TAXONOMIC STUDY OF SKULLS OF ORIENTAL RODENTS IN RELATION TO ECOLOGY*

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(With 41 Tables, 11 Text-figures and 30 Plates)

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I—INTRODUCTION

(*a*) *General*

Rodents constitute, in the number of species, the largest group of mammals. The taxonomy of the oriental rodents has been studied only by a few workers, *viz.*, Waterhouse (1839-48), Blyth (1863), Thomas (1881, 1915-20), Blanford (1888), Wroughton (1908-20), Hinton (1918-26), Allen (1940), Ellerman (1940-61), Roonwal (1948-50), Roonwal & Biswas (1961), Nath (1952-53), Tate (1954), Biswas & Khajuria (1955, 1957), and Moore (1956, 1958). Ellerman has revised the entire group and introduced the extensive use of skull-measurements for differentiating the various systematic categories. The other recent workers have also similarly utilized the skull measurements.

Nevertheless, many aspects of skull structure remain to be studied and, in particular, its relationship with ecological habitat. The present work was thus taken up with a view to make a comparative taxonomic study of rodent skulls in relation to ecology.

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(*b*) *Material*

By far the greater part of the material studied by me was from the collections present in the Zoological Survey of India. A few specimens were obtained on loan from the Bombay Natural History Society, while a few others, particularly the gerbils, were collected by me from Rajasthan and the Punjab.

(*c*) *Abbreviations for skull measurements*

The following abbreviations for skull measurements have been used in the text as well as the tables.

A.p.f., length of anterior palatine foramina.

B.m.a., bimeatal distance.

C.B.L., Condylobasal length.

Diast. l., length of diastema.

G. zyg. w., greatest zygomatic width.
G.L.M., greatest length of mandible.
I. temp. r. d., distance between temporal ridges.
Intp. w., width of interparietal bone.
Ioc. ht. and w., height and width of infraorbital canal.
L.i.o.w., least interorbital width.
L. diast. l., length of lower diastema (of mandible).
L. mol. l., length of lower molars at the root (of mandible).
Mand. l., mandibular length (of mandible).
Max. w., maximum width of mandible.
Mol. l., length of upper molars.
Nas. l., length of nasals.
Nas. w., width of nasals.
Occiput, height of occiput.
O.N.L., occipitonasal length.
Orb. l., length of orbit.
Pal. l., length of palate.
Par. w., combined width of parietal.
Pmx. w., width of ascending process of premaxillae.
P.p.f., length of posterior palatine foramina.
Rost. w., width of rostrum.
S. m. zy. w., width of supramaxillary root of zygoma.
T.b.l., length of tympanic bulla.

II—SKULLS OF RODENTIA

(*a*) *General*

The skulls of 20 genera and 61 species and subspecies of rodents were studied. A total of about 425 skulls were measured. All the material, except two species, namely, *Jaculus jaculus* Linn. (family Dipodidae) and *Atherurus africanus* Gray (family Hystricidae),belongs to the Oriental Region. The following is a summary of the material studied :—

	Genera	Species and Subspecies
Family 1. MURIDAE		
Subfamily (i) *GERBILLINAE*	3	12
„ (ii) *MICROTINAE*	2	5
„ (iii) *CRICETINAE*	2	2
„ (iv) *MURINAE*	4	16
Family 2. RHIZOMYIDAE	2	5
„ 3. MUSCARDINIDAE	1	1
„ 4. SCIURIDAE	3	15
„ 5. DIPODIDAE	1	1
„ 6. HYSTRICIDAE	2	4
TOTAL ..	20	61

To start with, the skull of one species of a genus is described in detail so as to bring out the salient points of structure. The other skulls are, however, described relatively briefly, only the important points of difference being emphasised. As the subfamilies Murinae and Microtinae of the family Muridae and the family Sciuridae are very large ones, only a few selected genera, representing the different habits and habitats, have been studied.

Keys for the identification of genera, species, etc., based on skull characters, are given where such keys are either not available or differ materially from those given by Ellerman (1947*a*, *b*).

(*b*) *Definitions of skull measurements and indices*

The following skull measurements were taken and in all cases they were "straight line" distances between two points and not along the curvatures of the skull ; abbreviations used in the tables and text are given in parentheses :—

1. *Occipitonasal length* (*O.N.L.*).
2. *Condylobasal length* (*C.B.L.*).
3. *Greatest zygomatic width* (*g. zyg.w.*).
4. *Least interorbital width* (*L.i.o.w.*).
5. *Length of tympanic bulla* (*T.b.l.*).
6. *Length of nasals* (*Nas.l.*).
7. *Width of nasals* (*Nas.w.*).
8. *Palatal length* (*Pal.l.*).
9. *Length of upper cheek-tooth row* (*Mol. l.*).
10. *Length of anterior palatine foramina* (*A.p.f.*).
11. *Length of diastema* (*Diast.l.*).
12. *Occiput* (*Occ.l.*).
13. *Length of orbito-temporal fossa* (*Orb. l.*).
14. *Parietal length* (*Par. l.*) : *Length of parietals in mid line, measured along the antero-posterior axis.*
15. *Parietal width* (*Par. w.*) : *Maximum combined width of parietals.*
16. *Frontal length* (*Fr. l.*) : *Length of frontals in mid line.*
17. *Width of superior maxillary root of zygoma.*
18. *Maximum height and width of infraorbital canal* (*ioc. ht. x w.*).
19. Maximum length along the antero-posterior axis and maximum width of interparietal.
20. *Cranial width* (*Cr. w.*).
21. *Bimeatal distance* (*Bim.d.*) : Distance between the external auditory meatus of both sides
22. *Greatest length of mandible* (*G.L.M.*) : From a point on the dorsal side of the mandible just behind the lower incisor to the hind most point on the condylar process.
23. *Mandibular length* (*Mand. l.*).
24. *Maximum width of mandible* (*Max. w.*) : From the tip of the coronoid process (or from the tip of condylar process when it is highest) to the ventral margin of the mandible).

25. *Root-length of lower molars* (*L. mol. l.*) : Maximum length of all the lower molars, including premolars, if present measured at the root.

26. *Length of lower diastema* (*L. diast. l.*) : From a point on the dorsal side of the mandible just behind the lower incisor to the anterior most lower cheek-teeth.

The following tooth indices were recorded—

Upper incisor index : Opisthodont—backwardly directed ; orthodont—straight or vertical ; proodont projected forward.

Molar index : Brachyodont low crowned ; hypsodont high or tall crowned.

For exact method of measurements and the definitions for items 1—13, 20 & 23, please *see* Roonwal and Agrawal (*Rec. Indian Mus.* Vol. 60, Pts. 1 & 29).

(*c*) *Descriptions of skulls*

Family 1. MURIDAE

Subfamily (i) *GERBILLINAE*

Three genera were studied, namely, *Tatera* Lataste, *Meriones* Illiger and *Gerbillus* Desmarest.

Genus (1) **Tatera** Lataste

1. **Tatera indica** Hardwicke

Key for identification of Oriental subspecies of Tatera indica, ***based on skull characters.***

O.N.L., Occipitonasal length.

1(2). Tympanic bullae over 1/4th of O. N. L. : superior maxillary root of zygomatic arch narrow, on an average under 3·2mm. or under 7·5 % of O. N. L.

...*T. indica indica* Hardwicke

2(1). Tympanic bullae under 1/4th of O. N. L. : superior maxillary root of zygomatic arch broad, over 3·2mm. or over 7·5 % of O. N. L.

3(4). Least interorbital width above 7·5mm. or over 17 % of O. N. L.

...*T. indica ceylonica* Wroughton

4(3). Least interorbital width under 7·5mm. or under 17 % of O. N. L.

5(6). Anterior palatine foramina over 18 % of O. N. L. ; upper cheek-tooth row on an average, over 14·5 % of O. N. L.

... *T indica hardwickei* Gray

6(5). Anterior palatine foramina below 18 % of O. N. L. ; upper cheek-tooth row on an average, below 14·5% of O. N. L.

...*T. indica cuvieri* Waterhouse

1*a*. Tatera indica indica Hardwicke

(Tables 1 & 2 : and Plate 13)

General : Skull large and massive, occipitonasal length 38·1—47·9 mm. (mean 41·9); dorsal surface smooth, slightly sloping anteriorly, with slight depression present or absent in postero-dorsal portion of nasals ; rostrum long and straight ; cranium flattened ; sutures between bones distinct and smooth ; occipitonasal length exceeding condylobasal length. *Nasals :* Long, over 38 per cent (38·5—45·0 per cent) of O.N.L. ; slanting anteriorly ; projecting slightly forwards over incisors ; anterior extremity rounded ; widest in anterior one-third portion ; laterally connected with premaxillae and posteriorly with frontals ; extending slightly behind or upto anterior orbital margin ; equal or slightly longer than ascending process of premaxillae. *Frontals :* Long and narrow ; frontal length over twice the parietal length ; least interorbital width under 17·5 per cent (15·4—17·5 per cent) of O.N.L. ; narrowest just behind lacrymals and ridged along their lateral edges ; ridges running backward through upper edge of squamosals, converging slowly to hinder end of parietals and then curving slightly outwards meeting the occipital crest. *Parietals :* Broader than long ; laterally extended ; lateral extensions nearly vertical and more than half the length of squamosals ; posteriorly meeting the occipitals ; fronto-parietal suture smooth and curving anteriorly on sides. *Interparietal :* Large ; situated in between parietals and supraoccipital, nearly posterior to a line joining posterior extremity of squamosals ; broader than long ; anterior border arched, pointing forward medially ; posterior border convex backward. *Occiput :* Vertical, with moderately developed ridges ; dorso-lateral portion of supraoccipital extending on both sides of interparietal upto its anterior border and touching squamosals on sides ; paroccipital processes distinct, closely applied to tympanic bullae. *Squamosals :* Form the sides of the cranium ; supratympanic portion posteriorly meeting mastoids and dorso-lateral extensions of supraoccipital ; supratympanic fenestrae small, situated above auditory meatus ; antero-dorsal extremity of squamosals with frontal ridges forming slight projection at lateral extremities of fronto-parietal suture. *Zygomatic arches :* Narrow, widest posteriorly ; greatest zygomatic width under 55 per cent (50·0—54·7 per cent) of O. N. L. ; slanting upwards in front to lacrymals with slight medial inflection ; anterior extremity of zygomatic process of maxilla stout and bifurcated into two portions ; a short and broad superior maxillary root forming roof of infraorbital canal, and a lower maxillary root projecting forwards to half of rostrum and forming laterally flattened zygomatic plate ; the latter ridged dorsally, and ventrally meeting the ventrolateral margin of maxilla ; zygomatic process of maxilla forked distally, receiving the jugal in the fork ; the jugal short, twisted, situated medially and connected posteriorly with flattened and ventro-laterally extended zygomatic process of squamosal ; infraorbital canal large, higher than broad, transmitting a portion of the masseter and the infraorbital nerve. *Palate :* Long ; over 50 per cent (51·7—56·2 per cent) of O.N.L., extending posteriorly behind molars ; higher anteriorly and sharply sloping posteriorly ; anterior palatine foramina long, 16·4—19·0 per cent (mean 17·7) of O.N.L., reaching posteriorly

upto the molars; posterior palatine foramina extending from first lamina of m^1 to m^3 ; palatine bone anteriorly forming postero-internal border of posterior palatine foramina and posteriorly forming anterior boundary of pterygoid fossa ; maxillopalatine suture feeble ; prominent groove running posteriorly from posterior end of each anterior palatine foramina on either side of median elevated tract and after crossing the maxillopalatine suture and posterior palatine foramina, terminating in the posterolateral depression of palatine ; the latter perforated by one or more small foramina ; upper cheek-tooth rows nearly parallel, 5·2—6·3 mm. (mean 5·8 mm. or 13·9 per cent of O.N.L.) and nearly half of diastema. Pterygoid bones perforated by interpterygoid foramen ; pterygoid fossae wide and deep, lower surface lying dorsal to basisphenoid ; mesopterygoid fossa narrow ; presphenoid laterally compressed ; basisphenoid narrow. *Tympanic bullae :* Oval ; situated obliquely to long axis of skull ; anteriorly touching the hamular process of pterygoids ; relatively smaller than in other genera of this subfamily, but always over 25 per cent (25·0—28·4 per cent) of O.N.L. ; auditory orifice large and connected with a small perforation below it ; mastoids fairly developed but not bulged out, slightly visible when viewed dorsally.

Mandible : Consisting of a pair of symmetrical rami diverging behind and meeting anteriorly at the symphysis ; each ramus laterally compressed, bearing three processes posteriorly—a small coronoid process pointed backward and sloping anteriorly to horizontal alveolar portion bearing three molar teeth ; an elevated condylar process projecting backward and inward beyond coronoid process ; and a narrow angular process considerably drawn backward nearly in a line with condylar process, and twisted out distally ; the coronoid process highest of all, and condylar and angular processes separated by a deep notch ; lower incisor root forming a knob in between roots of coronoid and condylar processes ; masseteric ridge moderately developed, starting from anterior end of m^1 and reaching the tip of angular process. Greatest length of mandible 20·1—25·8 mm. (mean 21·7) ; mandibular length under 50 per cent (46·0—49·0 per cent) of O.N.L. ; maximum width under 50 per cent (46—50 per cent) of G.L.M. ; lower diastema long, over 1/4th (mean 27·7 per cent) of G.L.M. and subequal to root-length of lower molars.

Cranial foramina :—Here 17 distinct foramina are described—15 in the skull proper and 2 in the mandible.

(i) *Skull foramina (Nos. 1—15)*

1. *Interpremaxillary foramen :* Very small ; situated in between premaxillary bone behind incisors. Not very distinct in this subfamily.

2. *Anterior palatine foramina (incisive foramina) :* Situated at thy anterior portion of the palate in front of molars. Partly formed by premaxilla and partly by maxilla.

3. *Posterior palatine foramina:* Situated in between cheek-tooth rows. Partly formed by maxilla and partly by palatine. Small foramina for palatine vein present in postero-lateral depressions of palatine.

4. *Infraorbital canal:* Formed of an upper wide portion invaded by masseter muscle and a narrow slit-like lower portion for passage of infraorbital nerve.

5. *Anterior ethmoidal foramen:* Present in frontal bone, antero-dorsal to the optic foramen.

6. *Spheno-palatine foramen:* Situated between orbital process of the maxillary and the palatine, anterior to the presphenoid.

7. *Foramen lacerum anterius (sphenoidal fissure):* Situated between orbitosphenoid and alisphenoid bones on either side of presphenoid.

8. *Stylomastoid foramen:* Situated at the junction of mastoid and external auditory meatus.

9. *Supratympanic fenestra of sqamosal (Subsquamosal foramen):* Situated in squamosal bone above external auditory meatus and below the crest joining the squamosal root of the zygomatic arch with occipital crest. The subsquamosal foramen present in squirrels (Hill, 1935) is probably this one.

10. *Foramen ovale:* Situated in postero-ventral portion of alisphenoid anterior to tympanic bulla.

11. *Optic foramen:* Present in orbitosphenoid bone dorsal to the presphenoid.

12. *Pretympanic fissure:* Situated at the antero-lateral side of the tympanic bulla ; fused with the postglenoid foramen.

13. *Foramen lacerum posterious (jugular foramen):* Situated between tympanic bulla and basioccipital, anterior to paroccipital process.

14. *Condylar foramen (hypoglossal foramen):* Situated at antero-lateral side of occipital condyle.

15. *Foramen magnum:* Situated at posterior extremity of the skull serving as the exit for the spinal cord.

(ii) *Mandibular foramina (Nos. 16 and 17)*

16. *Inferior dental foramen:* Situated on inner surface of mandible near the root of lower incisors.

17. *Mental foramen:* Situated at the antero-dorsal portion of the mandible just anterior to the molars.

Dentition: Consisting of a pair of incisors and three pairs of molars in each jaw. *Incisors:* Upper incisors long, opisthodont, yellowish and longitudinally grooved anteriorly ; thicker than wide ; passing posteriorly into maxillary bone, terminating at infraorbital canal. Lower incisors yellowish, long and ungrooved, less strongly curved than the upper and

deep-rooted ; posteriorly terminating into a knob at the root of the condylar process. Upper molars : Slightly hypsodont, rooted and transversely laminated ; laminae separated by folds ; laminae biserially cusped in young stage, jointed or unjointed ; outer folds longer than inner ; m^1 4-rooted ; m^2 3-rooted and m^3 single-rooted ; m^1 consisting of three transverse laminae separated by two folds on each side, first lamina being smaller than others ; m^2 consisting of two subequal laminae separated by a pair of folds ; m^3 small, bilaminate, with a shallow fold on either side. Lower molars : Exactly like the uppers, except that m_3 is always unilaminate.

Variations.—The above description is based on the study of skulls from West Pakistan (Baluchistan and Sind), and north-western and central India (Rajasthan, Punjab, Gujarat, Uttar Pradesh and Madhya Pradesh). Though the skulls are more or less subequal in occipitonasal length, they differ markedly in other measurements, and the following tendencies are noticeable :—

1. The length of tympanic bulla in relation to occipitonasal length decreases from Baluchistan (mean 27·2 per cent of O.N.L.) eastward (U.P. and M.P., mean 25·4 per cent) (Table 40).

2. The length of anterior palatine foramina increases from Baluchistan (mean 17 per cent of O.N.L.) eastward (Gujarat and M.P., mean 18·5 per cent).

3. Indian specimens (M.P., Rajasthan, and Gujarat) differ from the West Pakistan (Baluchistan and Sind) ones in having a longer palate (mean 54·5 *vs.* 53·0 per cent of O.N.L.) and a broader supra maxillary root of zygomatic arch (mean 7·2 *vs.* 6·2 per cent of O.N.L.).

4. Male (Table 1) skulls are slightly longer than those of the females. O.N.L. 38·7—47·9 mm. (mean 42·3) in males ; 38·1—45·9 mm. (mean 41·0) in females.

1*b*. **Tatera indica hardwickei** Gray

(Tables 1 and 2 ; and Plate 14)

Skull almost similar to that of *T indica indica* in size, etc., but differs as follows :—Superior maxillary root of zygoma broader, 7·2—8·7 per cent (mean 8·0) *vs.* 5·6—7·7 per cent (mean 7·0) of O.N.L. ; tympanic bullae smaller, under 25 per cent (22·9—25·3 per cent) of O.N.L. *vs.* over 25 per cent (25·0—28·4 per cent). The length of anterior palatine foramina ranges from 6·7—9·1 mm. (mean 7·9) rather than 10 mm. (Wroughton, 1917, p. 42). Mandibles narrower than in *T indica indica,* maximum width 43·3—47·5 per cent (mean 44·1) *vs.* 46·0—50·0 per cent (mean 47·0) of G.L.M.

Some of the other measurements are as follows :—Greatest zygomatic width 49·8—55·2 per cent (mean 51·7) of O.N.L.; least interorbital width 6·6—7·4 mm. (mean 7·0) or 15·4—17·4 per cent (mean 16·5) of O.N.L. ;

upper cheek-tooth row 5·9—6·6 mm. (mean 6·4) or 13·6—16·8 per cent (mean 14·9) of O.N.L. ; least intertemporal ridge distance 12·6—13·2 mm. ; anterior palatine foramina 17·6—19·4 per cent (mean 18·3) of O.N.L.

1*c*. **Tatera indica ceylonica** Wroughton

(Tables 1 and 2 ; and Plate 15)

Skull almost similar to that of *T indica hardwickei* in size, etc., but differs as follows :—Slightly narrower, greatest zygomatic width 48·4—51·2 per cent (mean 50·0) of O.N.L. *vs.* 49·8—55·2 per cent (mean 51·7) ; frontals wider, least interorbital width 7·0—8·3 mm. (mean 7·7) *vs.* 6·6—7·4 mm. (mean 7·0) or 16·5—18·0 per cent (mean 17·4) of O.N.L. *vs.* 15·4—17·4 per cent (mean 16·5) ; anterior palatine foramina smaller, under 17·8 per cent (16·5—17·7 per cent) of O.N.L. *vs.* over 17·6 per cent (17·6—19·4 per cent) ; the range of length of the foramina is 6·9—8·2 mm. (mean 7·5) rather than 6·0—7·0 mm. (Wroughton, 1917, p. 42 ; and 1919*b*, p. 780) ; upper cheek-tooth row smaller, 12·9—14·7 per cent (mean 13·7) of O.N.L. *vs.* 13·6—16·8 per cent (mean 14·9) ; temporal ridges distantly apart, least distance over 13·2 mm. (13·2—14·2 mm.) *vs.* under 13·2 mm. (12·6—13·2 mm.). Mandible narrower than *T indica hardwickei*, maximum width 37·9—45·1 per cent (mean 41·8) of G.L.M. *vs.* 43·3—47·5 per cent (mean 44·1).

Some of the other measurements are as follows :—Occipitonasal length 40·1—46·8 mm. (mean 44·2); tympanic bullae 22·8—25·4 per cent (mean 24·0) of O.N.L. ; width of superior maxillary root of zygoma 7·7—8·4 per cent (mean 8·0) of O.N.L. ; nasal length 39·6—42·6 per cent (mean 41·6) of O.N.L.

1*d*. **Tatera indica cuvieri** Waterhouse

(Tables 1 and 2 ; and Plate 16)

Skull almost similar to that of *T indica hardwickei*, but differs as follows :—Slightly smaller (in maximum range) and narrower ; occipitonasal length 40·9—45·3 mm. *vs.* 39·0—46·7 mm. ; greatest zygomatic width 48·6—50·3 per cent (mean 49·8) *vs.* 49·8—55·2 per cent (mean 51·7) of O.N.L. ; upper cheek-tooth row slightly shorter, 12·7—15·1 per cent (mean 13·6) *vs.* 13·6—16·8 per cent (mean 14·9) of O.N.L., ; anterior palatine foramina smaller, 15·8—18·7 per cent (mean 17·3) *vs.* 17·6—19·4 per cent (mean 18·3) of O.N.L.

Some of the other measurements are as follows :—Least interorbital width 6·4—7·5 mm. (mean 7·1) or 14·4—17·5 per cent (mean 16·2) of O.N.L. ; tympanic bullae 23·3—25·2 per cent (mean 24·4) of O.N.L. ; width of superior maxillary root of zygoma 8·0—9·5 per cent (mean 8·8) of O.N.L. ; maximum width of mandible 42·5—46·5 per cent (mean 43.8) of G.L.M.

Genus (2) **Meriones** Illiger

Key for identification of Oriental species of Meriones, *based on skull characters.*

O.N.L., Occipitonasal length.

1(4). Tympanic bullae under 1/3rd of O.N.L. ; zygomatic arches not touching external auditory meatus ; mastoids not projecting behind occiput ; bimeatal distance less than zygomatic width.

2(3). Zygomatic width over 55% of O.N.L. ; least interorbital width over 18 % of O.N.L. ; anterior palatine foramina under 6 mm. or under 17 % of O.N.L.

...*M. hurrianae* Jerdon

3(2). Zygomatic width under 55% and least interorbital width under 18% of O.N.L. ; anterior palatine foramina over 6 mm. or over 17 % of O.N.L.

...*M. persicus* Blanford

4(1). Tympanic bullae 1/3rd of O.N.L. ; zygomatic arches touching external auditory meatus ; bimeatal distance more than greatest zygomatic width ; mastoids projecting behind the occiput.

5(6). Least interorbital width under 6 mm. or under 17 % of O.N.L.

...*M. crassus swinhoe* Scully

6(5). Least interorbital width over 6 mm. or over 17 % of O.N.L.

...*M. libycns erythrourus* Gray

1. **Meriones hurrianae** Jerdon

1*a*. **Meriones hurrianae hurrianae** Jerdon

(Tables 3 and 4 ; and Plate 17)

General : Skull medium-sized, occipitonasal length 30·7—37·7 mm. (mean 33·8); broad and robust, with a marked depression in postero-dorsal portion of nasals ; rostrum short, strongly curved anteriorly ; rostral width 13·9—17·3 per cent (mean 15·5) of O.N.L. ; cranium sloping posteriorly ; greatest zygomatic width exceeding bimeatal distance ; occipitonasal length exceeding condylobasal length. *Nasals :* Smaller than in *Tatera indica*, under 38 per cent (33·7—38·6 per cent) of O.N.L. *vs.* over 38 per cent (38·5—45 per cent) ; strongly curved anteriorly and slightly projecting forwards over incisors ; narrowest posteriorly and gradually becoming wider anteriorly ; extending posteriorly upto anterior orbital margin and slightly shorter than ascending process of premaxillae. *Frontals :* Short ; frontal length less than twice the parietal length ; fairly broad, least interorbital width over 18·0 per cent (18·1—23·0 per cent) of O.N.L. ; narrowest just behind lacrymals and ridged along their lateral edges. *Parietals :* Broader than long ; laterally extended ; lateral extensions sloping downwards and more than half the length of squamosals ; fronto-parietal suture smooth, curving anteriorly on sides. *Interparietal :* Large ; nearly two-third portion situated behind a line joining posterior extremity of squamosals ; anterior border arched pointing forward medially ; posterior border convex backward. *Occiput :* Vertical, with moderately developed ridges ; dorso-lateral extensions of

supraoccipital narrow ; paroccipital processes distinct and closely applied to tympanic bullae. *Zygomatic arches :* Stout ; wider than in *T. indica* ; greatest zygomatic width over 55 per cent (55·2—61·0 per cent) of O.N.L. *vs.* under 55 per cent (50·0—54·7 per cent) ; zygomatic plate moderately thrown forward and having flattened anterior border ; infraorbital canal large ; wider dorsally than ventrally. *Squamosals :* Moderately developed ; supratympanic portion narrow ; supratympanic fenestrae large but filled partially or completely by anterior extension of mastoids. *Tympanic bullae :* Larger than in *T indica*, over 28 per cent (27·6—31·1 per cent) *vs.* under 28 per cent (25·0—28·4 per cent) of O.N.L. ; inflated ; external auditory meatus swollen antero-dorsally ; anteriorly not touching the zygomatic arch ; mastoids moderately developed, not extending posteriorly beyond occiput. *Palate :* Long, over 50 per cent (50·4—55·6 per cent) of O.N.L. ; posteriorly extending behind molars ; anterior palatine foramina short, below 6 mm. (4·2—6·0 mm.) or under 17 per cent (13·3—17·0 per cent) of O.N.L. ; posterior palatine foramina very small, situated in between third lamina of m^1 and first lamina of m^2 ; postpalatal pits perforated ; palatines slightly covering anterior portion of pterygoid fossae ; upper cheek-tooth rows nearly parallel, molar length 13·1—15·9 per cent (mean 14·5) of O.N.L. and over one-half of diastema length (23·4—26·3 per cent, mean 25·0, of O.N.L.). Pterygoid fossae small and deep ; lower surface lying dorsal to basisphenoid ; basioccipital and basisphenoid bones rather narrow.

Mandible : Relatively longer and broader than in *T. indica* ; mandibular length over 50 per cent (50·0—54·3 per cent) *vs.* under 50 per cent (46·0—49·0 per cent) of O.N.L. ; maximum width over 50 per cent (50·0—56·0 per cent) *vs.* under 50 per cent (46·0—50·0 per cent) of G.L.M. ; lower diastema length short, under 26 per cent (22·0—25·7 per cent) of G.L.M. and less than root-length of lower molars, 29·0—33·0 per cent (mean 30·6) of G.L.M. ; coronoid process small ; angular process twisted slightly outward.

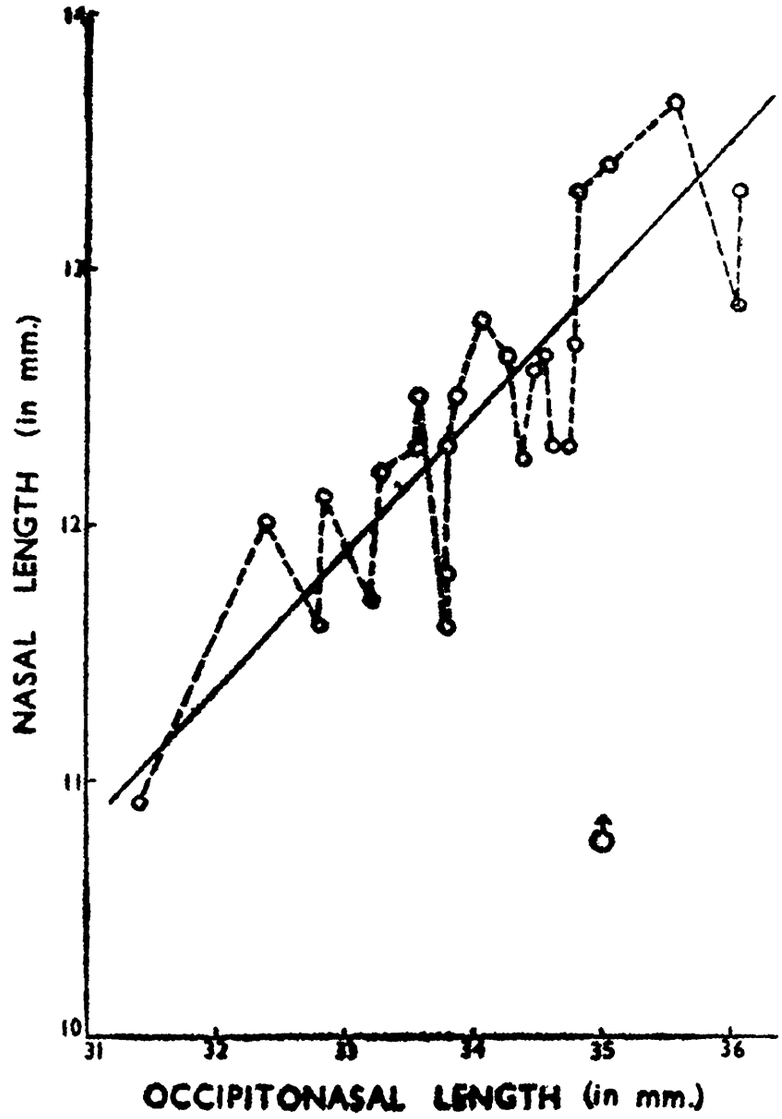
Cranial foramina : Similar to that of *T indica*.

Dentition : Upper incisors yellow, opisthodont and grooved ; lower incisors simple, ungrooved and long, terminating posteriorly into a knob in between condylar and coronoid processes. Molars hypsodont and rooted. Upper molars : m^1 four rooted, m^2 two rooted and m^3 single rooted ; molars divided into lozenge shaped subequal laminae separated by V-shaped infoldings of enamel ; laminae always jointed ; no sign of biserial cusping ; m^1 having three laminae, m^2 and m^3 bilaminate. Second innerfold of m^1 and inner fold of m^2 slightly longer than outer. Lower molars : Exactly like uppers except that m_3 is ring-shaped.

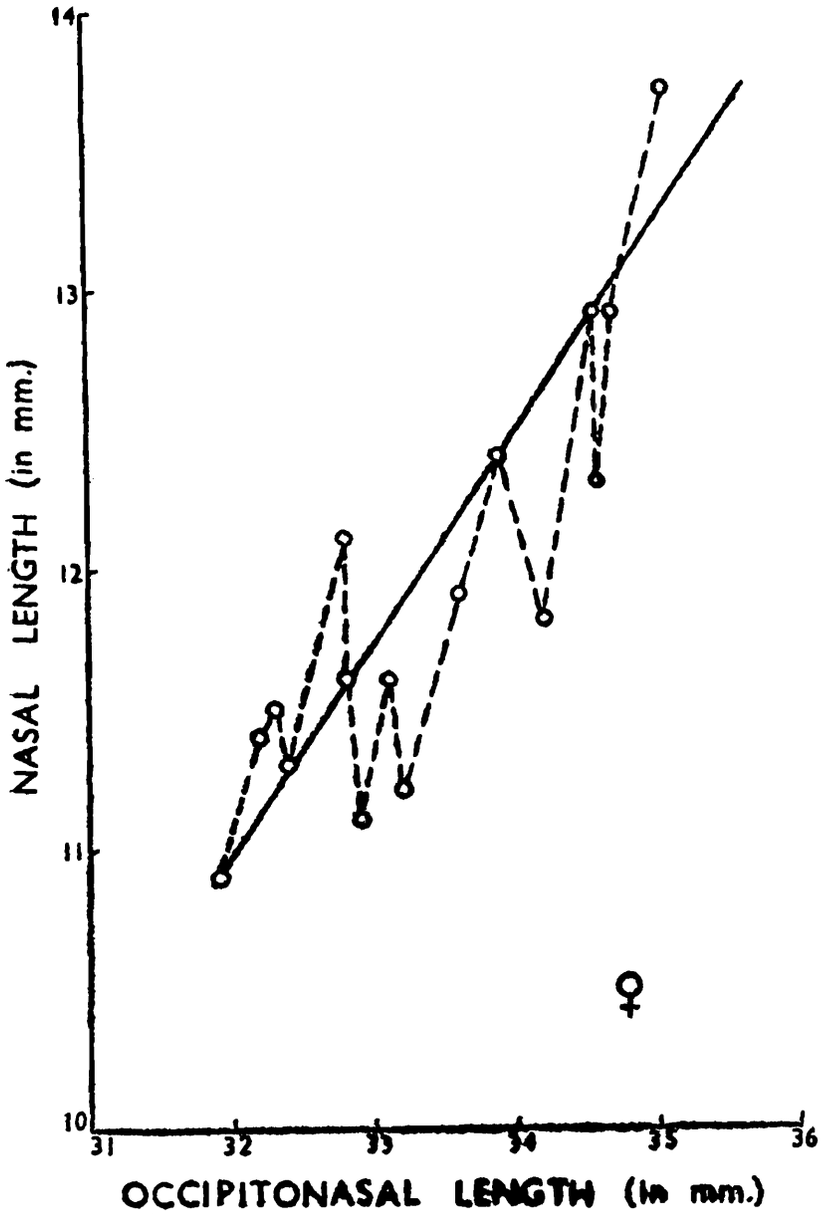
Variations.—The measurements of skulls of *Meriones hurrianae* from N.W. Pakistan (Waziristan) and western India (Rajasthan and Gujarat), show a tendency to become shorter in occipitonasal length and broader in interorbital width from Waziristan southwards to Gujarat. The occipitonasal length varies from 33·5—37·7 mm. (mean ♂♂ 37·5 ; ♀♀ 34·4) in Waziristan, 31·4—36·5 (mean ♂♂ 34·3 ; ♀♀ 33·4) in Rajasthan, and 30·7—33·6 (mean ♂♂ 31·9 ; ♀♀ 32·8) in Gujarat. Similarly, the least interorbital width averages 19·5 per cent (♂♂) and 18·8 per cent (♀♀) of

O.N.L. in Waziristan and Rajasthan, and 20·7 per cent (♂♂) and 19·5 per cent (♀♀) in Gujarat. Male skulls (Table 5) are slightly longer and less interorbitally constricted than female ones.

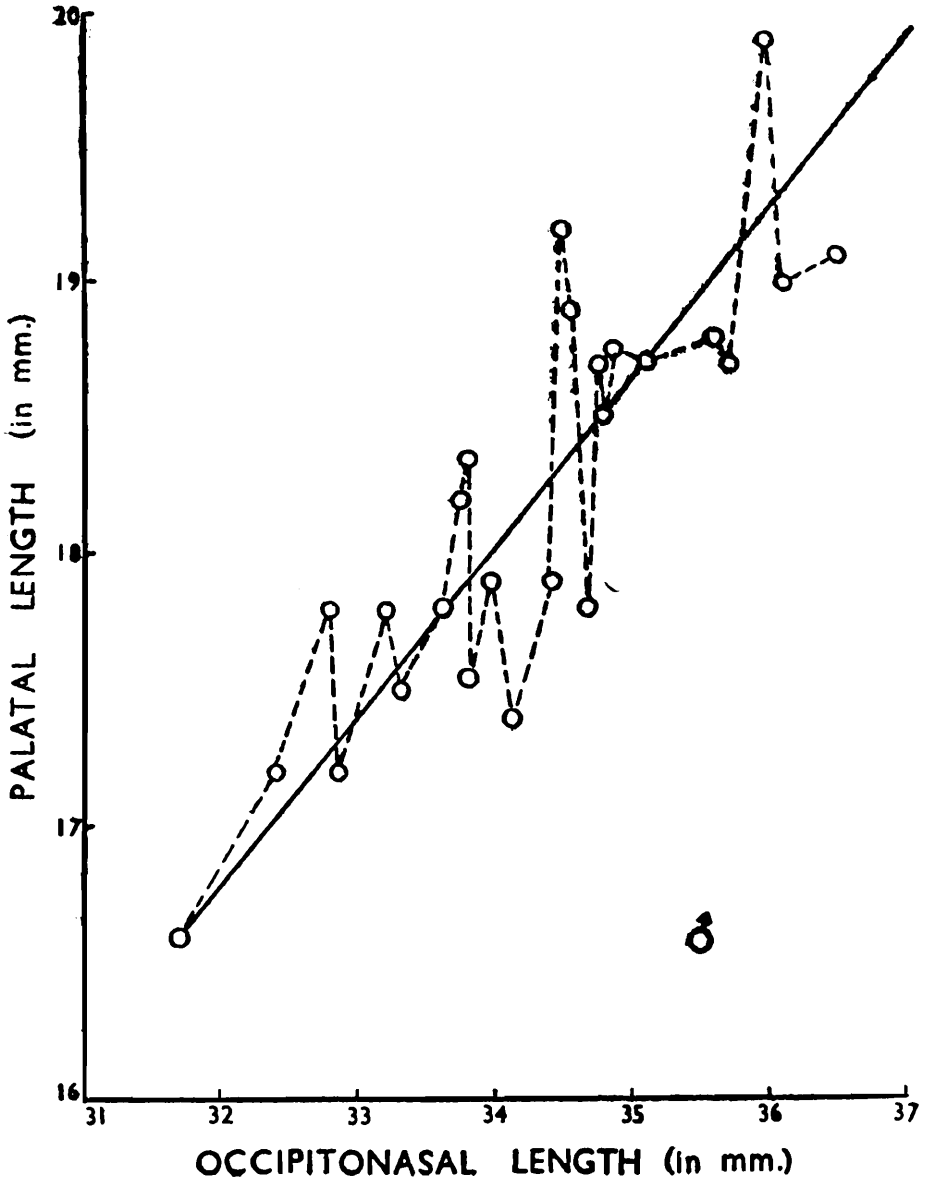
Size-correlation in adult skulls : The study of skulls from Rajasthan shows that there is relative increase in the size of the cranial bones like the nasals, the palate and the tympanic bullae (Text-figs. 1-6), with the increase in the occipitonasal length (total length) of the skull. The parietals and the interparietal slightly increase in absolute width. With the increase in the length of the mandible (Table 6), the lower molars and the diastema become longer, though the former increases less than the latter.



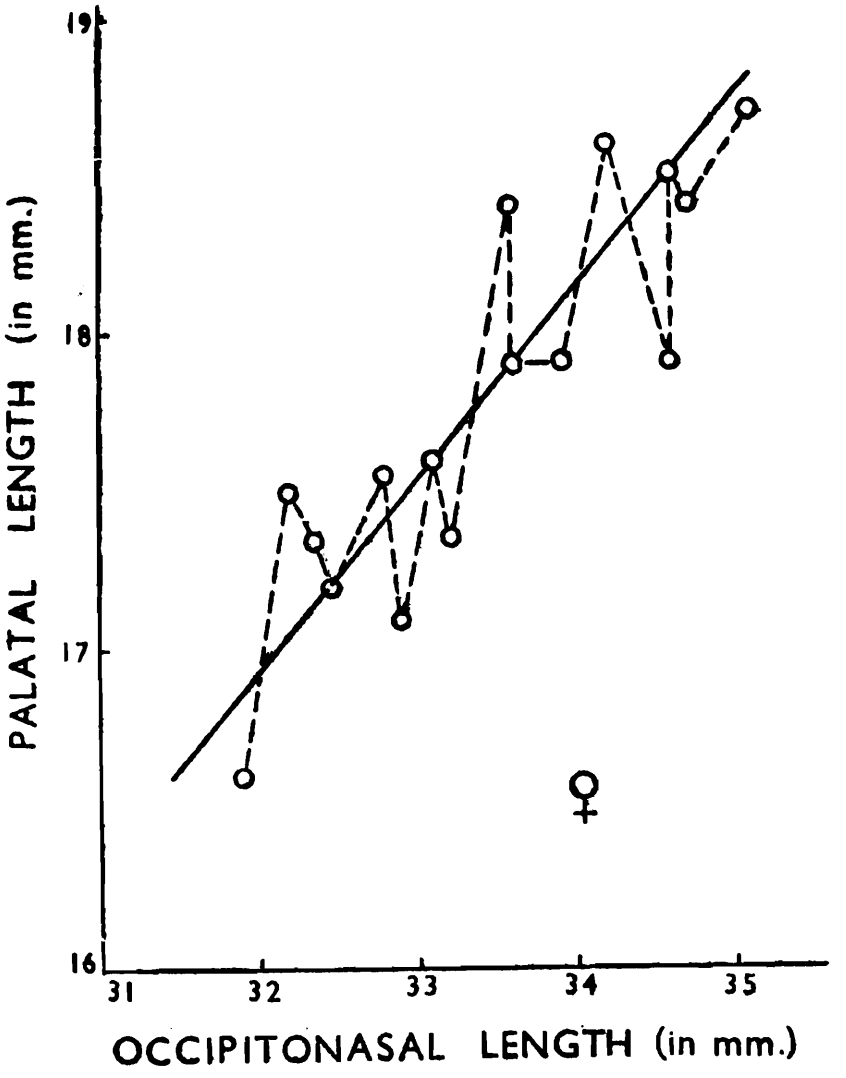
TEXT-FIG. 1.—*Meriones hurrianae* Jerdon. Graph showing correlation between the length of the nasal and the occipitonasal length of skull, in males. The former increases with the increase of the latter. (The thick line shows the trend.)



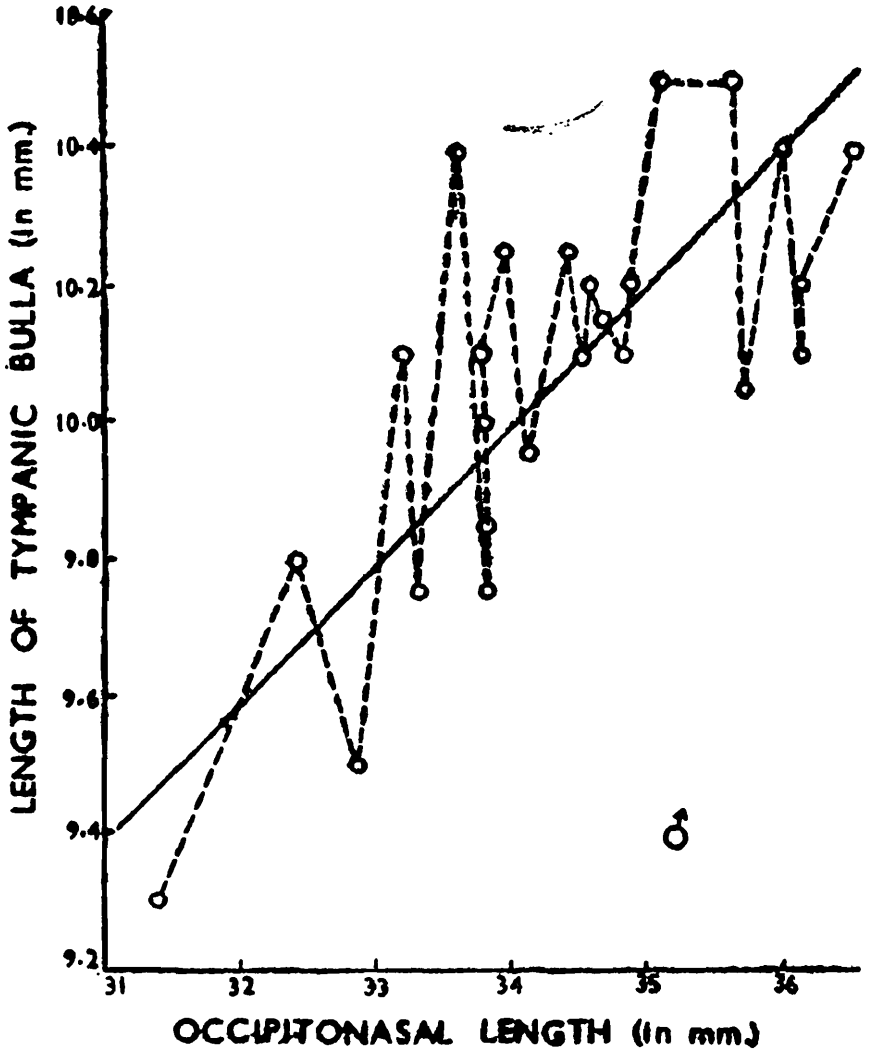
TEXT-FIG. 2.—*Meriones hurrianae* Jerdon. Graph showing correlation between the length of the nasal and the occipitonasal length of skull, in females. The former increases with the increase of the latter. (The thick line shows the trend.)



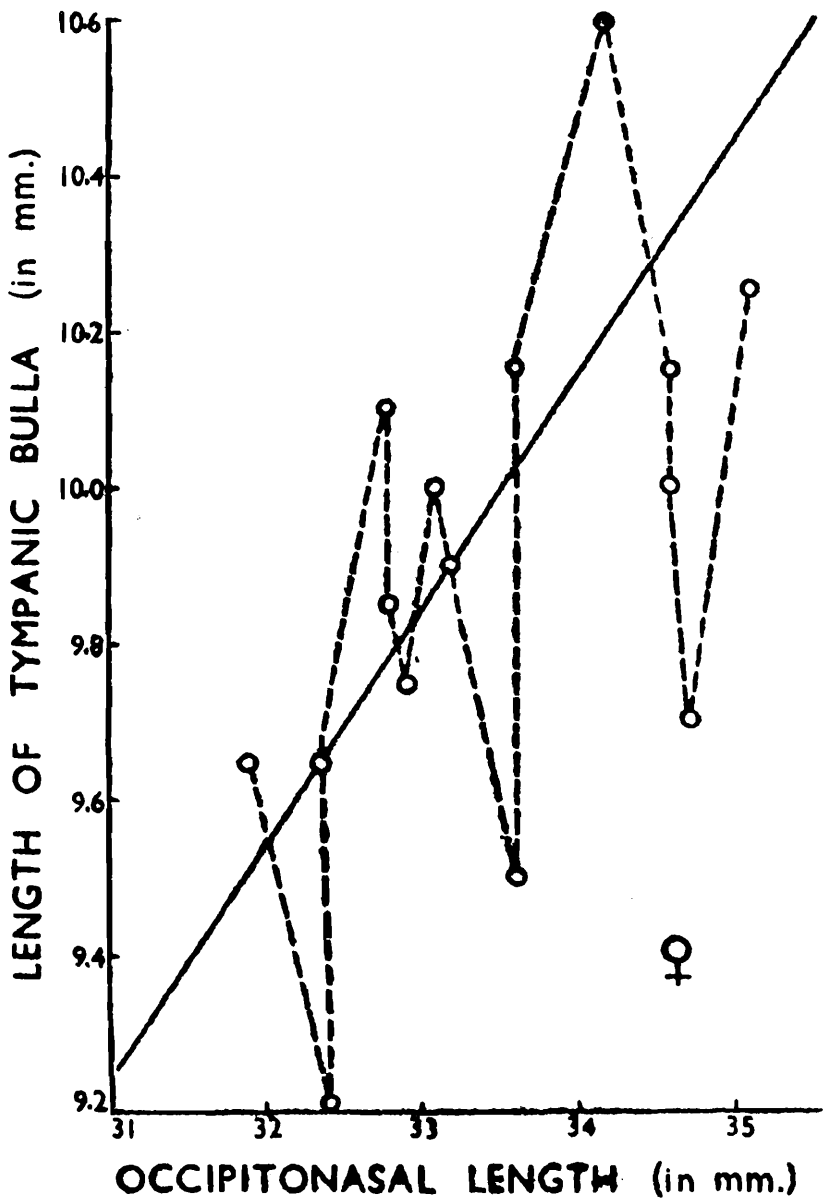
TEXT-FIG. 3.—*Meriones hurrianae* Jerdon. Graph showing correlation between the length of the palate and the occipitonasal length of skull, in males. The former increases with the increase of the latter. (The thick line shows the trend.)



Text-fig. 4.—*Meriones hurrianae* Jerdon. Graph showing correlation between the length of the palate and the occipitonasal length of skull, in females. The former increases with the increase of the latter. (The thick line shows the trend.)



TEXT-FIG. 5.—*Meriones hurrianae* Jerdon. Graph showing correlation between the length of the tympanic bulla and the occipitonasal length of skull, in males. The former slightly increases with the increase of the latter. (The thick line shows the trend.)



TEXT-FIG. 6.—*Meriones hurrianae* Jerdon. Graph showing correlation between the length of the tympanic bulla and the occipitonasal length of skull, in females. The former slightly increases with the increase of the latter. (The thick line shows the trend.)

2. Meriones persicus Blanford

2*a*. Meriones persicus persicus Blanford

(Tables 3 and 4 ; and Plate 18)

Skull almost similar to that of *M. hurrianae* in structure, etc., but differs as follows :—Longer and narrower ; occipitonasal length 43·2—44·1 mm. (mean 43·6) *vs.* 30·7—37·7 mm. (mean 33·8) and greatest zygomatic width under 55 per cent (50·4—53·7 per cent) of O.N.L. *vs.* over 55 per cent (55·2—61·0 per cent) ; nasals longer, over 39 per cent (39·1—41·6 per cent) of O.N.L. *vs.* below 39 per cent (33·7—38·6 per cent) ; frontals narrower, least interorbital width below 17 per cent (14·3—16·5 per cent) of O.N.L. *vs.* over 17 per cent (18·1—23·0 per cent) ; anterior palatine foramina longer, over 7 mm. (7·6—7·9 mm.) *vs.* under 7 mm. (4·2—6·0 mm.) or 17·6 per cent of O.N.L. *vs.* under 17 per cent (13·3—17·0 per cent) ; upper cheek-tooth row smaller, below 13 per cent (11·9—13·2 per cent) of O.N.L. *vs.* over 13 per cent (13·1—15·9 per cent) ; diastema longer, over 26 per cent (26·2—28·8 per cent) of O.N.L. *vs.* under 26 per cent (23·4—26·3 per cent) ; supraorbital ridges less prominent ; external auditory meatus spout-like, anteriorly not touching the zygomatic arches; tympanic bullae 12·1—13·2 mm. or 27·3—30·5 per cent (mean 28·9 per cent) of O.N.L.

Mandible : Relatively smaller and narrower than that of *M. hurrianae* ; mandibular length under 50 per cent (48·3—50·0 per cent) of O.N.L. *vs.* over 50 per cent (50·0—54·3 per cent) and maximum width under 50 per cent (46·7—48·5 per cent) of G.L.M. *vs.* over 50 per cent (50·0—56·0 per cent) ; lower diastema longer, over 26 per cent (27·6—28·6 per cent) of G.L.M. *vs.* under 26 per cent (22·0—25·7 per cent) and more than the root-length of lower molars (mean 25·5 per cent of G.L.M.).

Dentition : Similar to that of *M hurrianae.*

2*b*. Meriones persicus baptistae Thomas

(Tables 3 and 4 ; and Plate 19)

Skull almost similar to that of *M. persicus persicus*, but differing in having the nasals slightly smaller, 36·6 per cent of O.N.L. *vs.* 39·1—41·6 per cent (mean 40·4) ; frontals less interorbitally constricted, least interorbital width 17·5 per cent of O.N.L. *vs.* 14·3—16·5 per cent (mean 15·4).

Some of the other measurements are as follows :—1 subadult specimen : Occipitonasal length 36·0 mm. ; anterior palatine foramina 17·7 per cent of O.N.L. ; upper cheek-tooth row 13·8 per cent of O.N.L. ; tympanic bullae 10·8 mm. or 30·0 per cent of O.N.L.

Discussion.—Ellerman (1961), with limited material has differentiated the two subspecies, *M p. persicus* and *M. p. baptistae*, on the length of tympanic bullae, *i.e.*, over 11·9 mm. (or over 30 per cent of O.N.L.)

in *baptistae* and less than this in *persicus*. He further reported both the subspecies to occur in Kelat (Baluchistan). The specimens of *M. p. persicus* from Iran (Kohrud, Kuhibarzi) in our collection have tympanic bullae 12·1—13·2 mm. (or 27·3—30·5 per cent of O.N.L.). The differences between the two subspecies thus overlap.

3. **Meriones crassus** Sundevall

3*a*. **Meriones crassus swinhoei** Scully

(Tables 3 and 4 ; and Plate 20)

Skull almost similar to that of *M. hurrianae* in size, etc., but differs in the following details :—Skull fairly sloping anteriorly, broadest posteriorly ; bimeatal distance exceeding greatest zygomatic width ; rostrum short and straight ; narrower, 14·4 per cent of O.N.L. *vs.* 13·9—17·3 per cent (mean 15·5) ; frontals narrower, least interorbital width 15·7 per cent of O.N.L. *vs.* over 17 per cent (18·1—23·0 per cent) ; frontal ridges feeble; frontal suture disappearing ; tympanic bullae larger, over 1/3rd (38·1 per cent) of O.N.L. *vs.* under 1/3rd (27·6—31·1 per cent) ; fairly inflated, with large external auditory meatus ; the latter anteriorly touching zygomatic arches ; mastoids inflated ; anteriorly bulging out through supratympanic fenestrae of squamosal and posteriorly fairly projecting behind the occiput ; palate shorter, under 50 per cent (49·8 per cent) of O.N.L. *vs.* over 50 per cent (50·4—55·6 per cent) ; anterior palatine foramina longer, over 17 per cent (17·3 per cent) of O.N.L. *vs.* under 17 per cent (13·3—17·0 per cent) ; upper cheek-tooth row shorter, 12·2 per cent of O.N.L. *vs.* 13·1—15·9 per cent (mean 14·5) ; squamosal, basioccipital and basisphenoid bones becoming very narrow.

Mandible : Smaller than that of *M hurrianae* ; mandibular length 50 per cent of O.N.L. *vs.* over 50 per cent (50·0—54·3 per cent) ; root length of lower molars shorter, 25·9 per cent of G.L.M. *vs.* 29·0—33·0 per cent (mean 30·6) ; condylar process high and reaching the level of coronoid ; the latter relatively small and weak.

Dentition : Similar to that of *M. hurrianae* except that the upper m^3 is ring-shaped.

4. **Meriones libycus** Lichtenstein

4*a*. **Meriones libycus erythrourus** Gray

(Tables 3 and 4 ; and Plate 21)

Skull almost similar to that of *M. crassus swinhoei*, but differs as follows :—Larger, occipitonasal length 37·0—39·7 mm. (mean 38·4) *vs.* 31·8 mm. ; frontals less constricted, least interorbital width over 6 mm. (6·6—7·2 mm.) *vs.* 5 mm. or over 17 per cent (18·0—18·3 per cent) of O.N.L. *vs.* 15·7 per cent; tympanic bullae slightly smaller, 37·5 per cent of O.N.L. *vs.* 38·1 per cent ; mastoids less inflated but slightly projecting

posteriorly behind occiput ; upper cheek-tooth row longer, over 5 mm. (5·0—5·4 mm.) *vs.* under 5 mm. (3·9 mm.) or over 13 per cent (13·5—13·6 per cent) of O.N.L. *vs.* 12·2 per cent. Mandible long, G.L.M. over 20 mm. (20·4—21·2 mm.) ; root-length of lower molars longer than in *M. swinhoei*, over 5·8 mm. (5·9—5·95 mm.) *vs.* 4·25 mm.

Some other important measurements are as follows :—Greatest zygomatic width 53·7—57·4 per cent (mean 55·5) of O.N.L. anterior palatine foramina 16·2 per cent of O.N.L. bimeatal distance 56 per cent of O.N.L. ; nasal length 36·5—39·0 per cent, mean 37·7, of O.N.L.

Genus (3) **Gerbillus** Desmarest

Key for identification of Oriental species of Gerbillus, *based on skull characters.*

O. N. L., Occipitonasal length.

1(2). Least interorbital width over 5 mm. (or over 18 per cent of O.N.L.) anterior palatine foramina under 15 per cent of O.N.L.

.....*G. gleadowi* Murray

2(1). Least interorbital width under 5 mm. (or under 18 per cent of O.N.L.); anterior palatine foramina over 15 per cent of O.N.L.

.....*G. nanus nanus* Blanford

.....*G. dasyurus indus* Thoma

1. **Gerbillus nanus** Blanford

1*a*. **Gerbillus nanus nanus** Blanford

(Tables 7 and 8 ; and Plate 22)

General : Skull small ; occipitonasal length 23·9—26·8 mm. (mean 25·2), with slight depression in postero-dorsal portion of nasals ; rostrum straight and narrow; rostral width below 3·5 mm (2·9—3·4 mm.) or under 13% (11·8—12·6%) of O.N.L.; sutures between paired bones distinct ; occipitonasal length exceeding condylobasal length. *Nasals :* Smaller than in *Tatera indica*, under 38% (35·3—36·9 per cent) of O.N.L. *vs.* over 38 per cent (38·5—45·0 per cent) ; slanting anteriorly and projecting slightly forwards over incisors ; posteriorly extending upto anterior orbital margin and slightly shorter than ascending process of premaxillae. *Frontals :* Short, frontal length less than twice the parietal length ; narrowest just behind lacrymals ; least interorbital width under 5 mm. (3·9—4·5 mm.) or below 18 per cent (16·5—17·2 per cent) of O.N.L. ; ridged on sides. *Parietals :* Fairly well developed but relatively narrow, parietal width 11·2—12·2 mm. (mean 11·7) ; laterally extended ; lateral extensions nearly half the length of squamosals ; fronto-parietal suture smooth, curved anteriorly on sides. *Interparietal :* Wider than long ; anterior border slightly arched, pointing forward mediallv posterior

border convex posteriorly, with slight inflection in the middle. *Occiput :* Vertical, with moderately developed ridges ; paroccipital processes distinct, closely applied to tympanic bullae. *Zygomatic arches :* Narrow ; slanting upwards anteriorly to lacrymals ; greatest zygomatic width under 55 per cent (52·2—53·5 per cent) of O.N.L.; zygomatic plate moderately thrown forward on either side of rostrum and having flattened anterior border ; supramaxillary root of zygoma broad ; infraorbital canal large ; higher than wide. *Squamosals :* Small ; supratympanic portion narrow ; extending posteriorly upto mastoids ; supratympanic fenestrae small. *Tympanic bullae :* Oval ; large, 7·5—8·8 mm. (mean 8·2) or 30·5—32·9 per cent (mean 32·1 per cent) of O.N.L.; anteriorly touching the hamular process of pterygoids ; external auditory meatus inflated and protruding anteriorly ; touching or not touching the zygomatic process of squamosals ; mastoids slightly inflated ; posteriorly not extending beyond occiput. *Palate :* Shorter than in *T indica*, under 50 per cent (47·9—50·1 per cent) of O.N.L. *vs.* over 50 per cent (51·7—56·2 per cent), extending posteriorly behind molars ; anterior palatine foramina moderately long, over 15 per cent (15·1—17·1 per cent) of O.N.L. ; posterior palatine foramina small, under 1·7 mm. (1·3—1·65 mm.); extending from first inner fold of m^1 to first lamina of m^2; upper cheek-tooth rows nearly parallel and short, 11·2—12·7 per cent (mean 11·9 per cent) of O.N.L.; diastema short, under 25 per cent (22·9—24·4 per cent) of O.N.L.; pterygoid fossae fairly developed and deep ; mesopterygoid fossa and basisphenoid narrow.

Mandible : Small ; greatest length of mandible 12·5—13·8 mm (mean 13.2); mandibular length under 50 per cent (47·0—47·7 per cent) of O.N.L.; broader than in *T indica*, maximum width over 50 per cent (50·0—52·3 per cent.) *vs.* under 50 per cent (46·0—50·0 per cent) of G.L.M.; lower diastema length (2·8—3·1 mm., mean 3·0) less than root-length of lower molars (3·0—3·8 mm., mean 3·35); condylar process high, reaching the level of coronoid ; the latter m ll.

Cranial foramina : similar to that of *Tatera indica* described above.

Dentition : Upper incisors opisthodont, yellow and longitudinally grooved ; lower incisors long and ungrooved, terminating posteriorly at the root of condylar process. Molars slightly hypsodont, rooted and biserially cusped ; cusps on wearing, form transverse laminae ; laminae jointed or unjointed ; inner folds longer than outer. Upper molars : m^1 with a small anterior lamina and biserially cusped second and third laminae ; cusps asymmetrically arranged ; inner cusp of third lamina larger and slightly posterior to outer, thus forming a heel on outer border; antero-external and postero-internal folds larger and deeper than opposite ones ; m^2 bilaminate and separated by a pair of folds ; m^3 with a large anterior lamina and a small posterior tubercle. Lower molars : m_1 trilaminate ; anteriormost lamina lozenge-shaped ; first pair of folds meeting medially ; second inner fold deeper than outer and pushed anteriorly reaching the first pair ; m_2 bilaminate, m_3 unilaminate.

2. **Gerbillus dasyurus** Wagner

2*a*. **Gerbillus dasyurus indus** Thomas

(Tables 7 and 8 ; and Plate 23)

Skull almost similar to that of *Gerbillus nanus*, only differing from it in having slightly smaller tympanic bullae, 7·6—8·3 mm. (mean 7·9) *vs.* 7·5—8·8 mm. (mean 8·2) or 31·6 per cent. of O.N.L. *vs.* 30·5—32·9 per cent (mean 32·1 per cent).

Some of the other measurements are as follows :—Occipitonasal length 26·1 mm.; greatest zygomatic width 13·6 mm. or 52 per cent of O.N.L.; least interorbital width 4·4 mm. or 16·8 per cent of O.N.L.; nasal length 9·4—9·5 mm. (mean 9·4) or 36·0 per cent of O.N.L.; anterior palatine foramina 16·8 per cent of O.N.L.; upper cheek-tooth row 3·1—3·2 mm. (mean 3·15) or 11·8 per cent of O.N.L.; diastema length 6·2—6·2 mm. (mean 6·2) or 23·7 per cent of O.N.L.; greatest length of mandible 12·7—12·9 mm. (mean 12·8).

3. **Gerbillus gleadowi** Murray

3*a*. **Gerbillus gleadowi gleadowi** Murray

(Tables 7 and 8; and Plate 24)

Skull almost similar to that of *Gerbillus nanus*, but differs in the following details :—Larger, occipitonasal length 25·7—29·2 mm. (mean 27·5) *vs.* 23·9—26·8 mm. (mean 25·2) ; rostrum wider, over 3·5 mm. (3·6—3·9) *vs.* under 3·5 mm. (2·9—3·4 mm.) or above 13 per cent (13·3—14·0 per cent) of O.N.L. *vs.* under 13 per cent (11·8—12·6 per cent); frontals and parietals fairly broader ; least interorbital width over 5 mm. (5·0—5·8) *vs.* under 5 mm. (3·9—4·5) or above 18 per cent (18·9—19·4 per cent) of O.N.L. *vs.* under 18 per cent. (16·5—17·2 per cent) ; parietal width over 12·8 mm. (12·9—13·9 mm.) *vs.* under 12·8 mm. (11·2—12·2 mm.); palate longer, over 50 per cent (50·0—51·4 per cent) of O.N.L. *vs.* under 50 per cent. (47·9—50·1 per cent) ; anterior palatine foramina smaller, below 15 per cent. (13·2—14·8 per cent) of O.N.L. *vs.* over 15 per cent (15·1—17·1 per cent); posterior palatine foramina longer, 1·7—2·1 mm. (mean 1·9) *vs.* 1·3—1·65 mm. (mean 1·4) ; diastema longer, over 1/4th (24·5—26·0 per cent) of O.N.L. *vs.* under 1/4th (22·9—24·4 per cent); pterygoid fossae reduced ; tympanic bullae smaller, 29·9—30·9 per cent (mean 30·4 per cent) of O.N.L. *vs.* 30·5—32·9 per cent (mean 32·1 per cent); external auditory meatus not touching the zygomatic arch ; supramaxillary root of zygoma narrower.

Mandible : Narrower than in *G. nanus*, maximum width below 50 per cent (44·3—45·3 per cent) *vs.* over 50 per cent (50·0—52·3 per cent) of G.L.M.; lower diastema length (3·5—4·0 mm., mean 3·8) more than the root length of lower molars (3·4—3·8 mm., mean 3·6).

Subfamily (ii) *MICROTINAE*

Two genera were studied, namely, *Pitymys* McMurtrie and *Alticola* Blanford.

Genus (4) Pitymys McMurtrie

1. Pitymys sikimensis Hodgson

1*a*. Pitymys sikimensis sikimensis Hodgson

(Tables 9 and 10 ; and Plate 25)

General : Skull small, occipitonasal length 24·1—26·4 mm. (mean 25·75) ; dorsal surface flat ; rostrum short and straight ; sutures between paired maxilla and palatine bones disappearing ; condylobasal length exceeding occipitonasal length. *Nasals :* Short, under 1/3rd (27·8—32·1 per cent) of O.N.L.; anteriorly not reaching the incisors ; narrowest posteriorly and gradually becoming wider anteriorly ; width of anterior portion over twice the posterior ; anterior and posterior extremities truncated ; posteriorly extending upto anterior orbital margin and slightly shorter than ascending process of premaxillae. *Frontals :* Frontal length twice or less than twice the parietal length ; interorbital constriction considerable ; narrower than rostrum ; least interorbital width 13·1—16·6 per cent (mean 14·9) of O.N.L.; supraorbital ridges forming or not forming median interorbital crest ; posteriorly ridges diverging in transverse plane and crossing the anterior edge of parietals ; thence running posteriorly through the upper edge of squamosals, converging slowly to hinder part of parietals and interparietal, meeting the occipital. *Parietals :* Broader than long ; laterally extended ; lateral extensions nearly half the length of squamosals ; fronto-parietal suture plane and deeply concave ; parieto-squamosal suture posteriorly meeting the lateral sides of interparietal. *Interparietal :* Large ; broader than long ; width over twice the length ; situated anterior to a line joining posterior extremity of squamosals and laterally touching it ; anterior border arched, pointing forward medially and the posterior border convex backwards. *Occiput :* Vertical ; ridges moderately developed on sides ; supraoccipital not extending anteriorly on the sides of interparietal ; paroccipital processes distinct, posteriorly applied to tympanic bullae. *Squamosals :* Fairly well developed, forming major portion of the sides of cranium ; anteriorly encroaching upon frontals ; prominent peg-like projections present anteriorly for the attachment of temporal muscles ; supratympanic portion long, posteriorly meeting the occipitals and mastoids ; supratympanic fenestrae large. *Zygomatic arches :* Strong, widely spread laterally at anterior and posterior portion ; widest medially ; greatest zygomatic width 58·0—62·9 per cent (mean 60·0) of O.N.L.; lower maxillary root stout, placed obliquely to long axis of skull and supporting fore-part of the zygomatic arch ; not projecting anteriorly to supramaxillary root in form of zygomatic plate ; jugal short and narrow; zygomatic process of squamosal long, extending anteriorly and meeting

the posterior end of jugal ; infraorbital canal fairly developed ; higher than wide. *Tympanic bullae :* Well inflated, with large auditory orifice; relatively smaller than in other species of this genus, 5·6—6·4 mm. (mean 6·2) or under 25 per cent (22·6—25·2 per cent) of O.N.L. ; situated obliquely to long axis of the skull ; anteriorly touching the hamular process of pterygoids ; mastoids large but not bulged out. *Palate :* Fairly well developed, 56·4—61·6 per cent (mean 59·0) of O.N.L. rather than over 60 per cent (Ellerman, 1947*a*) ; not extending posteriorly behind molars ; posteriorly terminating between postero-lateral pits ; inner border of the pits connected with the sides of the median process of the palatine forming sloping septum ; portion of palate in between molars higher than anterior ; anterior palatine foramina narrow ; moderately long, 14·6—20·0 per cent (mean 17·0) of O.N.L. rather than over 1/5th of O.N.L. (Ellerman, 1962), ending anterior to the molars ; Darjeeling (N. Bengal) specimens having smaller foramina than Sikkim ones (14·6—17·1 per cent, mean 15·8, of O.N.L. *vs.* 18·1—20·0 per cent, mean 19·3) ; posterior palatine foramina very small, situated in between second pair of molars ; prominent groove running posteriorly from posterior end of each anterior palatine foramina on either side of median elevated tract, and after crossing the maxillo-palatine suture terminating in posterior palatine foramina ; postero-lateral pits perforated by numerous small foramina ; upper cheek-tooth rows long, 5·5—6·5 mm. (mean 6·1) or under 1/4th (22·3—25·1 per cent) of O.N.L. rather than over 1/4th of O.N.L. (Ellerman, 1947*a*), slightly diverging posteriorly ; diastema long, over 28 per cent (28·6—32·0 per cent) of O.N.L.; portion of maxillae supporting molars thickened and stout. Presphenoid and anterior portion of basisphenoid laterally compressed ; basisphenoidal canal connecting both the pterygoid fossae ; the latter deeper than mesopterygoid fossa ; foramen ovale and foramen lacerum medius large ; optic foramen small ; foramen interpremaxillary small but distinct.

Mandible : Robust ; horizontal ramus thick bearing hypsodont cheek-teeth ; coronoid process sickle shaped, acute and high ; condylar process extending posteriorly beyond angular process ; the latter small ; lower incisor-root forming slight protuberance between condylar and angular processes ; deep pits present for muscle attachment between the molars and coronoid process ; masseteric ridge anteriorly strong ; mandibular length over 58 per cent (58·1—62·6 per cent) of O.N.L.; maximum width 49·4—50·9 per cent (mean 50·3) of G.L.M.; root-length of lower molars (36·3—39·8 per cent, mean 38·1, of G.L.M.) more than lower diastema length (24·1—26·2, mean 25·2 per cent, of G.L.M.).

Dentition : Upper incisors orthodont or slightly proodont, yellow and ungrooved ; as thick as wide ; posteriorly extending upto first molar; lower incisors pale and ungrooved, longer and less curved than upper and posteriorly terminating into a knob in between condylar and angular processes. Molars $\frac{3}{3}$, hypsodont, prismatic and rootless. Upper molars : m^1 having 3 salient angles and 2 folds on each side, consisting of an anterior transverse loop and four alternating closed triangles ; first and third triangles being internal ; m^2 having 3 outer and 2 inner salient angles consisting of an anterior loop, 3 closed triangles and an extra postero-internal heel ; first and third triangle being external ; separated by two outer and one inner folds ; second inner fold half ;

m^3 with 3 outer and 4 inner salient angles, consisting of an anterior loop, three closed triangles and a posterior loop ; the latter having two lingually directed arms ; separated by 3 inner and 2 outer folds ; third outer fold half. Lower molars : m_1 consisting of a posterior loop, three alternating closed triangles, two pairs of confluent triangles and an anterior loop ; first and third triangle being internal ; separated by 4 outer and 5 inner folds ; anterior most outer fold shallow ; m_2 with a posterior loop and 4 alternating closed triangles of which first being internal ; separated by two folds on each side ; m_3 consisting of 3 transverse loops.

2. **Pitymys leucurus** Blyth

2*a*. **Pitymys leucurus leucurus** Blyth

(Tables 9 and 10)

Skull almost similar to that of *Pitymys sikimensis* Hodgson, but differs as follows :—Slightly wider, greatest zygomatic width 66·5 per cent *vs.* 58·0—62·9 per cent (mean 60) of O.N.L.; tympanic bullae larger and well inflated, over 7 mm. (7·2—7·35 mm.) *vs.* under 7 mm. (5·6—6·4mm.) or over 25 per cent (30·3 per cent) of O.N.L. *vs.* under 25 per cent (22·6—25·2 per cent); nasals slightly smaller, 26·8 per cent *vs.* 27·8—32·1 per cent (mean 29·2) of O.N.L; supraorbital ridges nearing fusion in interorbital region (fusion not complete); fronto-parietal suture relatively straight ; angular process of mandible slightly narrower ; root of lower incisors forming prominent knob below condylar process.

Dentition (Text-fig. 7, b, b') differing from that of *P. sikimensis* in the following details : Upper incisors proodont and pale ; m^3 reduced ; consisting of an anterior loop, two alternating closed triangles and a third triangle being confluent with posterior loop ; two folds on each side ; posterointernal fold deep. Lower m_1 consisting of a posterior loop, three alternating closed triangles, a pair of confluent triangles and an anterior loop ; separated by four inner and three outer folds ; anteroexternal fold shallow.

Some of the other measurements are as follows :—Occipitonasal length 24·2 mm.; condylobasal length 26·1 mm. upper cheek-tooth row 6·0 mm. or 25·0 per cent of O.N.L.; anterior palatine foramina 16·7 per cent of O.N.L.; palate 61·5 per cent of O.N.L.

Genus (5) **Alticola** Blanford

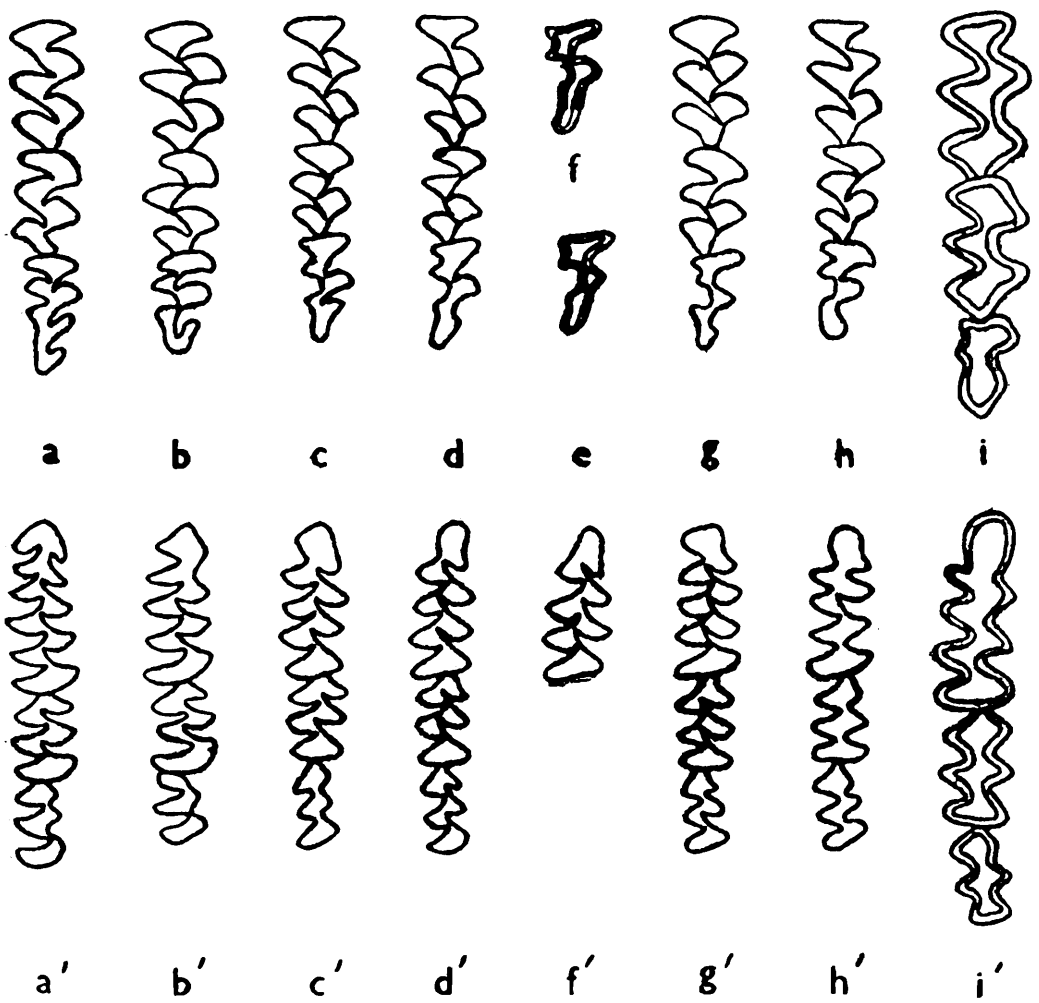
Key for identification of Oriental species of Alticola, *based on skull characters.*

O.N.L., Occipitonasal length.

1(2). Upper m^3 having two innerfolds ; nasal length below 30 per cent of O.N.L., posteriorly slightly shorter than ascending process of premaxillae ; rostral width over 18 per cent of O.N.L.
...*A. roylei roylei* Gray

2(1). Upper m^3 having one or two inner folds ; nasal length over 30 per cent of O.N.L., posteriorly equal to ascending process of premaxillae ; rostral width under 18 per cent of O.N.L.

...*A. bhatnagari* Biswas & Khajuria
...*A. stoliczkanus strachevi* Thomas



TEXT-FIG. 7.—Molar crown pattern in subfamily Microtinae, family Muridae.
a-i., right upper molars (m^1, m^2 and m^3).
a'-i'., right lower molars (m_1, m_2 and m_3).
a, a'., *Pitymys sikimensis* Hodgson (Z.S.I. Reg. No. 10511 ♂).
b, b'., *Pitymys leucurus* Blyth (No. 325/578 ♂).
c, c'., *Alticola roylei roylei* Gray (Z.S.I. Reg. No. 13277 ♂).
d, d'., *Alticola stoliczkanus stracheyi* Blanford (Z.S.I. Reg. No. 12433 ♀).
e., right m^3 of *Alticola stoliczkanus stracheyi* Blanford (Z.S.I. Reg. No. 12454 ♂).
f, f'. right m^3 and right m^1 of *Alticola bhatnagari* Biswas & Khajuria (Z.S.I. Reg. No. 12431 ♂).
g, g'., *Alticola bhatnagari* Biswas & Khajuria (Z.S.I. Reg. No. 12392 ♀).
h, h'., *Hyperacrius wynnei* Blanford (Sclater cat. No. 'b').
i, i'., *Ellobious fuscocapillus* Blyth

1. **Alticola roylei** Gray

1*a*. **Alticola roylei roylei** Gray

(Tables 11 and 12 ; and Plate 26)

General : Skull small, occipitonasal length 24·1—25·7 mm. (mean 25·1); dorsal surface flat ; rostrum short and straight ; sutures between paired maxilla and palatine bones disappearing ; condylobasal length exceeding or not exceeding occipitonasal length. *Nasals :* Short, under 30 per cent (28·2—28·8 per cent) of O. N. L.; anteriorly not reaching the front face of incisors ; narrowest posteriorly and gradually becoming wider anteriorly ; posteriorly slightly shorter than ascending process of premaxillae. *Frontals :* Frontal length over twice the parietal length ; less interorbitally constricted than in *Pitymys sikimensis*, least interorbital width 15·4—17·4 per cent (mean 16·2) of O.N.L. *vs.* 13·3—16·6 per cent (mean 14·9); supraorbital ridges not forming median interorbital crest. *Parietals :* Broader than long and laterally extended ; fronto-parietal suture deeply concave and slightly zigzaged. *Interparietal :* Large ; situated anterior to a line joining posterior extremity of squamosals; broader than long, width over twice the length ; laterally touching squamosals. *Occiput :* Vertical ; ridges moderately developed on sides ; paroccipital processes posteriorly applied to tympanic bullae. *Squamosals :* Fairly well developed ; encroaching anteriorly over frontals ; anteriorly forming prominent peg-like projections for the attachment of muscles ; supratympanic fenestrae large. *Zygomatic arches :* Strongly built ; widely spread laterally at anterior and posterior portion ; slightly narrower than in *P. sikimensis*, greatest zygomatic width 57·5—58·5 per cent (mean 58·0) *vs.* 58·0—62·9 per cent (mean 60·0) of O.N.L. *Tympanic bullae :* Small, 5·5—6·2 mm. (mean 6·0) or under 1/4th (22·8—24·2 per cent) of O.N.L.; situated obliquely to long axis of skull ; mastoids large, but not bulged out. *Palate :* Shorter than in *P. sikimensis*, under 55 per cent (49·9—53·7 per cent) *vs.* over 55 per cent (56·4—61·6 per cent) of O.N.L.; extending posteriorly upto third molar and terminating as a simple transverse shelf ; anterior palatine foramina long, 18·4—20·5 per cent (mean 19·5 per cent) of O.N.L., rather than over 1/5th of O.N.L. (Ellerman, 1962), ending posteriorly anterior to molars ; posterior palatine foramina very small ; postero-lateral pits deep, not in level with palate ; upper cheek-tooth rows 5·5—5·9 mm. (mean 5·7) or over 1/5th (21·9—23·0 per cent) of O.N.L. and slightly shorter than diastema length (26·5—29·7 per cent, mean 28·6 per cent, of O.N.L.).

Mandible : Robust, with sickle shaped and high coronoid process, posteriorly extending condylar process and hamulate angular process, masseteric ridge prominent ; mandible shorter than in *P. sikimensis*, mandibular length 55·4—58·8 per cent (mean 57·0) of O.N.L. *vs.* 58·1—62·6 per cent (mean 60·7); maximum width under 50 per cent (46·8—50·3 per cent) of G.L.M.; lower diastema length (22·4—27·0 per cent, mean 23·8, of G.L.M.) less than root-length of lower molars (36·3—38·9 per cent, mean 37·6, of G.L.M.).

Dentition : Upper incisors orthodont, pale and ungrooved ; as thick as wide ; lower incisors ungrooved, extending posteriorly upto the root of condylar process, but externally indistinct. Molars $\frac{3}{3}$; hypsodont, prismatic and rootless. Upper molars : m^1 consisting of an anterior loop and 4 alternating closed triangles, separated by two pairs of folds ; first triangle being internal ; m^2 with an anterior loop and 3 alternating closed triangles of which first being external, separated by two outer and one inner folds ; m^3 having 3 salient angles on each side, consisting of an anterior loop, 3 small triangles and a posterior loop ; the latter having a lingually directed lobe ; first triangle being confluent with anterior loop and third with posterior loop ; second triangle being internal and closed ; triangles separated by three outer and two inner folds ; third outer fold very shallow. Lower molars : m_1 having a posterior loop, four alternating closed triangles and a fifth triangle confluent with anterior loop ; three outer and four inner folds present; m_2 consisting of a posterior loop and two pairs of confluent triangles ; m_3 having three transverse loops.

2. **Alticola stoliczkanus** Blanford

2*a*. **Alticola stoliczkanus stracheyi** Thomas

(Tables 11 and 12)

Skull almost similar to that of *A. roylei roylei* in size, etc., but differs as follows :—Condylobasal length always exceeding occipitonasal length ; nasals slightly longer, 30·5—30·8 per cent (mean 30·6) *vs.* 28·2—28·8 per cent (mean 28·6) of O.N.L., extending posteriorly as far as ascending process of premaxillae ; slightly broader posteriorly ; fronto-parietal suture smooth ; palate longer, 55·4 per cent of O.N.L. *vs.* 49·9—53·7 per cent (mean 52·3) ; diastema slightly longer, 30·0—31·8 per cent (mean 30·9) *vs.* 26·5—29·7 per cent (mean 28·6) of O.N.L.; rostrum narrower, 16·4 per cent *vs.* 18·1—21·0 per cent (mean 19·2) of O.N.L. Mandible slightly longer than in *Alticola roylei ;* mandibular length 62·1—62·2 per cent (mean 62·15) *vs.* 55·4—58·8 per cent (mean 57·0) of O.N.L.

Dentition (Text-fig. 7 *d, e*) : Upper m^1 and m^2 as in *A. roylei;* m^3 displays two kinds of structure ; firstly having three salient angles on each side, consisting of an anterior loop, three alternating triangles of which second being internal and closed, and a posterior loop with slight indentation on inner side ; first and third triangles smaller and confluent respectively with anterior and posterior loops ; having three outer and two inner folds ; secondly there is tendency of reduction of third inner angle and indentation of posterior loop ; thus giving rise to two inner angles and two outer and one inner folds. Lower m_1 with four salient angles on each side, consisting of a posterior loop, five alternating closed triangles and an anterior loop ; triangles separated by three folds on each side ; sometimes a shallow fourth outer fold present ; m_2 with three salient angles on each side, consisting of a posterior loop, two alternating closed triangles, and a confluent posterior pair ; m_3 like m_2 but smaller.

Some of the other measurements are as follows :—Occipitonasal length 25·6—26·2 mm. (mean 25·9) ; condylobasal length 26·7—26·7 mm. (mean 26·7) ; greatest zygomatic width 58·4—59·0 per cent (mean 58·7) of O.N.L.; least interorbital width 15·6—16·0 per cent (mean 15·8) of O.N.L.; tympanic bullae 24·4 per cent of O.N.L.; cheek-tooth row 5·9—5.95 mm. (mean 5·9) or 22·7—23·0 per cent (mean 22·9) of O.N.L.; anterior palatine foramina 19·9—20·3 per cent (mean 20·1) of O.N.L.

3. **Alticola bhatnagari** Biswas & Khajuria

3*a*. **Alticola bhatnagari bhatnagari** Biswas & Khajuria

(Tables 11 and 12)

Skull almost similar to that of *A. stoliczkanus stracheyi* in structure, etc., but differs as follows :—Slightly smaller, occipitonasal length 24·45—24·7 mm. (mean 24·6) *vs.* 25·6—26·25 mm. (mean 25·9) ; having smaller tympanic bullae, under 6 mm. (5·75—5·9 mm.) *vs.* over 6 mm. (6·25—6·4 mm.) or under 24 per cent (23·4—23·8 per cent) of O.N.L. *vs.* over 24 per cent (24·4—24·4 per cent). Mandibles longer and narrower than in *A. roylei ;* mandibular length 61·4—61·9 per cent (mean 61·7) of O.N.L. *vs.* 55·4—58·8 per cent (mean 57·0 per cent); maximum width under 45 per cent (42·5—43·3 per cent) *vs.* over 45 per cent (46·8—50·3 per cent) of G.L.M.

Some of the other measurements are as follows :—Condylobasal length 25·0—25·2 mm. (mean 25·1) ; greatest zygomatic width 14·5 mm. or 58·7 per cent of O.N.L.; least interorbital width 16·4—16·7 per cent (mean 16·55) of O.N.L.; palate 54·6—54·8 per cent (mean 54·7) of O.N.L.; anterior palatine foramina 17·5—20·2 per cent (mean 18·8) of O.N.L.; upper cheek-tooth row 5·7—5·9 mm. (mean 5·8) or 23·2—24·0 per cent (mean 23·6) of O.N.L.; nasal length 30·0—30·2 per cent (mean 30·1) of O.N.L.

Discussion—Upper m^3 (Text-fig. 7 *f, g*), both in *Alticola stracheyi* and *A. bhatnagari* display two kinds of structure : (i) It consists of three salient angles on each side, separated by three outer and two inner folds, as in *A. roylei roylei.* (ii) Third inner angle shows reduction, thus giving rise to three outer and two inner salient angles separated by two outer and one inner folds ; the third outer fold becoming very shallow. Biswas & Khajuria (1957, p. 247) had mentioned the latter condition as a diagonastic character for *A. bhatnagari,* and Hinton (1926, p. 307) for adults of *A. stracheyi.*

Subfamily (iii) *CRICETINAE*

Two genera were studied, namely, *Calomyscus* Thomas and *Cricetulus* Milne Edwards.

Key for identification of Oriental genera and species of Cricetinae, *based on skull characters.*

O.N.L., Occipitonasal length.

1(3). Upper m^1 having 5 cusps.
. *Calomyscus* Thomas

2(4). Least interorbital width more than rostral width ; occiput low, under 3 mm. or under 10 per cent of O.N.L.; interparietal width over 30 per cent of O.N.L.
... *Calomyscus bailwardi bailwardi* Thomas

3(1). Upper m^1 having 6 cusps.
. *Cricetulus* Milne-Edwards

4(2). Least interorbital width less than rostral width ; occiput high, over 3·5 mm. or over 10 per cent of O.N.L.; interparietal width under 30 per cent of O.N.L.
. *Cricetulus migratorius fulvus* Blanford

Genus (6) **Calomyscus** Thomas

1. **Calomyscus bailwardi** Thomas

A description of the skull of the typical subspecies is given below.

1*a*. **Calomyscus bailwardi bailwardi** Thomas

(Tables 13 and 15 ; and Plate 27)

General : Skull small, occipitonasal length 25·3—25·35 mm. (mean 25·3) ; dorsal surface flat, slightly sloping anteriorly ; rostrum long and straight ; rather narrow, 13·4—14·2 per cent (mean 13·8) of O.N.L.; sutures between paired bones distinct ; occipitonasal length exceeding condylobasal length. *Nasals :* Medium-sized, 36·1—36·3 per cent (mean 36·2) of O.N.L.; slightly projecting forwards over incisors, anterior extremity truncated and posterior acute ; narrowest posteriorly; and gradually becoming wider anteriorly ; posteriorly extending up to ascending process of premaxillae. *Frontals :* Frontal length less than twice the parietal length ; interorbital constriction broader than rostrum; narrowest medially, least interorbital width 15·4—16·6 per cent (mean 16·0) of O.N.L.; unridged on sides. *Parietals :* Fairly well developed broader than long ; laterally extended ; posteriorly meeting the occipital on either side of interparietal.; fronto-parietal suture smooth *Interparietal :* Large and wide ; nearly two and half times wider than long, mean length and breadth respectively 13·2 and 35·5 per cent of O.N.L.; situated nearly posterior to a line joining posterior extremity of squamosals and laterally not touching it. *Occiput :* Weak ; low, 2·2—2·5 mm. (mean 2·35) or 8·7—9·9 per cent (mean 9·3) of O.N.L.; ridges poorly developed ; supraoccipital extending anteriorly on the sides of interparietal ; paroccipital processes small. *Squamosals :* Moderately developed ; post zygomatic portion reduced ; supratympanic processes oblique and posteriorly meeting the mastoids ; supratympanic fenestrae small ; postglenoid foramen large and shifted posteriorly above external

anditory meatus. *Zygomaticarches :* Thin and weak ; slightly diverging posteriorly, but nearly parallel ; greatest zygomatic width 50 per cent of O.N.L.; zygoma not descending ventrally to level of palate ; lower maxillary root of zygoma narrower than in Microtinae, not projecting anterior to supramaxillary root in form of zygomatic plate ; jugal long, but anteriorly not reaching to lacrymal ; zygomatic process of squamosal short ; infraorbital canal higher than wide ; wider above than below. *Tympanic bullae :* Small, 15·8—16·8 per cent (mean 16·3) of O.N.L.; inflated posteriorly and gradually becoming pointed anteriorly ; situated obliquely to longitudinal axis ; anteriorly touching hamular process of pterygoids ; auditory orifice large, situated ventro-laterally ; mastoids having distinct mastoid foramen, situated dorso-medially. *Palate :* Short, below 50 per cent (47·4—48·4 per cent) of O.N.L. ; extending posteriorly slightly behind molars ; palate in between molars in level with pterygoid fossae and basioccipital ; anterior palatine foramina long, over 18 per cent (18·1 per cent) of O.N.L.; situated at equal distance from incisors and molars ; posterior palatine foramina very small ; upper cheek-tooth rows nearly parallel and short, 3·2—3·6 mm. (mean 3·4) or 12·6—14·2 per cent (mean 13·4) of O.N.L.; diastema long, 24·5—26 per cent (mean 25·2) of O.N.L.; shallow groove running posteriorly from posterior end of each anterior palatine foramina and after crossing maxillo-palatine suture and posterior palatine foramina, terminating in the pterygoid fossae ; portion of maxillae supporting molars weak. Basioccipital and basisphenoid bones fairly developed ; basioccipital fairly high and gradually sloping anteriorly upto presphenoid ; pterygoid fossae very shallow, flat and slightly ventral to mesopterygoid fossa.

Mandible : Short ; mandibular length under 50 per cent (45·8—48·4 per cent) of O.N.L.; having acute and moderately developed coronoid process and small angular process ; the latter slightly extending posteriorly ; lower incisor-root forming slight protuberance between coronoid and condylar processes : masseteric ridge feeble ; maximum width of mandible 50·0—52·8 per cent (mean 51·4) of G.L.M.; lower diastema length (24·8 per cent of G.L.M.) subequal to root-length of lower molars (25·2 per cent of G.L.M.).

Dentition : Upper incisors opisthodont, yellow and ungrooved ; thicker than wide ; passing posteriorly into maxillary bone and terminating far anterior to molars ; lower incisors pale and ungrooved, posteriorly terminating as a protuberance in between coronoid and condylar processes. Molars $\frac{3}{3}$; brachyodont, biserially cuspidate and rooted. Upper molars : m^1 4-rooted ; m^2 4-rooted but posterior roots fused ; m^3 2-rooted ; m^1 having 5 cusps, arranged alternately in two rows ; first cusp being antero-external ; separated by two folds on each side ; outer folds obliquely projecting posteriorly ; no root below third cusp ; m^2 having 4 alternating cusps, of which first one being internal ; separated by two outer and one inner folds ; m^3 worn out but most likely formed of three cusps. Lower molars : m_1 having five and m_2 four main cusps, arranged alternately and two pairs of alternating folds ; anterior two cusps in m_1 fuse into one, with age ; antero—external fold shallow ; m_3 with three cusps separated by a fold in each side ; external fold shallow.

Genus (7) **Cricetulus** Milne Edwards

1. **Cricetulus migratorius** Pallas

The description of the subspecies *C. m. fulvus* Blanford is given below.

1*a*. **Cricetulus migratorius fulvus** Blanford

(Tables 13 and 15 ; and Plate 28)

General : Skull medium-sized ; occipitonasal length 31·1—31·4 mm. (mean 31·3), rather than only 26·7 mm. (Ellerman, 1961); dorsal surface sloping forward ; rostrum long and anteriorly curved downwards ; rostral width 17·0—17·3 per cent (mean 17·1) of O.N.L.; cranium sloping posteriorly ; sutures between paired bones distinct ; occipitonasal length exceeding condylobasal length. *Nasals :* Medium sized, 36·4—36·5 per cent (mean 36·4) of O.N.L.; slightly projecting forwards over incisors ; narrowest posteriorly and gradually becoming wider anteriorly; anterior extremity rounded ; posteriorly slightly shorter than ascending process of premaxillae ; the latter extending posteriorly behind lacrymals. *Frontals :* Frontal length less than twice the parietal length ; interorbital constriction narrower than rostrum ; least interorbital width 13·6—14·3 per cent (mean 14·0) of O.N.L.; supraorbital ridges feeble. *Parietals :* Fairly well developed ; broader than long ; laterally extended; posteriorly meeting the occipital on either side of interparietal ; fronto-parietal suture zigzaged. *Interparietal* : Situated anterior to a line joining posterior extremity of squamosals ; smaller than in *Calomyscus bailwardi* (mean length and breadth respectively 8·0 and 22·9 per cent of O.N.L. *vs.* 13·2 and 35·5 per cent); biconvex in shape ; laterally not touching squamosals. *Occiput :* Stout ; higher than that of *C. bailwardi*, 4·1—4·25 mm. (mean 4·2) *vs.* 2·2—2·5 mm. (mean 2·35) or 13·0—13·6 per cent (mean 13·3) of O.N.L. *vs.* 8·7—9·9 per cent (mean 9·3) ; ridges moderately developed ; supraoccipital not extending anteriorly on sides of interparietal ; paroccipital processes small. *Squamosals :* Moderately developed ; supratympanic portion stout ; supratympanic fenestrae and postglenoid foramen small. *Zygomatic arches :* Weak and thin ; greatest zygomatic width over 50 per cent (53·7—54·3 per cent) of O.N.L.; lower maxillary root of zygoma not projecting anterior to supra-maxillary root in form of zygomatic plate ; jugal short ; infraorbital canal higher than wide and wider above than below. *Tympanic bullae :* Moderately large and inflated, 5·5—5·7 mm. (mean 5·6) or over 17 per cent (17·7—18·1 per cent) of O.N.L.; anteriorly not so pointed as in *C. bailwardi*, but touching the hamular process of pterygoids ; mastoids reduced ; mastoid foramen indistinct. *Palate :* Short, below 50 per cent (47·7—49·2 per cent) of O.N.L.; extending posteriorly as far as molars; higher anteriorly and sloping posteriorly in between molars; anterior palatine foramina long, 18·1—18·3 per cent (mean 18·2) of O.N.L., ending posteriorly slightly anterior to molars ; posterior palatine foramina very small ; upper cheek-tooth rows parallel and short ; 4·3—4·4 mm. mean 4·35) or 13·8—14·0 per cent (mean 13·9) of O.N.L. rather than 4·6 mm. or

17·2 per cent of O.N.L. (Ellerman, 1961) ; diastema long, 28·6—29·5 per cent (mean 29·0) of O.N.L., over twice the length of cheek-tooth row ; maxillo-palatine suture distinct ; portion of maxillae supporting molars weak ; pterygoid fossae shallow and in level with mesopterygoid fossa ; basisphenoid and basioccipital bones fairly well developed.

Mandible : Longer than that of *C. bailwardi ;* mandibular length over 50 per cent (53·2—54·3 per cent) of O.N.L. *vs.* under 50 per cent (45·8—48·4 per cent) ; coronoid process stout, higher than condylar ; angular process extending posteriorly ; coronoid and angular processes separated from condylar by deep curved space; lower incisor-root situated at the root of condylar process ; maximum width of mandible 49·8—50·3 per cent (mean 50·0) of G.L.M.; lower diastema length (30·2—31·4 per cent, mean 30·8, of G.L.M.) longer than root-length of lower molars (24·4—26·7 per cent, mean 25·5, of G.L.M.).

Dentition : Upper incisors opisthodont, yellow and ungrooved ; slightly thicker than wide ; lower incisors pale and ungrooved, posteriorly terminating at the root of condylar process. Molars $\frac{3}{3}$; biserially cuspidate and rooted. Upper molars : m^1 and m^2 4-rooted, and m^3 3-rooted ; m^1 having 6 cusps, arranged in two longitudinal rows, separated by two inner and two deep posteriorly directed outer folds ; in addition an anterior fold in between first pair of cusps present ; anterior and outer folds on wearing leave three pits (the anterior shallow and the posterior two deep), one in between each pair of cusps ; m^2 having 4 large cusps and a small antero-external cusp ; separated by a shallow inner and two deep posteriorly directing outer folds ; outer cusps smaller than inner ; outer folds on wearing leave a pit in between each pair of cusps ; m^3 exactly like m^2 but smaller. Lower molars : m_1 having 6 main cusps and a rudimentary postero-internal one ; separated by three inner and two outer folds, and an anterior fold in between first pair of cusps ; m_2 having 4 main cusps and a rudimentary antero-external and a postero-internal cusp ; separated by two folds on each side ; antero-internal fold fairly deep ; m_3 like m_2 but smaller.

Subfamily (iv) *MURINAE*

Four genera were studied, namely, *Chiropodomys* Peters, *Rattus* Frisch, *Bandicota* Gray and *Nesokia* Gray.

Key for idenification of four Oriental genera of Murinae, *based on skull characters.*

O. N. L., Occipitonasal length.

1(4). Occipitonasal length exceeding condylobasal length ; interparietal generally (except in subgenus *Berylmys* of genus *Rattus*) situated posterior to a line joining posterior extremity of squamosals.

2(3). First upper molar consisting of 8 cusps ; postero-internal cusp absent ; zygomatic plate projecting anterior to supramaxillary root of zygomatic arch ; nasals over 1/3rd of O. N. L.

...*Rattus* Ficher

3(2). First upper molar consisting of 10 cusps ; postero-internal cusp and an extra cusp behind third row present ; zygomatic plate not projecting anterior to supramaxillary root of zygomatic arch ; nasals under 1/3rd of O. N. L.

...*Chiropodomys* Peters

4(1). Condylobasal length generally exceeding occipitonasal length ; interparietal always situated anterior to a line joining posterior extremity of squamosals.

5(6). Anterior palatine foramina long, over 6·5 mm. or over 15 per cent of O. N. L. ; first upper molar consisting of 9 cusps ; molars having the tendency to form transverse laminae.

...*Bandicota* Gray

6(5). Anterior palatine foramina small, under 6·5 mm. or under 15 per cent of O. N. L. ; molars always laminate.

...*Nesokia* Gray

Genus (8) **Chiropodomys** Peters

1. **Chiropodomys gliroides** Blyth

1*a*. **Chiropodomys gliroides gliroides** Blyth

(Tables 14 and 15 ; and Plate 29)

General : Skull small, occipitonasal length 22·3—26·0 mm. (mean 24·3) ; cranium broad and much sloping posteriorly ; rostrum short ; rostral width 16·9—19·2 per cent (mean 18·3) of O. N. L. ; sutures between paired bones distinct ; occipitonasal length exceeding condylobasal length. *Nasals :* Small, 25·9—31·6 per cent (mean 28·7) of O.N.L. ; extending anteriorly upto incisors and posteriorly upto ascending process of premaxillae ; anterior tip truncated or round and posterior acute. *Frontals :* Frontal length less than twice the parietal length ; slightly constricted ; narrowest just behind lacrymals ; least interorbital width 17·1—21·0 per cent (mean 19·2) of O.N.L. ; ridged on sides ; ridges diverging posteriorly over parietals, reaching the occiput. *Parietals :* Large ; much broader than frontals ; fronto-parietal suture plane and broadly V-shaped ; temporal ridges fairly wide apart. *Interparietal :* Large ; width nearly twice the length ; situated behind a line joining posterior extremity of squamosals and laterally not touching it ; anterior border arched, pointing forward medially ; posterior border convex backward. *Occiput :* Vertical ; low, 7·0—9·1 per cent (mean 8·25) of O.N.L. ; crests poorly developed ; extending anteriorly on both sides of interparietal ; paroccipital processes small ; foramen magnum situated somewhat ventrally. *Squamosals :* Small ; postzygomatic portion of squamosal rather narrow ; supratympanic fenestrae absent ; postglenoid foramen large and shifted posteriorly above external auditory meatus. *Zygomatic arches :* Weak ; greatest zygomatic width 57·3 per cent of O.N.L. ; anterior region narrower than posterior but relatively broader than in terrestrial genera of Murinae ; zygoma descending ventrally to level of palate ; inferior maxillary root of zygoma having straight anterior border and not projecting anterior to supramaxillary root ; jugal short and confined to posterior half of zygomatic arches ; infraorbital canal higher than wide. *Tympanic bullae :* Small, 14·4—15·2 per cent (mean 14·75) of O.N.L. ; anteriorly touching the hamular process of pterygoids ;

auditory orifice large, situated ventrolaterally ; mastoids small. *Palate :* Short ; under 50 per cent (47·3—49·6 per cent) of O.N.L., extending posteriorly upto hinder end of molars ; anterior palatine foramina small, under 15 per cent (12·4—13·9 per cent) of O.N.L. ; situated at equal distance from incisors and molars ; anterior half formed by premaxillae and posterior half by maxillae ; upper cheek-tooth rows nearly parallel and short, 12·7—15·2 per cent (mean 13·9) of O.N.L. ; diastema over 1/4th (25·4—27·9 per cent) of O.N.L. ; portion of maxillae supporting molars weak ; basioccipital broad ; pterygoid fossae shallow and ventral to mesopterygoid fossa.

Mandible : Long ; mandibular length over 50 per cent (53·2—55·8 per cent) of O.N.L. ; coronoid process small and reduced, little higher than condylar ; distance between coronoid and condylar processes considerable ; angular process short, slightly extending posteriorly ; root of lower incisors not prominent, lying below the coronoid process ; masseteric ridge feeble ; maximum width of mandible below 50 per cent (45·0—50·3 per cent) of G.L.M. ; lower diastema length (21·5—24·6 per cent, mean 22·9 per cent, of G.L.M.) slightly shorter than root-length of lower molars (21·7—26·2 per cent, mean 24·1 per cent, of G.L.M.).

Dentition : Upper incisors orthodont and ungrooved ; thicker than wide ; posteriorly terminating anterior to molars ; lower incisors long, posteriorly extending up to coronoid process. Molars $\frac{3}{3}$; brachyodont and rooted. Upper molars : m^2 smaller than m^1 ; m^3 much smaller than m^2 ; m^1 having 10 cusps arranged in three transverse rows of 3 cusps and an extra small postero-external cusp behind third row ; m^2 like m^1, except that the front lamina lacking the central cusp, and antero-external cusp reduced ; m^3 having an antero-internal cusp in front lamina, three cusps in second and two cusps in the third lamina. Lower molars : having two longitudinal rows of functional cusps and an outer row of vestigeal cusps; on wearing m_1 consisting of 3 laminae, m^2 and m^3 two each ; m_1 having 5 transverse rows of cusps, two small cusps in first row, two large and one small in each second, third and fourth row and a cusp behind it representing heel ; m_2 having an antero-external cusp in first row, two large and one small cusps in each second and third row and a heel ; m_3 with an antero-external cusp and two cusps in each second and third row.

Genus (9) **Rattus** Fischer

1. **Rattus rattus** Linnaeus

1*a*. **Rattus rattus arboreus** Horsfield

(Tables 16 and 17 ; and Plate 30)

General : Skull medium-sized ; occipitonasal length 38·3—41·4 mm. (mean 39·7); dorsal surface flat, slightly sloping anteriorly and posteriorly;

rostrum long ; rostral width 15·7—17·9 per cent (mean 16·6) of O.N.L. ; sutures between paired bones distinct ; cranium rather narrow ; occipitonasal length exceeding condylobasal length. *Nasals :* Small, 32·0 —36·8 per cent (mean 35·1) of O.N.L. ; slightly projecting forwards over incisors ; posteriorly slightly shorter than ascending process of premaxillae ; anterior extremity rounded and posterior acute. *Frontals :* Narrow ; interorbital constriction narrower than rostrum ; narrowest just behind lacrymals, least interorbital width 13·6—14·7 per cent (mean 14·1) of O.N.L. ; ridged on sides ; ridges extending posteriorly slightly diverging, over anterior half of parietals ; thence converging and meeting lateral ends of interparietal ; maximum distance between temporal ridges under 15 mm. (12·5—14 mm.). *Parietals :* Large ; parietal length over one-half the frontal length ; wider than long ; laterally extended ; the lateral extensions long, at least half the squamosal length ; fronto-parietal suture nearly straight, slightly curved anteriorly on sides. *Interparietal :* Large ; width twice or more, of the length ; situated nearly behind a line joining posterior extremity of squamosals ; anterior border arched, pointing forward medially ; posterior border convex backward. *Occiput :* Vertical ; low, 9·7—12·0 per cent (mean 10·9) of O.N.L. ; ridges moderately developed ; extending anteriorly on the sides of interparietal ; paroccipital processes distinct. *Squamosals :* Moderately large, with fairly developed crests ; supratympanic fenestrae absent. *Zygomatic arches :* Narrow ; widest medially and gradually becoming narrower anteriorly ; greatest zygomatic width 45·0—50·0 per cent (mean 48·65) of O.N.L. ; zygoma descending ventrally to level of palate ; jugal confined to posterior two-thirds of zygomatic arches ; zygomatic process of maxilla long, extending posteriorly to anterior two-thirds portion of zygomatic arches ; zygomatic plate extending anterior to supramaxillary root of zygoma and having nearly straight anterior border ; infraorbital canal higher than wide. *Tympanic bullae :* Moderately large ; inflated ; 16·9—18·5 per cent (mean 17·7) of O.N.L. ; situated slightly oblique to longitudinal axis ; converging anteriorly and touching the hamular process of pterygoids ; auditory orifice large : mastoids small. *Palate :* Long, over 50 per cent (51·9—54·7 per cent) of O. N. L., extending posteriorly behind molars ; portion of palate in between molars being in the same plane as the anterior ; anterior palatine foramina long, 15·6—17·6 per cent (mean 16·8) of O. N. L., reaching posteriorly to molars ; anterior one-third portion formed by premaxillae and posterior two-thirds by maxillae ; posterior palatine foramina very small ; shallow groove running backward from posterior end of each anterior palatine foramina and terminating in pterygoid fossa of respective side ; upper cheek-tooth rows parallel or slightly diverging posteriorly, 5·8—6·6 mm. (mean 6·2) or 15·0—16·3 per cent (mean 15·6) of O. N. L.; diastema 24·2—26·2 per cent (mean 25·3) of O. N. L. ; orbito-temporal fossa large, 32·7—35·2 per cent (mean 33·9) of O. N. L. ; portion of maxillae supporting molars weak. Pterygoid fossae moderately deep and in level with mesopterygoid fossa ; foramen ovale, foramen lacerum medius and interpterygoid foramina distinct.

Mandible : Long and broad ; mandibular length 49·1—52·8 per cent (mean 51·4) of O. N. L. ; maximum width over 50 per cent (52.2—55·7 per cent) of G. L. M. ; root-length of lower molars (28·2—31·2

per cent, mean 29·6, of G. L. M.) more than lower diastema length (23·1—27·9 per cent, mean 25·0 of G. L. M.) ; having moderately developed coronoid process and posteriorly extended angular process; masseteric ridge moderately developed ; lower incisor root not prominent, situated below coronoid process.

Dentition : Upper incisors orthodont and ungrooved ; thicker than wide ; posteriorly passing into maxillary bone and ending much anterior to molars ; lower incisors yellow, extending posteriorly up to the root of condylar process. Molars $\frac{3}{3}$; cuspidate and rooted. Upper molars : m^2 smaller than m^1, and m^3 smaller than m^2 ; outer row of cusps smaller than middle and inner rows. m^1 having 8 cusps, arranged in three transverse rows—three in each of the first and second rows and two in the third ; postero-internal cusp absent ; m^2 with 6 cusps, an antero-internal cusp in front lamina, three in the second and two in the third ; antero-external cusp generally absent or rudimentary ; m^3 like m^2. Lower molars : m_1 trilaminate, having two cusps in each lamina, and a heel posterior to this ; an additional outer cusp beside third lamina present ; m_2 like m_1 except the front lamina which is represented by only antero-external cusp ; m_3 having an antero-external cusp, two cusps in the anterior and one cusp in posterior lamina.

2. **Rattus rajah** Thomas

2*a*. **Rattus rajah surifer** Miller

(Tables 16 and 17)

Skull almost similar to that of *Rattus rattus arboreus* in structure etc., but differs as follows :—Longer and narrower ; occipitonasal length 39·5—47·3 mm. (mean 42·6) *vs.* 38·3—41·4 mm. (mean 39·7) and greatest zygomatic width under 46 per cent (41·7—45·4 per cent) of O. N. L. *vs.* over 46 per cent (45·8—50·0 per cent) ; frontals slightly less constricted, least interorbital width 13·4—17·4 per cent (mean 15·5) of O. N. L. *vs.* 13·6—14·7 per cent (mean 14·1) ; heavily ridged on sides ; ridges forming slight projection at lateral extremities of fronto-parietal suture ; temporal ridges widely separated, maximum distance between temporal ridges over 15 mm. *vs.* under 15 mm. (12·5—14 mm.) ; interparietal large ; posterior border broadly V-shaped, pointing backwards medially ; width less than twice the length ; occiput higher, 12·8—14·6 per cent (mean 13·6) of O. N. L. *vs.* 9·7—12·0 per cent (mean 10·9), and strongly ridged ; zygomatic plate projecting less anteriorly to supramaxillary root than in *R. arboreus ;* palate shorter, under 50 per cent (45·5—48·0 per cent) of O. N. L. *vs.* over 50 per cent (51·9—54·7 per cent) ; posteriorly not extending behind molars ; anterior palatine foramina smaller, under 15 per cent (12·0—14·6 per cent) of O. N. L. *vs.* over 15 per cent (15·6—17·6 per cent), situated at equal distance from incisors and molars ; cheek-tooth row slightly shorter, 12·8—15·7 per cent (mean 14·4) of O. N. L. *vs.* 15·0—16·3 per cent (mean 15·6) ; pterygoid fossae shallow and much elongated ; orbito-temporal fossa shorter,

under 1/3rd (28·1—31·1 per cent) of O. N. L. *vs.* over 1/3rd (32·7—35·2 per cent) ; tympanic bullae smaller, 10·3—11·7 per cent (mean 11·0) of O. N. L. *vs.* 16·9—18·5 per cent (mean 17·7).

Mandible : Differing from that of *R. rattus arboreus* in being smaller and narrower ; mandibular length under 50 per cent (46·4—49·2 per cent) of O. N. L. *vs.* 49·1—52·8 per cent (mean 51·4) and maximum width under 50·0 per cent (45·2—47·6 per cent) of G. L. M. *vs.* over 50 per cent (52·2—55·7 per cent) ; coronoid process relatively smaller and angular process less posteriorly extended.

Dentition : Similar to that of *R. rattus arboreus* except that the upper incisors are opisthodont instead of orthodont, and second upper molar having 7 cusps including a small antero-external cusp in the first lamina.

3. **Rattus cutchicus** Wroughton

3*a*. **Rattus cutchicus siva** Thomas

(Tables 16 and 17)

Skull differing from that of *R. rattus arboreus* as follows :—Smaller and narrower ; occipitonasal length 32·3—33·8 mm. (mean 33·1) *vs.* 38·3—41·4 mm. (mean 39·7) and greatest zygomatic width 44·6—47·7 per cent (mean 45·8) of O. N. L. *vs.* 45·8—50 per cent (mean 48·6) ; rostrum narrower, pointed and curved downwards anteriorly ; nasals longer, 39·0—40·0 per cent (mean 39·3) of O. N. L. *vs.* 32·0—36·8 per cent (mean 35·1), projecting much anteriorly over incisors ; parietals short, parietal length less than one-half the frontal length ; tympanic bullae smaller, 13·3—15·6 per cent (mean 14·7) of O. N. L. *vs.* 16·9—18·5 per cent (mean 17·7) ; palate shorter, under 50 per cent (46·3—48·6 per cent) of O. N. L. *vs.* over 50 per cent (51·9—54·7 per cent), not extending posteriorly beyond molars ; anterior palatine foramina long, over 1/5th (20·0—22·2 per cent) of O. N. L. *vs.* under 1/5th (15·6—17·6 per cent), extending posteriorly in between molars ; diastema shorter, 22·4—24·3 per cent (mean 23·4) of O. N. L. *vs.* 24·2—26·2 per cent (mean 25·3) ; pterygoid fossae shallow.

Mandible : Smaller and narrower ; mandibular length under 50 per cent (48·3—49·5 per cent) of O. N. L. *vs.* 49·1—52·8 per cent (mean 51·4) ; maximum width under 50 per cent (43·4—46·7 per cent) of G. L. M. *vs.* over 50 per cent (52·2—55·7 per cent) ; coronoid process small and weak.

Dentition : Incisors opisthodont ; second upper molar having 7 cusps ; antero-external cusp generally present in front lamina.

4. **Rattus fulvescens** Gray

4*a*. **Rattus fulvescens fulvescens** Gray

(Tables 16 and 17)

Skull similar to that of *R. rattus arboreus* in structure, etc., but differing as follows :—Lighter in built ; smaller and narrower ; occipitonasal length 34·9—39·2 mm. (mean 37·0) *vs.* 38·3—41·4 mm. (mean 39·7) and greatest zygomatic width 43·9—46·0 per cent (mean 44·7) of O. N. L. *vs.* 45·8—50·0 per cent (mean 48·6) ; zygomatic arches weaker ; frontals slightly less constricted, least interorbital width 13·2—16·8 per cent (mean 15·2) of O. N. L. *vs.* 13·6—14·7 per cent (mean 14·1) ; nasals slightly longer, 34·9—37·8 per cent (mean 36·8) of O. N. L. *vs.* 32·0—36·8 per cent (mean 35·1), projecting anterior to incisors ; temporal ridges over parietals more widely separated, maximum distance 13·5—15·0 mm. *vs.* 12·5—14·0 mm. ; palate shorter, under 50 per cent (46·4—49·9 per cent) of O. N. L. *vs.* over 50 per cent (51·9—54·7 per cent), not extending beyond molars ; anterior palatine foramina shorter and more open, 12·9—16·5 per cent (mean 15·0) of O. N. L. *vs.* 15·6—17·6 per cent (mean 16·8) ; orbito-temporal fossa shorter, under 1/3rd (29·6—32·4 per cent) of O. N. L. *vs.* over 1/3rd (32·7—35·2 per cent) ; tympanic bullae much smaller, under 5 mm. (4·5—5·0 mm.) *vs.* over 5 mm. (6·6—7·5 mm.) or 12·0—14·1 per cent (mean 12·7) of O. N. L. *vs.* 16·9—18·5 per cent (mean 17·7) ; pterygoid fossae shallower and much elongated ; mesopterygoid fossa broader.

Mandible : Shorter and narrower ; mandibular length 44·5—49·5 per cent (mean 47·5) of O. N. L. *vs.* 49·1—52·8 per cent (mean 51·4) and maximum width under 50 per cent (48·0—50·0 per cent) of G. L. M. *vs.* over 50 per cent (52·2—55·7 per cent) ; coronoid process small.

Dentition : Incisors opisthodont and smaller ; molars like that of *R. rattus arboreus.*

5. **Rattus manipulus** Thomas

5*a*. **Rattus manipulus manipulus** Thomas

(Tables 16 and 17)

Skull differing from that of *R. rattus arboreus* as follows :—Slightly smaller on an average, occipitonasal length 35·8—41·0 mm. (mean 37·3) *vs.* 38·3—41·4 mm. (mean 39·7) ; and broader, greatest zygomatic width over 50 per cent (50·1—53·6 per cent) of O. N. L. *vs.* under 50 per cent (45·8—50·0 per cent) ; zygomatic arches widest posteriorly ; nasals longer, 38·1—42·2 per cent (mean 39·8) of O. N. L. *vs.* 32·0—36·8 per cent (mean 35·1) ; anteriorly less projecting over incisors and posteriorly extending backwards beyond lacrymals ; frontals less constricted, least interorbital width 15·6—17·4 per cent (mean 16·45) of O. N. L. *vs.* 13·6—14·7 per cent (mean 14·1) ; feebly ridged ; temporal ridges

over parietals closer, maximum distance under 12·5 mm. *vs.* over 12·5 mm. (12·5—14·0 mm.) ; interparietal shorter antero-posteriorly, length being one-third of the width ; in adults situated nearly anterior to a line joining posterior extremity of squamosals ; occiput higher 14·6—16·4 per cent (mean 15·45) of O. N. L. *vs.* 9·7—12·0 per cent (mean 10·9) ; palate slightly longer on an average, 53·2—54·9 per cent (mean 54·1) of O. N. L. *vs.* 51·9—54·7 per cent (mean 53·2) ; posteriorly not extending behind molars ; upper cheek-tooth row shorter, 5·3—6·1 mm. (mean 5·6) *vs.* 5·8—6·6 mm. (mean 6·2) or 13·4—16·6 per cent (mean 14·9) of O. N. L. *vs.* 15·2—16·3 per cent (mean 15·7) ; anterior palatine foramina slightly longer, 17·0—19·5 per cent (mean 17·8) of O. N. L. *vs.* 15·6—17·6 per cent (mean 16·8), posteriorly not reaching to molars ; diastema longer, over 31 per cent (31·2—32·9 per cent) of O. N. L. *vs.* under 31 per cent (24·2—26·2 per cent) ; orbito-temporal fossa slightly smaller on an average, 30·7—33·3 per cent (mean 31·9) of O. N. L. *vs.* 32·7—35·2 per cent (mean 33·9).

Mandible : Differing from that of *R. rattus arboreus* in being slightly longer and narrower ; mandibular length 52·7—56·0 per cent (mean 54·8) of O. N. L. *vs.* 49·1—52·8 per cent (mean 51·4) and maximum width 51·1—54·0 per cent (mean 51·8) of G. L. M. *vs.* 52·2—55·7 per cent (mean 54·4) ; lower diastema length (25·9—30·0 per cent, mean 27·7, of G. L. M.) more than root-length of lower molars (24·0—28·4 per cent, mean 26·1, of G. L. M.) ; root of lower incisor forming prominent knob beside condylar process.

Dentition : Differing from that of *R. rattus arboreus* in having incisors slightly proodont instead of orthodont, and molars having slight tendency to form transverse laminae ; antero-external cusp of second upper molar absent.

6. **Rattus bowersi** Anderson

6*a*. **Rattus bowersi mackenziei** Thomas

(Tables 16 and 17)

Skull similar to that of *Rattus manipulus* in structure, etc., but differing as follows :—Longer and narrower ; occipitonasal length 43·8—49·0 mm. (mean 46·5) *vs.* 35·8—41·0 mm. (mean 37·3) and greatest zygomatic width under 50 per cent (47·8—49·0 per cent) of O. N. L. *vs.* over 50 per cent (50·1—53·6 per cent) ; frontals slightly more constricted, least interorbital width 14·1—16·0 per cent (mean 14·7) of O. N. L. *vs.* 15·6—17·4 per cent (mean 16·45) ; ridges feeble over parietals but extending up to occiput, rather than absent (Ellerman, 1961) ; interparietal not so reduced lengthwise, length over one-third the width ; tympanic bullae smaller, 13·3—13·8 per cent (mean 13·6) of O. N. L. *vs.* 14·1—15·3 per cent (mean 14·9) ; upper cheek-tooth row longer, over 7 mm. (7·7—8·0 mm.) *vs.* under 7 mm. (5·3—6·1mm.) or 16·2—17·9 per cent (mean 16·7) of O. N. L. *vs.* 13·4—16·6 per cent (mean 14·9) ; diastema shorter, under 30 per cent (28·0—29·3 per cent) of O. N. L. *vs.* over 30 per cent (31·2—32·9 per cent).

Mandible : Differing from that of *R. manipulus* in having lower diastema-length shorter than root-length of lower molars, and lower incisor-root less prominent.

Dentition : Incisors orthodont instead of proodont. Molars exactly like that of *R. manipulus*.

Genus (10) **Bandicota** Gray

Key for identification of Oriental species of Bandicota, *based on skull characters.*

O. N. L., Occipitonasal length.

1(6). Zygomatic width under 57 per cent of O. N. L. ; anterior palatine foramina posteriorly as wide as anteriorly ; tympanic bullae under 20 per cent of O. N. L. ; nasals over 1/3rd of O. N. L.
...*B. indica* Bechstein

2(3). O. N. L. under 50 mm. ; diastema less than half the palate.
...*B. indica savilei* Thomas

3(2). O. N. L. over 50 mm. ; diastema more than half the palate.

4(5). Nasals over 38 per cent of O. N. L. ; orbit length under 35 per cent of O. N. L.
...*B. indica indica* Bechstein

5(4). Nasals under 38 per cent of O. N. L. ; orbit length over 35 per cent of O. N. L.
...*B. indica nemorivaga* Hodgson

6(1). Zygomatic width over 57 per cent of O. N. L. ; anterior palatine foramina much narrower posteriorly than anteriorly ; tympanic bullae over 1/5th of O. N. L. ; nasals under 1/3rd of O. N. L.
...*B. bengalensis* Gray

1. **Bandicota bengalensis** Gray

1*a*. **Bandicota bengalensis bengalensis** Gray

(Tables 18 and 19)

General : Skull medium-sized, occipitonasal length 37·2—42·3 mm. (mean 39·4) ; dorsal surface nearly flat, slightly sloping anteriorly and posteriorly ; rostrum short and wide, rostral width 18·9—21·5 per cent (mean 20·4) of O. N. L. ; sutures between paired bones distinct ; cranium rather narrow ; condylobasal length exceeding occipitonasal length. *Nasals :* Small, under 1/3rd (28·8—33·3 per cent) of O. N. L. ; ending anteriorly behind incisors and posteriorly slightly shorter than ascending process of premaxillae ; posteriorly much narrower than anterior. *Frontals :* Frontal length less than twice the parietal length ; interorbital constriction narrower than rostrum ; narrowest at anterior one-third portion of zygomatic fossa ; least interorbital width 14·0—17·0 per cent (mean 15·5) of O. N. L. ; strongly ridged on sides ; frontal suture feeble. *Parietals :* Large, broader than long ; laterally extended ; lateral extensions posteriorly meeting the occiput on either side of interparietal ;

temporal ridges prominent and wider apart ; fronto-parietal suture zigzaged. *Interparietal :* Moderately developed ; situated anterior to a line joining posterior extremity of squamosals ; rectangular or dome-shaped ; reducing in width with narrowing of temporal ridges ; suture between parietals and interparietal much zigzaged. *Occiput :* High, 13·8—16·5 per cent (mean 15·4) of O. N. L. ; slightly sloping backwards and strongly ridged ; paroccipital processes small. *Squamosals :* Fairly developed ; postzygomatic portion moderately broad ; slight projection formed by frontal ridges at lateral extremities of frontoparietal suture ; supratympanic fenestrae absent. *Zygomatic arches :* Widely spread laterally ; greatest zygomatic width 59·4—65·5 per cent (mean 62·4) of O. N. L. ; zygoma not descending ventrally to level of palate ; zygomatic plate projecting anterior to supramaxillary root of zygomatic arch and having slightly concave anterior border ; zygomatic process of maxilla extending posteriorly up to two-thirds portion of zygomatic arch ; jugal narrow and reduced ; zygomatic process of squamosal fairly developed ; infraorbital canal higher than wide ; orbitotemporal fossa moderately long, 34·5—38·5 per cent (mean 37·2) of O. N. L. *Tympanic bullae :* Large, inflated ; over 1/5th (21·5—23·6 per cent) of O. N. L. ; mastoids small and uninflated ; supramastoid foramen small but distinct. *Palate :* Long, 59·4—63·1 per cent (mean 61·7) of O. N. L., extending posteriorly slightly behind molars ; portion of palate in between molars slightly higher than anterior ; anterior palatine foramina long, 7·0—8·6 mm. (mean 7·85) or 18·4—22·2 per cent (mean 19·9) of O. N. L. rather than over 1/5th of O. N. L. (Ellerman, 1961) ; posterior end of foramina much narrower than anterior and slightly extending in between molars ; anterior one-third portion formed by premaxillae and posterior two-thirds by maxillae ; posterior palatine foramina small ; cheek-tooth rows nearly parallel, 6·7—7·7 mm. (mean 7·25) or under 1/5th (16·5—19·3 per cent) of O. N. L. ; diastema long, 28·7—33·5 per cent (mean 30·8) of O. N. L. ; shallow groove running posteriorly from posterior end of each anterior palatine foramina, and after crossing posterior palatine foramina terminating in pterygoid fossa of respective sides. Pterygoid fossae deep, slightly deeper than the mesopterygoid fossa ; hamular process of pterygoids extending posteriorly up to tympanic bullae but are higher and not touching it ; foramen ovale, foramen lacerum medius and interpterygoid foramen distinct ; basioccipital extending anteriorly up to hamular process.

Mandible : Stout ; long, mandibular length over 60 per cent (60·2—64·1 per cent) of O. N. L. ; having high backwardly curved coronoid pocess and broad angular process ; lower incisor-root forming prominent knob beside condylar process, nearly as high as this ; masseteric ridge prominent ; maximum width of mandible 56·4—64·2 per cent (mean 60.3) of G. L. M. ; lower diastema length (6·0—7·25 mm., mean 6·9) shorter than root-length of lower molars (6·7—8·1 mm., mean 7·45).

Dentition : Upper incisors proodont, yellow and ungrooved ; slightly thicker than wide ; extending posteriorly upto posterior end of anterior palatine foramina ; lower incisors long, yellow and ungrooved ; terminating posteriorly into a prominent knob beside condylar process. Molars originally triserially cuspidate but with tendency towards fusion to form

transverse laminae ; rooted. Upper molars : m^1 5-rooted, m^2 4-rooted, and m^3 3-rooted ; m^1 trilaminate, 9 cusped rather than 8 cusped (Wroughton, 1919*b*, p. 783), 3 in each lamina ; m^2 7 cusped, an antero-internal cusp representing original front lamina, and three cusps in each of the second and third lamina ; m^3 exactly like m^2 but smaller ; number of cusps in the last lamina probably two ; rarely antero-external cusp also present. Lower molars : Number of laminae in each molar similar to uppers ; outer row of cusps vestigeal ; m_1 8-cusped, two in first lamina and three cusps in each of the second and third lamina ; m_2 having an antero-external cusp followed by three cusps in each succeeding lamina ; m_3 having an antero-external cusp and two cusps in each succeeding lamina.

1*b*. **Bandicota bengalensis kok** Gray

(Tables 18 and 19 ; and Plate 31)

Skull almost similar to that of *B. bengalensis bengalensis* in structure etc., but differs as follows :—Slightly smaller, occipitonasal length 36·0—40·9 mm. (mean 38·1) *vs.* 37·2—42·3 mm. (mean 39·4) ; anterior palatine foramina slightly smaller, 17·3—20·4 per cent (mean 19·1) of O. N. L. *vs.* 18·4—22·2 per cent (mean 19·9) rather than longer (Anderson, 1878, p. 221) ; cheek-tooth rows nearly equal in length, 6·8—7·8 mm. (mean 7·4) *vs.* 6·7—7·7 mm. (mean 7·3) rather than longer (over 7 mm.) in *B. b. kok* and smaller (under 7 mm.) in *B. b. bengalensis* (Ellerman, 1947*b*) or over 7·5 mm. in *B. b. kok* and under 7·5 mm. in *B. b. bengalensis* (Wroughton, 1908, p. 743 ; and 1919*b*, p. 787) ; palate slightly smaller on an average, 58·1—62·1 per cent (mean 60·1) of O. N. L. *vs.* 59·4—63·1 per cent (mean 61·5). Incisors slightly less proodont than in *B. b. bengalensis.*

Variations : Male skulls, both in *B. b. bengalensis* and *B. b. kok*, are slightly longer than those of females.

Some of the other measurements are as follows :—Greatest zygomatic width 57·5—63·2 per cent (mean 59·8) of O. N. L. ; least interorbital width 14·2—16·3 per cent (mean 15·2) of O. N. L. ; tympanic bullae 20·5—23·5 per cent (mean 21·7) of O. N. L. ; nasal length 28·8—32·7 per cent (mean 30·7) of O. N L. ; orbit-length 35·2—38·6 per cent (mean 37·4) of O. N. L.

1*c*. **Bandicota bengalensis varius** Thomas

(Tables 18 and 19)

Skull almost similar to that of *B. b. bengalensis* in structure, etc., but differs as follows :—Slightly longer, occipitonasal length 39·0*—44·2 mm. (mean 41·6) rather than over 44 mm. (Ellerman, 1947*b*) *vs.* 37·2—42·3 mm. (mean 39·4) ; nasals slightly longer 32·0—34·2 per cent (mean 33·1) of O. N. L. *vs.* 28·8—31·2 per cent (mean

*The skull having the occipitonasal length 39 mm. is much smaller than the others but has greatly worn molars.

30·9) ; orbitotemporal fossa shorter, 33·8—34·3 per cent (mean 34 0) of O. N. L. *vs.* 34·5—38·5 per cent (mean 37·2) ; length of upper cheek-tooth row 7·1—7·2 mm. rather than over 7·5 mm. (Wroughton, 1908, p. 743 ; and 1919*b*, p. 787), and slightly shorter than in *B. b. bengalensis*, 16·0—18·4 per cent (mean 17·2) of O. N. L. *vs.* 16·5—19·3 per cent (mean 18·4) ; mandibles slightly smaller, mandibular length 56·7—60·2 per cent (mean 58·4) of O. N. L. *vs.* 60·2—64·1 per cent (mean 61·7).

Some of the other important measurements are as follows:—Greatest zygomatic width 57·7 per cent of O. N. L. ; least interorbital width 14·4—15·6 per cent (mean 15·0) of O. N. L. ; length of tympanic bullae 21·0—21·5 per cent (mean 21·2) of O. N. L. ; palate 60·0—61·3 per cent (mean 60·6) of O. N. L. ; molar length 16·0—18·4 per cent (mean 17·2) of O. N. L. ; anterior palatine foramina 19·5—20·0 per cent (mean 19·7) of O. N. L.

1*d*. **Bandicota bengalensis wardi** Wroughton

(Tables 18 and 19)

Skull almost similar to that of *B. bengalensis bengalensis*, only differing as follows :—Cheek-tooth rows slightly longer, 7·5—8·0 mm. (mean 7·7) *vs.* 6·7—7·7 mm. (mean 7·3) or 17·7—21·2 per cent (mean 19·2) of O. N. L. *vs.* 16·5—19·3 per cent (mean 18·4). Occipitonasal length 37·7—42·6 mm. (mean 40·5) rather than 36·6—39·9 mm. (mean 38·2) (Ellerman, 1961).

Some of the other measurements are as follows :—Greatest zygomatic width 60 9 per cent of O. N. L. ; least interorbital width 15 7—16·3 per cent (mean 15·9) of O. N. L. ; length of tympanic bullae 20·6—22·6 per cent (mean 21·6) of O. N. L. ; nasal length 31·0—32·5 per cent (mean 31·8) of O. N. L. ; palate 61·4—63·0 per cent (mean 62·1) of O. N. L. ; anterior palatine foramina 18·0—20·7 per cent (mean 19·8) of O. N. L.

2. **Bandicota indica** Bechstein

2*a*. **Bandicota indica indica** Bechstein

(Synonym : *Bandicota malabarica* Shaw)

(Tables 20 and 21 ; and Plate 32)

Skull almost similar to that of *B. bengalensis bengalensis* in structure etc., but differs as follows :—Longer and narrower ; occipitonasal length 49·2—63·1 mm. (mean 57·1) *vs.* 37·2—42·3 mm. (mean 39·4) and greatest zygomatic width 52·1—56·3 per cent (mean 54·4) of O. N. L. *vs.* 59·4—65·5 per cent (mean 62·4) ; nasals longer, 18·7—26·1 mm. (mean 22·9) *vs.* 11·0—13·6 mm. (mean 12·0) or over 1/3rd (37·6—41·4 per cent) of O. N. L. *vs.* under 1/3rd (28·8—33·3 per cent) ; ending anteriorly slightly behind incisors ; posteriorly extending upto ascending process of premaxillae ; tympanic bullae smaller, under 1/5th (15·3—17·9 per cent) of O. N. L. *vs.* over 1/5th (21·5—23·6 per cent) ; anterior palatine foramina smaller, 17·2—19·8 per cent (mean 18·4) of O. N. L. *vs.* 18·4—22·2 per cent (mean 19·9), extending or not extending in between

molars ; posteriorly broader than in *B. bengalensis ;* palate slightly shorter on an average, 60·5 per cent of O. N. L. *vs.* 61·7 per cent, extending posteriorly slightly behind molars ; orbito-temporal fossa shorter, 32·1—34·0 per cent (mean 33·1) of O. N. L. *vs.* 34·5—38·5 per cent (mean 37·2) ; upper cheek-tooth rows slightly shorter on an average, 16·9 per cent of O. N. L. *vs.* 18·4 per cent.

Mandible : Differing from that of *B. b. bengalensis* in being shorter and slightly narrower ; mandibular length under 60 per cent (57·8—59·2 per cent) of O. N. L. *vs.* over 60 per cent (60·2—64·1 per cent) and maximum width 54·1—58·2 per cent (mean 55·9) of G. L. M. *vs.* 56·4—64·2 per cent (mean 60·3) ; lower incisor root forming prominent knob beside condylar process but not reaching so high as in *B. b. bengalensis ;* lower diastema length (10·0—11·4 mm., mean 10·8) generally more than root-length of lower molars (9·8—10·6 mm., mean 10·2) ; mandibular symphysis prominent.

Dentition : Upper incisors orthodont and ungrooved ; thicker than wide ; terminating posteriorly slightly anterior to the molars. Upper molars : Similar to *B. b. bengalensis ;* antero-internal cusp always present in m^2 and m^3 ; sometimes antero-external cusp also present in m^3. Lower molars : Number of cusps in each lower molar similar to that of *B. b. bengalensis* but arrangement slightly differs ; m_1 trilaminate, first lamina having two cusps, second two, third three and an extra cusp or heel posterior to this ; m_2 having an antero-external cusp in first row, two cusps in second, three cusps in third row and an extra cusp posterior to this ; m_3 having an antero-external cusp and two cusps in each of the two lamina ; heel absent.

2*b*. **Bandicota indica nemorivaga** Hodgson

(Tables 20 and 21)

Skull almost similar to that of *B. indica indica* in structure, etc., but differs as follows :—Slightly smaller, occipitonasal length 49·6—59·1 mm. (mean 56·4) *vs.* 49·2—63·1 mm. (mean 57·1) ; condylobasal length subequal to occipitonasal length ; frontals slightly narrower, least interorbital width 13·1—14·8 per cent (mean 13·8) of O. N. L. *vs.* 14·5—15·4 per cent (mean 14·9) ; tympanic bullae slightly larger 15·5—18·5 per cent (mean 17·1) of O. N. L. *vs.* 15·3—17·9 per cent (mean 16·2) ; nasals smaller, 16·5—22·3 mm. (mean 19·9) *vs.* 18·7—26·1 mm. (mean 22·9) rather than under 20·8 mm. in *B. nemorivaga* and over 20·8 mm. in *B. indica* (Ellerman, 1947*b*) ; and under 38 per cent (33·2—37·7 per cent) of O. N. L. *vs.* over 38 per cent (37·6—41·4 per cent) ; posteriorly slightly shorter than ascending process of premaxillae ; orbito-temporal fossa slightly longer, over 35 per cent (35·0—36·8 per cent) of O. N. L. *vs.* under 35 per cent (32·1—34·0 per cent).

Mandible : Differing from that of *B. indica indica* in having the root-length of lower molars (9·2—9·7 mm., mean 9·4) on an average more than the lower diastema length (7·6—9·65 mm., mean 8·8).

Some of the other measurements are as follows :—Greatest zygomatic width 52·3—54·6 per cent (mean 53·3) of O. N. L. ; palate 58·4—62·0 per cent (mean 60·1) of O. N. L. ; anterior palatine foramina 16·2—19·0 per cent (mean 17·5) of O. N. L. ; upper cheek-tooth row 14·9—17·9 per cent (mean 16·2) of O. N. L. ; mandibular length 56·7—60·0 per cent (mean 58·6) of O. N. L.

2*c*. **Bandicota indica savilei** Thomas

(Tables 20 and 21)

Skull almost similar to that of *B. indica indica* in structure, etc., but differs as follows :—Smaller, occipitonasal length 41·0—46·2 mm. (mean 43·8) *vs.* 49·2—63·1 mm. (mean 57·1) ; nasals smaller, under 38 per cent (32·9—35·2 per cent) of O. N. L. *vs.* over 38 per cent (37·6—41·4 per cent) ; posteriorly slightly shorter than ascending process of premaxillae ; fronto-parietal suture nearly straight, only slightly curved anteriorly on sides ; tympanic bullae larger, 18·4—20·3 per cent (mean 19·2) of O. N. L. *vs.* 15·3—17·9 per cent (mean 16·2) ; anterior palatine foramina slightly smaller, 16·1—18·2 per cent (mean 17·1) of O. N. L. *vs.* 17·2—19·8 per cent (mean 18·4) ; diastema shorter, under 30 per cent (26·1—28·5 per cent) of O. N. L. *vs.* over 30 per cent (30·0—34·3 per cent) ; orbito-temporal fossa longer, over 35 per cent (35·5—38·0 per cent) of O. N. L. *vs.* under 35 per cent (32·1—34 per cent) ; palate slightly shorter, 58·1—58·7 per cent (mean 58·4) of O.N.L. *vs.* 59·3—63·3 per cent (mean 60·5) ; upper cheek-tooth rows shorter than in *B. nemorivaga* in absolute measurements, 7·8—8·7 mm. (mean 8·2) *vs.* 8·7—9·5 mm. (mean 9·1) (Thomas, 1916*b*, p. 641) but are proportionately longer, 18·1—20·0 per cent (mean 18·8) of O. N. L. *vs.* 14·9—17·9 per cent (mean 16·2).

Mandible : Broader than in *B. indica*, maximum width over 60 per cent (60·0—61·0 per cent) of G. L. M. *vs.* under 60 per cent (54·1—58·2 per cent) ; root-length of lower molars (8·0—8·8 mm., mean 8·5) more than lower diastema length (6·3—7·4 mm., mean 6·8).

Genus (11) **Nesokia** Gray

1. **Nesokia indica** Gray

Key for identification of Oriental subspecies of Nesokia indica, *based on skull characters.*

O. N. L., Occipitonasal length.

1(2). Nasals over 47% of the palatal length ... *N. indica huttoni* Blyth.

2(1). Nasals under 47% of *the* palatal length ... *N. indica indica* Gray.

1*a*. **Nesokia indica huttoni** Blyth

(Tables 22 and 24 ; and Plate 33)

General : Skull medium-sized and robust ; occipitonasal length 37·2—42·9 mm. (mean 39·9) ; dorsal surface flat and sloping anteriorly ; rostrum short ; sutures between paired bones distinct ; condylobasal length exceeding occipitonasal length. *Nasals :* Small, under 1/3rd (29·1—31·9 per cent) of O. N. L. ; ending anteriorly slightly behind the incisors ; posteriorly slightly shorter than the ascending process of premaxillae ; wider anteriorly than posteriorly ; anterior extremity rounded. *Frontals :* Interorbital constriction narrower than rostrum ; narrowest slightly behind lacrymals ; least interorbital width 14·1—16·9 per cent (mean 15·6) of O. N. L. ; suture between frontals feeble ; strongly ridged on either side ; ridges extending posteriorly up to occiput. *Parietals :* Broader than long ; laterally extended ; lateral extensions posteriorly meeting the occiput on either side of interparietal ; fronto-parietal suture zigzaged. *Interparietal :* Situated anterior to a line joining posterior extremity of squamosals ; reducing in width with the narrowing of temporal ridges. *Occiput :* High, 13·6—17·9 per cent (mean 16·0) of O. N. L. ; sloping backwards ; strongly ridged ; *squamosals :* Fairly developed ; slight projection formed by squamosals with frontal ridges at lateral extremities of fronto-parietal suture ; supra-tympanic fenestrae absent ; postzygomatic portion small. *Zygomatic arches :* Stout and widely spread laterally ; wider than in *B. b. bengalensis*, greatest zygomatic width 63·4—69·0 per cent (mean 65·8) of O. N. L. *vs.* 59·4—65·5 per cent (mean 62·4) ; zygoma not descending ventrally to level of palate ; jugal small ; zygomatic process of squamosals fairly developed ; zygomatic plate projecting anterior to supra-maxillary root of zygomatic arch ; orbito-temporal fossa larger, 37·9—41·3 per cent (mean 40·3) of O. N. L. *vs.* 34·5—38·5 per cent (mean 37·2). *Tympanic bullae :* Large and inflated ; over 1/5th (20·0—20·8 per cent) of O. N. L. (1 exception out of 9 skulls) ; mastoids reduced. *Palate :* Longer than in *B. b. bengalensis*, 60·8—64·2 per cent (mean 62·3) of O. N. L. *vs.* 59·4—63·1 per cent (mean 61·7), extending posteriorly upto hinder margin of molars ; palate in between tooth rows considerably raised above the general level of the skull and narrow ; anterior palatine foramina much smaller than in *Bandicota*, under 15 per cent (8·9—13·2 per cent) of O. N. L. *vs.* over 15 per cent (16·1—22·2 per cent), situated medially between incisors and molars ; posterior palatine foramina very small molars wide ; upper cheek-tooth row longer than in *B. b. bengalensis*, 18·0—22·3 per cent (mean 20·5) of O. N. L. *vs.* 16·5—19·3 per cent (mean 18·4) ; diastema long, over 30 per cent (30·8—33·3 per cent) of O. N. L. ; pterygoid fossae deeper than the mesopterygoid fossa ; portion of maxillae supporting molars thick.

Mandible : Stout ; long, mandibular length 63·3—67·3 per cent (mean 65·2) of O. N. L. ; rather broad, maximum width 59·5—65·8 per cent (mean 62·2) of G. L. M. ; lower incisor root forming prominent knob beside condylar process, nearly as high as this ; coronoid process high ; masseteric ridge prominent.

Dentition : Upper incisors proodont and ungrooved ; slightly thicker than wide ; posteriorly extending upto posterior end of anterior palatine foramina ; lower incisors long with roots extending up to tip of condylar process. Molars laminate, hypsodont and rooted. Upper molars : m^1 5-rooted, m^2 4-rooted and m^3 3-rooted : m^1 trilaminate and m^2 and m^3 bilaminate ; antero-internal cusp (of original front lamina) in m^3 present or absent (present in two skulls out of eight) rather than always absent (Ellerman, 1947*b*, 1961). Lower molars : Like the uppers in structure ; antero-external cusp in m_2 present or absent.

1*b*. **Nesokia indica indica** Gray

(Tables 22 and 24)

Skull almost similar to that of *N. indica huttoni* in structure, etc., only differing as follows :—Slightly smaller, occipitonasal length 34·9—40·2 mm. (mean 37·1) *vs.* 37·2—42·9 mm. (mean 39·9) ; nasals slightly smaller, 25·8—29·2 per cent (mean 28·3) of O. N. L. *vs.* 29·1—31·9 per cent (mean 30·6) ; palate slightly longer, 62·6—66·4 per cent (mean 64·3) of O. N. L. *vs.* 60·8—64·2 per cent (mean 62·2) ; diastema slightly longer, 32·0—34·8 per cent (mean 33·5) of O. N. L. *vs.* 30·8—33·3 per cent (mean 32·4) ; upper cheek-tooth row and anterior palatine foramina relatively equal to that of *N. indica huttoni* rather than smaller (Anderson, 1878, p. 222).

Some of the other important measurements are as follows :—Greatest zygomatic width 64·6—68·0 per cent (mean 66·1) of O. N. L. ; least interorbital width 15·2—18·0 per cent (mean 16·3) of O. N. L. ; tympanic bullae 18·7—21·8 per cent (mean 20·3) of O. N. L. ; molar length 19·1—21·7 per cent (mean 20·5) of O. N. L. ; anterior palatine foramina 9·3—12·2 per cent (mean 10·6) of O. N. L. ; mandibular length 63·0—69·3 per cent (mean 66·1) of O. N. L.

Family 2. RHIZOMYIDAE

Two genera were studied, namely, *Rhizomys* Gray and *Cannomys* Thomas.

Key for identification of Oriental genera of Rhizomyidae, *based on skull characters.*

O. N. L., Occipitonasal length.

1(2). Upper m^1 equal or smaller than m^2 ; sagittal crest present only over parietals ; diastema under 38% of O. N. L.
...*Rhizomys* Gray

2(1). Upper m^1 larger than m^2 ; sagittal crest present over posterior half of frontals and whole parietals, diastema over 38% of O. N. L.
...*Cannomys* Thomas

Genus (12) **Rhizomys** Gray

Key for identification of Oriental species of Rhizomys, *based on skull characters.*

O. N. L., Occipitonasal length.

1(2). Greatest zygomatic width under 80% of O. N. L. ; diastema under 1/3rd and palate under 66% of O. N. L. ...*R. pruinosus* Blyth

2(1). Greatest zygomatic width over 80% of O. N. L. ; diastema over 1/3rd and palate over 66% of O. N. L. ...*R. sumatrensis cinereus* MacCL.

1. **Rhizomys sumatrensis** Raffles

1*a*. **Rhizomys sumatrensis cinereus** MacClelland

(Tables 23 and 24 ; and Plate 34)

General : Skull very large and massive ; occipitonasal length 67·5—76·5 mm. (mean 70·9) ; slightly sloping anteriorly ; dorsal surface ridged; rostrum short and broad ; rostral width 22·8—25·0 per cent (mean 23·8) of O. N. L. ; condylobasal length exceeding occipitonasal length. *Nasals :* Medium-sized, 34·0—38·6 per cent (mean 35·8) of O. N. L. ; anteriorly not reaching to front face of incisors ; posteriorly extending behind ascending process of premaxillae ; anterior extremity truncated and posterior acute ; fronto-premaxillary suture nearly transverse. *Frontals :* Frontal length slightly more than the parietal length ; interorbital constriction considerable ; narrowest near posterior one-third portion of zygomatic fossa ; least interorbital width 16·6—19·3 per cent (mean 17·9) of O. N. L. ; supraorbital ridges converging posteriorly but not forming sagittal crest over frontals ; frontal suture almost disappearing, except at anterior one-third portion. *Parietals :* Reduced in adult ; nearly as broad as long ; anterior portion much narrower than posterior ; sagittal crest present over whole length of parietals, posteriorly meeting the lambdoid crest ; ridges remaining separate in juvenile skulls ; fronto-parietal suture much reduced. *Interparietal :* Absent in adult though present in juveniles. *Occiput :* Slightly inclined forward : having strongly developed lambdoid crest ; height of occiput 23·7—27·1 per cent (mean 24·9) of O. N. L. ; paroccipital processes large, with tips directed backwards ; basioccipital broad and ridged. *Squamosals :* Fairly developed, forming major dorso-lateral portion of cranium : anteriorly encroaching upon frontals, coming very close to each other slightly anterior to fronto-parietal suture ; extending posteriorly behind external auditory meatus and touching mastoids ; supratympanic fenestrae absent. *Zygomatic arches :* Stout and widely spread laterally ; widest posteriorly greatest zygomatic width 78·9—88·0 per cent (mean 82·2) of O.N.L. ; zygomatic arches high, not descending to level of palate ; ju allar ge

zygomatic process of squamosals extending transversely from the skull ; infraorbital canal broader than high (mean width and height 5·6 mm. and 4·7 mm. or 7·8 per cent and 6·6 per cent respectively of O. N. L.) and situated completely above the zygomatic plate. *Tympanic bullae :* Small, 18·5—22·2 per cent (mean 20·2) of O. N. L. ; little inflated ; rectangular ; external auditory meatus tubular, projecting dorso-laterally on either side of lambdoid crest ; mastoids much reduced, confined between posterior extension of squamosals and paroccipitals. *Palate :* Long, 66·2—70·7 per cent (mean 68·1) of O. N. L., extending posteriorly upto posterior extremity of molars ; portion of palate in between molars higher than anterior ; the portion just behind anterior palatine foramina deeply excavated and laterally defined by strong ridges ; anterior palatine foramina small, 10·1—12·5 per cent (mean 11·4) of O. N. L., situated considerably in front of molars ; posterior palatine foramina very small ; upper cheek-tooth row short, under 1/5th (17·6—19·8 per cent) of O. N. L.; diastema long, over 1/3rd (33·8—38·3 per cent) of O. N. L. ; palatine bones small ; palatal margin of posterior nares broad and transverse portion of maxillae supporting molars thick and stout ; pterygoid fossae large and deep ; deeper than mesopterygoid fossa ; hamular process of pterygoids sickle-shaped and posteriorly not touching tympanic bullae.

Mandible : Large and stout ; mandibular length 72·8—77·2 per cent (mean 75·0) of O. N. L. ; coronoid process high ; condylar process short slightly curved upwards ; angular process broad, extending slighly posterior to condylar ; coronoid and condylar processes separated by a deep curved space ; lower incisor root forming prominent knob on outer side of condylar process, but never reaching its height ; mental foramen situated more ventrally than in other Murids ; masseteric ridge prominent. Greatest length of mandible 50·2—59·2 mm. (mean 54·3) ; maximum width of mandible over 66 per cent (66·3—70·1 per cent of G. L. M.) ; lower diastema length (mean 29·4 per cent of G. L. M.); subequal to root-length of lower molars (mean 30·1 per cent of G. L. M.).

Dentition : Upper incisors large, proodont and ungrooved ; nearly as thick as wide ; extending posteriorly up to root of second upper molar ; lower incisors ungrooved ; posteriorly terminating into a prominent knob on outerside of condylar process. Molars slightly hypsodont when unworn, rooted and flat crowned. Upper molars : m^1 subequal to m^2 and m^2 larger than m^3 ; m^1 wearing below level of m^2 ; folds becoming isolated as islands ; m^1 and m^3 4-rooted and m^3 3-rooted ; additional small roots may be present ; m^1 with 3 outer and one inner folds ; folds usually isolated as islands ; m^2 having two outer and one inner folds ; first outer and inner folds completely dividing the tooth into an anterior and a posterior lobes ; inner fold sending a branch in the anterior lobe ; posterior lobe having one outer fold ; m^3 similar to m^2 ; pattern complicated and varying due to wear. Lower molars ; m_1 narrower than m_2 and m_3 ; m_1 and m_3 3-rooted and m_2 4-rooted ; m_1 with two folds on each side ; second outer fold so deep as to, sometimes, cut the inner margin ; an isolated island present at anterior portion ; m_2 having one outer and two inner folds ; first inner fold reaching quite near the outer margin; anterior to this is an isolated island ; m_3 having an anterior inner and a posterior outer folds, reaching to opposite margins ; tip of inner fold bifurcated and may separate as island.

Growth changes.—The following tendencies are noticeable in the skulls of *Rhizomys sumatrensis cinereus* from the juvenile to the adult condition :—Nasals becoming relatively longer (17·3—28·0 mm. or 32·1—36·4 per cent of O. N. L.) ; parietals becoming narrower (21·2—27·1 mm.); interparietal gradually disappearing; gradual fusion of temporal ridges, forming sagittal crest ; gradual reduction of folds of molars, firstly separating as islands and then soon disappearing.

2. **Rhizomys pruinosus** Blyth

2*a*. **Rhizomys pruinosus pruinosus** Blyth

(Synonym : *Rhizomys senex* Thomas)

(Tables 23 and 24 ; and Plate 35)

Skull almost similar to that of *Rhizomys sumatrensis cinereus* in structure, etc., but differs as follows :—Slightly smaller and narrower ; occipitonasal length 60·6—72·0 mm. (mean 64·6) *vs.* 67·5—76·5 mm. (mean 70·9) and greatest zygomatic width 74·5—79·2 per cent (mean 76·8) of O. N. L. *vs.* 78·9—88·0 per cent (mean 82·2) ; zygoma converging anteriorly, giving conical appearance to skull ; nasals slightly longer and narrower ; nasal length 36·5—40·8 per cent (mean 39·2) *vs.* 34·0—38·6 per cent (mean 35·8) of O. N. L. and nasal width 12·2—14·3 per cent (mean 13·4) *vs.* 14·2—18·7 per cent (mean 15·9) of O. N. L. ; anterior extremity of nasals rounded ; generally extending or not extending posteriorly behind ascending process of premaxillae ; inter-orbital constriction occurring more anteriorly, near middle of zygomatic fossa ; sagittal crest present only over posterior two-thirds of parietals ; ridges not strongly fused together ; palate slightly shorter, 62·8—66·6 per cent (mean 64·9) *vs.* 66·2—70·7 per cent (mean 68·1) of O. N. L. ; anterior palatine foramina slightly smaller, 8·8—10·5 per cent (mean 9·9) *vs.* 10·1—12·5 per cent (mean 11·4) of O. N. L. ; upper cheek-tooth row longer, 19·0—22·9 per cent (mean 21·2) *vs.* 17·6—19·8 per cent (mean 18·85) of O. N. L. ; diastema shorter, under 1/3rd (30·3—33·3 per cent) *vs.* over 1/3rd (33·8—38·3 per cent) of O. N. L.

Mandible : Differing from that of *R. s. cinereus* in being smaller, mandibular length 67·9—70·4 per cent (mean 69·2) *vs.* 72·8—77·2 per cent (mean 75·0) of O. N. L. ; greatest length of mandible 42·7—49·6 mm. (mean 45·1).

Dentition : Almost similar to that of *R. s. cinereus*, but differing from it as follows :—Having orthodont incisors instead of proodont. Upper molars : m^1 smaller and worn to a lower level than m^2 ; m^3 smaller or equal to m^2. Lower molars : m_1 narrower than m_2 and m_3.

Genus (13) **Cannomys** Thomas

1. **Cannomys badius** Hodgson

Key for identification of Oriental subspecies of Cannomys badius, *based on skull characters.*

O. N. L., Occipitonasal length.

1(2). O. N. L. under 40 mm. ; upper cheek-tooth row under 9·2 mm.
...*C. badius castaneous* Blyth

2(1). O. N. L. over 40 mm. ; upper cheek tooth row over 9·2 mm.
...3

3(4). Occiput over 22·5% of O. N. L. ; least interorbital width under 20·5% of O. N. L.
...*C. badius pater* Thomas

4(3). Occiput under 22·5% of O. N. L. ; least interorbital width over 20·5% of O. N. L.
...*C. badius badius* Hodgson

1*a*. **Cannomys badius badius** Hodgson

(Tables 25 and 26 ; and Plate 36)

General : Skull small, occipitonasal length 40·2—46·1 mm. (mean 43·6) ; sloping anteriorly ; rostrum short and broad ; rostral width 21·3—23·1 per cent (mean 22·0) of O. N. L. ; condylobasal length exceeding occipitonasal length. *Nasals :* Medium-sized, 34·3—37·2 per cent (mean 35·7) of O. N. L. ; anteriorly not reaching to front face of incisors ; rather narrow, 12·1—13·8 per cent (mean 12·9) of O. N. L. ; truncated at both ends ; ascending process of premaxillae either extending behind nasals, touching supraorbital ridges or extending upto posterior extremity of nasals ; fronto-premaxillary suture curved anteriorly on outer side instead of transverse in *R. s. cinereus*. *Frontals :* Frontal length shorter than the parietal length ; less interorbitally constricted than in *R. s. cinereus*, least interorbital width 20·4—22·1 per cent (mean 21·0) *vs.* 16·6—19·3 per cent (mean 17·9) of O. N. L. ; narrowest near middle of zygomatic fossa ; strongly ridged on either side ; ridges forming sagittal crest over posterior half of frontals and whole length of parietals meeting posteriorly the lambdoid crest. *Parietals :* Small ; nearly as broad as long ; ridges not strongly fused over parietals; fronto-parietal suture extremely reduced. *Interparietal :* Present in juvenile skulls, gradually disappearing in adults ; when present, conical in shape. *Occiput :* Fairly inclined forward with strongly developed lambdoid

crest ; height less than in *R. s. cinereus*, 20·0—22·5 per cent (mean 21·3) *vs.* 23·7—27·1 per cent (mean 24·9) of O. N. L. ; paroccipital processes large, with tips directed backwards. *Squamosals :* Fairly well developed, forming major dorso-lateral portion of the cranium and coming close to each other slightly anterior to fronto-parietal suture. *Zygomatic arches :* Stout ; widely spread laterally ; greatest zygomatic width 78·3—82·9 per cent (mean 80·5) of O. N. L. ; zygomatic arches high, not descending ventrally to level of palate ; infraorbital canal nearly twice as broad as high (mean width and height 3·7 mm. and 1·8 mm. or 8·4 per cent and 4·2 per cent respectively of O. N. L.) and situated completely above the zygomatic plate. *Tympanic bullae :* Large, 21·7—24·3 per cent (mean 23·4) of O. N. L. ; external auditory meatus tubular, projecting dorso-laterally on either side of lambdoid crest ; anteriorly not touching hamular process of pterygoids ; mastoids much reduced. *Palate :* Longer than in *R. s. cinereus*, 69·9—75·8 per cent (mean 72·5) *vs.* 66·2—70·7 per cent (mean 68·1) of O. N. L. ; posteriorly not reaching the hind extremity of molars ; palate in between molars considerably high and sloping anteriorly ; portion behind anterior palatine foramina not excavated ; prominent groove running posteriorly from posterior end of each anterior palatine foramina on either side of median elevated tract, and terminating in posterior palatine foramina ; anterior palatine foramina small, 6·3—11·2 per cent (mean 9·3) of O. N. L. ; upper cheek-tooth row longer than in *R. s. cinereus*, over 1/5th (20·1—25·0 per cent) *vs.* under 1/5th (17·6—19·8 per cent) of O. N. L. ; diastema longer, 37·5—42·5 per cent (mean 39·9) *vs.* 33·8—38·3 per cent (mean 35·7) of O. N. L. ; palatal margin of the posterior nares narrow and arched ; portion of maxillae supporting molars thick and stout ; pterygoid fossae deep.

Mandible : Greatest length of mandible 31·3—35·8 mm. (mean 33·5); slightly narrower than in *R. s. cinereus*, maximum width 63·8—68·3 per cent (mean 65·6) *vs.* 66·3—70·1 per cent (mean 68·5) of G. L. M. ; lower incisor root forming prominent knob on outer side of condylar process generally reaching its height ; masseteric ridge prominent ; lower diastema length (7·7—10·5 mm., mean 9·0) shorter than root-length of lower molars (11·25—11·85 mm., mean 11·56).

Dentition : Upper incisors red, extremely proodont and ungrooved ; broader than thick ; posteriorly extending upto root of m^2 ; lower incisors long, red and ungrooved ; posteriorly terminating into a prominent knob on outer side of condylar process. Molars slightly hypsodont, flat-crowned and rooted. Upper molars : m^1 larger than m^2 and m^2 larger than m^3, m^1 and m^2 4-rooted and m^3 3-rooted ; folds wearing due to age ; m^1 originally with 3 outer and one inner folds ; anterior outer fold wearing in adult ; m^2 having 2 outer and one inner folds ; third outer fold present in one skull ; m^3 like m^2 ; posterior outer fold soon isolated as island and gradually disappearing. Lower molars : m_1 having 2 outer and three inner folds ; m_2 with 2 inner and one outer folds ; posterior inner fold soon disappearing in both ; m_3 with an anterior inner and a posterior outer folds, the latter generally cutting inner margin.

1*b*. **Cannomys badius pater** Thomas

(Tables 25 and 26)

Skull almost similar to that of *Cannomys badius badius* in size, etc., but differs as follows :—Frontals slightly narrower, least interorbital width 8·5—9·1 mm. (mean 8·7) rather than under 8·5 mm. (Ellerman, 1947*a*) *vs.* 8·8—9·7 mm. (mean 9·2) or 18·4—20·6 per cent (mean 19·7) of O. N. L. *vs.* 20·4—22·1 per cent (mean 21·0) ; occiput higher, 9·5—12·0 mm. (mean 10·7) rather than over 10·8 mm. (Ellerman, 1947*a*) *vs.* 8·5—10·1 mm. (mean 9·3) or 22·8—27·0 per cent (mean 24·2) of O. N. L. *vs.* 20·0—22·5 per cent (mean 21·3) ; infraorbital canal larger, mean height and width 5·8 and 9·0 per cent *vs.* 4·2 and 8·4 per cent respectively of O. N. L.

Some of the other measurements are as follows :—Occipitonasal length 41·5—46·0 mm. (mean 44·1) ; greatest zygomatic width 80·6—86·9 per cent (mean 82·8) of O. N. L. ; tympanic bullae 23·1—27·5 per cent (mean 24·7) of O. N. L. ; nasal length 35·6—38·9 per cent (mean 37·5) of O. N. L. ; palate 70·5—77·1 per cent (mean 74·0) of O. N. L. ; upper cheek-tooth row 9·8—10·7 mm. (mean 10·3) or 22·1—24·5 per cent (mean 23·3) of O. N. L. ; diastema 39·8—42·8 per cent (mean 40·9) of O. N. L. ; mandibular length 68·6—78·6 per cent (mean 74·7) of O. N. L.

1*c*. **Cannomys badius castaneus** Blyth

(Tables 25 and 26)

Skull almost similar to that of *Cannomys badius badius* in structure, etc., but differs as follows :—Smaller, occipitonasal length 37·5—39·3 mm. (mean 38·6) *vs.* 40·2—46·1 mm. (mean 43·6) ; tympanic bullae slightly larger, 24·3—26·9 per cent. (mean 25·5) of O. N. L. *vs.* 21·7—24·3 per cent (mean 23·5) ; least interorbital width under 8·8 mm. (8·25—8·6 mm.) *vs.* over 8·8 mm. (8·8—9·7 mm.) ; upper cheek-tooth row shorter, under 9 mm. (8·4—9·0 mm.) *vs.* over 9·0 mm. (9·3—10·4) ; infraorbital canal larger, mean height and width 6·1 per cent and 9·0 per cent. *vs.* 4·2 per cent and 8·4 per cent of O. N. L. respectively.

Some of the other measurements are as follows :—Condylobasal length 40·0—42·8 mm. (mean 41·8) ; greatest zygomatic width 28·6—31·3 mm. (mean 30·0) or 76·4—80·1 per cent (mean 78·3) of O. N. L. ; nasal length 32·9—37·6 per cent (mean 35·3) of O. N. L. ; palatal length 71·4—74·8 per cent (mean 72·7) of O. N. L. ; diastema 37·8—42·3 per cent (mean 40·8) of O. N. L. ; occiput 8·3—9·0 mm. (mean 8·5) or 21·1—23·2 per cent (mean 22·1) of O. N. L. ; mandibular length 70·1—76·9 per cent (mean 73·2) of O. N. L.

Family 3. MUSCARDINIDAE

Subfamily (i) *PLATACANTHOMYINAE*

One genus, *Platacanthomys* Blyth, was studied.

Genus (14) **Platacanthomys** Blyth

1. **Platacanthomys lasiurus** Blyth

1*a*. **Platacanthomys lasiurus lasiurus** Blyth

(Tables 27 and 28 ; and Plate 37)

General : Skull medium-sized, occipitonasal length 31·9—33·0 mm. (mean 32·3) ; dorsal surface slightly sloping anteriorly ; cranium broad, medially high and much sloping posteriorly ; rostrum short ; sutures between paired bones distinct ; occipitonasal length exceeding condylobasal length. *Nasals :* Short, below 30 per cent (29·3—29·6 per cent) of O. N. L., slightly projecting forwards over incisors ; anterior extremity rounded and posterior truncated ; narrowest posteriorly and gradually becoming wider anteriorly ; posteriorly extending upto anterior edge of lacrymals and equal to ascending process of premaxillae. *Frontals :* Frontal length less than twice the parietal length ; fairly broad ; narrowest slightly behind lacrymals ; least interorbital width over 20 per cent (20·7—21·7 per cent) of O. N. L. ; ridged on sides ; ridges diverging posteriorly over parietals meeting the occipitals. *Parietals :* Large ; much broader than frontals ; fronto-parietal suture nearly straight, only slightly curving anteriorly on sides. *Interparietal :* Fairly large ; width nearly 2½ times the length ; situated behind a line joining posterior extremity of squamosals ; anterior border slightly arched, pointing forward medially ; posterior border convex backward. *Occiput :* Vertical and low, 11·6—13·4 per cent (mean 12·3) of O. N. L. ; ridges poorly developed ; supraoccipital extending anteriorly on sides of interparietal ; paroccipital processes small. *Squamosals :* Moderately large ; ridges in posterior portion fairly developed ; anteriorly not forming any projection ; supratympanic fenestra absent ; supratympanic portion stout ; posteriorly reaching the occipital and mastoids. *Zygomatic arches :* Weak and thin ; widest posteriorly, greatest zygomatic width 18·6—19·5 mm. (mean 19·1) or 59·0 per cent of O. N. L. ; zygoma not descending ventrally to level of palate ; lower maxillary root of zygomatic arch not projecting anterior to supramaxillary root in form of zygomatic plate ; jugal small, confined to posterior half of zygomatic arches ; zygomatic process of squamosals short and broad ; infraorbital canal higher than wide ; wider above than below. *Tympanic bullae :* Small, 12·8—13·4 per cent (mean 13·1) of O. N. L. ; auditory orifice large, situated ventro-laterally ; mastoids small and uninflated. *Palate :* Weak ; short, under 50 per cent (47·7—49·7 per cent) of O. N. L., ending posteriorly in between third pair of molars ; broadest posteriorly and becoming narrower anteriorly ; portion in between molars more depressed than anterior and perforated by a pair of large posterior palatine foramina ; no marked groove between anterior and posterior

palatine foramina ; anterior palatine foramina very small, 6·3—7·2 per cent (mean 6·7) of O. N. L., situated nearer to incisors than molars ; anterior two-thirds portion formed by premaxillae and posterior one-third by maxillae, rather than formed only by premaxillae (Peter, 1865, p. 397) ; posterior palatine foramina 7·1—9·3 per cent (mean 8·4) of O. N. L. ; upper cheek-tooth rows 16·5—17·8 per cent (mean 17·0) of O. N. L., diverging posteriorly ; diastema long, 25·6—26·4 per cent (mean 26·1) of O. N. L. ; portion of maxillae supporting molars weak. Basioccipital and basisphenoid bones fairly broad and slightly sloping anteriorly upto presphenoid ; pterygoid fossae shallow and in level with mesopterygoid fossa.

Mandible : Long, mandibular length over 50 per cent (50·1—52·2 per cent) of O. N. L. ; coronoid process small, obtuse and nearly erect ; little higher than condylar and not projecting posteriorly ; condylar process short ; distance between coronoid and condylar processes considerable ; angular process broad and slightly twisted outwards ; lower incisor root not prominent, extending slightly behind molars ; masseteric ridge feeble ; maximum width of mandible 50·0—52·7 per cent (mean 51·5) of G. L. M. ; lower diastema length shorter than root-length of lower molars.

Dentition : Upper incisors orthodont, yellow and ungrooved ; narrow and pointed, posteriorly terminating at infraorbital canal ; lower incisors yellow, long and extending posteriorly slightly behind molars. Molars $\frac{3}{3}$; brachyodont, flat-crowned and rooted. Upper molars : m^1 subequal to m^2 ; m^2 larger than m^3 ; each upper molar having 5 laminae separated by four outer and one inner folds ; folds becoming isolated as islands on crown surface ; second outer and inner folds dividing the tooth into anterior and posterior portions ; former having one and the latter two folds ; folds obliquely directed inwards and backwards ; first and second laminae, and third, fourth and fifth laminae united together on inner side forming two inner cusps. Lower molars : Each having six transverse laminae and five folds ; first and second folds becoming isolated on crown surface, and others opening externally.

Family 4. SCIURIDAE

Three genera were studied, namely, *Funambulus* Lesson, *Petaurista* Link and *Marmota* Frisch.

Key for identification of three Oriental genera of Sciuridae, *based on skull characters.*

O. N. L., Occipitonasal length.

1(4). Occipitonasal length exceeding condylobasal length ; nasals under 1/3rd of O. N. L., projecting forwards over incisors ; palate under 55 per cent of O. N. L.

2(3). Skull large, over 60 mm. ; prominent interorbital depression ; zygomatic width over 64 per cent of O.N.L. ; orbits over 1/3rd of O. N. L. ; upper cheek-tooth row longer than diastema ; nasal width over 15 per cent of O. N. L. ; least interorbital width under 1/4th of O. N. L.

...*Petaurista* Link

3(2). Skull small, under 50 mm. ; no interorbital depression ; zygomatic width under 60 per cent of O. N. L. ; orbits under 1/3rd of O. N. L. ; upper cheek-tooth row shorter than diastema ; nasal width under 15 per cent of O. N. L. ; least intreorbital width over 1/4th of O. N. L.

...*Funambulus* Lesson

4(1). Condylobasal length equal or exceeding occipitonasal length ; nasals over 1/3rd of O. N. L., extending anteriorly upto incisors and posteriorly behind lacrymals ; palate over 55 per cent of O. N. L.

...*Marmota* Blumenbach

Genus (15) **Funambulus** Lesson

Key for identification of Oriental species of Funambulus, *based on skull characters.*

O. N. L., Occipitonasal length.

1(2). Tympanic bullae generally over 1/5th of O. N. L.

...*F. pennanti* Wroughton

2(1). Tympanic bullae under 1/5th of O.N.L.

...*F. palmarum* Linn.

1. **Funambulus pennanti** Wroughton

1*a*. **Funambulus pennanti pennanti** Wroughton

(Tables 29 and 30 ; and Plate 38)

General : Skull medium-sized, occipitonasal length 36·0—38·9 mm. (mean 37·4) ; dorsal surface smooth ; cranium broad, medially high and much sloping posteriorly ; rostrum short ; occipitonasal length exceeding condylobasal length ; sutures between paired bones feeble or disappearing. *Nasals :* Small, under 1/3rd (27·2—31·3 per cent) of O. N. L.; narrow, nasal width under 15 per cent (10·8—12·0 per cent) of O. N. L. ; slightly projecting forwards over incisors ; posteriorly shorter or equal to ascending process of premaxillae ; the latter fairly broad and equal or more than the combined width of nasals at the posterior end ; posterior extremity V-shaped or truncated ; narrowest posteriorly and gradually becoming wider anteriorly. *Frontals :* Broad ; less interorbitally constricted ; narrowest medially between lacrymals and postorbital processes ; least interorbital width over 1/4th (25·3—29·1 per cent) of O. N. L. ; postorbital projections small, projecting backwards and downwards ; no interorbital depression over frontals ; frontal suture feeble. *Parietals :* Wider than long ; feebly ridged, ridges forming short sagittal crest over posterior one-fourth portion ; parietal suture disappearing ; frontoparietal suture nearly straight medially and curving anteriorly on sides, reaching postorbital projections. *Interparietal :* Absent. *Occiput :* Upstanding and low, 14·2—16·5 per cent (mean 15·4) of O. N. L. ; feebly

ridged ; paroccipital processes small ; basioccipital fairly broad as compared to that of the Muridae. *Squamosals :* Moderately developed with strong zygomatic process ; supratympanic portion fairly broad posteriorly ; perforated by subsquamosal and postglenoid foramen. *Zygomatic arches :* Widest posteriorly at zygomatic process of squamosals and gradually becoming narrower anteriorly ; greatest zygomatic width under 60 per cent (54·4—58·4 per cent) of O. N. L. ; jugals extending the whole length of zygomatic arches ; anteriorly touching lacrymals and posteriorly extending below and behind the zygomatic process of squamosals ; zygomatic process of maxillae well tilted upwards and thrown forwards ; strongly ridged ; infraorbital foramen small, only transmitting the infraorbital nerve ; small projection present on outer lower side of the foramen for the attachment of muscles. *Tympanic bullae* : over 1/5th (19·8—21·0) of O. N. L. ; bullae are slightly larger in Baluchistan and Punjab specimens (mean 20·9 per cent of O. N. L.) than in Central India (Rajasthan, Gujarat, Madhya Pradesh and Bengal) specimens (mean 20·2 per cent of O. N. L.) ; situated nearly parallel to longitudinal axis ; auditory orifice large ; mastoids small, confined to back portion of tympanic bullae and squamosals. *Palate :* Short, under 50 per cent (47·1—50·5 per cent) of O. N. L., extending posteriorly slightly behind molars ; anterior palatine foramina small, under 5 per cent (2·7—4·4 per cent) of O. N. L., situated far anterior to premolars ; completely formed by premaxillae ; posterior palatine foramina very small, present over maxillo-palatine suture ; a separate canal for palatine vein present behind third molar (Hill, 1935) ; upper cheek-tooth row short, under 1/5th (17·4—19·5 per cent) of O. N. L. ; diastema short, under 1/4th (20·0—21·7 per cent) of O. N. L. ; orbito-temporal fossa small, under 1/3rd (28·9—31·6 per cent) of O. N. L. Pterygoid fossae moderately deep but shallower than mesopterygoid fossa ; perforated by large foramen ovale ; foramen lacerum medius absent (Hill, 1935) ; hamular process of pterygoids posteriorly extending to basi-occipital but not touching tympanic bullae.

Mandible : Moderately long ; greatest length of mandible 21·0—22·7 mm. (mean 22·0) ; mandibular length under 60 per cent (53·4—58·1 per cent) of O. N. L. ; rather narrow, maximum width under 55 per cent (48·6—53·7) of G. L. M. ; having low and reduced coronoid process, long posteriorly extended condylar process and slightly outwardly twisted angular process ; masseteric ridge feeble ; root-length of lower molars (29·5—33·7 per cent, mean 31·0, of G. L. M.) fairly longer than lower diastema length (15·4—18·5 per cent, mean 17·2 per cent, of G. L. M.).

Dentition : Upper incisors short, reddish or yellowish and ungrooved ; much thicker than wide ; terminating posteriorly slightly anterior to premolars ; lower incisors long and ungrooved, posteriorly extending slightly behind lower molars. Upper premolars and molars : 5 in number (2 premolars and 3 molars) ; rooted ; pm^3 single rooted, small and unicuspidate ; other teeth 3-rooted ; in pm^4, m^1 and m^2 four ridges diverging outward from the inner side, and in m^3 only three ; other details not clear. Lower premolars and molars : 4 in number (1 premolar and 3 molars) ; each having two main ridges bearing two outer and two inner cusps ; antero-internal cusp highest of all and postero-internal very shallow.

2. **Funambulus palmarum** Linnaeus

2*a*. **Funambulus palmarum palmarum** Linnaeus

(Tables 29 and 30)

Skull almost similar to that of *F. pennanti* in structure, etc., but differing in being slightly narrower, greatest zygomatic width 53·2—56·9 per cent (mean 55·0) *vs.* 54·4—58·4 per cent (mean 56·5) of O. N. L. ; tympanic bullae smaller, under 1/5th (18·5—20·1 per cent) of O. N. L. *vs.* over 1/5th (19·8—21·0 per cent) ; occiput slightly higher on an average, 14·9—18·8 per cent (mean 16·8) of O. N. L. *vs.* 14·2—16·5 per cent (mean 15·4) ; orbito-temporal fossa slightly smaller, 28·4—29·7 per cent (mean 29·1) *vs.* 28·9—31·6 per cent (mean 30·1) of O. N. L.

Some of the other measurements are as follows :—Occipitonasal length 36·5—39·0 mm. (mean 37·9) ; least interorbital width 9·5—11·5 mm. (mean 10·6) or 26·0—29·3 per cent (mean 27·7) of O. N. L. ; nasal length 27·3—30·8 per cent (mean 29·0) of O. N. L. ; palatal length 48·5—49·6 per cent (mean 49·0) of O. N. L. ; upper cheek-tooth row 17·2—20·8 per cent (mean 19·0) of O. N. L. ; mandibular length 53·7—55·7 per cent (mean 54·7) of O. N. L.

2*b*. **Funambulus palmarum kelaarti** Layard

(Tables 29 and 30)

Skull almost similar to that of *F. palmarum palmarum* in structure, etc., but differs as follows :—Slightly longer, occipitonasal length 36·6—41·0 mm. (mean 38·4) *vs.* 36·5—39·0 mm. (mean 37·9) ; frontals slightly less constricted, 28·3—30·4 per cent (mean 29·2) of O. N. L. *vs.* 26·0—29·3 per cent (mean 27·7) ; tympanic bullae slightly smaller on an average, 18·6—19·3 per cent (mean 19·0) of O. N. L. *vs.* 18·5—20·1 per cent (mean 19·5) ; occiput lower, 15·1—16·5 per cent (mean 15·8) of O. N. L. *vs.* 14·9—18·8 per cent (mean 16·8) ; nasal length 27·0—31·4 per cent (mean 29·2) of O. N. L. rather than exceeding 30 per cent (Ellerman, 1947*a*), and subequal to that of *F. palmarum palmarum*.

Some of the other measurements are as follows :—Greatest zygomatic width 54·1—56·1 per cent (mean 5·0) of O. N. L. ; palatal length 48·8—50·6 per cent (mean 49·5) of O. N. L. ; diastema 22·1—23·3 per cent (mean 22·4) of O. N. L. ; mandibular length 51·8—56·1 per cent (mean 53·85) of O. N. L.

2*c*. **Funambulus palmarum brodiei** Blyth

(Tables 29 and 30)

The only skull of *F. palmarum brodiei* available to me, does not show any appreciable difference from that of *F. palmarum kelaarti*. The least interorbital width is 28·6 per cent of O. N. L. rather than over 30 per cent (Ellerman, 1947*a*).

Some of the other measurements are as follows :—Occipitonasal length 38·1 mm. ; nasal length 10·5 mm. or 27·5 per cent of O. N. L. ; palate 49·2 per cent of O. N. L. ; diastema 22·0 per cent of O. N. L. ; tympanic bullae 7 mm. or 18·3 per cent of O. N. L. ; mandibular length 54·3 per cent of O. N. L.

2*d*. **Funambulus palmarum bellaricus** Wroughton

(Tables 29 and 30)

Skull almost similar to that of *F. palmarum palmarum*, but differs as follows :—Nasals slightly shorter, 26·0—28·0 per cent (mean 27·0) of O. N. L. *vs.* 27·4—30·8 per cent (mean 29·0) ; frontals slightly more constricted, least interorbital width 26·6—26·8 per cent (mean 26·7) of O. N. L. *vs.* 26·0—29·3 per cent (mean 27·7).

Some of the other measurements are as follows :—Occipitonasal length 37·5—38·6 mm. (mean 38·1) ; greatest zygomatic width 54.2 per cent of O. N. L. ; tympanic bullae 19·4—19·8 per cent (mean 19·6) of O. N. L. ; palate 48·1—49·4 per cent (mean 48·8) of O. N. L. ; upper cheek-tooth row 18·9 per cent of O. N. L. ; mandibular length 53·6—55·4 per cent (mean 54·5) of O. N. L.

2*e*. **Funambulus palmarum robertsoni** Wroughton

(Tables 29 and 30)

Skull almost similar to that of *Funambulus palmarum palmarum* in structure,etc., but differs as follows :—Nasals slightly smaller, 27·4—28·8 per cent (mean 28·1 per cent) of O. N. L. *vs.* 27·3—30·8 per cent (mean 29·0) ; frontals slightly less constricted, least interorbital width 26·7—31·1 per cent (mean 28·6) of O. N. L. rather than under 30 per cent (Ellerman, 1947*a*) *vs.* 26·0—29·3 per cent (mean 27.7) ; upper cheek-tooth row shorter, 6·2—7·2 mm. (mean 6·75) *vs.* 6·7—7·85 mm. (mean 7·25) rather than under 7 mm. in *F. robertsoni* and over 7 mm. in F. *palmarum palmarum* (Ellerman, 1947*a*), or 16·4—18·8 per cent (mean 17·7) of O. N. L. *vs.* 17·2—20·8 per cent (mean 19·0) ; occiput lower 5·6—5·8 mm. (mean 5·7) *vs.* 5·6—7·0 mm. (mean 6·4).

Some of the other measurements are as follows :—Occipitonasal length 37·8—38·5 mm. (mean 38·1) ; greatest zygomatic width 56·7—57·0 per cent (mean 56·8) of O. N. L. ; tympanic bullae 18·7—19·6 per cent (mean 19·3) of O. N. L. ; palate 48·4—49·3 per cent (mean 48·7) of O. N. L. ; mandibular length 55·5—55·9 per cent (mean 55·7) of O. N. L.

3. Funambulus tristriatus Waterhouse

3*a*. Funambulus tristriatus tristriatus Waterhouse

(Synonyms : *F. thomasi* Wroughton and Davidson ; and *F. numarius* Wroughton)

(Tables 29 and 30)

Skull almost similar to that of *F. pennanti* except for the following differences :—Larger, occipitonasal length over 40 mm. (39·6—42·3 mm., mean 41·0) *vs.* under 40 mm. (36·0—38·9 mm., mean 37·4) ; frontals slightly less constricted, least interorbital width 29·9—31·5 per cent (mean 29·5) of O. N. L. *vs.* 25·3—29·1 per cent (mean 27·4) ; tympanic bullae smaller, under 1/5th (17·8—18·7 per cent) of O. N. L. *vs.* over 1/5th (19·8—21·0 per cent) ; palate longer, over 20 mm. (20·0—21·2 mm.) *vs.* under 20 mm. (17·7—18·7 mm.) , and 49·6—51·3 per cent (mean 50·2) of O. N. L. *vs.* 47·1—50·5 per cent (mean 48·9) ; diastema longer, 22·4—23·2 per cent (mean 22·8) of O. N. L. *vs.* 20·0—21·6 per cent (mean 21·1).

Mandible : Large ; greatest length of mandible 24·4—25·6 mm. (mean 25·0) ; narrower than in *F. pennanti*, maximum width 46·4—49·6 per cent (mean 48·0) of G. L. M. *vs.* 48·6—53·7 per cent (mean 51·2) ; root-length of lower molars slightly smaller, below 30 per cent (28·2—30·1 per cent) of G. L. M. *vs.* over 30 per cent (29·5—33·7 per cent) ; lower diastema length slightly longer, 18·7—21·2 per cent (mean 20·1) of G. L. M. *vs.* 15·4—18·5 per cent (mean 17·06).

Some of the other measurements are as follows :—Condylobasal length 36·4—38·3 mm. (mean 37·3) ; greatest zygomatic width 53·2—56·5 per cent (mean 55·2) of O. N. L ; nasal length 27·8—30·7 per cent (mean 29·9) of O. N. L. ; upper cheek-tooth row 17·9—18·9 per cent (mean 18·3) of O. N. L. ; length of orbito-temporal fossa 27·5—30·0 per cent (mean 28·5) of O. N. L.

3*b*. Funambulus tristriatus wroughtoni Ryley

(Tables 29 and 30)

Skull almost similar to that of *F. tristriatus tristriatus* in structure, etc., but differing in being larger, occipitonasal length 43·9—46·6 mm. (mean 45·3) rather than over 44·7 mm. (Ellerman, 1947*a*) *vs.* 39·6—42·3 mm. (mean 41·0) ; palate slightly longer, 22·6—23·9 mm. (mean 23·5) rather than over 23·5 mm. (Ellerman, 1947*a*) *vs.* 20·0—21·2 mm. (mean 20·5) or 50·9—51·5 per cent (mean 51·1) of O. N. L. *vs.* 49·6—51·3 per cent (mean 50·2) ; tympanic bullae relatively smaller, 16·5—17·7 per cent (mean 17·35) of O. N. L. *vs.* 17·8—18·7 per cent (mean 18·25).

Some of the other measurements are as follows :—Greatest zygomatic width 55·1—57·6 per cent (mean 55·9) of O. N. L. ; least interorbital width 28·2—30·2 per cent (mean 29·0) of O. N. L. ; nasal length

29·1—31·7 per cent (mean 30·5) of O. N. L. ; upper cheek-tooth row 17·7—19·5 per cent (mean 18·6) of O. N. L. ; diastema length 23·1—24·5 per cent (mean 23·8) of O. N. L. ; greatest length of mandible 26·5—28·8 mm. (mean 27·6).

4. **Funambulus sublineatus** Waterhouse

4*a*. **Funambulus sublineatus sublineatus** Waterhouse

(Tables 29 and 30)

Skull almost similar to that of *F. pennanti* in structure, etc., but differs as follows :—Slightly smaller, occipitonasal length 33·0—34·5 mm. (mean 34·0) *vs.* 36·0—38·9 mm. (mean 37·4) ; frontals less constricted, least interorbital width over 29 per cent (29·7—30·3 per cent) of O. N. L. *vs.* below 29 per cent (24·0—29·1 per cent), even more than the nasal length ; postorbital processes relatively smaller ; tympanic bullae smaller, under 1/5th (17·2—17·5 per cent) of O. N. L. *vs.* over 1/5th (19·8—21·0 per cent) ; orbito-temporal fossa smaller, under 10 mm. (9·0) *vs.* over 10 mm. (10·8—11·7) ; parietals feebly ridged ; ridges remaining distant apart, not forming sagittal crest.

Mandible : Differing from that of *F. pennanti* in being smaller and narrower ; mandibular length 51·7—53·0 per cent (mean 52·3) *vs.* 53·4—58·1 per cent (mean 55·2) of O. N. L. and maximum width 49·5—50·5 per cent (mean 50·1) *vs.* 48·6—53·7 per cent (mean 51·2) of G. L. M.

Some of the other measurements are as follows :—Greatest zygomatic width 53·9 per cent of O. N. L. ; nasal length 26·3—29·0 per cent (mean 27·65) of O. N. L. ; palatal length 45·5—46·5 per cent (mean 46·0) of O. N. L. ; upper cheek-tooth row 17·5—17·8 per cent (mean 17·6) of O. N. L. ; diastema 20·5—20·9 per cent (mean 20·7) of O. N. L. ; greatest length of mandible 19·0—19·2 mm. (mean 19·1).

Genus (16) **Petaurista** Link

1. **Petaurista petaurista** Pallas

Provisional key for identification of Oriental subspecies of Petaurista petaurista, *based on skull characters.*

O. N. L., Occipitonasal length.

1(2). Tympanic bullae over 14 mm. (except one skull having 13·3 mm. or over 19 per cent of O. N. L.

... *P. p. cineraceus* Blyth

... *P. p. philippensis* Elliot

2(1). Tympanic bullae under 13 mm. or under 19 per cent of O. N. L.

... *P. p. albiventer* Gray

The descriptions of the skull of various subspecies are given below.

1*a*. **Petaurista petaurista cineraceus** Blyth

(Tables 31 and 32 ; and Plate 39)

General : Skull large, occipitonasal length 70·5—76·5 mm. (mean 73·7) ; dorsal surface highest over parietals ; sloping anteriorly and more so posteriorly, with prominent interorbital depression ; cranium broad ; rostrum short and broad ; great tendency of fusion of bones; occipitonasal length exceeding condylobasal length. *Nasals :* Short, under 1/3rd (30·8—32·5 per cent) of O. N. L. ; rather broad, over 15 per cent (17·2—17·7 per cent) of O. N. L. ; fairly extending forward over incisors ; posteriorly subequal to ascending process of premaxillae ; the latter broad, subequal to combined width of nasals at posterior end ; posterior extremity V-shaped or truncated ; much narrower posteriorly and gradually becoming wider anteriorly. *Frontals :* Narrow ; notched just anterior to postorbital process ; least interorbital width under 1/4th (21·3—22·6 per cent) of O. N. L. ; postorbital processes projecting transversely, slightly raised up, thus producing prominent interorbital depression ; frontal suture almost disappearing, only present in anterior one-third portion. *Parietals :* Broader than long ; feebly ridged ; ridges not forming sagittal suture, but running posteriorly from postorbital projections, at half the distance between mid-line and the lateral border of parietals and meeting supraoccipital ; parietal suture disappearing ; fronto-parietal suture nearly straight or slightly convex medially and curved anteriorly on sides. *Interparietal :* Absent. *Occiput :* Very low, 12·7—13·5 per cent (mean 13·2) of O. N. L. ; upstanding and feebly ridged ; basioccipital fairly broad ; suture between basisphenoid and basioccipital disappearing ; paroccipital processes large. *Squamosals :* Relatively smaller, with strong zygomatic process ; supratympanic portion broad, posteriorly meeting the mastoid and a portion of occipital. *Tympanic bullae :* Pomegranate-shaped ; large and inflated ; 14.7—15·9 mm. (mean 15·4) or over 1/5th (20·7—20·9 per cent) of O. N. L. ; external auditory meatus projecting anteriorly like the mouth of a jug ; auditory orifice large ; mastoids much reduced ; mastoid foramen distinct. *Zygomatic arches :* Wide ; widest just behind postorbital process of jugals and becoming narrower anteriorly, thus giving triangular shape to anterior portion of skull ; greatest zygomatic width over 60 per cent (64·0—66·5 per cent) of O. N. L. ; jugals extending the whole length of zygomatic arches ; anteriorly touching the lacrymals and posteriorly extending upto posterior truncated edge of zygomatic process of squamosals ; small projection, corresponding to postorbital process of frontal, present over jugal bones ; anterior portion of jugals slightly circular and ridged ; zygomatic process of squamosals broad and extending transversely from the skull, anteriorly projecting upto postorbital process of jugals ; infraorbital foramen small, only transmitting infraorbital nerve ; a large tubercle, situated ventro-laterally to the foramen, present for muscle attachment. *Palate :* Short, under 55 per cent (49·8—51·7 per cent) of O. N. L. ; flat ; extending or not extending posteriorly

behind molars ; anterior palatine foramina very small, 5·2—5·9 per cent (mean 5·6) of O. N. L. ; situated far anterior to molars ; completely formed by premaxillae ; posterior palatine foramina small ; canal for palatine vein present behind third upper molar (Hill, 1935) ; upper cheek-tooth row long, 16·9 mm. or over 1/5th (23·0 per cent) of O. N. L. ; diastema shorter than cheek-tooth row, under 1/4th (20·1—21·6 per cent) of O. N. L. ; orbito-temporal fossa large, over 1/3rd (34·3—35·7 per cent) of O. N. L. Hamular process of pterygoids long, touching or at least reaching the antero-lateral projection of tympanic bullae ; pterygoid fossae fairly reduced and shallow ; foramen ovale and foramen lacerum anterius large ; optic and sphenopalatine foramina present in optic fossa.

Mandible : Long, mandibular length over 60 per cent. (61·0—65·1 per cent) of O. N. L. ; fairly broad posteriorly, maximum width 69·2—71·2 per cent (mean 70·0) of G. L. M. ; coronoid process quite high, ascending from the ramus behind second lower molar ; condylar process very small ; angular process large ; masseteric ridge feeble ; root-length of lower molars (37·8—39·3 per cent, mean 38·5, of G. L. M.) much longer than lower diastema length (20·0—21·6 per cent, mean 20·9, of G. L. M.).

Dentition : Upper incisors orthodont, reddish and ungrooved ; thicker than wide ; extending posteriorly upto anterior end of premolars ; lower incisors long. Upper premolars and molars : 5 in number (2 premolars and 3 molars), rooted ; first tooth single-rooted, and very small ; other teeth 3-rooted ; pm^4, m^1 and m^2 subequal in size and m^3 slightly smaller ; four main ridges extending outwards from inner portion and surrounding three depressions or folds ; inner side having a short reetrant fold in postero-internal corner ; on wearing, folds isolating as islands ; in m^3 third ridge slightly curved posteriorly so that second fold becoming wider than in others. Lower premolars and molars : 4 in number (one premolar and 3 molars), increasing in size antero-posteriorly ; ridges on crown surface excessively wrinkled and fused, giving rise to complicated pattern.

1*b*. **Petaurista petaurista philippensis** Elliot

(Tables 31 and 32)

Skull almost similar to that of *P. petaurista cineraceus* in structure, etc., but differs as follows :—Slightly smaller, occipitonasal length 69·1—74·6 mm. (mean 72·2) *vs.* 70·5—76·5 mm. (mean 73·7) ; nasals slightly smaller, 27·6—30·3 per cent (mean 29·2) of O. N. L. *vs.* 30·8—32·5 per cent (mean 31·7) ; ascending process of premaxillae narrower than combined width of nasals at posterior end as against subequal in *P. p. cineraceus* ; interorbital depression shallower ; tympanic bullae slightly smaller, 13·3—15·3 mm. (mean 14·5) *vs.* 14·7—15·9 mm. (mean 15·4) ; upper cheek-tooth row shorter, under 16·8 mm. (14·7—16·7 mm.) *vs.* over 16·8 mm. (16·9 mm.).

Some of the other measurements are as follows :—Greatest zygomatic width 64·7—68·9 per cent (mean 65·8) of O. N. L. ; palate 49·3—52·4 per cent (mean 50·5) of O. N. L. ; upper cheek-tooth row 21·2—22·8 per cent (mean 22·0) of O. N. L. ; length of orbito-temporal fossa 34·7—36·7 per cent (mean 35·6) of O. N. L. ; mandibular length 59·3—63·3 per cent (mean 61·5) of O. N. L.

1*c*. **Petaurista petaurista albiventer** Gray

(Tables 31 and 32)

Skull almost similar to that of *P. petaurista cineraceus*, but differs as follows :—Smaller, occipitonasal length 66·4—69·3 mm. (mean 67·4) *vs.* 70·5—76·5 mm. (mean 73·7) ; tympanic bullae much smaller, under 13 mm. (12·2—12·8) *vs.* over 14 mm. (14·7—15·9 mm.) or under 1/5th (18·2—18·6 per cent) of O. N. L. *vs.* over 1/5th (20·7—20·9 per cent) ; nasals slightly smaller, 29·4—30·7 per cent (mean 30·0) of O. N. L. *vs.* 30·8—32·5 per cent (mean 31·7) ; ascending process of premaxillae much narrower than combined width of nasals posteriorly ; diastema shorter, under 1/5th (17·4—19·2 per cent) of O. N. L. *vs.* over 1/5th (20·1—21·6 per cent) ; interorbital depression shallower ; mandible slightly smaller, mandibular length 59·9—60·8 per cent (mean 60·3) *vs.* 61·0—65·1 per cent (mean 62·7) of O. N. L.

Some of the other measurements are as follows :—Greatest zygomatic width 64·0—66·5 per cent (mean 65·4) of O. N. L. ; palate 47·5—51·6 per cent (mean 49·8) of O.N.L. ; upper cheek-tooth row 22·5—24·5 per cent (mean 23·4) of O. N. L. ; length of orbito-temporal fossa 35·5—37·3 per cent (mean 36·4) of O. N. L. ; mandibular length 59·9—60·8 per cent (mean 60·3) of O. N. L.

2. **Petaurista magnificus** Hodgson

2*a*. **Petaurista magnificus magnificus** Hodgson

(Tables 31 and 32)

Skull almost similar to that of *P. petaurista cineraceus* in structure, etc., but differs as follows:—Smaller, occipitonasal length 68·4—72·2 mm. (mean 70·4) *vs.* 70·5—76·5 mm. (mean 73·7) ; tympanic bullae smaller 11·5—12·3 mm. (mean 11·9) *vs.* 14·7—15·9 mm. (mean 15·4) or under 1/5th (16·0—17·6 per cent)of O.N.L. *vs.* over 1/5th (20·7—20·9 per cent) ; nasals broader, 18·1—19·5 per cent (mean 18·7) of O.N.L. *vs.* 17·2—17·7 per cent (mean 17·4) ; orbito-temporal fossa slightly longer 35·5—37·1 per cent (mean 36·3) of O.N.L. *vs.* 34·3—35·7 per cent (mean 35·1) ; ascending process of premaxillae narrower than combined width of nasals posteriorly ; interorbital depression shallower ; mandible slightly smaller, mandibular length 59·2—61·9 per cent (mean 60·0) of O.N.L. *vs.* 61·0—65·1 per cent (mean 62·7).

Skull differing from that of *P. petaurista albiventer* (of nearly the same locality) in having slightly smaller tympanic bullae, 11·5—12·3 mm. (mean 11·9) *vs.* 12·2—12·8 mm. (mean 12·4) or 16·0—17·6 per cent (mean 17·0) of O.N.L. *vs.* 18·2—18·6 per cent (mean 18·4) ; and shorter cheek-tooth row, 20·9—23·0 per cent (mean 21·9) of O.N.L. *vs.* 22·5—24·5 per cent (mean 23·4).

Some of the other measurements are as follows :—Greatest zygomatic width 65·1—67·4 per cent (mean 65·8) of O.N.L. ; nasal length 28·9—31·4 per cent (mean 30·4) of O.N.L. ; palate 48·6—51·2 per cent (mean 50·2) of O.N.L.

3. **Petaurista alborufus** Milne Edwards

3*a*. **Petaurista alborufus candidulus** Wroughton

(Tables 31 and 32)

Skull almost similar to that of *P. petaurista cineraceus*, but differs as follows :—Slightly shorter in maximum range of occipitonasal length, 72·2—74·8 mm. *vs.* 70·5—76·5 mm.; tympanic bullae smaller, 13·2—13·7 mm. (mean 13·5) *vs.* 14·7—15·9 mm. (mean 15·4) or under 1/5th (18·0—18·7 per cent) of O.N.L. *vs.* over 1/5th (20·7—20·9 per cent) ; nasals slightly broader, 17·4—18·9 per cent (mean 18·2) of O.N.L. *vs.* 17·2—17·7 per cent (mean 17·4) ; ascending process of premaxillae narrower than the combined width of nasals posteriorly ; interorbital depression shallower ; suture between basioccipital and basisphenoid generally distinct *vs.* disappearing in *P. p. cineraceus*.

Some of the other measurements are as follows :—Greatest zygomatic width 65·2—68·1 per cent (mean 66·4) of O.N.L. ; least interorbital width 20·0—23·1 per cent (mean 21·4) of O.N.L. ; nasal length 28·8—31·6 per cent (mean 30·3) of O.N.L. ; palate 50·4—51·5 per cent (mean 51·0) of O.N.L. ; upper cheek-tooth row 22·6—24·5 per cent (mean 23·6) of O.N.L. ; length of orbito-temporal fossa 33·9—35·6 per cent (mean 34·7) of O.N.L.

Genus (17) **Marmota** Blumenbach

1. **Marmota bobak** Müller

The skull of the Indian subspecies is described below.

1*a*. **Marmota bobak himalayana** Hodgson

(Tables 33 and 35 ; and Plate 40)

General : Skull very large and stout ; occipitonasal length 92·2—110·7 mm. (mean 103·0) ; dorsal surface flat, slightly sloping posteriorly, with prominent sagittal and lambdoid crests ; cranium narrow ; rost-

rum short and broad ; condylobasal length equals or exceeds the occipitonasal length. *Nasals :* Long, over 40 per cent (41·6—43·2 per cent) of O.N.L. ; rather broad, nasal width over 15 per cent (17·2— 17·5 per cent) of O.N.L. ; extending anteriorly upto incisors and posteriorly beyond lacrymals, sufficiently behind the ascending process of premaxilae ; the latter very narrow ; posterior extremity of nasals truncated ; narrowest posteriorly and becoming wider anteriorly, with slight inflection at the anterior one-third portion. *Frontals :* Interorbital constriction broader than rostrum ; narrowest just behind lacrymals ; least interorbital width under 1/4th (23·0—24·6 per cent) of O.N.L. ; postorbital processes stout, projecting transversely ; strong ridges extending posteriorly from postorbital processes, forming long and sharp sagittal crest over parietals, meeting lambdoid crest ; frontal suture almost disappearing except at anterior one-third portion in subadult skulls ; portion of frontals behind postorbital processes very narrow. *Parietals :* Narrow ; longer than wide ; parieto-squamosal sutures nearly parallel to sagittal crest ; fronto-parietal suture indistinct. *Occiput :* High, 15·9—18·9 per cent (mean 17·8) of O.N.L. ; upstanding and strongly ridged ; lambdoid crest slightly projecting backwards ; paroccipital processes large. *Squamosals :* Fairly well developed; zygomatic process of squamosals stout and anteriorly projecting ; supratympanic portion fairly broad ; perforated by subsquamosal and postglenoid foramen. *Zygomatic arches :* Stout ; wide ; widest medially ; greatest zygomatic width over 60 per cent (60·3—63·7 per cent) of O. N. L.; zygoma not descending ventrally to level of palate ; jugals extending the whole length of zygomatic arches ; anteriorly touching lacrymals and posteriorly extending below and slightly behind the zygomatic process of squamosals ; the latter projecting anteriorly upto posterior one-third distance of zygomatic arches ; zygomatic process of maxillae quite high ; anterior outer margin of zygomatic arches and outer side of jugals ridged ; infraorbital foramen small, only transmitting infraorbital nerve ; prominent knob present on lower outer side of the foramen for the attachment of muscles. *Tympanic bullae :* Medium-sized, 16·7—18·9 per cent (mean 17·9) of O. N. L.; rounded ; auditory orifice large, somewhat dorso-laterally directed. *Palate :* Long, over 55 per cent (56·5—57·7 per cent) of O.N.L., extending slightly behind molars ; anterior palatine foramina small, under 10 per cent (7·5—8·5 per cent) of O. N. L., situated far anterior to molars ; whole foramina, except posterior extremity, formed by premaxillae ; posterior palatine foramina and palatine bones very small ; maxillopalatine suture distinct ; upper cheek-tooth row long, over 1/5th (22·0—24·7 per cent) of O.N.L. ; diastema long, over 1/4th (26·4—27·4 per cent) of O.N.L. ; orbitotemporal fossa large, over 1/3rd (33·8—36·1 per cent) of O. N. L. Hamular process of pterygoids quite high, extending posteriorly to basioccipital, but not touching tympanic bullae ; pterygoid fossae shallow, perforated by large foramen ovale ; large canal for palatine vein present behind m^3.

Mandible : Long, mandibular length over 65 per cent (66·0—68·4 per cent) of O. N. L.; rather broad, maximum width 55·0—60·5 per cent (mean 58·0) of G. L. M.; coronoid process fairly developed, ascending from the ramus behind third lower molar ; angular process slightly twisted outwards and extending posteriorly upto, or slightly behind,

condylar process ; masseteric ridge prominent ; root of lower incisor situated behind m^3; mental foramen very small ; root-length of lower molars (31·3—35·4 per cent, mean 33·4, of G.L.M.) more than lower diastema length (23·9—24·8 per cent of G. L.M .).

Dentition : Upper incisors white, slightly proodont and having several longitudinal striations over their front surface ; slightly thicker than wide ; extending posteriorly upto fourth premolar ; lower incisors plane and white. Upper premolars and molars : 5 in number (2 premolars and three molars) ; rooted ; gradually becoming large-antero-posteriorly ; third premolar relatively larger than in the other genera, but less than half of fourth premolar ; pm^4, m^1, m^2 and m^3, each having a large main inner cusp from which extending four ridges to outer border, separated by three outer folds ; two middle ridges prominent ; the fourth ridge narrow and fusing with third on wearing ; in m^3 third ridge more posteriorly curved, so that the second fold becoming wider than in other molars ; third fold generally isolating as island. Lower premolars and molars : 4 in number (one premolar and 3 molars) ; pm^4 slightly larger than m^1; m^3 largest of all ; each tooth consisting of two outer tubercles separated by an outer fold, and an antero-internal tubercle ; the latter highest of all ; postero-internal tubercle indistinct, anterior tubercles joined by a ridge.

Family 5. DIPODIDAE

Only one genus, *Jaculus* Erxleben, was studied.

Genus (18) **Jaculus** Erxleben

1. **Jaculus jaculus** Linnaeus

The description of only one subspecies is given below. This is the African species described in the present account ; no oriental species of the family was available to me.

1*a*. **Jaculus jaculus jaculus** Linnaeus

(Synonym : *Dipus aegyptius* Lichtenstein)

(Tables 33 and 35 ; and Plate 41)

General : Skull medium-sized, occipitonasal length 36·3—36·5 mm. (mean 36·4) ; very broad ; dorsal surface flat, with a depression over naso-frontal suture ; slightly sloping anteriorly and posteriorly ; rostrum narrow, 16·0—17·0 per cent (mean 16·5) of O.N.L. ; occipitonasal length exceeding condylobasal length ; greatest zygomatic width exceeding bimeatal distance ; sutures between paired bones distinct. *Nasals :* Long, over 40 per cent (40·2—43·2 per cent) of O. N. L.; rather broad ; widest anteriorly 14·6—15·4 per cent (mean 15·0) of O. N. L. ; anteri-

orly slightly shorter than the premaxillae ; posteriorly reaching to infraorbital canal and subequal to narrow ascending process of premaxillae ; posterior border of each, V-shaped. *Frontals :* Short ; frontal length equal to parietal length ; fairly broad ; narrowest immediately behind lacrymals, least interorbital width over 1/3rd (37·8—40·2 per cent) of O.N.L. ; unridged ; evenly divergent backwards ; postorbital processes absent. *Parietals :* Broader than frontals ; width nearly thrice the length ; fronto-parietal suture almost straight, not curving forward laterally ; parietals laterally forming well marked downwardly directing ridge, over squamosals. *Interparietal :* Large ; biconvex ; posterior border deeply convex backwards ; posterior three-fourths portion surrounded by supraoccipital. *Occiput :* Vertical ; dorso-lateral extensions of supraoccipital narrow and laterally touching squamosals ; basioccipital fairly narrow due to enlarged bullae ; paroccipital processes small, foramen magnum and occipital condyles slightly shifted ventrally. *Squamosals :* Much reduced ; supra-tympanic portion very narrow ; posteriorly extending in form of a process up to lateral extensions of supraoccipital, then curving slightly downwards behind auditory orifice ; supratympanic fenestrae large, filled by anterior extension of mastoids. *Tympanic bullae :* Excessively inflated, over 30 per cent (31·2—31·9 per cent) of O. N. L. ; situated obliquely to longitudinal axis, meeting anteriorly with each other over basisphenoid ; external auditory meatus anteriorly swollen ; auditory orifice large and directed posteriorly ; mastoids fairly large and inflated ; anteriorly bulging out through supratympanic fenestrae and posteriorly projecting behind occiput. *Zygomatic arches :* Situated ventrally ; fairly wide posteriorly ; greatest zygomatic width 71·3—75·3 per cent (mean 73·3) of O. N. L. ; infraorbital canal widely open (mean height and width 21·7 per cent and 13·2 per cent respectively of O. N. L.), with a separate passage for nerve transmission on its lower inner side ; inferior maxillary root of zygomatic arch becoming ventral, instead of lateral, to the canal, due to its (canal) enlargement ; jugals long, extending nearly the whole length of zygomatic arches ; anteriorly extending upto inferior maxillary root, then bending upwards at right angles reaching the lacrymals, parallel to outer wall of infraorbital canal ; lacrymals very large ; zygomatic process of squamosals extending transversely from ventral portion of the bones, with the tip protruding anteriorly *Palate :* Long, over 60 per cent (63·5—63·6 per cent) of O. N. L. ; posteriorly extending fairly behind molars and having a median bifurcated spinous process ; anterior palatine foramina medium-sized, 13·7—14·5 per cent (mean 14·1) of O. N. L., posteriorly extending to molars ; formed partly by premaxillae and partly by maxillae ; posterior palatine foramina small ; a small foramen for palatine vein present behind each m^3 ; upper cheek-tooth row 6·25 mm. or 17·2 per cent of O. N. L. ; diastema over 1/4th 28·3—28·4 per cent of O. N. L. ; pterygoid fossae small and deep ; hamular process of pterygoids posteriorly touching tympanic bullae ; basisphenoid lying below the junction of tympanic bullae.

Mandible : Weak ; coronoid process short and reduced ; angular process perforated by a large fenestra ; root of lower incisor forming knob on outer side of condylar process ; maximum width of mandible

41.1 per cent of G. L. M.: lower diastema length (25·7 per cent of G L. M.) less then root-length of lower molars (30·3 per cent of G.L.M.).

Dentition : Upper incisors orthodont or slightly proodont, white and longitudinally grooved ; extending posteriorly upto root of m^4 lower incisors white and ungrooved; posteriorly terminating into a knob on outer side of condylar process. Molars $\frac{3}{3}$: rooted. Upper molars : m^1 and m^2 4-rooted : m^3 2-rooted and smallest ; each upper molar bilaminate, with one inner and one deep outer folds ; the latter obliquely directed posteriorly : m^1 anteriorly notched ; inner fold of m^2 shallow. Lower molars : Bilaminate ; m_2 largest and m_3 smallest of all: m_1 having a fold on each side : m_2 with two outer and one inner folds ; m_3 with only one outerfold ; m_1 anteriorly notched.

Family 6. HYSTRICIDAE

Two genera, *Hystrix* Linnaeus and *Atherurus* Cuvier, were studied.

Key for identification of Oriental genera of Hystricidae, *based on skull characters.*

O. N. L., Occipitonasal length.

1(2). Nasals long, over 45 per cent of O.N.L.; fairly longer than frontals and extending posteriorly beyond lacrymals ; least interorbital width over 35 per cent of O.N.L.

...*Hystrix* Linnaeus

2(1). Nasals under 1/3rd of O.N.L.; fairly shorter than frontals and not reaching posteriorly to lacrymals ; least interorbital width under 35 per cent of O.N.L.

...*Atherurus* Cuvier

Genus (19) **Hystrix** Linnaeus

Key for identification of Oriental species of Hystrix, *based on skull characters.*

1(2). Ascending process of premaxillae broad posteriorly, over 20 mm.; extending nearly upto posterior extremity of nasals ; frontals longer than parietals.

...*H. indica* Kerr

2(1)Ascending process of premaxillae posteriorly very narrow, under 5 mm.; posteriorly extending upto two-thirds distance of nasals ; frontals subequal to parietals.

.....*H. hodgsoni subcristata* Swinhoe

1. **Hystrix indica** Kerr

1*a*. **Hystrix indica indica** Kerr

(Synonym : *H. leucura* Sykes)

(Tables 34 and 35 ; and Plate 42)

General : Skull very large, occipitonasal length 142·8—157·3 mm. (mean 150·2) ; slightly arched dorsally, with prominent sagittal and

lambdoid crests ; rostrum long and broad ; tendency of fusion of bones ; occipitonasal length subequal to condylobasal length. *Nasals :* Very long, 49·4—52·0 per cent (mean 50·9) of O.N.L.; fairly broad, width 26·8—27·4 per cent (mean 27·1) of O.N.L.; widest posteriorly ; lateral margins nearly parallel with slight medial inflection ; anteriorly not reaching the tip of premaxillae ; posteriorly extended little beyond the ascending process of premaxillae and terminating in a line with anterior portion of the orbits ; premaxillae broad posteriorly, 22·2—26·5 mm., nearly as broad behind as in front. *Frontals :* Longer than parietals and much smaller than nasals ; broad and unconstricted, least interorbital width 39 per cent of O.N.L.; feebly ridged on sides ; frontal suture disappearing ; fronto-parietal suture nearly straight and serrated. *Parietals :* Small ; confined posteriorly to zygomatic process of squamosals ; ridged ; ridges forming sagittal crest in posterior two-thirds portion ; the suture between parietals and supraoccipital, and parietal suture disappearing. *Interparietal :* Present in subadult, skull, but untraceable in adults ; when present, conical in shape. *Occiput :* Upstanding and high, 20·7—22·2 per cent (mean 21·6) of O.N.L., with powerful median and lambdoid crests ; paroccipital processes large. *Squamosals :* Moderately developed ; supratympanic portion narrow, but extending posteriorly upto occipital ; zygomatic process of squamosals large and slanting downwards ; anteriorly a furrow present over squamosals for the transmission of temporal muscles. *Tympanic bullae :* Very small, 12·8 per cent of O.N.L., with short tubular auditory meatus ; anteriorly touching the hamular process of pterygoids ; mastoids reduced ; stylomastoid foramen distinct. *Zygomatic arches :* Stout ; anterior zygomatic root placed over middle of cheek-tooth row ; widest across maxillary root of zygoma ; greatest zygomatic width 52·6 per cent of O.N.L.; infraorbital canal very large, having no separate passage for nerve transmission ; inferior maxillary root of zygoma slender and completely ventral to infraorbital canal ; superior maxillary root forming vertical outer wall of the opening and broad ; jugal long, laterally compressed and broader in front than behind ; extending anteriorly upto anterior orbital margin, but dorsally not reaching the lacrymal ; posteriorly extending upto posterior edge of zygomatic process of squamosal ; orbitotemporal fossa small, under 1/5th (19·4—20·0 per cent) of O.N.L. *Palate* ; Long, over 50 per cent (53·7—54·7 per cent) of O.N.L., not extending behind molars ; rather narrow ; anterior palatine foramina very small, 4·2—4·8 per cent (mean 4·4) of O.N.L.; much nearer to incisors than molars ; completely formed by premaxillae ; palatal surface perforated by a number of small foramina ; palatine bones much reduced ; posterior edge of palate angular ; upper cheek-tooth row over 1/5th (22·4—22·7 per cent) of O.N.L.; diastema long, 29·3—30·4 per cent (mean 29·9) of O.N.L.; portion of maxillae supporting molars stout and swollen. Pterygoid fossae narrow, situated fairly behind m^3 ; mesopterygoid fossa deep and large ; basisphenoid, basioccipital and presphenoid bones completely fused and fairly sloping anteriorly.

Mandible : Large and stout ; greatest length of mandible 100—101·2 mm. (mean 100·6) ; mandibular length 62·2—68·4 per cent (mean 64·9) of O.N.L.; coronoid process small, lower than condylar but stout ; angular process stout, powerfully distorted outwards and

situated outwardly to lower incisor root ; notch between angular and condylar processes absent ; posterior margin straight ; masseteric ridge prominent ; incisors deep rooted, extending posteriorly upto condylar process ; root-length of lower molars (34·6—35·0 mm., mean 34·8) more than lower diastema length (26·1—27·4 mm., mean 26·8).

Dentition : Consisting of a pair of incisors and four pairs of cheek-teeth. Upper incisors yellow, thick and ungrooved ; slightly proodont ; extending posteriorly upto premolar ; lower incisors long, extending backwards and terminating at the root of condylar process. Upper premolars and molars : 4 (one premolar and 3 molars) ; hypsodont and flat-crowned ; first tooth longer than wide and largest ; others nearly rounded or square ; each tooth having one inner and four outer folds ; the latter soon isolated as islands. Lower premolars and molars : 4 (one premolar and 3 molars) ; reversing the pattern of uppers ; not very clear due to attrition.

2. **Hystrix hodgsoni** Gray

2*a*. **Hystrix hodgsoni subcristata** Swinhoe

(Tables 34 and 35)

Only one subadult female skull was available to me ; hence mainly structural differences are mentioned.

Skull almost similar to that of *Hystrix indica indica,* but differs as follows :—Smaller. Occipitonasal length 119 mm. *vs.* 142·8—157·3 mm. (mean 150·2) ; fairly arched dorsally ; nasals slightly longer, 55·6 per cent of O.N.L. *vs.* 49·4—52·0 per cent (mean 50·9), extending more posteriorly and terminating at middle of orbito-temporal fossa as against at the anterior portion ; posteriorly one-and-half times wider than anteriorly ; ascending process of premaxillae posteriorly very narrow, 3·2 mm. *vs.* 22·2—26·5 mm. (mean 23·9), reaching posteriorly upto two-thirds distance of nasals ; consequently, frontals extending anteriorly on both sides of nasals, and maxilla shifting dorsally ; frontals reduced in length due to posterior extension of nasals and subequal to parietal length ; interparietal bone present and large.

Genus (20) **Atherurus** Cuvier

Key for identification of species of Atherurus, *based on skull characters.*

O.N.L., Occipitonasal length.

1(2). Palate long, over 50 per cent of O.N.L.; posterior margin truncated and extending upto last molar ; ascending process of premaxillae posteriorly broad, over 6 mm.

...*A. africanus* Gray

2(1). Palate short, under 50 per cent of O.N.L.; posterior margin angular and extending upto penultimate molar ; ascending process of premaxillae posteriorly narrow, under 5 mm.

...*A. macrourus* Linnaeus

1. **Atherurus macrourus** Linnaeus

1*a*. **Atherurus macrourus macrourus** Linnaeus

(Table 34)

General : Skull smaller than that of *Hystrix indica ;* occipitonasal length 91·5 mm. *vs.* 142·8—157·3 mm. (mean 150·2) ; rostrum short ; sutures between paired bones distinct, slight depression present over frontals ; occipitonasal length exceeding condylobasal length. *Nasals :* Short, under 1/3rd (27·4 per cent) of O.N.L.; and narrow, nasal width 17 per cent of O.N.L.; anteriorly slightly shorter than premaxillae ; posteriorly ending anterior to infraorbital canal and subequal to ascending process of premaxillae ; the latter posteriorly very narrow, 3·3—5·2 mm. *Frontals :* Much longer than nasals as against much shorter in *H. indica ;* slightly narrower, least interorbital width 32·7 per cent of O.N.L. *vs.* 39·0 per cent ; frontal bones projecting as triangular spine for a little distance between posterior margin of nasals (in all the three specimens) rather than having straight anterior border (Parsons, 1894, p. 676) ; frontal suture distinct. *Parietals :* Small ; confined posteriorly to orbito-temporal fossa ; posteriorly not reaching the occipital crest ; parietal suture distinct. *Interparietal :* Large ; conical ; prominent sagittal crest present over its whole length. *Occiput :* Vertical ; lower than in *H. indica,* under 1/5th (19·5 per cent) of O.N.L. *vs.* over 1/5th (20·7—22·2 per cent) ; median occipital and lambdoid crests powerfully developed ; paroccipital processes short ; foramen magnum and occipital-condyles situated slightly ventrally. *Squamosals :* Reduced ; supratympanic portion narrow and extending posteriorly upto occipitals ; anteriorly a furrow present for muscle transmission. *Tympanic bullae :* Larger than in *H. indica,* 15·8 per cent of O.N.L. *vs.* 12·8 per cent ; anteriorly touching the hamular process of pterygoids. Stylomastoid foramen distinct. *Zygomatic arches :* Stout ; anterior zygomatic root placed more anteriorly than in *H. indica,* situated over fourth premolar as against over middle of cheek-tooth row ; greatest zygomatic width 50·8 per cent of O.N.L.; infraorbital canal very large, having no separate passage for nerve transmission ; inferior maxillary root of zygoma completely ventral to infraorbital canal ; jugal long, laterally compressed, broader in front than behind ; extending anteriorly upto anterior orbital margin, but not reaching the lacrymals ; orbito-temporal fossa slightly longer than in *H. indica,* over 1/5th (22·6 per cent) of O.N.L. *vs.* under 1/5th (19·4—20·0 per cent). *Palate :* Short, under one-half (48 per cent) of O.N.L., extending posteriorly upto penultimate molar ; posterior margin angular ; perforated by several smaller pits ; anterior palatine foramina very small, 5·4 per cent of O.N.L., completely formed by premaxillae ; palatine bones much reduced ; upper cheek-tooth row shorter than in *H. indica,* under 1/5th (18·2 per cent) of O.N.L. *vs.* over 1/5th (22·4—22·7 per cent); portion of maxillae supporting molars weak and not swollen ; diastema 29·5 per cent of O.N.L.; pterygoid fossae narrow, situated fairly behind m^3 ; suture between basioccipital and basisphenoid bones distinct ; foramen lacerum anterius small ; foramen ovale large.

Mandible : Absent in the specimens available to me.

Dentition : Upper incisors red and ungrooved ; extending posteriorly upto premaxillary-maxillary suture. Cheek-teeth $\frac{4}{4}$ (one premolar and 3 molars) ; first three teeth nearly equal in size, and fourth one smaller ; pattern of molars not clear.

2. **Atherurus africanus** Gray

2*a*. **Atherurus africanus africanus** Gray

(Table 34)

Skull almost similar to that of *A. macrourus*, only differing in being slightly more robust and dorsally arched ; palate longer, over 50 per cent (56·1 per cent) of O.N.L. *vs.* under 50 per cent (48·0 per cent) ; posteriorly extending upto last molars ; posterior margin truncated ; ascending process of premaxillae posteriorly slightly wider, 6·9 mm. *vs.* 3·3—5·2 mm.; squamosals prominently ridged anteriorly for the attachment of muscles ; jugals reaching anteriorly nearer the lacrymals than in *A. macrourus ;* distance between its anterior suture and anterior border of infraorbital canal less than 4 mm. *vs.* over 5 mm. (5—7 mm.) ; upper incisors extending posteriorly behind premaxillary-maxillary suture forming knob over diastema.

Some of the other measurements are as follows :—Occipitonasal length 92·1 mm.; greatest zygomatic width 51·1 per cent of O.N.L.; least interorbital width 32·6 per cent of O.N.L.; tympanic bullae 15·9 per cent of O.N.L.; nasal length 25·1 per cent of O.N.L.; upper cheek-tooth row 20·3 per cent of O.N.L. ; diastema length 28·7 per cent of O.N.L.; occiput 18·9 per cent of O.N.L.

III—TENTATIVE KEYS FOR THE IDENTIFICATION OF SUPERFAMILIES, FAMILIES, GENERA, SPECIES AND SUBSPECIES OF ORIENTAL RODENTS, BASED ON MANDIBLE CHARACTERS.

The following tentative keys are based on the study of mandibles of 20 genera and 60 species and subspecies of Oriental Rodents. Though incomplete, they will, I hope, be helpful in the identification of the families, and several of the genera, species and subspecies. A study of the mandible showed that marked differences exist up to subgeneric rank, but in species and subspecies the differences are average rather than absolute.

(a) *Key for identification of superfamilies and families of Oriental Rodents.*

G. L. M., Greatest length of mandible.

O. N. L., Occipitonasal length of skull.

1(4). Angular process of lower jaw never distorted outwards and situated below the lower incisor root.

2(3). Lower cheek-teeth 3 in number, except in genus *Dryomys* (subfamily Muscardininae, family Muscardinidae) where it is four ; molars cuspidate laminate, prismatic or flat-crowned.

...Superfamily SCIUROIDEA.

...Superfamily MUROIDEA.

3(2). Lower cheek-teeth 4 in number ; molars having excessively wrinkled pattern or cusps at each corner.

...Superfamily HYSTRICOIDEA

...(Family SCIURIDAE).

4(1). Angular process of lower jaw specialized by distortion outwards and situated outwardly to lower incisor root ; lower cheek-teeth 4 in number and flat-crowned.

...(Family HYSTRICIDAE).

(b) *Key for identification of families and subfamilies of the Superfamily Muroidea.*

1(8). Lower cheek-teeth 3 in number ; molars cuspidate, laminate or prismatic in pattern.

...Family MURIDAE

2(3). Lower cheek-teeth prismatic in pattern and generally evergrowing: lower m_2 never bilaminate.

...Subfamily *MICROTINAE*

3(2). Lower cheek-teeth not prismatic and rooted.

4(7). Lower cheek-teeth biserially cuspidate or laminate.

5(6). Cusps arranged side by side ; lower m_2 always bilaminate, separated by a fold on each side.

...Subfamily *GERBILLINAE*

6(5). Cusps alternately arranged ; lower m_2 having more than one fold on each side.

...Subfamily *CRICETINAE*

7(4). Lower cheek-teeth triserially cuspidate or laminate ; outer row of cusps may be vestigeal ; lower m_2, except in genus *Nesokia*, having some trace of original front lamina, *i.e.*, trilaminate.

...Subfamily *MURINAE*

8(1). Lower molars generally flat-crowned ; folds isolating as islands on crown surface.

9(10). Lower cheek-teeth 3 in number ; G.L.M. over 25 mm. ; lower incisor root forming prominent knob on outer side of condylar process.

...Family RHIZOMYIDAE

10(9). Lower cheek-teeth 3 or 4 in number, G.L.M. under 25 mm. ; lower incisor root not forming prominent projection.

... Family MUSCARDINIDAE

(c) *Key for identification of genera, species and subspecies of subfamily Microtinae (family Muridae).*

1(2). Lower cheek-tooth row under 1/3rd of G.L.M. ; molars rooted and not having any closed triangle on the crown surface ; lower incisor root forming prominent knob on outer side of condylar process ; G.L.M. over 20 mm.

...Genus *Ellobius* Fischer
(*E. fuscocapillus* Blyth)

2(1). Lower cheek-tooth row over 1/3 of G. L.M. ; G.L.M. under 20 mm. ; molars rootless and generally having one or more closed triangles on its crown surface.

3(4). First lower molar having one (third triangle) or no closed triangle on its crown surface.

...*Hyperacrius wynnei* Blanford

4(3). First lower molar having three or more closed triangles on its crown surface.

5(8). Lower m_1 normally with three closed triangles ; maximum width of mandible over 8 mm

... Genus *Pitymys* McMurtrie

6(7). Lower m_1 having five inner and four outer folds ; root of lower incisors not prominent.

...*Pitymys sikimensis* Hodgson

7(6). Lower m_1 having four inner and three outer folds ; root of lower incisors prominent, forming knob on outer side of condylar process.

...*Pitymys leucurus* Blyth

8(5). First lower molar normally with four or five closed triangles ; maximum width of mandible under 8 mm.

...Genus *Alticola* Blanford

9(10). Maximum width of mandible over 45 per cent of G. L. M. ; mandibular length under 60 per cent of O. N. L.

...*Alticola roylei roylei* Gray

10(9). Maximum width of mandible under 45 per cent of G. L. M. ; mandibular length over 60 per cent of O. N. L.

...*Alticola stracheyi* Thomas
...*Alticola bhatnagari* Biswas & Khajuria

(d) *Key for identification of genera, species and subspecies of subfamily Gerbillinae (family Muridae).*

1(8). Molars biserially cuspidate ; cusps symmetrically arranged ; mandibular length under one-half of O. N. L.

2(5). G. L. M. over 20 mm. ; maximum width under one-half of G. L. M. ; diastema over 1/4th of G. L. M.

...Genus *Tatera* Lataste

3(4). Maximum width over 46 per cent of G. L. M.
... *Tatera indica indica* Hardwicke

4(3). Maximum width generally under 46 per cent of G. L. M.
...*T. indica cuvieri* Waterhouse
...*T. indica ceylonica* Wroughton
...*T. indica hardwickei* Gray

5(2). G. L. M. under 15 mm.

...Genus *Gerbillus* Desmarest

6(7). Maximum width over one-half of G. L. M. ; diastema under 1/4th of G. L. M. and less than root-length of lower molars.

...*Gerbillus nanus nanus* Blanford
...*Gerbillus dasyurus indus* Thomas

7(6). Maximum width under one-half of G. L. M. ; diastema over 1/4th of G. L. M. and more than root-length of lower molars.

...*Gerbillus gleadowi* Murray

8(1). Molars laminate ; laminae always jointed.

...Genus *Meriones* Illiger

9(14). Mandibular length over one-half of O. N. L. ; maximum width over one-half of G. L. M. ; lower diastema length less than root-length of lower molars.

10(11). Coronoid process stout and higher than condylar process.

...*Meriones hurrianae* Jerdon

11(10). Coronoid process weak and in level with condylar process.

12(13). G. L. M. over 20 mm. ; root-length of lower molars over 5 mm.; lower diastema length over 1/4th of G. L. M.

...*Meriones libycus erythrourus* Gray

13(12). G. L. M. under 20 mm. ; root-length of lower molars under 5 mm. lower diastema length under 1/4th of G. L. M.

...*Meriones crassus swinhoei* Scully

14(9). Mandibular length under one-half of O. N. L. ; maximum width under one-half of G. L. M. ; lower diastema length more than root-length of lower molars.

...*Meriones persicus persicus* Blanford
...*Meriones persicus baptistae* Thomas

(e) *Key for identification of genera, species and subspecies of subfamily Cricetinae (family Muridae).*

1(3). Lower m_1 having two folds on each side.

...Genus *Calomyscus* Thomas

2(4). Mandibular length under 50 per cent of O. N. L. ; lower diastema length under 1/4th of G. L. M.

...*Calomyscus bailwardi* Thomas

3(1). Lower m_1 having three inner and two outer folds.

...Genus *Cricetulus* M. Edwards

4(2). Mandibular length over 50 per cent of O. N. L. ; lower diastema length over 1/4th (30 per cent) of G. L. M.

...*Cricetulus migratorius fulvus* Blanford

(f) *Key for identification of species and subspecies of genus* Rattus *(subfamily Murinae, family Muridae).*

1(6). Mandibular length over 50 per cent of O. N. L. ; maximum width over 50 per cent of G. L. M.

2(3). G. L. M. over 25 mm. ; root-length of lower molars over 7·5 mm.

...*R. bowersi mackenziei* Thomas

3(2). G. L. M. under 25 mm. ; root-length of lower molars under 7·5 mm.

4(5). Lower diastema length more than root-length of lower molars.

...*R. manipulus manipulus* Thomas

5(4). Lower diastema length less than root-length of lower molars.

...*R. rattus arboreus* Horsfield

6(1). Mandibular length under 50 per cent of O. N. L. ; maximum width under 50 per cent of G. L. M.

7(8). G. L. M. over 20 mm., diastema length over 1/4th of G. L. M.

...*R. rajah surifer* Miller

8(7). G. L. M. under 20 mm.

9(10). Maximum width under 8·1 mm. or under 47 per cent of G. L. M. ; root-length of lower molars under 5 mm.

...*R. cutchicus siva* Thomas

10(9). Maximum width over 8·5 mm. or over 47 per cent of G. L. M., root-length of lower molars over 5 mm.

...*R. fulvescens* Gray

(g) *Key for identification of species and subspecies of genera* Bandicota *and* Nesokia *(subfamily Murinae, family Muridae).*

1(2). Lower molars laminate ; m_2 generally devoid of antero-external cusp ; mandibular length over 63 per cent of O. N. L.

...Genus *Nesokia* Gray
(*N. indica indica* Gray & Hardwicke)
(*N. indica huttoni* Blyth)

2(1). Lower molars triserially cuspidate, with tendency to form transverse laminae ; antero-external cusp present in m_2 ; mandibular length under 64 per cent of O. N. L.

...Genus *Bandicota* Bechstein

3(4). Mandibular length on an average, over 60 per cent of O. N. L. ; lower m_1 and m_2 devoid of heel or last cusp.

...*Bandicota bengalensis* Gray
(*B. bengalensis bengalensis* Gray
B. bengalensis kok Gray
B. bengalensis wardi Wroughton
B. bengalensis varius Thomas)

4(3). Mandibular length on an average, under 60 per cent of O. N. L. ; lower m_1 and m_2 generally having the heel.

...*Bandicota indica* Bechstein

5(6). G. L. M. under 30 mm. ; maximum width over 60 per cent of G. L. M.

...*Bandicota indica savilei* Thomas

6(5). G. L. M. over 30 mm. ; maximum width on an average, under 60 per cent of G. L. M.

...*Bandicota indica indica* Bechstein
...*Bandicota indica nemorivaga* Hodgson

(h) *Key for identification of genera, species and subspecies of family Rhizomyidae.*

1(4). G. L. M. over 40 mm. ; maximum width of mandible on an average over 67 per cent of G. L. M.; lower incisor root not reaching the top of condylar process.

...Genus *Rhizomys* Gray

2(3). G. L. M. over 50 mm. ; mandibular length over 70 per cent of O. N. L. ; maximum width under 70 per cent of G. L. M.

...*Rhizomys sumatrensis cinereus* MacClelland

3(2). G. L. M. under 50 mm. ; mandibular length under 70 per cent of O. N. L. ; maximum width over 70 per cent of G. L. M. (one exception out of 5 mandibles).

...*Rhizomys pruinosus* Blyth

4(1). G. L. M. under 40 mm. ; maximum width of mandible on an average under 67 per cent of G. L. M. ; lower incisor root generally reaching the top of condylar process.

...Genus *Cannomys* Thomas
(*C. badius badius* Hodgson
C. badius pater Thomas
C. badius castaneus Blyth)

(i) *Key for identification of genera and species of family Muscardinidae.*

1(2). Lower cheek-teeth 4 in number ; cuspidate ; angular process generally perforated (Ellerman, 1940).

...Genus *Dryomys* Thoma)
(*D. nitedula picta* Blanfords

2(1). Lowet cheek-teeth 3 in number ; flat crowned ; ridges, on wearing, isolate on crown surface ; angular process not perforated.

...Genus *Platacanthomys* Blyth
(*P. lasiurus* Blyth)

(j) *Key for identification of three genera of family Sciuridae.*

1(2). Lower molars complex and excessively wrinkled, lacking large central depression characteristic of other genera ; maximum width over 65 per cent of G. L. M. ; root-length of lower molars over 35 per cent of G. L. M.

... Genus *Petaurista* Link
(*P. petaurista* Pallas
P. magnificus Hodgson
P. alborufus Milne-Edwards)

2(1). Lower molar pattern not complex and with a large central depression ; maximum width under 65 per cent of G. L. M. ; root-length of lower molars under 35 per cent of G. L. M.

3(4). Mandibular length under 60 per cent of O. N. L. ; maximum width under 55 per cent of G. L. M.; lower diastema-length under 1/5th of G. L. M.

...Genus *Funambulus* Lesson

4(3). Mandibular length over 65 per cent of O. N. L. ; maximum width over 55 per cent of G. L. M. ; lower diastema-length over 1/5th of G. L. M.

...Genus *Marmota* Blumenbach
(*M. bobak himalayana* Hodgson)

(k) *Key for identification of species of genus* Funambulus *(family Sciuridae).*

1(2). G. L. M. over 24 mm. ; maximum width under one-half of G. L. M.

...*F. tristriatus* Waterhouse
(*F. tristriatus tristriatus* Waterhouse)
(*F. tristriatus wroughtoni* Ryley)

2(1). G. L. M. under 24 mm. ; maximum width (except in *F. palmarum kelaarti*) on an average, over one-half of G. L. M.

3(4). G. L. M. under 20 mm. ; root-length of lower molars under 6·3 mm.

...*F. sublineatus* Waterhouse

4(3). G. L. M. over 20 mm. ; root-length of lower molars over 6·3 mm.

...*F. pennanti* Wroughton
...*F. palmarum* Linnaeus
(*F. palmarum palmarum* Linn.
F. palmarum kelaarti Layard
F. palmarum robertsoni Wroughton
F. palmarum bellaricus Wroughton
F. palmarum brodiei Blyth)

(l) *Key for identification of species of genus* Hystrix (*family Hystricidae*).

1(2). G. L. M. over 100 mm. ; mandibular length over 60 per cent of O. N. L.

...*Hystrix indica* Kerr

2(1). G. L. M. under 90 mm. ; mandibular length under 60 per cent of O. N. L.

...*Hystrix hodgsoni subcristata* Swinhoe

IV—SKULL MODIFICATIONS IN RELATION TO ECOLOGY

(a) *General*

The ecology of rodents may now be considered in relation to the modifications in skull-structure. Only those habits are dealt with which are expected to influence the skull.

Our knowledge of the ecology of oriental rodents is relatively scanty. Short accounts have been given by Jerdon (1874), Blanford (1888), Finn (1929), Ogilvie (1949), Phillips (1935), Prater (1948), Roonwal (1949), Prasad (1954), Prakash (1956-60) and Khajuria (1962). The present author also had an opportunity to study some aspects of the ecology and biology of the Desert Gerbil, *Meriones hurrianae*, in the field ; an account of it is presented separately.

(b) *Summary of ecology of various genera of Oriental Rodents*

In the following brief review only those habits such as those connected with feeding, locomotion (*e.g.*, arboreal, saltatorial, fossorial), etc., which are likey to produce a modification in skull-structure, are touched upon.

1. Family MURIDAE

Subfamily *GERBILLINAE*

Gerbils are burrowers and move in a series of leaps. They are generally herbivorous and feed mainly on seeds and grains.

1. **Tatera indica** Hardwicke

Habits : Nocturnal. Lives in subterranean burrows dug by themselves in soft, sandy soil. Burrows are long and may be shallow or deep; these consist of a central chamber and one or more exits.

Food : Feeds mainly on grains and seeds but also relishes rhizomes, grass-leaves and flowers ; occasionally insectivorous.

2. **Meriones hurrianae** Jerdon

Habits : Diurnal. Lives in desert and semi-desert areas. Extensive burrower ; burrows long and shallow or deep ; dug in soft sandy soil, specially by means of fore- and hind-claws.

Food : Prefers seeds and grains ; also roots, stems, leaves and flowers occasionally insectivorous. Feeds on hard nuts and grains by gnawing and extracting the kernel.

3. **Meriones persicus** Blanford

Habits : Nocturnal. Burrows found beneath rocks on grass mountain sides.

Food : Feeds mainly on grains.

4. **Gerbillus nanus** Blanford

Habits : Nocturnal. A burrower ; the numerous burrow holes meet with beneath bushes on sand dunes.

Food : Consists of seeds, roots, stems and leaves.

Subfamily *MICROTINAE*

The Microtinae are mainly burrowers and live in high altitudes. They feed on coarse vegetable substances.

5. **Pitymys sikimensis** Hodgson

Habits : Diurnal. Found in high altitudes (2000—5000 metres) ; inhabits grasslands, rocks and forests ; burrows medium-sized, having several exits and covered with thick vegetation.

Food : Feeds on green vegetable matter ; takes grains with its entire husk or removing very little of it.

6. **Alticola roylei** Gray

Habits : Found at elevations of 3000 metres where they live in open uplands and rocky ground covered with coarse grass.

Food : Hard diet of coarse grasses and roots.

7. **Ellobius fuscocapillus** Blyth

Habits : Highly fossorial.

Subfamily *MURINAE*

8. **Bandicota indica** Bechstein

Habits : Nocturnal. Lives in large burrows dug deep in the soft and damp soil.

Food : Feeds on grains, seeds, fruits, tuberous roots, succulent shoots and the bark of certain shrubs.

9. **Bandicota bengalensis** Gr. & Hardw.

Habits : Nocturnal. Burrows fairly long (15-20 metres) ; dug in gardens and pastures or in cultivated fields.

Food : Chiefly feeds on grains (of paddy), considerable hoards of which are found in their burrows ; this also serves as food in off season.

10. **Nesokia** Gray

Habits : Extensive burrower ; burrows deep (*ca.* 60 cm.) and long, having several false galleries, generally dug in gardens and cultivated fields.

Food : Feeds on grasses, roots, herbs and grains.

11. **Chiropodomys gliroides** Blyth

Habits : Arboreal.

12. **Rattus manipulus** Thomas (*vide* Roonwal, 1949)

Habits : Common in oak scrub. It is a rat of the open country with essentially ground and burrowing habits—this being indicated by its small eyes.

Food : Consists of vegetable (grasses) and animal (insects and earthworms) matter.

12*a*. Other species of rats are generally omnivorous.

2. Family RHIZOMYIDAE

13. **Rhizomys** Gray
and
14. **Cannomys** Thomas

Habits : Nocturnal. Extensive burrowers ; excavate deep burrows with their powerful teeth and claws, under bamboo thickets at high altitudes on mountains or in open grass covered ground. Slow in movement and weak of sight.

Food : Feed mainly on roots and young shoots of bamboo and grasses. Also take other vegetable products and grains such as Indian corn, rice, etc.

3. Family MUSCARDINIDAE

Subfamily *PLATACANTHOMYINAE*

15. **Platacanthomys lasiurus** Blyth

Habits : Diurnal. Arboreal ; lives exclusively in large, old trees in which it hollows out little cavities, filling them with leaves and moss.

Food : Feeds on jack-fruit (*Artocarpus*) and pepper ; also fond of toddy.

4. Family SCIURIDAE

16. **Petaurista** Link

Habits : Nocturnal. Arboreal ; leaping from one tree to another, or generally gliding swiftly downwards from the tree top up to a distance of 10—80 metres. Usual roosting in a tree-hole or any sheltered place among branches.

Food : Feeding on fruits, nuts, young twigs, shoots, leaves and bark of trees, also on insects and their larvae.

17. **Petaurista magnificus** Hodgson

Habits : Lives on high altitude (2000—3000 metres).

Food : Feeds on acorn, chestnuts and other hard fruits.

18. **Funambulus** Lesson

Habits : Diurnal. Arboreal ; lives in forests and near human habitation ; swift runners ; making astonishing leaps from one branch to another. Makes nests of fibrous matter in branches of trees.

Food : Feeds on nuts, seeds, fruits, buds, flowers and young bark ; occasionally on insects.

19. **Marmota** Blumenbach

Habits : Diurnal. Strictly terrestrial ; burrowing extensively in the ground. Burrows deep and confined to high levels of Himalayas and the highlands above 4000 metres.

Food : Feeds on herbs and roots.

5. Family DIPODIDAE

20. **Jaculus** Erxleben

Habits : An active leaper and travelling at great speed by hind-limbs good burrower ; burrows deep ; avoids mountainous country.

Food : In captivity, feeds on wheat, rice, maize, other herbage raw potatoes and grains.

6. Family HYSTRICIDAE

21. **Hystrix** Linnaeus

Habits : Nocturnal. Lives in rocky caves or in extensive burrows on hill-sides, banks of rivers and tanks or in old mud walls. Burrows often large and deep. Possesses a keen sense of smell ; not a fast runner ; gnaws its way out through wooden traps.

Food : Feeds on vegetables, various sorts of roots, bark, garden crops (pea and carrot) and fruits like pineapple, jack-fruit, tuberous roots, sweet potatoes, etc. ; possesses the curious habit of gnawing dry bones, horns and elephant tusks.

(*c*) *Effect of ecology on skull-structure*

1. *General remarks*

Habits and habitats have considerable influence on the external structure of animals and, to a lesser extent on the internal parts, especially the skeleton. In the latter case, the limb-bones are more affected and the skull rather less. Here an attempt has been made to correlate ecology with skull-structure in oriental rodents. It appears that in rodents it is the food and the general locomotary habits (*e.g.*, arboreal, fossorial and saltatorial) which have mainly influenced skull-structure. A few earlier accounts about the ecological effect on the structure of rodents are by Dublin (1903), Shimer (1903), Lull (1917), Hinton (1926), Winge (1941) Ellerman (1956), Petter (1961) and Tilak (1961-62).

Rodents generally subsist on two varieties of food, *viz.*, (i) nuts, grains, seeds, flower-buds and fruits, which they eat by gnawing and crushing ; and (ii) plant-parts like roots, stems and leaves, which they eat by simple cutting and chewing. These two types of food and their mode of eating appear to have modified the dentition and skull-musculature and the latter, in turn, has modified skull-structure.

For convenience, changes in skull-structure are dealt with here under the following three categories :—

(i) Changes in dentition : (*a*) Incisors. (*b*) Molars.

(ii) Changes due to musculature.

(iii) Changes due to locomotary habits.

2. *Changes in dentition*

INCISORS : The incisors undergo two types of modifications in rodents : First, due to food-habits, and secondly, due to fossorial (digging) habits.

Rodents like *Funambulus* and *Petaurista* (Sciuridae), *Chiropodomys* (Murinae) and *Platacanthomys* (Muscardinidae), which subsist on hard-shelled nuts and fruits, *Tatera*, *Gerbillus* and *Meriones* (Gerbillinae), *Rattus* (several species) and *Bandicota* (Murinae), which feed mainly on seeds and grains, all eat by gnawing. They extract the kernel from hard nuts and grains by means of the incisors which have become much thicker than wide, and this feature helps in piercing through the hard food. Such animals generally have opisthodont (backwardly curved) or orthodont (straight) incisors which are better adapted mechanically to resist the powerful thrust of the lower incisors by which the chief work of gnawing is performed. In *Marmota* (Sciuridae), *Rhizomys* and *Cannomys* (Rhizomyidae), *Rattus manipulus* and *Nesokia* (Murinae), *Alticola*, *Pitymys* and *Ellobius* (Microtinae) and *Hystrix* (Hystricidae), which feed mainly on plant parts like roots, stems and leaves, the incisors have become slightly broader and chisel-shaped. Incisors of this type are better adapted for cutting the soft part of plants than for gnawing seeds. Here the cutting edges are sharp and brought into greater play.

In cases where the incisors assist in digging, they become proodont (directed forward) as compared to orthodont and opisthodont incisors in the arboreal and the ground-dwelling forms. This feature is seen to a certain extent (Text-fig. 10) in *Marmota* (Sciuridae), *Rattus manipulus*, *Bandicota bengalensis*, *Nesokia* and *Pitymys* and is much more pronounced in *Rhizomys cinereus*, *Cannomys*, *Hystrix*, *Ellobius*, etc. In fossorial forms like *Rhizomys pruinosus*, *Nesokia indica*, *Alticola*, and *Atherurus*, though the incisors are orthodont the premaxillae are protruded anteriorly and probably serve the same purpose as proodont incisors thougn to a lesser extent. Since the work falls more on the proodont incisors during digging, they are liable to undergo rapid attrition. To repair this damage, their pulps have become more active and deep-rooted, so much so that in extreme cases like *Cannomys* (Rhizomyidae) and *Ellobius* (Microtinae) the roots have become extended posteriorly upto the second upper molars whereas normally they end anterior to the molars.

Consequently, the lower incisors have also become long and deep-rooted ; the root extending posteriorly and becoming projected in the form of a prominent knob beside the condylar process (Text-fig. 8). This is less so in *Rattus manipulus*, *Bandicota* and *Rhizomys* and more so in *Nesokia*, *Cannomys* and *Ellobius*—in *Cannomys* the knob reaches the height of the condylar process. In *Hystrix*, although the incisor-roots are deep and posteriorly reach the condylar process, they do not form any outward projection due to the outward distortion of the angular portion of the mandible.

MOLARS : It is easier to crush the kernel of nuts and seeds, flowers, and fruits than to chew the bark of trees, roots, stems and leaves. In the former case mere pressure between the tooth-rows accompanied

by oblique motion is sufficient for the reduction of food. The brachyodont (low-crowned), tuberculate and rooted molars are best adapted for this purpose.

Chewing coarse food makes considerable and ever increasing demands upon the molars, and the old, normal method of mastication had slowly to be changed. Simple crushing no longer suffices for the reduction of food and is gradually replaced by shearing and slicing. Low-crowned, tuberculate teeth which are admirably adapted for the first use (crushing), had to be transformed into tall-crowned (hypsodont) structures fitted for the new purpose. Mere pressure between the tooth-rows, accompanied by a transverse and oblique motion of the lower jaw, had to be replaced by a powerful gliding stroke from behind forwards. In some forms such as *Rhizomys*, *Cannomys* (Rhizomyidae), *Hystrix* (Hystricidae), etc., the uneven surfaces of the primitive tuberculate teeth in the upper and lower molars, have become flat due to the reduction of the main tubercles and are overlaid with transverse folds. In other forms such as *Meriones* (Gerbillinae) and the subfamily Microtinae, they are replaced by a series of cutting blades (laminae or prisms) which shear with each other effectively as the lower jaw is pulled forwards and upwards. Step by step as the food has increased in harshness, the rate at which the substance of the teeth is wasted by attrition becomes more rapid. In compensation, the crowns of the teeth become progressively taller (hypsodont) their dentinal pulps and enamel organs more vigorous and more continually active, until at last in the highest forms the molars, like the incisors, have acquired the power of persistent growth.

In *Funambulus* and *Petaurista* (Sciuridae), *Chiropodomys* and *Rattus* (Murinae), and *Cricetulus* and *Calomyscus* (Cricetinae), the molars are brachyodont, rooted, and cuspidate, and are best adapted for crushing grains and seeds. In *Platacanthomys* (Muscardinidae), which subsists on soft diet of fruits, etc., the molars are brachyodont and flat-crowned. In *Tatera* and *Gerbillus* (Gerbillinae) and *Bandicota* (murinae), the molars have slightly taller crowns and the cusps soon fuse to form transverse laminae. In *Rhizomys* and *Cannomys* (Rhizomyidae) the molars are slightly hypsodont and rooted. But since these forms subsist on coarse plant parts, the crown surface has become flat and is overlaid with transverse folds which gradually wear away with age. In *Nesokia* (Murinae), *Meriones* (Gerbillinae), *Alticola* and *Pitymys* (Microtinae), *Atherurus* and *Hystrix* (Hystricidae), which mainly subsist on roots, stems, leaves, etc., the molars have become hypsodont. In *Atherurus* and *Hystrix* they are flat-crowned, having transverse folds over the surface ; in *Nesokia* and *Meriones* the crown surfaces are laminate, and in *Alticola* and *Pitymys*, they are prismatic. In the last two genera the molars have acquired the power of persistent growth.

As an adaptation to the greater need of surface for mastication, the cheektooth rows have increased in length in *Marmota* (22-25 per cent of the occipitonasal length), *Nesokia* (18-22 per cent), *Cannomys* (20-25 per cent), *Pitymys* (22-25 per cent), *Hystrix* (20-23 per cent), etc., as compared to *Platacanthomys*, *Funambulus*, *Chiropodomys*, *Rattus*, *Atherurus*, etc., (under 20 per cent of O. N. L.) which eat their food mainly by gnawing, and thus require less mastication.

Changes in skull due to hypsodont (tall-crowned) molars : The increased height of the molar crowns have necessarily led to the enlargement of the alveolar capsules in which the teeth are developed and supported. In *Meriones* and *Nesokia* the alveolar capsules are slightly enlarged and the portion of maxillae supporting the teeth have become stout. In *Rhizomys*, *Cannomys*, *Alticola*, *Pitymys* and *Hystrix*, the alveolar capsules are much swollen and, in the upper jaw, rise up in the floor of the orbit so that the optic formaina, etc., are much reduced. In the Microtines, the median suture between the maxillae and palatine bones has disappeared.

3. *Changes due to musculature*

The first Rodents probably subsisted on the kernel of hard-shelled seeds or nuts. The nuts would be too large to be cracked by the cheek-teeth, and this difficulty probably induced the habit of gnawing which modified the masticatory muscles and the incisors. For gnawing, the incisors must be driven with great force so as to enable the lower incisors to act against the upper. During this process the most effective muscles will be those which will be nearest to the incisors and which raise the lower jaw and move it forward and backward—*i.e.*, the masseter, the temporalis and the digaster muscles.

The masseter is divisible into two main layers, *viz.*, a superficial layer and a deep layer. In the Eocene Sciuromorph, *Paramys* (Matthew, 1910 ; Romer, 1945) the origin of the masseter is wholly behind the infraorbital foramen and confined over the zygomatic arch. During the course of evolution the masseter has become more and more horizontal in position. It has extended its origin forward from the zygomatic arch to the region in and around the infraorbital foramen so as to gain a strong attachment on the side of the muzzle in advance of the orbit, thus giving increased leverage to the incisors ; and posteriorly extending its area of insertion on the lower jaw upto the tip of angular process. This change has resulted in the forward and backward movement of the mandible.

The temporalis muscle which is less useful in gnawing, receeds to the lateral wall of the cranium. It is secondarily developed in rodents whose masticatory habit is well developed. The digaster, which originates from the paroccipital process of the skull, anteriorly shifts its attachment from the middle of the lower edge of the mandible (in *Funambulus*) to its anterior symphysis (in voles). Thus, by becoming more horizontal it helps in the forward and backward movement of the mandible. In fossorial rodents the muscles over the occiput, which are responsible for the movement of the head, are fairly well developed.

Such is the course of evolution of the masticatory muscles in oriental rodents. Out of these, the masseter and the temporalis are the principal muscles which mould skull-structure, and they are, therefore, dealt with below in some detail.

THE MASSETER : (1) *Changes due to gnawing* :—The anterior extension of the masseter has been brought about differently in the three principal groups of rodents, as discussed below.

In the family Sciuridae the superficial layer of the masseter is extended forward on the outer side of the maxilla above the infraorbital foramen, and the deeper portion remains confined to the zygomatic arch so that no portion of the masseter passes through the foramen. The result is that the latter is very small and only transmits the infraorbital nerve.

In the Hystricidae the anterior deep part of the masseter which is fairly well developed, passes through the infraorbital foramen. It expands the foramen strongly, in form of a canal, forces the lower maxillary root of the zygomatic arch ventral to the foramen and the anterior edge of the orbit backwards, thereby shortening the orbito-temporal fossa. The superficial part of the masseter is attached over the lower maxillary root.

In the superfamily Muroidea the superficial layer of the masseter is extended over the zygomatic plate, and the deep layer passes through the infraorbital foramen, which becomes wide in form of a canal. In the family Rhizomyidae the anterior deep portion of the masseter passes through the infraorbital foramen and gets itself attached over the rostrum, but the foramen itself is situated above the zygomatic plate. This is, probably, due to the better development of the masseter on the upper jaw, externally and in front of the infraorbital foramen. This condition presses the lower outer wall of the foramen towards the inner, the two fusing together and thus displacing it upward. In the Platacanthomyinae (Muscardinidae) and the Muridae the masseter is strong. The superficial portion of it is clearly separated from the deep portion. The latter passes through the infraorbital foramen and gets itself attached over the rostrum. The upper portion of the foramen transmits the muscle and the lower portion the infraorbital nerve. Consequently, the upper portion is wider than the lower. Due to the pressure caused by the anterior deep masseter, the inner wall of the foramen has become thin.

Since the masseter is particularly strong anteriorly, it causes the zygomatic arch to become strongly built in front. Furthermore, since the most powerful parts of the masseter originate on the zygomatic process of the maxilla, the latter shows a greater tendency to increase than the jugal bone and forms a large part of the zygomatic arch. The jugal is pressed back, loses its former connection with the lacrymal (in Sciuridae) and becomes restricted to the posterior two-third portion of the zygomatic arch. To provide space for the attachment of the fairly well developed posterior superficial masseter in the anterior region, the lower maxillary root of the zygomatic arch projects anteriorly in the form of a zygomatic plate on either side of the rostrum.

Within the family Muridae, the murines (Murinae) such as *Rattus Bandicota* and *Nesokia* and the gerbils (Gerbillinae) generally feed on a mixed diet of grains and other vegetable substances, but prefer the former ; whereas voles (microtinae) feed exclusively on roots, stems, leaves, etc. To bite off the green part of plants requires less effort than to gnaw through the shells of nuts and grains. Therefore, the muscles responsible for gnawing, *i.e.*, the anterior portion of the masseter, which anteriorly occupy the external and internal surfaces of the infraorbital canal, are better developed in the murines and the gerbils and relatively less developed in the voles. The result is that in *Rattus*, *Bandicota* and

Nesokia (Murinae), and *Tatera, Gerbillus* and *Meriones* (Gerbillinae) the zygomatic plate is much more projected anteriorly than in the voles (Microtinae).

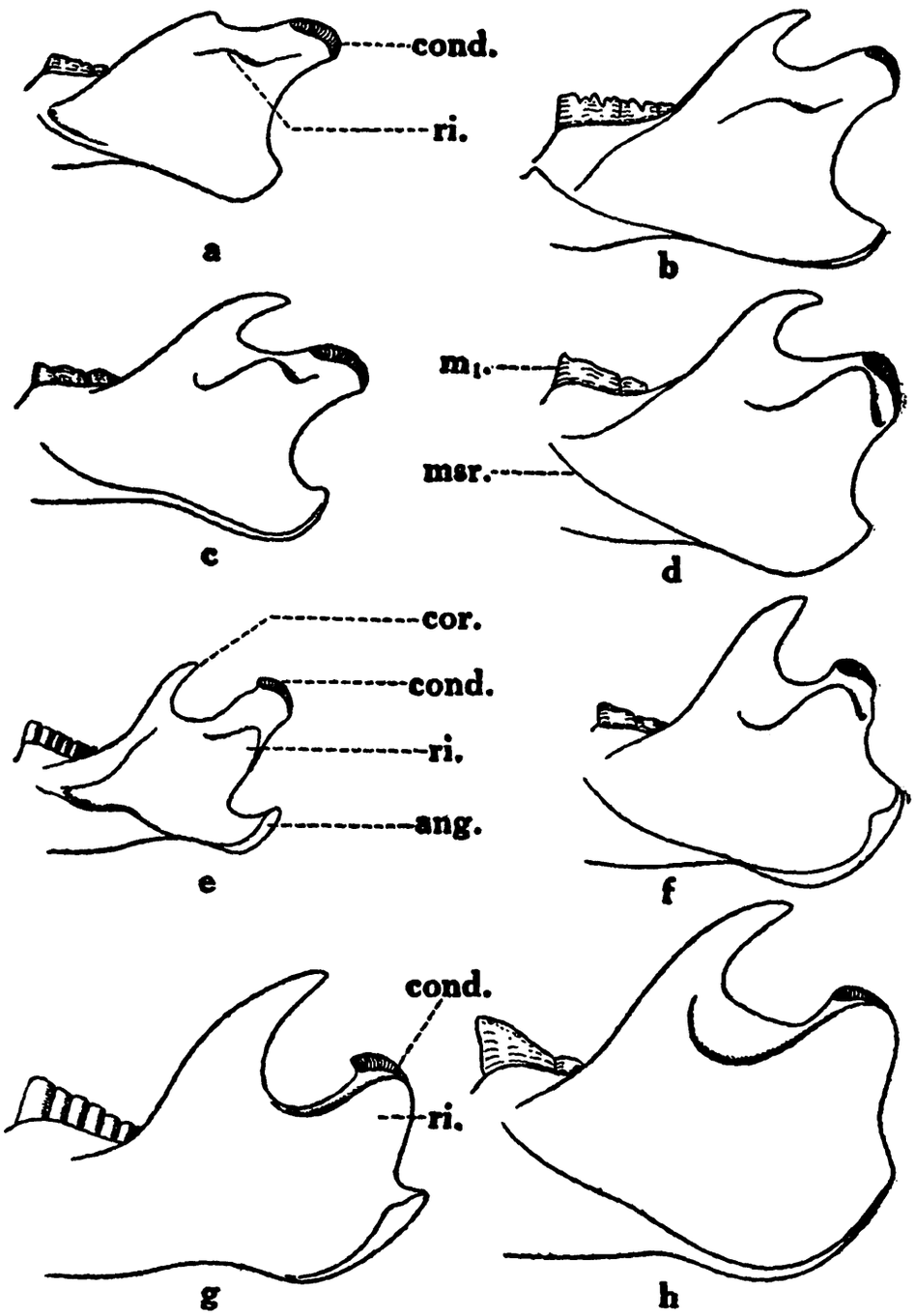
(ii) *Changes due to mastication* :—It is easier to crush the grains and kernel of seeds than to chew herbs and shrubs. The result is that the muscles which are helpful in mastication (such as the posterior portion of masseter and the temporalis) are less developed in the former than in the latter.

In *Funambulus* and *Petaurista* (Sciuridae), *Platacanthomys* (Muscardinidae), *Chiropodomys* and *Rattus* (Murinae), *Tatera* and *Gerbillus* (Gerbillinae), the posterior portion of the masseter is relatively less developed as they have to do less chewing work. Thereby, the zygomatic arch is less stout and the masseteric crest of the mandible feebly developed (also *vide* Pratt, 1943). In *Bandicota* and *Nesokia* (Murinae) and *Meriones* (Gerbillinae) which feed both on grains and coarse vegetable substances, the posterior portion of the masseter is moderately developed. In *Marmota* (Sciuridae), *Rhizomys* and *Cannomys* (Rhizomyidae) and the Microtines, the muscles are fairly well developed as they have to do more mastication work (these forms take in coarse substances like roots, stems and leaves). In consequence of this, the zygomatic arch is stout and the masseteric crest over the mandible prominent. In some cases, as in *Marmota*, the muscles leave a prominent scar on the zygomatic arch.

THE TEMPORALIS : In *Funambulus* and *Pataurista* (Sciuridae), *Platacanthomys* (Muscardinidae), *Rattus* (Murinae), *Calomyscus* (Cricetinae), *Tatera, Gerbillus* and *Meriones* (Gerbillinae) and *Jaculus* (Dipodidae) the temporalis muscle, which is less effective in gnawing and here little used for mastication, is reduced to a position on the lateral side of the cranium. Its point of insertion, the coronoid process of the mandible, is reduced likewise. In *Marmota* (Sciuridae), *Bandicota* and *Nesokia* (Murinae), *Hystrix* (Hystricidae), *Alticola, Pitymus* and *Ellobius* (Microtinae), *Rhizomys* and *Cannomys* (Rhizomyidae), the temporalis is fairly well developed in adaptation to the greater need for mastication and to certain extent due to fossorial habit. It is relatively less developed in *Bandicota* and *Nesokia* where it slightly ascends dorsally over the parietals, more developed in *Marmota, Rhizomys* and *Hystrix* where it meets with the fellow of the opposite side over the parietals, and most in *Cannomys* and *Ellobius* where this fusion extends forward upto the posterior half of the frontals. The temporal ridges, which give origin to the temporal muscles, likewise fuse to form the sagittal crest. In *Alticola* and *Pitymys* (Microtinae) the muscles are more developed anteriorly than posteriorly so that the temporal ridges form a median interorbital crest in the latter genus.

The squamosal bone, which gives origin to the greater part of the temporalis muscle, increases in size. Anteriorly it expands over the frontals and posteriorly it grows at the expence of the parietals and the interparietal, which, in their turn, become greatly reduced at the sides (Text-fig. 9), so much so that in *Rhizomys, Cannomys* (Pls. 34 & 36) and *Ellobius* the interparietal does not exist at all in the adult. In *Bandicota*

and *Nesokia* (Murinae) and *Cricetulus* (Cricetinae) though the interparietal is present, it is reduced at the sides. In *Alticola* and *Pitymys* (Microtinae) the squamosals posteriorly press the lateral extension of parietals and come in direct contact with the interparietal. In the Microtines the squamosals



TEXT-FIG. 8.—Outer side-view of posterior portion of left ramus of mandible of Oriental rodents showing lower incisor-root in arboreal and fossorial forms.

(*a*). *Chiropodomys gliroides.* (Muridae : Murinae.) (Arboreal.)
(*b*). *Rattus rattus arboreus.* (Muridae : Murinae.) (Terrestrial.)
(*c*). *Rattus manipulus manipulus.* (Muridae : Murinae.) (Moderately fossorial.)
(*d*). *Nesokia indica huttoni.* (Muridae : Murinae.) (Fossorial.)
(*e*). *Pitymys sikimensis.* (Muridae : Microtinae.) (Moderately fossorial.)
(*f*). *Rhizomys pruinosus.* (Rhizomyidae.) (Moderately fossorial.)
(*g*). *Ellobius fuscocapillus.* (Muridae : Microtinae.) (Fossorial.)
(*h*). *Cannomys badius badius.* (Rhizomyidae.) (Fossorial.)

ang., angular process ; *cond.*, condylar process ; *cor.* coronoid process ; *ml.*, first lower molar ; *ri.*, root of lower incisor.

anteriorly develop peg-like projections for the attachment of the temporalis muscle. The point of insertion of the muscle, *i.e.*, the coronoid process of the mandible, also becomes fairly well developed (Text-fig. 8) and stout (In this connection, also *vide* Washburn, 1947). Further, the muscle expands its point of insertion in the space between the cheek-teeth and the coronoid process. In *Hystrix* the coronoid process is small but stout.

The temporalis muscles have made room for themselves in the orbito-temporal fossa by driving the posterior portion of the zygomatic arches outwards and, wherever possible, by driving the eyes more forward. In arboreal squirrels, since the eyes are large and posteriorly guarded by the postorbital processes, the moderately developed temporalis muscles have made accommodation in the orbito-temporal fossa by pushing the zygomatic arches outwards (as in the forms where the muscles are fairly developed)—to a greater extent in *Petaurista* (Zygomatic width 64—69 per cent of O.N.L.) and to a lesser extent in *Funambulus* (zygomatic width 53—59 per cent). In the Hystricidae, since the orbito-temporal fossa is smaller, the temporalis muscle has made its way by slightly pressing the eye forward and making a temporal groove over the squamosal. In the Rhizomydae, the Microtinae, and the genera *Nesokia* (Murinae) and the *Marmota.* (Sciuridae), the highly developed temporalis muscle widens the temporal fossa by forcing the zygomatic arch more outwards (Zygomatic width in *Marmota* 60—64 per cent, *Nesokia* 63—69 per cent, *Rhizomys* 74—88 per cent, *Cannomys* 76—87 per cent, *Pitymys* 58—67 per cent and *Ellobius* 79 per cent of O. N. L.) and by compressing, the eye forward. The latter, being of less importance in fossorial forms, becomes reduced in size due to the combined pressure caused by the anterior deep masseter from the ventral side and the temporalis from the posterior, against the zygomatic process of the maxilla. The subconical shape of skulls in fossorial forms is due to the greater width of the zygomatic arches at the posterior end than at the anterior. This, in turn, is due to the smaller eyes at the anterior end and the fairly well developed temporalis muscles at the posterior, which push the zygomatic arches outward.

4. *Changes in skull due to locomotory habits*

Rodents have commonly adapted themselves to three conditions of locomotory life, *viz.*, (i) arboreal and volant (climbing and flying); (ii) fossorial (digging) ; and (iii) saltatorial (jumping).

ARBOREAL AND VOLANT ADAPTATIONS: The members of the family Sciuridae (*Funambulus*, etc.), a few murids like *Chiropodomys* and *Vandeleuria* (Muridae) and *Platacanthomys* (Platacanthomyinae) are arboreal in habit and have modified themselves for climbing. Locomotion on the trees requires great agility and muscular co-ordination, which, in turn, demands the corresponding development of the brain. For active movement and for protection from enemies, good eye sight is essential. In consequence, such forms have developed large eyes and show considerable development of the brain, especially the cerebellar and optic portions. With the increase in vision there is a corresponding decrease in the sense of smell.

In the skulls large eyes and the temporal muscles have made room for themselves in the orbito-temporal fossa by pushing the zygomatic arches slightly outwards. Eyes may not be deflected from their position during climbing, and for this purpose the postorbital process in squirrels are developed from the frontals to support the large eyes from the posterior side. The arboreal murids seems to be not much adapted to that habit, and that is why the post orbital processes are not developed. To accommodate the large brain, the parietals have become slightly broader and higher, thereby increasing the capacity of the cranium (Table 36).

Petaurista has undergone a step farther and has adapted itself to volant life for which it has acquired a flying membrane or patagium. In the skull this adaptation is exhibited by a partial or complete fusion of bones (the sutures between the frontals, the parietals and the interparietal, and those between the basioccipital and the basisphenoid disappear) which gives greater regidity to the skull. The large, crepuscular eyes have made room for themselves by enlarging the orbits (Table 37), which, in turn, causes the flaring of the lateral edges of the frontal bones, thus producing prominent interorbital depression. Furthermore, the eyes have pressed the anterior portion of the jugal bones (lower margin of the orbit) slightly outwards so that this portion has become slightly circular. The eyes, here, are better protected and supported posteriorly than in *Funambulus*, by large postorbital processes arising from the frontals and corresponding processes from the jugal bones. The cranium is enlarged as in the other arboreal forms to accommodate the large brain (Table 36).

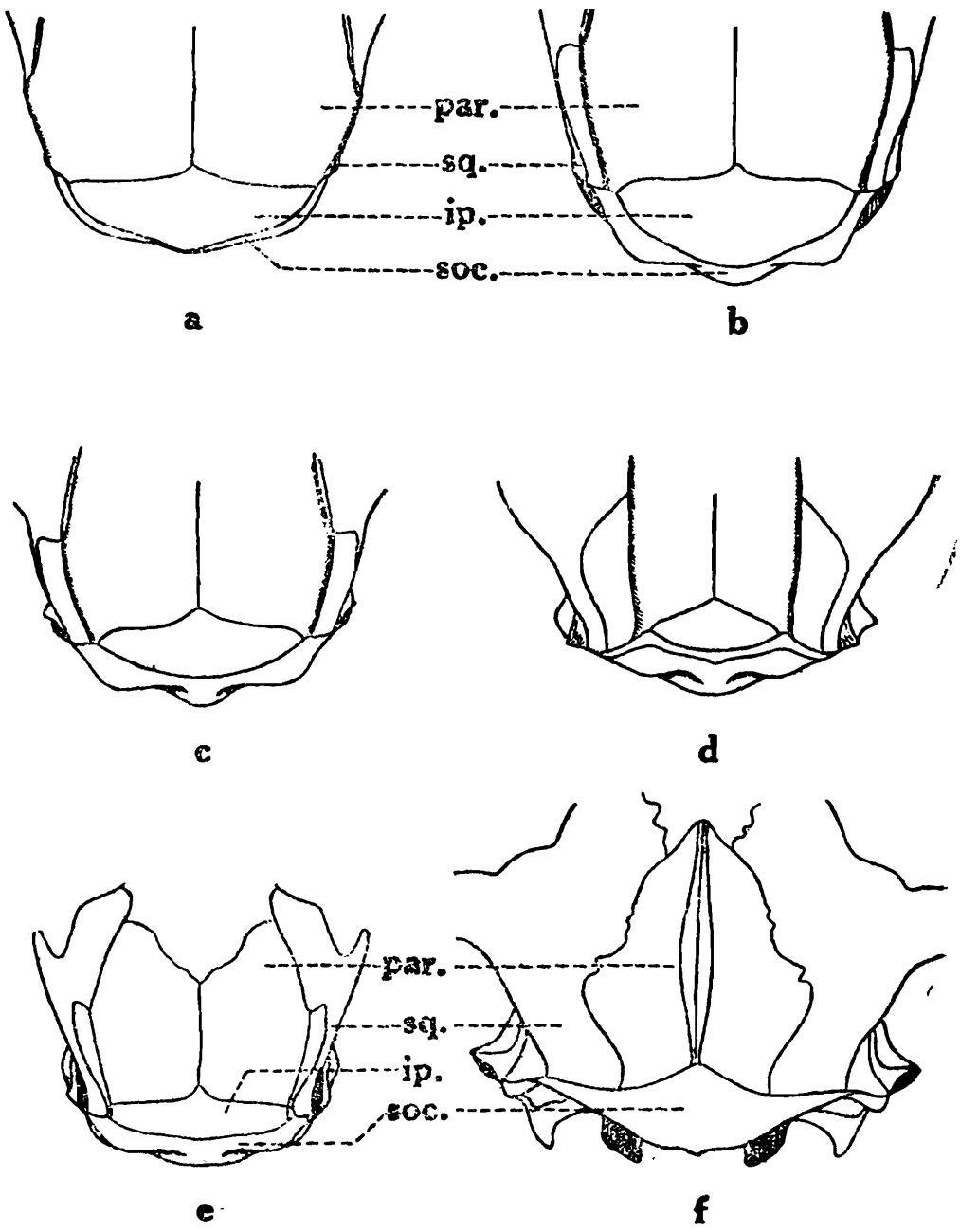
Since the squirrels live on trees having enough food all round, and the eyes are large enough to see it easily, the sense of smell is poorly developed. Thereby the nasal cavity, and consequently the nasals, are reduced in length (under one-third of the occipitonasal length) as compared to the ground-dwelling forms (over one-third of O. N. L.).

FOSSORIAL ADAPTATIONS : *Marmota* (Sciuridae), *Rhizomys* and *Cannomys* (Rhizomydiae), *Hystrix* (Hystricidae), *Cricetulus* (Cricetinae), *Bandicota* and *Nesokia* (Murinae), *Alticola*, *Pitymys* and *Ellobius* (Microtinae) are forms which are adapted to the fossorial mode of life. The degree of adaptation and the change of structure depends upon the degree to which the skull plays a role in the process of digging and the range of the period of fossorial life. Fossorial specialization had led to the reduction of eyes and external ears, the former through disuse and the latter due to hinderance in burrowing ; and to the shortening of the limbs and the tail, etc., the limb becoming powerfully clawed. Since the eyes are small, there is consequent development of the acuteness in the power of hearing.

To enable the incisors to be used underground for cutting roots, picking up seeds of grasses and for digging, these teeth have become proodont (forwardly directed) and more independent of the oral cavity and the snout. Thus, the mouth-cavity is more efficiently protected from the incoming earth and the nostrils from friction against the ground. The root of the incisors are extended further back into the jaws, affecting more and more the shape of the surrounding bones. The lower incisors

also become deep-rooted and project, in the form of a knob, beside the condylar process (Text-fig. 8).

To give support to proodont incisors, the premaxillae have become longer (Table 38 ; and Text-fig. 10). They become protruded anteriorly



TEXT-FIG. 9.—Dorsal view of posterior portion of skulls of Oriental rodents, showing the anterior shifting of interparietal bone from arboreal to fossorial forms.

(*a*). *Chiropodomys gliroides.* (Murinae : Muridae.) (Arboreal.)

(*b*). *Rattus rattus arboreus.* (Muridae : Murinae.) (Terrestrial.)

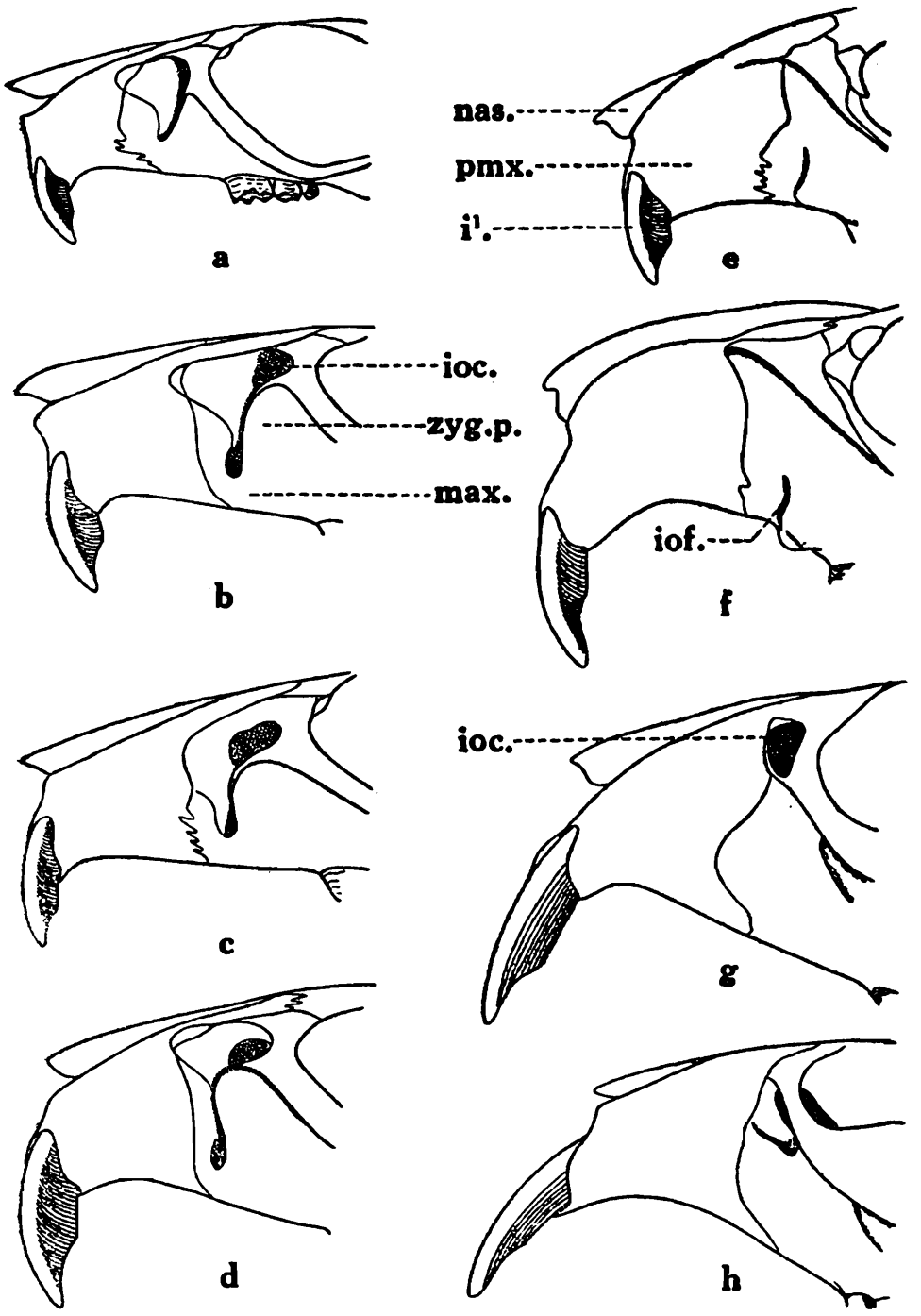
(*c*). *Rattus manipulus manipulus.* (Muridae : Murinae.) (Moderately fossorial.)

(*d*). *Nesokia indica huttoni.* (Muridae : Murinae.) (Fossorial.)

(*e*). *Alticola roylei roylei.* (Muridae : Microtinae.) (Moderately fossorial.)

(*f*). *Cannomys badius badius.* (Rhizomyidae.) (Fossorial.)

ip., interparietal ; *par.*, parietal ; soc., supraoccipital ; sq., squamosal.



TEXT-FIG. 10.—Lateral view of anterior portion of skulls of Oriental rodents, showing the forward projection of incisors from arboreal to fossorial forms.

(*a*). *Vandeleuria oleracea.* (Muridae : Murinae.) (Arboreal.)

(*b*). *Rattus rattus arboreus.* (Muridae : Murinae.) (Terrestrial.)

(*c*). *Rattus manipulus manipulus.* (Muridae : Murinae.) (Moderately fossorial.)

(*d*). *Bandicota bengalensis kok.* (Muridae : Murinae.) (Fossorial.)

(*e*). *Funambulus pennanti.* (Sciuridae) (Arboreal.)

(*f*). *Marmota bobak himalayana.* (Sciuridae.) (Moderately fossorial.)

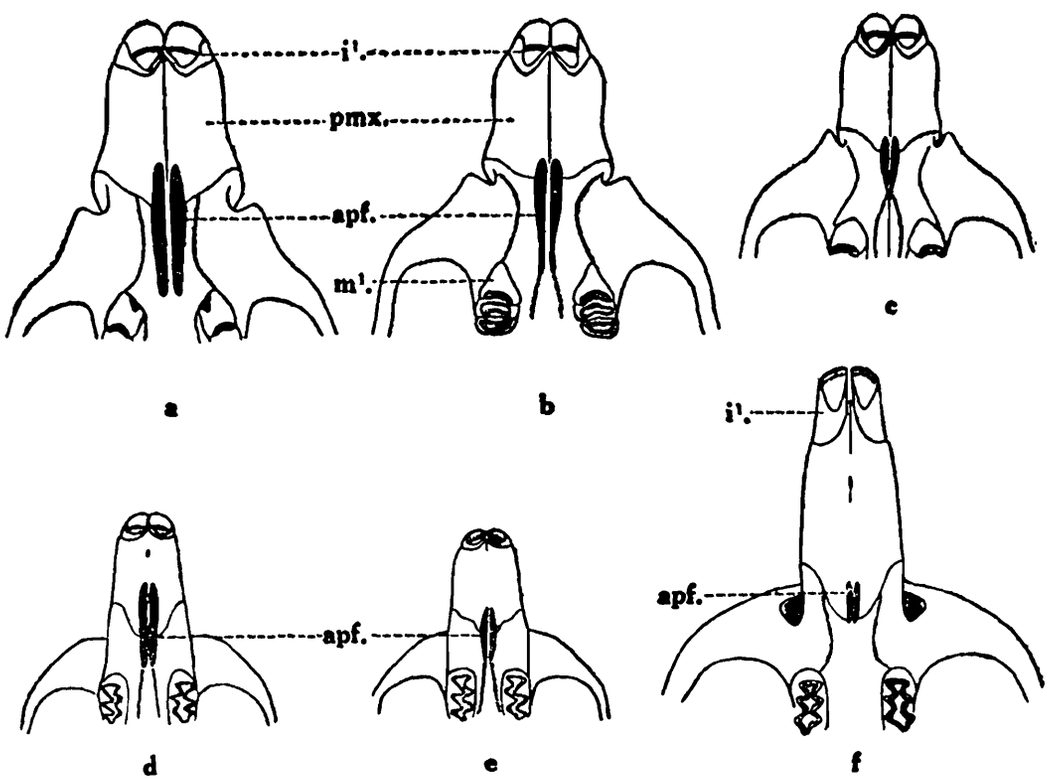
(*g*). *Cannomys badius badius.* (Rhizomyidae.) (Fossorial.)

(*h*). *Ellobius fuscocapillus.* (Muridae : Microtinae.) (Fossorial.)

(i^1)., upper incisor ; *ioc.*, infraorbital canal ; *max.*, maxilla ; *nas.*, nasal ; *pmx.* premaxilla zyg. p., zygomatic plate.

upto the tip of the nasals in *Marmota* ; slightly anterior to it in *Bandicota* and *Nesokia* (Murinae) ; and more so in *Rhizomys, Cannomys, Ellobius,* etc. With the increase in length of the premaxillae, the condylobasal length, the diastema and the palatal length are also increased. The result is that the condylobasal length, here, equals or exceeds the occipitonasal length as compared to the arboreal forms where the occipitonasal length exceeds the condylobasal length.

The anterior palatine foramina, which are long in the moderately fossorial rodents like *Rattus manipulus* (17—20 per cent of O. N. L.), *Bandicota indica* (16—20 per cent) and *Pitymys* (14—20 per cent) are reduced in the highly fossorial genera like *Nesokia* (9—13 per cent), *Cannomys* (6—12 per cent) and *Ellobius* (9 per cent, Ellerman, 1961). This reduction seems to be due to the pressure caused by the root of the upper incisors at the posterior end of the foramina. The transformation is clearly seen in Text-fig. 11. The foramina are equally broad at both ends in *Bandicota indica*, the posterior end has become fairly narrow in *Bandicota bengalensis* and is reduced from the posterior side in *Nesokia*. The gradual reduction is also seen from *Pityms* to *Ellobius*. This reduction may also be helpful in making the palatal portion stouter so as to support the long incisors.



TEXT-FIG. 11.—Ventral view of anterior portion of skulls of Oriental rodents, showing the reduction in size of the anterior palatine foramina from moderately to highly fossorial forms.

(*a*). *Bandicota indica indica*. Muridae : Murinae.) (Moderately fossorial.)
(*b*). *Bandicota bengalensis kok*. (Muridae : Murinae.) (Fossorial.)
(*c*). *Nesokia indica huttoni*. (Muridae : Murinae.) (Fossorial.)
(*d*). *Pitymys sikimensis*. (Muridae : Microtinae.) (Moderately fossorial.)
(*e*). *Hyperacrius wynnei*. (Muridae : Microtinae.) (Fossorial.)
(*f*). *Ellobius fuscocapillus*. (Muridae : Microtinae.) (Fossorial.)

apf., anterior palatine foramina ; *i.*, upper incisor ; *m'.*, first upper molar ; *pmx* premaxilla.

The rostrum has become dorso-ventrally as well as laterally compressed, so that it is somewhat more pointed than in the arboreal forms, and this feature helps in digging. The skull has become flattened and the occiput slopes forward due to the effect of using the head as a shovel. The sloping of the occiput provides more surface (Table 41) for the attachment of the muscles which move the head during digging. Where these muscles and the temporalis (responsible for mastication) are fairly well developed, as in *Marmota*, *Rhizomys* and *Cannomys*, there is formed a prominent lambdoidal crest.

Since the occiput is slanting anteriorly, the interparietal (which, in the arboreal and the ground dwelling forms like *Chiropodomys*, *Rattus rattus arboreus* (Murinae) and *Platacanthomys*, is situated behind a line joining the posterior extremity of the squamosals) comes to the anterior to it in the fossorial forms (Text-fig. 9) like *Bandicota* and *Nesokia* (Murinae), *Alticola* and *Pitymys* (Microtinae) and *Cricetulus* (Cricetinae). An intermediate condition is seen in *Rattus manipulus* where the interparietal is compressed and pushed anteriorly and nearly two-thirds portion of it has shifted anterior to the occiput. The interparietal disappears in *Rhizomys*, *Cannomys* (Pls. 34—36) and *Ellobius*, due to the joint pressure caused by the occiput from the posterior end and the temporalis muscles laterally.

Corresponding to the need for increased acuteness in the perception of the sound, the tympanic bullae become large and inflated. Such bullae probably help in resonating the sound vibrations. The bullae are small in the moderately fossorial forms like *Rattus manipulus* (14—15 per cent of O.N.L.), *Bandicota indica* (15—20 per cent) and *Rhizomys* (17—22 per cent) ; and larger in the highly fossorial genera like *Nesokia* (19—22 per cent), *Bandicota bengalensis* (20—24 per cent), *Cannomys* (21—27 per cent), *Alticola* (22—25 per cent) and *Pitymys* (22—30 per cent of O.N.L.).

The strong movements of the mandibular articulation during digging and chewing operations make the condylar process of the mandible press forcibly against the external meatus of the tympanic bone, thus modifying it and causing it to become spout-like and project slightly backward as in *Rhizomys* and *Cannomys* (Pls. 34—36).

In fossorial rodents there is a decrease in the length of nasals from less to highly fossorial forms, *viz.*, *Marmota* (41—43 per cent of O.N.L.), *Rattus manipulus* (38—42 per cent), *Rhizomys pruinosus* (36—41 per cent, mean, 39·2 per cent), *Bandicota indica* (33—41 per cent), *Cannomys* (34—39 per cent, mean 36·1 per cent), *Bandicota bengalensis* (28—34 per cent), *Nesokia* (25—32 per cent) and *Microtines* (under one-third of O.N.L.). It is difficult to offer any definite explanation for this tendency, but it seems to be an adaptation to digging habit, as anteriorly projected nasals will be a hinderance in burrowing and long nasals may have more chances of breakage than short ones. *Hystrix* (nasal length over 50 per cent of O.N.L.) is an exception.

Saltatorial and Desert Adaptations.—Deserts are characterized by open sandy areas and by scarcity of vegetation. To overcome these difficulties, the smaller mammals of those areas, like *Tatera*, *Meriones*

and *Gerbillus* (Gerbillinae) and *Jaculus* (Dipodidae), have acquired the leaping habit, acute power of vision and of sound perception, and the burrowing habit. This has resulted in the hindfoot becoming longer, the eyes and ears more developed, and both the limbs powerfully clawed. Although gerbils are both fossorial and saltatorial in habit, the former habit has the least effect on the form and structure of the skull since gerbils mainly dig by means of both pairs of limbs and not with the snout.

In the skull the saltatorial habit is reflected in the long and narrow rostrum which helps in quick progression during leaping. The tympanic bullae and the mastoids have become unusually large and inflated, evidently for better detection of sound in the open desert. As mentioned above, the inflated bullae probably acts as resonators and amplifiers of sound vibrations ; in addition, they may also be an aid in balancing while in active leap. The bullae (Table 39) are smallest in *Tatera*, slightly more developed in *Gerbillus*, *Meriones hurrianae*, *M. periscus* and *Jaculus*, and reach their maximum size in *Meriones swinhoe* and *M. erythrourus*. In the last two species the bullae and the external auditory meatus are so large and inflated that anteriorly they touch the zygomatic process of the squamosals and laterally they are extended more than the zygomatic arches, thus resulting in the maximum width of the skull.

The size and inflation of tympanic bullae seems to be correlated with desert conditions (Table 40). In *Tatera indica* (Gerbillinae), which is distributed throughout India (except Assam), Ceylon, Pakistan and Iran, there is a continuous decrease in the size of the bullae from Baluchistan (the desert region) eastward and southward (the non-desert regions). The same is true of *Gerbillus*. In *G. nanus* (Baluchistan) the bullae are slightly larger (30·5—32·8 per cent, mean 32·9 per cent, of O.N.L.) than in *G. indus* (Sind) (30·0—31·6 per cent, mean 30·7 per cent, of O.N.L.).

The mastoid is also inflated into an enormous structure. The inflation of the mastoids is less marked in *Tatera*, *Meriones hurrianae* and *M. persicus*, slightly more in *Gerbillus* (but they still do not project behind the occiput), and reaches its maximum in *Meriones erythrourus*, *M. swinhoe* and *Jaculus jaculus* where they are inflated into an enormous rounded chamber which extends laterally and posteriorly beyond the occiput.

The changes in the tympanic bullae and mastoids produce changes in the surrounding bones. The large size of the bullae has resulted in the narrowing of the basioccipital and the basisphenoid. The approximation of it anteriorly causes the reduction of the pterygoid fossae. Laterally the squamosals are pressed (reduced) and shifted dorsally, thereby causing slight reduction of the interparietal. The extent of reduction or narrowing of the bones depends upon the extent of enlargement of the tympanic bullae and the mastoids—it is least in *Tatera* and at its maximum in *Meriones swinhoe* and *M. erythrourus* (Plates 13, 20 and 21).

As earlier discussed, since the temporalis muscles are reduced in size, it provides more space to the enlarged eyes in the orbito-temporal fossa. Furthermore, in *Meriones hurrianae* (zygomatic width 55—61 per cent of O.N.L.), these organs (muscles and eyes) have made room by slightly pushing the zygomatic arches outwards. In *Jaculus jaculus* (Dipodidae) the anterior deep masseter muscle, which is particularly strong anteriorly, presses the large eyes posteriorly upon the lateral wall of the cranium which becomes membranaceous and conforms to the shape of the eyes. The zygomatic arches are pressed ventrally so as to provide more space to the enlarged eyes and to support them from the ventral side.

V—SUMMARY

1. This paper deals with the morphological structure of the skulls of 20 genera and 61 species and subspecies of rodents belonging to the following six families :—Muridae, Rhizomyidae, Muscardinidae, Sciuridae, Dipodidae and Hystricidae. All the species except two namely, *Jaculus jaculus* Linn. (family Dipodidae) and *Atherurus africanus* Gray (family Hystricidae), belong to the oriental region.

2. The skull, including the mandible, of one species of each genus is described in detail and the rest are relatively described. The description includes measurements, the morphological structure, skull foramina, etc., and is supported by illustrations.

3. The specific and subspecific differences in skulls have been pointed out, as far as possible. Keys for differentiating them have been given where such keys are either not available or differ materially from those given by earlier authors, particularly Ellerman (1947*a*,*b*).

4. The intra-subspecific variations, sexual variations and size correlations in skulls have been studied wherever possible.

5. Tentative keys for the identification of superfamilies, families, subfamilies, 20 genera and 60 species and subspecies of Oriental rodents based on mandible characters, are given.

6. The effect of ecology on the skull-structure of rodents is discussed.

7. The skull-structure is mainly influenced by food and locomotary habits (arboreal, fossorial and saltatorial). Food has modified the dentition and the skull-musculature, and the latter, in turn, has effected the skull-structure.

8. The incisors are thicker than wide in forms which feed on grains. They are broad and chisel shaped in herbivores for cutting the soft part of plants. To assist in digging the incisors become forwardly projected and deep-rooted. The lower incisor-root projects posteriorly in the form of a knob.

9. Normally, the molars are low-crowned, tuberculate and rooted and are best adapted for crushing the kernal of seeds and soft fruits. But in forms which chew the coarse vegetable substances, the molars have become tall-crowned, prismatic and have acquired the power of

persistent growth. The increased height of molar crowns has led to the enlargement of alveolar capsules and the strengthening of the maxillae.

10. In adaptation to the gnawing habit the masseter muscle has become more and more horizontal in direction for the forward and backward movement of the mandible. It has shifted its point of insertion anteriorly from the zygomatic arch to the portion in and around the infraorbital foramen. This shifting has taken place differently in the three major groups of rodents, *viz.*, Sciuromorpha, Hystricomorpha and Myomorpha, and likewise effected the shape of the infraorbital foramen and the surrounding bones. In Hystricomorpha and Myomorpha, where a portion of masseter passes through the infraorbital foramen, the latter becomes wide and takes the form of a canal. In the superfamily Muroidea, due to the strong development of the masseter over the zygomatic process of maxilla, the latter increases more than the jugal and forms a large part of the zygomatic arch. The jugal loses its connection with the lacrymals.

11. In forms where heavy mastication is required, the masseter and the temporalis muscles are fairly well developed. Consequently, the zygomatic arches become stout and the masseteric crest over the mandible becomes prominent. The temporal ridges ascend dorsally over the parietals and the frontals to form the sagittal crest. The squamosals, which provide the surface of attachment to the major portion of the temporalis muscles grow more at the expense of parietals and interparietal which in their turn, get reduced in size. The muscles have made room in the orbito-temporal fossa by driving the zygomatic arches outwards and compressing the eyes forward. The latter, being of less importance in the fossorial forms, become reduced. The point of insertion of the muscle, *i.e.*, the coronoid process of the mandible, becomes fairly well developed.

12. The arboreal rodents have developed prominent eyes and a large brain and have, in turn, enlarged the orbits and the cranium. The bones of the skull are fused to give greater rigidity.

13. In the fossorial forms incisors become projected forward for digging. The premaxillae become longer and protruded anteriorly to support the incisors. The rostrum becomes pointed and the anterior palatine foramina are reduced. The diastema, palate and condylobasa lengths increase. The occiput slopes forward and the interparietal is shifted anteriorly, to provide more surface for the attachment of muscles which move the head during digging. The tympanic bullae become inflated and large for acute perception of sound. The external auditory meatus becomes spout-like and backwardly projected.

14. The desert rodents have developed leaping habits and acute power of vision and sound perception. In the skull it is reflected by the long and pointed rostrum which helps in quick progression. The tympanic bullae and the mastoids become inflated for acute perception of sound. The inflation is also correlated with the desert condition. The enlargement of these have caused the reduction of the surrounding bones. The enlarged eyes are accommodated in the orbito-temporal

fossa due to the reduction of temporalis muscles, and further by slightly pushing the zygomatic arches outwards, and in some forms downwards.

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VII—ABBREVIATIONS USED IN PLATES

aef., anterior ethmoid foramen.

alc., alisphenoid canal.

alf., anterior lacerated foramen.

als., alisphenoid.

ang., angular process of mandible.

ang. f., fenestra in angular process.

ao., auditory orifice.

apf., anterior palatine foramen.

as. jug., ascending portion of jugal.

boc., basioccipital.

bsph., basisphenoid.

bul., tympanic bullae.

cf., condylar foramen.

cond., condylar process of mandible.

cor., coronoid process of mandible.

lp., foramen lacerum posterius.

fm., foramen magnum.

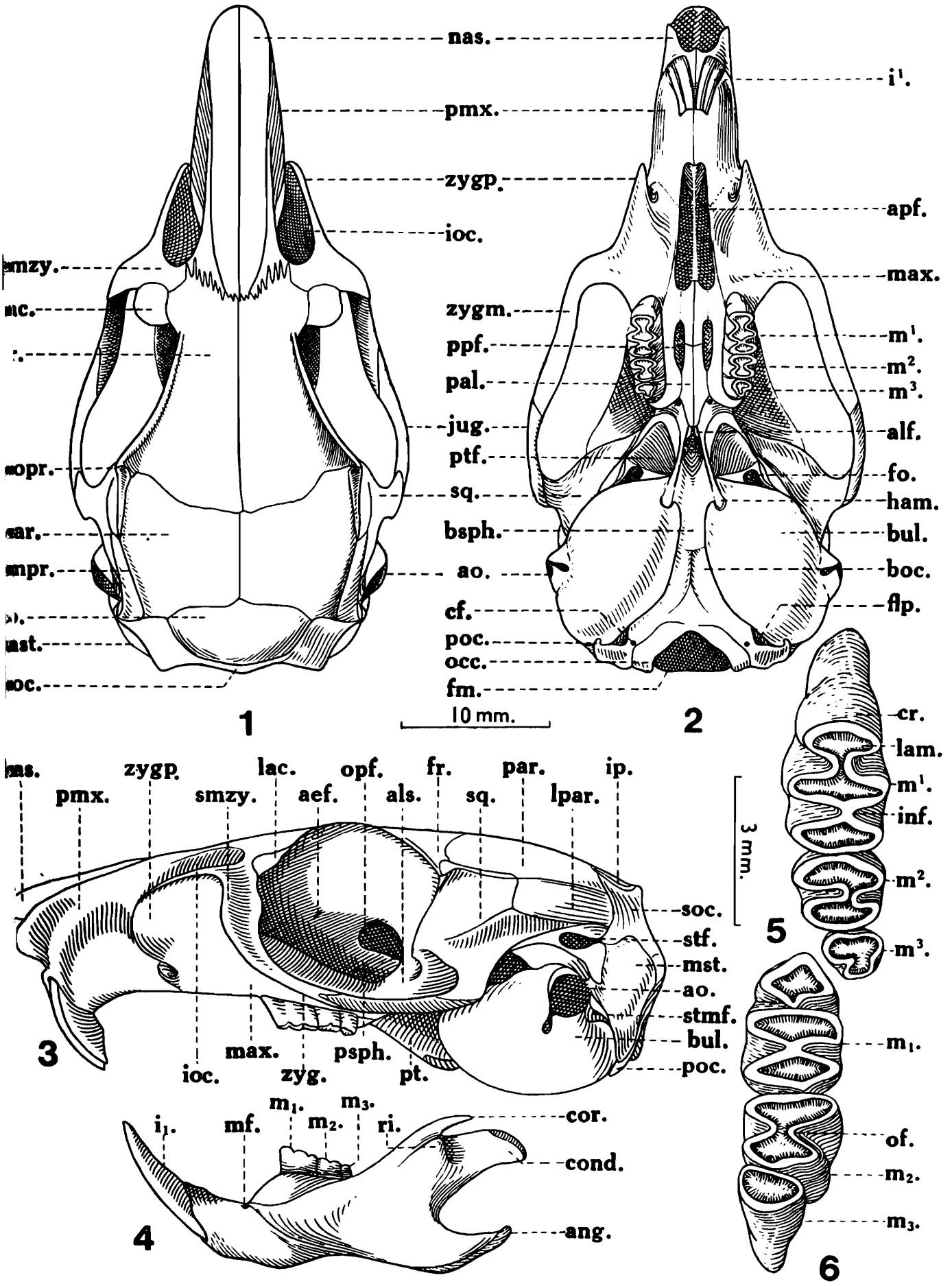
fo., foramen ovale.
pv., foramen for palatine vein.
fr., frontal.
ham., hamular process of pterygoid.
i^1, upper incisor.
ii_1, lower incisor.
inf., inner fold of molar tooth.
ioc., infra orbital canal.
iof., infra orbital foramen.
ip., interparietal bone.
jug., jugal bone.
lac., lacrymal.
lam., lamina of molar tooth.
m., molar tooth.
m^1-m^4., upper molar teeth ; first, second, third and fourth.
m_1-m_4., lower molar teeth ; first, second, third and fourth.
mst., mastoid.
msr., masseteric ridge of mandible.
max., maxilla.
mf., mental foramen.
nas., nasal bone.
occ., occipital condyle.
of., outer fold of molar tooth.
opf., optic foramen.
pal., palatine bone.
par., parietal.
par. r., parietal ridge.
pgf., postglenoid foramen.
pmx., premaxilla.
poc., paroccipital process.
popr., postorbital projection or process.
ppf., posterior palatine foramina.
ppp., posterior palatal pit.
psph., presphenoid.
pt., pterygoid.
ptf., pterygoid fossa.
i., root of lower incisor.
smzy., supramaxillary root of zygoma.
soc., supraoccipital.
sq., squamosal.
stf., supratympanic fenestra of squamosal.
stmf., stylomastoid foramen.
tmpr., temporal ridge.
zyg., zygomatic arch.
zyg. p., zygomatic plate or lower maxillary root of zygoma.
ygm., zygomatic process of maxilla.
y. sq., zygomatic process of squamosal.

PLATE 13

Tatera indica indica Hardwicke

Adult ♂, Z.S.I. Reg. No. 13164, Chaklala, Rawalpindi, Punjab, *ca.* 330 metres altitude, 10th July, 1921.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.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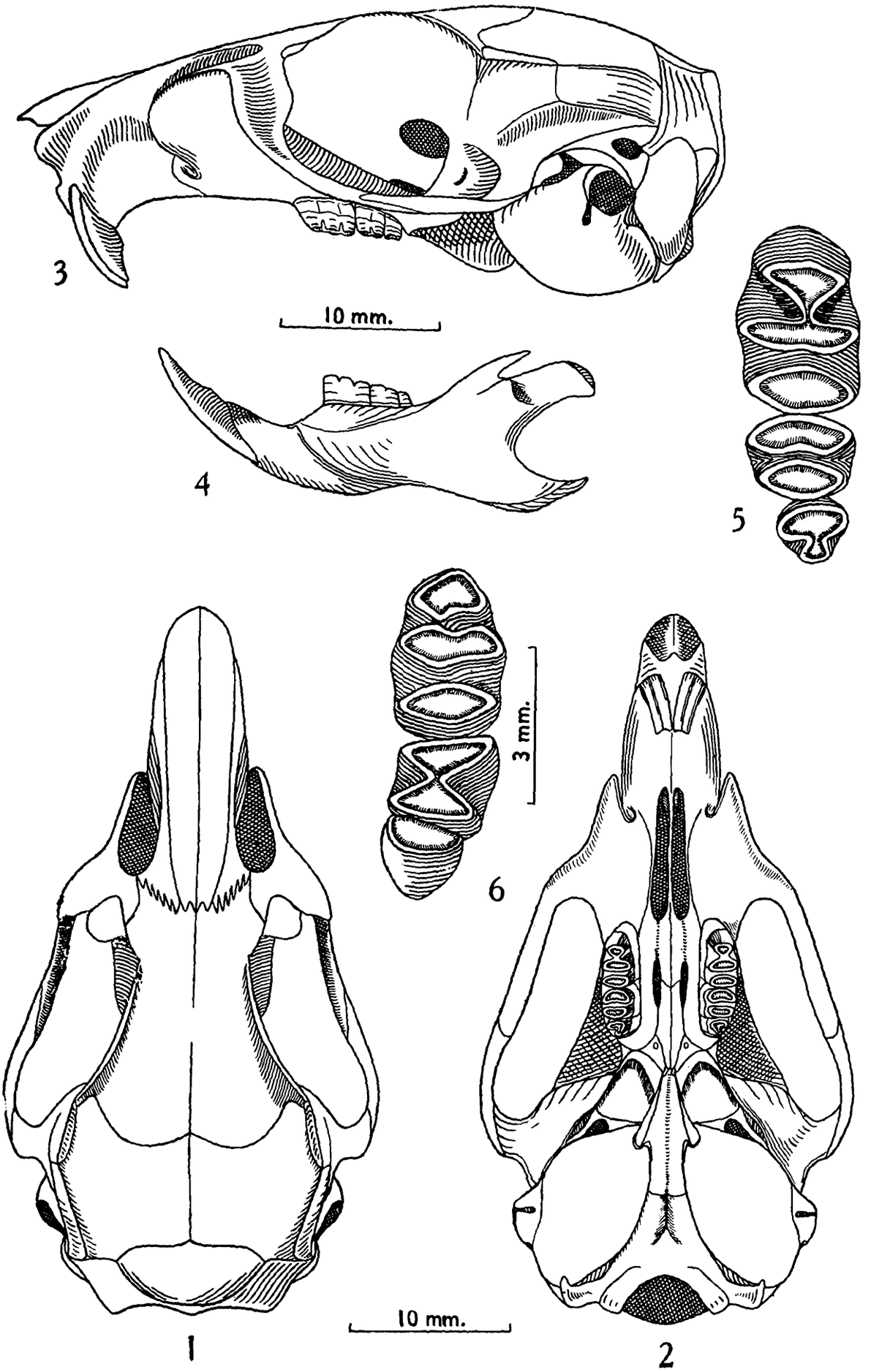
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PLATE 15

Tatera indica ceylonica Wroughton

Adult ♀, Z.S.I. Reg. No. 13214, Waligatta, South Province, Ceylon, 8th June, 1913.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.

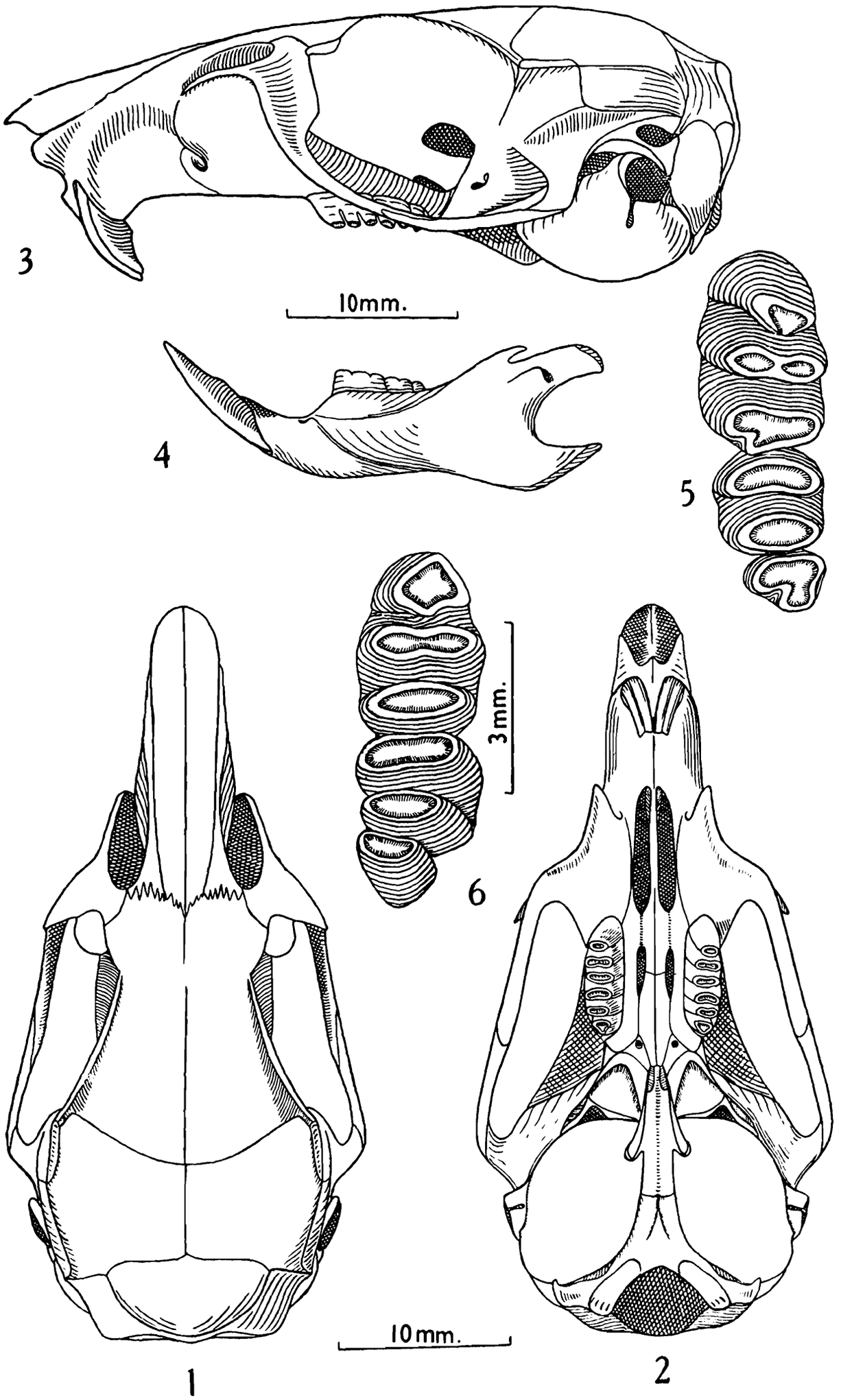
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PLATE 16

Tatera indica cuvieri Waterhouse

Adult ♀, Z.S.I. Reg. No. 13235, Cumbam, Madura, Madras, 28th May, 1917.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.

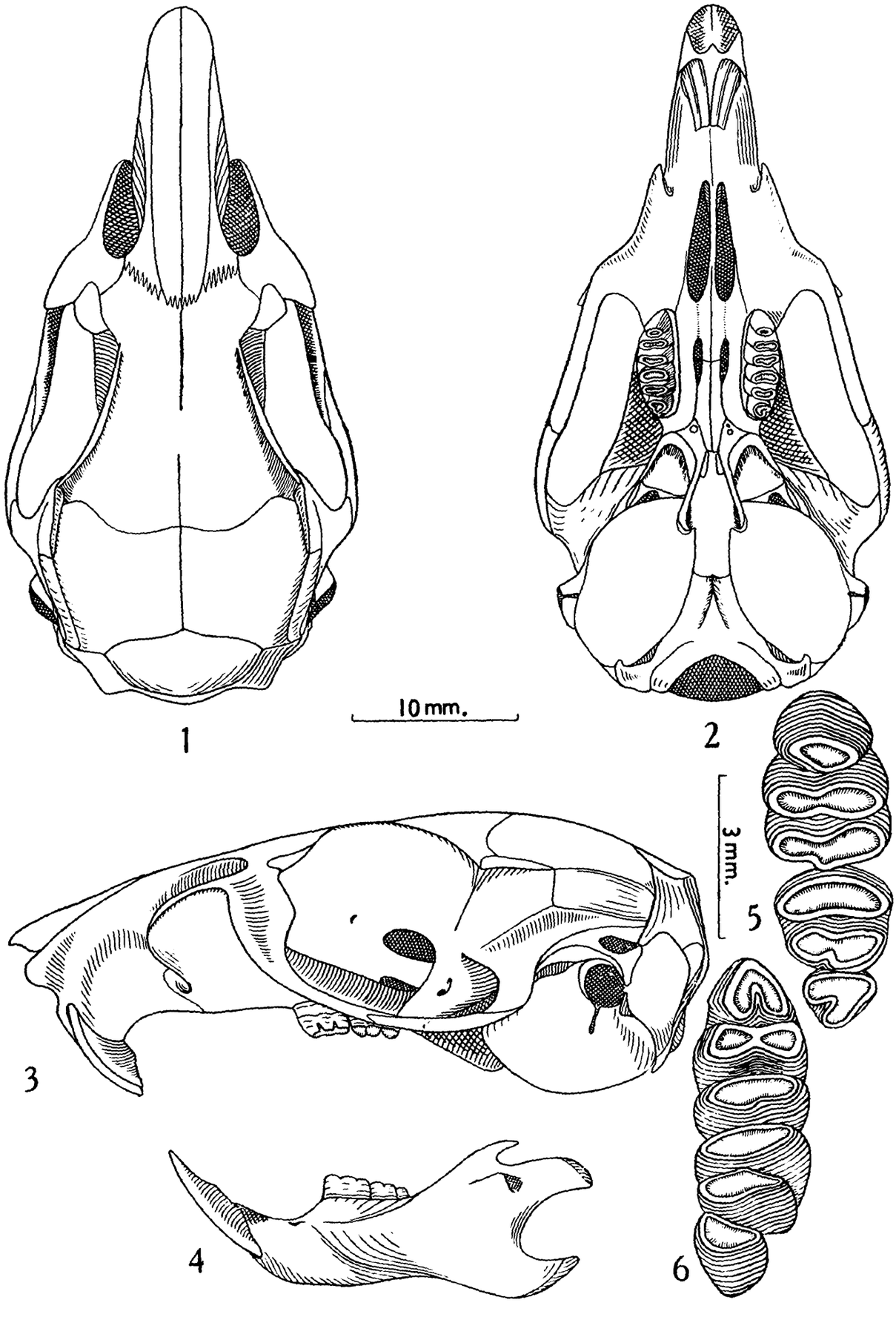
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PLATE 17

Meriones hurrianae hurrianae Jerdon

Adult ♀, Z.S.I. Reg. No. 13248, Dhangadhra, Gujarat, 22nd November, 1913.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.

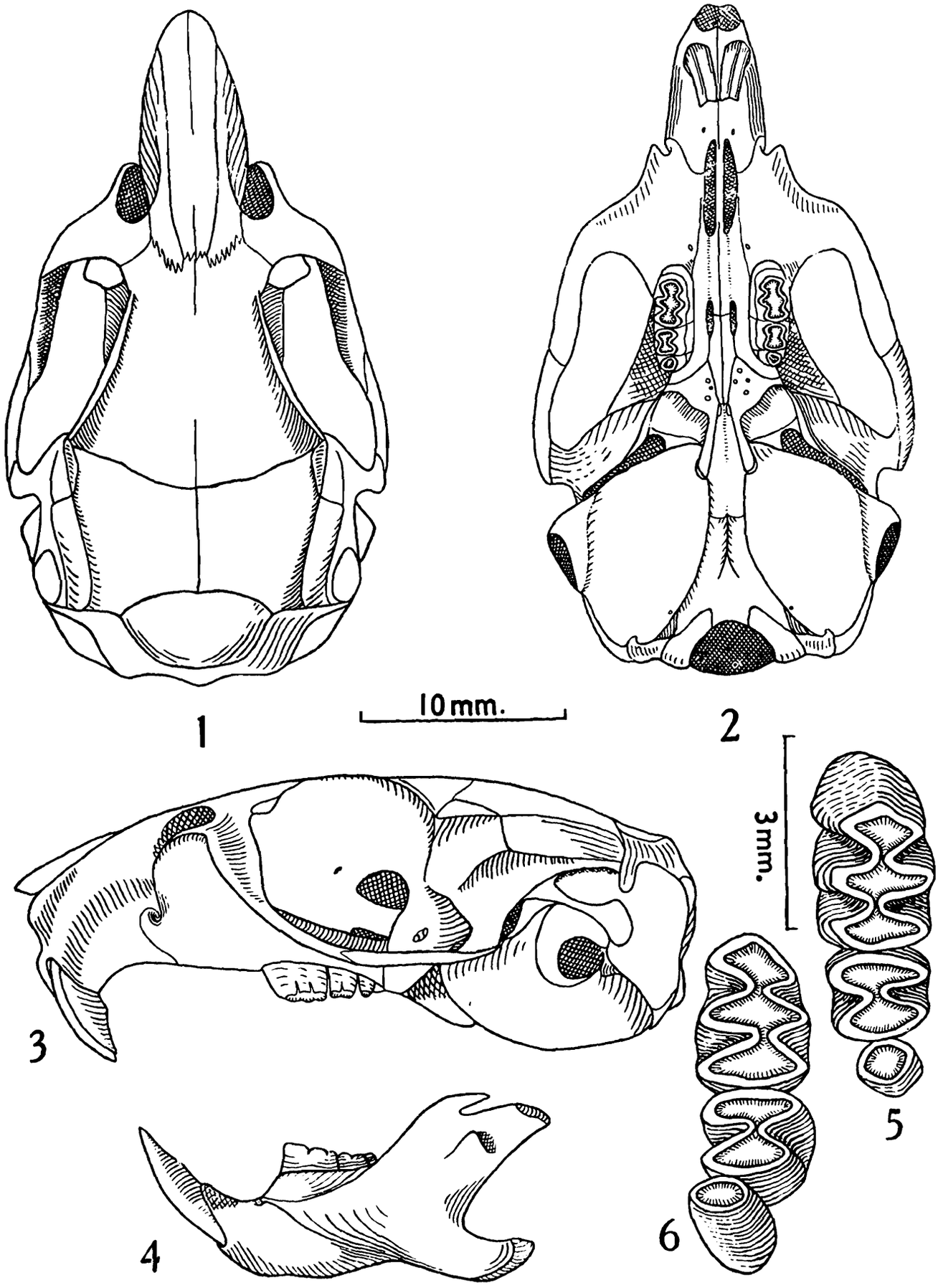
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PLATE 18

Meriones persicus persicus Blanford

Adult ♀, Mammal Survey Coll. No. 2410 (B.N.H.S), Kuh, Persia, 11th July, 1920.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.

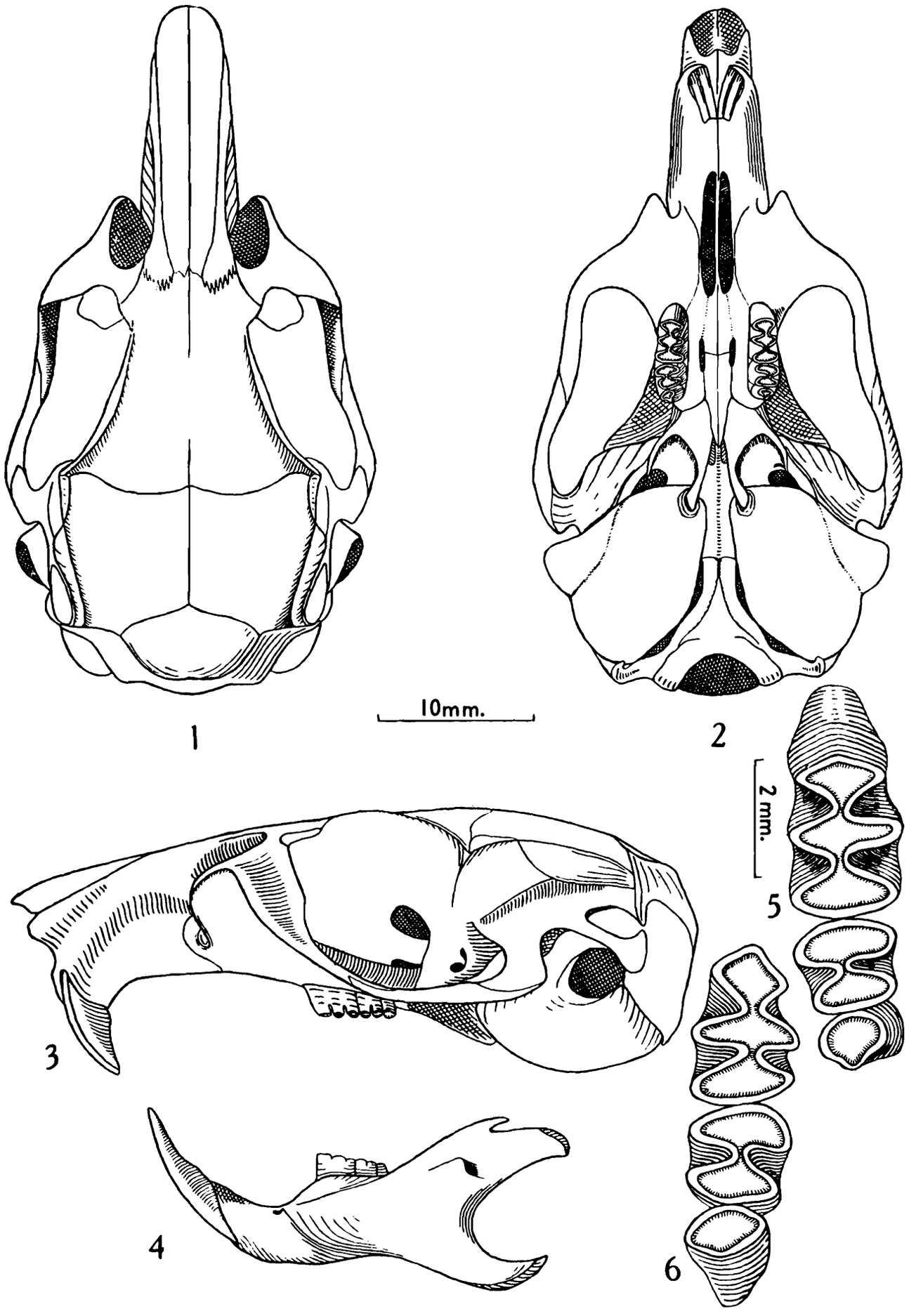
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PLATE 19

Meriones persicus baptistae Thomas

Adult ♂, Z.S.I. Reg. No. 13264, Kelat, Baluchistan, W. Pakistan, 4th August, 1917.

Fig. 1.—Dorsal view of skull (semidiagramatic).
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.

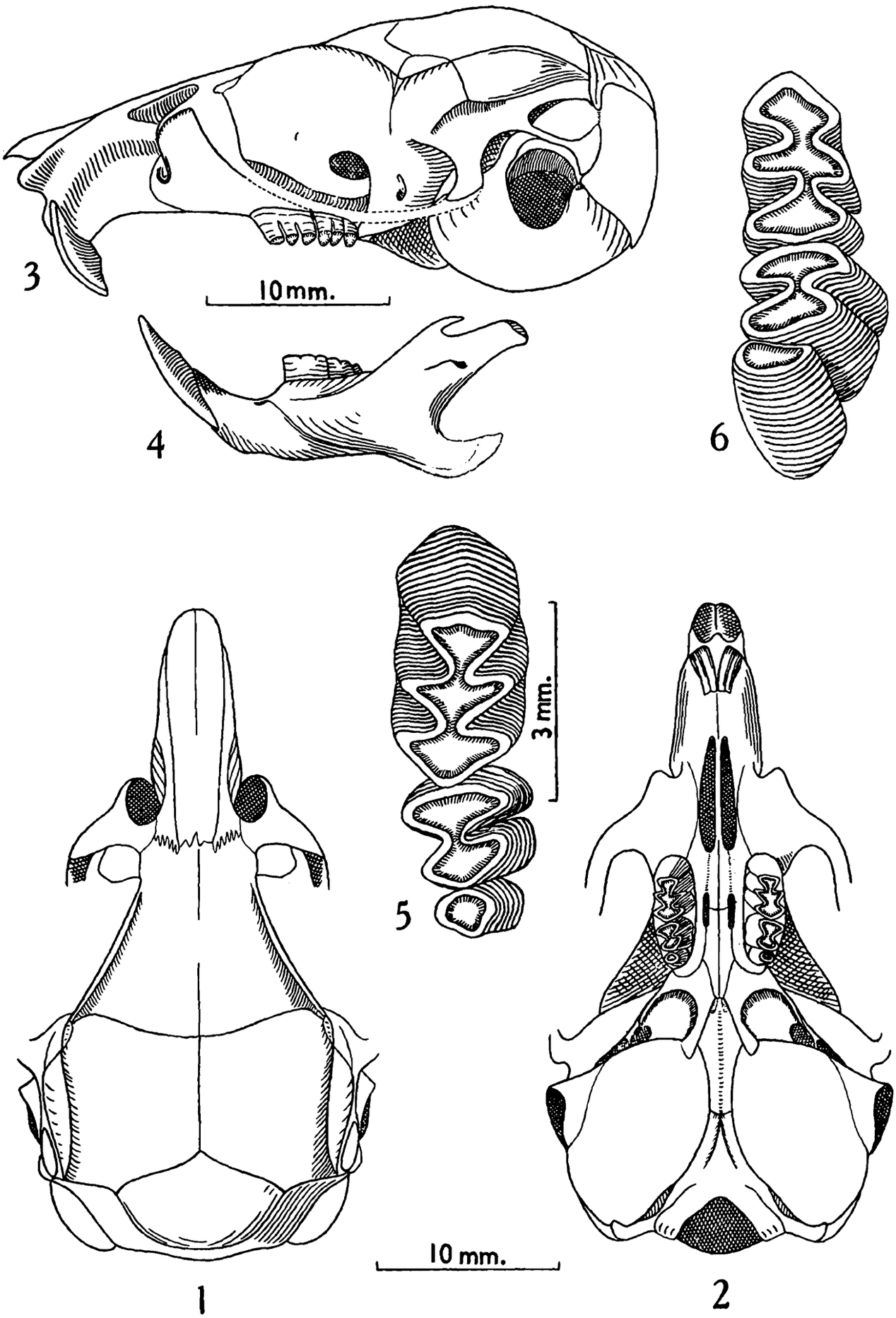
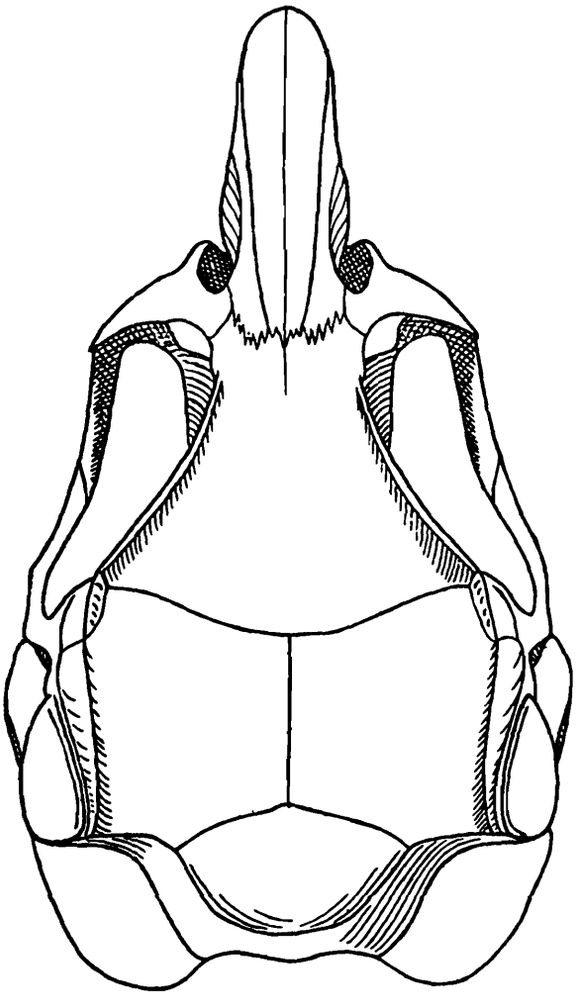

3
10 mm.
4
6
5
3 mm.
10 mm.
1
2

PLATE 20

Meriones crassus swinhoe Scully

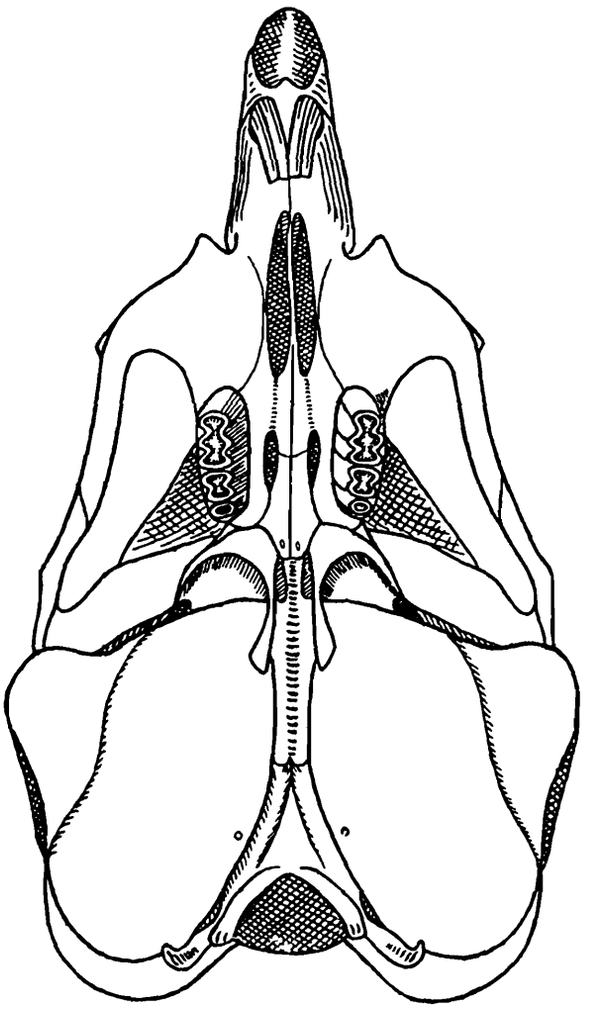
Adult ♂, Z.S.I. Reg. No. 13263, Wana, Waziristan, West Pakistan, *ca.* 1600 metres altitude, 2nd March, 1921.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.



1

10 mm.



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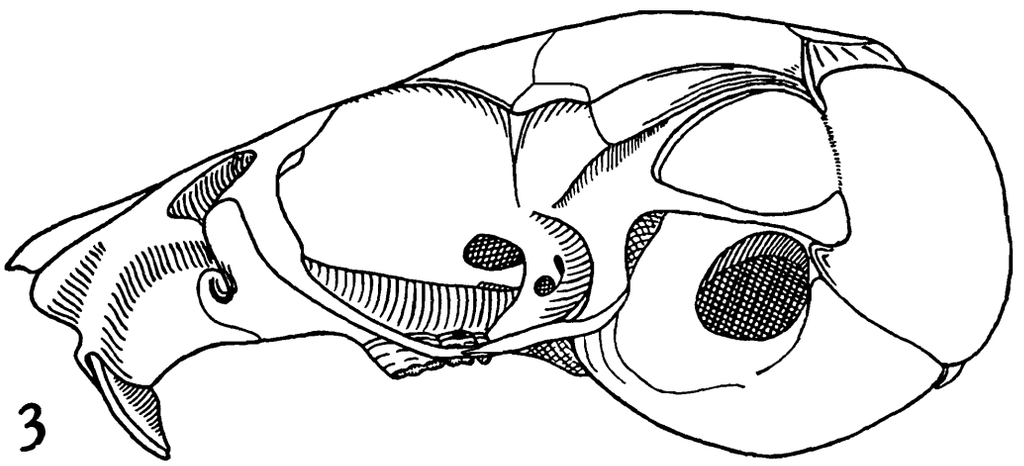
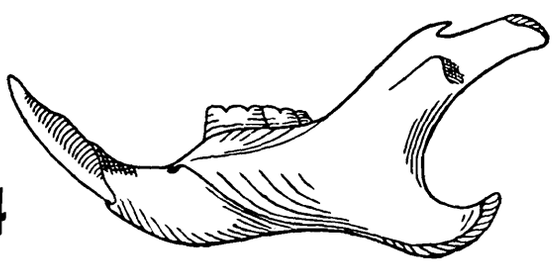


3

3 mm.

5



4

6

PLATE 21

Meriones libycus erythrourus Gray

Adult ♂, Mammal Survey Coll. No. 170 (B.N.H.S.), Sourab, Baluchistan, 22nd May, 1917.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.

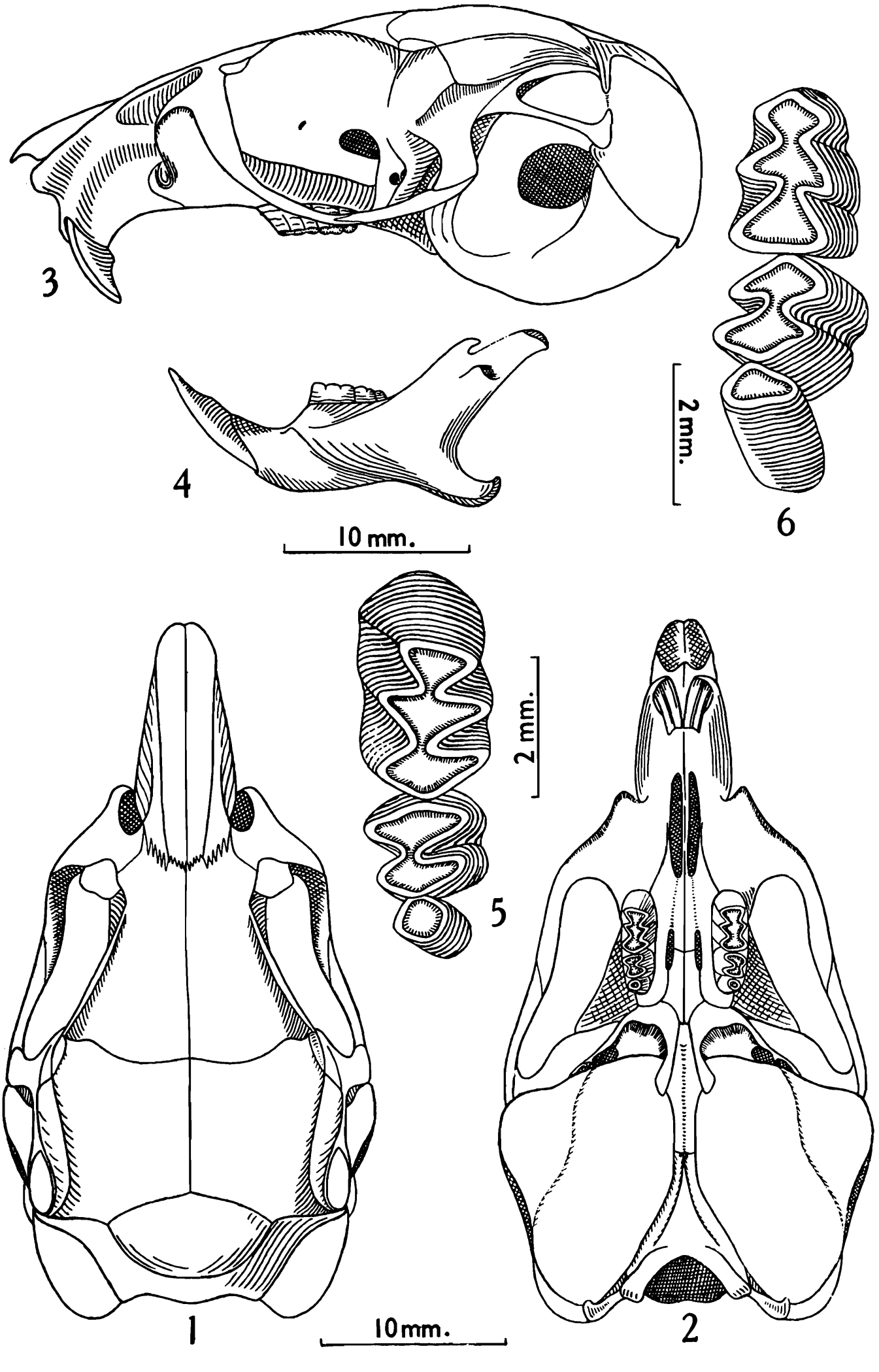

3
4
10 mm.
2 mm.
6
5
2 mm.
1
10 mm.
2

PLATE 22

Gerbillus nanus nanus Blanford

Adult ♂, Z.S.I. Reg. No. 13268, Pasni, Baluchistan, W. Pakistan, 19th February, 1918.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.

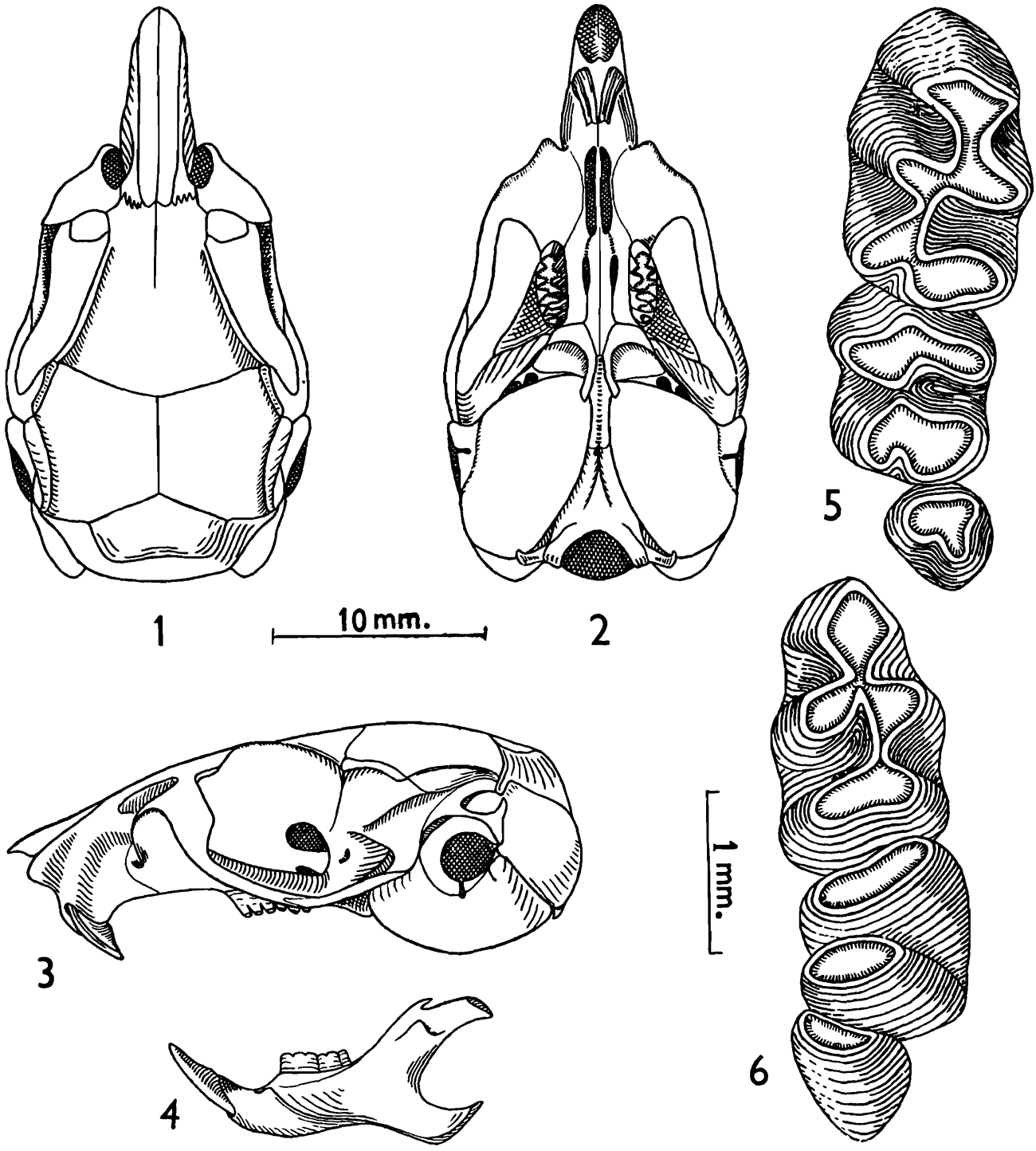

1
10 mm.
2
5
3
1 mm.
6
4

PLATE 23

Gerbillus dasyurus indus Thomas

Adult ♂, Z. S. I. Reg. No. 13270, Sukkur, Sind, W. Pakistan, 22nd March, 1915.

Fig. 1.—Dorsal view of skull.

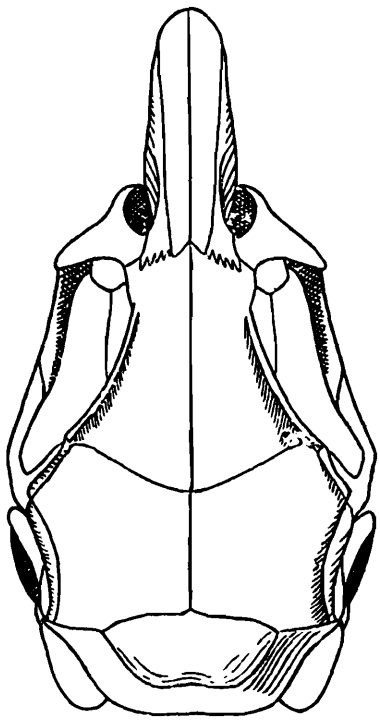
Fig. 2.—Ventral view of skull.

Fig. 3.—Lateral view of skull.

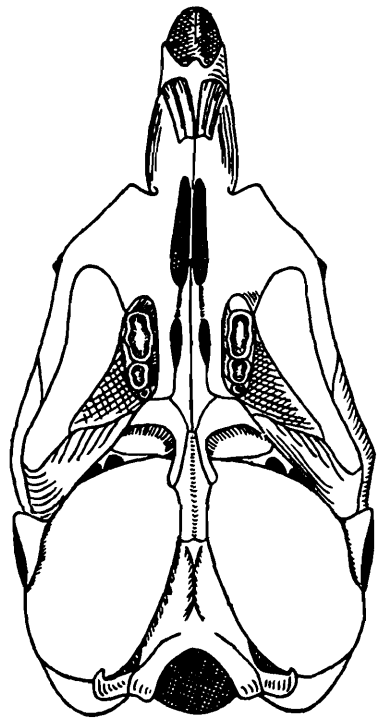
Fig. 4.—Outer side-view of left ramus of mandible.

Fig. 5.—Surface view of right upper molar crown (Z.S.I. Reg. No. 13271 ♂ Juv.).

Fig. 6.—Surface view of right lower molar crown (Z.S.I. Reg. No. 13271 ♂ Juv.).



1



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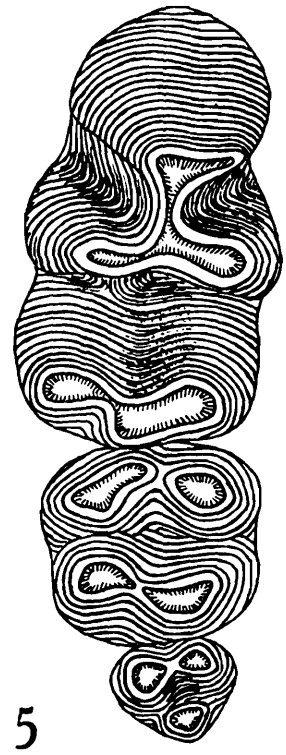

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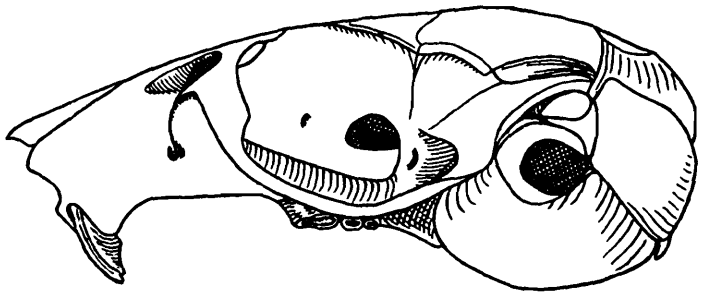
10mm.



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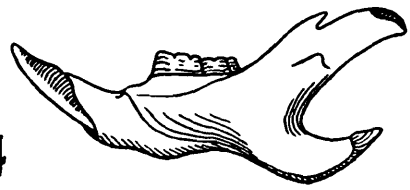
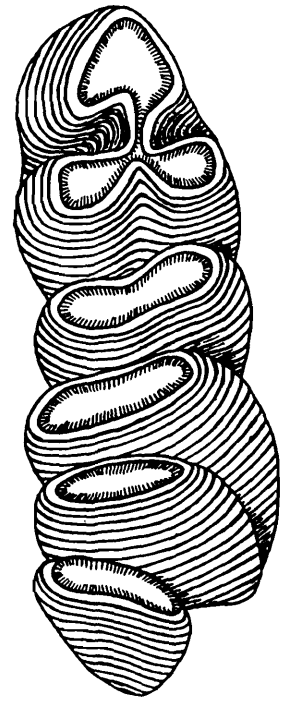


4

1 mm.



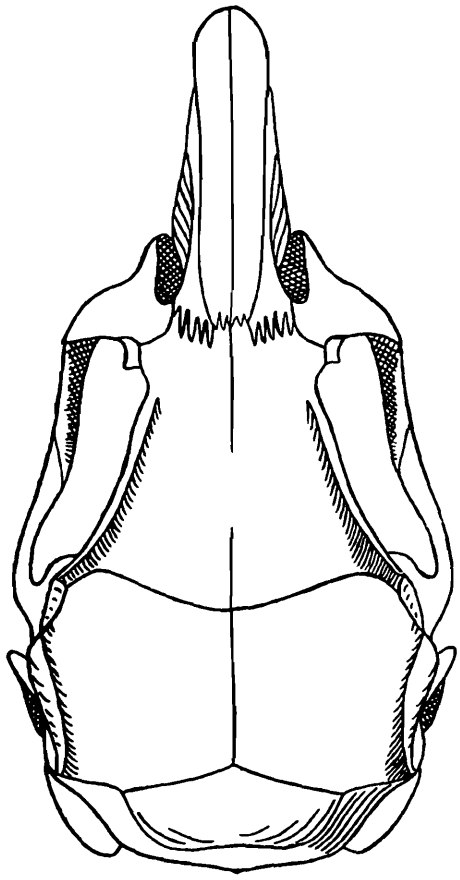
6

PLATE 24

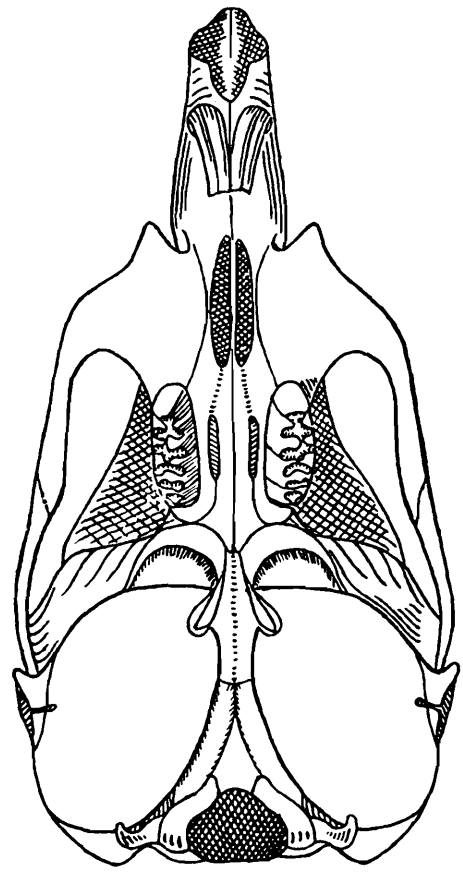
Gerbillus gleadowi gleadowi Murray

Adult ♂, Z. S. I. Reg. No. 15346, Sikar, Rajasthan, 15th November, 1960.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side—view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.

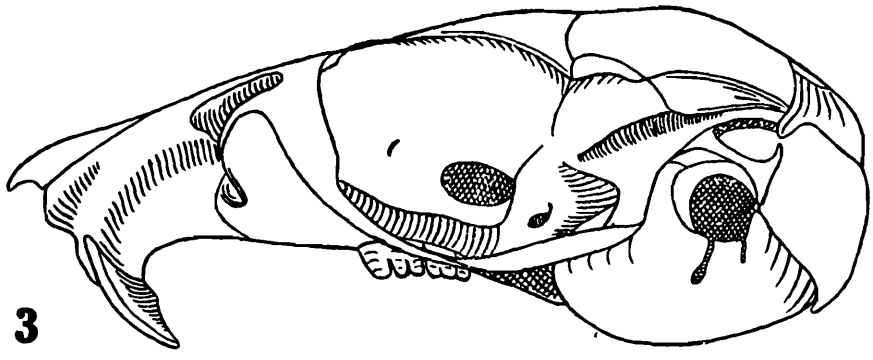


1



2

10 mm.



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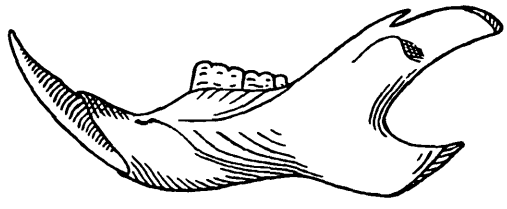
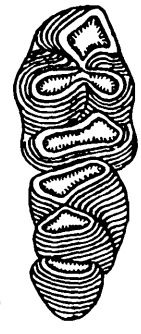


4

3 mm.

5

3 mm.



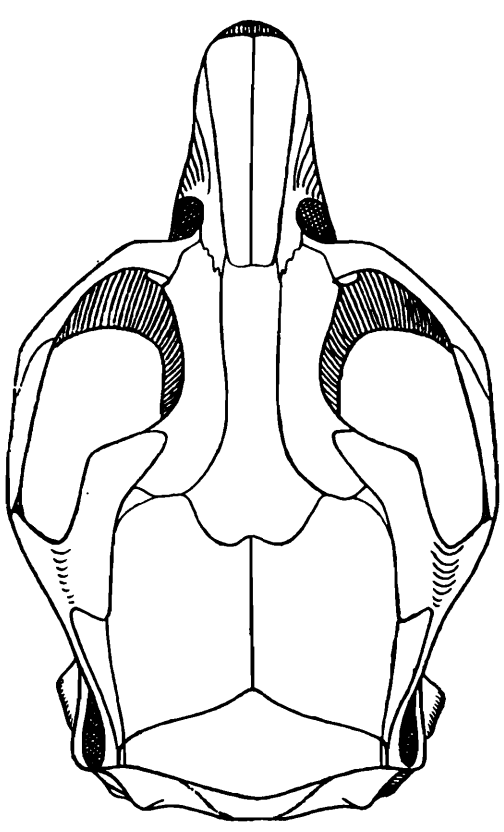
6

PLATE 25

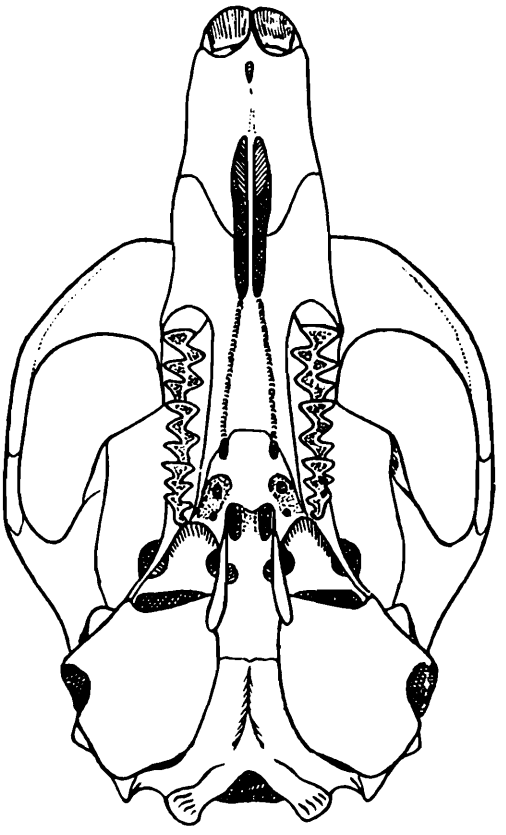
Pitymys sikimensis sikimensis Hodgson

Adult ♂, Z. S. I. Reg. No. 10511, Sikkim, 28th December, 1914.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.

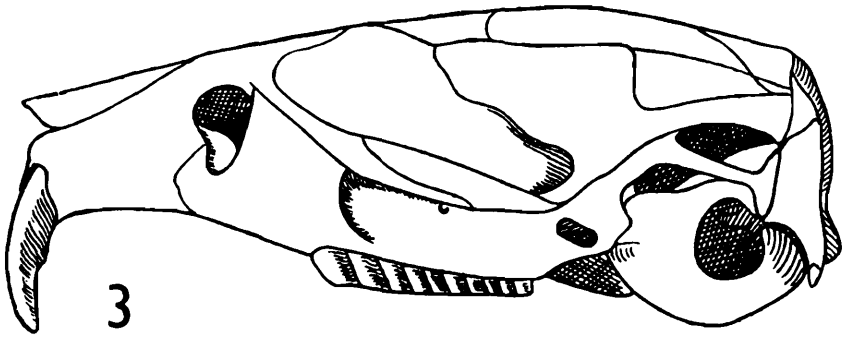


1



2

10mm.



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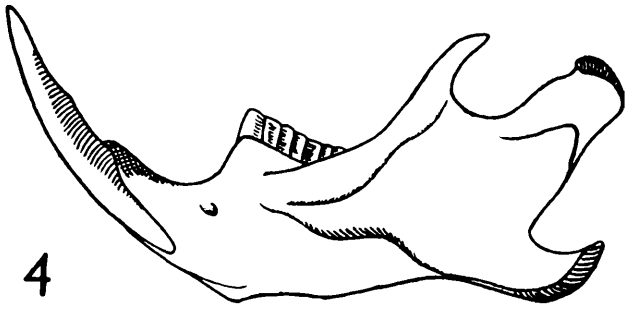


4

5

5 mm.

6

PLATE 26

Alticola roylei roylei Gray

Adult ♂, Z. S. I. Reg. No. 13276, Phurkia, Kumaon, Uttar Pradesh, 1st September, 1913.

Fig. 1.—Dorsal view of skull.

Fig. 2.—Ventral view of skull.

Fig. 3.—Lateral view of skull.

Fig. 4.—Outer side-view of left mandible (Z. S. I. Reg. No. 13277 ♂).

Fig. 5.—Surface view of right upper molar crown (Z. S. I. Reg. No. 13277♂).

Fig. 6.—Surface view of right lower molar crown (Z. S. I. Reg. No. 13277♂).

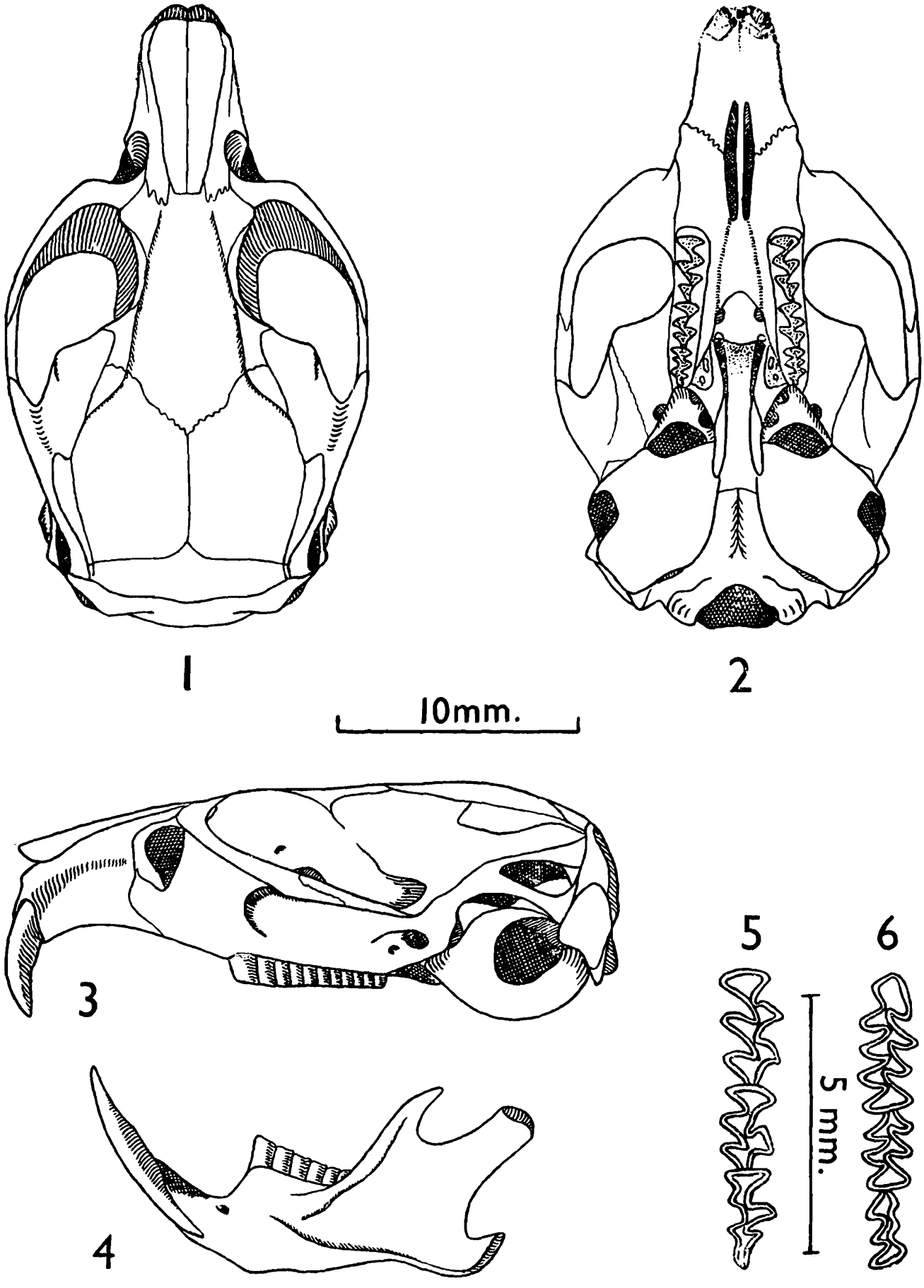

1
2
10mm.
3
4
5
6
5 mm.

PLATE 27

Calomyscus bailwardi bailwardi Thomas

Adult ♂, Z. S. I. Reg. No. 15273, Kelat, Baluchistan, W. Pakistan, 5th July, 1918.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.---Surface view of right lower molar crown.

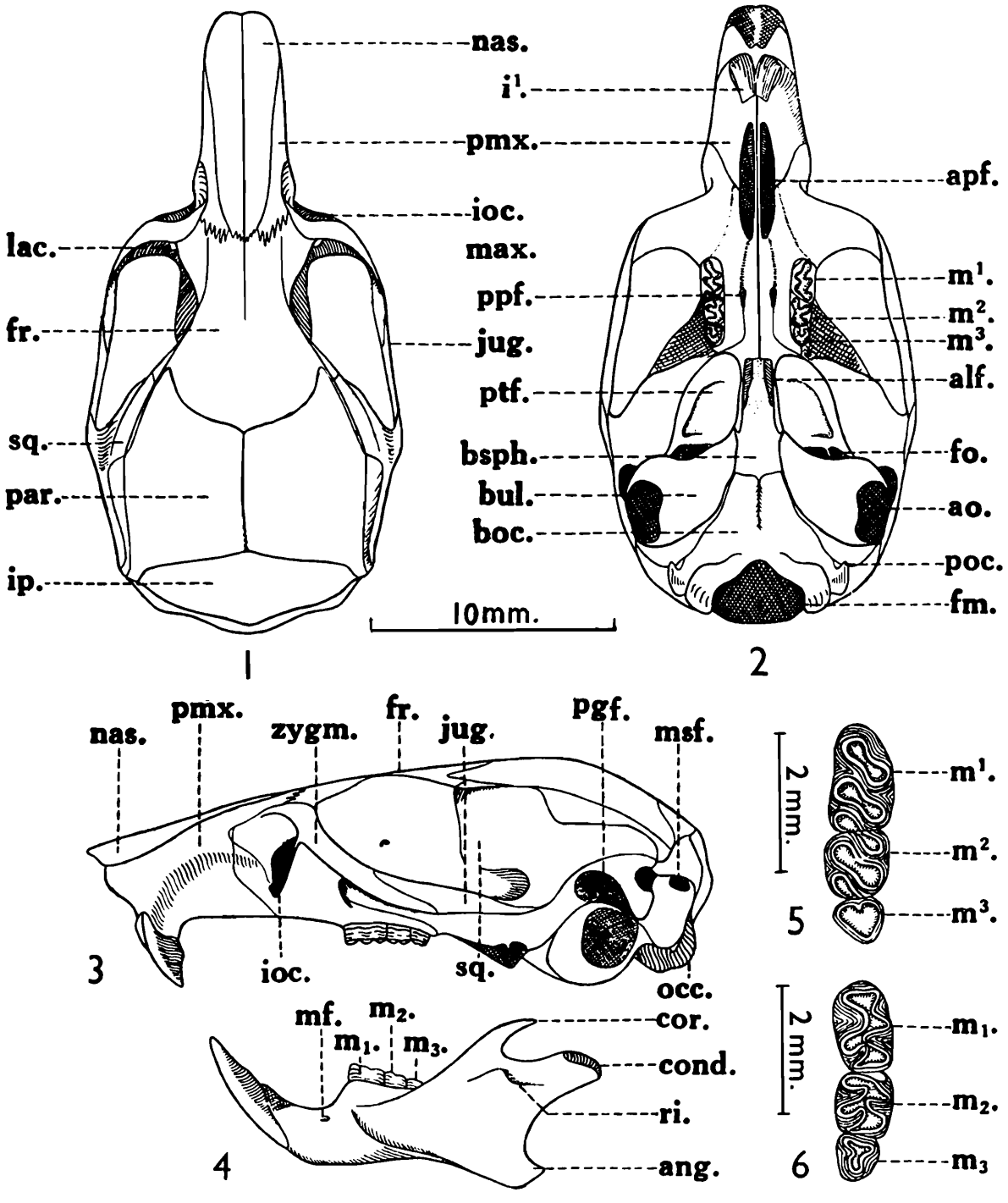

nas.
i¹.
pmx.
ioc.
max.
lac.
ppf.
fr.
jug.
ptf.
sq.
bsph.
par.
bul.
boc.
ip.
10mm.
1
apf.
m¹.
m².
m³.
alf.
fo.
ao.
poc.
fm.
2
nas.
pmx.
zygm.
fr.
jug.
pgf.
msf.
3
ioc.
sq.
occ.
mf.
m₂.
m₁.
m₃.
cor.
cond.
ri.
ang.
4
2 mm.
m¹.
m².
m³.
5
2 mm.
m₁.
m₂.
m₃
6

PLATE 28

Cricetulus migratorius fulvus Blanford

Adult ♀, I. M. No. 6912 (in spirit), Gilgit, Kashmir.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.

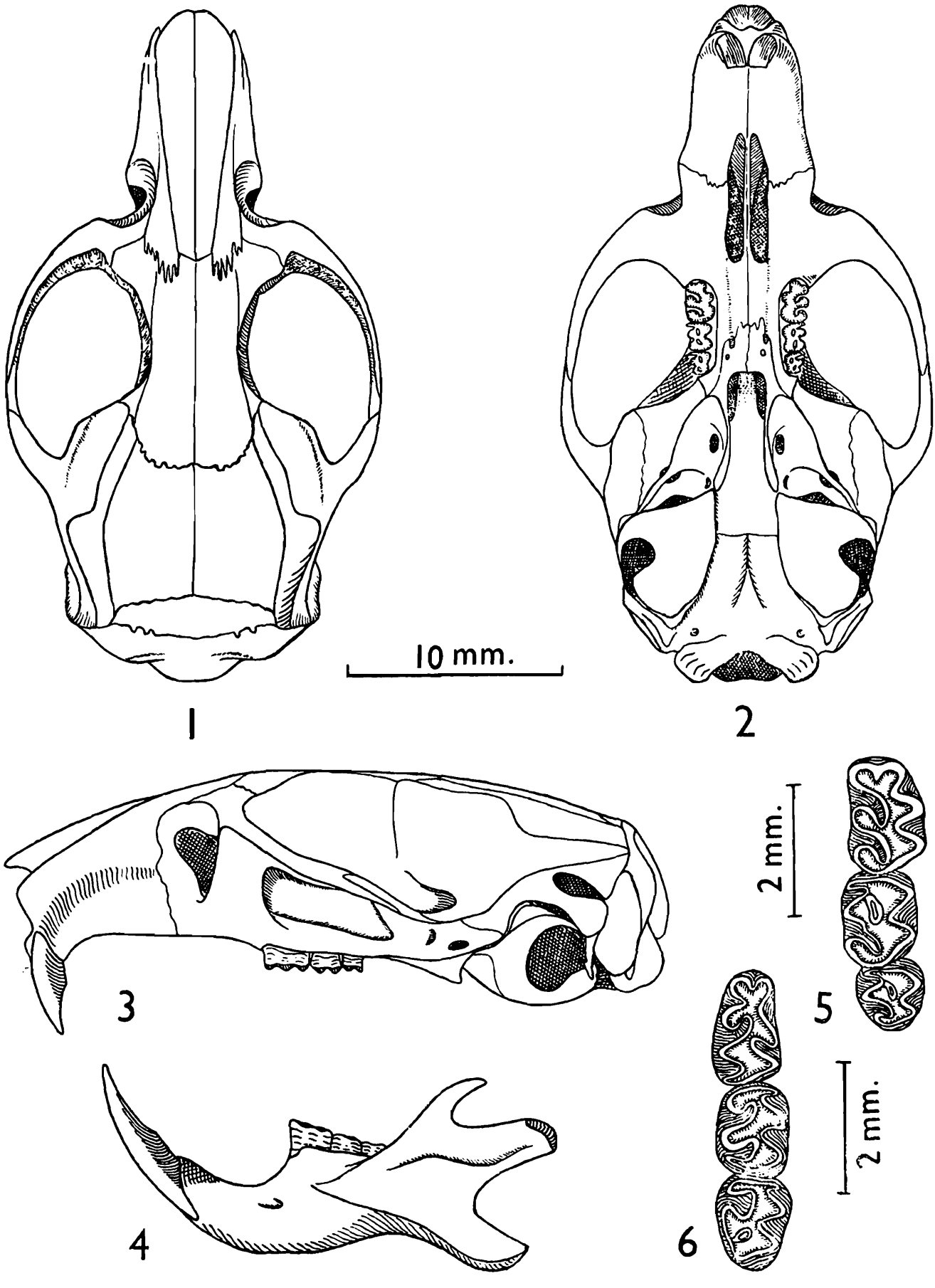

10 mm.
1
2
3
4
2 mm.
5
2 mm.
6

PLATE 29

Chiropodomys gliroides gliroides Blyth

Adult ♂, Z. S. I. Reg. No. 15189, Victoria point, Tenasserim, S. Burma, 11th December, 1913.

Fig. 1.—Dorsal view of skull.

Fig. 2.—Ventral view of skull.

Fig. 3.—Lateral view of skull.

Fig. 4.—Outer side-view of left ramus of mandible.

Fig. 5.—Surface view of right upper molar crown (Z.S.I. Reg. No, 15194 ♀).

Fig. 6.—Surface view of right lower molar crown (Z. S. I. Reg. No. 15194 ♀).

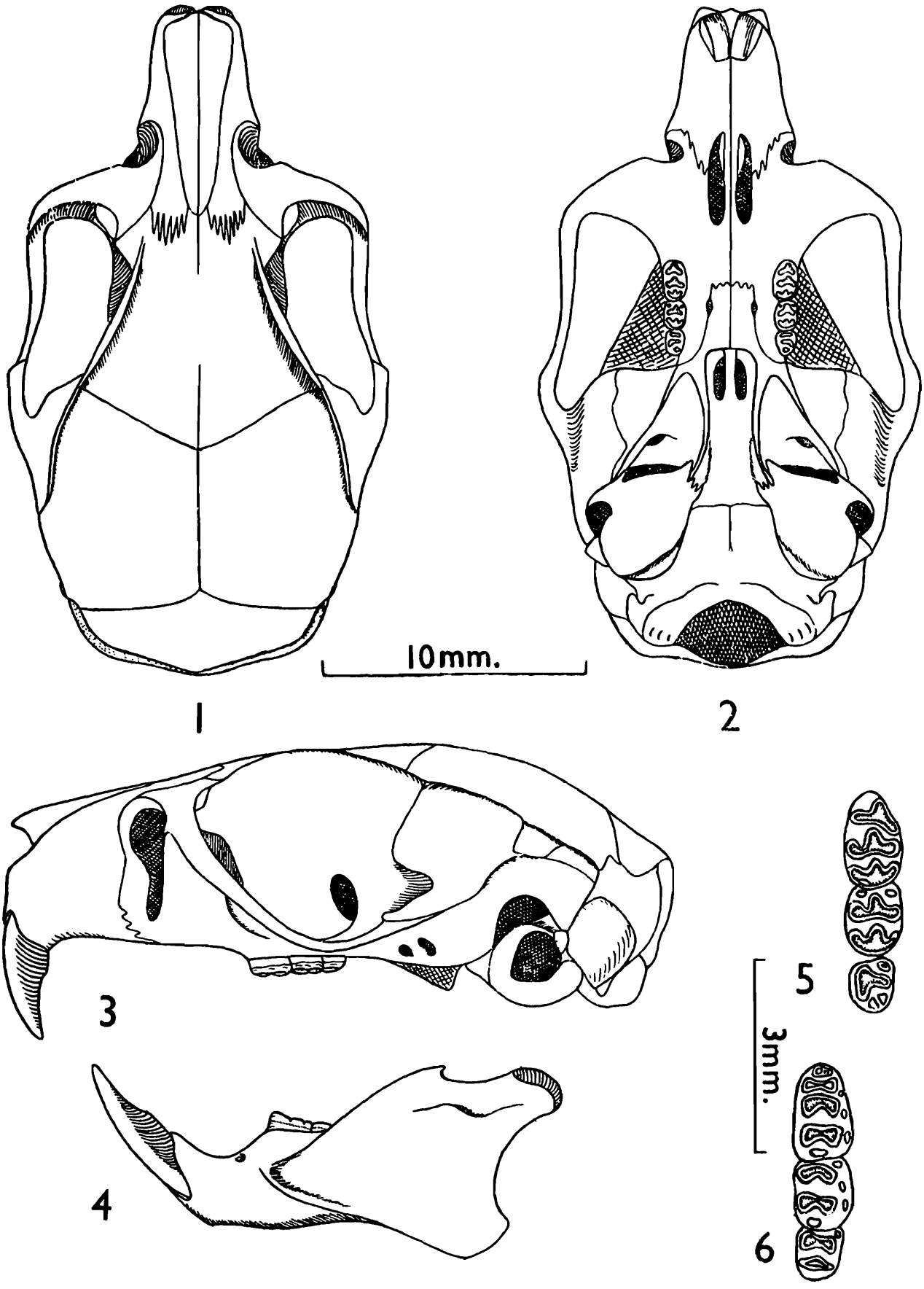

10mm.
1
2
3
4
5
3mm.
6

PLATE 30

Rattus rattus arboreus Horsfield

Adult ♂, Z. S. I. Reg. No. 13348, Gujhundi, Hazaribagh, Bihar, 16th May, 1914.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.

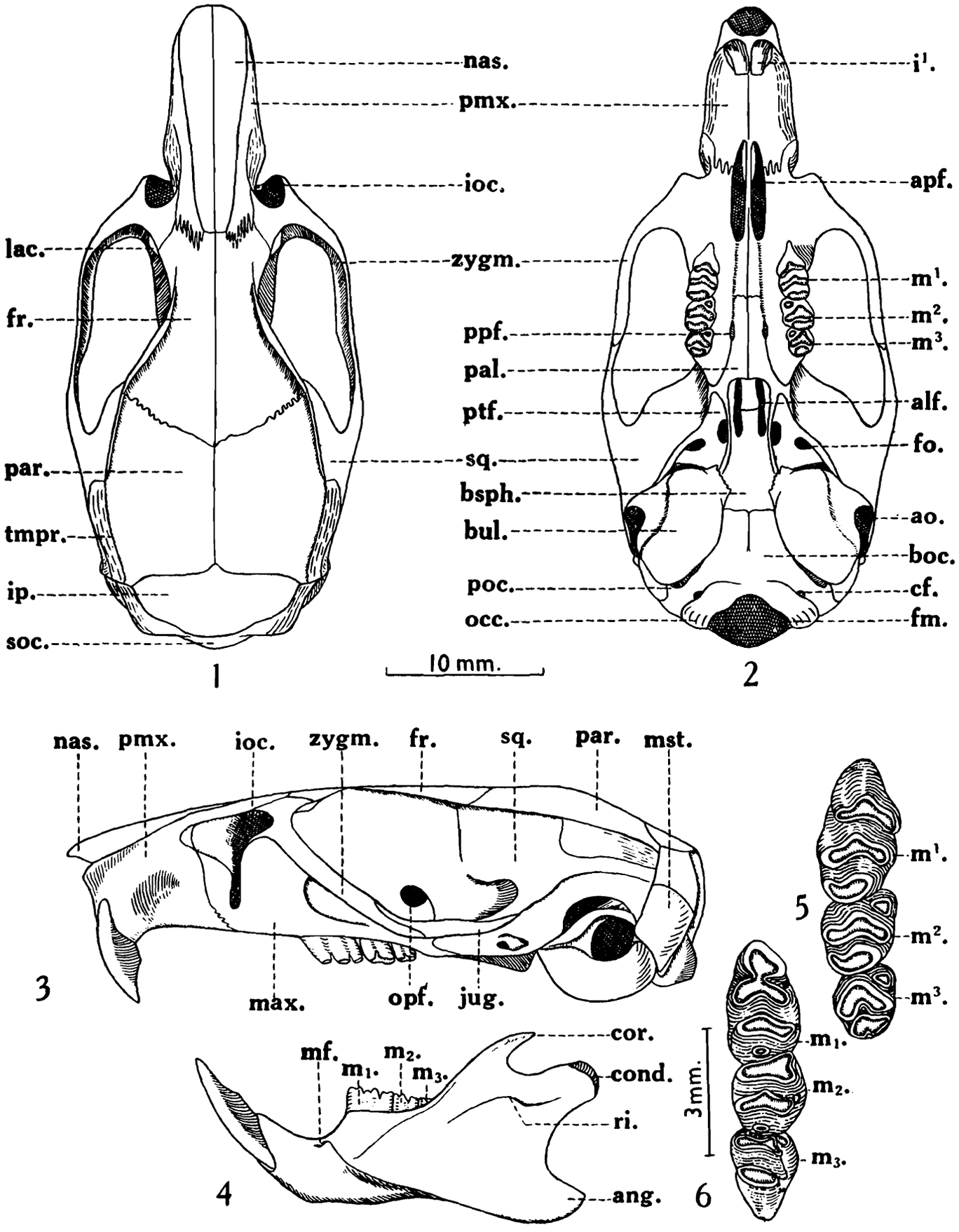

nas.
pmx.
ioc.
lac.
zygm.
fr.
ppf.
pal.
ptf.
par.
sq.
bsph.
tmpr.
bul.
ip.
poc.
soc.
occ.
1
10 mm.
2
i¹.
apf.
m¹.
m².
m³.
alf.
fo.
ao.
boc.
cf.
fm.
nas. pmx. ioc. zygm. fr. sq. par. mst.
3
max. opf. jug.
cor.
mf. m₂.
m₁. m₃.
cond.
ri.
ang.
4
5
m¹.
m².
m³.
3mm.
m₁.
m₂.
m₃.
6

PLATE 31

Bandicota bengalensis kok Gray

Adult ♂, Z. S. I. Reg. No. 14080, Gadag, S. Maharatta, Mysore, 22nd December, 1911.

Fig. 1.—Dorsal view of skull.

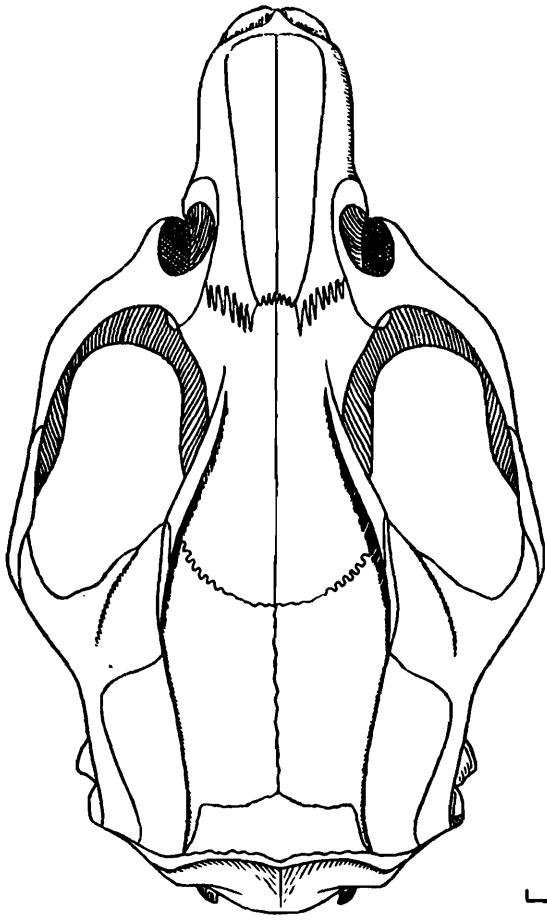
Fig. 2.—Ventral view of skull.

Fig. 3.—Lateral view of skull.

Fig. 4.—Outer side-view of left ramus of mandible.

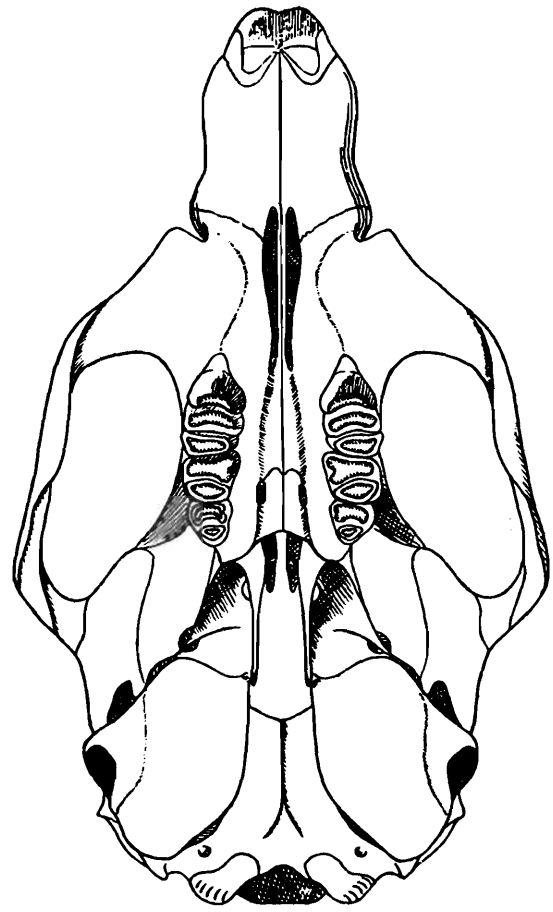
Fig. 5.—Surface view of right upper molar crown (Z. S. I. Reg. No. 14079 ♂ Juv.).

Fig. 6.—Surface view of right lower molar crown (Z. S. I. Reg. No. 14079 ♂ Juv.).



10 mm.

1



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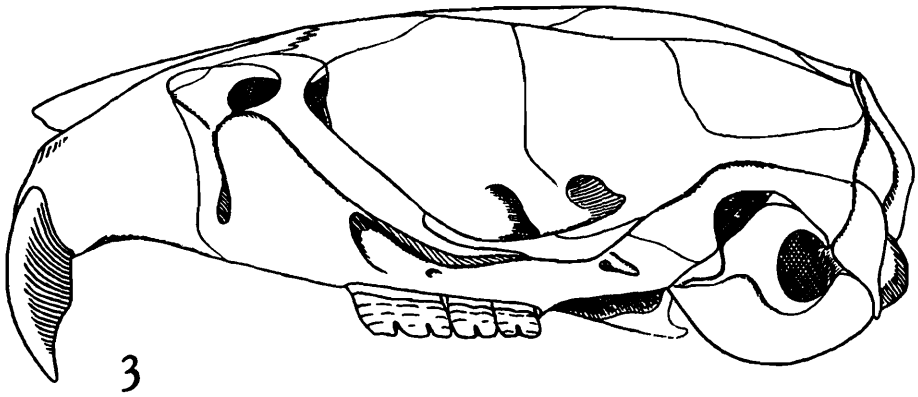

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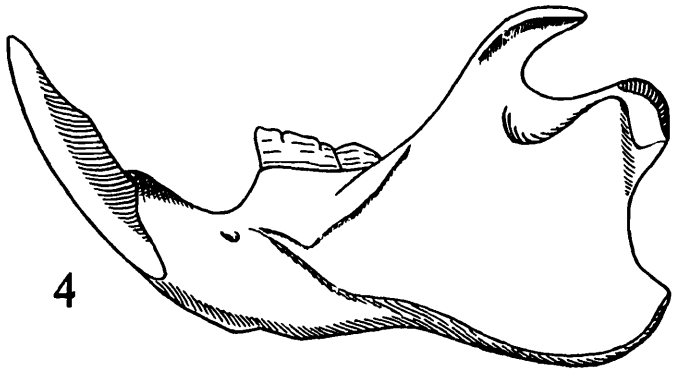


4

5 mm.

5

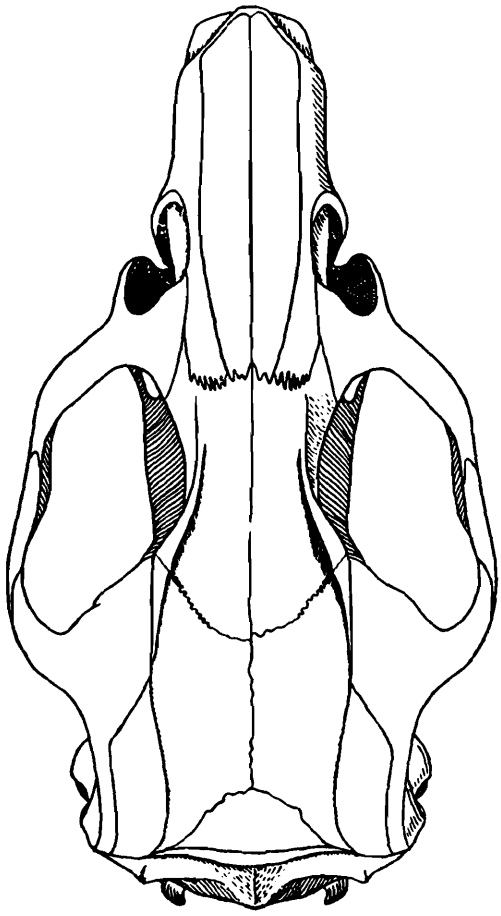
6

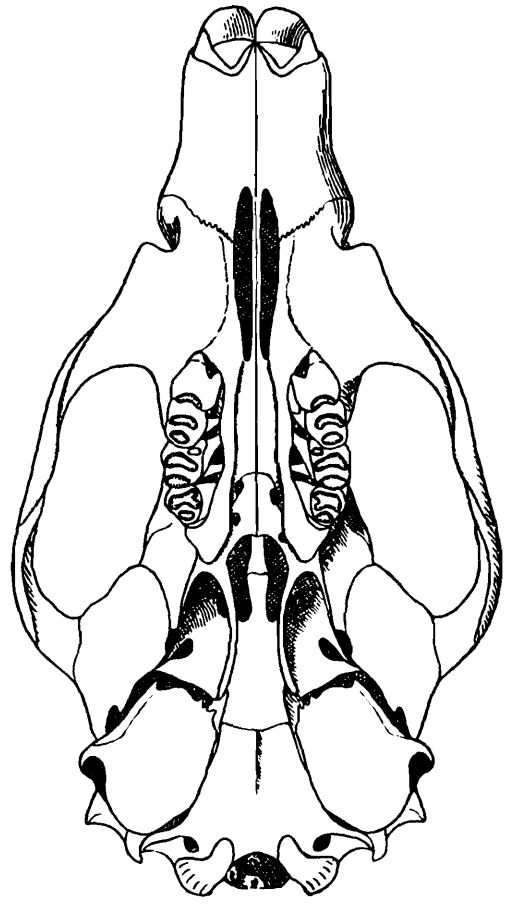
PLATE 32

Bandicota indica indica Bechstein

Adult ♀, Z. S. I. Reg. No. 15288, Palkonda hills, E. Ghats, Madras, 3rd June, 1930.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.

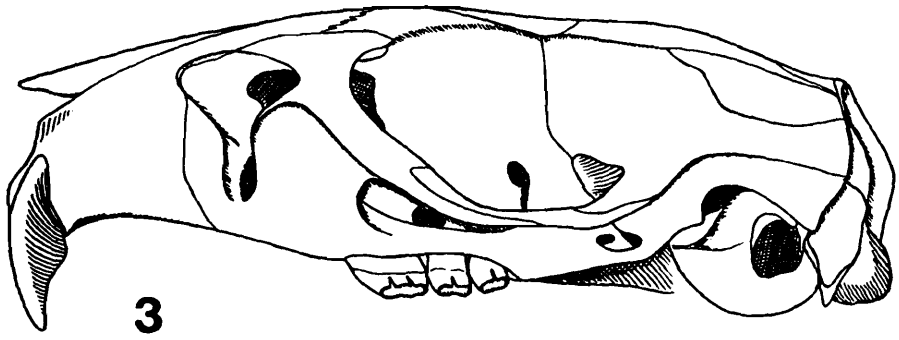




20mm.

1

2



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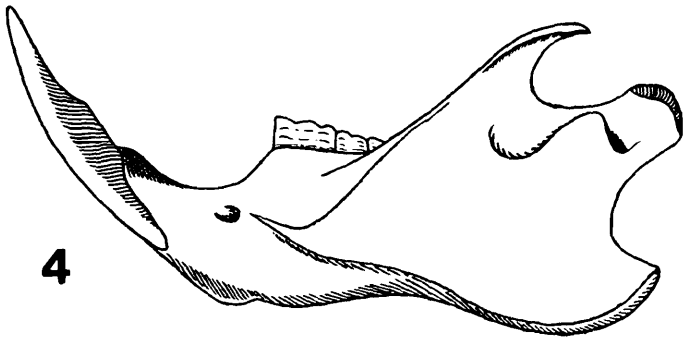


4

5 mm.

5

6

PLATE 33

Nesokia indica huttoni Blyth

Adult ♀, Z. S. I. Reg. No. 14109, Panjgur, Baluchistan, W. Pakistan, 29th January, 1918.

Fig. 1.—Dorsal view of skull.

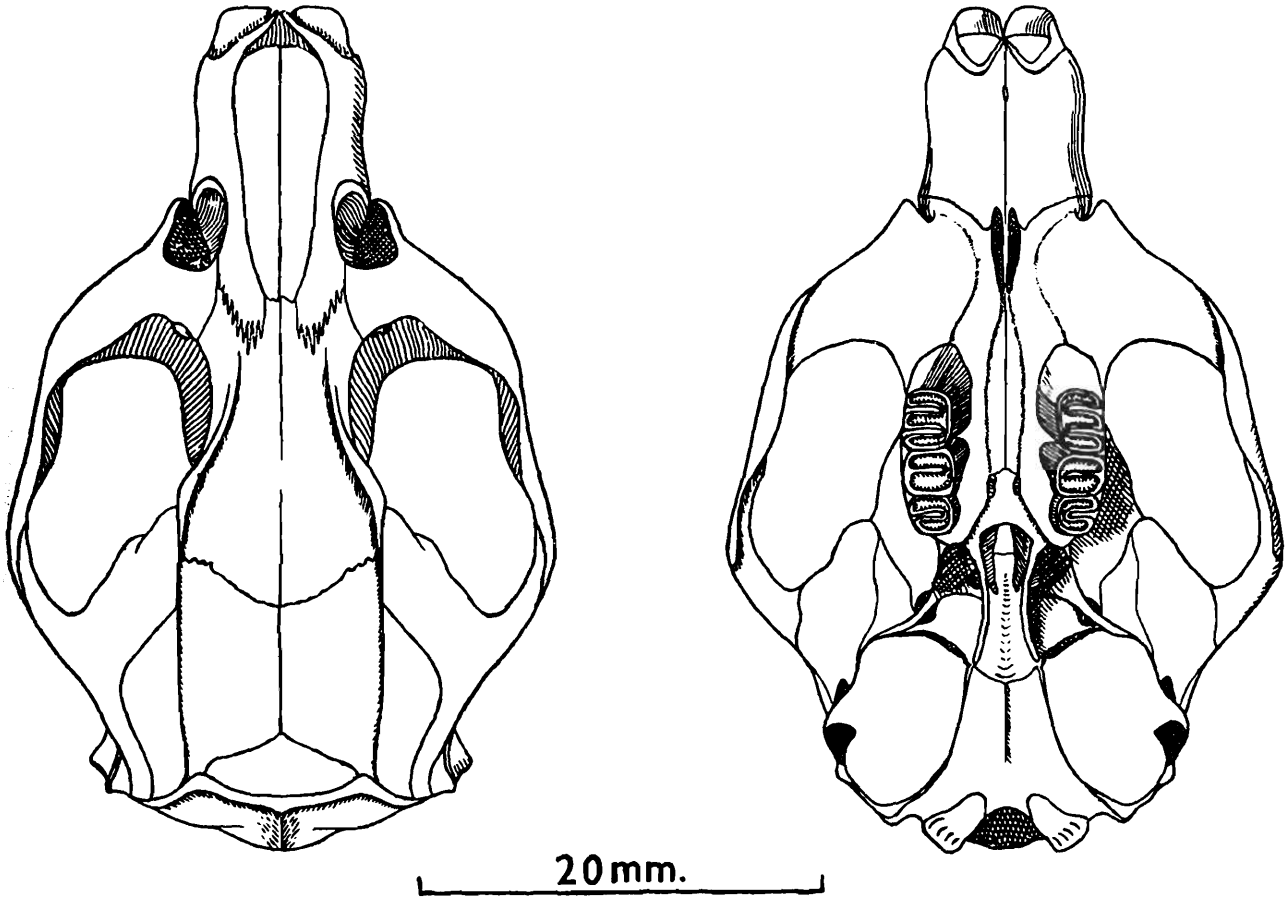
Fig. 2.—Ventral view of skull.

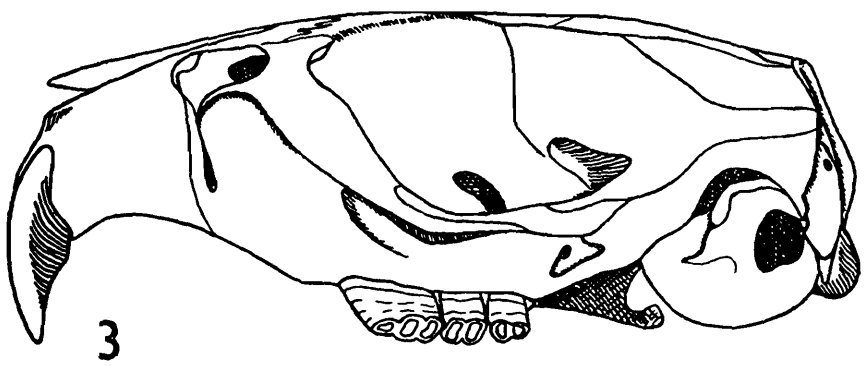
Fig. 3.—Lateral view of skull.

Fig. 4.—Outer side-view of left ramus of mandible.

Fig. 5.—Surface view of left upper molar crown (Z. S. I. Reg. No. 14107, adult ♂).

Fig. 6.—Surface view of left lower molar crown (Z. S. I. Reg. No. 14107, adult ♂).


20mm.
1
2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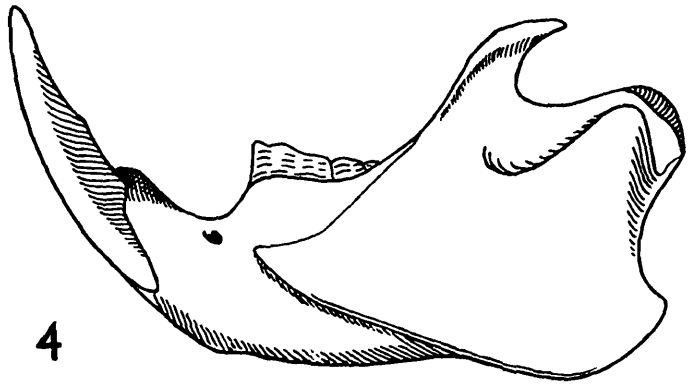
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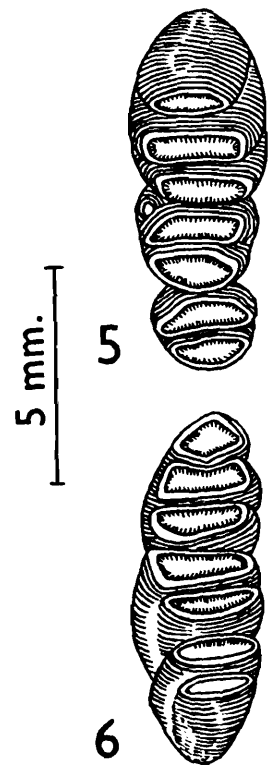
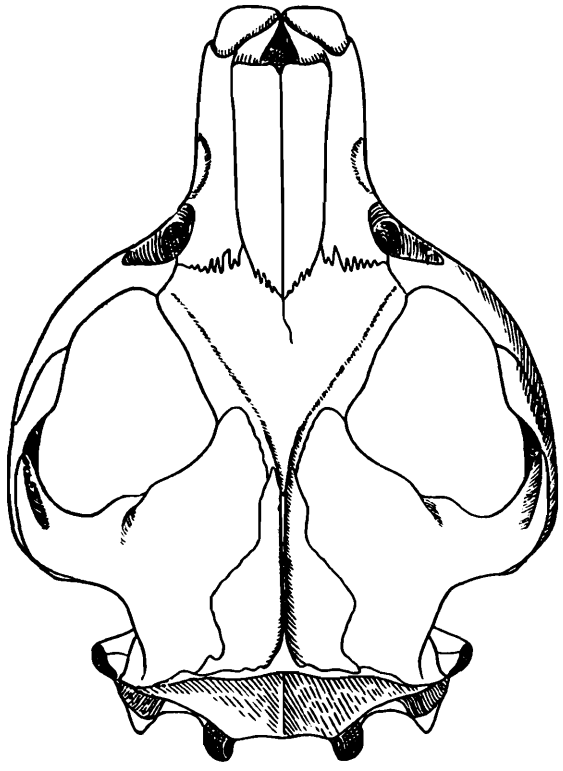

5 mm.
5
6

PLATE 34

Rhizomys sumatrensis cinereus MacClelland

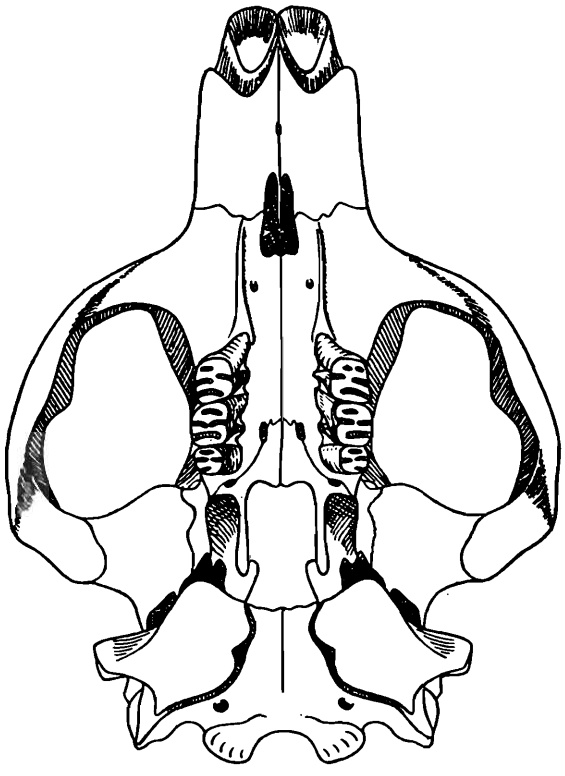
Adult ♀, Z. S. I. Reg. No. 15371, Mergui, Malaya, 16th April, 1922.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.
Fig. 7.—Anterior view of skull.



1

30mm.



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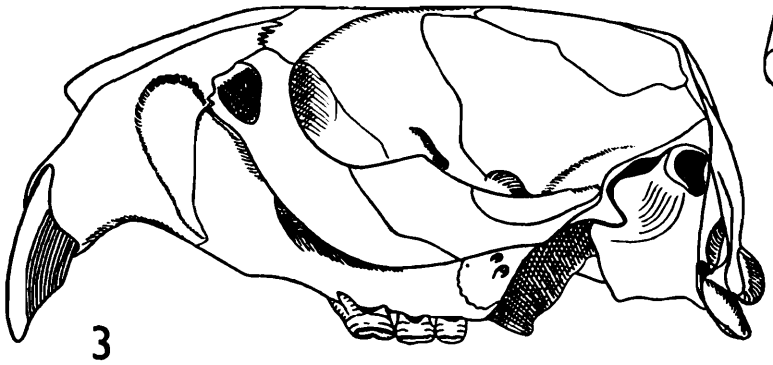

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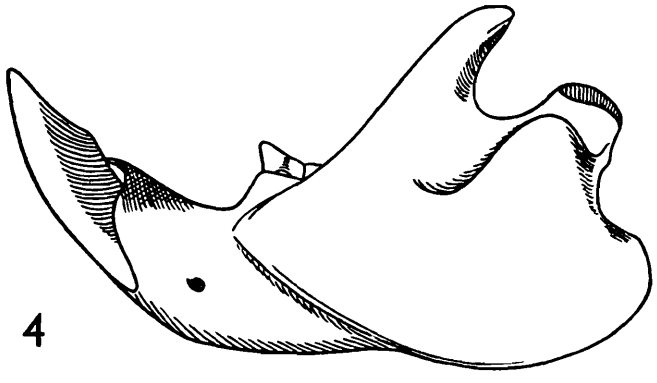

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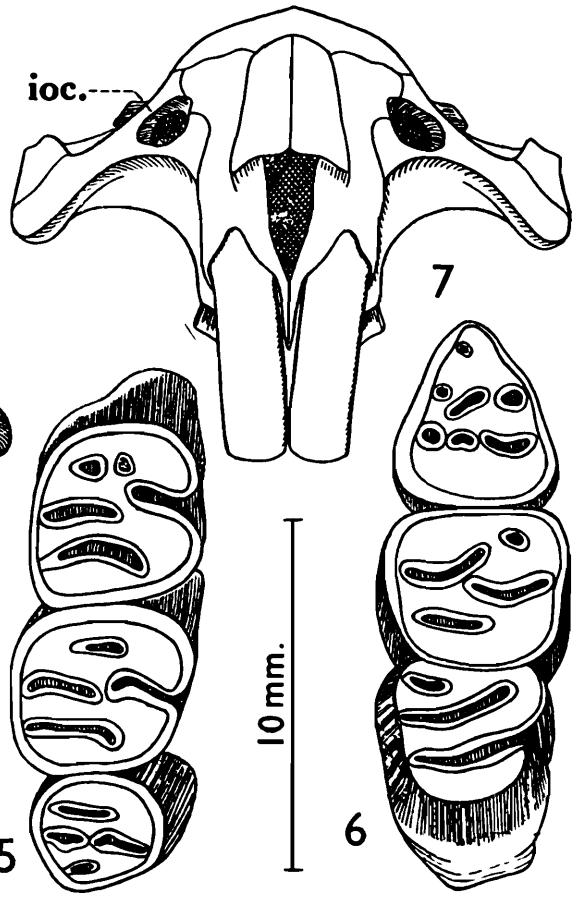


PLATE 35

Rhizomys pruinosus pruinosus Blyth

Adult ♀, Z. S. I. Reg. No. 15355 (in spirit), upper Burma.

Fig. 1.—Dorsal view of skull.

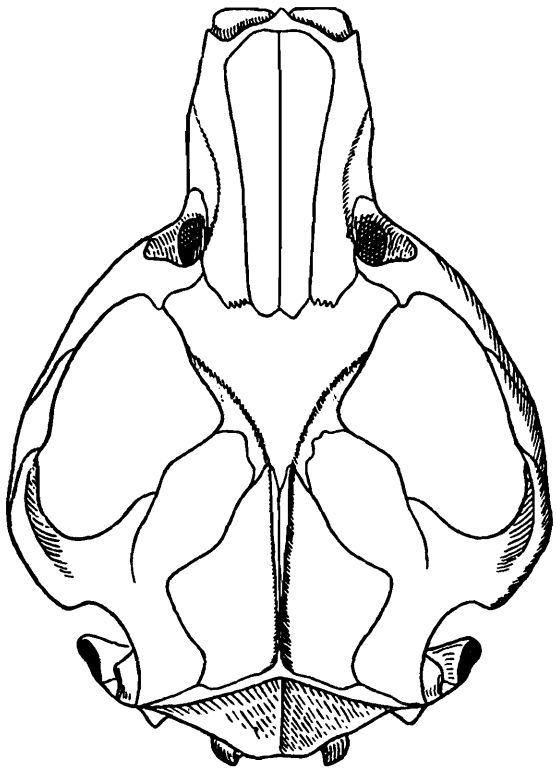
Fig. 2.—Ventral view of skull.

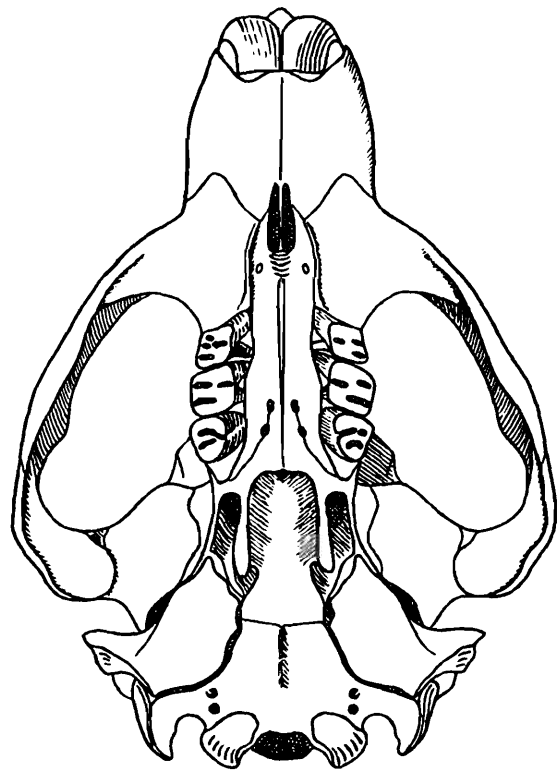
Fig. 3.—Lateral view of skull.

Fig. 4.—Outer side-view of left ramus of mandible.

Fig. 5.—Surface view of right upper molar crown (Sclater's cat. No. 'S', adult ♀).

Fig. 6.—Surface view of right lower molar crown (Sclater's cat. No. 'P', adult ♀).

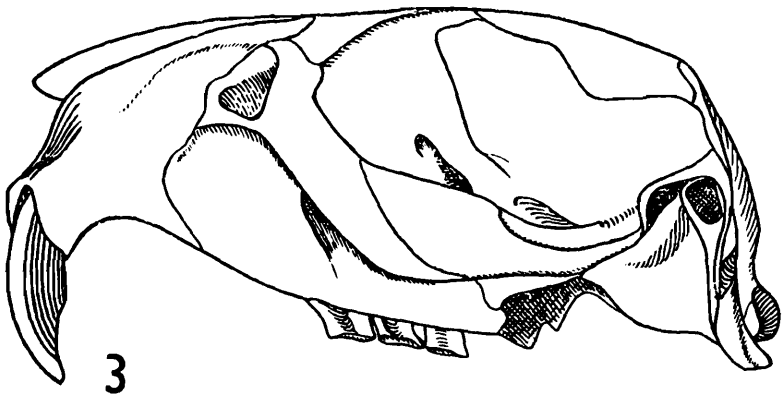




30mm.

1

2



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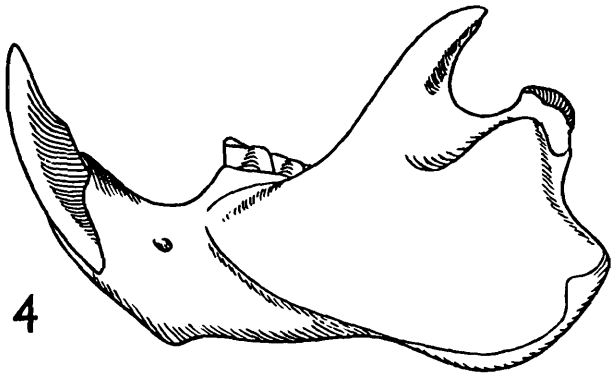
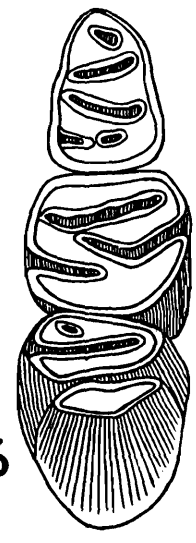


4

5

10mm.



6

PLATE 36

Cannomys badius badius Hodgson

Adult ♀, German expedition coll. No. m_1, Rongrenggir, Garo hills, Assam, 26th January, 1957.

Fig. 1.—Dorsal view of skull.

Fig. 2.—Ventral view of skull.

Fig. 3.—Lateral view of skull.

Fig. 4.—Outer side-view of left ramus of mandible.

Fig. 5.—Surface view of right upper molar crown (Juv. ♀, Z. S. I. Reg. No. 11384).

Fig. 6.—Surface view of right lower molar crown (Juv. ♀, Z. S. I. Reg. No. 11384).

Fig. 7.—Dorsal view of skull (Juv. ♂, Z. S. I. Reg. No. 15225) showing the interparietal bone.

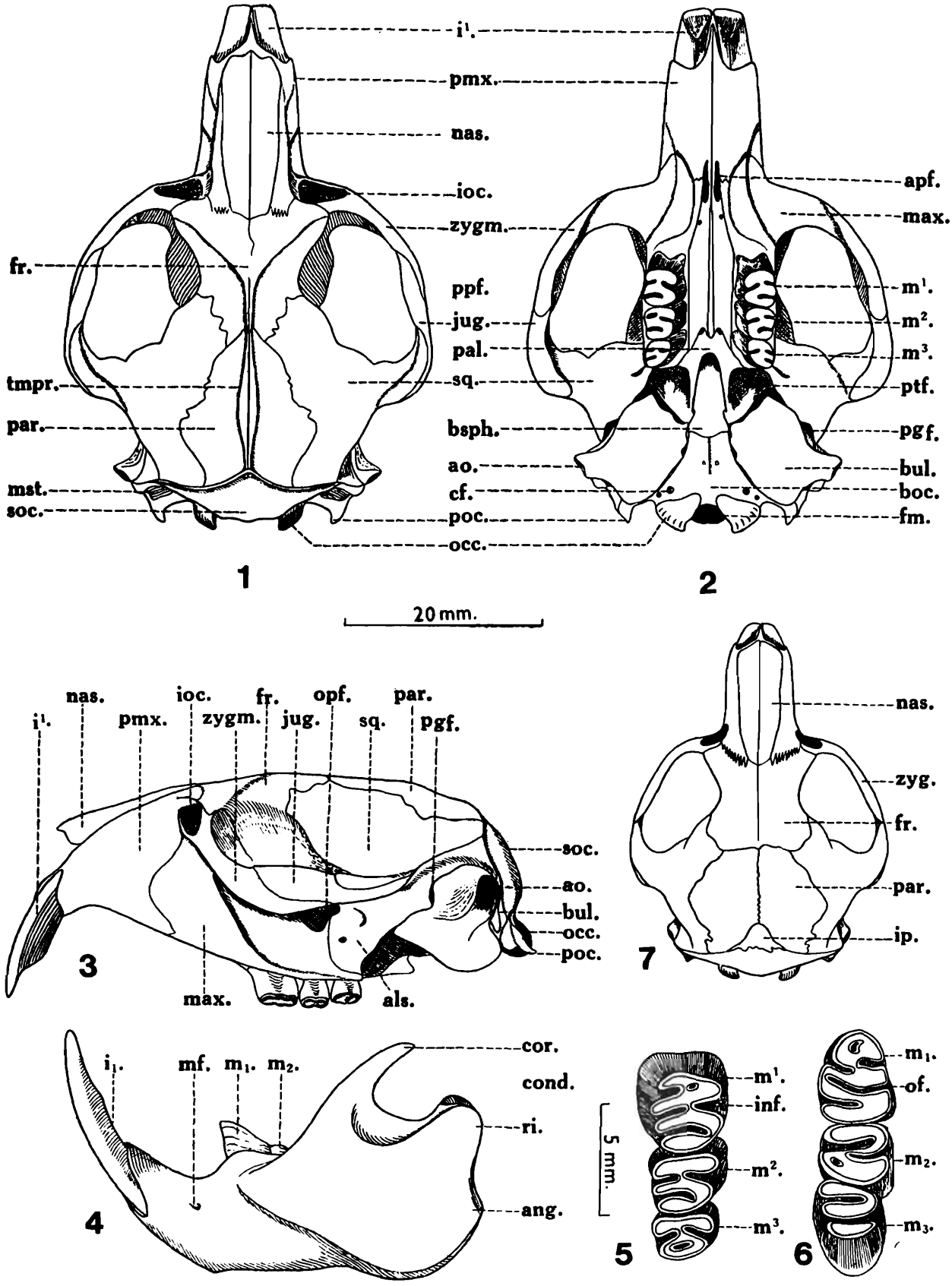

i¹.
pmx.
nas.
ioc.
zygm.
fr.
ppf.
jug.
pal.
tmpr.
sq.
par.
bsph.
mst.
ao.
soc.
cf.
poc.
occ.
apf.
max.
m¹.
m².
m³.
ptf.
pgf.
bul.
boc.
fm.
1
2
20 mm.
nas.
ioc.
fr.
opf.
par.
i¹.
pmx.
zygm.
jug.
sq.
pgf.
soc.
ao.
bul.
occ.
poc.
3
max.
als.
nas.
zyg.
fr.
par.
ip.
7
cor.
cond.
ri.
ang.
i₁.
mf.
m₁.
m₂.
4
m¹.
inf.
m².
m³.
5 mm.
5
m₁.
of.
m₂.
m₃.
6

PLATE 37

Platacanthomys lasiurus lasiurus Blyth

Adult ♀. Z.S.I. Reg. No. 15182, Corrg., Mysore, 24th January, 1913.

Fig. 1.—Dorsal view of skull.

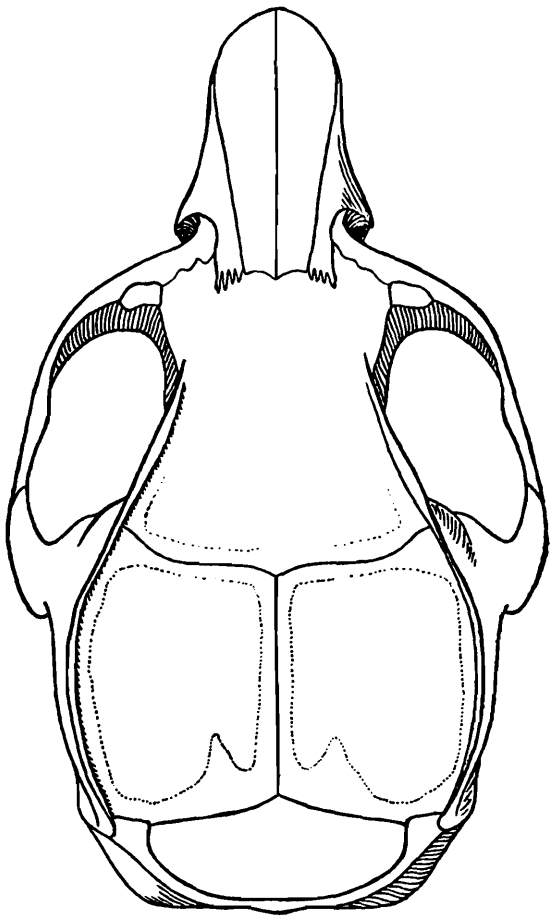
Fig. 2.—Ventral view of skull.

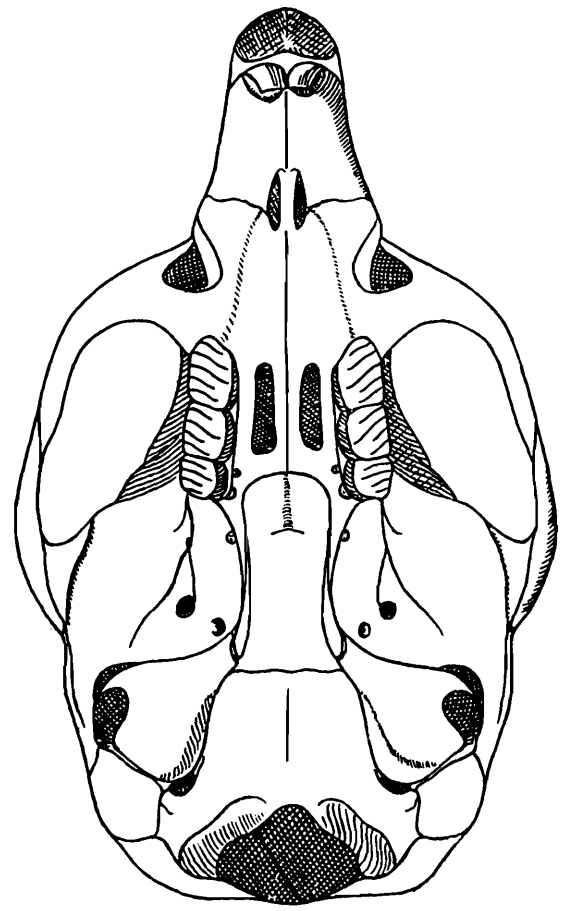
Fig. 3.—Lateral view of skull.

Fig. 4.—Outer side-view of left ramus of mandible.

Fig. 5.—Surface view of right upper molar crown (Adult ♂, Z. S. I. Reg. No. 15184).

Fig. 6.—Surface view of right lower molar crown (Adult ♂, Z. S. I. Reg. No. 15184).

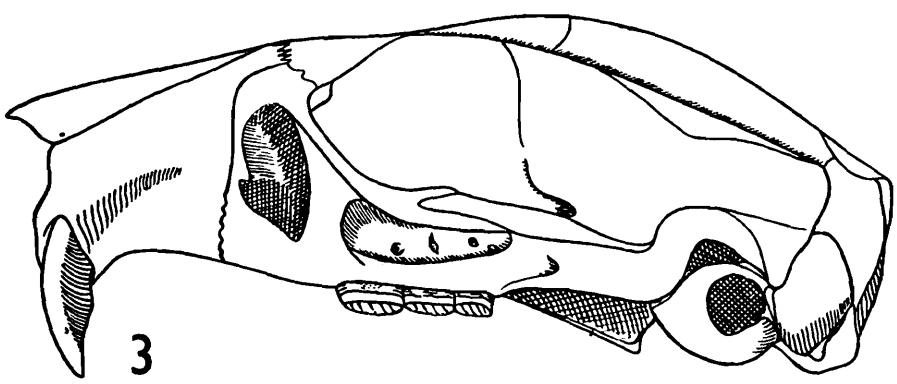




10mm.

1

2



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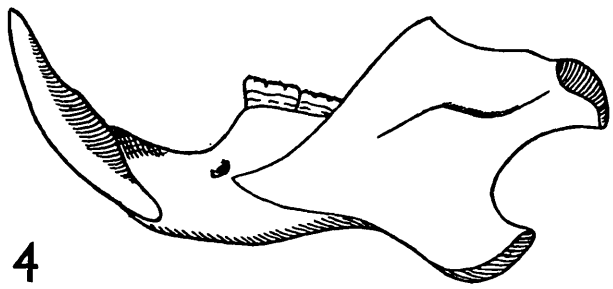
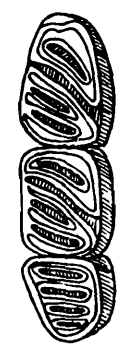


4

5 mm.



5

6

PLATE 38

Funambulus pennanti pennanti Wroughton

Adult ♀, Z. S. I. Reg. No. 15011, Rajkot, Gujarat, W. India, 10th December, 1912.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.

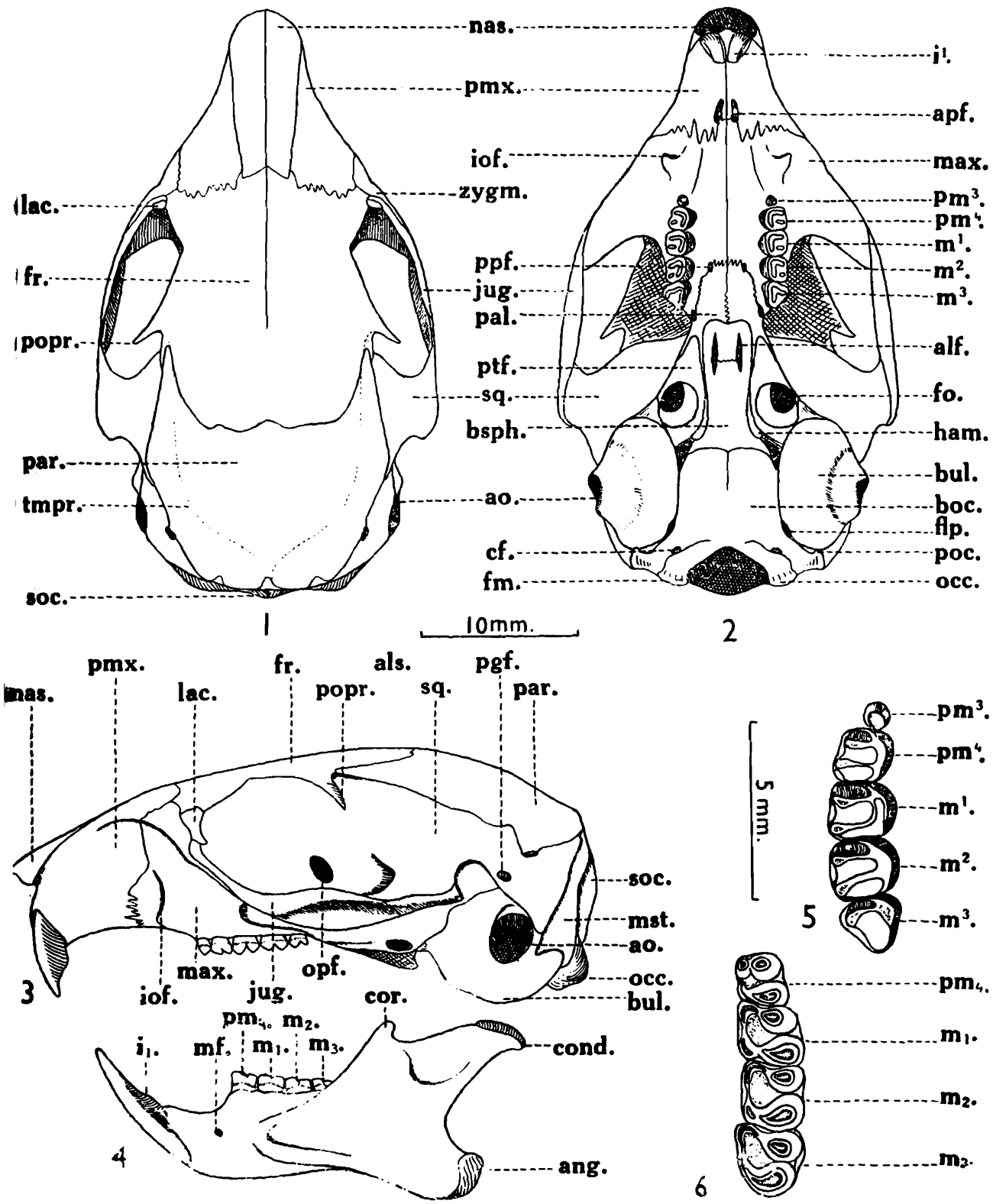
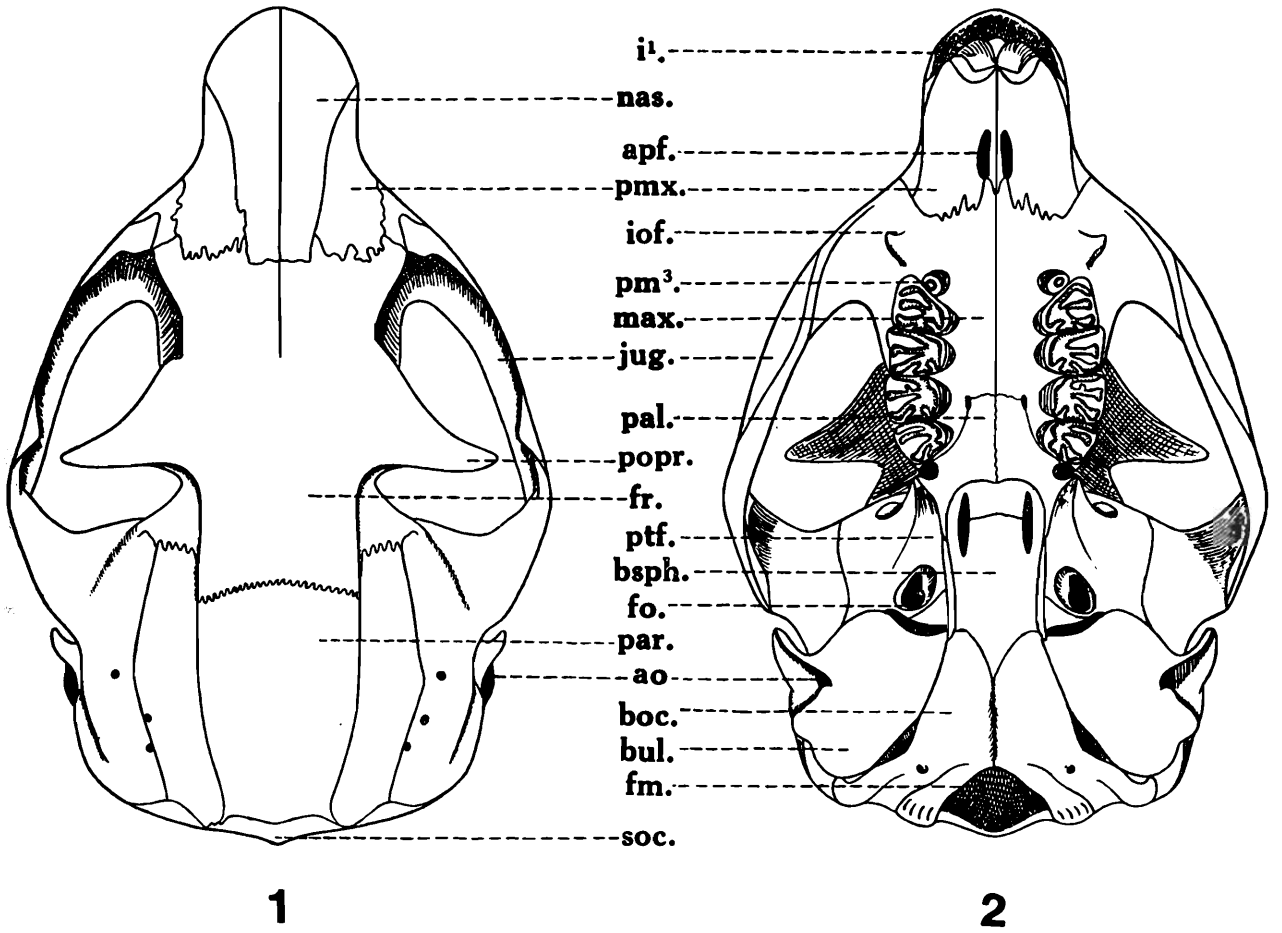

nas.
pmx.
iof.
zygm.
lac.
fr.
popr.
ppf.
jug.
pal.
ptf.
sq.
bsph.
par.
tmpr.
ao.
soc.
cf.
fm.
1
10mm.
2
j¹.
apf.
max.
pm³.
pm⁴.
m¹.
m².
m³.
alf.
fo.
ham.
bul.
boc.
flp.
poc.
occ.
pmx.
fr.
als.
pgf.
nas.
lac.
popr.
sq.
par.
soc.
mst.
ao.
occ.
bul.
cond.
ang.
max.
opf.
iof.
jug.
cor.
pm₄.
m₂.
i₁.
mf.
m₁.
m₃.
3
4
5 mm.
5
pm³.
pm⁴.
m¹.
m².
m³.
pm₄.
m₁.
m₂.
m₃.
6

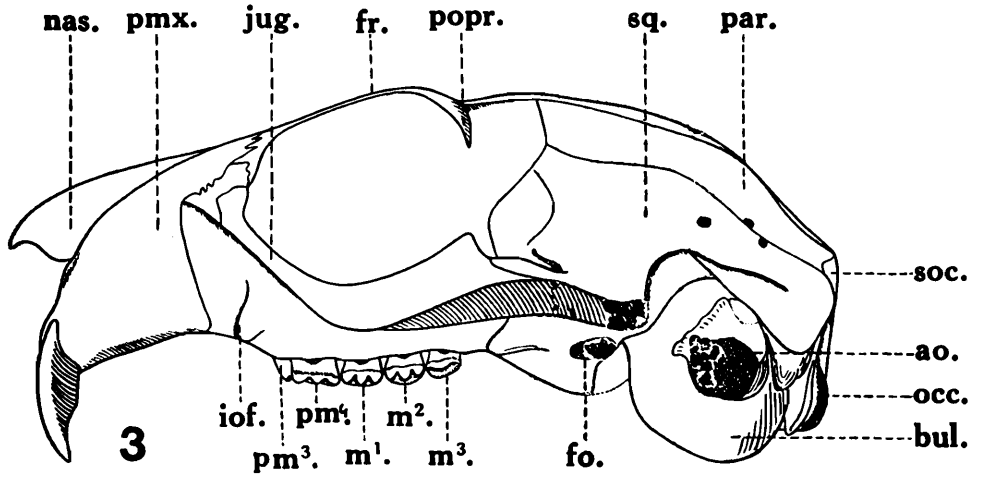
PLATE 39

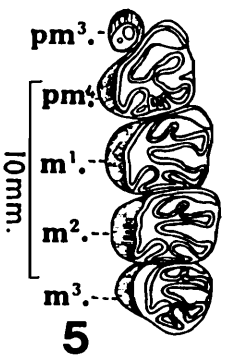
Petaurista petaurista cineraceus Blyth

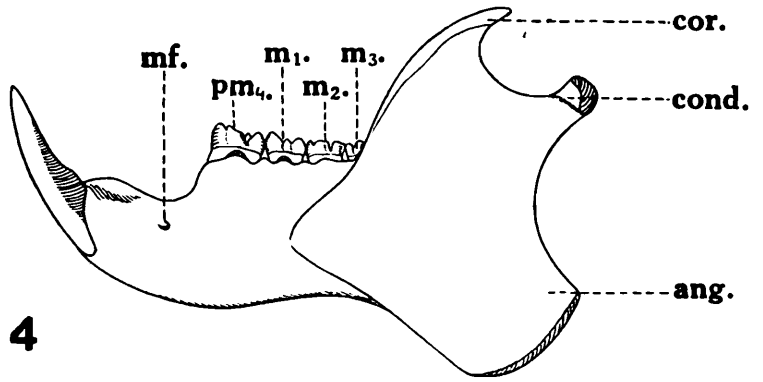
Adult ♀, Z. S. I. Reg. No. 15048, 20 metres N. of Toungoo, Burma, 12th April, 1927.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of left upper molar crown.
Fig. 6.—Surface view of right lower molar crown


i¹.
nas.
apf.
pmx.
iof.
pm³.
max.
jug.
pal.
popr.
fr.
ptf.
bsph.
fo.
par.
ao.
boc.
bul.
fm.
soc.
1
2
30 mm.


nas.
pmx.
jug.
fr.
popr.
sq.
par.
soc.
ao.
occ.
bul.
iof.
pm⁴.
m².
pm³.
m¹.
m³.
fo.
3


pm³.
pm⁴.
m¹.
m².
m³.
10mm.
5


cor.
mf.
m₁.
m₃.
pm₄.
m₂.
cond.
ang.
4

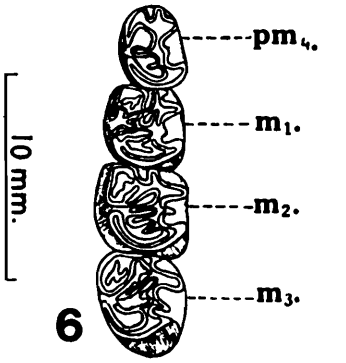

10 mm.
pm₄.
m₁.
m₂.
m₃.
6

PLATE 40

Marmota bobak himalayana Hodgson

Adult ♂, Z. S. I. Reg. No. 15348, Patseo, Lahue, Punjab, 2nd August, 1922.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4 —Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.

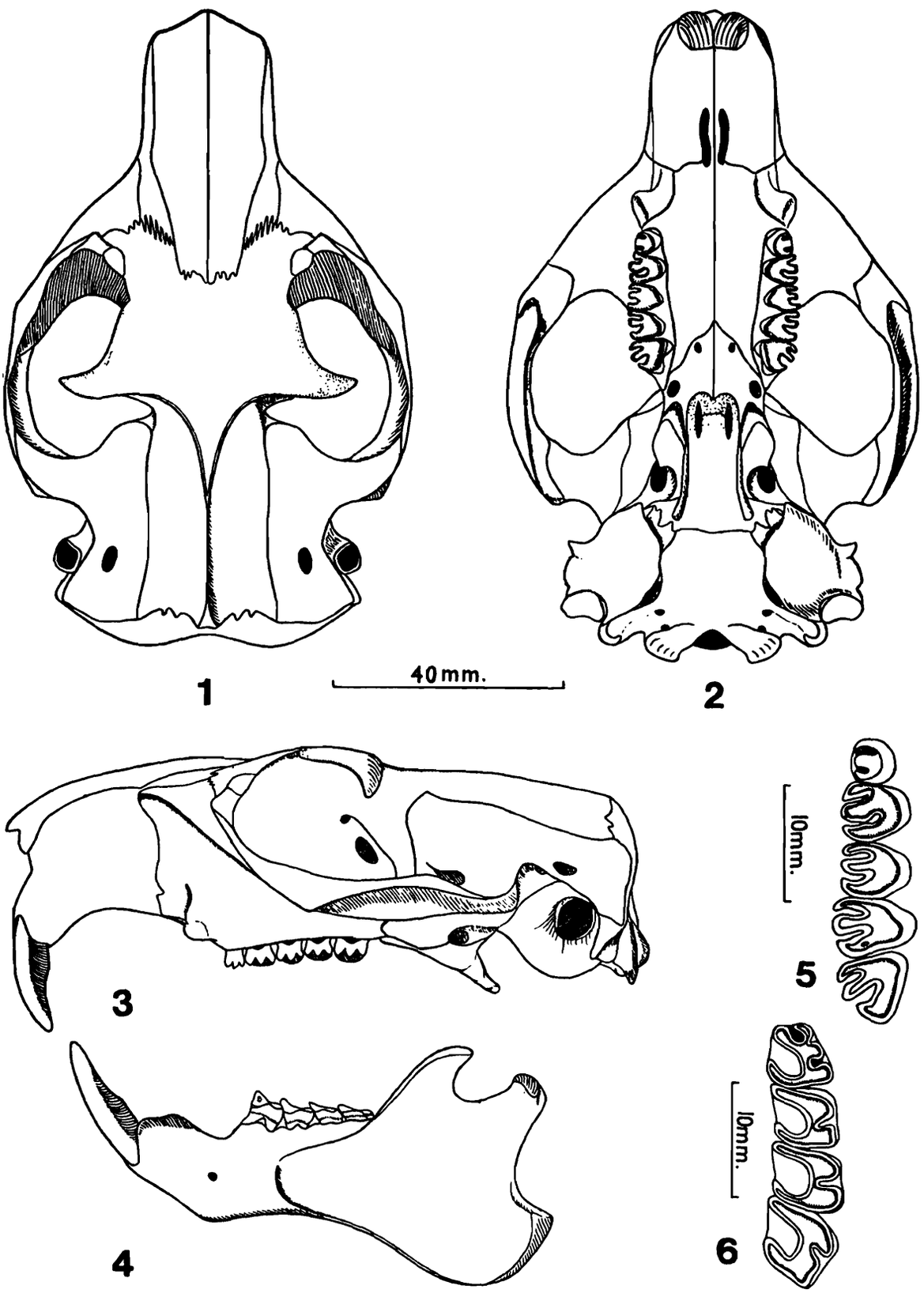
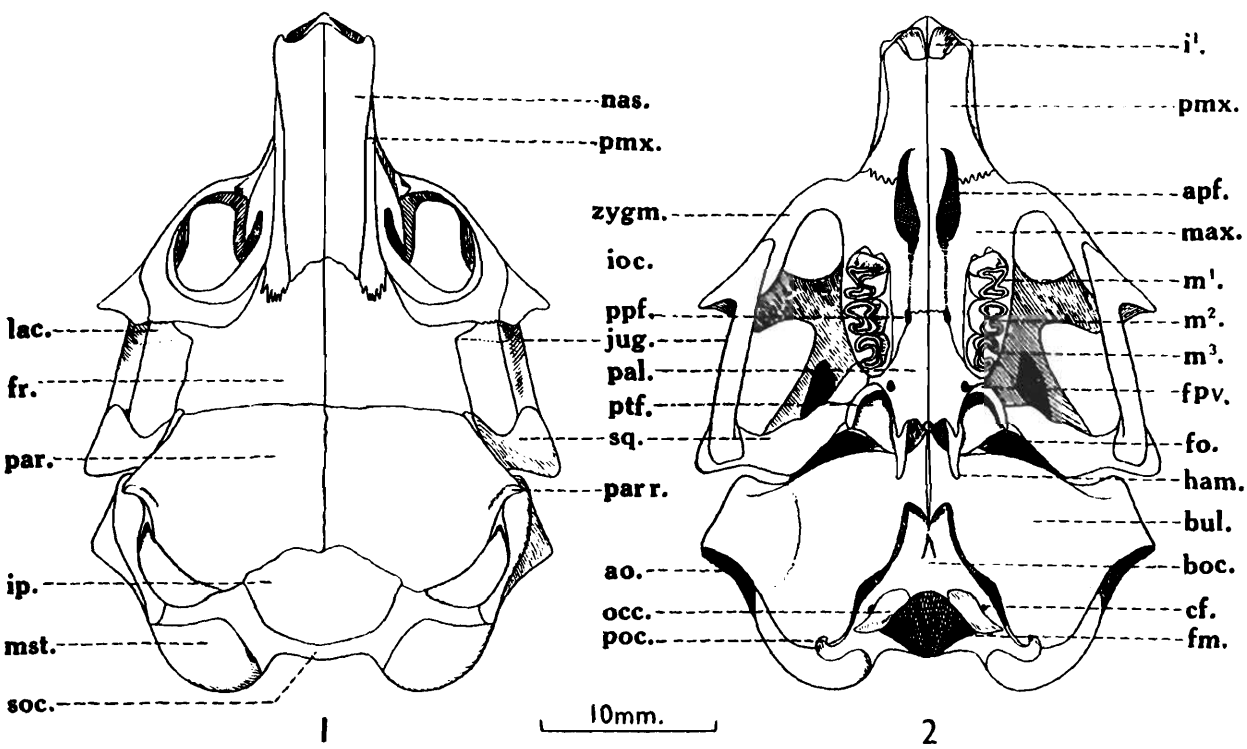

1
40mm.
2
3
10mm.
5
4
10mm.
6

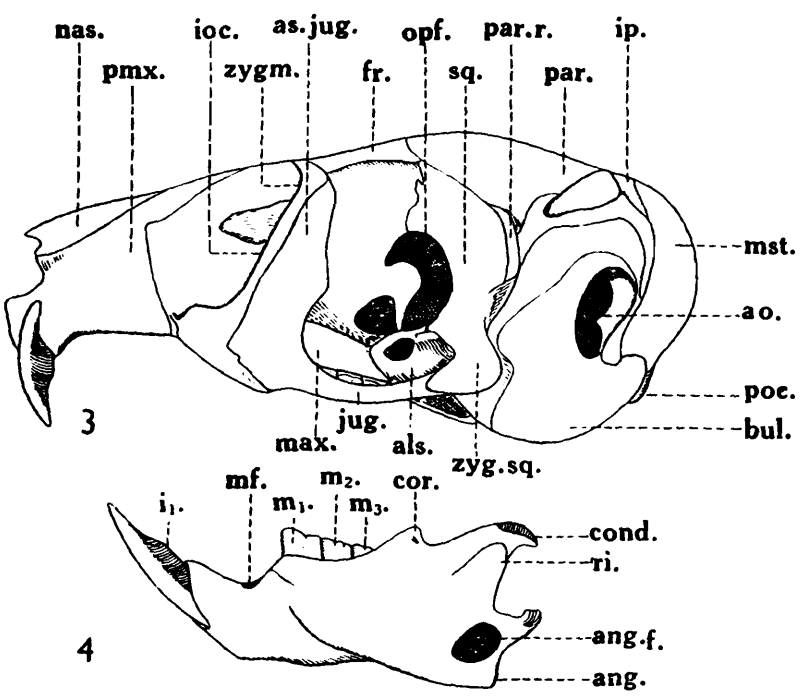
PLATE 41

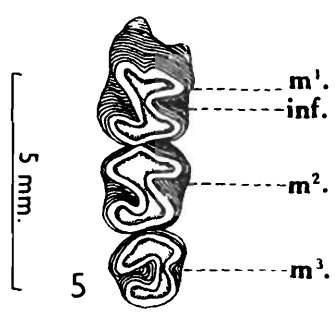
Jaculus jaculus jaculus Linnaeus

Adult, Z. S. I. Reg. No. 15271, Algeria.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.


nas.
pmx.
zygm.
ioc.
ppf.
jug.
pal.
ptf.
sq.
par r.
ao.
occ.
poc.
lac.
fr.
par.
ip.
mst.
soc.
i¹.
pmx.
apf.
max.
m¹.
m².
m³.
fpv.
fo.
ham.
bul.
boc.
cf.
fm.
10mm.
1
2


nas.
pmx.
ioc.
zygm.
as.jug.
fr.
opf.
sq.
par.r.
par.
ip.
mst.
ao.
poc.
bul.
3
max.
jug.
als.
zyg.sq.
mf.
m₂.
cor.
i₁.
m₁.
m₃.
cond.
ri.
ang.f.
ang.
4


5 mm.
m¹.
inf.
m².
m³.
5

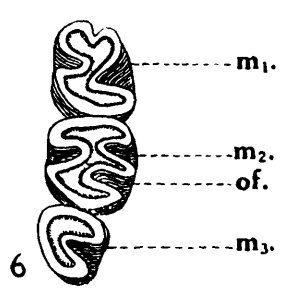

m₁.
m₂.
of.
m₃.
6

PLATE 42

Hystrix indica indica Ker

Adult, Z. S. I. Reg. No. 14484.

Fig. 1.—Dorsal view of skull.

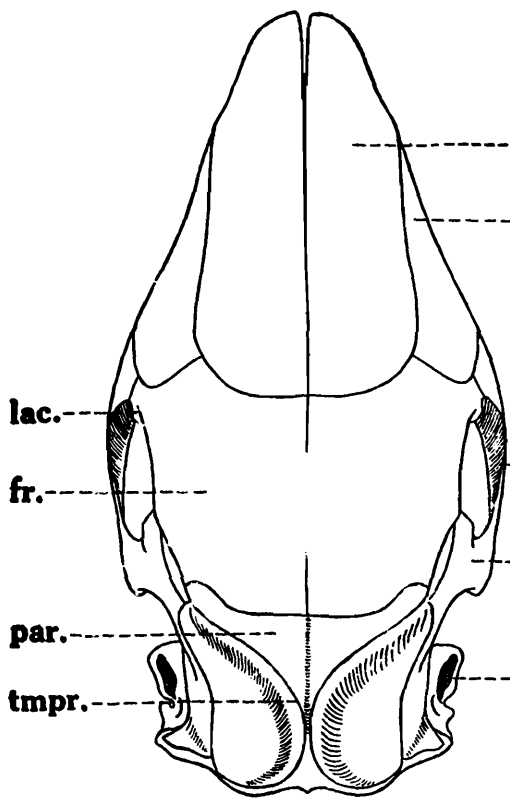
Fig. 2.—Ventral view of skull.

Fig. 3.—Lateral view of skull.

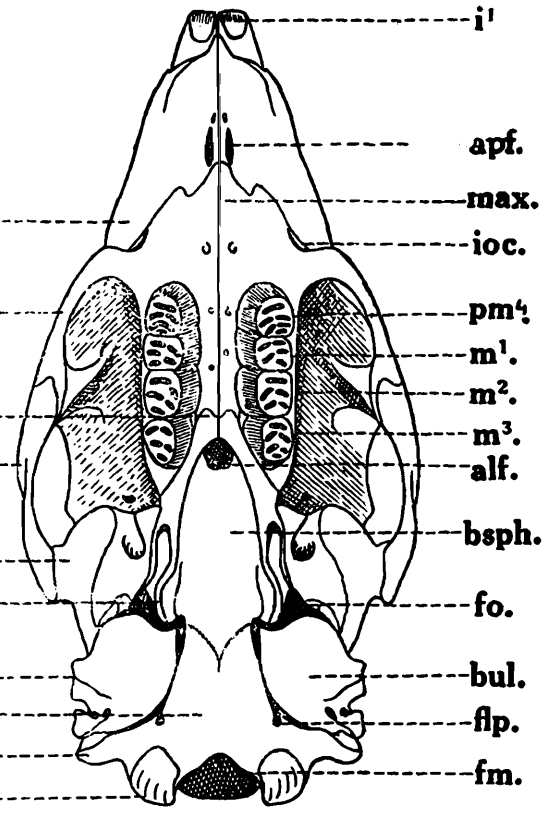
Fig. 4.—Outer side-view of left ramus of mandible.

Fig. 5.—Surface view of right upper molar crown (Sclater's Cat. No. 'm'/36-4-6-78).

Fig. 6.—Surface view of right lower molar crown (Sclater's Cat. No. 'm'/36-4-6-78).

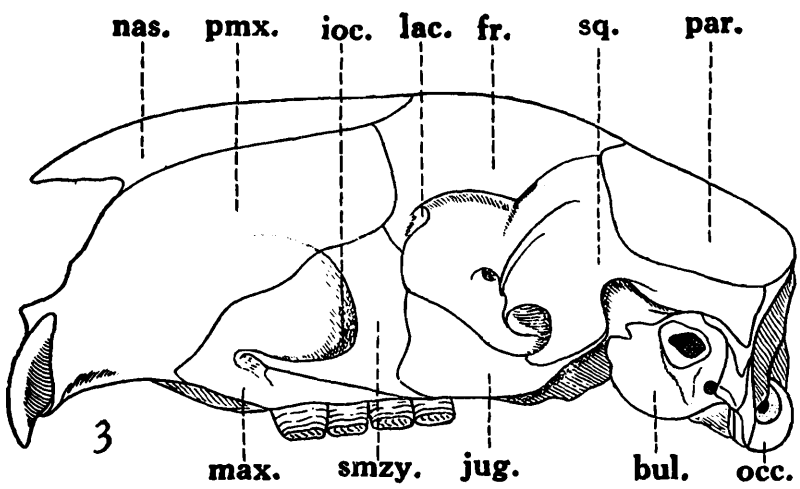


1



2

50 mm.



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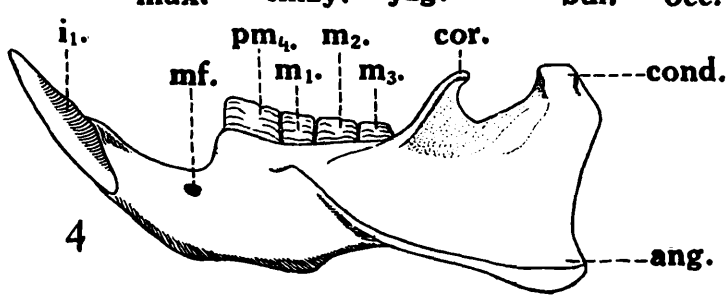
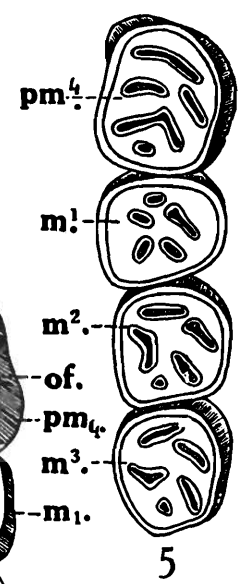


4



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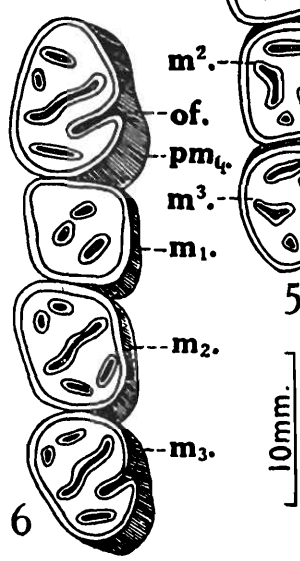

6

10mm.

PLATE 14

Tatera indica hardwickei Gray

Adult ♀, Z.S.I. Reg. No. 13134, Dharwar, Mysore, 29th October, 1911.

Fig. 1.—Dorsal view of skull.
Fig. 2.—Ventral view of skull.
Fig. 3.—Lateral view of skull.
Fig. 4.—Outer side-view of left ramus of mandible.
Fig. 5.—Surface view of right upper molar crown.
Fig. 6.—Surface view of right lower molar crown.

TABLE 1.—*Measurements (in mm.) of skulls of subspecies of* Tatera indica *Hardwicke (subfamily Gerbillinae, family Muridae)—concld.*

Abbreviations—As in text.

Name of subspecies and distribution	No. and sex	Range and Mean	O.N.L. Mol. 1.	C.B.L. Mand. 1.	O.N.L. S.m.zy.w.
(1) *Tatera indica indica*	25♂♂	Range	5·4—6·3	18·7—24·0	2·2—3·5
		Mean	5·8	20·2	3·0
India (Punjab, Rajasthan, U. P., Gujarat, M. P., Bihar), W. Pakistan and Iran.		Mean % of O.N.L.	13·7%	47·0%	7·0%
	21♀♀	Range	5·2—6·3	17·8—22·5	2·4—3·3
		Mean	5·8	19·8	2·7
		Mean % of O.N.L.	14·1%	48·0%	6·9%
(2) *Tatera indica cuvieri*	5♂♂	Range	5·5—6·2	19·5—21·8	3·4—4·4
		Mean	5·8	20·5	3·8
India (Andhra, Madras, Kerala).		Mean % of O.N.L	13·4%	47·5%	8·8%
	6 ♀♀	Range	5·5—6·2	20·2—21·4	3·5—4·1
		Mean	6·0	20·8	3·8
		Mean % of O.N.L.	13·8%	48·1%	8·8%
(3) *Tatera indica hardwickei*	7♀♀	Range	5·9—6·6	18·7—22·1	3·1—3·8
		Mean	6·4	20·4	3·4
India (Mysore).		Mean % of O.N.L.	15·0%	48·8%	8·0%
	3♀♀	Range .	6·2—6·4	19·9—21·9	3·0—3·9
		Mean .	6·3	20·8	3·5
		Mean % of O.N.L.	14·6%	48·2%	8·0%
(4) *Tatera indica ceylonica*	3♀♀	Range	5·9—6·4	19·4—22·7	3·6—3·8
Ceylon		Mean	6·1	21·3	3·7
		Mean % O.N.L.	13·75%	48·0%	8·09%
	4 ♀♀	Range .	5·8—6·25	20·7—22·1	3·4—3·9
		Mean	6·0	21·2	3·6
		Mean % of O.N.L.	13·65%	48·1%	8·6%

TABLE 2.—*Measurements (in mm.) of mandibles of subspecies of* Tatera indica *Hardwickie (subfamily Gerbillinae, family Muridae).*

Abbreviations—As in text.

Name of subspecies	No. and sex	Range and Mean	G.L.M.	Mand. l.	Max. w.	L. diast. l.	L. mol. l.
(1) *Tatera indica indica*	25 ♂♂	Range	20·1—25·8	18·7—24·0	9·2—12·2	5·4—7·2	5·0—6·5
		Mean	21·9	20·2	10·3	6·05	6·0
		Mean % of G.L.M.	—	—	47·0%	27·6%	27·5%
	20 ♀♀	Range	19·5—24·3	17·8—22·5	8·5—11·5	5·2—6·5	5·2—6·8
		Mean	21·5	19·4	10·1	5·96	6·0
		Mean % of G.L.M.	—	—	47·0%	27·7%	27·8%
(2) *Tatera indica cuvieri*	5 ♂♂	Range	20·7—23·1	19·5—21·8	8·9—10·7	5·3—6·1	5·8—6·2
		Mean	21·9	20·55	9·8	6·0	6·05
		Mean % of G.L.M.	—	—	44·5%	27·2%	27·5%
	7 ♀♀	Range	21·0—22·9	19·9—21·4	9·1—9·7	5·6—6·2	5·7—6·4
		Mean	22·0	20·6	9·5	5·9	6·1
		Mean % of G.L.M.	—	—	43·2%	26·8%	27·7%
(3) *Tatera indica hardwickei*	7 ♂♂	Range	20·1—23·8	18·8—22·1	8·8—10·7	5·2—6·4	6·1—6·8
		Mean	22·0	20·4	9·8	6·0	6·5
		Mean % of G.L.M.	—	—	44·5%	27·2%	29·5%
	3 ♀♀	Range	21·3—23·4	18·0—21·9	9·4—10·4	6·2—6·4	6·25—6·5
		Mean	22·2	20·1	9·9	6·3	6·4
		Mean % of G.L.M.	—	—	44·2%	28·3%	28·8%
(4) *Tatera indica ceylonica*	5 ♂♂	Range	20·8—25·1	19·4—22·9	8·5—11·1	5·7—7·0	6·1—6·3
		Mean	23·7	21·7	10·0	6·6	6·2
		Mean % of G.L.M.	—	—	42·2%	27·9%	26·4%
	5 ♀♀	Range	20·6—23·4	19·7—22·1	8·5—9·6	5·4—6·7	6·1—6·4
		Mean	22·2	20·9	9·2	6·1	6·3
		Mean % of G.L.M.		—	41·4%	27·4%	28·3%

TABLE 3.—*Measurements (in mm.) of skulls of family*

Abbreviations—

Name of species and distribution	No. and sex	Range and Mean	O.N.L.	C.B.L.
(1) *Meriones hurrianae* . .	29 ♂♂	Range . .	30·7—37·7	29·0—35·0
		Mean .	34·3	31·6
India (Rajasthan and Gujarat), and West Pakistan.	29 ♂♂	Range % of O.N.L.	—	—
		Mean	—	—
	17 ♀♀	Range . .	31·9—35·1	29·1—32·4
		Mean .	33·4	30·7
	17 ♀♀	Range % of O.N.L.	—	—
		Mean .	—	—
(2) *Meriones persicus persicus*	2 ♀♀	Range . . .	43·2—44·1	38·6—40·3
		Mean . .	43·6	39·5
	2 ♀♀	Range % of O.N.L.	—	—
W. Pakistan (Baluchistan) and Iran.		Mean .	—	—
(3) *Meriones persicus baptistae*	1♂	Range .	36·0	32·9
	Subadult	% of O.N.L.	—	—
W Pakistan (Baluchistan).				
(4) *Meriones libycus erythrourus*	2 ♂♂ 1 ♀	Range . . .	37·0—39·7	33·9—36·0
		Mean . . .	38·4	35·0
W. Pakistan (Baluchistan)	2 ♂♂	Range % of O.N.L.	—	—
		Mean . .	—	—
(5) *Meriones erassus swinhoei*	1 ♂	Range . .	31·8	28·8
Afghanistan.		% of O.N.L.	—	—

species of Meriones *Illiger (subfamily Gerbillinae, Muridae).*

As in text.

G.zyg.w.	L.i.o.w.	T. b. l.	Nas l.	A.p.f.	Mol. l.	Pal. l.
18·4—21·7	5·6—8·0	9·3—10·5	10·9—13·6	4·2—6·0	4·6—5·3	16·6—19·9
20·0	6·7	10·1	12·4	5·1	4·9	18·1
55·2—61·0%	18·1—23·0%	27·6—31·1%	33·8—38·6%	13·3—17·0%	13·1—15·9%	—
58·1%	19·5%	29·3%	36·2%	14·9%	14·4%	53·0%
18·2—20·0	5·7—6·8	9·1—10·6	10·9—13·7	4·4—5·6	4·5—5·0	16·6—18·7
19·25	6·35	9·75	12·0	5·0	4·9	17·9
56·0—50·4%	18·3—19·6%	27·9—31·0%	33·7—37·1%	13·5—16·0%	13·8—15·5%	—
57·7%	18·8%	29·3%	35·7%	15·1%	14·6%	53·1%
21·8—23·5	6·2—7·2	12·1—13·2	17·2—18·0	7·6—7·9	5·3—5·7	22·6—24·3
22·7	6·7	12·65	17·6	7·75	5·5	23·5
50·4—53·5%	14·3—16·5%	27·3—30·5%	39·1—41·6%	17·6%	11·9—13·2%	52·3—55·0%
52·0%	15·4%	28·9%	40·4%	17·6%	12·5%	53·7%
—	6·3	10·8	13·2	6·4	5·0	19·2
—	17·5%	30·0%	36·6%	17·7%	13·8%	53·3%
19·9—22·8	6·6—7·1	13·6—13·9	13·5—15·5	6·0—7·0	5·0—5·4	18·2—19·9
21·3	6·9	13·75	14·7	6·5	5·2	19·0
53·7—57·4%	18·0—18·3%	37·5%	36·5—39·0%	16·2%	13·5—13·6%	49·2%
55·5%	18·1%	37·5%	37·7%	16·2%	13·6%	49·2%
17·7	5·0	12·1	11·8	5·5	3·9	15·8
55·6%	15·7%	38·1%	37·8%	17·3%	12·2%	49·8%

TABLE 3.—*Measurements (in mm.) of skulls of species of* Meriones *Illiger (subfamily Gerbillinae, family Muridae).—concld.*

Abbreviations—As in text.

Name of species and distribution	Diast. l.	Rost. w.	Bim. d.	Mand. l.
(1) *Meriones hurrianae*	7·4—9·4	4·8—5·8	16·6—19·3	16·5—19·2
	8·6	5·3	17·5	17·7
ndia (Rajasthan and Gujarat), and West Pakistan.	23·4—26·3%	13·9—17·3%	—	50·0—54·3%
	25·1%	15·4%	51·0%	52·0%
	7·8—8·8	4·9—5·7	16·4—17·3	16·6—18·4
	8·3	5·25	16·9	17·5
	23·4—26·1%	15·2—16·6%	—	50·7—54·0%
	24·9%	15·7%	50·4%	52·5%
(2) *Meriones persicus persicus*	11·3—12·8	6·2—6·4	21·5—22·1	20·9—22·1
	12·0	6·3	21·8	21·5
	26·2—28·8%	14·3—14·8%	49·9—50·0	48·3—50·0%
W. Pakistan (Baluchistan) and Iran.	27·5%	14·5%	50·0%	49·2%
(3) *Meriones persicus baptistae*	9·2	4·9	19·1	17·8
	25·5%	13·6%	53·0%	49·3%
W. Pakistan (Baluchistan).				
(4) *Meriones libycus erythrourus*	8·7—10·0	5·1—5 3	20·7%	17·6—19·8
	9·3	5·2	20·7	18·7
W. Pakistan (Baluchistan).	23·5%	14·4%	56·0%	—
	23·5%	14·4%	56·0%	—
(5) *Meriones crassus swinhoei*	7·7	4·3	19·3	15·85
Afghanistan.	24·8%	13·4%	60·0%	50·0%

TABLE 4.—*Measurements (in mm.) of mandibles of species of* Meriones *Illiger (subfamily Gerbillinae, family Muridae).*

Abbreviations—As in text.

Name of species	No. and sex	Range and Mean	G. L. M.	Mand. 1	Max. w.	L. diast.	L. mol. 1.
(1) *Meriones hurrianae hurrianae*	27 ♂♂	Range	17·1—19·9	16·5—19·2	9·0—10·7	4·0—5·1	5·2—6·2
		Mean	18·4	17·7	9·8	4·4	5·7
	27 ♂♂	Range % of G.L.M.	—	—	50·0—56·0 %	22·0—25·7 %	29·0—33·0%
		Mean	—	—	52·9%	23·5%	30·7%
	17 ♀♀	Range	17·1—19·0	16·0—18·3	8·5—9·9	3·6—4·7	4·9—6·1
		Mean	18·0	17·3	9·4	4·3	5·57
	17 ♀♀	Range % of G. L. M.	—	—	50·0—55·0%	22·1—25·0%	29·0—32%
		Mean	—	—	52·0%	23·5%	30·5%
(2) *Meriones persicus persicus*	2 ♀♀	Range	22·7—23·5	21·0—22·3	10·6—11·4	6·5—6·5	5·7—6·1
		Mean	23·1	21·6	11·0	6·5	5·9
	2 ♀♀	Range % of G.L.M.	—	—	46·7—48·5%	27·6—28·6%	24·2—26·8%
		Mean	—	—	47·6%	28·1%	25·5%
(3) *Meriones persicus baptistae*	1 ♂ (Subadult)	Range	19·2	17·8	9·0	5·8	5·7
		% of G. L. M.	—	—	46·8%	30·2%	30·0%
(4) *Meriones libycus erythrourus*	2 ♂♂	Range	20·4—21·2	19·2—20·0	11·1	5·2—5·6	5·9—5·95
		Mean	20·8	19·6	11·1	5·4	5·9
	1 ♂	% of G. L. M.	—	—	52·3%	26·0%	28·5%
(5) *Meriones crassus swinhoei*	1 ♂	Range	16·4	15·85	8·3	4·0	4·25
		% of G. L. M.	—	—	50·6%	24·3%	25·9%

TABLE 5.—*Measurements (in mm.) of skulls of* Meriones hurrianae *Jerdon showing sexual and localitywise variations.*

Abbreviations—As in text.

Locality	No. and sex	Range and Mean	O. N. L.	L. i. o. w.
Waziristan	2 ♂♂	Range	37·4—37·7	6·9—7·9
		Mean	37·5	7·4
		Mean % of O. N. L.	—	19·6%
	2 ♀♀	Range	33·5—35·2	6·3—6·6
		Mean	34·4	6·45
		Mean % of O. N. L.	—	18·7%
Rajasthan	28 ♂♂	Range	31·4—36·5	5·6—8·0
		Mean	34·3	6·7
		Mean % of O. N. L.	—	19·5%
	17 ♀♀	Range	31·9—35·1	5·7—6·8
		Mean	33·4	6·35
		Mean % of O. N. L.	—	18·8%
Gujarat	4 ♂♂	Range	31·2—33·6	6·0—6·9
		Mean	31·9	6·6
		Mean % of O. N. L.	—	20·7%
	5 ♀♀	Range	30·7—33·6	5·8—6·9
		Mean	32·8	6·4
		Mean % of O. N. L.	—	19·5%

TABLE 6.—*Mandibular measurements (in mm.) of* Meriones hurrianae *Jerdon, showing the relative increase of lower diastema and lower molar lengths with the increase in length of the mandible.*

Abbreviations—As in text.

Age	No.	Range of G. L. M.	Mean G. L. M.	L. diast. 1.	L. mol. 1.	L. diast. 1./ L. mol. 1.
			(i) Males			
Juvenile	1	13·2	13·2	3·2	5·00	0·64
Do.	4	16·0—16·7	16·5	3·9	5·30	0·73
Adult	6	17·1—17·9	17·6	4·2	5·55	0·75
Do.	15	18·0—18·9	18·4	4·4	5·70	0·77
Do.	6	19·1—19·9	19·5	4·7	5·85	0·80
			(ii) Females			
Juvenile	1	15·1	15·1	3·3	5·2	0·63
Do.	2	16·1—16·8	16·4	3·8	5·3	0·71
Adult	8	17·1—17·9	17·5	4·0	5·4	0·74
Do.	8	18·2—18·8	18·4	4·5	5·7	0·78
Do.	1	19·0	19·0	4·75	6·0	0·79

TABLE 7.—*Measurements (in mm.) of (subfamily Gerbillinae,*

Abbreviations—

Name of species and distribution	No. and sex	Range and Mean	O. N. L.	C. B. L.
(1) *Gerbillus nanus nanus*	1 ♂	Range	26·8	23·7
		% of O. N. L.	—	—
W. Pakistan (Baluchistan)	1 ♀	Range	25·2	22·9
		% of O. N. L.	—	—
	3—	Range	23·9—25·7	21·2—22·8
		Mean	24·7	21·8
		Range % of O.N.L.	—	—
		Mean	—	—
(2) *Gerbillus dasyurus indus*	2 ♂♂	Range	25·5(?)*—26·1	22·9—23·2
		Mean	26·1	23·1
India (Gujarat, Rajasthan), W. Pakistan (Baluchistan).	1 ♂	% of O. N. L.	—	—
(3) *Gerbillus gleadowi gleadowi*	4 ♀♀	Range	25·7—29·2*	22·9—25·1
		Mean	27·5	23·9
India (Rajasthan), W. Pakistan (Sind).	3 ♀♀	Range % of O.N.L.	—	—
		Mean	—	—

*Skull damaged

skulls of species of Gerbillus *Desmarest family Muridae*).

As in text.

G. zyg. w.	L. i. o. w.	T. b. l.	Nas. l.	A. p. f.	Mol. l.	Pal. l.
14·0	4·5	8·8	9·5	4·2	3·2	12·9
52·2%	16·8	32·8%	35·4%	15·6%	12·1%	48·1%
13·5	4·2	8·3	8·9	4·1	3·2	12·6
53·5%	16·6%	32·9%	35·3%	16·2%	12·7%	50·0%
—	3·95—4·3	7·4—8·3	8·5—9·5	3·7—4·4	2·7—3·15	11·7—12·9
—	4·15	7·9	8·9	3·9	2·9	12·1
—	16·5—17·2%	30·5—32·3%	35·5—36·9	15·1—17·1%	11·2—12·2%	47·9—50·1%
	16·8%	31·4%	36·0%	15·9%	11·6%	49·1%
13·6	4·4—4·4	7·6—8·3	9·4—9·5	3·8—4·2	3·1—3·2	13·0—13·1
13·6	4·4	7·9	9·45	4·0	3·15	13·05
52·0%	16·8%	31·6%	36·0%	16·8%	11·8%	50·1%
14·7—15·6	5·0—5·8	7·8—8·7	9·4—10·8	3·4—4·2	3·3—3·6	12·9—14·8
15·2	5·3	8·3	10·1	3·85	3·4	14·0
51·5%	18·9—19·4%	29·9—30·9%	35·7—37·2%	13·2—14·8%	11·5—13·0%	50·0—51·4%
51·5%	19·1%	30·4%	36·5%	14·2%	12·4%	50·9%

TABLE 7.—*Measurements (in mm.) of skulls of species of* Gerbillus *Desmarest (subfamily Gerbillinae, family Muridae).—concld.*

Abbreviations—As in text.

Name of species and distribution	Diast. l.	Rost. w.	Par. w.	Mand. l.
(1) *Gerbillus nanus nanus*	6·2	3·4	12·2	12·8
	23·1%	12·6%	45·5%	47·7%
W. Pakistan (Baluchistan)	6·1	3·2	11·95	11·8
	24·4%	12·7%	47·4%	47·0%
	5·6—5·9	2·9—3·2	11·2—12·0	—
	5·8	3·0	11·5	—
	22·9·—23·7%	11·8—12·3%	45·9—47·2%	—
	23·3%	12·1%	46·6%	—
(2) *Gerbillus dasyurus indus*	6·2—6·2	3·3—3·3	11·7—12·0	12·1—12·3
	6·2	3·3	11·85	12·2
India (Gujarat, Rajasthan), W. Pakistan (Baluchistan).	23·7%	12·7%	45·8%	46·3%
(3) *Gerbillus gleadowi gleadowi*	6·3—7·5	3·6—3·9	12·9—13·9	12·0—14·0
	7·05	3·75	13·4	13·06%
India (Rajasthan) W. Pakistan (Sind).	24·5—26·0%	13·3—14·0%	47·3—50·1%	46·3—46·7%
	25·5%	13·67%	49·0%	46·5%

TABLE 8.—*Measurements (in mm.) of mandibles of species of* Gerbillus *Desmarest (subfamily Gerbillinae, family Muridae).*

Abbreviations—As in text.

Name of species	No. and sex	Range and Mean	G. L. M.	Mand. 1.	Max. w.	L. diast. 1.	L. mol. 1.
(1) *Gerbillus nanus nanus*	4 ♂♂	Range	12·9—13·7	12·2—13·0	6·7—7·1	2·8—3·1	3·0—3·8
		Mean	13·35	12·7	6·85	3·0	3·4
	4 ♂♂	Range % of G.L.M.	—	—	50·0—52·3%	20·6—23·2%	21·8—27·9%
		Mean	—	—	51·3%	22·3%	25·4%
	1 ♀	Range	12·5	11·8	6·45	3·1	3·2
		% of G. L. M.	—	—	51·6%	24·8%	25·6%
(2) *Gerbillus dasyurus indus*	1 ♂	Range	12·7	12·1	6·35	3·1	3·2
		% of G. L. M.	—	—	50%	24·4%	25·6%
	1 ♀	Range	12·9	12·3	6·5	3·4	3·6
		% of G. L. M.	—	—	50·3%	26·3%	28·3%
(3) *Gerbillus gleadowi gleadowi*	3 ♀♀	Range	13·0—14·8	12·0—14·0	6·3—6·7	3·5—4·0	3·4—3·8
		Mean	14·0	13·1	6·5	3·8	3·6
	3 ♀♀	Range % of G.L.M.	—	—	44·3—45·3%	26·7—27·3 %	25·0—26·7%
		Mean	—	—	44·8%	27·0%	25·9%

TABLE 9.—*Measurements (in mm.) of skulls of species of* Pitymys *McMurtrie (subfamily Microtinae, family Muridae).*

Abbreviations—As in text.

Name of species and distribution	No. and sex	Range and Mean	O. N. L.	C.B.L.	G.zyg.w.	L.i.o.w.	T. b. 1.	Nas. 1.
(1) *Pitymys sikimensis* . .	6♂♂	Range	24·1—26·3	23·3—26·9	14·0—15·6	3·6—4·2	5·6—6·4	6·7—8·4
		Mean . .	25·5	25·8	15·0	3·9	6·1	7·5
India (Kumaon, Sikkim, Darjeeling).	„	Range % of O.N. L.	—	—	58·0—60·0%	13·6—16·0%	22·6—25·2%	27·8—32·1%
		Mean . .	..	..	59·3%	15·3%	23·9%	29·4%
	6♀♀	Range . .	25·3—26·4	25·2—27·1	14·8—16·2	3·45—4·2	5·8—6·4	7·3—7·7
		Mean . .	26·0	26·6	15·7	3·8	6·20	7·56
	„	Range % of O.N.L.	—	—	58·0—62·9%	13·1—16·6%	22·9—24·7%	28·3—29·5%
		Mean . .	..	..	60·4%	14·6%	24·0%	29·0%
(2) *Pitymys leucurus* . . .	1♂	Range . .	24·2	26·1	16·1	3·6	7·3	6·5
India (Ladakh), Tibet and Chinese Turkestan.		% of O. N. L.	—	—	66·5%	14·8%	30·3%	26·8%

Mol. 1.	Pal. 1.	A. p. f.	Diast. 1.	Rost. w.	Maud. l.
5·5—6·5	13·5—16·1	3·7—5·2	6·9—8·2	4·7—5·1	15·0—15·8
6·05	14·9		7·9	4·9	15·3
22·8—24·9%	56·4—61·6%	15·0—20·0%	28·6—31·7%	18·6—20·3%	58·1—61·0%
23·7%	58·4%	17·2%	30·9%	19·2%	59·2%
5·8—6·3	14·8—16·1	3·8—5·2	7·6—8·4	4·9—5·4	15·1—16·1
6·15	15·54	4·4	8·1	5·1	15·76
22·3—25·1%	58·7—61·2%	14·6—19·9%	30·2—32·0%	18·7—20·4%	58·7—62·6%
23·6%	59·7%	16·9%	31·1%	19·6%	60·6%
6·0	14·9	4·0	7·7	4·3	15·7
25·0%	61·5%	16·7%	32·0%	17·7%	64·8%

TABLE 10.—*Measurements (in mm.) of mandibles of species of* Pitymys *McMurtrie*, Hyperacrius wynnei *Blanford and* Ellobius fuscocapillus *Blyth (subfamily Microtinae, family Muridae).*

Abbreviations—As in text.

Name of species	No. and sex	Range and Mean	G. L. M.	Mand. 1.	Max. w.	L. diast. 1.	L.mol. 1.
(1) *Pitymys sikimensis* . .	4♂♂	Range	15·7—16·7	15·0—15·8	8·2—8·4	3·8—4·3	6·0—6·5
		Mean	16·3	15·3	8·3	4·15	6·3
	,,	Range % of G. L. M.	—	—	49·4—50·9%	24·5—26·0%	36·8—39·8%
		Mean	—	—	50·1%	25·4%	38·5%
	6♀♀	Range	16·0—17·0	15·1—16·15	8·1	4·1—4·4	6·1—6·5
		Mean	16·75	15·76	8·1	4·2	6·35
	,,	Range % of G. L. M.	—	—	50·6%	24·1—26·2%	36·3—39·3%
		Mean	—	—	50·6%	25·0%	38·0%
(2) *Pitymys leucurus*	2♂♂	Range	16·6—16·7	15·4—15·7	8·1—8·3	4·1—4·2	5·8—6·0
		Mean	16·7	15·55	8·25	4·2	5·95
	,,	Range % of G. L. M.	—	—	48·8—49·9%	24·7—25·4%	35·0—36·1%
		Mean	—	—	49·3%	25·0%	35·55%
(3) *Hyperacrius wynnei*	2—	Range .	14·4—15·3	13·3—14·4	—	3·1—3·2	5·4—5·6
		Mean .	14·8	13·8	—	3·1	5·5
	,,	Range % of G. L.M.	—	—	—	20·9—21·5%	36·5—37·5%
		Mean .	—	—	—	21·2%	37·0%
(4) *Ellobius fuscocapillus* . . .	1—	Range .	25·0	23·1	13·3	6·3	8·0
		% of G. L. M.	—	—	53·2%	25·2%	32·0%

TABLE 11.—*Measurements (in mm.) of skulls of species of* Alticola *Blanford (subfamily Microtinae, family Muridae).—contd.*

Abbreviations—As in text.

Name of species and distribution	No. and sex	Range and Mean	O. N. L.	C. B. L.	G. zyg. w.	L. i. o. w.	T. b. l.
(1) *Alticola roylei roylei*	5♂♂	Range	24·1—25·7	23·5—25·4	14·4—14·8	3·9—4·3	5·5—6·21
		Mean	25·1	24·9	14·6	4·1	6·0
India (Kashmir) and Tibet.	,,	Range % of O.N. L.	—	—	57·5—58·5%	15·4—17·4%	22·8—24·2%
		Mean	—	—	58·0%	16·3%	23·7%
	1♀	Range	24·8	24·8	—	3·9	6·0
		% of O. N.L.	—	—	—	15·7%	24·1%
(2) *Alticola bhatnagari*	1♂	Range	24·4	25·2	—	4·1	5·7
	Paratype	% of O. N. L.	—	—	—	16·7%	23·4%
Nepal.	♀	Range	24·7	25·0	14·5	4·05	5·9
	Type	% of O. N. L.	—	—	58·7%	16·4%	23·8%
(3) *Alticola stoliczkanus stracheyi*	1♂	Range	25·6	26·7	15·1	4·0	6·2
		% of O. N. L.	—	—	59·0%	15·6%	24·4%
India (Ladak), Nepal and Tibet.	1♀	Range	26·2	26·7	15·5	4·2	6·
		% of O. N. L.	—	—	58·4%	16·0%	24·4%

TABLE 11.—*Measurements (in mm.) of skulls of species of* Alticola *Blanford (subfamily Microtinae, family Muridae).—concld.*

Abbreviations—As in text.

Name of species and distribution	Nas. l.	Mol. l.	Pal. l.	A. p. f.	Diast. l.	Rost. w.	Mand. l.
(1) *Alticola roylei roylei*	6·8—7·3	6·8—7·3	12·7—13·6	4·7—5·1	6·4—7·5	4·7—5·3	13·5—14·7
	7·2	5·7	13·1	4·85	7·15	4·9	14·26
India (Kashmir) and Tibet.	28·2—28·8%	21·9—23·0%	49·9—53·7%	18·4—20·0%	26·5—29·7%	18·2—21·0%	55·4—57·8%
	28·6%	22·6%	52.1%	19·3%	28·5%	19·5%	56·8%
	7·15	5·7	13·2	5·1	7·2	4·5	14·6
	28·8%	22·9%	53·2%	20·5%	29·0%	18·1%	58·8%
(2) *Alticola bhatnagari*	7·4	5·9	13·4	4·3	7·5	4·2	15·0
	30·2%	24·0%	54·8%	17·5%	30·6%	17·1%	61·4%
Nepal.	7·4	5·7	13·5	5·0	7·5	4·0	15·3
	30·0%	23·2%	54·6%	20·2%	30·3%	16·2%	61·9%
(3) *Alticola stoliczkanus stracheyi*	7·9	5·9	14·2	5·2	8·1	4·2	15·9
	30·8%	23·0%	55·4%	20·3%	31·8%	16·4%	62·1%
India (Ladak), Nepal and Tibet.	8·0	5·95	—	5·2	7·9	4·3	16·3
	30·5%	22·7%	—	19·9%	30·0%	16·4%	62·2%

TABLE 12.—*Measurements (in mm.) of mandibles of species of* Alticola *Blanford (subfamily Microtinae, family Muridae).*
Abbreviations—As in text.

Name of species	No. and sex	Range and Mean	G.L.M.	Mand. l.	Max. w.	L. diast. l.	L. mol. l.
(1) *Alticola roylei roylei*	5♂♂	Range	15·0—15·8	13·5—14·7	7·3—7·7	3·55—4·2	5·4—6·0
		Mean	15·55	14·3	7·6	3·8	5·8
	„	Range % of G. L.M.	—	—	46·8—49·6%	22·7—27·0%	36·3—38·1%
		Mean	—	—	48·5%	24·5%	37·4%
	3♂♂	Range	15·3—15·8	14·2—14·6	7·6—7·8	3·5—3·7	5·8—6·1
	„	Mean	15·6	14·45	7·65	3·6	5·9
	„	Range % of G. L.M.	—	—	48·4—50·3%	22·4—24·1%	37·1—38·9%
		Mean	—	—	49·4%	23·0%	38·0%
(2) *Alticola bhatnagari*	1♂	Range	16·5	15·0	7·1	4·0	6·1
	„	% of G.L.M.	—	—	43·3%	24·2%	37·2%
	1♀	Range	16·0	15·3	6·8	4·1	6·1
	„	% of G.L.M.	—	—	42·5%	25·6%	38·0%
(3) *Alticola stoliczkanus stracheyi*	1♂	Range	16·7	15·9	—	4·0	6·1
		% of G.L.M.	—	—	—	23·8%	36·6%
	1♀	Range . .	17·3	16·3	—	4·1	6·1
		% of G. L. M.	—	—	—	23·8%	34·7%

TABLE 13.—*Measurements (in mm.) of skulls of species of* Calomyscus *Thomas and* Cricetulus *Milne Edwards (subfamily Cricetinae, family Muridae).*

Abbreviations—As in text.

Name of species and distribution	No. and sex	Range and Mean	O.N.L.	C.B.L.	G. zyg. w.	L.i.o.w.	T.b.l.	Nas. l.
(1) *Calomyscus bailwardi bailwardi*	1♂	Range	25·3	22·6	12·6	3·9	4·0	9·2
		% of O.N.L.	—	—	50%	15·4%	15·8%	36·3%
Persia and W. Pakistan (Baluchistan).	1♂	Range .	25·3	22·2	—	4·2	4·2	9·1
		% of O.N.L.	—	—	—	16·6%	16·8%	36·1%
(2) *Cricetulus migratorious fulvus*	1♂	Range	31·4	29·6	16·7	4·5	5·7	11·4
		% of O.N.L.	—	—	53·7%	14·3%	18·1%	36·4%
India (Gilgit)	1♀	Range .	31·1	29·6	16·9	4·2	5·5	11·3
		% of O.N.L.	—	—	54·3%	13·6%	17·7%	36·5%

TABLE 13—*concld.*

Name of species and distribution.	Pal. 1.	A.p.f.	Mol. 1.	Diast. 1.	Occiput	Rost. w.	Intp. 1.& w.	Mand. 1.
(1) *Calomyscus bailwardi bailwardi.*	12·25	4·6	3·2	6·6	2·2	3·4	3·5 & 9·0	12·2
	48·4%	18·1%	12·6%	26·0%	8·7%	13·4%	13·8 & 35·5%	48·4%
Persia and W. Pakistan (Baluchistan).	12·0	4·6	3·6	6·2	2·5	3·6	3·2 & 8·9	11·6
	47·4%	18·1%	14·2%	24·5%	9·9%	14·2%	12·6 & 35·4%	45·8%
(2) *Cricetulus migratorius fulvus.*	15·0	5·7	4·4	9·0	4·1	5·35	2·9 & 7·1	17·1
	47·7%	18·1%	14·0%	28·6%	13·0%	17·0%	9·2 & 22·6 %	54·3%
India (Gilgit).	15·3	5·7	4·3	9·2	4·25	5·4	2·1 & 7·2	6·5
	49·2%	18·3%	13·8%	29·5%	13·6%	17·3%	6·7 & 23·0%	53·2%

TABLE 14.—*Measurements (in mm.) of skulls of* Chiropodomys gliroides *Blyth (subfamily Murinae, family Muridae).*

Abbreviations—As in text.

Name of species and distribution	No. and sex	Range and Mean	O.N.L.	C.B.L.	G. zyg. w.	L.i.o.w.	T.b.l.	Nas. l.
(1) *Chiropodomys gliroides gliroides.*	4♂♂	Range	24·7—26·0	23·2—24·1	14·1	4·3—4·9	3·6—3·7	5·6—7·7
		Mean	25·37	23·55	14·1	4·7	3·7	7·14
	,,	Range % of O.N.L.	—	—	57·3%	17·1—19·1%	14·4—14·7%	25·9—29·8%
		Mean	—	—	57·3%	18·4%	14·5%	28·1%
India (Assam) and Burma	3♀♀	Range .	22·3—24·2	20·3—22·1	—	4·4—4·7	3·3—3·7	6·4—7·6
		Mean	23·0	21·1	—	4·65	3·5	6·85
	,,	Range % of O.N.L.	—	—	—	19·6—21·0%	14·8—15·2%	28·3—31·6%
		Mean .	—	—	—	20·2%	15·1%	29·6%

TABLE 14.—*concld.*

Name of species and distribution	No. and sex	Range and Mean	Pal. l.	Mol. l.	A.p.f.	Diast. l.	Orb. l.	Rost. w.	Occiput	Mand. l.
(1) *Chiropodomys gliroides gliroides.*	4♂♂	Range	12·2—12·4	3·3—3·5	3·3—3·5	6·7—6·9	8·3—9·0	4·3—4·9	1·7—2·3	13·3—14·0
		Mean .	12·3	3·35	3·4	6·8	8·75	4·6	2·1	13·8
	„	Range % of O.N.L.	47·7—49·6%	12·7—13·6%	12·7—13·6%	26·1—27·9%	33·8—35·1%	17·1—19·1%	7·0—9·0%	53·3—55·8%
		Mean .	48·7%	13·2%	13·3%	26·7%	34·4%	18·2%	8·2%	54·65%
India (Assam) and Burma	3♀♀	Range	10·9—11·4	3·4—3·1	3·0—3·1	6·0—6·1	7·5—8·1	4·1—4·3	1·8—2·0	12·05—13·3
		Mean	11·1	3·4	3·1	6·1	7·8	4·2	1·9	12·6
	„	Range % of O.N.L.	47·3—48·6%	14·4—15·2%	12·4—13·9%	25·4—26·9%	33·2—35·4%	16·9—19·2%	7·6—9·1%	54·0—55·3%
		Mean .	48·0%	14·9%	13·2%	26·3%	34·0%	18·4%	8·3%	54·8%

TABLE 15.—*Measurements (in mm.) of mandibles of subspecies of* Calomyscus *Thomas,* Cricetulus *Milne Edwards (subfamily Cricetinae) and* Chiropodomys *Peters (subfamily Murinae).*

Abbreviations—As in text.

Name of species	No. and sex	Range and Mean	G.L.M.	Mand. l.	Max. w.	L. mol. l.	L. diast. l.
(1) *Calomyscus bailwardi bailwardi*	1♂	Range	13·3	12·2	6·6	3·2	3·3
		% of G.L.M.	—	—	50·0%	24·0%	24·8%
	1♀	Range	12·5	11·6	6·6	3·3	3·1
		% of G.L.M.	—	—	52·8%	26·4%	24·8%
(2) *Cricetulus migratorius fulvus*	1♀	Range	17·2	16·5	8·5	4·6	5·2
		% of G.L.M.	—	—	49·8%	26·7%	30·2%
	1♂	Range	17·85	17·1	9·0	4·3	5·6
		% of G.L.M.	—	—	50·3%	24·4%	31·4%
(3) *Chiropodomys gliroides gliroides*	5♂♂	Range	14·2—14·8	13·3—14·3	6·6—7·2	3·1—3·5	3·1—3·3
		Mean	14·4	13·8	7·0	3·3	3·2
	„	Range % of G. L.M.	—	—	46·1—50·3%	21·7—24·4%	21·5—23·1%
		Mean	—	—	48·5%	23·1%	22·4%
	4♀♀	Range	12·6—14·2	12·0—13·3	6·0—6·4	3·3—3·5	3·0—3·2
		Mean	13·15	12·6	6·2	3·35	3·1
	„	Range % of G.L.M.	—	—	45·0—47·2%	24·6—26·2%	22·5—24·6%
		Mean	—	—	46·2%	25·5%	23·6%

TABLE 16.—*Measurements (in mm.) of skulls of species of* Rattus *Frisch (subfamily Murinae, family Muridae).*

Abbreviations.—As in text.

Name of species and distribution	No. and sex	Range and Mean	O.N.L.	C.B.L.	G. zyg. w.
(1) *Rattus rattus arboreus*	8 ♂♂	Range	38·9—41·4	37·4—38·8	18·5—20·2
		Mean	40·33	38·1	19·5
India (U. P., Bihar, Bengal) and Nepal	,,	Range % of O.N.L.	—	—	45·8—50·0%
		Mean	—	—	48·6%
	6 ♀♀	Range	38·3—39·1	35·5—37·0	18·4—19·2
		Mean	38·7	36·5	18·9
	,,	Range % of O.N.L.	—	—	47·1—50·0%
		Mean	—	—	48·75%
(2) *Rattus fulvescens fulvescens.*	8 ♂♂	Range	36·1—39·2	32·0—35·1	16·6
		Mean	37·64	33·84	16·6
	,,	Range % of O.N.L.	—	—	46·0%
India (U.P., Assam), Nepal, Sikkim and Burma.		Mean	—	—	46·0%
	8 ♀♀	Range	34·9—38·0	31·2—33·8	15·6—15·8
		Mean	36·3	32·4	15·7
	,,	Range % of O.N.L.	—	—	43·9—44·3%
		Mean	—	—	44·1%
(3) *Rattus rajah surifer*	4 ♂♂	Range	43·4—47·3	38·6—43·0	18·5—21·5
		Mean	45·2	40·45	20·0
	,,	Range % of O.N.L.	—	—	41·7—45·4%
		Mean	—	—	43·5%
S. Burma (Tenasserim) and Mergui Archipelago.					
	5 ♀♀	Range	39·5—42·8	35·2—38·2	17·3
		Mean	40·5	36·2	17·3
	,,	Range % of O.N.L.	—	—	42·9%
		Mean	—	—	42·9%

TABLE 16.—*Measurements (in mm.) of skulls of species of* Rattus

Abbreviations—

Name of species and distribution	No. and sex	Range and Mean	L.i.o.w.	T.b.l.	Nas.l.
(1) *Rattus rattus arboreus*	8 ♀♀	Range	5·3—6·0	6·8—7·5	13·1—15·3
		Mean	5·7	7·23	14·4
India (U.P., Bihar, Bengal) and Nepal	,,	Range % of G.N.L.	13·6—14·4%	16·9—18·5%	33·6—36·8%
		Mean	14·0%	17·86%	35·5
	6 ♀♀	Range	5·4—5·7	6·6—7·1	12·4—14·2
		Mean	5·5	6·8	13·4
	,,	Range % of O.N.L.	13·8—14·7%	16·9—18·1%	32·0%—36·6%
		Mean	14·2%	17·5%	34·5%
(2) *Rattus fuivescers fulvescent.*	8 ♀♀	Range	4·9—6·1	4·5—4·9	13·0—14·8
		Mean	5·7	4·74	13·9
	,,	Range % of O.N.L.	13·2—16·2%	12·0—13·0%	36·0—37·7%
India (U.P., Assam), Nepal, Sikkim and Burma.		Mean	15·2%	12·6%	37·0%
	8 ♀♀	Range	5·1—6·0	4·5—5·0	12·4—14·0
		Mean	5·5	4·65	13·3
	,,	Range % of O.N.L.	13·8—16·8%	12·3—14·1%	34·9—37·8%
		Mean	15·2%	12·8%	36·7%
(3) *Rattus rajah surifer*	4 ♂♂	Range	6·3—7·0	4·8—5·2	17·0—18·3
		Mean	6·55	4·95	17·65
	,,	Range % of O.N.L.	13·4—17·4%	10·3—11·3%	38·8—39·2%
		Mean	15·0%	10·9%	39·0%
S. Burma (Tenasserim) and Mergui Archipelago.					
	5 ♀♀	Range	6·1—6·8	4·4—4·8	14·4—15·9
		Mean	6·5	4·6	14·8
	,,	Range % of O.N.L.	15·4—16·8%	11·0—11·7%	35·9%—36·4%
		Mean	16·1%	11·3%	36·3%

Frisch (*subfamily Murinae, family Muridae*)—contd.

As in text.

Pal. l.	Mol. l.	A. p.f.	Diast. l.	Rost. w.
20·7—22·4	6·0—6·6	6·3—7·1	9·5—10·7	6·3—7·0
21·5	6·34	6·8	10·15	6·65
52·4—54·7%	15·2—16·3%	15·6—17·6%	24·2—25·5%	15·7—16·8%
53·2%	15·7%	16·6%	15·1%	16·4%
20·1—21·1	5·8—6·4	6·4—6·75	9·3—10·2	6·3—7·0
20·6	6·05	6·6	9·9	6·55
51·9—54·6%	15·0—16·3%	16·7—17·4%	24·2—26·2%	16·4—17·9%
53·2%	15·6%	17·0%	25·5%	16·9%
16·8—18·8	5·5—6·0	5·2—6·4	8·4—10·0	5·3—6·4
18·1	5·65	5·66	9·2	5·9
46·4—49·1%	14·2—15·5%	13·4—16·3%	23·2—25·5%	14·1—16·9%
48·1%	15·0%	15·0%	24·4%	15·7%
16·7—18·5	5·3—5·7	4·6—6·1	8·3—9·3	5·4—6·1
17·4	5·46	5·5	8·9	5·7
46·9· 49·9%	14·2—16·0%	12·9—16·5%	23·7—25·1%	14·6—17·1%
48·0%	15·1%	15·1%	24·4%	15·8%
20·4—22·7	5·7—6·8	5·1—6·7	11·4—13·5	7·7—8·5
21·4	6·3	6·1	12·1	8·1
46·2—48·0%	12·8—14·7%	12·2—14·6%	25·9—28·5%	17·0—18·4%
47·2%	13·8%	13·6%	26·8%	17·7%
18·3—19·4	5·7—6·4	4·8—5·7	10·2—11·3	6·6—7·2
19·0	6·1	5·2	10·5	6·8
45·5—48·0%	14·4—15·7%	12·0—14·0%	25·2—26·3%	16·7—17·0%
47·0%	15·0%	12·8%	25·8%	16·8%

TABLE 16.—*Measurements (in mm.) of skulls of species of* Rattus *Frisch (subfamily Murinae, family Muridae.)*—contd.

Abbreviations—As in text.

Name of species and distribution	No. and sex	Range and Mean	Occiput	Orb.1	Mand. 1.
(1) *Rattus rattus arboreus*	8 ♀♀	Range	3·9—4·8	13·5—14·1	19·7—21·7
		Mean	4·5	13·8	20·7
India (U.P.; Bihar, Bengal) and Nepal	,,	Range % of O.N.L.	9·7—12·0%	33·1—35·2%	49·1—52·3%
		Mean	11·1%	34·16%	51·3%
	6 ♂♂	Range	4·0—4·3	12·7—13·2	19·5—20·5
		Mean	4·1	13·0	20·0
		Range % of O.N.L.	10·2—11·2%	32·7—34·1%	50·3—52·8%
		Mean	10·6%	33·5%	51·5%
(2) *Rattus fulvescens fulvescens,*	8 ♂♂	Range	3·3—5·2	11·1—12·4	16·3—19·4
		Mean	4·1	11·6	17·9
	,,	Range % of O.N.L.	8·5—13·5%	29·6—32·4%	44·5—49·5%
India (U.P.,Assam) Nepal, Sikkim and Burma		Mean	10·9%	30·8%	47·5%
	8 ♀♀	Range	3·5—4·9	10·6—11·4	16·1—18·2
		Mean	4·2	11·0	17·3
	,,	Range % of O.N.L.	9·6—13·1%	29·9—30·9%	46·1—49·2%
		Mean	11·4%	30·45%	47·5%
(3) *Rattus rajah surifer*	4 ♂♂	Range	5·8—6·4	12·7—14·3	21·1—23·3
		Mean	6·0	13·4	21·9
	,,	Range % of O.N.L.	12·8—13·5%	28·1—30·9%	47·2—49·2%
S. Burma (Tenasserim) and Mergui Archipelago.		Mean	13·2%	29·6%	48·2%
	5 ♀♀	Range	5·1—5·8	11·4—13·1	18·3—20·0
		Mead	5·6	12·2	19·3
	,,	Range % of O.N.L.	12·9—14·6%	28·4—31·1%	46·4—48·7%
		Mean	14·0%	30·0%	47·9%

TABLE 16.—*Measurements (in mm.) of skulls of species of* Rattus *Frisch (subfamily Murinae, family Muridae.)*—contd.

Abbreviations—As in text.

Name of species and distribution	No. and sex	Range and Mean	O.N.L.	C.B.L.	G. zyg. w.
(4) *Rattus cutchicus siva*	4 ♂♂	Range	32·3—33·8	27·9—29·6	15·1—15·4
		Mean	33·0	28·7	15·25
	,,	Range % of O.N.L.	—	—	44·8—45·5%
India (Mysore)		Mean	—	—	45·2%
	2 ♀♀	Range	33·3—33·6	29·3—29·4	15·0—15·9
		Mean	33·4	29·3	15·45
	,,	Range % of O.N.L.	—	—	44·6—47·7%
		Mean	—	—	46·9%
(5) *Rattus bowersi mackenziei.*	♂♂	Range	47·4—49·0	48·0	23·45
		Mean	48·2	48·0	23·45
	,,	Range % of O.N.L.	—	—	47·8%
India (Assam & Manipur) & W. Burma.		Mean	—	—	47·8%
	3 ♀♀	Range	43·8—46·5	42·5—44·7	21·5—22·7
		Mean	45·4	43·7	22·1
	,,	Range % of O.N.L.	—	—	48·8—49·0%
		Mean	—	—	48·9%
(6) *Rattus manipulus manipulus*	3 ♂♂	Range	37·6—41·0	36·7—39·8	19·3—20·5
		Mean	38·8	38·0	19·9
India (Assam & Manipur) & W. Burma.	,,	Range % of O.N.L.	—	—	50·1—51·0%
		Mean	—	—	50·5%
	6 ♀♀	Range	35·8—37·5	34·6—36·2	18·7—19·9
		Mean	36·6	35·8	19·2
	,,	Range % of O.N.L.	—	—	51·3 —53·6%
		Mean	—	—	52·5%

TABLE 16.—*Measurements (in mm.) of skulls of species of* Rattus

Abbreviation—

Name of species and distribution	No. and sex	Range and Mean	L. i.o.w.	T.b.i.	Nas. 1.
(4) *Rattus cutchicus siva*	4 ♂♂	Range	4·6—5·0	4·5—5·1	12·6—13·5
		Mean	4·8	4·75	13·0
	,,	Range % of O.N.L.	14·1—14·7%	13·3—15·1%	39·0—40·0%
India (Mysore).		Mean	14·4%	14·4%	39·3%
	2 ♀♀	Range	4·4—4·6	5·1—5·2	13·0—13·4
		Mean	4·5	5·15	13·2
	,,	Range % of O.N.L.	13·1—13·8%	15·1—15·6%	39·0—39·9%
		Mean	13·5%	15·3%	39·0%
(5) *Rattus bowersi mackenziei.*	♂♂	Range	6·7—6·9	6·5—6·5	18·9—20·0
		Mean	6·8	6·5	19·5
	,,	Range % of O.N.L.	14·1—14·2%	13·3—13·7%	40·0—40·8%
India (Assam & Manipur) and W. Burma.		Mean	14·2%	13·5%	40·4%
	3 ♀♀	Range	6·7—7·0	6·0—6·3	16·8—18·9
		Mean	6·85	6·25	17·9
	,,	Range % of O.N.L.	14·7—16·0%	13·6—13·8%	38·3—40·6%
		Mean	15·1%	13·7%	39·4%
(6) *Rattus manipulus manipulus.*	3 ♂♂	Range .	6·1—6·4	5·6—5·8	14·9—17·3
		Mean	6·3	5·7	15·8
	,,	Range % of O.N.L.	15·6—16·8%	14·1—14·9%	39·4—42·2%
India (Assam & Manipur) and W. Burma.		Mean	16·2%	14·6%	40·6%.
	6 ♀♀	Range	6·0—6·3	5·4—5·6	13·9—15·0
		Mean	6·07	5·5	14·4
	"	Range % of O.N.L.	16·2—17·4%	14·8—15·3%	38·1—40·5%
		Mean .	16·6%	15·0%	39·4%

Frisch (*Subfamily Murinae, family Muridae*).—contd.

As in text.

Pal. 1.	Mol. 1.	A. p.f.	Diast. 1.	Rost. w.
15·0—16·2	5·0—5·4	6·5—7·3	7·3—8·0	4·9—5·0
15·8	5·15	6·85	7·6	4·95
46·3—48·6%	15·4—16·0%	20·2—21·6%	22·4—23·7%	14·7—15·1%
47·6%	15·6%	20·7%	23·0%	14·9%
16·1—16·3	5·2—5·2	6·7—7·4	8·1—8·1	5·0—5·1
16·2	5·2	7·0	8·1	5·05
48·5—48·5%	15·6—15·7%	20·0—22·2%	24·1—24·3%	14·8—15·3%
48·5%	15·6%	21·1%	24·2%	15·0%
25·6—26·4	7·7—8·0	8·9—9·2	13·8—13·9	8·5—8·7
26·0	7·85	9·05	13·85	8·6
54·0—54·0%	16·2—16·3%	18·7—18·7%	28·1—29·3%	17·7—17·9%
54·0%	16·25%	18·7%	28·7%	17·8%
23·8—24·5	7·7—7·9	7·5—8·3	12·7—13·3	7·8—8·4
24·2	7·8	7·9	13·05	8·05
52·5—54·3%	16·5—17·9%	17·0—18·1%	28·0—29·0%	17·3—18·0%
53·3%	17·1%	17·4%	28·7%	17·7%
20·2—22·0	5·4—5·8	6·5—7·4	11·8—13·5	6·5—7·2
20·9	5·6	7·1	12·5	6·95
53·4—54·2%	13·4—15·3%	17·2—19·5%	31·2—32·9%	17·2—18·8%
53·7%	14·3%	18·3%	32·1%	17·9%
19·0—20·3	5·3—6·1	6·2—6·6	11·3—12·1	6·3—6·8
19·9	5·6	6·4	11·7	6·5
53·2—54·9%	14·5—16·6%	17·0—18·0%	31·3—32·2%	17·3—18·5%
54·3%	15·2%	17·5%	31·9%	17·7%

TABLE 16.—*Measurements (in mm.) of skulls of species of* Rattus *Frisch (subfamily Murinae, family Muridae.)*—concld.

Abbreviations—As in text.

Name of species and distribution	No. and sex	Range and Mean	Occiput	Orb. 1	Mand. 1
(4) *Rattus cutchicus siva*	4 ♂♂	Range	3·0—4·1	10·9—11·6	15·6—16·6
		Mean	3·65	11·4	16·2
	,,	Range % of O.N.L.	9·2—12·1%	33·5—34·9%	48·3—49·5%
ndia (Mysore)		Mean	11·0%	34·1%	49·0%
	2 ♀♀	Range	3·6—3·7	11·0—11·3	16·5—16·6
		Mean	3·65	11·2	16·6
	,,	Range % of O.N.L.	10·9—11·0%	32·8—34·0%	49·5—49·5%
		Mean	11·0%	33·4%	49·5%
(5) *Rattus bowersi mackenziei*	♂♂	Range	7·3—7·7	15·0—15·4	26·4—27·0
		Mean	7·5	15·2	26·7
	,,	Range % of O.N.L.	14·9—16·2%	31·4—31·6%	55·1—55·7%
India (Assam & Manipur) & W. Burma.		Mean	15·5%	31·5%	55·4%
	3 ♀♀	Range	5·8—7·0	14·4—15·6	24·4—26·4
		Mean	6·45	14·9	25·3
	,,	Range % of O.N.L.	13·3—15·0%	32·3—33·5%	54·5—56·6%
		Mean	14·1%	32·9%	55·6%
(6) *Rattus manipulus manipulus*	3 ♂♂	Range	5·9—6·0	11·8—12·6	20·2—21·6
	,,	Mean	6·0	12·15	54·0
		Range % of O.N.L.	14·6—15·9%	30·7—31·8%	52·7—55·5%
India (Assam & Manipur) & W. Burma.		Mean	15·4%	31·3%	54·0%
	6 ♀♀	Range	5·5—6·0	11·5—12·0	19·8—20·4
		Mean	5·7	11·8	20·2
	,,	Range % of O.N.L.	15·0—16·4%	31·5—33·3%	54·4—56·0%
		Mean	15·5%	32·3%	55·2%

TABLE 17.—*Measurements (in mm.) of mandibles of species of* Rattus *Frisch (subfamily Murinae, family Muridae).*

Abbreviations—As in text.

Name of species	No. and sex	Range and Mean	G.L.M.	Mand. 1.	Max. w.	L. mol. 1.	L. diast 1.
(1) *Rattus rattus arboreus*	8 ♂♂	Range	20·4—22·6	19·7—21·7	10·6—12·4	6·0—6·8	5·0—6·0
		Mean	21·8	20·8	11·66	6·5	5·36
	,,	Range % of G.L.M.	—	—	52·2—55·4%	28·2—21·3%	23·1—27·0%
		Mean	—	—	54·2%	29·8%	24·7%
	6 ♀♀	Range	20·3—22·0	19.5—20·5	11·0—12·1	6·0—6·4	4·9—5·8
		Mean	21·1	20·0	11·5	6·25	5·4
	,,	Range % of G.L.M.	—	—	52·8—55·7%	28·4—31·0%	23·7—27·9%
		Mean	—	—	54.7%	29.4%	25·3%
(2) *Rattus fulvescens fulvescens*	♂♂	Range	17·3—20·0	16·3—19·4	9·1	5·5—5·8	4·0—5·4
		Mean	18·8	17·9	9·1	5·64	4·74
	,,	Range % of G.L.M.	—	—	49·2%	27·5—32·6%	21·9—27·1%
		Mean	—	—	49·2%	30·0%	25·1%
	8 ♀♀	Range	17·0—18·8	16·1—18·2	8·5—9·1	5·1—5·7	4·2—5·0
		Mean	18·2	17·3	8·8	5·45	4·5
	,,	Range % of G.L.M.	—	—	48·0—50·0%	27·8—32·3%	23·1—26·6%
		Mean	—	—	48·8	30·16%	25·0%

TABLE 17.—*Measurement (in mm:) of mandibles of species of* Rattus *Frisch (subfamily Murinae, family Muridae)*.—contd.

Abbreviations—As in text.

Name of species	No. and sex	Range and Mean	G.L.M.	Mand. 1.	Max. w.	L. mol. 1	L. diast 1.
(3) *Rattus rajah surifer*	4 ♂♂	Range	22·4—25·0	21·2—23·3	10·2—11·3	5·7—6·5	6·0—7·2
		Mean	23·5	21·9	10·8	6·1	6·5
	,,	Range % of G.L.M.	—	—	45·2—47·6%	23·4—27·7%	26·7—28·8%
		Mean	—	—	46·1%	26·05%	27·5%
	5 ♀♀	Range	19·4—21·4	18·3—20·0	9·2—9·7	5·8—6·3	5·2—5·9
		Mean	20·5	19·3	9·4	6·0	5·5
	,,	Range % of G.L.M.	—	—	45·3—47·6%	28·5—30·0%	26·2—27·5%
		Mean	—	—	46·1%	29·4%	26·8%
(4) *Rattus cutchicus siva*	4 ♂♂	Range	16·6—17·5	15·6—16·6	7·6—8·0	4·6—4·9	3·7—4·1
		Mean	17·0	16·2	7·8	4·8	3·9
	,,	Range % of G.L.M.	—	—	43·4—46·7%	27·4—28·9%	21·5—23·6%
		Mean	—	—	45·6%	28·1%	22·9%
	2 ♀♀	Range	17·5—17·9	16·5—16·7	8·0—8·1	4·8—5·0	4·1—4·4
		Mean	17·7	16·6	8·05	4·9	4·25
	,,	Range % of G.L.M.	—	—	45·5—45·7%	27·4—28·2%	23·0—25·0%
		Mean	—	—	45·6%	27·8%	24·0%

TABLE 17—*concld.*

(5) *Rattus bowersi mackenziei*	2 ♂♂	Range	27·8—28·0	26·4—27·0	14·0—14·1	7·7—8·3	7·3—7·6
		Mean	27·9	26·7	14·05	8·0	7·5
	„	Range % of G.L.M.	—	—	50·3—50·5%	27·8—29·6%	26·1—27·6%
		Mean	—	—	50·4%	28·7%	26·8%
	3 ♀♀	Range	25·7—27·6	24·4—26·4	12·6—14·4	7·6—7·9	6·7—7·4
		Mean	26·6	25·3	13·3	7·7	7·1
	„	Range % of G.L.M.	—	—	48·3—52·1%	27·9—30·7%	26·0—27·1%
		Mean	—	—	49·8%	29·1%	26·6%
(6) *Rattus manipulus manipulus*	4 ♂♂	Range	21·5—23·3	20·2—21·6	11·0—12·6	5·6—5·7	5·9—6·5
		Mean	22·5	21·1	11·9	5·65	6·15
		Range % of G.L.M.	—	—	51·1—54·0%	24·0—26·0%	27·0—27·9%
		Mean	—	—	52·5%	25·0%	27·3%
	5 ♀♀	Range	21·2—21·9	19·8—20·4	10·9—11·45	5·5—6·2	5·5—6·5
		Mean	21·5	20·2	11·1	5·8	6·0
		Range % of G.L.M.	—	—	51·1—52·3%	25·8—28·4%	25·9—30·0%
		Mean	—	—	51·5%	26·9%	28·0%

TABLE 18.—*Measurements (in mm.) of skulls of subspecies* Bandicota

Abbreviations—

Name of subspecies and distribution	No. and sex	Range and Mean	O.N.L.	C.B.L.	G. zyg. w.
(1) *Bandicota bengalensis bengalensis*	6 ♂♂	Range	38·5—42·3	39·8—44·7	24·1—25·7
		Mean	40·3	42·4	25·0
	,,	Range % of O.N.L.	—	—	59·4—64·9%
		Mean	—	—	62·0%
India (Orissa, Bengal, Assam), Nepal, Bhutan & W. Burma.	10♀♀	Range	37·2—41·1	38·7—42·5	22·8—25·7
		Mean	38·9	40·5	24·2
	,,	Range % of O.N.L.	—	—	60·6—65·5%
		Mean	—	—	62·6%
(2) *Bandicota bengalensis kok*	8 ♂♂	Range	37·4—40·9	38·7—41·6	21·5—24·8
		Mean	38·8	40·4	23·4
	,,	Range % of O.N.L.	—	—	57·5—63·2%
		Mean	—	—	59·7%
India (Southern and Western) & W. Pakistan (Sind).	8 ♀♀	Range	36·0—39·7	36·9—41·0	21·6—23·6
		Mean	37·5	38·9	22·8
	,,	Range % of O.N.L.	—	—	59·0—60·9%
		Mean	—	—	60·0%
(3) *Bandicota bengalensis wardi*	1 ♂	Range	41·0	42·6	25·0
		% of O.N.L.	—	—	60·9%
India (Kashmir).	2 ♀♀	Range	37·7—42·6	39·7—44·7	—
		Mean	40·2	42·2	—
	,,	Range % of O.N.L.	—	—	—
		Mean	—	—	—
(4) *Bandicota bengalensis varius*	2 ♂♂	Range	39·0—44·2	40·0—46·1	22·5
		Mean	41·6	43·1	22·5
	,,	Range % of O.N.L.	—	—	57·7%
Burma (Toungoo).		Mean	—	—	57·7%

bengalensis *Gray and Hardw.* (*subfamily Murinae family Muridae,*)

As in text.

L.i.o.w.	T.b.1.	Nas. 1.	Pal. 1.	Mol. 1.	A.p.f.	Diast. 1
5·8—6·5	8·6—9·5	11·9—13·6	23·7—26·6	7·0—7·6	7·1—8·5	1 1·0—14·2
6·1	9·1	12·5	25·0	7·3	7·9	12·6
14·0—17·0%	21·5—23·6%	28·8—33·3%	61·5—63·1%	16·5—18·8%	18·4—20·0%	28·7—33·5%
15·2%	22·5%	30·9%	62·1%	18·0%	19·5%	31·1%
5·6—6·7	8·4—9·3	11·0—12·4	22·4—25·0	6·7—7·7	7·0—8·6	11·2—12·8
6·1	8·8	11·75	23·8	7·25	7·8	12·0
14·9—16·4%	22·1—23·2%	29·2—31·2%	59·4—63·0%	17·8—19·3%	18·8—22·2%	29·3—32·0%
15·7%	22·6%	30·2%	61·4%	18·6%	20·1%	30·6%
5·6—6·1	8·1—8·6	11·6—13·4	22·7—24·7%	6·8—7·8	6·7—7·9	11·1—12·7%
5·9	8·3	12·2	23·7	7·35	7·5	12·0
14·2—15·9%	20·5—22·1%	30·3—32·7%	59·1—62·1%	16·6—20·6%	17·9—20·4%	29·6—31·7%
15·1%	21·3%	31·4%	60·8%	18·9 %	19·2%	30·7%
5·6—5·6	8·1—8·7	10·6—12·3	21·5—23·5%	6·9—7·7%	6·5—7·5%	1 ·4—11·5%
5·8	8·3	11·3	22·3	7·4	7·06	11·0
14·8—16·3%	20·6—23·5%	28·8—31·5%	58·1—59·9%	19·2—20·7%	17·3—20·4%	28·7—30·6%
15·4%	22·2%	30·06%	59·4%	19·7%	18·8%	29·4%
6·5	9·3	13·1	25·2	7·7	7·3	12·2
15·8%	22·6%	31·9%	61·4%	18·8%	18·0%	29·7%
6·1—6·7	8·1—8·8	11·7—13·8	23·5—26·8	7·5—8·0	7·8—8·85	11·4—13·2
6·4	8·45	12·8	25·2	7·75	8·35	12·3
15·7—16·3%	20·6—21·5%	31·0—32·5%	62·0—63·0%	17·7—21·2%	20·6—20·7%	30·2—30·9%
16·0%	21·0%	31·7%	62·5%	19·4%	20·6%	30·5%
6·1—6·4	8·4—9·3	12·5—15·1	23·4—27·1	7·1—7·2	7·6—8·8	11·5—14
6·25	8·85	13·8	25·2	7·15	8·2	12·9
4·4—15·6%	21·6—21·5%	32·0—34·2%	60·0—61·3%	16·0—18·4%	19·5—20·0%	29·6—32·1%
15·0%	21·2%	33·1%	60·6%	17·2%	19·7%	30·8%

TABLE 18.—*Measurements (in mm.) of skulls of subspecies* Bandicota bengalensis *Gray and Hardw. (subfamily Murinae, family Muridae.)*—concld.

Abbreviations—An in text.

Name of subspecies and distribution	No. and Sex	Roast. w.	Orb. 1.	Occiput	Mand. 1.
(1) *Bandicota bengalensis bengalensis*	6♂♂	7·6—8·7	14·7—15·7	5·7—6·7	23·7—25·8
		8·2	15·1	6·0	25·2
		19·5—21·3%	36·2—38·5%	13·8—15·8%	60·6—64·1%
		37·5%	20·4%	14·8%,	62·2%
India (Orissa, Bengal, Assam), Nepa, Bhutan & W. Burma.	10♀♀	7·0—8·5	13·0—15·0	5·7—6·5	22·7—25·6
		8·0	14·3	6·15	23·7
		18·9—21·5%	34·5—38·4%	14·8—16·5%	60·2—64·1%
		20·4%	37·05%	15·8%	61·4%
(2) *Bandicota bengalensis kok.*	8♂♂	7·0—8·5	13·4—15·8	5·6—6·3	22·9—25·4
		7·7	14·7	6·1	24·0
		18·7—20·7%	35·9—38·6%	14·9—16·8%	60·1—65·1%
		19·9%	37·8%	15·7%	61·8%
India (Southern and Western) & W. Pakistan (Sind).	8♀♀	6·9—7·8%	13·5—14·4	5·3—6·3	22·3—23·8
		7·3	13·8	5·6	22·9
		18·6—20·7%	35·2—38·2%	14·2—16·0%	58·9—63·4%
		19·5%	36·9%	14·9%	61·2%
(3) *Bandicota bengalensis wardi*	1♂	8·1	14·9	6·6	25·2
		19·7%	36·3%	16·1%	61·4%
India (Kashmir)		7·8—8·5	14·4—16·8	5·4—6·3	24·1—26·1
		8·1	15·6	5·9	25·1
		20·0—20·6%	38·2—39·4%	14·3—14·7%	61·2—63·9%
		20·3%	38·8%	14·4%	62·5%
(4) *Bandicota bengalensis varius*	2♂♂	8·5—9·2	13·2—15·2	5·8—7·1	23·5—25·1
		8·9	14·2	6·4	24·3
		20·9—21·8%	33·8—34·3%	15·0—16·6%	56·7—60·2%
Burma (Toungoo)		21·3%	34·0%	15·8%	58·4%

TABLE 19.—*Measurements (in mm.) of mandibles of subspecies of* Bandicota bengalensis *Gray & Hardw. (subfamily Murinae, family Muridae).*

Abbreviation—As in text.

Name of species	No. and sex	Range and Mean	G.L.M.	Mand. 1.	Max. w.	L. diast. 1.	L. mol. 1.
(1) *Bandicota bengalensis bengalensis*	6 ♂♂	Range . .	25·2—27·8	23·7—25·8	15·7—17·0	6·3—7·2	7·2—8·0
		Mean .	26·5	25·2	16·2	6·85	7·6
	„	Range % of G.L.M.	—	—	56·4—64·2%	25·0—27·5%	25·9—31·1%
		Mean . .	—	—	61·1%	25·9%	28.9%
	10 ♀♀	Range . .	24·3—27·1	22·7—25·6	14·0—16·7	6·0—7·2	6·7—8·0
		Mean . .	25·3	23·7	15·1	6·9	7·35
	„	Range % of G.L.M.	—	—	57·6—62·5%	24·9—29·4%	26·9—32·1%
		Mean . .	—	—	59·8%	27·1%	29·1%

TABLE 19.—*Measurements (in mm.) of mandibles of subspecies of* Bandicota bengalensis *Gray & Hardw. (subfamily Murinae, family Muridae).*—concld.

Abbreviations—As in text.

Name of species	No. and sex	Range and Mean	G.L.M.	Mand. 1.	Max. w.	L. diast. 1.	L. mol. 1.
(2) *Bandicota bengalensis kok*	8 ♂♂	Range	24·4—26·7	22·9—25·4	15·2—16·5	6·4—7·3	6·8—7·8
		Mean .	25·3	24·0	15·8	6·8	7·3
	„	Range % of G.L.M.	—	—	61·6—64·6%	25·8—28·0%	26·2—30.9%
		Mean .	—	—	62·8%	26·9%	29·05%
	8 ♀♀	Range	23·1—25·8	22·3—23·8	14·2—16·6	5·75—7·0	6·7—8·0
		Mean	24·1	22·95	15·2	6·3	7·5
	„	Range % of G.L.M.	—	—	58·8—66·5%	24·8—28·9%	29·2—33·9%
		Mean	—	—	63·1%	26·0%	31·0%

(3) *Bandicota bengalensis wardi*	2 ♂♂	Range . .	26·1—26·3	25·0—25·2	16·3	7·1—7·2	7·6—8·1
		Mean	26·2	25·1	16·3	7·15	7·9
	„	Range % of G.L.M.	—	—	62·4%	27·1—27·5%	29·1—31·0%
		Mean	—	—	62·4%	27·3%	30·0%
	2 ♀♀	Range	25·9—28·0	24·1—26·1	15·7—17·7	6·7—8·0	7·6—8·1
		Mean	26·9	25·1	16·7	7·3	7·8
	„	Range % of G.L.M.	—	—	60·5—63·1%	25·8—28·5%	27·8—29·7%
		Mean	—	—	61·9%	27·1%	28·7%
(4) *Bandicota bengalensis varius*	2 ♂♂	Range .	25·5—27·6	23·5—25·1	14·8—16·5	7·2—8·2	7·1—7·5
		Mean	26·6	24·3	15·7	7·7	7·35
	„	Range % of G.L.M	—	—	58·2—59·9%	28·2—29·7%	26·1—29·4%
		Mean . .	—	—	59·0%	28·9%	27·7%

TABLE 20.—*Measurements (in mm.) of skulls of subspecies of* Bandicota

Abbreviations—

Name of species and distribution	No. and sex	Range and Mean	O. N. L.	C. B. L.	G. zyg. w.	L.i.o.w.
(1) *Bandicota indica indica*	1 ♂	Range	59·9	61·1	33·7	9·05
	,,	% of O.N.L.	—	—	56·3%	15·1%
India (West Bengal).	2 ♀♀	Range	57·0—59·8	57·5—62·1	31·3—32·7	8·5—8·8
		Mean	58·4	59·8	32·0	8·7
	,,	Range % of O.N.L.	—	—	54·6—54·8%	14·8—14·9%
		Mean	—	—	54·7%	14·85%
	4—	Range	49·2—63·1	49·3—64·3	25·65	7·6—9·4
		Mean	55·7	56·6	25·65	8·3
	,,	Range % of O.N.L.	—	—	52·1%	14·5—15·4%
		Mean	—	—	52·1%	14·9%
(2) *Bandicota indica nemorivaga*	1 ♂	Range	54·5	--	29·4	8·1
		% of O.N.L.	—	—	53·9%	14·8%
India (Bengal, Assam), Nepal and Burma.	2 ♀♀	Range	49·6—55·4	50·2—54·8	27·1—29·8	7·2—8·0
		Mean	52·5	52·5	28·45	7·6
	,,	Range % of O.N.L.	—	—	53·8—54·6%	14·4—146%
		Mean	—	—	54·2%	14·5%
	6—	Range	57·1—59·1	57·6—59·5	30·0—31·2	7·5—8·0
		Mean	58·1	58·4	30·45	7·85
	,,	Range % of O.N.L.	—	—	52·3—52·7%	13·1—14·2%
		Mean	—	—	52.5%	13·5%
(3) *Bandicota indica savilei*	2 ♂♂	Range	41·0—43·3	41·4—43·7	—	5·9—6·2
		Mean	42·15	42·55	—	6·05
	,,	Range % of O.N.L.	—	—	—	14·3—14·4%
Burma (Mt. Popa).		Mean	—	—	—	14·3%
	2 ♀♀	Range	44·7 —46·2	45·1 —46·2	24·4	6·5—6·7
		Mean	45·45	45·65	24·4	6·6
		Range % of O.N.L.	—	—	54·5%	14·5—14·5%
		Mean	—	—	54·5%	14·5%

indica *Bechstein* (*subfamily Murinae, family Muridae*).

As in text.

T.b.1.	Nas. 1.	Pal. 1.	A. p. f.	Mol. 1.	Diast. 1.
10·0	24·8	36·3	11·0	9·8	19·15
16·6	41·4%	60·6%	18·3%	16·3%	31·9%
9·2	23·5—24·3	34·1—37·9	10·3—11·85	9·5—9·8	17·7—20·5
9·2	23·9	36·0	11·1	9·65	19·1
16·1%	40·6—41·1%	59·7—63·3%	18·0—19·8%	15·8—17·2%	31·0—34·3%
16·1%	40·9%	61·5%	18·9%	16·5%	32·6%
8·5—9·6	18·7—26·1	29·2—37·9	8·5—11·0	9·0—9·9	14·7—20·3
9·0	22·0	83·9	10·2	9·6	17·7
15·3—17·9%	37·6—41·3%	59·3—60·5%	17·2—19·8%	15·3—19·7%	30·0—33·3%
16·2%	39·3%	60·0%	18·25%	17·3%	32·1%
9·3	19·2	33·8	10·4	9·15	17·25
17·0%	35·2%	62·0%	19·0%	16·8%	31·6%
8·6—10·2	16·5—18·7	29·0—32·5	8·3—10·3	8·9—9·4	14·7—17·1
9·4	17·6	30·7	9·3	9·15	15·9
17·4—18·5%	33·2—33·8%	58·4—58·8%	16·7—18·5%	16·9—17·9%	29·6—30·8%
17·9 %	33·5%	58·6%	17·6%	17·4%	30·2%
9·2—10·5	20·3—22·3	34·0—36·4	9·4—10·7	8·6—9·45	17·3—19·1
9·95	20·85	35·0	10·0	9·15	18·0
15·5—18·2%	35·3—37·7%	59·0—61·5%	16·2—18·1%	14·9—16·2%	30·1—32·3%
16·8 %	35·85%	60·2%	17·0%	15·7%	30·9%
8·3—8·5	13·5—14·7	23·8—25·4	6·6—7·9	7·8—8·2	10·7—12·3
8·4	14·1	24·6	7·2	8·0	11·5
19·7—20·3%	32·9—33·9%	58·1—58·7%	16·1—18·2%	18·1—20·0%	26·1—28·5%
20·0%	33·4%	58·4%	17·1%	19·1%	27·3%
8·2—8·5	15·8—16·0	26·2—27·0	7·6—7·9	8·1—8·7	12·6—12·8
8·4	15·9	26·6	7·8	8·4	12·7
18·4—18·4%	34·6—35·2%	58·4—58·4%	17·0—17·1%	18·1—18·9%	27·6—28·2%
18·4%	34·9%	58·4%	17·0%	18·5%	27·9%

TABLE 20.—*Measurements (in mm.) of skulls of subspecies of* Bandicota indica *Bechstein (subfamily Murinae, family Muridae).*—concld.

Abbreviations—As in text.

Name of species and distribution	No. and sex	Range and Mean	Rost. w.	Orb. 1.	Occiput	Mand. 1.
(1) *Bandicota indica indica*	1 ♂	Range	13·2	20·0	9·8	35·5
	,,	% of O.N.L.	22·0%	33·4%	16·4%	59·2%
India (West Bengal).	2 ♀♀	Range	12·0—12·7	18·3—20·0	10·0	33·6
		Mean	12·4	19·2	10·0	33·6
	,,	Range % of O.N.L.	21·0—21·3%	32·1—33·4%	16·7%	58·8%
		Mean	21·15%	32·7%	16·7%	58·8%
	4	Range	9·8—13·5	16·4—20·5	8·8—9·6	30·7—36·8
		Mean	11·4	18·5	9·2	33·7
		Range % of O.N.L.	19·4—21·4%	32·4—34·0%	15·2—16·5%	57·8—58·4%
		Mean	20·4%	33·2%	15·9%	58·2%
(2) *Bandicota indica nemorivaga*	1 ♂	Range	11·9	20·1	—	—
		%of O.N.L.	21·8%	36·8%	—	—
India (Bengal, Assam), Nepal and Burma.	2 ♀♀	Range	10·0—11·0	17·8—19·6	8·0—9·2	28·6—32·6
		Mean	10·5	18·7	8·6	30·6
	,,	Range % of O.N.L.	20·0—20·1%	35·3—35·8%	16·1—16·6%	57·6—58·8%
		Mean	20·0%	35·5%	16·3%	58·2%
	6	Range	11·3—13·5	20·5—20·8	8·1—9·4	32·8—35·5
		Mean	12·4	20·7	8·7	34·3
	,,	Range % of O.N.L.	19·6—22·8%	35·0—35·9%	14·0—15·9%	56·7—60·0%
		Mean	21·3%	35·56%	14·9%	58·6%
(3) *Bandicota indica savilei*	2 ♂♂	Range	7·8—8·1	15·6	6·6—6·7	23·7—25·5
		Mean	8·0	15·6	6·65	24·6
	,,	Range % of O.N.L.	18·8—19·0%	38·0%	15·2—16·3%	57·8—59·0%
Burma (Mt. Popa).		Mean	18·9%	38·0%	15·7%	58·4%
	2 ♀♀	Range	8·6—8·6	16·4—16·5	7·3—7·3	25·8—27·8
		Mean	8·6	16·45	7·3	26·8
	,,	Range % of O.N.L.	18·7—19·3%	35·5—36·8%	15·8—16·3%	57·5—60·1%
		Mean	19·0%	36·1%	16·1%	58·8%

TABLE 21.—*Measurements (in mm.) of mandibles of subspecies of* Bandicota indica *Bechstein (subfamily Murinae, family Muridae).*

Abbreviations—As in text.

Name of subspecies	No. and sex	Range and Mean	G.L.M.	Mand. 1.	Max. w.	L. diast. 1.	L. mol. 1.
(1) *Bandicota indica indica*	1 ♂	Range	39·1	35·5	21·6	11·0	10·4
	„	% of G.L.M.	—	—	55·3%	28·2%	26·7%
	2 ♀♀	Range	36·4—40·1	33·6—37·8	20·25—22·5	10·0—11·4	9·9—10·3
		Mean	38·3	35·7	21·4	10·7	10·1
	„	Range % of G.L.M.	—	—	54·1—55·3%	27·5—28·5%	25·6—27·3%
		Mean	—	—	54·7%	28·0%	26·5%
	3—	Range	34·7—39·0	30·7—36·8	19·0—22·6	10·4—11·0	9·8—10·6
		Mean	36·6	33·7	20·9	10·8	10·2
	„	Range % of G.L.M.	—	—	54·9—58·2%	28·3—30·0%	27·2—28·2%
		Mean	—	—	57·0%	29·4%	27·8%

TABLE 21.—*Measurement (in mm.) of mandibles of subspecies of* Bandicota indica *Bechstein (subfamily Murinae, family Muridae).*—concld.

Abbreviation—As in text.

(2) *Bandicota indica nemorivaga*	2 ♀♀	Range	29·8—34·2	28·6—32·6	20·8	7·6—9·7	9·2—9·5
		Mean	32·0	30·6	20·8	8·7	9·35
	„	Range % of G.L.M.	—	—	60·9%	25·5—28·3%	27·9—30·9%
		Mean	—	—	60·9%	26·9%	29·4%
	3—	Range	34·3—36·6	32·8—35·5	19·4—21·6	9·1—9·2	9·4—9·6
		Mean	35·5	34·3	20·55	9·15	9·5
	„	Range % of G.L.M.	—	—	56·2—60·8%	25·9—26·5%	27·1—27·4%
		Mean	—	—	57·9%	26·2%	27·25%
(3) *Bandicota indica savilei*	2 ♂♂	Range	25·0—26·8	23·7—25·5	15·0—16·3	6·5—6·9	8·0—8·8
		Mean	25·9	24·6	15·7	6·7	8·4
	„	Range % of G.L.M.	—	—	60·0—61·0%	25·7—26·2%	30·0—35·2%
		Mean	—	—	60·5%	25·9%	32·6%
	2 ♀♀	Range	27·1—28·7	25·8—27·8	16·5—17·4	6·3—7·4	8·4—8·8
		Mean	27·9	26·8	17·0	6·85	8·6
	„	Range % of G.L.M.	—	—	60·8—60·8%	23·2—25·7%	30·6—31·1%
		Mean	—	—	60·8%	24·5%	30·9%

TABLE 22.—*Measurements (in mm.) of skulls of subspecies of* Nesokia indica *Gray & Hardw. (subfamily Murinae, family Muridae).*

Abbreviation—As in text.

Name of species and distribution	No. and sex	Range and Mean	O.N.L.	C.B.L.	G.zyg.w.	L. i.o.w.	T. b. 1.	Nas. 1
(1) *Nesokia indica huttoni*	5 ♂♂	Range	38·0—42·9	39·1—44·9	24·1—28·3	5·8—6·5	7·5—8·3	11·6—13·7
West Pakistan		Mean	40·36	41·8	26·27	6·2	8·1	12·35
(Baluchistan)		Range % of O. N. L.	—	—	63·4—65·9%	14·6—16·0%	20·0—20·8%	29·3—31·9%
and Afghanistan.		Mean	—	—	65·0%	15·36%	20·4%	30·55%
	4 ♂♂	Range	37·2—41·8	39·0—43·4	24·6—27·8	5·9—6·5	7·5—8·5	11·2—13·3
		Mean	39·25	41·0	26·2	6·25	8·0	12·1
		Range % of O.N.L.			64·5—69·0%	14·1—16·9%	20·1—20·5%	29·1—31·9%
		Mean	—	—	66·8%	16·0%	20·3%	30·8%
Nesokia indica indica	7 ♀♀	Range	34·9—40·2	37·4—41·7	24·7—26·0	5·8—6·3	7·2—7·95	9·5—11·7
		Mean	37·1	38·7	25·2	6·1	7·54	10·5
	„	Range % of O.N.L.	—	—	64·6—68·0%	15·2—18·0%	18·7—21·8%	25·8—29·2%
India (Rajasthan, Punjab, N. Uttar Pradesh) and F. F. W. Pakistan.		Mean	—	—	66·1%	16·3%	20·3%	28·3%

TABLE 22.—*Measurements (in mm.) of skulls of subspecies of* Nesokia indica *Gray & Hardw (subfamily Murinae family Muridae).*—concld.

Abbreviation—As in text.

Name of species and distribution	No. and sex	Range and Mean	Mol. 1.	Pal. 1.	A.p.f.	Diast. 1.	Rost. w.	Orb. 1.	Mand. 1.	Occiput
(1) *Nesokia indica, huttoni*	5♂♂	Range	7·7—8·2	23·1—26·9	3·6—5·2	11·7—14·3	7·3—8·8	15·4—17·6	24·2—27·7	5·5—7·4
West Pakistan		Mean	8·0	25·0	4·33	13·0	8·24	16·2	26·0	6·5
(Baluchistan)		Range % of O.N.L.	18·0—21·7%	60·8—62·9%	8·9—13·2%	30·8—33·3%	19·2—21·6%	37·9—41·3%	63·3—66·4%	13·6—17·7%
and Afghanistan.		Mean	19·8%	61·9%	10·7%	32·2%	20·3%	40·2%	64·4%	16·0%
	4♂♂	Range	8·25—8·5	23·2—25·7	3·45—4·55	12·0—13·8	7·6—8·4	14·9—17·0	24·7—27·6	5·7—7·5
		Mean	8·39	24·6	3·95	12·8	7·9	15·9	26·0	6·4
	,,	Range % of O.N.L.	19·7—22·3%	61·4—64·2%	9·2—10·8%	31·9—33·2%	18·5—21·1%	40·0—40·9%	65·6—67·3%	14·9—17·9%
		Mean	21·1%	62·75%	10·0%	32·6%	20·15%	40·45%	66·3%	16·0%
(2) *Nesokia indica indica*	7♀♀	Range	7·0—8·2	22·7—25·8	3·2—4·7	11·85—13·7	7·8—8·2	14·1—15·7	23·3—24·2	5·9—7·0
		Mean	7·6	23·85	3·95	12·4	8·0	15·2	23·8	6·2
	,,	Range% of O.N.L.	19·1—21·7%	62·6—66·4%	9·3—12·2%	32·0—34·8%	20·5—22·7%	39·1—42·3%	63·0—69·3%	15·2—18·0%
India (Rajasthan, Punjab, Uttar Pradesh) and N. F. W. Pakistan.		Mean	20·5%	64·3%	10·6%	33·5%	21·5%	40·8%	66·1%	16·8%

TABLE 23.—*Measurements (in mm.) of skulls of species of* Rhizomys *Gray (family Rhizomyidae).*

Abbreviations—As in text.

Name of species and distribution	No. and sex	Range and Mean	O.N.L.	C.B.L.	G. zyg. w.	L.i.o.w.	T.b.1	Nas 1.
(1) *Rhizomys sumatrensis cinereus*	2 ♂♂	Range	67·5—68·6	74·2	53·3—55·5	11·4—12·8	13·25	23·2—23·3%
		Mean	68·1	74·2	54·44	12·2	13·25	23·03
	2 ♂♂	Range % of O.N.L.	—	—	78·9—80·9%	16·6—18·9%	19·3%	34·0—34·3%
Burma, Indo-China & Siam.		Mean	—	—	75·9%	17·75%	19·3%	34·1%
	4 ♀♀	Range	68·2—76·5	76·1—84·6	56·7—63·8	11·4—13·7	13·60—16·0	24·4—28·8
		Mean	72·4	79·8	60·3	13·0	14·9	26·06
	4 ♀♀	Range % of O.N.L.	—	—	80·7—88·0%	16·7—19·3%	18·5—22·2%	35·7—38·6%
		Mean	—	—	83·4%	18·0%	20·45%	36·65%
(2) *Rhizomys pruinosus pruinosus*	1 ♂	Range	60·	4·8	47·1	10·3	13·0	24·1
		% of O.N.L.			77·6%	17·0%	21·2%	39·7%
India (Assam), E. Burma, Yunnan Malaya & Indo-China.	4 ♀♀	Range	62·4—72·0	66·7—75·6	47·3—53·7	9·6—11·3	10·9—14·0	22·8—29·4
		Mean	65·6	70·3	50·6	10·4	13·0	25·7
	4 ♀♀	Range % of O.N.L.	—	—	74·5—79·2%	14·9—18·1%	17·0—21·7	36·5—40·8%
		Mean	—	—	76·5%	15·9%	19·7%	39·0%

TABLE 23.—*Measurements (in mm.) of skulls of species of* Rhizomys *Gray (family Rhizomyidae).*—concld.

Abbreviations—As in text.

Name of species and distribution	No. and sex	Range and Mean	Nas. w.	Pal. l.	A.p.f.	Mol. l.	Diast. l.	Occiput	Loc. (w. & ht.)	Mand. l.
Rhizomys sumatrensis cinereus.	2 ♂♂	Range	10·4—10·8	44·7—46·7	7·3—7·8	13·2—13·5	22·8—23·3	16·8	5·5&4·7 5·6&4·6	49·3—50.0
		Mean	10·6	45·7	7·55	13·55	23·1	6·7	5·5&4·6	49·7
	2 ♂♂	Range % of O.N.L.	15·3—15·7%	66·2—68·0%	10·6—11·5%	19·6—19·6%	33·8—33·9	24·4%	—	72·8—73·0%
Burma, Indo-China & Siam.		Mean	15·5%	67·1%	11·1%	19·6%	33·9%	24·4%	8·1&6·8%	72·9%
	4 ♀♀	Range	10·7—12·7	47·2—53·2	7·5—9·5	13·1—13·6	25·0—29·3	16·7—19·2	5·4&4·4	52·7—58·0
		Mean	11·7	49·6	78·4	13·35	26.5	18·1	6·2&5·2 5·6&4·7	55·1
	4 ♀♀	Range % of O.N.L.	14·2—18·7%	67·2—70·7%	10·1—12·5%	17·6—19·8%	35·6—38·3%	23·7—27·1%	—	75·0—77·2%
		Mean	16·2%	68·65%	11·6%	18·45%	36·65%	25·0%	7·7&6·5	76·1%
Rhizomys pruinosus pruinosus	1 ♂	Range	8·7	40·4	5·5	13·6	19·2	14·5	4·3	42·5
		% of O.N.L.	14·3%	66·6%	8·8%	22·4%	31·6%	23·9%	7·0%	70·1%
India (Assam), E. Burma, Yunnan, Malaya & Indo-China.	4 ♀♀	Range	7·8—9·6	39·2—46·8	6·2—7·3	13·1—14·7	19·3—23·6	15·7—17·5	4·9&3·8 8·0&5·5	42·4—48·9
		Mean	8·7	42·4	6·7	13·7	20·9	16·5	6·2&4·7	45·3
	4♀♀	Range % of O.N.L.	12·2—14·0%	62·8—65·8%	9·7—10·5%	19·0—22·9%	30·3—33·3%	24·3—26·4%	—	69·9—70·4%
		Mean	13·2%	64·5%	10·2%	21·0%	31·8%	25·1%	9.4&7·2%	69·0%

TABLE 24.—*Measurements (in mm.) of mandibles of subspecies of* Nesokia indica *Gray & Hardw (subfamily Murinae) and* Rhizomys *Gray (family Rhizomyidae).*

Abbreviations—As in text.

Name of species	No. and sex	Range and Mean	G.L.M.	Mand. 1.	Max. W.	L. diast. 1.	L. mol. 1.
(1) *Nesokia indica huttoni*	5 ♂♂	Range	25·2—29·1	24·2—27·7	15·2—18·0	6·8—7·7	7·8—8·2
		Mean	27·1	26·0	17·0	7·7	8·0
	5 ♂♂	Range % of G.L.M.	—	—	60·3—63·6%	25·0—27·1%	27·1—31·1%
		Mean	—	—	62·6%	26·1%	29·6%
	4 ♀♀	Range	25·2—28·7	25·0—27·6	15·0—18·9	6·0—7·4	8·4—8·5
		Mean	26·85	26·0	17·0	6·4	8·45
	4 ♀♀	Range % of G.L.M.	—	—	59.5—65·8%	21·7—25·7%	29·4—33·3%
		Mean	—	—	62·4%	23·9%	31·6%
(2) *Nesokia indica indica*	1 ♀	Range	24·65	23·3	14·75	5·8	8·0
		% of G.L.M.	—	—	60·0%	23·5%	32·7%

TABLE 24.—*Measurements (in mm.) of mandibles of subspecies of* Nesokia indica *Gray & Hardw (subfamily Murinae) and* Rhizomys *Gray (family Rhizomyidae).*—concld.

Abbreviations—As in text.

Name of species	No. and sex	Range and Mean	G.L.M.	Mand. l.	Max. W.	L. diast. l.	L. mol. l.
(3) *Rhizomys sumatrensis cinereus*	2 ♂♂	Range	50·2—50·5	49·3—50·0	33·4—34·7	14·5—15·5	16·0—16·7
		Mean	50·4	49·7	34·1	15·0	16·4
	2 ♂♂	Range % of G.L.M.	—	—	66·5—68·7%	28·8—30·7%	31·9—33·1%
		Mean	—	—	67·6%	29·7%	32·5%
	4 ♀♀	Range	53·9—59·2	52·7—58·0	37·5—41·2	15·1—17·6	15·6—16·0
		Mean	56·3	55·1	38·85	16·5	15·9
	4 ♀♀	Range % of G.L.M.	—	—	66·3—70·1%	28·0—30·2%	27·0—29·6%
		Mean	—	—	68·9%	29·3%	28·5%
Rhizomys pruinosus pruinosus	1 ♂	Range	42·7	42·5	29·8	11·0	15·3
		% of G.L.M.	—	—	70·0%	25·7%	35·8%
	4 ♀♀	Range	42·4—49·6	42·4—48·9	30·5—36·0	10·8—13·6	14·0—15·3
		Mean	45·7	45·3	32·5	12·0	14·55
	4 ♀♀	Range % of G.L.M.	—	—	67·0—73·3%	24·6—27·4	29·0—33·9%
		Mean	—	—	71·0%	26·1%	31·6%

TABLE 25.—*Measurements (in mm.) of skulls of subspecies of* Cannomys badius *Hodgson (family Rhizomyidae).*

Abbreviations—As in Text.

Name of subspecies and distribution	No. and sex	Range and Mean	O.N.L.	G.B.L.	G.zyg.w.	L.i.o.w.	T.b.l.	Nas. l.
(1) *Cannomys badius badius*	4 ♂♂	Range	40·2—44·4	44·2—49·1	31·5—35·6	8·9—9·3	9·5—10·4	14·1—16·2
		Mean	42·45	46·7	34·0	9·1	10·5%	15·2
India (Darjeeling, Assam), Nepal, Sikkim, Bhutan & N. Burma.	4 ♂♂	Range % of O.N.L.	—	—	78·3—82·9%	20·4—22·1%	22·9—24·0%	34·6—36·8%
		Mean	—	—	81·2%	21·4%	23·55%	35·7%
	5 ♀♀	Range	42·5—46·1	46·4—50·7	34·0—36·8	8·8—9·7	9·3—11·2	15·1—16·75
		Mean	44·5	48·7	35·7	9·27	10·3	15·9
	5 ♀♀	Range % of O.N.L.	—	—	78·9—82·0%	20·4—21·6%	21·7—24·3%	34·3—37·2%
		Mean	—	—	80·2%	20·8%	23·3%	35·6%
(2) *Cannomys badius peter*	2 ♂♂	Range	41·5—44·3	45·7—48·7	33·6%	8·5—9·1	10·3—10·9	15·8—16·1
		Mean	42·9	47·2	33·6%	8·9	10·6	15·95
Burma (Mt. Popa).	2 ♂♂	Range % of O.N.L.	—	—		20·5—20·6%	24·6—24·8%	35·6—38·9%
		Mean	—	—	80·9%	20·55%	24·7%	37·2%
	3 ♀♀	Range	43·6—46·0	48·4—50·0	37·1—37·9	8·5—8·7	10·6—12·0	16·5—17·5
		Mean	44·9	49·4	37·5	8·6	11·1	16·9
	3 ♀♀	Range % of O.N.L.	—	—	80·6—86·9%	18·4—19·5%	23·1—27·5%	36·4—38·8%
		Mean	—	—	83·7%	19·1%	24·8%	·7%
(3) *Cannomys badius castaneous*	3 ♀♀	Range	37·5—39·3	40·0—42·8	28·6—31·3	8·2—8·6	9·5—1·6	12·3—14·8
		Mean	38·6	41·8	30·0	8·4	9·9	13·65
Burma (Tenasserim)		Range % of O.N.L.	—	—	76·4—80·1%	20·9—22·5%	24·3—26·9%	32·9—37·6%
		Mean	—	—	78·3%	21·8%	25·5%	35·3%

TABLE 25.—*Measurements (in mm.) of skulls of subspecies of* Cannomys badius *Hodgson (family Rhizomyidae).* —concld.

Abbreviations—As in text.

Name of subspecies and distribution.	No. and sex	Range and Mean	Nas. w.	Pal. l.	A.p.f.	Mol. l.	Diast. l.	Occiput.	Ibc. (w. & hit.)	Mand. l.
(1) *Cannomys badius badius*	4 ♂♂	Range	5·5—6·0	29·8—32·0	4·2—4·7	9·8—10·0	15·2—17·2	8·5—9·6	3·3 & 1·2 4·1 & 2·0	30·0—32·2
		Mean	5·7	31·1	4·5	9·9	16·5	9·5	3·6 & 1·7 1·7—0·0	31·45
India (Darjeeling, Assam), Nepal, Sikkim, Bhutan & N. Burma.	4 ♂♂	Range % of O.N.L.	12·9—13·8%	69·9—75·8%	9·4—11·2%	22·0—25·0%	37·5—40·7%	20·1—22·4%	—	71·4—76·3%
		Mean	13·3%	73·3%	10·6%	23·3%	38·8%	21·3%	8·4 & 4·0%	73·9%
	5 ♀♀	Range	5·3—6·3	30·1—33·5	2·7—4·5	9·3—10·4	17·1—19·3	8·6—10·1	3·4 & 1·5— 4·1 & 2·5	30·8—34·1
		Mean	5·6	32·1	3·7	9·74	18·2	9·5	3·7 & 2·0	32·95
	5 ♀♀	Range % of O.N.L.	12·1—13·5%	70·7—73·7%	6·3—10·0%	20·1—23·1%	39·1—42·5%	20·0—22·5%	—	72·5—77·1%
		Mean	12·6%	72·0%	8·3%	21·9%	40·9%	21·3%	8·4 & 4·4%	74·0%
(2) *Cannomys badius pater*	2 ♂♂	Range	5·5	30·2—31·2	4·1—4·3	9·8—10·2	16·6—17·6	9·5—12·0	3·6 & 3·8— 3·8 & 2·3	30·4—30·4
		Mean	5·5	30·7	4·2	10·0	17·1	10·75	3·7 & 2·4	30·4
Burma (Mt. Popa).	2 ♂♂	Range % of O.N.L.	13·2%	70·5—72·7%	9·7—9·9%	22·1—24·5%	39·8—40·0%	22·8—27·0%	—	68·6—73·2%
		Mean	13·2%	71·6%	9·8%	23·25%	39·9%	24·9%	8·6 & 5·5%	70·9%
	3 ♀♀	Range	6·0—6·3	33·4—34·8	4·3—4·5	10·1—10·7	18·6—18·8	10·0—11·5	4·0 & 2·7— 2·7 & 2·8	34·3—35·1
		Mean	6·2	33·95	4·4	10·5	18·7	10·7	4.3 & 2·7	34·75
	3 ♀♀	Range % of O.N.L.	13·4—14·0%	73·1—77·1%	9·5—9·8%	23·0—23·7%	40·5—42·8%	22·9—25·0%	—	75·6—78·6%
		Mean	13·7%	75·06%	9·7%	23·3%	41·7%	23·8%	9·5—6·0%	77·4%
(3) *Cannomys badius castaneus*	3 ♀♀	Range	5·1—5·3	26·8—29·4	3·8—4·1	8·4—9·0	14·2—16·6	8·3—9·0	3·7 & 3·2— 3·2 & 2·7	26·3—30·0
		Mean	5·2	28·1	3·9	8·7	15·8	8·5	3·5 & 2·4	28·5
Burma (Tenasserim).		Range % of O.N.L.	18·4—13·7%	71·4—74·8%	9·9—10·4%	21·5—24·0%	37·8—42·3%	21·1—23·2%	—	70·1—76·9%
		Mean	13·55%	72·7%	10·2%	22·5%	40·8%	22·1%	9·0 & 6·1%	73·2%

TABLE 26.—*Measurements (in mm.) of mandibles of subspecies of* Cannomys badius *Hodgson (family Rhizomyidae).*

Abbreviations—As in text.

Name of subspecies	No. and Sex	Range and Mean	G.L.M.	Mand. 1.	Max. w.	L. diast. 1.	L. mol. 1.
(1) *Cannomys badius badius* .	4 ♂♂	Range	31·3—33·6	30·0—32·2	20·3—22·2	7·7—9·0	11·4—11·8
		Mean	32·5	31·4	21·4	8·25	11·65
	4 ♂♂	Range % of G.L.M.	—	—	63·8—68·3%	23·7—26·7%	34·6—37·8%
		Mean	—	—	65·9%	25.3%	35·8%
	5 ♀♀	Range	32·4—35·8	30·8—34·1	21·2—23·2	8·9—10·5	11·2—11·7
		Mean	34·3	32·95	22·7	9·65	11·5
	5 ♀♀	Range % of G.L.M.	—	—	64·6—66·8%	26·7—29·5	31·4—35·5
		Mean	—	—	65·7%	28·0%	33·5%

TABLE 26.—*Measurements (in mm.) of mandibles of subspecies of* Cannomys badius *Hodgson (family Rhizomyidae).* —concld.

Abbreviations—As in text.

Name of subspecies	No. and Sex	Range and Mean	G.L.M.	Mand. 1.	Max. w.	L. diast. 1.	L. mol. 1.
(2) *Cannomys badius pater*	1 ♂	Range	31·6	30·4	21·1	8·2	11·5
		% of G.L.M.	—	—	66·7	25·9%	36·3%
	3 ♀♀	Range	35·7—37·0	34·3—35·1	23·4—24·3	9·2—10·6	11·7—12·5
		Mean	36·3	34·8	24·0	9·8	12·1
	3 ♀♀	Range % of G.L.M.	—	—	65·5—67·1%	25·7—28·6%	31·6—35·1%
		Mean	—	—	66·0%	27·0%	33·3%
(3) *Cannomys badius castaneus*	3 ♀♀	Range	27·1—31·2	26·3—30·0	18·2—18·7	7·7—9·0	10·0—10·1
		Mean	29·6	28·5	18·45	8·5	10·5
	3 ♀♀	Range % of G.L.M.	—	—	61·7—67·1%	28·4—28·8%	32·0—37·1%
		Mean	—	—	64·4%	28·6%	34·1%

TABLE 27.—*Measurements (in mm.) of skulls of* Platacanthomys lasiurus *Blyth (family Muscardinidae).*

Abbreviations—As in text.

Name of species and distribution	No. and Sex	Range and Mean	O.N.L.	C.B.L.	G. zyg. w.	L.i.o.w.	T.b.i.
Platacanthomys lasiurus	2 ♂♂	Range	(?)*31·6—32·0	29·8—29·8	18·6	6·8—6·8	4·2—4·3
		Mean .	32·0	29·8	18·6	6·8	4·25
	1 ♂	% of O.N.L.	—	—	—	21·5%	13·4%
India (S.W Mysore & Kerala)	2 ♀♀	Range	31·9—33·0	29·8—30·5	19·5	6·6—7·2	4·1—4·30
		Mean . .	32·45	30·2	19·5	6.9	4·2
	2 ♀♀	Range % of O.N.L.	—	—	59·0	20·7—21·7%	12·8—13·0%
		Mean .	—	—	59·0%	21·2%	12·9%

*Skull damaged.

TABLE 27.—*Measurements (in mm.) of skulls of* Platacanthomys lasiurus *Blyth (family Muscardinidae)*—concld.

Abbreviations—As in text.

Name of species and distribution	No. and Sex	Range and Mean	Nas. l.	Pal. l	A.p.f..	P.p.f.	Mol. l.	Diast. l.	Occiput	Mand. l.
Platacanthomys lasiurus	2 ♂♂	Range	9·4	15·7—16·2	2·1—2·3	2·3—2·3	5·3—5·5	8·4—9·0	3·8—3·8	16·2—16·7
		Mean	9·4	16·0	2·2	2·3	5·4	8·7	3·8	16·45
	1 ♂	% O.N.L.	29·3%	49·0%	6·5%	7·1%	16·5%	26·2%	11·8%	50·6%
India(S. W. M & Kerala).	2 ♀♀	Range	9·4—9·8	15·7—15·9	2·1—2·3	2·8—3·1	5·5—5·7	8·4—8·5	3·8—4·3	16·6—16·7
		Mean	9·6	15·8	2·2	2·95	5·6	8·45	4·1	16·65
	2 ♀♀	Range % of O.N.L.	29·6—29·6%	47·7—49·7%	6·3—7·2%	8·7—9·3%	16·6—17·8%	25·6—26·4%	11·6—13·4%	50·1—52·2%
		Mean	29·6%	48·7%	6·8%	9·0%	17·2%	26·0%	12·5%	51·1%

TABLE 28.—*Measurements (in mm.) of mandibles of* Platacanthomys lasiurus *Blyth (family Muscardinidae).*

Abbreviations—As in text.

Name of Species	No. and Sex	Range and Mean	G.L.M.	Mand. 1.	Max. w.	L. diast. 1.	L. mol. 1.
Platacanthomys lasiurus	2 ♂♂	Range .	17·4—18·4	16·2—16·7	8·7—9·4	5·1—5·3	5·3—5·6
		Mean . .	17·9	16·45	9·5	5·2	5·45
	2 ♂♂	Range % of G.L.M.	—	—	50·0—51·0%	29·0—29·3	30·4—30·7%
		Mean .	—	—	50·5%	29·15%	30·55%
	2 ♀♀	Range	18·0—18·2	16·6—16·7	9·5—9·5	4·8—5·0	5·4—5·6
		Mean	18·1	16·65	9·5	4·9	5·5
	2 ♀♀	Range % of G.L.M.	—	—	52·2—52·7%	26·6—27·4%	30·3—31·0%
		Mean .	—	—	52·45%	27·0%	30·6%

TABLE 29.—*Measurements (in mm.) of skulls of species*

Abbreviations—

Name of species and distribution	No. and Sex	Range and Mean	O.N.L.	C.B.L.	G. zyg. w.	L.i.o.w.
(1) *Funambulus pennanti*	4 ♂♂	Range	36·1—37·3	33·3—34·7	20·5—21·2	9·7—10·2
		Mean	36·9	34·0	20·9	10·0
N. India & W. Pakistan.	4 ♂♂	Range % of O.N.L.	—	—	56·6—56·9%	26·0—28·2%
		Mean	—	—	56·8%	26·9%
	8 ♀♀	Range	36·0—38·9	33·3—36·0	20·4—22·0	9·6—10·9
		Mean	37·7	34·9	21·25	10·4
	8 ♀♀	Range % of O.N.L.	—	—	54·4—58·4%	25·3—29·10%
		Mean	—	—	56·3%	27·5%
(2) *Funambulus sublineatus*	1 ♂	Range	34·5	29·9	18·6	10·25
		% of O.N.L.	—	—	53·9%	29·7%
S. India (Madras & S. Mysore).	1 ♀	Range	33·0	—	—	10·0
		% of O.N.L.	—	—	—	30·3%
(3) *Funambulus tristriatus tristriatus*	3 ♂♂	Range	39·6—41·0	36·4—37·6	22·4	11·6—12·7
		Mean	40·3	36·8	22·4	12·1
S. India (Maharastra, N. Mysore & Madras).	3 ♂♂	Range % of O.N.L.	—		54·5%	29·1—31·5%
		Mean	—	—	56·5%	29·9%
	2 ♀♀	Range	41·8—42·3	37·8—38·3	22·5—23.4	12·1—12·3
		Mean	41·1	38·5	22·95	12·2
	2 ♀♀	Range % of O.N.L.	—	—	53·2—55·9%	29·0—29·0%
		Mean	—	—	54·5%	29·0%
(4) *Funambulus tristriatus wroughtoni*	3 ♂♂	Range	43·9—46·4	40·3—42·5	24·7—25·7	12·6—13·2
		Mean	44·9	41·1	25·2	13·0
S. India (Kerala & S. Mysore).	3 ♂♂	Range % of O.N.L.	—	—	55·4—57·6%	28.2—30·2%
		Mean	—	—	56·2%	28·9%
	1 ♀	Range	46·6	42·6	26·7	13·5
		% of O.L.T.	—	—	55·1%	28·9%

and subspecies of Funambulus *Lesson* (*family Sciuridae*)—contd.

As in text.

T.b.l.	Nas. l.	Nas. w.	Pal. l.	Mol. l.	A.p.f.
7·4—7·8	10·0—11·3	4·1—4·5	17·7—18·6	6·7—7·2	1·0—1·6
7·6	10·7	4·3	18·1	7·0	1·3
19·8—20·9%	27·7—30·5%	11·2—12·0%	48·3—50·0%	18·5—19·3%	2·7—4·4%
20·5%	29·0%	11·7%	49·0%	19·0%	3·6%
7·5—8·4	9·8—12·2	4·0—4·5	17·8—18·7	6·6—7·4	1·1—1·6
7·75	11·7	4·3	18·4	6·9	1·4
20·0—21·0%	27·2—31·3%	10·8—11·8%	47·1—50·5%	17·4—19·5%	2·9—4·2%
20·5%	29·4%	11·5%	48·8%	18·4%	3·64%
6·0	10·0	4·2	15·7	6·0	1·2
17·5%	29·0%	12·1%	45·5%	17·5%	3·4%
5·7	8·7	4·5	15·35	5·9	0·8
17·2%	26·3%	12·3%	46·5%	17·8%	2·4%
7·2—7·4	11·1—12·5	4·7—5·0	20·0—20·4	7·2—7·6	1·2—1·3
7·3	12·0	4·9	20·1	7·4	1·3
17·8—18·7%	27·8—30·7%	11·8—12·1%	49·6—50·5%	18·0—18·5%	2·9—3·3%
18·1%	29·7%	12·0%	49·9%	18·3%	3·01%
7·7—7·9	12·7—12·7	4·75—5·0	0·9—21·2	7·5—8·0	1·2—1·4
7·8	12·7	4·9	21·5	7·75	1·3
18·4—18·6%	30·1—30·3%	11·3—11·8%	50·0—51·3%	17·9—18·9%	2·8—3·3%
18·5%	30·2%	11·55%	50·6%	18·4%	3·1%
7·7—8·2	12·8—14·0	5·2—5·5	22·6—23·9	7·9—8·7	1·4—2·0
7·95	13·6	5·4	23·3	8·4	1·7
17·5—17·7%	29·1—31·4%	11·8—12·3%	50·9—51·5%	17·7—19·5%	3·1—4·3%
17·6%	30·2%	12·0%	51·2%	18·6%	3·7%
7·7·	14·8	5·7	23·7	—	2·0
16·5%	31·7%	12·2%	50·9%	—	4·2%

TABLE 29.—*Measurements (in mm.) of skulls of species*

Abbreviations—

Name of species and distribution	No. and Sex	Range and Mean	Diast. 1.	Occiput	Orb. 1.	Mand. 1.
(1) *Funambulus pennanti*	4♂♂	Range	7·4—8·0	5·5—5·8	10·8—11·7	19·8—20·9
		Mean	7·8	5·7	11·2	20·3
N. India & W. Pakistan.	4♂♂	Range % of O.N.L.	20·6—21·7%	15·0—15·6%	29·0—31·6%	54·3—56·0%
		Mean	21·1%	15·3%	30·4%	54·9%
	8♀♀	Range	7·3—8·4	5·3—6·3	10·8—11·5	20·1—21·3
		Mean	7·9	5·9	11·37	20·9
	8♀♀	Range % of O.N.L.	20·0—21·7%	14·2—16·5%	28·9—31·2%	53·4—58·1%
		Mean	20·8%	15·5%	29·9%	55·4%
(2) *Funambulus sublineatus*	1♂	Range	7·1	5·1	9·0	17·8
		% of O.N.L.	20·5%	14·7%	26·0%	51·7%
S. India (Madras & S. Mysore).	1♀	Range	6·9	5·2	9·0	17·5
		% of O.N.L.	20·9%	15·7%	27·2%	53·0%
(3) *Funambulus tristriatus tristriatus*	3♂♂	Range	8·9—9·4	1—6·4	11·1—11·9	22·2—22·9
		Mean	9·2	6·2	11·5	22·6
		Range % of O.N.L.	22·4—23·1%	15·1—15·8%	27·5—29·0%	55·2—57·8%
S. India (Maharashtra, N. Mysore & Madras).	3♂♂	Mean	22·8%	15·4%	28·4%	56·1%
	2♀♀	Range	9·5—9·7	6·5—7·0	11·7—12·5	23·3—23·4
		Mean	9·6	6·75	12·1	23·35
	2♀♀	Range % of O.N.L.	22·4—23·2%	15·3—16·7%	27·6—30·0%	55·2—56·0%
		Mean	22·8%	16·0%	28·8%	55·6%
(4) *Funambulus tristriatus wroughtoni*	3♂♂	Range	10·1—11·4	6·6—7·2	12·4—12·7	24·0—26·5
		Mean	1·7	6·85	12·55	24·95
S. India (Kerala & S. Mysore).	3♂♂	Range % of O.N.L.	23·1—24·5%	14·4—16·5%	26·9—28·9%	54·6—57·1%
		Mean	23·9%	15·2%	27·9%	55·5%
	1♀	Range	11·0	—	13·2	—
		% of O.N.L.	23·6%	—	28·3%	—

and subspecies of Funambulus *Lesson (family Sciuridae)*—contd.

As in text.

Name of species and distribution	No. and sex	Range and Mean	O.N.L.	C.B.L.	G. zyg. w.	L. i. o. w.
(5) *Funambulus palmarum palmarum*	6♂♂	Range	36·5—39·0	33·2—35·5	19·8—21·8	9·5—11·4
		Mean	37·8	34·75	20·8	10·45
India (Bihar, Bengal, Madras, Andhra and Kerala).	,,	Range % of O.N.L.	—	—	53·2—55·9%	26·0—29·3%
		Mean	—	—	54·7%	27·65%
	2♀♀	Range	38·1—38·3	34·5—35·5	20·8—21·7	10·6—10·8
		Mean	38·2	35·0	21·3	10·7
	,,	Range % of O.N.L.	—	—	54·3—56·9%	27·8—28·3%
		Mean	—	—	55·6%	28·5%
(6) *Funambulus palmarum kelaarti*	4♂♂	Range	36·6—41·0	33·7—35·4	20·3—22·2	11·0—11·9
		Mean	38·85	34·6	21·3	11·3
	,,	Range % of O.N.L.	—	—	54·1—55·4%	28·3—30·3%
Ceylon		ean	—	—	54·7%	29·0%
	2♀♀	Range	37·2—37·5	33·9—34·6	20·9	10·6—11·4
		Mean	37·35	34·02	20·9	11·0
	,,	Range % of O.N.L.	—	—	56·1%	28·6—30·4%
		Mean	—	—	56·1%	29·5%
(7) *Funambulus palmarum robertsoni*	3♀♀	Range	37·8—38·5	34·7—35·3	21·7—21·8	10·1—12·0
		Mean	38·1	35·1	21·8	10·9
India (Madhya Pradesh).	,,	Range % of O.N.L.	—	—	56·7—57·0%	26·7—31·1%
		Mean	—	—	56·8%	28·6%
(8) *Funambulus palmarum bellaricus*	2♂♂	Range	37·5—38·6	34·3—35·7	20·9	10·0—10·3
		Mean	38·1	35·0	20·9	10·2
India (Maharashtra and N. Mysore).	,,	Range % of O.N.L.	—	—	54·2%	26·6—26·8%
		Mean	—	—	54·2%	26·7%
(9) *Funambulus palmarum brodiei*	1♂	Range	38·1	35·1	20·9	10·9
Ceylon		% of O.N.L.	—	—	55·0%	28·6%

TABLE 29.—*Measurements (in mm.) of skulls of species*

Abbreviations—

Name of species and distribution	No. and sex	Range and Mean	T. b. 1	Nas. 1	Nas. w.	Pal.l.
(5) *Funambulus palmarum palmarum*	6♂♂	Range	7·1—7·7	10·3—11·6	4·0—4·7	17·8—19·2
		Mean	7·4	11·0	4·4	18·55
India (Bihar, Bengal, Madras Andhra and Kerala).	,,	Range % of O.N.L.	18·5—20·1%	27·3—30·8%	10·9—12·2%	48·6—49·6%
		Mean	19·6%	29·1%	11·55%	49·1%
	2♀♀	Range	7·3—7·4	10·5—11·4	4·5—4·5	18·6—18·7
		Mean	7·35	10·95	4·5	18·65
	,,	Range % of O.N.L.	19·1—19·4%	27·4—30·0%	11·7—11·8%	48.5—49·1%
		Mean	19·25%	28·7%	11·75%	48·8%
(6) *Funambulus palmarum kelaarti*	4♂♂	Range	6·8—7·9	10·5—12·9	4·4—5·2	17·9—20·6
		Mean	7·4	11·3	4·8	19·25
Ceylon.	,,	Range % of O.N.L.	18·7—19·3%	27·0—31·4%	11·2—13·4%	48·9—50·2%
		Mean	19·0%	28·9%	12·4%	49·5%
	2♀♀	Range	7·0—7·2	10·8—11·4	4·4—4·6	18·1—19·0
		Mean	7·1	11·1	4·5	18·6
	,,	Range % of O.N.L.	18·6—19·3%	29·0—30·5%	11·7—12·3%	48·8—50·6%
		Mean	18·9%	29·7%	12·0%	49·7%
(7) *Funambulus palmarum robertsoni*	3♀♀	Range	7·2—7·5	10·3—11·0	4·2—4·6	18·3—19·0
		Mean	7·4	10·7	4·4	18·6
India (Madhya Pradesh).	,,	Range % of O.N.L.	18·7—19·6%	27·4—28·8%	11·1—11·9%	48·4—49·3%
		Mean	19·3%	28·1%	11·6%	48·7%
(8) *Funambulus palmarum bellaricus*	2♂♂	Range	7·3—7·6	10·1—10·5	4·1—4·2	18·0—19·1
		Mean	7·5	10·3	4·1	18·6
India (Maharashtra and N. Mysore).	,,	Range% of O.N.L.	19·4—19·8%	26·0—28·0%	10·6—11·2%	48·1—49·4%
		Mean	19·6%	27·0%	10·9%	48·8%
(9) *Funambulus palmarum brodiei*	1♂	Range	7·0	10·5	4·4	18·7
Ceylon	,,	Range % of O.N.L.	18·3%	27·5%	11·5%	49·2%

and subspecies of Funambulus *Lesson (family Sciuridae)*—concld.

As in text.

Mol.l.	A.p.f.	Diast.l.	Occiput	Orb.l.	Mand.l.
6·7—7·8	0·8—1·5	7·7—8·6	5·6—7·0	10·7—11·6	19·9—21·
7·2		8·2	6·4	11·0	20 7
17·2—20·8%	2·1—3·8%	20·6—22·4 %	14·9—18·8%	28·4—29·7%	53·8—55·7%
19·0%	3·1%	21·7%	16·8%	29·2%	54·4%
7·0—7·6	0·7—1·1	7·9—8·5	6·2—6·5	11·0—11·1	20·6—21·1
7·3	0·9	8·2	6·35	11·5	20·9
18·2—20·0%	1·8—2·8%	20·7—22·1%	16·1—17·0%	28·7—29·1%	53·7—55·3%
19·1%	2·3%	21·4%	16·6%	28·9%	54·5%
7·1—7·8	1·3—1·6	8·1—9·1	5·5—6·4	10·8—11·5	19·8—21·9
7·5	1·4	8·7	6·0	11·2	21·2
19·0—19·5%	3·3—3·9%	22.1—23·3%	15·1—16·4%	27·9—30·0%	53·4—56·1%
19·3%	3·6%	22·4%	15·9%	28·9%	54·5%
7·4—7·6	1·2	8·3—8·5	5·8—6·2	11·2	20·3
7·5	1·2	8·4	6·0	11·2	20·3
19·9—20·2%	3·2%	22·1—22·8%	15·3—16·5%	30·1%	51·8%
20·1%	3·2%	22·4%	15·9%	30·1%	51·8%
6·2—7·2	1·2—1·5	8·4—8·8	5·6—5·8	10·7—11·2	21·1—21·5
6·75	1·3	8·6	5·7	11·0	21·3
16·4—18·8%	3·1—3·9%	22·2—23·0%	14·8—15·2%	27·8—29·6%	55·5 55·9%
17·7%	3·5%	22·7%	15·0%	28·7%	55 7%
7·1—7·3	1·0—1·0	8·1—8·4	5·8—6·3	11·1—11·38	20·7—20·8
7·2	1·0	8·25	6·1	11·2	20·75
18·9—18·9%	2·5—2·6%	21·6—21·7%	15·0—16·9%	29·2—29·4%	53·6—55·4%
18·9%	2·5%	21·6%	16·0%	29·3%	54·5%
7·7	1·0	8·4	6·0	11·4	20·7
—	2·6%	22·0%	15·7%	29·9%	54·3%

TABLE 30.—*Measurements (in mm.) of mandibles of species and subspecies of* Funambulus *Lesson (family Sciuridae).*

Abbreviations—As in text.

Name of species	No. and sex	Range and Mean	G.L.M.	Mand. l.	Max. w.	L. diast. l.	L. mol. l.
(1) *Funambulus pennanti*	4♂♂	Range	21·0—22·3	19·8—20·9	10·8—11·3	3·5—4·0	6·5—7·0
		Mean	21·6	20·3	11·1	3·8	6·75
	4♂♂	Range % of G.L.M.	—	—	50·0—52·5%	16·6—18·1%	30·2—32·2%
		Mean	—	—	51·2%	17·4%	31·2%
	8♀♀	Range	21·0—22·7	20·1—21·3	10·8—12·2	3·5—4·2	6·5—7·6
		Mean	22·15	20·9	11·35	3·8	6·85
	8♀♀	Range % of G.L.M.	—	—	48·6—53·7%	15·4—18·5%	29·5—33·7%
		Mean	—	—	51·2%	17·6%	30·9%
(2) *Funambulus sublineatus*	2♂♂	Range	19·2—19·2	17·85—17·85	9·65—9·7	3·5—3·6	5·6—5·9
		Mean	19· 2	17·85	9·65	3·55	5·75
	2♂♂	Range % of G.L.M.	—	—	50·4—50·5%	18·2—18·4%	29·1—30·7%
		Mean	—	—	50·4%	18·3%	29·9%
	1♀	Range	19·0	17·5	09·4	3·6	5·5
		% of G.L.M.	—	—	49·5	19·0%	29·0%

(3) *Funambulus wroughtoni* *tristriatus*	3♂♂	Range	26·55—28·3	24·0—26·5	12·4—14·3	5·0—6·5	7·4—8·3
		Mean	27·2	24·95	13·3	5·8	7·9
	3♂♂	Range % of G.L.M.	—	—	46·4—50·5%	18·8—22·9%	27·9—30·2%
		Mean	—	—	48·8%	21·4%	29·1%
	1♀	Range	28·8	—	14·1	6·1	—
	1♀	% of G.L.M.	—	—	48·9%	21·1%	—
(4) *Funambulus tristriatus* *tristriatus*	3♂♂	Range	24·4—25·0	22·2—22·9	11·4—12·3	4·6—5·3	6·9—7·1
		Mean	24·7	22·6	11·8	4·9	7·0
	3♂♂	Range % of G.L.M.	—	—	46·7—49·6%	18·7—21·2%	28·2—28·8%
		Mean	—	—	47·2%	20·1%	28·5%
	2♀♀	Range %	25·2—25·6	23·3—23·4	11·7—12·7	4·9—5·4	7·6
		Mean	25·4	23·35	12·2	5·15	7·6
	2♀♀	Range % of G.L.M.	—	—	46·4—49·6%	19·4—21·1%	30·1%
		Mean	—	—	48·0%	20·3%	30·1%

TABLE 30.—*Measurements (in mm.) of mandibles of species and subspecies of* Funambulus *Lesson (family Sciuridae)*—concld.

Abbreviations—As in text.

Name of species	No. and sex	Range and Mean	G.L.M.	Mand. 1.	Max. w.	L. diast. 1.	L. mol. 1.
(5) *Funambulus palmarum palmarum*	6♂♂	Range	21·7—23·3	9·9—21·5	10·6—12·4	3·6—4·5	6·4—7·4
		Mean	22·4	20·7	11·35	4·2	6·85
	6♂♂	Range % of G.L.M.	—	—	47·9—53·9%	16·7—20·7%	28·2—33·4%
		Mean	—	—	50·7%	18·56%	30·6%
	2♀♀	Range	22·5—22·6	20·6—21·1	11·0—11·9	3·6—4·3	7·5
		Mean	22·6	20·85	11·5	3·95	7·5
	2♀♀	Range % of G.L.M.	—	—	48·8—52·9%	16·0—19·0%	33·3%
		Mean	—	—	50·8%	17·5%	33·3%

(6) *Funambulus kelaarti*	*palmarum*	3♂♂	Range	21·7—24·0	19·8—21·9	10·6—11·5	4·0—5·0	7·0—7·4
			Mean	23·2	21·2	11·1	4·6	7·25
		3♂♂	Range % of G.L.M.	—	—	46·6—48·8%	18·4—20·8%	30·6—32·2%
			Mean	—	—	47·8%	19·8%	31·3%
		1♀	Range	22·2	20·3	11·2	4·4	7·0
			% of G.L.M.	—	—	50·4%	20·0%	31·7%
(7) *Funambulus robertsoni*	*palmarum*	2♀♀	Range	22·5—22·8	21·1—21·5	11·7	4·2—4·4	6·4—6·8
			Mean	22·65	21·3	11·7	4·3	6·6
		2♀♀	Range % of G.L.M.	—	—	51·3%	18·6—19·3%	28·4—29·6%
			Mean	—	—	51·3%	19·0%	29·0%
(8) *Funambulus bellaricus*	*palmarum*	2♂♂	Range	22·3—22·7	20·7—20·8	11·0—11·7	4·1—4·4	6·9—7·3
			Mean	22·5	20·75	11·35	4·25	7·1
		2♂♂	Range % of G.L.M.	—	—	49·3—51·5%	18·3—19·4%	30·9—32·1%
			Mean	—	—	50·4%	18·9%	31·5%
(9) *Funambulus brodiei*	*palmarum*	1♂	Range	22·3	20·7	—	4·7	7·2
		1♂	% of G.L.M.	—	—	—	21·0 %	32 2%

TABLE 31.—*Measurements (in mm.) of skulls of species and subspecies*

Abbreviations.—

Name of species and distribution	No. and sex	Range and Mean	O.N.L.	C.B.L.	G. zyg. w.
(1) *Petaurista petaurista cineraceus*	3 ♂♂	Range	70·5—76·5	67·1—70·8	48·9—49·0
		Mean	73·5	69·2	48·95
	3 ♂♂	Range % of O.N.L.	—	—	64·0—66·5%
S. Burma (Tenasserim)		Mean	—	—	65·2%
	1 ♀	Range	74·3	69·8	48·9
		% of O.N.L.	—	—	65·8%
(2) *Petaurista petaurista philippensis*	1 ♂	Range	71·35	68·4	46·7
		% of O.N.L.	—	—	65·5%
India (Orissa, Madras, Mysore & Kerala).	2 ♀♀	Range	72·1—74·1	65·7—69·7	46·8—48·2
		Mean	73·1	67·7	47·5
	2 ♀♀	Range % of O. N. L.	—	—	64·9—65·1%
		Mean	—	—	65·0%
	2—	Range	69·1—74·6	64·5—68·8	47·6—48·3
		Mean	71·8	66·6	48·0
	2—	Range % of O. N. L.	—	—	64.7—68·9%
		Mean	—	—	66·8%
(3) *Petaurista petaurista albiventer*	4 ♂♂	Range	66·4—69·3	60·6—64·2	42·5—46·1
		Mean	67·4	61·7	44·2
India (Assam, Punjab, U. P., N. W. F. P., Kashmir).	4 ♂♂	Range % of O.N.L.	—	—	64·0—66·5%
		Mean	—	—	65·4%
(4) *Petaurista magnificus*	1 ♂	Range	68·4	62·8	44·8
		% of O.N.L.	—	—	65·5%
India (Darjeeling) Nepal & Sikkim.	1 ♀	Range	69·8	63·9	47·1
		% of O.N.L.	—	—	67·4%
	2—	Range	71·1—72·2	66·4—67·0	46.3—47·0
		Mean	71·6	66·7	46·7
	2—	Range % of O.N.L.	—	—	65·1—65·1%
		Mean	—	—	65·1%
(5) *Petaurista alborufus candidulus*	1 ♂	Range	73·2	66·9	49·9
		% of O.N.L.	—	—	68·1%
	1 ♀	Range	74·2	69·7	48·9
		% of O.N.L.	—	—	65·9%
India (Assam, Manipur) and W. Burma.	—	Range	72·2—74·8	66·6—69·3	47·1—49·6
		Mean	73·5	68·0	48·3
	2 —	Range % of O.N.L.	—	—	65·2—66·3%
		Mean	—	—	65·8%

of Petaurista *Link* (*family Sciuridae*).

As in text.

L.i.o.w.	T.b.1.	Nas. 1.	Nas. w.	Pal. 1.	Mol. 1.	A.p.f.
16·0—16·3	14·7—15·9	21·7—24·9	12·5—13·3	36·5—38·1	16·9	4·2—4·3
16·15	15·3	23·4	12·9	37·3	16·9	4·2
21·3—22·6%	20·7—20·9%	30·8—32·5%	17·3—17·7%	49·8—51·7%	23·0%	5·4—5·9%
21·9%	20·8%	31·8%	17·5%	50·7%	23·0%	5·7%
16·5	15·5	23·4	12·8	38·3	—	3·9
22·2%	20·8%	31·4%	17·2%	51·5%	—	5·2%
16·2	15·3	20·7	13·2	37·4	15·55	4·4
22·7%	21.5%	27·6%	18·5%	52·4%	21·8%	6·1%
15·1—15·5	14·3—14·8	21·0—22·4	12·3—13·6	36·0—37·6	16.1—16·5	4·0—4·0
15·3	14·55	21·7%	12·95	36·8	16·3	4·0
20·3—21·5%	19·8—20%	29·1—30·2%	17·0—18·3%	50·0—50.8%	21·7– 22·8%	5·3—5·5%
20·9%	19·9%	29·6%	17·6%	50·4%	22·2%	5·4%
15·6—15·8	13·3—14·8	21·0—21·8	11·2—12·2	34·8—36·8	14·7—16·7	4·0—4·0
15·7	14·0	21·4	11·7	35·8	15·7	4·0
20·9—22·8%	19·2—19·8%	29·2—30·3%	16·2—16·3%	49·3—50·3%	21·2—22·3%	5·3—5·8%
21·9%	19·5%	29·8%	16·25%	49·8%	21·7%	5·5%
14·4—15·8	12·2—12·8	19·7—21·0	11·1—12·8	31·6—35·0	15·5—16·5	2·5—3·9
15·1	12·4	20·25	12·25	33·6	15·8	3·4
21·6—22·8%	18·2—18·6%	29·4—30·7%	16·7—19·1%	47·5—51·6%	22·5—24·5%	3·7—5·8%
22·4%	18·4%	30·0%	18·2%	49·8%	23·4%	5·0%
14·8	11·6	21·3	12·4	34·5	14·8	3·3
21·6%	16·9%	31·1%	18·1%	50·5%	21·6%	4·8%
14·5	12·3	20·2	13·2	35·8	16·0	3·6
20·7%	17·6%	28·9%	18·9%	51·2%	23·0%	5·1%
14·9—16·0	11·5—12·3	21·4—22·7	18·0—14·1	35·1—36·1	14·9—16·1	4·1—4·2
15·5	11·9	22·0	13·55	35·6	1·55	4·15
20·9—22·2%	16·0—17·3%	30·1—31·4%	18·2—19·5%	48·6—50·7%	20·9—22·3%	5·7—5·8%
21·5%	16·6%	30·7%	18·8%	49·6%	21·6%	5·75%
16·9	13·7	22·8	13·9	37·2	16·6	3·5
23·1%	18·7%	31·1	18·9%	50·9%	22·6%	4·7%
14·8	13·6	22·1	12·9	38·2	—	4·7
20·0%	18·3%	29·7%	17·4%	51·4%	—	6·3%
15·3—16·1	13·2—13·5	20·8—23·7	12·8—14·2	37·2—37·7	17·7	4·2—4·7
15·7	13·35	22·3	13·5	37·5	17·7	4·5
21·1—21·5%	18·0—18·2%	28·8—31·6%	17·7—18·9%	50·4—51·5%	24·5%	5·8—6·2%
21·3%	18·1%	30·2%	18·3%	50·9%	24·5%	6·0%

TABLE 31.—*Measurements (in mm.) of skulls of species and subspecies of* Petaurista *Link (family Sciuridae)*—concld.

Name of species and distribution	No. and sex	Range and Mean	Occiput	Orb. 1.	Diast. 1.	Mand. 1.
(1) *Petaurista petaurista cineraceus*	3 ♂♂	Range	9·5—9·7	25·2—26·3	14·5—15·8	45·4—46·7
		Mean	9·6	25·7	15·0	46·0
S. Burma (Tenasserim)	3 ♂♂	Range% of O.N.L.	12·7—13·4%	34·3—35·7%	20·1—20·6%	61·0—66·1%
		Mean	13·1%	35·0%	20·4%	62·1%
	1 ♀	Range	10·1	26·4	16·1	46·8
		%of O.N.L.	13·5%	35·5%	21·6%	63·0%
(2) *Petaurista petaurista philippensis*	1♂	Range	11·5	25·4	14·9	43·7
		% of O.N.L.	16·1%	35·6%	20·9%	61·2%
India (Orissa, Madras, Mysore & Kerala).	2 ♀♀	Range	9·7—10·3	25·9—26·0	15·0	42·8—46·9
		Mean	10·0	25·95	15·0	44·8
	2 ♀♀	Range % of O.N.L.	13·0—14·2%	35·0—35·9%	20·2%	59·3—63·3
		Mean	13·6%	35·5%	20·2%	61·3%
	2—	Range	8·9—9·8	25·4—25·9	14·0—14·1	46·6
		Mean	9·3	25·6	14·5	46·6
	2—	Range % of O.N.L.	12·8—13·1%	34·7—36·7%	18·9—20·2%	62·4%
		Mean	12·95%	35·7%	19·5%	62·4%
(3) *Petaurista petaurista albiventer*	4 ♂♂	Range	8·1—10·0	24·2—25·0	11·6—13·3	40·3—41·5
		Mean	9·25	24·5	12·2	40·8%
India (Assam, Punjab, U. P., N. W. F. P., Kashmir).	4 ♂♂	Range % of O.N.L.	12·2—14·9%	35·5—37·3%	17·4—19·2%	59·9—60·8%
		Mean	13·7%	36·4%	18·2%	60·3%
(4) *Petaurista magnificus*	1 ♀	Range% of O.N.L.	8·7	24·4	13·6	40·5
			12·7%	35·7%	19·9%	59·2%
India (Darjeeling), Nepal & Sikkim.	1 ♀	Range %	9·1	25·8	13·4	41·7
		of O.N.L.	13·0%	36·9%	19·2%	59·7%
	2—	Range	10·0—10·55	25·2—26·8	14·0—15·5	42·2—44·7
		Mean	10·2	26·0	14·7	43·5
	2—	Range% of O.N.L.	14·0—14·5%	35·5—37·1%	19·4—21·8%	59·3—61·9%
		Mean	14·2%	36·3%	20·6%	60·6%
(5) *Petaurista alborufus candidulus*	1 ♂	Range	10·5	25·5	14·6	45·5
		% of O.N.L.	14·3%	34·8%	20·0%	62·1%
	1 ♀	Range	9·2	25·6	15·3	45·0
		% of O.N.L.	12·4%	34·5%	20·6%	60·6%
India (Assam, Manipur) and W. Burma.	2—	Range	9·4—10·4	24·5—26·7	14·2—14·5	43·7—46·1
		Mean	9·9	25·6	14·35	44·9
	2—	Range % of O.N.L.	13·0—13·9%	33·9—35·6%	19·3—19·6%	60·5—61·6%
		Mean	13·5%	34·7	19·5%	61·0%

TABLE 32.—*Measurements (in mm.) of mandibles of species and subspecies of* Petaurista *Link (family Sciuridæ).*

Abbreviations—As in text.

Name of species	No. and sex	Range and Mean	G.L.M.	Mand. 1.	Max. w.	L. diast. 1.	L. mol. 1.
(1) *Petaurista petaurista cinereaceus*	3 ♂♂	Range	45·2—46·1	45·4—46·7	31·5—32·2	9·0—9·8	17·8
		Mean	45·5	46·0	32·0	9·4	17·8
	3 ♂♂	Range % of G.L.M.	—	—	69·8—71·1%	20·0—21·6%	39·3%
		Mean	—	—	70·3%	20·7%	39·3%
	1 ♀	Range	46·1	46·8	31·9	10·0	17·4
		% of G.L.M.	—	—	69·2%	21·6%	37·8%
(2) *Petaurista petaurista philippensis*	1 ♂	Range	43·7	43·7	30·3	9·3	16·4
		% of G.L.M.	—	—	69·3%	21·3%	37·5%
	2 ♀♀	Range	42·7—46·7	42·8—46·9	28·3—33·2	7·8—9·1	17·4
		Mean	44·7	44·8	30·7	8·45	17·4
	2 ♀♀	Range % of G.L.M.	—	—	66·2—71·1%	18·2—19·5%	37·2%
		Mean	—	—	68·6	18·8%	37·2%
	2—	Range	41·7—46·7	41·7—46·6	28·5—31·5	7·9—9·5	16·4—17·1
		Mean	44·2	44·2	30·0	8·7	16·7
	2—	Range % of G.L.M.	—	—	67·4—68·3%	18·9—20·3%	36·6—39·3%
		Mean	—	—	67·9%	19·6%	38·0%

TABLE 32.—*Measurements (in mm.) of mandibles of species and subspecies of* Petaurista *Link (family Sciuridae)*—concld.

Abbreviations—As in text.

Name of species	No. and sex	Range and Mean	G.L.M.	Mand. 1.	Max. w.	L. diast. 1.	L. mol. 1.
(3) *Petaurista petaurista albiventer*	3 ♂♂	Range	40·5—41·5	40·3—41·5	28·6—30·1	72·2—7·9	16·5—16·9
		Mean	40·9	40·8	29·2	7·5	16·7
	3 ♂♂	Range % of G.L.M.	—	—	70·2—72·5%	17·7—19·0%	40·1—41·5%
		Mean	—	—	71·4%	18·3%	40·8%
(4) *Petaurista magnificus*	1 ♂	Range	40·5	40·5	27·7	7·1	16·2
		% of G.L.M.	—	—	68·4%	17·5%	40·0%
	1 ♀	Range	42·7	41·7	29·3	8·1	17·2
		% of G.L.M.	—	—	68·6%	18·9%	40·2%
	1—	Range	44·1	44·7	29·6	8·7	17·4
		% of G.L.M.	—	—	67·1%	19·7%	39·4%

(5) *Petaurista alborufus candidulus*	1 ♂	Range	45·0	45·5	32·0	9·0	16·9
		% of G.L.M.	—	—	71·1%	20·0%	37·5%
	1 ♀	Range	45·2	45·0	30·5	9·1	17·65
		% of G.L.M.	—	—	67·4%	20·1%	39·9%
	2—	Range	43·5—45·8	43·7—46·1	27·8—32·0	8·1—8·6	18·0—18·3
		Mean	44·6	44·9	29·9	80·35	18·15
	2—	Range % of G.L.M.	—	—	63·9—70·0%	18·6—18·7%	39·3—42·0%
		Mean	—	—	67·0%	18·65%	40·6%

TABLE 33.—*Measurements (in mm.) of skulls of* Marmota bobak *Muller (family Sciuridae) and* Jaculus jaculus *Linn. (family Dipodidae).*

Abbreviations—As in text.

Name of species and Distribution	No. and Sex	Range and Mean	O.N.L.	C.B.L.	G. zyg. w.	L.i.o.w.	T.b. 1.	Nas. 1.	Nas. w.
(1) *Marmota bobak himalayana*	1♂	Range	109·5	109·3	69·8	26·5	18·3	46·2	18·9
		% of O.N.L.	—	—	63·7%	24·2%	16·7%	42·2%	17·2%
India (Northern U. P.), Nepal, Tibet & China.	3♀♀	Range	92·2—110·7	92·9—113·9	58·5—60·0	22·0—27·2	17·5—18·9	39·9—46·2	16·2—19·1
		Mean	100·8	102·6	59·2	24·0	18·4	42·5	17·5
	,,	Range % of O.N.L.	—	—	60·3—63·4%	23·0—24·6%	17·0—18·9%	41·6—43·2	17·2—17·5%
		Mean	—	—	61·8%	23·8%	18·3%	42·2	17·3%
(2) *Jaculus jaculus jaculus*	2—	Range	36·3—36·5	35·2—36·3	25·9—27·5	13·8—14·6	11·4—11·6	14·6—15·8	5·3—5·6
		Mean	36·4	35·7	26·7	14·2	11·5	15·2	5·5
Egypt, Libya, Tunisia and Algeria.	,,	Range % of O.N.L.	—	—	71·3—75·3%	37·8—40·2%	31·2—31·9%	40·2—43·2	14·6—15·4%
		Mean	—	—	73·3%	39·9%	31·5%	41·7	15·0%

Name of species and Distribution	No. and sex	Range and Mean	Pal. 1.	Mol. 1.	A.p.f.	Diast.1.	Occiput	Orb. 1.	Mand.1.
(1) *Marmota bobak himalayana*	1 ♂	Range % of O.N.L.	61·9	24·1	9·3	29·6	20·7	38·1	73·0
			56·5%	22·0%	8·4%	27·0%	18·9%	34·8%	66·6%
India (Northern U. P.), Nepal, Tibet & China.	3 ♀♀	Range	52·5—63·9	22·6—25·1	7·7—8·5	24·8—30·4	15·8—20·9	33·3—37·6	61·5—75·8
		Mean	57·7	24·1	8·2	27·2	17·7	35·6	67·7
		Range % of O.N.L.	56·8—57·7%	22·6—24·7%	7·5—8·5%	26·4—27·4%	15·9—18·8%	33·8—36·1%	66·0—68·4%
		Mean	57·2%	24·0%	8·1%	26·9%	17·4%	35·3%	67·0%
(2) *Jaculus jaculus jaculus*	2—	Range	23·1—23·2	6·2	5·0—5·3	10·3—10·4	6·1—6·3	—	—
		Mean	23·1	6·2	5·15	10·35	6·25	—	—
Egypt, Libya, Tunisia and Algeria.		Range % of O.N.L.	63·5—63·6%	17·2%	13·7—14·5%	28·3—28·4%	16·7—17·3%	—	—
		Mean	63·5%	17·2%	14·1%	28·3%	17·0 %	—	—

TABLE 34.—*Measurements (in mm.) of skulls of species of* Hystrix *Linn. and* Atherurus *Cuvier (family Hystricidae).*

Abbreviations.—As in text.

Name of species and distribution	No. and sex	Range and Mean	O.N.L.	C.B.L.	G.zyg. w.	L.i.o.w.	T. b. 1.	Nas. 1.	Nas. w.	Pmx. w.
(1) *Hystrix indica indica*	3—	Range	142·8—157·3	142·5—157·5	82·8	58·7—61·4	18·3—20·2	70·6—81·9	38·7—42·2	22·2—26·5
		Mean	150·2	151·3	82·8	60·0	19·2	76·6	40·7	23·9
India (West of Bihar), West Pakistan and Ceylon.	,,	Range % of O.N.L.	—	—	52·6%	39·0%	12·8—12·8%	49·4—52·0%	26·8—27·4%	14·6—17·5%
		Mean	—	—	52·6%	39·0%	12·8%	50·9%	27·1%	15·9%
(2) *Hystrix hodgsoni subscristata*	1♂ Sub-adult	Range	119·0	117·0	64·3	49·3	17·2	66·2	37·3	3·2
		% of O.N.L.	—	—	54·0%	41·4%	14·2%	55·6%	31·3%	2·7%
India (Manipur, Naga hills), S. Burma and S. China.										
(3) *Atherurus macrourus macrourus*	1—	Range	91·5	86·1	46·5	30·0	14·5	25·1	15·6	4·7
		% of O.N.L.	—	—	50·8%	32·7%	15·8%	27·4%	17·0%	5·1%
S. Burma and Malacca.										
(4) *Atherurus africanus africanus*	1—	Range	92·1	91·5	47·1	30·1	14·7	23·1	13·6	6·9
		% of O.N.L.	—	—	51·1%	32·6%	15·9%	25·1%	14·7%	7·4%
Africa.										

Name of species and distribution	No. and sex	Range and Mean	Mol. l.	A.p.f.	Pal. l.	Diat.s l.	Orb. l.	Occiput	Mand. l.
(1) *Hystrix indica indica*	3—	Range	32·0—34·3	6·0—6·9	78·0—84·5	42·8—47·9	28·5—30·5	31·2—34·7	94·7—101·0
		Mean	33·1	6·7	81·5	45·0	29·5	32·6	97·8
India (West of Bihar), West Pakistan and Ceylon.	,,	Range% of O.N.L.	22·4—22·7%	4·2— 4·8%	53·7—54·7%	29·3—30·4%	19·4—20·0%	20·7—22·2%	62·2—68·4%
		Mean	22·5%	4·4%	54·3%	29·9%	19·6%	21·6%	64·9%
(2) *Hystrix hodgsoni subscristatus*	1♀ Sub-adult	Range	—	5·4	61·1	32·0	24·8	22·9	70·5
		% of O.N.L.	—	4·5%	51·3%	26·8%	20·8%	19·1%	59·2%
India (Manipur, Naga hills), S. Burma and S. China.									
(3) *Atherurus macrourus macrourus*	1—	Range	16·7	5·0	44·0	27·0	20·7	17·9	—
		% of O.N.L.	18·2 %	5·4%	48·0%	29·5%	22·6%	19·5%	—
S. Burma and Malacca.									
(4) *Atherurus africanus africanus*	1—	Range	18·7	3·8	51·7	26·5	23·8	17·4	—
		% of O.N.L.	20·3%	4·1%	56·1%	28·7%	25·8%	18·9%	—
Africa									

TABLE 35.—*Measurements (in mm.) of mandibles of species of* Marmota bobak *Müller (family Sciuridae),* Jaculus jaculus *Linn. (family Dipodidae) and* Hystrix *Linn. (family Hystricidae).*

Abbreviations—As in text.

Name of subspecies	No. and sex	Range and Mean	G.L.M.	Mand. l	Max. w.	L. diast. l.	L. Mol. l
(1) *Marmota bobak himalayana*	1♂	Range	71·7	73·0	42·6	17·7	23·5
	,,	% of G. L. M.	—	—	59·4%	24·7%	32·8%
	3♀♀	Range	60·8—75·1	61·5—75·8	34·7—45·3	15·1—18·0	21·5—23·5
		Mean	67·4	67·7	38·9	16·3	22·6
	,,	Range % of G.L.M.	—	—	55·0—60·5%	23·9—24·8%	31·3—35·4%
		Mean	—	—	57·5%	24·2%	33·6%

(2) *Jaculus jaculus jaculus*	1—	Range	19·8	—	8·15	5·1	6·0
	,,	% of G.L.M.	—	—	41·1%	25·7%	30·3%
(3) *Hystrix indica indica*	2—	Range	100·0—101·2	94·7—101·0	45·2—45·9	26·1—27·4	34·6—35·0
		Mean	100·6	97·8	45·5	26·8	34·8
	,,	Range % of G.L.M.	—	—	45·2—45·3%	26·1—27·0%	34·2—35·0%
		Mean			45·3%	26·6%	34·6%
(4) *Hystrix hodgsoni subcristatas*	1♂ (subadult)	Range	75·0	70·5	34·3	—	—
	,	% of G. L. M.	—	—	45·7%	—	—

TABLE 36.—*Range and mean (figures within brackets) of width of cranium in some volant, arboreal and fossorial rodents.*

Family	Genus No. of skulls measured is given in brackets	Habit	Occipitonasal length (in mm.)	Cranial width (mm.)	Cranial width as % of O. N. L.
Sciuridae	*Petaurista*((5)	Volant	71·5—76·5	31·5—32·2	
			(74·1)	(31·8)	43%
	Funambulus (5)	Arboreal	37·0—38·2	16·6—17·4	
			(37·5)	(17·0)	45%
	Marmota (3)	Fossorial	95·5—110·5	33·0—36·5	
			(106·5)	(35·0)	33%
Platacanthomyinae	*Platacanthomys* (3)	Arboreal	31·5—32·7	14·3—15·1	
			(32·0)	(14·8)	46%
Murinae	*Chiropodomys* (4)	Arboreal	24·6—25.9	11·7—12·7	
			(25·2)	(12·0)	48%
	Rattus r. arboreus (5)	Terrestrial	38·2—41·2	15·2—16·0	
			(39·7)	(15·6)	39%
	Bandicota bengalensis (5)	Fossorial	37·7—39·4	15·2—16·2	
			(38·5)	(15·6)	40%

TABLE 37.—*Range and mean (figures in brackets) of the size of orbits in some volant, arboreal and fossorial squirrels.*

Definitions : Length of orbit : From lacrymal to the tip of the postorbital process.

Breadth of orbit : Maximum width of the orbit.

Genus No. of skulls measured is given within brackets	Habit	Occipito-nasal length (in mm.)	Orbit (length & breadth) (in mm.)	Orbit (length & breadth as % of O.N.L.)
Petaurista (5)	Volant	71·5—76·5	17·4 & 16·4—19·0 & 17·5	
		(74·1)	(97·8 & 16·7)	(24% ; 22%)
Funambulus (5)	Arboreal	37·0—38·2	7·7 & 7·0—8·0 & 7·6	
		(37·5)	(7·9 & 7·3)	(21% ; 19%)
Marmota (3)	Fossorial	99·5—110·5	20·0 & 20·0—21·5 & 21·5	
		(106·5)	(21·0 & 20·6)	(20·0 & 19·0%)

TABLE 38.—*Variation in length of premaxilla, maxilla and diastema in some arboreal and fossorial rodents.*

Abbreviations.—A., arboreal ; L.F., less fossorial ; F., fossorial ; O.N.L., Occipitonasal length of skull.
pmx., length of premaxilla (from a point just posterior to incisor upto premaxillo-maxillary suture on the palatal surface).

max., length of maxilla (from the premaxillo-maxillary suture upto the point just anterior to first cheek-tooth).

diast., length of diastema (from a point just posterior to incisor upto the point just anterior to first cheek-tooth).

Family or Subfamily	Genus & species	Habit	No. of skulls measured	Mean O.N.L. (mm.)	Mean length of Pmx. (mm.)	Pmx. as %of O.N.L.	Mean length of Max. (mm.)	Max. as % of O.N.L.	Mean Diast. length (mm.)	Diast. as % of O.N.L.
Sciuridae	*Funambulus*	A	5	38·0	3·95	10·3%	3·95	10·3%	7·9	20·6%
	Marmota	F	3	106·5	17·7	17%	11·1	10%	28·8	27%
Platacanthomyinae	*Platacanthomys*	A	3	32·0	4·2	13%	4·2	13%	8·4	26%

Murinae	*Chiropodomys*	A	4	25·3	3·2	12·5%	3·5	13·5%	6·7	26%
	Rattus manipulus	L.F.	4	37·3	6·7	18%	5·2	14%	11·9	2%
	Nesokia	F	5	39·3	6·9	17·5%	5·8	14.5%	12·7	32%
Microtinae	*Pitymys*	L.F.	4	25·6	4·3	16·5%	3·4	13·5%	7·7	30%
	Ellobius	F	1	..	8·4	..	4·5	..	12·9	..
Rhizomyidae	*Rhizomys pruinosus*	L.F.	2	61·1	11·1	18%	7·7	12%	18·8	30%
	Cannomys	F	3	43·7	9·6	22%	7·6	17%	17·2	39%
Hystricidae	*Hystrix*	F	1	158·0	24·5	15·5%	23·5	14·5%	48·0	30%

TABLE 39.—*Variation in size of tympanic bullae in subfamily Gerbillinae (family Muridae) and the family Dipodidae.*

Name of species	Distribution	No. of skulls measured	Mean length of Tymp. bullae as % of O.N.L.
I.—MURIDAE : GERBILLINAE.			
Tatera indica	Iran, W. Pakistan, India, Ceylon.	71	25·5%
Meriones hurrianae	W. Pakistan, Rajasthan, Gujarat.	46	29·3%
Meriones persicus	Persia & Baluchistan	2	28·9%
Meriones erythrourus	Baluchistan (W. Pakistan).	1	37·5%
Meriones swinhoe	Waziristan (W. Pakistan).	1	38·1%
Gerbillus nanus	Baluchistan	4	32·1%
Gerbillus indus	Sind	2	30·7%
Gerbillus gleadowi	Rajasthan	3	30·4%
II.—DIPODIDAE.			
Jaculus jaculus	Egypt	2	31·5%

TABLE 40.—*Variation in size of the tympanic bullae in subspecies of* Tatera indica *Hardwicke* (*Muridae, Gerbillinae*).

Name	Locality	No. of skulls measured	Mean length of tymp. bullae as % of O.N.L.
1. *Tatera indica indica*	Baluchistan	12	27·2%
	Sind	4	26·6%
	Punjab	6	26·3%
	Gujarat	9	26·1%
	Rajasthan	4	26·0%
	Uttar Pradesh & Madhya Pradesh.	9	25·4%
2. *Tatera indica cuvieri*	Andhra Pradesh	4	24·8%
	Madras	7	24·1%
3. *Tatera indica hardwickei*	Mysore	10	24·3%
4. *Tatera indica ceylonica*	Ceylon	6	24·0%

TABLE 41.—*Range and Mean (figures within brackets) of height of occiput in some volant, arboreal and fossorial rodents.*

Family and subfamily	Genus and species	Habit	Occiput as % of O.N.L.
Sciuridae	*Petaurista*	Volant	12·2—16·1% (13·5%)
	Funambulus	Arboreal	14·2—17·7% (15·7%)
	Marmota	Fossorial	15·9—18·9% (17·8%)
Platacanthomyinae	*Platacanthomys*	Arboreal	11·6—13·4% (12·3%)
Murinae	*Chiropodomys*	Arboreal	7·0—9·1% (8·2%)
	Rattus r. arboreus	Terrestrial	9·7—12·0% (10·9%)
	Rattus manipulus	Less fossorial	14·6—16·4% (15·4%)
	Nesokia	Fossorial	13·6—18·0% (16·4%)
Rhizomyidae	*Rhizomys*	Fossorial	23·7—27·1% (24·9%)
	Cannomys	Fossorial	20·0—27·0% (22·3%)