Appendix 3: Table showing mean scores calculated from Timed Species Counts (TSCs) for amphibians in the various sites in the Rwenzori mountains/Semliki forest region sampled.

SPECIES/SITES	Ru	Se	Ny	'A'	'B'	Ma	Ka	Bu
01. Afrixalus quadrivitattus	1.43	1.39						
02. Bufo kisoloensis		0.28		0.25		0.29		
03. Bufo maculatus		0.39						
04. Bufo regularis	2.58	0.67	1.87					
05. Hylarana albolabris	5.22	2.72						
06. Hyperolius cinnamomeoventris	5.07		5.87	1.38				
07. Hyperolius lateralis			4.99	5.88				
08. Hyperolius nasutus			1.50					
09. Hyperolius pussilus			1.18	1.75				
10. Hyperolius viridiflavus			0.84					
11. Kassina senegalensis	1.72							
12. Leptopelis christyi		0.17						
13. Phrynobatrachus acridoides			3.00	0.38	5.50			
14. Phrynobatrachus dendrobates				0.50	3.33	0.71		
15. Phrynobatrachus natalensis	0.43	0.39	9.05	10.13	9.83	1.29		
16. Phrynobatrachus plicatus				0.13				
17. Phrynobatrachus graueri			0.33					
18. Ptychadena mascareniensis	1.79	1.67						
19. Ptychadena porosissima	0.29	4.00						
20. Ptychadena chrysogaster		0.34						
21. Rana angolensis		0.56	0.54	1.00	1.67	4.00	2.50	3.05
22. Rana occipitalis		1.17						
23. Rana rwenzorica					p		p	

Where: Ru = River Ruugo, Se = Sempaya hot-springs, Ny = Nyakarengija swamp, 'A' stream 'A', 'B' = stream 'B', Ka = River Kamatwe, Bu = Bujuku ridge,

SMALL MAMMALS ALONG AN ELEVATIONAL GRADIENT IN RWENZORI MOUNTAINS NATIONAL PARK, UGANDA

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SUMMARY

During 1990 and 1991, zoologists from Makerere University (Kampala) and the Field Museum of Natural History (Chicago) conducted surveys of the small mammal community in Rwenzori Mountains National Park. Surveys were conducted along an elevational transect, along the Mubuku and Bujuku Rivers. Over the course of 2 field seasons, surveys were conducted at 5 main camps and two smaller ones. Results are compared to the British Museum Expedition of 1905-06, the only other published comprehensive survey of small mammals on the eastern slope. Data are presented relating to habitat associations, relative abundance, activity patterns and elevational range. For select taxa, additional data are presented relating to size variation, reproductive condition, and demographics. Six species of small mammals are added to the Rwenzori list. Although our survey was comprehensive on a local scale, many species either known or described from the Rwenzori, were not documented. Biogeographic and conservation implications are discussed.

METHODS

Surveys in the first season (November-December, 1990) were conducted at three camps: Kyoha River (1960 m), Mahoma River (2075 m) and Nyabitaba (2700 m). W.T. Stanley coordinated the 1990 small mammal field efforts, working with R.M. Kityo and R.L. Lubajo. During the second season (April-May, 1991) surveys were conducted at four main sites: Kyoha River (1960 m), Nyabitaba (2700 m), John Mate (3400 m) and Lake Bujuku (4000 m); smaller collections were made at Mahoma River (2075 m) and Lake Mahoma (3000 m). Kerbis Peterhans coordinated the 1991 small mammal field activities, working with P.K. Austin, Kityo, and Lubajo.

The retention of voucher specimens is fundamental to such surveys (see Appendix for discussion). Most small mammals were collected with Sherman live traps, Museum Special snap traps and Victor Rat traps. A single trap placed out for one night was equal to one trapnight. A variety of baits were employed including fish, worms, and peanut butter and oats.

Bats were collected from mist nets. Mist net effort is reflected in the Rwenzori bird paper (Willard et al., this volume). Most of the smaller shrews (<10 grams) were caught with pitfall traps. In this method, 5 liter buckets are buried into the soil so that their rims are flush with the ground; window screen netting connected the buckets across the midline (e.g. Voss & Emmons 1996, Fig. 7; Stanley et al., 1996). Buckets are placed 4-5 meters apart. Pitfall nights are recorded by dividing the length of the 'netting' by 10 meters. A thirty meter length of screening would translate to 3 pitfall nights.

Giant rats (*Cricetomys emini*) were collected with Conibears, local snares, Tomahawk live traps, and Victor Rat traps. Small carnivores (n=5) and hyrax (n=5) were collected with Conibears. Two squirrels (*Funisciurus c. carruthersi*) were collected from local Baluku Kanerya originating from the settlement of Ruboni, located on the left bank of the Mubuku River at an elevation of 5700ft.

Data on trap nights, habitat, and activity patterns are available for the 1991 field season. Animals retrieved from the traps in the morning were considered to have been nocturnal. Those recovered during the late afternoon were considered to have been diurnal. The proportion of diurnal captures is typically underestimated as it could take one hour to reach certain traplines; some nocturnal activity could be documented as diurnal activity.

Several fortuitously gathered and/or commensal specimens are not included in some totals: these include one *Hylomyscus d. denniae* and four *Lophuromys flavopunctatus* collected at Bigo Bog and 13 *Hylomyscus d. denniae* and 7 *Lophuromys flavopunctatus* collected within Bujuku Hut.

For the British Museum expedition, elevational data on small mammal occurrence were published in Woosnam (1909-1910) and Thomas & Wroughton (1910). There are conflicts between Woosnam's report and the data provided by Thomas and Wroughton (1910). Several species are not included in the Grass Zone in our tables as they are recorded by Thomas & Wroughton (1910) at 6000ft and above. However, Woosnam states (1909-1910) that the Forest Zone begins at 6500ft which implies that taxa found at 6000ft may occur in the Grass Zone. We include only those species listed by Thomas and Wroughton from 5,000ft and below, to be from the Grass Zone. Since this situation is problematic, the distinction between the Grass Zone and Lower Forest Zone small mammal faunas is not clear.

Dendromus insignis, is listed by Woosnam (1909-10) as occurring in the Forest-Zone (6500-8500ft) whereas the only specimen recorded by Thomas and Wroughton is listed as from 10,000ft. Here, we place this specimen in the Bamboo Zone at 10,000ft. *Chrysochloris stuhlmanni* is listed by Woosnam as representative of the Tree-Heath and Moss-Zone (10,000-12,500ft) whereas Thomas and Wroughton, quoting Woosnam himself say only it is 'found as high as 10,000ft (p. 493). *Myosorex blarina* is also included by Woosnam in the Bamboo and the Tree-Heath and Moss-Zone whereas Thomas and Wroughton, state that it was only recovered at 10,000ft. Indeed both specimens were recovered at the same place (Thomas and Wroughton, p.490). This elevation is within the bamboo zone, falling well below the Tree-Heath and Moss-Zone. Despite these inconsistencies, the only specimen which effects the elevational range of the Rwenzori species is the single record of *Dendromus insignis*.

Mammalian nomenclature follows Wilson and Reeder (1992) with the following exceptions. We follow Van der Straeten and Dudu (1990) who demonstrate the unique status of *Praomys jacksoni montis* (Thomas and Wroughton, 1910). However, future multivariate analyses may demonstrate the occurrence of two species of *Praomys* in our collection. We consider *Hybomys lunaris* to be restricted to the Rwenzori as this taxon was resurrected on the basis of material collected in more southerly Mountains of the Albertine Rift (Van der Straeten, personal communication; Van der Straeten, et al., 1986). Based on published accounts, the following taxa are

recognized: *Rousettus angolensis ruwenzorii* (Eisentraut, 1965), *Rhinolophus maclaudi ruwenzorii* (Smith and Hood, 1980), *Hylomyscus denniae vulcanorum* (Bishop, 1979). Based on unpublished surveys of adjacent mountain tops and historical museum records, we recognize the following sub-species *Sylvisorex granti granti*, *Sylvisorex lunaris lunaris*, *Otomys denti denti*, and *Otomys typus dartmouthi*. If we do not recognize subspecies we use the code 'ssp'.

Age was estimated using both body weight and dental wear. Using plots of body weight versus cranial metrics, juvenile status was estimated using the following weights: *Mus bufo* <8 grams, *Hylomyscus denniae* <20 grams, *Lophuromys woosnami* <30 grams, *Lophuromys flavopunctatus* <35 grams, *Praomys jacksoni montis* <35 grams. For all taxa, individuals were considered to be juvenile if they displayed dental wear stage 3 or less (sensu Verheyen and Bracke, 1966).

We use the following abbreviations for our campsites: Ky (Kyoha River), Ma (Mahoma River), Ny (Nyabitaba), LM (Lake Mahoma), JM (John Mate), Bu (Lake Bujuku).

Habitats Sampled

In his review of the British Museum expedition of 1905-1906, Woosnam (1908) discussed numerous vegetation zones on the Ugandan slope of the Rwenzori. Woosnam describes the foothills of the Rwenzori as belonging to the Grass-Zone (3000-6500ft), starting with short grass plains with scattered acacia and euphorbia, merging into elephant grass (*Pennisetum purpureum*) and *Hyparrhenia spp.* in the upper reaches (5,000-6500ft). On the slopes, thorny *Erythrina abyssinica* is conspicuous (Osmaston & Pasteur, 1972). Today, this zone is heavily cultivated. The common crops include cassava, millet, cooking bananas, beans, sweet potatoes and taro (Ibid.). Our group did not sample this habitat.

The British Museum expedition also sampled the animal communities in the dry plains just beyond the foothills of the mountain range. These specimens originate in the acacia woodland and open habitats of Muhokya ('Mokia' of Woosnam, 1909-1910, Fig. 1) at an elevation of 1000 meters (3280ft). Coincidentally, Delany (1964) collected 413 small mammals in the adjacent area of Queen Elizabeth National Park. The habitats he sampled are mostly grass savannah (*Imperata cylindrica* and *Cymbopogon afronardus*) sometimes associated with semi-deciduous thicket. Smaller collections came from semi-deciduous forest (Maramagambo with *Cynometra* sp. and *Celtis sp.*) and herb swamp. We did not sample this habitat.

Within the Rwenzori proper, both the British Museum Expedition and our surveys started along the Mubuku River. At the confluence of the Bujuku River however, our expedition followed the established hiker's routes and continued up the Bujuku whereas the British Museum expedition sent forays up the Mubuku River (Wollaston, 1908). According to Woosnam (1909-1910), the Forest-Zone begins at 6500ft, the lower margins of which include substantial trees (*Symphonia globulifera* and *Entandrophragma utile*). Tree ferns (*Cyathea deckenii*) are common and impatiens (*Impatiens* spp.)are plentiful near streams. The base camp for the BMNH expedition was in this area and was occupied for four months. Wollaston (1908) refers to this base camp as 'Bihunga' at an elevation of 6500ft (=1980m), formerly the site of a small 'village' of three native huts. Uganda survey maps (Sheet 66/1, 1:50,000, Lands and Surveys Department, 1958) represent this site as 'Mihunga', a small plateau at 6800ft, located just below the confluence of the Kyoha (=Choha) River. Later, Loveridge was to establish his camp at this very place (Allen & Loveridge, 1942).

We established camps in the lower section of the forest zone at the confluence of the Kyoha River (1920m) and at the confluence of the Mahoma River (2100m). Both camps were located on the right bank of the Mubuku River, just upstream from the actual confluence. The Kyoha site was surveyed on two occasions, 10-18 November 1990 and 8-14 April 1991. The Mahoma River site was predominantly surveyed 19-30th November, 1997; a smaller collection (n=24) was made 3-9 May, 1991.

According to Woosnam, the upper reaches of the "Forest-Zone" are marked by the occurrence of a single conifer, *Podocarpus milanjianus*, which appears around 7500ft but becomes most plentiful as the bamboo zone (8500ft) is reached. In the open valleys, bracken ferns (*Pteridium aquilinum*) and thorny blackberries (*Rubus runssorensis*) can dominate as they do just above Nyabitaba. Our camp at this point was located at the rest area, known as Nyabitaba (2670m = 8750ft) a ridge formed by a glacial moraine just below the confluence of the Mubuku and Bujuku Rivers on the right bank of the Mubuku. Wollaston (1908) refers to this site, the site of an "immense erratic boulder', still in place, as 'Vitaba' or 'Nakitawa'. Our group surveyed this site on two occasions; 2-12 December 1990 and 15 - 22 April 1991. We consider the area of Nyabitaba to be the upper reaches of the "Forest-Zone" as the once heavy bamboo stands have been transformed into a dense tangle of climbers and degraded bamboo.

The Bamboo-Zone, beginning at 8500ft (per Woosnam) is currently heavily degraded but was apparently more substantial at the time of the BMNH expedition. The BMNH considered the area around Nyabitaba as part of the bamboo zone (*Arundinaria alpina*) which Woosnam defined as 8500-10,000ft (2590-3050m). Wollaston (1908, p.85) describes the area: "After leaving the big rock, Vitaba, the track plunged almost at once into the bamboos"(p.85). Today, the degraded bamboo is intermingled with thick tangles of *Mimulopsis elliotii* as one leaves Nyabitaba for Lake Mahoma. At Nyabitaba. the first tree heath occurs in the form of *E. (P.) johnstonii* (Osmaston & Pasteur, 1972) as does the first Lobelia. In 1991, we found the purest stands of bamboo in the vicinity of Lake Mahoma (2960m = 9700ft), which we accessed from our camp at Nyabitaba. *Erica (Philippia) kingaensis* also makes its first appearance in the bog adjacent to Lake Mahoma (Osmaston, personal communication). We include only those specimens caught in the vicinity of the pure Lake Mahoma bamboo stand (3000m) to be originating from the "Bamboo-Zone".

Above Nyabitaba, we followed the course of the Bujuku River. The British Museum expedition sent forays up the Mubuku River (Wollaston, 1908). The British Museum Expedition undertook shorter 8-10 day excursions up the Mubuku from their base at 'Bihunga' (Woosnam, 1907). Our sample of the ericaceous zone was centered on the newly constructed tourist hut known as John Mate Camp (3370m), located on the left bank of the Bujuku River, midway between the former shelters known as Bigo and Nyamuleju. Woosnam terms this zone the "Tree-Heath-and-Moss-Zone" (10,000-12,500ft = 3050-3810m). This site was surveyed by us on one occasion, for 9 days, between 24th April and 2nd May 1991.

Our sample of the Senecio-and-Lobelia-Zone was centered on the hut known as Bujuku, above Lake Bujuku at an elevation of 3980m. Woosnam's range for this zone extends from 12,500-14,500ft (3810m-4420m). We camped at Bujuku on one occasion between 2nd May and 8th May, 1991. Neither we nor the BMNH surveyed the Snow-Zone (14,500-16,800ft). We did however proceed through the Stuhlmann Pass where we recovered specimens from a poacher's camp at 13,600ft.

RESULTS

Activity Patterns

Although most species are nocturnal, there are important exceptions (Table III). Eighty-eight per cent of the *Hybomys lunaris* (n=17), 65% of the *Lophuromys flavopunctatus* (n=84), and 38% of the *Mus bufo* (n=42) were captured during the day. Many of the large grass/sedge-dwelling rodents were caught during the day: *Dasymys montanus* (5/8), *Otomys typus dartmouthi* (6/15) and *Otomys denti denti* (1/4). Surprisingly, four of the shrew species, *Sylvisorex granti* (4/12), *Myosorex blarina* (1/3), *Crocidura montis* (2/3), and *Crocidura olivieri* (1/5) exhibited diurnal activity. Stanley et al. (1996) caught 50% (n=4) of their *Crocidura olivieri* sample during the day.

Reproductive Seasons and Demographics

Data on pregnancy for each species are presented in Table IV and age profiles for select taxa in Table V. Several species show a higher rate of pregnancy during the rainy season (Nov/Dec, 1990 vs. April/May, 1991) . These include *Hylomyscus d. denniae* (28% vs. 16%) and *Lophuromys flavopunctatus* (25% vs. 11%). Other species show the reverse pattern including *Praomys jacksoni montis* (20% vs. 35%), *Lophuromys woosnami* (14% vs. 44%) and *Mus b. bufo* (12% vs. 43%). Nearly 50% of the *Rousettus angolensis ruwenzorii* were pregnant in Nov/Dec 1990. *Cricetomys emini* was not pregnant (n=10) either season. There may be seasonal differences in the timing of reproduction in the congeners *Otomys d denti* and *Otomys typus dartmouthi*, with the later reproductively active in April/May. For other species, data are inadequate to document seasonal differences.

Twice as many *Hylomyscus denniae* juveniles were documented in 1991 while *Lophuromys woosnami* had proportionately more juveniles in 1990. The relatively few captures of *Lophuromys woosnami* in 1991 suggests a die-off in the interim.

We assumed that the relatively high number of pregnancies and fewer juveniles observed in Nov/Dec 1990 would result in observing fewer pregnancies and a higher number of individuals, particularly juveniles, in April/May, 1991. This prediction is based on assumptions of gestation and weaning which would need verification through longevity studies in captivity. The assumption apparently holds true only for *Hylomyscus denniae*. In 1990, based on dental criteria, 20% were classified as juveniles; this figure doubled to 40% in 1991. If body weight data are used to define age, similar increases are obtained. Nearly twice as many females were with embryos in 1990 (Table IV) suggesting that the high pregnancy rate of Nov/Dec provided the high juvenile cohort documented in 1991.

The inverse pattern holds for *Lophuromys woosnami* (Tables IV and V). Relatively few pregancies were recorded in Nov/Dec (14%). This resulted in an older age cohort (100% adults) with fewer indiviuduals during the April/May census (Table VI). Between December 1990 and April 1991, the demographic profile increased in age as relatively few births occurred. A decrease in the absolute population of *Lophuromys woosnami* during this interval suggests attritional mortality. The pregnancy rate rose to 44% in April/May.

The demographic data for several species are hard to interpret. The smallest murine, *Mus bufo* may have such rapid turnover that the coarse seasonal differences we are able to document (a 5 month gap between surveys) are inadequate to distinguish demographic changes. The data for *Praomys jacksoni montis* and *Lophuromys flavopunctatus* do not appear to be significantly different from season to season. It is possible that two taxa of the *Praomys jacksoni* group (*sensu* Van der Straeten and Dudu, 1990) are present in the Rwenzori thereby confounding our ability to document ecological, demographic and behavioral affinities. As an additional variable, most *Lophuromys flavopunctatus* were captured at higher elevations in 1991. Data for *Lophuromys flavopunctatus* and *Mus bufo* yield different demographic results depending on ageing methodology, also suggesting statistical insignificance.

New Rwenzori Records

As a result of these surveys, six species are added to the Ugandan Rwenzori small mammal list (*Pipistrellus kuhlii fuscatus, Miniopterus inflatus, Myotis welwitschii, Sylvisorex vulcanorum, Crocidura dolichura, and Dendromus kivu lunaris*). Two of the bat species from these surveys are new records for the country (Stanley, et al. 1996). Although this survey appears comprehensive, many small mammal species, either known or described from the Rwenzori, were not documented in our 1989-90 surveys (*Chrysochloris stuhlmanni stuhlmanni, Micropotamogale ruwenzorii, Paracrocidura maxima, Ruwenzorisorex suncoides, Dasymys incomtus medius, Grammomys dryas, Thamnomys venustus, Mus triton fors*).

Elevational Distribution

Raw data on small mammal elevational distribution for the 1990 and 1991 field seasons are presented in Table VI. Data for both field seasons is combined in Table VII. Finally, our data is merged with that from the British Museum and is presented in the form of presence/absence data (Table VIII).

Small mammal communities in the Rwenzori are clearly defined. Below the forest line, in the Zone of 'Elephant Grass', the British Museum expedition documented many species assumed to be typical of this habitat: *Epomophorus labiatus anurus, Nycteris hispida, Pipistrellus nanus, Arvicanthis niloticus ssp., Grammomys dryas, Lemniscomys striatus ssp., Mastomys hildebrandtii ssp., Mus musculoides grata*. We collected none of these species as we did not sample the 'Elephant Grass'. Three of these species were also encountered by the British Museum expedition in the lowermost reaches of the forest zone but this may be due to the location of a native settlement at their forest camp site of Bihunga at that time. Additionally, several species were collected at 'Mokia' (Mohokya), a site on the acacia savannahs of the adjacent Queen

Elizabeth National Park. These species include *Lavia frons, Tatera valida, Lemniscomys macculus, Rattus rattus*, and *Graphiurus microtis*.

In the lowermost forested habitats, *Praomys jacksoni montis* is the most dominant species, comprising 50% and 45% of the rodents at our two camps (Kyoha R., Mahoma R.). *Graphiurus murinus ssp.* is also restricted to this zone but the sample size is small (n=3, FMNH; n=3, BMNH). Both species disappear completely in the higher reaches of the forest zone. Other common rodents in the lower forest zone include *Mus bufo (n=74, 16%), Hybomys lunaris (n=47, 10%), and Lophuromys woosnami* (n= 40; 9%). Shrews, represented by three genera and seven species, have their highest diversity in the lower forest zone. Two species (*Crocidura dolichura* and *C. niobe*) were only collected at this elevation.

A major rodent turnover occurs at the level of Nyabitaba, which we consider to be the upper reaches of the forest zone. The once dominant *Praomys jacksoni montis* has completely disappeared. Squirrels, the giant rat *Cricetomys*, four additional murines (*Hybomys lunaris, Lophuromys woosnami, Mus bufo, and Oenomys hypoxanthus*), and two shrews (*Crocidura olivieri ssp., Sylvisorex vulcanorum*) make their final appearance at Nyabitaba. The 'shrew-mouse' *Lophuromys flavopunctatus* also emerges as a dominant species, now representing 35% of the rodent fauna (vs. 3% in the lower forest zone). Insectivorous bats were not observed frequently within the forest zone. Of the four species encountered, none were found above Nyabitaba. Both species of *Rousettus* were present, although Nyabitaba was the highest elevation we encountered *Rousettus angolensis*.

Our sample of the Bamboo Zone was inadequate. Our limited data (n=14) suggest the rodent community is quite similar to the upper forest zone near Nyabitaba with *Lophuromys flavopunctatus* and *Hylomyscus denniae* well represented. However, *Lophuromys w. woosnami* is especially common in the solid bamboo stands. A special effort was made to capture shrews with pitfalls in the mesic habitats around Lake Mahoma. Our first record of the montane endemic *Crocidura montis* is from here but the BMNH expedition did record this species in the lower parts of the forest zone.

The small mammal fauna of the Tree-Heath and Moss Zone at 3400m (John Mate Camp) appears to be identical to the impoverished fauna from the Senecio and Lobelia Zone at Lake Bujuku. *Hylomyscus denniae* and *Lophuromys flavopunctatus* continue to dominate in number (39% and 25%). New additions include *Dendromus insignis*, the first multi-individual record of *Dendromus kivu and* the debut of the Rwenzori endemic, *Otomys typus dartmouthi*. *Rousettus lanosus* occurs in high numbers, as many occupy the nearby cliffs. After incorporating the British Museum records, the small mammal fauna is identical in the Senecio-Lobelia Zone of Lake Bujuku (one possible exception being *Chrysochloris stuhlmanni*).

DISCUSSION

Species Replacement

In order to interpret the abundant rodent data, we have lumped the rodent and bat species into groups (Table IX) which reflect our preliminary interpretations of their co-variation. These groups are determined by combinations of guild, niche and systematic relationship.

The displacement of *Rousettus angolensis ruwenzorii* by *Rousettus lanosus lanosus* may be due to roosting preference. *Rousettus lanosus* only roosts in caves, such as are found in the open cliffs above tree line, while *R. angolensis* prefers to roost in trees (Kingdon, 1974). *R. angolensis* may therefor be limited by the tree line which is why it may not occur above Nyabitaba. As there is no fruit in the upper elevations where it roosts, *R. lanosus* makes daily excursions to lower elevations to forage (Thomas and Wroughton, 1910).

It is possible that *Hybomys lunaris* (dropping from 12% to 2%) is replaced at Nyabitaba by the diurnal *Lophuromys flavopunctatus* (rising from 3% to 35%) but it is not clear if this may be due to a common body size and activity pattern (both diurnal, 40-50 grams) or to similar diets, as both can be insectivorous (Delany, 1975). Stomach contents are available to resolve the issue. The insectivorous *Lophuromys flavopunctatus* (Hatt 1940, Delany 1964) might be expected to fill the void vacated by a less diverse shrew community at Nyabitaba (which has dropped to 4 taxa) but the largest shrews are still plentiful (e.g. the 25-30 gram *Crocidura olivieri*).

Praomys jacksoni montis is apparently supplanted by the related taxon, *Hylomyscus d. denniae* which rises to 38% of the fauna (from 5% in the lower forest zone). These numerically dominant, nocturnal murines, were once considered to be congeneric (Misonne, 1974); they are currently considered to be closely related (Chevret *et al.* 1994).

By definition, above tree line (Nyabitaba), numerous forest species disappear. There appears to be little difference between the faunas of John Mate and Bujuku, so data are combined. Two new guilds of stenocephalic (narrow-headed) rodents appear, replacing the forest taxa in the now open moorland. One guild includes the species *Dasymys montanus*, *Otomys typus dartmouthi*, and *Otomys denti denti*. All three species are herbivorous, vole-like, large-bodied, thickly furred, short-tailed, and long-clawed. They represent 20% of the rodent fauna (Table IX) at this elevation. None of these species represented more than 1% of the rodent fauna at lower elevations.

The second stenocephalic guild is represented by the Dendromurines *Dendromus kivu* and *Dendromus insignis*. These species with their small, light build, prehensile tails and specialized cheiridia are thought to be grass-seed specialists clambering about on thin vertical supports (Kingdon, 1974). These two species represent 16% of the small mammal fauna at John Mate, 10% at Bujuku Hut. Only one Dendromurine was captured at lower elevations.

Similar patterns have been shown in the moorland of Ethiopia where the endemics *Otomys t. typus*, *Stenocephalymys albocaudata*, and *Dendromus lovati* are restricted to the ericaceous and moorland zone (Yalden, 1988). In describing the genus *Stenocephalymys*, Frick states, "The form most nearly approaching the new genus in its peculiar orbital constriction is *Dasymys*" (1914, p.7). In the moorlands of Ethiopia, *Stenocephalymys* may be the ecological vicar of *Dasymys*.

The stenocephalic condition facilitates dorsal rotation of the orbits, which, in open country, is conceivably useful in avoiding aerial predators (e.g. owls). It is relevant to note that all three Rwenzori species are often diurnal (12 of the 1[illegible] individuals collected in 1991 were collected during the day; Table III). In the Bale Mountains, Yalden (1973) documented small mammal prey remains from [illegible] Abyssinian long-eared owl (*Asio abyssinicus*) beneath a giant heath at 3940m. Of the 92 individuals recovered, 73 (79%) were either *Otomys t. typus* or *Stenocephalymys albocaudata*. Clearly these plump rodents are subject to severe predation pressure; perhaps diurnal activity, as exhibited by our Rwenzori taxa, reduces this pressure. On the other hand, the Rwenzori dendromurines discussed here were all trapped at night.

Diversity, Endemism, Biogeography and Conservation

A common pattern in tropical montane systems is that of decreasing vertebrate diversity with elevation. This trend has been documented for birds in the Rwenzori (Willard et al., this volume; with references). For small mammals and other vertebrates, this pattern is common (Peterson et al. 1993; Patterson et al. 1989; Patterson et al., in press, with references). Unfortunately, our lowest camp already begins at a high elevation (1900m). Among our well-surveyed Rwenzori camps (Low Forest, High Forest, Heath, Senecio), small mammal species diversity decreases with elevation (from 33 species to 21 to 13 to 12). However, the proportion of endemic species increases (from 52% to 62% to 77% and 75%). These data suggest that conservation efforts need to target both mid-elevation forests and high elevation moorlands, in order to maximize the maintenance of biodiversity. Only the maintenance of continuous longitudinal transects will provide effective conservation solutions.

The Rwenzori are an area of immense importance in discussions of central African biogeography and small mammal alpha-taxonomy. Since 1894, a minimum of 38 taxa (33 small mammals) have been described from the Rwenzori and its foothills (summarized in Table X). Twenty-six of the 33 taxa remain valid, while 21, an extraordinarily high number, are Albertine Rift endemics (Table VIII). The relatively low overall number of taxa may be due to the likely long-term isolation of the Rwenzori as well as the absence of low to mid-elevation forests in the Mubuku River valley. Additional surveys, targeting lower elevation forests and grasslands, such as those on the NW slope, might provide additional species records.

Eight hundred and forty one of the specimens described here are topotypical. As such, they are essential for defining levels of variation within these taxa. Rwenzori collections serve as a baseline for comparison with other reputed taxa. Based on our surveys, and those from mountains to the south, a minimum of 6 taxa are now known to be restricted to the Rwenzori: *Myosorex blarina*, *Hybomys lunaris*, *Dasymys montanus*, *Hylomyscus denniae denniae*, *Praomys jacksoni montis*, and *Cephalophus rubidus*. This unique suite of mammals enables us to delineate a 'Rwenzori' subdivision within the Albertine Rift zone of endemism. Recognition of taxa and their geographic and elevational distribution, is the most fundamental component in biodiversity surveys and assessments. Sound conservation management decisions must be based on the distribution of these taxa.

ACKNOWLEDGMENTS

Bats were collected by accompanying ornithologists Dave Willard, Tom Gnoske, and Joseph Obua. Our Bakonzo guides and field assistants were invaluable in the field. They include Jesitasi Bwambale, Silas Bakyulana, and Baluku Erisania. Two of our field colleagues, Joseph Obua and Robert Lubajo have since died. Field work was sponsored by a grant from the Marshall Field III Fund of Field Museum and the Ellen Thorne Smith Fund of Field Museum. We thank Rwenzori Mountain Services, the Ugandan Forest Department (B. Munyakabere, F. Kigenyi), Ugandan Game Department (Mr. J. Okua) and D. Pomeroy (Makerere University) for their support in this project.

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TABLE I: Trap Success for 1991 Survey

	Trapnights	Animals	Trap Success
Kyoha River	1217	117	9.6 %
Mahoma River	180	14	7.8%
Nyabitaba Camp	1197	125	10.4%
John Mate Camp	1245	68	5.5 %
Bigo Camp (1 night)	20	5	25.0%
Lake Bujuku	742	62	8.4 %
Lake Bujuku (cabin)	24	22	91.7%
Total	4601	413	9.0%

	Bats from Mistnets	Shrews from Pitfalls*	Pitfall Nights
Kyoha River	1	1	15
Mahoma River	-	5	10
Nyabitaba Camp	5	3	10
Lake Mahoma	-	3	20
John Mate Camp	23	6	15
Lake Bujuku	-	0	15

TABLE II: Daily Capture Rate and Species Diversity for Well Surveyed Camps (bats and carnivores excluded)

	Days	Captures	Avg.Daily Capture	Species Captured
Kyoha, 1990	9	146	16.2	14
Kyoha, 1991	7	132	18.9	10
Nyabitaba, 1990	11	186	16.9	11
Nyabitaba, 1991	8	133	16.6	11

Table III: Activity Patterns of Specimens Collected in 1991

Species	N=	Nocturnal	Diurnal
Cricetomys emini	9	9	-
Crocidura montis	3	1	2
Crocidura niobe	1	1	-
Crocidura olivieri	5	4	1
Dasymys montanus	8	3	5
Dendrohyrax arboreus	3	2	1
Dendromus insignis	7	7	-
Dendromus kivu	5	5	-
Galerella sanguineus	1	-	1
Genetta servalina	3	2	1
Hybomys lunaris	17	2	15
Hylomyscus denniae	127	125	2
Lophuromys flavopunctatus	84	36	48
Lophuromys woosnami	14	14	-
Miniopterus inflatus	1	1	-
Mus bufo	42	26	16
Myosorex blarina	3	2	1
Oenomys hypoxanthus	1	1	-
Otomys denti	4	3	1
Otomys typus	15	9	6
Praomys jacksoni	78	77	1
Rousettus angolensis	2	2	-
Rousettus lanosus	24	24	-
Sylvisorex granti	12	8	4
Sylvisorex lunaris	4	4	-
Sylvisorex vulcanorum	1	1	-

TABLE IV: Percentage of Sub-Adult/Adult Females with Embryos

	1990				1991					
Species	Ky	Ma	Ny	Total	Ky	Ma	Ny	JM	Bu	Total
Cricetomys emini	0/1	0/3	0/1	0/5	0/3	0/1	0/1	-	-	0/5
Crocidura dolichura	-	-	-	-	0/1	-	-	-	-	0/1
Crocidura montis	-	-	-	-	-	-	0/1	0/2	-	0/3
Crocidura niobe	-	1/4	-	1/4		-	-	-	-	-
Crocidura olivieri	0/1	1/2	0/4	1/7	-	-	1/2	-	-	1/2
Dasymys montanus	-	-	0/1	0/1	-	-	-	0/3	-	0/3
Dendrohyrax arboreus	-	-	-	-	-	-	-	-	0/1	0/1
Dendromus lunaris	-	0/1	-	0/1	-	-	-	0/2	0/1	0/3
Dendromus insignis	-	-	-	-	-	-	-	0/1	0/2	0/3
Funisciurus carruthersi	-	-	-	-	1/1	-	-	-	-	1/1
Graphiurus murinus	-	0/1	-	0/1	-	-	-	-	-	-
Galerella sanguinea	-	0/1	-	-	-	-	-	-	-	-
Hybomys lunaris	2/4	0/10	1/1	3/15	1/4	-	-	-	-	1/4
Hylomyscus denniae	0/2	1/5	9/29	10/36	1/2	1/13	2/20	3/10	2/13	9/57
Lophuromys flavopunct.	0/1	1/3	8/32	9/36	-	0/1	1/15	3/7	1/16	4/37
Lophuromys woosnami	2/7	1/9	1/12	4/28	3/3	1/1	0/5	-	-	4/9
Miniopterus inflatus	-	-	-	-	-	-	-	-	-	-
Mus bufo	2/9	0/3	0/5	2/17	5/10	-	1/4	-	-	6/14
Myosorex blarina	0/2	-	-	0/2	-	-	-	0/1	0/1	0/2
Myotis welwitschii	0/1	-	-	0/1	-	-	-	-	-	-
Oenomys hypoxanthus	0/1	1/2	-	1/3	-	-	0/1	-	-	0/1
Otomys denti	-	0/1	0/1	0/2	-	-	-	0/1	0/1	0/2
Otomys typus	-	-	-	-	-	-	-	1/3	2/6	3/9
Praomys jacksoni montis	8/22	3/32	-	11/54	9/23	0/3	-	-	-	9/26
Rousettus angolensis	3/4	9/18	1/5	13/27	-	-	1/1	-	-	1/1
Rousettus lanosus	-	-	1/3	1/3	-	-	-	5/17	-	5/17
Sylvisorex granti	-	-	-	-	-	0/1	0/2	0/1	-	0/4
Sylvisorex lunaris	0/4	-	-	0/4	-	-	-	0/1	-	0/1
Sylvisorex vulcanorum	0/1	-	-	0/1	-	-	-	-	-	-

TABLE V: Percentage of Juveniles for Common Species

	By Weight Nov/Dec 1990	By Weight Feb/Mar 1991
Hylomyscus denniae	7/44 = 16%	20/65= 31%
Mus bufo	11/55 = 20%	6/40 = 15%
Lophuromys flavopunctatus	13/82 = 16%	21/91 = 23%
Lophuromys woosnami	6/58 = 10%	0/13 = 0%
Praomys jacksoni montis	47/131 = 36%	32/73 = 44%

	By Dental Wear Nov/Dec 1990	By Dental Wear Feb/Mar 1991
Hylomyscus denniae	9/45 = 20%	26/65= 40%
Mus bufo	9/31 = 29%	13/25 = 52%
Lophuromys flavopunctatus	25/57 = 44%	15/46 = 33%
Lophuromys woosnami	10/32 = 31%	0/10 = 0%
Praomys jacksoni montis	37/65 = 57%	39/54= 72%

Table VI: Diversity as a Function of Elevation 1990 & 1991 Field Seasons Separate

Camp	Ky	Ma	Ny	1990 Total	Ky	Ma	Ny	LM	JM	Bu	1991 Total
Species											
Cricetomys emini ssp.	2	12	2	16	6	2	3	-	-	-	11
Crocidura dolichurassp.	-	-	-	-	1	-	-	-	-	-	1
Crocidura montis	-	-	-	-	-	-	-	1	2	-	3
Crocidura niobe	9	-	-	9	1	-	-	-	-	-	1
Crocidura olivieri ssp.	1	2	6	9	-	-	5	-	-	-	5

Table VI cont.

Camp	1990 Ky	1990 Ma	1990 Ny	1990 Total	1991 Ky	1991 Ma	1991 Ny	1991 LM	1991 JM	1991 Bu	1991 Total
Dasymys montanus	-	-	2	2	-	-	1	-	7	-	8
Dendrohyrax arboreus ssp.	-	1	-	1	-	-	-	-	1	2	3
Dendromus kivu	-	1	-	1	-	-	-	-	7	3	10
Dendromus insignis ssp.	-	-	-	-	-	-	-	-	4	3	7
Funisciurus carruthersi ssp.	-	-	-	-	2	-	-	-	-	-	2
Genetta servalina ssp.	-	-	-	-	1	1	1	-	-	-	3
Graphiurus murinus ssp.	-	4	-	4	-	-	-	-	-	-	-
Herpestes sanguineus ssp.	-	1	-	1	-	1	-	-	-	-	1
Hybomys lunaris	7	22	6	35	17	1	-	-	-	-	18
Hylomyscus d. denniae	6	13	54	73	5	-	61	2	27	33	128
Lophuromys flavopunctatus ssp.	4	7	73	84	2	2	32	5	17	32	90
Lophuromys w. woosnami	12	23	23	58	3	2	6	6	-	-	17
Miniopterus inflatus	-	1	-	1	-	-	-	-	-	-	0
Mus b. bufo	36	13	15	64	24	1	18	1	-	-	44
Myosorex blarina	4	-	-	4	-	-	-	-	2	1	3
Myotis welwitschii venustus	1	-	-	1	-	-	-	-	-	-	-
Oenomys hypoxanthus ssp.	1	5	-	6	-	-	1	-	-	-	1
Otomys d. denti	-	1	2	3	1	-	-	-	2	1	4
Otomys typus dartmouthi	-	-	-	-	-	-	-	-	5	11	16
Pipistrellus kuhlii fuscatus	-	-	-	-	-	-	1	-	-	-	1
Praomys jacksoni c.f. montis	57	80	-	137	69	9	-	-	-	-	78
Rhinolophus m. ruwenzorii	-	1	1	2	-	-	2	-	-	-	2
Rousettus a. ruwenzorii	4	29	4	37	1	-	1	-	-	-	2
Rousettus l. lanosus	1	-	3	4	-	-	1	-	23	-	24
Sylvisorex g. granti	1	-	2	3	-	3	3	2	4	1	13
Sylvisorex l. lunaris	5	-	-	5	-	1	1	-	2	-	4
Sylvisorex vulcanorum	1	1	1	3	-	1	-	-	-	-	1

Table VII: Diversity as a Function of Elevation
1990 & 1991 Field Seasons Combined

Camp	Ky	Ma	Ny	LM	JM	Bu	Total
INSECTIVORA							
Crocidura dolichura ssp.	1	-	-	-	-	-	1
Crocidura montis	-	-	-	1	2	-	3
Crocidura niobe	10	-	-	-	-	-	10
Crocidura olivieri ssp.	1	2	11	-	-	-	14
Myosorex blarina	4	-	-	-	2	1	7
Sylvisorex granti granti	1	3	5	2	4	1	16
Sylvisorex lunaris lunaris	5	1	1	-	2	-	9
Sylvisorex vulcanorum	1	2	2	-	-	-	5
CHIROPTERA							
Rousettus angolensis ruwenzorii	5	29	5	-	-	-	39
Rousettus lanosus lanosus	1	-	4	-	23	-	28
Rhinolophus maclaudi ruwenzorii	-	1	3	-	-	-	4
Miniopterus inflatus	-	1	-	-	-	-	1
Myotis welwitschii venustus	1	-	-	-	-	-	1
Pipistrellus kuhlii fuscatus	-	-	1	-	-	-	1
CARNIVORA							
Genetta servalina ssp.	1	1	1	-	-	-	3
Galerella sanguineus ssp.	-	2	-	-	-	-	2
HYRACOIDEA							
Dendrohyrax arboreus ssp.	-	1*	-	-	2	2	5
RODENTIA							
Funisciurus carruthersi ssp.	2	-	-	-	-	-	2
Cricetomys emini ssp.	8	14	5	-	-	-	27
Dendromus kivu ssp.	-	1	-	-	7	3	11
Dendromus insignis percivali.	-	-	-	-	4	3	7
Dasymys montanus	-	-	3	-	7	-	10
Hybomys lunaris	24	23	6	-	-	-	53
Hylomyscus d. denniae	11	13	115	2	27	20	201
Lophuromys flavopunctatus ssp.	6	9	105	5	17	25	174
Lophuromys woosnami ssp.	15	25	29	6	-	-	75
Mus bufo ssp.	60	14	33	1	-	-	108
Oenomys hypoxanthus ssp.	1	5	1	-	-	-	7
Praomys jacksoni montis	126	89	-	-	-	-	215
Otomys denti denti	1	1	2	-	2	1	7
Otomys typus dartmouthi	-	-	-	-	5	11	16
Graphiurus murinus ssp.	-	4	-	-	-	-	4
TOTAL RODENTIA	254	198	299	14	69	63	917

Table VIII: Small Mammals known from the Ugandan Slope of Rwenzori and their Elevational Range

vegetation type	Grass	Forest Low	Forest High	B'boo	Heath	S'cio
elevation beginning at (m)	1500	1900	2600	2960	3300	3800
INSECTIVORA						
Chrysochloris s. stuhlmanni	-	B	B	B	B	-
Crocidura dolichura ssp.	-	F	-	-	-	-
Crocidura montis[1]	-	-	-	F	F	B
Crocidura niobe	B?	BF	-	-	-	-
Crocidura olivieri nyansae	B?	BF	BF	-	-	-
Myosorex blarina (R)	-	F	-	B	F	F
Sylvisorex g. granti	-	F	F	BF	F	F
Sylvisorex l. lunaris	B?	BF	F	B	B	B
Sylvisorex vulcanorum	-	F	F	-	-	-
CHIROPTERA						
Epomophorus labiatus anurus	B	-	-	-	-	-
Rousettus angolensis ruwenzorii	B	BF	F	-	-	-
Rousettus lanosus lanosus	-	F	F	-	BF	B
Rhinolophus maclaudi ruwenzorii	-	F	F	-	-	-
Nycteris hispida ssp.	B	-	-	-	-	-
Miniopterus inflatus ssp.	-	F	-	-	-	-
Myotis welwitschii venustus	-	F	-	-	-	-
Pipistrellus nanus ssp.	B	-	-	-	-	-
Pipistrellus kuhlii fuscatus	-	-	F	-	-	-
CARNIVORA						
Nandinia binotata ssp.	B	-	-	-	-	-
Genetta maculata ssp.	B?	B	-	-	-	-
Genetta servalina ssp.	-	BF	BF	-	-	-
Galerella sanguineus ssp.	B	BF	-	-	-	-
Mungos mungo ssp.	B	-	-	-	-	-
RODENTIA						
Paraxerus boehmi emini	B?	B	-	-	-	-
Funisciurus carruthersi ssp.	-	BF	-	-	-	-
Heliosciurus ruwenzorii ssp.	-	B	B	-	-	-
Cricetomys emini ssp.	B?	BF	F	-	-	-
Dendromus insignis percivali	-	-	-	B	F	F
Dendromus kivu ssp.	-	F	-	-	F	F
Arvicanthis niloticus ssp.	B	-	-	-	-	-
Dasymys incomtus ssp.	B?	B	B	-	-	-
Dasymys montanus (R)	-	-	F	-	BF	B
Grammomys dryas	B	B	-	-	-	-
Hybomys lunaris (R)	B?	BF	F	-	-	-

(cont. next page)

Table VIII (cont.): Small Mammals known from the Ugandan Slope of Rwenzori and their Elevational Range

vegetation type	Grass	Forest Low	Forest High	B'boo	Heath	S'cio
elevation beginning at (m)	1500	1900	2600	2960	3300	3800
RODENTIA (cont.)						
Hylomyscus d. denniae (R)	B?	BF	BF	BF	BF	BF
Lemniscomys striatus ssp.	B	B	-	-	-	-
Lophuromys flavopunctatus ssp.	B?	BF	BF	BF	BF	BF
Lophuromys woosnami ssp.	B?	BF	BF	F	-	-
Mastomys hildebrandtii ssp.	B?	B	-	-	-	-
Mus bufo ssp.	B?	BF	F	F	-	-
Mus musculoides grata	B?	B	-	-	-	-
Mus triton fors (NE Rwenzori)	-	B	-	-	-	-
Oenomys hypoxanthus ssp.	B?	BF	F	-	-	-
Praomys jacksoni montis (R)	B?	BF	-	-	-	-
Thamnomys venustus ssp.	-	-	B	-	-	-
Otomys d. denti	B?	BF	F	B	F	F
Otomys typus dartmouthi	-	-	-	-	BF	BF
Graphiurus murinus ssp.	B	B?F	-	-	-	-
Total Number of Species[2]	?	33	21	11	13	12
Total Number Endemics	?	17	13	9	10	9
% Endemics	?	52%	62%	82%	77%	75%

Boldface = Albertine Rift Endemic
(R) = Rwenzori Endemic
F = Field Museum/Makerere Expedition
B = British Museum Expedition
B?= see Methods
[1] = also known from Mt. Meru and Imatong Mts., Demeter and Hutterer 1986
[2] = Carnivora excluded

Table IX: Distribution of Rwenzori Small Mammals by Guild and Elevation

camp	**Ky**	**Ma**	**Ny**	**JM**	**Bu**
elevation	**1920m**	**2100m**	**2650m**	**3350m**	**3900m**
FOREST ZONE FALLOUT					
Funisciurus carruthersi	<1%	-	-	-	-
Graphiurus murinus	-	2%	-	-	-
Cricetomys emini	3%	7%	2%	-	-
Lophuromys woosnami	6%	13%	10%	-	-
Mus bufo	24%	7%	11%	-	-
Oenomys hypoxanthus	<1%	3%	<1%	-	-
	34%	**32%**	**24%**		
STENOCEPHALIC GUILDS					
Grass-Seed Eaters					
Dendromus insignis	-	-	-	6%	5%
Dendromus kivu	-	<1%	-	10%	5%
Grazers					
Dasymys montanus	-	-	1%	10%	0%
Otomys denti	<1%	<1%	<1%	3%	2%
Otomys typus	-	-	-	7%	17%
				36%	**29%**
DIURNAL DISPLACEMENT					
Hybomys lunaris	**9%**	**12%**	**2%**	-	-
Lophuromys flavopunctatus	2%	5%	**35%**	**25%**	**40%***
DOMINANT NOCTURNAL MURINES					
Hylomyscus d. denniae	4%	7%	**38%**	**39%**	**32%***
Praomys jacksoni montis	**50%**	**45%**	-	-	-
Total Rodents	99%	101%	100%	100%	101%

*does not include 13 H. denniae and 7 L. flavopunctatus captures **within** Bujuku Hut

ROOST COMPETITORS (as % of all fruit bats captured)					
Rousettus angolensis	**7%**	**43%**	7%	-	-
Rousettus lanosus	1%	-	**6%**	**34%**	-

TABLE X: Mammal Taxa Described from the Rwenzori: 1894-1997

Taxon Named	Current Status	Author	Year
Potamogale ruwenzorii	Micropotamogale ruwenzorii	de Witte & Frechkop	1955
Chrysochloris stuhlmanni	Chrysochloris stuhlmanni	Matschie	1894
Crocidura fumosa montis	Crocidura montis	Thomas	1906
Crocidura niobe	Crocidura niobe	Thomas	1906
Myosorex blarina	Myosorex blarina	Thomas	1906
Sylvisorex granti	Sylvisorex granti	Thomas	1907
Sylvisorex lunaris	Sylvisorex lunaris	Thomas	1906
Sylvisorex suncoides	Ruwenzorisorex suncoides	Osgood	1936
Rousettus angolensis ruwenzorii	R. a. ruwenzorii	Eisentraut	1965
Rousettus lanosus	Rousettus lanosus	Thomas	1906
Rhinolophus ruwenzorii	R. maclaudi ruwenzorii	Hill	1942
Cercopithecus stuhlmanni carruthersi	Cercopithecus mitis	Pocock	1907
Colobus ruwenzorii	Colobus angolensis	Thomas	1901
Crossarchus fasciatus macrurus	Mungos mungo	Thomas	1907
Mungos gracilis proteus	Galerella sanguinea	Thomas	1907
Felis pardus ruwenzorii	Panthera pardus	Camerano	1906
Procavia (Dendrohyrax) ruwenzorii	Dendrohyrax arboreus	Neumann	1902
Cephalophus rubidus	Cephalophus rubidus	Thomas	1901
Funisciurus carruthersi	F. carruthersi	Thomas	1906
Sciurus rufobrachiatus ruwenzorii	Heliosciurus ruwenzorii	Schwann	1904
Dendromus lunaris	Dendromus kivu	Osgood	1936
Tatera ruwenzorii	Tatera valida	Thomas & Wroughton	1910
Dasymys medius	Dasymys incomtus medius	Thomas	1906
Dasymys montanus	Dasymys montanus	Thomas	1906
Leggada bufo	Mus bufo	Thomas	1906
Leggada fors	Mus triton	Thomas & Wroughton	1910
Leggada grata	Mus musculoides	Thomas & Wroughton	1910
Arvicanthus macculus	Lemniscomys macculus	Thomas & Wroughton	1910
Lophuromys woosnami	L. woosnami	Thomas	1906
Mus denniae	Hylomyscus denniae	Thomas	1906
Mus univittatus lunaris	Hybomys lunaris	Thomas	1906
Mus jacksoni montis	Praomys montis	Thomas & Wroughton	1910
Oenomys bacchante editus	Oenomys hypoxanthus	Thomas & Wroughton	1910
Thamnomys dryas	Grammomys dryas	Thomas	1907
Thamnomys venustus	Thamnomys venustus	Thomas	1907
Otomys dartmouthi	Otomys typus dartmouthi	Thomas	1906
Otomys denti	Otomys denti	Thomas	1906
Graphiurus soleatus	Graphiurus murinus	Thomas & Wroughton	1910

Appendix: Notes on the Collection of Voucher Specimens

1) Conservation efforts should prioritize the maintenance of ecosystems rather than individual organisms. Collections, and the publications based on them, will establish a baseline so that future monitoring efforts have a reference for comparison.

2) Vouchers must be deposited in maintained museums and herbaria both in Uganda and elsewhere. In this way, specimens are available for review by scientists in order to resolve discussions over taxonomic status. Such accredited institutions are designed to care for these irreplaceable specimens.

3) We must be able to identify that which we are attempting to conserve. For small mammals and most other organisms, this requires the collection of specimens. Most organisms cannot be identified without voucher specimens. Identification in the hand is often impossible. For small mammals we depend upon skins, skulls, teeth, ectoparasites, DNA, chromosomes, genitalia, bacula, soft anatomy, etc.; often requiring the sacrifice of the animal. The three most speciose mammalian groups are shrews (428), bats (925) and rodents (2021); one African shrew genus, *Crocidura*, alone contains 149 species (Wilson and Reeder 1992). These three groups comprise 73% of mammalian diversity and many species cannot be properly identified in the field.

4) Among small mammal identification keys, the best available (e.g. Delany, 1975; Meester & Setzer, 1972) are terribly out-of-date and are, at best, good to the level of genus only. Further, these keys can only be used when a clean skull is available. Collections, such as ours, will help to construct keys with greater resolution.

5) Large series of specimens are often required to resolve species identifications. For example, in this Rwenzori survey, 201 individuals of *Hylomyscus denniae denniae* were collected from all 7 sites. Of these, only 28 were fully grown adult males (dental age stage 5 and above, Verheyen and Bracke 1966). This sample of 28 barely allowed us to demonstrate that this species did not vary with elevation. Using these data, we can demonstrate that much smaller specimens, previously referred to as "*Hylomyscus denniae*" from Mgahinga Gorilla National Park, are really a distinct taxon known as "*Hylomyscus denniae vulcanorum*", described from the Virungas in 1925 (Lonnberg and Gyldenstolpe). This also means that *Hylomyscus denniae denniae* may only be known from the Rwenzori.

6) Scientific methodology requires the collection of vouchers. Data must be verifiable, refutable and subject to further analyses. For example, the first worldwide mammal checklist (Honacki et al., 1974) listed 433 species of mice versus the most recent checklist (Wilson & Reeder, 1992) which lists 529, an increase of 22%. However, most of these are not newly described species. Of the total of 460 new mammal taxa recognized in this 18 year period, 290 (63%) were resurrected from synonymy (meaning from previously described specimens residing in museums). This reflects our changing perceptions of species definitions as well as the increasing number of tools available to discriminate closely related taxa (DNA, chromosomes, multivariate statistics, etc.).

7) We use the standard Species Accumulation Curve in determining whether we have accurately documented the fauna of a given camp. Numbers of new species encountered each day are plotted against cumulative trap effort (e.g. trapnights). When the curve reaches a plateau, and no new species are encountered for several days, we

assume that we have documented most of the mammal species targeted by our methodology. Invariably, species that are the most common or abundant are encountered first and in the highest numbers. Only after the removal of the more common species are less frequent species observed. The number of camps is chosen to sample the maximum number of ecological zones within the protected area. These zones are typically determined by elevational range, edaphic conditions and vegetation communities.

8) After a particular protected area is properly surveyed for small mammals, specimens are distributed to the appropriate institutions and alpha-taxonomists. Identification keys can then be developed in order to identify the relevant species in the hand. At this point, ecological studies can begin. However, even at this point, representative vouchers should be retained. Without this, ecological studies may be severely flawed. For example, numerous South African studies of *Mastomys natalensis* failed to realize that two sibling species were involved. It is now impossible to resolve which species was the subject of the dozens of ecological, behavioral, and medical studies which were conducted (Meester, 1990).

9) Our methodologies have minimal impact on communities of small mammals. Small mammals, especially rodents, have exceptionally high reproductive turnover. The Makerere University/ Field Museum Rwenzori expedition of 1990/1991 gathered 1039 rodents, shrews and bats from 6 camps along a single transect. This number of small mammals would be consumed by a single owl (actually 1.15 owls) over the same three month time period (assuming a daily capture rate of 10 rodents; Yates, et al. 1987).

Daniel Aleper (1995) provided relevant data from Bwindi-Impenetrable National Park. In his one hectare open-canopy study plot, small mammal numbers increased from 31 to 73 individuals during a three month period. This translates into a 1½ million increase in the small mammal population for the 331 km^2 park during this period. This is an underestimate; including accurate population estimates for shrews, bats and larger rodents might double these figures. The removal of several hundred small mammals from different localities in Bwindi would have a negligible impact.

In order to have an indication of small mammal density and to understand the level of trapping intensity, we present trapnight data from the 1991 field season (Table I). Although we do not have data on trap success for our first expedition, it is worth noting that trap success in 1991 is quite high for Kyoha and Nyabitaba (averaging 10%), only five months after the first expedition. Sites unsampled in 1990 (John Mate and Lake Bujuku) have relatively low trap success (5.5% and 8.4%) but this may simply reflect differing small mammal densities in the different habitats.

Assuming similar trapping effort between the two field seasons, a comparable number of specimens were recovered on a daily basis from the two intensively surveyed camps (Table II): Kyoha, approx. 16 specimens per day in 1990 vs. 19 in 1991; Nyabitaba, approx. 17 specimens per day in both 1990 and 1991. Available data do not suggest a depletion of small mammal numbers from one field season to the next. This suggests that our trapping efforts have little effect on small mammal demographics and, in fact, that other variables are far more influential in affecting small mammal populations.