

A new species of *Rattus* from the mountains of West Flores, Indonesia

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Abstract

Rattus hainaldi sp. nov. is described from Gunung Ranakah near Ruteng, West Flores, from a single adult male collected from lower montane rainforest at ca. 1300 m altitude. A juvenile male from nearby Ranamese is tentatively referred to this species.

This is the first endemic rodent species in Nusa Tenggara placed unequivocally in *Rattus*.

Introduction

Musser (1981) notes that species of native *Rattus* seem to be present on all the archipelagos and the continent east of the Sunda Shelf, except for the Lesser Sunda Islands (Nusa Tenggara). He writes further (p. 168) that "whether this pattern is real or whether it simply reflects insufficient biological exploration on Nusa Tenggara is important to determine in order to reveal the source of native *Rattus* in the Moluccas, the New Guinea area, and the Australian region". He considers that the *Rattus* known from Nusa Tenggara (*R. exulans*, *R. argentiventer*, *R. norvegicus* and *R. rattus*) are introduced human commensals, but allows (p. 166) the possibility that one of the two former species may prove to be native. Recently, Kitchener *et al.* (1991) described a new species of rodent from south west Timor, Nusa Tenggara, which they tentatively placed in *Rattus*.

As part of a biological survey of Nusa Tenggara by the Western Australian Museum and the Museum Zoologicum Bogoriense, initiated in 1987 and still continuing, two expeditions have been made to Flores I. (October 1989 and May 1990). In the first of these expeditions, to Central and East Flores, a specimen of a long-nosed murid, *Paulamys* cf. *P. naso*, initially known only from Holocene and Pleistocene fossils (Musser 1981; Musser *et al.* 1986) was collected in mountainous country on Gunung Kelimutu (Kitchener *et al.* 1991). On the second expedition, to West Flores, a single specimen of a distinct small, long-tailed *Rattus* was collected near Desa Longko, Manggarai District (Figure 1). This specimen is herein described as a new species. A juvenile *Rattus* collected from nearby Ranamese is tentatively referred to this species.

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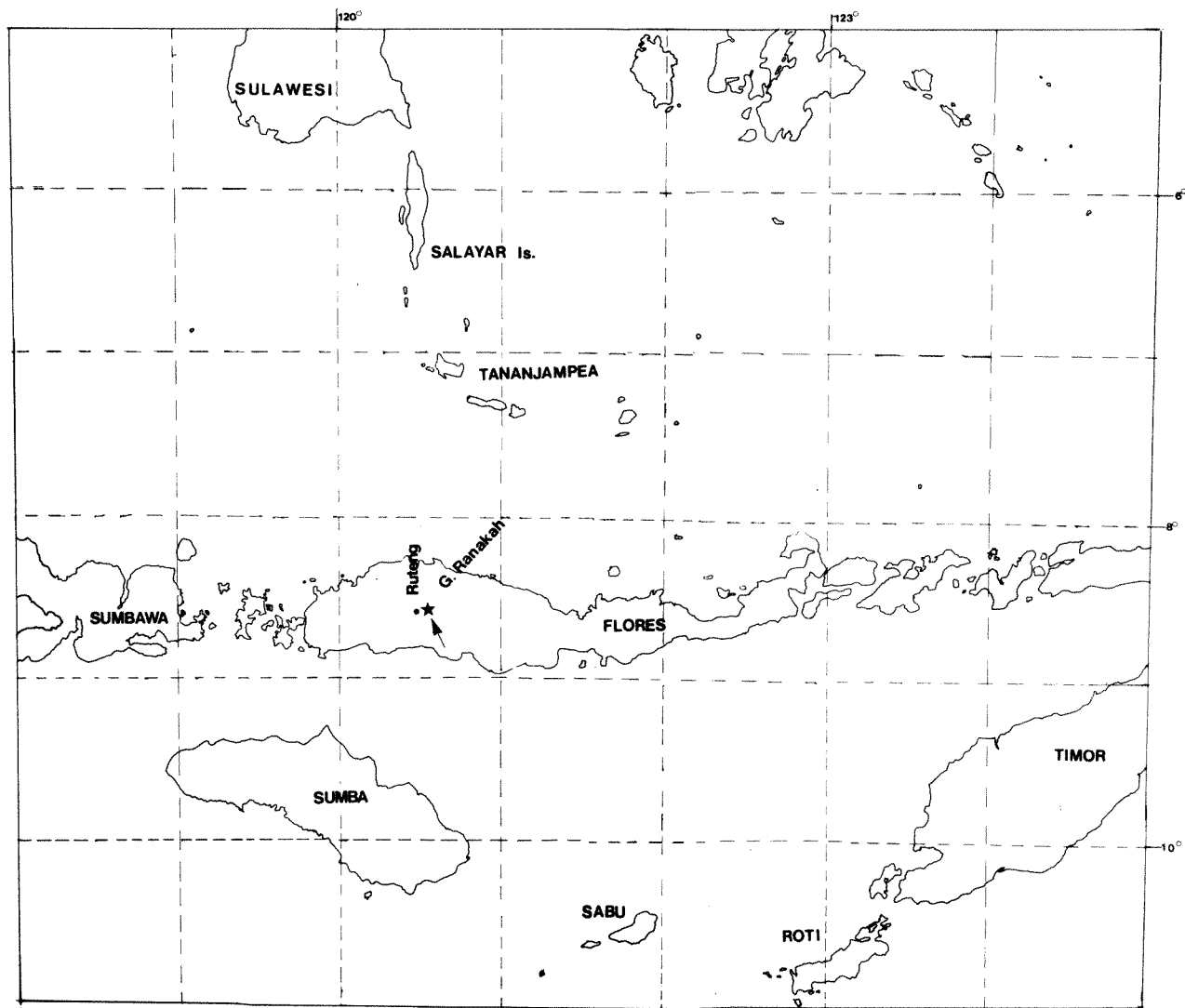


Figure 1: Location in Nusa Tenggara of type locality of *Rattus bairaldi* (arrowed)

Methodology

Measurements, in mm, and descriptions

External measurements were recorded from *R. hainaldi* holotype and WAM M33039 and *R. exulans* following their preservation in 70% ethanol, weight was taken in the field prior to fixation. Cranial and dental measurements were taken with dial calipers to the nearest tenth millimetre. Measurement points are mostly illustrated in Musser (1970) and described in Musser and Newcomb (1983). Measurements not in Musser (1970) are: nasal projection length, length between the distal tip of nasal and the anterior edge of premaxilla beneath nasal; condyle to dorsal incisor base, length from posterior edge of dentary condyle to anterior point of dentary between incisors on dorsal aspect; M_1 to dorsal incisor base, length from anterior face of M_1 to anterior point of dentary between incisors on dorsal aspect; dentary height at M_1 , height of dentary at middle of M_1 anterior labial cusp perpendicular to dentary ventral edge. Description of occlusal structure of teeth follows Musser and Newcomb (1983). Terminology of cranial bones and foramina is from Musser (1981).

Colour

Pelage and skin colour where they follow Ridgway (1912) are capitalized.

Systematics

Rattus hainaldi sp. nov.

(Table 1, Figures 2-7)

Holotype

Western Australian Museum, WAM M32877*, adult male, weight 81 gm, body fixed in 10% formalin, preserved in 70% ethanol; skull and dentaries separate; collected in commercial 'break-back' trap on 8 May 1990 by Dr Chris Watts.

Type locality

On a steep slope of the active volcano Gunung Ranakah, at an altitude *ca.* 1300 m (Figure 2), above KampongRobo, Desa Longko, 8 km SSE Ruteng, W. Flores (8°35'S, 120°33'E). The vegetation at this site is, following the classification of Whitmore (1984), lowland montane forest and is described by Ron Johnstone (pers. comm.) as "tall to moderately tall (15-35 m) montane forest. Canopy and emergent trees (some with lichen 'beards') included the following genera: *Terminalia*, *Garuga*, *Ficus*, *Celtis*, *Melia* and *Albizia* (Figure 3). Lower strata consisted mostly of slender trees and shrubs and some vines. The ground had litter that was sparse on slopes but dense in gullies with occasional ferns and some moss. Forest edges and where trees had been felled were overgrown with a white flowering composite 2-3 m high".

Diagnosis

Rattus hainaldi is distinguished from all other South East Asian species of *Rattus* described in the literature by a combination of: small body; tail considerably longer than snout to vent length (161 v. 133), bicoloured with whitish undersurface; dorsal pelage orange brown flecked with dark brown; ventral pelage creamy white but on chest and

*Final disposition will be the collections of the Museum Zoologicum Bogoriense, Bogor.



Figure 2: Gunung Ranaka, near Ruteng, Flores I., the type locality of *Rattus hainaldi* is on slopes in foreground.

Photo: R.A. How.

particularly more posteriorly flecked with pale grey; pelage soft, with long guard hairs on dorsum and flanks; skull small, greatest skull length 35.1, and generally slight; post-orbital and temporal ridges low; incisive foramen moderately short (2.4) and broad; bulla moderate, averaging 18 percent of greatest skull length, and rostrum short and moderately broad.

Of the recorded *Rattus* species of Flores (*R. exulans*, *R. argentiventer*, *R. rattus* and *R. norvegicus*) it could only be confused with *R. exulans*. It differs from Floresian *Rattus exulans* in being generally larger (see Table 1, and Figures 5, 6) and more robust; the anterodorsal edge of zygomatic plate projects less anteriorly; nasals blunt rather than angular, terminating closer to anterior edge of premaxilla; rostrum less curved anteriorly in lateral profile; interparietal wider and narrower; incisive foramen shorter relative to palatal length 0.32 v. 0.37 (0.35-0.39); postorbital and temporal ridges less pronounced, terminate before sharp ventral inflection of parietal/squamosal suture rather than reaching to that inflection and occasionally posterior to it; ventral masseteric ridge stronger and more sharply curved dorsally; dentary deeper, ratio of dentary height below M_1 to dentary length 0.29 v. 0.25 (0.23-0.27); pelage softer with numerous long guard



Figure 3: Vegetation at trap site of type locality of *Rattus hainaldi*.

Photo R.E. Johnstone.

hairs, particularly on back and flanks that are absent in *R. exulans*; feet darker coloured dorsally.

Description

Skull and dentary (Table 1, Figure 4)

Skull small with moderate length rostrum, palatal length 51% of greatest skull length; zygomatic breadth moderately wide (18); nasal short, terminate posterior to orbit, internal anterior edge, slightly inflated anteriorly, distal tip only very slightly rounded; rostrum short and moderately broad; slight dorsal ridges outline interorbital region, originate *ca.* 1 mm posterior to frontal — nasal suture and posteriorly traverse dorsal margin of postorbital and temporal regions, highest in postorbital region and decrease in size immediately posterior to frontal — parietal suture, very slight posterior to point of downward inflection of parietal-squamosal suture; interparietal large; between slight temporal ridge and zygomatic root braincase slopes slightly and gently outwards; postglenoid vacuity moderately spacious; zygomatic plate anterior edge slightly curved forward, its anterodorsal inflection well posterior to its most anteroventral point; incisive

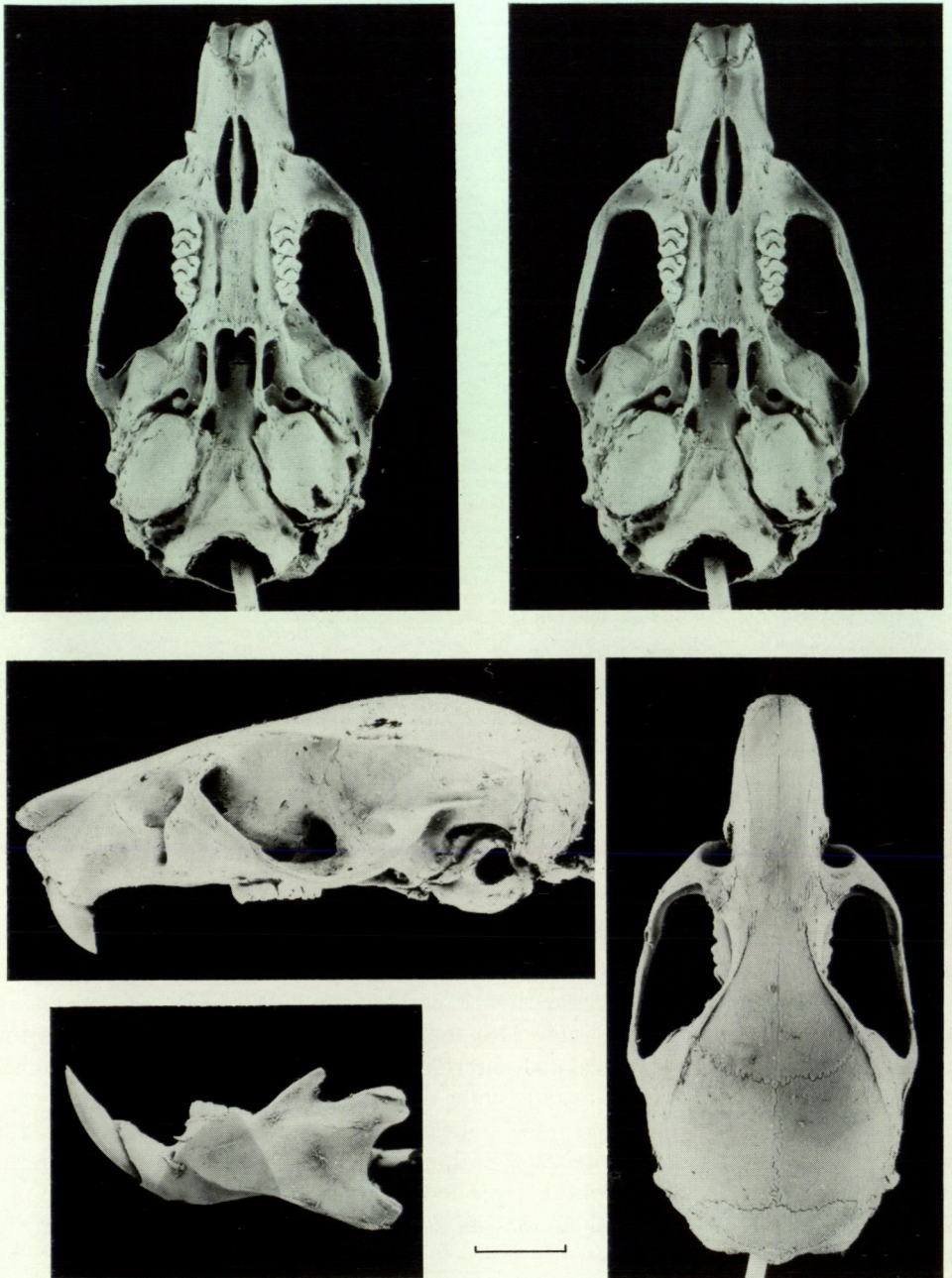
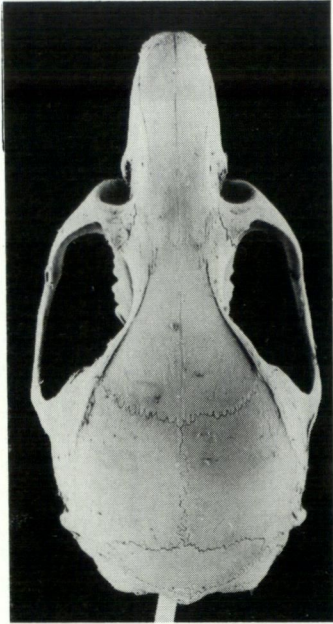
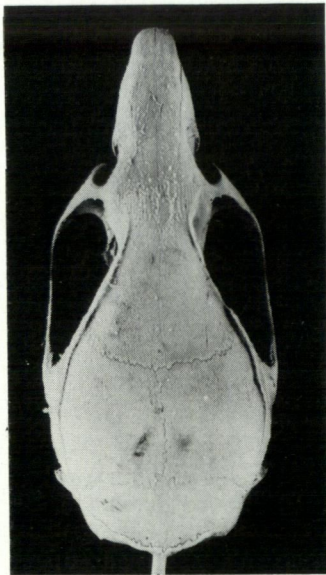


Figure 4: Skull and mandible of *Rattus hainaldi*; ventral view as stereopairs. Scale line, 5 mm.

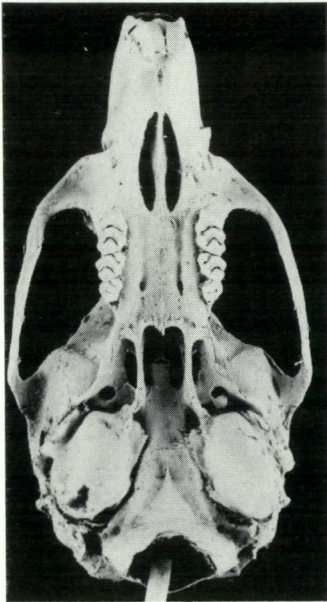
A



B



A'



B'

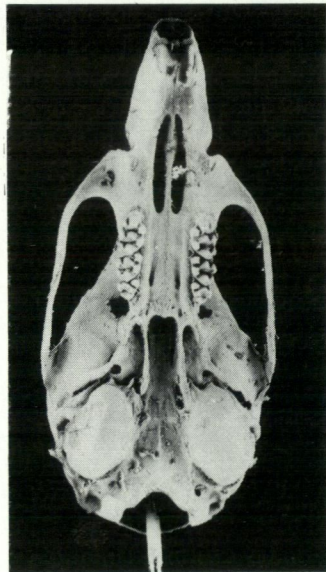


Figure 5: Dorsal (A, B) and ventral (A', B') views of A, A' — *Rattus hainaldi* holotype; B, B' — *R. exulans*, WAM M32609 (Flores). Scale line, 5 mm.

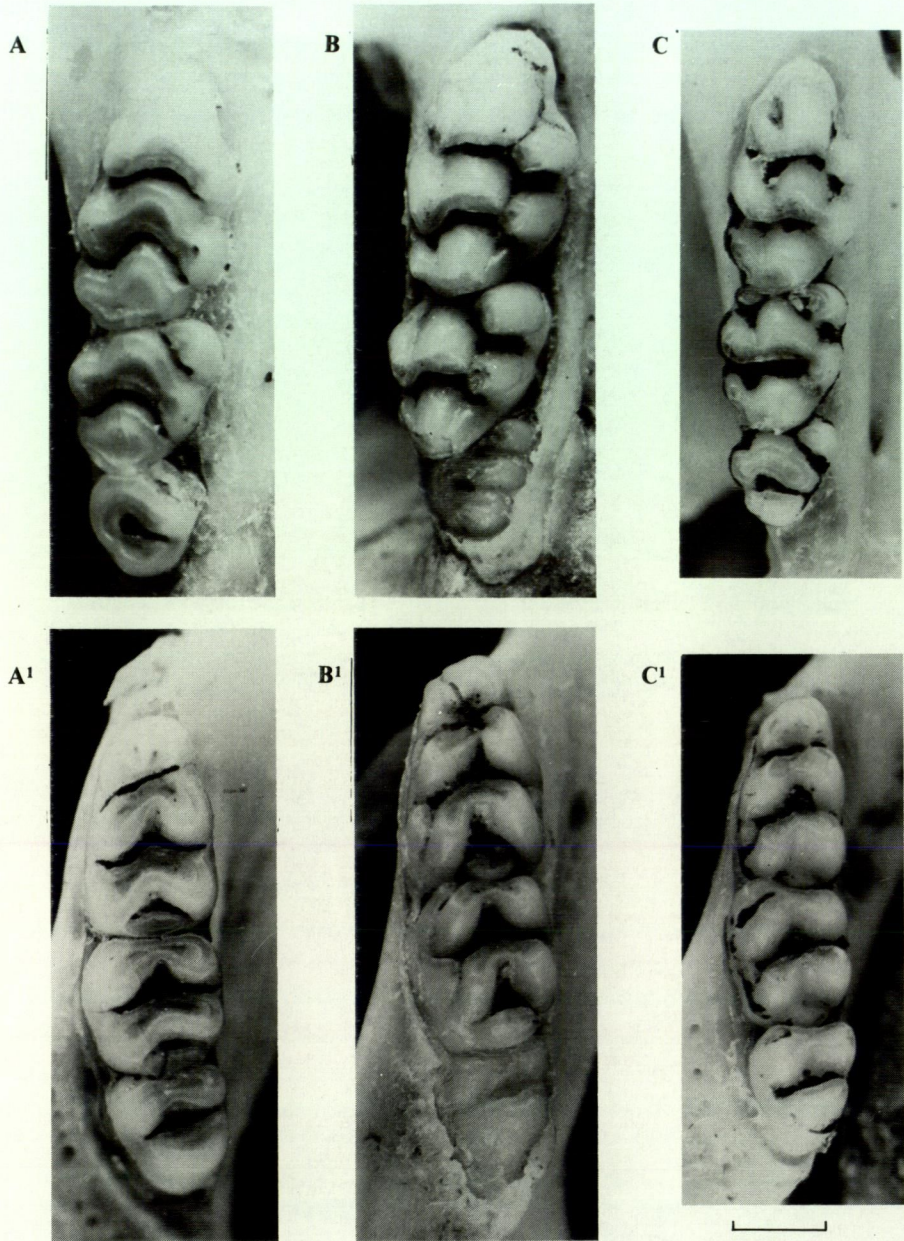


Figure 6: Left hand side upper (A-C) and lower (A'-C') molar rows of: A, A' — *Rattus hainaldi* holotype, B, B' — *R. sp. cf. R. hainaldi* WAM M33039 and C, C' *R. exulans ephippium*, WAM M32609 (Flores I.). Scale line, 1 mm.

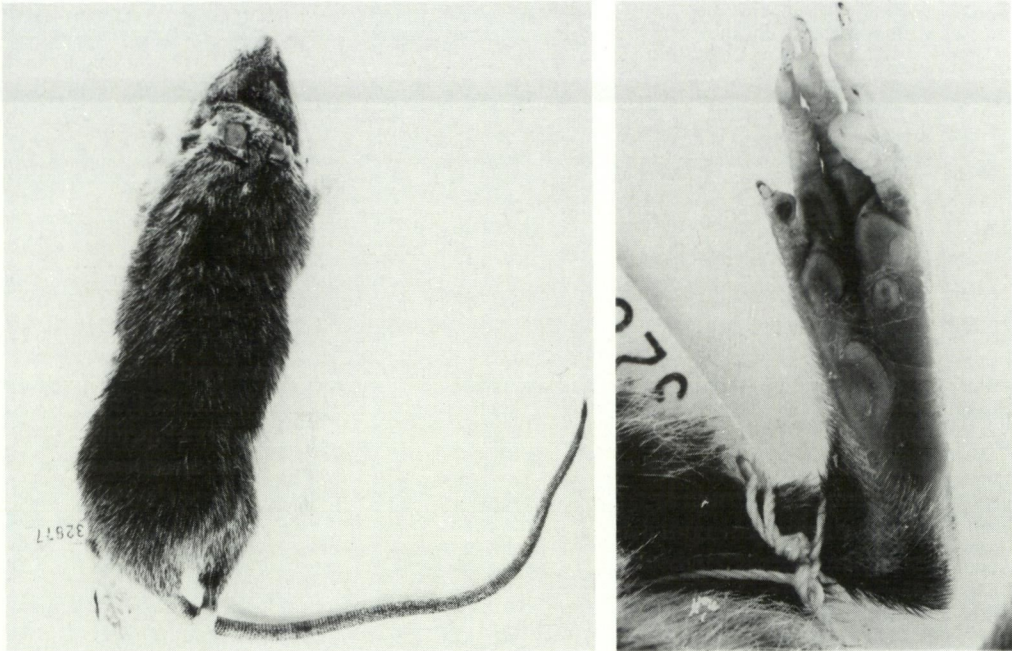


Figure 7: Alcohol preserved specimen of carcass and pes of *Rattus hainaldi* holotype.

foramen short, moderately broad, terminate posteriorly in line level with M^1 anterior face; maxilla — premaxilla suture located anterior of mid point of incisive foramen lateral edge; mesopterygoid fossa and palatal bridge moderately wide; palatal bridge extends *ca.* 1.2 posterior to M^3 posterior edge with short median spine; ventral surface of palatal bridge mostly smooth with two lateral and shallow palatal grooves; posterior palatine foramen small, oval, in line with M^2 posterior edge, palate pitted with *ca.* 32 tiny vascular foramina which are concentrated in rugose area at posterior edge; pterygoid fossa moderately wide and deep; foramen ovale small, oval, and slightly excavated; sphenopalatine vacuity long, extends to pterygoid process mid length; sphenopterygoid vacuity large; sphenopalatine foramen located dorsal to M^2 , well anterior to small suboval dorsal palatine foramen

Dentary robust, below M_1 deep, anterior to M_1 short, robust and moderately curved; masseteric ridge strong and sharply curved dorsally.

Dentition (Table 1, Figure 6)

Upper incisors opisthodont, anterior surface with brown-orange enamel; lower incisors with only a trace of pale orange enamel on anterior face. Occlusal pattern of upper and lower incisors in *R. hainaldi* holotype and WAM M33039 are shown in Figure 6; tooththrows of moderate length in relation to palatal bridge. General morphology of molars and their root pattern similar to those in many species of *Rattus*

Table 1: Skull, dentary and teeth measurements (in mm) for *Rattus hainaldi* holotype, *R. sp. cf. R. hainaldi* WAM M33039 and *R. exulans* from Flores I. The latter two species as mean \pm standard deviation (range), and weight (gm).

	<i>R. hainaldi</i>		<i>R. exulans</i> (Flores)	
	Holotype	Referred juvenile	N = 10♂♂	
Measurement/ weight				
Weight (gm)	81	22.6	49.2 \pm 11.2	(31 — 72)
Snout to vent length	133.4	81.2	109.5 \pm 10.4	(93.8 — 123.5)
Tail length	161.1	129.2	130.2 \pm 13.9	(101.9 — 146.4)
Hind foot length	29.5	26.6	25.0 \pm 1.0	(23.7 — 26.6)
Ear length	21.1	16.9	16.5 \pm 15.6	(15.9 — 18.4)
Greatest skull length	35.1	29.1	31.6 \pm 1.5	(30.2 — 33.8)
Condylbasal length	32.4	25.8	29.1 \pm 1.1	(27.7 — 31.1)
Zygomatic breadth	18.0	13.9	14.8 \pm 0.2	(14.2 — 16.0)
Interorbital breadth	5.3	4.6	4.7 \pm 0.1	(4.6 — 4.9)
Nasal length	13.2	9.6	11.6 \pm 0.8	(10.9 — 12.8)
Nasal breadth	4.3	3.7	3.2 \pm 0.2	(3.0 — 3.5)
Nasal projection length	0.1	—	0.8 \pm 0.2	(0.6 — 1.0)
Rostrum length	10.7	8.8	9.9 \pm 0.5	(9.3 — 10.3)
Rostrum breadth	6.5	4.9	5.4 \pm 0.3	(4.9 — 5.9)
Braincase breadth	15.3	13.9	13.3 \pm 0.3	(12.6 — 13.7)
Braincase height	10.5	9.9	9.0 \pm 0.3	(8.6 — 9.6)
Zygomatic plate breadth	3.5	2.1	3.1 \pm 0.2	(2.8 — 3.4)
Interparietal breadth	10.7	10.3	9.5 \pm 0.3	(9.1 — 9.9)
Interparietal length	4.0	4.7	4.9 \pm 0.3	(4.4 — 5.3)
Breadth across incisor tips	1.9	1.5	1.5 \pm 0.1	(1.4 — 1.7)
Diastema length	8.7	6.6	8.3 \pm 0.5	(7.6 — 9.1)
Palatal length	18.0	14.6	16.2 \pm 0.8	(15.3 — 17.8)
Post palatal length	12.1	9.3	10.6 \pm 0.5	(9.9 — 11.3)
Palatal bridge length	6.8	5.8	6.0 \pm 0.5	(5.4 — 7.0)
Palatal bridge breadth at M ¹	4.0	2.8	3.2 \pm 0.3	(2.7 — 3.5)
Palatal bridge breadth at M ³	4.7	—	3.7 \pm 0.4	(3.1 — 4.3)
Mesopterygoid fossa breadth	2.4	2.0	2.0 \pm 0.1	(1.8 — 2.2)
Incisive foramina length	5.8	4.4	5.9 \pm 0.2	(5.7 — 6.2)
Incisive foramina breadth	2.4	1.8	2.2 \pm 0.2	(1.9 — 2.5)
Bulla length	6.4	5.6	5.8 \pm 0.2	(5.6 — 6.1)
Bulla height	5.7	5.2	5.2 \pm 0.2	(4.9 — 5.5)
M ¹⁻³ length (crown)	5.4	—	5.2 \pm 0.2	(5.0 — 5.4)
M ¹⁻³ length (alveolar)	5.7	—	5.4 \pm 0.2	(5.1 — 5.7)
M ¹ breadth (crown)	1.7	1.9	1.6 \pm 0.1	(1.5 — 1.7)
M ¹ breadth (alveolar)	1.5	1.8	1.4 \pm 0.1	(1.3 — 1.6)
M ² breadth (crown)	1.6	1.8	1.5 \pm 0.1	(1.4 — 1.7)
M ² breadth (alveolar)	1.5	1.8	1.3 \pm 0.1	(1.2 — 1.6)
M ³ breadth (crown)	1.2	—	1.2 \pm 0.1	(1.1 — 1.2)
M ³ breadth (alveolar)	1.2	—	1.0 \pm 0.1	(0.9 — 1.1)
M ₁₋₃ length (crown)	5.5	—	4.9 \pm 0.2	(4.6 — 5.2)
Condyle to dorsal incisor base	18.9	15.7	17.2 \pm 0.9	(16.3 — 18.8)
M ¹ to dorsal incisor base	5.2	4.8	4.9 \pm 0.3	(4.3 — 5.4)
Dentary height at M ₁	5.4	4.1	4.3 \pm 0.2	(4.0 — 4.5)

(Musser and Newcomb 1983), particularly to *R. exulans ephippium* (Figure 6). Upper molar labial cusps more developed than their lingual cusps; M^2 with t_3 barely perceptible; M^{1-2} with posterior cingulum vestigial; M_1 anterior lingual and labial cusps subequal.

Pelage and skin (Figure 7)

Fur soft and moderately long, on dorsum hairs 10-11 long; on flanks *ca.* 13 long and on ventral surfaces *ca.* 8 long; scattered throughout dorsum are numerous guard hairs which range in length from 13 behind shoulders to up to 35 on lower back and flanks. These guard hairs creamy white at base and tipped with Drab. On lower back and flanks these hairs tipped with creamy white. Predominant colour of dorsal surface Clay Color (orange brown) flecked with Hair Brown (dark brown); on flanks this merges gradually into Cream Buff and to Pale Smoke Gray (pale grey) on inside of arms and legs and to creamy white on throat, chest and abdomen; chest and abdomen strongly flecked with a light grey. Scrotum creamy white; over much of body basal hair colour Neutral Gray (blue grey) but on dorsum a darker Deep Gray.

Hair on fingers white, reaches tip of claws, dorsal and palmar surface of manus Pale Olive Buff to White, flecked at base with Drab. Undersurface of manus Cream Buff. Hairs on distal phalanx of toes white, reach to just in front of claw; plantar surface of pes Lilac Gray with pads Cream Buff, dorsal surface creamy white internally but mostly Light Drab.

Ears moderately long (21.5), smoothly rounded and thinly covered with short Drab hairs.

Tail long (161.1), 121% of snout to vent length; basal one-third with 10 scales/cm, middle one-third 12 scales/cm and distal one-third 16 scales/cm; dorsal skin colour Drab, ventrally Pale Smoke Gray to almost White at base; dorsal hairs Drab; ventral hairs: at basal 2/5 white and 2 long, middle 2/5 Pale Smoke Gray and *ca.* 3 long, distal 1/5 increasingly Drab, *ca.* 4.5 long, distal hairs Drab, 6 long.

Vibrissae

Forearm with: 6 white ulnar carpals *ca.* 11 long; 3 white medial antebrachials *ca.* 9 long; and 2 white anconeals *ca.* 10 long. Each side of face with: numerous long (up to 60) mysticals, these blackish dorsally and much shorter (*ca.* 20) and white ventrally; a single black genal vibrissae, *ca.* 30 long; 6 submentals, *ca.* 6 long; and 6 white interramals, *ca.* 10 long.

Pes and manus (Figure 7)

Moderately long; pes 29.5, manus 14.8; thumb very short (*ca.* 2) with flat nail. Pes with 6 moderately large pads, smooth with subsurface striae; interdigital pads large, separate, hypothenar pad one-third size and 0.4 posterior to interdigital pad at base of digit V (which has a small oblong, posterolateral accessory pad; thenar pad elongate, 4.7 long).



Figure 8: Vegetation at Ranamese, Flores, site of capture of *Rattus* sp. cf. *R. hainaldi* WAM M33039.

Photo D. King.

Remarks

The phylogenetic affinities of *Rattus hainaldi* will have to be determined by comparing its features, both morphological and biochemical, with native *Rattus* like species in the Indo-Australian region.

Etymology

This species is named in memory of the late Mr Hainald, Head, IPTEK, Lembaga Ilmu Pengetahuan Indonesia (LIPI), Jakarta Selatan, for his untiring and gracious efforts to facilitate the bureaucratic aspects of this series of expeditions to Nusa Tenggara.

Tentatively referred specimen

Collection

WAM M33039, juvenile male, weight 22.6 gm, body fixed in 10% formalin, preserved in 70% ethanol; skull and dentaries separate; liver and blood separate, preserved in liquid nitrogen in the field and in an ultra freeze refrigerator at the Western Australian Museum; collected in commercial 'break-back' trap on 27 May 1991 by the authors above Lake Ranamese, at an altitude of 1250 m (8°36'S, 120°34'E), ca. 20 km E

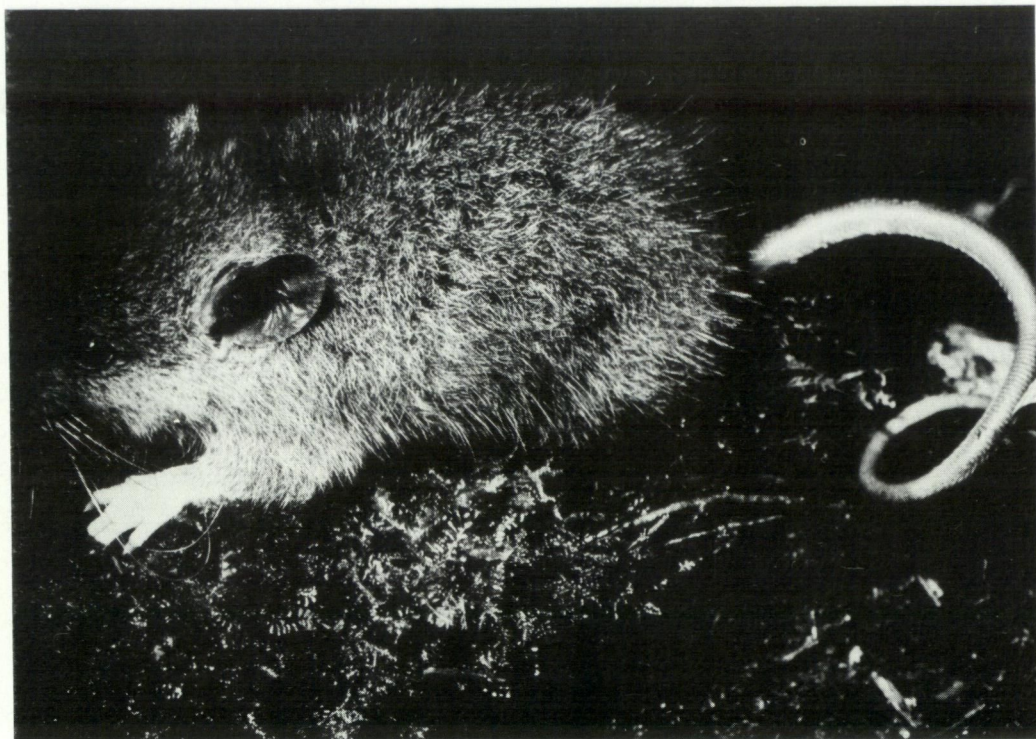


Figure 9: *Rattus* sp. cf. *R. hainaldi* WAM M33039 photographed shortly after its capture.

Photo R.E. Johnstone.

Kampong Robo. Vegetation at this site is a low montane forest (Figure 8) with many floristic elements in common with the type locality, but with a considerably denser (up to 15 cm) layer of leaf litter, denser moss and lichen, and a much more abundant fern layer.

Description

This specimen is a juvenile, M^3 not yet erupted above gum line. Its measurements are in Table 1. The shape of its skull, dentary and teeth are shown in Figure 10 and its photo in life in Figure 9. It shares many features with the holotype of *R. hainaldi* but differs as follows: interparietal relatively longer than it is broad 0.46 v. 0.37; M^1 with small anterior lingual accessory cusp which is absent in *R. hainaldi*; M_{1-2} posterior cingulum appear slightly more oval even allowing for their reduced wear; M_1 anterior lingual cusp appears relatively larger than its associated labial cusp; M_{1-2} anterior lamella appears to be at a sharper angle to the posterior lamella; M_{1-2} posterior labial cusplets appear much larger. These differences may all be a function of age and wear, but without specimens of intermediate age to examine, we cannot be certain they are conspecific. Certainly the relatively large size of interparietal may be unimportant. The measurement of a large

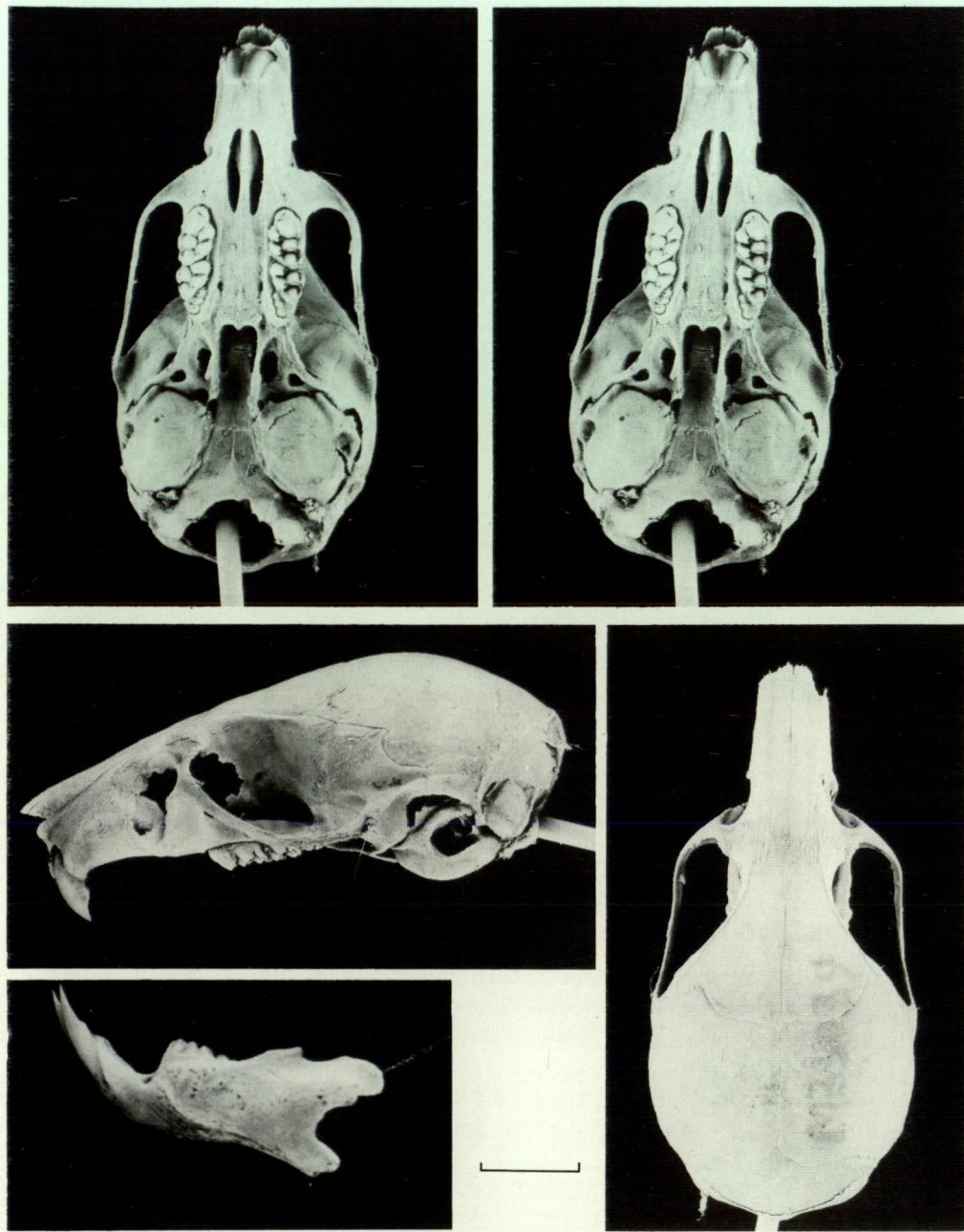


Figure 10: Skull and mandible of *Rattus* sp. cf. *R. hainaldi* WAM M33039; ventral view as stereopairs. Scale line, 5 mm.

number of specimens of *R. exulans* in Nusa Tenggara revealed no correlation between age (judged by greatest skull length and molar tooth eruption and wear) and relative size of the interparietal. Frequently, juveniles had considerably larger interparietals than adults.

Colour of pelage of WAM M33039 darker than holotype with Dark Neutral Grey of underfur showing through all over body — this tipped with Chamois (orange drab) on flanks and shoulder and creamy white on abdomen, chest, feet and hands. Tail coloured as for *R. hainaldi* except that ventral surface of tail not as markedly pale. The development of long guard hairs are obvious on back and flanks.

Allozyme electrophoresis, involving some 35 loci, has been carried out on this referred specimen with reference to *Rattus exulans*, *R. rattus*, *R. argentiventer* (from Flores) and *R. tiomanicus* (from Java). These data, which will be published separately, indicate that this referred specimen is quite distinct genetically from these other species (Dr L. Schmitt, pers. comm.).

Acknowledgement

We are grateful for the assistance and good company on the May 1990 expedition to W. Flores of our colleagues Ron Johnstone, Western Australian Museum; Chris Watts, South Australian Museum; and Dennis King, Western Australian Agricultural Protection Board.

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Anne Nevin, Western Australian Museum, typed the manuscript.

Other specimens measured

Rattus exulans ephippium (all adult males, Flores I.)

Desa Woloara: WAM (M32012, M32013, M32043, M32044, M32046, M32047, M32071, M32081); Desa Daraloeng: WAM M32609; Desa Longko: WAM 32808.

References

- Kitchener, D.J., How, R.A. and Maharadatunkamsi (1991). *Paulamys* sp. cf. *P. naso* (Musser, 1981) (Rodentia: Muridae) from Flores Island, Nusa Tenggara, Indonesia — description from a modern specimen and a consideration of its phylogenetic affinities. *Rec. West. Aust. Mus.* **15**: 171-189.
- Kitchener, D.J., Aplin, K., and Boeadi (1991). A new species of *Rattus* from Gunung Mutis, South West Timor Island, Indonesia. *Rec. West. Aust. Mus.* **15**: 445-461.
- Musser, G.G. (1970). Species-limits of *Rattus brahma*, a murid rodent of northeastern India and northern Burma. *Am. Mus. Novit.* **2406**: 1-27.

- Musser, G.G. (1981). The giant rat of Flores and its relatives east of Borneo and Bali. *Bull. Am. Mus. nat. Hist.* **169**: 69-175.
- Musser, G.G. and Newcomb, C. (1983). Malaysian murids and the giant rat of Sumatra. *Bull. Am. Mus. nat. Hist.* **174**: 327-598.
- Musser, G.G., Vand de Weerd and Strasser, E. (1986). *Paulamys*, a replacement name for *Floresomys* Musser, 1981 (Muridae), and new material of that taxon from Flores, Indonesia. *Am. Mus. Novit.* **2850**: 1-10.
- Ridgway, R. (1912). 'Color standards and color nomenclature' (Ridgway, Washington).
- Whitmore, T.C. (1984). Tropical rainforests of the Far East, 2nd ed. New York: Oxford Univ. Press.