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RESULTS OF A SURVEY OF SMALL MAMMALS IN THE KWAMGUMI FOREST RESERVE, EAST USAMBARA MOUNTAINS, TANZANIA

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ABSTRACT

The small mammals of Kwamgumi Forest Reserve, a habitat representing transition between coastal and Eastern Arc forest types, and one of the lower forest reserves of the East Usambara Mountains, Tanzania, were sampled to gain a preliminary perspective on the diversity and abundance of the shrews, bats and rodents of this unique forest. While the species documented are reminiscent of those found at higher elevations in the East and West Usambara Mountains, the abundance of shrews and rodents, based on trap success, was much lower than in the montane forests of the Eastern Arc Mountains.

INTRODUCTION

The forest reserves of Tanzania are important habitats for a wide variety of flora and fauna, many taxa of which are endemic to Tanzania. The need for improved knowledge of the natural history of these reserves and precisely what biodiversity they protect is critical given past destruction that has occurred and human encroachment presently threatening most, if not all reserves.

While some vertebrate groups that live in Tanzania's forest reserves have been studied intensively in the recent past *i.e.* birds (Stuart, 1981; Stuart *et al.*, 1987; Newmark, 1991; Dinesen *et al.*, 1993; Dinesen *et al.*, 1994), very little is known about the small mammals (insectivores, bats, rodents), although our understanding of this fauna is improving (see Stanley *et al.*, 1996; Stanley & Hutterer 2000; Stanley *et al.*, 2005; Stanley & Olson, in press). As part of a long-term project to document the small mammals of various Tanzanian forests, we report here results of a survey in the Kwamgumi Forest Reserve in northeastern Tanzania. This forest is important for two reasons: 1) it is a habitat that is transitional between coastal forest and Eastern Arc forest types, and 2) it is one of the lower forest reserves of the East Usambara Mountains. The East Usambaras (figure 1a) are part of the Eastern Arc Mountains, an ancient fault block group of mountains renowned for their high level of endemism (Rogers &

Homewood, 1982; Lovett & Wasser, 1993). Previous surveys of Kwamgumi Forest Reserve documented the soils and various aspects of the flora (Hamilton & Bensted-Smith, 1989), and only some of the small mammals (Cambridge-Tanzania Rainforest Project, 1994; Clark & Stubblefield, 1995; Doggart *et al.*, 1999), but we know of no other studies designed to quantify various ecological aspects of the small mammal fauna of this forest. Our preliminary survey systematically sampled small mammals in Kwamgumi in order to document both occurrence and density of this fauna. Surveys such as these provide valuable data for the design and implementation of conservation strategies to preserve Tanzania's unique and important biota.

MATERIAL AND METHODS

Study area

The Kwamgumi Forest Reserve (figure 1b) is approximately 17.1 km^2 and is contiguous with both the Segoma and Bamba Ridge Forest Reserves (Doggart *et al.*, 1999). The reserve ranges in elevation from 150 to 915 m, the highest point being Mount Mhinduro. The forest has been logged in the past 40 years and exhibits signs of this impact. Doggart et al. (1999) present a superbly detailed description of the habitat of Kwamgumi. The soils, root density, herbs, and forest profiles of this forest are described by Hamilton and Bensted-Smith (1989). Additional details regarding Kwamgumi and surrounding reserves can be found in a report assembled by the Cambridge-Tanzania Rainforest Project (1994).

In July, 1994, we surveyed the forest based at the following locality: Tanzania, Tanga Region, Muheza District, western edge of Kwamgumi Forest Reserve, 4.4 km west of Mount Mhinduro, 2 km south of Kwamtili Estate offices, 4°56'30"S, 38°44'00"E, 230 m. Temperatures during our survey ranged from lows of 15.3–20.6°C (mean = 18.3°C, n = 9) to highs of 25.6–28.3°C (mean = 26.6°C, n = 8). Approximately 1 mm of rain fell on the morning of 18 July, 6 mm on 20 July, and 7 mm on 23 July. Other days were without precipitation.

Survey methods

Between 16–24 July 1994, small mammals were sampled using a variety of techniques. Bats were sampled with standard 12 metre mist nets. Insectivores and rodents were sampled using both pitfall lines and traplines consisting of three different trap types. The pitfall lines consisted of eleven 15-liter buckets set 5 m apart with a 50 cm high fence running over the top (Stanley *et al.*, 1996). The traplines consisted of three different types of traps: small snap traps (Museum Specials, 14 x 7 cm), large snap traps (Victor rat traps, 17.5 x 8.5 cm), and medium-sized Sherman live traps (23 x 9.5 x 8 cm). Our traplines consisted of between 20 to 100 traps, with Museum Specials and Victor rat traps making up approximately 85% of the line, and Sherman traps making up the balance. Approximately 80% of the traps were on the ground and the remaining traps were set on vines and tree limbs. Height off the ground, and nature of microhabitat was noted for each trap. Specimens were prepared as study skins and skeletal elements, or were preserved in formalin with transfer later to 70 % ethanol, and tissues were frozen in liquid nitrogen for DNA studies. Specimens are deposited in the Field Museum of Natural History (FMNH) and some will later be returned to the University of Dar es Salaam.

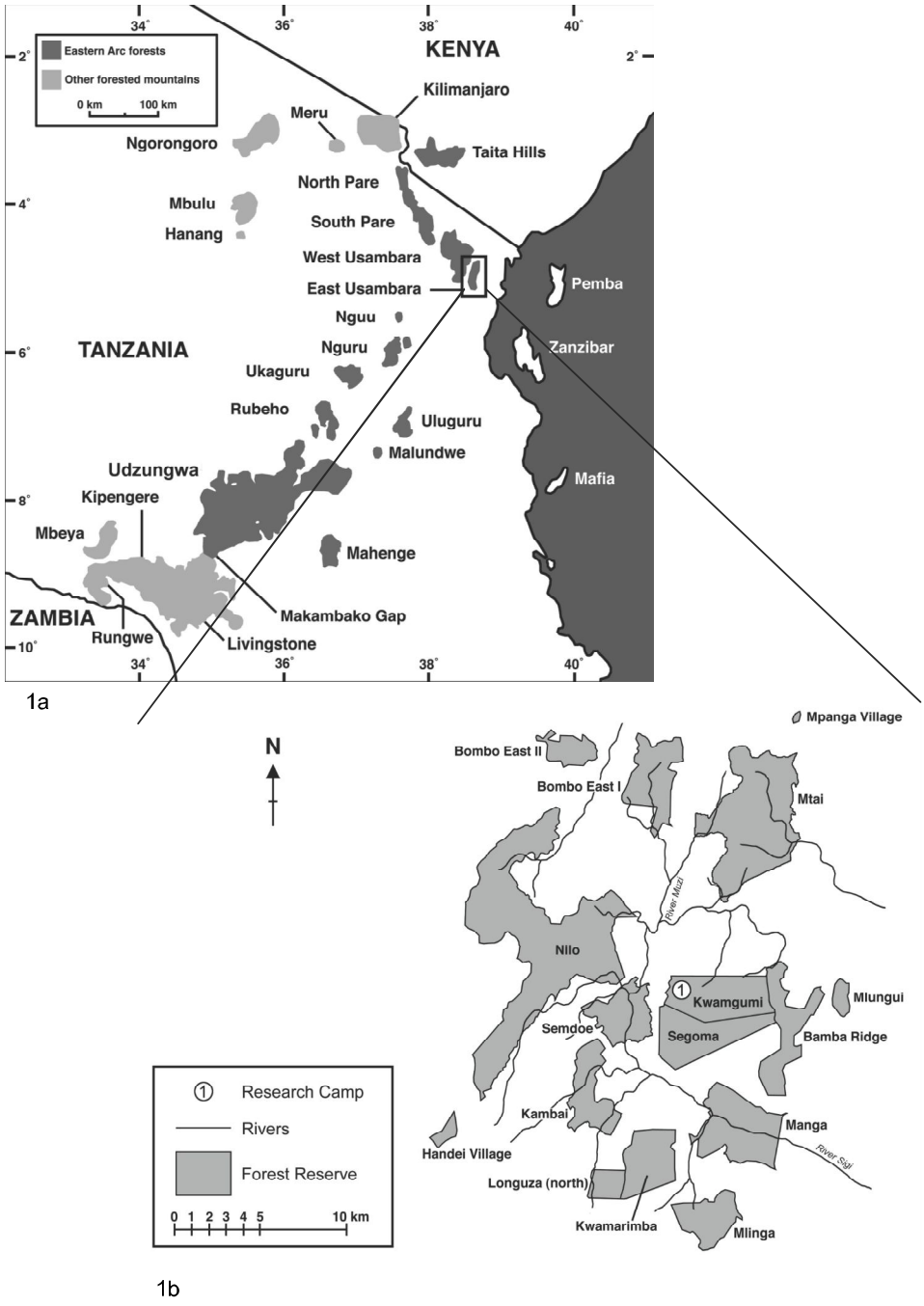


Figure 1. Study site. 1a) shows the Eastern Arc forests with the East Usambaras indicated in the box. 1b) shows the Kwamgumi Forest Reserve and location of the study site.

RESULTS

A total of 21 small mammals were captured during the sampling period, representing 11 species. These consisted of two species of shrew, four species of bats, and five species of rodents (table 1). Overall trap success for the pitfall lines was 1.5 % (9 captures in 594 bucket-nights). The majority of specimens captured in the pitfall lines were shrews. The trap lines caught no shrews and had an overall trap success of 0.6 % (8 captures in 1358 trap-nights). The four bats captured were all representatives of the sub-order Microchiroptera. Nets to capture bats were operated on an opportunistic basis and, consequently, our results for bats should not be viewed as a clear representation of the populations present.

All of the animals we collected were adults based on tooth eruption criteria and the degree of fusion between the basioccipital and the basisphenoid bones of the skull. The majority of the species collected showed no sign of being reproductively active, except for *Praomys delectorum,* which showed indications of reproductive activity in all specimens captured.

In the following species accounts we summarise the natural history data for each of the species we observed. Measurements listed are in millimetres, except for weight which is in grams, and include total length (TL; from tip of the nose to last caudal vertebrae), head and body length (HB; from tip of nose to the junction of the tail and body of animal as seen from the dorsal surface), tail length (T; from the base of the tail (held at right angles to the body) to the end of the last caudal vertebra), hind foot length (HF; from rear edge of heel to tip of the longest claw on foot), ear length (E; from basal notch to the distal tip of the pinna), forearm length in bats (FA; from outside edge of wrist to proximal end of ulna), weight (WT; measured with Pesola spring scales to the nearest 0.5 g). FMNH catalogue numbers are listed for all specimens examined.

Table 1. Species of small mammal sampled in the Kwamgumi Forest Reserve during the study period.

Species	total	# male	# female
Crocidura elgonius Osgood, 1910	6	3	3
Crocidura hirta velutina Thomas, 1904	1	1	0
Crocidura sp.	1	0	1
Nycteris thebaica E. Geoffroy, 1818	1	1	0
Rhinolophus deckeni Peters, 1867	2	1	1
Rhinolophus fumigatus Rüppell, 1842	1	1	0
Rhinolophus hildebrandti Peters, 1878	1	1	0
Hipposideros cyclops (Temminck, 1853)	1	1	0
Beamys hindei Thomas, 1909	2	2	0
Grammomys dolichurus (Smuts, 1832)	1	0	1
Praomys delectorum (Thomas, 1910)	3	1	2
Rattus rattus (Linnaeus, 1758)	1	0	1
Graphiurus cf. *kelleni* (Reuvens, 1890)	1	1	0

Insectivora (shrews)

Crocidura elgonius Osgood, 1910

While this species was originally described from Mt. Elgon, it has recently been documented in forests of the Eastern Arc (Stanley *et al.*, 1998b). We collected three males and three females. Within the males, the length x width of the testes ranged from 2 x 3 to 2 x 4 mm. None of the females were pregnant. External measurements are given in table 2. FMNH 153903-153908.

Crocidura hirta velutina Thomas, 1904
An adult male was collected on 24 July. External measurements (n = 1): TL-149, HB-93, T-55, HF-15, E-10; WT-16.5; FMNH 153843.

Crocidura sp.
A juvenile nulliparous female was collected on 19 July. Because of the age of the animal, specific identification was not attempted. External measurements (n = 1): TL-144, HB-75, T-64, HF-15, E-10; WT-6.6; FMNH 153916.

Chiroptera (bats)
Nycteris thebaica E. Geoffroy, 1818
The only specimen captured was a male found caught by the wing in a Victor trap set on the ground. *N. thebaica* is the most widely distributed species in the genus and is known to take prey from the ground (Kingdon, 1974). We suspect that the animal was attracted to insects, possibly crickets that were feeding on the bait in the trap. The testes were scrotal and measured 3 x 1.5 mm. The epididymides were not convoluted. External measurements (n = 1): TL-104, T-50, HF-10, E-30, FA-44; WT-8.5; FMNH 153926.

Rhinolphus deckeni Peters, 1867
One female was netted over a small stream on 18 July and one male with abdominal testes was netted at 19:00 h on 19 July. External measurements (n = 2): TL-94, 94; T-24, 26; HF-14, 13; E-24, 24; FA-56, 54; WT-15, 13.5; FMNH 153927, 153850.

Rhinolphus fumigatus Rüppell, 1842
One male with abdominal testes was netted at 19:00 h on 22 July. External measurements (n = 1): TL-91, T-26, HF-13, E-24, FA-53; WT-14.5; FMNH 153852.

Rhinolphus hildebrandti Peters, 1878
The only species that could be confused with this large rhinolophid is *R. eloquens* K. Anderson, 1905 (Csorba et al., 2003). Cranial measurements identify the Kwamgumi specimen as *R. hildebrandti* (greatest length of skull=26.44 mm; span between anterior face of upper canine and posterior edge of third upper molar=9.71 mm). The specimen captured was a male with abdominal testes netted at 19:00 h on 22 July. External measurements (n=1): TL-117, T-39, HF-14, E-34, FA-61; WT-20.5; FMNH 153851.

Hipposideros cyclops (Temminck, 1853)
We caught one female with a closed pubic symphysis, small nipples and no embryos on 20 July. External measurements (n = 1): TL-106, T-22, HF-17, E-34, FA-66; WT-24; FMNH 153929.

Rodentia (rodents)
Heliosciurus undulatus (True, 1982)
Squirrels are considered agricultural pests in the cacao plantation of Kwamtili Estates bordering Kwamgumi Forest Reserve, and are regularly hunted. A lactating female was given to us by a local resident. The tail was removed to collect the bounty offered by the Kwamtili Estates administration. External measurements (n = 1): HB-230, HF-61, E-18; WT(w/o tail)-370; FMNH 153859.

Beamys hindei Thomas, 1909
On 18 July, a male was caught in a Victor trap on the ground near a 5 cm high x 7 cm high hole

under an 8 cm diameter root. The testes were abdominal, one measured 4 x 3 mm with an epididymis that was not convoluted. Three days later, another male with abdominal testes was caught approximately 120 m away from the first one, in a Victor trap set under a log, which was covered in herbaceous vegetation. External measurements (n = 2): TL-264, 279; HB-130, 135; T-122, 134; HF-23, 24; E-19, 21; WT-59, 61; FMNH 153933 & 153862.

Grammomys dolichurus (Smuts, 1832)
A juvenile female was caught in a pitfall bucket. The vagina was imperforate. External measurements (n = 1): TL-172, HB-75, T-103, HF-20, E–14, WT-9.5; FMNH 153941.

Praomys delectorum (Thomas, 1910)
Two females and one male were captured. One animal had no embryos, but the uterus was enlarged and highly vascularized; there were 3 placental scars in the left uterine horn (none in the right). The other female had four embryos (2 in each uterine horn), the largest with a crown-rump length of 17 mm. The male had scrotal testes, one of which measured 14 x 8 mm with a convoluted epididymis. While *Praomys* was the most common murine mouse captured during our survey, the low abundance of this species (as measured by trap success) did not approximate numbers found in other Eastern Arc Mountains (Stanley *et al.*, 1998a, 2000) or in the forests at higher elevations in the East Usambara Mountains near Amani (W.T. Stanley, unpublished data). External measurements are given in table 2. FMNH 153997-153999.

Rattus rattus (Linnaeus, 1758)
A juvenile female was caught approximately 1.5 m from the edge of a stream under a rock ledge. The vagina was perforate. External measurements (n = 1): TL-281, HB-125, T-149, HF-29, E 22; WT-56; FMNH 153901.

Graphiurus cf. *kelleni* (Reuvens, 1890)
A single specimen was collected on a 15 cm diameter vine running from ground to the upper canopy. The animal was a male with abdominal testes, one of which measured 3 x 1.5 mm and with an epididymis that was not convoluted. External measurements (n = 1): TL-133, HB-77, T-61, HF-16, E-13, FA–66, WT-14.5. FMNH 154001.

Potamochoerus porcus (Linnaeus, 1758)
The skull of a male was donated to us by a local resident who captured it approximately 1 km north of our camp.

Table 2. External measurements for species for which there were more than two specimens measured.

Species	TL	HB	T	HF	E	WT
Crocidura elgonius	97.3 ± 5.5	59.7 ± 4.5	37.7 ± 2.1	9.7 ± 0.6	8 ± 1	3.13 ± 0.5
males (n = 3)	91-101	55-64	36-40	9-10	7-9	2.5-3.5
Crocidura elgonius	95 ± 3	55.3 ± 0.6	35.7 ± 0.6	10 ± 0	7. 2 ± 1.0	2.6 ± 0.4
females (n = 3)	92-98	55-56	35-36	10	6-8	2.3-3.0
Praomys delectorum	236	100	132	25	17	32.5
males (n = 1)						
Praomys delectorum	216.5	101	115.5	23	18	26
females (n = 2)	208, 225	(n = 1)	109, 122	23, 23	(n = 1)	18, 34

DISCUSSION

The low trap success of this preliminary survey was striking when compared to results from surveys conducted at higher elevations in the East and West Usambara Mountains (Stanley *et al.*, 2000). For example, during a 1994 survey in the Ambangulu Tea Estate in the West Usambara Mountains (1300 m elevation), 205 bucket-nights caught 21 shrews for a trap success of 10.2%, and 240 trap-nights captured 29 rodents, yielding a trap success of 12.1%. Both values are an order of magnitude greater than what was documented during our survey of Kwamgumi. It is also interesting to note that rodent species such as *Beamys hindei* appeared in numbers and in sequence of capture during the Kwamgumi survey that is consistent with results from higher elevations, but the relative number of *Praomys* captured was much lower than in these other surveys. *Praomys* is normally the most common rodent encountered in small mammal surveys of the Eastern Arc (Stanley *et al.*, 1998a,b). Doggart et al. (1999) found many more *Praomys* in their highest Kwamgumi site (910 m) compared to the other sites they sampled (all <500 m). This is in keeping with our observations of higher densities of this rodent in submontane forests compared to forests at lower elevations (W.T. Stanley, unpublished data). Hopefully, future surveys will reveal whether the results of these surveys are related to elevation, as is suggested in these studies, or the consequence of other factors such as seasonal variations in population size.

Two other surveys of small mammals in Kwamgumi have been published (Cambridge-Tanzania Rainforest Project, 1994; Doggart *et al.*, 1999 (=Frontier Survey)) but comparison of our results (for soricid shrews, bats and rodents only) should be considered with caution because sampling regimes varied among studies. Some examples of this variation include: the diameter of the pitfall buckets used by the Cambridge study was smaller (8 cm) than either of the buckets used by Frontier or us, the Frontier study used different bait in at least some of their snap traps than we did (the Cambridge report does not state what bait they used), and the Frontier study used mist nets more intensively than we did (the Cambridge report does not record netting effort) (Cambridge–Tanzania Rainforest Project, 1994; Doggart *et al.*, 1999). Nevertheless, comparisons to these other studies do present interesting observations. For example in all three studies the most common rodents sampled were *Beamys hindei* and *Praomys delectorum*. Both the Cambridge and Frontier studies captured more *Beamys* than *Praomys*; we caught one more *Praomys* than *Beamys* (table 1). The Cambridge survey documented a shrew species that neither we, nor the Frontier study encountered (*C. fuscomurina* (Heuglin, 1865)), and Frontier documented many more species of bats than either we, or the Cambridge study did (although many of those species were recorded from outside the reserve). These comparisons lead us to conclude that a complete list of small mammal fauna for Kwamgumi Forest Reserve has not yet been attained, and more surveys are required to achieve this list.

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