

A new species of *Microgale* (Insectivora, Tenrecidae), with comments on the status of four other taxa of shrew tenrecs

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SYNOPSIS. A new species of *Microgale* is described from rainforest localities in Madagascar. Evidence is presented that *M. drouhardi* is a distinct species, with *M. melanorrhachis* as a synonym, and similarly that *M. pulla* is a synonym of *M. parvula*.

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INTRODUCTION

The Family Tenrecidae is currently divided into four subfamilies, three of which, the Geogalinae, Oryzictinae and Tenrecinae are endemic to Madagascar, while the fourth, the Potamogalinae, occurs only in Africa (see Hutterer, 1993). Within this highly diverse family, the most diverse of all are the shrew tenrecs belonging to the Oryzictine genus *Microgale* Thomas, 1882, which at various times has been subdivided into four genera or sub-genera, comprising as many as 22 species. Despite the revision by MacPhee (1987) based on specimens available at that time in museum collections, in which only ten species were considered valid, the species composition of *Microgale* remains unclear. Subsequent to this revision, the number of specimens of *Microgale* available has probably doubled as a result of several recent expeditions to different localities in Madagascar. These expeditions have attempted to provide an inventory of the small mammal fauna, for taxonomic and biogeographic purposes and for the development of conservation strategies. These intensive surveys suggested that some of the species synonymised in MacPhee's revision, are in fact distinct (Nicoll & Rathbun, 1990; Raxworthy & Nussbaum, 1994; Stephenson, 1995; Jenkins *et al.*, 1996; Goodman *et al.*, 1996) and revealed the presence of several undescribed species of *Microgale* (Jenkins, 1988, 1992, 1993; Jenkins *et al.*, 1996). Specimens from five widely separated localities, distinctive in external appearance, are believed to be conspecific and to represent an additional undescribed species, the description of which is given below.

During the course of these surveys, good samples of adult and juvenile specimens of *Microgale* were collected from a wide range of localities, allowing re-evaluation of the specific status of four taxa, *M. drouhardi* Grandidier, 1934, *M. parvula* Grandidier, 1934, *M. melanorrhachis* Morrison-Scott, 1948 and *M. pulla* Jenkins, 1988. The first three species were originally described from juvenile specimens, a problematic situation in this genus, where the deciduous and permanent dentitions may differ considerably, so causing confusion over the correct specific attribution of juveniles and adults (see MacPhee, 1987). *Microgale drouhardi*, *M. parvula* and *M. pulla* were also known only from their respective type localities, and *M. parvula* and *M. pulla* only from their holotypes. Both *M. drouhardi*

and *M. melanorrhachis* are of uncertain status and were considered to be synonyms of *M. cowani* Thomas, 1882 by MacPhee (1987) but evidence is presented below to show that *M. drouhardi* is a distinct species with which *M. melanorrhachis* is synonymous. Likewise, it is demonstrated that *M. pulla* is a synonym of *M. parvula*.

MATERIALS AND METHODS

In each of the surveys listed above, small mammals were collected in pitfall traps, usually operating for five to ten days at each site. For detailed information on collection methods see Raxworthy & Nussbaum (1994; 1996) and Goodman *et al.* (1996).

Measurements, in millimetres, were recorded using dial calipers and a microscope measuring stage. External measurements include head and body length (HB) from the tip of the nose to the distalmost point of the body (at base of tail); tail length (TL) measured from the base of the tail to the end of the distalmost vertebra, excluding terminal hairs; hind foot length (HF) from the heel to the distal part of the longest toe, excluding the claw; ear length (EL) measured from the notch at the base of the ear to the distalmost edge of the pinna; weight (WT) measured with Pesola spring scales, animals weighing less than 10 gm within 0.2 gm and 10–100 gm within 0.5 gm. Cranial measurements were taken as follows: condyloincisive length (CIL) cranial length from first upper incisor to occipital condyle; upper toothrow length (UTL) from anterior of first upper incisor to posterior of third upper molar, parallel to the long axis of the skull; breadth of braincase (BB) the greatest distance measured across the squamosals; height of braincase (BH) greatest height in the midline from basioccipital to parietal.

The dental nomenclature follows that of Mills (1966), Swindler (1976), Butler & Greenwood (1979) and MacPhee (1987). Dental notations are given in parentheses in the text; premaxillary and maxillary teeth are denoted by upper case, mandibular teeth by lower case, as follows: incisor (I/i), canine (C/c), premolar (P/p), molar (M/m); a prefix 'd' indicates deciduous teeth, thus (dI) refers to a deciduous upper incisor.

Age classes are defined as follows:

Infant: individuals in which the deciduous antemolar dentition and the molars are not fully erupted; premaxillary, parietal and basioccipital sutures unfused.

Juvenile: individuals in which the molars are fully erupted and the deciduous antemolar dentition is erupted and in the process of replacement by the permanent teeth; cranial sutures are in the process of fusing. The eruption sequence of the permanent teeth has been subdivided into four stages by MacPhee (1987).

Adult: individuals with a fully erupted permanent dentition; cranial sutures generally fused although their position is usually clearly marked.

Abbreviations used for institutions include, BMNH – The Natural History Museum, London [formerly British Museum (Natural History)]; FMNH – Field Museum of Natural History, Chicago; MCZ – Museum of Comparative Zoology, Harvard; UMMZ – University of Michigan, Museum of Zoology, Michigan; USNM – National Museum of Natural History, Washington [formerly United States National Museum].

Abbreviations used for protected sites in Madagascar: PN – Parc National; RNI – Réserve Naturelle Intégral; RS – Réserve Spécial. Other abbreviations used are: RAN – UMMZ field tag series; gm – grams; km – kilometres; m – metres; mm – millimetres.

RESULTS

Microgale fotsifotsy sp. nov.

Figs 1–5

HOLOTYPE. UMMZ 168468 (RAN 38784) adult male, fixed in formalin, preserved in alcohol, skull extracted. Collected by Christopher Raxworthy [CR] 13 January 1992.

TYPE LOCALITY. Camp 2, Antomboka River Fitsahana, Parc National de la Montagne d'Ambre, Antsiranana Fivondronana, Antsiranana Province 12°29'S 49°10'E, altitude 650m, rain forest.

PARATYPES. Camp 2, Antomboka River Fitsahana, Parc National de la Montagne d'Ambre, Antsiranana Fivondronana, Antsiranana Province 12°29'S 49°10'E, altitude 650–670m, rain forest: UMMZ 171056 (RAN 38596), juvenile; BMNH 1996.278 (RAN 38648), adult female; UMMZ 171057 (RAN 38710), juvenile; UMMZ 168470 (RAN 38740), juvenile; UMMZ 168466 (RAN 38752), juvenile; UMMZ 171058 (RAN 38753), adult male; UMMZ 168467 (RAN 38754), adult male; UMMZ 168469 (RAN 38791), adult male; UMMZ 171059 (RAN 38821), adult male. Collected by CR 2–17 January 1992. All specimens fixed in formalin, preserved in alcohol, skulls extracted.

Camp 1, Antomboka River, Parc National de la Montagne d'Ambre 12°32'S 49°10'E, altitude 1150m, rain forest: UMMZ 171055 (RAN 38192), adult female, collected by CR 23 November 1991. Fixed in formalin, preserved in alcohol, skull extracted.

Parc National de la Montagne d'Ambre, 5.5 km SW of Joffreville [Ambohitra], 12°31'S 49°10'E, altitude 1000m, disturbed rain forest: FMNH 154590 adult male; FMNH 154591 juvenile male; FMNH 154592 juvenile male; FMNH 154593 juvenile male; FMNH 154594 juvenile; FMNH 154595 juvenile male; FMNH 154596 juvenile male. Collected by Steven Goodman 28 March–1 April 1994. All skins and skulls.

REFERRED MATERIAL. RS d'Ambatovaky, Soanierana-Ivongo Fivondronana, Toamasina Province 16°51'S 49°08'E, 600m, in rain forest: BMNH 91.247.

RNI de Zahamena, Ambatondrazaka Fivondronana 17°40'S–17°42'S 48°46'E, 850–1180m: UMMZ 171060–171065; BMNH 96.279.

Maitso, RNI d'Andringitra, 22°10'S 46°50'E, 1400 m, in disturbed forest, 20 yards [18.3 m] from stream; found drowned in puddle on top of shelter 5 feet [1.5 m] above the ground: BMNH 95.257. 40 km S of Ambalavao, along Volotsangana River, RNI d'Andringitra, 22°13'S 46°58'E, altitude 1210 m, in montane forest: FMNH 151646–151647.

Marosohy Forest, 16 km WNW of Ranomafana-Sud, Fivondronana Tolagnaro [Tölanaro Fivondronana], Toliara Province, 24°34'S 46°48'E, 650m, in rain forest: USNM 578787; USNM 578887.



Fig. 1 Dorso-lateral view of *Microgale fotsifotsy* to show external features.

Table 1 Dimensions of adult *Microgale fotsifotsy* presented as range, mean $\pm$ standard deviation and number of specimens in parentheses.

	Combined	PN Montagne d'Ambre 650–1150m	RNI Zahamena 850–1180m	RNI d'Andringitra 1200–1400m	Marosohy forest 650m
Head and body length	63.9–81.0 69.0 $\pm$ 5.11 (17)	63.9–70.0 66.2 $\pm$ 2.17 (8)	66.7–69.2 68.2 $\pm$ 1.02 (4)	70.1–81.0 76.7 $\pm$ 5.8 (3)	64, 77 (2)
Tail length	71.4–94.0 79.8 $\pm$ 6.16 (16)	71.4–82.7 77.3 $\pm$ 4.31 (7)	75.0–84.0 79.5 $\pm$ 3.21 (4)	85–94 89.3 $\pm$ 4.51 (3)	71, 79 (2)
Hind foot length	14–18 15.7 $\pm$ 1.03 (17)	14–16 15 $\pm$ 0.71 (8)	16–17 16.5 $\pm$ 0.50 (4)	15–18 16.3 $\pm$ 1.25 (3)	15, 16 (2)
Ear length	11–16 14.1 $\pm$ 2.03 (16)	11–15 12.6 $\pm$ 1.22 (8)	15–16 15.7 $\pm$ 0.47 (3)	16–17 16.7 $\pm$ 0.47 (3)	12, 16 (2)
Ratio of tail length to head and body length	1.0–1.3 1.2 $\pm$ 0.08 (16)	1.1–1.2 1.2 $\pm$ 0.05 (7)	1.1–1.3 1.2 $\pm$ 0.07 (4)	1.1–1.3 1.2 $\pm$ 0.09 (3)	1.0, 1.1 (2)
Condylolincisive length	19.8–21.6 20.6 $\pm$ 0.55 (16)	19.8–20.9 20.3 $\pm$ 0.32 (8)	20.7–21.6 21.1 $\pm$ 0.38 (4)	20.7–21.2 21.0 $\pm$ 0.29 (3)	19.8 (1)
Upper toothrow length	9.5–10.6 10.0 $\pm$ 0.37 (16)	9.5–10.0 9.7 $\pm$ 0.16 (8)	10.2–10.5 10.4 $\pm$ 0.13 (4)	10.0–10.6 10.3 $\pm$ 0.3 (3)	9.5 (1)
Maxillary breadth from M3–M3	5.8–6.6 6.1 $\pm$ 0.26 (16)	5.8–6.3 6.0 $\pm$ 0.17 (8)	6.0–6.5 6.3 $\pm$ 0.21 (4)	6.1–6.6 6.3 $\pm$ 0.21 (3)	5.8 (1)
Braincase breadth	8.6–9.7 9.1 $\pm$ 0.38 (16)	8.6–9.0 8.8 $\pm$ 0.15 (8)	9.2–9.6 9.5 $\pm$ 0.15 (4)	9.5–9.7 9.6 $\pm$ 0.12 (3)	9.1 (1)
Ratio of tail length to condylolincisive length	3.6–4.4 3.9 $\pm$ 0.25 (15)	3.6–4.1 3.8 $\pm$ 0.20 (7)	3.6–3.9 3.8 $\pm$ 0.13 (4)	4.0–4.4 4.2 $\pm$ 0.21 (3)	4.0 (1)

DIAGNOSIS. Digits of fore and hind feet and tail tip light coloured, contrasting with darker coloration of head, body and tail. Ears pale and conspicuous. Third upper and lower incisors (I3 and i3) small, I3 slightly greater in crown height than distostyle of second upper incisor (I2), i3 subequal in height to posterior accessory cusp of second lower incisor (i2); i2 greater in breadth than first lower incisor (i1); upper and lower canines greater in crown height than second upper and lower premolars (P3 and p3)

DESCRIPTION. Small to medium in size, tail longer than head and body (see Figs 1–2 and Table 1). Pinnae prominent and conspicuous, pale in colour, reaching beyond eye if pressed forward along head. Dorsal pelage soft in texture and grizzled yellowish brown and grey; hairs with silvery grey bases, bright buff distally, usually with dark brown tips; guard hairs slender, dark brown to black, some with pale tips. Ventral pelage light grey with buff or reddish wash; individual hairs with light silvery grey bases and light cream tips. Tail more or less bicoloured, grey brown above, light grey buff below; with contrastingly light coloured tip, usually with thin pencil of white hairs. Tail scale hairs moderately dense, approximately three scales in length. Fore and hind feet brown with contrasting light coloured digits, often with light lateral line along outer side of foot. Fifth digit of hind foot elongated and scarcely shorter than second digit; cheiridia on the hind feet elongated. Skull small to medium in size (see Table 1). Rostrum moderately broad; interorbital region moderately short; maxillary process of zygoma at right angles to long axis of cranium; braincase broad and short (see Fig. 3). Dentition illustrated in Figs 3–4. First upper incisor (I1) robust, slightly proodont, distostyle prominent, lingual cingulum present, buccal cingulum with accessory cusp; second upper incisor (I2) with small anterior accessory cusp, distostyle and prominent

anterolingual cusp; I3 small, slightly greater than the distostyle of I2 in crown height, trace of distostyle evident in unworn teeth. Upper canine (C) much greater than second upper premolar (P3) in crown height, with indistinct anterior accessory cusp, distostyle and lingual cingulum present. First upper premolar (P2) with small anterior accessory cusp and distostyle; mesostyle of P3 small but distinct, anterior ectostyle distinct and distostyle present; mesostyle of third upper premolar (P4) large and distinct, anterior ectostyle broad and distinct but posterior ectostyle and distostyle distinct or indistinct; talon large and bicuspid in some specimens. Talon of first and second upper molars (M1 and M2) large and bicuspid; third upper molar (M3) subequal to or broader than M2. Diastemata present between I1 and I2 and between I3 and C, C and P3. Lower first incisor (i1) procumbent, with distinct hypoconulid; lower second incisor (i2) spatulate, subequal in crown height but broader than i1 and much larger than very reduced third lower incisor (i3); i3 subequal in height to posterior accessory cusp of i2. Lower canine (c) procumbent, anterolingual cingulum present but anterior accessory cusp lacking. First lower premolar (p2) smaller than c and anteroflexed, anterior cusp very small or absent in some individuals. Protoconid of second lower premolar (p3) lower in crown height than that of third lower premolar (p4) and paraconid present; p4 and first and second lower molars (m1 and m2) lack distinctive features, except for anterior and posterior buccal cingula in most specimens. Talonid of third lower molar (m3) incomplete and reduced to a hypoconulid, hypoconid indistinct or absent, entoconid and entoconid ridge absent and entoconid basin indistinct or absent. Diastemata generally absent, although present in some individuals between c and p2.

Deciduous Dentition Deciduous anterior teeth smaller than permanent anterior teeth, in particular first upper and lower deciduous

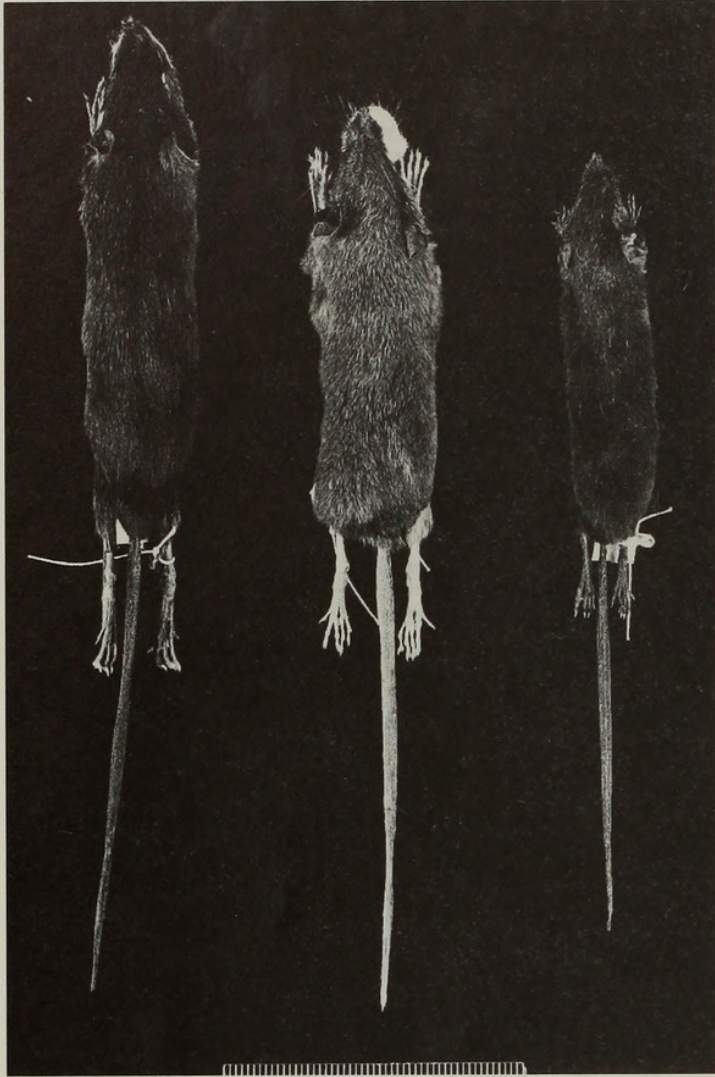


Fig. 2 Dorsal view of skins from left to right of *Microgale drouhardi* (FMNH 154565), *M. fotsifotsy* (FMNH 154590) and *M. parvula* (FMNH 151620).

incisors (dI1 and di1) respectively considerably smaller than I1 and i1 (see Figs 4 and 5). Principal cusp of dI1 slender, distostyle present, no anterior accessory cusp; morphology of deciduous second upper incisor (dI2) similar to I2 but smaller; deciduous third upper incisor (dI3) very small, less than height of distostyle of dI2. Deciduous upper canine (dC) subequal in height to deciduous second upper premolar (dP3), distostyle distinct, anterior accessory cusp present. Trace of anterior cuspid on deciduous first upper premolar (dP2); deciduous second upper premolar (dP3) with distinct mesostyle and distostyle present. Deciduous first lower incisor (di1) subequal in height to second deciduous lower incisor (di2) but considerably smaller in occlusal area; di2 similar in morphology to i2, with or without a small lingual cusp. Deciduous third incisor (di3) shed in all specimens examined. Deciduous lower canine (dc) and first lower premolar (dp2) similar in morphology to respective permanent counterparts but smaller, with trace of anterolingual cuspid; deciduous second lower premolar (dp3) taller than dc (unlike permanent dentition), metaconid present or indicated.

Eruption sequence partially determined: i3 to I3, I1 to i1, P2/p2, I2/i2, P4/p4; P3/p3 and C/c last teeth to erupt but sequence remains to be determined.

INTRASPECIFIC VARIATION. The known populations of this undescribed species are geographically widely separated and this is reflected in the moderately high degree of intraspecific variation. There is slight variation in pelage coloration: specimens from PN de la Montagne d'Ambre are generally paler than those from RS d'Ambatovaky, RNI de Zahamena and RNI d'Andringitra which also often have a reddish buff wash; specimens from RNI de Zahamena often show a reddish buff wash ventrally, while those from RNI d'Andringitra have a buff wash. Specimens from the RNI d'Andringitra and RNI de Zahamena populations are larger on average than either of the other populations (see Table 1), particularly in cranial dimensions. The two specimens from Marosohy, although geographically closer to the RNI d'Andringitra specimens in southeastern Madagascar are, however more similar to the PN de la Montagne d'Ambre specimens in size, as is the single juvenile specimen from RS d'Ambatovaky. There is some evidence of correlation between size and altitude; specimens from localities at lower

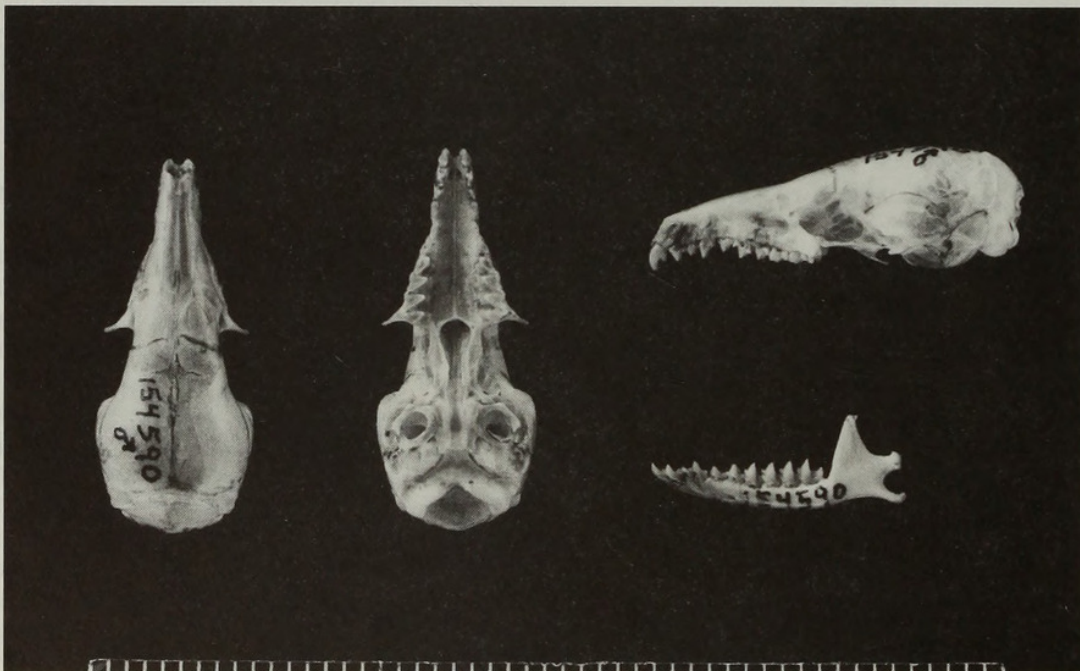


Fig. 3 Cranium of *Microgale fotsifotsy* (FMNH 154590) from left to right, dorsal, ventral, and lateral view of cranium and mandible.

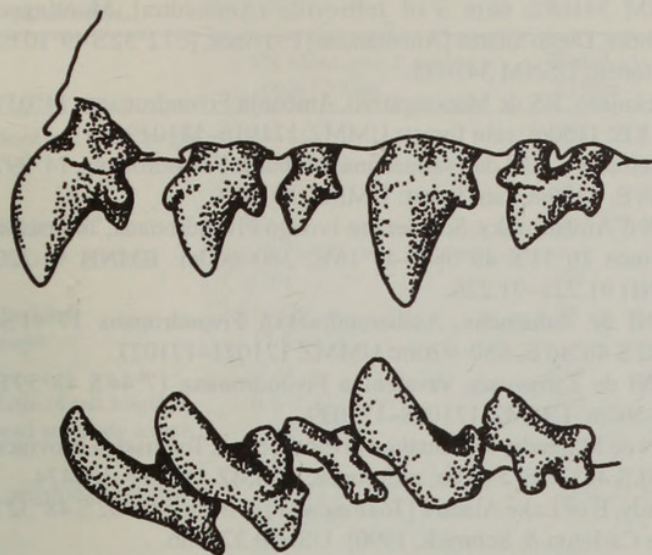


Fig. 4 Buccal view of left permanent anterior dentition of *Microgale fotsifotsy* (UMMZ 168468) I1–P2 above, i1–p2 below. Scale = 1 mm.

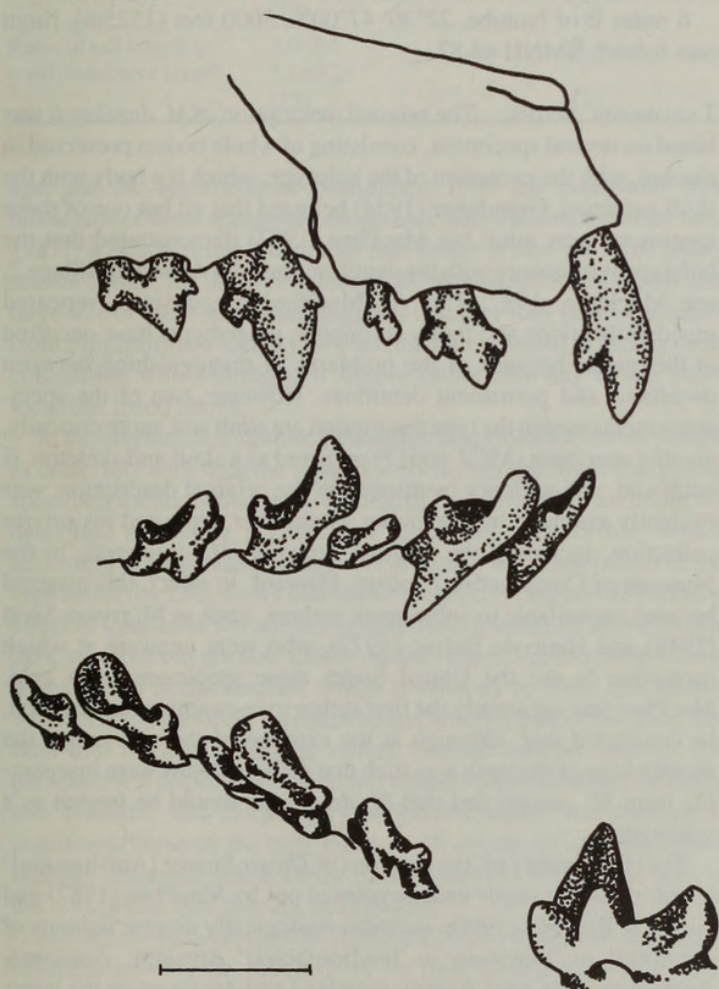


Fig. 5 Deciduous right anterior dentition of *Microgale fotsifotsy* (FMNH 154529) buccal view of dI1–dP2 above; buccal view middle, lingual view below of di1, di2, i3, dp2. Below right lingual view of right m3. Scale = 1 mm.

Table 2 Altitudinal size variation in adult *Microgale fotsifotsy*.

	Altitude 650m–670m	Altitude 850m–1400m
Condylolincisive length	19.8–20.4 20.1±0.25 (7)	20.0–21.6 20.8±0.49 (9)
Upper tooththrow length	9.5–9.9 9.7±0.15 (7)	9.7–10.6 10.2±0.28 (9)
Braincase breadth	8.5–9.1 8.9±0.16 (7)	9.0–9.7 9.5±0.23 (8)
Ratio of tail length to condylolincisive length	3.5–4.0 3.8±0.17 (6)	3.6–4.4 4.0±0.24 (9)

altitudes averaging smaller than their counterparts from higher altitudes (see Table 2).

ETYMOLOGY. *Fotsifotsy* is Malagasy for pale or whitish. The name is used here as 'the pale one' in reference to the light coloured fore and hind feet and tail tip, as well as the dorsal pelage which is paler than in most other species of *Microgale*.

COMPARISONS WITH OTHER SPECIES. *Microgale fotsifotsy* differs from other species of *Microgale* in a number of external and craniodental features. The combination of light body coloration and conspicuously pale coloured feet and tail tip, and the large, pale ears are unique to this species (see Figs 1 and 2). The early stages of the eruption sequence apparently differs from that ascribed to *M. cowani* and *M. pusilla* Major, 1896b by MacPhee (1987) and to *M. soricoides* Jenkins, 1993. In the sequence common to the three latter species, I3 and i3 erupt in the first stage, followed in sequence by P2, p2, p4, and I1 and i1 at the end of the second stage. In the specimens available of *M. fotsifotsy*, the sequence progresses from i3 to I3, to I1 to i1, to p2 then P2, so that, unusually the first upper and lower permanent incisors replace the deciduous teeth before any of the permanent premolars have erupted. *Microgale fotsifotsy* resembles *M. longicaudata* Thomas, 1882 in having elongated cheiridia and fifth digits on the hindfeet and with a tail longer than head and body length; the tail is, however, considerably longer in *M. longicaudata* than in *M. fotsifotsy* (ratio of TL to HB 1.03–1.3, mean 1.2 ± 0.08 , $n = 16$ in *M. fotsifotsy*; 1.7–2.4, mean 2.1 ± 0.22 , $n = 11$ in *M. longicaudata*). Despite some similarities to *M. longicaudata* in external proportions, the crania of the two species differ markedly. That of *M. fotsifotsy* is larger and the braincase is relatively broader, shorter and shallower than that of *M. longicaudata* in which the skull is slightly concave in profile.

Despite the differences in size and external appearance, the skull of *M. fotsifotsy* is more similar in overall proportions to *M. soricoides* than to any other species. The skull of *M. fotsifotsy* is much smaller and more delicate than that of *M. soricoides*. The rostrum is much more slender and elongated but the maxillary processes of the zygoma are flared at right angles to the long axis of the cranium in both species, and the braincase is similarly short and broad, although the occipital is proportionately much smaller in *M. soricoides*. There are also more features common to the dentitions of these two species than to others. In both *M. fotsifotsy* and *M. soricoides*, I1 is robust and somewhat similar in its proportions, but that of *M. fotsifotsy* is less pro-odont, and a larger cuspid is present on the buccal cingulum. In both species, I2 is very similar in shape and proportions but I3 is less reduced than in *M. soricoides*, in which P2 is also very reduced, unlike *M. fotsifotsy*. These two species also differ considerably in the anterior ectostyle of P3 which is distinct in *M. fotsifotsy* but very

reduced in *M. soricoides*. In the mandibular dentition of *M. soricoides*, both i3 and p2 are very reduced and the latter is unusual in having a single root; both of these teeth in *M. fotsifotsy* are reduced but less markedly so and p2 has two roots. The lower canine is similar in both species but p3 is more caniniform in *M. soricoides*. The third lower molar shows a similar degree of reduction of the talonid in both species.

The dentition of the new species is distinctive and does not readily group with any of the species clusters described by MacPhee (1987) but, as outlined above, does show some similarity to *M. soricoides*, which may represent a separate cluster. The degree of development of accessory cusps on I1–C is similar to that of members of the *cowani* cluster but less marked than in the *longicaudata* cluster, also the presence of interproximal gaps between the upper incisors occurs in *M. fotsifotsy* and the *cowani* cluster. In contrast, *M. fotsifotsy* is more similar to the *longicaudata* cluster in that the buccal aspects of P3 and P4 are similar in shape, the lower canine lacks a paraconid and the crown of p2 appears anteroflexed as in *c*, due to the shorter convex anterior slope and longer concave posterior slope. The relative proportions of the anterior teeth of *M. fotsifotsy* differ from either the *cowani* or the *longicaudata* cluster, they are similar to, but less extreme than those in *M. soricoides*, as shown in Table 3.

Table 3 Relative proportions of the anterior teeth of *Microgale fotsifotsy* in comparison with *M. cowani* cluster, *M. longicaudata* and *M. soricoides*.

<i>cowani</i> cluster	I1 > I2 > I3 < C > P2 <	P3	C ≡ P3
<i>longicaudata</i>	I1 > I2 > I3 < C > P2 >	P3	C > P3
<i>fotsifotsy</i>	I1 > I2 » I3 < C » P2 < or ≡	P3	C > P3
<i>soricoides</i>	I1 » I2 » I3 « C » P2 «	P3	C > P3
<i>cowani</i> cluster	i1 ≡ i2 > i3 < c ≡	or < p2 < p3	c < p3
<i>longicaudata</i>	i1 < i2 > i3 < c >	p2 < p3	c ≡ p3
<i>fotsifotsy</i>	i1 ≥ i2 » i3 < c »	p2 < p3	c ≥ p3
<i>soricoides</i>	i1 » i2 » i3 « c »	p2 « p3	c ≡ p3

Microgale drouhardi G. Grandidier, 1934

Microgale melanorrhachis Morrison-Scott, 1948

Microgale cowani Thomas: MacPhee, 1987, in part.

HOLOTYPE. MCZ 45034 (specimen A in original description) juvenile female, body in alcohol, skull extracted, collected by Monsieur Drouhard.

TYPELOCALITY. environs of Diego-Suarez [Antsiranana, c. 12°16'S 49°18'E—see MacPhee, 1987].

PARATYPES. MCZ 46007–46011 (specimens B–F in original description), MCZ 46012 (juvenile mentioned in original description), all in alcohol. All from the same locality as the holotype.

REFERRED MATERIAL. environs of Diego-Suarez [Antsiranana, c. 12°16'S 49°18'E]: MCZ 46013–46019.

PN de la Montagne d'Ambre, 5.5 km SW of Joffreville [Ambohitra], 12°31'S 49°10'E, 1000m, in relatively undisturbed rain forest: FMNH 154489; FMNH 154491; FMNH 154493–154494; FMNH 154499; FMNH 154514–154515; FMNH 154517; FMNH 154561–154564; FMNH 154567–154571.

Camp 1, Antomboka River, PN de la Montagne d'Ambre, Antsiranana Fivondronana, Antsiranana Province, 12°32'S 49°10'E, 1150–1250m, rain forest: UMMZ 171000–171015; BMNH 1996.280; BMNH 1996.281.

5km S of Joffreville [Ambohitra], Mont[agne] d'Ambre, Diego

Suarez [Antsiranana] Province, [c 12°32'S 49°10'E], rain forest: USNM 341692; 6km S of Joffreville [Ambohitra], Mont[agne] d'Ambre, Diego Suarez [Antsiranana] Province, [c 12°32'S 49°10'E], rain forest: USNM 341693.

Bekolosy, RS de Manongarivo, Ambanja Fivondronana, 14°03'S 48°18'E, 1150m, rain forest: UMMZ 171016–171019.

Matsabory, RNI de Tsaratanana, Ambanja Fivondronana, 14°09'S 48°58'E, 2350m, rain forest: UMMZ 171020.

RS d'Ambatovaky, Soanierana-Ivongo Fivondronana, Toamasina Province 16°51'S 49°08'E–49°16'E, 360–600m: BMNH 91.220; BMNH 91.221–91.226.

RNI de Zahamena, Ambatondrazaka Fivondronana 17°41'S–17°42'S 48°46'E, 850–920m: UMMZ 171021–171027.

RNI de Zahamena, Vavatenina Fivondronana 17°44'S 48°59'E, 420–560m: UMMZ 171028–171039.

PN de Mantady, Moramanga Fivondronana, Toamasina Province, 18°51'S 48°27'E, 1100m, rain forest: UMMZ 168471–168474.

Didy, E of Lake Alaotra [Toamasina Province, c 18°02'S 48°32'E – see Carleton & Schmidt, 1990]: USNM 328686.

Périnet [= Andasibe], near Moramanga, eastern Madagascar, 19°00'S 48°30'E, 3000 feet [915m]: BMNH 48.88 (holotype of *Microgale melanorrhachis*).

43 km S of Ambalavao, junction of Sahanivoraky and Sahavatovy Rivers, RNI d'Andringitra, 22°13'S 47°00'E, 810m: FMNH 151627; FMNH 151756. 45 km S of Ambalavao, E bank of Iantara River, along Ambalamanenjana–Ambatamboay Trail, edge of RNI d'Andringitra, 22°13'S 47°01'E, 720m: FMNH 151626.

6 miles E of Ivohibe, 22°30' 47°00'E, 5000 feet [1525m], [high rain forest]: BMNH 48.87.

TAXONOMIC NOTES. The original description of *M. drouhardi* was based on several specimens, consisting of whole bodies preserved in alcohol, with the exception of the holotype, which is a body with the skull extracted. Grandidier (1934) believed that all but one of these specimens were adult but MacPhee (1987) demonstrated that the holotype is immature with the dentition partially deciduous (Stage 2, see MacPhee, 1987: 13). As MacPhee emphasised, repeated misidentifications and faulty taxonomic judgements have occurred in this genus because of the problems of distinguishing between deciduous and permanent dentitions. However, two of the specimens mentioned in the type description are adult and, more critically, another specimen (MCZ 46017) prepared as a skull and skeleton, is adult and, although not mentioned in the original description, was evidently available to Grandidier. Grandidier deposited his private collection, including the original series of *M. drouhardi*, in the Museum of Comparative Zoology, Harvard. In effect, this material became unavailable to subsequent authors, such as Morrison-Scott (1948) and Heim de Balsac (1972), who were unaware at which institution in the the United States these specimens were held. MacPhee was apparently the first author to re-examine this material, he concluded that, although at the extreme of the size range, the morphology of the teeth was such that the specimens were inseparable from *M. cowani* and that *M. drouhardi* should be treated as a synonym.

The type locality of 'the environs of Diego-Suarez [Antsiranana]' is unfortunately vague and, as pointed out by MacPhee (1987) and Nicoll & Rathbun (1990), includes ecologically diverse habitats of dry forest on limestone at Tendrombohitra Antsingy, Ankarana, Analamera and Cap d'Ambre, grassland and dry forest on the lower slopes of the basaltic Montagne d'Ambre, with rain forest at higher altitudes of Montagne d'Ambre. Since most species of *Microgale* are recorded from rain forest (*M. pusilla* Major, 1896b and *M. principula* Thomas, 1918 contained in owl pellets of indeterminate

Table 4 Variation between populations of adult *Microgale drouhardi*. Dimensions given as range, mean±standard deviation and number of specimens in parentheses.

	PN Montagne d'Ambre 1000–1250m	Bekolosy 1150m	RS d'Ambatovaky 360–600m	RNI Zahamena 420–1180m	Didy	PN Mantady 1100–1150m
Head and body length	64–83 75.8±5.39 (16)	73.0, 73.3 (2)	62.5–74.4 68.8±4.00 (7)	63.0–76.8 69.7±3.78 (17)	80.1 (1)	69.8–75.4 72.5±1.98 (4)
Tail length	67–83 74.7±4.85 (16)	70.5, 72.4 (2)	52.9–62.3 56.7±3.24 (7)	52.7–62.1 58.3±2.83 (16)	–	63.7–71.0 67.7±2.66 (4)
Hind foot length	16–19 17.6±0.77 (17)	17 (2)	13–15 14.1±0.64 (7)	14–15 14.6±0.49 (17)	–	16–18 17.0±0.71 (4)
Ratio of tail length to head and body length	0.8–1.2 1.0±0.10 (16)	1.0 (2)	0.8–0.9 0.8±0.05 (7)	0.8–0.9 0.9±0.05 (15)	–	0.9–1.0 0.9±0.04 (4)
Condylolincisive length	22.5–23.9 23.3±0.45 (18)	22.0, 22.5 (2)	21.0–21.6 21.3±0.22 (7)	20.5–22.3 21.4±0.45 (17)	22.3 (1)	22.4, 22.5 (2)
Upper toothrow length	10.6–11.5 11.1±0.21 (19)	10.3, 10.7 (2)	9.8–10.3 10.1±0.16 (7)	9.7–10.4 10.0±0.23 (17)	10.2 (1)	9.9–10.5 10.2±0.26 (4)
Maxillary breadth from M3–M3	6.0–6.7 6.4±0.14 (19)	6.2 (2)	6.1–6.3 6.2±0.09 (7)	5.9–6.4 6.1±0.17 (17)	6.2 (1)	6.3–6.9 6.6±0.11 (4)
Braincase breadth	9.0–9.7 9.4±0.18 (19)	9.5, 9.8 (2)	8.5–9.1 8.8±0.20 (7)	8.5–9.2 8.9±0.20 (17)	9.2 (1)	8.9–9.5 9.3±0.26 (3)
Ratio of tail length tp condylolincisive length	3.0–3.6 3.2±0.21 (15)	3.1, 3.3 (2)	2.4–2.9 2.7±0.17 (7)	2.6–2.9 2.7±0.12 (15)	–	3.0 (2)

age, and *M. brevicaudata* Grandidier, 1899 are exceptions [for discussion of these apparently anomalous drier habitats see MacPhee, 1987]) it is conjectured here that rain forest is also the most likely source habitat for the type series of *M. drouhardi*. Additionally the large size of these specimens suggests that they may have originated from a high altitude locality (see section on variation), which is most compatible with Montagne d'Ambre rather than any of the other localities listed above.

In the original description, Grandidier described the dorsal pelage as uniformly dark with the venter barely lighter in colour. The young specimen mentioned in the type description (evidently an infant) is described as having a black line along the mid-dorsum, which according to Grandidier, disappears in adults. Re-examination of the type series (by CR) shows that due to the discoloring and deleterious effect of long-term storage in alcohol, these specimens are no longer dark in colour but are now a dull reddish brown. Furthermore, a dark dorsal stripe is discernable, which is obvious in some specimens, where it is most evident on the head and anterior part of the body, but faint and difficult to see in others. Shared features such as the presence of a dorsal stripe, size and relative proportions of the body and cranium, and morphology of the deciduous and permanent dentitions, between the type series of *M. drouhardi* and specimens recently collected (particularly from Montagne d'Ambre), lead to the conclusion that they are conspecific.

Microgale melanorrhachis Morrison-Scott, 1948 was originally distinguished by the presence of its dark mid-dorsal stripe. The description was based on the skin and skull of the juvenile holotype (believed to be adult by the author) from Perinet [Andasibe], plus a damaged skin from another locality (Ivohibe). Following the original description, an additional specimen was recorded by Eisenberg & Gould (1970) from Didy, east of Lake Alaotra and references to

the species were included in the literature (Heim de Balsac, 1972; Genest & Petter, 1975). MacPhee (1987), however, observed that a proportion of *M. cowani* also exhibited a variable tendency to a mid-dorsal stripe, and he synonymised *M. melanorrhachis* with *M. cowani* on the basis of its dentition. Subsequent authors disregarded MacPhee's opinion and continued to treat *M. melanorrhachis* as a distinct species (Nicoll & Langrand, 1989; Nicoll & Rathbun, 1990; Raxworthy & Nussbaum, 1994; Stephenson, 1995). The conclusion drawn from the current study comparing recently collected large series of adult and juvenile specimens from the localities listed above with the type series of *M. drouhardi* and *M. melanorrhachis*, is that they are conspecific.

DESCRIPTION. Medium sized (see Table 4), tail slightly shorter or subequal to head and body length. Dorsal pelage dark brown, brown or rufous brown with well demarcated, distinctly darker brown mid-dorsal stripe, extending from crown of head to base of tail (see Fig. 2); hairs of dorsal pelage have light grey bases, red distally with brown tips; hairs of mid-dorsal stripe dark brown for most of their length, with grey bases, lacking red band; guard hairs also dark brown with grey bases. Ventral pelage silvery buff, buff or rufous buff, individual hairs having grey bases and buff or reddish buff tips; transition between dorsal and ventral coloration moderately distinct. Tail bicolored, dark brown above, buff or reddish buff below; tail scales readily visible, scale hairs short, each overlapping c 2 scales on basal third of tail. Hind feet dark brown on outer dorso-lateral and ventral surface, reddish buff or buff on inner dorso-lateral surface.

Skull medium in size (see Table 4 and Fig. 6), with moderately elongated and shallow but broad rostrum, nasals extend beyond zygomatic plate into interorbital region; frontals slightly dorso-laterally inflated; braincase moderately broad, short and shallow;

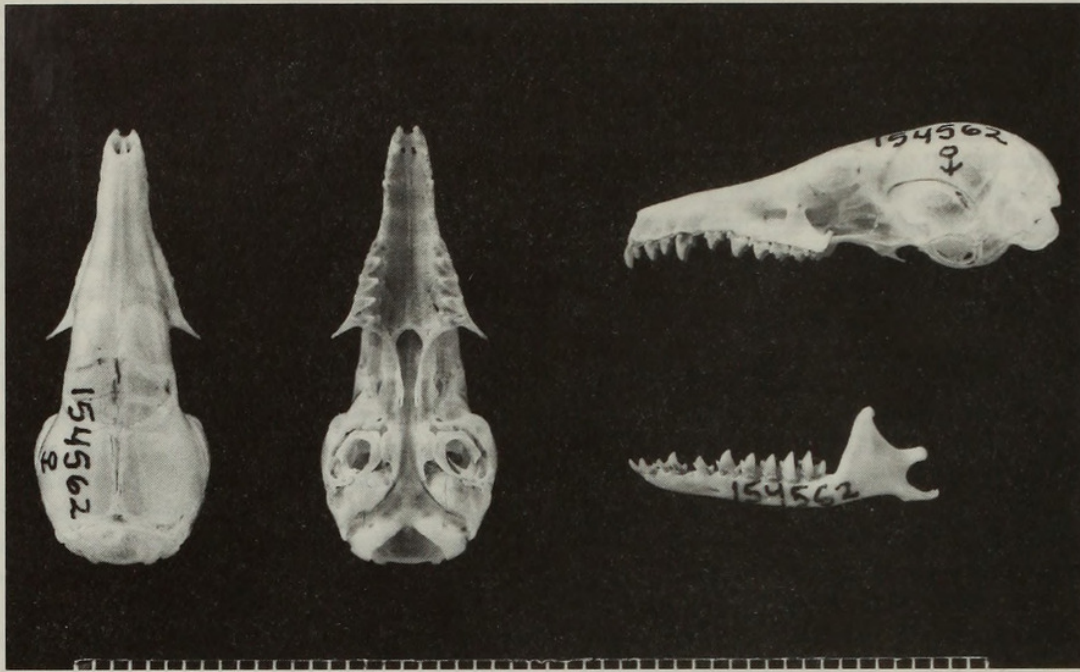


Fig. 6 Cranium of *Microgale drouhardi* (FMNH 154562) from left to right, dorsal, ventral, and lateral view of cranium and mandible.

parietal–supraoccipital junction rounded or subangular. Short diastemata present between anterior teeth from I1 to P3 and usually present on either side of p2; I3 often distinctively caniniform, usually anteroflexed, anterior accessory cusp usually absent or very reduced and distostyle may be reduced (see Fig. 7). Upper canine long and slender, notably greater in crown height than other teeth in upper dentition (including P3), root usually evident externally as swelling in rostrum. Talonid of m3 slightly reduced, talonid basin narrow and entoconid lacking (see Fig. 8).

VARIATION. There is a moderately high degree of variation in pelage coloration between populations. Specimens from PN de la Montagne d'Ambre are usually dark brown, with or without a rufous

wash; those from Bekolosy, PN de Mantady, Didy and Andasibe, also RS d'Analamazaotra (see Stephenson, 1995) are bright rufous or rufous brown dorsally, with a buff or rufous wash ventrally; specimens from RS d'Ambatovaky are dull rufous brown dorsally, grey ventrally; those from RNI de Zahamena are light rufous brown dorsally, with a rufous wash ventrally; while specimens from RNI

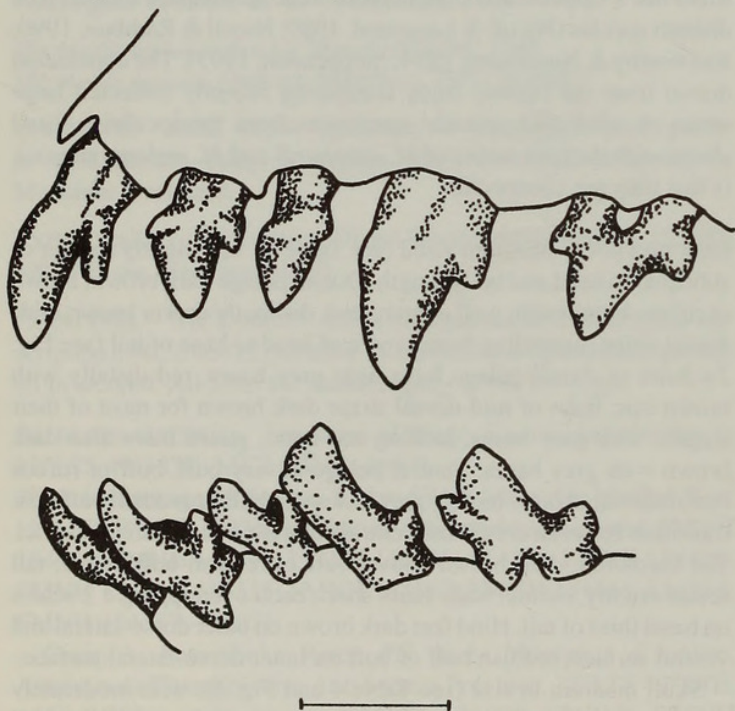


Fig. 7 Buccal view of left permanent anterior dentition of *Microgale drouhardi* (FMNH 154514) I1–P2 above, i1–p2 below. Scale = 1 mm.

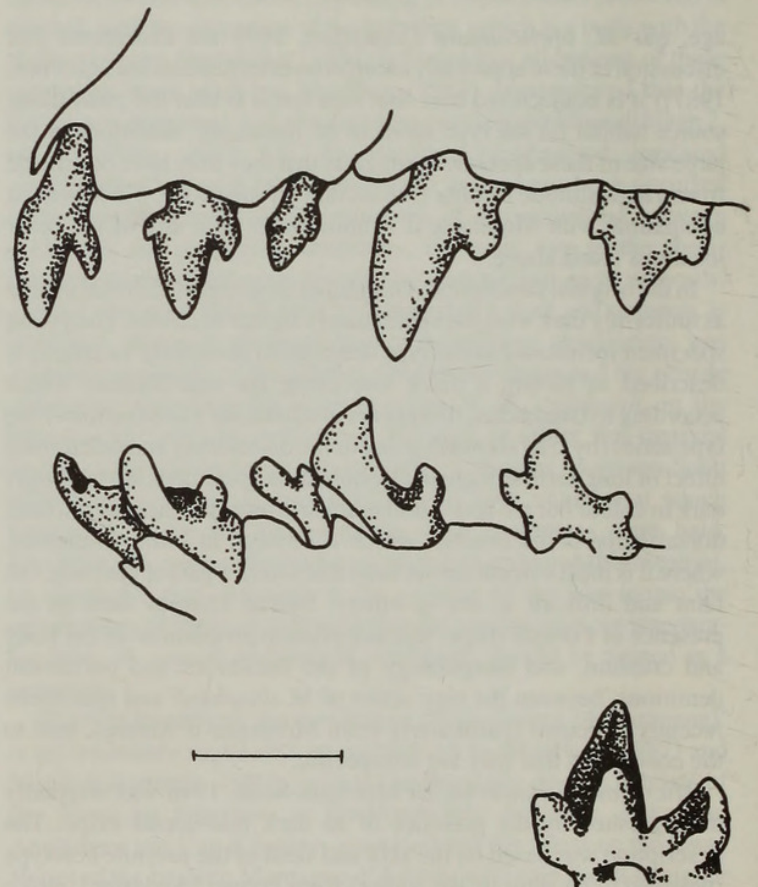


Fig. 8 Deciduous left anterior dentition of *Microgale drouhardi* (UMMZ 168480): buccal view of dI1–dP2 above, buccal view of di1–dp2 below. Below right lingual view of right m3. Scale = 1 mm.

Table 5 Altitudinal size variation in adult *Microgale drouhardi*.

	Altitude 360m–920m	Altitude 1000m–1250m
Condylolincisive length	20.5–22.3 21.4±0.47 2 (15)	21.1–23.9 23.0±0.78 (23)
Upper tooththrow length	9.7–10.5 10.1±0.23 (22)	9.9–11.4 10.8±0.47 (25)
Braincase breadth	8.5–9.3 8.9±0.20 (22)	8.6–9.8 9.4±0.31 (23)
Ratio of tail length to condylolincisive length	2.5–2.9 2.7±0.14 (20)	2.7–3.6 3.1±0.21 (20)

d'Andringitra (all juveniles) have a grey brown dorsum, grizzled with yellowish buff. Although always present and distinctly demarcated, there is some variation in the width and length of the dorsal stripe. The intensity of the rufous buff coloration of the venter, undersurface of the tail and lateral surfaces of the hind feet also shows within-population variability. The pelage of juveniles from all localities is indistinguishable in coloration and degree of striping from that of adults, which refutes the view of Grandidier (1934) that striping is a juvenile characteristic and confirms MacPhee's observation that striping occurs also in dental adults.

This species exhibits an exceptional degree of inter-population size variation (see Table 4). Specimens from RS d'Ambatovaky and RNI de Zahamena are notably smaller than those from PN de la Montagne d'Ambre and Bekolosy, although the extremes shown by these populations are bridged by specimens from PN de Mantady, (and RS d'Analamazaotra, see Stephenson, 1995) which are intermediate in size. Such a high degree of size variation is much greater than encountered in any other species of *Microgale* so far investigated. There is no apparent correlation between size and geographical location, although there is some evidence of a link with altitude. Specimens from lower altitudes are smaller, those from higher altitudes average larger (see Table 5).

COMPARISONS. *Microgale drouhardi* is most similar in size and dentition to *M. cowani* and *M. taiva* Major, 1896b. *Microgale taiva* is another taxon regarded as a synonym of *M. cowani* by MacPhee (1987), however recently collected specimens suggest that the two species are distinct and the descriptions of both have been amplified (see Jenkins *et al.*, 1996). *Microgale drouhardi* is readily distinguished from both species by the presence of the sharply demarcated, dark, mid-dorsal stripe; also in life, *M. drouhardi* has a much paler

venter than *M. cowani* and *M. taiva*. *Microgale cowani* is distinguished from *M. drouhardi* by the more elongated rostrum with longer diastemata between the teeth of the anterior dentition, by the broader, deeper braincase and by the presence of all elements of the talonid of m3 (see Table 6). *Microgale taiva* has a relatively broader, deeper braincase than that of *M. drouhardi*, the tail is relatively longer, and the ratio of the anterior teeth (from I1 to P3) to the upper tooththrow is greater on average (see Table 6).

Microgale parvula Grandidier, 1934

Microgale pulla Jenkins, 1988

HOLOTYPE. MCZ 45465, juvenile male, body in alcohol, skull extracted, collected by Monsieur Drouhard.

TYPE LOCALITY. environs of Diego-Suarez [Antsiranana, c. 12°16'S 49°18'E – see MacPhee, 1987]

REFERRED MATERIAL. Camp 1, Antomboka River, PN de la Montagne d'Ambre, Antsiranana Fivondronana, Antsiranana Province, 12°32'S 49°10'E, 1125–1225m, rain forest: UMMZ 171043–171044.

Bekolosy, RS de Manongarivo, Ambanja Fivondronana, Antsiranana Province, 14°03'S 48°18'E: BMNH 96.282.

RNI de Marojejy, Andapa Fivondronana, 14°26'S 49°46'E, 650–900m: UMMZ 171045–171051.

Forêt d'Anandrivola, c 10 km southwest of Maintimbato Village, c 40 km southwest of Maroantsetra, northeast Madagascar, 15°46'S 49°35'E, 450–625 m: BMNH 87.132 (holotype of *M. pulla*).

RNI de Zahamena, Ambatondrazaka Fivondronana 17°40'S 48°46'E, 1180–1270m: UMMZ 171052–171053.

RS d'Ambositantely, Ankazobe Fivondronana 18°11'S 47°17'E: UMMZ 171054.

PN de Mantady, Moramanga Fivondronana, Toamasina Province, 18°51'S 48°28'E, 1100m: UMMZ 171040–171042; BMNH 96.283.

38 km S of Ambalavao, along Volotsangana River, RNI d'Andringitra, 22°11'S 46°58'E, 1625 m: FMNH 151623; FMNH 151723; FMNH 151793–151794; FMNH 151801; FMNH 151805–151806. 40 km S of Ambalavao, along Volotsangana River, RNI d'Andringitra, 22°13'S 46°58'E, 1210 m: FMNH 151722; FMNH 151764; FMNH 151766. 43km S of Ambalavao, junction of Sahanivoraky and Sahavatoy Rivers, RNI d'Andringitra, 22°13'S 47°00'E, 810 m: FMNH 151622. 45 km S of Ambalavao, east bank of Iantara River, along Ambalaman-jana–Ambatamboay Trail, edge of RNI d'Andringitra, 22°13'S 47°01'E 720 m: FMNH 151621.

Ampamakiesiny Pass, Tôlanaro Fivondronana, Toliara Province, 24°32'S 46°51'E, 750–850m. UMMZ 167258; UMMZ 167261–167263.

Marosohy Forest, 16 km WNW of Ranomafana-Sud, Fivondronana Tolagnaro [Tôlanaro Fivondronana], Toliara Province, 24°34'S 46°48'E, 700–800m: USNM 578784–578785; Marosohy Forest, near Tsitongatona River, 15 km WNW of Ranomafana-Sud, Fivondronana Tolagnaro [Tôlanaro Fivondronana], Toliara Province, 24°34'S 46°48'E, 580m: USNM 578786.

Nahampoana, Vohimena Mountains; Tôlanaro Fivondronana, 24°58'S 46°58'E, 120m: UMMZ 167233.

Manantantely, Vohimena Mountains, Tôlanaro Fivondronana, 24°59'S 46°58'E, 100–300m: UMMZ 167222–167223; UMMZ 167228–167229; UMMZ 167231.

TAXONOMIC NOTES. *Microgale parvula* was described originally from a single specimen, erroneously considered to be adult by the

Table 6 Comparison of adult *Microgale drouhardi*, *M. cowani* and *M. taiva*. Dimensions presented as range, mean±standard deviation and number of specimens in parentheses.

	<i>M. drouhardi</i>	<i>M. cowani</i>	<i>M. taiva</i>
Ratio of tail length to condylolincisive length	2.4–3.6 3.0±0.27 (33)	2.5–3.1 2.9±0.19 (14)	3.5–4.2 3.9±0.19 (14)
Condylolincisive length	20.5–23.9 22.4±1.02 (39)	21.4–23.7 22.5±0.52 (16)	22.1–23.5 22.8±0.44 (14)
Ratio of anterior dentition(I–P3) to upper tooththrow length	41.6–50.9 48.8±1.87 (41)	52.8–56.4 54.0±1.00 (16)	49.1–52.8 50.7±0.88 (14)
Braincase breadth	8.5–9.8 9.2±0.36 (40)	9.8–10.4 10.1±0.19 (18)	9.6–10.3 9.9±0.22 (14)

Table 7 Comparison of adult *Microgale parvula* and *M. pusilla*. Dimensions presented as range, mean±standard deviation and number of specimens in parentheses.

	<i>M. parvula</i>	<i>M. pusilla</i>
Head and body length	49.6–64 56.1±3.8 (19)	52 (1)
Tail length	46.5–66 54.8±5.9 (19)	72 (1)
Hind foot length	9–11 10.0±0.64 (19)	12 (1)
Ratio of tail length to head and body length	0.8–1.1 1.0±0.08 (18)	1.4 (1)
Condylolincisive length	15.5–17.1 16.4±0.36 (17)	15.6–16.8 16.4±0.4 (6)
Upper tooththrow length	6.9–7.8 7.4±0.21 (18)	7.2–7.9 7.6±0.19 (9)
Maxillary breadth from M3–M3	4.3–4.6 4.5±0.08 (19)	4.9–5.2 5.0±0.11 (9)
Braincase breadth	6.4–6.9 6.7±0.15 (18)	6.8–7.3 7.0±0.16 (6)
Braincase height	3.6–4.3 4.0±0.17 (18)	4.7–5.4 5.0±0.24 (6)
Ratio of tail length to condylolincisive length	2.9–4.0 3.4±0.33 (17)	4.4 (1)

author but later demonstrated to have a deciduous dentition by MacPhee (1987). Perhaps because its very small size presents collection difficulties, no further specimens were recorded in the literature nor represented in the major museum collections accessed by MacPhee (1987). The dentition of this specimen was illustrated by MacPhee (1987), who also corrected the measurements given in

the original description. He was in no doubt about the validity of this distinctively small species, which he grouped in the *cowani* cluster on the basis of phenetic characters. The origin of the holotype of *M. parvula* is the same as for *M. drouhardi* and similar arguments may be applied, suggesting that it was most probably collected from Montagne d'Ambre and from rain forest. It was assumed that the species might be confined to northern Madagascar. *Microgale pulla* Jenkins, 1988 was described from another single, although adult specimen, from further south. MacPhee (personal communication) advised that this specimen might simply represent the adult of *M. parvula* and this possibility was mentioned in the original description of *M. pulla*, although the data available at that time suggested otherwise. Recent collections from different localities extending from Montagne d'Ambre in the extreme north to the eastern forest as far south as Manantantely, included adult and juvenile specimens positively ascribable to the same taxon, directly associating the adult *pulla* with the juvenile *parvula*. *Microgale pulla* was synonymised with *M. parvula* (see Jenkins *et al.*, 1996).

DESCRIPTION. Very small (see Table 7 and Fig. 2), tail subequal in length to that of head and body. Dorsal pelage dark brown, ventral pelage dark grey brown, tail and feet uniform dark grey brown. Individual hairs of dorsal pelage with grey bases, orange red distally with brown tips, guard hairs flattened, with grey bases and brown tips. Hairs of ventral pelage with grey bases and brown or reddish buff tips. Tail scales visible beneath moderately dense scale hairs, 2.5–3 scales in length. Skull very small, delicate and elongated in appearance (see Fig. 9); rostrum slender, moderately short; braincase shallow and long, frontals and occipital large relative to parietals, occipital condyles postero-dorsally orientated. Diastemata present between I1 and I2 and on either side of C and P2; anterior and posterior accessory cusps present on I2, I3 and P2. Diastema between c and p2. Talonid of m3 with well developed hypoconulid but reduced hypoconid, entoconid and entoconid ridge, and narrow, shallow talonid basin. See Fig. 10 for illustrations of permanent and deciduous dentitions.

VARIATION. There is no obvious intraspecific variation in pelage coloration or size between the populations studied, nor any evidence

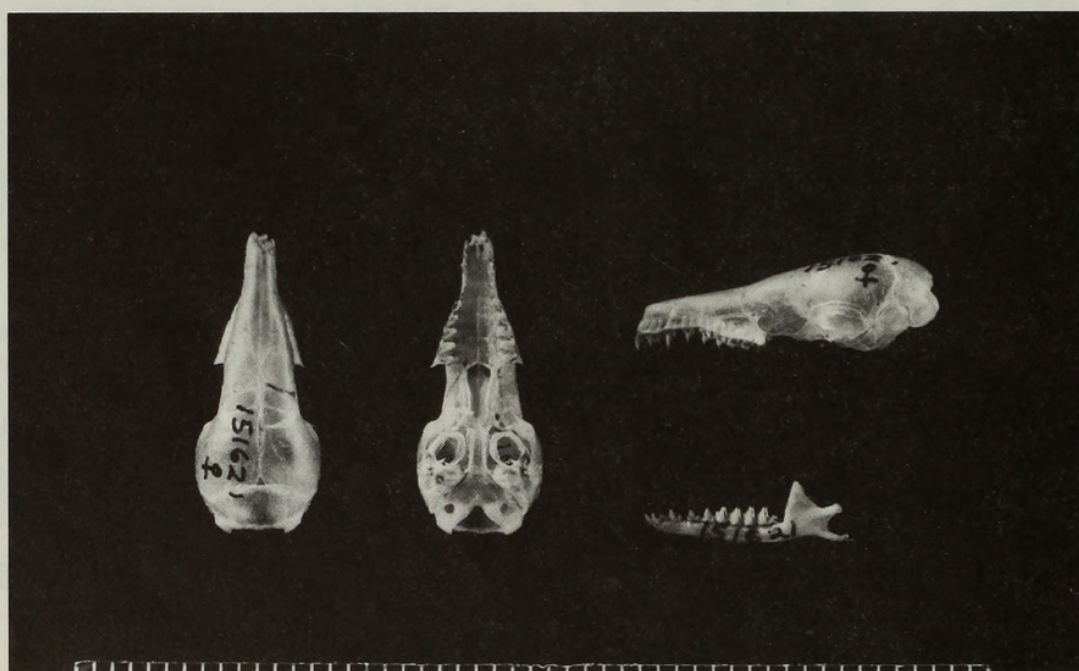


Fig. 9 Cranium of *Microgale parvula* (FMNH 151621) from left to right, dorsal, ventral, and lateral view of cranium and mandible.

of altitudinal variation. Variation may, however, be present but obscured by the small sample size from individual localities.

COMPARISONS. *Microgale pusilla* Major, 1896b is the only species with which *M. parvula* is likely to be confused because of similarities in size. The two species differ in coloration: *M. parvula* is dark grey brown dorsally, grading into grey ventrally, with a dark grey tail which is only slightly paler ventrally; in contrast, *M. pusilla* is reddish buffy brown dorsally, with a moderately abrupt transition to the buffy grey brown venter and with the tail darker grey brown above than below. Although the skull of both species is of a similar length (see Table 6), the skull proportions differ considerably and, in particular the braincase of *M. parvula* is shallower than that of *M. pusilla* and the occipital condyles are more postero-dorsally aligned (see Fig. 9 and Jenkins, 1988: Fig. 1). The major dental difference between the two species is that p2 has a single root in *M. pusilla* but is double rooted in *M. parvula*.

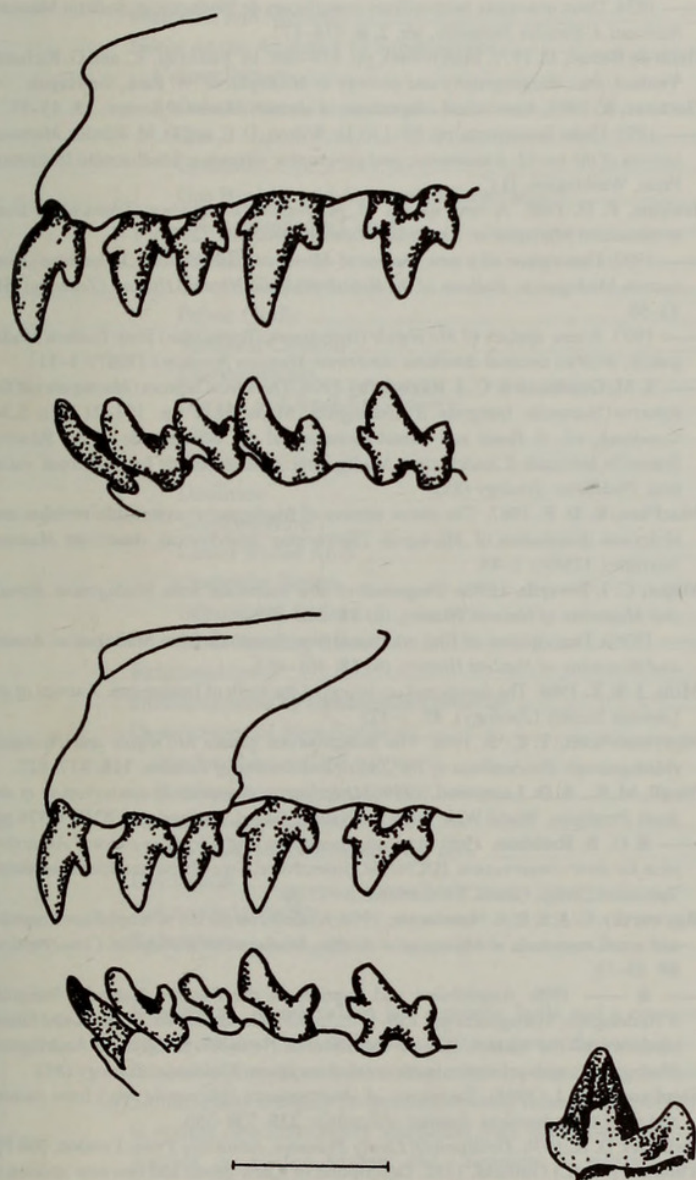


Fig. 10 Top: left permanent anterior dentition of *Microgale parvula* (FMNH 151623) buccal view of I1–P2 above, buccal view of i1–p2 below. Below: deciduous left anterior dentition of *Microgale parvula*, buccal view of dI1–dP2 (FMNH 151806) above, buccal view of di1–dp2 (FMNH 151622) below. Lower right: lingual view of right m3 (FMNH 151622). Scale = 1 mm.

DISCUSSION

Purely on a phenetic basis, MacPhee (1987) grouped the species of *Microgale* into six species 'clusters', as follows:

cowani cluster: *M. cowani*, *M. thomasi*, *M. parvula*. Species considered by MacPhee to be synonyms of *M. cowani*, but subsequently removed from synonymy, namely *M. taiva* (see Jenkins *et al.*, 1996) and *M. drouhardi* (this paper) continue to be assigned to this group.

gracilis cluster: *M. gracilis*

longicaudata cluster: *M. longicaudata*, *M. principula*

pusilla cluster: *M. pusilla*

brevicaudata cluster: *M. brevicaudata*

dobsoni cluster: *M. dobsoni*, *M. talazaci*

Of those species described after MacPhee's revision, *Microgale dryas* Jenkins (1992) was considered to group with members of both the *cowani* and *gracilis* clusters, while the unusual dentition of *M. soricoides* Jenkins, 1993, was believed to be sufficiently distinct to merit a separate cluster. Because of its greater resemblance in craniodental morphology and proportions to *M. soricoides* rather than any other species, *M. fotsifotsy* is placed in the *soricoides* cluster.

Surprisingly, although *Microgale fotsifotsy* represents a new species, the distribution of this shrew tenrec extends through almost the entire length of the rain forest belt (from latitude 12°–24°S) in Madagascar. It has been collected from six different regions: Montagne d'Ambre, Marojejy, Ambatovaky, Zahamena, Andringitra and Marosohy Forest, near RNI Andohahela (Anosy Mountains). The elevational range for this species is 600–1400m, suggesting that it is primarily restricted to mid-altitude rain forest. Because trapping in lower elevations at Ambatovoky, Zahamena and the Anosy Mountains (as well as other sites) did not yield further examples of *M. fotsifotsy*, we conclude that this species is absent from forest below 600m altitude.

The habits of this species remain largely unknown; most captures so far have been made with pitfall traps in primary rain forest, demonstrating that it is active on the forest floor. One specimen, however, was found on top of a shelter 1.5m above the ground, suggesting that it may also be partly arboreal. This view is supported by morphological features such as the relatively long tail and elongated hind foot with a long fifth digit, adaptations which are associated with arboreality in Soricidae (Hutterer, 1985) and occur in a more extreme form in another species of shrew tenrec, *M. longicaudata*, (see Thomas, 1918) a species for which there is some behavioural evidence of arboreal adaptation (CR personal observation; Goodman, personal communication).

Microgale drouhardi and *M. parvula* are also widely distributed in the rain forest regions of Madagascar. Both occur as far north as Montagne d'Ambre (latitude 12°S) and as far south as Andringitra (22°S) for *M. drouhardi*, and Manantantely, Vohimana Mountains (25°S) for *M. parvula*. *Microgale drouhardi* has one of the largest elevational ranges known for the genus, from 360–2350m. The only other species with a similar elevational range is *M. talazaci* Major, 1896a which occurs from 100m (Raxworthy, unpublished) to about 2300m (Albignac, 1970). *Microgale drouhardi*, *M. talazaci* (and *M. cowani*, Goodman personal communication) appear to be the most montane *Microgale* known. The elevational range of *M. parvula* is also large, between 100–1550m altitude. None of these species of *Microgale* are specialists of a single elevational zone, having been collected from low, mid and even montane evergreen forest. *Microgale drouhardi* occurs

sympatrically in parts of its range with several other species similar in size and external morphology, notably *M. cowani* and *M. taiva*. Obvious ecological differences have yet to be determined between these species, except that *M. drouhardi* is known from higher elevations. The only *Microgale* species similar in size to *M. parvula* is *M. pusilla*, and based on MacPhee's (1987) distribution summary, they are broadly sympatric over much of the eastern rain forest belt (latitude 18°–21°S), although there is as yet no evidence of microsympatry.

The broad elevational and latitudinal distributions of these rain forest species of *Microgale* are surprising in as much as *M. parvula* was previously only known by the holotype and *M. fotsifotsy* was unknown. Conventional small mammal traps are inefficient at trapping the smaller shrew-sized mammals, which fail to trigger the trap mechanism. This may explain why *M. fotsifotsy*, and more particularly, the very small, light weight, *M. parvula* were previously unrecorded or rarely recorded. *Microgale drouhardi*, although more commonly collected, is only represented by small series in museum collections and, following the revision of MacPhee (1987) has been considered as a synonym of *M. cowani*. One of the main reasons for this situation is that most *Microgale* material was collected in the last century (see MacPhee, 1987), with modern specimens being rare in museums. The pitfall trapping method that we used in this study has proved to be extremely productive at sampling *Microgale* populations.

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