

American Museum Novitates

PUBLISHED BY THE AMERICAN MUSEUM OF NATURAL HISTORY
CENTRAL PARK WEST AT 79TH STREET, NEW YORK, N. Y. 10024

NUMBER 2384

AUGUST 15, 1969

Results of the Archbold Expeditions. No. 91 A New Genus and Species of Murid Rodent from Celebes, with a Discussion of its Relationships

BY GUY G. MUSSER¹

In the course of my systematic studies on Indo-Australian rodents, I have examined the large collection of murids in the American Museum of Natural History that was obtained in Celebes by Gerd Heinrich during the early 1930's. Much of Heinrich's material was studied and reported on by George H. H. Tate (1936). Apparently Tate did not study Heinrich's entire collection for there are small series and individual specimens that were examined cursorily or passed over entirely. In sorting through a series, which had been identified as *Rattus penitus*, I found one specimen of a long-nosed animal that is definitely not an example of *Rattus*, but represents instead an undescribed genus and species. More importantly, the specimen provides additional information on the morphological, ecological, and phyletic diversity of murids on Celebes.

It is a pleasure to name this rodent after George Henry Hamilton Tate. He, more than any other worker of his day, made extensive, significant, and long-standing contributions to taxonomic knowledge of Indo-Australian mammals, particularly rodents. His many published papers, and unpublished notes and manuscripts, form a body of infor-

¹ Archbold Assistant Curator, Department of Mammalogy, the American Museum of Natural History.

mation that present-day students of Indo-Australian mammals find indispensable.

TATEOMYS, NEW GENUS

TYPE SPECIES: *Tateomys rhinogradoides*.

DEFINITION: The genus is characterized by the following combination of external and cranial features. Upper parts of the head and body are dark brown; underparts are grayish buff. The pelage is dense, short, and velvety. The eyes are tiny and the muzzle is elongate and shrewlike. The forefeet are robust, and the cylindrical front claws are nearly as long as their respective digits. The hind feet are long and slender with long digits and claws. The tail is longer than the head and body, slender, and finely haired.

The skull is elongate and delicately built. The rostrum is long and slender; the nasal and premaxillary bones form a short tube that projects in front of the incisors. The interorbital region is wide and inflated. The braincase is inflated, smoothly rounded, and elliptical in dorsal view. Slanting, thin and narrow zygomatic plates originate above the first molars. Thin and delicate zygomatic arches extend just beyond each side of the braincase. The pterygoid region and basicranial area are elongate. The tympanic bullae are small; each has a large external auditory meatus and a long, narrow, and bony canal through which the eustachian tube passes. The short, orthodont incisors are thin and narrow, their enamel layers are unpigmented, and their cutting tips are V-shaped. The three maxillary teeth are low-crowned, basined, and simple in topography.

DIAGNOSIS: *Tateomys* is morphologically most closely allied to *Melasmothrix naso* Miller and Hollister (1921b), a small long-nosed murid from middle Celebes. *Tateomys* is readily distinguished from *Melasmothrix* by its much larger head and body; long and pale brown tail (instead of a blackish brown tail that is shorter than body and head length); dark brown upper parts and grayish buff underparts (instead of both upper parts and underparts being dark reddish brown); ears and feet that are either pale brown or unpigmented (instead of brownish black ears and feet); tiny eyes; long snout with a conspicuous white patch above the nostrils (contrasted with a shorter snout and no white patch); larger, more elongate, and more delicately built skull with a longer, wider, and more inflated braincase; smaller and more slanted zygomatic plates; smaller maxillary teeth that are more simple in structure; smaller tympanic bullae with their long and narrow eustachian canals; and smaller, weaker, and white incisors with V-shaped cutting edges (in

contrast to stronger, larger, and orange incisors, with cutting edges that are nearly straight, like those of *Rattus*).

***Tateomys rhinogradoides*, new species**

HOLOTYPE: An adult male, A.M.N.H. No. 196591 in the Archbold Collection of the American Museum of Natural History, from Latimodjong Gebirge, southwestern Celebes. It was obtained at an elevation of 2200 meters by Gerd Heinrich (original number 37) on June 26, 1930. Latimodjong Gebirge is in the northern part of the southwest peninsula of Celebes near latitude 3° 50' S., longitude 120° 10' E. The highest elevation of those highlands exceeds 3000 meters.

A study skin and cranium comprise the holotype. Although the skin is slightly overstuffed, it was well prepared and in good condition. The cranium, however, is incomplete. Part of the interorbital region, the right side and top of the braincase near the occiput, the jugal bone of the right zygomatic arch, and the second and third right upper molars are missing. Portions of the pterygoid region are either missing or are broken. Unfortunately, the mandibles were apparently lost. I cannot locate them in the mammal collections at the American Museum.

DISTRIBUTION: Known only from Latimodjong Gebirge.

MEASUREMENTS: External and cranial measurements of the holotype, the only known specimen, are listed in table 1.

DIAGNOSIS: Because *rhinogradoides* is the only known species of *Tateomys*, the generic and specific diagnoses are the same.

DESCRIPTION OF HOLOTYPE: External form of the body resembles that of a terrestrial species of *Rattus*, particularly a type like *Rattus coelestis*, a species endemic to Celebes. Yet, at the same time, the velvety pelage, elongation of the facial area, and the tiny eyes are shrewlike (fig. 1). Upper parts of the head and body are dark brown with burnished highlights. The sides of the body are slightly paler. The texture of the pelage is thick, short, and compact. The overhairs along the back and rump are rarely longer than 8 or 9 mm. and are only slightly longer than the underfur. The hairs are gray basally and for most of their length, and each hair is tipped with brown. Because the pelage is so compact, the underlying gray is not conspicuous except where the pelage is worn. There are no long, black guard hairs. The sides of the rostrum at the bases of the vibrissae are dark brown and contrast with the lighter head. The fur on the upper surface of the nose is short (about 1 mm. in length) and grows toward the midline where it forms a middorsal dark brown ridge that extends from the tip of the nose posterior to about the level of the bases of the long vibrissae. The very tip of the nose above the nostrils

TABLE 1

EXTERNAL AND CRANIAL MEASUREMENTS (IN MILLIMETERS) OF ADULTS
OF *Tateomys*, *Melasmothrix*, *Echiothrix*, AND *Rhynchomys*

	<i>Tateomys</i> <i>rhingradoides</i> (A.M.N.H. No. 196591, ♂)	<i>Melasmothrix</i> <i>naso</i> (U.S.N.M. No. 219752, ♂)	<i>Echiothrix</i> <i>leucura</i> (A.M.N.H. No. 101246, ♀)	<i>Rhynchomys</i> <i>sorcioides</i> (F.M.N.H. No. 62289, ♀)
Length of head and body	137	124	220	195 ^b
Length of tail	168	90 ^a	235 ^b	132 ^b
Length of hind foot	36 ^b	26	55 ^b	41 ^b
Length of ear (from notch)	17 ^b	16 ^b	33	20 ^b
Greatest length of skull	38.1	32.3	57.1	49.3
Length of nasals	14.4	12.5	24.1	20.2
Length of rostrum ^c	13.9	11.8	23.6	22.2
Breadth of rostrum	5.3	5.1	7.7	7.3
Zygomatic breadth	15.3	13.2	24.3	18.2
Interorbital breadth	6.5	6.2	7.1	6.3
Cranial breadth	14.8 ^d	13.9	19.3	16.5
Cranial height ^e	9.4	8.4	14.7	12.1
Width of zygomatic plate	1.3	1.6	3.6	2.2
Length of diastema	10.0	7.4	20.4	16.7
Palatal length	15.3	11.9	28.4	24.8
Length of incisive foramina	6.1	5.1	10.0	7.5
Length of palatal bridge ^f	6.9	5.7	12.3	14.3
Breadth of mesopterygoid fossa	2.0	2.0	2.6	2.1
Tympanic bullae (left side)				
length ^g	4.9	5.1	6.0	5.0
width	5.0	5.2	6.4	4.8
height	3.4	4.0	5.3	4.5

TABLE 1—(Continued)

	<i>Tateomys rhinogradoides</i> (A.M.N.H. No. 196591, ♂)	<i>Melasmolhrix naso</i> (U.S.N.M. No. 219752, ♂)	<i>Echiohrix leucura</i> (A.M.N.H. No. 101246, ♀)	<i>Rhynchomys sortoides</i> (F.M.N.H. No. 62289, ♀)
Alveolar length of M ¹⁻³ (left side)	4.6	5.3	6.5	2.2 ^h
Crown length of M ¹⁻² (left side)	3.7	4.4	5.3	2.2
Crown of left M ¹ : length	2.4	2.8	3.4 ⁱ	1.4 ⁱ
width	1.7	1.8	2.3 ⁱ	0.8 ⁱ
Crown of left M ² : length	1.3	1.6	2.3 ^j	0.8 ^j
width	1.5	1.7	2.1 ^j	0.7 ^j
Crown of left M ³ : length	1.2	1.1	1.7 ^k	—
width	0.8	0.7	1.7 ^k	—

^a Excludes the missing tip.^b Measured on the dry study skin; other external measurements are those of the collectors and were taken from labels on the study skins.^c Measured from the tip of the nasals perpendicular to a line connecting the anterolateral margin of the dorsal maxillary root of each zygomatic arch. This one and most of the other cranial measurements were taken with Anderson's (1968) craniometer with the Spaulding instrument attached; the rest were obtained with dial calipers graduated in tenths of millimeters.^d Estimated.^e Measured from the ventral surface of the basisphenoid bone to the dorsal surface of the braincase.^f Measured from the posterior edges of the incisive foramina to the anterior border of the mesopterygoid fossa.^g Excludes the bony eustachian canal.^h Alveolar length of M¹⁻².ⁱ Right M¹.^j Right M².^k Right M³.

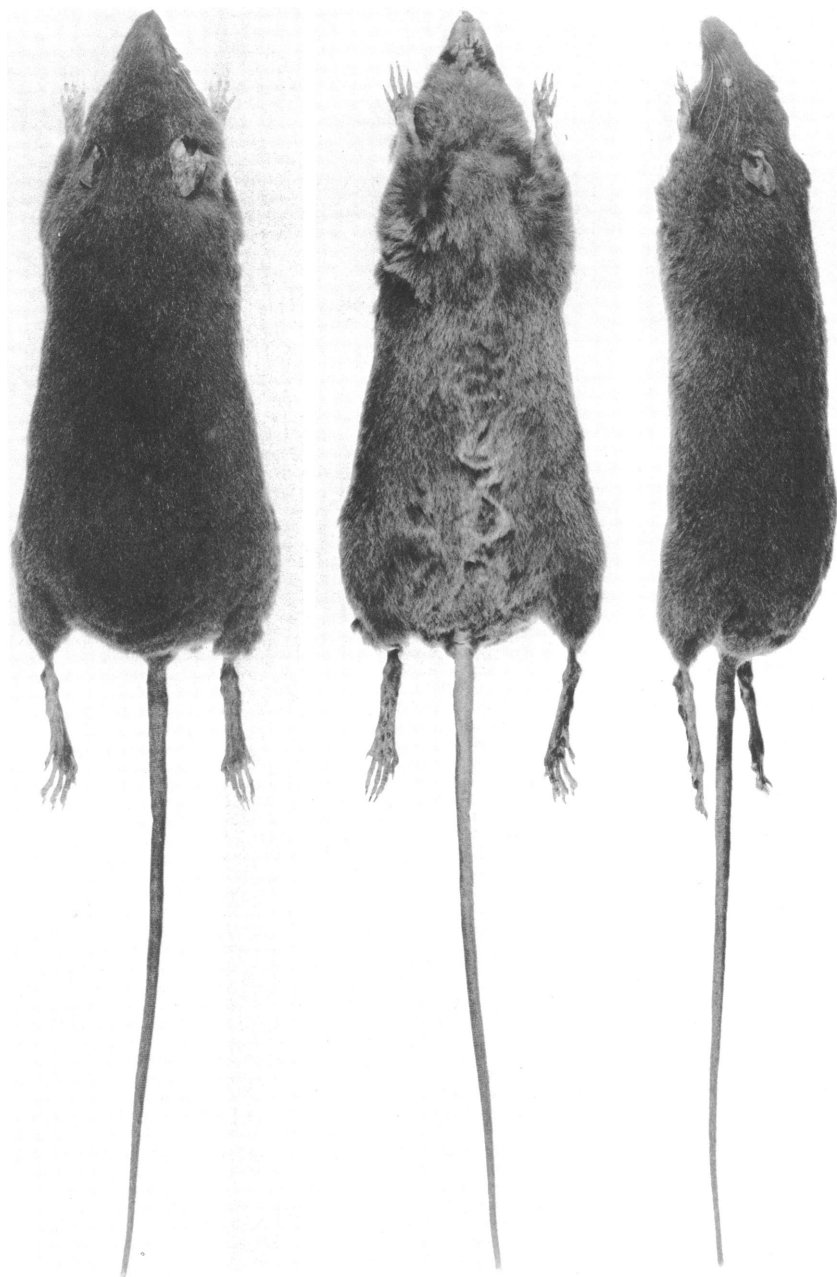


FIG. 1. *Tateomys rhinogradoides*. Dorsal, ventral, and lateral views of holotype. Approximately $\times \frac{1}{2}$.

is white and the area around the mouth is grayish brown. The vibrissae, when laid back alongside the head, extend beyond the external pinnae, but rarely exceed 50 to 55 mm. in length.

The eyes are very small. The widest diameters between eyelids measure 3 mm. on the stuffed skin (as contrasted with 6 mm. on a specimen of *Rattus rattus* of comparable size, for example). The eyelids are darker than the head, nearly brownish black.

The ears are small. In the dry state they are 17 mm. long (as measured from the notch). I would judge that they were probably not more than 1 or 2 mm. longer when the animal was alive. The ears are covered, both inside and out, with brown, short, fine hair.

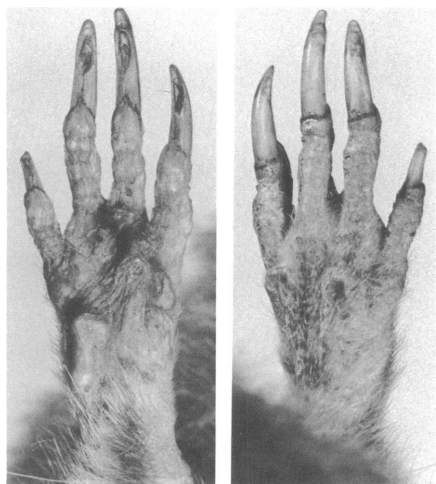


FIG. 2. Right front foot of *Tateomys rhinogradoides*. Dorsal and ventral views of holotype. Approximately $\times 3$.

The pelage of the underparts is not as thick as that of the upper parts, but is similar in length. The throat is light gray, but the rest of the underparts are buffy gray. The hairs that cover most of the underparts are light gray for most of their length, but are tipped with pale buff. There is a small, whitish to pale buff, patch behind each front foot. Although the underparts are paler than the upper parts, the demarcation between them is inconspicuous.

The front feet (fig. 2) are stout and broad and the fingers are long. The dorsal surface of each forefoot near the wrist is lightly pigmented with brownish hues and sparsely haired; otherwise the metacarpal region and digits are unpigmented and naked. The inside of the forearms behind the wrists is also scantily haired. The claws on digits two to five of each forefoot are long, shallowly arched, and cylindrical. Claws of the

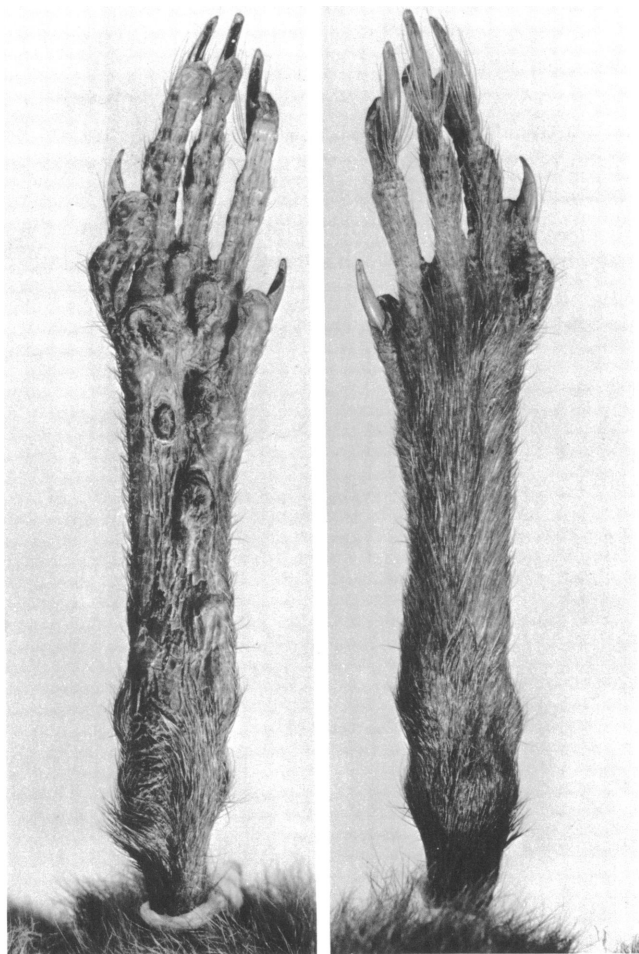


FIG. 3. Right hind foot of *Tateomys rhinogradoides*. Dorsal and ventral views of holotype. Approximately $\times 3$.

first three digits are nearly as long as each finger; the third claw is the longest (measured along its dorsal surface, the left claw is 5.3 mm. long, the right claw is 5.5 mm. long). All claws are oval in cross section. The prominent lateral metacarpal tubercle near the wrist is large and rectangular, and is tough and bonelike in consistency. The medial metacarpal tubercle and the three more distal palmer pads are small and inconspicuous. In the dried skin they are small mounds barely elevated

above the surface of the palm.

The hind feet are long and slender (fig. 3). Dorsally, the ankle, metatarsal region, and digits are sparsely covered with pale brown hair. There is a tuft of whitish brown hairs at the base of each claw. Except for a few scattered hairs, the sole is naked from the calcaneum to the tips of the digits. The area from the posterior edge of the calcaneum to nearly the base of the first digit, including most of the plantar tubercles, is dark brown; the rest of the foot is unpigmented. The digits and claws are long; the length of each claw is about half the length of its respective digit (the right third claw is 4.2 mm. long and the left third claw is 4.1 mm. long). The padlike metatarsal tubercle and the five distal plantar pads are well developed and conspicuous.

The slender tail is gradually tapered and is longer than the head and body (123 per cent of the length of head and body). The dorsal surface and the entire distal third of the tail is pale brown; the remaining proximal two-thirds of its undersurface is unpigmented. Overlapping scales that cover the tail are small, 16 to 17 rows per centimeter. Short, fine whitish brown hairs clothe the tail, each slightly more than twice the length of each scale. There are three hairs per scale.

The skull is delicately built and elongate (figs. 4, 6, and 8). The rostrum is long and tapered, its length 36 per cent of the greatest length of the skull. At its widest point (between the openings of the nasolacrimal canals) the rostrum is 5.2 mm. wide and tapers distally to a tip that is 2.6 mm. wide. The gradual proximal-distal taper of the rostrum is broken by inflated areas over the alveolar capsules that contain the proximal portions of the incisors. The nasal bones are long, slender, and lanceolate-shaped in dorsal view. They extend 2.3 mm. posteriorly beyond their union with the premaxillary and frontal bones. From the most posterior point of attachment of the nasals with the premaxillary bones, where the nasals are 1.2 mm. wide, they taper gradually outward to and over the incisor capsules, expand abruptly (here they are 3.1 mm. wide) then decrease in width distally where they are 2.9 mm. wide at their tips. Although the nasals are inclined downward for most of their length, their distal tips (about 5 mm. from the ends) are directed upward. The nasal and premaxillary bones protrude in front of the incisors, forming a short nasal tube.

The nasolacrimal canal is higher than wide, and its outer walls are compressed against the sides of the rostrum (fig. 8). Its crescent-shaped opening is directed posterior and slightly dorsad.

Behind the nasals the skull is about twice as wide as the rostrum. The regions above the dorsal roots of the zygomatic plates, which contain

the frontal sinuses, and the region between the anterior walls of the orbit in front of the cribiform plate, which contains part of the ethmoturbinal partitions, are appreciably inflated. Dorsally, however, the frontal bones are depressed between the inflations of the frontal sinuses. The inter-orbital area behind the frontal inflations and just in front of the braincase is slightly constricted. Although part of the braincase is missing, there is enough remaining to indicate that it is lightly built, smoothly rounded and inflated, and longer than broad (oblong in dorsal view). The occiput overhangs the occipital condyles, extending beyond them by 1.1 mm.

The zygomatic arches are thin and delicate. In lateral view their graceful ventral sweep is pronounced. In dorsal view they are narrowest near their attachments with the zygomatic plates, they gradually bow outward posteriorly, and they are widest anterior to their attachment with each squamosal bone. Judged from the intact left side of the skull, the distance from one arch to the other is only slightly wider than the breadth of the braincase. Each backward-slanting zygomatic plate is thin, narrow, and without a spine on its anterior edge. The lateral edge of each plate is almost smooth, without conspicuous sculpturing. The areas in which each superficial masseter muscle originates, usually prominent tubercles in many species of murid rodents, are represented only by slightly raised and roughened areas in this specimen of *T. rhinogradoides*.

The lacrimal bone is large and conspicuous. Its dorsal surface is triangular and forms a prominent shelf that is continuous with the dorsal root of the zygomatic plate.

The orbital regions are distinctive in several features. Because the area in front of the cribiform plate is appreciably inflated, the anterior walls of the orbit bow outward (see fig. 6) rather than being flat or concave as is typical of most species of *Rattus*, for example. Each sphenopalatine foramen is small and slitlike (the left opening is 0.7 mm. long and 0.3 mm. high), and although each foramen is situated in the anterior half of its orbit, rather than in about the middle as is usual in *Rattus*, it has the same relative position as in *Rattus* and many other species of murids; that between the orbital process of the maxillary and the orbital process of the palatine bones, and at the same level as the posterior palatine foramina. Both the two main openings in the posterior wall of each orbit, the optic foramen and the sphenoidal fissure, are small, and in side view are hidden behind a thin bony partition that extends from the floor of each orbit to the anterior margin of each side of the braincase.

The long diastema (fig. 6) is 26 per cent of the greatest length of the skull. The incisive (anterior palatine) foramina are long and slitlike.

Their attenuate posterior borders terminate 1.5 mm. in front of the anterior alveolar margins of the first molars. The bony palatal bridge is slightly longer than the incisive foramina and much longer than the maxillary tooth row. It extends 1.5 mm. in front of the anterior alveolar borders of the first molars and 0.4 mm. behind the posterior alveolar margin of the third molars. It is perforated by a pair of foramina at the level of the second upper molars, near the suture between the maxillary and palatine bones. These are small (0.3 mm.) slits roofed and floored by bone; each is directed medially into a shallow but conspicuous groove. In position and probably function, these foramina correspond to openings of the posterior palatine canals which transmit the palatine artery and palatine nerve (Hill, 1935, p. 124). This vessel and nerve are likely the primary structures which lie along each palatal groove. A large pair of openings in the palate behind the posterior palatine foramina are covered over with dry tissue, and behind these, tiny foramina, either paired or single, penetrate the palate and adjoining surfaces of the pterygoid plates.

The mesopterygoid fossa is elongate and narrow; its breadth is conspicuously greater than the width of one of the zygomatic plates, but about the same as the greatest breadth of one of the adjacent pterygoid fossa (fig. 6). Large sphenopalatine vacuities (about 3 mm. long; their limits are difficult to determine because the edges are either eroded or broken away), are found in the walls of the mesopterygoid fossa. The pterygoid plates and fossae are long and narrow. The surface of each pterygoid plate is nearly flat and level with the surface of the palatal bridge. Posteriorly, the floor of each plate contains a large opening. Because the edges of these vacuities have been broken away or eroded, their exact size and shape are difficult to determine. Judged from the remaining intact edges, they were probably oval and about 1 mm. in their greatest diameter. These openings may correspond to the interpterygoid foramina of Greene (1962, p. 27) or to what Hill (1935, p. 126) called the sphenopterygoid foramina. At about the level of each internal auditory meatus the posterior margin of each pterygoid plate and adjacent lateral floor of the cranium, which is formed by the basisphenoid bone, is inflated and perforated by two large foramina. The outer one of each pair is the ventral (or posterior) opening of the foramen ovale. This opening is separated from another opening that is anterior (and dorsal) by the lateral pterygoid ridge. Although the position of each foramen and ridge are similar to that described and illustrated for *Rattus* by Guthrie (1963, p. 463, fig. 2), each lateral pterygoid ridge is flat and wide, nearly covering each foramen ovale; these pterygoid ridges

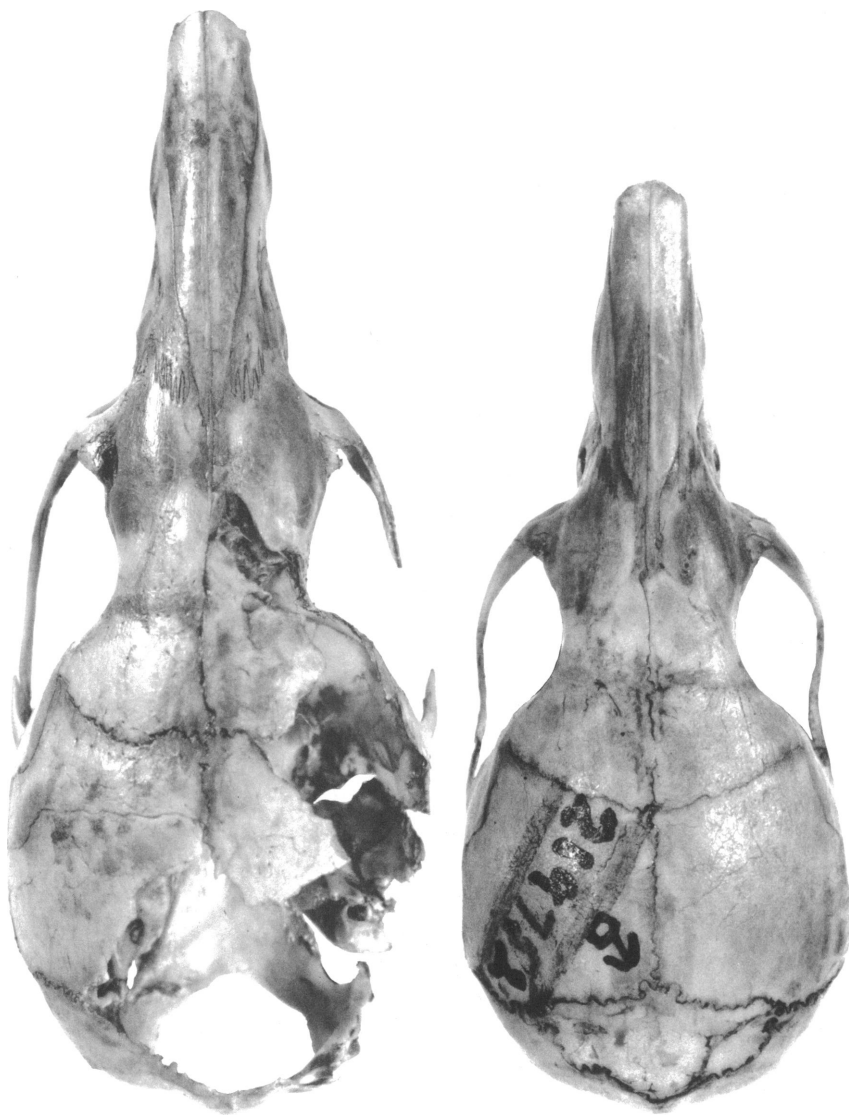


FIG. 4. Dorsal views of crania. The holotypes of *Tateomys rhinogradoides* (left) and *Melasmothrix naso* (right). Approximately $\times 4$.

of *Tateomys* are unlike the narrow, thin ridges seen in *Rattus*.

The more medial of the pair of openings near the base of each pterygoid plate is larger than the adjacent ventral opening of the foramen

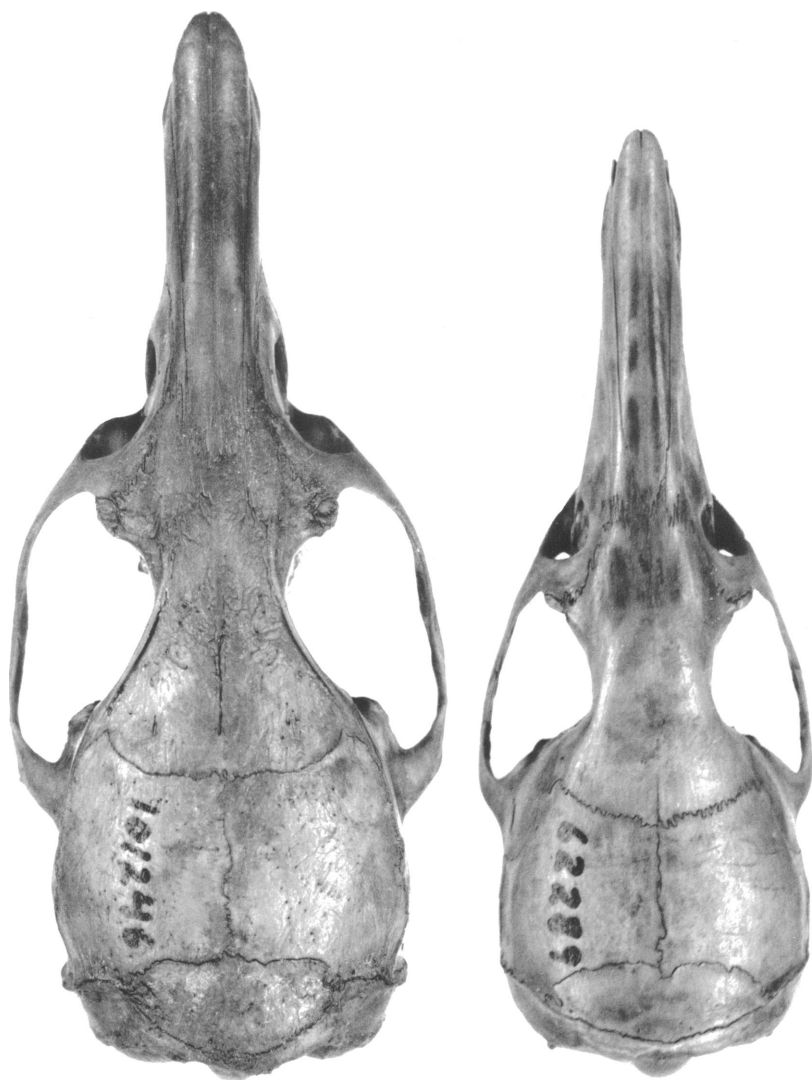


FIG. 5. Dorsal views of crania. Left: *Echiothrix leucura* (A.M.N.H. No. 101246, female), from Roeroekan, Celebes. Right: *Rhynchomys soricoides* (F.M.N.H. No. 62289, female), from Mt. Data, Luzon Island, Philippines. Approximately $\times 2.5$.

ovale. Although the medial opening is conspicuous and communicates with the foramen ovale by one or two tiny foramina in its lateral wall, I do not know its function. Each of these medial foramina may well cor-

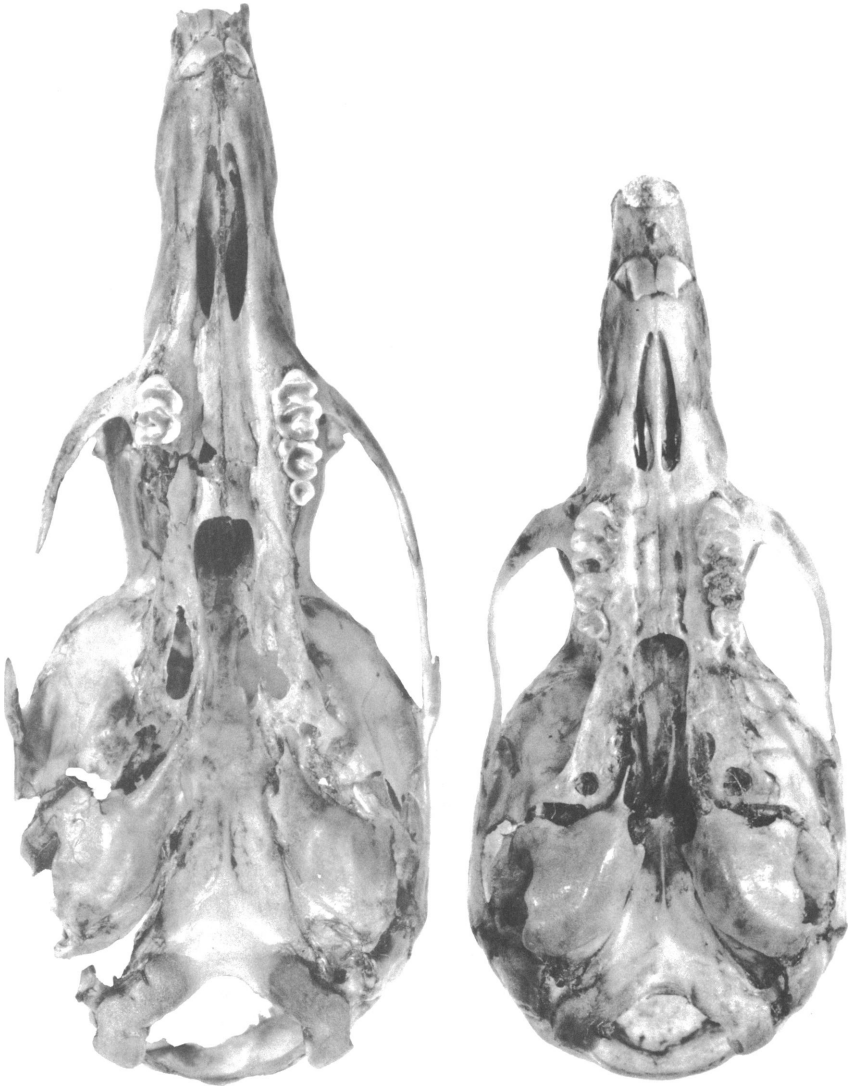


FIG. 6. Ventral views of crania. The holotypes of *Tateomys rhinogradoides* (left) and *Melasmothrix naso* (right). Approximately $\times 4$.

respond to the foramina through which each vidian artery, a branch of the stapedia artery, passes, as has been illustrated for *Rattus* by Guthrie (1963, p. 463, fig. 2).

The posterior opening of each alisphenoid canal, although similar in

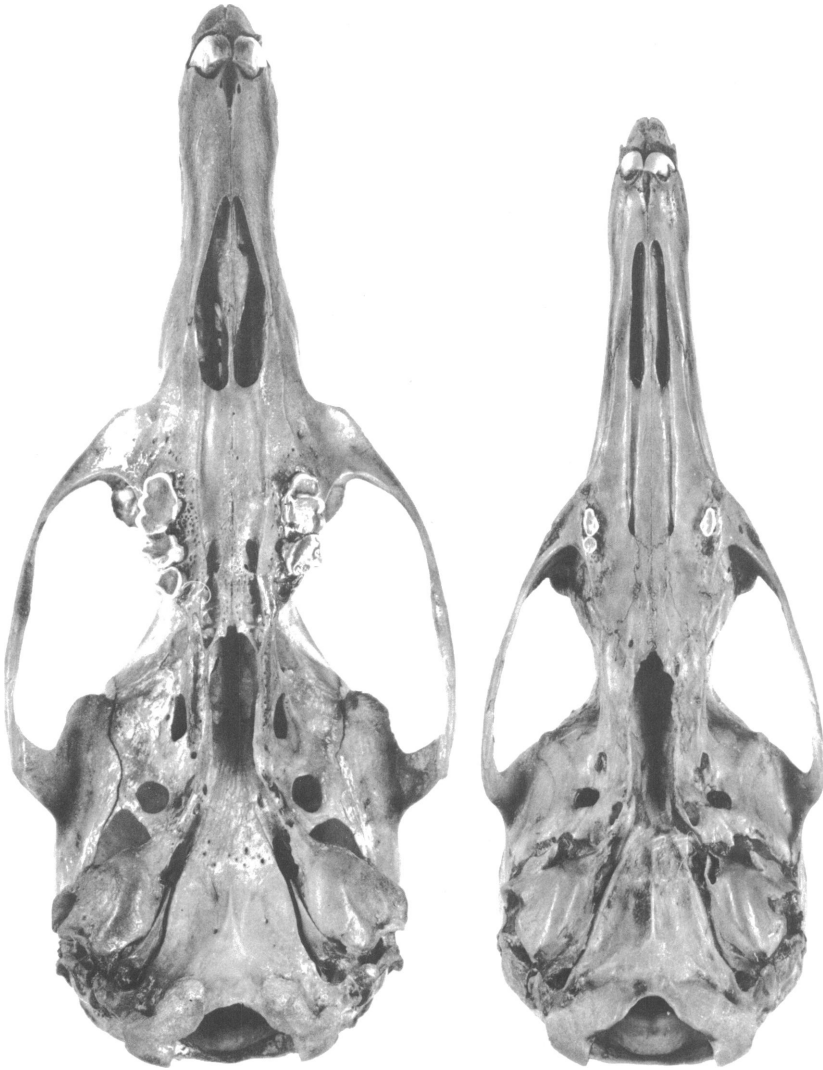


FIG. 7. Ventral views of crania. The same examples of *Echiothrix leucura* (left) and *Rhynchomys soricoides* (right) as shown in figure 5. Approximately $\times 2.5$.

position to that in *Rattus*, directly above each pterygoid plate and just anterior to each foramen ovale, is more elongate. The longest diameter of the left opening is 1.6 mm. and its greatest height is 0.6 mm.

The tympanic bullae are small, moderately inflated (ventrally, the



FIG. 8. Lateral views of crania. The holotypes of *Tuleomys rhinogradoides* (top) and *Melasmolhrix naso* (bottom). Approximately $\times 4$.



FIG. 9. Lateral views of crania. The same examples of *Echiothrix leucura* (top) and *Rhynchomys soricoides* (bottom) as shown in figure 5. Approximately $\times 2.5$.

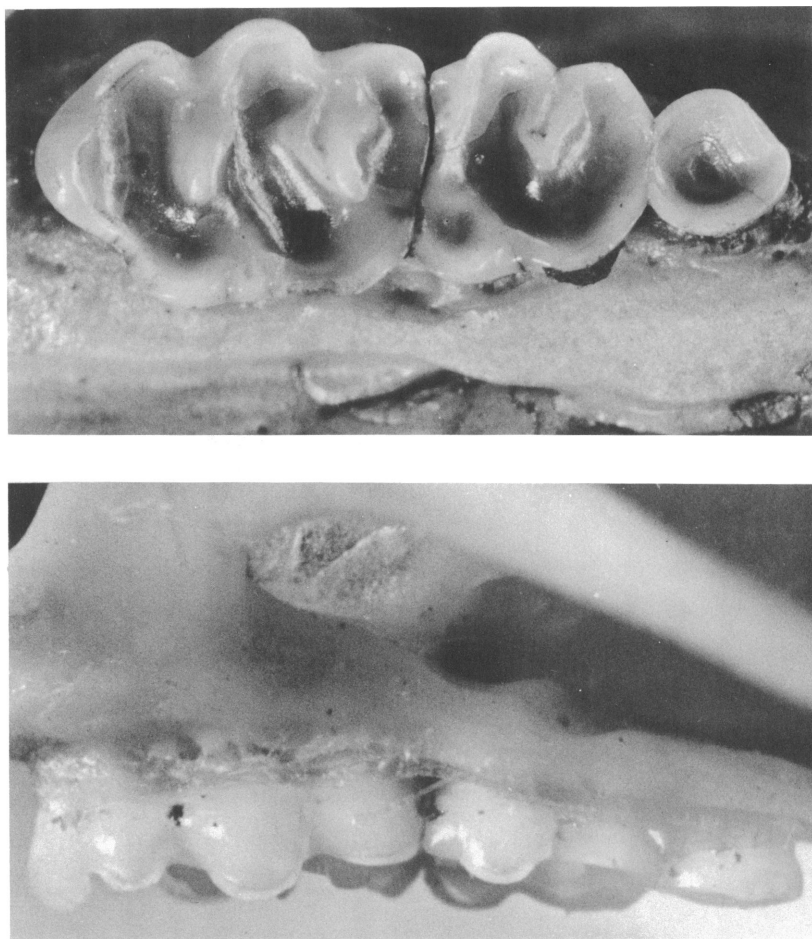


FIG. 10. Maxillary teeth of *Tateomys rhinogradoides*. Occlusal and labial views of left tooth row of holotype. Approximately $\times 20$.

bullae barely extend beyond the ventral margins of the braincase), and thin walled. Anteriorly, each bulla terminates in a long and narrow, bony, eustachian canal (the left canal, for example, is 1.6 mm. wide, and its length is 45 per cent of the length of the left bulla). Each external auditory meatus is large relative to the size of each bulla (for example, the greatest diameter of the left meatus is 2.3 mm., 46 per cent of the length). The mastoid regions are moderately, but not conspicuously inflated.

The ventral surface of the braincase between the tympanic bullae is elongate, smooth, and nearly flat except for two long, shallow depressions in the basioccipital bone. The basioccipital bone is elongate and wide and forms half or more of the mid-floor of the braincase.

The incisors are short, weak, and directed downward at a right angle to the rostrum (orthodont). Each is slender (anterior-posterior width is about twice the lateral thickness) and they emerge from the rostrum at acute angles so that the anterior margins of their distal tips and cutting edges meet one another at nearly a right angle. Almost all of the lateral surface of each incisor is formed by unpigmented enamel; thus the teeth are white and hard. The teeth are slightly notched just behind their tips.

The maxillary teeth are small, low-crowned, and their occlusal surfaces are basined and simple in structure (fig. 10). The first molar is the largest of the three teeth. Its occlusal surface consists of two basins surrounded by six simple and relatively high cusps: two lingual, one anterior, and three labial. In crown view the anterior basin is shaped like an arch and is separated from the rear basin by a low, moundlike ridge. The posterior basin curves in a C-shape around a large mound that connects with the valley between the second and third labial cusps by a low, but wide ridge. The second molar is smaller than the first and its occlusal surface consists of a large, C-shaped basin that curves around a distorted U-shaped ridge that is attached to the labial side of the tooth. Two conspicuous anterior cusps, one lingual, one on the labial side, form the anterior rim of the basin. The posterior rim is smooth and now without cusps. Low, posterior lingual and labial cusps may be present in younger animals, however. The third molar is small and simple. It is less than one-third the size of the first molar and consists of a shallow basin surrounded by a low, smooth rim. Its crown is oval in ventral view.

HABITAT

The specimen of *T. rhinogradoides* was taken in virgin cloud forest at an elevation of 2200 meters on Latimodjong Gebirge. The following brief description comes from my personal conversations with the collector, Gerd Heinrich. According to his recollections, the forest at 2200 meters was wet and cold and shrouded in mist during most of his stay. The trees were draped with various types of epiphytes and covered with moss and lichens. A thick, wet blanket of moss covered the forest floor, as well as rocks and rotting tree trunks that were scattered over the ground. Heinrich distinctly remembered the specimen of *T. rhinogradoides*. He trapped it on the ground in an especially dense part of the cloud

forest. He looked for runways, but could find none. He did, however, find many burrows in the general vicinity of his trapline. Examples of *Eropeplus canus*, *Rattus dominator*, *R. mollicomulus*, and *R. penitus* were obtained at the same locality.

RELATIONSHIPS

To determine the affinities of *Tateomys rhinogradoides* I have tried to answer two questions. What relationship does *Tateomys* bear to other species of long-nosed murids that are known from either the Indo-Malayan or the Indo-Australian region? Can *Tateomys* be linked to a species or group of species of murids that are less specialized in morphology, and that lack the unique traits of the long-nosed forms in general, and of *Tateomys* in particular? The results of my analyses of available data, primarily obtained from skins and skulls, indicate that *Tateomys* needs closest comparisons with three long-nosed rodents of the Indo-Australian region, namely *Melasmothrix naso*, *Echiothrix leucura*, and *Rhynchomys soricoides*; and that to my knowledge, among known living and fossil murids, *T. rhinogradoides* is most closely related to *M. naso*. In addition, there is strong evidence that *T. rhinogradoides* can be linked morphologically to the *Rattus chrysocomus* group of species, all of which are endemic to Celebes, through *M. naso*.

COMPARISONS BETWEEN *Tateomys*, *Melasmothrix*, *Echiothrix*, AND *Rhynchomys*

Tateomys rhinogradoides, *Melasmothrix naso*, and *Echiothrix leucura* are known only from Celebes, whereas *R. soricoides* is endemic to the island of Luzon in the Philippines. *Melasmothrix naso* was described and named by Miller and Hollister (1921b, p. 93) on the basis of an adult male obtained at Rano Rano, middle Celebes, by H. C. Raven. The species is still known only from the holotype (U.S.N.M. No. 219752), a stuffed skin with a skull in the United States National Museum of the Smithsonian Institution. Aspects of the biology of *M. naso* are virtually unknown. For example, the information on its habitat consists only of Miller and Hollister's (1921b, p. 94) statement that, "Mr. Raven's field catalogue states that this specimen was caught in a trap set under rotten moss-covered logs." The relationships of *M. naso* to other species of Indo-Australian murids has been unclear. Miller and Hollister compared it with *Echiothrix*, but they thought the few points of resemblance between *Melasmothrix* and *Echiothrix* to be superficial and not indicative of close relationship.

Echiothrix is known from several localities in middle and northern

Celebes (Miller and Hollister, 1921a, p. 67; Tate, 1936, p. 586; Sody, 1941, p. 318). *Echiothrix leucura* was originally described and named by Gray (1867, p. 599), who thought that the specimen he examined had been obtained in Australia. It has now been established, however, that *E. leucura* is not a member of the Australian fauna, but is instead endemic to Celebes (Jentink, 1883, p. 177; Tate, 1936, p. 585). In 1921, Miller and Hollister described and named *E. centrosa* and *E. brevicula*, but in the most recent list of mammals of Celebes, that of Laurie and Hill (1954), *centrosa* and *brevicula* are considered subspecies of Gray's *E. leucura*.

Echiothrix, like *Melasmothrix naso*, is not well known in regard to most aspects of its biology. Specimens of *Echiothrix* have been taken only from localities on coastal plains and adjoining foothills. Its relationships to other kinds of murids from the Indo-Australian region are obscure. Oldfield Thomas (1898) compared *Echiothrix* with *Rhynchomys*, thought the two to be definitely related, and suggested that *Echiothrix* should be transferred to the same subfamily that contained *Rhynchomys*. On the other hand, Tate (1936) agreed with Miller and Hollister's (1921b) opinion, that *Echiothrix* was only superficially similar to *Melasmothrix*, and disagreed with Thomas, stating that *Echiothrix* was unrelated to *Rhynchomys* and was instead a specialized derivative of the *Rattus xanthurus* species-group. Ellerman (1941, p. 269), however, considered *Echiothrix* to be far removed from any species of *Rattus* and implied that in even considering it a derivative of the *Rattus xanthurus* species-group, Tate misjudged the distinctness of *Echiothrix*.

Rhynchomys soricoides was described and named by Oldfield Thomas (1895, p. 160) on the basis of five specimens obtained by John Whitehead from Mt. Data, at an elevation of 8000 feet, in the northwestern part of Luzon Island in the Philippines. Later, Thomas (1896b) erected a subfamily for *Rhynchomys*, the Rhynchomyinae. Although there are still fewer than a dozen specimens of *Rhynchomys* in museum collections (see Sanborn, 1952, p. 135, for example), and although virtually nothing is known regarding most aspects of its biology, the habitat from which specimens of *R. soricoides* was obtained (mossy, cold, and wet forest) is somewhat better known and has been briefly described by Whitehead (see Thomas, 1898, p. 379) and Hoogstraal (1951, p. 30).

I have compared the holotypes of *T. rhinogradoides* and *M. naso* with two examples of *Rhynchomys soricoides* (both are in the Field Museum of Natural History, and were obtained from Mt. Data, Luzon Island) and with the following 11 specimens of *Echiothrix leucura* from Celebes: six specimens in the American Museum of Natural History, one from Boemboelan, five from Roeroekan; five specimens in the United States

National Museum of the Smithsonian Institution, from Gimpoe, Pine-dapa, Kwandang Molengkapoti, Temboan, and Besoa.

The cranial and dental similarities between *Tateomys* and *Melasmothrix* and their fundamental dissimilarities with either *Echiothrix* or *Rhynchomys* can be seen in figures 4 to 9, and in figure 11. From those illustrations it is clear that the crania of *Tateomys* and *Melasmothrix* differ from those of *Echiothrix* and *Rhynchomys* in being smaller and in configuration. The region between the dorsal roots of the zygomatic plates are appreciably inflated in *Tateomys* and *Melasmothrix*, and the interorbital region of each is wide and its contours smooth—features that resemble *Rhynchomys* but that are strikingly different from the interorbital region of *Echiothrix*, with its prominent supraorbital ridges. In *Tateomys* and *Melasmothrix* the braincase is low, smoothly rounded, either oblong or oval, and conspicuously overhangs the occipital condyles; all are features that contrast with the high, cubelike, and somewhat angular braincase of *Echiothrix* and *Rhynchomys*. In those forms the occipital regions barely extend beyond the condyles.

Elongate rostral regions characterize all four genera and in each one the tip of the nasals is bent upward to some degree. Elongation of the rostrum is most extreme in *Rhynchomys* and *Echiothrix*, but the configuration in each is different, the rostrum of *Rhynchomys* is nearly cylindrical, whereas that of *Echiothrix* is about twice as deep as it is wide. *Tateomys* and *Melasmothrix* are alike and each is unlike the other two genera in the general configuration and proportions of the rostrum.

The configuration of the nasolacrimal canal in *Tateomys* is similar to the shape of that structure observed in *Rhynchomys*. In both of those forms the canal is elongate, narrow, and compressed against the sides of the rostrum. The openings are crescent-shaped and directed backward. The nasolacrimal canals of *Echiothrix* and *Melasmothrix*, on the other hand, are larger, wider, and inflated, and the openings are rectangular and directed upward rather than backward, a configuration that resembles the shape of the canals in *Rattus*.

The zygomatic arches of *Tateomys* and *Melasmothrix* are slender, delicate, and are either even with the edges of the braincase or extend outward barely beyond them. The arches in *Echiothrix* and *Rhynchomys*, however, are stronger and thicker, and they bow outward well beyond the edges of the braincase. *Tateomys* and *Melasmothrix* are also alike in shape of the zygomatic plates and position of their ventral roots, although in both features, those genera resemble *Rhynchomys* more than *Echiothrix*, with its relatively less-specialized and *Rattus*-like zygomatic plates.

Tateomys and *Melasmothrix* are similar in configuration of the bony palatal bridge. The palatal bridge in each of those forms is unlike the long and simple palatal bridge of *Rhynchomys* on one hand, and the wide and complex palatal bridge of *Echiothrix* on the other. In fact, the configuration of the posterior one-third of the bridge of *Echiothrix* is unlike that observed in any of the other three genera. It consists of a series of ridges, deep grooves, pits, and foramina (see fig. 7), whereas in *Tateomys*, *Melasmothrix*, and *Rhynchomys* it is relatively simple.

Although the pterygoid region of each animal is distinctive, those of *Tateomys* and *Melasmothrix* resemble each other and are dissimilar to the pterygoid regions in either *Echiothrix* or *Rhynchomys*. In both *Tateomys* and *Melasmothrix* the pterygoid fossae are long and wide, and the hamular processes are elongate and low, but in size and position of the various foramina of the pterygoid area the two genera are dissimilar (see table 2). In *Rhynchomys* and *Echiothrix* the pterygoid fossae are long and narrow, the hamular processes are high and well developed, particularly in *Echiothrix*, and the foramina of the pterygoid region differ in position and size from the foramina in *Tateomys* and *Melasmothrix*.

In features of the tympanic bullae, *Tateomys* stands apart from the other genera. None of the other forms compared here has the small tympanic bullae that are characteristic of *Tateomys*, bullae with elongate, wide, and bony eustachian canals. Of the three genera, the configuration of the bullae in *Rhynchomys* is most like that seen in *Tateomys*, but the eustachian canals of *Rhynchomys* are relatively shorter and narrower.

In morphology of incisors, *Tateomys* resembles *Rhynchomys* more than *Melasmothrix* or *Echiothrix*. The incisors of *Tateomys* and *Rhynchomys* are small and appear weak compared with the large and stronger *Rattus*-like incisors of both *Melasmothrix* and *Echiothrix*. The enamel layers in the incisors of both rodents are white, in contrast to the pale yellow seen in *Echiothrix* or the orange observed in the enamel layers of *Melasmothrix*. In details, however, the incisors of *Tateomys* differ strikingly from those of *Rhynchomys* in that they are less recurved; their cutting edges are wider and meet at a right angle, in contrast to the narrow cutting edges seen in *Rhynchomys*, cutting edges that are straight as in *Rattus*; and enamel forms almost the entire lateral surface of each incisor, whereas in *Rhynchomys* the enamel layer is restricted mostly to the anterior surfaces of the incisors, a condition more like that of the teeth of *Melasmothrix* and *Echiothrix*. Of the four genera, the incisors of *Tateomys* seem to be the most specialized.

The maxillary teeth of *Tateomys*, *Melasmothrix*, *Echiothrix*, and *Rhynchomys* are compared in figure 11. The illustration shows that the teeth

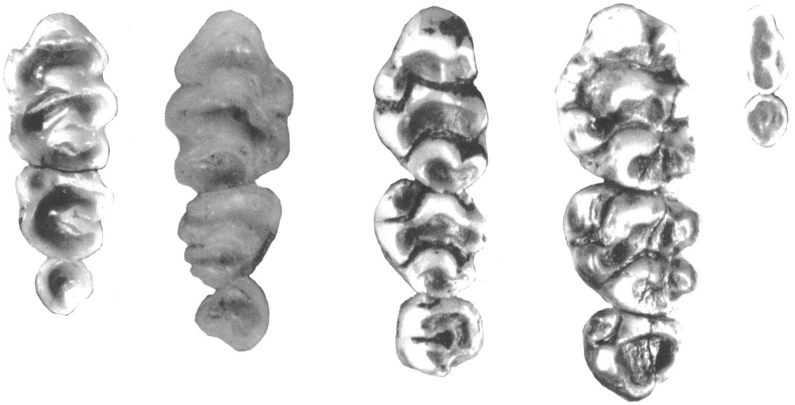


FIG. 11. Occlusal views of maxillary teeth. From left to right: left tooth row of *Tateomys rhinogradoides* (holotype); right tooth row of *Melasmothrix naso* (holotype); left tooth row of *Rattus coelestis* (A.M.N.H. No. 101144, adult female), from G. Wawokaraeng, Lompobatang Gebirge; left tooth row of *Echiothrix leucura* (U.S.N.M. No. 219750, subadult female), from Besoa, Celebes; right tooth row of *Rhynchomys soricoides* (F.M.N.H. No. 62289). Approximately $\times 8$.

of *Tateomys* are basically like those of *Melasmothrix* in size and configuration, and that the teeth of each of those genera are unlike the molars of either *Rhynchomys* or *Echiothrix*. *Rhynchomys*, with its four tiny and simple molars, stands well apart in dental morphology from the other three genera. The teeth of *Echiothrix* are the most *Rattus*-like of the three genera, and they are strikingly different from the smaller, basined, and relatively simple teeth of *Melasmothrix*. Miller and Hollister (1921b, p. 93) thought that the teeth of *Melasmothrix* were "apparently not different from those of *Echiothrix*," but they were probably misled by viewing the teeth of *Melasmothrix* as "much worn," which in fact they are not, and comparing them with worn dentitions of *Echiothrix*.

Each of the four genera compared here is characterized by a distinctive combination of external features, and the information obtained from study of those features sheds little light on any affinities between the four kinds of rodents. For example, the large head and body, long tail, agouti upper parts, white or pale yellow underparts, and the coarse and bristle-like pelage—all features characteristic of *Echiothrix*—clearly set that form apart from *Tateomys*, *Melasmothrix*, and *Rhynchomys*. The color, thickness, and texture of the pelage in *Rhynchomys* resembles that of *Tateomys*, but the pelage of *Rhynchomys* is longer and not as velvety; the two forms differ in most other external traits. *Tateomys* and *Melasmothrix* stand together in

having short, velvety pelage and in having long claws on the forefeet and hind feet, but beyond those features there is no especially close resemblance between the two genera. Finally, the unique features of *Tateomys*, particularly its long and cylindrical front claws, wide and robust forefeet, lateral metacarpal tubercles that are angular and bonelike, tiny eyes, and white-tipped nose, separate *Tateomys* from other genera.

The comparisons between *Tateomys*, *Melasmothrix*, *Echiothrix*, and *Rhynchomys* that I have discussed above are based on qualitative observations of skulls and study skins. To determine similarities and dissimilarities in proportions of external and cranial features between samples of the four genera, I constructed a series of ratio diagrams, a method of graphic analysis that was introduced by Simpson (1941) and has since been used effectively by other workers (see Hooper, 1952, for example). The method of constructing ratio diagrams was described in some detail by Simpson in his 1941 paper, and a shorter and simplified version of his instructions is available elsewhere (Simpson, and others, 1960). Although the reader is referred to those sources for a full discussion of the method, figures 12 and 13 require a brief explanation.

The ratio diagrams for *Tateomys*, *Melasmothrix*, *Echiothrix*, and *Rhynchomys* were constructed from data obtained from a single specimen representing each of those genera. Any comparisons, of course, would be more reliable if my samples of each kind were larger. But, *T. rhinogradoides* and *M. naso* are each known only from one specimen, and of the few examples of *R. soricoides* and *E. leucura* that were available to me, I found only one of each kind of approximately the same age as the examples of *Tateomys* and *Melasmothrix* and complete enough to allow me to take all the necessary measurements; unfortunately, both specimens of *Rhynchomys* and *Echiothrix* are females, whereas the examples of *Tateomys* and *Melasmothrix* are males. The absolute values of the external and cranial dimensions of the four specimens that were used to construct the ratio diagrams are listed in table 1. Absolute values of the four external and 17 cranial measurements obtained from each specimen were converted to logarithms. The specimen of *Tateomys* was chosen as the standard. For each dimension the logarithm of the standard was subtracted from the logarithm of each of the three other specimens and the resulting differences were plotted. Measurements larger than the standard are represented on the diagram by positive values, those smaller than the standard are represented by negative values. For each specimen a line was constructed by connecting the points representing values of that specimen. Specimens with the same proportions as the standard in the 21 dimensions that were measured will be represented by points on a line parallel to that of the

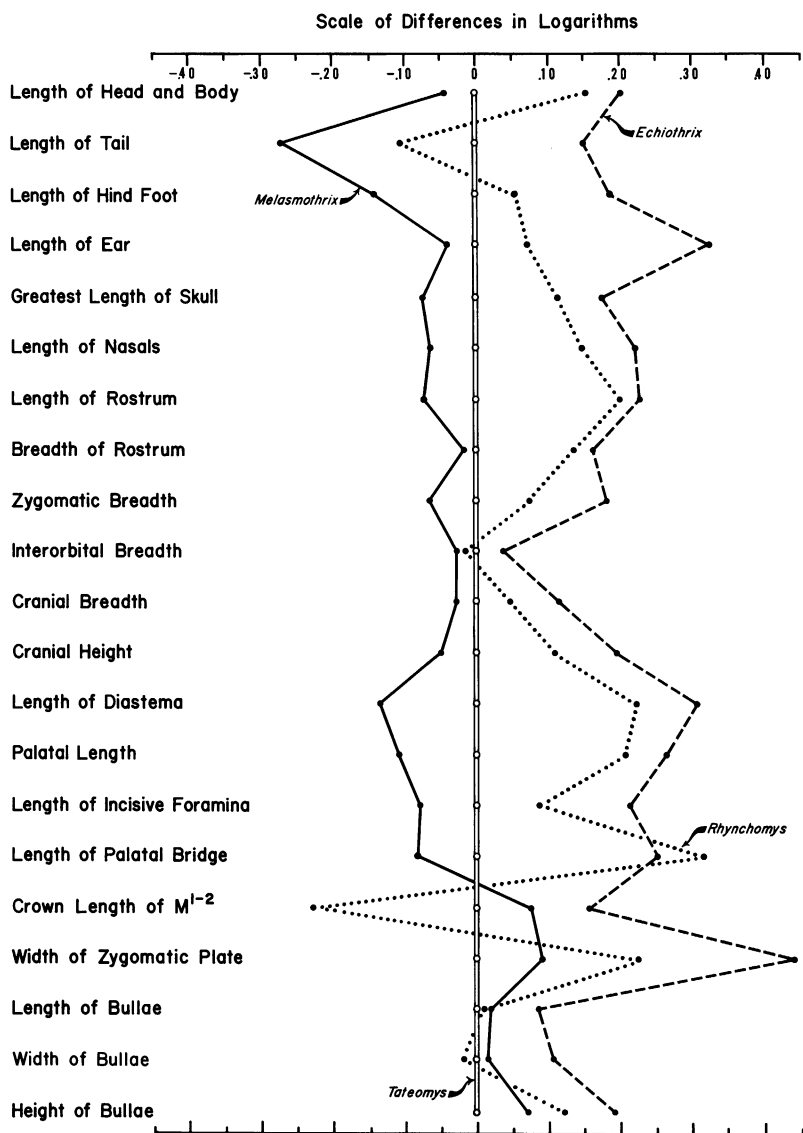


FIG. 12. Ratio diagram comparing 21 dimensions of skin and skull in the holotypes of *Tateomys rhinogradoides* and *Melasmothrix naso*, a specimen of *Echiothrix leucura*, and one of *Rhynchomys soricoides*. See text.

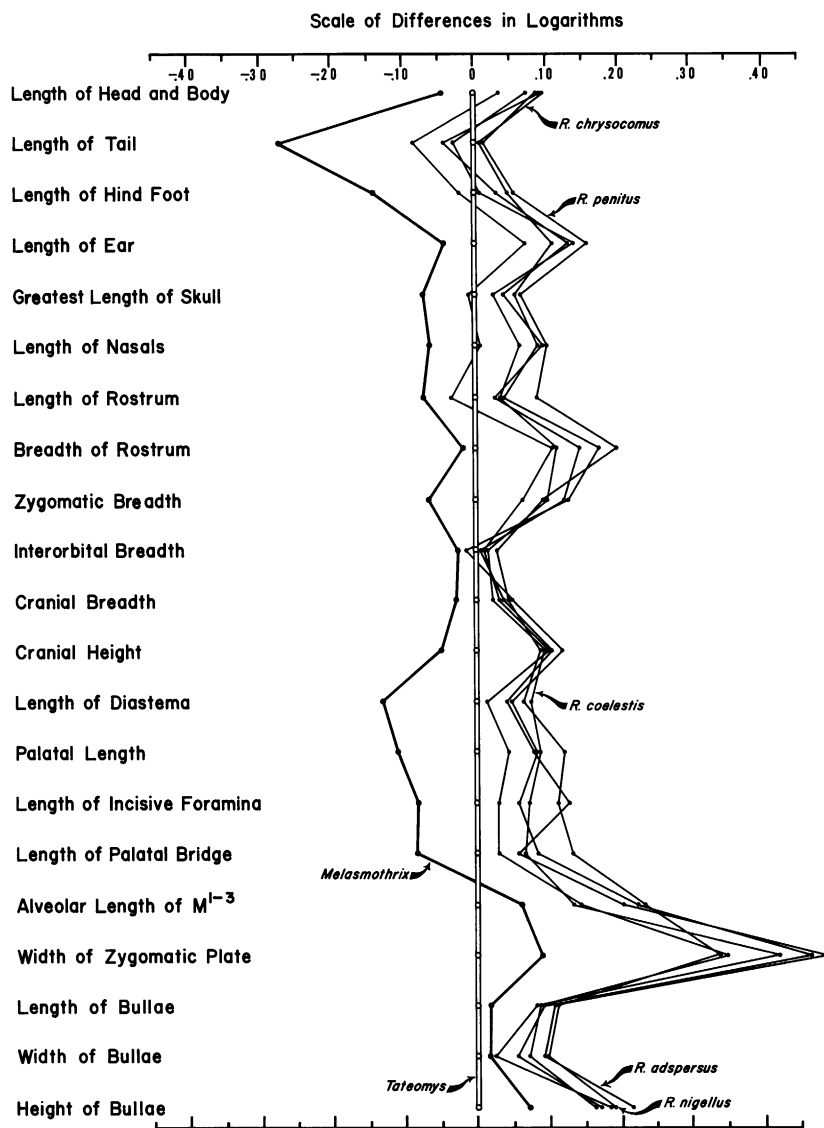


FIG. 13. Ratio diagram comparing 21 dimensions of skin and skull in the holotypes of *Tateomys rhinogradoides* and *Melasmothrix naso*, and in samples of five species in the *chrysocomus* group of *Rattus*. See text.

standard, regardless of whether those specimens are larger or smaller than the standard. Furthermore, if values for the specimens being compared with the standard are similar in absolute size they will be close together on the diagram, and, if proportions between any of the measured dimensions are similar, the relative positions of their points to each other on the horizontal scale will be similar.

In figure 12, most of the points that represent the specimen of *Melasmothrix* cluster around the standard, *Tateomys*. Although the points representing *Melasmothrix* do not fall along a straight line directly parallel to the standard, the shape and position of the line connecting them resembles the straight line of the standard more than the lines of either *Rhynchomys* or *Echiothrix*; the shape and position of the lines representing specimens of those latter genera are unlike either *Tateomys* or *Melasmothrix*. It is also apparent that with respect to *Tateomys*, *Melasmothrix* is smaller in the measured external dimensions and smaller in most of the measured cranial dimensions, but that *Melasmothrix* has longer first and second molars, a wider zygomatic plate, and larger bullae than in *Tateomys*. In addition, *Melasmothrix* has the tail and hind feet shorter relative to its length of head and body than in *Tateomys*, and the ear similar relative to length of head and body, but larger relative to hind foot and tail. *Melasmothrix* also has a wider rostrum, interorbital region, and braincase relative to its cranial length than in *Tateomys*; but a shorter diastema, palate, incisive foramina, and palatal bridge relative to either cranial length or breadth; similar lengths of nasals and rostrum relative to cranial length; and deeper bullae relative to either their lengths or widths. Notice also, that the specimen of *Melasmothrix* has longer first and second molars relative to its palatal bridge than in either *Tateomys*, *Rhynchomys*, or *Echiothrix*.

Some of the more striking proportional differences between *Tateomys* and *Melasmothrix* on one hand, and *Echiothrix* and *Rhynchomys* on the other, are also evident in figure 12. Thus, with respect to *Tateomys*, each of the examples of *Echiothrix* and *Rhynchomys* has longer nasals, rostrum, diastema, palate, and palatal bridge relative to its cranial length than either *Tateomys* or *Melasmothrix*. Moreover, *Echiothrix* and *Rhynchomys* each has a higher braincase relative to its breadth, but shorter teeth relative to its length of palatal bridge than in either example of *Tateomys* or *Melasmothrix*. Many other differences and similarities in proportions of the dimensions that were measured in the four specimens are indicated in the diagram.

The data presented in figure 12, although obtained from only one specimen of each animal, indicate that in proportions of the measured

external and cranial dimensions, *Tateomys* is more closely allied to *Melasmothrix* than to either *Rhynchomys* or *Echiothrix*. This indication is reinforced by the many qualitative similarities observed between *Tateomys* and *Melasmothrix* and their dissimilarities with *Rhynchomys* and *Echiothrix*. In fact, the many salient similarities between *Tateomys* and *Melasmothrix*, primarily in cranial features and proportions, suggest that the two were probably derived from a common ancestral population. On the other hand, the observed similarities between *Tateomys* and *Rhynchomys* that were pointed out are best explained by convergence rather than by close genetic relationship. The few points of resemblance between those two genera, for example, elongate rostral region, upturned nasal tips, configuration of the nasolacrimal canals, smoothly rounded interorbital region, shape and position of the zygomatic plates, and size and color of incisors, are likely specializations associated with the "long-nosed" morphological form, and such peculiar features have probably evolved independently in *T. rhinogradoides* and *R. soricoides*. Certainly, this explanation is the most compatible with the available data.

COMPARISONS BETWEEN *Tateomys* AND *Melasmothrix*

Some of the external and cranial similarities between *T. rhinogradoides* and *M. naso* were pointed out above and are evident in the illustrations of crania (figs. 4, 6, and 8), teeth (fig. 11), and the ratio diagrams (fig. 12). The features that contrast the two genera are listed in detail in table 2; some of those differences can also be seen in the figures.

The magnitude of difference observed between some of the features that contrast the two species appear to be no greater than the magnitude of difference seen between morphologically peripheral species within the same genus in some other murids. For example, the differences observed between *T. rhinogradoides* and *M. naso* in color and texture of pelage, and in size and proportions of external dimensions parallel those observed between native *Rattus rattus* and *R. hylomysoides* of Sumatra, and between *Oryzomys albigularis* and *O. caliginosus* of Latin America, the two best sets of examples that come to mind. Both *R. rattus* and *O. albigularis* are scampering forms with light to dark brown pelage, large bodies, and tails that are much longer than the head and body, whereas *R. hylomysoides* and *O. caliginosus* are small, volelike animals with chestnut pelage, and with tails that either equal the head and body in length, or are shorter. With these external features, however, the parallel between *T. rhinogradoides* and *M. naso* and the two other sets of species ends. The pronounced morphological dissimilarities between *T. rhinogradoides* and *M. naso* indicate that each form is specialized in a different way, and that each species

TABLE 2
EXTERNAL AND CRANIAL FEATURES CONTRASTING *Tateomys* WITH *Melasmothrix*

Feature	<i>T. rhinogradoides</i>	<i>M. naso</i>
Size and form	Medium-sized; scampering form, like <i>Rattus rattus</i> , for example	Small-sized; volelike form (see Walker, 1964, p. 934, for a photograph of the skin)
Pelage and color	Short, dense, and velvety; upper parts dark brown, underparts grayish buff	Short, dense, and velvety; both upper parts and underparts dark chestnut
Ears	Brown, no basal tuft of black hairs	Brownish black, each with a basal tuft of black hairs
Eyes	Small, 3 mm. between eyelids on study skin	Same actual size, but larger relative to size of head
Face	Snout elongate; area around lips grayish brown; white patch above nostrils	Snout actually shorter, and shorter relative to length of head and body; area around lips brown; blackish brown above nostrils
Forefeet	Robust and broad; mostly unpigmented; long curved claws, each oval in cross section; lateral metacarpal tubercle a large, rectangular, bonelike process	Less robust and smaller, brownish black; shorter claws, each more laterally compressed; lateral metacarpal tubercle a soft, rounded pad
Hind feet	Long and slender; light brown above, heel dark brown, otherwise unpigmented	Shorter; brownish black everywhere
Tail	Longer than head and body (123 per cent); pale brown except unpigmented ventral surface; finely haired; 16–17 scale rows per cm.	Shorter than head and body (73 per cent) ^a , brownish black except for midventral chestnut strip (1 mm. wide); densely covered with short hairs; 14 scale rows per cm.
Rostrum	Long and slender (36 per cent of greatest cranial length)	Actually shorter, but similar relative to greatest length of skull (37 per cent of greatest cranial length)
Nasals	Long and slender; extend 2.3 mm. behind union with premaxillary and frontal bones	Shorter; extend 3.3 mm. behind union with premaxillary and frontal bones
Braincase	Inflated, smoothly rounded, and oblong (much longer than wide) in dorsal view	Inflated and smoothly rounded, but smaller, almost circular in dorsal view
Zygomatic plates	Narrow, thin, and slanted backward; lateral faces nearly smooth; no masseteric tubercles	Wider, thicker, straighter; lateral faces prominently sculptured near top; conspicuous masseteric tubercles

TABLE 2—(Continued)

Feature	<i>T. rhinogradoides</i>	<i>M. naso</i>
Zygomatic arches	Thin and graceful arcs that bow outward slightly beyond each side of braincase	Weaker and parallel, do not curve outward beyond each side of braincase
Nasolacrimal canal	Outer walls compressed against sides of rostrum; opening directed backward and slightly upward	Outer walls inflated; opening is larger, directed mostly upward and slightly backward
Incisive foramina	Long (61 per cent of diastemal length) and slitlike; attenuate anterior and posterior margins	Actually shorter, but longer relative to length of diastema (69 per cent of diastemal length); attenuate anteriorly, broad posteriorly, with nearly truncate posterior margins
Palatal length	Long (40 per cent of greatest cranial length)	Actually shorter, and shorter relative to greatest length of skull (37 per cent of cranial length)
Bony palatal bridge	Moderately long (18 per cent of greatest cranial length) and wide; posterior edge truncate, extends 0.4 mm. behind posterior alveolar margin of third molar	Actually shorter and narrower, but length proportionally similar (also 18 per cent of greatest cranial length); posterior margin shallowly concave, ends just anterior to posterior alveolar edge of third molar
Pterygoid region	Elongate and simple; rear of pterygoid plates and adjacent basisphenoid bones inflated; ventral opening of foramen ovale small and situated near lateral edge of each pterygoid plate; medial "vidian" foramen larger than ventral opening of foramen ovale	Structurally similar but less elongate; rear of pterygoid plates and basisphenoid bones not conspicuously inflated; ventral opening of foramen ovale larger and situated in middle of pterygoid plate; medial "vidian" foramen tiny, its size and position like in <i>Rattus</i>
Tympanic bullae	Small, both actually and relative to size of braincase; long, slender, bony eustachian canals	Much larger, both actually and relative to size of braincase; short eustachian canals, similar to condition in <i>Rattus</i>
Basicranial region	Elongate and simple	Similar in structure but less elongate
Incisors	Short, slender, and weak; cutting edges meet at a right angle; unpigmented enamel forms most of lateral surface of each tooth	Larger and stronger; cutting edges meet at broad obtuse angle; orange enamel restricted to anterior surface of each tooth, as in <i>Rattus</i>

TABLE 2—(Continued)

Feature	<i>T. rhinogradoides</i>	<i>M. naso</i>
Maxillary tooth row	Small, low-crowned, and simple; crown of M ¹ with anterior basin separated from posterior C-shaped basin by a low ridge, this basin curves around a mound that connects with labial side of tooth by a low ridge; M ² a C-shaped basin curving around a ridge connected to labial side of tooth; M ³ a shallow basin, nearly circular in crown view	Structurally similar but larger, more complex, and deeper basins; crown of M ¹ with three deep basins separated from one another by two high transverse and arch-shaped ridges; M ² with two deep basins separated by a high curved ridge; M ³ basined and triangular in crown view

^a Tip of tail is missing, but even an intact tail would be shorter than length of head and body.

probably has a different mode of existence.

I view *T. rhinogradoides* as a scampering form. Morphologically, it is perfectly capable of constructing burrows through moist and soft soil, and it probably utilizes such burrows, either those made by itself or ready-made shelters it has found, for nesting sites and refuge. Outside of activities related to the nesting area, *T. rhinogradoides* probably spends much of its time scampering over the moist forest floor, stopping here and there to probe with its long nose the leaf litter and moss. Where there is promise of food, the rodent could dig into the moss and litter and probably well into the soft soil. *Tateomys rhinogradoides* is well suited for this activity with its long and strong claws, and its stout and broad front feet with their lateral metacarpal tubercles, which are angular and tough. The tubercles add surface area and strength to the inner surface of each hand, which the animal may use to push dirt and litter away from the depression. Within the leaf litter and moss, and underneath the surface of the soil, the rodent would probably locate what are the main components of its diet: earthworms, grubs, and other soft-bodied arthropods. The short incisors of *T. rhinogradoides*, with their sharp V-shaped cutting tips and smooth enamel-covered sides, are admirably suited to pierce and impale squirming, mucous-covered earthworms, and soft, turgid beetle larvae. The molars are also well adapted for crushing and masticating such items of food. A variety of fungi, as well as soft fruits, are probably also eaten. On occasion, the animal may even seek grubs in tree trunks and limbs scattered over the forest floor, in which it may dig into the rotten wood that has decomposed to a soft and friable point.

Melasmothrix naso is volelike in form and probably utilizes runways through litter and moss, alongside of fallen tree trunks, and around rocks. It may utilize, and even construct, burrows for nesting sites and refuge. *Melasmothrix naso* also probably digs here and there into the moss, leaf litter, and soft soil of the forest floor to find food. It likely eats a variety of invertebrates, but fruit and seeds may form a greater part of its diet than do soft-bodied arthropods. Morphology of its incisors and maxillary teeth suggest that *M. naso* may be more catholic in food preferences than is *T. rhinogradoides*, and it probably shares more of the omnivorous habits of a species like *Rattus rattus*.

These possible habits of *T. rhinogradoides* and *M. naso* are, of course, purely conjectural. But, such habits are certainly compatible with their known morphology and habitat.

COMPARISONS OF *Tateomys* AND *Melasmothrix* WITH THE *Rattus chrysocomus* GROUP OF SPECIES

Tateomys rhinogradoides and *M. naso* can be morphologically connected to the *Rattus chrysocomus* group of species, an assemblage of populations known to occur only on Celebes. In my opinion that group is comprised of 13 taxa: *chrysocomus*, *fratrorum*, *adspersus*, *penitus*, *sericatus*, *inferior*, *heinrichi*, *andrewsi*, *nigellus*, *rallus*, *brevimolaris*, *coelestis*, and *koka*. My view of the contents of the group is similar to that of Tate (1936), except for *coelestis* and *koka*, taxa which he listed under *Bunomys* (although Tate regarded that genus as closely allied to the *chrysocomus* group). Of the 13 taxa that I would place together, Ellerman (1949) grouped 11 of them into an assemblage, the "*coelestis* Group," and placed it in the subgenus *Rattus*. He excluded *chrysocomus* and *fratrorum* from that group, however, and regarded them as the "*chrysocomus* Group," and listed that group under the subgenus *Maxomys*. At the present time I am completing a systematic revision of *R. chrysocomus* and the species closely allied to it, and will report on the results of that study in a later paper. In it I will document the relationships between all the named forms contained in the *chrysocomus* group. For the purposes of the present discussion I need only to point out that samples of the named populations can be separated into at least five distinctive morphological types, each probably representing reproductively isolated populations, to which the names *chrysocomus*, *adspersus*, *penitus*, *nigellus*, and *coelestis* apply.

External and cranial proportions from samples of these five kinds of *Rattus* are illustrated in the form of ratio diagrams in figure 13, and compared with diagrams of *M. naso* and *T. rhinogradoides*. The external and cranial dimensions that were measured are the same as those in figure 12,

except that the alveolar length of the maxillary tooth row was measured instead of the crown length of the first two molars. Each of the points on the graph that was derived from each sample of *Rattus* represents the logarithmic difference between the mean of a particular sample and the specimen of the standard, *T. rhinogradoides*. The data are plotted on the same scale that is used for the graph in figure 12. The samples of *Rattus* (comprised only of males) and number of specimens that were used to construct the ratio diagrams are as follows: *R. chrysocomus*, Temboan, 26 specimens; *R. adspersus*, Pinedapa, five specimens; *R. penitus*, Goenoeng Lehi, four specimens; *R. nigellus*, Bumbaroedjaba, three specimens; *R. coelestis*, Wawokaraeng, 13 specimens.

With respect to *Tateomys*, the five kinds of *Rattus* are similarly proportioned in the measured external and cranial dimensions. The values for samples of the five forms are close together on the diagram and the relative positions of their points to one another on the horizontal scale is similar. Certainly a close inspection of the lines connecting the points for each sample will reveal differences in proportions between samples of the five types of *Rattus*. For example, with respect to *Tateomys*, *R. adspersus* has longer incisive foramina relative to its palatal length than in the other four species of *Rattus*, and this is one of the distinctive features of *adspersus*. But, for this discussion, there are two important items to focus on in figure 13. First, is the basic similarity in proportions between the five kinds of *Rattus*.

Second, is the striking similarity between the shape of the line connecting the values of the specimen of *M. naso* and the configuration of the five lines that represent proportions in the samples of *Rattus*, particularly those of external dimensions. Moreover, the configurations for *Rattus* resemble that of *M. naso* more than the straight line of the standard, *T. rhinogradoides*.

On the other hand, there are obvious size and proportional differences between *M. naso* and each species of *Rattus*. With respect to *Tateomys*, the specimen of *M. naso* is smaller in all the measured dimensions than any of the samples of *Rattus*. *Melasmothrix naso* has a wider interorbital breadth and wider braincase relative to its zygomatic breadth than in the samples of *Rattus*, in which each interorbital and cranial breadth is smaller in relation to its zygomatic breadth. Furthermore, *M. naso* has a shallow braincase relative to its breadth, whereas all forms of *Rattus* have a high braincase relative to their respective cranial breadths. In these features *M. naso* is proportionally more like *T. rhinogradoides*. Other proportional differences and similarities between the samples are evident in the graph.

Not only can *M. naso* be linked to the *chrysocomus* species-group by ex-

ternal and cranial proportions, but in particular qualitative features of skin and skull, *M. naso* lies structurally between the *chrysocomus* group and *T. rhinogradoides*. Some of these features can be seen in figures 11, 14, and 15, in which the maxillary teeth and crania of *T. rhinogradoides*, *M. naso*, and *R. coelestis* (this form and *R. nigellus* are closely related morphologically and of the five types in the *chrysocomus* group, *coelestis* and *nigellus* are closest to *M. naso* in features of skin and skull) are compared. For example, the incisors of *M. naso* are intermediate in size between *R. coelestis* and *T. rhinogradoides*, but their configuration, and position and pigmentation of the enamel layers are more like the condition observed in *R. coelestis*. In size and topography of crowns, the maxillary teeth of *M. naso* also lie between *T. rhinogradoides* and *R. coelestis* (fig. 11). In fact, the patterns of the crowns observed in *M. naso* could well have been derived from a pattern similar to the one seen in *R. coelestis*, or even a pattern like that in the closely related *R. nigellus*.

The configuration of the pterygoid region and its associated foramina, and the shape of the zygomatic plate in *M. naso* fall between *R. coelestis* and *T. rhinogradoides*. Of those two structural complexes in *M. naso*, the shape of the zygomatic plate is more like that of *T. rhinogradoides*, and the pterygoid region recalls that of *R. coelestis* more than the distinctive pterygoid region of *T. rhinogradoides*.

In absolute size and in proportions, the tympanic bullae of *M. naso* resemble those of *R. coelestis* more than the bullae of *T. rhinogradoides*.

The external proportions of *M. naso* are similar to those of *R. coelestis* and the other forms in the *chrysocomus* group and dissimilar to those of *T. rhinogradoides* (fig. 13). In addition, the front feet of *M. naso*, although much smaller in absolute measurements than those of *R. coelestis*, are structurally more similar to that form than to *T. rhinogradoides*. The length of the front claws of *M. naso*, however, proportionally resembles the elongate claws of *T. rhinogradoides* more than the claws of *R. coelestis*, which are elongate (Thomas, 1896a, p. 248), and are, relative to size of the front foot, longer than the claws of most other species of *Rattus*. In shape, the claws of *M. naso* are neither as cylindrical as those of *T. rhinogradoides*, nor as flattened as those of *R. coelestis*; they lie between those two forms in structure.

The other external features observed in *M. naso* and *T. rhinogradoides* offer few clues that positively indicate any direct link with the *chrysocomus* group of *Rattus*. On the other hand, there are no special external characteristics of any of the species in the group that suggest such a link would be impossible. For example, the pelage is long, soft, and thick in all species of the *chrysocomus* group in general, and in *R. coelestis* in particular.

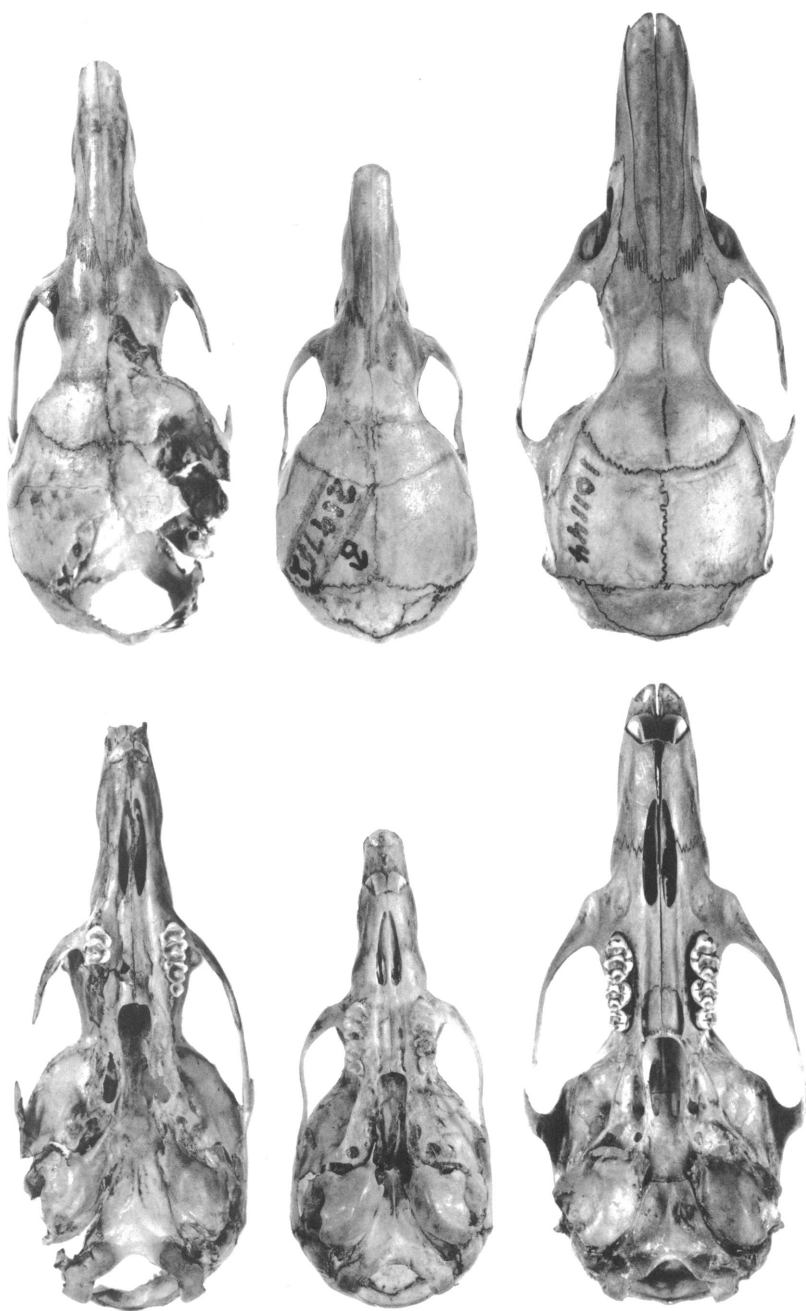


FIG. 14. Dorsal (top) and ventral (bottom) views of crania. From left to right, the holotypes of *Tateomys rhinogradoides* and *Melasmothrix naso* are compared with *Rattus coelestis* (A.M.N.H. No. 101144). Approximately $\times 2$.

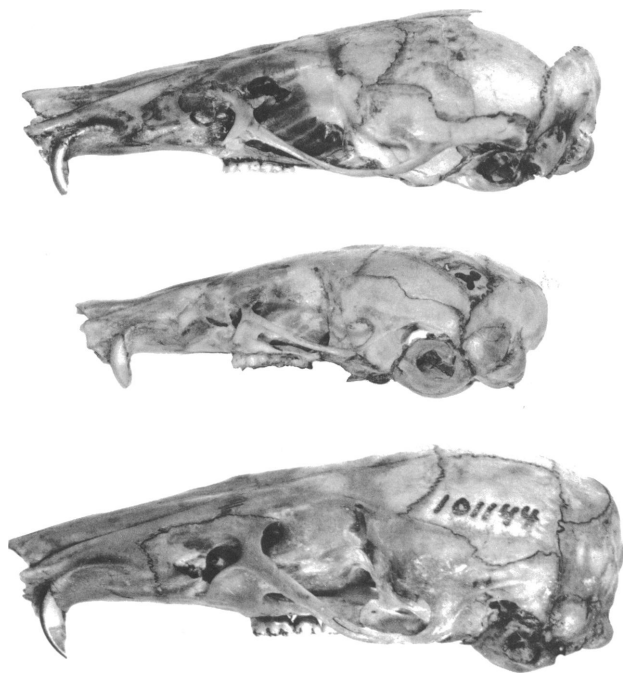


FIG. 15. Lateral views of crania. From top to bottom, the holotypes of *Tateomys rhinogradoides* and *Melasmothrix naso* are compared with *Rattus coelestis* (A.M.N.H. No. 101144). Approximately $\times 2$.

In fact, the pelage of *R. coelestis* resembles the pelage of *T. rhinogradoides*; the main difference between the two kinds is in length, that of *R. coelestis* is about twice as long. Further, coloration of the upper parts and underparts of *T. rhinogradoides* is similar to that of *R. coelestis*; it is certainly more like that species of *Rattus* than like the coloration observed in *M. naso*. Finally, the tails in samples of the *chrysocomus* group are finely haired and scaled (in *R. coelestis*, for example, there are 13–14 scale rows per cm.) as are the tails of both *T. rhinogradoides* and *M. naso*.

CONCLUSIONS

Five genera of murids are known to be endemic to Celebes: *Tateomys*, *Melasmothrix*, *Echiothrix*, *Lenomys*, and *Eropeplus*. The first three are monotypic and contain long-nosed forms. Of those, *Tateomys rhinogradoides* is morphologically closely related to *Melasmothrix naso* and neither of those species has any close morphological affinities to *Echiothrix leucura* or to

Rhynchomys soricoides, the long-nosed rodent of the Philippines. Moreover, *T. rhinogradoides* can be morphologically linked to the *chrysocomus* species-group of *Rattus* through *M. naso*. *Tateomys rhinogradoides* is morphologically and probably phyletically farthest removed from the *chrysocomus* group; it shares few characters with any form in that assemblage. *Melasmothrix naso*, although characterized by its own suite of distinctive features, is closer to *T. rhinogradoides* in most cranial characters, but in other cranial features and proportions, and in most external traits, *M. naso* resembles species in the *chrysocomus* group; it is certainly morphologically closer to that group than is *T. rhinogradoides*.

In utilizing the information presented in this report, the reader should be aware of three important items. First, the linking of *T. rhinogradoides* and *M. naso* to the *Rattus chrysocomus* group of species is based on small samples and on data obtained primarily from skins and skulls. My conclusion should be taken only as a best estimate, a reasonable explanation of affinities that must be tested further with additional and other kinds of data.

Second, neither *M. naso* nor *T. rhinogradoides* can be considered actual derivatives of either the extant *Rattus coelestis* or *R. nigellus*. Those two forms, out of all the morphological types that comprise the *chrysocomus* group, simply represent the best-known morphotype from which the features of *M. naso* and *T. rhinogradoides* could have been derived. Most external and cranial features of *R. coelestis* and *R. nigellus* lie within the morphological framework that forms the structural limits of *Rattus* (as defined by Ellerman, 1941, 1949). But, in some external and cranial proportions and configurations, *R. coelestis* and *R. nigellus*, more than any other extant species of *Rattus*, possess a suite of characteristics that begin to bridge the morphological gap between *Rattus* at one end and *M. naso* and *T. rhinogradoides* at the other. Features, such as certain proportions of external and cranial dimensions, elongate hind feet, finely scaled tail, elongate claws, long and soft pelage, elongation of the rostrum and palate, long incisive foramina, shape of the zygomatic plates, a tendency toward a rounded interorbital region and braincase, and molars with simplified occlusal topography, portend the structural specializations seen in *M. naso* and *T. rhinogradoides*.

Finally, I have no new data with which to assess the morphological and probable affinities of either *Echiothrix leucura* or *Rhynchomys soricoides*. In this report I merely indicate that neither of those species is especially closely related to *Tateomys rhinogradoides*, and that the similarities observed between *T. rhinogradoides* and *R. soricoides* are probably due to convergence rather than to close genetic and phyletic relationship. The

relationships of *E. leucura* and *R. soricoides*, despite the various opinions and guesses scattered throughout the literature, are still unclear. Each is a specialized rodent and each occupies a peripheral position in the remarkable pattern of adaptive radiation seen in murids of the Indo-Australian region. Further study of Indo-Australian murids is needed before the affinities of either *E. leucura* or *R. soricoides* can be elucidated with any confidence.

ACKNOWLEDGMENTS

The efforts of several people have contributed in important ways to this report. Dr. Gerd Heinrich deserves special mention. Besides collecting the specimen of *T. rhinogradoides* 39 years ago, he has been most helpful in supplying information about the habitat from which the animal was taken. Dr. Heinrich told me that when he took the rodent out of the trap, he knew at once that it was either undescribed or of special interest. He tried to obtain more specimens but was unsuccessful.

Dr. Charles O. Handley, Jr., placed the large collection of rodents from Celebes that is in the United States National Museum of the Smithsonian Institution (U.S.N.M.) at my disposal. I appreciate his help and interest, and the many courtesies he extended to me during my work there. I thank Dr. Joseph Curtis Moore for allowing me to borrow examples of *Rhynchomys soricoides* from the Field Museum of Natural History (F.M.N.H.). I am also grateful to Dr. Karl F. Koopman for reading the manuscript and for his good advice, and to Dr. Sydney Anderson for allowing me extensive use of his craniometer.

The photographs (except for the teeth of *Melasmothrix naso* in figure 11, which were photographed by Mr. Paul Ryan) are the work of Mr. Robert E. Logan, staff photographer for the American Museum of Natural History. He has achieved his usual, excellent results.

Mrs. Nylene Gilbert refined my rough typewritten pages into finished manuscript.

LITERATURE CITED

ANDERSON, S.

1968. A new craniometer and suggestions for craniometry. Jour. Mammal., vol. 49, no. 2, pp. 221-228, figs. 1-3.

ELLERMAN, J. R.

1941. The families and genera of living rodents. London, British Museum (Natural History), vol. 2, Family Muridae, 690 pp.
1949. The families and genera of living rodents. London, British Museum (Natural History), vol. 3, pt. 1, 210 pp.

GRAY, J. E.

1867. Notes on the variegated or yellow-tailed rats of Australasia. Proc. Zool.

- Soc. London, pp. 597-600, 1 fig.
- GREENE, E. C.
1962. Gross anatomy. In Farris, E. J., and J. Q. Griffith, Jr. (eds.), *The rat in laboratory investigation*. Second edition. New York, Hafner Publ. Co., pp. 24-50, figs. 28-49.
- GUTHRIE, D. A.
1963. The carotid circulation in the Rodentia. *Bull. Mus. Comp. Zool.*, vol. 128, no. 10, pp. 455-481, 5 figs.
- HILL, J. E.
1935. The cranial foramina in rodents. *Jour. Mammal.*, vol. 16, no. 2, pp. 121-129, figs. 1-3.
- HOOGSTRAAL, H.
1951. Philippine Zoological Expedition 1946-1947. Narrative and itinerary. *Fieldiana: Zool.*, vol. 33, no. 1, 86 pp., 7 figs., 7 pls.
- HOOPER, E. T.
1952. Notes on mice of the species *Peromyscus boylei* and *P. pectoralis*. *Jour. Mammal.*, vol. 33, no. 3, pp. 371-378, figs. 1-2.
- JENTINK, F. A.
1883. A list of species of mammals from West-Sumatra and North-Celebes, with descriptions of undescribed or rare species. *Notes Leyden Mus.*, vol. 5, note 16, pp. 170-181.
- LAURIE, E. M. O., AND J. E. HILL
1954. List of land mammals of New Guinea, Celebes and adjacent islands 1758-1952. London, British Museum (Natural History), 175 pp.
- MILLER, GERRIT S., JR., AND N. HOLLISTER
1921a. Descriptions of sixteen new murine rodents from Celebes. *Proc. Biol. Soc. Washington*, vol. 34, pp. 67-76.
1921b. Twenty new mammals collected by H. C. Raven in Celebes. *Ibid.*, vol. 34, pp. 93-104.
- SANBORN, C. C.
1952. Philippine Zoological Expedition 1946-1947. Mammals. *Fieldiana: Zool.*, vol. 33, no. 2, 158 pp., figs. 8-22.
- SIMPSON, G. G.
1941. Large Pleistocene felines of North America. *Amer. Mus. Novitates*, no. 1136, pp. 1-27, figs. 1-11.
- SIMPSON, G. G., A. ROE, AND R. C. LEWONTIN
1960. *Quantitative Zoology*. Revised edition. New York, Harcourt, Brace and Co., 440 pp., 64 figs., 5 tables.
- SODY, H. J. V.
1941. On a collection of rats from the Indo-Malayan and Indo-Australian regions. *Treubia*, vol. 18, pt. 2, pp. 255-325.
- TATE, G. H. H.
1936. Results of the Archbold Expeditions. No. 13. Some Muridae of the Indo-Australian region. *Bull. Amer. Mus. Nat. Hist.*, vol. 77, pp. 501-728, figs. 1-13.
- THOMAS, O.
1895. Preliminary diagnoses of new mammals from Northern Luzon, collected by Mr. John Whitehead. *Ann. Mag. Nat. Hist.*, ser. 6, vol. 16, pp. 160-164.

- 1896a. On mammals from Celebes, Borneo, and the Philippines recently received at the British Museum. *Ibid.*, ser. 6, vol. 18, pp. 241–250.
- 1896b. On the genera of rodents: an attempt to bring up to date the current arrangement of the order. *Proc. Zool. Soc. London*, pp. 1012–1028.
- 1898. On the mammals obtained by Mr. John Whitehead during his recent expedition to the Philippines. *Trans. Zool. Soc. London*, vol. 14, pt. 6, no. 1, pp. 377–412, pls. 30–37.

WALKER, E. P.

- 1964. *Mammals of the world*. Second edition. Baltimore, The Johns Hopkins Press, vol. 2, pp. 647–1500.

