A case of the sympatric occurrence of *Microgale brevicaudata* and *M. grandidieri* (Afrosoricida, Tenrecidae) in the Beanka Forest, Maintirano

Steven M. Goodman[1,2], Haridas H. Zafindranoro[2,3] & Voahangy Soarimalala[2,3]

[1] Field Museum of Natural History, 1400 South Lake Shore Drive, Chicago, Illinois 60605, USA
E-mail: sgoodman@fieldmuseum.org

[2] Association Vahatra, BP 3972, Antananarivo 101, Madagascar
E-mail: vsoarimalala@vahatra.mg, sgoodman@vahatra.mg

[3] Département de Biologie Animale, Faculté des Sciences, Université d'Antananarivo, BP 906, Antananarivo 101, Madagascar
E-mail: zafrosina@yahoo.fr

Abstract

Recent systematic research on a poorly known species group of shrew-tenrecs (Family Tenrecidae), *Microgale brevicaudata*, has revealed that it is composed of at least two species, which resulted in the description of a new taxon, *M. grandidieri*. Recent field inventories in the dry deciduous Beanka Forest, to the east of Maintirano, have revealed the first case of syntopic occurrence of these two species. Details are also presented about ecological conditions in the Beanka Forest, specifically where these animals were captured within the zone of strict sympatry.

Résumé

Des études récentes sur la systématique d'un complexe d'espèces de petits mammifères mal connus (famille des Tenrecidae), *Microgale brevicaudata*, ont révélé qu'il était composé d'au moins deux espèces et ont aboutit à la description d'un nouveau taxon, *M. grandidieri*. Des inventaires récents réalisés dans la forêt sèche caducifoliée de Beanka, à l'Est de Maintirano, ont permis de découvrir pour la première fois ces deux espèces vivant en syntopie. Des détails sur les différentes conditions écologiques prévalant dans la forêt de Beanka où ces animaux ont été capturés sont également donnés, en particulier ceux existant dans la zone de stricte sympatrie.

Introduction

The island of Madagascar is home to the family Tenrecidae, which is composed of a diverse array of endemic genera, including the genus *Microgale*, also known as shrew-tenrecs, and currently comprising 23 species (Soarimalala & Goodman, 2011). When MacPhee (1987) conducted his revision of this genus based on a considerable portion of the world's museum holdings, the available material of *M. brevicaudata* was not sufficient to properly evaluate patterns of geographic variation. Over the subsequent decades, numerous small mammal inventories were conducted across the island, including sites in the western dry forest and south western dry spiny forest-thicket (sensu Moat & Smith, 2007), resulting in a considerable increase in the number of specimens referred to *M. brevicaudata* (Olson *et al*., 2009).

On the basis of these new collections, Olson *et al*. (2009) conducted a morphological and molecular genetic analysis of patterns of geographic variation in *M. brevicaudata* across its known range. They concluded that two species should be recognized: 1) the more robust *M. brevicaudata* occurring from lowland areas in the northeast, west to the Sambirano region, and south to at least the Bemaraha Plateau and 2) a new species to science, which was named *M. grandidieri*, found from the Namoroka Massif south to the Onilahy River. The genetic distance between these two species was pronounced and several morphological and cranio-dental characters allowed their clear differentiation. Based on the specimens available, Olson *et al*. (2009) noted a zone between the Bemaraha and Namoroka massifs where the two species overlap in distribution, but found no evidence of them occurring in strict sympatry. We recently conducted small mammal inventories in the Beanka Forest, to the east of Maintirano, where we found clear evidence of these two species in syntopy. The results of this work are presented herein, as well as the ecological settings where these animals were trapped.

Methods

Our study sites were in the Beanka Forest, which is a zone of *antsingy* dry deciduous forest resting on limestone. The field camp was at the edge of Ambinda village (approximately 18°01'S, 44°31'E), 70 km E of Maintirano and in close vicinity to the Maintirano-Tsiroanomandidy road, which passes through the southern portion of the Beanka Forest (see Goodman

Goodman, S. M., Zafindranoro, H. H. & Soarimalala, V. 2011. A case of the sympatric occurrence of *Microgale brevicaudata* and *M. grandidieri* (Afrosoricida, Tenrecidae) in the Beanka Forest, Maintirano. *Malagasy Nature*, 5: 104-108.

et al. [2011] for a locality map). Two sites in the Beanka Forest were surveyed with different habitat settings. The principal method we captured shrew-tenrecs was with pitfall lines.

Three different pitfall lines were installed per site, each line 100 m long, with 11 buckets with a capacity of 15 l, spaced 10 m apart, and dug into the earth until the rim was flush with the ground. A 80 cm high plastic drift fence was erected that passed directly across the center of each bucket and with approximately 10 cm of the drift fence buried into the ground to impede the passage of animals. At each site, we installed the lines in different ecological settings.

Details on the two sites and the different pitfall lines include:

Site 1: Madagascar: Province de Mahajanga, District de Maintirano, Région de Melaky, Forêt de Beanka, 1,1 km E d'Ambinda (village), 18°01'25''S, 44°30'08''E, 220 m. Dry deciduous forest, with a portion of the surveyed zone following the westerly exposed valley of the seasonal Kinahengo River, distinctly sandy soils, and another portion in *antsingy* forest habitat resting on exposed limestone. Canopy was notably open and with local signs in the forest of human exploitation, including removal of dead wood, tree cutting, and cattle grazing.

Pitfall 1 – on alluvium soils, running parallel to steam bed (dry in October and with some water in January), and bordered on one side by limestone outcrops. Forest was partially disturbed, and in close proximity to the line some rotten and fallen logs, some leaf litter, and the upper portion of the soil had little organic material.

Pitfall 2 – placed along slope in zone with numerous limestone outcrops and along seasonal stream. Forest showed few signs of disturbance, trees reaching 20 m in height, open understory, little leaf litter, and the upper portion of the soil had little organic material.

Pitfall 3 – placed along slope in zone with numerous limestone outcrops. Forest showed signs of disturbance, some tall trees, relatively open understory, and notably thick leaf litter.

Site 2: Madagascar: Province de Mahajanga, District de Maintirano, Région de Melaky, Forêt de Beanka, 4,9 km S d'Ambinda (village), 18°03'45''S, 44°31'31''E, 320 m. Dry deciduous forest largely placed on southern exposed slope of *antsingy* forest resting on limestone. Closed canopy forest with few signs of human activity with the exception of old lemur traps. Forest less exposed to direct sunlight than site 1 and approaching sub-humid.

Pitfall 4 – placed in a slight depression in a zone with numerous limestone outcrops. Forest showed no signs of disturbance, tall trees, relatively open understory, and notably thick leaf litter.

Pitfall 5 – placed within valley in a zone with numerous limestone outcrops. Forest showed no signs of disturbance, tall trees, relatively open understory, and notably thick leaf litter.

Pitfall 6 – placed on slightly raised crest in a zone with numerous limestone outcrops. Forest showed no signs of disturbance, tall trees, relatively open understory, and notably thick leaf litter.

Each site was surveyed twice, once during the end of the dry season (October) and again during the wet season (January) with pitfall lines 1-3 in operation from 18-23 October 2009 and 9-15 January 2010 and pitfall lines 4-6 from 25-31 October 2009 and 17-22 January 2010. We used six nights of trapping for each line (66 accrued pitfall nights) during each visit as the basis of standard comparison of capture results.

As members of the genus *Microgale* are largely insectivorous (Soarimalala & Goodman, 2003) and their distribution has been closely tied to soil type and terrestrial invertebrate density and diversity (Goodman *et al.*, 1996), we examine aspects of soil characteristics from trapping sites in the Beanka Forest to search for correlates to explain the distribution of local *Microgale* species. A single soil sample was collected in close proximity to each pitfall line at the end of the dry season survey. Each sample measured 10 x 10 x 10 cm and included soil litter, although large woody material was not collected. Each soil specimen was placed in a cotton bag and submitted for analysis to the soil laboratory of Ecole Supérieure des Sciences Agronomiques de l'Université d'Antananarivo.

Small mammal specimens and associated tissue samples were collected. The specimens are housed and catalogued at the Field Museum of Natural History (FMNH) or the Université d'Antananarivo, Département de Biologie Animale (UADBA). We used the external and cranio-dental characters outlined in Olson *et al*. (2009) to identify the specimens to either *M*. *brevicaudata* or *M*. *grandidieri.*

Results

During the course of the small mammal inventories in the Beanka Forest, 24 different specimens of *Microgale* were captured in the pitfall lines, representing four individuals of *M*. *brevicaudata* and 20 *M*. *grandidieri* (Table 1). No other member of this genus was obtained, although other locally occurring species of Tenrecidae include *Tenrec ecaudatus* and

Setifer setosus and those of the Soricidae include *Suncus etruscus* and *S. murinus*, both of which are introduced (see Omar *et al.,* 2011, for details on *S. etruscus*). At site 1, nine individuals were captured, all referable to *M. grandidieri*, of which seven were obtained during the dry season (October 2009) and two during the wet season (January 2010) visits. At Site 2, of the 15 *Microgale* trapped, four were referable to *M. brevicaudata* and 11 to *M. grandidieri*. At site 2 during the dry season (October 2009), we obtained one *M. brevicaudata* and 10 *M. grandidieri* and during the wet season (January 2010), three *M. brevicaudata* and one *M. grandidieri*.

Table 1. Results of *Microgale* spp. captured in six pitfall lines installed at two different sites in the Beanka Forest during two seasons. The comparisons are presented as the number of animals trapped during 66 accrued pitfall nights per line.

	M. brevicaudata	*M. grandidieri*
Site 1		
Trap success	0 %	4.5 %
Pitfall 1		
Dry season	0	4
Wet season	0	0
Pitfall 2		
Dry season	0	2
Wet season	0	1
Pitfall 3		
Dry season	0	1
Wet season	0	1
Total site 1		
Dry Season	0	7
Wet season	0	2
Site 2		
Trap success	2.0 %	5.6 %
Pitfall 4		
Dry season	1	2
Wet season	1	0
Pitfall 5		
Dry season	0	6
Wet season	0	0
Pitfall 6		
Dry season	0	2
Wet season	2	1
Total site 2		
Dry Season	1	10
Wet season	3	1

At Site 2, we captured both *M. grandidieri* and *M. brevicaudata* in two of the three pitfall lines. In pitfall line 4, an individual of *M. grandidieri* was trapped on 27 October 2009 in bucket 11 (UADBA 48798) and on 30 October 2009, an individual of *M. brevicaudata* was captured in bucket 10 (UADBA 48799). In a similar situation with pitfall 6, during the night of 17 January 2010, two *M. brevicaudata* were obtained, one in bucket 3 (FMNH 209211) and the other in bucket 10 (UADBA 48114), and one *M. grandidieri* in bucket 5 (UADBA 48115). Hence, these results demonstrated strict physical and temporal sympatry between these two species within the Beanka Forest. This is the first site these two species have been found living in syntopy.

Discussion

We found no evidence of *Microgale brevicaudata* at Site 1 and all of the nine individuals trapped with pitfall lines 1-3 were referable to *M. grandidieri*. In contrast, Site 2 yielded both species, including four *M. brevicaudata* and 11 *M. grandidieri*. The forest structure at Site 2 was distinctly less disturbed, with a more closed canopy, taller and larger trees, and distinctly less sandy soils than Site 1. Further, at Site 2, limestone outcrops were uniformly present in close vicinity to the pitfall lines, which was not necessarily the case for the three lines installed at Site 1.

Six different soil samples were collected in the Beanka Forest, each being associated with a different pitfall line, and the results are presented of the physical characteristics (Table 2) and chemical properties (Table 3). With regards to the physical characteristics of the samples obtained at Site 1 (pitfall lines 1 and 2), sand represented approximately 50% of each soil sample, as compared to Site 1 (pitfall line 3) and Site 2 (all three lines), where clay and loam were dominate (Table 2).

Table 2. Physical characteristics of the soil specimens collected next to the six pitfall lines at the two different sites in the Beanka Forest.

	% sand	% clay	% loam	Color	Vegetation
Site 1					
Pitfall 1	45.6	19.7	33.1	Chestnut	Dry forest with little disturbance
Pitfall 2	62.9	13.3	22.5	Dark chestnut	Dry forest with little disturbance
Pitfall 3	8.7	36.3	53.1	Blackish	Dry forest with little disturbance
Site 2					
Pitfall 4	8.8	32.9	56.2	Blackish	Undisturbed dry forest
Pitfall 5	11.2	33.0	54.3	Chestnut	Undisturbed dry forest
Pitfall 6	16.7	29.1	52.4	Red with black spots	Undisturbed dry forest

Notable differences between the six soil samples were found in certain chemical characteristics (Table

Table 3. Chemical characteristics of the soil samples collected next to six pitfall lines at the two different sites in the Beanka Forest. The parameters presented here are pH, percentage of carbon (C), percentage of nitrogen (N), carbon/nitrogen ratio (C/N), percentage of organic matter (OM), percentage of phosphorus (P_2O_5), percentage of potassium (K_2O), percentage of magnesium (MgO), percentage of calcium (CaO), and cation exchange capacity (CEC), me = milli-equivalents.

	pH	C%	N%	C/N	OM %	P_2O_5 ‰	K_2O me %	MgO me %	CaO me %	CEC me %
Site 1										
Pitfall 1	6.4	1.2	0.06	20.0	2.2	0.06	0.08	0.06	0.04	7.4
Pitfall 2	6.6	2.1	0.10	21.2	3.9	0.06	0.07	0.05	0.03	6.4
Pitfall 3	7.0	2.4	0.12	20.3	4.4	0.05	0.07	0.05	0.04	9.8
Site 2										
Pitfall 4	7.0	1.4	0.06	23.3	2.5	0.08	0.08	0.07	0.05	9.4
Pitfall 5	6.8	2.3	0.14	16.4	4.2	0.12	0.10	0.07	0.04	13.2
Pitfall 6	6.3	6.2	0.43	14.4	11.3	0.13	0.12	0.08	0.04	14.4

3). In comparing the two sites, levels of phosphorus were notably higher at Site 2, and to a slightly lesser extent potassium and magnesium, as compared to Site 1. Further, the carbon/nitrogen ratios of the samples from Site 2, with the exception of pitfall 4, show a greater tendency to have soil organic material more decomposed than Site 1. Numerous soil characteristic variables associated with the pitfall 6 sample, where two of the four individuals of *M*. *brevicaudata* were obtained, showed the highest levels of percentage of carbon, nitrogen, organic matter, phosphorus, potassium, and magnesium, as well as the greatest capacity of cation exchange, of any of the six soil samples. In contrast, pitfall line 4, which also resulted in the capture of the other two *M. brevicaudata*, had in general lower values for these different variables than pitfall 6 or for that matter all three lines at Site 1. The single exception is the percentage of phosphorus, which was higher at Site 2 than Site 1. Further research is needed on the relationships between the differences in physical and chemical found aspects amongst the six samples with the soil invertebrate fauna, which are presumably correlated with the density and species richness of insectivorous mammals.

The Beanka Forest holds a notably rich vertebrate fauna for a dry deciduous forest, including numerous regional endemics, such as a recently described bird species (Goodman *et al*., 2011). The local fauna includes organisms showing affinities to the other regional *antsingy* massifs of Namoroka to the north and Bemaraha to the south, which both have numerous microendemics. The Beanka Forest is the subject of a community development-conservation project under the management of Biodiversity Conservation Madagascar. Given its rich biota and relatively intact state, this forest block should be given high priority for conservation.

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