

AFRICAN SHREWS ENDEMIC TO THE ALBERTINE RIFT: TWO NEW SPECIES OF *MYOSOREX* (MAMMALIA: SORICIDAE) FROM BURUNDI AND THE DEMOCRATIC REPUBLIC OF CONGO

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ABSTRACT

The genus *Myosorex* has a classic relict distribution within sub-Saharan Africa. Montane populations in eastern and western equatorial Africa are separated by *ca.* 2900 km. Until this study, the closest known populations in southern Africa were separated by nearly 2000 km from the closest populations in the Albertine

Rift Valley. Here we document previously unknown populations of *Myosorex*, representing two new endemic taxa from montane forests adjacent to the Albertine Rift. In conjunction with additional data from Malawi, we fill in major gaps in our knowledge of the biodiversity and distribution of this genus in the areas of the Albertine and Malawi Rift Valleys. We demonstrate that this gap is an artefact of survey effort and collecting serendipity. The two new species described herein, as well as other species of *Myosorex* from north of the Zambezi River, exhibit limited distributions and are confined to montane habitats, typically above 1000 m. Our new species of *Myosorex* from Kahuzi-Biega NP (DRC) is the second known species of *Myosorex* from that park where it is syntopic with *Myosorex babaulti*. This is the first time that two species of *Myosorex* co-occur in any forest north of the Zambezi River. This suggests either sympatric speciation or a secondary re-invasion during times of climatic amelioration and forest expansion. The two species described here (*Myosorex jejei* and *Myosorex bururiensis*) are associated with two phenetically-defined species groups: the former with a more narrow hexagon-shaped skull, long-tail, and short claws ('narrow-headed group') and the latter with a more broad hexagon-shaped skull, short tail and long claws ('broad-headed group').

Keywords: African shrews; *Myosorex*; Albertine Rift; endemism; evolution; biogeography; Bururi Forest; Kahuzi-Biega National Park; conservation.

INTRODUCTION

The documentation and description of African shrews (Soricidae) has lagged behind the discovery and description of most other mammalian species because of the difficulty of their capture and their generally cryptic appearance. Between 1989 and 2009, only 10 species of shrews, but 45 species of rodents and 47 species of primates, were described as new for Africa (including Madagascar; Hoffmann *et al.*, 2009). A review of the distribution of collecting localities in sub Saharan Africa (Schlitter & Delany, 1985) indicated that there have been substantial gaps in the documentation of African mammals. This may lead to incorrect assumptions on species distributions. In this paper we fill in gaps in small mammal collecting localities along the Albertine Rift (figure 1). Combined with our recent report (Kerbis Peterhans *et al.*, 2008) our results suggest that disjunct distributions within the genus *Myosorex* (Gray, 1838) are an artefact of collecting effort, collecting techniques, collecting serendipity, and of course, disjunct montane distribution. Our results further confirm that north of the Zambezi, the genus *Myosorex* is confined to relictual montane forest habitats, suggesting that these forest-litter dependent species have limited dispersal abilities. Fortunately, morphological variation within the genus is notable, and, provided comparative materials are at hand, adequate characters are available for review and analysis.

The Albertine Rift ranges from the northern end of Lake Albert in the north to the southern tip of Lake Tanganyika (Plumptre *et al.*, 2007). This area is also known as

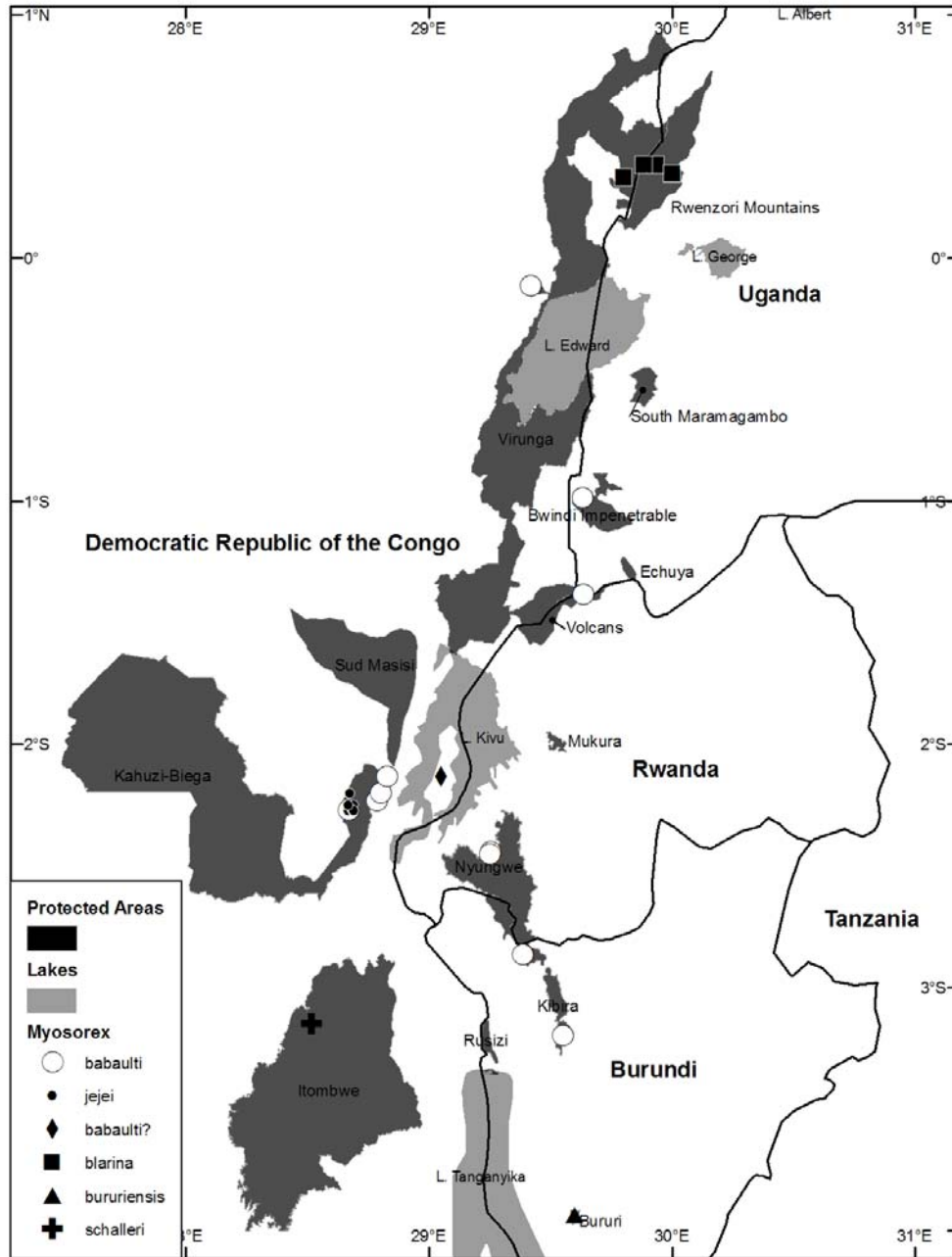


Figure 1. Map of the Albertine Rift region, with localities of various species of *Myosorex* as indicated.

the 'Great Lakes' region of Africa and it is a topographically distinctive feature of the continent. The Albertine Rift is part of a large tectonically active system that separates

the east-central part of the continent from the remainder. To the north, this system has already split off the Arabian Peninsula, creating the Red Sea. Tectonic activity has led to uplift on both sides of the lake-bearing rift depression. Climatic vicissitudes during the Pleistocene and elevational gradients have isolated the uplifted montane forests. Some of these highlands are assumed to have had intermittent connections in the past; current isolation has led to speciation within some of these montane archipelagos (reviewed in Kingdon, 1989). As a consequence, these highlands house Africa's richest endemic montane faunas of birds (Prigogine, 1985; Collar & Stuart, 1988), butterflies (Carcasson, 1964) and small mammals (Kityo *et al.*, 2003; unpublished data). In this paper we address specimens collected in disjunct forests on opposite sides of the Albertine Rift Valley: Kahuzi-Biega National Park, a World Heritage site in the eastern Democratic Republic of Congo and the tiny and virtually unknown Bururi Forest (16 km²) in southern Burundi.

MATERIAL AND METHODS

The species reported on here result from two inventory programs conducted by different teams and organizations between 1990 and 2007. Work in Bururi Forest (Burundi) was coordinated by the U.S. Peace Corps/USAID Biodiversity Program in conjunction with the Institut National pour l'Environnement et la Conservation de la Nature (INECN). Small mammal and bird surveys were conducted at three locations within the Bururi Forest Reserve, Burundi: Nyagatarugwa Valley (1785 m), 6–11 August 1992 by LD; Ruhinga Hill (2170 m), 9–15 March 1993 by JLU and LD; Mumushwizi Valley (1880 m), 17–25 August 1993 by JLU and LD. The survey of Muisi Swamp and environs was carried out by JCKP and the DR Congo's Centre de Recherche en Sciences Naturelles team based at Lwiro: JM, BN, Kayeye, Prince Kaleme, Baliwa, Masunga, Katamba and Jeje (Norbert) Balulu during 18–23 July 2005. The survey of an elevational gradient of Mount Kahuzi (DR Congo) was carried out by JCKP and CRSN (JM, BN, Linjanja) between 18–29 July 2007. The survey began in Mugaba Swamp, continued to the adjacent Cinya Swamp along Mugaba Gate, and proceeded up the slope, crossing the three summits of the mountain. Security issues prevented the field team from camping on the mountain, and resulted in lesser coverage of the higher elevations.

Surveys of Kahuzi-Biega National Park, Democratic Republic of Congo (DRC) were coordinated with the scientific staff at Lwiro, Centre de Recherche de Sciences Naturelles (CRSN); the ICCN (L'Institut Congolais pour la Conservation de la Nature) and the Field Museum of Natural History (Chicago). In both instances, terrestrial small mammals (mice and shrews) were collected using a variety of snap traps (Victor Rat and Museum Special), live traps (Shermans) and pitfall lines (PF, described in Voss & Emmons, 1996). The traps were baited with peanut butter and oatmeal and a variety of other foods, including fish and worms.

Measurements generally follow Dippenaar (1977) and are illustrated in Stanley *et al.* (2005a). External dimensions are represented by: total length (Tot), tail vertebrae (Tail), hind foot including claw (HF), fore claw (Fclaw), hind claw (Hclaw), length of

ear from notch (Ea), and weight (Wt). Length of Head and Body (HB) was obtained by subtracting Tail from Tot. Cranial and dental measurements and their abbreviations include: condylo-incisive length (CI), upper tooth row length (UTR), maxillary breadth (MB), greatest width of braincase (GW), height of cranial capsule (HCC), least interorbital width (IO), mandible from tip of incisor to articular condyle (MD), and lower tooth row length (LTR). We also add breadth across the post-glenoid processes (PGL) and the maximum height of the coronoid process of the mandibular ramus (COR). Fore and hind claw measurements were taken along the dorsal aspect of digit III.

Drawings of tooth and skull features were made with the aid of a camera lucida attached to a stereomicroscope. The nomenclature of cranial bones and teeth mainly follows Meester (1963), with the exception that upper unicuspid teeth following the first upper incisor are simply called U1 to U4 for convenience. Hutterer (2005b) discussed the homology and naming of these teeth in detail which probably represent incisors, a canine, and a premolar. *Myosorex* species with a more narrow-skull ($GW/CI < 0.5$), long-tail, and short claws are defined herein as the 'narrow-headed group'. The other group, with a more broad skull ($GW/CI > 0.5$), short tail and long claws is defined herein as the 'broad-headed group'.

With the exception of the type and only specimen of *Myosorex schalleri* (Heim de Balsac, 1966), only adult specimens were included in the analyses. Adulthood was determined on the basis of the fusion of the basioccipital-basisphenoid suture. Specimens examined, measured, or figured are listed in the appendix 1.

Acronyms for museum collections used in this report are: AMNH, American Museum of Natural History, New York; CMNH, Carnegie Museum of Natural History, Pittsburg; FMNH, Field Museum of Natural History, Chicago; JCK, collector number of Julian C Kerbis Peterhans, housed at FMNH; MNHN, Muséum National d'Histoire Naturelle, Paris; RMCA, Royal Museum for Central Africa, Tervuren; TBR, Tanzanian Belgian Rodent Program, University of Antwerp (specimens now transferred to RMCA); SMNS, Staatliches Museum für Naturkunde, Stuttgart; ZFMK, Zoologisches Forschungsmuseum Alexander Koenig, Bonn; and ZMUC, Zoological Museum and University, Copenhagen. MLWM refers to field numbers for uncatalogued Malawi mammals, Field Museum of Natural History.

RESULTS

The genus *Myosorex* is part of the subfamily Myosoricinae (Hutterer, 2005a), along with *Congosorex* (Heim de Balsac & Lamotte, 1956) and *Surdisorex* (Thomas, 1906). All species in this subfamily show the myosoricine crown pattern of the lower p4, in which the enamel surface of this tooth forms a reversed letter V (see figure 2), and all display a distinct interparietal bone (figure 3, as discussed by Heim de Balsac & Lamotte, 1956). The three genera were regarded as separate entities since Heim de Balsac (1967), and were redefined by Hutterer *et al.* (2001). The three species of *Surdisorex* (reviewed by Kerbis Peterhans *et al.*, 2009) are characterized by the absence of ear pinnae, long front claws, minute eye openings, three upper unicuspids, and the absence of lower p3. *Surdisorex* is

also characterized by the shape of the interparietal bone (figure 3), which is represented by a flattened triangle in all three species. *Congosorex* (reviewed by Stanley *et al.*, 2005a) has reduced ear pinnae, short front claws, minute eye openings, three upper unicuspid, and a variably occurring lower p3. The interparietal bone is wing-shaped (figure 3d) but closer to *Myosorex*. The latter genus has normal-sized ear pinnae, short to long front claws,

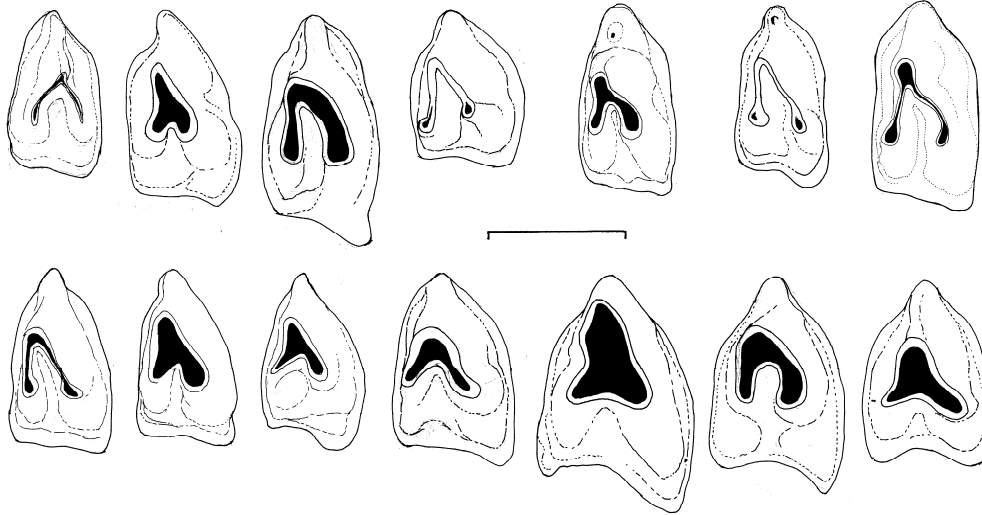


Figure 2. Comparison of the fourth lower premolar (p4) in species of the narrow-skulled group (top row) and the broad-skulled group (bottom row) of *Myosorex*. Top row from left to right: *M. schalleri* (MNHN 1981-1107, holotype), *M. varius* (ZFMK 82.135), *M. cafer* (ZFMK 2003.357), *M. gnoskei* (FMNH 191568, holotype), *M. eisentrauti* (ZFMK 69.373), *M. jejei* nov. sp. (FMNH 189098, holotype), *M. longicaudatus* (ZFMK 81.1293); bottom row from left to right: *M. zinki* (SMNS 4505, holotype), *M. cf. geata* (TBP 6268), *M. kahaulei* (ZMUC M 2134), *M. okuensis* (ZFMK 69.376, holotype), *M. bururiensis* nov. sp. (FMNH 155923, holotype), *M. rumpii* (ZFMK 69.375, holotype), *M. babaulti* (FMNH 160175). Scale bar is 1mm.

a larger eye opening, four upper unicuspid, and always a lower p3. The interparietal bone is rather variable in *Myosorex*, as rising species numbers seem to increase the morphological variability as well.

Although all forms of *Myosorex* are diagnosed by their hexagon-shaped skulls (*e.g.* Heim de Balsac & Meester, 1971) our reviews of *Myosorex*, including that of Kerbis Peterhans *et al.* (2008) and the two taxa described here, enable us to now place artificial groupings into two morphological types: a more narrow-skulled group (but still with a hexagon-shaped skull) represented by *M. schalleri*, *M. gnoskei* (Kerbis Peterhans, *et al.* 2008), and seven other species (table 1), and a more broad-skulled group (with a markedly hexagon-shaped skull), represented by *M. blarina* (Thomas, 1906), *M. babaulti* (Heim de Balsac & Lamotte, 1956) and a further six species. These latter members of the genus have a more pronounced hexagonal shape to the braincase as reflected in a wide braincase (GW) relative to the condylo-incisive length (CI). The two new species described below

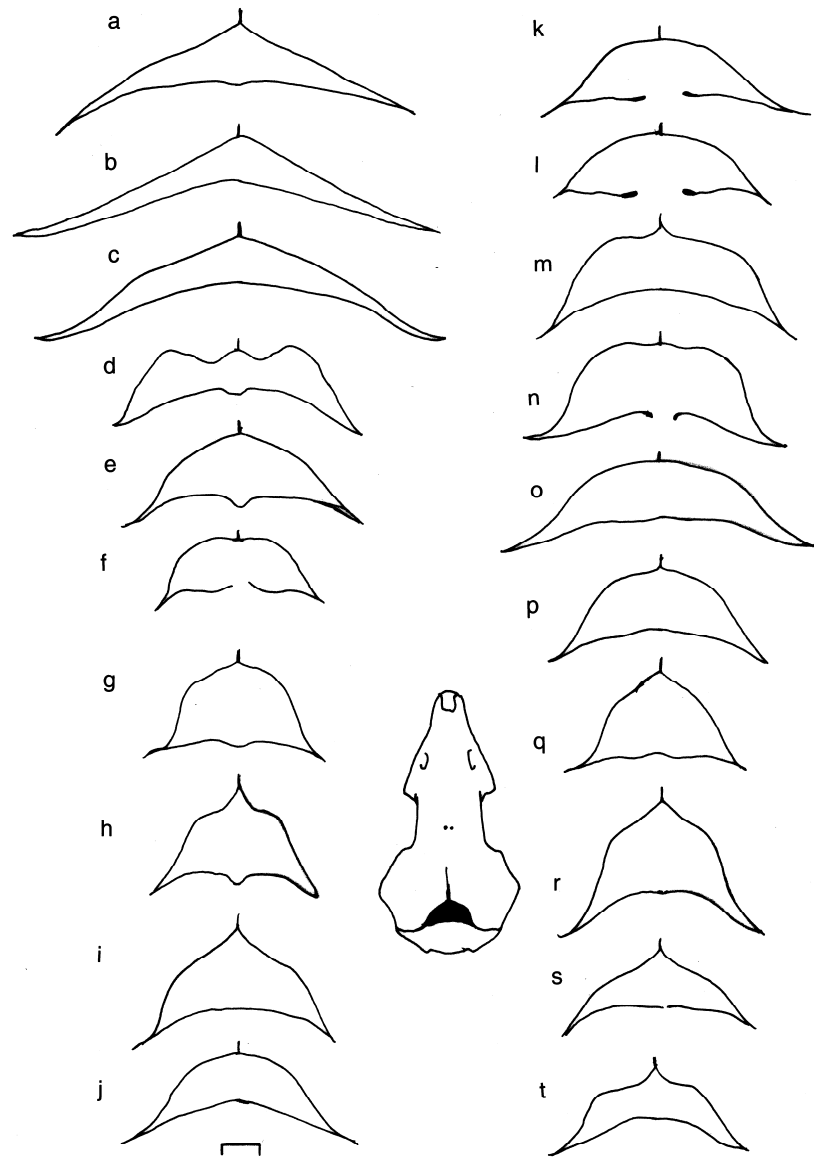


Figure 3. Comparison of interparietal bones of species of *Surdisorex* (a-c), *Congosorex* (d-f), and *Myosorex* (g-t): a, *Surdisorex norae* (FMNH 190262); b, *S. polulus* (FMNH 43846); c, *S. schlitteri* (FMNH 195069, holotype); d, *Congosorex phillipsorum* (FMNH 177682); e, *C. polli* (MRAC 23.234, holotype); f, *C. verheyeni* (ZFMK 99.932, holotype); g, *Myosorex varius* (ZFMK 82.135); h, *M. cafer* (ZFMK 2009.336); i, *M. longicaudatus* (ZFMK 81.1293); j, *M. eisentrauti* (ZFMK 69.374); k, *M. gnoskei* (FMNH 191568, holotype); l, *M. jejei* nov. sp. (FMNH 189276); m, *M. babaulti* (ZFMK 68.545); n, *M. bururiensis* sp.nov. (FMNH 155923, holotype); o, *M. rumpii* (ZFMK 69.375, holotype); p, *M. okuensis* (ZFMK 69.388); q, *M. cf. geata* (TBP 2305); r, *M. kishaulei* (FMNH 10984); s, *M. tenuis* (CMNH 69654); t, *M. zinki* (FMNH 174120). Inset skull shows the position of the interparietal bone. Scale bar is 1mm.

are representative of each group. The division between these groups, however, is arbitrary and is here defined as a ratio of greatest width of braincase to condylo-incisor length (GW/CI) of 0.5 or greater for the broad-skulled group (table 1). This subdivision is also partly reflected by other cranio-dental features, such as the shape (long and narrow versus short and broad) of the lower p4 (figure 2).

Based on holotypes, data on tail length (Tail) relative to head and body length (HB) were compiled by Hutterer *et al.* (2001). Tail length ranges from 41.7%–83.8% of HB within the genus *Myosorex*. This range also includes values for recently described taxa of *Myosorex*: *M. kishaulei* (Stanley & Hutterer, 2000: 52.4%, 8 M; 54.3% 2 F), *M. gnoskei* (60%, n=13, table 2) as well as one described below as *M. jeje* (66.5%, n=11, table 2). However, the second species described herein (*M. bururiensis*, 29.5%) is the only species of *Myosorex* to possess a tail to body ratio (*ca.* 30%, n=1) that falls within the range of the other highly fossorial endemic African sorcid genera (*Congosorex* and *Surdisorex*). These include *Congosorex verheyeni* (Hutterer, *et al.* 2002) at 30.2%, *Congosorex polli* (Heim de Balsac & Lamote, 1956) at 40% (based on holotypes, Stanley, *et al.* 2005a), *Surdisorex norae* (Thomas, 1906) at 27.6% (n=19) and *Surdisorex polulus* (Hollister, 1916), 30.1% (n=11, Kerbis Peterhans *et al.*, 2009). The recent description of the relatively long-tailed *Congosorex phillipsorum* (Stanley *et al.* 2005a, holotype=57.9 %) has further eliminated 'relative tail length' as a character useful in distinguishing *Myosorex* from *Congosorex*.

Table 1 Phenetic separation of the species of *Myosorex* species into more narrow-headed and more broad-headed groups, based on length-width relations of the skull. Note that the new records of *M. gnoskei* have formalin-erosion damage to the first upper incisor; therefore, only the measurements of the type specimen are presented for the affected measurements. Mean values provided; sample size as indicated in column N.

more narrow-headed taxa	N	CI	GW	GW/CI	MB	MB/GW	MB/CI	Source
<i>schalleri</i> *	1	18.9	8.3	.439	5.3	.638	.280	MNH 1981-1107
<i>varius</i>	13–22	22.7	10.8	.476	7.0	.648	.308	Meester & Dippenaar, 1978
(Pt St. Johns)								
<i>cafer</i>	22–42	23.3	11.1	.476	7.0	.631	.300	Meester & Dippenaar, 1978
<i>gnoskei</i>	5	20.47*	10.36	.484*	6.11	.589	.297*	This study, table 3
<i>tenuis</i>	2–3	21.57	10.43	.484	6.15	.590	.285	Roberts, 1951
<i>eisentrauti</i>	5	23.4	11.34	.485	6.34	.559	.271	Heim de Balsac, 1968
<i>sclateri</i>	2–3	25.17	12.27	.487	7.75	.632	.308	Roberts, 1951
<i>longicaudatus</i>	25	22.7	11.25	.496	6.65	.591	.293	Meester & Dippenaar, 1978
<i>jejei</i> nov. sp.	6	20.1	10.02	.498	5.89	.588	.293	This study, table 3
more broad-headed taxa								
<i>zinki</i>	11	22.8	11.5	.504	6.5	.566	.285	Stanley <i>et al.</i> , 2005b
<i>geata</i>	6	20.89	10.54	.505	6.44	.611	.308	Stanley & Hutterer, 2000
<i>kishaulei</i>	10	20.26	10.40	.513	6.38	.613	.315	Stanley & Hutterer, 2000
<i>okuensis</i>	10	22.45	11.93	.531	6.72	.563	.299	ZFMK specimens
<i>bururiensis</i> *	1	22.5	11.96	.532	7.55	.631	.336	This study, table 3
nov. sp.								
<i>blarina</i>	4–7	21.99	11.73	.534	7.24	.617	.329	FMNH specimens
<i>rumpii</i>	1	23.3	12.6	.541	7.4	.587	.318	ZFMK specimen
<i>babaulti</i>	11	21.84	12.01	.550	7.34	.611	.336	FMNH specimens

* holotype only

SPECIES DESCRIPTIONS**Bururi forest shrew *Myosorex bururiensis* Kerbis Peterhans & Hutterer, nov. sp.****Holotype**

FMNH 155923, old male with teeth in heavy wear. Alcoholic carcass with skull removed (figure 4). Collected 22 August 1993 in a pitfall trap (PF 2, bucket) by Jay L. Udelhoven; original number JLU 193.

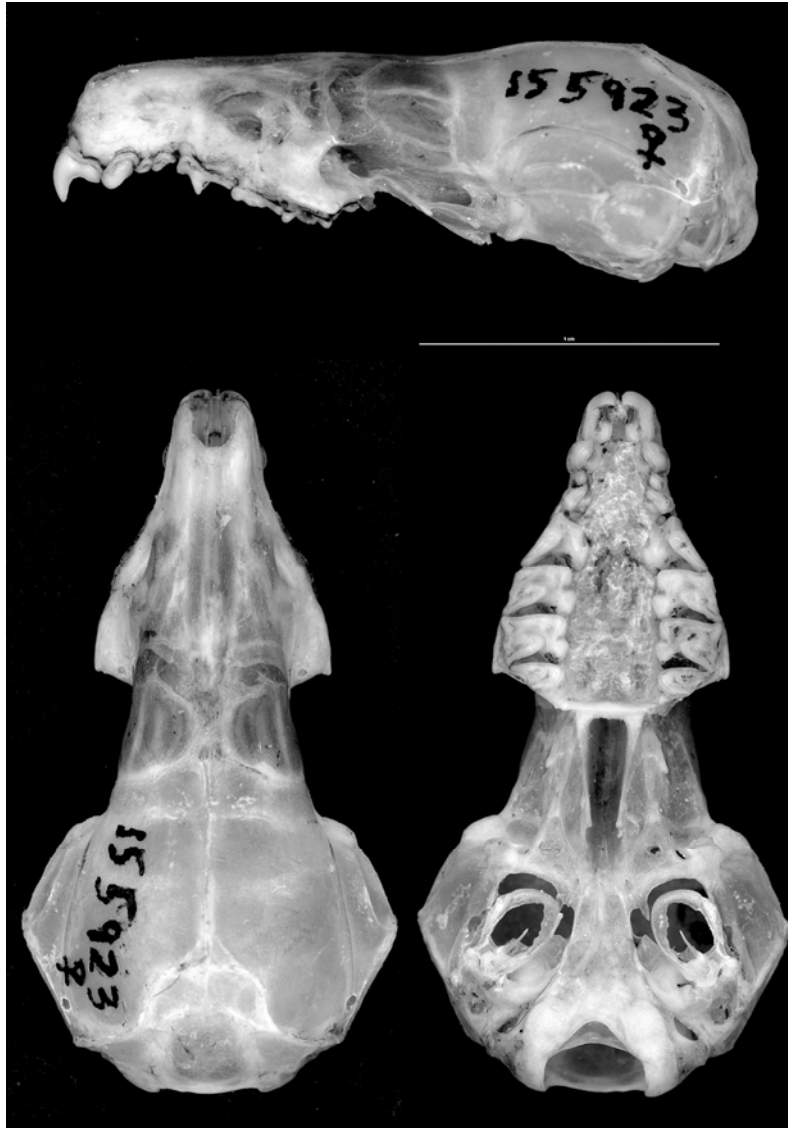


Figure 4. Clockwise from top: lateral, ventral and dorsal aspects of the cranium of *Myosorex bururiensis* nov. sp. (FMNH 155923, holotype). Scale bar is 1cm.

Table 2. External measurements (mm, Wt in g) of some species of *Myosorex* considered in this paper. Note the additional records and measurements of *M. gnoskei* collected on the Nyika Plateau, Malawi. Notable differences in the new metrics for *M. gnoskei*, when compared with the single type specimen, are highlighted in bold.

Voucher	Species	Tot	HB	Tail	HF	Ea	Wt	Tail/HB	Fclaw	Hclaw
MNHN 1981.1107	<i>schalleri</i>	-	52.5	44	12	-	-	83.8%	-	-
FMNH 191568 (type)	<i>gnoskei</i>	114	75	39	13.5	8.5	8	52%	2.4	1.9
FMNH, mean, n=13	<i>gnoskei</i>	112	70	42	13.7	8.4	12	60%		
FMNH range, n=13	<i>gnoskei</i>	100-128	60-86	35-47	12-14	7-10	9-13.5	48-75%		
FMNH 189098 (type)	<i>jejei</i>	115	72	43	11	6	7.3	60%	2.0	1.9
FMNH 189276	<i>jejei</i>	112	70	42	13	8	7.6	60%	2.1	1.6
JCK 5307	<i>jejei</i>	117	74	43	13	9	7.8	58%	1.7	1.6
JCK 5308	<i>jejei</i>	117	75	42	12	8	6.3	56%	2.0	1.8
JCK 5335	<i>jejei</i>	105	59	46	13	7	7	78%	2.0	1.7
JCK 5347	<i>jejei</i>	102	53	49	12	10	6	92%	2.0	2.0
JCK 5351	<i>jejei</i>	110	65	45	14	7	7	69%	2.3	2.0
JCK 5353	<i>jejei</i>	108	63	45	11	10	7.4	71%	2.2	1.7
JCK 5393	<i>jejei</i>	120	78	42	12.5	8	7.7	54%	2.1	1.8
JCK 5415	<i>jejei</i>	121	76	45	13	9	8.5	59%	2.2	1.9
JCK 5425	<i>jejei</i>	103	59	44	11	7	7	75%	2.1	1.9
FMNH, mean, n=11	<i>jejei</i>	111.8	67.6	44.2	12.3	8.1	7.2	67%	2.1	1.8
FMNH, range, n=11	<i>jejei</i>	102-121	53-78	42-49	11-14	6-10	6.0-8.5	56%-92%	1.7-2.3	1.6-2.0
JCK 5346	<i>babaulti</i>	125	82	43	14	6	14	52%	3.3	2.5
JCK 5350	<i>babaulti</i>	115	75	40	14	6	12	53%	3.2	2.3
JCK 5354	<i>babaulti</i>	115	80	35	15	8	13	44%	3.0	2.5
FMNH 155923 (type)	<i>bururiensis</i>	114	88	26	15	5	14	29.5%	3.15*	2.8

Type locality and distribution

Known only by the type specimen, preserved in alcohol with skull removed, from the Mumushwizi River Valley (3°56'20"S, 29°35'49"E) at 1880 m, Bururi Forest Reserve, Bururi Province, Burundi.

Etymology

The specific epithet honours the miniscule forest (Bururi Forest Reserve, 16 km²; Vedder *et al.*, 1992) from which it originates. This greatly threatened forest island, in the heart of one of Africa's most densely populated regions, contains an endemic biotic community that we hereby recognize and call attention to.

Diagnosis

M. bururiensis is a large member of the broad-skulled group of the genus (tables 1–3) and distinguished from other members both externally (table 2) and cranio-dentally (table 3). Pelage bicoloured above and below with slate grey bases and coppery tips. Tail unicoloured, very short (29.5% HB), thick, and light in colour. Skull large and robust, with a broad braincase and a wide maxillary region. Upper U1 to U3 very large, with strongly developed lingual crests (figure 5c). U3 at least ½ the size of U1. Upper M3 long and wide. Lower p2 not visible. Lower premolars very broad and heavy. Mandibular ramus very deep; coronoid process very high.

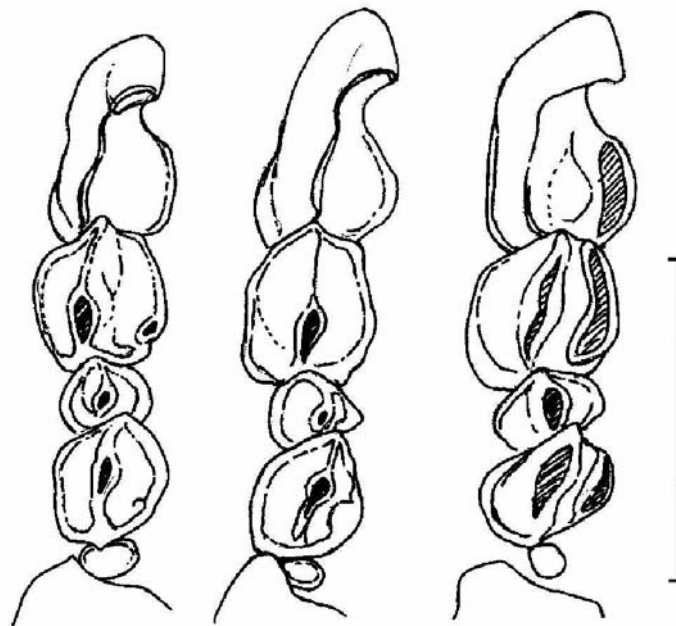


Figure 5. Sketches of the upper anterior dentition (I1 – U4) in occlusal view of *Myosorex babaulti* (ZFMK 68.545), *M. rumpii* (ZFMK 69.375, holotype), and *M. bururiensis* nov. sp. (FMNH 155923, holotype). Scale bar is 1mm.

Table 3. Cranio-dental measurements of select specimens of *Myosorex* discussed in this paper.

Voucher	Species	CI	UTR	MB	GW	HCC	PGL	IO	MD	LTR	COR
MNH 1981.1107	<i>schalleri</i> type	18.9	8.4	5.4	8.3	5.9	-	4.4	-	7.9	4.2
FMNH 191568	<i>gnoskei</i> , type	20.47	8.58	6.08	9.91	6.1	6.65	4.19	12.52	7.76	5.15
	<i>gnoskei</i> , range (n=5)	NA	NA	5.98-6.40	9.95-10.65	5.73-6.13	6.53-6.92	4.02-4.6	NA	NA	4.97-5.58
	<i>gnoskei</i> , mean (n=5)	NA	NA	6.11	10.36	5.95	6.73	4.27	NA	NA	5.17
FMNH 189098	<i>jejei</i> , type	20.1	8.7	5.75	10.2	5.7	6.95	4.2	12.6	8.0	4.6
FMNH 189276	<i>jejei</i>	20.1	8.85	5.98	9.92	6.0	6.57	4.28	12.76	8.07	4.49
JCK 5307	<i>jejei</i>	20.2	8.75	5.93	10.05	5.48	6.55	4.35	12.8	8.07	4.49
JCK 5308	<i>jejei</i>	19.68	8.54	5.75	9.77	5.6	6.73	4.15	12.47	7.73	4.41
JCK 5393	<i>jejei</i>	20.08	8.58	5.93	10.28	5.55	6.77	4.33	12.66	7.85	4.47
JCK 5415	<i>jejei</i>	20.54	8.79	6.0	9.9	5.83	6.76	4.21	12.95	8.0	4.59
	<i>jejei</i> range (n=5)	19.68-20.54	8.54-8.85	5.75-6.0	9.9-10.28	5.48-6.0	6.55-6.95	4.15-4.33	12.47-12.95	7.73-8.07	4.41-4.6
FMNH 155923	<i>jejei</i> mean n=5	20.1	8.7	5.89	10.02	5.69	6.72	4.25	12.70	7.95	4.51
	<i>bururiensis</i> , type	22.5	9.92	7.55	11.96	6.34	7.65	5.03	14.59	8.88	6.21

Description

The single known specimen preserved in alcohol displays very thick and woolly fur, and is bicoloured above and below. Mid-dorsal pelage length 7.2 mm: basal 5.0 mm dark slate grey, apical 2.2 mm copper-tipped. Blondish hairs throughout tail, pes and manus, but perhaps due to age. Tail light above and below; hairs light brown. Fore paws lighter in colour and with lighter brown coloured hairs than the dark brown hairs of pes. Fore claws (digit III) 3.15 mm in length, hind claw (digit III) 2.8 mm in length; both heavily worn. Tail very short (Tail 26 mm, HB 88 mm = 29.5%), thick, unicolored light brown above and below, and without elongate bristle hairs.

Body large (14 g) and skull very large (CI 22.5 mm). Maxilla particularly broad (7.55 mm), fitting well within the broad-headed group of *Myosorex*. Interparietal bone large and bell-shaped (Figures 3n, 4). Upper U4 very small and medially displaced from the UTR (figures 4, 5). Slight gap in upper tooth row in lateral view between U4 and upper P4 (Figure 4, 5c). Upper P4 moderately built without expansive posterior concavity. Lower incisor with one major denticulation. Lower 2nd premolar not visible in either view but may be tucked within. Mandibular ramus massive in its dorso-ventral depth. Lower premolars large and heavy (figure 2).

Comparisons

With its large size and broad braincase and maxilla, *M. bururiensis* needs comparison with the broad-headed subdivision of *Myosorex* with a condylo-incisive length of over 21.5 mm (table 1): *M. babaulti* (Heim de Balsac & Lamotte, 1956), *M. blarina* (Thomas 1906), *M. okuensis* (Heim de Balsac, 1968), *M. rumpii* (Heim de Balsac, 1968) and *M. zinki* (Heim de Balsac & Lamotte, 1956). Its short relative tail length of ca. 30% of HB distinguishes it from all other species, the closest of which seems to be *M. rumpii* (42%; Hutterer *et al.*, 2001). The upper dentition of *M. bururiensis* is heavier than that of *M. rumpii* and *M. babaulti* (figure 5) The heavier dentition of *M. bururiensis* is reflected in its broader upper (figure 2, 5c) and lower unicuspid, especially the width of U1, U3 (0.95 mm), and p4. Further, the mandible of *M. bururiensis* is very deep as indicated by the high value of COR (6.2 mm, the highest for any *Myosorex*).

The exceptionally broad maxilla of *M. bururiensis* (MB 7.55 mm) distinguishes it from the geographically distant West African forms *M. okuensis* and *M. rumpii*, as well as from *M. zinki* from Mount Kilimanjaro. Despite a broader maxilla, *M. bururiensis* has a much shorter skull and narrower braincase compared with *M. rumpii*. From *M. blarina* and *M. babaulti* it can be distinguished by its shorter tail, the displaced upper P4 (*M. babaulti*) and a much heavier dentition and mandible.

Ecological remarks and associated flora and fauna

Habitat consisted of upland primary forest with dense stands of *Entandrophragma* C.DC. sp., *Parinari* Aubl. sp., *Symphonia* L.f. sp. and many climbers. The site was located in the Mumushwizi Valley, adjacent to the Mumushwizi Stream at an elevation of 1880 m. Mumushwizi Valley is a west-facing valley located on the west side of the Ruhinga Ridge.

Also documented in Bururi Forest were fresh nests and frequent calls of chimpanzees (*Pan troglodytes schweinfurthii* Giglioli, 1872). Blue monkeys (*Cercopithecus mitis* Wolf, 1822) were evident. Bururi Forest Reserve is host to other

extremely rare small mammals as listed in table 4. For example, the semi-aquatic shrew (*Ruwenzorisorex suncooides*) has been previously documented by less than 10 specimens. *Praomys degraaffi* (van der Straeten & Kerbis Peterhans, 1999) replaces *Praomys jacksoni* at higher elevations (table 4) as anticipated in van der Straeten & Kerbis Peterhans (1999).

Kahuzi swamp shrew *Myosorex jejei* Kerbis Peterhans & Hutterer, nov. sp.

Holotype

FMNH 189098 (field no. PB 631), adult female, fluid specimen with skull removed (figure 6). No teats visible. Collected in a Museum Special snap trap by Jeje Bululu (Papa Jeje) and Prince Kaleme on 22 July 2005.

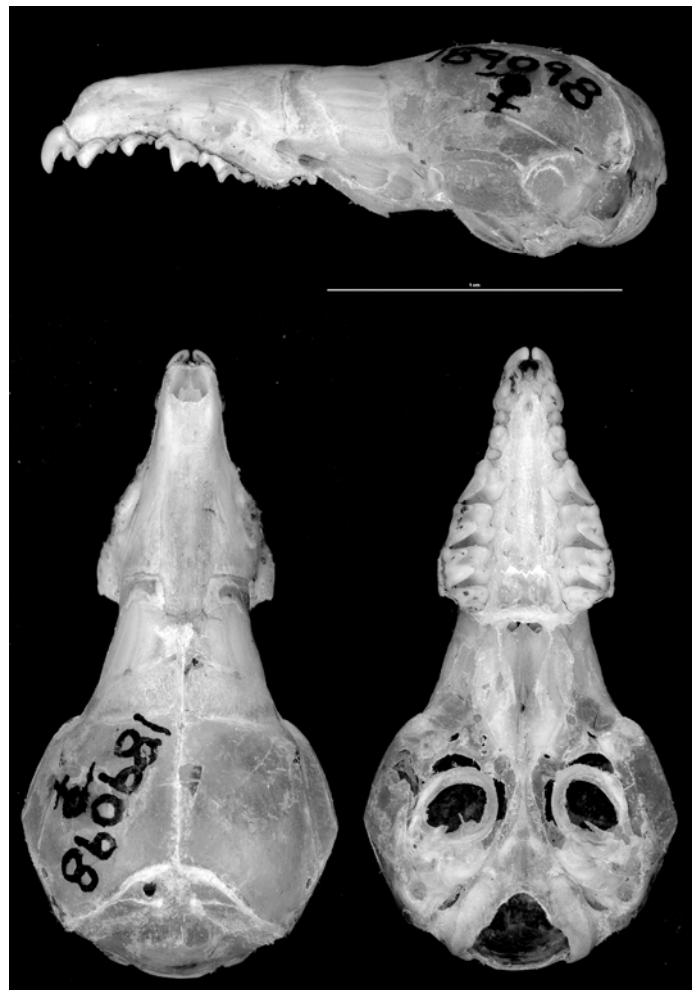


Figure 6. Clockwise from top: lateral, ventral and dorsal aspects of the cranium of *Myosorex jejei* nov. sp. (FMNH 189098, holotype). Scale bar is 1cm.

Table 4. Small mammal fauna documented from three sites within the Bururi Forest Reserve, Burundi by the United States Peace Corps Biodiversity Program (1992–1993). Albertine Rift endemics in bold.

Specific Locality	Nyagatarugwa Valley	Mumushwizi Valley	Ruhinga Ridge	Total
Elevation	1785 m	1880 m	2170 m	
<i>Chrysochloris c.f. stuhlmanni</i> (Matschie, 1894)	1			1
<i>Crocidura niobe</i> (Thomas, 1906)			1	1
<i>Crocidura olivieri</i> (Lesson, 1827)	1			1
<i>Myosorex bururiensis</i> (nov. sp.)		1		1
<i>Ruwenzorisorex suncooides</i> (Osgood, 1936)	1	1		2
<i>Suncus megalura</i> (Jentink, 1888)	1		7	8
<i>Suncus c.f. hututsi</i> (Kerbis Peterhans <i>et al.</i> 2009)			1	1
<i>Sylvisorex lunaris ruandae</i> (Lönnerberg & Gyldenstolpe, 1922)	3	2		5
<i>Sylvisorex vulcanorum</i> (Hutterer & Verheyen, 1985)	2	3	3	8
<i>Epomophorus labiatus</i> (Temminck, 1837)			1	1
<i>Epomophorus wahlbergi</i> (Sundevall, 1846)		1		1
<i>Lissonycteris angolensis</i> (Bocage, 1898)	8	4	22	34
<i>Rousettus aegyptiacus</i> (Geoffroy, 1810)	1			1
<i>Rousettus lanosus</i> (Thomas, 1906)			3	3
<i>Rhinolophus clivosus zuluensis</i> (Andersen, 1904)	1			1
<i>Hipposideros ruber</i> (Noack, 1893)		1		1
<i>Nycteris arge</i> (Thomas, 1903)			1	1
<i>Graphiurus</i> (Smuts, 1832) <i>sp.</i>	1	6		7
<i>Dendromus insignis</i> (Thomas, 1903)			1	1
<i>Lophuromys aquilus</i> (True, 1892)			14	14
<i>Lophuromys rahmi</i> (Verheyen, 1964)		1		1
<i>Lophuromys woosnami</i> (Thomas, 1906)	15	5	11	31
<i>Colomys goslingi</i> (Thomas & Wroughton, 1907)	2	2		4
<i>Grammomys c.f. dryas</i> (Thomas, 1907)		1	2	3
<i>Hylomyscus vulcanorum</i> (Lönnerberg & Gyldenstolpe, 1925)	1	11	2	14
<i>Mus bufo</i> (Thomas, 1906)			3	3
<i>Oenomys hypoxanthus</i> (Pucheran, 1855)	1			1
<i>Praomys degraaffi</i> (van der Straeten & Kerbis Peterhans, 1999)		38	29	67
<i>Praomys jacksoni</i> (De Winton, 1897)	15	4	6	25
<i>Praomy</i> (Thomas, 1915) <i>sp. indet.</i>		1	1	2
<i>Tachyoryctes c.f. ankoliae</i> (Thomas, 1909)			1	1
TOTAL	54	82	109	245
Captures/trap nights	na	na	60/1262	
Trap success (%)			4.8%	
Captures/ Bucket nights	na	na	18/720	
Trap success (%)			2.5%	

Type locality and distribution

The holotype is from Musisi Swamp (2°16'24"S, 28°41'27"E, 2200 m), Mugaba Sector, Kahuzi Biega National Park, North Kivu Province, Democratic Republic of Congo.

Paratype

FMNH 189276 (field no. PB 615), adult female, skin, skull and skeleton. Collected in a pitfall trap in Musisi Swamp by the Project Beatra Mammal team, specifically Jacques Mwanga and Kayeye, on 21 July 2005.

Referred specimens

JCK field numbers: 5307, 5308, 5335, 5347, 5351, 5353, 5393, 5415, 5425. All referred specimens are known only from the immediate vicinity of Mount Kahuzi, Mugaba Sector, Kahuzi-Biega National Park, including the summit, forested slopes and swamps below. These collecting localities also include Mugaba Swamp (2°16'16.1"S, 28°39'58.4"E, 2277 m), a forested gradient above Mugaba Swamp (02°12'7"S; 28°40'24.4"E, 2560 m), and even on the summit of Mount Kahuzi (2°14'59.9" S, 28°41'19.6"E, 3308 m).

Etymology

The specific epithet honors Mr. Jeje (Norbert) Songo Bululu, affectionately known as 'Papa Jeje' (figure 7), recognizing his over half century long contributions to the small mammal work in the Kivu area of eastern DR Congo. While enduring the political and socio-economic upheaval in the region, he has carried on bringing great knowledge, warmth and enthusiasm to all of those that surround him. He remains an inspiration as he enters his ninth decade (born Uvira, 1928). He collected the type specimen at the age of 78.



Figure 7. Jeje (Norbert) Songo Bululu, known as 'Papa Jeje', in Bukavu in 2006.

Diagnosis

Pelage modestly bicoloured, grey with brown tips. Size very small for a member of the genus (mean CI=20.1 mm, mean Wt. 7.2 g; tables 1–3). Tail moderately long (mean = 66.5% of HB, range = 54–92%) and unicoloured. Braincase very narrow, maxilla exceptionally so, rostrum slender (figure 6). Fourth upper unicuspid tooth (U4) placed

within tooth row, separating U3 from P4; visible in lateral view. Upper third unicuspid (U3) half size of upper first unicuspid (U1). Upper M3 of moderate size. Lower p2 relatively large and visible in medial view.

Description

Pelage only slightly bicoloured with dark greyish appearance. Pelage length 6.6 mm on dorsum. Basal 5.3 mm of individual hairs dark slate grey, apical 1.3 mm brown. Tail moderately long (avg. 66.5% HB) unicoloured, thin, and void of long bristle hairs. Claws very short; fore claws average 2.1 mm, hind claws average 1.8 mm (table 2).

A *Myosorex* of very small body size; skull small and slender (CI 19.6–20.6 mm). Braincase (GW 9.7–10.3 mm) and maxilla (MB 5.7–6.0 mm) very narrow. U4 somewhat variable in size, 2/3 size of U2 in FMNH 189098, 1/5 size of the U2 in FMNH 189276. Third unicuspid (U3) 3/4 the size of U1. U4 conspicuous in lateral view and easily separating the upper P4 from the U3. Upper P4 lightly built with expansive posterior concavity between metastyle and talonid, and with a well developed cingulum (figure 8). Upper M3 well developed. Two denticulations on lower incisor. Lower p2 relatively large and visible in medial view. Mandibular ramus vertically extremely thin, concave ventral profile below last premolar/first molar. Ascending ramus of mandible terminates orthogonal to axis of mandible. Condyle similar to *M. gnoskei* but smaller (figure 8).

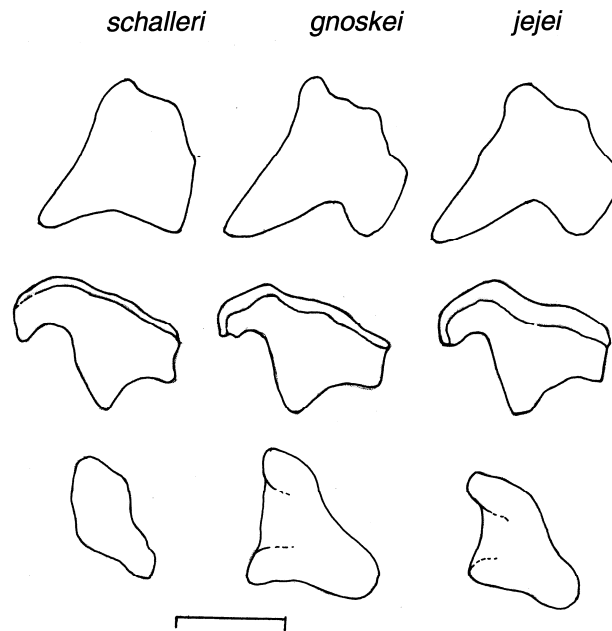


Figure 8. Occlusal view of right upper P4 (top row), lateral view of left upper P4 (middle row), and outline of mandibular condyle (bottom row) of *Myosorex schalleri* (left, MNHN 1981-1107, holotype), *M. gnoskei* (center, FMNH 191568, holotype), and of *Myosorex jejei* nov. sp. (right, FMNH 189276, holotype). Scale bar is 1mm. Mandibular condyle shown in posterior view.

Comparisons

Our analyses of Afrotropical *Myosorex* place this new species within the 'narrow-headed' group (GB/CI<0.50; table 1). Since it is one of the broader-headed members of this group (at 0.496), we also compare it with *M. zinki* and *M. geata* of the broad-headed group. *M. zinki* is much larger in all cranio-dental dimensions (mean CI>22.8) and is only known from Mount Kilimanjaro. *M. geata* is only known from the Uluguru Mountains of Tanzania and is easily distinguished by its larger size in all cranio-dental measurements (table 1) and mottled pelage; each hair on the dorsal surface displays a yellowish band sandwiched around bands of dark grey or black. The narrow-headed taxa found north of the Zambezi River are *M. eisentrauti*, *M. gnoskei*, and *M. schalleri*. *M. eisentrauti* is much larger (CI=23.4 mm) and is only known from the Atlantic island of Bioko (Equatorial Guinea). The maxilla (mean=5.89 mm) of *M. jejei* is exceptionally narrow for a member of the genus, surpassed only by the juvenile and only known specimen of *M. schalleri* (table 1, table 3). *Myosorex schalleri* is notably smaller in all dimensions compared to all other *Myosorex*. The skull of *M. schalleri* is exceptionally narrow (GW/CI=0.439, table 1). The tail is proportionately much longer (83.8% of HB) than any member of the genus. Note also that the size and shape of the upper P4 and lower p4 are different between *M. schalleri*, *M. gnoskei*, and *M. jejei* (figures 2 & 8). The condyle of *M. schalleri* is very small although this may be due to its young age.

The east and central African taxon with which it needs to be most closely compared is *M. gnoskei* (Kerbis Peterhans *et al.*, 2008). *M. jejei* has a dark grey, slightly bicoloured pelage vs the mottled brown tricoloured pelage of *M. gnoskei*. The Tail/HB ratio is higher for *M. jejei* (67%) than for *M. gnoskei* (60%, table 2). *M. jejei* has a relatively longer tail than *M. gnoskei* (66.54 % vs. 60.0 %). *M. jejei* is notably smaller in most cranio-mandibular dimensions than *M. gnoskei*. For example, *M. jejei* has narrower maxillary breadth, greatest width, height of the cranial capsule and an especially lower coronoid height (*M. jejei* averages 4.51 vs. 5.17 for *M. gnoskei*). *M. jejei* has smaller unicuspid (especially U3 and U4) and a smaller upper M3 than *M. gnoskei*. Unlike *M. gnoskei*, *M. jejei* does not have a convex profile, in lateral view, of the undersurface of the mandible (especially beneath last mandibular premolar).

Ecological remarks and associated flora and fauna

Musisi Swamp, surveyed in 2005, is comprised of *Cyperus latifolius* Poir. with abundant *Syzygium rowlandii* Sprague and *Hypericum revolutum* Vahl. The swamp is surrounded by montane forest dominated by *Symphonia globulifera* L.f., *Carapa grandiflora* Sprague, *Ficalhoa laurifolia* Hiern and *Chrysophyllum gorungosanum* Engl. This montane forest is then separated from the bamboo *Arundinaria alpina* K.Schum. forest by secondary forest dominated by *Macaranga kilimandscharica* Pax. Musisi Swamp was previously surveyed and described by Dieterlen and Heim de Balsac (1979). The soricid community they described included *Crocidura stenocephala*, *Suncus megalura* and *Sylvisorex granti* (Dieterlen & Heim de Balsac, 1979: table 10). The new *Myosorex*, as well as *Crocidura kivuana* (Heim de Balsac, 1968) were not previously recovered from Musisi Swamp. Their reference to *Sylvisorex granti* (Thomas, 1910) may refer to *S. vulcanorum*, described since.

Table 5. Results from two surveys of terrestrial small mammals in Musisi Swamp and along an elevational gradient from Mugaba swamp (2240m) to the peak of Mt. Kahuzi (3300m). **Albertine Rift endemics in bold.**

Specific Locality	Musisi Swamp	Mugaba Swamp	Mugaba Periphery Forest	Cinya Swamp	Mt Kahuzi Slope	Mt Kahuzi Slope	Mt Kahuzi Slope	Mt Kahuzi Summit	TOTAL
Elevation (m)	2200	2240	2250-2270	2260	2600	2800-2850	2930	3300	
<i>Crocidura kivuana</i>	1								1
Heim de Balsac, 1968									
<i>Crocidura niobe</i>		1	2			1			4
<i>Crocidura olivieri</i>		2	2	1					5
<i>Crocidura stenocephala</i>	3			1					4
Heim de Balsac, 1979									
<i>Myosorex jejei</i>	2	5			2	1		1	11
nov. sp									
<i>Myosorex babaulti</i>		1	1		1				3
Heim de Balsac & Lamotte, 1956									
<i>Sylvisorex lunaris ruandae</i>		1		1					2
<i>Sylvisorex vulcanorum</i>	7	11	1	1	3				23
<i>Paraxerus boehmi</i>			1						1
Reichenow, 1886									
<i>Graphiurus sp.</i>					1	2			3
Smuts, 1832									
<i>Lophuromys aquilus</i>	4	6		3		8	3	4	28
<i>Lophuromys rahmi</i>		1	3				1		5
<i>Lophuromys woosnami</i>		3	4		9	5			21
<i>Otomys tropicalis</i>								1	1
Thomas, 1902									
<i>Grammomys c.f. dryas</i>			1		1	1			3
Thomas, 1915									
<i>Hylomyscus vulcanorum</i>	2		3	6		2			13
<i>Mus bufo</i>		1	2						3
<i>Praomys jacksoni</i>	2	1	1	2	1				7
<i>Praomys degraaffi</i>	2		5	2	1	6			16
<i>Praomys sp.</i>				1					1
TOTAL	23	33	26	18	19	26	4	6	155
Captures/	12/250	17/495	23/545	16/150	13/223	25/480	4/88	6/224	116/2455
Trap nights									
Trap success (%)	4.8%	3.4%	4.2%	10.7%	5.8%	5.2%	4.5%	2.7%	

Our complete list of small mammal captures from Musisi Swamp is documented in table 5. This is the first published DR Congo record for *P. degraaffi* as well as the first record of this mouse from the western slopes of the Albertine Rift.

Additional habitats surveyed for small mammals in 2007 (table 5), include Mugaba Swamp, Cinya Swamp and the slopes leading to the summit of Mount Kahuzi. The saturated parts of the swamp are dominated by *Cyperus latifolius*; other plant taxa include *Polygonum senegalens* Meisn, *Brillantaisia patula* T.Anderson, *Mikania cordata* B.L.Rob, *Triumfetta cordifolia* A.Rich., *Rubus apetalus* Poir., and *Commelina diffusa* Burm.f. Herbaceous elements in the unsaturated parts of the swamp included *Hypericum revolutum* and *Alchemilla kiwuensis* Engl. At 2600 m, the canopy is semi-closed, mixed *Podocarpus* L'Hér. ex Pers. forest, with a height of 12 m. Dominant species include *Nuxia floribunda* Benth., *Agauria salicifolia* (Comm. ex Lam.) Hook.f. ex Oliv., *Macaranga kilmandscharica*, *Podocarpus usambarensis* Pilg. whereas the understory includes: *Chassalia subochreatea*, (De Wild.) Robyns, *Polygala ruwenzoriensis* (Chodat), *Sericostachys scandens* Gilg & Loppr., *Mimulopsis solmsii* Schweinf., *Mikania cordata*, *Arundinaria alpina* and *Tricalysia* sp. A.Rich.ex DC. At 2800 m (locally known as 'le sommet premier', the first summit) dominant species include *Erica* L. sp. and *Agauria* (DC.) Benth. & Hook.f. sp. The canopy is semi-closed at a height of 5 m. The understory includes the following species: *Erica arborea* L., *Rapanea melanophloeos* (L.) Mez, *Hypericum revolutum*, *Vernonia jugalis* Oliv. & Hiern, *Agauria salicifolia*, and *Oldenlandia herbacea* (L.) Roxb. A limited ericaceous zone occurs on the summit of Mount Kahuzi at 3300 m.

At Mugaba Swamp, in addition to *M. babaulti*, we captured *Crocidura niobe*, *Crocidura olivieri*, *Sylvisorex lunaris ruandae*, *Sylvisorex vulcanorum* and the following rodents: *Lophuromys aquilus*, *Lophuromys rahmi*, *Lophuromys woosnami*, and *Mus bufu*. In the ericaceous zone at the summit of Mount Kahuzi (3308 m), other mice found include *Otomys tropicalis* ssp. and *Lophuromys aquilus* ssp.

In two of the aforementioned localities (*Cyperus* swamp and mixed *Podocarpus* forest), *M. jejei* has been caught in the same pitfall lines as *M. babaulti*. This is the first record of co-occurring species of *Myosorex* in Africa north of the Zambezi River. In South Africa, *M. varius* occurs with *M. longicaudatus* in the southern Cape Province and with *M. cafer* in Natal and the eastern Cape Province (reviewed in Meester & Dippenaar, 1978). Further north in South Africa, *M. tenuis* and *M. sclateri* co-occur with *M. cafer* in Mpumalanga Province and Kwa-Zulu Natal Provinces, respectively (Wolhuter cited in Smithers, 1983).

DISCUSSION

We make no claim that our arbitrary division into narrow and broad-skulled groups of *Myosorex* has any phylogenetic significance. These divisions are simply representative of a 'grade' of evolution. Skull shape is likely subject to convergence as skulls of the broader type have greater dorso-ventral leverage, enhancing the ability of the species to root through the soil and litter. Other African semi-fossorial Soricidae (e.g. *Congosorex*, *Surdisorex*), Asian *Anourosorex* (Milne-Edwards, 1872) and certain

Soriculus (Blyth, 1854), as well as moles (Talpidae) and golden moles (Chrysochloridae) share the distinctive hexagonal cranial outline of the broad-skulled *Myosorex*. In this genus, the relative breadth of the braincase is associated with broad maxillae and interorbital regions, a heavy upper first unicuspid, and heavy upper and lower second unicuspid. The heavy dentition may be useful in subduing and consuming prey. The obvious relation of the morphology to the ecology and life history of shrews may obscure any phylogenetic signal; therefore caution is required.

Heim de Balsac (1955) was the first to systematically review the genus *Myosorex* noting that the genus retains unique features that he considered primitive, such as the presence of an interparietal bone (unique among Myosoricinae) and 'archaic' features of the dentition including two tubercles on the upper P4 and the retention of a vestigial lower p3. Later, Heim de Balsac (1958) compared an Idjwi Island (Lake Kivu, eastern DR Congo) specimen of *Myosorex* with the Eocene Nyctitheriid *Saturninia* (Stehlin, 1940); he claimed the enlarged upper M3 of the Idjwi Island individual as an additional primitive character of the group (the posterior trigonid disappears in more evolved forms), complete with a large talon and the presence of a metastyle on the hypocone. He also elaborated on the retention of a postero-external cusp (a sort of vestigial talonid) on the lower p4.

As subsequently suggested by Heim de Balsac (1966), the narrow-skulled *M. schalleri* is representative of even more primitive stock of the genus. Accordingly, he discussed the following characters as representative of a primitive grade (compared with the more derived and more fossorial *Surdisorex*): inflated braincase, gently curving and rectangular braincase in dorsal view (as opposed to more sharply hexagonal), well developed interparietal, large (non-vestigial) upper U4, large talon on the incisor and reduced parastyle of the upper P4. We add that the external characters observed in some of the narrow-skulled forms are primitive for the genus: longer ears and tails, and less developed fore- and hind-claws.

Willows-Munro & Matthee (2009) studied genetic relationships between 12 South African and two Tanzanian species of *Myosorex* and two samples of *Congosorex verheyeni* (reported by Quèrouil *et al.*, 2001). In their phylogenetic trees, the South African species (*M. cafer*, *M. varius*, *M. sclateri*) appear monophyletic, whereas *Congosorex*, the Tanzanian species, and *M. longicaudatus* form a sister group. This result is interesting because it raises doubt on the generic status of *Congosorex* and because it postulates certain relations among species of *Myosorex*. Their study, however, is hampered by the fact that the two *Myosorex* from Tanzania are misidentified. Their sample of "*Myosorex blarina*" from Mount Kilimanjaro represents *M. zinki*, the only *Myosorex* species on that mountain (Stanley *et al.*, 2005b); their sample of "*Myosorex geata* (Allen and Loveridge, 1927)" from "Burundi, Tanzania" in fact represents a yet unidentified *M. cf. geata* from Rungwe Mountain, Tanzania (specimen under study by Hutterer; see Stanley & Hutterer, 2000). The interesting fact is that both species fall in our group of broad-skulled *Myosorex*, whereas *M. longicaudatus* fits into the group of narrow-skulled species (table 1).

In Kahuzi-Biega National Park, both narrow- and broad-skulled forms of *Myosorex* live side-by-side. It is possible that the suggested primitive form (the narrow-skulled

member) was the original denizen of the area and that the more specialised broad-skulled forms were subsequent invaders, during times when climatic change allowed movement of these forest litter species.

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REFERENCES

- Carcasson, R.H. (1964). A preliminary survey of the zoogeography of African butterflies. *East African Wildlife Journal* **2**:122–157.
- Collar, N. & S. Stuart (1988). Key Forests for Threatened Birds in Africa. ICBP Monograph No. 3, International Council for Bird Preservation. Cambridge, UK.
- Dieterlen, F. & H. Heim de Balsac (1979). Zur Ökologie und Taxonomie der Spitzmäuse (Soricidae) des Kivu-Gebietes. *Säugetierkundliche Mitteilungen* **27**: 241–287.
- Dippenaar, N.J. (1977). Variation in *Crocidura mariquensis* (A. Smith, 1844) in southern Africa, Part 1 (Mammalia: Soricidae). *Annals of Transvaal Museum* **32**: 1–34.
- Heim de Balsac, H. (1955). Notions nouvelles sur l'évolution des Soricidae (Mammifères Insectivores). *Compte Rendus des Séances de l'Académie des Sciences, Paris* **241**: 1997–1998.
- Heim de Balsac, H. (1958). Persistance inattendue de certains caractères ancestraux

- dans la denture de Soricidae (Mammifères Insectivores). *Compte Rendus des Séances de l'Académie des Sciences, Paris* **247**: 1499–1501.
- Heim de Balsac, H. (1966). Évolution progressive et évolution régressive dans la denture des Soricinae (Mammifères Insectivores). *Compte Rendus des Séances de l'Académie des Sciences, Paris* **263**: 920–923.
- Heim de Balsac, H. (1967). Faits nouveaux concernant les *Myosorex* (Soricidae) de l'Afrique orientale. *Mammalia* **31**: 610–628.
- Heim de Balsac, H. (1968). Étude des Soricidae de Fernando Po et du Cameroun. *Bonner Zoologische Beiträge* **19**: 20–29.
- Heim de Balsac, H. & M. Lamotte (1956). Evolution et phylogénie des Soricidés africains. *Mammalia* **20**: 140–167.
- Heim de Balsac, H. & J. Meester (1971). Part 1. Order Insectivora. In J. Meester & H.W. Setzer (eds.), *The Mammals of Africa, An Identification Manual*. Smithsonian Institution Press, Washington D.C.
- Hoffmann, M., P. Grubb, C.P. Groves, R. Hutterer, E. Van der Straeten, N. Simmons & W. Bergmans (2009). A synthesis of African and West Indian Ocean Islands mammal taxa (Class: Mammalia) described between 1988 and 2008: an update to Allen (1939) and Ansell (1989). *Zootaxa* **2205**: 1–36.
- Hutterer, R. (2005a). Order Soricomorpha. In D.E. Wilson & D.A. Reeder (eds.), *Mammal Species of the World: a Taxonomical Reference. Third edition*. John Hopkins University Press, Baltimore. Pp. 220–311.
- Hutterer, R. (2005b). Tooth formula and tooth nomenclature in shrews. In J.F. Merritt, S. Churchfield, R. Hutterer & B. Sheftel (eds.), *Recent Advances in the Biology of Shrews II*. Carnegie Museum of Natural History, Pittsburgh, PA. International Society of Shrew Biologists, Special Publication 1. Pp. 397–404.
- Hutterer, R., P. Barriere & M. Colyn (2001). A new myosoricine shrew from the Congo Basin referable to the forgotten genus *Congosorex* (Mammalia: Soricidae). *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Biologie* **71** Suppl.: 7–16.
- Kerbis Peterhans, J., R. Hutterer, P. Kaliba & L. Mazibuko (2008). The first record of *Myosorex* (Mammalia: Soricidae) from Malawi with description as a new species, *Myosorex gnoskei*. *Journal of East African Natural History* **97**: 19–32.
- Kerbis Peterhans, J., W.T. Stanley, R. Hutterer, T.C. Demos & B. Agwanda (2009). A new species of *Surdisorex* Thomas, 1906 (Mammalia, Soricidae) from western Kenya. *Bonner Zoologische Beiträge* **56**: 175–183.
- Kingdon, J. (1989). *Island Africa*. Princeton University Press, Princeton.
- Kityo, R., A.J. Plumtre, J. Kerbis Peterhans, J. Pilgrim & D. Moyer (2003). Section 2: Mammals. In A. J. Plumtre, M. Behangana, T. Davenport, C. Kahindo, R. Kityo, E. Ndomba, D. Nkuutu, I. Owunji, P. Ssegawa, & G. Eilu (eds.), *The Biodiversity of the Albertine Rift*. Albertine Rift. Technical Reports No. 3. Wildlife Conservation Society, New York. Pp. 20–29.
- Meester, J. (1963). A systematic revision of the genus *Crocidura* in Southern Africa. *Transvaal Museum Memoir* **13**: 1–127.
- Meester, J. & N.J. Dippenaar (1978). A new species of *Myosorex* from Knysna, South Africa (Mammalia: Soricidae). *Annals of Transvaal Museum* **31**: 29–43.

- Plumptre, A.J., T.R.B. Davenport, M. Behangana, R. Kityo, G. Eilu, P. Ssegawa, C. Ewango, D. Meirte, C. Kahindo, M. Herremans, J. Kerbis Peterhans, J.D. Pilgrim, M. Wilson, M. Languy & D. Moyer (2007). The Biodiversity of the Albertine Rift. *Biological Conservation* **134**: 178–194.
- Prigonine, A. (1985). Conservation of the avifauna of the forests of the Albertine Rift. In A. W. Diamond and T. E. Lovejoy (eds.), *Conservation of Tropical Forest Birds*. ICBP Technical Publication No. 4, International Council for Bird Preservation. Cambridge, UK. Pp. 275–295.
- Quèrouil, S., R. Hutterer, P. Barrière, M. Colyn, J.C. Kerbis Peterhans, & E. Verheyen (2001). Phylogeny and evolution of African shrews (Mammalia: Soricidae) inferred from 16S rRNA sequences. *Molecular Phylogenetics and Evolution* **20**: 185–195.
- Roberts, A. (1951). *The Mammals of South Africa*. The “Mammals of South Africa” Book Fund. Cape Times Limited, Cape Town.
- Schlitter, D.A. & M.J. Delany (1985). Geographic areas of Africa poorly represented in mammal research collections. *Acta Zoologica Fennica* **170**: 47–48.
- Smithers, R.H.N. (1983). *The Mammals of the Southern African Subregion*. University of Pretoria, Pretoria.
- Stanley, W.T. & R. Hutterer (2000). A new species of *Myosorex* Gray, 1832 (Mammalia: Soricidae) from the Eastern Arc mountains, Tanzania. *Bonner Zoologische Beiträge* **49**: 19–29.
- Stanley, W.T., M.A. Rogers & R. Hutterer (2005a). A new species of *Congosorex* from the Eastern Arc Mountains (Tanzania), with significant biogeographical implications. *Journal of Zoology* **265**: 269–280.
- Stanley, W.T., M.A. Rogers & R. Hutterer (2005b). A morphological assessment of *Myosorex zinki*, an endemic shrew on Mount Kilimanjaro. *Belgian Journal of Zoology* **135** Suppl.: 141–144.
- Van der Straeten, E. & J.C. Kerbis Peterhans (1999). *Praomys degraaffi*, a new species of Muridae from eastern Africa. *South African Journal of Science* **34**(2): 80–90.
- Vedder, A., J. Hall & A. Harcourt (1992). Burundi and Rwanda. In Sayer, J.A., C.S. Harcourt & N.M. Collins (eds.), *The Conservation Atlas of Tropical Forests: Africa*. Macmillan, London. Pp. 102–109.
- Voss, R.S. & L.H. Emmons (1996). Mammalian diversity in Neotropical lowland rainforests: A preliminary assessment. *Bulletin of the American Museum of Natural History* **230**: 1–115.
- Willows-Munro, S. & C.A. Matthee (2009). The evolution of the southern African members of the shrew genus *Myosorex*: Understanding the origin and diversification of a morphologically cryptic species. *Molecular Phylogenetics and Evolution* **51**: 394–398.

APPENDIX 1: SPECIMENS EXAMINED

Congosorex phillipsorum: TANZANIA, Ndundulu Forest, West Kilombero Scarp Forest Reserve, 1900 m, FMNH 177682, 1 F. *Congosorex polli*: DR CONGO, Lubondaie via Tshimbulu, MRAC 23.234 1M. *Congosorex verheyeni*, DR CONGO, Mbomo, Parc National d'Odzala, ZFMK 99.932, 1 F. *Myosorex babaulti*: UGANDA, Bwindi-Impenetrable NP, 1850 m, FMNH 160175 1M, Mgahinga Gorilla NP, 2980 m, FMNH 157410 1M; BURUNDI, Kibira NP, 2100-2350 m, FMNH 148937 1M, 148938 1M, 148265 1M; DR CONGO, Kahuzi-Biega NP, Tshibati, FMNH 189275 1M, ZFMK 68.545, 1F, Lwiro Falls, 6900', AMNH 180956-180961, 6M. *Myosorex blarina*: UGANDA, Rwenzori Mtns NP, FMNH 144205-144211, 2M, 4F, 1?, 6200'-13050'; DR CONGO, Rwenzori Mtns, FMNH 26285-26287 2M, 1F. *Myosorex cafer*: R. SOUTH AFRICA, Cape Province, ZFMK 2003.357, 1M. *Myosorex eisentrauti*: EQUATORIAL GUINEA, Bioko Island, ZFMK 69.373, 1F. *Myosorex geata*: TANZANIA, Uluguru Mts, Uluguru North Forest Reserve 1345-1535 m, FMNH 158298-158302, 158487 3M, 3F. *Myosorex cf. geata*: TANZANIA, Rungwe Mts, TBR 6268, 1F. *Myosorex gnoskei*: MALAWI, Chelinda Rest Camp, Nyika NP, 2285 m, FMNH 191568, 1F; Chelinda, Nyika NP, 2287m, MLWM 1198, 1200, 1206 1F, 2M; Chelinda, below Dam 2, Nyika NP, 2173m, MLWM 1221, 1223, 1224, 1225, 1226, 1231, 1237, 1238 5F, 1M; Mwenembwe Forest, Nyika NP, 2233m, MLWM 1277, 1288, 1310 1F, 2M. *Myosorex kihaulei*: TANZANIA, Udzungwa Mts, New Dabaga/Ulangambi Forest Reserve, 1816-1940 m, FMNH 169509-169516, 7F, 1?; West Kilombero Scarp Forest Reserve, 1140 m, FMNH 169501, 1?. *Myosorex longicaudatus*: R. SOUTH AFRICA, Diepwalle State Forest, ZFMK 81.1293, 1M. *Myosorex okuensis*: CAMEROON, Oku Mts, ZFMK 69.376, 1M, holotype. *Myosorex rumpii*: CAMEROON, Mt Rumpi, ZFMK 69.375, 1M, holotype. *Myosorex schalleri*: DR CONGO, Itombwe Forest, area of Nzombe, ca. 1664 m, MNHN 1981-1107, holotype, 1M. *Myosorex tenuis*: SOUTH AFRICA, CMNH 69654, 1M. *Myosorex varius*: R. SOUTH AFRICA, Goodhope Estate 1425-1500 m, FMNH 165628 1M, 165588-165592, 1M, 3F, 1?, 165623-165627, 165667, 4F, 1M, 1?, Cape Province, ZFMK 82.135, 1F. *Myosorex zinki*: TANZANIA, Mt Kilimanjaro, SMNS 4505, holotype, FMNH 174120. *Surdisorex norae*: KENYA, Aberdare Mountains, FMNH 190262, 1M. *Surdisorex polulus*: KENYA, Mt. Kenya, AMNH 87262, FMNH 43846. *Surdisorex schlitteri*: KENYA, Mt Elgon, FMNH 195069, holotype.