AMERICAN MUSEUM
Novitates

PUBLISHED BY THE AMERICAN MUSEUM OF NATURAL HISTORY
CENTRAL PARK WEST AT 79TH STREET, NEW YORK, N.Y. 10024
Number 2850, pp. 1–10, figs. 1–5, tables 1, 2 June 30, 1986

Paulamys, a Replacement Name for *Floresomys* Musser, 1981 (Muridae), and New Material of that Taxon from Flores, Indonesia

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ABSTRACT

Paulamys, a new name, is proposed to replace *Floresomys* Musser (1981), the generic name for a species of long-nosed murid known by subfossil fragments from the island of Flores in Nusatenggara, Indonesia. New specimens of the species are listed and described and their significance to understanding the native Floresian murids discussed.

INTRODUCTION

Twelve species of murids are recorded from Flores, one of the larger islands in Nusatenggara (Lesser Sunda Islands) east of Bali and south of Sulawesi. Six of them (*Rattus rattus, Rattus argentiventer, Rattus exulans, Rattus norvegicus, Mus caroli,* and *Mus musculus castaneus*) were introduced and now live on Flores in ecological associations tied to humans—towns, villages, gardens, agricultural fields, scrub, and disturbed forest and savanna (Musser, 1981). The other six species are native. *Papagomys armandvillei* is known by subfossil and recent specimens and still lives on Flores. *Papagomys theodorverhoeveni, Floresomys naso, Komodomys rintjanus,* and *Spelaeomys florensis* are represented by subfossil fragments, and *Hooijeromys nusatenggara* by Pleistocene samples. Except for *Komodomys,* which now occurs on Rintja and Padar, the small islands between Flores and Komodo, all the native species have been found on Flores and nowhere else (Musser, 1981).

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 ISSN 0003-0082 / Price $1.35

The subfossil and Pleistocene fragments were collected by Dr. Theodorus Verhoeven, described by Hooijer (1957, 1967), and then redescribed by Musser (1981). That material came from Liang Toge (*Liang* is Indonesian for cave). Dr. Verhoeven also collected specimens of rats from other caves in Flores and these samples were sent to the Instituut voor Aardwetenschappen at the Rijksuniversiteit Utrecht, where the specimens were cleaned, catalogued, and recently loaned to Musser. Examples of the six native species discussed by Musser (1981) are in the new samples, and some of the species are represented by abundant material. There are also samples of three new species. Two of these are related to *Papagomys armandvillei* and the third is a shrew rat in which the morphology of the dentary resembles the large-bodied shrew rats of the Philippines (*Chrotomys*) and the smaller shrew mice native to New Guinea (*Neohydromys*). These new specimens reinforce the view that the native Floresian murids comprise two primary groups. One is clustered around *Papagomys,* which is phylogenetically tied to faunas found to the north and west on Sulawesi and the Sunda Shelf; the other is represented by *Spelaeomys* and the shrew rat, which are linked with murids endemic to the New Guinea and Australian region, and possibly to the Philippines.

Among the new specimens are seven dentary fragments of *Floresomys naso,* all less than 4000 years old, collected from three caves. Although some of the specimens are no more complete than the four examples described by Musser in 1981, one dentary is nearly complete and enough remains of two others to provide new information about certain structural aspects of the species.

In this report, we place on record the new specimens of *Floresomys naso* and clear up a nomenclatorial problem. Several persons had mentioned to us that *Floresomys* is preoccupied. Musser provides a replacement name that is needed at this time to satisfy the requests of those, including ourselves, who are preparing classifications and faunal lists in which the name will be included.

We are indebted to Dr. Verhoeven who allowed us to study the new material and related details about the caves and their excavations. Drs. Karl F. Koopman, Michael D. Carleton, and James L. Patton gave us intelligent and helpful criticisms of the manuscript; we appreciate their contributions. Peter Goldberg photographed the specimens and provided his usual excellent prints.

Ms. Elizabeth Strasser thanks the Greenwall Foundation for her award (administered by the American Museum of Natural History) from the Undergraduate-Graduate Research Program.

The present report is number 116 in Results of the Archbold Expeditions.

THE REPLACEMENT NAME (BY GUY G. MUSSER)

During the last three years, Dr. V. Fahlbusch and Dr. R. Hutterer, among others, kindly pointed out to me that *Floresomys,* the generic name I had applied to a murid from Flores, was preoccupied by *Floresomys* Fries, Hibbard, and Dunkle (1955), which had been proposed for a species of sciuravid. I read that report long ago but forgot about the name, for which I apologize. *Floresomys* Musser (1981) should be replaced by the following.

Paulamys Musser, 1986

The diagnosis, genotype, and included species for *Floresomys* as proposed by Musser (1981) apply to the replacement name *Paulamys.*

In 1980, Dr. Verhoeven and his wife, Paula Hamerlinck, visited me at the American Museum of Natural History. I had recently submitted a manuscript to the publisher that contained descriptions of specimens Dr. Verhoeven had collected from Liang Toge in western Flores during the 1950s. We talked about those fragments and his excavations. I showed him and his wife some of the new material that he had collected, which had just been sent to me from Utrecht. I related how important this undescribed material was in understanding the nature of the murids native to Flores, and that some of the samples represented new species which provided special insight into the past evolutionary history of the rats. Dr. Verhoeven asked questions about the fauna and spoke of his experiences working in the different caves. The time passed quickly and before my guests left, Dr.

TABLE 1
Measurements (in Millimeters) and Ratios (in Percent) of Lower Molars and Incisors from Adult *Paulamys naso*[a]

Cave and specimen	Length and breadth						Ratio		
	CLM_{1-3}	ALM_{1-3}	BI	BM_1	BM_2	BM_3	$\frac{BM_2}{BM_1}$	$\frac{BM_3}{BM_1}$	$\frac{BM_3}{BM_2}$
Liang Toge									
Spec. 1[b]	7.6	7.9	1.0	2.0	2.1	1.9	105	95	90
Spec. 2	7.5	7.9	1.2	2.1	2.2	1.8	105	86	82
Spec. 3	—	—	1.1	2.0	2.2	—	110	—	—
Spec. 4	7.5	7.7	1.2	2.0	—	1.8	—	90	—
LT 47	—	—	1.2	—	—	—	—	—	—
Liang Soki									
LS 9	7.3	7.5	—	1.9	2.1	1.8	111	95	86
Liang Bua									
LB 90	7.6	8.0	1.2	1.8	2.0	1.8	111	100	90
LB 15	—	—	—	1.9	2.2	—	116	—	—
LB 20	—	8.1	1.2	—	2.2	2.0	—	—	91
LB 13	—	7.7	—	1.8	—	—	—	—	—
LB 85	—	—	—	—	—	1.8	—	—	—

[a] Abbreviations: CLM, crown length of molar row; ALM, alveolar length of molar row; BI, breadth of incisor taken where the tooth emerges from the ramus; BM, breadth of molar.
[b] Holotype. Specimens 1–4 are described and illustrated by Musser (1981).

Verhoeven asked if it might be possible to name one of the rats after Paula. I would be happy to do so, I told him. By combining the Greek *mys,* for mouse (or rat), with the name Paula, I honor the companion of Dr. Verhoeven, the man who has contributed so much to our knowledge of the recent past on Flores.

THE CAVES

The caves yielding the specimens we report here are located in the *Lepidocyclina*-limestone (Ehrat, 1928), a formation of Miocene age occurring in the northern part of the Manggarai and Ngada districts of western Flores. Ehrat (1928) reported that the limestone formation has been intensively eroded into a karst topography containing numerous caves. Sediments in some of the caves had been explored for remains of artifacts (mainly Mesolithic) and other human remains (Verhoeven, 1968). Fragments of postcranial skeletal elements, crania, mandibles, and isolated molars and incisors are common in some of the cave deposits described below.

LIANG TOGE: This is a rock shelter located in the northwestern part of the Ngada District, 2 km south of the abandoned village Lepa, near Teong. The shelter was discovered in 1952 by Dr. Verhoeven and excavated during 1954 and 1960. The rock ceiling of the cave has an overhang of about 4 m, and the shelter itself is about 11 m broad. Its deposits are divisible into three units. The top unit is 1–1.6 m thick and is the only one that concerns us here. A human skeleton, described by Jacob (1967), was found about 1 m deep in this unit and it is from this level that a radiocarbon date of 3550 ± 525 years old was obtained. Specimens 1–4 of *Paulamys naso* described by Musser (1981) were collected in Unit 1 but the level at which they were found is unknown. The additional specimen (table 1) we report here was obtained from either the surface or top level of Unit 1.

LIANG BUA: This cave is north of the village of Teras, 10–12 km northwest of Ruteng, the capital of the Manggarai District. About 30 m broad and 34 m deep, with a ceiling 10 m high, the cave was used as a school building by the Teras residents and was visited by Dr. Verhoeven in 1950 and excavated in 1965.

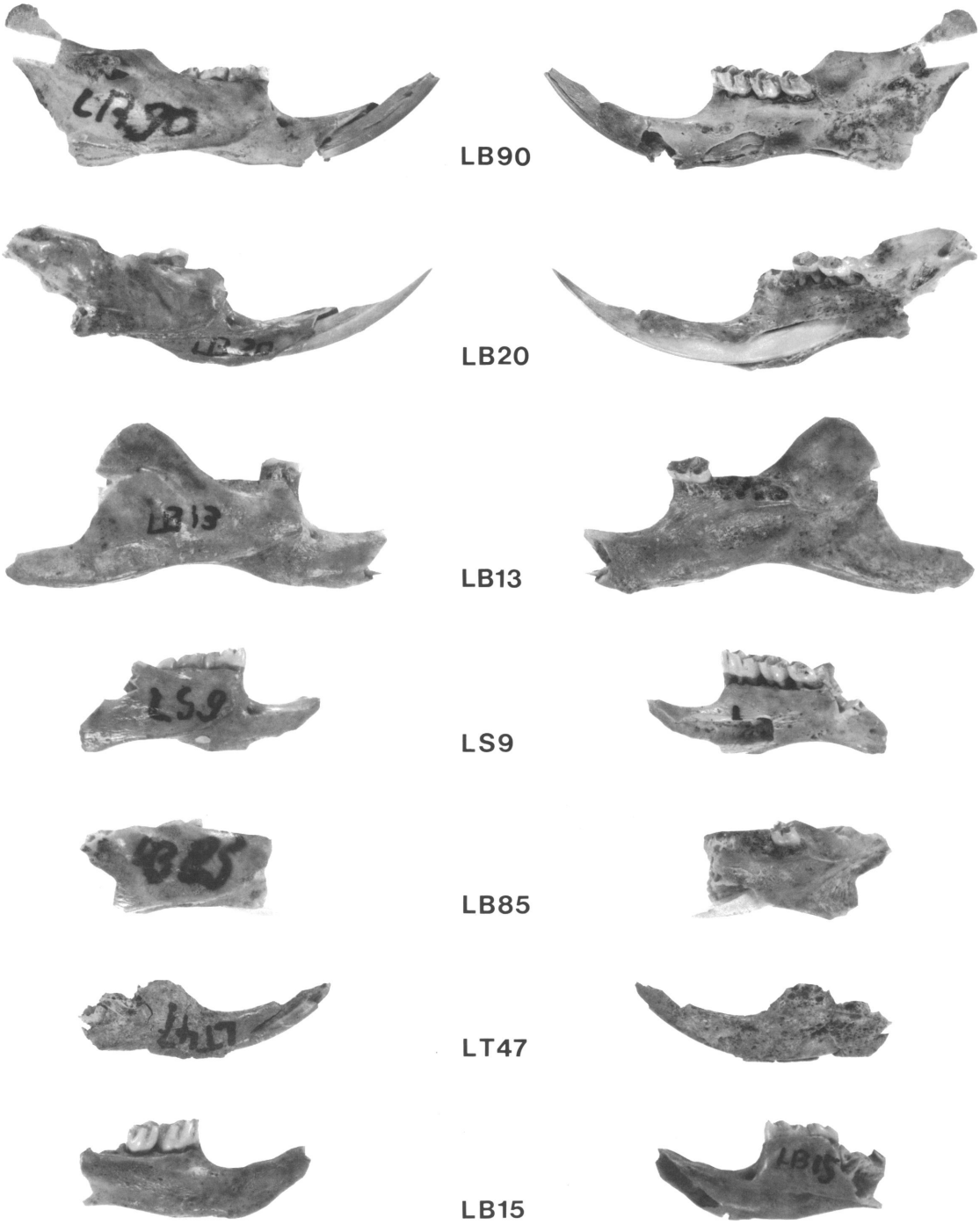

Fig. 1. Dentary fragments of *Paulamys naso* from Liang Bua, Liang Soki, and Liang Toge. See table 1. Approximately ×2.

Several Neolithic graves were discovered at a depth of 90–115 cm. An older, probably Paleolithic, grave was found at approximately 2 m. Five specimens of *Paulamys naso*

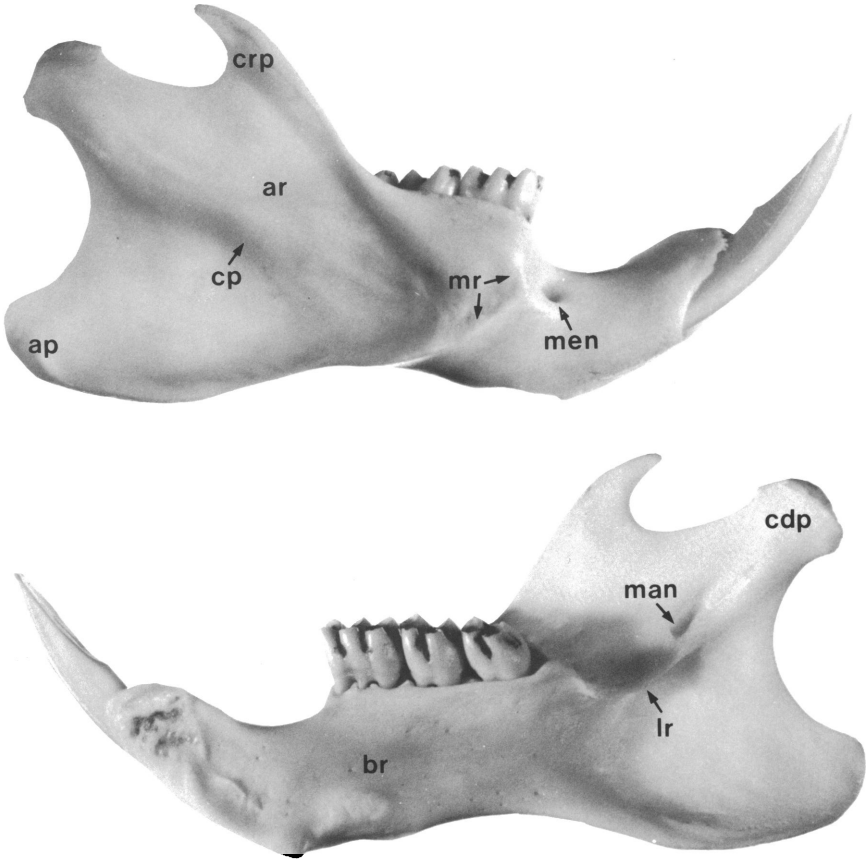

Fig. 2. Labial (top) and lingual (bottom) views of the dentary of *Papagomys armandvillei* (Museum Zoologicum Bogoriense 2395). Approximately ×2. Compare this dentary with those of *Paulamys naso* on the opposite page. Abbreviations: **ap,** angular process; **ar,** ascending ramus; **br,** body of ramus; **cdp,** condylar process; **cp,** capsular process (encloses base of the incisor); **crp,** coronoid process; **lr,** lingual ridge; **man,** mandibular foramen; **men,** mental foramen; **mr,** dorsal and ventral masseteric ridges.

from this cave (table 1) were discovered in the sediments above the graves; we do not know the exact level at which they were collected.

LIANG SOKI: We know little about this cave except that it is located about 15 km north of Ruteng in the Manggarai District. A single specimen of *Paulamys naso* (table 1) was discovered in a shallow test excavation.

THE SPECIMENS

The four fragments of *Paulamys naso* described by Musser in 1981 (Specimens 1–4 from Liang Toge) represent adults. Each consists of a partial mandibular ramus with a molar row that is either complete or missing the second or third molar. The ascending ramus is absent in three and present but badly eroded in one. The bony covering of the incisor anterior to the molar row is present in two specimens but incomplete in the other two. The fragments were originally determined to come from species of *Rattus* (Hooijer, 1967; Musser, 1972) but the "shapes of the first two laminae on the first molar, the absence of an anterolabial cusp from the third molar, the proportion of small molar size to large dentary, the elongated segment of the dentary in front of the toothrow, and the slim incisors is a combination of features not found in *Rattus*" (Musser, 1981, p. 118).

Although fragmentary, enough characters are preserved in Specimens 1–4 to indicate a species characterized by an elongate mandible, which implies a long rostrum.

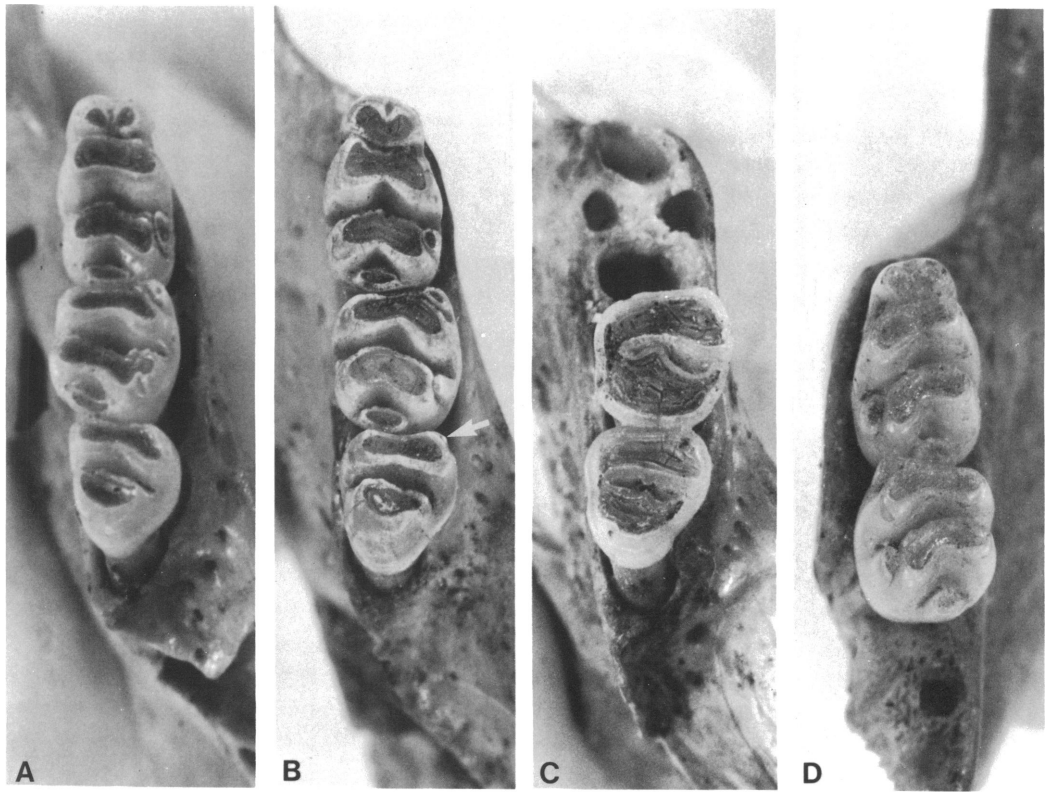

Fig. 3. Mandibular molar rows of *Paulamys naso*. **A,** LS 9; **B,** LB 90; **C,** LB 20; and **D,** LB 15. Arrow points to small anterolabial cusp. Approximately ×8. Measurements are listed in table 2.

The seven new pieces represent seven individuals that range in age from young to old adults (table 1). Four of the pieces (LS 9, LT 47, LB 15, and LB 85) are small fragments (fig. 1) and contain no additional information beyond that derived from the original Specimens 1–4. Three of these four (LS 9, LT 47, and LB 15) have enough of the dentary remaining anterior to the molar row to indicate the dentary was elongate and closely similar to Specimens 1–4.

The other new fragments (LB 90, LB 20, and LB 13) are relatively complete (table 1; fig. 1) and together provide details about mandibular configuration. The bony sheath containing the incisor anterior to the molar row is long and slim. A large mental foramen is present just anterior to the junction of the strong dorsal and ventral masseteric ridges. Projecting from the labial side of the dentary is a large, globular capsule containing the base of the incisor. A remnant of the condylar process is associated with LB 90 and it is small, thin, and delicate. The angular process is broken on all specimens but there is enough remaining on LB 90 and LB 13 to suggest that it was shaped like the process in *Papagomys armandvillei* (fig. 2). The coronoid process is missing from all the pieces. The back edge of the dentary is probably shallowly concave, judging from the gently dished intact segment that forms the top half of LB 90.

Parts of the lingual surface of the dentary are preserved in the specimens. A prominent feature is a lingual shelflike ridge that extends from behind the molar row, slants gradually upward, and fades into the base of the condylar process. Dorsal to this ridge and near the base of the condylar process is the large oval mandibular foramen. At the front of the dentary, the elongate conformation of the bony incisor sheath is conspicuous in lingual view.

Incisors in the new samples resemble those

already described by Musser in 1981. The three most complete incisors are long, slender, and 1.2 mm thick (measured just beyond the end of the bony sheath). In LB 20, the tooth ends in a long, gently curved wear facet and sharp tip (fig. 1). The incisor enamel is pale or dark orange in the new material as it is in Specimens 1–4 from Liang Toge.

Molars (fig. 3) of the new specimens are similar in size, occlusal patterns, and number of roots to those in the holotype and the three other specimens described previously (Musser, 1981). One of the new pieces has a shorter molar row than any of the others and the first molars of four fragments are slightly narrower, increasing the observed range in length of molar row and molar breadth (table 2). Cusps and cusplets in the new sample resemble those of Specimens 1–4 with one exception. The third molar of LB 90 has a small anterolabial cusp (fig. 3), which is absent in third molars of the other specimens, including the original material from Liang Toge.

SIGNIFICANCE

We have been unable to identify any cranial or postcranial fragments that might belong to *Paulamys naso.* Pieces of crania and body skeletons, as well as upper molars and incisors of the other Floresian species, are either absent or uncommon; dentary fragments, lower molars, and lower incisors constitute the bulk of the more than 300 pieces. This is unfortunate because elements of the cranium and postcranial skeleton would provide more information about the overall morphology of *Paulamys naso* and its phylogenetic position within the cluster of native Floresian murids. The new material we record here nonetheless expands our information to a different set of limits. We better understand the shape of the dentary and know more about variation in molar size and the occurrence of certain cusplets. Information derived from the new material reaffirms the original hypothesis about the possible ecology of the species (Musser, 1981).

The entire dentary of *Paulamys naso* is low and long, compared with that of *Papagomys armandvillei,* for example (fig. 2). This conformation is especially evident in the elongate and gracefully curved bony sheath that

TABLE 2
The New Specimens of *Paulamys naso* from Flores (see fig. 1)

Cave and specimen	Age	Description
Liang Toge		
LT 47	adult	anterior portion of right dentary with a segment of incisor; no molars
Liang Soki		
LS 9	adult	part of right ramus with intact molar row; no incisor; inferior masseteric ridge evident; mental foramen intact; occlusal surfaces of molars moderately worn (fig. 3)
Liang Bua		
LB 90	adult	a nearly complete right dentary; part of incisor is missing as are the coronoid and angular processes; molar row is intact, its surface moderately worn (fig. 3)
LB 20	old adult	anterior three-fourths of right dentary with complete incisor and second and third molars; masseteric ridges evident, mental and mandibular foramina present; molar surfaces moderately worn (fig. 3)
LB 13	old adult	ramus of right dentary with first molar only; masseteric ridges and capsular projection of incisor alveolus are intact; mental foramen evident; molar surface very worn
LB 85	adult	fragment of right ramus with intact third molar, roots of first molar, and a short segment of incisor; molar surface moderately worn
LB 15	young adult	anterior part of left dentary with intact first and second molars; no incisor; mental foramen present; parts of masseteric ridges intact; occlusal surfaces of molars slightly worn (fig. 3)

Fig. 4. *Bunomys chrysocomus.* An adult caught in primary tropical evergreen rainforest at 1000 m in Lindu Valley, Central Sulawesi. Photographed by Margareta Becker.

encloses the incisor anterior to the molar row, the relatively low ramus beneath the first molar, and the lingual ridge behind the molars, which extends posteriorly and then gradually dorsad. In *Papagomys,* the incisor capsule is chunky, bends dorsad at a sharper angle, and is shorter relative to the body of the ramus; the body of the ramus is relatively higher; and the shelf behind the molar row extends back and dorsad at a sharper angle. The combination of elongate dentary; long, slender, and sharp lower incisor; and small simple teeth set in a long dentary as seen in *P. naso* recalls characters associated with murids that have a long rostrum and attendant adaptations pointing to terrestrial life in wet forest and a diet of invertebrates (Musser, 1982).

A possible living analog of *Paulamys naso* is the terrestrial *Bunomys chrysocomus,* which is native to Sulawesi. About the size of a houserat (see the measurements listed by Musser and Newcomb, 1983, p. 394), *B. chrysocomus* is soft-furred and dark; it has a tail shorter than length of head and body, small eyes, and a long snout (fig. 4). It is common under dense cover in the wetter parts of primary forests and feeds mainly on insects (beetle larvae, moths, cicadids, crickets, katydids, cockroaches, and wasps), earthworms, snails, small frogs and lizards, and occasionally fruit. The mandible is low and elongate, the lower incisor long and sharp, the rostrum long (fig. 5), and the molars simple in occlusal patterns (see the figures in Musser and Newcomb, 1983, pp. 398–399). The rat is a good invertebrate predator, but does not have the extreme specializations characteristic of the native Sulawesian shrew rats such as *Tateomys rhinogradoides* and *T. macrocercus,* which apparently feed only on earthworms (Musser, 1982).

The new material provides little additional data useful in identifying the closest relative of *Paulamys naso.* The samples only reinforce Musser's (1981) earlier conclusion that there are no specialized characters of the dentary, incisor, or molars which associate *P. naso* closely with any murid known from the Indo-Australian region outside of Flores, and that among Floresian murids, *P. naso* morphologically clusters with the described species of *Papagomys, Komodomys,* and

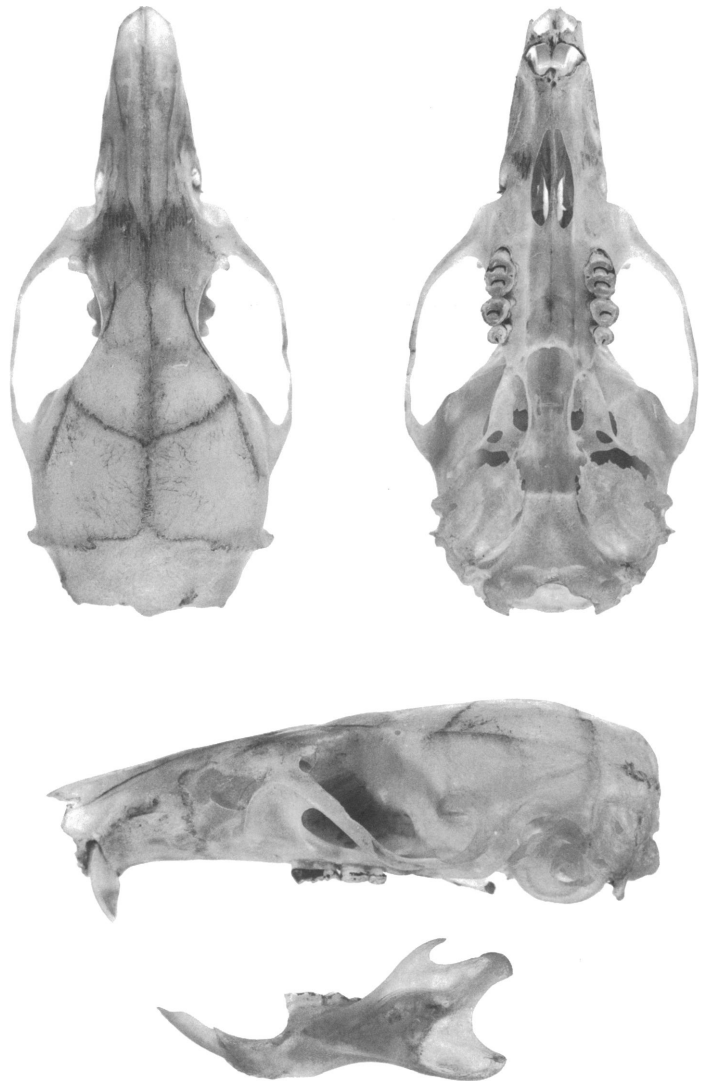

Fig. 5. Cranium and left dentary of *Bunomys chrysocomus* (American Museum of Natural History 224698) from Central Sulawesi. Approximately ×2.

Hooijeromys rather than with *Spelaeomys*. We hypothesize that *P. naso* may be related to species of *Papagomys*. Among the new samples of *Papagomys* which we will discuss in a later paper, there are two undescribed species with molar characteristics resembling those seen in *P. naso*. We may be able to say more about the phylogenetic relationship of *P. naso* in the context of our final report, which will identify all the taxa in the new samples.

Although the new specimens of *Paulamys naso* provide limited phylogenetic information, they support a view that *P. naso* is a unique member of an assemblage of murids native to Flores and possibly other islands in Nusatenggara. The long-nosed morphology of *P. naso*, implied from dentary conformation, reflects a particular ecological position within a murid fauna that includes a gerbil-like savanna species (*Komodomys rintjanus*), at least one and possibly more terrestrial forest herbivores (some species of *Papagomys*), arboreal herbivores (*Spelaeomys florensis* and

possibly one species of *Papagomys*), and a terrestrial shrew rat (forest or grassland) that is specialized (more so than *Paulamys naso*) for a diet of earthworms. Other than *Papagomys armandvillei* on Flores and *Komodomys rintjanus* on the islands of Padar and Rintja, we do not know if *Paulamys naso* or any of the other rats that are represented only by subfossil fragments still survive on Flores or other islands in Nusatenggara. Flores requires better biological survey than it has received to determine just what murids are still living there.

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