

An annotated checklist of terrestrial small mammals of Nyungwe National Park in Rwanda based on recent reassessments (2009–2023)

Methode Majyambere^{1,2*}, Philbert Ndahayo³, Alexis Nsabimana² and Antoine Nsabimana^{1,2}

¹*Department of Biology, College of Science and Technology, University of Rwanda;* ²*Center of Excellence in Biodiversity and Natural Resource Management, Rwanda;* ³*Nyungwe Management Company, African Parks, Rwanda*

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Abstract: Terrestrial small mammals, including rodents, shrews and a few allied species, are a diverse group among mammals. Nyungwe National Park, located in Rwanda, is a biologically rich tropical rainforest in the Albertine Rift. This article generates an annotated species checklist of terrestrial small mammals of Nyungwe National Park, considering the results of field reassessments from 2009 to 2023 and existing checklists. Voucher specimens and Cytb sequencing results were examined to confirm the identification of many cryptic species. The results indicated 58 species of terrestrial small mammals of Nyungwe natural habitat, including 40 rodents (Rodentia), 16 shrews (Eulipotyphla), one mole, and one otter-shrew (Afrosoricida). Six species were recorded outside the natural forest, such as the buffer zone or agricultural lands. An annotation on each species indicates details of its occurrence, updated taxonomic information, and key ecological characteristics based on our surveys and the literature. Around 20 species were added to the existing checklists of Nyungwe terrestrial small mammals owing to field survey efforts and advanced taxonomic approaches. The current checklist promotes small mammal studies in Nyungwe and will be a valuable reference for future studies. Furthermore, the park managers will use this checklist in tourism and biodiversity monitoring plans.

Key words: Diversity; small mammal; field; species checklist; Nyungwe.

Introduction

Groups of mammals designated as small mammals due to their relatively small size, even if their anatomical or morphological similarities are not evident, include rodents (Rodentia), bats (Chiroptera), shrews (Eulipotyphla), elephant shrews (Macroscelidea), golden moles, otter-shrews, and tenrecs (Afrosoricida), and some small-sized marsupials (Barnett and Dutton 1995; Bennun et al. 2004). Among the significant small mammal clades, the orders Rodentia, Eulipotyphla, and Chiroptera are highly represented in species. They are among the major faunal components of tropical ecosystems, owing to their diversity, relatively significant biomass, and crucial position in the food chains.

*Corresponding author. E-mail: m.majyambere@ur.ac.rw

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The Albertine Rift is a region of exceptional biodiversity characterized by a high level of endemism. Most of Rwanda, particularly the western region, lies within the Albertine Rift zone, a biodiversity hotspot. The inventory of mammals is important for various purposes, including distribution maps and the comparison between sites (Tobler *et al.* 2008). Census tools that combine multiple levels of accuracy, reliability, cost-effectiveness, and easy application are the best choices because such studies allow repeated and consistent monitoring (Jackson *et al.* 2006). An accurate description of species is not only necessary for establishing species checklists, but also for the invaluable information it holds to respond to many questions of biology and ecology (Nicolas *et al.* 2010). Correct identification is critical when working with small mammals and is essential before exploring other ecological aspects.

Small mammals have been surveyed in the primary forest of Nyungwe National Park, also referred to as Nyungwe, although systematic surveys were conducted less frequently. Plumptre *et al.* (2007) realized that small mammals had been poorly surveyed in much of the Albertine Rift, especially in the southern end; therefore, more species were likely to be discovered. In Nyungwe, Dowsett and Dowsett-Lemaire (1990) conducted an in-depth survey of small mammals, including bats. Observations of terrestrial small mammals of Cyamudongo forest were compared to those of Nyungwe, with eight and 28 species, respectively (Geider and Kock 1991). Most of the recent data on terrestrial small mammals of Nyungwe, starting from 2009, are not peer-reviewed publications: they include the results from an extensive survey (Kerbis Peterhans and Ntare 2009), a Master's thesis (Majyambere 2013), and survey results on Cyamudongo and other small forest fragments annexed to Nyungwe (Majyambere 2019). Those two last studies revealed challenges in ascertaining the identification to species level for some rodents and shrews relying on morphology. Through recent molecular analyses on samples from 2021-2023 surveys, we reviewed the literature, field records, and DNA results to generate a checklist for the terrestrial small mammals of Nyungwe. Such a checklist will support conservation science, field research, ecotourism, and wildlife management plans and strategies in Nyungwe and academic institutions nationally, regionally, and internationally.

Materials and Methods

Study area

This article discusses the terrestrial small mammals recorded from Nyungwe National Park, which we will call Nyungwe, a tropical montane rainforest in southwestern Rwanda. Initially gazetted as a nature reserve, Nyungwe was officially established as a national park in 2005. Nyungwe was officially designated a UNESCO World Heritage Site in September 2023. Its surface area is 1,019.637 km² (or 1,019.637 ha), which contains 1,015.156 km² of Nyungwe natural forest, 4.304 km² of Cyamudongo natural forest, and 0.177 km² of Gisakura natural forest (IUCN 2023). The Nyungwe main forest lies between 2.26° to 2.84°S and 28.97° to 29.45°E as visualized in ggmap (Kahle and Wickham 2013). Nyungwe extends between 2.26° to 2.84°S and 28.97° to 29.45°E on the eastern side when Cyamudongo forest, located 10 km away, is included. In the South, Nyungwe is continuous with the Kibira National Park of Burundi. Between 2009 and 2023, numerous sites were sampled, yielding data on the described species (Figure 1). These include studies of small mammals in 2009, 2011, 2012, 2019, and 2021-2023.

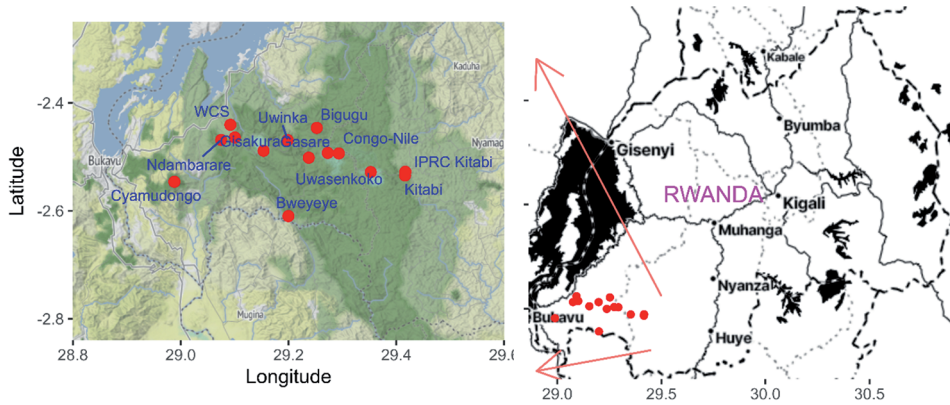


Figure 1. Map of Nyungwe National Park (showing Nyungwe main forest and Cyamudongo) and different sites sampled between 2009 and 2023 for terrestrial small mammals.

Fieldwork and species identification

During the field surveys, standard morphometric data were taken from captured individuals: Weight (WT), Head-Body Length (HBL), Tail Length (TL), Ear Length (EL), and Hind Foot Length (FL). In 2009, specimens were prepared. In 2011–2012 study, live methods with capture-mark-recapture were used. As some voucher specimens are necessary for identifying species reliably (Rickart 2001; Weier et al. 2016; Palma et al. 2017), some individuals were sacrificed, and voucher specimens were prepared. In 2021–2023 studies, live trapping was performed, but specimens were also prepared. The specimens were deposited in zoological collections of the Center of Excellence in Biodiversity and Natural Resource Management (CoEB). Species were identified based on morphological identification in the field. For the species recorded in 2021–2023, DNA laboratory work for Cytb sequencing was conducted at the Institute of Vertebrate Biology of the Czech Academy of Sciences. For some species where identification was partial or reference sequences did not correspond to a fully identified species, “cf.” is used, such as *Lophuromys* cf. *cinereus*. This means that the specimen best fits within the morphological variation, with the possibility of another species being identified under further examination (Nicolas and Colyn 2006).

Documentation

We used unpublished data from our studies conducted from 2009 to 2023 in Nyungwe: survey of terrestrial small mammals in Nyungwe (2009), Master’s thesis (2012), field survey at Cyamudongo and Gisakura forests (2019), biodiversity summer school team for terrestrial small mammals (2021 and 2022), and field results for PhD research in Nyungwe (2022 to 2023). We also downloaded the database of the world’s mammals from the ASM Mammal Diversity Database (Burgin et al. 2018; Upham et al. 2025) to select mammals specifically known to range in Rwanda, which helped us analyze the different records individually and cross-check the sources of information case by case. We documented the references that indicated the checklists of the mammals of Nyungwe specifically, and we conducted only terrestrial small mammals.

Data analysis

We compiled checklists of mammals recorded in various published documents related to Nyungwe National Park (formerly known as Nyungwe Forest Reserve, Forêt de Ruggege, and Nyungwe Forest) in Microsoft Excel spreadsheets, considering multiple studies and previous checklists. The Mammal Diversity Database (MDD) also helped with the higher classification of species (main taxa and intermediate taxa), and we arranged the taxa properly to produce a harmonized list. We indicated the species' orders, suborders, and families in a continuous list, after which the species were arranged alphabetically in each family. The references are integrated into the annotations to the checklist for more clarification, where necessary.

Results

The terrestrial small mammals of Nyungwe, reassessed based on surveys conducted intermittently since 2009, comprise 58 species in the natural forest distributed in three orders: Afrosoricida, Eulipotyphla, and Rodentia. The three orders comprise two, 16, and 40 species, respectively. Six species in the checklist exist in agricultural and agroforestry patches. Among the 58 species, about half have been reassessed and proven by various means, including our field records, observations, and shared data. About half of the listed terrestrial small mammal species are still considered extant in Nyungwe based on the literature, despite the absence of recent evidence.

Annotated list of terrestrial small mammal species of Nyungwe National Park

Order Afrosoricida

Family Chrysochloridae

1. *Chrysochloris stuhlmanni* (Matschie, 1894), Stuhlmann's golden mole

This species was also documented at Uwinka in the 1960s. We recorded it at Bigugu (2009), Uwinka (2002), and Gisakura (2022), representing respectively the highest, medium, and lowest elevation ranges in Nyungwe. The body mass of the individuals at high and low altitudes was similar (32–33 g with 113 mm of body length). In comparison, the individuals at the middle altitude were larger (40 g with 123 mm of length). Its habitat at the peak of Bigugu is humid, covered by alpine moss. At Uwinka, it was captured near a small stream around muddy soils during a rainy period. Though a few individuals were recorded, its typical habitat is known to be associated with well-drained soils.

Family Potamogalidae

2. *Micropotamogale ruwenzorii* (de Witte & Frechkop, 1955), Rwenzori otter-shrew

We recorded this species for the first time in Rwanda in 2009. We captured one individual at an elevation of 2120 m in the Nyabishwati River (2°30'5.29"S 29°14'15.21"E). The habitat was humid and distant from the road edges, and the canopy was closed. Our record marks the only time the range of that species was recorded outside the Democratic Republic of the Congo (DRC) and Uganda. Apart from its known association with rivers in tropical rainforests or gallery forests, other ecological characteristics in Rwanda, particularly in Nyungwe, are unexplored.

Order Eulipotyphla

Family Soricidae

3. *Crocidura dolichura* (Peters, 1876), Long-tailed white-toothed shrew
We captured this small shrew at Bigugu (high altitude, distant from the edge) and Bweyeeye (1730 m of elevation, near the edge) in 2009 as its first record in Nyungwe. The individual recorded at Mount Bigugu marks the broader altitudinal range of the species beyond the presumed limits of 2300 m indicated by Hutterer et al. (2016). This species was relatively abundant among other shrew records in the DRC (Gambalemoke et al. 2008). The observation on the iNaturalist platform may refer correctly to that species (<https://www.inaturalist.org/observations/32996087>), which might have been missed through morphological analysis between 2011 and 2020.
4. *Crocidura hildegardae* (Thomas, 1904), Hildegard's white-toothed shrew
This species was recorded in the 1960s with a note on its rare observation in montane forests, and later was not confirmed in Nyungwe, but at other places in Rwanda, such as Butare (Hutterer et al. 1987). The description of a record at Kitabi in 2012 relied on morphology, but such observation does not contradict its occurrence since it is occasionally documented in forests elsewhere.
5. *Crocidura lanosa* (Heim de Balsac, 1968), Kivu long-haired white-toothed shrew
Two individuals of this species were collected at Nyabishwati River, not far from Uwinka, in 2009; other previous resources also document this record in Nyungwe, precisely at Uwinka (Hutterer et al. 1987), but none after 2009. It has so far been recorded in Rwanda and the DRC (closer to Lake Kivu). The woolly pelage covering this large-sized shrew (18–34 g) could be an adaptation to cold environments (Happold and Happold 2013).
6. *Crocidura maurisca* (Thomas, 1904), Gracile white-toothed shrew
Two individuals were collected at two sites inside the park (Bweyeeye, Gasare) in 2009, but no earlier survey mentioned this species in Nyungwe. It was also documented in 2019 from morphological analysis. It was identified from four individuals captured in the mid-altitude swamp (~2367 m) at Uwasenkoko in 2021, confirmed by Cytb sequencing. Its habitat has proven to be a marshland with sedge, as from the literature, but this species does not seem to be as rare as thought.
7. *Crocidura niobe* (Thomas, 1906), Niobe's white-toothed shrew
We captured one individual at Mount Bigugu in 2009, marking the presence of this species. Documented DNA sequence of its presence in Nyungwe is our record registered under GenBank as specimen "FMNH 207667". Hutterer et al. (1987) have not mentioned this species for Rwanda. The habitat selection of montane forests at high altitude, often associated with marshes, is inferred from our study.
8. *Crocidura olivieri* (Lesson, 1827), African giant white-toothed shrew
This species was always documented in Nyungwe, often with the name of *C. occidentalis* (*C. olivieri occidentalis* (Pucheran, 1855)). We found this species at all the sites covered in Nyungwe in 2009. This species was also documented in subsequent surveys, including those conducted in 2012, 2019, 2022, and 2023. In 2022–2023, tissues for most of the shrews (at least 80% of samples) were identical to *C. olivieri* from Cytb gene sequences. Its taxonomy has been revisited over time, indicating a potential for splitting it into more species. It has invaded the savannah and forest habitats of Africa and is characterized by synanthropic habits (Jacquet et al. 2015); therefore, it should be widespread.

9. *Myosorex babaulti* (Heim de Balsac & Lamotte, 1956), Babault's mouse shrew
We captured two individuals at a high altitude of Mount Bigugu in 2009. In 2022, we collected a carcass on a trail at mid-altitude level (2°32'03.1"S 29°13'40.2"E) at Uwinka, which was identified in the field at the genus level and was later confirmed by Cytb gene sequencing. Moist and shady habitats are preferred by this species, and it must certainly be rare, as so far documented. Our record corresponds to the observation at <https://inaturalist.lu/photos/221966500>. The species was not documented in Rwanda by earlier records, including the country list of the shrews (Hutterer *et al.* 1987).
10. *Paracrocidura maxima* (Heim de Balsac, 1959), Greater large-headed shrew
This species was documented in Nyungwe prior to our 2009 survey, but was documented afterwards. It was recorded in a stream at the edge of the primary forest (2°26'00"S 29°11'00"E) (Hutterer 1986). It could have been recorded in the Nyirakesha valley (Dowsett and Dowsett-Lemaire 1990), which should not be confused with a small remnant plot of natural forest (2.7 ha) in 500-700 m from the park (2°24'12.04"S 29°10'31.09"E) where that river passes (Majyambere 2019).
11. *Ruwenzorisorex suncooides* (Osgood, 1936), Rwenzori shrew
The only records of this species are from a handful of specimens in Rwanda and neighboring countries; often, one specimen was collected at each locality. In Nyungwe, it was recorded at Uwinka in the 1960s as *Sylvisorex suncooides*, which indicates a change of the genus and taxonomic updates. This should be a very scarce species as noted, which lives near shallow streams in montane forests, and has adopted some semi-aquatic morphological traits and behavioral habits (Happold and Happold 2013).
12. *Scutisorex somereni* (Thomas, 1910), Armored hero shrew
The armored hero shrew is a large-sized shrew primarily characterized by its thick fur with harsh hairs. Around ten specimens were collected at Uwinka before the 1980s. However, no further record was documented. The species does not have restrictions for altitudes or habitat types within primary and secondary forests, including swampy zones (Happold and Happold 2013). Its unique vertebral morphology leads to inference into foraging adaptations, and a second species under this genus emerged, known in the DRC (Stanley *et al.* 2013). One photographic illustration of that species could be currently accessible online at <https://inaturalist.org/taxa/46784>.
13. *Suncus hututsi* (Kerbis Peterhans & Hutterer, 2009), Hutu-Tutsi dwarf shrew
As this was only recently described, it was subsequently identified in Nyungwe. The very small dark shrew (4-7 g) has a relatively long tail with bristle-hairs covering ca. 50 % of its length (Kerbis Peterhans and Hutterer 2009). The occurrence of three individuals near Bweyeye (2°36'35.1"S 29°11'59.39"E) denotes the range overlap with the type locality, Kibira National Park, a continuation of Nyungwe into the neighboring Burundi. The Hutu-Tutsi dwarf shrew was listed as Data Deficient in IUCN status until recent reassessment (2024) when the status changed to Least Concern.
14. *Suncus megalurus* (Jentink, 1888), Climbing shrew
There is a recent change of species epithet from "megalura" to "megalurus" according to the MDD. This species was documented for the first time in Nyungwe in 2009, with one individual recorded at the Bweyeye site (2°36'35.1"S 29°11'59.39"E, 1730 m). It was previously recorded as *Sylvisorex megalura* in two other locations in Rwanda (Hutterer *et al.* 1987). The holotype is currently accessible online at <https://biportal.naturalis.nl/nl/multimedia/RMNH.MAM.39039> for this small shrew with a relatively long tail and hind feet. We could not find other records after 2009.

15. *Sylvisorex granti* (Thomas, 1907), Grant's forest shrew
Documented in Nyungwe only prior to 2009, this species was missed in later records. The only specimen recorded at Kitabi in the Nyungwe edge habitat helped document the species for the first time in Rwanda (Hutterer et al. 1987). It is a very small shrew that typically inhabits swamps, montane forests, and moist bushy vegetation. The altitude at which it was captured in Nyungwe is within the norms, above 1500 m, as defined in its description. It has a wide but patchy distribution across Central and Eastern Africa. The IUCN maps its occurrence in Rwanda, but does not indicate Rwanda among the countries of its distribution, which should be subject to adjustment.
16. *Sylvisorex johnstoni* (Dobson, 1888), Johnston's forest shrew
We captured two individuals at Bweyeye in 2009. This species had not been previously documented in Rwanda and has not been re-recorded since then. Considered present in most of the countries across a narrow range of Central Africa, including Rwanda, this species is little documented. Although little is known about the ecological and distributional status of this species in Rwanda, its DNA is well documented in GenBank. As from its description, the minute to tiny shrew (2-4 g) has high contrast between the dorsal and ventral pelage, and its tail length is relatively medium.
17. *Sylvisorex lunaris* (Thomas, 1906), Moon forest shrew
This species was recorded at Bigugu (six individuals) and Bweyeye (two individuals) in 2009. One individual was also recorded at Gisakura in 2012. Other previous studies had found this species, including a record at Uwinka in the 1960s. In 2021, it was captured by a drift fence in Kamiranzovu Swamp. It can be adaptive to a wide range of habitats. It was common in our records at the high-altitude Bigugu, contrary to the description of its altitudinal range.
18. *Sylvisorex vulcanorum* (Hutterer & Verheyen, 1985), Volcano forest shrew
The dark shrew has a relatively long tail. Documented in 2009 at Bigugu, Bweyeye, and Nyabishwati sites, with 8, 4, and 3 individuals, respectively, it was missed in later studies. Its size ranges from minute to very small, and it is the smallest in the genus. It was recorded in Nyungwe in 1981 and 1982, and then was described as a new species long afterwards (Hutterer and Verheyen 1985). Its distribution in Rwanda was considered to be confined to the Volcanoes and Nyungwe forests (Hutterer et al. 1987). Currently, the range extends to DRC, Burundi, and Uganda. Records of its distribution from the lowest to the highest altitudinal range in Nyungwe are thus documented by our surveys.

Order Rodentia
Suborder Hystricomorpha
Family Hystricidae

19. *Atherurus africanus* (Gray, 1842), African brush-tailed porcupine
The brush-tailed porcupine was mentioned in Nyungwe in the early 1980s based on an unpublished report and records from the park rangers (Dowsett and Dowsett-Lemaire 1990). As with other big rodents, such as giant pouched rats, they could not be captured by the standard traps we used. They are primarily known during patrols for snares set by bushmeat poachers. Trails or lost quills of porcupines can be rarely seen. When we encountered this species captured in a poacher's trap (around 2°27'52.87"S 29°10'57.18"E) in 2013, we recognized the species and subsequently released it. The IUCN does not locate this species in Rwanda but in neighboring countries (Kenya and

Uganda) in Eastern Africa. Information about its habitat selection in Nyungwe is incipient, apart from being known to avoid edges and being traceable (lost quills or trails) in remote or rarely used areas of the park.

Family Thryonomyidae

20. *Thryonomys swinderianus* (Temminck, 1827), Greater cane rat

The greater cane rat was documented in Nyungwe in the 1960s near the Banda village, close to the Uwinka site. Considered a non-typical forest species mostly relying on grassy vegetation in moist places, we informally learned from park rangers in 2022 about two potential sites for its occurrence, including one within and another at the edge of the forest, approximately 2°29'23.29"S 29°17'25.46"E and 2°46'23.06"S 29°25'8.18"E. It probably inhabits specialized habitats and might have a patchy distribution in Nyungwe that would require prior documentation before its survey.

Suborder Sciuromorpha

Family Gliridae

21. *Graphiurus murinus* (Desmarest, 1822), Forest African dormouse

We had several records of a few individuals in different periods: one individual near the WCS office in Gisakura in 2009, two individuals in the interior habitat, and one in the forest edge at Kitabi and Gisakura in 2012, and two individuals at Uwinka in 2023. DNA barcoding performed in 2024 confirmed this species. The latter two female individuals, which weighed 17.5 and 24 g, showed slight differences in tail length and the structure of the tufty tail hairs despite being the same species. This species appears to be common, even if its population is not likely abundant. Its typical habitat is a forest where it exhibits arboreal behaviors similar to those of squirrels.

Family Sciuridae

22. *Funisciurus carruthersi* (Thomas, 1906), Carruther's mountain squirrel

Documented in Nyungwe in the 1960s, this squirrel is the most common in Nyungwe. It was abundant at Gisakura (around 2°28'21.78"S 29°5'16.28"E) in 2022, where it was associated with the pristine, moist, and less-disturbed habitat. Several individuals were captured in our studies: three in 2009 at two sites, four at three sites in 2012, two at Kamiranzovu in 2021, and 33 in 2022-2023 at three sites. Its identification could not be verified by DNA, but with morphological records and observations, as there are no Cytb gene sequences for comparison under GenBank. It is attracted to the natural forest, but can live close to human presence, such as at Uwinka, and occurs around the trails in the forest. The presence at Gisakura indicates its preference for moist forest.

23. *Funisciurus pyrropus* (Cuvier, 1842), Fire-footed rope squirrel

Found among the records of squirrels of Nyungwe in the 1960s, this species is distinguished from *F. carruthersi* by a stripe on each flank and bright reddish limbs. Other traits distinguish the two species as well, including size, body color, and length of the tail and its hairs. Only sighted on several occasions, it was captured in 2022 at the Gisakura (two individuals) and Uwinka (one individual). Plumtre *et al.* (2002) also recorded it in Nyungwe. As for *F. carruthersi*, there were no Cytb gene sequences in GenBank for comparison. Its ecological adaptations should be similar to *F. carruthersi*. However, it appears that its population size is smaller, and it might exhibit elusive behaviors.

24. *Heliosciurus ruwenzorii* (Schwann, 1904), Ruwenzori sun squirrel
Recorded in Nyungwe in the 1960s as *Aethosciurus ruwenzorii*, this species was not captured during our surveys from 2009 to 2023. Plumptre et al. (2002) recorded this species. It was also documented by Monfort (1992) and was occasionally observed near Uwinka in 2013. It was sighted in a small forest housing the Gisakura office (2°27'35.98"S 29°5'43.13"E) in 2022 and was photographed by a member of our field team. Aspects of its ecology in Nyungwe are undocumented. Cytb sequences have not yet been covered in GenBank for this species.
25. *Paraxerus boehmi* (Reichenow, 1886), Boehm's bush squirrel
This species was recorded by Elbl et al. (1966) as *Tamiscus vulcanorum* (Thomas, 1918), documented by Monfort (1992), and observed by Plumptre et al. (2002). One individual of this species was recorded at Bweyeye (2°36'35.1"S 29°11'59.39"E) in 2009. Since then, it has been only rarely sighted. *Paraxerus alexandri* (Thomas & Wroughton, 1907), noted by some field observers, was confused with *Paraxerus boehmi*. A few personal media pages exist for this species in Nyungwe, such as the "Jean Marie Wild" Facebook page. At present, no reference gene sequence for this species is housed in GenBank. There are no basic data to infer the ecological traits of this species in Nyungwe.
26. *Protoxerus stangeri* (Waterhouse, 1842), Forest giant squirrel
The forest giant squirrel was mentioned in Nyungwe for the first time by Dowsett and Dowsett-Lemaire (1990), who consider its most common occurrence at an altitude below 2000 m. Our studies did not record this species; however, some online sources, including the park's official websites, note its presence. A photo taken from Nyungwe in 2016 was posted on the "Rwanda Mammal Atlas" Facebook page. There are no Cytb sequences for this species under GenBank. The ecological aspects noted by Dowsett and Dowsett-Lemaire (1990) indicate its predation on large seeds.

Suborder Supramyomorpha

Family Anomaluridae

27. *Anomalurus derbianus* (Gray, 1842), Lord Derby's flying squirrel
The species which has not been noted on all surveys and reports before 1990 was mentioned in Nyungwe for the first time by Monfort (1992) based on occasional sightings. Due to the unique nature and behaviors of this special rodent, which has membranes and can fly, it has not been documented in recent surveys (2009-2023) using traps for terrestrial small mammals. Recent occasional or anecdotal observations are also lacking. Furthermore, its behavior is predominantly nocturnal.

Family Muridae

28. *Colomys goslingi* (Thomas & Wroughton, 1907), East African wading rat
Three individuals were captured at Bweyeye, and four individuals were captured at Nyabishwati during the 2009 survey. One individual was captured in 2022 during the study at Gisakura, and the habitat was associated with a large stream. This species has been consistently recorded in previous surveys, even though it was associated with unique habitats, and abundance was often very low. In its first record in Nyungwe in the 1960s, there was a note on its occurrence near rivers or swamps.
29. *Dasymys incomtus* (Sundevall, 1847), African shaggy marsh rat
The species was indicated in earlier surveys, mostly outside of protected areas. It was captured in an agricultural area at Cyamudongo (Geider and Kock 1991). It was found

in 2009 in marshy habitats at Gasare (2°29'33.29"S 29°16'22.01"E, 2350 m), which matches its habitat preferences. The records of 2009 were provisionally described as *Dasymys incomtus*, but later studies of the specimens did not confirm this species. This can lead to reflection about *Dasymys rwandae* (Verheyen, Hulselmans, Dierckx, Colyn, Leirs & Verheyen, 2003), which is still considered a synonym by IUCN and has not yet been genotyped for Cytb. The typical habitat should mostly be outside a natural habitat.

30. *Dasymys rwandae* (Verheyen, Hulselmans, Dierckx, Colyn, Leirs & Verheyen, 2003), Rwandan shaggy marsh rat

This species was first described from Rwanda and has not been recorded anywhere else. Its presence at Uwinka was indicated by Verheyen *et al.* (2003). Its type locality is the Volcanoes in Rwanda at an elevation of 2250 m, which matches the elevation range at Uwinka. There is a possibility that the two *Dasymys* species are sympatric or not within Nyungwe. The individual we captured in 2009 was identified only as *Dasymys* sp. IUCN currently considers *D. rwandae* as a synonym of *D. incomtus*. There are no reference genetic sequences under GenBank.

31. *Deomys ferrugineus* (Thomas, 1888), Congo forest rat

The species was previously documented since the 1960s, which marked its first record in Rwanda. We recorded two individuals near Bweyeye associated with a river. Later observations in 2012 and 2022, which captured at least six individuals at Gisakura (one left only a portion of the tail in the trap) and three at Uwinka, revealed striking variations in two subgroups of that species, which should be subject to further research investigation. The habitat preference of this species is a closed-canopy habitat of moist forest with sparse or patchy undergrowth, and it is typically found near a stream or river. Its habitat was noticed to overlap closely with that of *Malacomys longipes*.

32. *Grammomys* sp., Thicket rat

Grammomys dryas (Thomas, 1907) was the original suggestion for the species recorded in 2009, which later remained unidentified as *Grammomys* sp. In 2012, three individuals were recorded and named *Grammomys dolichurus* (Smuts, 1832). However, *G. dolichurus* does not range in Rwanda based on the MDD, and *G. dryas* was previously considered a subspecies of *G. dolichurus*. DNA sequencing has not yet confirmed the existence of *G. dryas* in Nyungwe. The records of 2021 to 2023 were retained as *Grammomys* sp., as they did not match *G. dryas* or *Grammomys surdaster* (Thomas & Wroughton, 1908), which are also considered extant in Rwanda. At Bigugu, the habitat of the unidentified species was an open, humid habitat with *Erica* sp. shrubs and thick alpine moss.

33. *Hybomys* sp., Striped mouse

In most of the sites in Nyungwe, this will be among the most common mice. Variations within this species are striking. Some individuals have brighter colors than others, and often the dark ones accumulate darker colors on the rump. The visibility and extent of the single dorsal stripe also vary among individuals. Individuals also exhibit different variations in proportional colors between the upper (dark) and lower (pale) sides of the tail. Cytb gene sequencing has demonstrated the presence of *Hybomys* species in Nyungwe but has not identified it as *Hybomys univittatus* (Peters, 1876). The 2009 study was inconclusive about the species and listed it as *Hybomys* sp. The DNA results for 2022–2023 studies showed a lower percentage of Cytb gene similarity (94.71–95.02%) to *Hybomys lunaris* (Thomas, 1906), which does not allow for confirmation.

34. *Hylomyscus aeta* (Thomas, 1911), Beaded wood mouse
This species was not recorded in Nyungwe, probably also not in Rwanda, before our survey. In 2009, this rare species was recorded at the Bweyeye and other surveyed sites, marking its first record in Nyungwe. It was recorded at Uwinka, Gisakura, and Kitabi in 2012 and identified morphologically. The species was also documented in Uwinka in 2022 and 2023, which was confirmed by a Cytb gene study. This species was sympatric with *Hylomyscus stella* (Thomas, 1911) at Uwinka, a species to which it is slightly larger, where habitat preferences should be close.
35. *Hylomyscus stella* (Thomas, 1911), Stella wood mouse
In 2009, this species was among the common records at the Nyabishwati site and the Bweyeye site and was associated with the presence of the river and its riparian vegetation. It was recorded at Uwinka, Gisakura, and Kitabi in 2012. This species was more abundant than *H. aeta* in our records. In the summer school in 2022, it was recorded, but not *H. aeta*; its records include ones outside the park at Kitabi. With a body weight generally varying between 17 and 20 grams in adults, these mice with relatively long tails are climbers and often attracted to habitats with many shrubs, especially *Alchornea hirtella* or similar shrubs in Nyungwe, with canopy cover of shrubs or trees.
36. *Hylomyscus vulcanorum* (Lönnerberg & Gyldenstolpe, 1925), Albertine Rift wood mouse
First recorded in Nyungwe in 2009, this species was very common, occurring at four sites, including the high-altitude Bigugu. In 2012, it occurred at Uwinka and Kitabi. In 2022, this species was also captured at Gisakura. Cytb gene results indicated identity to *Hylomyscus denniae vulcanorum* (Lönnerberg & Gyldenstolpe, 1925); however, *H. vulcanorum* already has a species status, and the known range of *Hylomyscus denniae* (Thomas, 1906) does not extend to Rwanda. The records at Uwinka in the 1960s were named *H. denniae* (Rahm 1967). The species was recorded at all altitude ranges (lower, average, and upper), but always appears to be associated with humid forest zones.
37. *Lophuromys* cf. *cinereus* (Dieterlen & Gelmroth, 1974), Western Rift brush-furred rat
Described in 1974, and to date assumed to be distributed only in the DRC, it was found at Cyamudongo (three individuals) and Gisakura (one individual) in the 2022–2023 study, which were confirmed with the Cytb gene sequencing. This marks the first recorded occurrence of this species in Rwanda; thus, its known range is expanding. Under GenBank, it is still described as *Lophuromys* cf. *cinereus*. It was pre-identified as *L. laticeps* (Thomas & Wroughton, 1907), as the morphological differences between the two species are slight, and splitting from the *L. laticeps* complex is recent.
38. *Lophuromys laticeps* (Thomas & Wroughton, 1907), Albertine Rift brush-furred rat
This was the most common *Lophuromys* species in Nyungwe and was observed at all sites. With its characteristic rusty, speckled fur, *L. laticeps* has also shown many variations in size, pelage color, belly color, and general body shape. Many authors have classified the records from Nyungwe as *Lophuromys aquilus* (True, 1892) and others as *Lophuromys flavopunctatus* (Thomas, 1888); however, several researchers raised objections regarding the range of the different species within the group, and *L. laticeps* was confirmed in Rwanda. Despite its detailed discussion in the current African rodent taxonomy (e.g., Onditi et al. 2021), IUCN and some online portals have not yet recorded *L. laticeps* to replace *L. flavopunctatus* for East Africa, including Rwanda. This widespread species in Nyungwe does not show preferences for habitat, although moist places with thick undergrowth are probably the main habitats for this forest-floor species. Foraging habits on grass were occasionally observed.

39. *Lophuromys medicaudatus* (Dieterlen, 1975), Western Rift brush-furred rat
Not recorded prior to our survey, Dowsett and Dowsett-Lemaire (1990) alluded to its possible occurrence in Nyungwe. *L. medicaudatus* was described based on morphological characteristics from 2022-2023, as Cytb gene sequences for this species are missing from GenBank for comparison. The morphological description of this species, for which documentation of its records in Rwanda was not traceable, was rather convincing. The species occurred at variable elevations, but abundances were relatively small: three individuals at Bigugu, two at Uwinka, and two at Gisakura. In all cases, the species was found to be associated with moist vegetation or forest and to avoid edge disturbances.
40. *Lophuromys rahmi* (Verheyen, 1964), Rahm's brush-furred rat
This species was described for the first time by Verheyen (1964), who recorded three specimens at Uwinka in 1962. Two individuals of *Lophuromys rahmi* were recorded in one site, Nyabishwati, in 2009. Seven individuals recorded in 2012 at Kitabi (around 2°32'33.27"S 29°24'37.69"E) were first misidentified as *Lophuromys sikapusi* (Temminck, 1853). *L. rahmi* was also recorded in 2022 at Uwinka. DNA samples were not collected at the beginning of the study, and their records were missed in the subsequent sessions. At least three specimens of the species are housed in the Rwandan zoological collections. One reference Cytb sequence exists under GenBank for future comparisons. The habitat preferences should be similar to those of *L. medicaudatus*, but our observations do not allow us to confirm that they could be sympatric in the same microhabitats.
41. *Lophuromys woosnami* (Thomas, 1906), Woosnam's brush-furred rat
This was always recorded in Nyungwe, starting in the 1960s. At most locations, it had a significantly high abundance, being third or fourth after *L. laticeps*, *Praomys jacksoni* (Eisenbraut, 1968), and *Hybomys* sp. The Cytb gene has demonstrated the presence of *L. woosnami* in Nyungwe, distinguished from *L. luteogaster* and *L. medicaudatus* among the subgenus *Lophuromys*. In 2024, we confused some *L. woosnami* with a similar species, *Lophuromys luteogaster* (Hatt, 1934), but we did not find convincing evidence for the latter. The habitat of this *L. woosnami* in Nyungwe often overlaps with *L. laticeps*, with some differences: often where one species was abundant, the other was less abundant; *L. woosnami* selected habitats with shrubs, as it occasionally walks along trees, unlike the mostly terrestrial *L. laticeps*; finally, *L. woosnami* occurred more often on the open forest floor.
42. *Malacomys longipes* (Milne-Edwards, 1877), Long-footed swamp rat
It has always been documented for the first time in Nyungwe in the 1960s. In 2009, seven individuals were recorded at the Nyabishwati River, 23 at Bweyeye, and one at Cyamudongo. In 2012, 16 individuals were recorded at Gisakura, and one at Uwinka. Various records were also made from 2021 to 2023 in Nyungwe. One significant observation is related to variations in fur color according to age. Generally, the young individuals had a black and greyish color, while adult and aged individuals turned brownish. The IUCN and MDD have not yet confirmed this species in Rwanda. While it is typically known as a swamp species, we found that in Nyungwe, the main habitat feature is a river or stream. Steep places in habitats with sparse vegetation were most favorable for its capture. Spaces distant from rivers, 100-150 m away, could also still record this species. All the records were below 2000 m of elevation, except for one record at Uwinka at around 2300 m.

43. *Mus bufo* (Thomas, 1906), Toad mouse

It was recorded in the 1960s in Nyungwe under the name *Leggada bufo* from surrounding agricultural fields. We captured many individuals of this species in 2009: 11 at Bweyeye, five at Cyamudongo, and one at Gasare swamp. DNA data confirmed this species in Nyungwe from the 2022-2023 study. During the biodiversity field summer school 2021-2022, two individuals were captured outside the park, and three individuals were recorded inside. At Cyamudongo, 22 individuals were recorded, and one individual was documented at Uwinka. At Cyamudongo, this species was abundant in and around an interior forest clearing inside the forest with tall grasses (2°32'53.95"S 28°59'40.60"E).

44. *Mus minutoides* (Smith, 1834), Sub-Saharan pygmy mouse

This species was noted in Nyungwe by the studies in the 1960s. Individuals captured in 2012 were confused as *M. minutoides* based on morphological descriptions; they might include *M. bufo* as well. Van der Straeten and Verheyen (1983) indicated its capture in a eucalyptus plantation in the buffer zone of Nyungwe at Kitabi. Lacking clear information to distinguish it morphologically from other *Mus* spp. in Nyungwe, reliance on confirmation with DNA analysis will be more promising. IUCN indicates Rwanda among countries where the presence of this widely distributed species is uncertain.

45. *Mus triton* (Thomas, 1909), Gray-bellied pygmy mouse

Documented in Nyungwe in the 1960s first as *Leggada triton*, then with Geider and Kock (1991), our study did not record this species, as individuals recorded as *Mus triton* in 2009 were not correctly assigned to that species. It was not documented until our survey, which extended to March 2023. Those observations reveal a lack of conclusive information about the distribution of this species recorded in the 1960s at Uwinka (around 2400 m of altitude).

46. *Oenomys hypoxanthus* (Pucheran, 1855), Common rufous-nosed rat

It was first recorded in Nyungwe in the 1960s within buffer zone forest plantations. It occurred both within Nyungwe and outside in more recent surveys, but in limited numbers. In 2009, eight individuals were recorded at three sites: Bweyeye, Bigugu, and Cyamudongo. Single individuals were recorded at Gisakura in 2012 and at Bigugu in 2022. During the biodiversity field summer school 2021–2022, six individuals were captured at Kitabi, some 500 m from the natural forest, and were hosted in *Rubus* sp. shrub vegetation. Its typical habitat in and around Nyungwe consists of thickets.

47. *Praomys degraaffi* (van der Straeten & Kerbis Peterhans, 1999), De Graaff's soft-furred mouse

Praomys degraaffi was described as a new species in 1999. This species is similar to *Praomys jacksoni* (de Winton, 1897) in most morphological aspects. The main recorded differences concern the lateral line, body coloration, and number of tits. This species was recorded in relatively lower numbers at various locations in Nyungwe than *P. jacksoni*, except at Bigugu, where it was a dominant record in 2009. During the 2021-2022 summer school, we had two records from Bigugu and two from Kitabi valley. Its presence was confirmed through Cytb gene sequencing in 2024.

48. *Praomys jacksoni* (de Winton, 1897), Jackson's soft-furred mouse

This is recognized as the most abundant rodent species in Central African forests (Mizerovská et al. 2019). In general, it was consistently abundant in all our surveys. This species exhibits noticeable slight variations in form, size, color, and other morphological aspects. The individuals recorded at Uwinka near the buffer zone (2012

and 2022-2023) and in the buffer zone (2012) showed more similarities, unlike several groupings with inconspicuous variations, especially at Cyamudongo. The individuals of *Praomys* have been well recognized through DNA analysis, despite morphological differences, where one grouping was called *Praomys jacksoni* Clade Ib, which is large-sized with brownish fur (Mizerovská *et al.* 2019). Mostly adaptive and widespread without habitat, climatic, or altitudinal preferences in the natural forest, it might probably not be attracted to a typical natural wetland.

49. *Thamnomys kemp* (Dollman, 1911), Kemp's thicket rat

In 2009, when the species was documented for the first time in Nyungwe, five individuals were captured at two places abutting rivers (Nyabishwati, Bweyeye). It was recorded in a valley at the park's edge at Kitabi in 2022 during a summer school. In October 2022, this species was also captured at Gisakura and was confirmed through DNA. We noticed its association especially with running waters (rivers, streams, or creeks), as all three sites where we recorded have such features. Its association with running waters is a particular feature in Nyungwe. *Sericostachys scandens* and *Urera hypselodendron*, noted in Happold (2013), were among the plants associated with its record at Gisakura.

50. *Thamnomys kuru* (Thomas & Wroughton, 1907), Eastern rainforest thicket rat

This species has recently changed its name from *Grammomys kuru* to *Thamnomys kuru*; therefore, it was listed under the name *Grammomys kuru* when it was previously recorded. *Thamnomys kuru* was recorded by Elbl *et al.* (1966) and Monfort (1992). Our 2009 survey pre-identified some records as *Grammomys kuru*, which were later also identified as *T. kemp*. We did not record this species in later surveys. It needs further careful examination, as its Cytb gene sequences are lacking in GenBank. This means that its identification in Nyungwe might have relied on morphological examination. Some of the 14 individuals recorded in 2009 may be *T. kuru*, which needs further investigation.

51. *Thamnomys venustus* (Thomas, 1907), Thomas's thicket rat

The record documented in the 1960s at Uwinka as *Thamnomys kemp major* was *Thamnomys venustus* (Dowsett and Dowsett-Lemaire 1990). We captured this species near the trail to the Kamiranzovu Swamp in 2021 (2°29'19.28"S 29° 9'13.32"E, 1979 m), approximately 200-250 m from the swamp. This juvenile individual was confirmed through Cytb sequencing. The vegetation was mixed between marshland and forest, as its main habitat is thickets; therefore, the species might exhibit transitory passages into the swamp area.

52. *Otomys denti* (Thomas, 1906), Dent's vlei rat

A record was obtained at Uwinka in the 1960s. In 2009, one individual was recorded in a swamp at Gasare, near the Center of the Park. *O. denti* was again collected in Nyungwe forest before our survey (Geider and Kock 1991). The main differences with its sympatric *Otomys tropicalis* (Thomas, 1902) are based on the fur structure and other features such as tail length and coloration, and the differences in habitat selection: *O. denti* ranges only in protected or natural forests, unlike the other species.

53. *Otomys tropicalis* (Thomas, 1902), East African vlei rat

This species was also collected for the first time in Nyungwe at Uwinka in the 1960s. In that period, it was recorded outside the forest rather than in the natural forest at Uwinka. We recorded this species at Mount Bigugu in 2009, but we did not record it in later surveys. The range of *O. tropicalis* at high altitude at Bigugu challenges the consideration that the species avoids natural forested habitats and would be solely

associated with human disturbance (Happold 2013). However, Bigugu microhabitat does not consist of a forest, but a humid mountainous zone dominated by Ericaceous shrubs.

Family Nesomyidae

54. *Cricetomys emini* (Wroughton, 1910), Forest giant pouched rat

The species and *Cricetomys kivuensis* (Lönnerberg, 1917) existing in Nyungwe have often been mistaken for *Cricetomys gambianus* (Waterhouse, 1840). A skin tissue sample collected on the road in 2022 was submitted for sequencing and resulted in *Cricetomys emini*. In 2022–2023, we captured two rats at Uwinka, and DNA sequencing resulted in *C. emini*. This species should be common and widespread in Nyungwe. Populations of this species are often attracted to settlements and campsites inside Nyungwe forest, as witnessed at all the camp sites we used during 2022–2023, where eventually the two specimens were collected. Its habitat is a forest, regardless of the level of disturbance.

55. *Cricetomys kivuensis* (Lönnerberg, 1917), Kivu giant pouched rat

The species found in Nyungwe was often recorded as *Cricetomys gambianus* (Waterhouse, 1840) prior to our surveys. The two species were later assumed to exist in Rwanda following Montfort (1992). *C. kivuensis* is the one most similar to *C. gambianus* in comparison to *C. emini*; therefore, it could be the one most observed in the past. The ecology of the species in Nyungwe is known mainly from its large seed handling, contributing to the dispersal of the tree *Carapa grandiflora* (Nyiramana et al. 2011). No information was obtained about the association of the two species in Nyungwe.

56. *Delanymys brooksi* (Hayman, 1962), Delany's swamp mouse

This species was recorded at Mount Bigugu (2°26'27.49"S 29°15'11.02"E, 2954 m) in 2009 and in Uwasenkoko Swamp (02°31'41" S 29°21'09"E, 2367 m) in 2021. It was not documented in the 1960s in Nyungwe, but other studies noted it. In 2021, the individual we recorded weighed 8 g with a very long tail (101 mm of tail). It is wetland-dependent: its typical habitat is high-altitude marshes, but non-marshy habitats have also been recorded (Happold 2013); this is supported by our findings, which recorded it in high-altitude humid zones but not associated with marshlands.

57. *Dendromys mesomelas* (Brants, 1827), Brants's African climbing mouse

This species was documented in Nyungwe from 1990 to 1992, but it has been missed from our surveys since 2009. Dowsett and Dowsett-Lemaire proved that the species collected by Elbl et al. (1966) at Uwinka was *D. mesomelas*. The species has a preference for wet, moist habitats associated with swamps or grasslands (Happold 2013).

58. *Dendromys nyasae* (Thomas, 1916), Kivu African climbing mouse

Only one individual of *Dendromys* was captured in a swamp in Nyungwe in 2009 and identified as *D. nyasae*. It was documented in Rwanda but not yet in Nyungwe. *D. nyasae* was also recorded in the Kamiranzovu Swamp during a field summer school in 2021. We recorded it at the edge of the wetland towards the forest habitat (2°29'07"S 29°09'10"E). Among preferred habitats, edges of swamps are also noted, where they need thick vegetation due to their climbing habits (Happold 2013). IUCN still considers this species a synonym of *D. mesomelas*.

Species found in the buffer zone or outside Nyungwe National Park

The six species indicated here were previously observed by the researchers in Nyungwe before our surveys, but they have not been recorded in the forest. Most of those records were documented in the low-altitude habitat range near Uwinka towards the neighboring Banda village.

Family Muridae

1. *Lemniscomys striatus* (Linnaeus, 1758), Typical striped grass mouse

The occurrence of this species was indicated in Nyungwe before 2009. However, according to Dowsett and Dowsett-Lemaire (1990), the species was collected outside the park towards Banda village. The general knowledge of its habitat preference suggests that the records in Nyungwe did not occur in the natural forest. Its presence is widespread in Rwanda, especially in unprotected landscapes. Grass cover is the main clue to predict the occurrence of the species, whether in human-modified ecosystems or farmlands, in use or abandoned.

2. *Mus musculoides* (Temminck, 1853), West African pygmy mouse

We recorded this species at Kitabi outside the park, near the IPRC Kitabi premises. Three individuals were captured in 2021–2022. Those individuals were identified through DNA barcoding as *Mus cf. gratus*. A change is known for updating *Mus cf. gratus* to *Mus musculoides* according to the MDD. While there were doubts about the distribution of this species from Western towards East Africa, including Rwanda, our result is conclusive about the presence, outside the natural forest.

3. *Mastomys natalensis* (Smith, 1834), Natal multimammate mouse

No study prior to the 1990s noted the presence of this species in Nyungwe. Monfort (1992) notes this small mouse as present in Nyungwe, recorded as *Praomys natalensis*. One individual we recorded at Uwinka in 2012 was named *Mastomys* sp. There is no evidence to confirm that this species could be found in the natural forest, supporting its formally known habitat description as a species not attracted to natural forests, but to human-modified ecosystems.

4. *Rattus rattus* (Linnaeus, 1758), Common house rat

This species was recorded in Nyungwe in the 1960s at Banda village, not far from Uwinka. It was later recorded at Cyamudongo in agricultural lands (Geider and Kock 1992). From 2009 to 2023, this species was not recorded in Nyungwe, despite the work in the buffer zones and outside the buffer zones, such as tea plantations and in the premises of IPRC Kitabi. Apart from abandoned farmlands or settlements, and habitats abutting urban areas and human settlements, which we have not covered, we have not proven the presence of this species in Nyungwe forest or its immediate buffer zone.

Family Spalacidae

5. *Tachyoryctes splendens* (Rüppell, 1835), African root rat

The root rat *Tachyoryctes ruandae* (Lönnberg & Gyldenstolpe, 1925) recorded by Elbl et al. (1966) has not been confirmed by open scientific databases. Lacking key features to distinguish it from the widespread *T. splendens*, the latter was taken as the valid species. In 2022, the species recorded at Kitabi was identified as *T. splendens* through DNA barcodes. We had also captured it outside the natural forest at Kitabi in 2012. We assume all records in Nyungwe were in agricultural fields or the buffer zone. The MDD considers that future work could unravel the complexity of this species.

Family Soricidae

6. *Crociodura nigrofuscus* (Matschie, 1895), African black white-toothed shrew
The record, previously identified by Elbl et al. (1966) as *C. hildegardeae*, was reassessed and determined to be *C. nigrofuscus* (Hutterer et al., 1987). We have not recorded this species since 2009. The species was located at Uwinka by mistake according to Dowsett and Dowsett-Lemaire (1990); it was recorded outside the park. This supports existing information that *C. nigrofuscus* might not be a forest species, but rather of forest-savannah mosaics, swampy areas, or secondary forests.

Conservation status and endemic species

Apart from the species under the IUCN category of Least Concern (LC), we have the following records in our checklist: *Crociodura lanosa*, *Delanymys brooksi*, *Lophuromys medicaudatus*, *Ruwenzorisorex suncoides*, and *Thamnomys kemp* as Vulnerable (VU), *Lophuromys rahmi* and *Sylvisorex lunaris* as Near Threatened (NT), and *Lophuromys cf. cinereus* as Data Deficient (DD). We also considered the endemic species in our records, with consideration of the Albertine Rift. These are the endemic mammals of the Albertine Rift found in Nyungwe from our records: *Cricetomys kivuensis*, *Crociodura lanosa*, *Crociodura niobe*, *Dasymys rwandae*, *Delanymys brooksi*, *Funisciurus carruthersi*, *Heliosciurus ruwenzorii*, *Lophuromys cinereus*, *Lophuromys rahmi*, *Lophuromys woosnami*, *Micropotamogale ruwenzorii*, *Mus bufo*, *Myosorex babaulti*, *Paracrociodura maxima*, *Praomys degraaffi*, *Ruwenzorisorex suncoides*, *Sylvisorex lunaris*, *Sylvisorex vulcanorum*, *Thamnomys kemp*, and *Thamnomys venustus*. The current range of these species makes them Near Endemic: *Dendromus nyasae* and *Scutisorex somereni*.

Discussion

The diversity of the Nyungwe terrestrial small mammal species also encompasses their differential distribution into higher taxa, such as orders, suborders, families, and genera. The most species-rich order is Rodentia, and the Muridae family in this order is also the most species-diverse. More species of shrews in Nyungwe belong to the genus *Crociodura* known as white-toothed shrews. There is always a difficulty associated with recognizing the different species within this genus, as their external features are not evident enough to distinguish them. The main clues for the species were the body color, relative size, and hairs on the tail, which are apparent features seen in the photos illustrated in Kingdon (2015). In 2022, we documented two individuals in the genus *Sylvisorex* that were not identified to the species level. For the record at Uwinka, the Cytb gene did not have matching nucleotides in the GenBank for comparison. It remained *Sylvisorex sp.* One of them can possibly match the species listed in Nyungwe under this genus.

The variations of rodents belonging to the Nesomyidae family are considerable, as they include individuals varying from the biggest forest rodents (giant pouched rats) to ones of the smallest rodent species (e.g., *Dendromus* spp.). The species of *Cricetomys* occurring in Rwanda was often recorded as *Cricetomys gambianus*. Monfort (1992) mentioned *C. gambianus* and the later compiled list (Chao 2008) indicated *C. gambianus*. The identity of the species existing in Nyungwe was clarified soon after in Nyiramana et al. (2011) as *C. kivuensis*, as determined from research conducted at the Uwinka site. Later evidence showed that two species exist, as *C. gambianus* does not range in Rwanda. Individuals were recorded in the genus *Dendromus* as *Dendromus sp.*, but the species was not

determined in Elbl *et al.* (1966) and Monfort (1992) and they were possibly among the mentioned *Dendromys* species.

The Muridae contains most species. The genus *Hylomyscus* contains species mainly characterized by a small body size compared to the average mouse. They have a characteristically long tail in comparison to their body. They are adapted to climbing, standing on small branches or herbs, and moving through the bush near the ground or at higher heights. It is not uncommon to capture the species of *Hylomyscus* at different places in Nyungwe, but even if they occur in different sites and habitats, they are often specialized. The co-occurrence of the species was confirmed at Bweyeye in 2009, where three species were found at the same site. The genus *Grammomys* comprises individuals rarely recorded in Nyungwe, but the final identification of the species boundaries and their distinction has not yet been established. There is a change for one species reclassified from *Grammomys kuru* to *Thamnomys kuru* through a recent study (Mikula *et al.* 2021). Individuals of the genus *Otomys* are rare records; none were recorded between 2011 and 2023, but both were recorded in 2009, and earlier records have been documented.

The genus *Lophuromys* should be among the four most dominant rodent genera in Nyungwe: *Lophuromys*, *Praomys*, *Hybomys*, and *Hylomyscus*. However, two species are often the most common in Nyungwe: *Lophuromys laticeps* and *Lophuromys woosnami*, with most places favoring *L. laticeps*. There are significant variations in species of the *Lophuromys* group regarding sizes, shapes, colors, tails, and other external features. The cladistic classification also distinguishes two subgenera, with one subgenus, *Lophuromys* (*Lophuromys*), characterized by short tails, and the other, *Lophuromys* (*Kivumys*), characterized by longer tails. The *Lophuromys* branch further splits into two groups, representing the *L. sikapusi* group, comprising unspeckled short-tailed rats, and the *L. flavopunctatus* group, comprising speckled short-tailed brush-furred rats (Onditi *et al.* 2021). The *flavopunctatus* group contains individuals with speckled fur, and the *sikapusi* group comprises individuals with non-speckled fur. The genus *Kivumys* consists of three species of unspeckled rats with long tails: *L. woosnami*, *L. medicaudatus*, and *L. luteogaster*.

Mammal studies in Nyungwe were first comprehensively documented in the 1960s (Elbl *et al.* 1966). This paper indicated 58 species terrestrial small mammals of Nyungwe comprising three orders: Rodentia (rodents), Eulipotyphla (shrews), and Afrosoricida (moles and otter shrews). Comparatively, terrestrial small mammal checklists of Nyungwe from research records indicated 30 species (Elbl *et al.* 1966), 33 species (Dowsett and Dowsett-Lemaire 1990), 29 species (Geider and Kock 1991), and 42 species (Monfort 1992). Hutterer *et al.* (1987) worked on the shrews of Rwanda (family Soricidae) and indicated 10 species that were recorded in Nyungwe; the current study added six species, including some that were first records, such as *Suncus hututsi*. One unpublished record was made later, and mammals were compiled from the literature at Nyungwe. Records were also included from camera traps, which resulted in 36 species among terrestrial small mammals (Chao 2008). A more recent publication was also based on a literature review to illustrate 46 species that should be considered for Nyungwe (Cockar 2022).

Overall, the current records do not confirm the presence of all 58 species, but this number is likely. New records have been documented since 2009, including first records in Rwanda found in Nyungwe, such as *Micropotamogale ruwenzorii* (2009), *Lophuromys* cf. *cinereus*, and *Lophuromys medicaudatus* (most recent study). The differences with other checklists highlight that at least 15 terrestrial small mammal species are formally listed in publications beyond the existing individual checklists, documented in Nyungwe from 2009 to 2023. Amori *et al.* (2012) indicated a gap in Rwanda's knowledge of rodents, and these

new records, documented between 2009 and 2023, support those conclusions. Not only are most new records rodents, but also most species that have pending identification or have been misidentified for so long are rodents. The DNA results show unknown species among those named, such as *Hybomys univittatus* and *Grammomys dolichurus*. Due to insufficient or inefficient sampling, many species still have not been verified or re-assessed. Especially, many shrews have been missed in the 2009–2023 survey period. Future assessments should focus on the methods and strategies that are particular to shrews, such as using pitfalls and targeting wetlands.

Conclusions

The indication of 58 species of terrestrial small mammals likely existing in Nyungwe underscores the richness of this forest located in the Albertine Rift hotspot, and future taxonomic insights and reassessments are needed. Several species require field rechecking. Not only publications of their records are necessary, but also associated evidence and scientific information for later monitoring, including geographic coordinates, habitat characteristics (vegetation, forest floor, disturbance, canopy, altitude, etc.), positional and biogeographical dimensions (edge, interior, closeness to road or major trails, edge effects, etc.), environmental variables, and microhabitat characteristics (temperature, moisture, etc.). Particular habitats need to be targeted in future surveys of terrestrial small mammals of Nyungwe: more sampling in various wetlands across Nyungwe, consideration of rivers, streams, and riparian habitats, trapping in different levels of vertical position of forest, bamboo habitat, and remote places where studies of small mammals could have left a large part of the park not covered. Further studies should also consider the occurrence of terrestrial small mammals around buildings and infrastructures inside Nyungwe.

Authors' contributions

All the authors have effectively contributed to the realization of this review paper. MM initiated the review article and contributed to most of the draft writing work; PN and AN were involved in the field work and data analysis; AN provided research supervision and revised the draft, and all the authors contributed to reviewing the manuscript before submission. All the authors have read and approved the final version of the manuscript and agreed to be held accountable for all aspects of the work.

Conflict of interest

The authors declare no potential conflict of interest.

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Availability of data and materials

All data generated or analyzed during this study are available and can be shared freely by the authors upon request.

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References

- Amori G, Masciola S, Saarto J, Gippoliti S, Rondinini C, Chiozza F, Luiselli L. 2012. Spatial turnover and knowledge gap of African small mammals: using country checklists as a conservation tool. *Biodiversity and Conservation*. 21:1755–1793. <https://doi.org/10.1007/s10531-012-0275-5>
- Barnett A, Dutton J. 1995. Expedition field techniques, small mammals (excluding bats). London: Royal Geographical Society with IBG. 126 pp. <https://doi.org/10.5962/p.384319>
- Bennun L, Davies G, Howell K, Newing H, Linkie M. 2004. African forest biodiversity: a field survey manual for vertebrates. Oxford: Earthwatch Institute (Europe). 161 pp.
- Burgin CJ, Colella JP, Kahn PL, Upham NS. 2018. How many species of mammals are there? *Journal of Mammalogy*. 99(1):1–14. <https://doi.org/10.1093/jmammal/gyx147>
- Chao N. 2008. Bird & mammal lists: Nyungwe National Park. Final Report Submitted to the Protected Areas Biodiversity Project (PAB), REMA/GEF/UNDP, Rwanda. 17 pp.
- Cockar ZS. 2022. A checklist of the mammals of Rwanda. *Journal of East African Natural History*. 111(1):1–17. <https://doi.org/10.2982/028.111.0101>
- Dowsett RJ, Dowsett-Lemaire F. 1990. Les mammifères de la forêt de Nyungwe (Rwanda): état des connaissances. In: Dowsett RJ, editor. Survey of the flora and fauna of Nyungwe Forest, Rwanda. Jupille-Liege (Belgium): Touraco Research Report No 3. p. 111–121.
- Elbl A, Rahm UH, Mathys G. 1966. Les mammifères et leurs tiques dans la forêt du Ruggege (République Rwandaise). *Acta Tropica*. 23:223–263. <https://doi.org/10.5169/seals-311344>
- Gambalemoke M, Mukinzi I, Amundala D, Katuala G, Kennis J, Dudu A, Hutterer R, Barrière P, Leirs H, Verheyen E. 2008. Shrew trap efficiency: experience from primary forest, secondary forest, old fallow land and old palm plantation in the Congo River basin (Kisangani, Democratic Republic of Congo). *Mammalia*. 72(3):203–212. <https://doi.org/10.1515/MAMM.2008.039>
- Geider M, Kock D. 1991. Small mammals of the fogged forest of Nyungwe, Rwanda. *Natur und Museum*. 121(1):210–216.
- Happold DCD. 2013. Mammals of Africa. Volume III: Rodents, Hares and Rabbits. London: Bloomsbury Publishing. 784 pp.
- Happold M, Happold DCD. 2013. Mammals of Africa. Volume IV: Hedgehogs, Shrews and Bats. London: Bloomsbury Publishing. 800 pp.
- Hutterer R. 1986. Synopsis der Gattung *Paracrocridura* (Mammalia: Soricidae), mit Beschreibung einer neuen Art. *Bonner Zoologische Beiträge*. 37(2):73–90. <https://www.biodiversitylibrary.org/page/44675767>
- Hutterer R, Howell K, Jenkins P. 2016. *Crocridura dolichura* (errata version published in 2017). The IUCN Red List of Threatened Species. <https://www.iucnredlist.org/species/40628/115176367> (accessed 28 July 2025).
- Hutterer R, Van der Straeten E, Verheyen WN. 1987. A checklist of the shrews of Rwanda and biogeographical considerations on African Soricidae. *Bonner Zoologische Beiträge*. 38(3):155–172. https://www.zobodat.at/publikation_articles.php?id=214390
- Hutterer R, Verheyen WN. 1985. A new species of shrew, genus *Sylvisorex*, from Rwanda and Zaire (Insectivora: Soricidae). *Zeitschrift für Säugetierkunde* 50:266–271. <https://www.biodiversitylibrary.org/page/45510929>

- IUCN. 2023. World Heritage Nomination - IUCN Technical Evaluation. Nyungwe National Park (Rwanda) – ID N° 1697. In: IUCN World Heritage evaluations 2022 and 2023: IUCN evaluations of nominations of natural and mixed properties to the World Heritage List. Riyadh: World Heritage Committee. p. 137–144.
- Jackson RM, Roe JD, Wangchuk R, Hunter DO. 2006. Estimating snow leopard population abundance using photography and capture-recapture techniques. *Wildlife Society Bulletin*. 34(3):772–781. [https://doi.org/10.2193/0091-7648\(2006\)34\[772:ESLPAU\]2.0.CO;2](https://doi.org/10.2193/0091-7648(2006)34[772:ESLPAU]2.0.CO;2)
- Jacquet F, Denys C, Verheyen E, Bryja J, Hutterer R, Kerbis Peterhans JC, Stanley WT, Goodman SM, Couloux A, Colyn M, et al. (2015). Phylogeography and evolutionary history of the *Crocidura olivieri* complex (Mammalia, Soricomorpha): from a forest origin to broad ecological expansion across Africa. *BMC Evolutionary Biology*. 15(1):71. <https://doi.org/10.1186/s12862-015-0344-y>
- Kahle D, Wickham H. 2013. ggmap: Spatial Visualization with ggplot2. *The R Journal*. 5(1):144–161. <http://journal.r-project.org/archive/2013-1/kahle-wickham.pdf>
- Kerbis Peterhans JC, Hutterer R. 2009. The description of a new species of *Suncus* (Soricidae, Mammalia) from Central Africa. *Bonner Zoologische Monographien*. 55:141–159. <https://www.biodiversitylibrary.org/page/44817905>
- Kerbis Peterhans JC, Ntare N. 2009. Major findings: small mammal survey at Nyungwe National Park, Rwanda, July–August 2009. Preliminary Report Submitted to the Wildlife Conservation Society and ORTPN, Kigali, Rwanda. 7 pp.
- Kingdon J. 2015. The Kingdon field guide to African mammals (2nd edition). London: Bloomsbury Publishing. 640 pp.
- Majyambere M. 2013. Small mammal community response to buffer zone, edge, and interior habitats in Nyungwe National Park, Rwanda. Unpublished MSc Thesis. National University of Rwanda, Rwanda. 50 pp.
- Majyambere M. 2019. Preliminary survey of diversity and abundance of terrestrial small mammal species in forest fragments outside Nyungwe National Park, Rwanda. Final Report Submitted to the Wildlife Conservation Society, Kigali Office, Rwanda. 54 pp.
- Mikula O, Nicolas V, Šumbera R, Konečný A, Denys C, Verheyen E, Bryjová A, Lemmon AR, Lemmon EM, Bryja J. 2021. Nuclear phylogenomics, but not mitogenomics, resolves the most successful Late Miocene radiation of African mammals (Rodentia: Muridae: Arvicanthini). *Molecular Phylogenetics and Evolution*. 157:107069. <https://doi.org/10.1016/J.YMPEV.2021.107069>
- Mizerovská D, Nicolas V, Demos TC, Akaibe D, Colyn M, Denys C, Kaleme PK, Katuala P, Kennis J, Kerbis Peterhans JC, et al. 2019. Genetic variation of the most abundant forest-dwelling rodents in Central Africa (*Praomys jacksoni* complex): evidence for Pleistocene refugia in both montane and lowland forests. *Journal of Biogeography*. 46(7):1466–1478. <https://doi.org/10.1111/jbi.13604>
- Monfort A. 1992. Mammals of Rwanda: a provisional annotated checklist. *Journal of African Zoology*. 106(2):141–151.
- Nicolas V, Akpatou B, Wendelen W, Kerbis Peterhans J, Olayemi A, Decher J, Missoup AD, Denys C, Barriere P, Cruaud C, et al. 2010. Molecular and morphometric variation in two sibling species of the genus *Praomys* (Rodentia: Muridae): implications for biogeography. *Zoological Journal of the Linnean Society*. 160(2):397–419. <https://doi.org/10.1111/j.1096-3642.2009.00602.x>
- Nicolas V, Colyn M. 2006. Relative efficiency of three types of small mammal traps in an African rainforest. *Belgian Journal of Zoology*. 136(1):107–111.
- Nyiramana A, Mendoza I, Kaplin BA, Forget PM. 2011. Evidence for seed dispersal by rodents in tropical montane forest in Africa. *Biotropica*. 43(6), 654–657. <https://doi.org/10.1111/j.1744-7429.2011.00810.x>
- Onditi KO, Demos TC, Peterhans JK, Chen Z-Z, Bryja J, Lavrenchenko LA, Musila S, Verheyen E, Van de Perre F, Akaibe BD, et al. 2021. Historical biogeography, systematics, and integrative taxonomy of the non-Ethiopian speckled pelage brush-furred rats (*Lophuromys flavopunctatus* group). *BMC Ecology and Evolution*. 21(89):1–27. <https://doi.org/10.1186/s12862-021-01813-w>
- Palma RE, Gutiérrez-Tapia P, González JF, Boric-Bargetto D, Torres-Pérez F. 2017. Mountaintops

- phylogeography: a case study using small mammals from the Andes and the coast of central Chile. *PLoS ONE*. 12(7):e0180231. <https://doi.org/10.1371/journal.pone.0180231>
- Plumptre AJ, Davenport TRB, Behangana M, Kityo R, Eilu G, Ssegawa P, Ewango C, Meirte D, Kahindo C, Herremans M, et al. 2007. The biodiversity of the Albertine Rift. *Biological Conservation*. 134(2):178–194. <https://doi.org/10.1016/j.biocon.2006.08.021>
- Plumptre AJ, Masozera M, Fashing PJ, McNeilage A, Ewango C, Kaplin BA, Liengola I. 2002. Biodiversity surveys of the Nyungwe Forest Reserve in S.W. Rwanda. Bronx, New York: WCS Working Paper No. 19. 96 pp.
- Rahm U. 1967. Les muridés des environs du Lac Kivu et des régions voisines (Afrique Centrale) et leur écologie. *Revue Suisse de Zoologie*. 74(9):439–519. <https://archive.org/details/biostor-111103>
- Rickart EA. 2001. Elevational diversity gradients, biogeography, and the structure of montane mammal communities in the intermountain region of North America. *Global Ecology and Biogeography*. 10:77–100.
- Stanley WT, Robbins LW, Malekani JM, Mbalitini SG, Migurimu DA, Mukinzi JC, Hulselmans J, Prévot V, Verheyen E, Hutterer R, et al. 2013. A new hero emerges: another exceptional mammalian spine and its potential adaptive significance. *Biology Letters*. 9(5):20130486. <http://dx.doi.org/10.1098/rsbl.2013.0486>
- Tobler MW, Carrillo-Percastegui SE, Leite Pitman R, Mares R, Powell G. 2008. An evaluation of camera traps for inventorying large- and medium-sized terrestrial rainforest mammals. *Animal Conservation*. 11(3):169–178. <https://doi.org/10.1111/j.1469-1795.2008.00169.x>
- Upham N, Burgin C, Widness J, Liphardt S, Parker C, Becker M, Rochon I, Huckaby D, Zijlstra J. 2025. Mammal Diversity Database (Version 2.0). <https://doi.org/10.5281/zenodo.15007505>
- Van der Straeten E, Verheyen WN. 1983. Nouvelles captures de *Lophuromys rahmi* et *Delanymys brooksi* en République Rwandaise. *Mammalia*. 47(3):426–429.
- Verheyen WN. 1964. Description of *Lophuromys rahmi*, a new species of Muridae from Central Africa. *Revue de Zoologie et de Botanique Africaines*. 69:206–213.
- Verheyen WN, Hulselmans JIJ, Dierckx T, Colyn M, Leirs H, Verheyen E. 2003. A craniometric and genetic approach to the systematics of the genus *Dasymys* Peters, 1875, selection of a neotype and description of three new taxa (Rodentia, Muridae, Africa). *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique*. 73:27–71.
- Weier SM, Linden VMG, Gaigher I, White PJC, Taylor PJ. 2016. Changes of bat species composition over altitudinal gradients on northern and southern aspects of the Soutpansberg mountain range, South Africa. *Mammalia*. 81(1):49–60. <https://doi.org/10.1515/mammalia-2015-0055>

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