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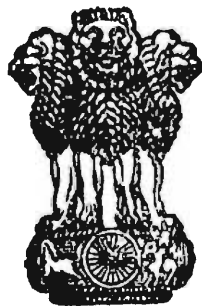
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CONTRIBUTIONS TO THE FAUNA OF MANIPUR STATE, ASSAM.  
PART III.—MAMMALS, WITH SPECIAL REFERENCE TO THE FAMILY  
MURIDÆ (ORDER RODENTIA).

By M. L. ROONWAL<sup>1</sup>, M.Sc., Ph.D. (Cantab.), F.N.I., Major, Zoological  
Survey of India, Indian Museum, Calcutta.

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Field Typhus Research Team.

## I.—INTRODUCTION.

*General.*

As mentioned in Part I of this series (General Introduction, Roonwal, 1949a), the collection reported upon here was made mainly by the writer and his associates of the General Headquarters (India) Field Typhus Research Team during the period June-December 1945, mostly from central Manipur; a few specimens were also collected in the Kabaw Valley (W. Burma) south up to Kalewa on the R. Chindwin. In addition, a few mammals collected by a Zoological Survey of India Party from the Naga Hills and Manipur during February-March 1936 have also been incorporated in the report.

A detailed account of the ecology and bionomics of these mammals will be found in Roonwal's (1949c) monograph while the same paper as well as another (Roonwal, 1948) contain a preliminary account of their systematics, including a description of 3 new subspecies of rats and mice (Rodentia: Muridae). In the present paper, which must be read in conjunction the two others mentioned above, the systematic aspect is amplified, especially with regard to the Muridae; fuller descriptions of the 3 new subspecies are provided, and illustrations are provided of the skulls of several species and subspecies of Muridae which have never before been either fully or satisfactorily figured.

A total of nearly 500 specimens were collected and examined. Of these, the Common Manipur White-bellied Rat, *Rattus rattus bullocki* Roonwal, constituted the majority—about 359 specimens. This study includes 35 species and subspecies, thus: Insectivora 5, Chiroptera 1, Carnivora 6, Primates 2, Rodentia 20 and Ungulata 1.

*Measurements.*

The following body- and skull-measurements were generally taken; in all cases, they were 'straight-line' measurements between two points, and not along the curvatures of the body- or skull-parts.

## BODY-MEASUREMENTS.

The following 'lengths' were measured on freshly-killed animals, with the body-parts fully relaxed and pressed against a flat surface; no stretching was allowed:—(i) *Head-and-body* (H. & B.): From the tip of the nose to the ventral root of the tail just above the anus. (ii) *Tail* (Tl.): From the ventral root of the tail to the tip of the tail vertebrae, excluding the hair. (iii) *Hind-foot* (H.F.): From the outer, most prominent surface of the heel to the tip of the longest toe, excluding the claw or nail. (iv) *Ear* (E.): From the most prominent surface of the tragus to the farthest edge of the pinna.

## SKULL-MEASUREMENTS.

The measurements were taken under a large table-lens magnifying about  $2\frac{1}{2}$  times, and by means of a vernier calliper with a dial graduation reading up to 0.1 mm. The following 'lengths' were generally measured, especially in the Muridae (Rodentia):—

(i) *Greatest length (or occipitopremaxillar length)*.—From the hindmost point of the occipital surface in the middle line to the most forward point of the premaxilla.

(ii) *Codylobasal length*.—From the hindmost point of the occipital condyle of one side to the most forward point of the premaxilla of that side. (This is slightly different from the “condylobasal” of Ellerman 1947c, p. 250, who measures it from “the occiput to the front of the incisors”.)

(iii) *Occipitonasal length*.—From the hindmost point of the occipital surface in the middle line to the most forward tip of the nasals.

(iv) *Greatest zygomatic width*.—Greatest width across the outer surfaces of the two cheek bones (zygomatic arches), measured at right angles to the long axis of the skull.

(v) *Least interorbital width*.—Least width, between the orbits, of the frontal bone as viewed from above. (This is the “frontals width” of Ellerman, 1947c, p. 250.)

(vi) *Cranial width*.—Greatest width of the cranium or brain-case just above the squamosal roots of the zygomatic arches.

(vii) *Occipital breadth*.—Breadth of the occipital region just above the external auditory meatus and in front of the mastoid processes of the periotic.

(viii) *Median depth of occiput*.—Vertical median height of the occiput, from the highest surface of the occipital crest in the middle line to the lowest surface of the foramen magnum in the middle line. (This is different from the “occiput” of Ellerman, 1947c, p. 250.)

(ix) *Postmolar length*.—From the hindmost point of the occipital condyle of one side to the hindmost point of the base of the last molar or  $m_3$  of that side where it emerges from the maxilla.

(x) *Auditory length*.—From the hindmost point of the occipital condyle to the most forward surface of the tympanic bulla of that side.

(xi) *Length of tympanic bulla*.—Maximum length of the bulla proper, from a point immediately next to the paroccipital process to the opposite point on the inflated bulla, excluding the spinous processes and the mastoid portion when swollen.

(xii) *Length of nasals*.—Maximum length of nasals along the antero-posterior axis.

(xiii) *Greatest combined width of nasals*.—Measured at right angles to the antero-posterior axis of the nasals.

(xiv) *Palatal length*.—From the hindmost edge of the palate in the middle line, excluding the palatal spine when present, to the most forward point of the premaxilla on the ventro-lateral side where it meets the back or posterior edge of the first incisor or  $i_1$ . (Ellerman, 1947c, p. 250, however, measures it, for rodents, “from the front of the incisors to the back of the palate, ignoring the spinous process if it is present”, thus obtaining larger values.)

(xv) *Length of diastema*.—From a point on the ventro-lateral side of the premaxilla where it meets the back or posterior edge of the first incisor or  $i_1$  to the most forward point of the base of the first (most anterior) tooth present in the premolar-molar series of that side where it emerges from the maxilla.

(xvi) *Length of anterior palatine foramina.*—The maximum length long the antero-posterior axis.

(xvii) *Greatest combined width of anterior palatine foramina.*—Maximum width of the two foramina, at right angles to the antero-posterior axis.

(xviii) *Length of upper molars.*—Maximum total length of all the upper molars (excluding the premolars) on the crowns.

(xix) *Mandibular length.*—From the hindmost point of the mandibular condyle to the most forward point of the mandible on the ventro-lateral side where it meets the posterior edge of the first incisor or  $i_1$ .

#### *Mammalogy of Manipur State.*

The larger mammals, especially the game animals, of Manipur are more or less well known, and accounts of them will be found in Allen (1905, pp. 9-10), Higgins (1933*a-c*, 1934*a-b*), and elsewhere. The medium-sized and smaller mammals, particularly such inconspicuous ones as the Insectivora (moles, shrews, etc.), and the Muridae (rats and mice), are, however, imperfectly known. In addition to a number of individual records scattered in the literature, mention must be made of the small but interesting collection that A.O. Hume made in Manipur in the last quarter of the 19th century and which was reported upon by Thomas (1886). Annandale (1921, p. 538) casually mentioned that otters are plentiful in Manipur but did not name the species.

While the surrounding districts of Assam and Burma were fairly worked out by the various surveys conducted by the Bombay Natural History Society in the early part of this century, Manipur has remained comparatively unknown. In recent years, owing to the War, considerable collections have been made in Manipur, especially of the Insectivora and Rodentia. Ellerman (1947*a-d*) records from Manipur a number of Rodents, specially rats, including the rare species *Hadromys humei* (Th.) and *Diomys crumpi* Th. A recent account of the systematics, ecology and bionomics of some of the Manipur mammals will be found in the accounts by Roonwal (1949*a-c*), and the present account should be read in conjunction with these papers.

#### *Acknowledgments.*

The excellent drawings of skulls which illustrate this paper were made, under the writer's supervision, by the Zoological Survey of India's staff artists, Mr. Subodh Chandra Mondal and Mr. Akhoy Kumar Mondal. A few doubtful rats (Muridae) were referred to Sir John R. Ellerman of the Mammal Department, British Museum (Natural History), London, and his opinions are referred to in appropriate places.

#### *Addendum.*

Whilst this paper was in page-proof, J. R. Ellerman's *The Families and Genera of Living Rodents*, vol. III, part 1, 4+210 pp., London, March 1949 came into my hands. It contains interesting observations, among others, on *Rattus niviventer niviventer*, *R. n. mentosus* and the genus *Hadromys*. As far as I can judge, no major change in my conclusions is called for.

## II.—SYSTEMATIC ACCOUNT.

## Order 1.—INSECTIVORA.

## Family (i) TUPAIIDAE (Tree-shrews).

1. *Tupaia belangeri* (Wagner) (?subspecies).

(The ?Burmese Tree-Shrew.)

1841. *Cladobates belangeri* Wagner, *Schreber's Säugethiere*, Supplement bd. II, p. 42. (Type-locality: Siriam, Pegu District, Burma.)

1949. *Tupaia belangeri* (?subsp.), Roonwal, *Trans. nation. Inst. Sci. India* III, p. 72.

*Material*.—5 adults—2 from Manipur (Assam) and 3 from the Kabaw Valley (Upper Chindwin District, W Burma) collected during August to November 1945, as follows :—

Manipur : 1 adult ♂ (Z.S.I. Registered No. 11,135) at milestone 34, south-east of Imphal on Tamu Road, *ca.* 4,000 ft., on 14 November ; 1 adult ♂ (No. 11,136) at milestone 117, about 16 miles north of Imphal on Dimapur Road, *ca.* 3,500 ft., on 27 November.

Kabaw Valley : 1 unsexed adult (no Registered No. ; Collection No. CT22/10-8-45) at Moreh near Manipur -Burma frontier, *ca.* 580 ft., on 10 August ; 2 adult ♂♂ (Nos. 11,133 and 11,134) on Tamu-Kalewa Road, *ca.* 400 ft., on 28 August and 2 September.

*Size, etc.*—4 adult ♂♂ gave the following measurements, in mm. :—Head-and-body 165-182 ; tail 'over 145' -178 ; hind-foot 40-43 ; ear 15-19 (Text-fig. 1).

*Systematic note*.—The specimens are too variable to be satisfactorily assigned to any of the subspecies known from eastern India and Burma, but are allied to *siccata* Th., *assamensis* Wr. and *versurae* Th. With regard to the 4 specimens now available, the following may be stated :—

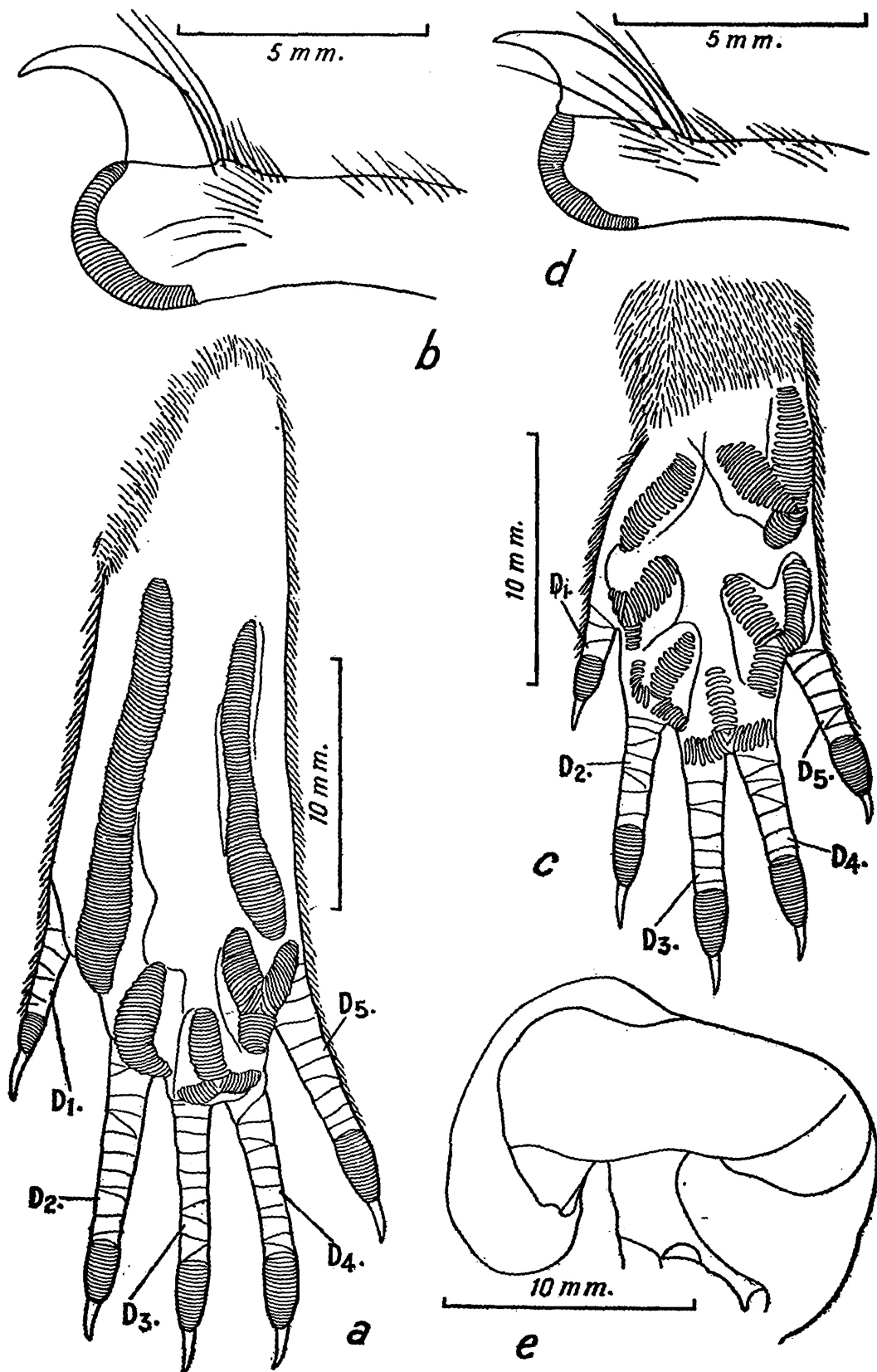
No. 11,133, August 28, Kabaw Valley : Dorsum, including tail, grizzly dark olivaceous, and uniform throughout ; hairs on lower back 8-15 mm. long ; faint remains of buff shoulder stripes, about 8 mm. long, present on either side. Venter dull pale buffy.

No. 11,134, September 2, Kabaw Valley : The white venter would place it near *siccata* Th., but the shoulder stripes are ill-developed and are buffy as in *versurae* Th.

No. 11,135, November 14, Manipur : Dorsum, including tail, grizzly dark olivaceous, and uniform throughout ; hairs on back 14-20 mm. long. Faint remains of buff shoulder stripes, about 10 mm. long, present on either side. Venter dull pale buffy.

No. 11,136, November 27, Manipur : Similar to No. 11,135, but differs in following respects : No shoulder stripes visible ; venter bright buffy, nearly ochraceous on chest ; inguinal hairs slaty-based.

The last two specimens are close to *assamensis* Wr. and *versurae* Th.



TEXT-FIG. 1.—*Tupaia belangeri* (Wagn.) (?subspecies).

Adult ♂, Z. S. I. Reg. No. 11,133, Tamu-Kalewa Road, Kabaw Valley, W. Burma ca. 400—500 ft., 28 August 1945.

(a) Lower view of right hind-foot, to show the pads.  $\times 3$ . (b) Middle toe ( $D_3$ ) of right hind-foot, in side view.  $\times 6$ . (c) Lower view of right hand, to show the pads.  $\times 3$ . (d) Middle finger ( $D_3$ ) of right hand, in side view.  $\times 6$ . (e) Left ear.  $\times 3$ .

$D_1$ — $D_5$ , first to fifth digits.

## Family (ii) TALPIDAE (Moles).

2. *Talpa micrura* Hodgson.

(The Short-tailed Mole.)

1840. *Talpa micrura* Hodgson, *J. Asiat. Soc. Bengal* X, p. 910 (Type-locality : Darjeeling, N. Bengal.)1949. *Talpa micrura*, Roonwal, *Trans. nation. Inst. Sci. India*. III, p. 73.

*Material*.—1 specimen collected in late June 1945 in the “Kanglatongbi area” about 16 miles north of Imphal, Manipur, ca. 3,500 ft. Not preserved.

*Distribution*.—Himalayas from Nepal, *via* Sikkim, N. Bengal (Darjeeling) to Assam and Upper Burma (Myitkyina). The present would appear to be the first record from Manipur.

## Family (iii) SORICIDAE (Shrews).

3. *Suncus caeruleus fulvocinereus* (Anderson).

(The Grey Assam Shrew.)

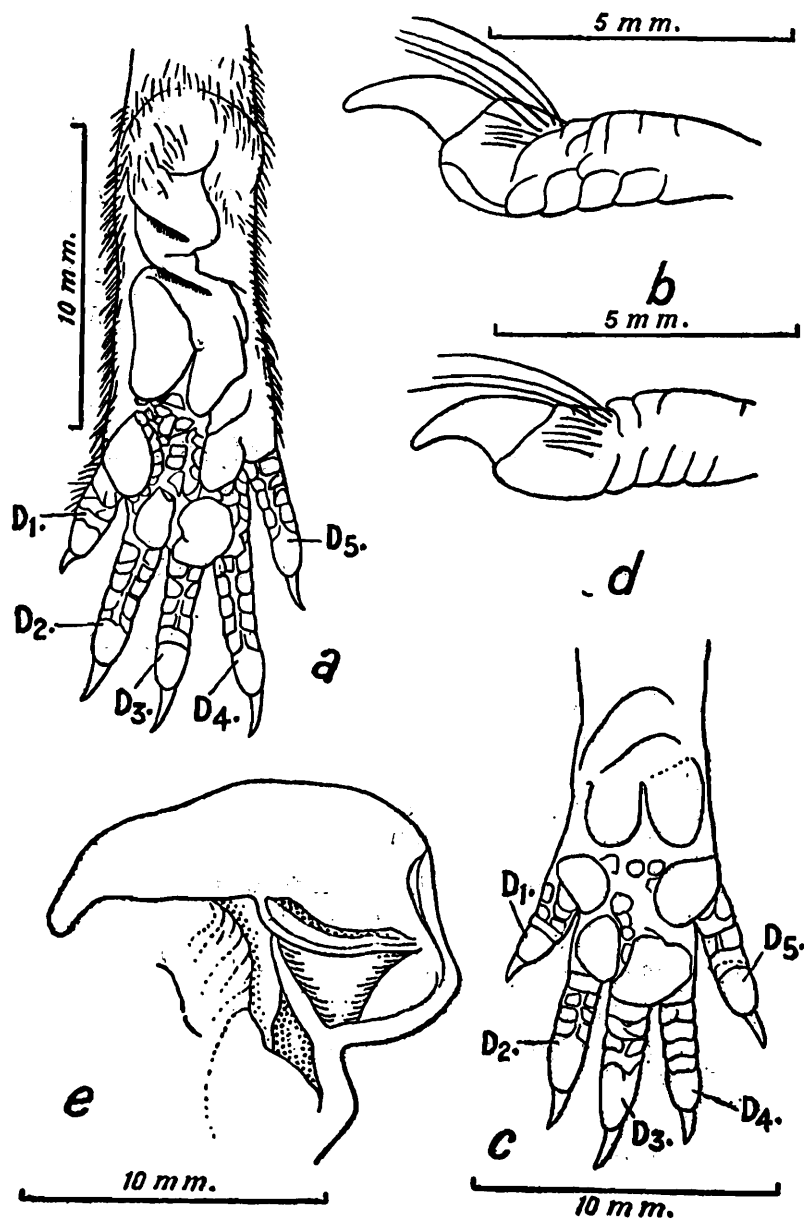
1877. *Crocidura (Pachyura) fulvocinereus* Anderson, *J. Asiat. Soc. Bengal* XLVI, p. 263. (Type-locality : Gauhaty, Assam.) Types in Zoological Survey of India, examined.1881. *Crocidura (Pachyura) caeruleus*, var. *fulvocinerea*, Anderson, *Catal. Mamm. Indian Mus. Calcutta*, Pt. 1, p. 178.1888. *Crocidura caerulea* (in part), Blanford, *Fauna Brit. India, Mamm.*, Pt. 1, p. 236.1929. *Suncus caeruleus fulvocinereus*, Lindsay, *J. Bombay nat. Hist. Soc.* XXXII (2), p. 330.1949. *Suncus caeruleus fulvocinereus*, Roonwal, *Trans. nation. Inst. Sci. India* III, p. 74.

*Material*.—26 specimens were collected during June-December 1945, as follows :—(i) 25 (12 ♂♂, 11 ♀♀, 2 unsexed), collected 6-23 miles north of Imphal on Dimapur Road, Manipur, ca. 3,000-3,500 ft., June to end-December. Of these, 16 (Z.S.I. Registered Nos. 11,138-11,140 and 11,142-11,154) were preserved. (ii) 1 (No. 11,141) collected on road between Tamu and Kalewa, Kabaw Valley, W Burma, ca. 500 ft., during last week of August.

*Size, etc.*—16 adults (10 ♂♂, 5 ♀♀, 1 unsexed) gave the following measurements, in mm. :—Head-and-body 120-149 ; tail 65-84 ; hind-foot 17-20 ; ear 9-13. (See Text-fig. 2.)

The mammary formula is : Th. 0+abd. 3 = 6.

*Habitat*.—This shrew prefers moist places such as evergreen jungle ; it is found less often in the drier areas, *e.g.*, oak scrub. Not infrequently, it occurs in human habitations, *e.g.*, army camps. For further details about its ecology, breeding, etc., see Roonwal (1949c).



TEXT-FIG. 2.—*Suncus caeruleus fulvocinereus* (And.).

Adult ♀, from Imphal Valley, Manipur, Assam, ca. 3,500 ft., September 1945.

(a) Lower view of right hind-foot, to show the pads.  $\times 3$ . (b) Middle finger ( $D_3$ ) of right hind-foot, in side view.  $\times 6$ . (c) Lower view of right hand, to show the pads.  $\times 3$ . (d) Middle finger ( $D_3$ ) of right hand, in side view.  $\times 6$ . (e) Left ear.  $\times 3$ .

$D_1$ — $D_5$ , first to fifth digits.

*Skull*.—No other differences, except the following, are noticeable between the skulls of the two species of shrews mentioned in the present account :—

*S. ca. fulvocinereus* : Skull larger. Development of supraoccipital crest irregular usually ill developed, though in a few specimens well developed.

*S. griffithi* : Skull smaller. Supraoccipital crest prominent in all skulls.

*Colour notes, etc.*—The fur on the dorsum is brownish grey, on the venter paler and more greyish. Several skins have irregular tiny patches of whitish hair both above and below. The tail is coloured like the body and is swollen at the base.

The smaller specimens, some of which at least might be juveniles, are difficult to distinguish from *S. griffithi*, but, as already reported (Roonwal, 1949c), the following characters have helped to distinguish them from the latter :—

*S. c. fulvocinereus*: Paler above and below and distinctly more greyish; venter grey with little or no brown; tail swollen at base.

*S. griffithi*: Darker all over; rich rusty brown above; below similar but paler, with little or no grey; tail not swollen at base.

*Distribution.*—Assam, including Manipur; Kabaw Valley (Upper Chindwin District, W. Burma). Up to at least 3,500 feet altitude. The present would appear to be the first record from Manipur and the Kabaw Valley.

#### 4. *Suncus griffithi* (Horsfield).

(The Brown Assam Shrew.)

1851. *Sorex griffithi* Horsfield, *Catal. Mamm. Mus. E. India Coy. London*, p. 134. (Type-locality: Afghanistan, *errore*=Khasi Hills, Assam, *vide* Blyth, 1863, *infra*.)

1863. *Sorex griffithi*, Blyth, *Catal. Mamm. Mus. Asiat. Soc. Bengal*, p. 83.

1877. *Crocidura (Pachyura) blythii* Anderson, *J. Asiat. Soc. Bengal XLVI*, p. 264. (Type-locality: Assam.)

1881. *Crocidura murina* (Linn.) (in part), Anderson, *Catal. Mamm. Indian Mus. Calcutta*, Pt. 1, p. 180.

1888. *Crocidura murina* (Linn.) (in part), Blanford, *Fauna Brit. India, Mamm.*, Pt. 1, p. 233.

1929. *Suncus griffithi*, Lindsay, *J. Bombay nat. Hist. Soc. XXXIII* (2), p. 333.

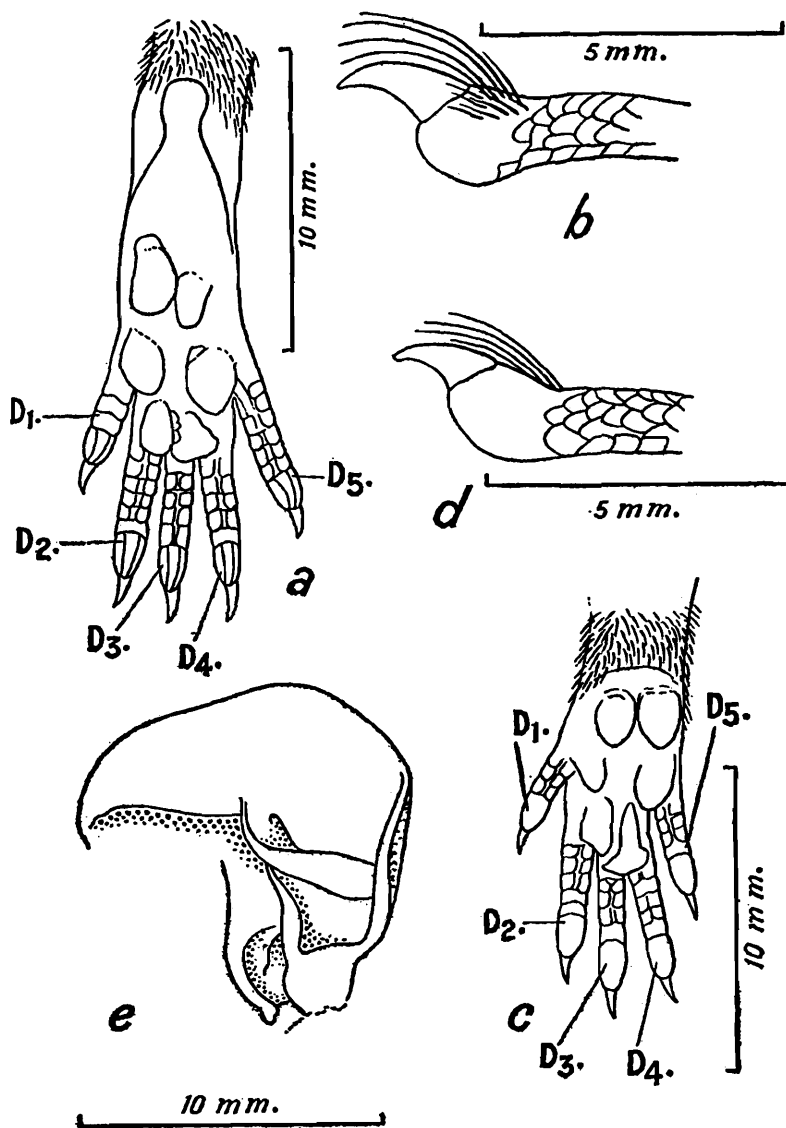
1949. *Suncus griffithi*, Roonwal, *Trans. nation. Inst. Sci. India III*, p. 76.

*Material.*—15 specimens were collected during July to December 1945 from Manipur (Assam) and the Kabaw Valley (W. Burma), as follows :—

Manipur : 3 ♂♂, 8 ♀♀, 3 unsexed, collected 6-17 miles north of Imphal on Dimapur Road, *ca.* 3,500 ft., during July-December. Of these, 8 (Z.S.I. Registered Nos. 11,155-11,158 and 11,160-11,163) were preserved.

Kabaw Valley : 1 adult ♀ (Z.S.I. Registered No. 11,159), collected on road between Tamu and Kalewa, *ca.* 500 ft., in last week of August.

*Size, etc.*—13 adults (3 ♂♂, 9 ♀♀, 1 unsexed), gave the following measurements, in mm. :—Head-and-body 100-141; tail 53-72; hind-foot 16-19; ear 9-13. (*See* Text-fig. 3.)



TEXT-FIG. 3.—*Suncus griffithi* (Horsf.).

Adult, ♀ from Imphal Valley, Manipur, Assam, ca. 3,500 ft., October 1945.

(a) Lower view of right hind-foot, to show the pads.  $\times 3$ . (b) Middle finger ( $D_3$ ) of right hind-foot, in side view.  $\times 6$ . (c) Lower view of right hand, to show the pads.  $\times 3$ . (d) Middle finger ( $D_3$ ) of right hand, in side view.  $\times 6$ . (e) Left ear.  $\times 3$ .

$D_1$ — $D_5$ , first to fifth digits.

The colour, skull, etc. have been discussed above under *S. caeruleus fulvocinereus*.

The mammary formula is : Th. 0 + abd. 3 = 6.

*Habitat*.—Like *S. caeruleus fulvocinereus*, *S. griffithi* prefers moist places such as evergreen jungles; it is semi-arboreal. For further details of its ecology and bionomics, see Roonwal, 1949c.

*Distribution*.—Assam, including Manipur; Western Burma, e.g., Kabaw Valley (Upper Chindwin District) and Arakan. Up to at least 3,500 feet altitude. The present would appear to be the first record from Manipur and the Kabaw Valley.

5. *Suncus* sp.

*Material*.—1 unsexed adult(?) (Z.S.I. Registered No. 11,326), collected by Major S. L. Kalra on 26 August 1945, on road between Tamu and Kalewa, Kabaw Valley, Western Burma, ca. 500 ft.

This specimen could not be satisfactorily identified. It resembles *Suncus caeruleus fulvocinereus* in body-size, etc., but is much paler, especially on the venter which is silvery hoary. The skull also differs in having the median fronto-parietal crest and the lateral occipital crests well developed, the later being wing-like. In *S. c. fulvocinereus* both these crests are generally absent, and, when present, they are but poorly developed.

## Order 2. CHIROPTERA.

Family (i) PTEROPODIDAE (Flying-foxes or Fruit-bats).

6. *Pteropus giganteus leucocephalus* Hodgson.

(The Himalayan Fruit-Bat or Flying-Fox.)

1835. *Pteropus leucocephalus* Hodgson, *J. Asiat. Soc. Bengal* IV, p. 700. (Type-locality : Central region of Nepal.)  
 1839. *Pteropus assamensis* McClelland, *Proc. zool. Soc. London*, p. 148. (Type-locality : Assam.)  
 1886. *Pteropus medius*, Thomas, *Proc. zool. Soc. London*, p. 59. (One ♂ Kotschim-kooleh, Manipur, 7 April, 1881.)  
 1891. *Pteropus medius*, Temm. (in part), Blanford, *Fauna Brit. India. Mamm.*, Pt. 2, p. 257. And of several older authors.  
 1912. *Pteropus giganteus leucocephalus*, K. Andersen, *Catal. Chiroptera Brit. Mus.* (2nd ed.) I, *Megachiroptera*, p. 333.  
 1949. *Pteropus giganteus leucocephalus*, Roonwal, *Trans. nation. Inst. Sci. India* III, p. 77.

*Material*.—11 specimens (7 ♂♂, 4 ♀♀, Z.S.I. Registered Nos. 11,164-11,174) were collected from Imphal Town, Manipur, ca. 2,600 ft., during September to November 1945. Of these 8 (5 ♂♂, 3 ♀♀) were adults, the remainder being either juveniles or subadults.

*Size, etc.*—8 adults (5 ♂♂, 3 ♀♀) gave the following measurements, in mm. :—Head-and-body 219=270 ; hind-foot 117=132 ; ear 36=42 ; wing expanse 1,003=1,210.

The fur in adults is long, as shown by the following measurements (in mm.) on 4 ♂♂ and 3 ♀♀ : On mantle : ♂ 12=20, ♀ 14=16 ; on back : ♂ 11=19, ♀ 10=16 ; on abdomen : ♂ 10=17, ♀ 12=13.

*Habitat*.—This bat occurs in hundreds on the tall trees in the vicinity of Imphal Town, hanging on the trees during the day and leaving them and flying to nearby forests (?) at dusk.

*Distribution*.—Sub-himalayan region from Kulu Valley (E. Punjab) in the west, to Nepal and Assam, including Manipur. The only previous record from Manipur is of a single male from Kotschim-kooleh (Eastern Manipur), recorded by Thomas (1886, p. 59) and K. Andersen (1912, p. 335).

## Order 3. CARNIVORA.

## Family (i) FELIDAE (Cats).

7. *Prionailurus bengalensis bengalensis* (Kerr).

(Pennant's Leopard Cat.)

1792. *Felis bengalensis* Kerr, *Anim. Kingd.*, p. 151. (Type-locality : Southern Bengal.)1888. *Felis bengalensis*, Blanford, *Fauna Brit. India, Mamm.*, Pt. 1, p. 78.1918. *Felis bengalensis*, Wroughton, *J. Bombay nat. Hist. Soc.* XXVI (1), p. 43.1939. *Prionailurus bengalensis bengalensis*, Pocock, *Fauna Brit. India, Mamm.* (2nd ed.) I, p. 268.1949. *Prionailurus bengalensis bengalensis*, Roonwal, *Trans. nation. Inst. Sci. India* III, p. 79.

*Material.*—1 adult ♂ (Z.S.I. Registered No. 11,175), collected on 28 November 1945 near Kanglatongbi village, about 11 miles north of Imphal on Dimapur Road, Manipur, ca. 3,500 ft.

*Size* (in mm.).—Head-and-body 465 ; tail 250 ; hind-foot 106 ; ear 46.

*Habitat.*—This specimen, which was the only one found, was shot at night in oak scrub. This cat is evidently less common than the Jungle Cat, *Felis chaus*.

*Distribution.*—Southern India, Bengal, southern Assam (including Manipur) ; and Burma to Indo-China.

8. *Felis chaus* Güldenstädt (?subspecies).

(The Jungle Cat.)

1776. *Felis chaus* Güldenstädt, *Nov. Com. Acad. Petrop.* XX, p. 483 and pls.1949. *Felis chaus*, Roonwal, *Trans. nation. Inst. Sci. India* III, p. 79.

*Material.*—6 adults (2 ♂♂, 4 ♀♀) (Z.S.I. Registered Nos. 11,176—11,181), were collected from 10 November to 4 December 1945 from the Imphal Valley and immediate vicinity (up of 18 miles north of Imphal on Dimapur Road and 10 miles south-east of Imphal on Palel-Tamu Road), ca. 2,600—3,500 ft.

*Size, colour, etc.*—5 adults measured as follows, in mm :—

	H. & B.	Tl.	H.F.	E.
1♂ :	655	215	147	73
4♀♀:	506-615	232-245	110-140	64-75

An adult ♂ (No. 11,118) stood 42 mm. (ca. 17 in.) at the shoulders, and 390 mm. (ca. 15½ in.) at the hindquarters. An adult ♀ (No. 11,178) stood 363 mm. (ca. 14½ in.) at the shoulders. Males would appear to be slightly larger than females.

The mammary formula is : Th. 2+abd. 2 = 8.

*Habitat.*—This cat is very common in the Imphal Valley, roaming about at night in open country, e.g., oak scrub, patches of tall grass, etc. (See also Roonwal, 1949c.)

*Distribution.*—It is widely distributed in Asia and North Africa. Several subspecies are recognized, but it has not been possible to satisfactorily place the Manipur specimens subspecifically.

### 9. Domestic Cat.

In addition to the Jungle Cat, *Felis chaus* Güld., mentioned above, 10 specimens (7 ♂♂, 3 ♀♀) of what appears to be the Domestic Cat were collected in the Imphal Valley, ca. 2,600=3,500 ft., during November and December 1945. All of them were shot at night in open country.

*Size, etc.*—7 adults measured as follows, in mm. :—

	H. & B.	Tl.	H.F.	E.
5 ♂♂:	455-540	220-280	107-125	55-60
2 ♀♀:	400-450	194-230	98-102	54-56

*Systematic note.*—The majority of these specimens are of the ' *Felis chaus* type ' Some are close to the wild *chaus*, others close to the tabby or domestic cat common near houses all over India, and still others intermediate. All of them must be regarded as derived from the wild *Felis chaus* either by hybridisation with tabby cats, or by a process of domestication. It is noteworthy that in all cases the skulls are much broader in the zygomatic region than in the wild *Felis chaus*.

### Family (ii) VIVERRIDAE (Civets).

#### 10. *Viverricula indica* (Geoffroy) (?subspecies).

##### (The Small Indian Civet.)

1788. *Viverra malaccensis*, Gmelin, *Syst. Nat.* I, p. 92. *Nomen confusum.*  
 1803. *Civetta indica*, Geoffroy, *Cat. Mamm.*, p. 113. (Type-locality: Maha Oya, Eastern Province, Ceylon.)  
 1888. *Viverricula malaccensis*, Blanford, *Fauna Brit. India, Mamm.*, Pt. 1, p. 100. And of most older authors.  
 1933. *Viverricula indica*, Pocock, *J. Bombay nat. Hist. Soc.* XXXVI, p. 629.  
 1939. *Viverricula indica*, Pocock, *Fauna Brit. India, Mamm.*, (2nd ed.) I, p. 363.  
 1949. *Viverricula indica*, Roonwal, *Trans. nation. Inst. Sci. India* III, p. 81.

*Material.*—1 adult ♀ (Z.S.I. Registered No. 11,182) was collected on 4 December 1945 at milestone 18, south-east of Imphal on Imphal-Palel-Tamu Road, Manipur, Assam, ca. 3,000 ft.

*Size* (in mm.).—Head-and-body 483; tail 315; hind-foot 84; ear 36. The ♀ stood 204 mm. (ca. 8 in.) at the shoulders and 230 mm. (ca. 9 in.) at the hind-quarters.

*Colour, etc.*—Iris dark chocolate-grey. Nose and rhinarium dirty pale horny. Tongue pale fleshy. Mouth pinkish white. Claws pale fleshy, smoky horny at tips. Pads of hands and feet smoky pink.

The ♀ had a pair of prominent swollen scent glands situated 10 mm. below the vagina and the same distance above the anus; each swelling was 10 mm. broad and 17 mm. high; the median slit-like vertical opening of the gland was about 16 mm. long.

*Habitat.*—The specimen collected was shot at night on the road in open country in the vicinity of rice fields where it was evidently feeding. (See also Roonwal, 1949c.)

*Distribution.*—Whole of India, Burma and Ceylon; also extends farther east into Malaya Peninsula, Siam and Indo-China.

It is a very variable species, and several subspecies, which are difficult to distinguish, have been recognized. Two subspecies, *V i. baptistae* Pocock and *V i. thai* Kloss, are found in Assam.

### Family (iii) (HERPESTIDAE) (Mongoose).

#### 11. *Herpestes urva* (Hodgson).

(The Crab-eating Mongoose.)

1836. *Gulo urva*, Hodgson, *J. Asiat. Soc. Bengal* V, p. 238. (Type-locality; Nepal.)  
 1888. *Herpestes urva*, Blandford, *Fauna Brit. India, Mamm.*, Pt. 1, p. 129.  
 1918. *Mungos urva*, Wroughton, *J. Bombay nat. Hist. Soc.* XXVI (1), p. 58.  
 1941. *Herpestes urva*, Pocock, *Fauna Brit. India, Mamm.* (2nd ed.) II, p. 51. (Gives full synonymy, etc.)  
 1949. *Herpestes urva*, Roonwal, *Trans. nation. Inst. Sci. India* III, p. 82.

*Material.*—1 adult ♀ (Z.S.I. Registered No. 11,183) was collected on 1 December 1945 from the hill-forest near Modbung village, about 16 miles north of Imphal, off Dimapur Road, Manipur, Assam, ca. 3,500 ft. (Purchased.)

*Size* (in mm.), *colour*, etc.—Head-and-body 400; tail 258; hind-foot 90; ear 25. Height at shoulders 215 mm. (ca. 8½ in.). Horizontal length of eye 13 mm. Iris brownish. Lips, tongue and tooth-gums fleshy. Rhinarium dirty pink. Hands and feet: Soles smoky with fleshy tinge; claws smoky-fleshy at base, pale horny at tips. For habitat, etc., see Roonwal (1949c.)

*Distribution.*—*Indian*: Nepal, Sikkim, Bhutan, Bengal Duars and Assam (including Manipur, present record). *Extra-Indian*: Burma, S. China, Formosa, Hainan Is., Malaya Peninsula, Siam and Indo-China.

### Family (iv) CANIDAE (Jackals, etc.).

#### 12. *Canis aureus indicus* Hodgson.

(The Himalayan Jackal.)

1833. *Canis aureus indicus*, Hodgson, *Asiat. Res.* XVIII, p. 237. (Type-locality: Nepal.)  
 1888. *Canis aureus* Linn. (in part), Blandford, *Fauna Brit. India, Mamm.* Pt. 1, p. 140.  
 1919. *Canis indicus indicus*, Wroughton, *J. Bombay nat. Hist. Soc.* XXVI (2), p. 339.  
 1941. *Canis aureus indicus*, Pocock, *Fauna Brit. India, Mamm.* (2nd ed.) II p. 100.  
 1949. *Canis aureus indicus*, Roonwal, *Trans. nation. Inst. Sci. India* III, p. 82.

*Material.*—3 specimens, *e.g.*, 1 unsexed adult (Z.S.I. Registered No. 11,184) August 1945, and 2 adult ♀♀ (Nos. 11,185 and 11,186) 14 November and 4 December 1945, were collected in Imphal Valley both north and south-east of Imphal, Manipur, Assam, *ca.* 2,600-3,000 ft.

*Size.*—2 adult ♀♀ gave the following measurements, in mm.:—Head-and-body 675-720; tail 175-188; hind-foot 142-150; ear 73-74. Height at shoulders (No. 11,186), 483 mm. (*ca.* 19 in.).

*Colour* (in No. 11,186).—Iris golden brown; pupil grey; rhinarium of nose black; tongue fleshy pink. Hands and feet: Claws horny black; pads dirty grey.

*Habitat.*—The jackals are common in open country, *e.g.*, oak scrub, riverine scrub, riverine meadow and cultivated fields, throughout the Imphal Valley, usually roaming about at night in small packs of about 4 or 5, rarely singly. During the day they ascend the wooded hills whence they could be heard howling, several together. They were about equally common throughout the period of observation (July-December). (*See also* Roonwal, 1949*c.*)

*Distribution.*—N.E. India from Nepal eastward, *e.g.*, Nepal, Sikkim, Bengal, Assam; extending into Burma and S.W. Siam. Up to 12,000 ft. in some parts.

#### Order 4. PRIMATES.

Family (i) CERCOPITHECIDAE (Macque monkeys, etc.).

##### 13. *Macaca mulatta mulatta* (Zimmermann).

(The Indian Rhesus Macaque.)

1770. *Cercopithecus mulatta*, Zimmermann, *Geogr. Gesch. Mensch.* II, p. 195. (Type-locality: India.)

1939. *Macaca mulatta mulatta*, Pocock, *Fauna Brit. India, Mamm.*, (2nd ed.) I, p. 45.

*Material, etc.*—1 adult ♀ was purchased locally in October 1945, but no wild examples were seen. It measured as follows (in mm.):—Head-and-body 460; tail 225; hind-foot 140; ear 35.

*Remarks.*—This ♀, which was kept in captivity, menstruated on 3rd November. The menstrual flow lasted 3 days during which the blood discharge was moderate; there was no particular swelling or reddening of the hind-quarters during this period.

##### 14. *Macaca assamensis assamensis* McClelland.

(The Assamese Macaque.)

1839. *Macaca assamensis*, McClelland in Horsfield, *Proc. zool. Soc. London*, p. 148. (Type-locality: Assam.)

1879. *Macaca assamensis*, Anderson, *Anat. & Zool. Res. Two Exped. W. Yunnan*, p. 64. Re-description of the type.

1888. *Macacus assamensis*, McCl. (in part), Blanford, *Fauna Brit. India, Mamm.*, Pt. 1, p. 15.
1921. *Macaca assamensis*, Hinton and Wroughton, *J. Bombay nat. Hist. Soc.* XXVII (4), p. 669.
1932. *Macaca assemensis coolidgei* Osgood, *Field Mus. nat. Hist. Chicago (Zool.* XVIII, p. 209. (Type-locality: Hoi Xuen, Annam.)
1939. *Macaca assamensis assamensis*, Pocock, *Fauna Brit. India, Mamm.*, (2nd ed.) I, p. 53.
1941. *Macaca assamensis assamensis*, Pocock, *Fauna Brit. India, Mamm.*, (2nd ed.) II, Appendix, p. 470.
1949. *Macaca assamensis assamensis*, Roonwal, *Trans. nation. Inst. Sci. India* III, p. 83.

*Material.*—1 subadult ♂ (Z.S.I. No. 11,187) collected in the Imphal Valley, off milestone 129, about 4 miles north of Imphal on Dimapur Road, Manipur, Assam, ca. 3,000 ft. One subadult ♀, purchased at Myitkina, Burma, also examined alive.

*Size.*—1 subadult ♂ (Imphal) measured as follows, in mm. :—Head-and-body 410; tail 201; hind-foot 137; ear 38.

*Habitat.*—The above ♂ was shot from a large school (several schools?) of well over a hundred individuals inhabiting the edge of a clearing (named Lulworth Cove by the Army) in evergreen jungle at the base of a hill. Such schools frequently visited the camp kitchens, especially in the evenings—their appearance was as sudden as their disappearance into the thick wood when alarmed.

*Distribution.*—*India*: Assam, e.g., Mishmi and Naga Hills; Manipur (present record); Bengal (?); Upper Burma. *S. E. Asia*: Tong-King and Annam. At about 2,000-6,000 ft. altitude. The only other well-established subspecies, *M. a pelops* Hodgs., inhabits the sub-Himalayan region west of the typical subspecies, e.g., from Bhutan, through Sikkim and Nepal, to Mussoori (U.P.) in the west; this too occurs at about 2,000-6,000 ft. altitude.

*Systematic note.*—Some interesting points of difference, as noted in living specimens, between *Macaca mulatta* (Manipur specimen) and *M. assamensis* (Manipur and Burmese specimens) may be mentioned here, particularly since the remarks in Pocock (1939; 1941) were based on preserved skins only.

The colour of subadult ♂ and ♀ of *M. assamensis* was as follows :—Dorsum rich olivaceous brown with pale grey wash; hind-parts deep rusty. Face pale fleshy (as in *M. mulatta*), but with many (4 to 5) deep, diagonal wrinkles; in *M. mulatta* these wrinkles are entirely wanting in the relaxed face, while only 3 or 4 faint ones are seen under emotional tension. Cheek whiskers dark smoky, much darker and more extensively distributed than in *M. mulatta*. Arms outside like dorsum but with less olivaceous and more grey, much darker than in *M. mulatta*; hands like arms; palms dark fleshy; nails dark horny as in *M. mulatta*. Outer sides of legs as dorsum but more rufous, the rufous decreasing towards the extremity; feet dirty grey; soles and claws as in hand. Inner sides of arms and legs and whole of venter paler than dorsum, and as in *M. mulatta*. Callosities near hind-quarters dirty pinkish

horny as in *M. mulatta*, but with no bare area around them. Hind-quarters coloured like rest of body, not red as in *M. mulatta*. Tail like dorsum, darker above than below. Fur on body slightly "felted" or "matted"; no trace of felting in *M. mulatta*.

The direction of the hair on the head is interesting. Pocock (1939, pp. 52-53) wrote :

"The growth-direction of the head, not recorded in the living animal, is very variable in made-up skins, but typically, at all events, there is a short median parting just behind the brow-ridges, whence the hair diverges to right and left and sweeps round the sides of the crown above the ears, the rest of the hair on the crown being directed backwards. But in some skins the crown exhibits a distinct whorl, whence the hair radiates in all directions forming a kind of 'cap' with well-defined anterior edge much resembling that of *M. nemestrina* and *M. silenus*."

Again, Pocock (1941, p. 470) wrote that in the several preserved skins that he examined from Burma, some had the parting of hair and the whorl, and the others did not. In the two live examples examined by-me, the hair-direction, contrary to what Pocock stated, was of the "brushed back" type, exactly as in *M. mulatta*, and there was not even a suggestion of either a whorl or a partition; nor was there any cap-formation.

## Order 5. RODENTIA.

### Family (i) SCIURIDAE (Squirrels, etc.).

#### 15. *Hylopetes alboniger* (Hodgson).

(The Parti-coloured Flying-Squirrel.)

1836. *Sciuropterus alboniger*, Hodgson, *J. Asiat. Soc. Bengal* V, p. 231. (Type-locality: Nepal.)  
 1891. *Sciuropterus alboniger*, Blanford, *Fauna Brit. India, Mamm.*, Pt. 2, p. 367.  
 1919. *Pteromys (Hylopetes) alboniger*, Wroughton, *J. Bombay nat. Hist. Soc.* XXVI (2), p. 359.  
 1940. *Hylopetes alboniger*, Ellerman, *Fam. & Genera Living Rodents* I, p. 300.  
 1947. *Hylopetes alboniger*, Ellerman, *J. Mammal.* XXVIII (3), p. 257.  
 1949. *Hylopetes alboniger*, Roonwal, *Trans. nation. Inst. Sci. India* III, p. 84.

*Material*.—1 juvenile ♂ (Z.S.I. Registered No. 11,118) was collected on 10 December 1945 in hill-forest near Modbung, ca. 16 miles north of Imphal, off Dimapur Road, ca. 4,000 ft. (Purchased.)

*Size* (in mm.).—Head-and-body 196; tail 178; hind-foot 43; ear 32.

*Distribution*.—Himalayas from Nepal eastwards, including Bengal Duars (Darjeeling) and Bhutan Duars; also southern Assam (Naga Hills, Silhet, Manipur); Sikkim; W. Burma (Chin Hills and Upper Chindwin District). At about 3,000-5,000 feet altitude.

16. *Callosciurus erythraeus erythrogaster* Blyth.

(The Manipur Squirrel.)

1842. *Sciurus erythrogaster* Blyth, *J. Asiat. Soc. Bengal* XI, p. 970. (Type-locality: Manipur, Assam.)  
 1891. *Sciurus erythraeus* Pall. (in part), Blanford, *Fauna Brit. India, Mamm.*, Pt. 2, p. 377, No. 245.  
 1916. *Callosciurus erythraeus nagarum*, Thomas and Wroughton, *J. Bombay nat. Hist. Soc.* XXIV (2), p. 228. (Type-locality: Sadiya, Assam.)  
 1918. *Callosciurus erythraeus erythrogaster*, Robinson and Kloss, *Rec. Indian Mus.* XV, p. 197.  
 1919. *Callosciurus erythraeus erythrogaster*, Wroughton, *J. Bombay nat. Hist. Soc.* XXVI (2), p. 369.  
 1940. *Callosciurus erythraeus erythrogaster*, Ellerman, *Fam. & Genera Living Rodents* I, p. 358.  
 1947. *Callosciurus erythraeus erythrogaster*, Ellerman, *J. Mammal.* XXVIII (3), p. 270.  
 1949. *Callosciurus erythraeus* ?*erythrogaster*, Roonwal, *Trans. nation. Inst. Sci. India* III, p. 84.

*Material*.—2 specimens (1 adult ♀, Coll. No. R4/24.9.45; and 1 unsexed, Coll. No. R5/2-10-45) were obtained on 24 September and 2 October 1945, off milestone 117, about 16 miles north of Imphal on Dimapur Road, Manipur, Assam, ca. 3,500 ft.

*Size*.—1 adult ♀ measured as follows, in mm.:—Head-and-body 236; tail 204; hind-foot 53; ear 23.

*Habitat*.—This squirrel was rare in the “Kanglatongbi Area” near Imphal, only 2 or 3 specimens having been obtained. No. R4/24-9-45 was obtained in evergreen jungle, and No. R5/2-10-45 in riverine scrub. (Also see Roonwal, 1949c.)

*Distribution*.—Assam, including Manipur; W. Burma.

17. *Dremomys lokriah macmillani* Thomas and Wroughton.

(Macmillan's Squirrel.)

1916. *Dremomys macmillani* Thomas and Wroughton, *J. Bombay nat. Hist. Soc.* XXIV (2), p. 238. (Type-locality: Tatkon, on west bank of R. Chindwin near Kindat, Upper Chindwin District, Burma.)  
 1916. *Dremomys macmillani*, Wroughton, *J. Bombay nat. Hist. Soc.* XXIV (2), p. 306.  
 1916. *Dremomys macmillani*, Thomas, *J. Bombay nat. Hist. Soc.* XXIV (3), p. 418.  
 1916. *Dremomys macmillani*, Wroughton, *J. Bombay nat. Hist. Soc.* XXIV (4), p. 771.  
 1918. *Dremomys macmillani*, Robinson and Kloss, *Rec. Indian Mus.* XV, p. 236.  
 1919. *Dremomys macmillani*, Wroughton, *J. Bombay nat. Hist. Soc.*, XXVI (2), p. 364.  
 1923. *Dremomys macmillani*, Mills, *J. Bombay nat. Hist. Soc.*, XXIX (1), p. 227.  
 1940. *Dremomys lokriah macmillani*, Ellerman, *Fam. & Genera Living Rodents* I, p. 381.  
 1947. *Dremomys lokriah macmillani*, Ellerman, *J. Mammal.* XXVIII (3), p. 264.  
 1949. *Dremomys lokriah macmillani*, Roonwal, *Trans. nation. Inst. Sci. India* III, p. 85.

*Material*.—12 specimens (8 ♂♂, 3 ♀♀, 1 unsexed) were examined from 25 September to 18 December 1945, 15—16 miles north of Imphal on Dimapur Road, Manipur, Assam, ca. 3,500 ft. Of these, 11 (Z.S.I. Registered Nos. 11,189—11,199) were preserved.

*Size, etc.*—8 adults measured as follows, in mm. :—

	H. & B.	Tl.	H.F.	Ear
5♂♂:	160-210	110-160	44-47	19-21
3♀♀:	180-194	133-153	42-45	19-22

In 3 adult examples the horizontal length of the eye was about 9 mm. In 2 ♀♀, collected on 25 September and 30 November, the mammary formula was : Th. 1 + abd. 2 = 6.

*Habitat.*—This squirrel is common in the “Kanglatongbi area” north of Imphal. It occurs both in evergreen jungle and oak scrub, perhaps frequenting the latter association somewhat more than the former. A specimen was also trapped in riverine scrub. It is arboreal and diurnal. (Also see Roonwal, 1949c.)

*Distribution.*—E. Assam (Garo, Jaintia and Naga Hills, and Manipur) and W. Burma (Kabaw Valley in Upper Chindwin District, and Chin Hills). Up to about 5,000 ft. altitude.

#### Family (ii) MURIDAE (Rats, etc.).

#### 18. *Bandicota bengalensis bengalensis* (Gray and Hardwicke).

(The Indian Mole-Rat.).

1833. *Arvicola bengalensis*, Gray & Hardwicke, *Illustr. Indian Zool.* II, pl. 21. (Type-locality: Bengal.)

1941. *Bandicota bengalensis bengalensis*, Ellerman, *Fam. & Genera Living Rodents* II, p. 278.

1947. *Bandicota bengalensis bengalensis*, Ellerman, *J. Mammal.* XXVIII, p. 367.

1949. *Bandicota bengalensis bengalensis*, Roonwal, *Trans. nation. Inst. Sci. India* III, p. 86.

*Material.*—10 specimens were obtained as follows:—9 from an area 16—22 miles north of Imphal on Dimapur Road, ca. 3,500 ft., during late July to early December 1945; and 1 from Moreh near Tamu on Manipur-Burma frontier, Upper Chindwin District, W Burma, ca. 500 ft., on 10 August 1945. Of these, 9 were preserved, e.g., Z.S.I. Registered Nos. 11,200—11,208.

This is a very variable form in so far at least as body-size is concerned. 6 adults (4 ♂♂, 2 ♀♀) gave the following lengths (in mm.): Head-and-body 183-204 (mean 194); tail 150-197 (mean 163); hind-foot 34-39 (mean 36.7); ear 22-23 (mean 22.3). The tail was 76-87%, once 108%, (mean 84%) of head-and-body; and the hind-foot 17.3—20.5% (mean 18.7%).

The skull is equally variable in size (Table 1a). It is strong and well-built and very like that of *Rattus rattus*, but larger. The mandibular knob at the basal tip of the lower incisors is only moderately developed, as is also the case in *Rattus rattus bullocki*; it is much less developed than in the delicate skull of *Rattus manipulus* described below.

*Habitat.*—The mole-rat was trapped both in evergreen jungle and in oak scrub.

*Distribution.*—Central and Eastern India, up to W. Burma.

19. *Bandicota bengalensis* ?*varius* (Thomas).

(The Malay Mole-Rat.)

1907. *Gunomys varius* Thomas, *Ann. Mag. nat. Hist.* (7) XX, p. 204. (Type-locality: Georgetown, Penang, Malay.)  
 1947. *Bandicota bengalensis varius*, Ellerman, *J. Mammal.* XXVIII, p. 366.  
 1949. *Bandicota bengalensis* ?*varius*, Roonwal, *Trans. nation. Inst. Sci. India* III, p. 87.

*Material*.—1 adult ♂ (Coll. No. 597) collected on 30 August 1945 at Kalewa on R. Chindwin, W. Burma, ca. 360 ft. Head-and-body 224 mm.; tail 186 mm.; hind-foot 41 mm.; ear 23 mm. The specimen was not preserved; it was quite similar in coloration to *Bandicota bengalensis*, *bengalensis* but owing to its large size I regard it as *varius*.

20. *Rattus rattus bullocki* Roonwal.

(The Common Manipur White-bellied Rat.)

(Pl. I, Fig. 1; and Pl. II.)

1948. *Rattus rattus bullocki* Roonwal, *Proc. nation. Inst. Sci. India* XIV, p. 385. (Type-locality: 16 miles N. of Imphal on Dimapur Road, Manipur, Assam, ca. 3,500 ft.)  
 1949. *Rattus rattus bullocki*, Roonwal, *Trans. nation. Inst. Sci. India* III (2), p. 87.

A brief, preliminary description was given in Roonwal (1948, p. 385), and a fuller one is now provided.

*Material*.—(i) About 359 specimens were obtained during end-June to end-December 1945 from the following areas in Manipur and the adjoining parts of W. Burma, but mostly in the former area:—(a) 307 from “Kanglatongbi Area” up to about 22 miles north of Imphal on Dimapur Road, ca. 2,600—4,000 ft., (b) 7 from the “Palel Area” about 34—37 miles south-east of Imphal on Tamu Road, ca. 4,000 ft. (c) 37 from the “Tamu and Moreh Areas” on the Manipur frontier, W. Burma, ca. 580 ft.; (d) Kabaw Valley, Upper Chindwin District, W. Burma, especially along road from Tamu to Kalewa on R. Chindwin, ca. 360—580 ft. Of these, 92 were preserved either as stuffed skins or in spirit, e.g., Z.S.I. Registered Nos. 11,098 and 11,209—11,300. (ii) 1 unsexed, adult (Z.S.I. Registered No. 11,347) was obtained by the Zoological Survey of India Party from Nanglea Atrow, 63 miles west of Imphal on Silchar Road, W. Manipur, ca. 3,250 ft.

*Diagnosis.*

*Colour*.—*Dorsum*: Dark grey to ochraceous tawny with the grey tinge grizzled with black owing to long black hairs; with steel-blue sheen in certain lights. Ground colour more grey than tawny, especially in mid-dorsal line where a wide, diffuse black stripe is sometimes formed on lower back and rump. Fur slaty-based, with a subterminal band (2 mm. long) ochraceous tawny, and a narrower terminal tip black. With numerous soft, flattened bristles, all longer than under-fur, with basal half white and terminal half black; the longer bristles with the basal two-thirds or more whitish. Whiskers almost all black; occasionally

a few (2 or 3) of the lower whiskers being either wholly or terminally white. *Venter* : Ranging from : (i) pure white and ivory white (cream), with all hairs white to the bases, to : (ii) white, with a few hoary patches (owing to hairs having slaty bases and white tips), especially on chest, and forming a mid-ventral pectoral streak; in addition, sometimes having irregular ochraceous to buff and yellow patches and streaks (with hair slaty-based, with ochraceous buff or yellowish tips); or (iii) silvery hoary with or without buff patches or streaks; or (iv) grey or buffy grey; this last coloration being similar to the one found in domesticated examples (*R. rattus rufescens*); only two such specimens found in a total of nearly 359 examined. A pure white venter tends usually to be sharply demarcated from the dorsum at the sides. *Tail* : Dark brown, unicolorous above and below; hairs stiff, short and dark brown with paler tips; in 2 specimens, with the extreme tip (5—20 mm. long) white all round. In length averaging subequal to head-and-body. *Hands and feet* (Pl. II, Figs. 7-10): White above, sometimes with dusky patches on the metacarpel areas; claws pale pink; tufts of vibrissae above claws silvery white. *Ears* (Pl. II, Fig. 11): Dusky grey outside; paler, with pink tinge inside, darker towards edges.

*Size, etc.*—111 adults (about half males, half females) gave the following lengths (in mm.) of the body-parts:—Head-and-body 148—197 (mean 172); tail 130—216 (mean 172); hind-foot 28—36 (mean 32); ear 15—26 (mean 21). Considered as percentages of head-and-body, these lengths are : Tail 72—127% (mean 100.4 %); hind-foot 12—22% (mean 18%); ear 10—15% (mean 13%). In the 7 specimens from Tamu and Moreh in the Kabaw Valley, the tail averages slightly larger (107% of hand-and-body length).

The eyes are large, measuring about 7.25×5.0 mm. in horizontal and vertical lengths respectively, or about 4.26%×2.94% of the head-and-body length. The mammary formula is mostly th. 3 + abd. 3=12 (35 examples); and occasionally with 11 teats (2 examples), one of the thoracic teats of one side being absent; and 2+3=10 (3 examples). Breeding examples were found in August-November. Further details of the ecology of this rat, e.g., habitat preferences, food, etc., will be found in Roonwal (1949c).

*Skull* (Table 1b; and Pl. II, Figs. 1—6).—The skull is typical of the wild forms of the *Rattus rattus* group. Twenty-six adult skulls (13♂♂, 13♀♀) gave the following measurements (in mm.) : Greatest length 36.2—42.0 (mean 38.7); condylobasal length 35.4—41.3 (mean 38.1); occipitonasal length 37.0—43.5 (mean 40.3); greatest zygomatic width 18.9—21.0 (mean 19.9); least interorbital width 5.3—6.6 (mean 5.95); cranial width 15.3—16.7 (mean 15.9); occipital width 13.4—15.1 (mean 14.5); median depth of occiput 8.7—10.4 (mean 9.4); post-molar length 15.6—18.7 (mean 17.1); auditory length 9.3—11.2 (mean 10.1); length of tympanic bulla 6.6—7.7, once 8.5 (mean 7.2); length of nasals 12.2—16.7 (mean 15.2); greatest combined width of nasals 3.6—4.9 (mean 4.2); palatal length 16.6—20.5 (mean 18.5); length of diastema 8.9—12.7 (mean 10.4); length of anterior palatine foramina 6.2—8.0 (mean 7.2); greatest combined width of anterior palatine foramina 2.0—2.8, once 3.4 (mean 2.4); length of upper molar

crowns 6.2—7.5 (mean 6.9); mandibular length 20.2—24.0 (mean 22.1). The tympanic bulla is 17.0—18.7%, once 15.5% and 19.7% (mean 17.9%) of the occipitonasal length. The upper incisors are bent backwards (opisthodont).

*Types*.—Deposited in the Zoological Survey of India Collections. *Holotype* (Pl. I, Fig. 1; and Pl. II, Figs. 1-6): Z.S.I. Registered No. 11,228. Original Collector's No. FL1/4-8-45. Adult ♀; stuffed skin, with separate skull. Collected on 4th August 1945 by Major M. L. Roonwal in evergreen jungle near milestone 117, about 16 miles north of Imphal on Dimapur Road, Manipur, ca. 3,500 ft. Head-and-body 166 mm.; tail 167 mm.; hind-foot 33 mm.; ear 21 mm. Mammae 3 + 3 = 12. Dorsum ochraceous tawny with grey tinge, especially at the sides. Venter white, with a mid-ventral pectoral streak of grey tinged with buff. Skull measurements (in mm.): Greatest length 40.5; condylobasal length 38.1; occipitonasal length 41.3; greatest zygomatic width 21.0; least interorbital width 6.1; cranial width 16.5; occipital width 15.1; median depth of occiput 9.8; post-molar length 17.4; auditory length 10.4; length of tympanic bulla 7.4; length of nasals 15.6; combined width of nasals 4.7; length of diastema 12.7; length of anterior palatine foramina 7.5; greatest combined width of anterior palatine foramina 2.3; length of upper molars 6.8; mandibular length 23.1. Upper incisors opisthodont. Tympanic bulla 17.9% of occipitonasal length.

*Paratypes*: All stuffed skins of adults, with separate skulls; collected from the type-locality. Z.S.I. Registered Nos. 11,230 (♂), 11,253 (♀), 11,274 (♂), 11,286 (♂), 11,291 (♀).

*Habitat*.—See Roonwal, 1949c, pp. 87-99.

*Distribution*.—Known mostly from central Manipur, e.g., the Imphal Valley and the surrounding hills up to about 22 miles north of Imphal along Dimapur Road and about 37 miles south-east of Imphal along Tamu Road. One specimen examined from Nanglea Atrow (W. Manipur). Upto ca. 4,000 ft. altitude. Specimens from Tamu, Moreh and Kalewa (Kabaw Valley, W. Burma) differing only slightly, having rather longer tails (107% of head and-body), and may be intermediate between *bullocki* Roon. and *khyensis* Hint.

*Comparisons*.—*R. r. bullocki* is closely allied to the following five subspecies: *khyensis* Hint., *tatkonensis* Hint., *tikos* Hint., *tistae*<sup>1</sup> Hint. and *brunneusculus* Hodgs. (syn. *sikkimensis* Hint.); of these it is closest, both geographically and otherwise, to the first two. It, can however, be separated by the key given below. The head-and-body in *bullocki* is the longest, and the tail proportionately the shortest, being, on the average, subsequential ((100.4%) to head-and-body. Ellerman (1947d, p. 380) assigns specimens from the Manipur Valley (Bishenpur and Lake Loktak, i.e., within about 40 miles of the area where *R. r. bullocki* were obtained) to two subspecies, *brunneusculus* Hodgs. (syn. *sikkimensis* Hint.) and *tistae* Hint., but I think that they may prove to be *bullocki*.

<sup>1</sup>Ellerman (1947d, p. 380) puts *tistae* among the dark-bellied forms, whereas Hinton (1918) in his original description and key stated that it is primarily white-bellied, only about a third of the specimens having a dark venter.

*Key to some subspecies of Rattus rattus from Eastern India and Burma.*  
(Average measurements are given.)

1. (4.) Size larger ; head-and-body length over 160 mm.
2. (3.) Tail length short, being 100% of head-and-body ; not infrequently shorter than head-and-body. Hind-foot length 18% of head-and-body. Tympanic bullae moderately large (length 7.2 mm., or 17.9% of occipitonasal length). Mammae mostly 3+3=12 ; rarely less. Dorsal colour dark grey to ochraceous tawny with pronounced grey tinge. Venter white or ivory cream, often with streaks or patches of grey, yellow or buff.

1. *R. r. bullocki* Roon.

3. (2.) Tail longer, 110-120% of head-and-body. Hind-foot 19-20% of head-and-body. Bullae larger (length averaging 7.5-8.4 mm., or 18.5-20% of occipitonasal length.) Mammae mostly 3+3=12. Dorsal colour bright or dull rusty red with some grey. Venter white or cream, sometimes with slaty streaks.

2. *R. r. khyensis* Hint. 3. *R. r. tatkonsensis* Hint.

4. (1.) Size smaller ; head-and-body length below 160 mm. (5.)

5. (6.) Tail shorter, 108% of head-and-body. Hind-foot 21% of head-and-body. Mammae tend to reduction in many specimens, 10-12 in number. Dorsal colour dull umber brown, with darker hairs ; venter as in *khyensis*.

4. *R. r. tikos* Hint.

6. (5.) Tail longer 123-131% of head-and-body. Hind-foot 21-22.5% of head-and-body. Dorsal colour dark olive-brown. Venter white or cream, in some individuals of *tistae* suffused with slaty or buff either wholly or in patches or streaks. Mammae tend to be fewer in *tistae* (2+8=10) ; the normal 12 in *brunneusculus*.

5. *R. r. tistae* Hint.

6. *R. r. brunneusculus* Hodgs. (syn. *sikkimensis* Hint.)

## 21. *Rattus rattus* ?*khyensis* Hinton.

1919. *Rattus rattus khyensis* Hinton, *J. Bombay nat. Hist. Soc.* XXVI (2), p. 398. (Type-locality : 25 miles W. of Kindat, Chin Hills, W. Burma, 600 ft.)

1941. *Rattus rattus khyensis*, Ellerman, *Fam. & Gen. Living Rodents* II, p. 176.

1947. *Rattus rattus khyensis*, Ellerman, *J. Mammal.* XXVIII, p. 380.

*Material.*—3 specimens (1 ad. ♂, 1 ad. ♀, 1 unsexed subad.?, e.g., Z.S.I. Registered Nos. 11,318—11,320), collected by Major S. L. Kalra on 28 August 1945 from Kalewa on R. Chindwin, W. Burma, ca. 360 ft.

*Size, colour, etc.*—The 2 adults measure as follows (in mm.) : Head-and-body 141—162 ; tail 155—165 (or 101—110% of head-and-body) ; hind-foot 30-32. The coloration above is more dull and colder than in *R. r. bullocki* Roon. already described. The venter is pure white ; the feet white above, and the tail dark brown throughout. The specimens having been obtained in the hot season, the fur in the adults is coarse and mixed with spines. The mammary formula in No. 11318 is : Th. 2 + abd. 3 = 10.

*Skull.*—The skull measurements are given in Table 1c. The length of the tympanic bullae is 6.7—7.9 mm. or 18—19.2% of the occipitonasal length.

*Distribution.*—Western portion of Upper Burma, and Central Burma (Ellerman, 1947d).

TABLE

*Skull-measurements, in mm., of some Muridae (Rodentia) of the genera*  
*Figures within brackets are percentages of the occipitonasal length.*  
*of adults.*

Abbreviations.—(i) *State of wear of molars* : H, half worn out ; M, incisor 'index' : Opi., opisthodont (bent backward) ; Ort., orthodont

Registered Number (Z.S.I.)	Collection Number	Locality	Sex	Age. (State of wear of molars.)	Upper incisor "index"	Measurements	
						Greatest length 1	Condylbasal length 2

(a)—*Bandicota bengalensis*

11,200	FL1/25-7-45	Nr. Imphal	♂	S	Opi.	42.5	42.0
11,201	FL6/25-7-45	Nr. Imphal	♂	H	"	45.3	44.5
11,203	FL6/26-7-45	Nr. Imphal	♂	S	"	42.8	42.5
11,205	R6/9-10-45	Nr. Imphal	♂	S	"	—	—
11,206	R5/27-10-45	Nr. Imphal	♂	H	"	41.1	40.0
11,207	R1/12-11-45	Nr. Imphal	♂	S	"	40.7	40.2
11,202	FL4/26-7-45	Nr. Imphal	♀	M	"	42.4	41.8
Number of samples						6	6
Range						40.7-45.3	40.0-44.5
Mean						42.5	41.8

(b)—*Rattus rattus bullocki* Roonwal. (13 ♂♂, 13 ♀♀. All from "Kangla dont in all.).

Number of samples						25	24
Range						36.2-42.0	35.4-41.3
Mean						38.7	38.1

(c)—*Rattus rattus*

11,320	K3/28-8-45	Kalewa, W. Burma.	♂	S	Opi.	40.4	40.0
11,318	K1/28-8-45	Kalewa, W. Burma.	♀	N	"	36.2	35.2
11,319	K2/28-8-45	Kalewa, W. Burma.	(?)	N	"	36.6	35.3

1(a-l).

Bandicota, Rattus and Hadromys from Assam and W Burma.

*All measurements, except when otherwise stated (e.g., 'subadults'), are**much worn out ; N, not worn out ; S, slightly worn out. (ii) Upper (straight or vertical) ; Pro., proodont (bent forward).*

Occipitonasal length	Greatest zygomatic width	Least interorbital width	Cranial width	Occipital breadth	Med. depth of occiput	Post-molar length	Auditory length
3	4	5	6	7	8	9	10

*bengalensis* (Gr. & Hardw.).

44.6	20.1	6.1	16.6	15.0	10.1	19.8	10.8
45.8	21.5	6.3	16.8	15.4	10.7	20.4	11.1
44.4	20.0	6.2	16.6	14.9	10.5	19.7	10.6
—	—	—	17.4	15.7	10.5	—	10.8
42.2	—	6.5	16.5	14.5	10.0	18.5	10.2
42.0	—	6.2	16.8	14.6	9.8	18.0	9.9
44.2	21.3	6.5	17.1	15.0	10.5	19.4	10.5
6	4	6	7	7	7	6	7
42.0-45.8	20.0-21.5	6.1-6.5	16.5-17.4	14.5-15.7	9.8-10.7	18.0-20.4	9.9-11.1
43.9	20.7	6.3	16.8	15	10.3	19.2	10.6

tongbi area " near Imphal, Central Manipur. Upper incisors opistho-

22	4	26	24	19	21	26	24
37.0-43.5	18.9-21.0	5.3-6.6	15.3-16.7	13.4-15.1	8.7-10.4	15.6-18.7	9.3-11.2
40.3	19.9	5.95	15.9	14.5	9.4	17.1	10.1

*?khyensis* Hinton.

41.2	19.4	5.9	16.5	14.6	9.2	18.1	10.9
37.2	—	5.3	16.1	14.2	8.9	15.6	9.5
37.4	17.2	5.8	15.6	13.8	9.1	15.5	9.6

TABLE 1(a-l)—

Registered Number (Z.S.I.)	Collection Number	Locality	Sex	Age. (State of wear of molars.)	Upper incisor "index"	Length of tympanic bulla	
						11	12

(a)—*Bandicota bengalensis*

11,200	FL1/25-7-45	Nr. Imphal	♂	S	Opi.	6.6	17.8
11,201	FL6/25-7-45	Nr. Imphal	♂	H	"	7.0	18.0
11,203	FL6/26-7-45	Nr. Imphal	♂	S	"	6.4	18.2
11,205	R6/9-10-45	Nr. Imphal	♂	S	"	7.4	19.5
11,206	R5/27-10-45	Nr. Imphal	♂	H	"	7.4	15.8
11,207	R1/12-11-45	Nr. Imphal	♂	S	"	6.7	16.4
11,202	FL4/26-7-45	Nr. Imphal	♀	M	"	6.8	17.7
Number of samples						7	7
Range						6.4-7.4	15.8-19.5
Mean						6.9	17.6

(b)—*Rattus rattus bullocki* Roonwal (contd.). (13 ♂♂, 13 ♀♀. All from opisthodont in all.)

Number of samples						25	22
Range						6.6-7.7 (once 8.5)	12.2-16.7
Mean						7.2	15.2

(c)—*Rattus rattus*

11,320	K3/28-8-45	Kalewa, W. Burma.	♂	S	Opi.	7.9	15.3
11,318	K1/28-8-45	Kalewa, W. Burma.	♀	N	"	6.7	13.9
11,319	K2/28-8-45	Kalewa, W. Burma.	(?)	N	"	6.9	13.6

*continued.*

Gr. comb. width of nasals	Palatal length	Length of diastema	Length of ant. palatine foramina	Gr. comb. width of ant. palatine foramina	Length of upper molar crowns	Mandibular length
13	14	15	16	17	18	19

*bengalensis* (Gr. & Hardw.) (*contd.*).

5.0	—	11.8	8.2	2.6	6.2	24.2
5.0	22.0	12.8	8.5	2.8	7.2	25.0
5.0	20.7	12.0	8.0	2.6	6.8	23.9
5.3	—	11.7	8.0	3.1	7.0	25.1
4.4	19.6	11.0	7.7	2.6	6.9	22.9
4.7	20.5	10.7	8.0	2.7	7.0	22.8
4.9	20.8	12.1	7.9	2.7	6.6	24.0
7	5	7	7	7	7	7
4.4-5.3	19.6-22.0	10.7-12.8	7.7-8.5	2.6-3.1	6.2-7.2	22.8-25.1
4.99	20.6	11.7	8	2.7	6.8	24

“Kanglatongbi area” near Imphal, Central Manipur. Upper incisors

25	19	25	26	26	25	24
3.6-4.9	16.6-20.5	8.9-12.7	6.2-8.0	2.0-2.8 (once 3.4)	6.2-7.5	20.2-24.0
4.2	18.5	10.4	7.2	2.4	6.86	22.06

*?khyensis* Hinton (*contd.*).

4.5	19.6	10.2	7.8	2.1	7.3	22.2
4.5	—	9.2	6.6	2.2	6.8	20.7
4.0	16.3	9.0	6.4	2.0	7.1	20

TABLE 1(a-l)—

Registered Number (Z.S.I.)	Collection Number	Locality	Sex	Age. (State of wear of molars.)	Upper incisor "index"	Length of tympanic bulla		Length of nasals.	
						1	2	1	2

(d)—*Rattus rattus* (? subspecies). Grey-bellied. Probably close to

11,316	FL11/25-7-45	C. Manipur	(?)	S	Opi.	39.2	38.7
11,317	FL19/25-7-45	C. Manipur	♀	S	"	34.8	34.1
11,321	602/2-9-45	E. Manipur, nr. Tamu.	♂	S	"	37.2	36.1

(e)—*Rattus nitidus*

11,340	—	W. Manipur	♂	S	Opi.	35.9	35.0
11,322	R3/8-12-45	Nr. Imphal (C. Manipur)	♂ (subad.?)	S	Opi.	—	—

(f)—*Rattus manipulus*

11,307	R1/19-10-45	C. Manipur	♂ subad.	N	Pro.	—	—
11,309	R1/3-11-45	C. Manipur	"	N	"	34.7	34.3
11,312	R1/7-12-45	C. Manipur	"	N	"	34.1	33.7
11,303	R1/25-8-45	C. Manipur	♀	M	"	38.5	38.1
11,304	R1/11-9-45	C. Manipur	♂	M	"	40.0	40.0
11,311	R1/3-12-45	C. Manipur	♂	N	"	37.1	36.5
Adults only {						3	3
Number of samples							
Range						37.1-40.0	36.5-40.0
Mean						38.5	38.2

*continued.*

Occipitonasal length	Greatest zygomatic width	Least interorbital width	Cranial width	Occipital breadth	Med. depth of occiput	Post-molar length	Auditory length
3	4	5	6	7	8	9	10

*R. r. bullocki* Roonwal and *R. r. khyensis* Hinton.

40.0	18.7	5.7	16.3 (40.8%)	14.8 (37%)	9.6 (24%)	17.6 (44%)	9.7
35.8	—	5.6	16.0 (44.7%)	14.4 (40.2%)	9.0 (25.1%)	15.8 (44.1%)	9.3
38.6	—	5.9	16.8 (43.5%)	14.5 (37.6%)	9.0 (23.3%)	15.8 (40.9%)	9.4

*obsoletus* Hinton.

37.2	—	5.5	15.9	14.5 (39%)	8.7	15.2 (40.1%)	8.9
—	—	—	—	14.2	8.9	—	9.0

*manipulus* (Thomas). Upper incisors slightly proodont.

—	—	6.6	14.9	14.2	10.2	14.7	8.8
35.6	—	6.7	15.7	14.5	10.5	15.3	9.0
—	—	6.3	14.9	13.9	10.0	15.2	9.1
—	—	6.9	15.8	—	11.2	17.2	9.4
41.3	21.1	6.7	15.7	14.4	11.0	18.0	10.1
38.0	19.6	6.5	15.7	14.1	10.1	16.4	9.0
2	2	3	3	2	3	3	3
38.0-41.3	19.6-21.1	6.5-6.9	15.7-15.8	14.1-14.4	10.1-11.2	16.4-18.0	9.0-10.1
99.7	20.4	6.7	15.7	14.3	10.8	17.2	9.5

TABLE 1(a-l)—

Registered Number (Z. S. I.)	Collection Number	Locality	Sex	Age. (State of wear of molars.)	Upper incisor "index"	Length of tympanic bulla	
						11	12

(d)—*Rattus rattus* (? subspecies) (contd.). Grey-bellied. Probably

11,316	FL11/25-7-45	C. Manipur	(?)	S	<i>Opi.</i>	6.6 (16.5%)	15.3 (38.3%)
11,317	FL19/25-7-45	C. Manipur	♀	S	"	6.5 (18.2%)	13.3 (37.2%)
11,321	602/2-9-45	E. Manipur, nr. Tamu.	♂	S	"	6.4 (16.7%)	15.7 (40.7%)

(e)—*Rattus nitidus*

11,340	—	W. Manipur	♂	S	<i>Opi.</i>	6.2 (16.7%)	15.0 (40.3%)
11,322	R3/8-12-45	Nr. Imphal (C. Manipur).	(♂ subad.?)	S	<i>Opi.</i>	6.5	13.7

(f)—*Rattus manipulus*

11,307	R1/19-10-45	C. Manipur	♂ subad.	N	<i>Pro.</i>	5.7	—
11,309	R1/3-11-45	C. Manipur	"	N	"	6.0	13.8
11,312	R1/7-12-45	C. Manipur	"	N	"	5.8	—
11,303	R1/25-8-45	C. Manipur	♀	M	"	6.2	—
11,304	R1/11-9-45	C. Manipur	♂	M	"	6.0	17.8
11,311	R1/3-12-45	C. Manipur	♂	N	"	6.0	15.5
Adults only {						3	2
Range						6.0-6.2	15.5-17.8
Mean						6.1	16.7

*continued.*

Gr. comb. width of nasals	Palatal length	Length of diastema	Length of ant. palatine foramina	Gr. comb. width of ant. palatine foramina	Length of upper molar crowns	Mandibular length
13	14	15	16	17	18	19

close to *R. r. bullocki* Roonwal and *R. r. khyensis* Hinton.

4.6 (11.5%)	19.1 (47.8%)	11.1 (27.8%)	7.8 (19.5%)	3.0	6.6 (16.5%)	21.6
4.2 (11.7%)	17.4 (48.6%)	9.7 (27.2%)	6.7 (18.7%)	2.4	6.4 (17.0%)	19.6
4.5 (11.7%)	—	10.2 (26.4%)	6.6 (17.3%)	2.4	6.7 (17.4%)	20.4

*obsoletus* Hinton (*contd.*).

4.4 (11.8%)	17.6 (47.3%)	9.6 (25.8%)	6.2 (16.7%)	2.2	6.6 (17.7%)	20.7
4.0	—	9.1	6.7	—	6.5	—

*manipulus* (Thomas) (*contd.*). Upper incisors slightly proodont.

—	17.1	10.7	6.5	2.2	5.7	21.2
3.6	—	11.0	6.2	2.2	6.1	21.0
—	17.5	11.6	6.5	2.2	5.9	21.1
—	18.8	13.0	7.5	2.5	5.4	—
4.6	19.9	14.1	7.9	2.5	5.7	23.6
4.0	18.5	12.1	8.0	2.0	5.9	22.7
2	3	3	3	3	3	2
4.0-4.6	18.5-19.9	12.1-14.1	7.5-8.0	2.0-2.5	5.4-5.9	22.7-23.6
4.3	18.7	13.1	7.8	2.3	5.7	23.2

TABLE 1(a-l)—

Registered Number (Z.S.I.)	Collection Number	Locality	Sex	Age. (State of wear of molars.)	Upper incisor "index"	Measurements	
						Greatest length 1	Condylobasal length 2

(g)—*Rattus manipulus kekrimus* Roonwal. From Kekrima, Naga Hills

11,342	1	Naga Hills	♂	S	Pro.	36.2	35.6
11,341 (Holotype)	2	Naga Hills	♂	M	"	39.8	38.7
11,343	3	Naga Hills	♂	S	"	36.6	36.0
11,344	4	Naga Hills	♀	H	"	37.5	37.1
Number of samples						4	4
Range						36.2-39.8	35.6-38.7
Mean						37.5	36.9

(h)—*Rattus bowersii*

10,078 (Holotype)	—	K a k h y a n Hills (S. Yunnan).	♀	H	Orth.	52.2	50.5
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(i)—*Rattus bowersii*

11,345	—	W. Manipur	♂	M	Orth.	48.2	47.2
11,346	—	W. Manipur	♂	H	"	47.1	46.8

(j)—*Rattus niviventer*

11,130	R2/11-9-45	C. Manipur	♂	—	Opi.	36.2	35.5
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*continued.*

Occipitonasal length	Greatest zygomatic width	Least interorbital width	Cranial width	Occipital breadth	Med. depth of occiput	Post-molar length	Auditory length
3	4	5	6	7	8	9	10

Assam. Upper incisors slightly proodont.

—	19.4	6.4	14.8	13.1	9.8	15.5	9.0
40.2	—	6.4	15.2	—	10.5	17.1	—
—	—	6.4	15.6	14.1	10.2	15.0	8.6
37.9	—	6.6	—	—	10.5	16.4	—
2	1	4	3	2	4	4	2
37.9-40.2	19.4	6.4-6.6	14.8-15.6	13.1-14.1	9.8-10.5	15.0-17.1	8.6-9.0
39.1	19.4	6.5	15.2	13.6	10.3	16.5	8.8

*bowersii* (Anderson).

53.5	—	8.0	21.1	19.6	13.3	21.5 (40.2%)	12.5
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*mackenziei* (Thomas).

50.2	—	7.5	18.8	16.6	12.8	20.3 (40.4%)	11.1
48.8	24.4	7.5	19.5	17.0	13.0	20.2 (41.4%)	11.0

*niviventer* Hodgson.

37.5	16.1 (42.9%)	6.1	14.5 (38.7%)	12.2	8.0 (21.3%)	15.0	8.4
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TABLE 1(a-l)—

Registered Number (Z.S.I.)	Collection Number	Locality	Sex	Age. (State of wear of molars.)	Upper incisor "index"	Length of tympanic bulla		Length of nasals.	
						11	12		

(g)—*Rattus manipulus kekrimus* Roonwal (contd.). From Kekrima,

11,342	1	Naga Hills	♂	S	Pro.	5.8	—
11,341 (Holotype).	2	Naga Hills	♂	M	"	—	—
11,343	3	Naga Hills	♂	S	"	5.8	—
11,344	4	Naga Hills	♀	H	"	—	15.4
Number of samples						2	1
Range						5.8	15.4
Mean						5.8	15.4

(h)—*Rattus bowersii*

10,078 (Holotype).	—	K a k h y a n Hills (S., Yunnan).	♀	H	Orth.	8.3 (15.5%)	20.6 (38.5%)
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(i)—*Rattus bowersii*

11,345	—	W. Manipur	♂	M	Orth.	6.6 (13.1%)	20.5 (40.8%)
11,346	—	W. Manipur	♂	H	"	6.5 (13.3%)	19.7 (40.4%)

(j)—*Rattus niviventer*

11 130	R2/11-9-45	C. Manipur	♂	—	Opi.	5.2 (13.9%)	13.8 (36.8%)
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*continued.*

Gr. comb. width of nasals	Palatal length	Length of diastema	Length of ant. palatine foramina	Gr. comb. width of ant. palatine foramina	Length of upper molar crowns	Mandibular length
13	14	15	16	17	18	19

Naga Hills, Assam. Upper incisors slightly proodont.

—	18.3	12.0	6.7	1.7	6.3	—
—	19.8	13.7	7.4	2.3	6.0	23.8
—	19.2	12.4	7.1	1.8	6.4	22.0
4.0	18.8	12.2	7.0	2.2	6.4	—
1	4	4	4	4	4	2
4.0	18.3-19.8	12.0-13.7	6.7-7.4	1.7-2.3	6.0-6.4	22.0-23.8
4.0	19	12.6	7.1	2.0	6.3	22.9

*bowersii* (Anderson) (*contd.*).

5.2 (9.7%)	25.1 (46.9%)	16.6 (31%)	9.0 (16.8%)	—	8.2 (15.3%)	31.1
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*mackenziei* (Thomas) (*contd.*).

5.0 (10%)	23.8 (47.4%)	15.6 (31.1%)	9.4 (18.7%)	2.7	7.9 (15.7%)	28.2
5.5 (11.3%)	23.1 (47.9%)	14.6 (29.9%)	9.2 (18.9%)	3.0	8.4 (17.2%)	28.6

*niviventer* (Hodgson) (*contd.*).

4.0 (10.7%)	16.6 (44.3%)	10.0	6.5 (17.3%)	2.5	5.6	18.2
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TABLE 1(a-l)—

Registered Number (Z.S.I.)	Collection Number	Locality	Sex	Age. (State of wear of molars.)	Upper incisor "index"	Greatest length	
						1	2

(k)—*Rattus*

11,126	FL3/25-7-45	C. Manipur	♂	M	<i>Opi.</i>	36.5	35.5
11,131	R1/25-12-45	C. Manipur	♂	H	"	38.3	37.1
11,127	FL4/25-7-45	C. Manipur	♀	H	"	36.0	35.0
11,128	FL1/3-8-45	C. Manipur	♀	M	"	35.1	33.6
11,129	R6/29-10-45	C. Manipur	♀	M	"	35.7	34.6
No. of samples						5	5
Range						35.1-38.3	33.6-37.1
Mean						36.3	35.2

(l)—*Hadromys*

11,116	R1/14-11-45	C. Manipur	♂	H	<i>Opi.</i>	31.8	31.0
11,117	R3/18-12-45	C. Manipur	♂	S	"	29.5	28.4
11,132	FL4/27-7-45	C. Manipur	♂	H	"	31.9	30.5
11,112	K1/17-9-45	C. Manipur	♀	S	"	29.7	28.6
No. of samples						4	4
Range						29.5-31.9	28.4-31.0
Mean						30.7	29.6

*continued.*

Occipitonasal length	Greatest zygomatic width	Least interorbital width	Cranial width	Occipital breadth	Med. depth of occiput	Post-molar length	Auditory length
3	4	5	6	7	8	9	10

*mentosus* Thomas.

37.3	—	6.0	14.7	12.4	8.7	15.8	8.1
39.7	—	6.2	15.7	12.7	8.8	16.5	7.6
37.0	16.5	5.8	14.6	12.3	8.7	15.6	7.9
37.3	17.0	6.0	15.2	13.0	8.6	15.0	8.0
36.5	—	6.4	—	12.7	8.5	15.5	8.6
5	2	5	4	5	5	5	5
36.5-39.7	16.5-17.0	5.8-6.4	14.6-15.7	12.3-13.0	8.5-8.8	15.0-16.5	7.6-8.6
37.6	16.8 (44.7%)	6.1	15.1 (40.2%)	12.6 (12.2%)	8.7 (23.1%)	15.7	8.04

*humei* (Thomas).

32.3	—	5.2	12.7	—	7.8	13.8	—
—	—	4.6	12.6	—	6.8	12.6	7.0
32.3	15.9	4.7	13.0	12.4	8.4	13.3	7.7
30.8	14.9	4.6	12.4	11.2	7.4	12.6	7.2
3	2	4	4	2	4	4	3
30.8-32.3	14.9-15.9	4.6-5.2	12.4-13.0	11.2-12.4	6.8-8.4	12.6-13.8	7.0-7.7
31.8	15.4	4.8	12.7	11.8	7.5	13.1	7.8

TABLE 1(a-l)—

Registered Number (Z. S. I.)	Collection Number	Locality.	Sex	Age. (State of wear of molars.)	Upper incisor "index"	Length of	
						tympanic bulla	nasals
						11	12

(k)—*Rattus*

11,126	FL3/25-7-45	C. Manipur	♂	M	Opi.	4.7	14.5
11,131	R1/25-12-45	C. Manipur	♂	H	"	4.9	15.5
11,127	FL4/25-7-45	C. Manipur	♀	H	"	4.5	14.5
11,128	FL1/3-8-45	C. Manipur	♀	M	"	4.7	14.6
11,129	R6/29-10-45	C. Manipur	♀	M	"	4.7	14.5
No. of samples						5	5
Range						4.5-4.9	14.5-15.5
Mean						4.7 (12.5%)	14.7 (99.1%)

(l)—*Hadromys*

11,116	R1/14-11-45	C. Manipur	♂	H	Opi.	—	10.0
11,117	R3/18-12-45	C. Manipur	♂	S	"	4.8	—
11,132	FL4/27-7-45	C. Manipur	♂	H	"	5.1	11.5
11,112	K1/17-9-45	C. Manipur	♀	S	"	4.8	10.3
No. of samples						3	3
Range						4.8-5.1	10.0-11.5
Mean						4.9	10.6

*continued.*

Gr. comb. width of nasale	Palatal length	Length of diastema	Length of ant. palatine foramina	Gr. comb. width of ant. palatine foramina	Length of upper molar crowns	Mandibular length
13	14	15	16	17	18	19

*mentosus* Thomas (*contd.*).

4.5	15.4	9.1	5.5	2.5	5.5	18.7
4.4	16.7	9.4	5.8	2.7	6.4	19.0
4.2	15.2	9.0	—	2.5	5.7	19.6
4.0	15.0	9.6	6.5	2.5	5.6	19.0
4.5	15.6	9.5	5.7	2.5	5.7	19.0
5	5	5	4	5	5	5
4.0-4.5	15.0-16.7	9.0-9.6	5.5-6.5	2.5-2.7	5.5-6.4	18.7-19.6
4.4 (11.7%)	15.6 (40.2%)	9.3	5.9 (15.7%)	2.5	5.8	19.2

*humei* (Thomas) (*contd.*).

—	—	7.9	—	—	5.4	18.5
—	13.6	7.6	5.7	1.1	5.1	16.6
3.5	13.6	8.4	5.7	1.1	5.5	18.4
3.2	13.2	7.5	5.7	1.2	5.3	16.8
2	3	4	3	3	4	4
3.2-3.5	13.2-13.6	7.5-8.4	5.7	1.1-1.2	5.1-5.4	16.8-18.5
3.4	13.5	7.9	5.7	1.13	5.3	17.6

22. *Rattus rattus* (?subspecies). (Grey-bellied.)

*Material.*—3 adult specimens collected by Major M. L. Roonwal as follows :—1 unsexed (Z.S.I. Registered No. 11,316) and 1♀ (No. 11,317) from milestone 111, about 22 miles N. of Imphal on Dimapur Road, ca. 3,500 ft., both collected on 25 July 1945; and 1♂ (No. 11,321) from "Mite Hill", ca. 63½ miles from Imphal on Tamu Road, eastern Manipur (near India-Burma frontier), collected on 2 September 1945.

*Size, colour, etc.*—The 3 adults measure as follows (in mm.) :—Head-and-body 135—154; tail 127—140 (or 91—97% of head-and-body); hind-foot 30—35 (or 22—24% of head-and-body); ear (1♂) 20. The coloration is rather similar to *R. r. ?khyensis* described above, except that the venter is grey in all the three specimens; the fur too is softer.

*Skull.*—The skull measurements are given in Table 1*d*. The tympanic bullae are rather smaller (length 6.4—6.6, mean 6.5 mm.) than in *R. r. bullocki* and *R. r. ?khyensis*, but otherwise the skull appear to resemble these forms.

*Comparisons.*—These examples are difficult to place. Sir John Ellerman, to whom they were referred, regards them as *R. r. tistae* Hint., evidently because of the grey venter, and indeed, he has recorded (Ellerman 1947*d*, pp. 380—381) 'tistae' from almost all over Assam (including Manipur) and Sikkim (this last being the type-locality). As already stated above under *Rattus rattus bullocki* (p. 22, foot-note), Hinton's (1918) original *tistae* from Pashok (Sikkim, 3,500 ft.) are primarily white-bellied. The present examples, though grey-bellied, are closer to the subspecies *khyensis* and *bullocki* than to *tistae*. I am rather inclined to the view that, at any rate in the white-bellied forms of the eastern Himalayas, Assam and W. Burma, fully grey-bellied forms arise independently in the various subspecies, and may be regarded more as 'mutants' than as discrete subspecies.

23. *Rattus nitidus obsoletus* Hinton.

1919. *Rattus nitidus obsoletus* Hinton, *J. Bombay nat. Hist. Soc.* XXVI (2), p. 415. (Type-locality: 50 miles west of Kindat, Chin Hills District, Upper Burma, 5,000 feet.)

1919. *Rattus nitidus obsoletus*, Wroughton, *J. Bombay nat. Hist. Soc.* XXVI (3), pp. 792, 795.

1941. *Rattus nitidus obsoletus*, Ellerman, *Fam. & Gen. Living Rodents* II, p. 180.

1947. *Rattus nitidus obsoletus*, Ellerman, *J. Mammal.* XXVIII, p. 378.

*Material.*—2 specimens from Manipur, collected as follows :—1 adult ♂ (Z.S.I. Registered No. 11,340), collected by Zoological Survey of India Party on 11 February 1936 at Regailous Camp, ca. 3,250 ft., about 63 miles west of Imphal on Silchar Road; and 1 adult or subadult ♂ (No. 11,322), collected by Major M. L. Roonwal on 8 December 1945, about 16 miles north of Imphal on Dimapur Road, ca. 3,500 ft.

*Size, colour, etc.*—Measurements (in mm.) :—Head-and-body 155, 150 ; tail 140, 138 (or 97 and 92% of head-and-body) ; hind-foot 34, 35 ; ear 25. Dorsum mummy brown ; venter rusty brown mixed with dark grey. Hands whitish on anterior half, the remainder dark brown ; feet dark brown. Tail brown all over. For skull measurements, see Table 1e.

*Distribution.*—Assam, in the western hills and central portion (Imphal Valley) of Manipur, upto ca. 3,500 ft. ; and the Chin Hills in Western Burma. The present is the first record from Assam.

This is a poorly known form, and the only previous records are the 5 adults of the type-series from the Chin Hills. It is possible that it is merely a dark-bellied mutant of *R. n. nitidus*, in much the same way as happens in *Rattus rattus tistiae* Hint. and other white-bellied subspecies of *Rattus rattus*, as mentioned above.

#### 24. *Rattus* sp.

*Material.*—1 adult ♂ (Z.S.I. Registered No. 11,313) collected by “ Scrub Typhus Research Team, Imphal ”, in June 1945, near milestone 127, about 6 miles north of Imphal on Dimapur Road, ca. 2,600 ft., Manipur.

This example shows a remarkable superficial resemblance to *Rattus nitidus obsoletus* Hint. in colour, size, body-proportions and the nature of the fur. But the presence of a 20 mm. long white tip to the tail throws this identification in considerable doubt. (The short white tip of the tail is very unusual in the *rattus* and *nitidus* groups of the genus *Rattus*, and it may belong to one of the other groups in the genus ; but as there is no skull, it is difficult to be certain.)

#### 25. *Rattus manipulus manipulus* (Thomas).

(The Manipur Rat.)

(Pl. III)

1886. *Mus berdmorei* Bly., Thomas, *Proc. zool. Soc. London*, 1886, p. 62. (Kopum Thall, Manipur. Wrong identification, vide Thomas 1916, *infra*.)
1891. *Mus berdmorei* (in part), Blanford, *Fauna Brit. India, Mamm.*, pt. 2, p. 410.
1916. *Epimys berdmorei*, Wroughton, *J. Bombay nat. Hist. Soc.*, XXIV (2), p. 308. (W. Burma : e.g., Yuyu River, Hkamti, Upper Chindwin District ; and Chin Hills. Wrong identification.)
1916. *Epimys manipulus* Thomas, *J. Bombay nat. Hist. Soc.* XXIV (3), p. 413. (Type-locality : Khampat, 20 miles W. of Kindat, Kabaw Valley, Upper Chindwin District, W. Burma, 600 ft.)
1916. *Rattus manipulus*, Wroughton, *J. Bombay nat. Hist. Soc.*, XXIV (4), p. 772. (Kabaw Valley and Chin Hills, W. Burma.)
1919. *Rattus manipulus*, Wroughton, *J. Bombay nat. Hist. Soc.*, XXVI (3), p. 797. (Manipur, Assam ; Kabaw Valley and Chin Hills, Burma.)
1941. *Rattus manipulus*, Ellerman, *Fam. & Genera Living Rodents II*, p. 204.

1947. *Rattus (Berylmys) manipulus*, Ellerman, *Proc. zool. Soc. London* CXVII, p. 268.
1947. *Rattus (Berylmys) manipulus manipulus* (in part), Ellerman, *J. Mammal.* XXVIII(4), p. 373. (Bishenpur and Hopum Thal in Manipur; Naga Hills; Kabaw Valley.)
1948. *Rattus manipulus manipulus*, Roonwal, *Proc. nation. Inst. Sci. India*, XIV, p. 386.
1949. *Rattus manipulus manipulus*, Roonwal, *Trans. nation. Inst. Sci. India*, III, (2), p. 100. (Central Manipur.)

*Material.*—21 specimens were collected and examined, from 26 June to 29 December 1945, in Manipur, as follows: 20 from an area about 6—22 miles north of Imphal on Dimapur Road, *ca.*, 3,500—3,800 ft.; and 1 about 34 miles south-east of Imphal on Tamu Road, *ca.*, 4,000 ft. Of these, 13 (Z.S.I. Registered Nos. 11,110 and 11,301—11,312) were preserved—some dry, others in spirit.

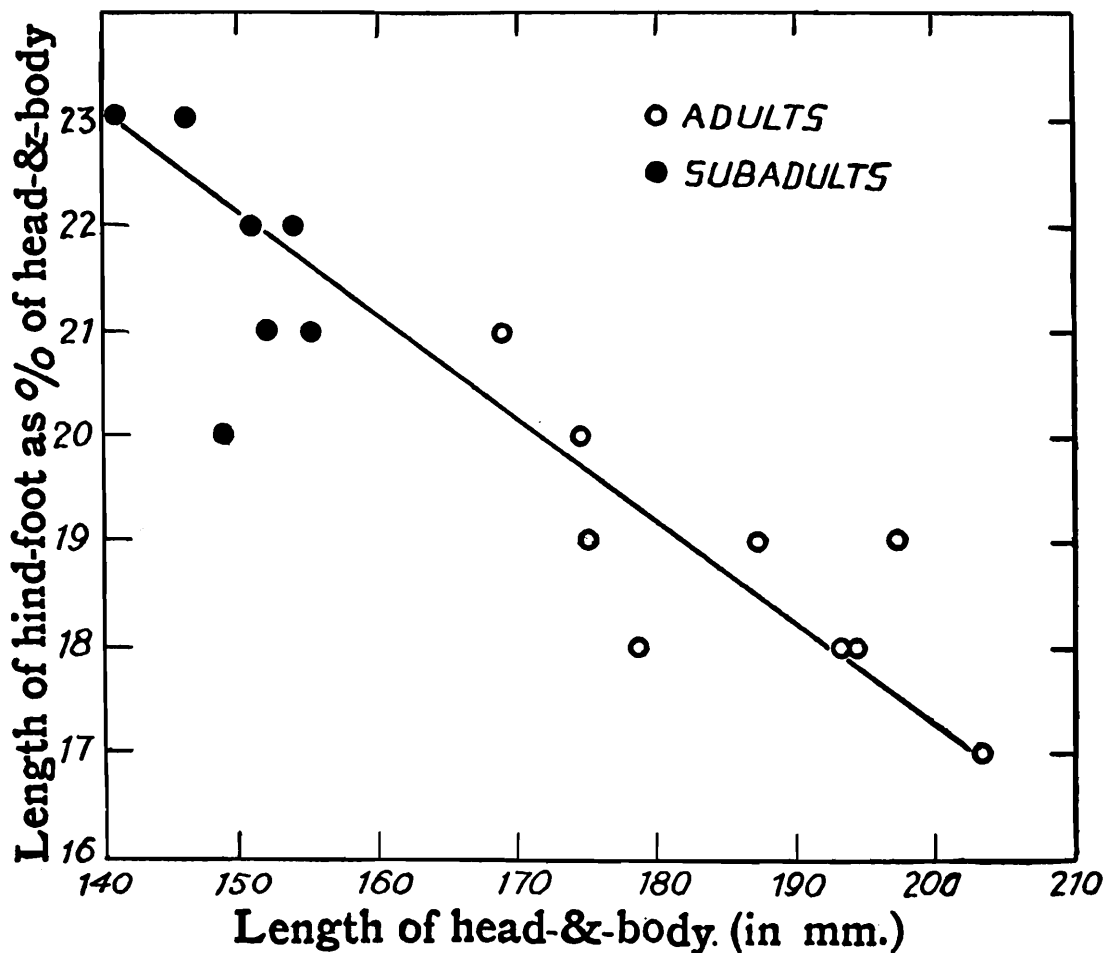
*Size, colour, etc.*—The variation in the size of the body-parts is given below in Table 2.

TABLE 2.

*Size-range, etc. of body-parts in adults of Rattus manipulus.*

Range and Mean	Length in mm.				Length as % of H.-&-B.	
	Head-and-body	Tail	Hind-foot	Ear	Tail	Hind-foot
1. <i>Rattus manipulus manipulus</i> (Th.). (From central Manipur. 6 ♂♂, 6 ♀♀, 1 unsexed.)						
Range :	149-203	139-183	30-37	21-24	81-115%	17-22%
Mean :	175.6	162.8	33.8	22.4	92.7%	19.3%
2. <i>Rattus manipulus kekrinus</i> Roonwal ( <i>vide infra</i> ). (From Kekrima, Naga Hills. 3 ♂♂, 1 ♀.)						
Range :	139-177	150-172	34-39		95-124%	20-28%
Mean :	154.8	160.8	36.5		104.8%	23.8%

The hind-foot is much longer, in proportion to the head-and-body length, in juveniles than in adults; among the latter the proportionate length of the hind-foot steadily decreases with the increasing head-and-body length (Text-fig. 4). The same applies, though to a less marked degree, to the tail-length (Text-fig. 5).

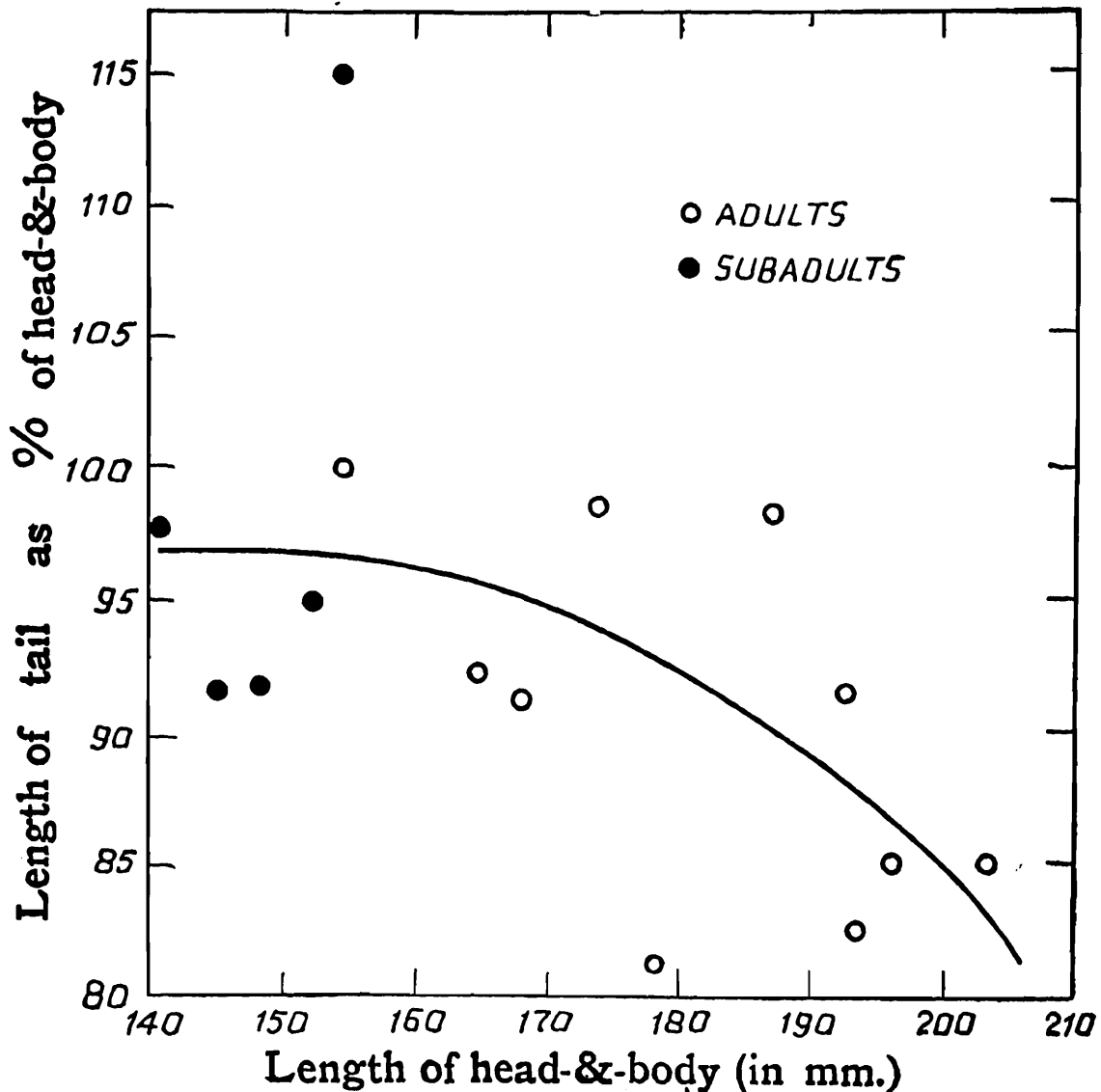


TEXT FIG. 4.—*Rattus manipulus manipulus* (Th.).

Graph showing correlation between the length of hind-foot (as percentage of head and-body length) and the length of head-and-body. The former decreases with the increase of the latter. (The regression line has been drawn by visual inspection only.)

The brief note on colour originally given by Thomas (1916, p. 413) needs supplementing. This may be done as follows, my observations being based on several living and freshly killed specimens:—Head and body: Dorsum: Grissly grey, darker middorsally, almost giving the appearance of a diffuse dark middorsal stripe in some. Individual hairs grey, with a broad subterminal white band and narrow, black tip; bristles, which are stiffer and more numerous in the hotter months (as is seen in Coll. No. JH/26-6-45 collected on 26 June) than in winter (November, December), black, with basal half whitish. Length (in mm.) of hairs and bristles: in summer (June), hair 5, bristles 10—12; in winter, hair 10—12, bristles 16—17. Ventrums: Pure white, sharply demarcated from dorsum; hairs white to the bases. Tip of nose pink; above this grey suffused with brown. Upper lip at the tip greyish brown, the remainder pink; lower lip greyish pink. Whiskers black with white tips. Ears (Pl. III, Fig. 11) pinkish smoky on outside; on inside, dirty pink at base, shading to greyish pink at the edges. Tail: Distal half whitish pink with small stiff hairs entirely white; proximal half dark brown above with black hair, and whitish pink below with hairs mostly white to the bases but some hairs, especially the lateral ones, dark-brown at the base and white terminally. The distal pale

part of tail not always sharply demarcated from the proximal dark part; its proportionate length varying considerably, being in 11 specimens (7 ♂♂, 3 ♀♀, 1 unsexed) 29—57% of the total tail-length. Thomas (1916, p. 413) gave this as: "Tail with its terminal two-fifths to a half white all round." Hands and feet (Pl. III, Figs. 7—10): Hands pinkish white all round with white hairs, the two carpal pads sometimes with a grey spot on each. Feet pinkish white all round, except the proximal part of the soles and some of the pads which are dark grey. Claws on hands and feet dirty pink at base, smoky at tips. Penis pale pink. Area around anus smoky pink.



TEXT FIG. 5.—*Rattus manipulus manipulus* (Th.).

Graph showing correlation between the length of tail (as percentage of head-and-body length) and the length of head-and-body. The former tends to gradually decrease with the increase of the latter. (The regression line has been drawn by visual inspection only.)

The eyes are very small, the mean horizontal and vertical lengths being about 5.3 and 4.5 mm. respectively, or about 3.43% and 2.9% of the head-and-body length. This contrasts with the large eyes of *Rattus rattus bullocki* Roonwal where the correspondig measurements are about 7.3×5.0 mm., or 4.3%×2.94% (*vide* Roonwal, 1949c).

The mammary formula is : Th. 3+ abd. 2=10.

*Skull* (Tables 1f and 3 ; and Pl. III, Figs. 1—6).—The skull is of delicate build and is practically devoid of frontal ridges and other such prominences in contrast to the skull in the *Rattus rattus* group. The incisors are slightly proodont. The mandibular knob marking the inner concealed tip of the lower incisors is, however, exceptionally developed in adults—much more so than in *Rattus rattus bullocki* or any of the other rats dealt with here.

*Habitat.*—This rat is common in oak scrub which is its favourite habitat ; it also occurs in evergreen rain jungle, riverine meadow and oak parkland, but was never obtained in or near human habitations. Its food consists of both vegetable (grasses, etc.) and animal matter, *viz.*, insects and earthworms. In commonly eating earthworms, whenever available, this rat appears to be unique. Further details of its ecology, etc., will be found in Roonwal (1949c).

*Distribution.*—The Khasia Hills (?) and central Manipur in Assam, to the adjoining tracts of W Burma, *e.g.*, Upper Chindwin District (Kabaw Valley and “ Yuyu [= Uyu] River, Hkamti ”), and the Chin Hills District. Up to about 4,000 feet altitude.

The Khasia Hills are included on Blanford's record (1891, p. 411), as this northern specimen is likely to be *R. manipulus* rather than *R. berdmorei*.

The Naga Hills specimens belong to a separate subspecies, *vide infra*.

## 26. *Rattus manipulus kekrimus* Roonwal.

(The Naga Hills Race of Manipur Rat.)

1948. *Rattus manipulus kekrimus* Roonwal, *Proc. nation. Inst. Sci. India* XIV, p. 386.

A brief, preliminary diagnosis was given in Roonwal (1948, p. 386), and a fuller description is now provided.

*Material.*—4 adults (3♂♂, 1♀), Z. S. I. Registered Nos. 11,341-11,344, collected on 23 January 1936, by a Zoological Survey of India Party at Kekrima (=Chekrimi), *ca.*, 5,390 ft., about 10 miles (air distance) south-east of Kohima, Naga Hills District, Assam.

### *Diagnosis.*

Similar to *Rattus manipulus manipulus* (Th.), but differing in the following respects : Colour of dorsum paler, with less grey and more brown. Tail longer, being on an average about 105%, as against 93%, of the head-and-body length. Differences in skull characters are given below, while the body-measurements will be found in Table 2 above.

*Skull* (Tables 1g and 3).—Differs from that of *R. m. manipulus* as follows : Skull smaller, mean condylobasal length 36.9 mm. *versus* 38.2 mm. Other characters, considered here as percentages of condylobasal length, differing thus : Post-molar length shorter (43.4% *vs.* 45%). Palatal length greater (51.7% *vs.* 50%). Anterior palatine foramina much smaller (length 19.1% *vs.* 20.5% ; greatest combined width 5.4% *vs.* 6.3%). Length of upper molar crowns much greater (17.1% *vs.* 14.9%).

TABLE 3.

*Some skull-characters of Rattus manipulus.*

Character	<i>Rattus m. manipulus</i> (Th.) (6 specimens: 2 ad. ♂♂, 3 subad. ♂♂, 1 ad. ♀)				<i>Rattus m. kekrimus</i> Roon. (4 specimens: 3 ad. ♂♂, 1 ad. ♀)			
	Size (mm.) (Adults only)		% of condylobasal length		Size (mm.) (Adults only)		% of condylobasal length	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
1. Post-molar length . . .	16.4—18.0	17.2	44.6—45.1%	45%	15.0—17.1	16	41.7—44.2%	43.4%
2. Palatal length . . .	18.5—19.9	18.7	49.3—50.8% (Adults only)	50%	18.3—19.8	19	50.7—53.3%	51.7%
3. Anterior palatine foramina								
(a) Length	7.5—8.0	7.8	19.7—21.9% (Adults only)	20.5%	6.7—7.4	7.05	18.8—19.7%	19.1%
(b) Greatest combined width .	2.0—2.5	2.3	5.5—6.7%	6.3%	1.7—2.3	2.0	4.8—5.9%	5.4%
4. Length of upper molar crowns .	5.4—5.9	5.7	14.2—16.2% (Adults only)	14.9%	6.0—6.4	6.3	15.5—17.8%	17.1%

The most striking difference between the *adults* of the two subspecies would appear to be in the length of the upper molar crowns, both as regards absolute size and as a percentage of the condylobasal length. Although the *kekrimus* skull is smaller, the absolute length of the upper molar crowns is 6.0—6.4 mm. (mean 6.3 mm., or about 11% larger than in *R. m. manipulus*) whereas in the typical *manipulus*, which has a larger skull, the figure is 5.4—5.9 mm. (mean 5.7 mm.). The same applies, though to a lesser extent, to the palatal length. As seen in *R. m. manipulus*, subadults, however, have longer upper molars than adults in proportion to skull-size (condylobasal length).

*Types.*—Deposited in the Zoological Survey of India Collections. All are stuffed skins with separate skulls. *Holotype*: Z. S. I. Registered No. 11,341. Original Collector's No. 2. Adult ♂, collected on 23rd January 1936 at Kekrima, ca., 5,390 ft., Naga Hills, Assam, by a Zoological Survey of India Party. Body-measurements (in mm.): H.-and-B. 139; Tl. 172; H. F. 39. *Paratypes*: Z. S. I. Registered Nos. 11,342 (ad. ♂), 11,343 (ad. ♂), and 11,344 (ad. ♀), all from Kekrima.

*Distribution.*—Known only from the type-locality. The 2 specimens<sup>s</sup> from "Naga Hills" mentioned by Ellerman (1947*d*, p. 374) may also belong here.

#### Key to subspecies of *Rattus manipulus*.

Skull larger (mean condylobasal length 38.2 mm.). Palatal length smaller (50% of condylobasal length). Length of upper molar crowns much shorter (14.9% of condylobasal length). Tail shorter (93% of head-and-body length)... *R. m. manipulus* (Th.).

Skull smaller (mean condylobasal length 36.9 mm.). Palatal length greater (51.7% of condylobasal length). Length of upper molar crowns much greater (17.1% of condylobasal length). Tail longer (105% of head-and-body length)... *R. m. kekrimus* Roon.

#### 27 *Rattus bowersii*<sup>1</sup> *mackenziei* (Thomas).

(Mackenzie's Rat.)

(Pl. V.)

1916. *Epimys mackenziei mackenziei* Thomas, *J. Bombay nat. Hist. Soc.* XXIV (3), p. 411. (Type-locality: Haingyan, 50 miles W. of Kindat, Chin Hills District, W. Burma, 5,000 ft.)
1919. *Rattus mackenziei*, Wroughton, *J. Bombay nat. Hist. Soc.* XXVI (3), p. 797.
1921. *Rattus wellesi* Thomas, *J. Bombay nat. Hist. Soc.* XXVIII (1), p. 26. (Type-locality: Mawphlang, 5,550 ft. Khasi Hills, Assam.) Ellerman synonymises it with *mackenziei* Th.
1941. *Rattus mackenziei mackenziei*, Ellerman, *Fam & Gen. Living Rodents* II, p. 204.
1947. *Rattus bowersi mackenziei*, Ellerman, *Proc. zool. Soc. London*, CXVII, p. 264.
1947. *Rattus bowersi mackenziei*, Ellerman, *J. Mammal.* XXVIII, p. 374.

*Material.*—2 adult ♂♂ (Z. S. I. Registered Nos. 11,345 and 11,346) collected by Zoological Survey of India Party on 9 February 1936 at Luanglong Khulen, ca. 3,250 ft., about 63 miles west of Imphal on Silchar Road, Manipur, Assam.

<sup>1</sup> The original spelling (Anderson, 1878, p. 304) is *bowersii*, not *bowersi* of some subsequent authors.

*Size, colour, etc.*—The two males measure (in mm.) as follows:—Head-and-body 205, 205; tail 245, 237; and hind-foot 48, 50. These lengths in terms of the percentages of the head-and-body are: Tail 119.5%, 115.6%; hind-foot 23.4%, 24.4%.

The colour-pattern is very similar to that of *Rattus manipulus*, with this difference that the dorsum is more brown and with less of the iron-grey, and is rather less sharply separated from the white venter. In the tail the distal one-third to one-half is whitish all round. There are 6 plantar pads.

*Skull* (Pl. V).—The skull-measurements are given in Table 1i. For comparison, the measurements of the type-skull of *Rattus bowersii bowersii* (Anderson 1878) (Pl. IV), which is present in the Zoological Survey of India Collections (Reg. No. 10,078; the type-skin is in spirit), are given (Table 1h). The two *R. b. mackenziei* skulls from Manipur differ from the type *bowersii* skull from Yunnan in the following respects: Skull smaller in length; but the following characters are proportionately (as percentages of occipitonasal length) larger, viz., nasals (40.4-40.8% vs. 38.5%), and length of anterior palatine foramina (ca. 19% vs. 17%). The tympanic bullae are considerably smaller (size 6.5-6.6 mm., vs. 8.3 mm. or 13.1-13.3%, vs. 15.5%). This last feature constitutes a striking difference. The upper incisors are short, stout and almost vertically set (orthodont). I have no material of *R. b. wellesi* Th. and *R. b. feae* Th. for comparison, but Ellerman (1947a, c) tends to synonymise them with *mackenziei*.

*Distribution.*—Ellerman (1947d) gives the following range of *R. b. mackenziei* Th. (including *wellesi* Th., but not *feae* Th.): Eastern Assam, e.g., Khasi and Naga Hills, central and eastern Manipur and W. Burma. To this we may add the western hills (Luanglong Khulen) of Manipur on the basis of the present record.

Ellerman records *R. b. bowersii* also from Machi in Manipur.

## 28. *Rattus niviventer*<sup>1</sup> *niviventer* Hodgson.

(Hodgson's White-bellied Rat.)

(Pl. VI.)

1836. *Mus (Rattus) niviventer* Hodgson, *J. Asiat. Soc. Bengal* V, p. 234.  
(Type-locality: Central region of Nepal.)
1891. *Mus niveiventer*, Blanford, *Fauna Brit. India, Mamm.*, pt. 2, p. 412.
1941. *Rattus niveiventer*, Ellerman, *Fam. and Gen. Living Rodents*, II, p. 192.
1947. *Rattus niviventer*, Ellerman, *Proc. zool. Soc. London*, CXVII, p. 264.
1947. *Rattus niviventer niviventer*, Ellerman, *J. Mammal.* XXVIII, p. 377.

*Material.*—1 adult ♂ (Z. S. I. Registered No. 11,130) collected on 11 September 1945 off milestone 34, south-east of Imphal on Tamu Road, ca. 4,000 ft. Trapped in grassy area in oak parkland.

<sup>1</sup> The original spelling (Hodgson 1836, p. 234) is *niviventer*, not *niveiventer* of some subsequent authors.

*Size, colour, etc.*—Head-and-body 150 mm. ; tail (slightly damaged) 165 mm. (or 110% of head-and-body) ; hind-foot 29 mm. ; ear 21 mm.

The following notes on colour, etc. are based on a freshly killed specimen :—Dorsum slaty brown ; individual hairs slaty-based with pale brownish tips ; no bright rusty tinge as in *R. mentosus*. Fur mixed with numerous flattened spines which are thinner than in *R. mentosus* ; spines whitish, translucent and with black tips. Ventrums white, sharply demarcated from dorsum ; hairs white to the bases ; no dark midventral stripe. Tail dark brown above, whitish below. Hands and feet above : Distal half pale pink with faint grey tinge ; proximal half more or less like dorsum of body. Both palmar and plantar pads and lobes on the finger tips are well developed but appreciably less so than in *R. mentosus*, suggesting less arboreal and more ground habits.

*Skull* (Table 1j ; and Pl. VI).—The skull is very similar to that of *Rattus mentosus*, but is narrower and also differs in the following respects, the dimensions being given as percentages of the occipitonasal length :—The following parts are shorter : Zygomatic width (43% vs. 45%) ; cranial width (39% vs. 40%) ; median depth of occiput (21% vs. 23%) ; nasal length (37% vs. 39%) ; nasal width (11% vs. 12%). The following parts are longer : Palatal length (44% vs. 40%) ; length of anterior palatine foramina (17% vs. 16%) ; length of tympanic bullae (14% vs. 12-13%), and, as a consequence, the auditory length too.

Although the present specimen almost certainly belongs to the typical subspecies in Ellerman's (1947*d*, p. 337) arrangement, the skull is much larger—occipitonasal length 37.5 mm. as against a maximum of 33.5 mm. allowed by Ellerman.

*Distribution.*—Himalayan region, from Simla Hills (Punjab) in the west, through Kumaon and Nepal to Manipur (E. Assam) and Kachin area (N. Burma) in the east. From about 4,000 ft. upwards. The present is the first record from Manipur. Ellerman (1947*d*, p. 377) recognizes 4 Indian subspecies, namely, *niviventer* Hodgs., *lepcha* Wr., *bukit Bonh.* and *mentosus* Th. In the present account I have considered *mentosus* Th. as a separate species (*vide infra*) purely for convenience.

## 29. *Rattus mentosus* Thomas.

(The Chin Hills Rat.)

(Pl. VII.)

1916. *Epimys jerdoni* Bly., Wroughton, *J. Bombay nat. Hist. Soc.* XXIV (2), p. 307. (Hakamti and Chin Hills, Upper Burma. Wrong identification *vide* Wroughton 1916, *infra*.)
1916. *Rattus mentosus* Thomas, *J. Bombay nat. Hist. Soc.* XXIV (4), p. 643. (Type-locality : " Hakampti " [= Singkaling Hakamti = Zingkaling Hakamti], Upper Chindwin District, W. Burma, 500 ft.)
1916. *Rattus mentosus*, Wroughton, *J. Bombay nat. Hist. Soc.* XXIV (4), p. 772.

1923. *Rattus mentosus*, Mills, *J. Bombay nat. Hist. Soc.* XXIX (1), p. 227. (Mokokchung, Naga Hills, 5,000 ft.)
1941. *Rattus mentosus*, Ellerman, *Fam. & Gen. Living Rodents* II, p. 194.
1943. *Rattus mentosus*, Carter, *Bull. Amer. Mus. nat. Hist.* LXXXII, p. 113. (Dalu and Lonklin, Upper Burma.)
1947. *Rattus niviventer mentosus*, Ellerman, *Proc. zool. Soc. London* CXVII, p. 264.
1947. *Rattus niviventer mentosus*, Ellerman, *J. Mammal.* XXVIII, p. 377.
1949. *Rattus mentosus*, Roonwal, *Trans. nation. Inst. Sci. India* III (2), p. 103.

*Material.*—6 adults (2♂♂, 4♀♀) were obtained in late July, August, October and late December 1945, from an area 6—18 miles north of Imphal along Dimapur Road, Manipur, ca. 2,600—3,500 ft. Of these, 5 (e.g., Z. S. I. Registered Nos. 11,126—11,129 and 11,131) were preserved.

*Size, colour, etc.*—5 adults (2♂♂, 3♀♀) gave the following measurements (in mm.): Head-and-body 138—156 (mean 147.6); tail 174—195 (mean 187.8); hind-foot 28—31 (mean 29.3); ear 18—21 (mean 19.5). The tail in 4 examples was 114.5—138.4% (mean 129.4%) of head-and-body.

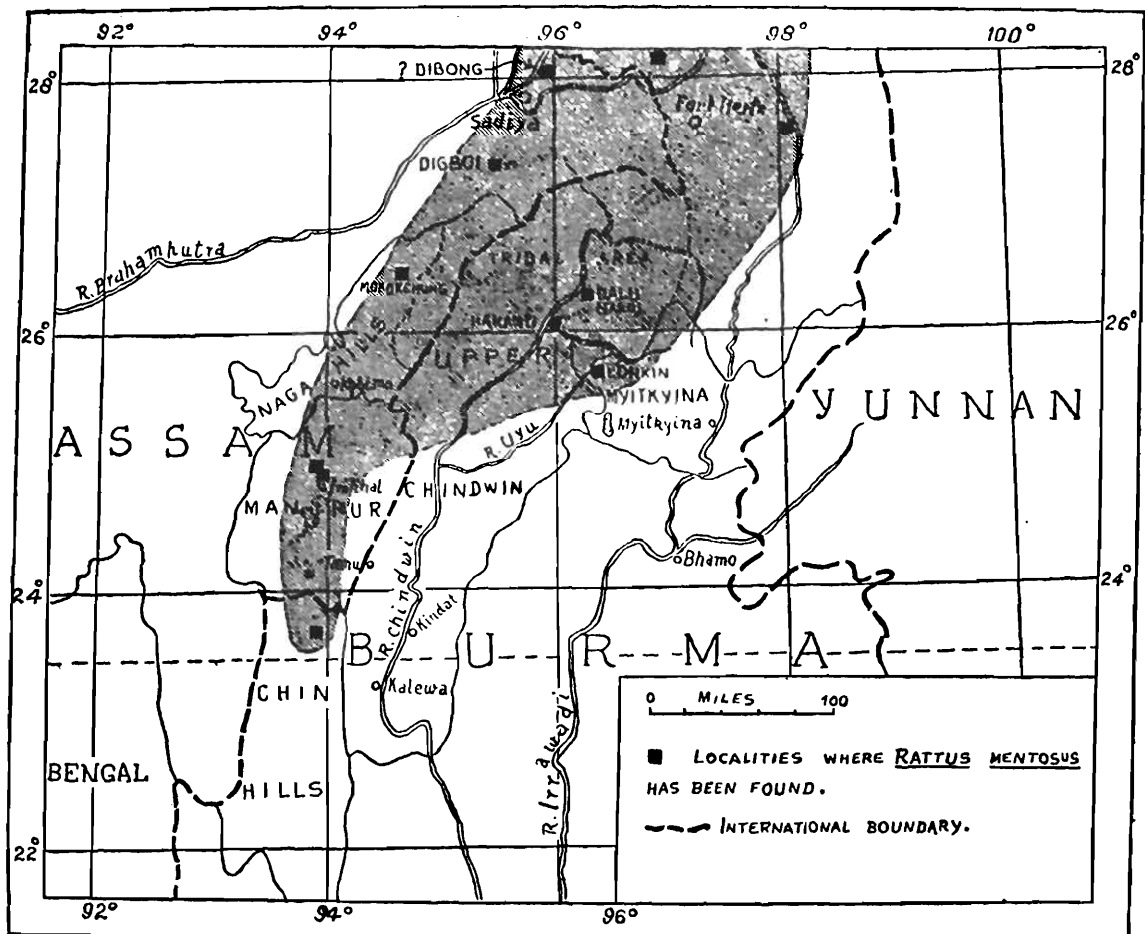
The following notes on colour are based on freshly killed specimens :— Dorsum rusty red mixed with black in summer; tending to be ochraceous buff and colder in tint in winter owing to the fur-hairs having their terminal halves so coloured. Venter pure white with hairs white to the bases; sharply demarcated at the sides from dorsum. Tail dark dirty brown above, pale beneath. Length of hair and spines 9—10 mm. and 14—15 mm. respectively in July—October; about 12 mm. and 18 mm. respectively in December. July and October specimens tending to be very spiny, but August and December ones distinctly less so and possessing much softer fur. Hands and feet (Pl. VII, Figs. 7—10): Upper surface brownish grey up to centre of metacarpels and metatarsals, being rather dark in the central areas; distal portions whitish. Hind-foot with bunches of long, silvery white hairs springing dorsally at base of claws and overhanging the latter. Similar hairs present on hands, but are shorter and less profuse. Pollex very reduced, without claw or nail; all other digits with claws. Pads heavy; plantar pads 6; palmar pads 5. Tips of digits heavily lobular, specially in hind-feet, suggesting adaptation to arboreal habit.

Mammae (in 2♀♀): Th. 2+ abd. 2=8.

*Skull* (Pl. VII, Figs. 1—6 and Table 1k).—The skull, as studied in 5 adults (2♂♂, 3♀♀) is moderately large (occipitonasal length 36.5—39.7 mm. mean 37.6 mm.) and rather well built. The frontal and parietal ridges are well developed; the bullae are comparatively small, being 4.5—4.9 mm. (mean 4.7 mm.) long, or 12.2—12.9% (mean 12.5%) of occipitonasal length. The upper incisors are short and strongly built as in *Rattus rattus bullocki* Roon., and have the front surface orange; they are bent backwards (opisthodont). The lower incisors are long, delicate and with sharp edges. The mandibular knob at the base of the incisors is moderately well developed—rather more so than in *Bandicota bengalensis* and *Rattus r. bullocki*, and distinctly less than in *Rattus manipulus*,

*Habitat.*—*R. mentosus* occurs as a rule in the vicinity of streams in evergreen jungle ; an evidently exceptional individual was found in tall dry grass on a hill-slope about 20 miles away from the nearest jungle. (Also see Roonwal, 1949c, pp. 103-105.)

*Distribution* (Text-fig. 6).—E. Assam, e.g., Manipur, Naga Hills, Sadiya Frontier Tract, and the Mishmi Hills ; and Upper Burma, e.g., Upper Chindwin, Chin Hills and Myitkina Districts, including the Adung and Nam Nat Valleys (Wroughton, 1916 ; Carter, 1943 ; Ellerman, 1947, all *op. cit.*). Upto about 5,000 feet altitude. The present is evidently the first record from Manipur.



TEXT-FIG 6.—Map of Assam and Burma, showing the range of distribution (shaded portion) of *Rattus mentosus* Th. Also add : “ Mode Forest (Mansi) ” and “ Nam Nat Valley ”, both in Upper Burma.

### 30. *Hadromys humei* (Thomas).

(The Manipur Bush Mouse.)

(Pl. VIII.)

- 1886 (January). *Mus humei*, Thomas, *Ann. Mag. nat. Hist.* (5) XVII, p. 84. (Type-locality : Moirang, Manipur, Assam.) Preliminary diagnosis.
- 1886 (January 19th). *Mus humei*, Thomas, *Proc. zool. Soc. London*, p. 63, pl. V. Fuller diagnosis.
1891. *Mus humei*, Blanford, *Fauna Brit. India, Mamm.*, pt. 2, p. 421.
1891. *Mus humei*, Selater, *Catal. Mamm. Indian Mus. Calcutta*, pt. 2, p. 70.
1911. *Hadromys humei*, Thomas, *J. Bombay nat. Hist. Soc.* XX (4), p. 999.

1920. *Hadromys humei*, Wroughton, *J. Bombay nat. Hist. Soc.* XXVI (4), p. 964.  
 1926. *Hadromys humei*, Hinton and Lindsay, *J. Bombay nat. Hist. Soc.* XXXI (2), p. 22. (One ♀, Angarakhata, N. Kamrup, Assam, 300 ft.)  
 1941. *Hadromys humei*, Ellerman, *Fam. and Genera Living Rodents* II, p. 127.  
 1947. *Hadromys humei*, Ellerman, *Ann. Mag. nat. Hist.* (11) XIII, p. 204. ("Bishampur, Manipur.")  
 1947. *Hadromys humei humei*, Ellerman, *J. Mammal.* XXVIII, p. 370.  
 1949. *Hadromys humei*, Roonwal, *Trans. nation. Inst. Sci. India.* III, p. 105.

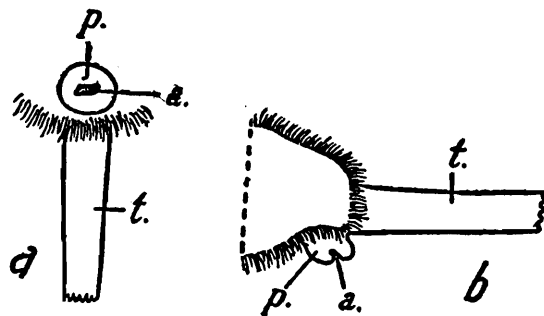
*Material.*—7 adults were obtained during end-July to mid-December 1945 from central Manipur—2♂♂ off milestone 117, *i.e.*, about 16 miles north of Imphal on Dimapur Road, *ca.* 3,500 ft.; and 5 (4♂♂, 1♀), off milestones 34, on Imphal-Tamu Road, *ca.* 4,000 ft. Of these, 6 were preserved, *e.g.*, Z. S. I. Registered Nos. 11,112—11,117 and 11,132.

*Size, colour, etc.*—6 adult males gave the following lengths (in mm.): Head-and-body 92—140 (mean 123·5); tail 121—135 (mean 128·4); hind-foot 24—27 (mean 25·5); ear 15—19 (mean 17·3). Considered as percentages of the head-and-body length, these measurements are: Tail 96—118%, once 136% (mean 108%); hind-foot 18—26% (mean 21·1%).

The colour agrees closely with the original description of Thomas (1886). The following additional notes are based on either living or freshly killed specimens: Dorsum dark salt-and-pepper coloured, with rusty red tinge especially on the rump. Venter dirty white, tinged with buff here and there but especially so at the sides of the lower throat and on the thighs. Hands and feet (Pl. VIII, Figs. 8-11) buff coloured; unusually hairy above. Palm dirty pink, with 5 pads; soles of feet dark pinkish smoky, with 6 pads. Tail dark horny black above, dirty pale pinkish below. Ears (Pl. VIII, Fig. 12) pinkish smoky; very hairy, even inner sides having numerous short brown and chestnut hair in the upper half of pinna.

The mammary formula in one ♀ was: Th. 2+abd. 2=8.

The eyes are small, the horizontal and vertical lengths being about 4·5×2·8 mm., or 3·4%×2·1% of head-and-body length. The anus lies on a prominent papilla, about 4 mm. high, at the base of the tail (Text-figs. 7a, b).



TEXT-FIG 7.—*Hadromys humei* (Th.).

Base of tail to show the anal papilla in adult ♂ from Imphal Valley, Manipur, Assam, *ca.* 3,500 ft., 18 December 1945.

(a) Ventral view. (b) Side view.  
 a; anus; p., anal papilla; t., tail.

*Skull* (Pl. VIII, Figs. 1-7 ; and Table 11).—The skull agrees with the accounts of Thomas (1886) and Ellerman (1947*a*, *d*). The upper incisors are strong, well built and bent backwards (opisthodont). Some of the measurements (in mm.) are as follows: Occipitonasal length 30.8—32.3 (mean 31.8); palatal length 13.2—13.6 (mean 13.5), or 42—43% of occipitonasal length; length of anterior palatine foramina 5.7, or 17.6—18.5% of occipitonasal length; length of tympanic bullae 4.5—5.1 (mean 4.9), or about 15.7% of occipitonasal length, or 16.8% of condylobasal length.

*Habitat*.—*Hadromys humei* is commonly found in oak parkland; an odd specimen was trapped in oak scrub. (Also see Roonwal, 1949 *c*.)

*Distribution*.—Northern and eastern Assam, upto about 4,000 ft.

This rare and interesting rat appears to have a very restricted distribution. After the first few examples obtained on 23 March 1881 (Thomas 1886) from Moirang in Manipur, the only other specimen obtained until recent years was a ♀ from Angarakhata (N. Kamrup, Assam, 300 ft.) reported by Hinton and Lindsay (1926, *op. cit.*). Ellerman (1947*a*, *d*) reports on a recent collection from "Bishampur" [=Bishenpur], Manipur; while the present series was obtained in 1945 from central Manipur.

### **Leggada nagarum** THOMAS.

The following are the available references on *L. nagarum* Th. :—

- 1921. *Leggada nagarum* O. Thomas, *J. Bombay nat. Hist. Soc.* XXVII, p. 597. (Type-locality: Golaghat, 300 ft., Sibsagar District, Assam.)
- 1926. *Leggada nagarum*, Hinton and Lindsay, *J. Bombay nat. Hist. Soc.* XXXI, p. 399.
- 1931. *Leggada nagarum*, Fry, *J. Bombay nat. Hist. Soc.* XXXIV, p. 918.
- 1941. *Mus nagarum*, Ellerman, *Fam. & Genera Living Rodents* II, p. 250.
- 1947. *Mus cervicolor nagarum*, Ellerman, *J. Mammal.* XXVIII, p. 384.

### **31. Leggada nagarum imphalensis** Roonwal.

(The Manipur Jungle Mouse.)

(Pl. I, Fig. 2 ; and Pl. IX.)

- 1948. *Leggada nagarum imphalensis*, Roonwal, *Proc. nation. Inst. Sci. India* XIV, p. 386. Type-locality: About 16 miles N. of Imphal on Dimapur Road, Manipur, Assam, ca. 3,500 ft.
- 1949. *Leggada nagarum imphalensis*, Roonwal, *Trans. nation. Inst. Sci. India* III (2), p. 107.

A brief, preliminary description was given in Roonwal (1948, p.38)6, and a fuller one is now provided.

*Material*.—5 adults (4♀♀, 1 unsexed) were collected by Major M. L. Roonwal from Central Manipur (Assam) and W Burma as follows :— (i) 4♀♀ (Z. S. I. Registered Nos. 11,119, 11,120, 11,122, 11,123), 16-17 miles north of Imphal on Dimapur Road, ca. 3,500 ft., 26 July to 5 October 1945. (ii) 1 unsexed (No. 11,121), from Kalewa on R. Chindwin, Kabaw Valley, W. Burma, ca. 360 ft., July 1945.

#### *Diagnosis.*

*Colour*.—*Dorsum* : Grizzled dark mummy brown, becoming paler and more tawny at the sides, especially so in the anterior half. Hair : slaty-based for about  $\frac{2}{3}$ rd the length, then rufous and finally black at the tip ; the longer hairs entirely black-tipped, without any rufous. Rump hairs : Under-fur 5—7 mm. long ; long hairs 7—9 mm. long. *Venter* : Silvery grey ; fur slaty-based with white tips, on the oar and chin white to the bases. Ears dark brown. *Tail* : Covered with numerous short (about 0.5—1 mm. long) fine stiff hairs. Tail hairs above dark brown with pale rufous tips ; below white, except about a centimetre at the tip where they are as on the upper side. Scale rings 20—26 to the centimetre, being more numerous towards the two ends and less numerous in the middle. *Hands and feet* : Dull pinkish white with pale grey-brown tinge.

The Kalewa specimen is much paler than the others all over and has the hands and feet silvery white. In three specimens of *L. n. nagarum* examined (*vide* Table 4*b*), the colour of the dorsum is much warmer and has less grey than is the case in *imphalensis* ; the venter shows no difference.

*Size, etc.*—5 adults gave the following measurements, in mm. :— Length of head-and-body 85—91 (mean 87.8) ; tail 56—64 (mean 60) ; hind-foot 15—17 ; ear 12—13. The tail is 63—72% (mean 68.4%) of head-and-body.

In typical *nagarum*, whose measurements are given below, the head and body is distinctly shorter, and the tail longer both actually and proportionately :—

	H.-&-B.	Tail	Tail as % of H.-&-B.
(a) Type-specimen for Gola-ghat, Upper Assam (Thomas, 1921).	76 mm.	77 mm.	101%
(b) Average of several specimens (Fry, 1931).	75.5 mm.	62 mm.	82%
(c) Three specimens (1♂, 2♀♀) from Jaintia Hills and Cheerapunji, Assam, in collection of Bombay Nat. Hist. Soc.	72-81 mm.	63-70 mm.	82-90%

The meristematic formula in 2♀♀ of *L. n. imphalensis* is : Th. 3+abd. 2=10.

*Skull* (Pl. IX and Table 4).—Similar to that of *L. n. nagarum*, but differs in the following points: (i) Anterior margin of zygomatic plate straight instead of convex. Margin convex in three examples of *L. n. nagarum* (in coll. of Bombay Nat. Hist. Soc.) examined, but in one No. M4304) only slightly so. (ii) Upper incisors slightly proodont rather than orthodont, with front surface orange coloured. Lower incisors very pale orange in front. (iii) skull slightly larger (mean greatest length 21.4 mm. *vs.* 21 mm.). (iv) Nasals much longer, 8.4—9.1 mm. (mean 8.7) *vs.* 7.6—8.2 mm. (mean 7.8). *Measurements* (in mm.): greatest length 20.6—22.3 (mean 21.4); condylobasal length 19.7—21.8 (mean 20.6); greatest zygomatic width 10.0—10.6 (mean 10.3); length of nasals 8.4—9.1 (mean 8.7); length of muzzle 4.5—5.0 (mean 4.9); breadth across front basal edges of upper molars 3.4—3.7 (mean 3.5); total length of upper molars on crowns 3.5—3.8 (mean 3.7); cranial width 9.6—10.2 (mean 9.9); length of anterior palatine foramina 4.8—5.6 (mean 5.2).

*Types*.—Deposited in the Zoological Survey of India Collections. *Holotype* (Pl. I, Fig. 2; and Pl. IX): Z. S. I. Registered No. 11,120. Original Collector's No. FL2/26-7-45. Adult ♀ (stuffed skin and separate skull), from 16 miles north of Imphal on Dimapur Road, about 3,500 feet altitude, Manipur, E. Assam. Collected on 26 July 1945 by Major M. L. Roonwal. Body-measurements, in mm., are as follows: Head-and-body 86; tail 59 (or 68.6% of head-and-body); hind-foot 15; ear 13. The skull-parts (Pl. IX) measure as follows (in mm.), the figures within brackets being the percentages in terms of the occipitonasal length: Greatest length 20.6; condylobasal length 19.7; occipitonasal length 21.4; greatest zygomatic width 10.0; least interorbital width 3.7; cranial width 9.6; occipital width 8.8; median depth of occiput *ca.* 5.5; post-molar length 9.6; auditory length 5.7; length of tympanic bulla 3.8 (18.1%); length of nasals 8.4 (39.3%); greatest combined width of nasals 2.7; length of muzzle 4.5 (21%); length of diastema 6.2 (29%); length of anterior palatine foramina 5.0; greatest combined breadth of anterior palatine foramina 1.7; total length of upper molar crowns 3.6; breadth across front basal edges of upper molars 3.5. The upper incisors are slightly proodont and are orange-coloured on the whole of the front surface.

*Paratypes*.—All stuffed skins of adult ♀♀, with separate skulls; collected from the type-locality. Z. S. I. Registered Nos. 11,119, 11,222 and 11,123.

*Distribution*.—Central Manipur, Assam, *ca.* 3,500 ft.; also Kalewa in Kabaw Valley, W. Burma, 360 ft. This is east of the range of *L. n. nagarum* which covers practically the whole of eastern Assam, including the Sibsagar and Kamrup Districts and the Jaintia, Khashi and Mishmi Hills (*vide* Thomas, 1921; Hinton and Lindsay, 1926; Fry, 1931).

*Habitat*.—Trapped near streams in riverine scrub and riverine meadow with no tall trees (tree canopy entirely open), short to medium grass (shrub canopy half to fully open), and with ground canopy half-covered; soil moist to water-logged. (Also see Roonwal, 1949*c*, p. 107.)

TABLE 4(a-l).

Skull-measurements (in mm.), etc. of *Leggada nagarum* adults.

Registered Number (Z.S.I. or B.N.H.S.)	Collector's Number.	Sex.	Age. (State of wear of molars).	Date of collection.	Locality.	Greatest length.	Condylolbasal length.	Greatest zygomatic width.	Length of nasals.	Length of muzzle*.	Breadth across front basal edges of upper molars.	Length of upper molars on crowns.	Cranial width.	Length of anterior palatine foramina.	Upper incisors.
(a) <i>Leggada nagarum imphalensis</i> Roonwal. (In coll. of Zool. Surv. India; collected in 1945 by Major M. L. Roonwal.)															
11,121	..	..	Not worn out.	July	Kalewa	..	..	10.2	8.4	4.8	3.4	3.8	..	5.2	Slightly proodont
11,119	FL1/26-7-45	♀	Much worn out	26 July	Near Imphal.	22.3	21.8	..	9.1	5.5	3.7	3.8	10.2	5.6	Ditto.
11,120	FL2/26-7-45	♀	Not worn out.	26 July	Ditto.	20.6	19.7	10.0	8.4	4.5	3.5	3.6	9.6	5.0	Ditto.
11,122	R11/5-10-45	♀	Half worn out	5 Oct.	Ditto.	21.0	20.2	10.6	..	4.7	3.4	3.6	10.0	4.8	Ditto.
11,122	R2/8-10-45	♀	Half worn out	8 Oct.	Ditto.	21.6	20.7	..	8.7	5.0	3.4	3.5	9.6	..	Ditto.
Mean :						21.4	20.6	10.3	8.7	4.9	3.5	3.7	9.9	5.2	..
(b) <i>Leggada nagarum nagarum</i> Th. (3 in coll. of Bombay Nat. Hist. Soc.; collected in 1920 by H. W. Wells.)															
M4,302	885	♂	Half worn out	5 Aug.	Shang-pung, Jaintia Hills, Assam, 4,000 ft.	21.0	20.7	10.5	8.2	..	..	..	..	..	Orthodont. (Front orange at base only.)
M4,303	928	♀	Partly worn out	10 Aug.	Ditto.	20.6	20.0	..	7.7	..	..	..	..	..	Ditto. (Front surface orange.)
M4,304	489	♀	Not worn out	21 Apr.	Cheera-punji, Assam.	..	..	..	7.6	..	3.5	3.6	..	..	..
Type (Measurements of O. Thomas, 1921.)	260	♂	..	12 Feb.	Golaghat, Assam.	21.5	20.6	10.3	8.0	..	..	4.0	10.3	4.9	..
Mean :						21	20.4	10.4	7.9	..	..	9.8	..	..	..

\* Length of muzzle is the distance from front margin of premaxilla to lower corner of zygomatic plate.

*Comparisons.*—The following differences would separate the two subspecies of *Leggada nagarum* :—

*L. n. nagarum* Thomas.*L. n. imphalensis* Roonwal.

- |   |   |
|---|---|
| <p>1. <i>Size.</i>—Head-and-body shorter (72-81, mean about 75.5 mm.). Tail much longer both absolutely (62-77, mean 62 mm.) and proportionately (82-101%, mean about 89.7% of H.-&amp;-B.).</p> <p>2. <i>Colour.</i>—Dorsum warmer, with less grey.</p> <p>3. <i>Skull.</i>—Smaller (greatest length about 20.6-21.5, mean 21 mm.). Nasals much shorter (7.6-8.2, mean 7.9 mm.). Anterior margin of zygomatic plate markedly or slightly convex, not straight. Upper incisors orthodont.</p> | <p>1. <i>Size.</i>—Head-and-body longer (85-91, mean 87.8 mm.). Tail much shorter both absolutely (56-64, mean 60 mm.) and proportionately (63-72%, mean 68.4% of H.-&amp;-B.).</p> <p>2. <i>Colour.</i>—Dorsum colder and darker, with more grey.</p> <p>3. <i>Skull.</i>—Larger (greatest length 20.6-22.3, mean 21.4 mm.). Nasals much longer (8.4-9.1, mean 8.7 mm.). Anterior margin of zygomatic plate straight. Upper incisors proodont.</p> |
|---|---|

*L. n. imphalensis* would also appear to be close to *Mus cervicolor nitidulus* Bly. (as understood by Ellerman, 1947*d*, p. 384). But specimens of '*Mus nitidulus*' Bly., as listed by Sclater (1891, p. 76; wrongly spelt as *nitulidus*), and now present in the Zoological Survey of India Collections, are markedly different. The tail length is usually above 100% of head-and-body; and in the two skulls examined, the anterior margin of the zygomatic plate is slightly convex, while the upper incisors are orthodont. On the whole, it would appear that *Leggada nagarum imphalensis* might be entitled to specific rank, but for the present I prefer to retain it as a subspecies of *L. nagarum*.

32. *Mus musculus* ?*musculus* Linnaeus.

1758. *Mus musculus*, Linnaeus, *Syst. Nat.* (10th ed.) I, p. 62. (Type-locality : Upsala, Sweden.)
1941. *Mus musculus musculus*, Ellerman, *Fam. & Gen. Living Rodents* II, p. 243.
1949. *Mus musculus musculus*, Roonwal, *Trans. nation. Inst. Sci. India*. III, p. 107.

*Material.*—1 adult ♀ (Z.S.I. Registered No. 11,124), obtained on 22 October 1945 in oak scrub, about 16 miles north of Imphal on Dimapur Road, Manipur, Assam, ca. 3,500 ft.

*Size, colour, etc.*—Head-and-body 71 mm.; tail 78 mm.; hind-foot 16 mm.; ear 11 mm. The colour of the dorsum is similar to *M. m. homourus*, but more grey; the ventrum is pure grey. The skull measures thus (in mm.): Greatest length 19.2; condylobasal length 18.5; greatest zygomatic width 10.6; length of nasals 7.6; length of muzzle 4.6; breadth across front basal edges of upper molars 3.5; length of upper molars on crowns 3.5; cranial width 9.6; length of anterior palatine foramina 4.5.

33. *Mus musculus homooourus* Hodgson.

1845. *Mus dubius* Hodgson, *Ann. Mag. nat. Hist.* XV, p. 268, line 34. (Type-locality: Central Nepal, Himalayas.) Preoccupied by *M. dubius* Fischer, *Syn. Mamm.*, 1829, p. 326, a S. American species.
1845. *Mus homooourus* Hodgson, *Ann. Mag. nat. Hist.* XV, p. 268, line 38. (Type-locality: Central Nepal, Himalayas.)
1941. *Mus musculus homooourus* Ellerman, *Fam. & Genera Living Rodents* II, p. 245.
1947. *Mus musculus homooourus*, Ellerman, *J. Mammal.* XXVIII, p. 386.
1949. *Mus musculus homooourus*, Roonwal, *Trans. nation. Inst. Sci. India* III, p. 108.

*Material*.—1 adult ♂ (Z.S.I. Registered No. 11,125), obtained on 24 September 1945 in a hut in army camp about 16 miles north of Imphal on Dim pur Road, Manipur, Assam, ca. 3,500 ft.

*Size, colour, etc.*—Head-and-body 80 mm.; tail 71 mm.; hind-foot 14 mm.; ear 11 mm. The dorsum is dark, grizzled and tinged with fawn, especially in front of the ears, at the base of the tail, and at the sides; the fur is slaty-based, tipped with fawn or brown. The venter is similar to dorsum but more grey. The skull measures thus (in mm.): Greatest length 20.4; condylobasal length 19.8; greatest zygomatic width 10.7; length of nasals 7.6; length of muzzle 3.8; breadth across front basal edges of upper molars 3.5; length of upper molars on crowns 3.5; cranial width 9.6; length of anterior palatine foramina 4.9.

## FAMILY (iii) HYSTRICIDAE (Porcupines).

34. *Hystrix hodgsonii subcristatus* Swinhoe.

(The Crestless South Chinese Porcupine.)

1870. *Hystrix subcristata* Swinhoe, *Proc. zool. Soc. London*, p. 638. (Type-locality: "Swatow (province Kwangtung) and at Foochow (province Fokien)", S. China.)
1940. *Hystrix subcristatus subcristatus* (also *H. klossi klossi* Th. and *H. k. millsii* Th.), Ellerman, *Fam. & Gen. Living Rodents* I, p. 218.
1947. *Hystrix hodgsonii subcristatus*, Ellerman, *J. Mammal.* XXVIII, p. 251.
1949. *Hystrix (Acanthion) hodgsonii*, Roonwal, *Trans. nation. Inst. Sci. India* III, p. 108.

*Material*.—One subadult ♀ (Z.S.I. Registered No. 11,349) collected on 29 November 1945 (shot at night while crossing the road) near milestone 115, about 18 miles north of Imphal on Dimapur Road, Manipur, ca. 3,500 ft.

*Size, colour, etc.*—Head-and-body 555 mm.; tail 120 mm.; hind-foot 85 mm.; ear 37 mm. The main quills have a comparatively narrow, dark band and a much longer terminal white area; the thinner, long hair-like quills are wholly white. The skull is with the upper and lower M<sub>3</sub> just erupting. It measures as follows (in mm.): Greatest length 121; condylobasal length 117; occipitonasal length 119; greatest zygomatic width 64.3; least interorbital width 49.3; post-molar length 49.7; length of nasals 66.2; combined width of nasals 37.3; length of frontal in middle line 30; palatal length 55; length of diastema 32; length of tympanic bulla 17.2; mandibular length 75.5.

*Distribution.*—Naga Hills (Assam), S. Burma and S. China (Ellerman, 1947c). Manipur, E. Assam (present record).

### Order 6. UNGULATA.

#### Family (i) CERVIDAE (Deer, etc.).

#### 35. *Muntiacus muntjak* (Zimmermann) (?subspecies).

(The Rib-faced or Barking Deer.)

1780. *Cervus muntjak* Zimmermann, *Geog. Gesch.* II, p. 131. (Type-locality :?)

1891. *Cervulus muntjak*, Blanford, *Fauna Brit. India, Mamm.*, pt. 2, p. 532.

1920. *Muntiacus* (?spp.), Wroughton, *J. Bombay nat. Hist. Soc.* XXVII (2) pp. 302-303.

*Material.*—None was procured inspite of many attempts, but several were heard barking. During the period of observation (from July to December, 1945) at the "Kanglatongbi" Field Thphus Station, near Imphal, I heard them barking at night and in the early morning from November onward; they were very common in December, having evidently come down from the higher hills to the camp site in oak scrub at ca. 3,600 ft. altitude. The bark was a short, hoarse one, repeated several times.

### III.—SUMMARY.

1. The paper comprises a systematic report, with special reference to the family Muridae (order Rodentia), upon a collection of mammals made in June to December 1945, by the writer and his associates, principally in central Manipur (Imphal Valley and the neighbouring foothills), and, to a lesser extent, in eastern Manipur (Imphal-Palel-Tamu Road) and in the Kabaw Valley, western Burma, right up to Kalewa on R. Chindwin. A small collection, made in February-March 1936 by a Zoological Survey of India Party in central and western (along Imphal-Silchar Road) Manipur and in the immediately adjoining portions of the Naga Hills, is also included.

2. INSECTIVORA : The following species are dealt with :—Tupaïidae : *Tupaia belangeri* (Wagn.) (?subsp.). Talpidae : *Talpa micrura* Hodgs. Soricidae : *Suncus caeruleus fulvocinereus* (And.) ; *S. griffithi* (Horsf.) ; and *Suncus* sp.

3. CHIROPTERA : Pteropodidae : *Pteropous giganteus leucocephalus* Hodgs. is recorded from Manipur.

4. CARNIVORA : The following species are dealt with : Felidae : *Prionailurus bengalensis bengalensis* (Kerr) ; *Felis chaus* (Güld.) (?subsp.) and Domestic Cat (*Felis chaus* type). Viverridae : *Viverricula indica* (Geoff.) (?subsp.). Herpestidae : *Herpestes urva* Hodgs. Canidae : *Canis aureus indicus* Hodgs.

5. PRIMATES : The following monkeys were recorded : Cercopithecidae : *Macaca mulatta mulatta* (Zimm.) and *M. assamensis assamensis* McCl. Some observations on live specimens of the latter species are mentioned regarding the body-coloration and the hair-direction on the head ; certain differences between the two above-mentioned species are also discussed. It was also noted that in a ♀ of *M. mulatta* the menstrual flow lasted 3 days (from 3-5 November, 1945), and that during this period the blood discharge was moderate and there was no particular swelling or reddening of the hind-quarters.

6. RODENTIA : Non-Muridae : The following species were recorded : Sciuride : *Hylopetes alboniger* (Hodgs.) ; *Callosciurus erythraeus erythrogaster* Bly. ; and *Dremomys lokriah macmillani* Th. & Wr. Hystricidae : *Hytrix hodgsonii subcristatus* Swin.

7. RODENTIA (contd.) : Muridae: The following species were recorded : *Bandicota bengalensis* (Gr. & Hardw.) ; *B. bengalensis ?varius* (Th.) ; *Rattus rattus bullocki*\* Roon. ; *R. r. ?khyensis* Hint. ; *R. rattus* (?subsp.) ; *Rattus* sp. ; *R. manipulus manipulus*\* (Th.) ; *R. m. kekrimus* Roon. ; *R. bowersii mackenziei*\* (Th.) ; *R. niviventer niveventer*\* Hodgs. ; *R. mentosus*\* Th. ; *Hadromys humei*\* (Th.) ; *Leggada nagarum imphalensis*\* Roon. ; *Mus musculus ?musculus* Linn. ; and *M. musculus homoourus* Hodgs. Detailed skull-measurements are provided in most of the above cases. Skull-drawings are given for the majority of cases (marked with an asterisk\*), either because no drawings were hitherto available in the literature or, if available, they were not suitable for systematic comparisons. In addition, skull-drawings of *Rattus bowersii bowersii*\* (And.) are provided for comparison with that of *R. b. mackenziei* (Th.). Fuller diagnoses are given of the following three forms whose brief preliminarily diagnoses had appeared earlier (Roonwal, 1948) : *Rattus rattus bullocki*, *R. manipulus kekrimus* and *Leggada nagarum imphalensis*. In *R. manipulus manipulus* the hind-foot is much longer, in proportion to the head-and-body length, in juveniles than in adults ; among the latter, the proportionate length of the hind-foot steadily decreases with the increasing head-and-body length, and the same applies to the tail length.

8. UNGULATA : Cervidae : *Muntiacus muntjak* (Zimm.) (?subsp.) was commonly heard barking in central Manipur, but no specimens were procured.

9. The following are new distributional records from either Manipur or W. Burma (vide also Roonwal, 1948 ; 1949 a-c) : INSECTIVORA : *Talpa micrura* Hodgs. Imphal Valley, central Manipur, ca. 3,500 ft. ; hitherto recorded in E. Himalayas only from higher altitudes. *Suncus caeruleus fulvocinereus* (And.) and *Suncus griffithi* (Horsf.), Imphal Valley, central Manipur, ca. 3,000-3,500 ft. and the Kabaw Valley, W. Burma, ca. 500 ft. CARNIVORA : *Herpestes urva* (Hodgs.), Manipur. PRIMATES : *Macaca assamensis assamensis* McCl., Manipur. RODENTIA : *Rattus nitidus obsoletus* Hint., Manipur. *Rattus bowersii mackenziei* (Th.), western hills of Manipur. *Rattus niviventer niviventer* Hodgs., S.-E. Manipur, ca. 4,000 ft. *Rattus mentosus* Th., central Manipur, ca. 2,600-3,500 ft. *Leggada nagarum* Th., central Manipur (3,500 ft.) and the Kabaw Valley, W. Burma (360 ft.)—this form is *L. n. imphalensis* Roonwal (1948). Hystricidae : *Hytrix hodgsonii subcristatus* Swin., central Manipur.

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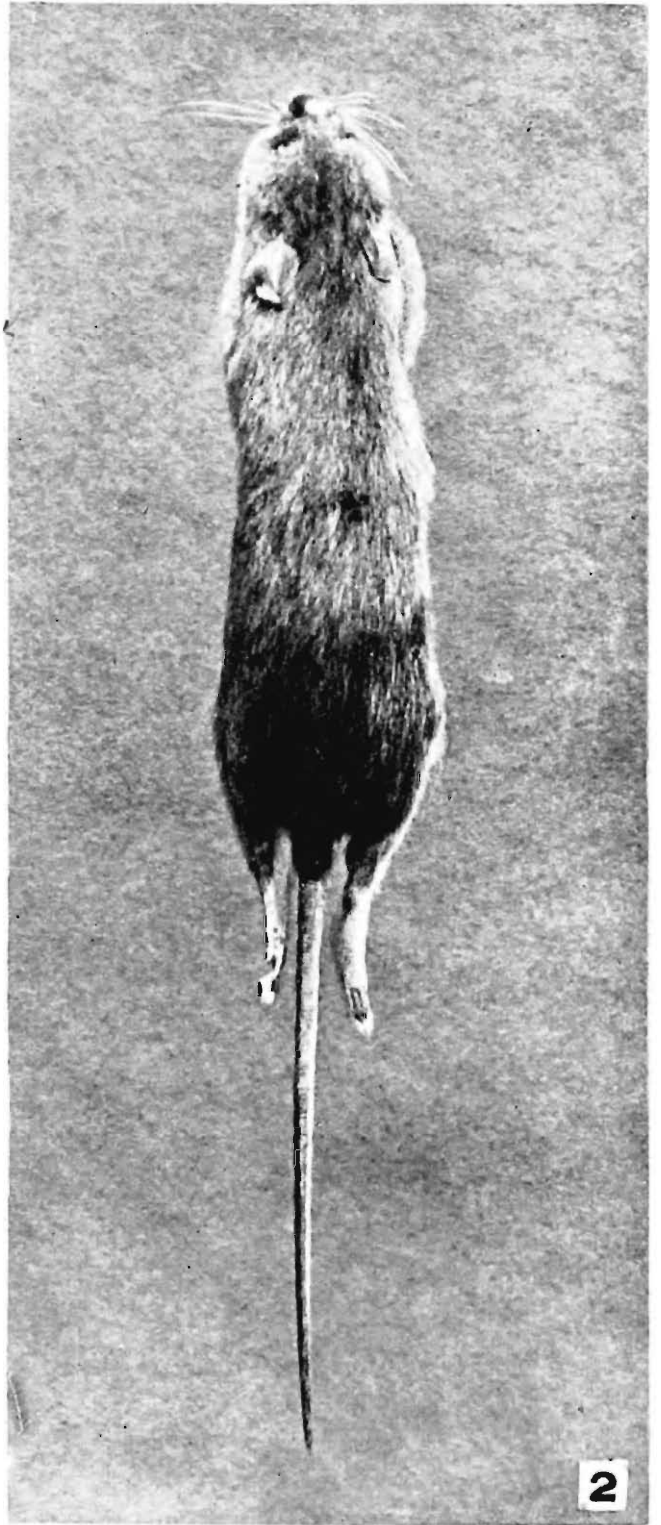
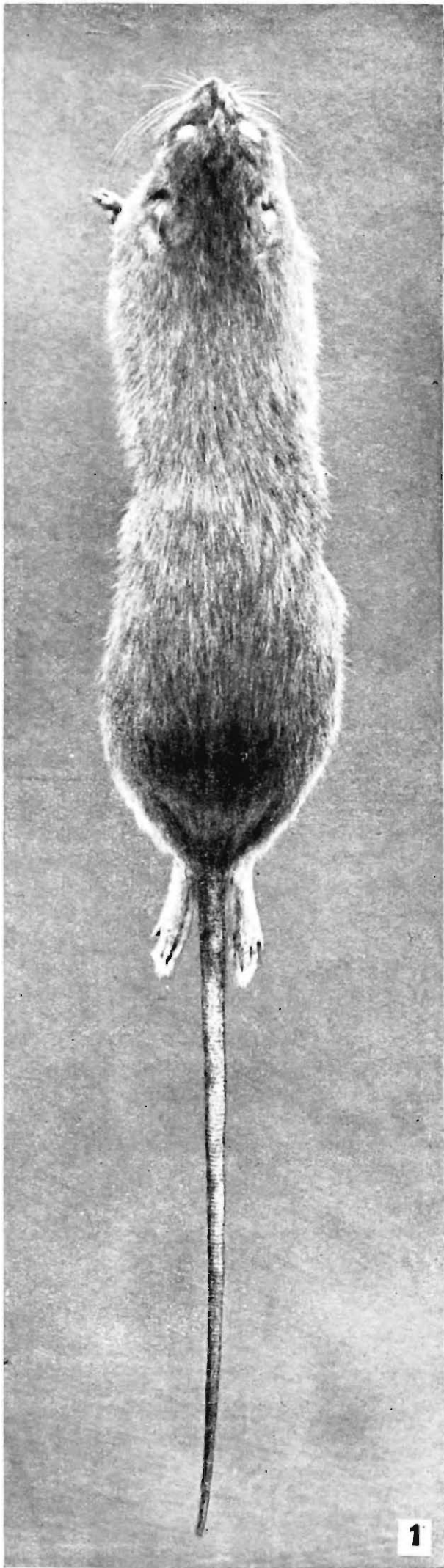
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- 1920*a*.—Ditto. Part V Rodentia (*part*). *Ibid.* XXVI (4), pp. 955-967.
- 1920*b*.—Ditto. Part VI. Rodentia (*concl'd.*) and Ungulata (*part*). *Ibid.* XXVII (1), pp. 57-85.
- 1920*c*.—Ditto. Part VII. Ungulata (*concl'd.*), Edentata, Sirenia and Cetacea. *Ibid.* XXVII (2), pp. 301-313.
- 1921. Ditto. Appendix and list of forms. *Ibid.* XXVII (3), pp. 520-534.

### EXPLANATION OF PLATE I.

Photographs of stuffed type-specimens of two Muridae, in dorsal view.

FIG. 1.—*Rattus rattus bullocki* Roonwal.  $\times$  ca.  $\frac{5}{8}$ ths. Holotype. Adult ♀, Z. S. I. Reg. No. 11,228, milestone 117, about 16 miles north of Imphal on Dimapur Road, Manipur, Assam, ca. 3,500 ft., 4 August 1945.

FIG. 2.—*Leggada nagarum imphalensis* Roonwal. Holotype. Adult ♀, Z. S. I. Reg. No. 11,120, milestone 117, about 16 miles north of Imphal on Dimapur Road, Manipur, Assam, ca. 3,500 ft., 26 July 1945.



## EXPLANATION OF PLATE II.

### *Rattus rattus bullocki* (Roonwal).

*Lettering* : D<sub>1</sub>-D<sub>5</sub>, first to fifth digits.

FIGS. 1-6.—Holotype. Adult ♀, Z. S. I. Reg. No. 11,228, milestone 117, about 16 miles north of Imphal on Dimapur Road, Manipur, Assam, ca. 3,500 ft., 4 August 1945.

FIG. 1.—Dorsal view of skull. × ca. 2·6.

FIG. 2.—Ventral view of skull. × ca. 2·6.

FIG. 3.—Left side-view of skull. × ca. 2·6.

FIG. 4.—Outer side-view of left mandible. × ca. 2·6.

FIG. 5.—Upper molar crowns of right side, in surface view. × ca. 7·8.

FIG. 6.—Lower molar crowns of right side, in surface view. × ca. 7·8.

FIGS. 7-11.—Adult ♀, Z. S. I. Reg. No. 11,210, "Kanglatongbi Area," about 16 miles north of Imphal on Dimapur Road, Manipur, Assam, ca. 3,500 ft., 15 July 1945.

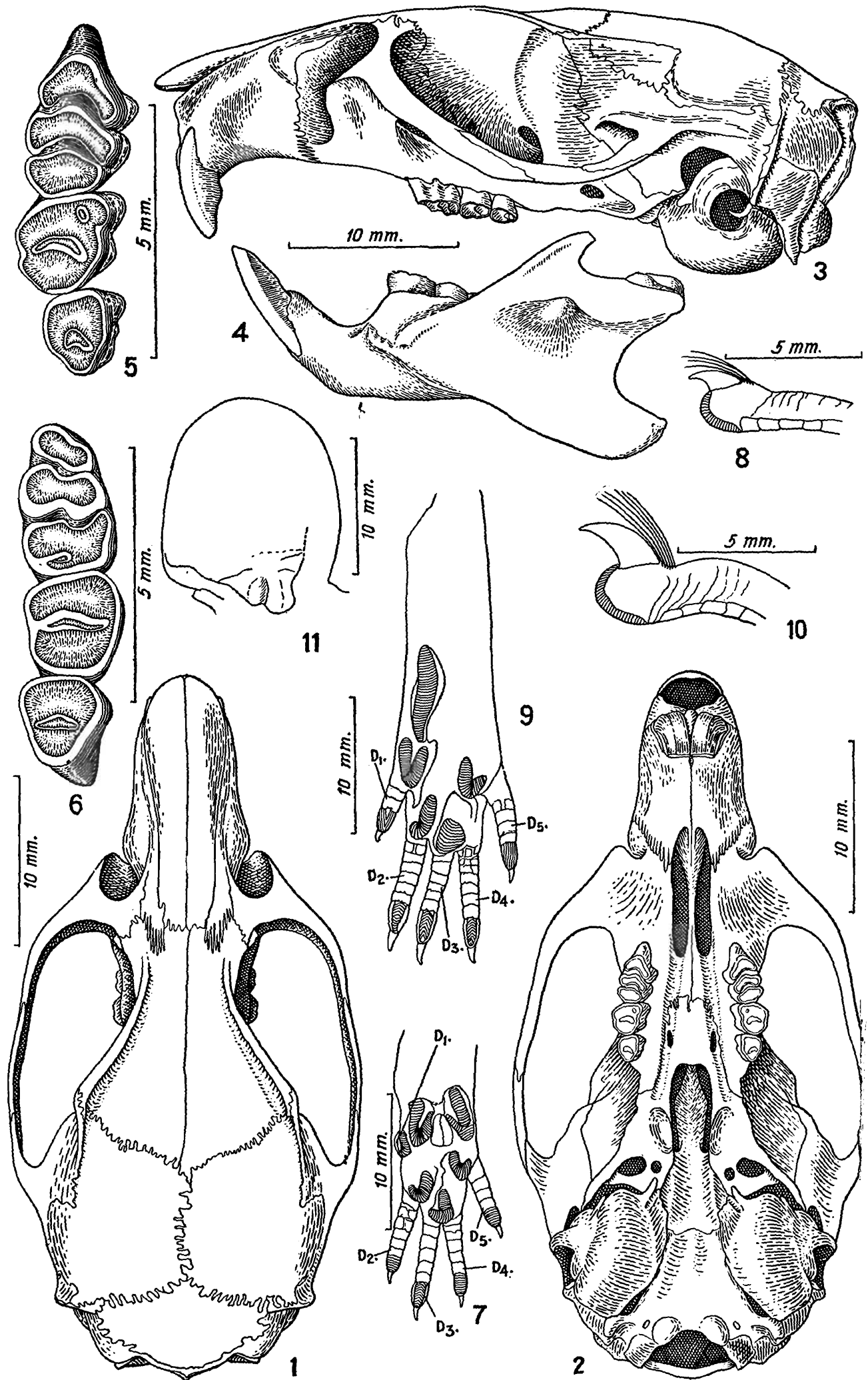
FIG. 7.—Lower view of right hand. × ca. 2·1. Note the pattern of sulci on the digital and palmar pads.

FIG. 8.—Side-view of mid-finger (D<sub>3</sub>) of right hand. × ca. 4·2.

FIG. 9.—Lower view of right hind-foot. × ca. 2·1. Note the pattern of sulci on the digital and plantar pads.

FIG. 10.—Side-view of mid-toe (D<sub>3</sub>) of right hind-foot. × ca. 4·2.

FIG. 11.—left ear. × ca. 2·1.



### EXPLANATION OF PLATE III.

*Rattus manipulus manipulus* (Thomas).

*Lettering* : D<sub>1</sub>-D<sub>5</sub>, first to fifth digits.

FIGS. 1-6.—Adult ♂, Z. S. I. Reg. No. 11,311, below Modbung village, about 16 miles north of Imphal on Dimapur Road, Manipur, Assam, *ca.* 3,500 ft., 3 December 1945.

FIG. 1.—Dorsal view of skull.  $\times ca.$  2.6.

FIG. 2.—Ventral view of skull.  $\times ca.$  2.6.

FIG. 3.—Left side-view of skull.  $\times ca.$  2.6.

FIG. 4.—Outer side-view of left mandible.  $\times ca.$  2.6.

FIG. 5.—Upper molar crowns of right side, in surface view.  $\times ca.$  7.8.

FIG. 6.—Lower molar crowns of right side, in surface view.  $\times ca.$  7.8.

FIGS. 7-11.—Adult ♂, Z. S. I. Reg. No. 11,308, about 16 miles north of Imphal on Dimapur Road, Manipur, Assam, *ca.* 3,500 ft., 21 October 1945.

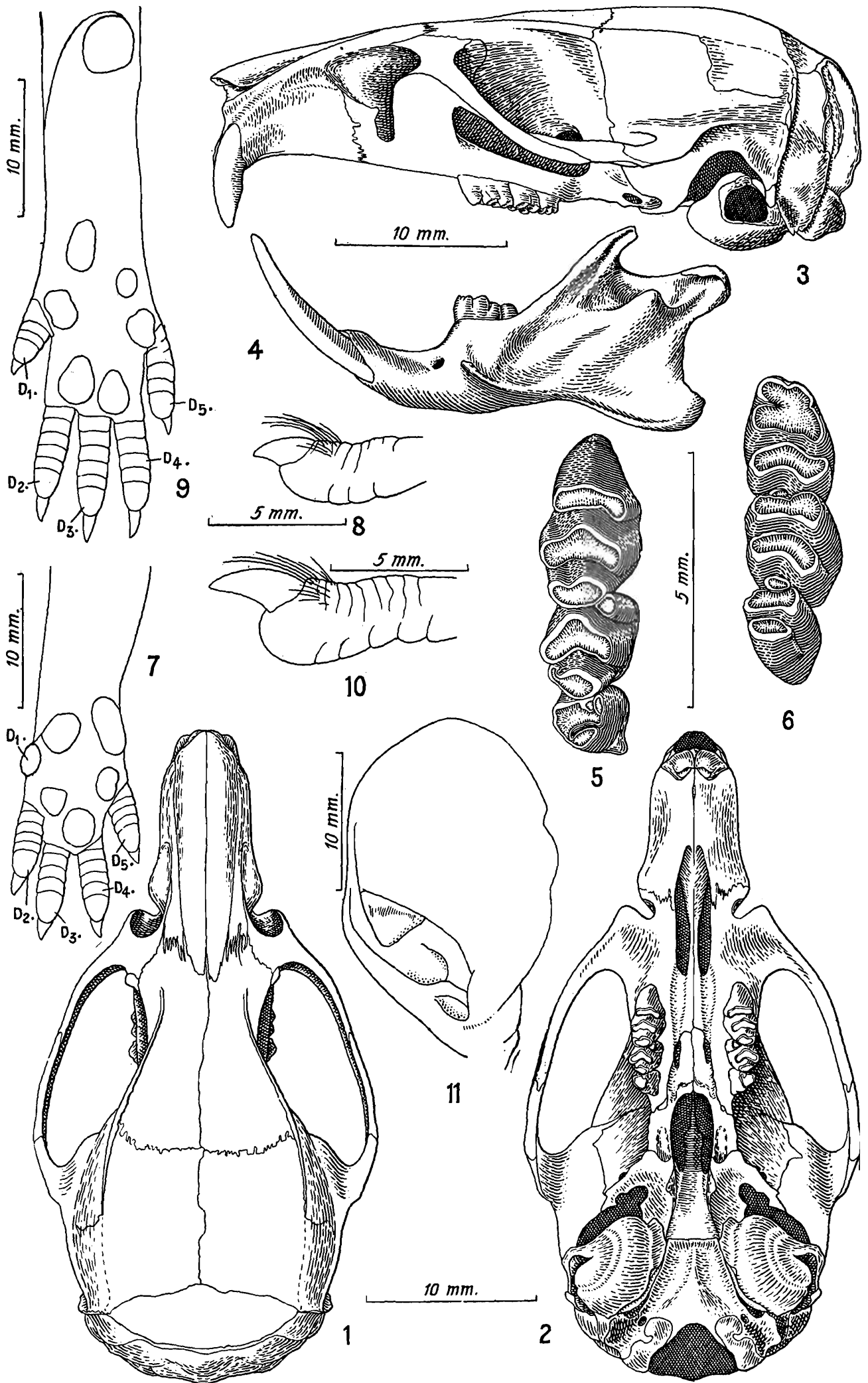
FIG. 7.—Lower view of right hand.  $\times ca.$  2.1.

FIG. 8.—Side-view of mid-finger (D<sub>3</sub>) of right hand.  $\times ca.$  4.2.

FIG. 9.—Lower view of right hind-foot.  $\times ca.$  2.1.

FIG. 10.—Side-view of mid-toe (D<sub>2</sub>) of right hind-foot  $\times ca.$  2.1.

FIG. 11.—Left ear.  $\times ca.$  2.1.



#### EXPLANATION OF PLATE IV.

*Rattus bowersii bowersii* (Anderson). Holotype. Adult ♀, Z. S. I.  
Reg. No. 10,078 Hotha, Kakhyan Hills, Yunnan, S. China.

FIG. 1.—Dorsal view of skull.  $\times ca.$  2·3.

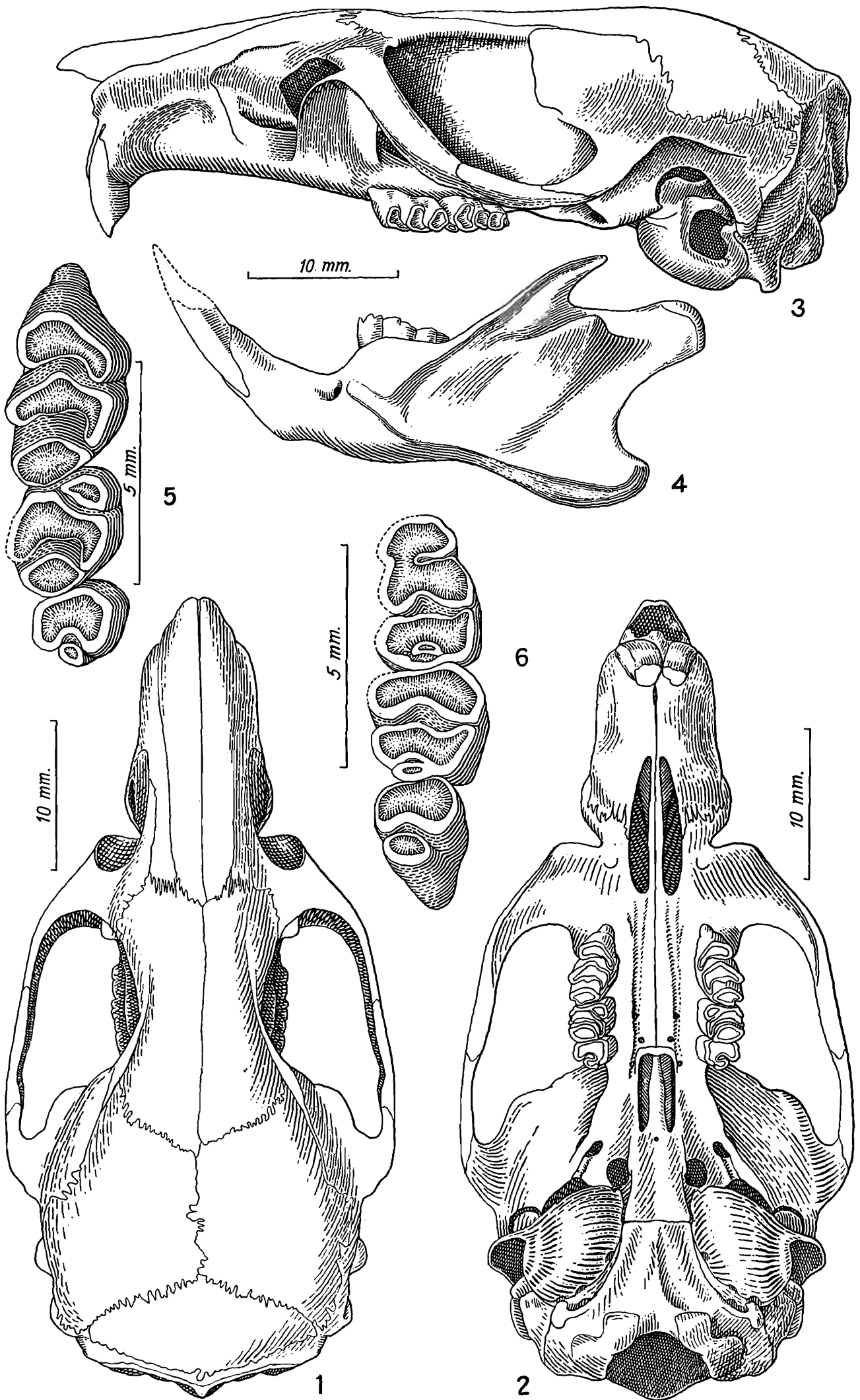
FIG. 2.—Ventral view of skull.  $\times ca.$  2·3.

FIG. 3.—Left side-view of skull.  $\times ca.$  2·3.

FIG. 4.—Outer side-view of left mandible.  $\times ca.$  2·3.

FIG. 5.—Upper molar crowns of right side, in surface view.  $\times ca.$  6·9.

FIG. 6.—Lower molar crowns of right side, in surface view.  $\times ca.$  6·9.



### EXPLANATION OF PLATE V.

*Rattus bowersii mackenziei* (Thomas). Adult ♂, Z. S. I. Reg. No. 11,346  
Luanglong Khulen, about 63 miles west of Imphal on Silchar Road,  
Manipur, Assam, ca. 3,250 ft., 9 February 1936.

FIG. 1.—Dorsal view of skull.  $\times ca. 2.4$ .

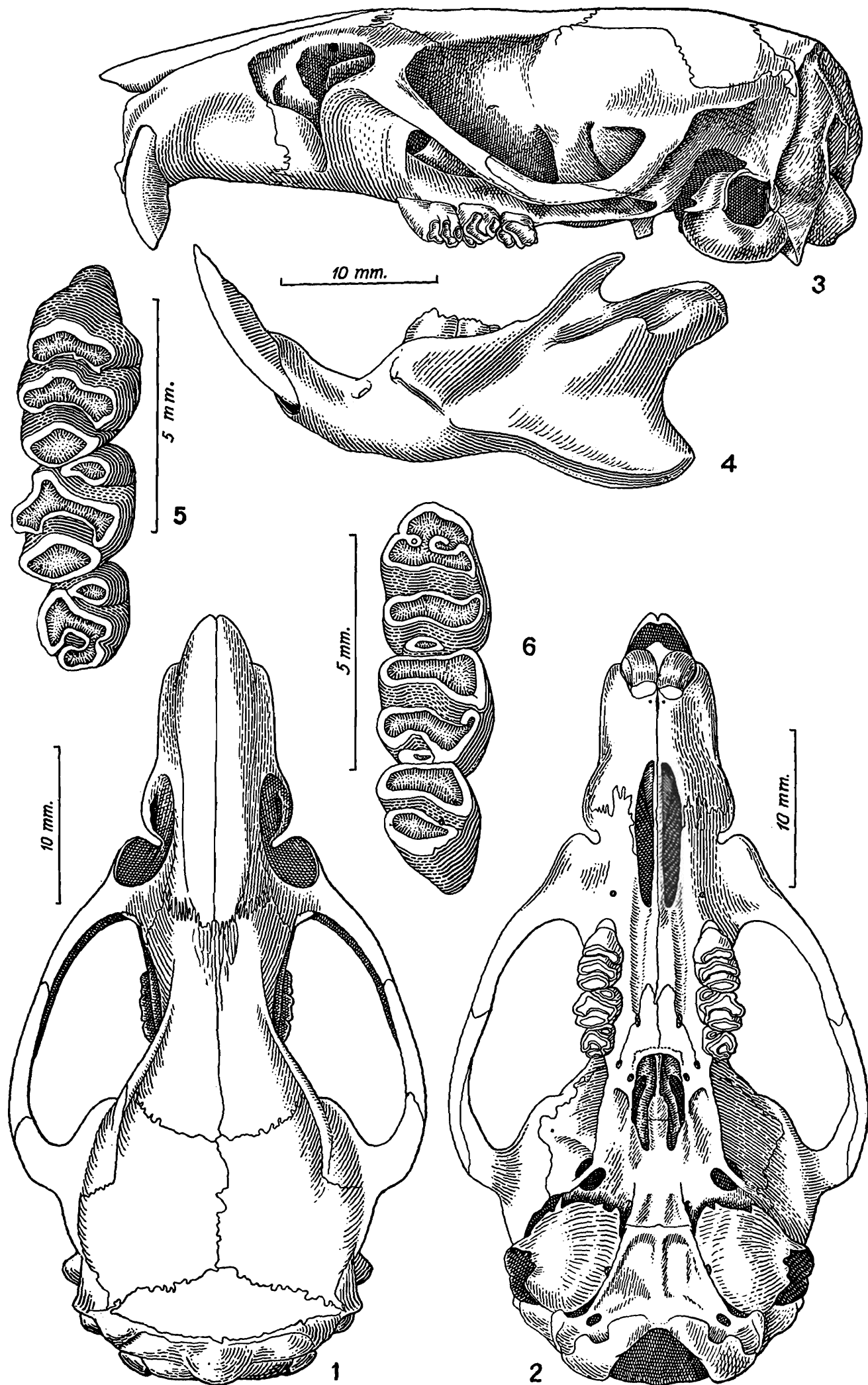
FIG. 2.—Ventral view of skull.  $\times ca. 2.4$ .

FIG. 3.—Left side-view of skull.  $\times ca. 2.4$ .

FIG. 4.—Outer side-view of left mandible.  $\times ca. 2.4$ .

FIG. 5.—Upper molar crowns of right side, in surface view.  $\times ca. 7.2$ .

FIG. 6.—Lower molar crowns of right side, in surface view.  $\times ca. 7.2$ .



### EXPLANATION OF PLATE VI.

*Rattus niviventer niviventer* (Hodgson). Adult ♂, Z. S. I. Reg. No. 11,130, milestone 34, south-east of Imphal on Tamu Road, Manipur, Assam, ca. 4,000 ft., 11 September 1945.

FIG. 1.—Dorsal view of skull.  $\times ca. 3.3$ .

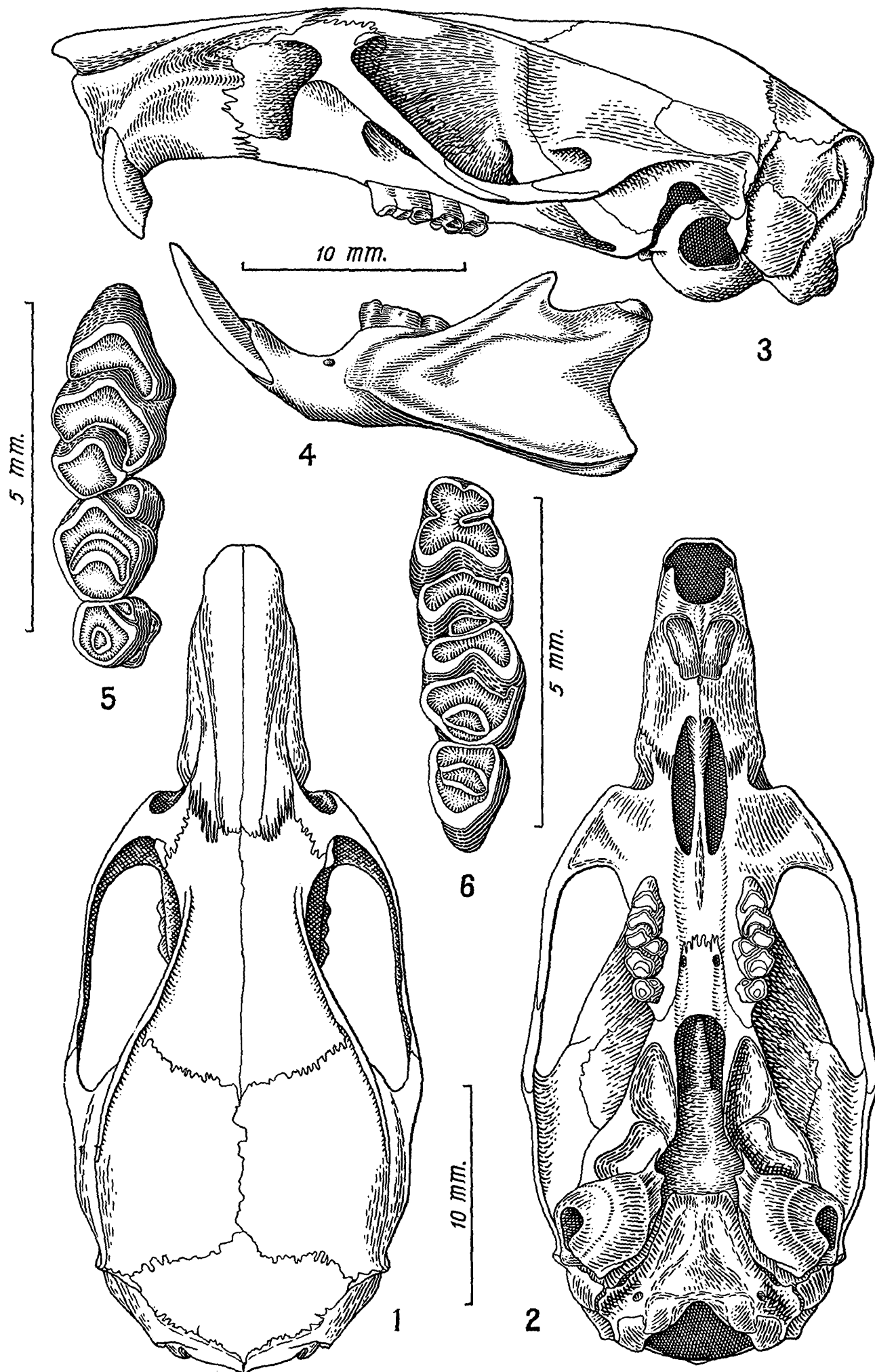
FIG. 2.—Ventral view of skull.  $\times ca. 3.3$ .

FIG. 3.—Left side-view of skull.  $\times ca. 3.3$ .

FIG. 4.—Outer side-view of left mandible.  $\times ca. 3.3$ .

FIG. 5.—Upper molar crowns of right side, in surface view.  $\times ca. 9.9$ .

FIG. 6.—Lower molar crowns of right side, in surface view.  $\times ca. 9.9$ .



## EXPLANATION OF PLATE VII.

*Rattus mentosus* (Thomas). Manipur, Assam, *ca.* 3,500 ft.

*Lettering* : D<sub>1</sub>-D<sub>5</sub>, first to fifth digits.

FIGS. 1-6.—Adult ♀, Z. S. I. Reg. No. 11,128, milestone 117, about 16 miles north of Imphal on Dimapur Road, 3 August 1945.

FIG. 1.—Dorsal view of skull. × *ca.* 3.

FIG. 2.—Ventral view of skull. × *ca.* 3.

FIG. 3.—Left side-view of skull. × *ca.* 3.

FIG. 4.—Outer side-view of left mandible. × *ca.* 3.

FIG. 5.—Upper molar crowns of right side, in surface view. × *ca.* 9.

FIG. 6.—Lower molar crowns of right side, in surface view. × *ca.* 9.

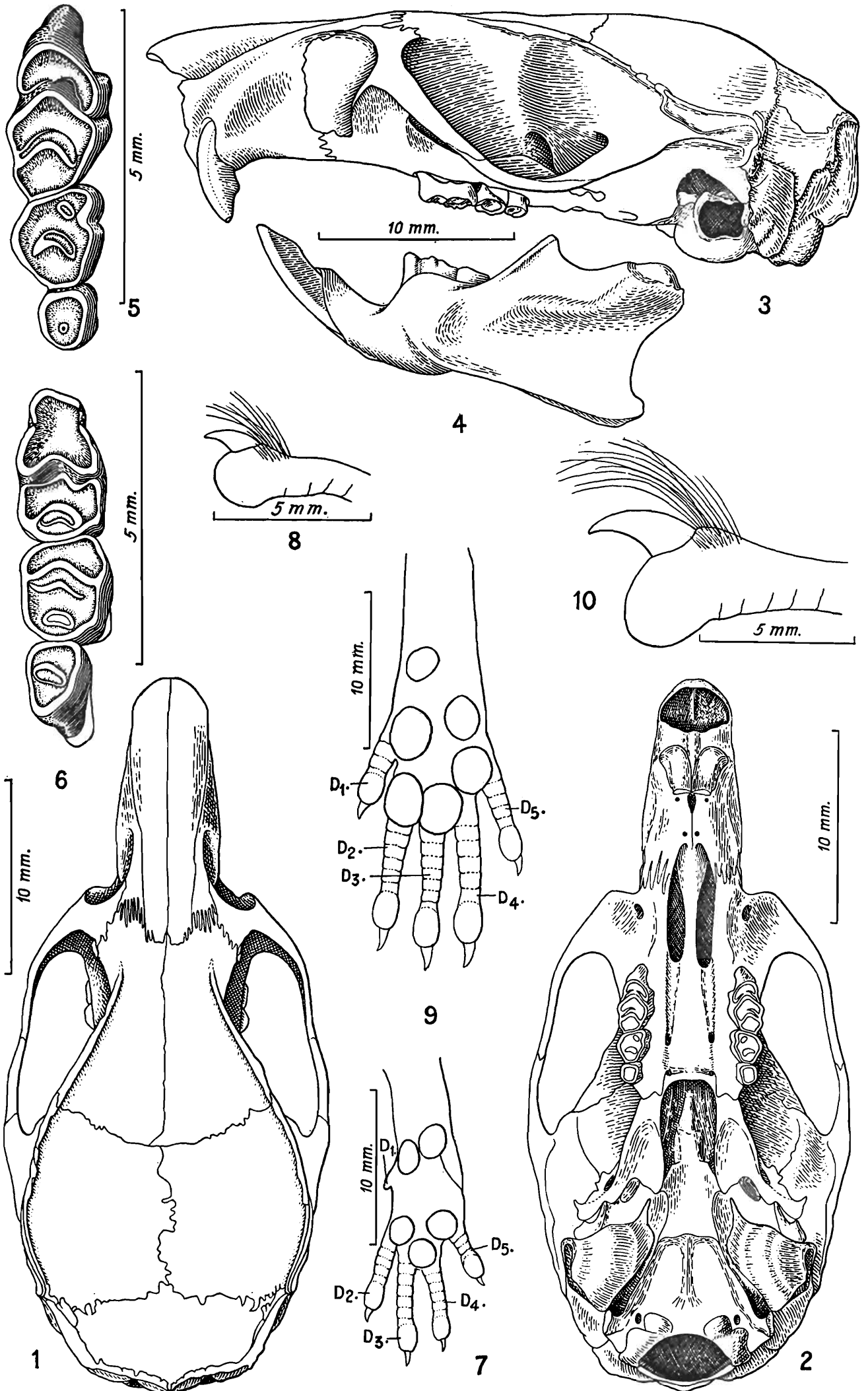
FIGS. 7-10.—Adult ♂, Z. S. I. Reg. No. 11,131, about 17 miles north of Imphal on Dimapur Road, 25 December 1945.

FIG. 7.—Lower view of right hand. × *ca.* 2·5.

FIG. 8.—Side-view of mid-finger (D<sub>3</sub>) of right hand. × *ca.* 5·1.

FIG. 9.—Lower view of right hind-foot. × *ca.* 2·5.

FIG. 10.—Side-view of mid-toe (D<sub>3</sub>) of right hind-foot. × *ca.* 5·1.



### EXPLANATION OF PLATE VIII.

*Hadromys humei* (Thomas). Adult ♀, Z. S. I. Reg. No. 11,112, milestone 34, south-east of Imphal on Tamu Road, Manipur, Assam, *ca.* 4,000 ft., 17 September 1945.

*Lettering* : D<sub>1</sub>-D<sub>5</sub>, first to fifth digits.

FIG. 1.—Dorsal view of skull. × *ca.* 3.

FIG. 2.—Ventral view of skull. × *ca.* 3.

FIG. 3.—Left side-view of skull. × *ca.* 3.

FIG. 4.—Outer side-view of left mandible. × *ca.* 3.

FIG. 5.—A portion of the left side-view of skull (same as in Fig. 3), further enlarged to show the concave anterior margin of the zygomatic arch. × *ca.* 9.

FIG. 6.—Upper molar crowns of right side, in surface view. × *ca.* 9.

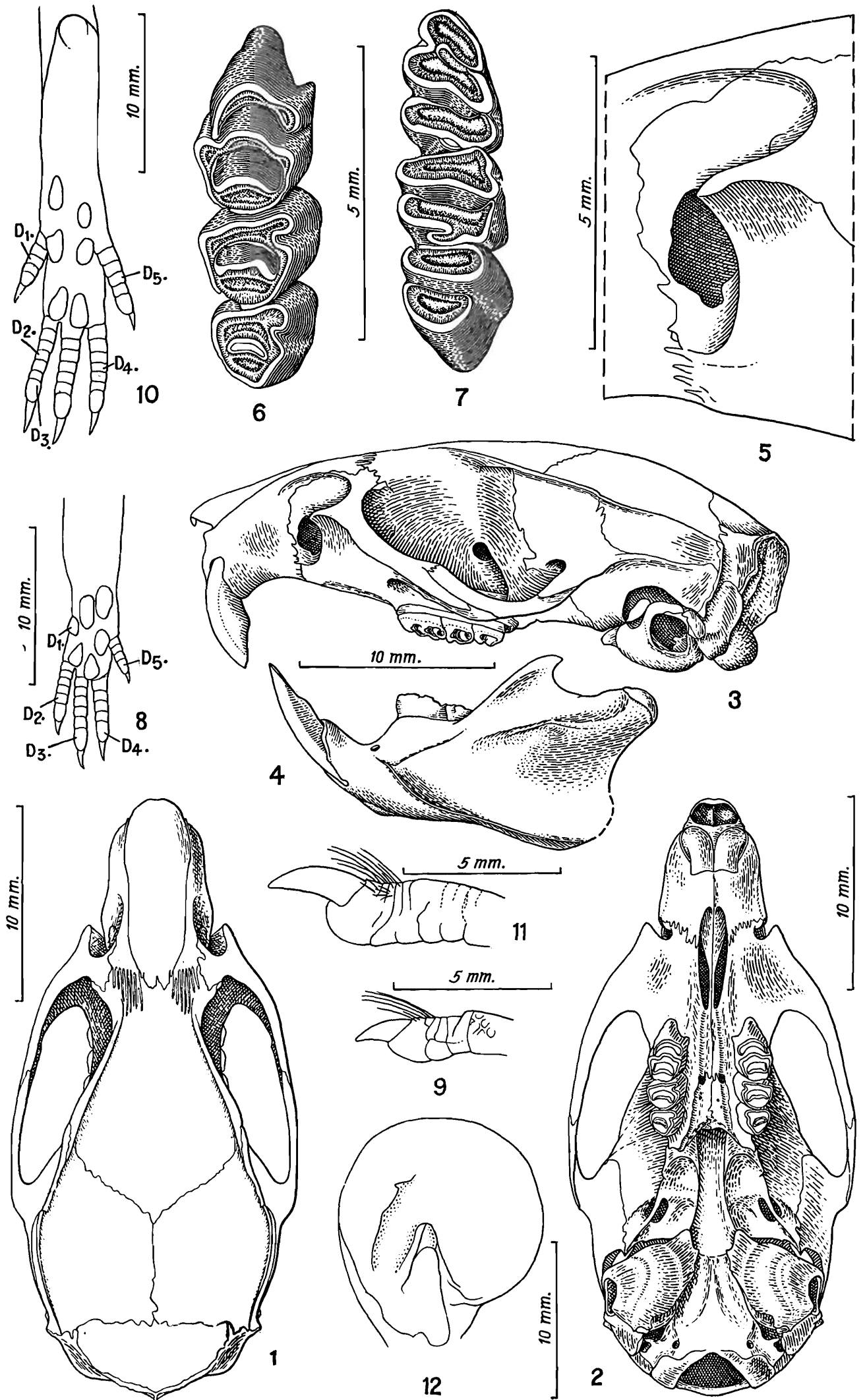
FIG. 7.—Lower molar crowns of right side, in surface view. × *ca.* 9.

FIG. 8.—Lower view of right hand. × *ca.* 2·4.

FIG. 9.—Side-view of mid-finger (D<sub>3</sub>) of right hand. × *ca.* 4·8.

FIG. 10.—Lower view of right hind-foot. × *ca.* 2·4.

FIG. 11.—Side-view of mid-toe (D<sub>3</sub>) of right hind-foot. × *ca.* 4·8.



## EXPLANATION OF PLATE IX.

*Leggada nagarum imphalensis* Roonwal. Holotype. Adult ♀, Z. S. I. Reg. No. 11,120 (Coll. No. FL2/26-7-45), milestone 117, about 16 miles north of Imphal on Dimapur Road, Manipur, Assam, ca. 3,500 ft., 26 July 1945.

FIG. 1.—Dorsal view of skull. × ca. 5·2.

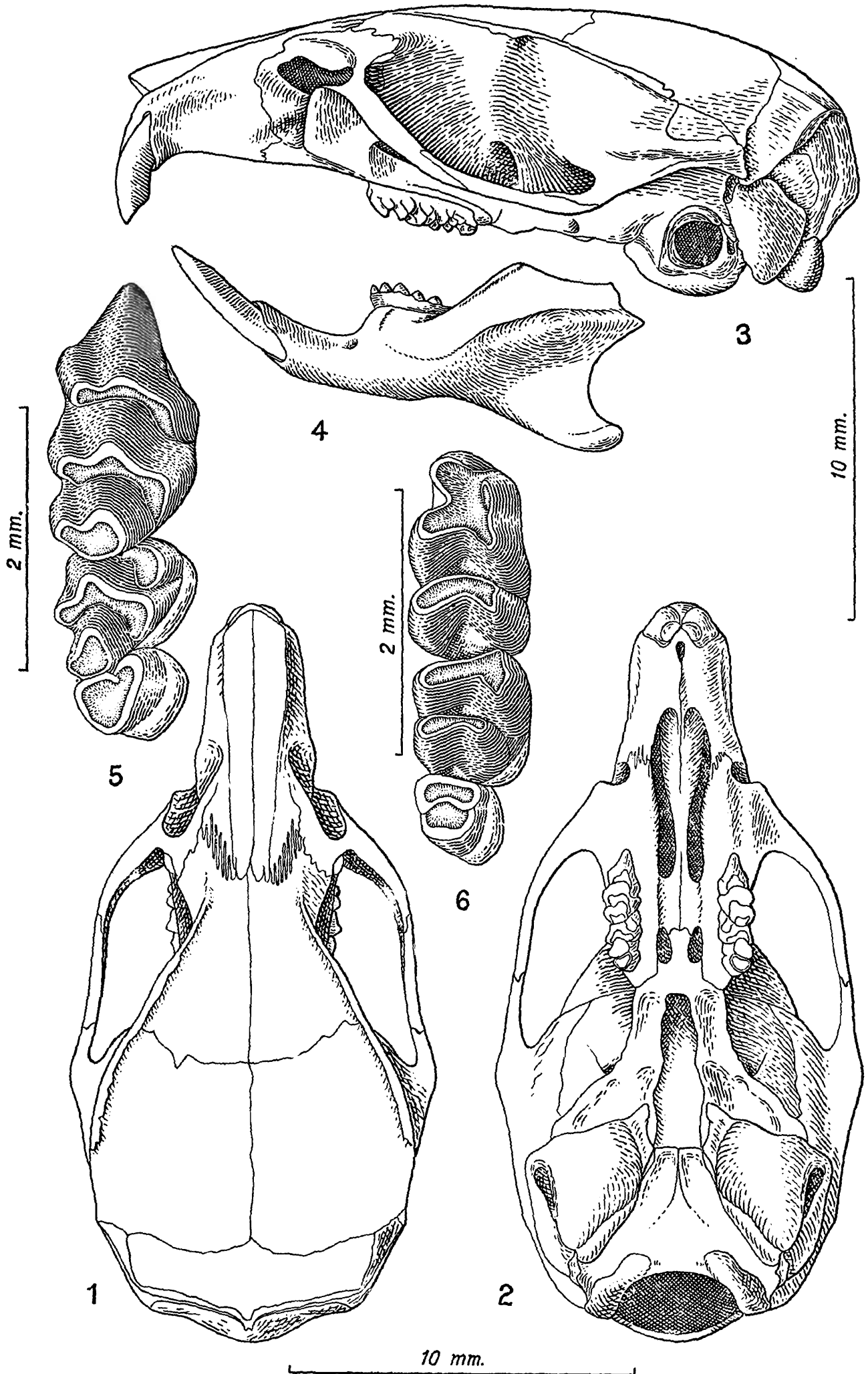
FIG. 2.—Ventral view of skull. × ca. 5·2.

FIG. 3.—Left side-view of skull. × ca. 5·2.

FIG. 4.—Outer side-view of left mandible. × ca. 5·2.

FIG. 5.—Upper molar crowns of right side, in surface view. × ca. 19·5.

FIG. 6.—Lower molar crowns of right side, in surface view. × ca. 19·5.



## VARIATION IN SIZE AND WEIGHT IN FIVE SPECIES OF HOUSE-RATS (RODENTIA: MURIDÆ), IN RANGOON, BURMA

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### INTRODUCTION.

The "average" length of the body-parts is frequently used as a specific or subspecific character. Yet, the average or mean lengths of most animals are rarely known with accuracy. Take, for example, the following key for the bandicoots, condensed form Wroughton (1919):—

Size larger, head and body more than 250 mm ; mammae 3+3=12	<i>Bandicota.</i>
Size smaller, head and body at most 225 mm.— Mammae 16 to 18	<i>Gunomys.</i>
Mammae 2+2=8	<i>Nesokia.</i>

What, then, is our specimen No. 23.7.11 of length 190 mm., mammae 14; or No. 6. 23. 10 of length 240 mm., mammae 17; or No. 4. 1. 11, a. of length 270 mm. ? Clearly, there is need for more information about the range of variation of our commonest animals—variation both of individuals in the same population and of communities in different districts. Huxley (1940, p. 39) points out the importance of measurements of a few characters on a reasonably long series of animals.

In Rangoon, during 1945, rat control measures gave us the opportunity of examining some thousands of bodies of rats of five species. Some standard measurements were made and the statistical results are given here.

Summarizing such results presents a difficulty. The "average" so often quoted, may imply arithmetic or geometrical mean, mode median, or more doubtful statistics. The "range", which is even more often used, depends so much on the number of specimens examined and the chance occurrence of extremes that it is of little value and may indeed mislead. The arithmetic mean with the standard deviation is the best way of expressing results which are distributed normally, and it is the method suggested by Huxley, but is not suitable for skew distributions, and most of our results show marked negative skewness. The method adopted, therefore, has been to give the arithmetic mean, the range and an abbreviated frequency table showing the percentage of measurements in each group to the nearest one per cent.\* indicates that observations occurred in that group, but with a frequency of less than 0.5%.

Our thanks are due to Capt. R. A. Davis, *M. Sc.*, to U Myo Khin, *B. Sc.*, and to Maung Gale, *B. Sc.*, for their help in the routine examination of these rats.

## OBSERVATIONS.

The following measurements were recorded :—(1) Length of head-and-body (in mm.) measured from the tip of the nose to the anus. (2) Length of tail (in mm.), measured with the tail in line with the body, from the anus to the tip, excluding hairs. This is expressed here as a percentage of the head-and-body length. (3) Length of hind-foot, excluding claws (in mm.). (4) Weight in grams.

These are tabulated for all apparently adult rats (see below) in Tables 2 to 7, while the mean values for the members of the youngest litter which had been obtained for each species are given in Table 1. Such litters were newly born or a few hours old. The sexes have been tabulated separately where a sufficient number of specimens were available.

The species of rats dealt with, together with some additional observations on each, are summarized below. The nomenclature is as given in Ellerman (1941 ; 1947).

1. *Bandicota bengalensis* (Gray and Hardwicke).

Syn.—*Nesocia bengalensis* of Blanford and *Gunomys bengalensis* of Wroughton.

This species was one of the most abundant. The number of mammae recorded was variable and frequently asymmetrical. The frequency of the various totals in 281 females examined were :—

No. of mammae	12	13	14	15	16	17	18	19	20
Frequencies	3	2	10	33	96	68	44	21	4

The number of embryos in 33 visibly pregnant females varied from 2 to 13, with no marked mode.

2. *Rattus norvegicus* (Berkenhout).

This species was of limited distribution and less than 100 adults were examined. The mammary formula was uniformly 3+3=12. In 9 visibly pregnant females the number of embryos varied from 3 to 9.

3. *Rattus rattus* (Linné).

The Rangoon form of this species appears to be allied to *R. r. khyensis* Hinton and *R. r. tikos* Hinton. There appears to be a cline in this species from *R. r. khyensis* in the Chin Hills to *R. r. jalorensis* in Malaya (Chasen, 1933). Of 154 specimens seen only 3 tended towards the grey bellied cosmopolitan form, and two more showed a dark streak down the centre of the underside ; the remainder were bright brown above and brilliant white below. The number of mammae was variable. In 79 females, the frequencies were :—

Mammæ 2+3=10		8 rats
Mammæ 11	.	5 rats
Mammæ 3+3=12	.	66 rats

The number of embryos in 15 visibly pregnant females varied from 3 to 8.

4. *Rattus exulans concolor* (Blyth).

This was the commonest rat. The number of mammæ was uniformly  $2+2=8$ . The number of embryos in 62 visibly pregnant females varied thus :—

2 embryos in each of 4 rats

3 embryos in each of 17 rats

4 embryos in each of 22 rats

5 embryos in each of 14 rats

6 embryos in each of 5 rats

5. *Mus musculus* Linnè.

The number of mammæ was uniformly  $3+2=10$ . Only 2 pregnant females were seen, each with 5 embryos.

## GENERAL REMARKS.

“ Apparently adult ” is a rather vague classification. In the absence of detailed investigation of the gonads, the final criterion used was that the length of the hind-foot should be less than 25 per cent. of the body-length. This rather arbitrary criterion seemed to work fairly well with *Rattus* spp., but not so well with *Bandicota* in which the hind-feet are shorter in relation to the body.

The numbers of rats on which Table 4 (tail-length) is founded are in each species less than those of other dimensions. This is due to the discarding of rats with damaged tails. If longer tails are more likely to be damaged, the Table will be biased for shorter tails. The proportions of rats with damaged tails in different species throws some light on this, as will be seen from the following data regarding the percentage of specimens with damaged tails :—

*Percentage of specimens with damaged tails.*

	♂	♀
<i>B. bengalensis</i>	18	10
<i>R. norvegicus</i>	21	17
<i>R. rattus</i>	24	21
<i>R. e. concolor</i>	13	12

The three larger species show a decided increase of damage with tail length, but *R. e. concolor*, with a tail of great relative length (although small absolute length) upsets the series. It is noticeable that 25% of specimens of *R. norvegicus* had tails as long as or longer than the body. In Europe, “ tail shorter than the body ” is a usual diagnostic character of this species. Perhaps this is an example of “ Allen’s rule ” that the relative size of exposed portions of the body decreases with a decrease of mean temperature.

Fuller statistics of the data presented here have been deposited in the Library of the University of London (Woodville, 1947).

## SUMMARY.

1. The measurements of the length of head-and-body, tail, hind-foot, and weight of some thousands of house rats belonging to 5 species, killed in Rangoon in 1945, are summarized. The species were: *Bandicota bengalensis* (G. & H). *Rattus norvegicus* (Berk.), *R. rattus* (L.), *R. exulans concolor* (Bly.) and *Mus musculus* L.

2. The frequency distributions of measurements are negatively skew; so the results are expressed as abbreviated frequency tables.

3. Some notes are given on number of mammæ and embryos, and on the size of young at birth.

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TABLE 1.

*Dimensions, etc. of new born rats (youngest litter seen).*

Species.	No. of litters seen.	No. of individuals in each litter.	Head and body (mm.).	Tail as % of H. & B.	H. Foot (mm.).	Weight (gm.).
<i>B. bengalensis</i>	3	7, 7, 11	47	49	18.7	5.8
<i>R. norvegicus</i>	2	5, 6	52	34	8.8	5.6
<i>R. rattus</i>	5	4, 4, 4, 4, 5	45	34	8.2	4.0
<i>R.e. concolor</i>	11	2.5	37	38	6.0	2.0
<i>M. musculus</i>	1	6	22	45	5.0	0.8

TABLE 2.  
*Length of head-and-body, by 25 mm. groups.*

Length (mm.).	B. bengalensis.		R. norv.	R. rat.	R. e. concolor.		M. mus.
	♂	♀			♂	♀	
50—74	0	0	0	0	0	0	53
75—	0	0	0	0	12	17	46
100—	2	1	0	5	70	74	1
125—	8	5	6	28	18	10	0
150—	6	7	17	47	0	0	0
175—	16	28	26	19	0	0	0
200—	32	43	47	1	0	0	0
225—	29	16	3	0	0	0	0
250—	5	0*	1	0	0	0	0
275—299	1	0	0	0	0	0	0
Range	112—290	115—260	130—250	114—200	82—140	82—145	60—100
Mean	207	202	190	158	113	109	77
No. of specimens	391	336	98	154	414	493	80

\*See text.

TABLE 3.  
*Length of head-and-body, in the smaller species, by 10 mm. groups.*

Length (mm.).	R. rattus.	R. e. concolor.		M. mus.
		♂	♀	
60—69	0	0	0	17
70—	0	0	0	49
80—	0	3	3	20
90—	0	9	14	13
100—	0	24	30	1
110—	3	35	36	0
120—	5	21	15	0
130—	9	7	2	0
140—149	16	1	1	0
150 and over	67	0	0	0

TABLE 4.  
*Length of tail, given as percentage of head-and-body.*

Percentage.	B. bengalensis.		R. norv.	R. rat.	R. e. concolor.		M. mus.
	♂	♀			♂	♀	
60—69	1	1	0	0	0	0	0
70—	32	27	1	0	0	0	0
80— . .	56	60	39	0	0	0*	0
90— . .	10	13	35	3	1	1	13
100— . .	0	0	20	28	18	15	24
110— . .	0	0	4	36	40	38	41
120— . .	0	0	1	27	33	33	16
130— . .	0	0	0	6	7	10	5
140—149 . .	0	0	0	0	1	2	0
Range	68—96	69—99	72—125	90—153	93—143	87—143	92—137
Mean . .	82	83	95	115	117	119	113
No. of specimens	319	303	80	121	359	435	75

\*See text.

TABLE 5.  
*Length of hind-foot by 2 and 4 mm. groups.*

Length (mm.).	B. bengalensis.		R. norv.	R. rat.	R. e. concolor.		M. mus.
	♂	♀			♂	♀	
12—13 .	}	0	0	0	0	0	3
14—15 .							
16—17 . .	}	0	0	0	0	0*	50
18—19 .							
20—21 .	}	0	0	1	10	13	11
22—23 .							
24—25 . .	}	2	1	2	3	33	19
26—27 . .							
28—31 .	7	3	2	49	0	0	0
32—35 .	15	30	13	44	0	0	0
36—39 . .	51	64	37	3	0	0	0
40—43 . .	25	3	41	0	0	0	0
44—47 . .	1	0	5	0	0	0	0
Range .	24—44	25—42	25—46	21—37	20—30	16—27	13—23
Mean	37	36	38	31	23	23	17
No. of specimens	391	336	98	154	414	493	80

\* See text.

TABLE 6.

*Body-weight by 50 and 100 gm. groups.*

Weight (gm.).	B. bengalensis.		R. norv.	R. rat.	R. e. concolor.		M. mus.
	♂	♀			♂	♀	
0—49	} 10	5	10	9	85	91	100
50—					35	15	9
100—	} 16	17	33	55	0	0	0
150—199					5	0	0
200—299	18	33	44	0	0	0	0
300—	20	37	13	0	0	0	0
400—	22	7	0	0	0	0	0
500—	12	1	0	0	0	0	0
600—699	3	0	0	0	0	0	0
<hr/>							
Range	40—650	55—560	42—375	40—190	12—71	15—71	8—27
Mean	326	279	214	104	39	38	15
No. of specimens	391	336	98	154	414	493	80

TABLE 7.

*Body-weight, in the small species, by 5 and 10 gm. groups.*

Weight (gm.).	R. e. concolor.		M. mus.
	♂	♀	
5—9	0	0	8
10—14	} 3	3	47
15—19			
20—24	} 16	13	8
25—29			
30—39	30	39	0
40—49	36	36	0
50—59	13	7	0
60 and over	2	1	0



## SYSTEMATIC POSITION OF THREE SPECIES OF PALÆMONID PRAWNS FROM THE PHILIPPINES AND CHINA.

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This short note deals with the systematic position of three species of palæmonid prawns, two described by Blanco from the Philippines and one by Yü from Yunnan. Blanco's two species, *Palaemon luzonensis* and *P. lagdaoensis*, are referable to the genus *Leander* (Desm.), whereas Yü's *P. yunnanensis* is identical with de Man's *P. hendersoni*. These conclusions are elucidated in the following systematic accounts of the species.

### ***Leander luzonensis* (Blanco).**

1938. *Palaemon luzonensis*, Blanco, *Philippine J. Sci.* LXVII, pp. 201-203, pl. i, figs. 1-11.

Blanco, while giving the diagnostic features of *Palaemon luzonensis*, refers to the absence of a hepatic spine and the presence of a branchiostegal spine. His figure also shows only a branchiostegal spine in the usual position. This species is, therefore, referable to the genus *Leander* (Desm.) as defined by Stimpson<sup>1</sup> (p. 40). Its estuarine habitat also lends support to its being a *Leander*. Unfortunately, I have not examined any specimens of this species, but Blanco's description and figures, although not quite complete in certain details, are adequate for its correct diagnosis.

This species comes under the 'Styliferus' group of Leanders, since it possesses a dorsal crest on the rostrum<sup>2</sup>. Its closest allies appear to be *L. annandeli* Kemp<sup>3</sup>, *L. tenuipes* Henderson<sup>4</sup> and *L. hastatus* Aurivillius<sup>5</sup>, and in some respects it is an intermediate form between *L. annandeli* and the above mentioned two species. From *L. hastatus* it differs in the presence of lesser number of teeth on the dorsal crest of the rostrum and in having four to five teeth on the carapace, against one in *hastatus*.

*L. luzonensis* differs from *L. tenuipes* in the following characters:—

1. *Rostrum*.—Rostrum appears to be somewhat shorter than in *L. tenuipes*. The number of teeth on the carapace is larger (four to five) than in *L. tenuipes* (two to four).

2. *Eyes*.—There is a well marked ocellus in the eye of *L. luzonensis*. Kemp (*op. cit.*) did not notice any visible ocellus in the case of *L. tenuipes*.

<sup>1</sup> Stimpson, W., *Proc. Acad. Nat. Sci. Philadelphia*, pp. 22-47 (1860).

<sup>2</sup> Kemp, S., *Rec. Ind. Mus.* XIII, pp. 203-231, pl. viii-x (1917).

<sup>3</sup> Kemp, S., *ibid.*, pp. 211-213.

<sup>4</sup> Henderson, J. R., *Trans. Linn. Soc., Zool.* (2), V, p. 440, pl. xl, figs. 14, 15, (1893); also Kemp, S., *loc. cit.*, pp. 206-210, pl. viii, fig. 1.

<sup>5</sup> Aurivillius, C., *Bihang till K. Svenska Vet.-Akad. Handl.* XLIV afd. iv., no. 1, p. 27, pl. iv, figs. 3-6 (1898).

3. *Antennule*.—The lateral spine on the basal segment of the peduncle is well developed in *L. luzonensis*, while it is 'very inconspicuous' in *L. tenuipes*. The shorter branch of the flagellum is *unsegmented* in *luzonensis* whereas it is *segmented* in *tenuipes*.

4. *Second pair of peraeopods*.—In the structure of the second pair of peraeopods, *L. luzonensis* appears to be more allied to *hastatus*, for, in the latter, fingers are less than twice the length of palm. The following are the proportions of various segments of second leg in *L. luzonensis* (after Blanco) and *L. tenuipes* (after Kemp) :—

	<i>L. luzonensis.</i>	<i>L. tenuipes.</i>
Finger	1.75 times as long as palm	About 2.0 times as long as palm in females; a trifle longer in males.
Carpus	2.66 in merus	4.0 in merus in males; 3.2 in females.

5. *Third, fourth and fifth pairs of peraeopods*.—As in *L. tenuipes*, the peraeopods are long and slender, the fifth being the longest. In *tenuipes* the dactyli are very long and slender, being twice as long as the propodus and much longer than the combined length of carapace and rostrum in the fifth peraeopod. In *L. luzonensis*, on the other hand, the dactylus is only slightly longer than propodus and considerably shorter than the combined length of carapace and rostrum. This condition of posterior peraeopods resembles that in *L. hastatus*. In *L. luzonensis*, however, these segments are more slender and somewhat longer. In *L. annandeli*, the third pair of peraeopods is normal, the fourth shows an increase in the length of propodus and dactylus, and in the fifth both the propodus and dactylus are still longer and more slender. This condition of the posterior three pairs of peraeopods in *L. luzonensis* is, thus, intermediate between that in *L. annandeli* and *L. tenuipes*.

6. *Pleopods*.—In *L. tenuipes* the pleopods are very long, the first being one and a half times as long as carapace. In *L. luzonensis* although the pleopods appear to be long, they are proportionately shorter than in *L. tenuipes*.

7. *Abdominal somites*.—It appears from Blanco's figure (Pl. I, fig. 1) that the pleura are rather shallow. The shape of the second abdominal somite appears to be somewhat different.

8. *L. luzonensis*, although very closely allied to *L. tenuipes*, possesses certain distinctive features which justify its retention as a distinct species. The discovery of this species which serves as a connecting link between the Chinese *L. annandeli* and Indian *L. tenuipes*, is very interesting, for it demonstrates how a form like *L. tenuipes* with peculiar propodites and dactyli of posterior three pairs of peraeopods, could be derived from normal ancestors.

*Distribution*.—*L. tenuipes* is widely distributed along the West and East coast of India, and along the Burma Coast. *L. luzonensis* was recorded by Blanco from the estuarine waters of the Luzon Island in the Philippines. *L. annandeli* was described by Kemp from Shanghai.

**Leander lagdaoensis** (Blanco).

1939. *Palaemon lagdaoensis*, Blanco, *Philippine J. Sci.* LXIX, pp. 17, 168, pl. I, figs. 1-6.

Blanco's *Palaemon lagdaoensis* is a *Leander*, for it possesses a branchio-tegal spine and inhabits estuaries. In the dentition of the rostrum and the structure of the second pair of peraeopods it appears to be closely allied to *Leander concinnus* (Dana) from Fiji Islands, and *L. potitinga* Ortman from Brazil. In the absence of any specimen for examination and relying only on description and figures given by Blanco, I am unable to comment upon the specific identity of this species in relation to earlier known forms.

**Palaemon hendersoni** deMan.

1907. *Palaemon* (*Parapalaemon*?) *hendersoni*, deMan, *Trans. Linn. Soc. Zool.* (2), IX, p. 446, pl. xxxiii, figs. 66-68.

1910. *Bithynis* (*Parapalaemon*) *hendersoni*, Rathbun, *Bull. Mus. comp. Zool. Harvard* LII, p. 316, pl. v, fig. 3.

1913. *Palaemon hendersoni*, Kemp, *Rec. Ind. Mus.* VIII, pp. 303-305, pl. xix, figs. 19-23.

1918. *Palaemon hendersoni*, Kemp, *Rec. Ind. Mus.* XIV, pp. 95, 96.

1936. *Palaemon yunnanensis*, Yü, *Bull. Fan Mem. Inst. Biol., Peiping* VI, pp. 308-311, figs. 3, 4.

The species described by Yü from the Yunnan Province in South China agrees in almost all details with the description of *Palaemon hendersoni* deMan, redescribed by Kemp (1913) from Abor region in Assam. The only character in which Yü's examples differ from those collected in the Abor country is the length of the dactylus which is a trifle longer than palm in the Assamese examples. In this character, however, the Chinese examples appear to agree with those described by Rathbun from Gotkeik gorge, on the border of southern Shan States in Burma, as also with deMan's original examples from Darjeeling. As such differences are within the range of variation of a species, I am definitely of the opinion that Yü's *Palaemon yunnanensis* is referable to *P. hendersoni* deMan.

*Distribution.*—*P. hendersoni* is recorded from Darjeeling (deMan), Abor country in Assam (Kemp, 1913), Yawngghwe State in Burma (Kemp, 1918) and Gotkeik gorge on the border of North Shan States, Burma (Rathbun). Extension of its range to Yunnan district of China is very interesting from the zoo-geographical point of view. In the un-named collection of Palaemons in the Zoological Survey of India, there is a large series of specimens of this species from different localities in Burma, Assam, Bengal, Eastern Himalayas and the Satpura-Vindhya trend of mountains in Bihar, the United Provinces and the Central Provinces

The range of distribution of this species fits in with Hora's<sup>1</sup> concept of the origin and migration of hill stream fish fauna of India. *P. hendersoni* is exclusively a hill-stream prawn, and its distribution is governed, in general, by factors affecting the distribution of other aquatic animals inhabiting hill-streams. In the course of my examination of a large number of examples of this species from different localities in India and Burma, I have noticed interesting variations in the form and dentition of the rostrum which appear to be correlated with variations in habitats and geographical distribution.

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<sup>1</sup>Hora, S. L., *Proc. Nat. Inst. Sci. India* X, pp. 423-434 (1944).

ON HERMIT-CRABS (FAMILY PAGURIDAE) IN THE COLLECTION OF THE INDIAN MUSEUM.

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This short note deals with a small collection of the Hermit-crabs preserved in the collection of the Zoological Survey of India. Besides descriptive notes on some known forms, one new genus based on the characters of a female, and one new variety have been described.

My very sincere thanks are due to Dr. S. L. Hora, Director, Zoological Survey of India, for placing the material at my disposal, to Dr. B. N. Chopra, Deputy Fisheries Development Adviser to the Government of India, for his kindness in critically examining my material and checking my identifications, to Dr. B. S. Chauhan, Assistant Superintendent, for his encouragement and help and to Mr. K. K. Tiwari, Assistant Zoologist, also for his willing help.

Family PAGURIDAE.

Sub-family PAGURINAE.

**Paguropsis typicus** (Henderson).

1888. *Paguropsis typicus*, Henderson, *Challenger Anomura*, p. 99.  
1899. *Chloenopagurus andersoni*, Alcock, *Journ. As. Soc. Bengal* LXVIII, p. 115.  
1905. *Paguropsis typica*, Alcock, *Cat. Indian Dec. Crust.* Part II, p. 414.  
1943. *Paguropsis typica*, Thompson, *Sci. Rep. John Murray Exped.* VII, No. 5, p. 414.

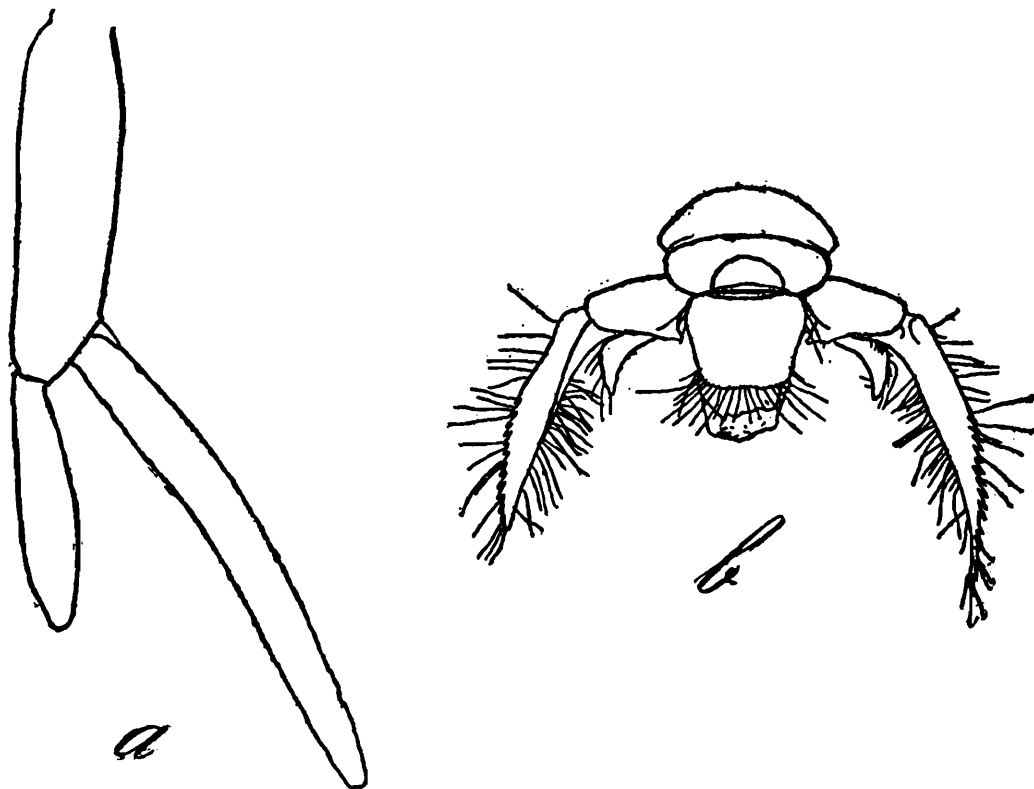
The genus *Paguropsis*, containing only one species, was described by Henderson. Since then it has been revised by Alcock (*op. cit.*) and its range of distribution extended by Thompson (*op. cit.*) to Zanzibar.

After a critical examination of a large series of this species preserved in the Zoological Survey of India, the following remarks are added to supplement the descriptions already published.

Only in females and young males, the antennal acicle is shorter than the eye-stalks. In medium-sized males, the antennal acicle is as long as, and in very large-sized males from Waltair, stout and distinctly longer than the eye-stalks. The size of the antennal peduncle also varies with age. In females and young males it is only one-fourth as long as the antennular peduncle, in older males half as long and in large-sized males it is three fourths as long as the antennular peduncle.

The form and structure of the abdominal appendages of the males differ from those given in the earlier descriptions; the first two segments of the abdomen carry a pair of uniramous appendages each. The segments three to five carry only one appendage, either on the right or on

the left side, but out of the 205 specimens examined, 163 carry it on the right side. These appendages according to Henderson (1888) and Alcock (1899) are uniramous, but on examining them under binoculars, I find them to be biramous (Text-fig. 1a), although the endopodite is rudimentary. The tail fan in the males is symmetrical but in the females the ramus of the uropod on the side bearing pleopods is longer than on the other side (Text-fig. 1b).



TEXT-FIG. 1.—*Paguropsis typicus* Henderson. a. Pleopod of male :  $\times 14$ ; b. Uropod of female :  $\times 62$ .

In the rest of the characters the specimens agree with the descriptions of Henderson and Alcock.

*Distribution.*—*Paguropsis typicus* has been recorded from the Philippine Islands (Henderson), Gulf of Martban and Cape Comorin (Alcock) and Zanzibar (Thompson). The specimens from Waltair Coast examined by me come within this range.

#### ***Diogenes custos* var. *waltairensis*, nov.**

The following description of this new variety of *Diogenes custos* is based on two examples collected at Waltair (Text-fig. 2d):

The carapace is almost as long as broad. The cervical groove is deep; the portion anterior to it is octagonal, and the lateral sides are straight. The surface is irregularly ridged with ridges of various sizes. The posterior margins of the carapace are rounded. The rostrum is prominent extending up to the base of the eye-stalks and is slightly longer than the ophthalmic scales. The antennal angles are prominent from where the frontal border of the carapace runs outwards and backwards and joins the sides.

The eye-stalks are long and slender, the cornea occupying one-fourth of their length. They are a little more than half the length of the anterior border of carapace and much shorter than the antennal and antennular peduncles. Ophthalmic scales are well developed and lie closely applied to the rostrum and their margins are finely serrated.

The antennular peduncles are glabrous and longer than the antennal peduncles. The antennal peduncles are hairy and the basal segment bears a stout spine on its outer anterior margin. The acicle, whose anterior margin is ciliate, is conspicuously bifurcate and its outer fork touches the base of the terminal peduncular segment. The flagellum is as long as the median length of the carapace and is uniseriably setose throughout its length.

Chelipeds are dissimilar and unequal, the left being twice as long as the right. The former is slightly shorter and stouter than the legs and less hairy than the right cheliped. The right cheliped, unlike the other appendages, is neither spinose nor tuberculose. The merus of the left cheliped is high. Its lower and outer margins are finely serrate, and just below and parallel to the upper margin there is a row of rounded granules. Carpus is longer than broad, its lower half studded with low, small granules interspersed with spines, which are less than those of the upper surface. Its upper half is granular and spinose, the upper edge possessing two rows of well defined spines. The movable finger is studded with rounded tubercles which form longitudinal rows on the upper margin.

Second and third pairs of legs are similar, being longer than the left cheliped by about half their dactylus and the second pair slightly exceeds the third pair. The upper, inner edges of merus and carpus of two pairs are beset with strong and forwardly directed spines. Their outer surfaces are uniformly granulose. The granules are small and low. The dactyli are ridged and the two upper ridges are serrate, and bear two rows of silky hairs, one on the upper and the other on the lower border while the rest of the segments are destitute of hairs.

The anterior region of the carapace and merus, are reddish-pink, the carpus of the legs and the carpus and the hand of the chelipeds are with violet patches, and the posterior three-fourths of propodus and dactylus of the legs are violet in one of the specimens. The other specimen is predominantly creamy yellow but the upper surfaces of the propodus and dactylus of the appendages are orange in colour.

The two specimens are of the same size and measurements (in millimetres) of one of them are given below :—

Greatest breadth of carapace	11.2
Median length of carapace	11.3
Length of eye-stalk (excluding cornea)	3.1
Length of antennular peduncle	7.5
Length of antennal peduncle	6.0
Anterior breadth of carapace	5.2

The following table illustrates the differences between *D. custos* *waltairensis* and other known varieties :

	<i>D. custos.</i>	<i>D. c. affinis.</i>	<i>D. c. violaceus.</i>	<i>D. c. planimanus.</i>	<i>D. c. waltairensis.</i>
<i>Eye-stalk</i>	Less than $\frac{3}{4}$ of the frontal border of carapace.	Less than $\frac{3}{4}$ of the frontal border of carapace.	Less than $\frac{3}{4}$ of the frontal border of carapace.	Less than $\frac{3}{4}$ of the frontal border of carapace.	Slightly more than half the length of the ant. border of carapace.
<i>Rostrum</i>	Reaches well beyond ophthalmic scales.	Only slightly longer than ophthalmic scales.	Only slightly longer than ophthalmic scales.	Only slightly longer than ophthalmic scales.	As long as ophthalmic scales.
<i>Antennal and Antennular peduncles.</i>	Are of equal length.	Antennular peduncle shorter than antennal peduncle.	Are of equal length.	Antennular peduncle shorter than antennal peduncle.	Antennular peduncle longer than antennal peduncle.
<i>Antennal acicle</i>	Outer fork reaches well beyond the base of the terminal joint.	Outer fork does not reach to the base of the terminal joint and indistinctly bifurcate.	Outer fork reaches well beyond the base of the terminal joint.	Outer fork reaches well beyond the base of the terminal joint.	Reaches well beyond the base of last segment and distally bifurcate.
<i>Hand</i>	Short and broad; dactylus does not make up $\frac{3}{4}$ the total length of hand. Lower edge of fixed finger sinuous.	Short and broad; dactylus does not make up $\frac{3}{4}$ the total length of hand. Lower edge of fixed finger sinuous.	Longer than broad and the fixed finger has straight lower margin.	As long as high and the fixed finger is straight.	One and a half times as broad, the tip of fixed finger turned outwards and proximal portion concave.

*Locality.*—Lawson's Bay, Waltair, 14.2.47. Caught in fishermen's nets.

*Type-specimen.*—Regd. No.C 2892/1, Zoological Survey of India, Calcutta.

### **Diogenes miles** (Henderson).

1905. *Diogenes miles*, Alcock, *Indian Mus. Dec. Crust.*, Part II, Anomura, p. 62.

Twenty specimens collected from Madras Coast and one from a *Conus* shell at Waltair, agree fairly well with the description of Alcock and are undoubtedly referable to this species.

The specimens from the Madras coast carry an exceptionally large number of eggs for their size. The abdomen of a fairly large specimen measures around 16 mm. but it carries on an average 1,200 eggs of 302 $\mu$  in diameter whereas, according to Jackson *Eupagurus bernhardus* (Leach) which is twice as large as *D. miles*, carries on an average not more than 1,600 eggs of the same size as those of *D. miles*. The pleopods are more hairy than in the typical forms and the upper surface of the abdomen on the right side is thickly setose. On the antennular peduncles and on the lower surfaces of the appendages there are, deep red, rounded spots which are absent in specimens described by Alcock. Moreover, the present specimens are not fastidious about the choice of their shells while the known specimens so far collected were found only in the shells of *Oliva*. Small fish, prawns, polychaete worms, and molluscs were found as commensals in the shell and also on the body of the crab.

The specimen from the *Conus* shell has the calcified regions of the carapace, the rostrum, the ophthalmic scales, the antennal acicle, the merus and carpus of chelipeds as well as those of the second, third and fourth pairs of legs, pink and white patches. The eye-stalks, dactyli and propodites of the chelipeds and legs are longitudinally banded with pink.

**Diogenes diogenes** (Henderson).

1905. *Diogenes miles*, Alcock, *Indian Mus. Decap. Crust.*, Part II, Anomura, p. 67.

Two specimens from Lawson's Bay, Waltair, one from *Babylonia* shell and the other from *Murex* shell are referable to this species.

The specimen from the *Babylonia* shell has the anterior region of the carapace, the ophthalmic scales, the antennal peduncles, acicles and the upper surfaces of the appendages pinkish on a light cream ground colour. The eye-stalks are longitudinally banded with pink.

The specimen from the *Murex* shell has the flagellum thickly setose throughout its length, whereas according to Alcock it is only sparsely setose at the base.

**Pagurus guttatus** de Man.

1905. *Pagurus guttatus*, Alcock, *Indian Mus. Decap. Crust.*, Part II, Anomura, p. 37.

There is a single specimen of this species in the unnamed collection.

This specimen differs from Alcock's description in the following characters :—

1. The right cheliped is twice as stout as the left and longer than it by a dactylus length. Alcock, however, mentions that the chelipeds are equal and similar in form.
2. This specimen is less hairy.
3. The left cheliped is studded with sharp acute horny spines which are numerous on the hand and the fixed finger, these being absent on the right cheliped.
4. The spur is thick and fleshy and is not very hairy. The colour of the specimen is purplish crimson.

**Neopagurus** gen. nov.

Carapace moderately elongate, broadened posteriorly, strongly calcified in front of the cervical groove and partially in the cardiac region the rest of the carapace being soft and pliable. A pair of conspicuous, brown, oval patches on the posterior part of the gastric region. Rostrum absent. Antennal projections very prominent, reaching beyond the base of the ophthalmic scales.

Abdomen well developed, spirally coiled; the terga broad, widely separated and fairly calcified.

Eye-stalks stout, fairly elongate; ophthalmic scales large and widely separated.

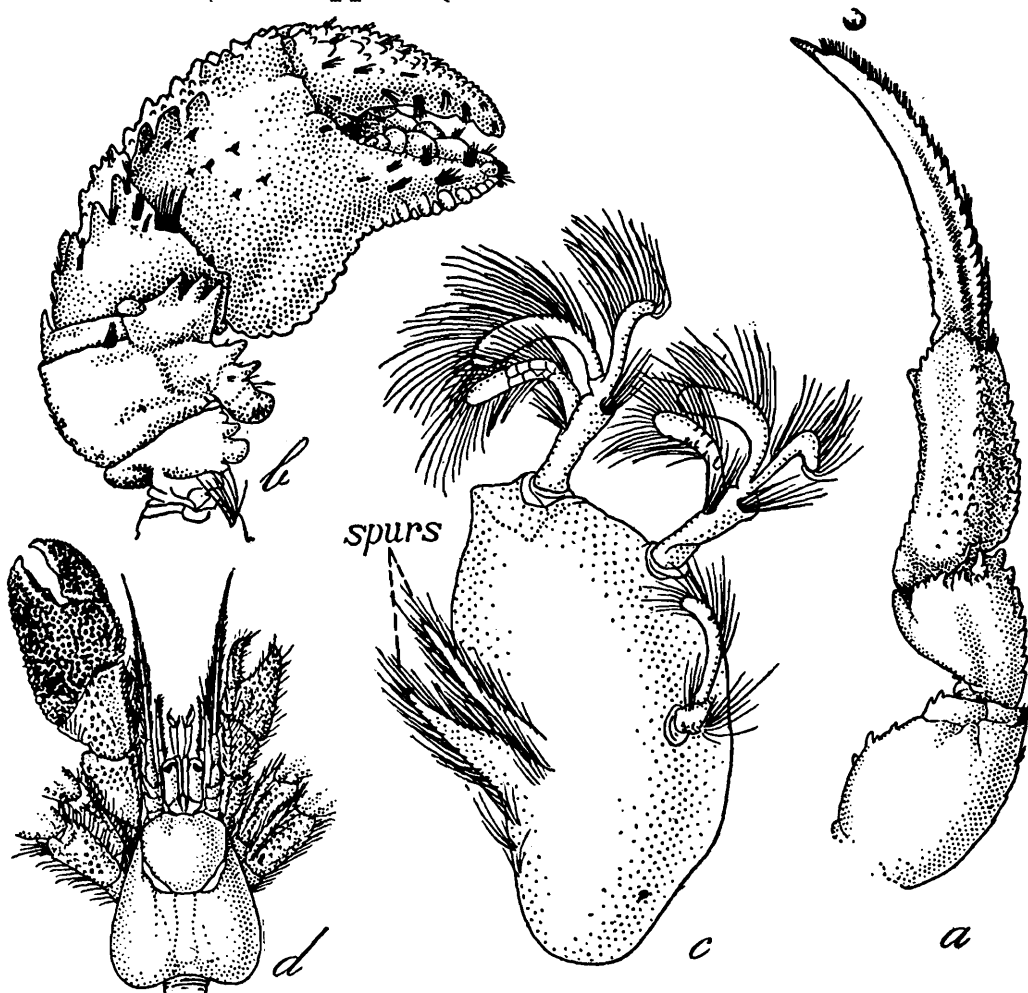
Antennules long and stout; antennae broad, antennal acicle short, the flagellum long and non-setose.

External maxillipeds approximated at base; the exopodites of all three pairs of maxillipeds with a well developed flagellum, the endopodite of the first maxillae non-flagellate.

The chelipeds dissimilar and unequal, the left being greatly the larger; finger tips blackened and articulating in a vertical plane.

Crawling legs long, those on the right side longer than those on the left, the right third leg being the longest. The fourth pair subchelate and the fifth pair chelate; both with a patch of imbricating corneous granules, near the tip on the outer surface, this patch being more prominent in the fourth pair.

The abdominal appendages four in number, excluding the tail-fan, placed on the left side on somites 2-5. First three very large, massive and triramous, the fourth minute and uniramous. *Two* soft, partly calcified *setose spurs* (Text-fig. 2c) present on the abdomen ventrolaterally; one between the second and the third appendages and the other just behind the third appendage.



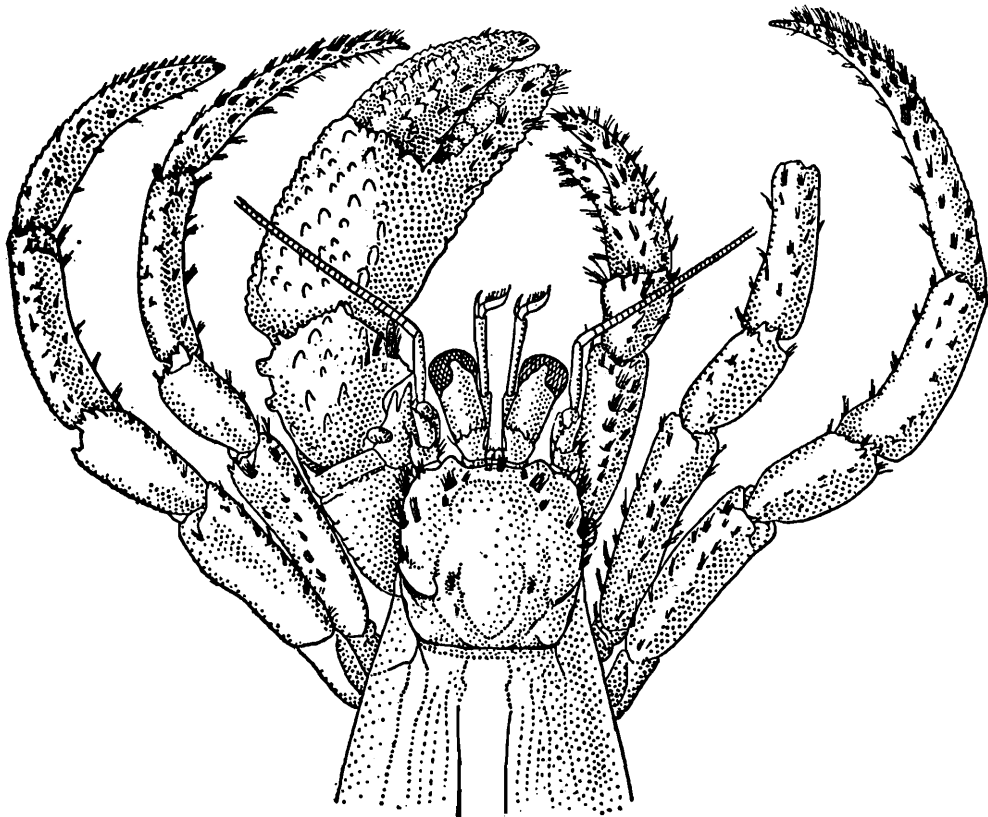
TEXT FIG. 2.—*Neopagurus horai*, gen. et sp. nov. a. Third leg:  $\times 1$ ; b. Left cheliped:  $\times 1$ ; c. abdomen:  $\times 1$ . d. Anterior region of the body of *Diogenes custos* var. *waltirensis*, nov.  $\times 1$ .

Branchiae 14 in number, phyllobranchiate, arranged as in *Pagurus*.  
*Locality*.—Unknown.

This genus is closely allied to *Pagurus* Fabr. from which it differs in having two spurs in the abdomen (Text-fig. 2c) and having the antennal acicle blunt and not elongated.

***Neopagurus horai***<sup>1</sup> gen. et sp. nov.

The following description is based on a single female holotype :



TEXT-FIG. 3.—Dorsal view of the anterior region of the body of *Neopagurus horai*, gen. et. sp. nov. ×.

Carapace is not depressed, its greatest breadth across the branchial region is less than half its length in the middle line, setose only on the antero-lateral margins.

Eye-stalks are not very depressed. They are slightly broadened distally, being half the length of the carapace, and reach little beyond the second joint of the antennular peduncle and up to two-thirds the length of the terminal joint of the antennal peduncle, and are slightly constricted in the middle. Eyes are reniform and occupy three-fourths the length of the eye-stalk. Ophthalmic scales are broad, three-edged, upper edge being serrate at the tip.

Antennal acicle is truncated. It just touches the base of the terminal joint of the antennal peduncle and possesses two spines and setae.

Except in the terminal joints, the legs and chelipeds are sparsely setose. The left cheliped, which is about one and three quarters of the median dorsal length of the carapace, is vastly the larger. The lower border of the merus is elate and strongly and irregularly serrate. The elation is divided into an anterior and a posterior portion. The former

<sup>1</sup> Named after Dr. S. L. Hora, Director, Zoological Survey of India.

is tridentate and the latter is also tridentate but in the former all the teeth are of the same size while in the latter the posterior tooth is highly enlarged and has a truncated tip. Wrist has the upper and outer surface beset with strong teeth of which those along the inner border are the largest. The hand is short and deep. In addition to a row of sharp teeth along the inner border, it bears two raised longitudinal rows of tubercles along its upper surface. Its lower border is well defined and crenulate, but the lower part of its outer surface is smooth. The dactylus (Text-fig. 2 *b*) is beset with rounded, smooth tubercles and its inner upper edge which is not crested, is marked by straight row of uniform tubercles. There are a few tufts of setae on the inner anterior surface of the carpus, the propodite and the dactylus.

The legs on the right side are longer than these on the left and reach well beyond the larger cheliped, the third pair being longer than the second.

The anterior border of the merus is spinose. The upper surfaces of the propodites are beset with tubercles. The dactylus has a single continuous row of spines on its outer border in the third left leg, in the rest of the legs this row is broken. The inner and upper surfaces of the dactyli are beset with setae, arising in groups.

The animal is uniformly cream-yellow in colour, except for the membranous region of the carapace, the abdominal terga and the setae, which are brown in colour.

The measurements (in millimetres) of the specimen are given below :—

1. Median length of gastric region of carapace	41.9
2. Median length of posterior part of carapace	. 31.8
3. Anterior breadth of carapace	. 18.9
4. Length of eye-stalk	8.2
5. Length of antennal peduncle	15.3
6. Length of antennular peduncle	. . 14.2

*Type-specimen*.—One female. Regd. No. C 2896/1, Zoological Survey of India, Calcutta.

*Locality*.—Unknown.

*Neopagurus horai* is closely allied to *Pagurus deformis* M-Edw., from which, besides the two spurs on the abdomen, it can be distinguished by the following characters :—

1. The inner edge of the upper surface of the dactylus of the left cheliped does not form an upstanding crenulated crest.
2. In the male, the whole of the dactylus is beset with very well formed granules.
3. The thin, sharp, finely-crenulated, *overhanging crest* on *outer edge* of the *upper surface* of the *third leg* is *absent*. (Text-fig. 2 *a*).
4. The antennal acicle has a truncated tip and is very short, reaching only up to the base of the terminal peduncular joint.

**Neopagurus** sp.

A single male specimen from South Seas, bearing the number 1289 in the register of the Zoological Survey of India, and labelled as "*Pagurus* M-Edw." is undoubtedly referable to the genus *Neopagurus*, since it possesses the *two spurs* on the abdomen, characteristic of this genus.

This specimen differs from the female, described above, in some respects and it is not sure whether the differences are due to sexual dimorphism or they are specific in nature. The following are the characters in which this specimen differs from the female of *Neopagurus horai* :—

1. The eye-stalks are surrounded by a whitish thickening in the middle.
2. The terminal joint of the antennal peduncle possesses two spine only and no setae.
3. The teeth on the upper outer surface of the wrist are larger and more numerous than in the female.
4. The hand does not possess two raised longitudinal rows of tubercles along its upper surface. The tubercles are more pronounced and numerous and are irregularly scattered, even in the lower part of the outer surface. The setae are more numerous than in the female.

The measurements (in millimetres) of the male specimen are given below :—

1. Median length of gastric region of carapace	48.3
2. Median breadth of gastric region of carapace	41.3
3. Anterior breadth of carapace	25.1
4. Length of antennal peduncle	19.2
5. Length of antennular peduncle	16.9

It differs from *Pagurus gemmatus* M-Edw. in *lacking* the strong *crenulated crest* on the *propodite* of the *third leg* and in having *two spurs* on the abdomen.

Until more material of *Neopagurus horai* is available for examination, I defer assigning any specific name to this specimen.



# ON A FEW LEPTOCEPHALI FROM THE TRIVANDRUM COAST

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(Plate X)

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## INTRODUCTION.

While engaged on a study of the larval and post-larval fishes of the Trivandrum Coast, a number of Leptocephali were obtained in tow-nets and close-meshed seines. On most occasions, these were brought to the laboratory either dead or about to die, and it had not been possible to rear them in aquaria and study their metamorphosis with a view to correlating them to their species. On one occasion, a few were obtained alive, but they succumbed soon after arrival in the laboratory, probably, owing to the imperfect handling at the time of capture.

The collection represents six different types of Leptocephali including those of *Congrellus anago* Schleg. previously described by the author (Gopinath, 1946) and *Muraenesox cinereus* described from Madras by Nair (1947). The other four types, even though they could be described under new specific names according to the definition of Lea (1913), are provisionally denoted by letters A, C, E and F, since studies are being continued and it is hoped to identify them on some future occasion.

## EARLIER LITERATURE ON INDO-PACIFIC LEPTOCEPHALI.

The complete biology and life history of most of the European and American eels are known, while practically very little has been worked out regarding the development and life history of Indo-Pacific forms. Probably the earliest work on any such subject is the description by Cantor (1850) of *Leptocephalus dentex* taken from the stomach of a specimen of *Johnius diacanthus* at Penang. Kaup (1856), cataloguing the Apodal fishes in the British Museum, described *Leptocephalus acuticaulatus* and *L. dussumieri* collected from the Malabar coast, *L. taenia* Lesson from India and Maldives and lastly *L. marginatus* from Pondicherry. *L. lineo-punctatus* described by him was also considered to

have an Indian origin. Bleeker (1864) described from the Indo-Pacific region *L. ceramensis*, *L. taenoides* and *L. hypselosoma*; the last species he originally included under the generic name *Leptocephalichthys*. *L. taenia*, *L. marginatus* and *L. lineo-punctatus* of Kaup were grouped together by Günther (1870) under much elongated forms which appear to have been collected from the surface of open ocean. The adult eels to which they belong are not known, but Grassi and Calandruccio (1892) suggested that *L. taenia* is probably the larva of *Spagebranchus*. Giglioli and Issel in their report on the voyage of "Magenta", cited by Cunningham 1895, record the capture of some beautiful Leptocephali from off the coast of Java, and Stromman (1896) described *L. scheelei* and *L. javanicus* collected by Capt. von Scheele from the Indo-Malayan region in 1885. From the collection of Siboga Expedition, Weber (1913) described nine forms of Leptocephali including four new forms, *L. indicus*, *L. peterseni*, *L. schmidtii* and *L. hjorti*. Southwell and Prashad (1919) described two Leptocephali, *L. milnei* and *L. vermicularis* from the brackish waters of the Gangetic delta, and of these, the latter is obviously the elver stage of the former as seen from the similarity in the number of myotomes and other details. Schmidt (1924) described two Leptocephali of *Anguilla mauritania* taken from off Celebes by the Albatross during the Philippine Expedition 1907-1910, and subsequently recorded the larvae of *Anguilla bicolor* and *A. elphinstoni* from the west coast of Sumatra. Seven types of eel eggs, their embryonic forms and two or three advanced Leptocephali have been described by Delsman (1933), and although their exact identities are not given, he suggested that at least two larvae with serial pigment spots along the gut belonged to the Ophichthid group, viz., one to *Ophichthys macrochir* and another to *Pisodonophis bcro*, while a third larva with two thickenings along its gut, he suggested, probably belonged to the Nettastomid *Venetica procera*. Deraniyagala (1934) also described nine interesting forms of Leptocephali from the Ceylon Pearl Banks and the Wadge Bank, off Cape Comorin. In revising the types of Leptocephali kept in the Upsala Museum and described by Stromman, Bertin (1936) suggested that *L. ekmani* of Stromman is synonymous with *L. taenia* Kaup and that *L. scheelei* is identical with *L. taenia* described by Weber, both differing only in their length and age and that this probably belonged to *Ophisoma anago* Schleg. The exact identity of *L. javanicus*, Bertin said, could not be established. Aiyar, Unny and Varkey (1944) described a collection of eel eggs and some Leptocephali from the Madras plankton, and in their rearing experiments one Leptocephalus was found to metamorphose into *Muraenesox cinereus*. Another one was suggested to belong to *Ophichthys boro* from a comparative study of the myotome count of the Leptocephalus, elver and adult. A number of Leptocephali along with a few elvers were collected from the Trivandrum coast, and from a comparative study of the myotomes and other details of the Leptocephalus and the elver, the author (1946) provisionally described it as that of *Congrellus anago*. Nair (1946) gave a short description of the Leptocephalus of *Uroconger lepturus* obtained from Madras, and the same author (1947) described the complete metamorphosis of the Leptocephali of *Muraenesox cinereus* and *Muraena macrura* obtained from the Madras plankton.

These probably constitute all that has so far been done regarding *Leptocephali* of the Indo-Pacific region, and with the exception of Kaup's description of a few *Leptocephali* from Malabar and Maldives, there is no further record of any *Leptocephali* from the west coast.

## LEPTOCEPHALI FROM TRIVANDRUM COAST.

*Leptocephalis* A.

Year.	Month.	Number collected.	Length.
1944	January	4	72--99 mm.
1945	January and February	13	68--93 mm.
1946	January	4	68--97 mm.

The transparent larva is moderately long and slightly thick, and the body has a rather uniform height (6-8 mm.) throughout, which is contained about 10-11 times in the total length. The head is small and is contained about 19-21 times in the length. The snout is pointed and both jaws are equal in length, and gape of mouth extends to below the first quarter of the eye. There are about 22 teeth in the upper jaw and about 20 in the lower, all pointing, as in other *Leptocephalids*, towards the front. The marginal diaphanous zone is found both along the dorsal and ventral borders, and the latter is much broader than the former. There are 156 myotomes in the body of which 63 are pre-anal. The alimentary canal is looped, and between the heart region and the anal opening there are eight distinct loops. At the angle between two successive loops is a small ganglion-like swelling with a characteristic pigment concentration over it (Text-fig. 1a).

There are three to four small chromatophores on the middle of the sides of the upper jaw. Most of the myocomma bear one or two elongated and much-branching chromatophores along its middle region, below the level of the vertebral column, and these are observed to exist from the anterior end of the body to the tip of the tail, although there is no regularity in their arrangement, *i.e.*, these chromatophores are not present in every myocomma, but found only at irregular intervals of two to three or sometimes even four myotomes. Ventral to the heart there is a large chromatophore, while along the alimentary canal, dorsal to the ganglion-like swellings, there are thick groups of chromatophores which are clearly visible in fresh specimens through the transparent body wall and partially visible in preserved ones. At the region of the ganglia, externally, on the body wall are found groups of large closely arranged chromatophores. Along the post-anal part of the body, between the anal opening and the tip of the tail, are found 9-10 black patches along the side, at intervals of 9-10 myotomes. These are really composed of pigment cells placed internally below the level of the vertebral column and clearly visible in fresh specimens. The anal fin has a row of branched chromatophores along its base, the pigment cells being placed

in groups at irregular intervals along the base of the finrays. The dorsal fin is devoid of any pigment cell.

The pectoral fin fold is feeble and vestigial. Dorsal fin is imperfectly developed and is found only over a short distance in front of the tip of the tail. Only 33-35 rays could be counted in this fin, while there are 209-211 rays in the anal fin. The last few rays in both these fins are the longest, and both the fins stop some distance behind the tail the pointed tip of which projects freely out.

This species very closely resembles the *Leptocephalus* with seven sections and constrictions along the gut described by Delsman (*op. cit.*) from Labuan in Sunda Strait. But the intestine is not 'constricted' as he has put it, but is looped festoon-fashion, and at the angle formed by two loops there is a slight thickening with pigment concentrations. In Delsman's specimens there were seven such constrictions, whereas in the present specimens there are eight sectors. The position of the anus also is different in the two specimens. In the specimens described here, the anal opening is situated on the 63rd myotome, while in the Java specimen it opens below the 51st. The dark patches found along the sides of the larva between the anal opening and the tip of the tail has also not been observed by Delsman. Loops in the intestine are also observed in the figures of larvae V and VI recorded by Deranyiagala (*op. cit.*).

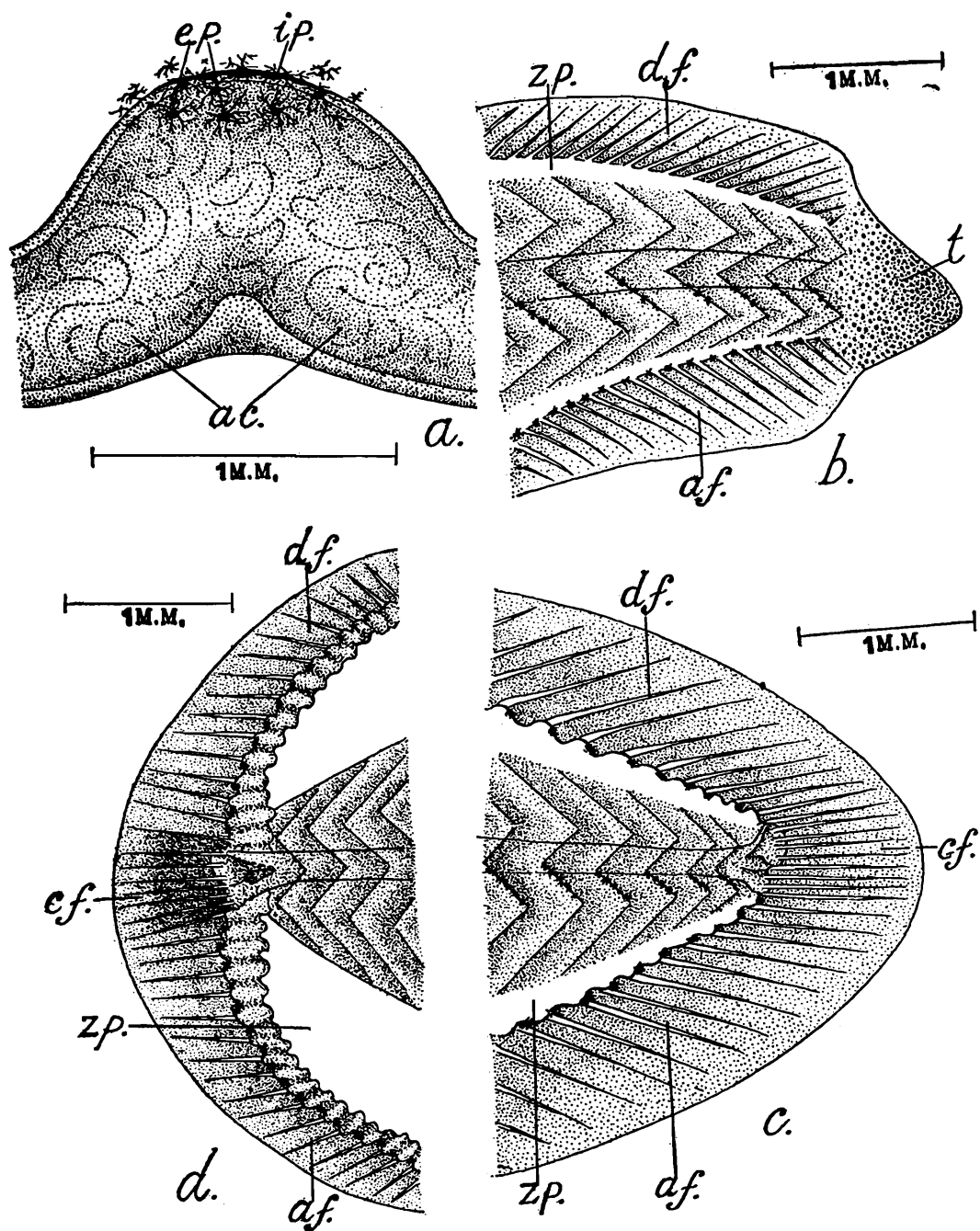
The festooned intestine and the free tail indicate that the present specimens belong to some species of the Ophichthid group, in which the free tail is a characteristic feature.

#### ***Muraenox cinereus* (Forks.).**

Year.	Month.	Number collected.	Length.
1944	January	2	68—81 mm.
1945	February	8	70—81 mm.
1946	January	1	80 mm.

This larva represents stage 1 described by Nair (*op. cit.*) and completely agrees with his description. However, the following additional characters are also worth mentioning.

The body tapers towards the head and tail, and the maximum height, which is at the region immediately in front of the anal opening, is contained about 7-8 times in the total length. The head is long and is contained about 15-17 times in the total length. Both the jaws possess teeth, there being 32 in the upper and 30 in the lower. The dorsal fin starts far in advance of the anal and possesses about 256-262 rays of which the posterior ones are much longer than the anterior ones. The anal possesses 209-212 rays, and here also the posterior rays are longer. Both these fins are continuous with the caudal fin, the rays of which are about twice the length of the posterior rays of the dorsal and anal fins, thus giving a tapering appearance to the caudal portion as a whole.



TEXT-FIG. 1.—*Leptocephali* from the Trivandrum Coast. *a*. The thickening and pigmentation between two successive loops in *Leptocephalus* A; *b*. Tail of *Leptocephalus* C; *c*. Caudal portion of the *Leptocephalus* of *Congrellus anago*; *d*. Caudal portion of *Leptocephalus* E.

*ac.*, alimentary canal; *af.*, anal fin; *cf.*, caudal fin; *df.*, dorsal fin; *ep.*, external pigment; *ip.*, internal pigment patch; *t.*, tail; *zp.*, zona pelucida.

***Leptocephalus* C.**

Year.	Month.	Number collected.	Length.
1944	February	23	73—82 mm.

This *Leptocephalus* is transparent, slightly thick and has a body which gradually tapers to the head and tail. The post-anal part is longer than the trunk, and this larva is comparatively smaller in height (5.5-3 mm.), which is contained about 24-26 times in the total length. The snout is bluntly rounded and the upper jaw is longer than the lower. The gape extends to a level beyond the posterior border of the eye, and the full set of teeth is wanting. Only about 10 teeth in the upper and 14 in the lower jaw are found, and protuberances in place of other teeth indicate that they have dropped out. The alimentary canal is rather straight, but has 8-9 distinct humps on its dorsal side. Myotomes vary from 205-206, of which 79 are pre-anal.

There are two to three chromatophores on the middle of the sides of the upper jaw. Two to three chromatophores are also found on the ventral side of the heart, and there are a few patches along the ventral border of the alimentary canal. These patches are placed close together along the anterior part, immediately behind the heart, and more distantly placed towards the posterior region. On the dorsal side of the humps along the alimentary canal and also between them, internally, are to be found patches of chromatophores of varying size, and these are very clear in fresh specimens. Viewed from the ventral side, the alimentary canal appears to possess a series of black patches along its entire length. The patch found immediately above the anal opening is rather very large and composed of complexly branching chromatophores. Along the middle of the myocomma, below the mid-lateral line, at intervals of two to three myotomes are found rows of three to four large branching chromatophores. This chromatophore arrangement is observed right up to the tip of the tail. The anal fin has a complete row of prominent chromatophores at its base, while the dorsal fin is devoid of any pigment cells.

The pectoral fin fold is developed and a few rays could be distinguished. In the dorsal fin only 98-101 rays could be clearly counted in front of the tip of the tail, while in the anal fin there are 315-317 rays. The posterior rays of both these fins are longer than the rest and these stop some distance short of the tail, which clearly protrudes out as a free pointed tip (Text-fig. 1b).

The partial loss of larval teeth, the comparatively thick body and the well developed free tail indicate that this specimen represents an advanced stage in which metamorphosis has already begun. This larva resembles to a large extent *L. kefersteini* with "seven spots composed of points along the intestine, and anus a little behind the middle of the body", described by Kaup (1860) from Messina. *Leptocephali* with serial intestinal spots have been described by Delsman also from the Java Sea. *L. kefersteini* Kaup was found to metamorphose into *Ophichthys serpens*=*Ophisurus serpens* Linn.) by Grassi and Calandruccio (*op. cit.*), while Delsman suggested that his specimens belonged to the Ophichthid group, probably to *O. macrochir* and *Pisoodonophis boro*. Thus the pigment spots along the intestine and the free pointed tail in the present specimen also suggest that this might belong to some species of the Ophichthid group.

**Congrellus anago** Schleg.

Year.	Month.	Number collected.	Length.
1941	November to February	118	116—132 mm.
1942			
1943			
1944	January	19	123—132 mm.
	February	31	
1945	January	22	145—150 mm.
	February	17	145—158 mm.
1946	February	9	138—148 mm.

This is probably the longest *Leptocephalus* represented in the present collection. It has a rather uniform height of 10-10.5 mm. throughout, and only slightly tapers to the head and tail. The head is small and is contained about 28-30 times in the total length. The snout is short and bluntly pointed, and the upper jaw is slightly longer than the lower. The gape of the mouth is oblique and extends to below the middle of the bulging and prominent eye. There are minute teeth on both jaws, those of the upper jaw being more prominent. There are 115 myotomes on the body of which 78 are pre-anal. Each intersegmental septum, along its lower half, has a row of small chromatophores arranged on it, and this arrangement is observed right up to the tip of the tail. The anal fin is placed slightly in advance of the dorsal and both are continuous with the caudal, giving the caudal region a broadly pointed appearance (Text-fig. 1c). The dorsal has 115-120 distinct rays and a number of closely placed rays at the anterior end which could not be counted, and the anal has 100-104 distinct rays and a number of indistinct rays at the anterior end. Each ray of the dorsal and anal fins carries a chromatophore at its base. The pectorals are feebly developed with a number of indistinct rays.

A number of Elvers showing some of the distinct characters of *Congrellus anago* were obtained along with the *Leptocephali* from this coast during 1941, and from a comparative study of the number of myotomes, branchiostegals and hypurals, the latter was provisionally identified as that of *Congrellus anago* Schleg. by the present writer (*op. cit.*). Bertin (1936) suggested that *L. taenia* described by Weber (*op. cit.*) from Ceram Sea and *L. scheelei* described by Stromman (*op. cit.*) from Banda Sea are in all respects the same, representing only different ages, and that this is the larva of *Ophisoma anago* (*Congrellus anago* Schleg.). *L. taenia* and *L. scheelei* resemble the present specimens in the number of myotomes, pigmentation of the fins and details of the head. But in the former two the anus opens by far behind, *viz.*, below the 103rd myotome, and the dorsal and anal fins composed of fewer rays are confined to the caudal extremity, whereas in the present specimens the anus opens below the 78th myotome and the fins are comparatively long, composed of a larger number of rays and cover about one-third the total length of the body.

**Leptocephalus E.**

Year.	Month.	Number collected.	Length.
1945	January	8	48—68 mm.

This transparent and strongly compressed *Leptocephalus* is spindle-shaped, with broadly rounded ends. It is comparatively high, and the maximum height, which is immediately behind the anal opening, is contained about  $5\frac{1}{2}$  times in the total length. The head is short and rounded, and is contained about  $21-22\frac{1}{2}$  times in the length. The snout is rounded and the upper jaw is slightly longer. The gape of the mouth extends to below the middle of the bulging eye, and both jaws possess minute larval teeth, 26 in the upper and 22 in the lower. The alimentary canal is straight and opens below the 79th myotome. The dorsal and ventral diaphanous zones are equal in breadth, and these become very broad towards the posterior region, behind the anal opening. There are 132 myotomes in the body.

Compared with the other specimens in the present collection, this one has fewer chromatophores on the body. The large elongate chromatophores found along the myocomma in most of the other species are wanting in this. In smaller specimens, a row of chromatophores is found ventral to the intestine up to the 21st myotome, and beyond that dorsal to the intestine up to the anal opening. These are, however, missing in larger specimens. A few small chromatophores are found on the nape, some at the base of the rudimentary pectoral fold and four or five in the neighbourhood of the heart. Both the dorsal and anal fins possess a row of deeply coloured chromatophores along their base,

The dorsal fin starts far in front of the anal and possesses 323 rays, whereas the latter possesses about 203 rays. Both these fins are continuous with a broadly rounded caudal (Text-fig. 1a). The pectoral fin is rudimentary and it is difficult to count the rays.

**Leptocephalus F.**

Year.	Month.	Number collected.	Length.
1946	January	1	104 mm.

This long transparent *Leptocephalus* has almost a uniform height of 7 mm. throughout. Compared with the other species, this is much smaller in height which is contained about 15 times in the total length. The head is short and bluntly pointed. Both jaws possess teeth, 24 in the upper and 22 in the lower, and are of equal length. The gape of the mouth extends to below the middle of the orbit. The intestine possesses six humps along its entire length. The marginal diaphanous zones are very narrow. The specimen had 183 myotomes of which 66 were pre-anal.

The middle of the sides of the upper and lower jaws have three to four chromatophores, and there is one very large one below the angle of the jaws. Three chromatophores, two large and one small, are found in a slanting line behind the eye. There is a group of pigment cells ventral to the heart and a few irregularly scattered groups along the ventral border of the intestine, confined especially to its anterior region. The six humps along the intestine and also the interspace between them possess a series of black patches on the dorsal surface. These patches are placed on the dorsal surface of the intestine, internally, and are visible through the transparent body wall. The last patch over the anal opening is large and composed of complexly branching chromatophores. Each myocomma along its middle portion, below the mid-lateral line, carries a row of elongated and branching chromatophores. Both the dorsal and anal fins have along their base pigment cells in groups of four or five.

The dorsal fin is short and placed very near the caudal region ; 45 rays could be counted in this, while the anal fin has 212 rays which are clearly visible. The posterior rays in both the fins are longer, and instead of being continued round the tail, stop some distance short of the tip, beyond which the free tail projects out. The pectoral fold is small with indications of a few faint rays.

*Measurements in millimetres of the Leptocephali of the Trivandrum Coast.*

Species.	A.	<i>Muraenesax cinereus</i>	C.	<i>Congrellus anago</i>	E.	F.
Number Collected	21	11	23	216	6	1
Total length	68-99	68-81	73-82	110-158	48-68	104
Length of head	3-4-5	4-5-5	3-3-4	3-5-4-5	2-3-3	3-5
L. from Snout to anus	33-47	44-54	33-34	74-102	29-46	43-5
L. from anus to tip of tail	35-62	24-27	40-48	35-56	19-22	60-5
Height without fins	6-8	9-5-10	5-5-3	10-10-5	9-12-5	7-0
Height with fins	7-8-5	10-5-11	6-5-7	10-5-11	9-5-13	7-5
Number of myotomes	156	138	206	115	132	183
Number of pre-anal myotomes	63	78	79	78	79	66

GENERAL OBSERVATIONS.

Investigations of Grassi and Calandruccio (*op. cit.*), Cunningham (1895) and Schmidt (1906, 1911) have shown that the Leptocephali of the European eels are demersal in their distribution. This has been supported by subsequent collections of Leptocephali not only from around the British Isles but also from the Atlantic. The tropical Leptocephali, on the other hand, show much variation in their distribution. *L. taenia*, *marginatus* and *lineo-punctatus* of Kaup (*op. cit.*) are suggested by Günther to belong to elongated forms collected from the surface of open ocean. Weber (*op. cit.*) collected three of his specimens from surface in tow-nets, one in estuarine waters and five from varying depths between 600—1,200 fathoms. *L. milnei* and *L. vermicularis* described by Southwell and Prashad were obtained by operating a small beam trawl in

the Doorakara area of the Gangetic delta, and therefore, may be considered to have been taken from a depth. Albatross collection of Leptocephali of *Anguilla mauritania* was made from survey over considerable depths, off Celebes. The advanced Leptocephali described by Deisman were collected along with young *Stolephorus* in a type of purse-seine net at Labuan in Sunda Strait from surface waters. The collections of Aiyar, Unny and Varkey (*op. cit.*) and Nair (*op. cit.*) were made from Madras plankton, and evidently had a surface distribution.

Along the Trivandrum coast, the Leptocephali were collected mostly in seine nets and rarely in tow-nets. Only on two occasions did tow-net collections contain any Leptocephali the species obtained being A and F. All the other specimens described in this paper were taken in seine sets. These shore seines, after being shot at a distance of about half a mile in 6-8 fathoms of water are dragged towards the shore, and are operated in any desired depth by the adjustment of floats along the head-rope and weights along the foot-rope. During January and February, when Leptocephali are caught in plenty, larvæ and post-larvæ of other teleosteans, especially Clupeids and Scopelids, are also plentiful in the coastal waters (Gopinath, 1942), and the seines are operated in slightly mid-water position at about 5-6 fathoms in order to gather the largest number of post-larvæ.

Some of the common characters observed in most of the Leptocephali are the transparent and thin body, presence of larval teeth including the front grasping teeth, presence of chromatophores along the myocomma, base of the dorsal and anal fins and lastly the pointed or rounded caudal fin with which the median fins are continuous. The number of larval teeth in the various types differs, but in all they show a regular increase in length from the posterior ones to the anterior ones. Except in species E, chromatophores are present along the myocomma in all, regularly arranged in some and at intervals in others. *Congrellus anago*, E and F have chromatophores along the base of the dorsal as well as anal fins, whereas in A, *Muraenesox cinereus* and C, these are present only along the anal fin. The intestine is straight in *M. cinereus*, *C. anago* and E, while it has humps along its dorsal side in C and F. In A, it is looped with eight distinct loops and ganglion-like swellings on the dorsal side.

Schmidt (1912) suggested the division of eels into two groups, *viz.*, those which spawn over great depths and those which spawn in comparatively shallow waters inside the 100-fathom line. Those which spawn far from the coast are supposed to have a specialised larva, while those which spawn in shallow waters have not. A Leptocephalus with anus situated far back is considered as a specialised larva since it leads a longer larval life and takes a longer time for its anus to assume the normal position. Bertin (1926) suggested a formula for this anal movement as  $\frac{a^2 - a^1 \times 100}{t}$  in which  $a^2$  is the number of pre-anal myotomes

in the Leptocephalus,  $a^1$  the number of pre-anal myotomes in the adult and  $t$ , the total number of myotomes, and called this "the percentage amplitude of anal displacement". Those species which show a high percentage amplitude value indicate that the anus moves over a larger number of myomeres and *vice versa*, and the value of the amplitude always depends on the position of the anus in the Leptocephalus.

On this basis, a rough calculation of the percentage amplitude for the six species in the present collection shows that there are two distinct groups, one with a high percentage amplitude value consisting of *M. cinereus*, *C. anago* and E, and another group with a low percentage value consisting of A, C and F. Probably the first group of *M. cinereus*, *C. anago* and E may belong to eels which spawn far from the coast, while A, C and F might belong to species which spawn in shallow waters.

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#### SUMMARY.

1. Six different types of Leptocephali obtained from the Trivandrum coast are described in detail. Their seasons of occurrence are also given.
2. The probable identities of the various specimens are discussed in the light of work done on other Indo-Pacific Leptocephali.

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## EXPLANATION OF PLATE X.

## Leptocephali from the Trivandrum Coast.

FIG. 1.—*Leptocephalus* A.

FIG. 2.—*Leptocephalus* of *Muraenesox cinereus* (Forsk.)

FIG. 3.—*Leptocephalus* C.

FIG. 4.—*Leptocephalus* of *Congrellus anago* Schleg.

FIG. 5.—*Leptocephalus* E.

FIG. 6.—*Leptocephalus* F.

(All figures are approximately of natural size).



ON *PARYPHOSTOMUM HORAI* SP. NOV. (TREMATODA :  
ECHINOSTOMATIDAE), WITH A NOTE ON THE SYSTEMATIC  
POSITION OF *PARYPHOSTOMUM NOVUM* VERMA, 1936.

By S. C. BAUGH, M. Sc., *Research Scholar, Zoological Survey of India,  
Calcutta.*

In 1945, Dr. M. L. Roonwal of the Zoological Survey of India, collected at Allahabad three specimens of an Echinostome parasite from the intestine of a domestic duck, *Anas poecilorhyncha* Forster. On examination, they were found to represent a new species of the genus *Paryphostomum* Dietz, 1910 which is described below.

***Paryphostomum horai*,<sup>1</sup> sp. nov.**

The parasite is elongate with dorso-ventrally flattened body which tapers at both ends. The length of the worm is 3.05 mm. and the maximum width, in the region of ovary, 0.61 mm. Cuticle is studded on the ventral surface with broad scale-like, backwardly directed spines which are present upto the anterior testis. These spines are very closely placed upto the acetabular region but sparsely distributed posterior to it. The pre-acetabular spines are much larger and stouter than those of the post-acetabular region. They gradually decrease in size till they altogether disappear near the posterior end. The marginal spines on the body are comparatively long and blunt. They are present upto the level of acetabulum.

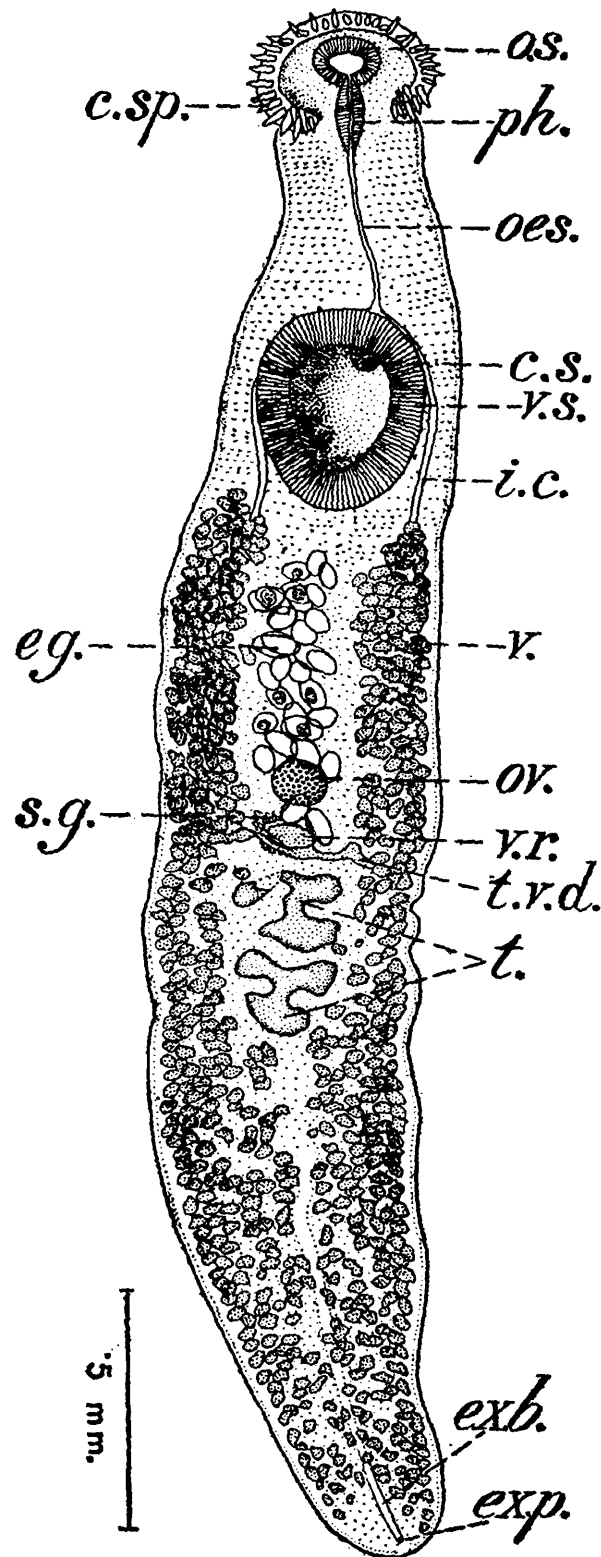
The oral collar measures 0.19 × 0.35 mm. It is incomplete ventrally and carries 39 large and strong spines. The ventro-lateral collar spines (Text-fig. 2a) are arranged in a single row but the dorsal ones show a tendency towards a double arrangement. They measure 0.03—0.05 × 0.009—0.014 mm. The end-group collar spines are five on the right side and six on the left but they are not arranged in pairs. They greatly vary in size, one of them in each group being slightly stouter and broader than others and measures 0.044—0.049 × 0.19 mm. Besides this spine, in the type specimen, there is an additional very long spine on each side near the end-group, the right one being of the same length as the left one but much broader and almost cylindrical, and lies so close to the end-group spines that it is included amongst them, while the left one is quite apart. This spine measures 0.058 × 0.014—0.019 mm. The smallest spine present in the end-groups of both sides measures 0.039 × 0.014 mm. The end-group of the left side has an extra very small spine measuring 0.029 × 0.009 mm.

The mouth is terminal and surrounded by a well developed transversely oval oral sucker measuring 0.098 × 0.137 mm. Prepharynx

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<sup>1</sup> Named in honour of Dr. S. L. Hora, Director, Zoological Survey of India.

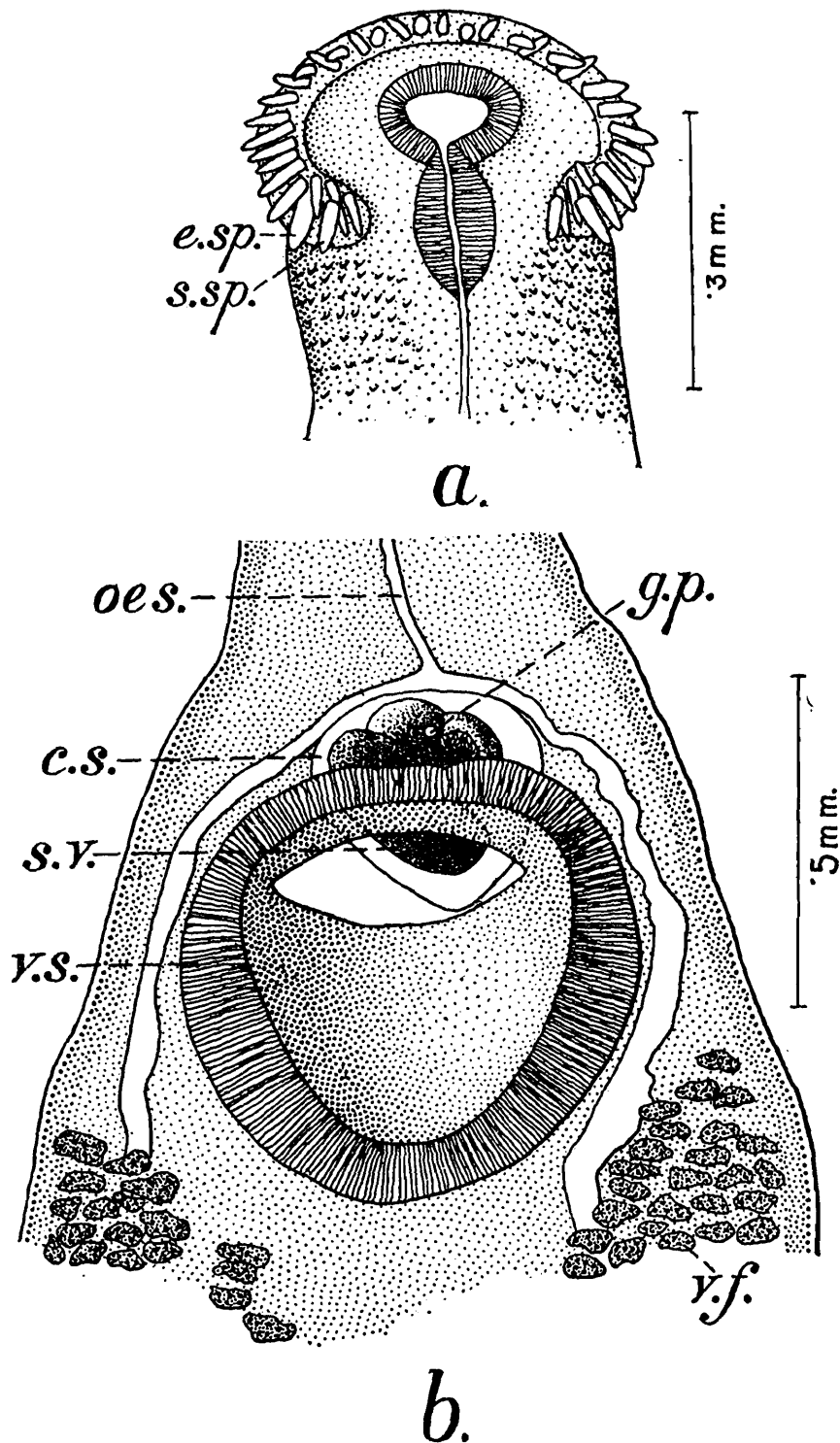
is absent. Pharynx is oval and strongly muscular measuring  $0.117 \times 0.058$  mm. Pharyngeal or oesophageal glands are absent. Oesophagus is 0.27 mm. long and bifurcates at a distance of 0.47 mm. from the anterior end. The intestinal caeca run laterally almost upto the posterior end of the body. Ventral sucker is nearly circular, much larger than



TEXT-FIG. 1.—*Paryphostomum hoari* sp. nov.; Ventral view.

*c. s.* cirrus sac; *c. sp.* collar spine; *e. sp.* extra long spine; *eg.* egg; *ex. b.* excretory bladder; *ex. p.* excretory pore; *g. p.* genital pore; *i. c.* intestinal caeca; *oes.* oesophagus; *o. s.* oral sucker; *ov.* ovary; *ph.* pharynx; *s. g.* shell gland; *s. sp.* stout spine; *s. v.* seminal vesicle; *t.* testes; *t. v. d.* transverse vitelline duct; *v.* vitellaria; *v. f.* vitelline follicle; *v. r.* vitellin reservoir; *v. s.* ventral sucker.

the oral sucker, the ratio of the two being approximately 1:3.8. It is situated at the anterior third of the body, at a distance of 0.49 mm. from the anterior end. It measures  $0.37 \times 0.33$  mm.



TEXT-FIG. 2.—*Paryphostomum horai* sp. nov.; Ventral view.

a. collar region; b. acetabular region (paratype) showing position of cirrus sac.

For explanations, see Text-fig. 1.

Testes are post-equatorial, trilobed and tandem in position. The lobes are simple and broad. The posterior testis is usually slightly larger than the anterior testis. The anterior testis measures  $0.15 \times 0.19$  mm. while the posterior one  $0.190 \times 0.21$  mm. The cirrus—sac is strongly muscular, pear-shaped and lies dorsal to the acetabulum, parallel

to the longitudinal axis of the body. Its anterior end abuts against the oesophageal arch (Text-fig. 2*b*) while its posterior end extends posteriorly over the anterior third of the acetabulum. Vesicula seminalis is well developed, occupying the major portion of the cirrus—sac and is bent on itself, thereby giving a bipartite appearance. Its proximal part is much larger and covers up a portion of the distal part. Pars prostatica is short and opens into the cirrus.

Ovary is equatorial, almost round and medially placed. It measures  $0.098 \times 0.137$  mm. Vitellaria are extra-caecal and partly inter-caecal, extending along the sides of the body from the level of the posterior border of the acetabulum upto the posterior end of the body. They merge into each other behind the posterior testis. The transverse vitelline ducts arise, on either side, at a level slightly in front of the anterior testis and open into a prominent pear-shaped yolk-reservoir lying in the mid-longitudinal line of the body. The apex of the reservoir is directed obliquely forward. The yolk-reservoir is a very characteristic feature of all these specimens. It measures  $0.117 \times 0.058$  mm. The shell-gland is situated medially just posterior to the ovary. It is almost spherical and measures  $0.078 \times 0.101$  mm. Laurer's canal is present. Receptaculum seminis is absent. The uterus is confined to the inter-caecal field in front of the testes. The uterine coils are few, containing only 30 eggs. The posterior end of the uterus passes dorsal to the acetabulum as the metraterm and opens into the genital pore. The eggs are oval, non-operculate and measure  $0.058-0.098 \times 0.039-0.058$  mm. The development of the embryo seems to precede the egg laying as there are eggs in the uterus containing multinucleated bodies. Genital pore is single, lying in the mid-longitudinal line in front of the acetabulum.

The excretory vessel is cylindrical and is seen extending upto the level of the posterior testis. The excretory pore is sub-terminal in position.

TABLE

*Important measurements of Paratype specimens, in millimetres.*

	Specimen 1.	Specimen 2.
Length	6.97	6.66
Breadth . . . . .	1.56	1.76
No. of collar spines	38	?
Collar	$0.274 \times 0.509$	$0.294 \times 0.627$
Oral sucker	$0.196 \times 0.196$	$0.137 \times 0.215$
Pharynx	$0.215 \times 0.137$	$0.235 \times 0.137$
Oesophagus	0.646	0.548
Ventral sucker	$0.705 \times 0.646$	$0.686 \times 0.725$
Ovary . . . . .	$0.196 \times 0.313$	$0.196 \times 0.509$
Anterior testis	$0.47 \times 0.50$	$0.41 \times 0.66$
Posterior testis	$0.56 \times 0.58$	$0.50 \times 0.62$
Cirrus sac	$0.254 \times 0.352$	$0.333 \times 0.352$
Shell gland	$0.235 \times 0.49$	$0.235 \times 0.45$
Yolk reservoir	$0.215 \times 0.078$	$0.235 \times 0.137$
Eggs	$0.078-0.098$ $\times 0.058$	$0.078-0.098$ $\times 0.058$
Distance of intestinal bifurcation from anterior end	1.078	0.94
Distance of ventral sucker from anterior end.	1.176	1.117
Distance between intestinal bifurcation and ventral sucker.	0.137	0.098

*Variations.*—The marked differences shown by the paratype specimens, as regards the size of the body and of various other organs, have been given in the above table. Besides this, the paratypes show some random variations in their morphological characters. The collar spines in one specimen are 38 and are arranged in a double alternate row; in the other, the dorsal spines have fallen out but the ventro-lateral spines are in a single row. In both, the number of end-group spines is 4 on each side, of which one is more prominent than others, and they are arranged in pairs. The oral sucker is round in one whereas it is transversely oval in the other. In one of the specimens, two lobes of the anterior testis are very faintly indented. In both paratype specimens, ovary is oval, just post-equatorial and dextral in position. The shell-gland is also oval. The uterus is densely coiled and packed with numerous eggs.

*Discussion.*—The parasite has branched testes, confluent vitellaria in the post-testicular region, and therefore belongs to the genus *Paryphostomum* Dietz<sup>1</sup>, 1910. Bhalerao,<sup>2</sup> 1927 created the genus *Testisaculus* with *T. indicum* as the genotype which he recorded from *Uromastix hardwickii*. Later, however, when the full account was published, he<sup>3</sup> (Bhalerao, 1931) placed this species under the genus *Paryphostomum*. Evidently his new genus is a synonym of *Paryphostomum* and in this, Bhalerao also agrees. So far only eight species (excluding *P. novum* Verma, 1936) have been assigned to this genus, viz., *P. radiatum*<sup>4</sup> (Dujardin, 1845) Dietz, 1910; Edward,<sup>5</sup> 1927; *P. segregatum* Dietz, 1910; *P. sufrartyfex* (Lane,<sup>6</sup> 1915) Bhalerao,<sup>7</sup> 1931; *P. tenuicollis* (Johnston,<sup>8</sup> 1917) Price,<sup>9</sup> 1931; *P. indicum* Bhalerao, 1931; *P. testitri-fo- lium* Gogate,<sup>10</sup> 1934; *P. pentalobum* Verma, 1936 and *P. phalacrocoracis* Goss,<sup>11</sup> 1940. The absence of a prepharynx in the author's species distinguishes it from all others excepting *sufrartyfex* which, according to Faust<sup>12</sup>, also lacks a prepharynx. It differs from others in the number of collar spines but comes close to *sufrartyfex*, in which the collar spines are 32 according to Lane, but 39-42 according to Bhalerao. The presence of a stout and prominent spine in the end-groups readily distinguishes the present species from all others but

<sup>1</sup> Dietz, E., *Zool Anz.*, Leipzig, XXXIV, pp. 180-190 (1909); *Zool. Jahrb.*, Jena, Suppl. XII, pp. 368-376 (1910).

<sup>2</sup> Bhalerao, G. D., *Proc. Indian Sci. Congr.* Cal. XIV, p. 191 (1927).

<sup>3</sup> Bhalerao, G. D., *Parasitology* XXIII, pp. 99-102 (1931).

<sup>4</sup> According to Johnston (*Trans. Roy. Soc. S. Australia* LXVI, pp. 226-242, 1943) *P. tenuicollis*, *P. testitri-fo- lium* and *P. phalacrocoracis* are synonyms of *P. radiatum* Yamashita (*Volumen Jubilare pro Prof. Yashida*, Osaka II, pp. 173-186, 1939) regards *P. radiatum* and *P. segregatum* to be synonymous. These two publications were not accessible to the writer.

<sup>5</sup> Edward, E. E., *Parasitology* XIX, pp. 245-259 (1927).

<sup>6</sup> Lane, C., *Indian J. Med. Res.* II, pp. 977-983 (1915).

<sup>7</sup> Bhalerao, G. D., *Rec. Ind. Mus.* XXXIII, pp. 475-479 (1931).

<sup>8</sup> Johnston, S. J., *J. Roy. Soc. Sydney*, N. S. W. L, p. 206 (1917).

<sup>9</sup> Price, E. W., *Proc. U. S. Nat. Mus.* LXXIX, pp. 1-13 (1931).

<sup>10</sup> Gogate, B. S., *Rec. Ind. Mus.* XXXVI, pp. 139-141 (1934).

<sup>11</sup> Goss, O. M., *J. Roy. Soc. West. Australia* XXVI, pp. 1-6 (1940).

<sup>12</sup> Faust, E. C., *Human Helminthology, Philadelphia*, pp. 181-183.

*sufrartyfex*. In the trilobed nature of the testis, it resembles *testitri-folium* but differs from it in other respects. The extent, size and position of the cirrus—sac further distinguish this species from *sufrartyfex*, *radiatum*, *testitri-folium* and *phalacrocaracis*. In the absence of a definite receptaculum seminis, it differs from *testitri-folium* and *indicum*, and in the equatorial position of ovary, from *radiatum*, *segregatum*, *testitri-folium* and *phalacrocaracis*. It further differs from *tenuicollis* in the extent of the cirrus sac and vitellaria, and also in the distinct lobation of testes. The presence of a prominent yolk-reservoir is also very characteristic of the new species.

*Type-specimen*.—No. W3755/1; *Paratypes*.—Nos. W3756 & 3757/1, Zoological Survey of India, Calcutta.

### ***Echinostomum novum* (Verma).**

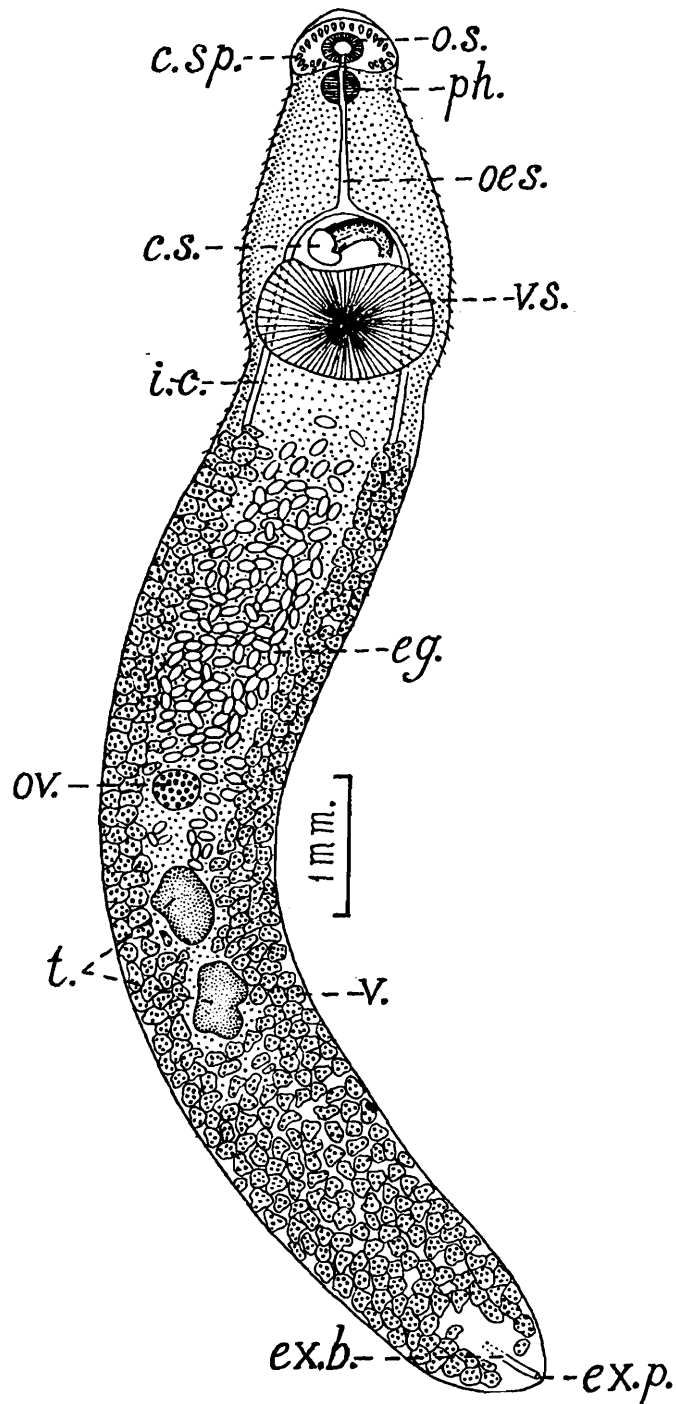
Verma,<sup>1</sup> 1936, described this species under the genus *Paryphostomum* Dietz, 1909. By the courtesy of Mr. S. C. Verma, the writer had an opportunity to examine the type specimen. Since the original account of the species by Verma does not contain any figure of his new species, a figure of the type-specimen is being provided in this paper, and as he published only a brief diagnosis, his description is supplemented as below :

The end-group spines are five on each side, the gap near the end-group spines on right side seems to indicate that a spine has fallen out. The flat scale-like spines are visible on the ventral surface only upto the acelabular region. The sharp marginal body spines are seen upto the level of ovary. The oesophagus shows a few diverticula at its posterior end (Text-fig. 4b). The testes are post-equatorial, almost equal in size; the anterior one is roughly oval with an extero-lateral protuberance on the right side, the posterior one is rather irregular with a lateral depression on the left side. They are, however, not branched. The cirrus sac (Text-fig. 4b) is a prominent structure lying transversely in the space between the intestinal arch and acetabulum. The vesicula seminalis is a voluminous structure and is full of sperms. It leads into a long and club-shaped pars prostatica into which open the prostatic cells, it is followed by the cirrus. The ovary is post-equatorial in position and oval in shape. Receptaculum seminis and Laurer's canal are present. The shell gland is seen as a diffused structure. The genital pore is, however, not clearly seen, but seems to be situated on the left side. The excretory pore is sub-terminal.

The principal character which Dietz used to distinguish the genus *Paryphostomum* from *Echinostomum* is, the strongly branched testes in the former. Besides this, the cirrus—sac is always in front of the acetabulum in the genus *Echinostomum* whereas in the genus *Paryphostomum* it extends posteriorly over the acetabulum. The testes in Verma's species are not branched, the faintly crenated appearance of the testes is, in the opinion of the writer, due to fixation. There are, however, species assigned to the genus *Echinostomum* in which the testes are faintly lobed. Since the diagnosis of the genus *Echinostomum* admits the inclusion of such species in which the testes are either entire

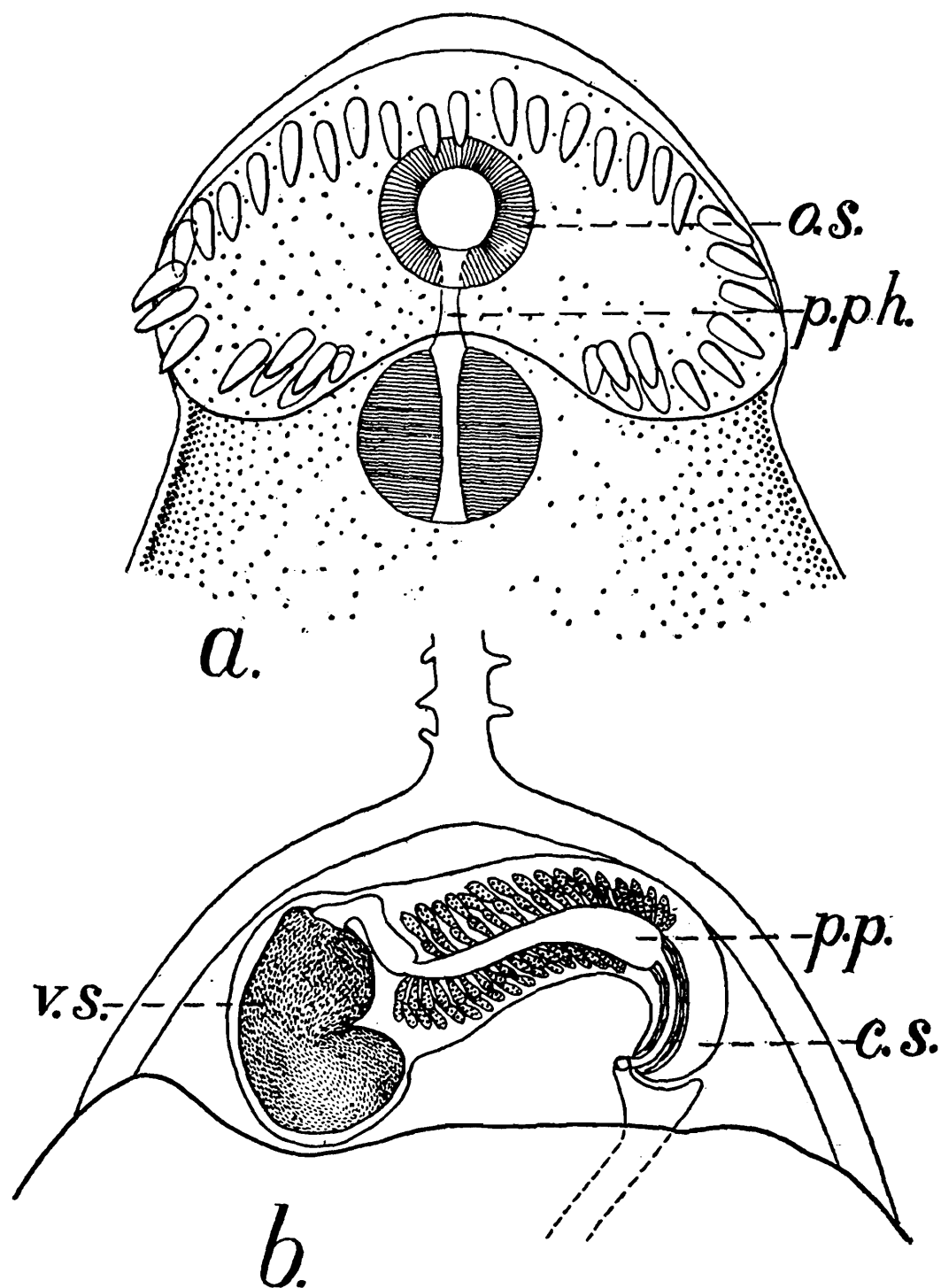
<sup>1</sup> Verma, S. C., *Allahabad Uni. Studies* XII, pp. 158-159 (1936).

or faintly lobed and the cirrus—sac lies in front of the acetabulum, the writer is of the opinion that the species *novum* Verma, 1936 should be transferred to the genus *Echinostomum*.



TEXT-FIG. 3.—*Echinostomum novum* (Verma); Ventral view.

*c. s.* cirrus sac; *c. sp.* collar spines; *eg.* egg; *ex. b.* excretory bladder; *ex. p.* excretory pore; *i. c.* intestinal caeca; *oes.* oesophagus; *o. s.* oral sucker; *ov.* ovary; *ph.* pharynx; *t.* testes; *v.* vitellaria; *v. s.* ventral sucker.



TEXT-FIG. 4.—*Echinostomum novum* (Verma); ventral view.

*a.* Anterior end showing collar spines; *b.* Acetabular region showing cirrus sac.

*c. s.* cirrus sac; *o. s.* oral sucker; *p. p.* pars prostatica; *p. ph.* prepharynx; *v. s.* vesicula seminalis.

#### ACKNOWLEDGMENTS.

My grateful thanks are due to Dr. S. L. Hora, Director, Zoological Survey of India, for getting me the type-specimen of *Paryphostomum novum* and to Dr. B. S. Chauhan for kindly going through the manuscript and giving valuable suggestions for its improvement.

# BREEDING HABITS OF BOMBAY ELASMOBRANCHS

By

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## INTRODUCTION.

The present paper is a record of an examination of gravid females of twenty species of sharks and rays from the Bombay waters, which the authors carried out during the quinquennium from 1940 to 1944. The observations, set forth in a tabulated form, are chronologically arranged and describe the various stages of gestation as well as salient features of embryonic development. As a result of these observations, it has been possible to add notes of a generalised nature on the breeding habits of these species.

Observations on more or less similar lines by such authors as Alcock (1890, 1892), Woodmason and Alcock (1891), Southwell (1910) Southwell and Prashad (1919) and Mahadevan (1940) are sketchy and scarcely contain a complete account of the life-history of even one form. These gaps are, to a considerable extent, filled by our account.

**Scoliodon palasorrah (Cuvier).**

Date of capture.	Length of parent female.	Total No. of embryos.	Length of embryos.	Remarks.
28-9-42	25"	1+2=3	112 mm.	Intermediate pregnancy; embryos enclosed in shell-membrane sacs devoid of any liquid; yolk-sac, with little yolk, folded all over its face to form rudimentary placental connection with uterine trophonema; appendicula long, thread-like and much-branched.
9-10-42	24·0"	2+1=3	63 mm.	Intermediate pregnancy; rudimentary placenta present even at this stage.
16-11-42	24·0"	2+1=3	63 mm.	
17-11-42	25·5"	1+2=3	33 mm.	Early pregnancy; embryos enclosed in water-filled shell membrane sacs; spiracles and branchial filaments present; appendicula very short.
17-11-42	27·25"	3+2=5	110 mm.	Intermediate pregnancy.
11-1-44	26·0"	1+3=4	256 mm.	Preparturition stage; left ovary with three big, oval eggs each 12 mm. × 13 mm. and full of bright yellow yolk; 'entire' placenta.
10-10-47	25·5"	2+2=4	126 mm.	Intermediate pregnancy.

The species does not appear to grow beyond 30" in length, the maximum length recorded being 27·25" The smallest adult male, with well-developed fusiform claspers measured only 22" in total length. Observations of the female show that only the left ovary is present and the largest ovarian egg measures 12 mm. × 13 mm. It is ovoid in shape and contains bright yellow yolk. Mahadevan (1940) states, however, that both the ovaries are present and that the largest ovarian egg measures only 3 mm. to 4 mm. in diameter. The nidamental gland consists of two spirally twisted horns. Ordinarily, the minimum number of offsprings at a time is three, two from one uterus and one from the other. At birth, they measure from 275 mm. to 300 mm. in total length. The peak of parturition period appears to be January and February. The foetal placenta is of the 'entire' variety. The maternal placenta in advanced stages of pregnancy is a more or less circular bunch of highly vascular, close-set plaits and folds of the uterine mucous membrane in the posterior part of the uterine compartment—the trophonematous cup—this being definitely elevated above the general surface of the uterine mucosa so as to look like a flowery mass borne on a thalamus.

***Scoliodon walbeehmi* (Bleeker).**

Date of capture.	Length of parent female.	Total No. of embryos.	Length of embryos.	Remarks.
29-10-42	31.5"	0+2=2	237 mm.	Advanced pregnancy ; right uterus abortive, with only a shell-membrane tuft; fetuses enclosed in shell-membrane sacs ; 'entire' placenta; short thin; appendicula with rounded tips.
15-12-43	31.5"	..	..	Post-pregnant stage; each uterus with one compartment and one atrophying trophonema; only left ovary present and the biggest ovarian egg round 20 mm. in diameter and with yellow yolk.
10-10-47	30.25"	0+2=2	45 mm.	Right uterus abortive with, two barren shell membrane tufts; embryos enclosed in water-filled sacs; appendicula in the form of rounded disc-like knobs.

This species does not appear to grow beyond 37" in total length. The smallest adult male measured only 29" in total length. In the female only the left ovary is present and a fully mature ovum measures about 20 mm. in diameter. The nidamental glands are exactly similar to those of *Scoliodon palasorrah*. Embryos are enclosed in shell membrane sacs and the placental cords bear short, close-set and flattened appendicula with rounded and bifid extremities. Fetuses in advance stages of development are faithful replicas of their parents except for the fact that the margins of their teeth are entire and not roughened as in the adult. The number commonly born at a time is two, one from either uterus or both from one uterus, the other uterus being abortive. The parturition period appears to be sometime in November and December. The placenta formed is of the 'entire' variety.

***Hypoprion macloiti* (Müller & Henle).**

Date of capture.	Length of parent female.	Total No. of embryos.	Length of embryos.	Remarks.
7-2-42	33"	1+1=2	412 mm.	Advanced pregnancy; shell membrane sacs enclosing embryos without any liquid at this stage; no appendicula on placental cords; 'entire' placenta.
22-9-42	30"	1+1=2	27 mm.	Early pregnancy; embryos enclosed in water-filled sacs of shell membrane; spiracular slits and branchial filaments present; no placenta at this stage.
5-11-42	33"	0+1=1	187 mm.	Intermediate pregnancy; right uterus with only an unfertilized egg enclosed in shell membrane; shelly sacs of embryos devoid of any albuminous liquid; rudimentary placental connection present.

**Hypoprion macloiti (Müller & Henle)—contd.**

Date of capture.	Length of parent female.	Total No. of embryos.	Length of embryos.	Remarks.
18-2-43	34"	..	..	Pregnant condition; only right ovary with five big oval eggs; each 20 mm. $\times$ 19 mm. and with golden yellow yolk; uteri showed readiness to receive eggs.
22-11-43	35"	1+1=2	237 mm.	Intermediate pregnancy.
29-2-44	34"	1+1=2	425 mm.	Advanced pregnancy.
2-3-44	34"	1+1=2	450 mm.	„ „

The species is a small one and does not grow beyond 36" in total length. Males seem to attain maturity when only about 27" in total length. Only the right ovary is present. Mature eggs are oval in outline, full of bright yellow yolk and the largest measures 20 mm.  $\times$  19 mm. Unlike *Scoliodon palasorrah* and *S. walbeehmi*, each nidamental gland consists of two coiled horns. The commonest number of young ones born is two, one from either uterus and at birth, they measure from 450 mm. to 500 mm. in total length. The foetal placenta is of the 'entire' variety. Males of this species are very common and constitute 95 % of the quantity landed. Females are rare.

**Carcharinus limbatus (Müller & Henle).**

Date of capture.	Length of parent female.	Total No. of embryos.	Length of embryos.	Remarks.
21-12-42	5'-9"	3+2=5	144 mm.	Intermediate pregnancy; left uterus also contained an unfertilized egg; branchial filaments present; spiracles absent; rudimentary placenta formed.
22-12-42	6'	1+1=2	575 mm.	Preparturition stage; right uterus also contained an unfertilized egg and the left a degenerating embryo; 'entire' placenta.
17-5-43	5'-4"	..	..	Post-pregnant condition; compartmental walls no longer visible.
22-9-43	5'-2"	3+3=6	225 mm.	Intermediate pregnancy; no pigmentation yet developed in the embryo.
4-11-43	6'	2+2=4	225 mm.	„ „
27 8-43	5'-4"	3+3=6	175 mm.	„ „
5-11-43	5'-9"	2+2=4	190 mm.	Each uterus also contained an unfertilized egg.
21 1-44	5'-7"	3+3=6	400 mm.	Advanced pregnancy.
29 2-44	5'-9"	3+3=6	475 mm.	„
11-4-44	5'-9"	..	..	Post-pregnant condition.

The species grows to a length of about 6'. The smallest adult female measured 5'-2" in total length and the smallest adult male only 4'-8" Only the left ovary is present ; the mature egg measures about 25 mm. in diameter and possesses yellow yolk. Throughout their intrauterine life, the embryos are enclosed in water-filled sacs of shell membranes which afford protection to the embryos. The number commonly born at a time is six, three from each uterus and at birth they measure about 24" in length. The peak of parturition period in Bombay waters appears to be January, February and March. The placenta formed is of the 'entire' variety.

The species is cosmopolitan in its distribution, appearing in tropical and subtropical seas. Nichols and Breder (1927) state that breeding females of this species measure from 5' to 5'-6" in total length and 'are ready to be released in April in the Bay of Florida'

***Carcharinus melanopterus* (Quoy & Gaimard).**

Date of capture.	Length of parent female.	Total No. of embryos.	Length of embryos.	Remarks.
28-11-40	9'- 2"	9+9=18	550 mm.	Advanced pregnancy ; fetuses enclosed in water-filled shell membrane sacs ; 'discoid, placenta ; no appendicula on placental cord.
17-1-41	10'	6+6=12	600 mm.	" "
26-9-41	8'	..	..	Pre-pregnant condition ; only left ovary with small, pea-sized and colourless eggs.
17-2-42	8'- 9"	5+5=10	550 mm.	Advanced pregnancy.
19-2-42	9'- 4"	..	..	Pre-pregnant stage ; left ovary with 30 big ripe eggs from 38 mm. to 50 mm. in diameter.
29-4-42	10'	6+6=12 eggs.	..	Each uterus with six spindle-shaped eggs enclosed in shell membranes.
20-5-42	9'-10"	6+5=11	120 mm.	Early pregnancy ; only one compartment in the left uterus contained an unfertilised egg ; embryos enclosed in water-filled shell membrane sacs ; spiracles present ; no placenta at this stage.
11-2-43	10'- 2"	9+9=18	775 mm.	Advanced pregnancy ; fetuses still enclosed in water-filled sacs ; firm placental connection.
28-4-43	10'- 2"	.. -	..	Post-pregnant stage ; uteri reduced in size with sagging walls and atrophying trophonementa ; ovary with pea-sized, pale ova.
6-1-44	9'- 4"	..	..	Post-pregnant condition ; left ovary with 24 big eggs 37 mm. in diameter ; uteri empty, without compartments and containing degenerating fragments of shell membranes.
9-5-44	10'- 2"	7+6=13	70 mm.	Early pregnancy ; the uteri also contained a few unfertilized eggs and some barren shell membrane tufts ; sexes differentiated even at this stage.

The maximum length of the species recorded by us is 10'-2" Females attain maturity when about 8' long. Alcock (1890) described a gravid female of *C. melanopterus* as being only 5' in length. It is very likely that Alcock's species was not *C. melanopterus* but some other shorter form such as *C. limbatus* or *C. sorrah*. Only the left ovary is present and functional. The mature ovarian egg is round and measures from 37 mm. to 50 mm. in diameter. As many as 30 ripe eggs may be produced at a time. The commonest number of young ones produced is 12, six from each uterus and at birth, they measure from 750 mm. to 900 mm. in total length. Sexes of the embryos are differentiated externally as early as 80 mm. stage. The parturition period appears to extend from December to March. Throughout their intrauterine life, the embryos are enclosed in water-filled sacs affording protection to the embryos. Even in advanced stages of pregnancy, the uterine compartments are more or less transverse in disposition and in this respect the condition resembles that in *Galeocerdo tigrinus* (Sarangdhar, 1943). The foetal placenta is of the 'discoïd' variety.

***Carcharinus sorrah* (Müller & Henle).**

Date of capture.	Length of parent female.	Total No. of embryos.	Length of embryos.	Remarks.
13-3-42	4'- 3"	2+2=4	512 mm.	Advanced pregnancy; only left ovary present with small pale ova not bigger than peas; foetuses enclosed in water-filled sacs; 'discoïd' placenta.
12-3-43	4'- 0"	3+3=6	425 mm.	Advanced pregnancy.
4-11-43	4'- 2"	3+2=5	225 mm.	Intermediate pregnancy; rudimentary placenta formed while yolk-sac still contains thin, lemon-yellow yolk.
5-11-43	4'- 3"	2+2=4	275 mm.	Intermediate pregnancy; tips of pectorals and lower lobe of caudal just becoming blackish.
21-1-44	4'- 3"	2+1=3	475 mm.	Advanced pregnancy.
29-2-44	4'- 8"	3+3=6	425 mm.	" "
1-3-44	4'- 4"	3+2=5	500 mm.	Advanced pregnancy; left uterus also contained an unfertilized egg.
2-5-44	4'- 3"	2+1=3	550 mm.	Parturition stage.

The species does not appear to grow beyond 5' in total length, adult females commonly ranging from 4'-0" to 4'-6" in total length. Only the left ovary is present and functional. The number of young ones commonly born at a time is six and measure at birth about 600 mm. in total length. Throughout their intrauterine life, they are enclosed in water-filled sacs of shell membranes. The delivery period extends from March to May. The characteristic blackening of the tips of the fins begins to be noticeable when the embryos are 275 mm. long. The shortest adult male with stout, well-developed claspers measured 3'-7" in length. Embryos develop 'discoïd' type of placenta.

**Carcharinus menisorrah** (Müller & Henle).

Date of capture.	Length of parent female.	Total No. of embryos.	Length of embryos.	Remarks.
29-10-42	35.5"	1+1=2	80 mm.	Intermediate pregnancy; only left ovary present; largest ovarian egg 18 mm. in diameter and with bright yellow yolk; embryos enclosed in shell membrane sacs devoid of liquid; basal wall of yolk-sac with minute folds which form placental connection with uterine trophonema; no appendicula.
2-11-42	32.5"	0+1=1	62 mm.	Early pregnancy; right uterus contained an unfertilized egg; embryo enclosed in shell membrane sac with little albuminous liquid; embryonic spiracles and branchial filaments present; no placental connection.
12-11-42	29"	0+1= 1	212 mm.	Advanced pregnancy; right uterus abortive; 'entire' placenta.
24-11-42	33"	1+1= 2	350 mm.	Parturition stage.
12-5-43	34"	1+1= 2	163 mm.	Intermediate pregnancy.
21-11-43	35"	1+1= 2	275 mm.	Advanced pregnancy.
5-12-43	34"	0+1= 1	325 mm.	Advanced pregnancy; right uterus abortive.
28-2-44	34"	1+1= 2	325 mm.	" "
29-2-44	35"	1+1= 2	300 mm.	" "
6-3-44	34"	1+1= 2	375 mm.	Parturition stage.

Mature specimens, both male and female, of this species do not exceed 3' in length, although Day (1878) records that it attains 12' or more in length. The smallest adult female measured 29" in total length while the smallest male recorded measured only 27". Only the left ovary is present and functional and the largest ovarian egg measures about 18 mm. in diameter. The usual number of young ones born is two, one from either uterus, although occasionally the right may be abortive. The foetus at birth measures from 350 mm. to 400 mm. in total length. The period of parturition in Bombay waters is fairly long, extending from November to March or even April. The placenta formed is of the 'entire' variety.

**Carcharinus temminckii** (Müller & Henle).

Date of capture.	Length of parent female.	Total No. of embryos.	Length of embryos.	Remarks.
8-8-42	5'- 3"	4+4= 8	27 mm.	Early pregnancy; embryos enclosed in water-filled shell membrane sacs; spiracles and branchial filaments present; no appendicula.
19-8-42	4'- 9"	4+4= 8	43 mm.	Early pregnancy; sexes not yet distinguished externally.
5-2-42	5'- 0"	4+4= 8	375 mm.	Advanced pregnancy; embryos still enclosed in water-filled shell-membrane sacs; 'discoid' placenta.
30-4-43	4'-10"	4+4= 8	450 mm.	Advanced pregnancy.
5-5-43	5'- 0"	4+4= 8	525 mm.	" "
12-5-43	5'- 4"	4+4= 8	575 mm.	" "
9-10-43	4'- 7"	5+3= 8	128 mm.	Intermediate pregnancy; embryos in water-filled sacs; yolk-sacs still containing yolk but rudimentary interdigitating placenta formed; sexes distinguished externally.
11-10-43	4'-3"	4+2= 6	375 mm.	Advanced pregnancy.
27-1-44	4'-11"	1+3= 4	306 mm.	" "
28-1-44	4'-10"	2+2= 4	350 mm.	" "
29-2-44	4'-11"	4+4= 8	375 mm.	" "
13-4-44	4'-8"	4+3= 7	462 mm.	Advanced pregnancy; left uterus also contained an unfertilized egg enclosed in shell membrane.

The species does not seem to grow beyond 5'-6" in total length, the maximum length so far recorded being only 5'-4" The minimum length of an adult female recorded is only 4'-3" The adult males are comparatively shorter than females, the smallest adult male thus far recorded being only 3'-9" in total length. Only one ovary is present and functional. The biggest ovarian egg is about 10 mm. in diameter. The commonest number of young ones produced at a time is eight, four from each uterus and at birth they measure from 450 mm. to 600 mm. in total length. Throughout their intrauterine life, they are enclosed in water-filled sacs of shell membranes which afford additional protection to the embryos. The peak period of parturition in Bombay waters is before the outbreak of the monsoon, viz., April and May. The placenta formed is of the 'discoid' variety. Males and females in this species appear to be equally distributed.

**Galeocerdo tigrinus Müller & Henle.**

Date of capture.	Length of parent female.	Total No. of embryos.	Length of embryos.	Remarks.
15-12-41	12'	18+18=36	70 mm.	Early pregnancy; besides the 18 embryos 4 compartments from each uterus also contained 4 unfertilised eggs; no pigmentation yet.
17-1-42	13'-1"	21+21=42	500 mm.	Advanced pregnancy; fetuses enclosed in water-filled sacs of shell membranes; no placenta formed.
4-5-43	12'-9"	14+13=27	725 to 750 mm.	Parturition stage; no placenta; the left uterus also contained one unfertilised egg.
21-10-43	9'-3"	14+15=29	200 mm.	Intermediate pregnancy; branchial filaments present; no pigmentation yet.

The species has so far, been observed to grow to a maximum length of 13'-1" in Bombay waters. Its developmental stages have been described in detail by Sarangdhar (1943; 1946). It is a prolific breeder and brings forth any number from 27 to 44 young ones at a time the latter number being by far the most common. It is a non-placental form and the yolk in the yolk-sac suffices to bring about the complete intrauterine growth, thus not necessitating the formation of a placenta. Throughout the intrauterine life, the embryos are enclosed in water-filled sacs of shell membranes which afford protection to the embryos. At birth, the fetuses measure about 750 mm. in length and have the characteristic tiger-like markings on their backs. The yolk-sacs and umbilical cords are completely absorbed before birth.

**Hemigaleus balfouri Day.**

Date of capture.	Length of parent female.	Total No. of embryos.	Length of embryos.	Remarks.
16-10-42	32"	3+1=4	135 mm.	Intermediate pregnancy; shell membrane sacs disintegrated; yolk-sacs with very little yolk and with walls folded all over its face to form a placenta; umbilical cords with thin thread-like appendicula.
24-11-42	33"	2+2=4	200 mm.	Advanced pregnancy; 'entire' placenta.
9-11-43	23"	1+1=2	115 mm.	Intermediate pregnancy; placenta formed.
9-11-43	25"	1+0=1	145 mm.	Intermediate pregnancy; the left uterus contained two abortive tufts of shell membranes.
29-2-44	31"	1+1=2	175 mm.	Advanced pregnancy.
15-10-47	26"	1+0=1	112 mm.	Intermediate pregnancy.

The species does not grow to beyond 36" in total length the maximum length recorded being 33" and the minimum length of an adult female being only 23" The commonest number of young ones born is two, one from each uterus and their length at birth is from 200 mm. to 225 mm. Female foetuses predominate. The placental condition is established early and the placenta formed is of the 'entire' variety. The peak of parturition period appears to be February and March. As in *Scoliodon sorrakowah*, the shell membranes enclosing the embryos undergo early degeneration, most probably nutritive and supply additional nutriment to embryo.

***Sphyrna blochii* (Cuvier).**

Date of capture.	Length of parent female.	Total No. of embryos.	Length of embryos.	Remarks.
1-9-41	4'-5"	4+4=8	70 mm.	Early pregnancy; embryos enclosed in shell membrane sacs with clear albuminous liquid; each oculo-narial expansion shorter than its width; branchial filaments present; umbilical cords with thin, circular, locular appendicula; no placenta formed.
11-12-41	3'-11"	3+3=6	287 mm.	Intermediate pregnancy; sacs enclosing embryos with little albuminous liquid; oculo-narial expansions curved backwards to give a horseshoe shape to the head region; rudimentary placenta formed; characteristic appendicula present.
25-2-42	4'-0"	3+3=6	362 mm.	Advanced pregnancy; oculo-narial expansions still directed posteriorly; 'entire' placenta.
28-9-42	4'-4"	3+3=6	43 mm.	Very early pregnancy (shark-like stage); in addition to the embryos, each uterus also contained 2 unfertilized eggs; no appendicula on umbilical cords.
5-2-43	3'-10"	3+4=7	325 mm.	Advanced pregnancy; right uterus also contained an abortive egg.
25-3-43	3'-11"	3+3=6	350 mm.	Advanced pregnancy.
30-4-43	4'-2"	3+3=6	350 mm.	" "
17-5-43	4'-0"	3+3=6	400 mm.	" "
14-7-43	..	..	..	Free-swimming young ones with fresh umbilical scars 450 mm. to 525 mm. long.

**Sphyrna blochii** (Cuvier)—*contd.*

Date of capture.	Length of parent female.	Total No. of embryos.	Length of embryos.	Remarks.
25-9-43	3'-5"	2+2=4	66 mm.	Early pregnancy; embryonic development arrested due, in all possibility, to the bursting of the embryonic yolk-sacs.
7-10-43	3'-9"	3+3=6	60 mm.	Early pregnancy.
7-10-43	3'-9"	3+3=6	45 mm.	'Shark-like' stage.
23-10-43	4'-3"	4+4=8	125 mm.	Intermediate pregnancy; unpigmented embryos enclosed in water-filled shelly sacs; rudimentary placenta formed.
25-1-44	3'-10"	5+4=9	325 mm.	Advanced pregnancy.
4-2-44	4'-8"	5+4=9	375 mm.	" "
28-2-44	3'-9"	3+3=6	375 mm.	" "
6-3-44	4'-3"	3+3=6	450 mm.	" "
11-5-44	4'-6"	..	..	Post-pregnant condition; ovary with ova measuring 5-6 mm. in diameter and possessing yellow yolk.

The species has not, so far, been observed to grow beyond 4'-8" in length and apparently it hardly exceeds 5" at the most. The smallest adult female measured only 3'-5" in length while the smallest adult male recorded was 3'-7" in length. Only the right ovary is present and functional and the mature egg measures about 10 mm. in diameter. The number of young ones born is commonly six, three from each uterus though the maximum number so far recorded is 9. Female fetuses predominate. Newly born young ones measure about a foot and half in total length. The peak of parturition period in Bombay waters is April and May, just before the monsoon. Sexual activity appears to be the highest during the monsoon as, in September and October, immediately after the monsoon, females are in early and intermediate stage of pregnancy. The embryos during their early and intermediate stage of development are enclosed in protective water-filled shell membrane sacs but the protective liquid diminishes in quantity as pregnancy advances. The placenta formed is of the 'entire' variety.

Gravid females of this species furiously attack one another, when they are so heavily buffeted that the yolk-sacs of the developing embryos burst and the embryos undergo abortive changes.

**Rhynchobatus djiddensis (Forskäl).**

Date of capture.	Length of parent female.	Total No. of embryos.	Length of embryos.	Remarks.
22-8-41	8'-1"	..		Prepregnant stage; both ovaries full of eggs 37 mm. in diameter; uteri empty, with smooth mucous membranes.
18-3-42	8'-8"	5+5=10	150 mm.	Intermediate pregnancy; both ovaries full of eggs ranging from 25 mm. to 62 mm. in diameter egg-cases enclosing embryos disintegrated; uterine mucous membrane with plaits and frills.
29-8-42	8'-3"	5+5=10	130 mm.	Intermediate pregnancy.
20-7-43	7'-0"	4+4=8	95 mm.	Intermediate pregnancy; shelly egg-case broken up into fragments.
26-8-43	9'-9"	3+4=7	45 mm.	Early pregnancy; 'shark-like' stage in each uterus; one egg-case enclosing embryos; egg-case compartmented.
6-10-43	8'-9"	4+4=8	157 mm.	Intermediate pregnancy.
Do	9'-2"	4+4=8	200 mm.	Commencement of advanced pregnancy.
Do	9'-5"	6+3=9	235 mm.	" "
7-10-43	9'-7"	4+4=8	287 mm.	Advanced pregnancy.
9-10-43	9'-3"	3+4=7	437 mm.	" "
13-10-43	9'-1"	3+3=6	..	Three eggs in each egg-case, each egg measuring 87 mm. in diameter.
12-4-44	7'-9"	..	..	Post-pregnant condition.
8-10-47	8'-3"	2+3=5	245 mm.	Commencement of advanced pregnancy.

The maximum length of this species so far recorded is 9'-9" and the minimum length of an adult female only 7'. It is an ovo-viviparous, form. Both ovaries are present and functional and produce large-round eggs full of viscous yellow yolk. The largest ovarian egg measures about 62 mm. in diameter. Early embryos are enclosed in compartmented, leathery egg-cases formed from shell-membranes but these last only a short while and disintegrate after a certain stage of embryonic development. The smallest embryonic stage when the egg-case was already in a disintegrating condition was observed to be the 95 mm. stage. The commonest number of young ones produced is eight, four from either uterus, although the maximum recorded is 10. The maximum number of healthy embryos from a single uterus was six. At birth, they measure from 450 mm. to 500 mm. in total length. The greatest reproductive activity appears to be during the monsoon months

for, gravid females in early or intermediate stages of pregnancy are landed in August, September and October. Fishermen state that these fish are caught during these months within three to four miles off-shore indicating that the breeding grounds of this species are located quite near Bombay. The parturition period appears to be towards the end of the year.

***Pristis cuspidatus* Latham.**

Date of capture.	Length of parent female.	Total No. of embryos.	Length of embryos.	Remarks.
15-3-43	8'-2"	4+4=8	33 mm.	Early pregnancy ; 'shark-like' stages.
"	..	..	..	A free-swimming ; newly born young one 425 mm. long ; (including saw); yolk-sac and stalk just absorbed.
15-5-43	..	..	..	A free-swimming newly born young one 600 mm. long ; yolk-sac and stalk just absorbed.
4-2-44	9'-3"	3+3=6	53 mm.	Early pregnancy ; 'saw-fish' stage.
2-3-44	8'-1"	3+3=6	43 mm.	Early pregnancy ; rostrum just originated.
6-3-44	8'-11"	3+	537 mm.	Parturition stage ; teeth on saw not yet cut throughout the membrane enveloping them ; yolk-stalk and sac nearly completely reduced ; large internal yolk-sac.

This species has been rarely observed to grow beyond 10' in Bombay waters, though Day (1888) records sizes of 20', and upwards in length. It is ovo-viviparous. Both the ovaries are present and functional and a fully mature ovarian egg measures about 25 mm. in diameter. In early stages of development a number of embryos are enclosed in a soft leathery egg-case, compartmented internally. The egg-case lies in the uterus which, however, is not compartmented. The uterine mucous membrane is, however, thrown into plaits and frills, is extremely glandular and produces a milky secretion which must serve as additional nutrition to the developing embryos. Six appears to be the commonest number of young ones born at a time, three from either uterus, their total length then varying from 425 mm. to 600 mm. The parturition period in Bombay waters appears to be March, April and May. The lateral teeth on the 'saw' are cut only after the assumption of free life.

**Dasyatis uranak** var. **variegatus** (Annandale).

Date of capture.	Width across disc of parent female.	Total No. of embryos.	Width across disc of embryos.	Remarks.
5-10-43	5'-2"	2	325 mm.	Parturition stage ; only left uterus well-developed and containing foetuses ; solid brown spots on back of foetues ; yolk-stalks and sacs completely absorbed.
9-10-43	5'-0"	1	294 mm.	Advanced pregnancy ; very short yolk-stalk and sac present.
25-10-43	5'-0"	2	300 mm.	Parturition stage ; dorsal colouration of foetus as in <i>D. uranak</i> .
26-10-43	5'-0"	2	425 mm.	„ „

This has been rightly described by Annandale (1909) as only a colour variety of *D. uranak* (Forskål). Embryological observations reveal that the colour variation of the two forms is of a merely superficial nature, induced in certain cases by age, for the female of *D. variegatus* (with a dorsal colouration of hollow rings and an irregular network of wavy lines) invariably brings forth fully-formed young one with large round or oval dark brown or black spots) which could be described as *D. uranak*. It is at once obvious that the solid spots in the young condition (*D. uranak*) sometimes become hollowed out with age and converted into rings or wavy lines which coalesce to form the reticulum characteristic of the colour pattern on *D. variegatus*.

The maximum width across disc of this variety observed by us in Bombay waters is 5'-2" Only the left ovary, left oviduct and left uterus are developed. A reduced nidamental gland is present above the upper pole of the left uterus. The commonest number of young ones born is two and at birth they measure from 300 mm. to 450 mm. across disc. The parturition period in Bombay waters appears to be October and November.

**Dasyatis bleekeri** (Blyth).

Date of capture.	Width across disc of parent female.	Total No. of embryos.	Width across disc of embryos.	Remarks.
14-11-41	42"	1	187 mm.	Parturition stage ; yolk-stalk and sac completely absorbed ; uterine mucous membrane with trophonematous villi.
17-5-43	40"	1	152 mm.	Preparturition stage ; embryo with only a short yolk-stalk.

The maximum size recorded for this species is 42" across disc. Only the left ovary, left oviduct and left uterus are present and functional. Only a single young one is born and brought forth at a time, its size across the disc then being about 200 mm. to 225 mm.

***Dasyatis walga* (Müller & Henle).**

Date of capture.	Width across disc of parent female.	Total No. of embryos.	Width across disc of embryos.	Remarks.
9-9-41	9.5"	2	50 mm.	Advanced pregnancy ; only left ovary present ; ovarian egg 15 mm. in diameter.
Do.	9.4"	2	45 mm.	Advanced pregnancy ; short yolk-stalk and sac present (30-40 mm. long).
2-11-42	9.1"	2	55 mm.	" "
13-1-43	10"	1	75 mm.	Parturition stage ; yolk-stalk and sac almost completely absorbed.
29-3-43	9.3"	2	50 mm.	Advanced pregnancy.

The maximum size of this species recorded is 10" across the disc. Only the left ovary is present and the mature ovarian egg measures about 15 mm. in diameter and contains bright yellow yolk. Only the left uterus is developed and bears two embryos at a time which at birth, measure from 70-80 mm. across the disc. The uterine mucous membrane bears flat, spatulate trophonematous villi. Gravid females at full term are frequently landed during December and January. Reproductive organs on the right side are entirely absent.

***Dasyatis zugei* (Müller & Henle).**

Date of capture.	Width across disc of parent female.	Total No. of embryos.	Width across disc of embryos.	Remarks.
9-9-41	11.75"	1	42 mm.	Early pregnancy ; very tiny unpigmented embryos with prominent yolk-stalks and sacs ; uterine mucous membrane with crowded glandular villi.
6-2-42	11"	2	112 mm.	Advanced pregnancy ; fetuses pigmented and with nearly completely reduced yolk-stalks and sacs.
29-3-43	13.25"	2	118 mm.	" "
11-1-44	12.5"	2	108 mm.	" "

The maximum size of this species is observed to be 13.25" across the disc and the minimum of an adult female as 11" across disc. Only the left uterus is developed and contains usually two embryos which, at birth measure from 112 mm. to 125 mm. across the disc. February, March and April are by far the commonest months when fully developed young ones, ready for birth are found in the wombs of gravid females. The reproductive organs on the right side are in a rudimentary state of development.

**Gymnura poecilura** (Shaw).

Date of capture.	Width across disc of parent female.	Total No. of embryos.	Width across disc of embryos.	Remarks.
29-10-42	43.5"	2+2=4	216 mm.	Advanced pregnancy ; both uteri well-developed and containing embryos ; uterine mucous membrane with glandular villi.
22-4-43	37"	0+1=1	262 mm.	Parturition stage ; right uterus empty and had probably liberated its young one in the sea.
20-5-43	32"	3+3=6	212 mm.	Parturition stage.
30-12-43	31"	0+2=2	250 mm.	Parturition stage ; right uterus empty and had probably delivered its contents into the sea.
11-4-44	36"	2+2=4	237 mm.	Parturition stage.

The gestation and embryonic history of a closely allied Indian species, *Pteroplatea* (Syn. *Gymnura*) *micrura* have been studied in detail by Woodmason and Alcock (1891) and by Alcock (1892). Our observations on *G. poecilura* agree in every respect with the observations of the aforesaid authors. We were not able to obtain gravid females of our species in early stages of pregnancy but Gudger (1912) records that in *Pteroplatea maclura* the eggs and early embryos are enclosed in shell membrane sacs.

The number of young ones commonly born is four, two from either uterus, and their size at birth is about 250 mm. across the disc. Their yolk stalks and sacs are completely absorbed before birth. Pale white round dots on the embryonic sac are quite conspicuous at birth. There seems to be no fixed parturition period for this species in Bombay waters.

**Rhinoptera javanica** Müller & Henle.

Date of capture.	Width across disc of parent female.	Total No. of embryos.	Width across disc of embryos.	Remarks.
22-9-41	48"	1	200 mm.	Intermediate pregnancy ; yolk-stalk 100 mm. long ; no dorsal pigmentation ; uterine mucous membrane with elongated spatulate villi.
21-7-43	43"	1	450 mm.	Parturition stage ; yolk-stalk and sac completely absorbed.
12-4-44	51"	..	..	Post-pregnant condition ; short villiform trophonemata also present on the mucosa of the right undeveloped uterus.

Only the left ovary, left oviduct and left uterus are developed, the right oviduct and uterus being present but in a rudimentary condition of development and non-functional. A small nidamental gland is present above the upper pole of each uterus. A single young one is born at a time and at birth measures about 450 mm. across the disc. The yolk-stalk and sac are completely absorbed before birth.

***Mobula diabolus* (Shaw).**

Date of capture.	Width across disc of parent female.	Total No. of embryos.	Width across disc of embryos.	Remarks.
6-5-43	45"	1	400 mm.	Parturition stage ; uterine mucous membrane beset with trophonemata ; yolk-stalk and sac completely absorbed.
7-5-43	48"	1	400 mm.	" "
11-4-44	50"	1	375 mm.	" "

Only the left oviduct and left uterus are present. A small nidamental gland is present immediately above the upper pole of the uterus. A single young one is born at a time measuring, at birth, 400 mm. across the disc. It lies in a supine position within the uterus with its 'wings' folded backwards and its cephalic horns folded ventrally and medially. The parturition period of this species is definitely April and May since a large number of gravid females at full term are then landed in large numbers.

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A CONTRIBUTION TO THE SYSTEMATICS OF *SCOLIODON ACUTUS* (RÜPPELL), *HEMIPRISTIS ELONGATUS* (KLUNZINGER) AND *TORPEDO ZUGMAYERI* ENGELHART.

By S. B. SETNA, *M.Sc., F. R. M. S., Ph.D. (Cantab), F.N.I.*, and P. N. SARANGDHAR, *M.Sc., Ph.D., F.Z.S., Department of Fisheries, Bombay.*

( Plate XI )

INTRODUCTION.

In our studies on the systematics of Bombay elasmobranchs, we came across three species, *viz.*, *Scoliodon acutus* (Rüppell), *Hemipristis elongatus* (Klunzinger) and *Torpedo zugmayeri* Engelhart, existing accounts of which are far too meagre to permit of easy identification of the species. They are not well-known to ichthyologists and none of them is of common occurrence in Bombay waters, *Hemipristis elongatus* (Klunzinger) being recorded here for the first time from the Indian seas. Detailed descriptions of these forms are therefore included in this paper and their systematic position is discussed.

All the forms are fully illustrated. All text-figures have been prepared by Babu R. Bagchi, Artist, Zoological Survey of India, Calcutta, from specimens supplied by the authors, who take this opportunity of thanking both Dr. S. L. Hora, Director, Zoological Survey of India and Babu R. Bagchi for their kind help and co-operation.

SYSTEMATIC ACCOUNT.

*Scoliodon acutus* (Rüppell).

1835. *Carcharias acutus*, Rüppell, *N. W. Fische*, p. 65, pl. xviii, fig. 4.

1841. *Carcharias acutus*, Müller and Henle, *Plagiost.*, p. 29.

1870. *Carcharias acutus*, Günther, *Cat. Fish. Brit. Mus.* VIII, p. 358.

1878. *Carcharias acutus*, Day, *Fish. India*, p. 712, pl. clxxxiv, fig. 3.

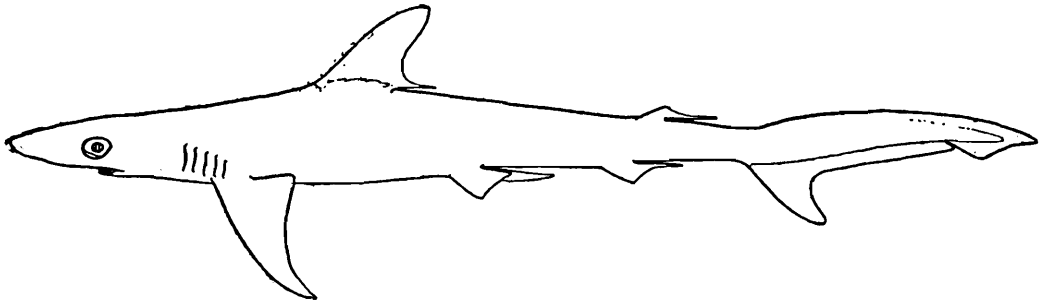
1946. *Scoliodon ceylonensis*, Setna and Sarangdhar, *Proc. Nat. Inst. Sci. Ind.* XII, pp. 246-252.

Four species of the genus *Scoliodon*, *viz.*, *S. sorrakowah* (Cuv.), *S. palasorrah* (Cuv.), *S. acutus* (Rüpp.) and *S. walbeehmi* Blkr. have, so far, been recorded from the Indian seas. Müller and Henle, Günther and Day accepted *S. acutus* as a distinct valid species, but later ichthyologists like Garman<sup>1</sup> and Fowler<sup>2</sup> considered it as only a synonym of *S. palasorrah* (Cuv.). Careful scrutiny of our collection of these fishes from Bombay waters leads us to infer that *S. acutus* (Rüpp.) is a valid species. Its detailed description is given below and its affinities pointed out.

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<sup>1</sup> Garman, S., *Mem. Mus. Comp. Zool. Harvard* XXXVI (1913).

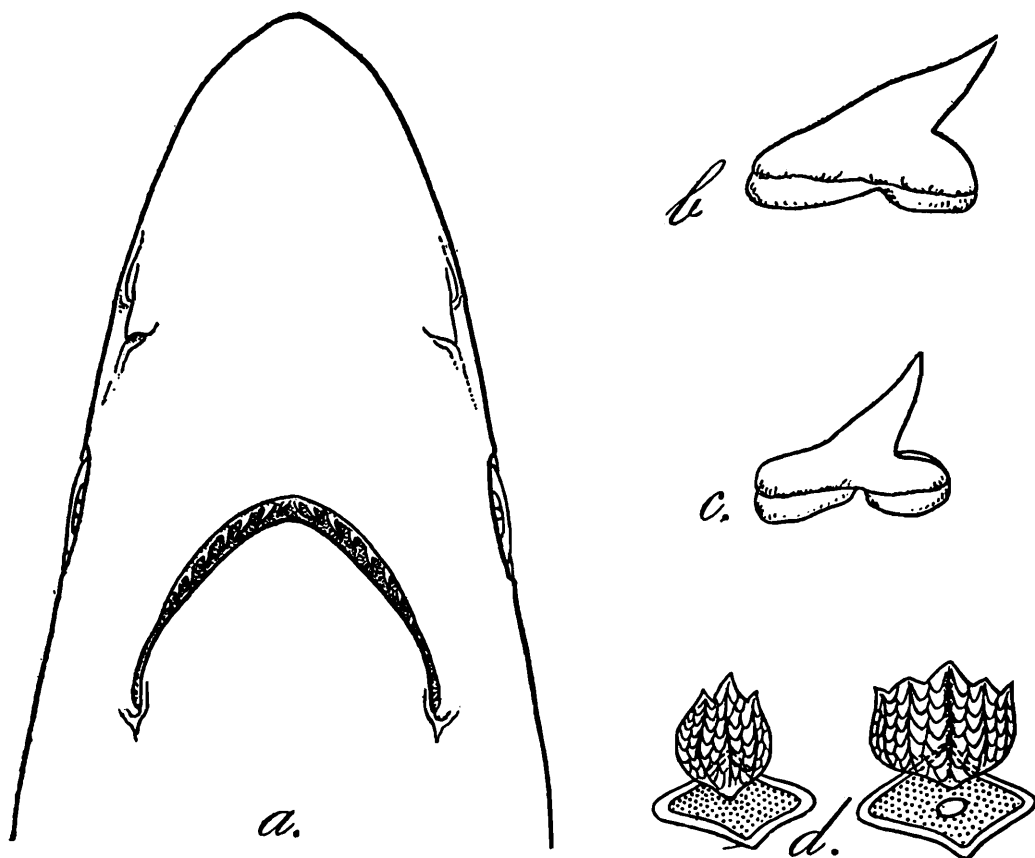
<sup>2</sup> Fowler, H. W., *U. S. Nat. Mus. Bull.* (100) XIII (1941).



TEXT-FIG. 1.—Lateral view of *Scoliodon acutus* (Rüpp):  $\times \frac{1}{7}$ .

The snout is rather elongated and triangular in outline, with a broadly acute, but rounded, tip. The length of its preoral portion is one and a half times the width of the mouth at the angles and nearly equal to the distance between the eye and the first gill-opening. The nostrils, with small, triangular, flap-like, anterior valves, are nearer to the apex of the mouth than to the end of the snout. The grooves at the angles of the mouth are short and extend very slightly along the lower jaw only, but not on the upper (Text-fig. 2a).

Eyes are big, the iris being black with horizontally oval pupils. The gill-slits are about the size of the eyes.



TEXT-FIG. 2.—*Scoliodon acutus* (Rüpp).

- a. Ventral surface of head:  $\times \frac{4}{10}$ ; b. A tooth from upper jaw:  $\times 6\frac{2}{5}$ ; c. tooth from lower jaw:  $\times 6\frac{2}{5}$ ; d. Dermal denticles:  $\times 6\frac{2}{5}$ .

*Teeth* (Text-fig. 2*b, c*).—Dental formula:  $\frac{12.1.12}{12.1.1.12} = \frac{25}{26}$ . There is

a small median tooth on the upper jaw, whereas the lower has two. The teeth on both jaws are obliquely situated, those on the upper being distinctly bigger than those on the lower. All the teeth are externally notched and have entire borders both on notches and cusps. Their bases are not swollen.

*Dermal denticles* (Text-fig. 2*d*).—The spines are mostly tricuspid and tricarinate, and higher than broad. Very often, the lateral cusps are not sharply marked off. They tend to converge towards the middle line, whenever they are present. Such a spine bears, in outline, resemblance to a typical ovate leaf. A pentacrenate and pentacarinata spine is rarely encountered. Such spine is broader than long. The basal plates are broad and quadrangular, with rounded angles.

*Fins*.—The pectoral fin originates below the second gill-slit. Its outer border is nearly thrice the length of its inner. Its hind border is obliquely concave, the outer angle of the fin extending well behind the inner. The former reaches just below the origin of the dorsal when applied to the sides of the body. The first dorsal fin is situated midway between the inner angles of the pectorals and origin of the pelvic fins. It is sickle-shaped, its hind border being deeply concave. It has a pointed tip extending posteriorly, but stopping well ahead of the pelvic origin.

The pelvic fins are rather small and located midway between the origin of the pectorals and the root of the caudal. The anal fin has a broad lower angle and a gently concave hind border not deeply excavated. Its free posterior tip is nearly as long as its base. The position of the anal fin in relation to the pelvic and caudal fins may thus be fixed. The distance between the posterior end of the anal base and the root of the caudal is two-thirds that between the posterior end of the pelvic base and the origin of the anal. The former distance is also only slightly greater than that between the posterior end of the base of the second dorsal and the root of the caudal fin.

The second dorsal fin originates above the posterior end of the anal base. The length of its base is about half that of the latter fin, and the fin itself is only two-thirds as high as the anal. Its upper angle is very obtuse, while its hind border is nearly straight and considerably elongated. This fin, too, has a pointed tip extending posteriorly. The caudal fin is about one-fourth the total length, with a gently convex upper border. The sub-caudal lobe is prominent and has an almost vertical posterior border. The posterior notch on the caudal blade is located at the junction of the middle and posterior third of the caudal blade.

*Colour*.—Grey above, dull white at sides and beneath. Fins grey with light edges.

*Size*.—Specimens measuring 600 mm. to 750 mm. in total length are landed during November and December.

*Food.*—Small fishes, such as ‘ Dhoma ’ (*Sciaena glauca*), ‘ Mandeli ’ (*Coilia dussumieri*), etc. and prawns, shrimps and cuttlefish are usually among the stomach contents.

*Breeding habits.*—Viviparous; three to four young ones, at least 300 mm. long are probably brought fourth at a time.

*Distribution.*—Red Sea, Seas of India to the Malay Archipelago and beyond.

*Remarks.*—*Scoliodon acutus* is closely allied to *Scoliodon palasorrah* in general body form, but the two can easily be distinguished by the following table of characters :—

*Scoliodon acutus.*

*Scoliodon palasorrah.*

- |   |   |
|---|---|
| i. Labial folds in the angles of mouth and slightly along the lower jaw.                              | i. Labial folds prominent along lower jaw and occasionally also along the upper for a short distance. (The latter character is conspicuously marked in juvenile forms.) |
| ii. D. F. $\frac{12.1.12}{12.1.12} = \frac{25}{26}$   | ii. D. F. $\frac{11.1.11}{11.0.11} = \frac{23}{22}$   |
| iii. Appendicula on the placental cords of embryos as flat out-pushings of the placental cord sheath. | iii. Appendicula as elongated, thread-like and much-branched structures.  |

**Hemipristis elongatus** (Klunzinger).

(Plate XI, fig. 1.)

1871. *Dirrhizodon elongatus*, Klunzinger, *Verh. Zool-Bot. Ges. Wien.* XXI, p. 665.

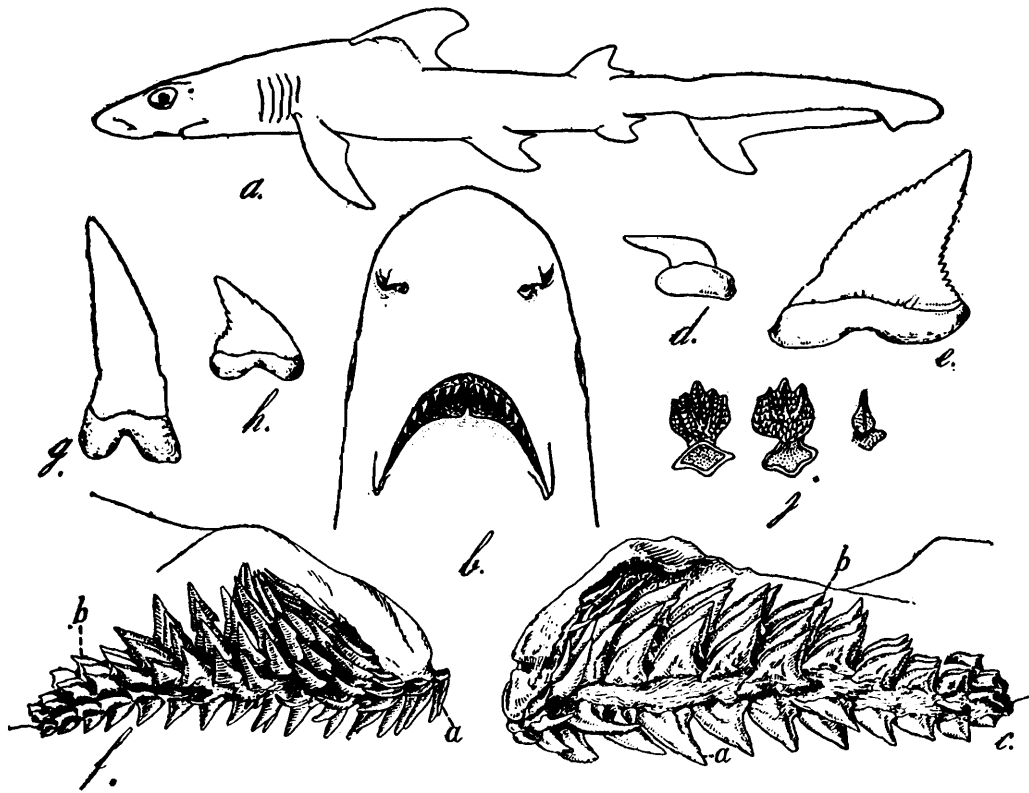
1938. *Hemipristis elongatus*, Leriche, *Mem. Soc. Palae. Suisse* LXI, pp.11-18.

1941. *Hemipristis elongatus*, Fowler, *Bull. U. S. Nat. Mus.* (100) XIII, p.193.

1946. *Hemipristis pingali*, Setna and Sarangdhar, *Proc. Nat. Inst. Sci. India* XII, pp. 246, 253.

*Local name.*—Pingal or Datri.

The snout (Text-fig. 3a, b) is rounded and semi-circular in outline, its sides being nearly parallel. The length of its preoral portion is slightly greater than the width of the mouth in immature specimens, but distinctly less in adult individuals. Nostrils are situated midway between the apex of the mouth and the tip of the snout. Their anterior borders have medial, triangular, flap-like valves, while their posterior borders have slight grooves and folds medially (Text-fig. 3b). Prominent labial folds are present on both jaws, but those on the upper are about twice as long as those on the lower. Eyes are oval in outline, pupils roughly diamond-shaped and the iris is golden. Spiracles are very minute oval slits, situated behind the eyes at a distance of about half the orbital diameter. Gill-slits (Text-fig. 3a) are wide and about twice the size of orbits. The first four are of the same size, but the fifth is slightly smaller.



TEXT-FIG. 3.—*Hemipristis elongatus* (Klunzinger).

- a. Lateral view:  $\times \frac{1}{6}$ ; b. Ventral surface of head:  $\times \frac{1}{3}$ ; c. Internal view of right ramus of upper jaw:  $\times \frac{1}{3}$ ; d. A medial tooth on upper jaw:  $\times 1\frac{1}{3}$ ; e. A lateral tooth on upper jaw:  $\times 1\frac{1}{3}$ ; f. Internal view of right ramus of lower jaw:  $\times \frac{1}{2}$ ; g. A medial tooth on lower jaw:  $\times 1\frac{1}{3}$ ; h. A lateral tooth on lower jaw:  $\times 1\frac{1}{3}$ ; j. Dermal denticles.  
 a. Teeth in use; b. Teeth in reserve.

*Teeth.*—D. F.  $\frac{13-14.0.13-14}{15, 3.0.3, 15} = \frac{26-28}{36}$

The jaws are scantily covered by lips, and several rows of teeth project from them, strongly suggesting that several rows are in use at a time (Plate XI, fig. 1). The teeth on both jaws are distinctly dimorphic (Text-fig. 3c, f). There are no median symphyseal teeth on either jaw. The teeth on the upper jaw are all located on the outside (Text-fig. 3c). In one or two of the most medial rows, they are slender and pointed, awl-shaped and non-serrated (Text-fig. 3d). Teeth in the other rows are flat, triangular in outline and outwardly deflected, their outer margins being distinctly concave. Both the margins of these teeth are sharply serrated (Text-fig. 3e). (In young specimens, however, only the outer margins are prominently serrated, the serrations on the inner margins are less conspicuous and almost wanting in teeth of more medial rows). On the lower jaw three rows on either side of the symphysis are located on the inside (Text-fig. 3f). Altogether, six to eight rows on either side of the symphysis of this jaw are elongate, sub-cylindrical and claw-shaped, with non-serrated borders. Some of these teeth have, however, very minute serrations down on either side of the base (Text-fig. 3g). The teeth flatten out gradually in more lateral rows, become distinctly deflected outwardly and develop more serrations on their outer margins, so that these now become distinctly serrated (Text-fig. 3h). Rather inconspicuous serrations are also developed on their inner margins. The result is

that the teeth in the lateral rows of the lower jaw resemble those on the upper, though, of course, they are distinctly smaller. All the teeth have swollen, bifid bases. On either jaw a few teeth in the angles are very small.

*Dermal denticles* (Text-fig. 3j).—The spines are ovoid in form, being longer than broad. They are widest near the top third and narrow down basally. Some are trident with three keels, there being a rudimentary dent without a keel on either side of the lateral cusp. Other spines are pentacuspoid with five cusps and five keels. The keels in either case do not, however, reach the base of the spine, but extend to only two-thirds its length. They are convergent basally. The cusps are either angular or squarish, the central cusp being the highest. The basal plates are small and rhombic in outline. In some scales, however, the spines are in a rudimentary condition, the cusps not being developed. The spines of such scales are spear-shaped in outline.

*Fins*.—A characteristic feature of the fins of this species that strikes the eye, is the deeply concave appearance of the hind borders. The pectoral fin originates behind the fourth gill-slit. It is falciform in outline, its posterior border being obliquely concave and its outer angle sharply pointed. Its medial border is nearly one-third its lateral and the fin extends well below the first dorsal. The latter fin originates above the inner angle of the pectoral. Its anterior margin is about one and a half times its base. Its hind border tapers posteriorly, but does not extend to the roots of the pelvics. The pelvic fins are fairly large with deeply concave posterior borders. The anal fin starts below the middle of the base of the second dorsal fin and is about half the size of the pelvic fins. It, too, has a deeply notched posterior border. The second dorsal fin originates in front of the anal and is about one and a half times the latter fin in size. The caudal fin has a well-developed sub-caudal lobe and is obliquely notched posteriorly. It is contained about four times in the total length. The upper caudal pit is present as a marked depression, but the lower is not quite so conspicuous.

*Colour*.—Light ashy brown above, dull white at sides and below.

*Size*.—Maximum length recorded so far is 2.175 meters.

*Food*.—Prawns, Shrimps, Bombay ducks (*Harpodon nehereus*) 'Mandela' (*Coilia dussumieri*), 'Dhoma' (*Sciaena glauca*), smaller sharks (*Carcharinus limbatus*), Butterfly rays (*Pteroplatea poecilura*), 'Shingala' (*Arius* sp.), Mackerel (*Scomber microlepidotus*) etc., are usually among the stomach contents. The formidable nature of the teeth in this form justifies the havoc that it creates not only among the smaller fishes but also among such large fish as sharks and rays.

*Breeding habits*.—Viviparous; six to eight young ones probably about 450 mm. in total length at birth are brought forth at a time.

*Distribution*.—Bombay waters; Red Sea.

*Remarks*.—Only a single species of the genus *Hemipristis* is known to be living; viz., *H. elongatus* (Klunzinger), and this has been described

from a single specimen collected by Klunzinger (1871) from the Red Sea. Unfortunately, Klunzinger's description is not quite lucid, nor did he illustrate the species.

The description of our specimens from the Bombay waters differs notably from that of Klunzinger in that the spiracles in our specimens are comparatively much smaller than the eyes and are also located nearer the eyes than in Klunzinger's specimen. Also, Klunzinger was not able to give the correct dental formula of the species, which has since been correctly described by Leriche (1938), who has also given a thorough account of the dentition in the species. Leriche has, however, described the most medial rows of teeth on either jaw as "Symphyseal" teeth. This term cannot, however, be said to be quite appropriate in view of the fact that these teeth are not located on the symphysis of the jaws, there being a pronounced toothless symphyseal space on either jaw.

The gestation and embryos of this singular species will be described by us in a subsequent publication.

### ***Torpedo zugmayeri* Engelhart.**

(Plate XI, Figs. 2 and 3.)

1912. *Torpedo zugmayeri*, Engelhart, *Zool. Anz.* XXXIX, p. 647.

Two species of the genus *Torpedo*, viz., *T. marmorata* Risso and *T. zugmayeri* Engelhart have, so far, been recorded from the Indian seas. Fowler (1941) regards *T. zugmayeri* as only a synonym for *T. marmorata*, remarking that the two species have been separated only on minor differences. Prashad,<sup>1</sup> however, ascertained after personal examination of a specimen of *T. zugmayeri* in the Quetta Museum that the species is quite distinct from *T. marmorata*.

The description of the specimens obtained by us agrees closely with that of *T. zugmayeri* Engelhart, although there are the following points of difference. The second dorsal fin in our specimens is from half to two-thirds the size of the first dorsal, whereas in *T. zugmayeri* it is nearly three-fourths of that fin in size. Secondly, the distance between the outer margins of the eyes in our specimens is not equal to the distance between the eye and the body edge, whereas in *T. zugmayeri*, it is equal to the latter dimension.

The foregoing points of differences do not, however, appear to be sufficiently distinctive to justify the creation of a new species, and hence we are assigning the Bombay specimens to *T. zugmayeri*. We are, however, describing the species in greater detail, as Engelhart's account of it is very brief, dealing mainly with features distinctive from those of *T. marmorata* Risso.

The disc is subcircular. It is a little broader than long. The tail (the portion of the body behind the disc) is as long as, or slightly longer than, the disc. Starting at a point slightly ahead of the second dorsal origin, two skinny keels run along the sides of the tail to terminate on

<sup>1</sup> Prashad, B., *Rec. Ind. Mus.* XIX, pp. 98-99 (1920).

either side of the caudal fin a short distance behind its origin. The snout has a rounded anterior margin. Its length (in front of the interorbital line) is only slightly greater than the interorbital distance. The eyes are small and oval in outline. The iris is pale green and the pupil triangular, with its apex directed below. There is a very small superior protective flap.

Spiracles, which are more or less rounded in outline<sup>1</sup> are situated at least one orbital diameter behind the eyes and are from two to three times as large as they are. They have a slightly oblique axis. Each spiracular valve is a thick skinny fold beset posteriorly with eight very small papillae. The medial and posterior rims of the spiracles are studded with a single row of very small, conical warts. Nostrils are fairly prominent. The anterior nasal valves are confluent, forming a thick, broad quadrangular flap with a small median, backwardly directed, lobe-like projection. The latter merges behind into a median raphe, which is continued posteriorly into the upper lip. The anterior nasal flap does not cover the upper jaw. Each posterior nasal valve has a free, triangular, lobe-like section directed postero-laterally and an anterior section curving outwards and forwards in a half-loop to merge into the antero-lateral margin of the nostril. The mouth is small, gently arched and situated between two deep longitudinal folds. The teeth are arranged in pavement pattern. They are small, delicate and fragile, with sharp, slender cusps directed backwards. The dental plates do not extend along the entire length of the jaws, but are deficient laterally. They are small, nearly flat and without any angularities. Gill-openings are fairly big and semi-lunar in outline. The last pair is the smallest. The rows of gill-slit are more convergent posteriorly.

*Fins.*—More than half the base of the first dorsal fin is situated above the posterior extremity of the base of the pelvic. It is from one and half times to twice as large as the second dorsal, which is situated almost midway between the posterior end of the base of the first dorsal and the root of the caudal. The shape of the two dorsals is similar. The caudal fin is a single triangular flap with rounded angles, the lower angle being more rounded than the upper. The pelvic fins are large, with wide bases, convex outer borders and sharply pointed posterior tips. They arise slightly behind the posterior margin of the disc. Claspers are well developed, elongated, more or less cylindrical rods, with rather flattened, triangular posterior apices. They are swollen near their posterior ends. A well-defined, but tightly closed, longitudinal groove extends throughout the length of the dorsal surface of each clasper and there are two lateral open grooves extending along the posterior third of each.

Both the surfaces of the body are studded with minute flattened tubercles, these being especially concentrated along the margins of the disc and the lateral borders of the pelvic fins. Also, two rows of prominent skin pores are discernible ventrally near the lateral margins of the disc, commencing right from its anterior rim.

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<sup>1</sup> Engelhart describes the spiracles as being semilunar in outline, stating that their cavities are compressed inwards by thick, fleshy pads. We find, however, that the semilunar character of the spiracles is not a permanent feature, in view of the contractile nature of the spiracular valves.

*Colour.*—The dorsal surface is brown, marked all over with numerous, thick, chocolate-brown streaks and narrow blotches intermingled in an irregular network. The undersurface is, for the most part, white, being bespeckled occasionally with purplish pigment. The ventral margins of the disc and those of the pelvic fins are dark, chocolate-brown. The under surface of the caudal penduncle, too, is of a chocolate-brown hue.

*Size.*—Specimens of this species occur but rarely in Bombay waters. The description given above pertains to a male specimen (Plate XI, fig. 3) obtained at Sassoon Dock, Bombay, in September, 1941. It had the following dimensions :—

Total length	. . . . .	343 mm.
Length of disc.	. . . . .	168 mm.
Length of tail	. . . . .	175 mm.
Width of disc	. . . . .	182 mm.
Length of clasper	. . . . .	42 mm.

A female specimen obtained by us from Worli, Bombay, on April 9, 1944, measured 287 mm. in total length (Plate XI, fig. 2). Its pelvic fins were comparatively much smaller in size and almost completely fused with the sides of the body, there being hardly any free projecting portions behind their wide bases. There were, also, no flattened tubercles on either surface of the body as noted in the male specimen described before. The specimen was immature, the ovaries not having yet developed. Both the oviducts were, however, present though in an undeveloped state.

*Distribution.*—Bombay waters ; Mekran Coast, Baluchistan.

## EXPLANATION OF PLATE XI.

Elasmobranch fishes of Bombay.

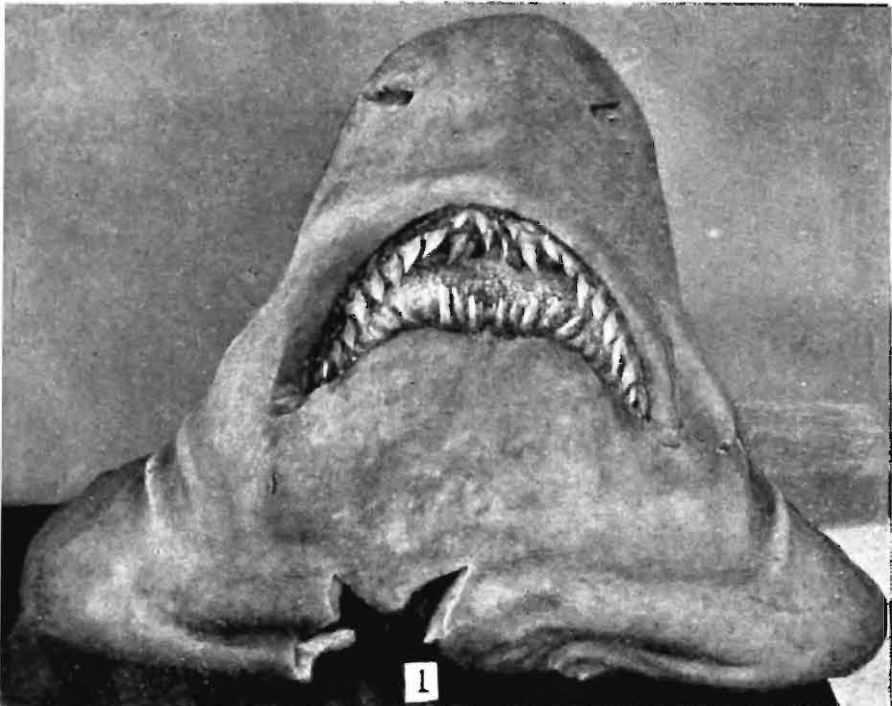
*Hemipristic elongatus* (Klunzinger.)

FIG. 1.—Ventral surface of head in a female specimen measuring 2·175 meters in total length.

*Torpedo zugmayeri* Engelhart.

FIG. 2.—Photograph of a female specimen.

FIG. 3.—Photograph of a male specimen.



**A CATALOGUE OF THE NAMED CEYLONESE TETRIGIDAE,  
EUMASTACIDAE AND ACRIDIDAE (INSECTA: ORTHOP-  
TERA) IN THE COLLECTION OF THE COLOMBO MUSEUM,  
WITH RECORDS OF DISTRIBUTION.**

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National Museums of Ceylon, Colombo.*

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INTRODUCTION.

In 1944, Mr. G. M. Henry, Assistant in Systematic Entomology, Colombo Museum, suggested that a Catalogue of Ceylon Insects should be published. Accordingly, a commencement was made with the family Mantidae and a joint paper by Mr. Henry and myself was prepared for publication, followed by a second paper on the family Tettigoniidae. At Mr. Henry's wish who has retired and is now living in England, the Director of National Museums, Ceylon, forwarded the typescript of these two papers to enable him to bring them up to date according to the latest literature. In the meantime, I have prepared the following paper which is based on the named material of the Ceylonese forms of Short-horned Grasshoppers belonging to the families Tetrigidae, Eumastacidae and Acrididae in the collection of the Colombo Museum. The total number recorded from Ceylon included in the present list is 114 species, distributed among 85 genera. The following catalogue is intended to facilitate the study of the known species and also to furnish a basis for their future study. It is desired to place on record observations on local distribution. The references to original descriptions of the species have been worked out as far as is practicable from the literature contained in the Colombo Museum Library.

Family TETRIGIDAE.

Genus *Deltonotus* Hancock, 1904.

*Deltonotus subcucullatus* (Walker).

1871. *Cat. Derm. Salt. Brit. Mus.* V, p. 830.

*Localities.*—Kandy; Hantane; Woodside, Urugala; West Haputale, Ohiya (Central Province); Rakwana (Sabaragamuwa Province); Badulla; Haputale; Punduloya (Uva Province); Ritigala (North Central Province).

*Type* in the British Museum (Natural History).

**Deltonotus humilis** Hebard.

1929. *Rev. Suisse Zool. Genève*. XXXVI, p. 568.

*Localities*.—Woodside, Urugala ; Mavusakanda, Gammaduwa (Central Province).

The *type-specimen* is a female collected at Elkhill, Nilgiris, South India, in January 1927. *Type* in the Geneva Museum.

Genus **Cladonotus** Saussure, 1861.

**Cladonotus humbertianus** Saussure.

1861. *Ann. Soc. Ent. Fr.* IV, p. 478.

*Localities*.—Kandy ; Mavusakanda, Gammaduwa (Central Province).

*Type* in the collection of the late De Saussure.

**Cladonotus latiramus** Hancock.

1904. *Spolia Zeylan. Colombo* II, pp. 114-116.

*Locality*.—Kandy (Central Province).

The *type-specimen* is a male collected by Mr. E. E. Green at Kandy, Ceylon in August, 1903. *Type* in the collection of Prof. Hancock.

Genus **Tettilobus** Hancock, 1909.

**Tettilobus pelops** (Walker).

1871. *Cat. Derm. Salt. Brit. Mus.* V, p. 843.

*Localities*.—Labugama (Western Province) ; Bulutota (Sabaragamuwa Province).

*Type* in the British Museum (Natural History).

Genus **Gignotettix** Hancock, 1909.

**Gignotettix burri** Hancock.

1909. *Trans. Ent. Soc. London*, p. 398, pl. xxii, fig. 5.

*Locality*.—Ohiya (Central Province).

The *type-specimen* is a male collected by Mr. E. E. Green at Punduloya, Ceylon. *Type* in the Oxford Museum.

Genus **Scelimena** Serville, 1839.

**Scelimena gavialis** Saussure.

1861. *Ann. Soc. Ent. Fr.* IV, p. 485.

*Localities*.—Labugama (Western Province) ; Kandy ; Woodside, Urugala ; Nitre Cave, Medamahanuwara ; Ohiya (Central Province) ; Balangoda ; Kitulgala ; Belihul Oya (Sabaragamuwa Province) ; Norwood ; Haldummulla ; Punduloya (Uva Province) ; Deniyaya (Southern Province).

**Scelimena logani** Hancock.1904. *Spolia Zeylan. Colombo II*, pp. 120-122.

*Localities.*—Kandy ; Sigiriya (Central Province) ; Balangoda ; Belihul Oya (Sabaragamuwa Province) ; Tissamaharama (Southern Province) ; Horovupotana ; Mihintale (North Central Province) ; Trincomalee ; Kantalai ; Kanniyai (Eastern Province).

*Type* in the Chicago Museum.

Genus **Gavialidium** Saussure, 1861.

**Gavialidium crocodilus** (Saussure).1861. *Ann. Soc. Ent. Fr.* IV, p. 481.

*Localities.*—Kandy ; Peradeniya ; Woodside, Urugala ; Mavusakanda, Gammaduwa ; Matale ; Madugoda (Central Province) ; Balangoda ; Kitulgala ; Belihul Oya ; Madola, Opanake (Sabaragamuwa Province) ; Haldummulla ; Wellawaya ; Bibile ; Punduloya (Uva Province).

*Type* in the Geneva Museum.

Genus **Thoradonta** Hancock, 1909.

**Thoradonta sinuata** Hancock.1915. *Rec. Ind. Mus.* XI, p. 81.

*Locality.*—Kandy (Central Province).

**Thoradonta spiculoba** Hancock.1912. *Mem. Dept. Agric. Ind. Ent.* IV, p. 138.

*Locality.*—Kandy (Central Province).

Genus **Eucriotettix** Hebard, 1929.

**Eucriotettix spinilobus** (Hancock).1904. *Spolia Zeylan. Colombo II*, pp. 129, 130.

*Localities.*—Colombo ; Labugama (Western Province) ; Kandy ; Woodside, Urugala (Central Province) ; Ratnapura ; Balangoda ; Kitulgala (Sabaragamuwa Province) ; Punduloya (Uva Province) ; Anuradhapura (North Central Province).

**Eucriotettix tricarinatus** (Bolivar).1887. *Ann. Soc. Ent. Belg.* XXXI, p. 224.

*Localities.*—Colombo ; Labugama ; Ingiriya (Western Province) ; Kandy (Central Province) ; Rakwana ; Belihul Oya (Sabaragamuwa Province) ; Wellawaya ; Kuda Oya (Uva Province) ; Horovupotana ; Mihintale (North Central Province) ; Tissamaharama (Southern Province) ; Kanniyai ; Trincomalee (Eastern Province).

Genus **Loxilobus** Hancock, 1904.

**Loxilobus acutus** Hancock.

1904. *Spolia Zeylan. Colombo* II, pp. 134, 135.

*Localities.*—Colombo ; Battaramulla ; Dehiwela ; Panadure (Western Province) ; Galle (Southern Province).

**Loxilobus hancocki** Kirby.

1910. *Syn. Cat. Orth.* III, p. 18.

*Localities.*—Peradeniya (Central Province) ; Punduloya (Uva Province).

Genus **Criotettix** Bolivar, 1887.

**Criotettix miliarius** (Bolivar).

1887. *Ann. Soc. Ent. Belg.* XXXI, p. 226.

*Localities.*—Colombo ; Kotte ; Battaramulla ; Dehiwela ; Panadure (Western Province) ; Kandy ; Ohiya (Central Province) ; Haldummulla ; Wellawaya (Uva Province) ; Balangoda (Sabaragamuwa Province).

*Type* in the collection of Brunner von Wattenwyl.

Genus **Systolederus** Bolivar, 1887.

**Systolederus greeni** Bolivar.

1901. *Ann. Soc. Ent. Fr.* LXX, p. 584.

*Localities.*—Labugama (Western Province) ; Kandy ; Woodside, Urugala ; Madugoda (Central Province) ; Balangoda ; Kitulgala ; Belihul Oya ; Ougaldowa ; Morningside, Rakwana (Sabaragamuwa Province) ; Maskeliya ; Badulla ; Punduloya (Uva Province).

*Type* in the collection of Pantel and Bolivar.

Genus **Eurymorphopus** Hancock, 1906.

**Eurymorphopus latilobus** Hancock.

1908. *Spolia Zeylan. Colombo* V, pp. 113, 114.

*Localities.*—Labugama (Western Province) ; Undugoda (Sabaragamuwa Province).

Genus **Spadotettix** Hancock, 1910.

**Spadotettix fletcheri** Hancock.

1910. *Spolia Zeylan. Colombo* VI, p. 147.

*Localities.*—Mavusakanda, Gammaduwa ; Madugoda (Central Province) ; Randeniya, Wellawaya ; Bintenne ; Madulsima ; Badulla (Uva Province) ; Trincomalee ; Kanniyai (Eastern Province) ; Habarane (North Central Province).

Genus **Apterotettix** Hancock, 1904.**Apterotettix obtusus** Hancock.1904. *Spolia Zeylan. Colombo* II, pp. 140, 141.

*Localities.*—Colombo (Western Province); Kandy; Peradeniya; Ohiya; Mavusakanda, Gammaduwa; Woodside, Urugala; Matale (Central Province).

Genus **Amphinotus** Hancock, 1915.**Amphinotus pygmaeus** Hancock.1915. *Rec. Ind. Mus.* XI, pp. 96, 97.

*Localities.*—Mavusakanda, Gammaduwa; Ohiya; Hakgala; Goatfell, Kandapola; Nuwara Eliya (Central Province); Haputale (Uva Province).

**Amphinotus muscosus** Henry.1933. *Ceylon J. Sci. (B)*. XVII, pp. 157-159.

*Localities.*—Mavusakanda, Gammaduwa (Central Province).

The *type-specimen* is a male captured at Mavusakanda Estate, Gammaduwa, Ceylon by Mr. G. M. Henry on 9-xi-1929. *Type* in the British Museum (Natural History).

Genus **Gingalina** Hebard, 1932.**Gingalina salebrosa** Hebard.1932. *Ceylon J. Sci. (B)*. XVII, pp. 23-25, fig. 2.

*Localities.*—Hakgala; Ohiya; Nuwara Eliya; Goatfell, Kandapola; Pidurutalagala (Central Province).

The *type-specimen* is a male collected by Mr. G. M. Henry at Nuwara Eliya, Ceylon on 12-v-1927. *Type* in the British Museum (Natural History).

Genus **Mazarredia** Bolivar, 1887.**Mazarredia insularis** Bolivar.1887. *Ann. Soc. Ent. Belg.* XXXI, p. 239.

*Localities.*—Peradeniya; Madugoda; Woodside, Urugala; Mavusakanda, Gammaduwa; Matale (Central Province); Rakwana; Belihul Oya; Ougaldowa; Madola, Opanake (Sabaragamuwa Province); Punduloya (Uva Province).

**Mazarredia sculpta** Bolivar.1887. *Ann. Soc. Ent. Belg.* XXXI, p. 238.

*Locality.*—Murunkan (Northern Province).

*Type* in the collection of Brunner von Wattenwyl.

Genus **Xistra** Bolivar, 1887.

**Xistra stylata** Hancock.

1907. *Trans. Ent. Soc. London*, pp. 231, 232.

*Locality*.—Lubugama (Western Province).

The *type-specimen* is a female collected from Puttalam, Ceylon. *Type* in the Oxford Museum.

Genus **Acrydium** Geoffroy, 1762.

**Acrydium ceylonum** (Hancock).

1904. *Spolia Zeylan. Colombo* II, pp. 143, 144.

*Localities*.—Colombo ; Ingiriya (Western Province) ; Peradeniya (Central Province).

Genus **Paratettix** Bolivar, 1887.

**Paratettix cingalensis** (Walker).

1871. *Cat. Derm. Salt. Brit. Mus.* V, p. 827.

*Localities*.—Colombo ; Ingiriya ; Battaramulla (Western Province) ; Peradeniya ; Ohiya ; Hakgala (Central Province) ; Ratnapura ; Balangoda ; Rakwana (Sabaragamuwa Province) ; Bandarawela ; Wellawaya ; Lunugala (Uva Province) ; Deniyaya (Southern Province).

*Type* in the British Museum (Natural History).

Genus **Copotettix** Bolivar, 1887.

**Copotettix fossulatus** Bolivar.

1887. *Ann. Soc. Ent. Belg.* XXXI, p. 288.

*Localities*.—Vavuniya ; Marichchukaddi (Northern Province).

Genus **Hedotettix** Bolivar, 1887.

**Hedotettix attenuatus** Hancock.

1904. *Spolia Zeylan. Colombo* II, pp. 151, 152.

*Localities*.—Colombo ; Kotte (Western Province) ; Peradeniya (Central Province) ; Kitulgala (Sabaragamuwa Province) ; Bibile (Uva Province) ; Maha Oya (Eastern Province) ; Galle (Southern Province).

**Hedotettix gracilis** (De Haan).

1842. *Temn. Verh. Orth.* p. 169.

*Localities*.—Colombo ; Kotte (Western Province) ; Badulla ; Wellawaya (Uva Province) ; Peradeniya (Central Province) ; Kitulgala (Sabaragamuwa Province) ; Maha Oya (Eastern Province) ; Wirawila (Southern Province).

**Hedotettix gracilis** (Haan) var. **abortus** Hancock.1904. *Spolia Zeylan. Colombo* II, p. 151.

*Localities.*—Colombo ; Kotte (Western Province) ; Kandy (Central Province) ; Niroddumunai ; Trincomalee (Eastern Province).

Genus **Euparatettix** Hancock, 1904.**Euparatettix corpulentus** Hancock.1912. *Mem. Dept. Agric. Ind. Ent.* IV, p. 153.

*Localities.*—Kandy (Central Province) ; Wirawila (Southern Province) ; Niroddumunai ; Trincomalee (Eastern Province) ; Vavuniya ; Murunkan (Northern Province).

**Euparatettix personatus** (Bolivar).1887. *Ann. Soc. Ent. Belg.* XXXI, p. 278.

*Localities.*—Colombo ; Kotte ; Dehiwela ; Panadure (Western Province) ; Kandy ; Peradeniya ; Sigiriya (Central Province) ; Kitulgala (Sabaragamuwa Province) ; Maha Oya (Eastern Province).

**Euparatettix variabilis** (Bolivar).1887. *Ann. Soc. Ent. Belg.* XXXI, p. 276.

*Localities.*—Horovupotana (North Central Province) ; Wellawaya (Uva Province) ; Trincomalee (Eastern Province).

*Type* in the British Museum (Natural History).

Genus **Ergatettix** Kirby, 1914.**Ergatettix dorsifera** (Walker).1871. *Cat. Derm. Salt. Brit. Mus.* V, p. 825.

*Localities.*—Colombo (Western Province) ; Peradeniya (Central Province) ; Bibile (Uva Province) ; Trincomalee (Eastern Province).

*Type* in the British Museum (Natural History).

**Ergatettix nodulosus** (Hancock).1912. *Mem. Dept. Agric. Ind. Ent.* IV, p. 155.

*Localities.*—Dehiwela (Western Province) ; Elephant Pass (Northern Province).

## Family EUMASTACIDAE.

Genus **Phyllochoreia** Westwood, 1839.**Phyllochoreia equa** Burr.1899. *An. Soc. Esp. Madrid* XXVIII, p. 301.

*Localities.*—Woodside, Urugala ; Mavusakanda, Gammaduwa ; Madugoda (Central Province) ; Kalawewa (North Central Province) ; Marai Villu (North Western Province) ; Katagamuwa ; Butawa Modera (Southern Province) ; Trincomalee (Eastern Province) ; Vavuniya ; Puliyan-kulam (Northern Province).

*Type* in the Oxford Museum.

Genus **Orchetypus** Brunner von Wattenwyl, 1898.**Orchetypus rotundatus** Brunner von Wattenwyl.1898. *Abh. Senck. Ges.* XXIV, pp. 220, 221.

*Localities.*—Woodside, Urugala ; Mavusakanda, Gammaduwa ; Madugoda Ohiya ; Hakgala ; Nuwara Eliya (Central Province) ; Balangoda ; Rakwana (Sabaragamuwa Province) ; Deniyaya (Southern Province).

*Type* in the collection of Brunner von Wattenwyl.

**Orchetypus rugifrons** (Waterhouse).1914. *Faun. Brit. Ind. Orth.*, p. 81.

*Locality.*—Lubugama (Western Province).

*Type* in the British Museum (Natural History).

Genus **Burrinia** Bolivar y. Pieltain, 1930.**Burrinia humbertiana** (Saussure).1903. *Rev. Suisse. Zool. Genève* XI, p. 78.

*Localities.*—Marai Villu (North Western Province) ; Sigiriya (Central Province) ; Horovupotana ; Kalawewa (North Central Province) ; Balangoda (Sabaragamuwa Province) ; Katagamuwa (Southern Province) ; Tennamarawadi ; Trincomalee (Eastern Province) ; Elephant Pass ; Vavuniya ; Marichchukaddi ; Illuppaikkadavi ; Mannar (Northern Province).

## Family ACRIDIDAE.

Subfamily *ACRIDINAE*.Genus **Acrida** Linnaeus, 1758.**Acrida exaltata** (Walker).1859. *Ann. Mag. Nat. Hist.* IV, p. 222.

*Localities.*—Colombo ; Kotte ; Dehiwela (Western Province) ; Peradeniya ; Ohiya ; Hakgala ; Mavusakanda, Gammaduwa ; Uda Pussellawa (Central Province) ; Marai Villu (North Western Province) ; Polonnaruwa ;

Horovupotana (North Central Province); Timbolketiya (Sabaragamuwa Province); Katagamuwa; Hambantota (Southern Province); Malpota; Welimada; Bandarawela; Bintenne; Galge; Wellawaya; Halgranoya (Uva Province); Kantalai; Kanniyai; Niroddumunai; Trincomalee; Maha Oya; Batticoola (Eastern Province); Elephant Pass; Murunkan (Northern Province).

*Type* in the British Museum (Natural History).

Genus **Acridella** Bolivar, 1893.

**Acridella indica** Bolivar.

1901. *Ann. Soc. Ent. Fr.* LXX, p. 589.

*Localities*.—Marai Villu (North Western Province); Anuradhapura (North Central Province); Galge; Tellula (Uva Province); Butawa Modera; Katagamuwa; Talgasmankada; Villapalawewa (Southern Province); Bagura; Mudamkulam (Eastern Province); Paranthan; Marichchukaddai; Talaimannar (Northern Province).

Genus **Gelastorrhinus** Burr, 1902.

**Gelastorrhinus semipictus** (Walker).

1870. *Cat. Derm. Salt. Brit. Mus.* III, pp. 512, 513.

*Localities*.—Kandy; Mavusākanda, Gammaduwa; Matale (Central Province); Belihul Oya (Sabaragamuwa Province); Randeniya; Wellawaya; Bintenne; Haldummulla (Uva Province).

*Type* in the British Museum (Natural History).

Genus **Psectrocnemus** Henry, 1940.

**Psectrocnemus longiceps** (Bolivar).

1901. *Ann. Soc. Ent. Fr.* LXX, p. 595.

*Localities*.—Marai Villu (North Western Province); Kopay, Jaffna (Northern Province).

*Type* in the collection of M. Pantel.

Genus **Pasiphimus** Bolivar, 1914.

**Pasiphimus sagittaeformis** Bolivar.

1914. *Trab. Mus. Cienc. Madrid* XX, p. 103.

*Localities*.—Bandarawela; Wellawaya; Bibile; Wewelakelle, Namunukula (Uva Province).

Genus **Leva** Bolivar, 1909.

**Leva indica** (Bolivar).

1901. *Ann. Soc. Ent. Fr.* LXX, p. 596.

*Locality*.—Murunkan (Northern Province).

**Leva cruciata** Bolivar.

1914. *Trab. Mus. Cienc. Madrid* XX, p. 65.

*Localities*.—Anuradhapura (North Central Province); Wellawaya (Uva Province); Niroddumunai; Trincomalee (Eastern Province); Vavuniya; Murunkan (Northern Province).

Genus **Wellawaya** Uvarov, 1927.

**Wellawaya greeni** Uvarov.

1927. *Ceylon J. Sci. (B)*. XIV, p. 98.

*Localities*.—Hakgala; West Haputale, Ohiya; Horton Plains (Central Province); Balangoda; Rakwana; Timbolketiya; Madola, Opanake (Sabaragamuwa Province); Haputale; Bandarawela; Koslanda; Bintenne; Wellawaya; Haldummulla (Uva Province).

The *type-specimen* is a male collected by Mr. E. E. Green at Wellawaya, Ceylon in November 1905. *Type* in the British Museum (Natural History).

Genus **Zygophlaeoba** Bolivar, 1901.

**Zygophlaeoba bolivari** Henry.

1933. *Ceylon J. Sci. (B)*. XVII, pp. 160-162, pl. xxviii, figs. 1, 2.

*Localities*.—Timbolketiya (Sabaragamuwa Province); Vilapalawewa; Wirawila (Southern Province); Galge; Bibile; Bintenne (Uva Province).

The *type-specimen* is a female collected by Mr. G. M. Henry at Bibile, Ceylon on 19-vii-1929. *Type* in the British Museum (Natural History). *Paratypes* in the Colombo Museum.

**Zygophlaeoba varicornis** Henry.

1933. *Ceylon J. Sci. (B)*. XVII, pp. 162-164, pl. xxviii, figs. 3-5.

*Localities*.—Marai Villu (North Western Province); Horovupotana (North Central Province); Wellawaya (Uva Province); Pulmoddai; Tennamaravadi; Kantalai; Kalkudah; Yan Oya; Trincomalee (Eastern Province); Elephant Pass; Vavuniya; Jaffna (Northern Province).

The *type-specimen* is a male collected by Mr. G. M. Henry at Kantalai, Ceylon on 16-vii-1927. *Type* in the British Museum (Natural History). *Paratypes* in the Colombo Museum.

Genus **Bababuddinia** Bolivar, 1918.

**Bababuddinia dimorpha** Henry.

1933. *Ceylon J. Sci. (B)*. XVII, pp. 164-166, pl. xxix, figs. 1-4.

*Localities*.—Mihintale (North Central Province); Kantalai (Eastern Province).

The *type-specimen* is a male collected by Mr. G. M. Henry at Kantalai, Ceylon on 16-vii-1927. *Type* in the British Museum (Natural History).

Genus **Pseudophaeoba** Bolivar, 1914.**Pseudophaeoba henryi** Bolivar.1914. *Trab. Mus. Cienc. Madrid* XX, p. 91.

*Localities.*—Kotte ; Battaramulla ; Labugama (Western Province) ; Kandy ; Peradeniya ; Mavusakanda, Gammaduwa ; Woodside, Urugala ; Matale (Central Province) ; Kurunegala (North Western Province) ; Ritigala (North Central Province) ; Rakwana ; Madola, Opanake (Sabaragamuwa Province) ; Badulla ; Bintenne (Uva Province).

Genus **Paraduronia** Bolivar, 1909.**Paraduronia simoni** (Bolivar).1901. *Ann. Soc. Ent. Fr.* LXX, p. 593.

*Localities.*—Horton Plains ; Nuwara Eliya (Central Province).  
*Type* in the collection of Dr. Bolivar.

Genus **Aeolopus** Fieber, 1853.**Aeolopus tamulus** (Fabricius).1798. *Ent. Syst. Suppl.* p. 195.

*Localities.*—Colombo ; Kotte (Western Province) ; Mavusakanda ; Gammaduwa (Central Province) ; Marai Villu (North Western Province) ; Mihintale ; Horovupotana (North Central Province) ; Yala (Southern Province) ; Pulmoddai ; Trincomalee (Eastern Province) ; Murunkan ; Elephant Pass (Northern Province).

*Type* in the British Museum (Natural History).

Genus **Aulacobothrus** Bolivar, 1901.**Aulacobothrus luteipes** (Walker).1871. *Cat. Derm. Salt. Brit. Mus.* V, *Suppl.* p. 82.

*Localities.*—Kandy ; Hakgala ; Uda Pussellawa ; Sigiriya (Central Province) ; Marai Villu (North Western Province) ; Anuradhapura ; Polonnaruwa ; Mihintale (North Central Province) ; Randeniya ; Wellawaya ; Bibile ; Bintenne ; Galge ; Tellula ; Oodoowerre, Demodera (Uva Province) ; Belihul Oya (Sabaragamuwa Province) ; Katagamuwa ; Talgasmankada ; Hiniduma ; Yala (Southern Province) ; Pullumalai ; Kantalai ; Kalkudah ; Trincomalee (Eastern Province) ; Cheddikulam (Northern Province).

*Type* in the British Museum (Natural History).

Subfamily *OEDIPODINAE*.Genus **Pternoscirta** Saussure, 1884.**Pternoscirta cinctifemur** (Walker).1859. *Ann. Mag. Nat. Hist.* IV, p. 223.

*Localities*.—Kandy ; Mavusakanda, Gammaduwa ; Uda Pussellawa ; Woodside, Urugala ; West Haputale, Ohiya ; Hatton ; Hakgala ; Matale (Central Province) ; Balangoda ; Ougaldowa ; Belihul Oya (Sabaragamawa Province) ; Maskeliya ; Punduloya ; Odoowerre, Demodera ; Kalugala, Namunukula ; Badulla (Uva Province).

*Type* in the British Museum (Natural History).

Genus **Chloebora** Saussure, 1884.

**Chloebora marshalli** (Henry).

1933. *Ceylon J. Sci. (B)*. XVII, pp. 166-169, pl. xxix, figs. 5-7.

*Locality*.—Bandarawela (Uva Province).

The *type-specimen* is a male collected by Mr. G. M. Henry at Bandarawela, Ceylon on 7-iv-1931. *Type* in the British Museum (Natural History)-*Paratypes* in the Colombo Museum.

Genus **Morphacris** Walker, 1871.

**Morphacris fuscata** Saussure var. **sulcata** (Thunberg).

1815. *Mem. Ac. Petersb.* V, p. 234.

*Localities*.—Colombo ; Kotte (Western Province) ; Anuradhapura ; Horovupotana (North Central Province) ; Kalkudah ; Niroddumunai, Trincomalee (Eastern Province) ; Vavuniya (Northern Province).

Genus **Dittopternis** Saussure, 1884.

**Dittopternis turbata** (Walker).

1870. *Cat. Derm. Salt. Brit. Mus.* IV, p. 776.

*Localities*.—Colombo ; Kotte (Western Province) ; Marai Villu (North Western Province) ; Kandy (Central Province) ; Ratnapura ; Balangoda ; Belihul Oya (Sabaragamaya Province) ; Mihintale (North Central Province) ; Hambantota ; Yala (Southern Province) ; Wellawaya ; Bandarawela ; Bintenne ; Haldummulla (Uva Province) ; Niroddumunai ; Trincomalee (Eastern Province) ; Elephant Pass ; Vavuniya ; Paranthan ; Talaimannar (Northern Province).

*Type* in the British Museum (Natural History).

Genus **Heteropternis** Stål, 1873.

**Heteropternis respondens** (Walker).

1859. *Ann. Mag. Nat. Hist.* IV, p. 223.

*Localities*.—Woodside, Urugala ; Mavusakanda, Gammaduwa Ohiya ; Hakgala ; Uda Pussellawa (Central Province) ; Bandarawela Maskeliya (Uva Province).

*Type* in the British Museum (Natural History).

Genus **Oedaleus** Fieber, 1853.

**Oedaleus abruptus** (Thunberg).

1815. *Mem. Ac. Petersb.* V, p. 233.

*Localities.*—Colombo (Western Province); Katugastota; Peradeniya; Ohiya; Woodside, Urugala; Uda Pussellawa; Horton Plains (Central Province); Horovupotana (North Central Province); Welimada; Galge; Bandarawela (Uva Province); Butawa Modera (Southern Province); Niroddumunai; Trincomalee; Kumena Wewa (Eastern Province); Marichchukaddi; Jaffna (Northern Province).

Genus **Gastrimargus** Saussure, 1884.

**Gastrimargus africanus** Saussure var. **orientalis** Sjostedt.

1928. *Sv. Ak. Handl.* VI, p. 41.

*Localities.*—Colombo; Kotte (Western Province); Kandy; Hantane; Hakgala; Ohiya; Woodside, Urugala; Movusakanda, Gammaduwa; Matale; Uda Pussellawa; Horton Plains (Central Province); Bandarawela; Welimada; Haldummulla; Halgranoya; Wellawaya; Bintenne; Badulla (Uva Province); Horovupotana (North Central Province); Pulmoddai; Trincomalee (Eastern Province); Vavuniya; Cheddikulam (Northern Province).

Genus **Trilophidia** Stål, 1873.

**Trilophidia ceylonica** Saussure.

1884. *Mém. Soc. Genève* XXVIII, p. 158.

*Localities.*—Colombo; Kotte; Battaramulla; Labugama (Western Province); Kandy; Horton Plains; Peradeniya; Hantane; Uda Pussellawa (Central Province); Anuradhapura; Mihintale (North Central Province); Belihul Oya (Sabaragamuwa Province); Deniyaya; Katalgamuwa (Southern Province); Wellawaya; Bintenne; Lunugala (Uva Province); Kantalai; Tennamaravadi; Trincomalee; Maha Oya; Batticaloa (Eastern Province); Vavuniya; Marichchukaddi; Murunkan (Northern Province).

*Type* in the British Museum (Natural History).

Genus **Acrotylus** Fieber, 1853.

**Acrotylus humbertianus** Saussure.

1884. *Mém. Soc. Genève* XXVIII, p. 189.

*Localities.*—Colombo (Western Province); Kandy; Hantane; Woodside, Urugala; Peradeniya (Central Province); Bintenne; Lunugala (Uva Province); Butawa Modera; Yala (Southern Province); Niroddumunai; Trincomalee (Eastern Province); Elephant Pass; Vavuniya; Murunkan; Marichchukaddi; Talaimannar (Northern Province).

Subfamily *PYRGOMORPHINAE*.Genus **Aularches** Stål, 1873.**Aularches miliaris** (Linnaeus).1758. *Syst. Nat.* (ed. 10), I, p. 432.

*Localities*.—Madampe ; Wellawa (North Western Province) ; Kandy ; Horton Plains ; Woodside, Urugala ; Mavusakanda, Gammaduwa (Central Province) ; Ambepussa (Sabaragamuwa Province) ; Haldummulla ; Wellawaya ; Badulla (Uva Province) ; Pulumalai (Eastern Province).

Genus **Atractomorpha** Saussure, 1861.**Atractomorpha crenulata** (Fabricius).1793. *Ent. Syst.* II, p. 28.

*Localities*.—Colombo ; Kotte ; Labugama (Western Province) ; Kandy ; Peradeniya ; Woodside, Urugala ; Mavusakanda, Gammaduwa (Central Province) ; Ratnapura ; Balangoda (Subaragamuwa Province) ; Mihintale (North Central Province) ; Wellawaya ; Bandarawela ; Bibile ; Maskeliya (Uva Province) ; Katagamuwa ; Yala (Southern Province) ; Pulmoddai ; Andankulam ; Trincomalee (Eastern Province) ; Murunkan ; Jaffna ; Cheddikulam ; Marichchukaddi ; Talaimannar (Northern Province).

Genus **Orthacris** Bolivar, 1884.**Orthacris filiformis** Bolivar.1884. *An. Soc. Esp. Madrid* XIII, pp. 439, 496.

*Localities*.—Kotte ; Battaramulla ; Dehiwela (Western Province) ; Matale (Central Province) ; Anuradhapura ; Polonnaruwa (North Central Province) ; Warahamankada ; Katagamuwa ; Butawa Modera ; Yala (Southern Province) ; Timbolketiya (Sabaragamuwa Province) ; Niroddumunai ; Tennamaravadi ; Kanniyai ; Trincomalee ; Kalkudah (Eastern Province) ; Elephant Pass ; Marichchukaddi ; Murunkan ; Talaimannar (Northern Province).

*Type* in the collection of Brunner von Wattenwyl.

Genus **Rakwana** Henry, 1933.**Rakwana ornata** Henry.1933. *Ceylon J. Sci.* (B). XVII, pp. 170, 171, pl. xxx, figs. 1-4.

*Localities*.—Rakwana ; Kitulgala (Sabaragamuwa Province).

The *type-specimen* is a male collected by Mr. G. M. Henry at Rakwana, Ceylon on 2.v.1929. *Type* in the British Museum (Natural History). *Paratypes* in the Colombo Museum.

Subfamily *CATANTOPINAE*.Genus **Euthymia** Stål, 1875.**Euthymia finoti** Kirby.1914. *Faun. Brit. Ind. Orth.* p. 197.*Locality*.—Marai Villu (North Western Province).The *type-specimen* is a female collected at Trincomalee, Ceylon. *Type* in the British Museum (Natural History).**Euthymia kirbyi** Finot.1903. *Ann. Soc. Ent. Fr.* LXXI, pp. 629, 630.*Locality*.—Labugama (Western Province).Genus **Tarbaleus** Brunner von Wattenwyl, 1898.**Tarbaleus cingalensis** Kirby.1914. *Faun. Brit. Ind. Orth.* p. 201.*Localities*.—Woodside, Urugala ; Madugoda (Central Province) ; Glenmore, Haputale (Uva Province).The *type-specimen* is a female collected by Mr. E. E. Green at Punduloya, Ceylon in June 1903. *Type* in the British Museum (Natural History).**Tarbaleus gracilis** Uvarov.1927. *Ceylon J. Sci. (B)*. XIV, pp. 101, 102, pl. xii, fig. 2.*Localities*.—Ohiya ; Hakgala ; Goatfell, Kandapola ; Nuwara Eliya (Central Province).The *type-specimen* is a female collected by Mr. G. M. Henry at Hakgala, Ceylon on 5-iv-1924. *Type* in the British Museum (Natural History)**Tarbaleus crassibrachiatus** Henry.1933. *Ceylon J. Sci. (B)*. XVII, pp. 171-173, pl. xxxi, figs. 1, 2.*Locality*.—Labugama (Western Province).The *type-specimen* is a male captured in jungle by Mr. G. M. Henry at Labugama, Ceylon on 17-vi-1932. *Type* in the British Museum (Natural History).**Tarbaleus gammaduensis** Henry.1933. *Ceylon J. Sci. (B)*. XVII, pp. 173-176, pl. xxxi, figs. 3, 4.*Locality*.—Mavusakanda, Gammaduwa (Central Province).The *type-specimen* is a male collected by Mr. G. M. Henry at Mavusakanda Estate, Gammaduwa, Ceylon on 24-x-1932. *Type* in the British Museum (Natural History). *Paratypes* in the Colombo Museum.

Genus **Eliya** Uvarov, 1927.**Eliya pedestris** Uvarov.

1927. *Ceylon J. Sci. (B)*. XIV, pp. 103, 104, pl. xii, fig. 3.

*Localities*.—Woodside, Urugala ; Mavusakanda Gammaduwa ; Nuwara Eliya (Central Province).

The *type-specimen* is a female collected by Mr. G. M. Henry at Elk Plains, Nuwara Eliya, Ceylon on 5-v-1923. *Type* in the British Museum (Natural History). *Paratype* in the Colombo Museum.

**Eliya pictipes** Uvarov.

1927. *Ceylon J. Sci. (B)*. XIV, pp. 104, 105, pl. xii, fig. 4.

*Locality*.—Deniyaya (Southern Province).

The *type-specimen* is a female collected by Mr. G. M. Henry at Deniyaya, Ceylon on 18-ix-1923. *Type* in the British Museum (Natural History).

**Eliya gibbosa** Henry.

1933. *Ceylon J. Sci. (B)*. XVII, pp. 176-179, pl. xxxi, figs. 1-3.

*Localities*.—Kurunegala—Dambulla (North Western Province) ; Rakwana ; Timbolketiya (Sabaragamuwa Province) ; Wellawaya (Uva Province).

The *type-specimen* is a female captured in jungle by Mr. G. M. Henry at Rakwana, Ceylon on 4-vi-1929. *Type* in the British Museum (Natural History). *Paratype* in the Colombo Museum.

**Eliya venusta** Henry.

1933. *Ceylon J. Sci. (B)*. XVII, pp. 179-182, pl. xxxii, figs. 4, 5.

*Localities*.—Labugama (Western Province) ; Rakwana (Sabaragamuwa Province).

The *type-specimen* is a male captured in jungle undergrowth by Mr. G. M. Henry at Rakwana, Ceylon on 4-vi-1929. *Type* in the British Museum (Natural History). *Paratypes* in the Colombo Museum.

Genus **Cercina** Stål, 1878.**Cercina obtusa** Stål.

1878. *Bih. Sv. Ak. Handl.* V, pp. 49, 97.

*Localities*.—Ohiya, Hakgala ; Horton Plains ; Nuwara Eliya (Central Province).

*Type* in the collection of Brunner von Wattenwyl.

**Cercina phillipsi** Henry.

1933. *Ceylon J. Sci. (B)*. XVII, pp. 184-187, pl. xxxiii, figs. 1, 2.

*Localities*.—Mavusakanda, Gammaduwa ; Patnagala, Gammaduwa (Central Province) ; Punduloya (Uva Province).

The *type-specimen* is a male collected by Mr. G. M. Henry at Mavusakanda Estate, Gammaduwa, Ceylon on 1-viii-1932. *Type* in the British Museum (Natural History). *Paratypes* in the Colombo Museum.

Genus **Spathosternum** Krauss, 1877.

**Spathosternum prasiniferum** (Walker).

1871. *Cat. Derm. Salt. Brit. Mus.* V, Suppl. p. 65.

*Localities*.—Colombo ; Kotte (Western Province) ; Kandy ; Hakgala ; Woodside, Urugala ; Matale ; Uda Pussellawa ; Peradeniya ; Oriya (Central Province) ; Anuradhapura (North Central Province) ; Ratnapura (Sabaragamuwa Province) ; Bandarawela ; Welimada ; Galge ; Wellawaya ; Bintenne ; Maskeliya (Uva Province) ; Katagamuwa (Southern Province) ; Kanniyai ; Kantalai ; Kalkudah ; Trincomalee ; Batticaloa (Eastern Province).

*Type* in the British Museum (Natural History).

Genus **Tristria** Stål, 1873.

**Tristria pulvinata** (Uvarov).

1921. *Ann. Mag. Nat. Hist.* VII, p. 497.

*Localities*.—Marai Villu (North Western Province) ; Woodside, Urugala (Central Province) ; Ritigala (North Central Province) ; Balongoda (Sabaragamuwa Province) ; Bintenne ; Haldumulla ; Wellawaya ; Badulla (Uva Province) ; Katagamuwa (Southern Province) ; Kantalai ; Kalkudah ; Kumena Wewa (Eastern Province) ; Cheddikulam (Northern Province).

*Type* in the British Museum (Natural History).

Genus **Oxya** Serville, 1831.

**Oxya intricata** Stål.

1861. *Eugenie's Resa. Orth.* p. 335.

*Localities*.—Colombo ; Kotte (Western Province) ; Kandy (Central Province) ; Badulla (Uva Province).

**Oxya asinensis** Willemse.

1925. *Tijdschr. Ent. Amsterdam* LXVIII, p. 32.

*Localities*.—Kandy ; Peradeniya (Central Province) ; Balangoda (Sabaragamuwa Province) ; Maskeliya (Uva Province).

The *type-specimen* is a female collected at Periya Ghat, Malabar District, South India on 6-x-1917. *Type* in the collection of the Imperial Bureau of Entomology, London.

**Oxya nitidula** (Walker).

1870. *Cat. Derm. Salt. Brit. Mus.* IV, p. 631.

*Localities*.—Colombo ; Kotte (Western Province) ; Kandy ; Peradeniya (Central Province) ; Mihintale ; Horovupotana (North Central Province) ; Murunkan (Northern Province).

*Type* in the British Museum (Natural History).

Genus **Oxyrrhepes** Stål, 1873.

**Oxyrrhepes extensa** (Walker).

1859. *Ann. Mag. Nat. Hist.* IV, p. 222.

*Localities*.—Labugama (Western Province); Kandy; Mavusakanda Gammaduwa; Nitre Cave, Medamahanuwara (Central Province); Belihul Oya (Sabaragamuwa Province).

*Type* in the British Museum (Natural History).

Genus **Leptacris** Walker, 1870.

**Leptacris filiformis** Walker.

1870. *Cat. Derm. Salt. Brit. Mus.* IV, p. 676.

*Localities*.—Polonnaruwa (North Central Province); Haldummulla; Wellawaya; Bintenne (Uva Province); Kantalai (Eastern Province).

*Type* in the British Museum (Natural History).

Genus **Ischnacrida** Stål, 1873.

**Ischnacrida gracilis** Henry.

1933. *Ceylon J. Sci. (B)*. XVII, pp. 192-194, pl. xxxvi, figs. 1-4.

*Localities*.—Polonnaruwa (North Central Province); Randeniya Wellawaya; Bintenne; Galge (Uva Province).

The *type-specimen* is a male captured in a grassy glade in the Bintenne District about 12 miles east of Alutnuwara, Ceylon by Mr. G. M. Henry on 11-x-1928. *Type* in the British Museum (Natural History).

Genus **Ochlandriphaga** Henry, 1933.

**Ochlandriphaga xanthelytrana** Henry.

1933. *Ceylon J. Sci. (B)*. XVII, pp. 188, 189, pl. xxxiv, figs. 1-5.

*Locality*.—Labugama (Western Province).

The *type-specimen* is a male collected by Mr. G. M. Henry in jungle undergrowth at Labugama, Ceylon on 17-vi-1932. *Type* in the British Museum (Natural History). *Paratypes* in the Colombo Museum.

Genus **Bambusacris** Henry, 1933.

**Bambusacris greeni** Henry.

1933. *Ceylon J. Sci. (B)*. XVII, pp. 190-192, pl. xxxv, figs. 1-6.

*Locality*.—Labugama (Western Province).

The *type-specimen* is a male collected by Mr. G. M. Henry at Labugama, Ceylon on 2-viii-1932. *Type* in the British Museum (Natural History). *Paratype* in the Colombo Museum.

Genus **Urugalla** Uvarov, 1927.

**Urugalla pearsoni** Uvarov.

1927. *Ceylon J. Sci. (B)*. XIV, pp. 106, 107, pl. xii, figs. 5, 6.

*Localities*.—Woodside, Urugala; Mavusakanda, Gammaduwa (Central Province).

The *type-specimen* is a male collected by Mr. G. M. Henry at Woodside, Urugala, Ceylon on 17-iv-1924. *Type* in the British Museum (Natural History).

Genus **Acaeropa** Uvarov, 1927.

**Acaeropa indica** (Bolivar).

1884. *An. Soc. Esp. Madrid* XIII, p. 492.

*Localities*.—West Haputale, Ohiya ; Hakgala ; Horton Plains ; Elk Plains ; Sita Eliya ; Nuwara Eliya ; Ambawela (Central Province) ; Kitulgala (Sabaragamuwa Province) ; Haputale ; Muskeliya (Uva Province).

*Type* in the collection of Brunner von Wattenwyl.

Genus **Mesambria** Stål, 1878.

**Mesambria dubia** (Walker).

1870. *Cat. Derm. Salt. Brit. Mus.* IV, p. 632.

*Localities*.—Labugama (Western Province) ; Kandy ; Woodside, Urugala ; Mavusakanda, Gammaduwa ; West Haputale, Ohiya ; Madugoda (Central Province) ; Ratnapura ; Balangoda ; Kitulgala ; Rakwana ; Timbolketiya ; Opanake (Sabaragamuwa Province) ; Deniyaya ; Hiniduma (Southern Province) ; Haputale ; Bibile ; Punduloya ; Bintenne (Uva Province).

*Type* in the British Museum (Natural History).

Genus **Genimen** Bolivar, 1918.

**Genimen ceylonicum** Uvarov.

1927. *Ceylon J. Sci. (B)*. XIV, p. 110, pl. xii, figs. 7, 8.

*Localities*.—Labugama (Western Province) ; Kandy ; Lady Horton's Drive (Central Province) ; Kitulgala ; Madola, Opanake ; Timbolketiya (Sabaragamuwa Province) ; Deniyaya (Southern Province).

The *type-specimen* is a male collected by Mr. G. M. Henry at Kandy, Ceylon on 7-i-1924. *Type* in the British Museum (Natural History).

Genus **Genimenoides** Henry, 1934.

**Genimenoides subapterum** (Uvarov).

1927. *Ceylon J. Sci. (B)*. XIV, p. 111, pl. xii, fig. 9.

*Localities*.—Labugama ; Battaramulla (Western Province) ; Rakwana Balangoda ; Timbolketiya (Sabaragamuwa Province) ; Deniyaya (Southern Province) ; Wellawaya (Uva Province) ; Kanniyai ; Trincomalee (Eastern Province).

The *type-specimen* is a female collected by Mr. G. M. Henry at Kotte, Ceylon on 25-iii-1921. *Type* in the British Museum (Natural History).

**Genimenoides coloratum** Henry.

1934. *Ceylon J. Sci. (B)*. XVIII, pp. 196, 197, pl. xiv, figs. 3-6.

*Localities*.—Lady Horton's Drive, Kandy (Central Province).

The *type-specimen* is a male collected by Mr. G. M. Henry at Lady Horton's Drive, Kandy, Ceylon on 13-v-1933. *Type* in the British Museum (Natural History).

Genus **Anacridium** Uvarov, 1923.

**Anacridium flavescens** (Fabricius).

1793. *Ent. Syst.* II, p. 52.

*Localities*.—Marai Villu (North Western Province); Gadapotugala (North Central Province); Tissamarahama; Katagamawa; Yala (Southern Province); Bibile; Wellawaya (Uva Province); Marichchukaddi (Northern Province).

Genus **Patanga** Uvarov, 1923.

**Patanga succincta** (Linnaeus).

1763. *Amoen. Acad.* VI, p. 398.

*Localities*.—Matale (Central Province); Polonnaruwa (North Central Province).

Genus **Pachyacris** Uvarov, 1923.

**Pachyacris violascens** (Walker).

1870. *Cat. Derm. Salt. Brit. Mus.* III, pp. 587, 588.

*Localities*.—Dehiwela (Western Province); Kandy; Hantane; Horton Plains; Hakgala; Woodside, Urugala; Mavusakanda, Gammaduwa (Central Province); Bandarawela; Haldummulla; Badulla (Uva Province).

*Type* in the British Museum (Natural History).

Genus **Cyrtacanthacris** Walker, 1870.

**Cyrtacanthacris tatarica** (Linnaeus).

1758. *Syst. Nat.* (ed. 10), I, p. 432.

*Localities*.—Kotte; Battaramulla (Western Province); Kandy; Peradeniya; Mavusakanda, Gammaduwa; Woodside, Urugala (Central Province); Marai Villu (North Western Province); Polonnaruwa; Kalawewa (North Central Province); Hambantota; Wirawila; Katagamawa (Southern Province); Wellawaya; Randeniya; Bibile; Bintenne; Galge (Uva Province); Niroddumunai; Trincomalee (Eastern Province); Vavuniya; Murunkan (Northern Province).

Genus **Teratodes** Brulle, 1835.

**Teratodes monticollis** (Gray).

1832. *Griffith's Anim. Kingd.* XV, p. 215, pl. lxiv.

*Localities.*—Sigiriya (Central Province) ; Kekirawa (North Central Province).

*Type* in the British Museum (Natural History).

Genus **Pelecinotus** Bolivar, 1901.

**Pelecinotus lankae** Henry.

1933. *Ceylon J. Sci. (B).* XVII, pp. 195-197, pl. xxxvi, figs. 5-7.

*Localities.*—Marai Villu (North Western Province) ; Anuradhapura (North Central Province) ; Marichchukaddi ; Vavuniya (Northern Province).

The *type-specimen* is a male collected by Mr. G. M. Henry at Marichchukaddi, Ceylon on 15-iii-1933. *Type* in the British Museum (Natural History). *Paratypes* in the Colombo Museum.

Genus **Eucoptacra** Bolivar, 1901.

**Eucoptacra ceylonica** Kirby.

1914. *Faun. Brit. Ind. Orth.* p. 241.

*Localities.*—Labugama ; Battaramulla ; Puwakpitiya (Western Province) ; Kandy ; Madugoda ; Uda Pussellawa ; Lady Horton's Drive ; Rattota ; Mavusakanda, Gammaduwa (Central Province) ; Anuradhapura ; Mihintale ; Horovupotana ; Ritigala (North Central Province) ; Balangoda ; Madola, Opanake ; Ratnapura ; Rakwana ; Belihul Oya ; Timbolketiya (Sabaragamuwa Province) ; Tissamaharama ; Katagamuwa ; Butawa Modera ; Deniyaya (Southern Province) ; Wellawaya ; Bibile ; Bintenne (Uva Province) ; Kantalai ; Tennamaravadi ; Pulmoddai ; Yan Oya ; Trincomalee (Eastern Province) ; Elephant Pass ; Vavuniya (Northern Province).

*Type* in the British Museum (Natural History)

Genus **Epistaurus** Bolivar, 1889.

**Epistaurus sinetyi** Bolivar.

1901. *Ann. Soc. Ent. Fr.* LXX, p. 623.

*Localities.*—Battaramulla (Western Province) ; Anuradhapura (North Central Province) ; Katagamuwa ; Talgasmankada (Southern Province).

*Type* in the collection of Dr. Bolivar.

Genus **Pirithoicus** Uvarov, 1940.

**Pirithoicus ramachendrai** (Bolivar).

1918. *Rev. Ac. Cienc. Madrid.* XVI, p. 403.

*Localities.*—Marai Villu (North Western Province) ; Kandy ; Madugoda ; Mavusakanda, Gammaduwa (Central Province) ; Horovupotana (North Central Province) ; Bintenne ; Randeniya ; Wellawaya ; Oodowerre, Demodera (Uva Province) ; Katagamuwa (Southern Province) ; Kanniyai, Niroddumunai ; Tennamaravadi ; Trincomalee (Eastern Province) ; Vavuniya ; Cheddikulam ; Marichchukaddi (Northern Province).

Genus **Catantops** Schaum, 1853.

**Catantops splendens** (Thunberg).

1815. *Mem. Ac. Petersb.* V, p. 236.

*Localities.*—Labugama (Western Province) ; Marai Villu (North Western Province) ; Woodside, Urugala ; Hantane ; Mavusakanda, Gammaduwa (Central Province) ; Horovupotana (North Central Province) ; Ratnapura ; Rakwana ; Madola, Opanake ; Timbolketiya (Sabaragamuwa Province) ; Wellawaya ; Bintenne ; Galge ; Maskeliya (Uva Province) ; Marichchukaddi (Northern Province).

**Catantops innotabile** (Walker).

1870. *Cat. Derm. Salt. Brit. Mus.* IV, p. 629.

*Localities.*—Colombo ; Battaramulla (Western Province) ; Mihintale ; Anuradhapura ; Polonnaruwa ; Horovupotana (North Central Province) ; Galge ; Randeniya ; Wellawaya (Uva Province) ; Tissamaharama ; Warahamankada ; Katagamuwa (Southern Province) ; Niroddumunai ; Trincomalee ; Kalkudah ; Kumena Wewa ; Tirukovil (Eastern Province) ; Marichchukaddi ; Cheddikulam (Northern Province).

Genus **Belonocnemis** Bolivar, 1914.

**Belonocnemis elegantulus** (Bolivar).

1908. *Mem. Soc. Ent. Belg.* XVI, p. 118.

*Localities.*—Randeniya ; Wellawaya (Uva Province).

Genus **Thisoicetrus** Brunner von Wattenwyl, 1898.

**Thisoicetrus pulcher** (Bolivar).

1901. *Ann. Soc. Ent. Fr.* LXX, p. 630.

*Localities.*—Marai Villu (North Western Province) ; Horovupotana ; Kalawewa (North Central Province) ; Bintenne (Uva Province) ; Pulmoddai ; Tennamaravadi ; Trincomalee ; Kantalai ; Kalkudah ; Arugam Bay (Eastern Province) ; Vavuniya ; Madawachchi (Northern Province).

*Type* in the collection of Pantel and Bolivar.

Genus **Tyloptropidius** Stål, 1873.**Tyloptropidius varicornis** (Walker).1870. *Cat. Derm. Salt. Brit. Mus.* IV, p. 667.

*Localities.*—Marai Villu (North Western Province) ; Woodside, Urugala ; Uda Pussellawa (Central Province) ; Polonnaruwa (North Central Province) ; Balangoda ; Belihul Oya ; Timbolketiya (Sabaragamuwa Province) ; Wellawaya ; Band arawela ; Haldummulla ; Kalugala, Namunukula ; Bintenne ; Galge (Uva Province) ; Marichchukaddi (Northern Province).

*Type* in the British Museum (Natural History).

Genus **Euprepocnemis** Stål, 1873.**Euprepocnemis alacris** (Serville).1839. *Hist. Nat. Ins. Orth.* p. 682.

*Localities.*—Colombo ; Battaramulla (Western Province) ; Polpitiya (North Western Province) ; Kandy ; Peradeniya ; Ohiya ; Hakgala ; Uda Pussellawa : Mavusakanda, Gammaduwa ; Nuwara Eliya ; Ragalla (Central Province) ; Polonnaruwa ; Kalawewa (North Central Province) ; Miyanapalawa (Sabaragamuwa Province) ; Deniyaya ; Hiniduma ; Katagamawa (Southern Province) ; Wellawaya ; Punduloya ; Oodoo-  
werre, Demodera ; Badulla (Uva Province) ; Kantalai ; Kumuna Wewa (Eastern Province) ; Vavuniya ; Madawachchi (Northern Province).

*Type* in the Paris Museum.

**Euprepocnemis kalkudensis** Henry.1937. *Ceylon J. Sci. (B).* XX, pp. 343, 344, pl. xiv, figs. 1-4.

*Localities.*—Kalkudah (Eastern Province) ; Talaimannar (Northern Province).

The *type-specimen* is a male collected by Mr. G. M. Henry in scrub jungle at Kalkudah, Ceylon on 24-iv-1931. *Type* in the British Museum (Natural History).

Genus **Dubitacris** Henry, 1937.**Dubitacris robustus** Henry.1937. *Proc. Ent. Soc. London* VI, pp. 199, 200.

*Localities.*—Marai Villu (North Western Province) ; Anuradhapura ; Polonnaruwa ; Horovupotana ; Kalawewa (North Central Province) ; Niroddumunai ; Trincomalee (Eastern Province) ; Vavuniya (Northern Province).

The *type-specimen* is a female collected by Mr. G. M. Henry at Kalawewa, Ceylon on 25-i-1937. *Type* in the British Museum (Natural History). *Paratypes* in the Colombo Museum.



**SEX DIFFERENCES IN THE CHALIMUS AND ADULT FORMS OF  
*CALIGUS POLYCANTHI*, SP. NOV (CRUSTACEA : COPEPODA)  
PARASITIC ON *BALISTES MACULATUS* FROM MADRAS.**

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INTRODUCTION.

Over a dozen specimens of a caligid Copepod were found on the skin of *Balistes maculatus* caught on the Madras shore during February 1947. As these appear to be different from *Caligus balistae* (Steenstrup & Lutken) and distinct from other species of *Caligus*, recorded or described by Bassett-Smith, Scott, Leigh-Sharpe, Wilson and others, they are described as belonging to a new species, *Caligus polycanthi*. Since our knowledge of Copepods parasitic on Indian fishes is scanty, a detailed description of the adult female, and notes on the differences shown by the adult male (*allotype*) are given in the first section of this paper.

The *type-specimens* will be deposited in the collection of the Zoological Survey of India.

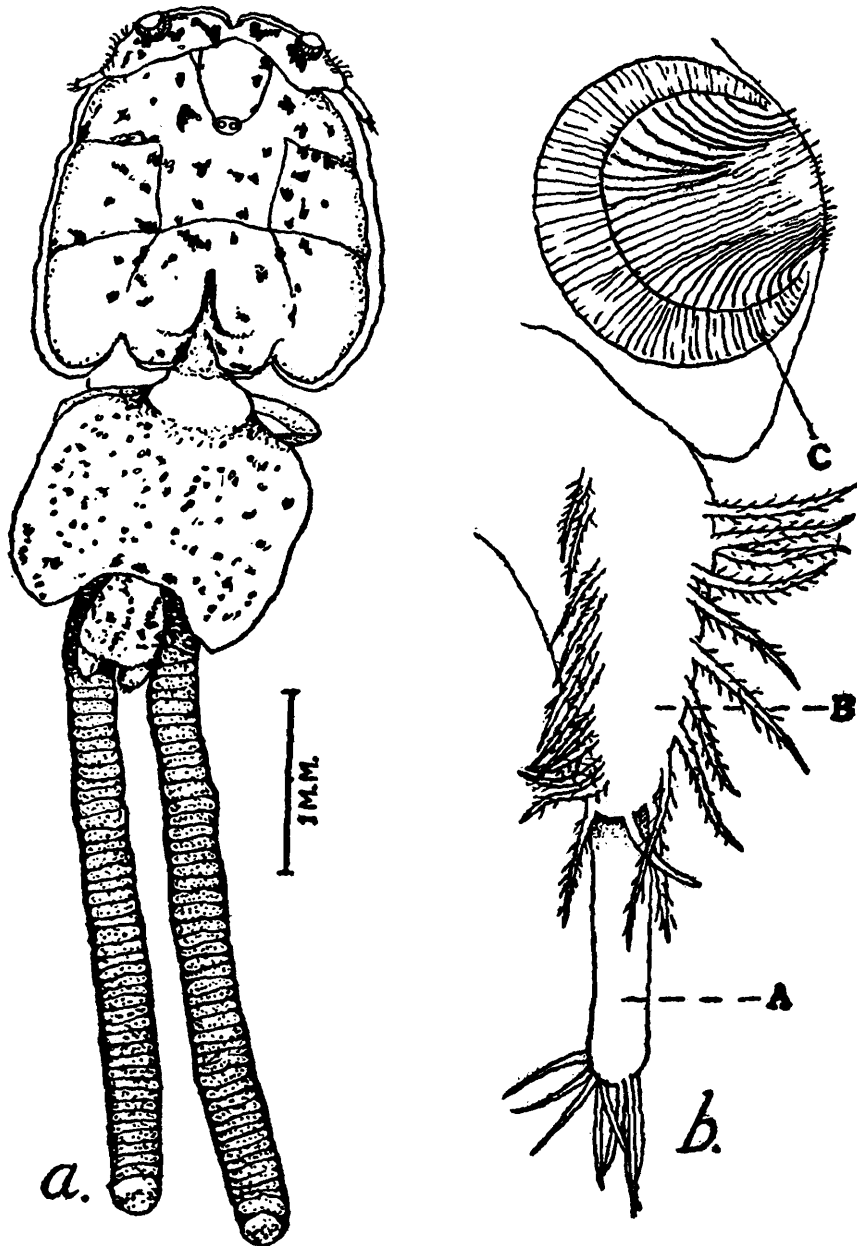
A careful study of the specimens showed that four were egg-bearing females, two were adult females, and one was an adult male and the remaining six belonged to late Chalimus stages of development. Of the six immature forms, two were distinctly female and the others male. As in this species the adult male differs markedly from the female and as these differences could be made out even in the Chalimus stages of the two sexes, a detailed account of the sex dimorphism is given in the second section of this paper.

***Caligus polycanthi*, sp. nov.**

*Size : Adult Female*.—The entire body is 4 mm. long (excluding the anal setae and the egg strings) of which the carapace forms one half, being 2 mm. long. The carapace is nearly as broad as long but owing to the lateral edges being curved ventralwards it is somewhat elliptical in outline; dorsally it measures 1.5 mm. at the anterior quarter and 1.8 mm. at the posterior quarter of its length.

*Cephalothorax*.—The dorsal surface of the cephalothorax is of a dirty yellow colour speckled with reddish dots. The double median eye and the longitudinal and transverse grooves or fissures of the carapace can be seen. The frontal margin is formed by the anterior edges of the first antennae and the frontal plate. Medially there is a notch in the frontal plate, and is occupied by the frontal stalk in the Chalimus stage. The under surface of the dorsally convex carapace, is concave and this concavity facilitates a cupping adhesion to the host's skin. This is further aided by the edges of the carapace being extended into a

wide thin transparent membranous fringe. The posterior border of the carapace extends over the first two segments of the thorax and, being concave behind, exposes the third segment. The free or fourth segment forms a "waist", being constricted to a width of 0.18 mm. in front and twice as much behind. The genital segment (V and VI segments fused) is very prominent, being 1 mm. long medially and about 1.6 mm. broad. It has a quadrangular form but has its lateral edges convex, posterior margin concave and the hind corners extended behind as obtuse lobes. The posterior corner lobes bear the vestiges of the fifth legs, visible dorsally.

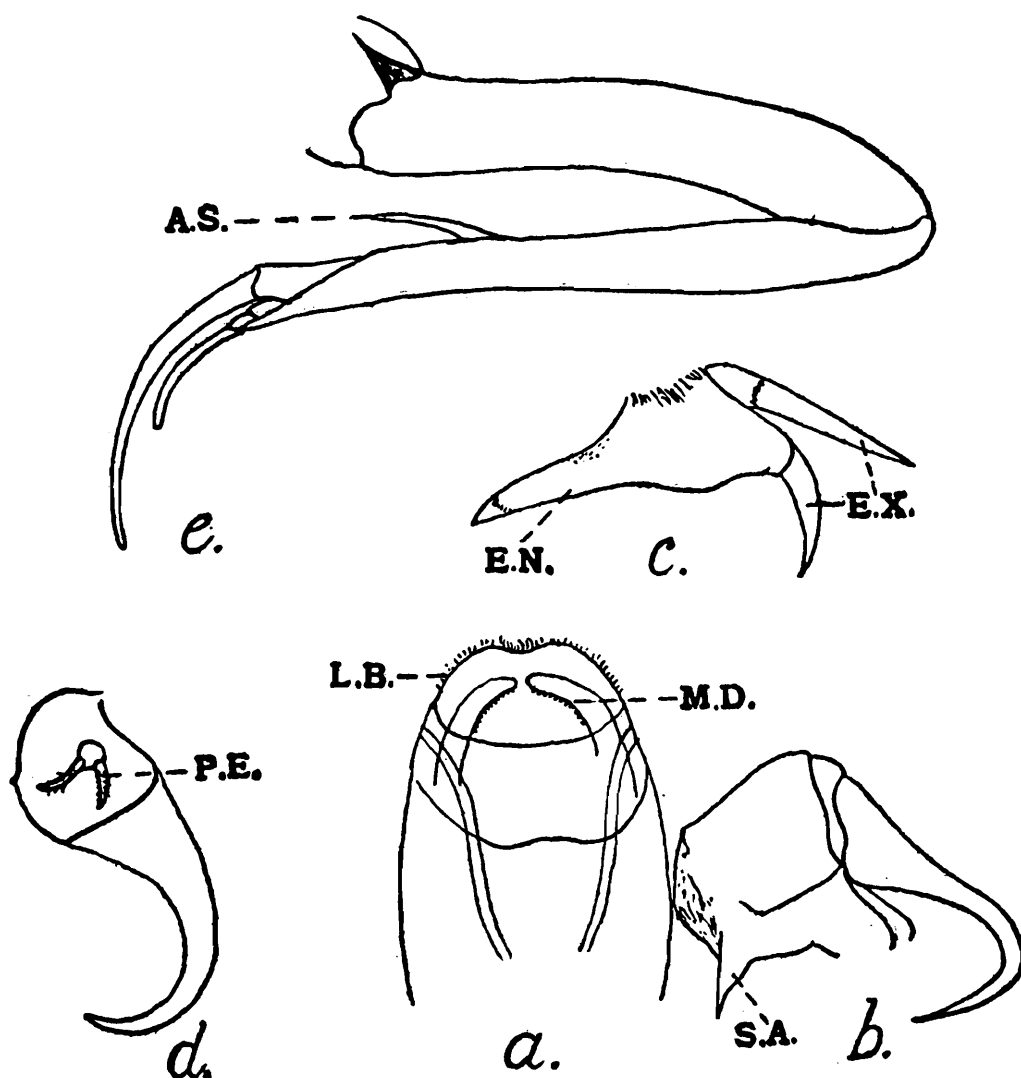


TEXT-FIG. 1.—*Caligus polycanthi*, sp. nov

a. Egg-bearing adult female; b. First antenna. A, distal segment bearing nine pines; B, middle segment bearing two rows of setae; C, basal segment bearing lunule.

*Appendages of head and thorax.*—The first antenna is very large, three-jointed and uniramous. The basal joint, which is continuous with the frontal plate, bears the large circular lunule. This sucking disc occupies nearly the whole width of the segment, the remaining portion of the segment is fringed with fine hairs. The second joint is as stout

as the first but tapers slightly at its distal end. This joint is furnished with two rows of forwardly directed setae, which though plumose, assist in adhesion to the host on account of their pointed and forward ends being buried in the skin of the host. Of the two rows, the more anterior has ten, and the other twelve setae, the more distal setae of each set being shorter and thinner than the rest. The third joint is short, slender and cylindrical and is articulated to the second joint a little before the distal tip. The round outer end of this joint bears nine spines of varying length and thickness. The second antenna is two-jointed. The basal joint is large and stout. It bears a thick, sharp-pointed spur directed obliquely backwards. The second joint is formed by a stout, recurved, sharp-pointed claw prehensile in character. The mandible is a scythe-shaped, curved blade whose cutting edge is finely serrated. The two mandibles curve towards each other at their inner tips and are held



TEXT-FIG. 2.—Cephalothoracic appendages of *Caligus polycanthi*, sp. nov.

a. Mouth tube ; b. Second antenna ; c. Second maxilla ; d. First maxilla ; e. First maxillipede.

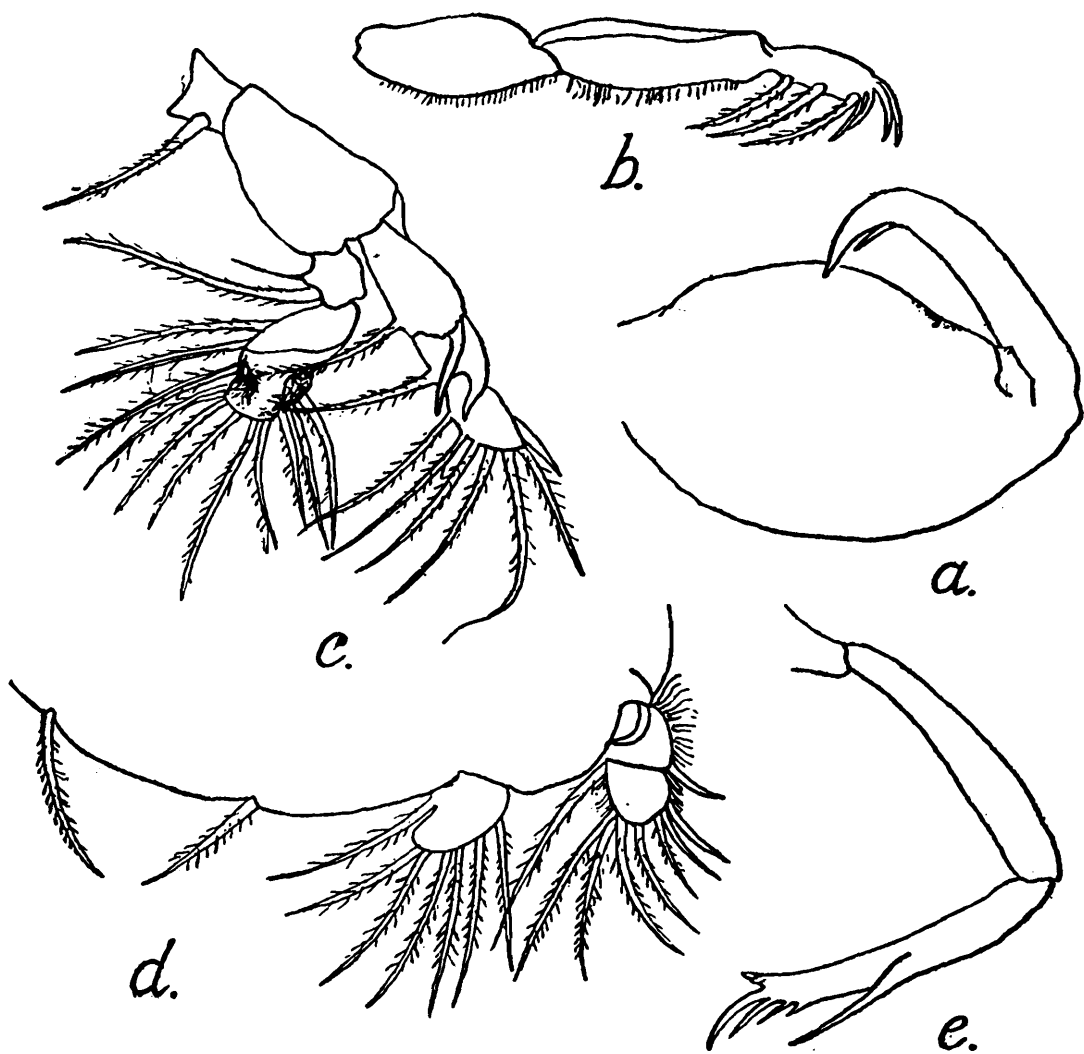
A.S., accessory spine of first maxillipede ;

E.N., endopod of second maxillae ;

A.S., accessory spine of first maxillipede ; E.N., endopod of second maxillae ; E.X., exopod of second maxilla ; L.B., labium of mouth tube ; M.D. mandible ; P.E., palp or exopod of first maxilla ; S.A., spur of second antenna.

within a short conical mouth tube stiffened by several chitinous rods. The lower edge of the tube can be distinguished as the labium. The first maxilla consists of a single joint and is attached more laterally than the other mouth parts. It is a long, sharp-pointed, recurved claw, smaller than the second antenna. On the inner aspect of its base is seen a pair of spines representing the exopod or palp of the appendage. The second maxilla is biramous and is attached close to the median line, though on the same level as the first maxilla. The endopod is long, stout and cylindrical and ends in a point. It is directed medially obliquely. The exopod consists of two long spine-like structures. These spines may be turned ventrally or outward. It is probable that the second maxilla with its sharp processes may serve to irritate the host-skin and cause bleeding.

The first maxillipede is attached further behind but more outwards. It is three-jointed. The basal joint, which is stout and short, confers great mobility on this appendage. The second and third joints are extremely long and setose. The last joint ends in two curved, finger-like processes, and bears a small accessory spine a little behind the tip. Of the two terminal processes, one is twice as long as the other. It is possible that, besides being flung out to hold on to the skin of the host



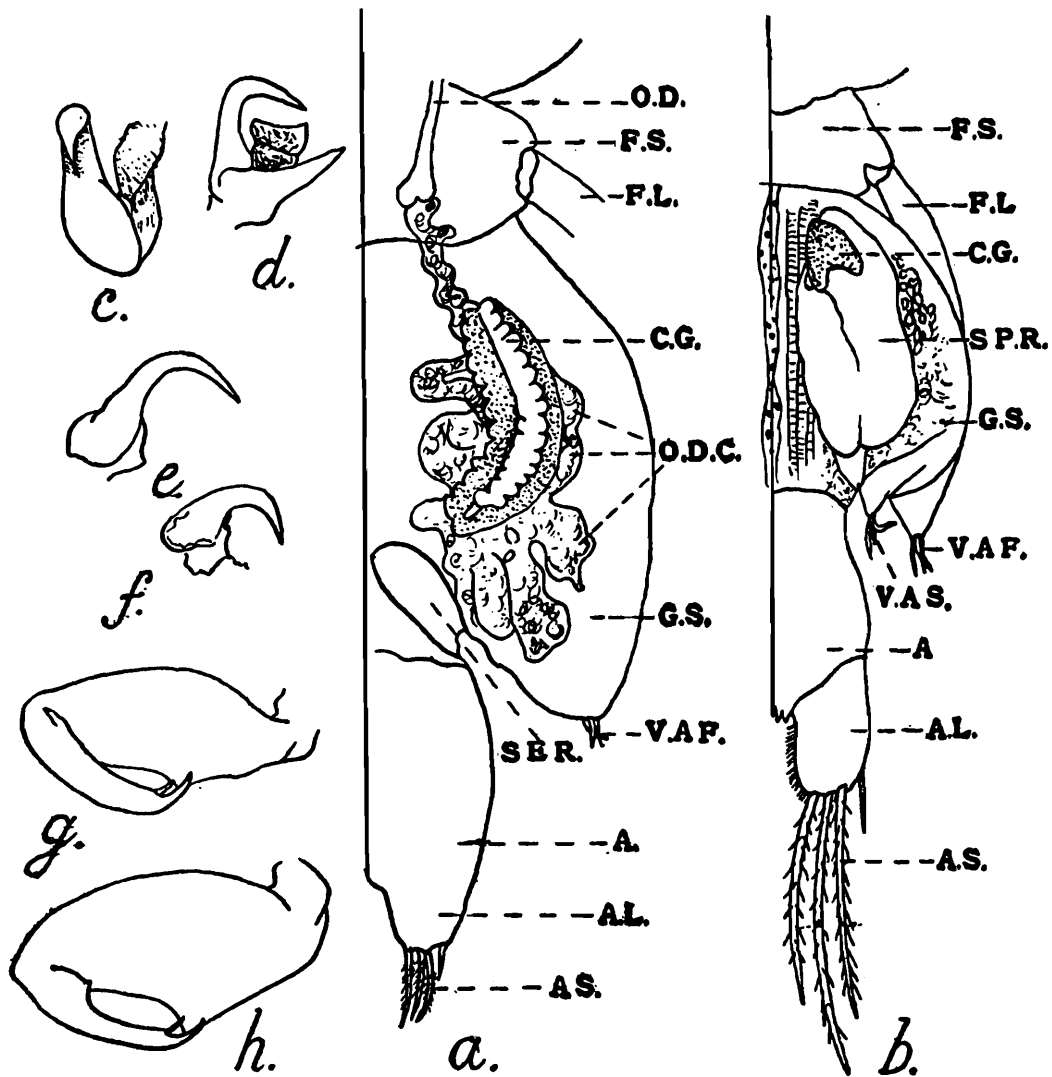
TEXT-FIG. 3.—*Caligus polycanthi*, sp. nov.

a. Second maxillipede; b. First swimming leg; c. Second swimming leg; d. Third swimming leg; e. Fourth leg.

when necessary, the first maxillipede may serve to comb the tip of the mouth tube clean. The second maxillipede is attached close to the middle line and consists of two joints. The first joint is large, stout and muscular, while the second is more slender, sharp-pointed, moving like the blade of a pocket-knife on the first joint. Close behind the sharp tip of the second joint can be seen a small accessory spine.

*Swimming appendages.*—The first leg, like the fourth, is uniramous. The basal joint, which is stout and large, carries the two-jointed exopod; the first joint of the exopod is twice as long as the basal joint of the leg but is more slender, while the second or distal joint is as long as the basal joint, but cylindrical and club-shaped. The distal joint bears four long spines at the tip and three longer and stouter plumose setae on its hinder edge, directed back at an angle of  $45^\circ$ . The second leg is biramous and typical. The protopodite is two-jointed, the first joint being small and the second much larger and stouter. A plumose seta directed backwards and medialwards, is borne on the first joint. The exopod is three-jointed and is attached in a direct line with the protopodite. The first of the three joints of the exopod is long, cylindrical and bears a slender plumose seta directed obliquely backwards, the second bears a plumose seta and two backwardly curved spines and the flattened terminal joint ends in a straight distal spine and bears six long plumose setae round its tip and hinder margin. The endopod also is triarticulate and is directed almost perpendicular to the protopodite and the exopod. The first joint bears a long, plumose seta, the second bears two, while the third, which is broad and elliptical, bears nine setae round its distal edge. The third leg is definitely foliaceous and unites with its fellow across the middle line. It extends far behind the third segment and even covers a part of the fourth segment. The two rami of this appendage are proportionately far smaller than the laminate protopodite. The plumose setae of the protopodite extend behind from the posterior edge of the lamina, close to the middle line. The exopod and the endopod are inserted into notches on the outer part of the hind margin of the lamina. In the exopod, the three divisions can be made out, the first joint is distinguished by a single stout claw, the second by a straight spine and the third by two spines and six plumose setae. The first joint is narrow while the second and the third are broad and flat. The endopod also is flat but smaller. It appears to be of two joints, the first being indicated by one long, plumose setae on the inner edge and the second being marked by a fringe of six plumose setae. Both the exopod and the endopod are tomentose. *The fourth leg* is uniramous. The exopod, which is two-jointed, is borne by a long basal joint. Of the two joints of the exopod, the first is long and has its distal edge prolonged into a long spine; the second bears three long plumose setae at its tip which is also marked by two lateral tooth-like spiny projections. *The fifth leg* is represented by three short spines at the posterior tips of the lateral lobes of the genital segment. Two of these are attached close together, while the third is more removed. Each spine appears to have a thick, cylindrical cushion-like base bearing a slender spine once and half as long as the base. The tip of the spine is sharp and curved. No trace of the sixth appendage, which is present

in the male, is seen in the female. In adults without egg sacs, clusters of two or three spermatophores can be seen close to the external opening of the genital ducts. Each spermatophore is long, slender and tapering at both ends. In the egg-bearing forms, the egg sacs vary in length. In the type, on which this description is based, the sacs are slender, cylindrical and as long as the body. Each sac contains a single row of 50 eggs packed one behind the other. The egg strings are narrower than the abdomen.



TEXT-FIG. 4.—*Caligus polycanthi*, sp. nov.

Camera lucida drawings of fourth segment, genital segment and abdomen, as well as of second antennae, first maxillae and second maxillipede of a male and female of same age.

*a.* Right half of the body of a female; *b.* Right half of the body of a male; *c.* Second antenna of male; *d.* Second antenna of female; *e.* First maxilla of male; *f.* First maxilla of female; *g.* Second maxillipede of female; *h.* Second maxillipede of male.

A, abdomen; A.L., anal laminae; A.S., anal setae; C.G., cement gland; F.L., fourth leg; F.S., free segment; G.S., genital segment; O.D., oviduct; O.D.C., oviducal cells; S.E.R., semen receptacle of female, S.P.R., spermatophore receptacle of male; V.A.F., vestigial appendage of fifth segment; V.A.S., vestigial appendage of sixth segment.

*The abdomen.*—Proportionate to the rest of the body, the abdomen is small, being only 0.62 mm. long (the anal setae being excluded from all measurements of length) and about 0.43 mm. broad just in front of the laminae where it is broadest. The anal laminae are short and bear four short setae. In several egg-bearing females the setae appeared broken off and even when present are short, slender and weak as compared with those of the male.

*The male.*—As in all Copepoda, the male is slightly smaller in size than the female. It is only 3.72 mm. long and the genital segment is smaller than in the female. The greater length of the anal laminae and anal setae, however, give the male a more slender appearance. The cephalothorax is marked by a greater length (2.19 mm. as against 2 mm. in the female) and greater breadth (2.19 mm. as against 1.47 mm. in the female). Hence, the outline of the carapace is different from that of the female. The hind margin of the carapace being wider, the third segment is more conspicuous and exposed than in the female. The free fourth segment being of the same width in front and behind, makes the "waist" appear longer in the male. The genital segment is obviously different in outline and smaller in size. It measures 0.44 mm. in length medially and 0.71 mm. in width at its broadest point. The two lateral sides being convex and the anterior side narrower than the posterior concave side, the contour of the genital segment is strikingly different from that of the quadrangular form obtained in the female. Further, the two posterior lateral lobes are far shorter, smaller and more acute. Each lateral lobe bears two tufts of setae. A groove running forward between the two tufts divides the lobe lengthwise. The two tufts probably represent the vestiges of two appendages indicating the two units of which the genital segment is formed, the more medial tufts of three setae being probably the vestiges of the sixth appendage and the outer tuft of three setae those of the fifth appendage.

*The other appendages* are all similar to those of the female in structure, though proportionately larger (*vide infra*). The abdomen is longer, being 0.7 mm. in length, and narrower. The anal laminae are more marked as also the anal setae, which are as long as the abdomen itself. The length and plumose character of the three anal setae are probably correlated with the greater motility of the male.

*Taxonomy.*—Though the presence of lunules in the present form may point to eight genera of the sub-family Caliginae, the size of the carapace, the structure of the fourth leg and the first maxillae, and the form of the furca indicate that it belongs to the genus *Caligus*. From Wilson's (1906, pp. 555-561) very useful key (which is rightly based on the relative lengths of the different body regions) it is seen that the present species, which has a carapace just half as long as the body does not belong to *Caligus balistae*, which also, like the present form is a parasite of *Balistes maculatus*. As is already well known, different species of *Caligus* may parasitise the same species of fish and a particular species of the parasite may not be confined to one host-species and as judging from Wilson's description of *Caligus balistae*, there are several features of resemblance

between this species and the present form, a detailed comparison of the two species is given below :

*C. balistae* Steenstrup & Lutken.

*C. polycanthi*, sp. nov.

- |   |   |
|---|---|
| 1. Carapace (2.6 mm.) more than half the entire length (4.5 mm.) in female and nearly twice the length of the rest of the body in male. | Carapace just half the total length in the females; difference in male within 8 per cent. as allowed by Wilson. |
| 2. Genital segment of female obovate with short acute lobes.  | Genital segment quadrangular with an emarginate hind border and rounded lateral lobes.                          |
| 3. Abdomen same length as genital segment in male and half the length in female.  | Abdomen longer than genital segment in male and more than half the length of genital segment in female.         |
| 4. Fourth legs with four spines.  | Fourth legs with three plumose setae and two short spines.  |
| 5. Vestiges of fifth legs not visible dorsally in female.   | Vestiges of fifth legs visible dor. in female.  |

Species mentioned in Wilson's key, in which the carapace is about half the total length, are found to differ from the present form in the size and proportions of the abdomen and the genital segment or in the size of fourth leg. In view of these differences, the present form is considered a new species and owing to the bunch of nine spines on the distal tip of the first antennae is named *Caligus polycanthi* sp. nov. Based on the foregoing description of the female (*holotype*) and the features of the male (*allotype*) this new species may be defined as follows :

*Description of the species.*—The carapace is about half the total length of the body, excluding the anal setae. The frontal plate and the lunules are conspicuous. The mandible is curved and serrated at the anterior end. The first maxilla bears a pointed, backwardly directed endopod and a pair of short spines representing the exopod. The first leg is well developed uniramous and bears on its terminal segment three plumose setae and four distal spines. The fourth leg is also well-developed and uniramous, bearing three plumose setae and two short spines terminally on the exopod. The vestiges of the fifth appendage can be seen in a dorsal view of the female while in the male the remnants of the sixth appendage also persist. The sexes differ in the length of the abdomen, anal laminae and anal setae as well as in the size and shape of the genital segment. The abdomen and anal laminae, taken together are longer than the genital segment in the male and more than half the length of the genital segment in the female. The anal setae are nearly as long as the abdomen itself in the male while far shorter in the female.

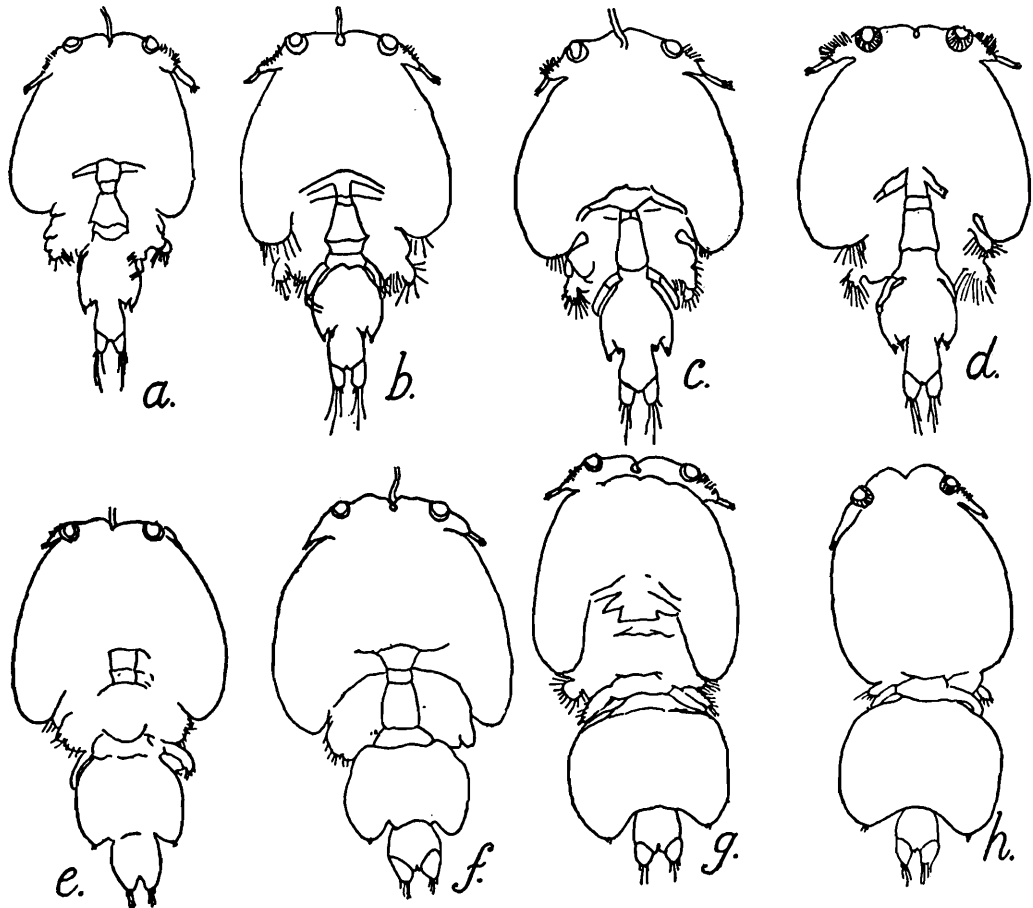
#### LATE CHALIMUS STAGES AND THE INCIDENCE OF SEX DIFFERENCES.

*Chalimus forms of male and female.*—Seven specimens of this immature stage of the parasite were found on the skin of the fish host, along with the adults. All these were attached only by the frontal stalks and were capable of movement round this point of attachment. The organs

of prehension in the adult were not in use. The lunules especially were not applied to the skin, their mouths being covered by membrane, and the entire frontal plate lacked the prominence and forward displacement which would enable the lunules of the adult to reach the host's skin. The attachment by frontal filament was so firm, that the young parasites had to be forcibly removed from the skin of the host.

*Male Chalimus.*—Though they varied in size, the four specimens taken and studied showed a remarkable uniformity in the structure of their appendages and in their general body outline. The steady increase in size denotes uniform growth of the body and genital segment to adult form—in fact the adult does not differ except for a slight increase in length and breadth. This was specially so as regards the form of the genital segment and the disposition of the genital organs visible through the transparent chitin.

*Female Chalimus.*—The three specimens of the stalked Chalimus stage, when compared with the adult which has not yet formed the egg-sacs, show gradual modification of body contours starting from a stage not very different from that of the male Chalimus. There is a slight decrease in width of the cephalothorax (so that the outline becomes more elliptical), while the genital segment increases rapidly in length and breadth and becomes quadrangular. A comparison of the appendages of the male and female Chalimus forms of the same total.



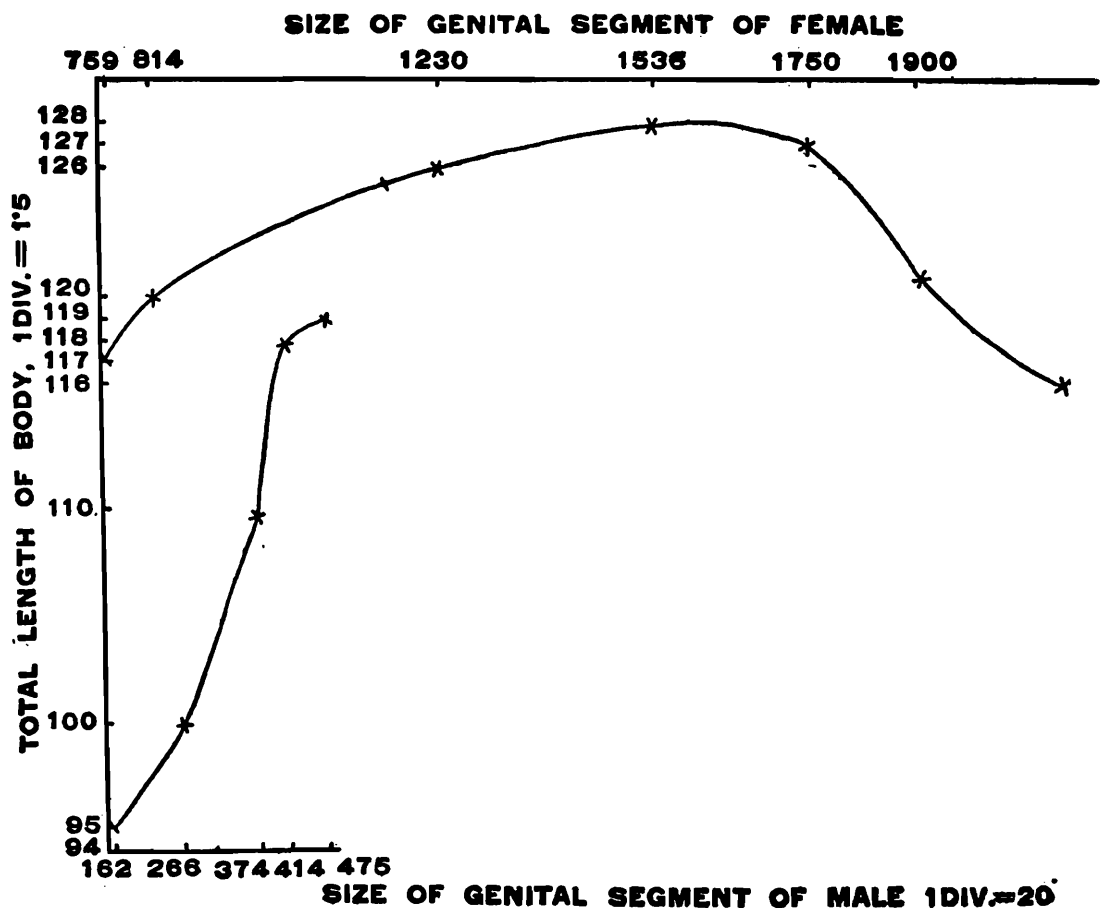
TEXT-FIG. 5.—*Caligus polycanthi*, sp. nov.

Change of form of male and female Chalimi developing into adults.

a., b., c. three stages of Chalimi of male; d. Adult male; e., f. Chalimus stages of female; g. young adult; h. mature adult.

length sketched with the help of a camera lucida, shows that the second antennae the first maxillae and the second maxillipedes are definitely larger and better adapted for prehension in the male. The same, however, cannot be said about the first maxillipedes and the fourth legs since they appear very nearly the same in size and form in both sexes. The vestiges of the sixth legs appear to have been lost in the female *Chalimus* as in the adult; on the other hand, the vestiges of the fifth legs appear more conspicuous and well formed in the *Chalimus* than in the adult female, in which owing to the swelling of the genital segment including the posterior lobes, the full length of the setose vestiges becomes somewhat hidden. The form of the abdomen, the anal laminae and setae marks the two sexes as distinctly as the form of the genital segment. In the male, the abdomen is slightly longer and more slender and the anal laminae more conspicuous than in the female. The long plumose anal setae of the male distinguish it from the female beyond any mistake. The free segment of the thorax also is markedly broader and longer in the female the "waist" of the male appearing far more slim. A study of these late *Chalimus* forms of the females makes it clear that the final female form of the body is in the process of being settled during this period, whereas the external form of the male appears established much earlier. It is probable that this is due to the maturing of the reproductive organs earlier in the male than in the female.

The measurements of the thirteen *Chalimus* and adult forms of the parasite, especially of the total length of the body and the size of the genital segment (length multiplied by breadth), when tabulated. (Tables



TEXT-FIG. 6.—Graph showing the increase of size of genital segment in relation to age or length of body of female and male, *Chalimus* and adult form.

I and II) and plotted on graph support the above conclusions. In the males the length, the breadth and therefore, the size of the whole body increase with the size of the genital segment, or the development of the sexual organs, steadily from the smallest of the *Chalimus* forms to the mature adult. In the females on the other hand, the size of the genital segment increases to a marked extent when the *Chalimus* becomes sexually mature and continues to increase in size during the adult period, as can be seen from the table; whereas the sizes of the body increase from the *Chalimus*, till sexual maturity is reached but thereafter during the adult period gradually decreases, till it becomes smaller than that of the *Chalimus*. Though the fact of the older adult being smaller than *Chalimus* and young adult has been recorded for other copepod parasites, the exact measurements are given here for the first time. This difference between the sexes in the change of size of the genital segment as well as the rest of the body during the *Chalimus* and adult stages, cannot be compared with the difference between "high" and "low" forms Sewell (1912, pp. 317-330) found among certain genera of free living copepods. The data collected and presented in this paper are too scanty for any application of Brooke's law of growth, Fowler (1909) used for explaining changes in size of Ostracoda.

TABLE I.—*Female. Readings; 32=1 mm.*

No.	Total length of body.	Maximum breadth, i.e., carapace breadth.	Product indicating size of body.	Length of genital segment.	Breadth of genital segment.	Product indicating the size of genital segment.	Remarks.
1	117	65	7605	23	33	759	<i>Chalimus</i> .
2	120	68	8160	22	37	814	<i>Chalimus</i> .
3	126	70	8820	30	41	1230	Adult with egg sacs.
4	128	64	8192	32	48	1536	Adult with egg sacs.
5	127	62	7874	35	50	1750	Adult with egg sacs.
6	121	60	7260	38	50	1900	Adult.
7	116	50	5800	46	46	2116	Adult.

TABLE II.—*Male.*

No.	Total length of body.	Maximum breadth, i.e., carapace breadth.	Product indicating size of body.	Length of genital segment.	Breadth of genital segment.	Product indicating the size of genital segment.	Remarks.
1	95	55	5225	9	18	162	Chalimus.
2	100	56	5600	14	19	266	Chalimus.
3	110	66	7260	17	22	374	Chalimus.
4	118	68	8024	18	23	414	Chalimus.
5	119	69	8142	19	25	475	Adult.

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