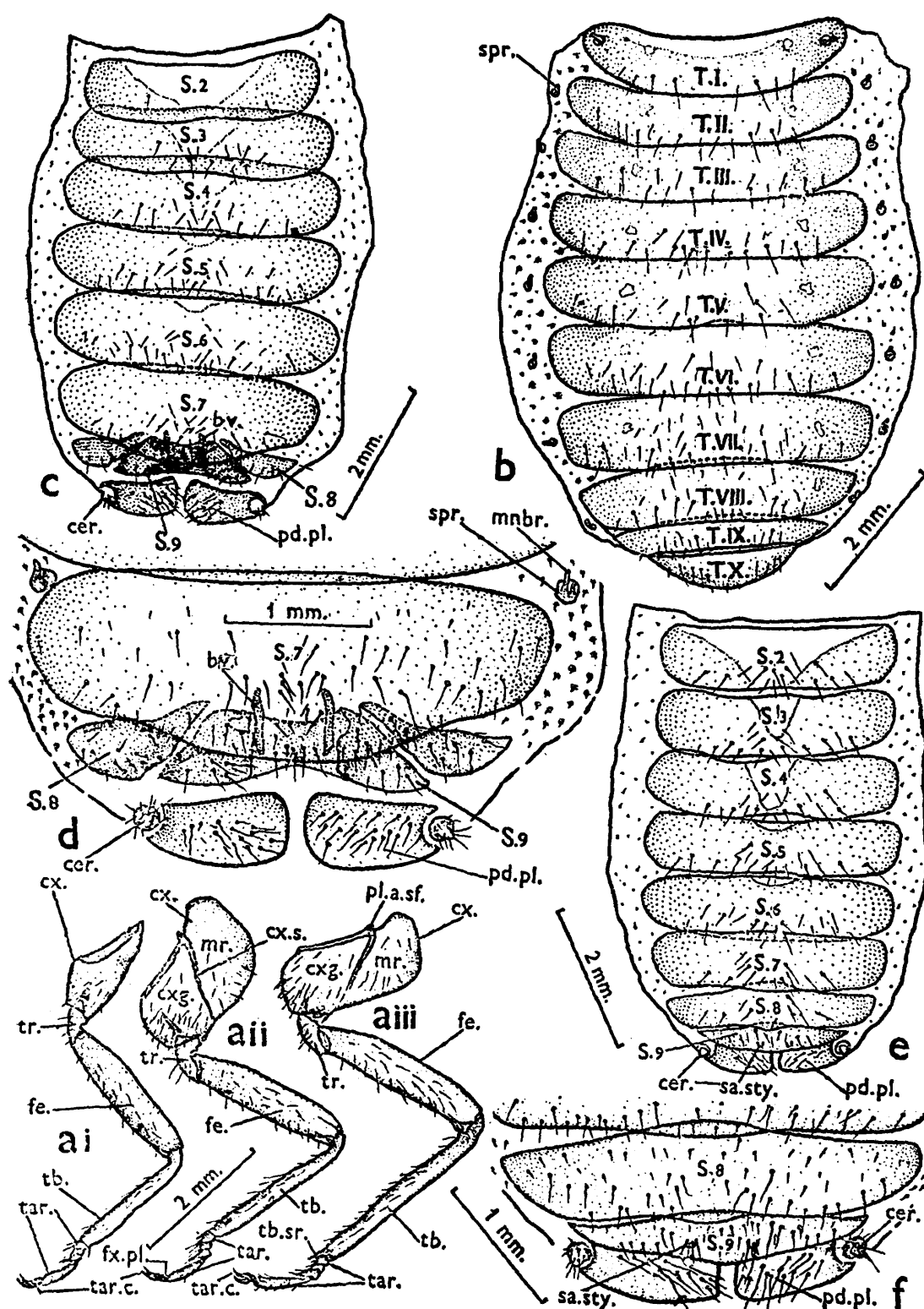
The specialization of the wing venation in *Odontotermes obesus* is evident by a reduction of some of the anterior veins as in *Heterotermes* [*Leucotermes*] and other higher Isoptera (*vide* Imms, 1948). The *costa* and *subcosta* (*C. + Sc.*) are probably fused with the costal margin which is greatly thickened. The *radius* (*R*) is represented as a stout and unforked vein which may, according to Imms (1948), be $R\ 4 + 5$. Before entering the wing scale of the hind wing the radius is joined by the media whereas in the case of forewing the media runs closer to the cubitus and not joining the radius. The *media* (*M*) branches in the distal half to give several accessory branches which occupy most of that region. The *cubitus* (*Cu*) is another multi-branched vein occupying the remaining proximal region of the wing.

4. *Abdomen*

(Text-fig. 7 b-f)

The abdomen is broadly attached to the thorax and distinctly segmented into 10 segments, though some of the postgenital segments, particularly in the females, are considerably reduced and modified. As in Isoptera in general, the first abdominal tergum is very closely attached to the metanotum.

Of the eight abdominal pairs of *spiracles* (*spr.*), the first pair is larger and is situated at the lateral edges of the first tergum. The remaining seven pairs are situated on the pleural membrane near the lateral margins



TEXT-FIG. 7.—*Odontotermes obesus* (Rambur), alate caste.

(ai, aii, aiii). Fore-, middle-, and hind-legs respectively, of the right side. (b). Dorsal view of the abdominal tergites. (c). Ventral view of the abdominal sternites of female. (d). Same, only VII, VIII, IX, and X (podical plates) sternites, magnified. (e). Ventral view of the abdominal sternites of male. (f). Same, only VIII, IX and (podical plates) sternites, magnified.

bv., basivalvulae; *cer.*, cercus; *cx.*, coxa; *cxg.*, coxa genuina; *cx.s.*, coxal suture; *fe.*, femur; *fx.pl.*, flexor plate; *mnbr.*, manubrium; *mr.*, meron; *pd. pl.*, podical plates; *pl.a.sf.*, pleural articular surface; *S.2-9.*, sterna 2-9; *sa.sty.*, sub-anal styles; *spr.*, spiracle; *T.I.*, *T.II.*, — *T.X.*, terga first, second, to tenth; *tar.*, tarsus; *tar.c.*, tarsal claw; *tb.*, tibia; *tb.sr.*, tibial spur; *tr.*, trochanter.

of their corresponding terga, i.e., terga 2-8. In each spiracle the integument seems to get inflected to form a movable and an immovable wall, the former being conspicuously prolonged into a *process* or *manubrium* (*mnbr.*).

Following Snodgrass (1935), for insects in general, segments VIII and IX of the female and the IX segment of the male may be termed here as the *genital segments*; those preceding them as the *pregenital* or *visceral segments*; and those following them as the *postgenital segments*.

Corresponding to the 10 segments, there are 10 tergites (TI-TX), nearly uniform in their structure and arrangement except that the posterior ones are somewhat narrower and smaller in size. The first sternite is absent, as in soldier; only sterna 2-10 being present—the second sternum is, therefore, the first visible sternum. In the females of alates the genital plate or VII sternite is greatly developed. Both paragenital or VIII sternite and the subgenital or IX sternite, have undergone reduction in size. The VIII sternite is split up into a pair of considerably reduced sclerites with their tapering ends obliquely directed forwards and situated outwards on either side of the IX sternite. The latter occupies the inner position in between the sclerites of the VIII sternite. The paired, narrow and linear sclerites adjacent to the anterior border of the IX sternite are the *basivalvulae* (*bv.*).

In the males there is no marked modification in the VII, VIII and IX sternites, except that the last one is very narrow. A pair of small, unjointed, setose, nipple-shaped and closely set *subanal styles* (*sa. sty.*) are borne on the IX sternite of the males alone.

The X sternite is represented in both the sexes by a pair of broad *podical plates* (*pd. pl.*) which are densely hirsute. Adjacent to their outer lateral margins on either side are situated the *anal cerci* (*cer.*).

The sternites of the alates of termites have been variously named. Fuller (1924) suggested the term *genital plate* for the VII sternite, *paragenital* for the VIII, *subgenital* for the IX, and *subanal plates* for the X sternite. Imms (1948) termed the enlarged VII sternite as the *subgenital plate*.

Roonwal (1956) has recently provided illustrations of the genital segments of the two sexes of *Odontotermes obesus* alates, and a summary of the position as occurring in Isoptera in general. He has also given a critically revised terminology of the external genitalia and associated structures of the Isoptera.

The arrangement of the abdominal segments in the two sexes may be expressed as in Table 1.

TABLE 1.—*The segmental position of the abdomen of alate in Odontotermes obesus (Rambur).*

Note.—Roman numerals denote the abdominal segments ; those enclosed in a circle are completely atrophied, while those enclosed within brackets are reduced. The presence of the following body-parts in each segment is indicated by the appropriate abbreviation, thus :—*cer.*, cercus ; *pd. pl.*, podical plate ; *sa. sty.*, subanal styles ; *spr.*, spiracle.

Sclerites

Male

Tergites	I spr.	II	III	IV	V	VI	VII	VIII	IX	X
Pleura	—	spr.	spr.	spr.	spr.	spr.	spr.	spr.	—	—
Sternites	I	II	III	IV	V	VI	VII	VIII	IX sa. sty.	(X=pd. pl) cer.

Female

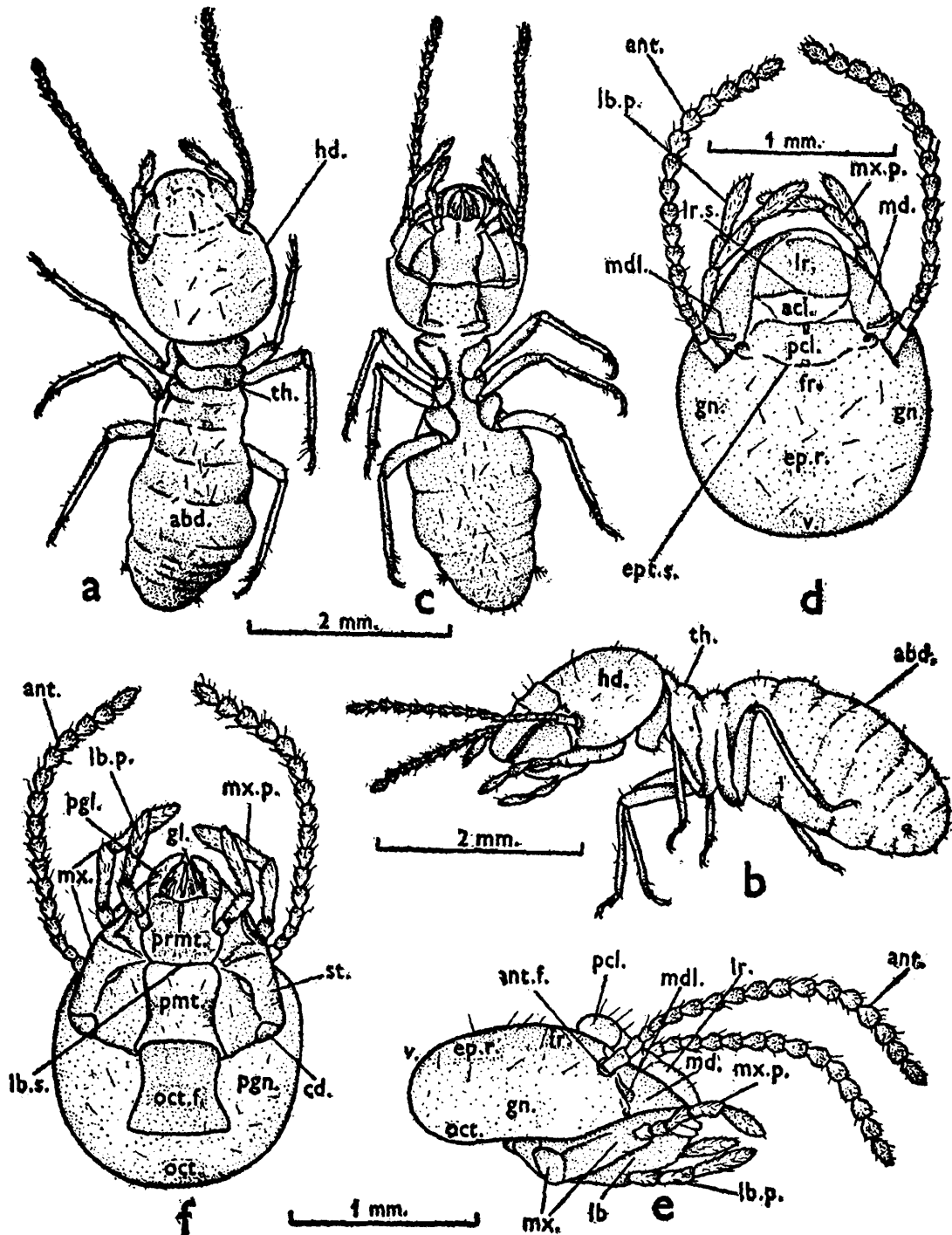
Tergites	I spr.	II	III	IV	V	VI	VII	VIII	IX	X
Pleura	—	spr.	spr.	spr.	spr.	spr.	spr.	spr.	—	—
Sternites	I	II	III	IV	V	VI	VII	(VIII)	(IX)	(X= pd. pl) cer.

IV—MORPHOLOGY OF THE WORKERS

1. Head

(a) *General.*—The head, its appendages and tentorium, together with the cervix, of the worker bear close similarity to that of the alates except in size, the worker head being generally smaller. It is, therefore, not necessary to give a detailed description, and only the particulars in which the worker head differs from that of the alates will be mentioned here. The cuticle is least chitinized in workers as compared to the

soliders and alates. The general colour of the head is pale yellow, with the thorax and abdomen paler still ; the intersegmental areas appear whitish. There are no compound eyes or ocelli.



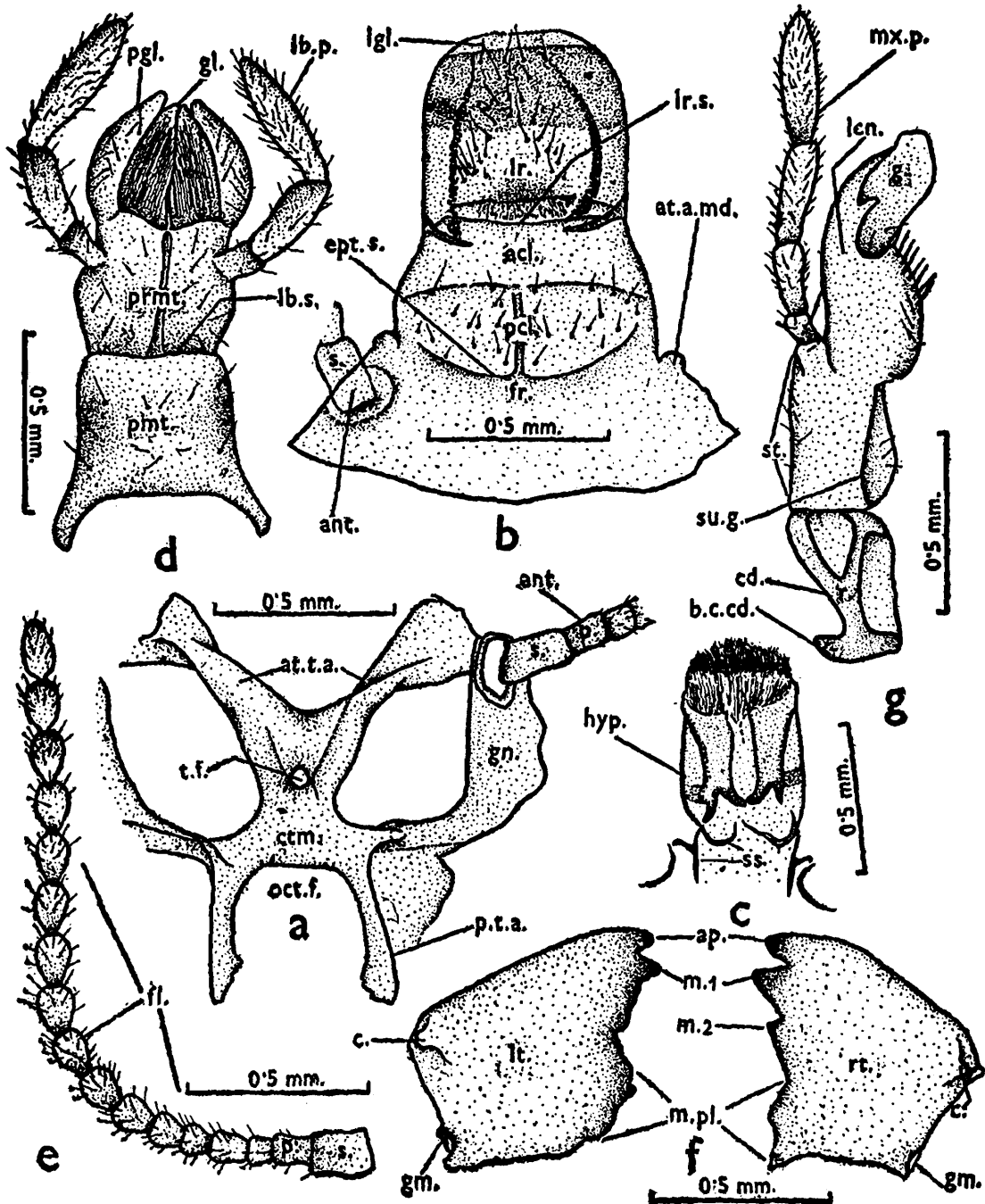
TEXT-FIG. 8.—*Odontotermes obesus* (Rambur), worker caste.

(a). Whole body in dorsal view. (b). Same, in lateral view. (c). Same, in ventral view. (d). Head, in dorsal view. (e). Same, in lateral view. (f). Same, in ventral view.

abd., abdomen ; *acl.*, anteclypeus ; *ant.*, antenna ; *ant. f.*, antennal foveola ; *cd.*, cardo ; *ep.r.*, epicranial region ; *fr.*, frons ; *gl.*, glossa ; *gn.*, gena ; *hd.*, head ; *lb.*, labium ; *lb.p.*, labial palp ; *lr.*, labrum ; *lr.s.*, labral suture ; *md.*, mandible ; *mcl.*, mandibularia (or trochantin of mandible) ; *mx.*, maxilla ; *mx.p.*, maxillary palp ; *oct.*, occiput ; *oct.f.*, occipital foramen ; *pcl.*, postclypeus ; *pgl.*, paraglossa ; *pgn.*, postgena ; *pmt.*, postmentum ; *prmt.*, prementum ; *th.*, thorax ; *v.*, vertex.

All the sutures described in the case of the alates are distinct here except the ocular suture which is suppressed (Text-figs. 8*d,f* and 10).

The workers closely resemble the alates in respect of all the cranial areas (Text-figs. 8 *d-f* and 10), but for the postocciput which is a broader region. The frontal gland is visible but the fontanelle is indistinct. The tentorial foramen is somewhat smaller than that of the soldier (Text-figs. 9*a* and 10).

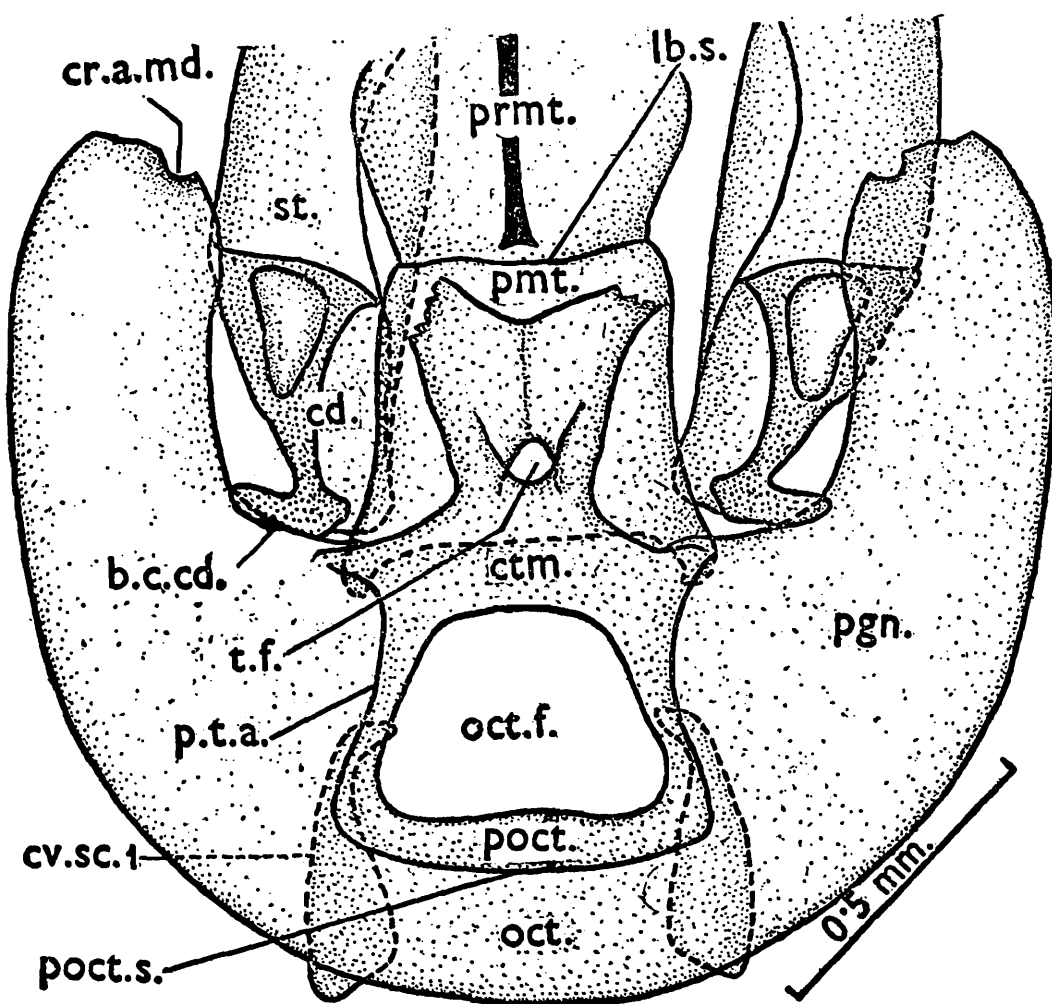


TEXT-FIG. 9.—*Odontotermes obesus* (Rambur), worker caste.

(*a*). Tentorium. (*b*). Dorsal view of labrum and clypeus. (*c*). Hypopharynx. (*d*). Labium in ventral view. (*e*). Left antenna. (*f*). Left and right mandibles. (*g*). Maxilla.

acl., anteclypeus; *ant.*, antenna; *ap.*, apical tooth of mandible; *at.a.md.*, anterior articulation of mandible; *at.t.a.*, anterior tentorial arm; *b.c.cd.*, basal condyle of cardo; *c.*, condyle of mandible; *g.*, galea; *gm.*, ginglymus; *gn.*, gena; *hyp.*, hypopharynx; *lb.p.*, labial palp; *lb.s.*, labial suture; *lcn.*, lacinia; *lgl.*, lingula (hyaline tip of labrum); *lr.*, labrum; *lr.s.*, labral suture; *lt.*, left; *m1*, *m2*, marginal teeth of mandible; *m.pl.*, molar plate of mandible (or molar lobe, mola, pars molaris); *mx.p.*, maxillary palp; *oct.f.*, occipital foramen; *p.*, pedicel; *pcl.*, postclypeus; *pgl.*, paraglossa; *pmt.*, postmentum; *prmt.*, prementum; *p.t.a.*, posterior tentorial arm; *r.*, ridge; *rt.*, right; *s.*, scape; *ss.*, suspensoria; *st.*, stipes; *su.g.*, sutural groove of stipes; *t.f.*, tentorial foramen.

(b) *Head-appendages* (Text-fig. 9b-g).—The *labrum* (*lr.*) has sub-parallel lateral margins which get broadly rounded distally to end in a hyaline tip or *lingula* (*lgl.*). The segments of the *labial palpi* (*lb. p.*), starting from the proximal segment, vary, as regards length in the following proportion : 6 : 16 : 24. The *antennae* (*ant.*) have 17 segments. The *mandibles* (*md.*) are subquadrangular with more or less the same arrangement of teeth on the cutting edges as in alates except that the left one has only two prominent teeth (*ap.* and *m.1*) and the right one only three (*ap.*, *m.1.*, and *m.2.*). The mandibles are 0.73—0.82 mm. long from the basal condyle to the tip of the apical tooth. The proportional lengths of the segments of the *maxillary palpi* from the proximal one onward are as 5 : 6 : 12 : 17 : 21.



TEXT-FIG. 10.—*Odontotermes obesus* (Rambur), worker caste.

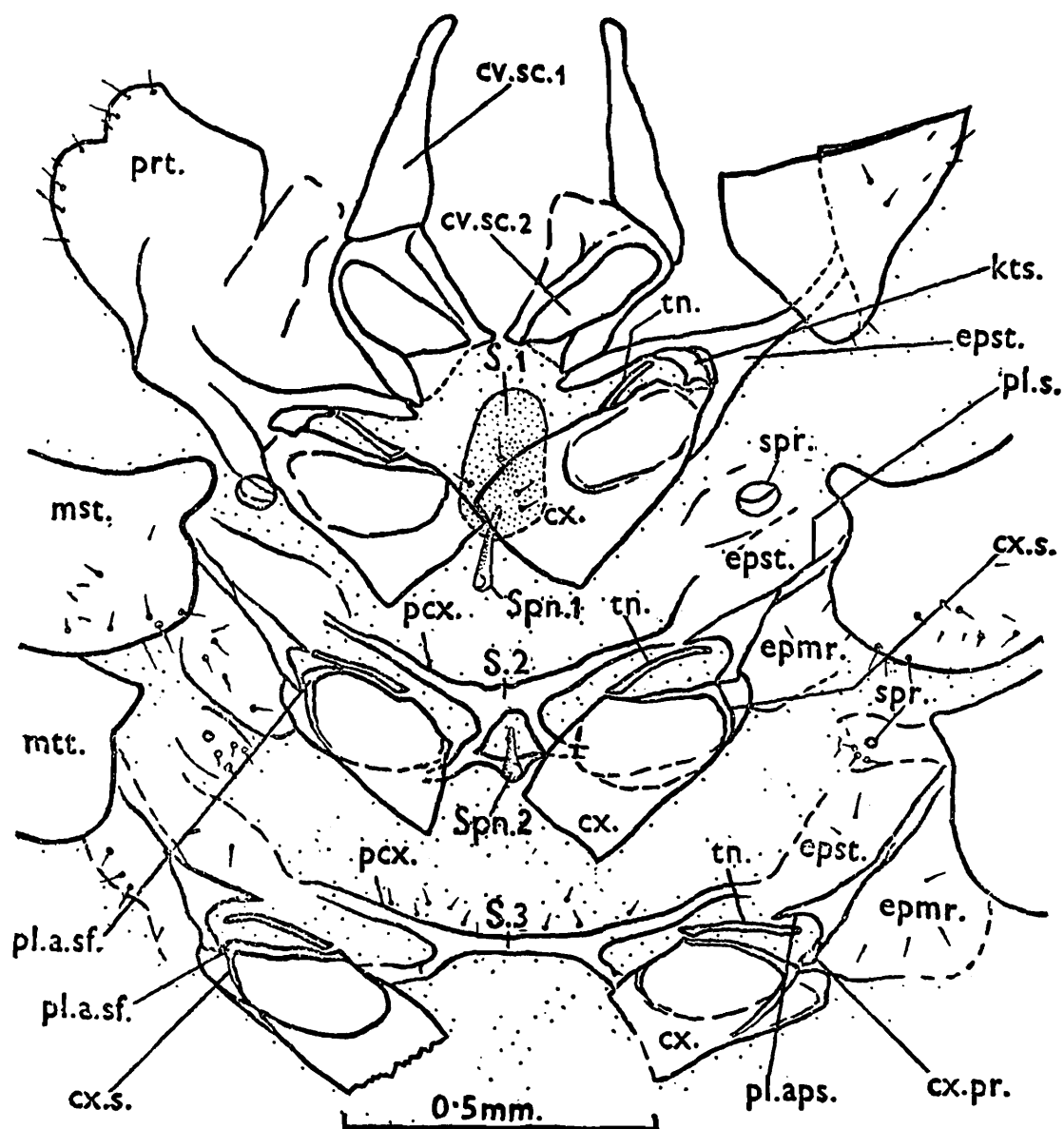
Ventral wall of the cranium, showing points of attachment of the tentorium, labium, maxillae and cervix.

b.c.cd., basal condyle of cardo ; *cd.*, cardo ; *cr.a.md.*, cranial articulation of mandible ; *ctm.*, corporotentorium ; *cv.sc.1.*, first cervical sclerite ; *lb.s.*, labial suture ; *oct.*, occiput ; *oct.f.*, occipital foramen ; *pgn.*, postgena ; *pmt.*, postmentum ; *poct.*, postocciput ; *poct.s.*, postoccipital suture ; *prmt.*, prementum ; *p.t.a.*, posterior tentorial arm ; *st.*, stipes ; *t.f.*, tentorial foramen.

2. Thorax and abdomen

(Text-figs. 11 and 12)

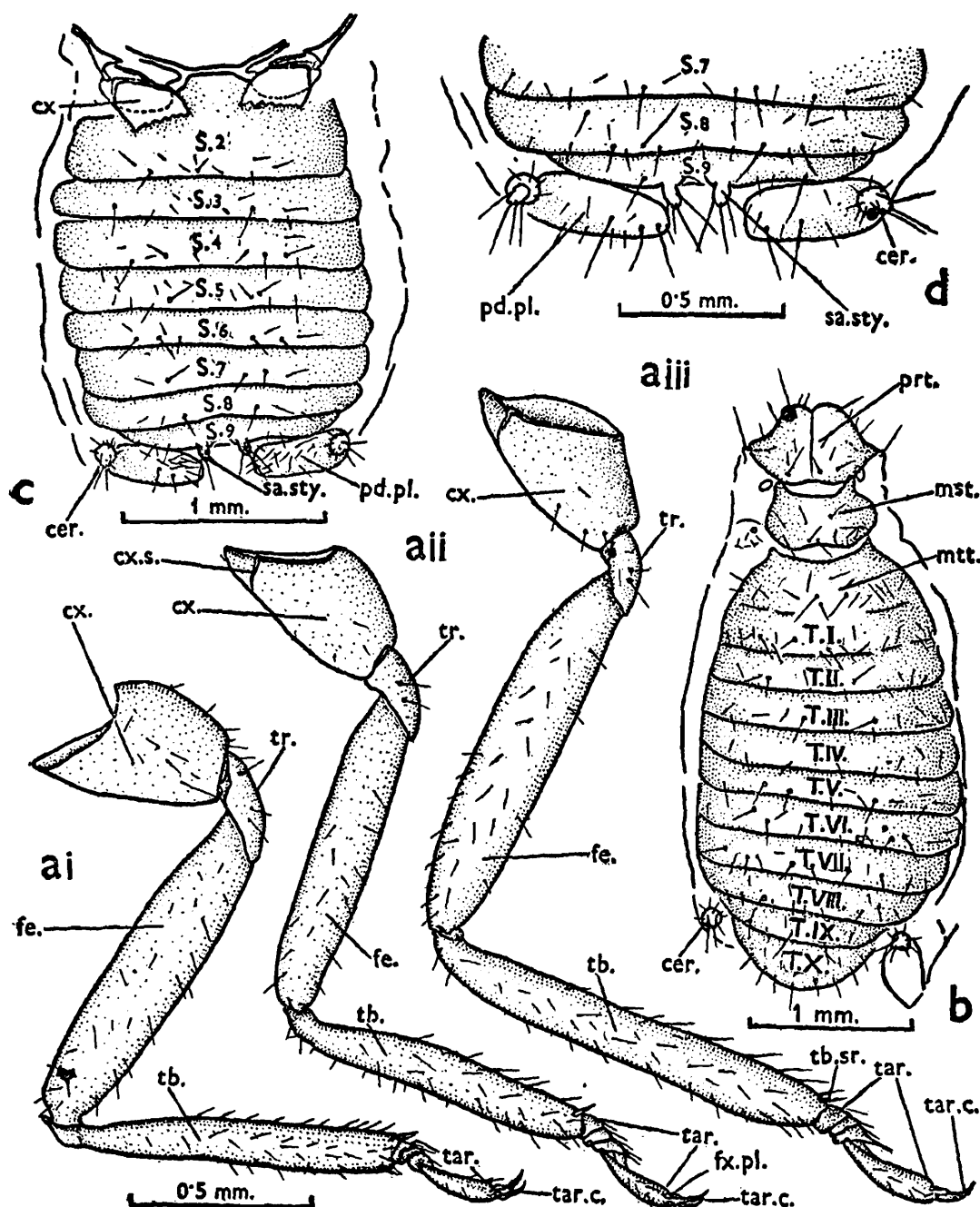
The thorax and abdomen are almost similar to that in soldier as regards the tergites, pleural sclerites, sternites, legs, spiracles and the terminal abdominal appendages in shape and size.



TEXT-FIG. 11.—*Odontotermes obesus* (Rambur), worker caste.

Thorax, showing the various ventral and lateral sclerites and the attachment of the coxae together with the tergites out and spread out flat on either side.

cv.sc.1., first cervical sclerite; cv.sc.2., second cervical sclerite; cx., coxa; cx.pr., coxal process; cx.s., coxal suture; epmr., epimeron; epst., episternum; kts., katopisternum; mst., mesonotum; mtt., metanotum; pcx., precocoxale; pl.aps., pleural apophysis; pl.a.sf., pleural articular surface; pl.s., pleural suture; prt., pronotum; S2-3, sterna 2-3. spr., spiracle; tn., trochantin of leg.



TEXT-FIG. 12.—*Odontotermes obesus* (Rambur), worker caste.

(ai, aii, aiii). Fore-, middle-, and hind-legs respectively of the left side. (b). Dorsal view of the thoracic and abdominal tergites. (c). Ventral view of the abdominal sternites. (d). Same, only VII, VIII, IX and X (podical plates) sternites, magnified.

cer., cercus ; cx., coxa ; cx.s., coxal suture ; fe., femur ; fx.pl., flexor plate ; mst., mesonotum ; mtt., metanotum ; pd. pl., podical plates ; prt., pronotum ; S.2—9, sterna 2—9 ; sa.sty., sub-anal styles ; T.I., T.II., . . . T.X., terga first, second, etc. ; tar., tarsus ; tar.c., tarsal claw ; tb., tibia ; tb.sr., tibial spur.

V—SUMMARY

1. The external morphology of the alate and the worker castes of *Odontotermes obesus* (Rambur) is described. The material was collected from areas around Dehra Dun (U.P.).

2. The workers resemble the alates in the configuration of their head, but they resemble the soldiers in the configuration of their thorax and abdomen.

3. The paired compound eyes and the ocelli are developed only in the alates.

4. The antennae in alates are 19-segmented ; in workers 17-segmented.
5. The more complex pterothoracic segments differ structurally from the simpler prothorax in respect of the terga, the pleura and the sterna.
6. The two pairs of wings are divided by the humeral suture into the permanent wing-stump or scale and the temporary lamina.
7. The three basal articular sclerites (axillaries) participate in complex wing-thorax joint.
8. The costal and subcostal veins of the wings are fused with the costal margin.
9. The abdominal spiracles of the alates show a conspicuous manubrium.
10. The first abdominal sternite is atrophied in both alates and workers. In the female of alates, the VII sternite is hyperdeveloped, while sternites VIII and IX are reduced and each divided into two halves. The paired podical plates represent the X sternite in both alates and workers.
11. In the alates, the subanal styles are borne on the IX sternite of the males alone.

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