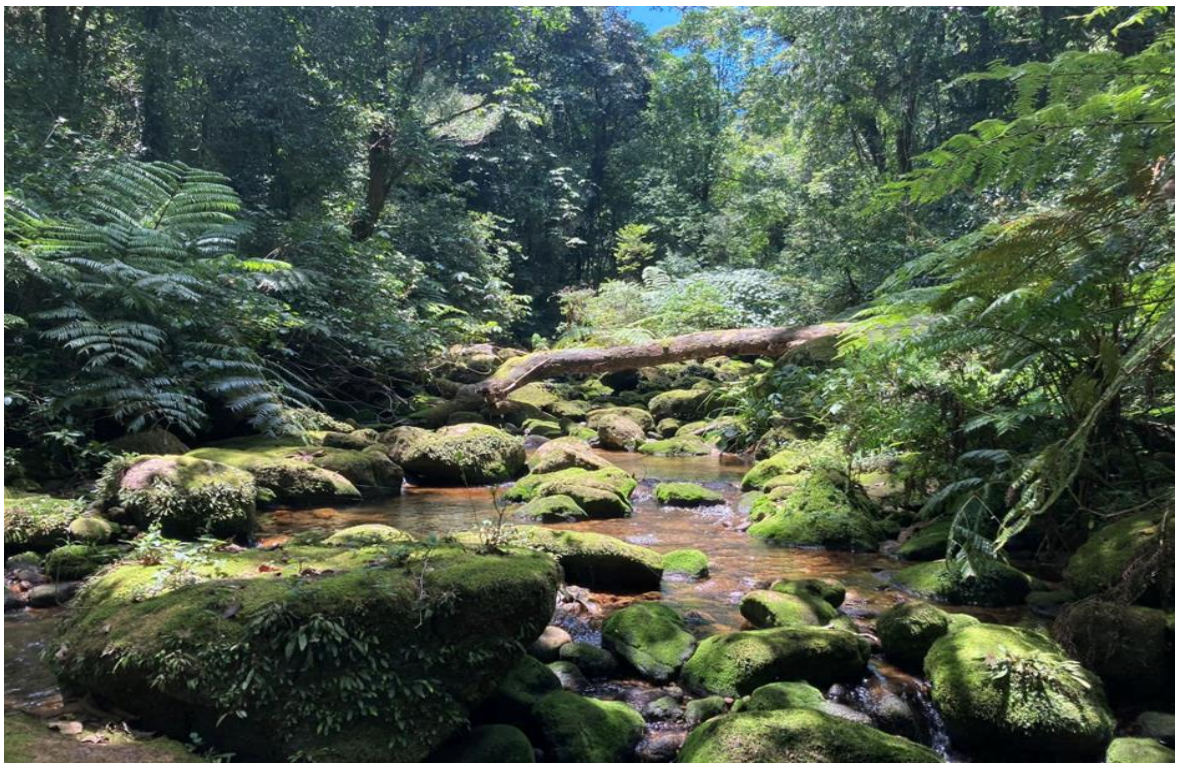
Mabu Forest expedition 27th May to 12th June 2024
- Preliminary Scientific Results vs1



Compiled by:

Julian Bayliss (Editor) - Science and Conservation Coordinator (MMCP)

Contents

Rationale

This short report represents an internal project summary document of the main preliminary findings of the Mt Mabu scientific expedition to the centre of Mabu forest that occurred from 27th May to 12th June 2024. This is not the main scientific report which will be produced once the final species identification results have been received. The purpose of this report is to provide initial feedback only on the 2024 Mabu scientific expedition to help guide management prescriptions and to inform the project staff. This report should be treated as an initial draft of results until the specimens collected have been formally identified by the taxonomic experts at which time this report will be updated and finalised. Until this time these results provide here represent the known and suspected results as of October 2024.

Summary of Main Results of the 2024 Mabu expedition

- BBC World News Documentary of the expedition (approx. 30 minutes), which featured on every BBC News channel (BBC World News, World Service, BBC UK News) during the week of 16th / 17th July 2024, thus promoting Mabu forest across the world. This also provides a world class documentary of the work at Mabu which the project can use for future promotional and fundraising purposes.
- The expedition and the project also featured on Mozambique National Television and in Mozambican newspapers at the start and at the end of the expedition, thus promoting the project nationally.
- Re-discovery of the Namuli Apalis (*Apalis thoracica lynesi*) at Mabu forest – Mozambique's' only endemic bird and the second population (after Mt Namuli) in Mozambique, making Mabu forest vital to its survival.
- New species of Fish.
- New species of Beetles.
- New species of Bush Cricket.
- New species of Spider.
- Possible new species of Dragonfly.
- Possible new species of Small Mammal (Shrew) .
- Possible new species of Bat.
- Many new records of species occurrences for Mabu – all of the species new to science ('new species') plus previously unrecorded rare species such as the frog *Hyperolius spingularis* and the flower *Dietes irridoides* (Moraea).
- Two botanical permanent sampling plots were established on the forest edge and in the centre of Mabu forest for future forest composition monitoring.
- The 2024 Mabu expedition was also the first ever scientific expedition into the centre of Mabu forest.
- Significant amounts of hunting, through the use of gin traps, was recorded even in the centre of Mabu forest.

Mabu Expedition Team- 27th May to 12th June 2024

Forest Expedition Team

Julian Bayliss (UK/ReGeCom/WWF Mozambique) – Expedition/Science Coordinator and Lepidoptera
Ara Monadjem (University of Eswatini) - Small mammal
Mnqobi Mamba (University of Eswatini) - Small mammals
Cesaria Huo (Limpopo Basin GEF7-IW Program, Mozambique) - Small mammals
Erica Tovela (Museu de História Natural, Mozambique) – Freshwater fauna
Noé dos Santos Hofiço (UniZambezi Mozambique) - Botany
Fernando Macia (UniZambezi Mozambique) - Botany
Claire Spottiswoode (Percy FitzPatrick Institute/South Africa) - Birds
Callan Cohen (Africa Birding/South Africa) - Birds
Gerhard Diedericks (South Africa) - Dragonflies
Gimo Daniel (South Africa/Mozambique) - Beetles
Papin Mucaleque (Instituto de Investigação Agrária de Moçambique - IIAM MSBP) - Botany
João Belto (Instituto de Investigação Agrária de Moçambique - IIAM MSBP) - Botany
Anthony Mapaura (Zimbabwe) - Botany
Raheela Ahmed (Mulanje Mountain Conservation Trust/Malawi) - Botany
Carl Bruessow (Mulanje Mountain Conservation Trust/Malawi) - Herpetology
Ruben Foquet (4Forests/EU) – Reptiles and Amphibians
Tim Brammer (4Forests/South Africa) – Reptiles and Amphibians
Christophe Bernier (France) - Camp manager/photography
https://www.christophebernier.com/mt-mabu-2024
Luciano Mariano (WWF Mozambique) - Logistics
Murray Crow (UK) - Camp manager/Chef
Arie Glas (Netherlands) - Doctor

BBC World News Team

Jonah Fisher (UK) – World News reporter
Anthony Jolie (UK) - Cameraman

Support Team

Jose Monteiro (ReGeCom, Mozambique) – RT Coordinator
Antonio Serra (WWF Mozambique) – Biofund Coordinator
Daniel Maula (RADEZA, Mozambique) – Community Coordinator
Edna Fernandes (WWF Mozambique) – Finance Coordinator

BBC Links

BBC article on the main expedition
https://www.bbc.com/news/articles/c51ylgr1zpxo.amp

Main Documentary on BBC iPlayer and YouTube
https://www.youtube.com/watch?v=DLlEX6nYosU
https://www.bbc.co.uk/iplayer/episode/m0021ftd/mabu-saving-the-secret-forest
and a Mabu drone sequence
https://www.bbc.co.uk/iplayer/episode/m0021kgl/from-above-saving-the-rainforest

Field Schedule

People converged in the town of Mocuba (from across Mozambique, South Africa and Malawi) on the evening of 27th and 28th May, and deployed to the forest on 29th May.

Expedition Dates: May/June 2024

27th May - Mocuba / Nampula
28th May - Mocuba / Nampula
29th May - Forest Edge camp
30th May - Forest Centre camp / Forest Edge camp
31st May - Forest Centre camp / Forest Edge camp
1st June - Forest Centre camp / Forest Edge camp
2nd June - Forest Centre camp / Forest Edge camp
3rd June - Forest Centre camp
4th June - Forest Centre camp
5th June - Forest Centre camp
6th June - Forest Centre camp / Forest Edge camp
7th June - Forest Centre camp / Forest Edge camp
8th June - Forest Centre camp / Forest Edge camp
9th June - Limbue
10th June - Mocuba / Nampula
11th June - Mocuba / Nampula
12th June - Malawi / Maputo / South Africa

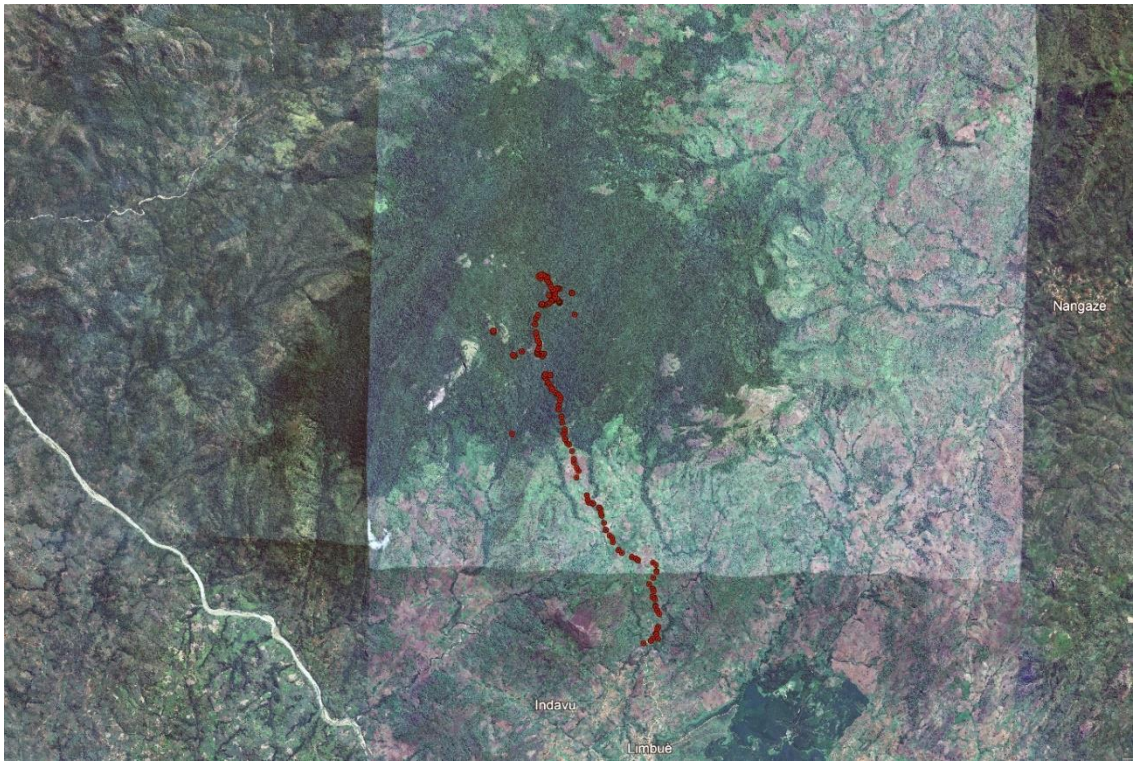


Figure 1. Satellite image of Mabu forest showing the extent of the forest and the route taken by the expedition from where they stopped the vehicles to the centre of Mabu forest.

Small Mammals

Ara Monadjem, Mnqobi Mamba, and Cesaria Huo

Background

Despite the increasing number of recent surveys, the mammals of Mozambique remain poorly known (Monadjem et al., 2010, 2015; Neves, Mathias, & Bastos-Silveira, 2018), and this is particularly true of high-elevation, montane areas. Mt Mabu, in northern Mozambique, is one of the most important sites in Mozambique for forest biodiversity, with a high level of endemism (Bayliss et al., 2014). In response to this, more than a dozen field surveys have been conducted at Mt Mabu over the past two decades. Small mammals (i.e. bats, rodents and shrews) have been collected here before, although prior to the 2022 survey, this was mostly opportunistic in nature. In 2022, a team conducted the first dedicated small mammal survey of Mt Mabu (Monadjem et al., 2022; Bayliss et al., 2023). During these previous surveys, a total of 15 species of bats, six species of rodent, and three species of shrew have been collected at Mt Mabu (Bayliss et al., 2014; Monadjem et al., 2022; Bayliss et al., 2023).

All the previous surveys were conducted on the eastern edge of the forest. The current study is the second intensive survey of the small mammals (including bats) in Mt Mabu, and the first such survey in the centre of Mabu forest. The focus of the study was to capture new species of small mammals previously unrecorded from Mt Mabu. In particular, we attempted to collect more specimens of *Crocidura cf. denti*; this probably refers to an undescribed species and we only captured a single individual in our 2022 survey. We also attempted to sample different habitats from those we encountered in the east of Mt Mabu in 2022.

Methods

A 13-day survey of the mammals of Mt Mabu, Mozambique, was conducted from the 29th May to the 10th June 2024. The base camp was situated in mid-elevation forest ca. 1,300 m above sea level, in a central valley below an isolated peak at above 1,500 m (Figures 1&2). The forest at Mt Mabu is extensive, covering ca. 7800 ha, of which only the extreme eastern portion was previously surveyed (Figures 1&2). Above 1,500 m above sea level, the forest gave way to a small patch of high elevation grassland, which is visible in the map (Figures 1&2).

The focus of the mammal team was on capturing small mammals of the orders Chiroptera (bats), Rodentia (rodents), and Eulipotyphla (shrews), using a variety of standard methods such as Sherman live traps, pitfall traps, mist nets and harp trap. Bats were also recorded through their echolocation calls using an ANABAT Walkabout ultrasonic recorder.

For rodents and shrews, 40 Sherman traps were set in two traplines (20 traps for each trapline) and 14 pitfalls were set both in the satellite camp (situated in mid-elevation at 970m above sea level) and the base camp (> 1,300 m above sea level). At both sites, Sherman traps were baited with a mix of rolled oats, peanut butter, and raisins, and were set in various habitats including hillside and riparian habitats. Traps were placed on the ground, on fallen logs, and up in trees or lianas. At the satellite camp, the pitfall traps were set along two transects, 1 m apart, and each transect with seven buckets. At the main camp, we set a single transect of 14 buckets, in a T-shape. At all pitfall lines, buckets were connected with a drift fence made of builder's plastic sheeting.

For bats, mist nets were set at least an hour before sunset, usually between 15:30 and 16:00, and were closed between 20:00 and 21:00 when bat activity had dropped. We monitored the nets continuously, or every 5 or 10 min if the nets were set apart. Trapped bats were removed immediately to reduce

stress and risk of injury. A small harp trap was set up for four nights in the satellite camp along a small stream surrounded by thick riparian vegetation, and for eight nights at the base camp, where it was moved on a nightly basis to points close to the river.

Larger mammals were recorded incidentally through direct observation of the animal, its spoor or faeces and other signs. The location of trapping sites is shown in Figure 2.

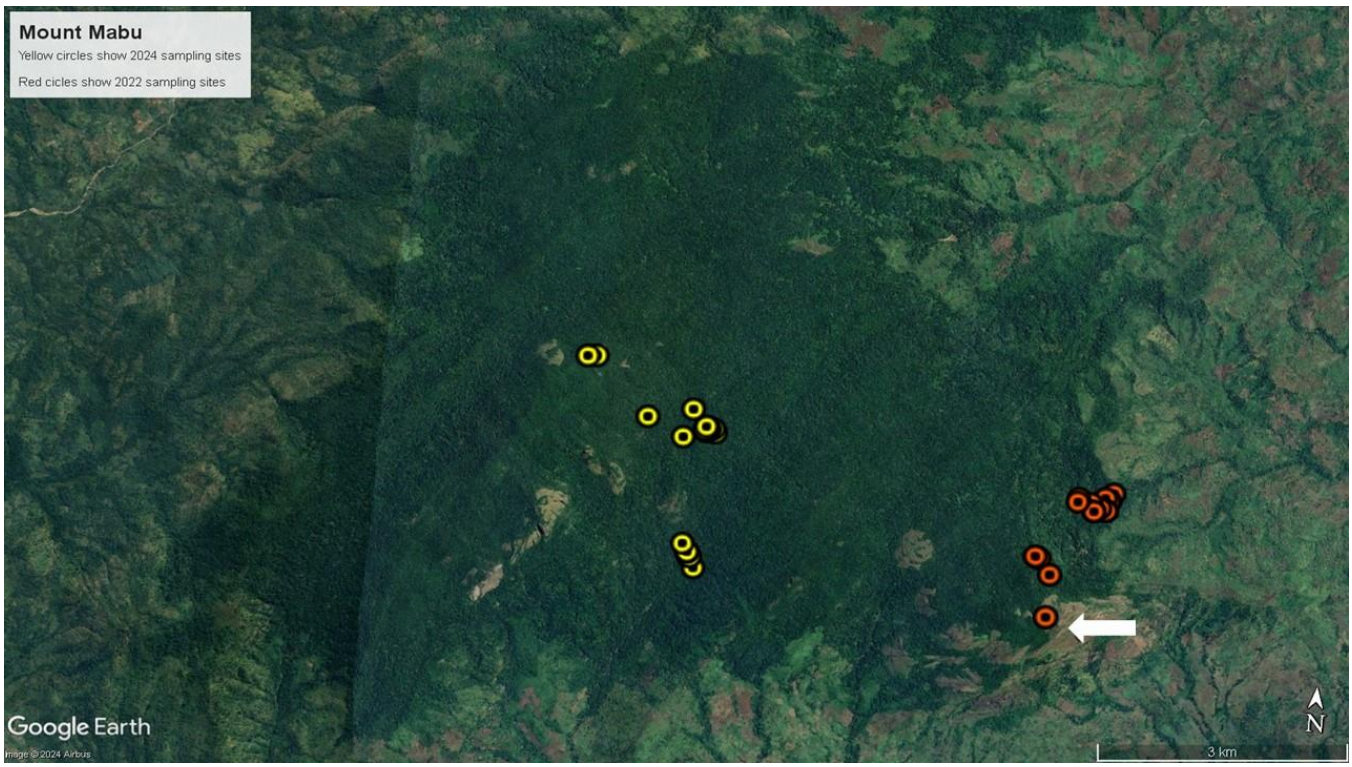


Figure 2. Location of small mammal trapping sites. Red points are 2022 expedition, yellow = 2024 expedition trapping sites.

Results

Based on preliminary identifications, a total of at least 12 species of small mammals were recorded in mid- and high-elevation habitats of central Mabu forest including 8 species of bats, 3 species of rodents, and one or two species of shrew. All these species have previously been recorded from Mt Mabu, except for the two uncertain species of Rhinolophus bats (which await morphological and genetic analysis before species affinities can be confirmed). Table 1 lists all the species recorded during this survey.

None of the species captured on our recent survey is threatened, however, one species (*Lophuromys machangui*) is data deficient, and another species (*Miniopterus wilsoni*) has not yet been evaluated (see Table 1). However, we do not as yet know the species identities of the two Rhinolophus species (cf. *darlingi* and cf. *rhodesiae*), and the one shrew (*Crocidura luna*?).

Of the 10 bat species recorded during this survey (Table 1), at least five are widespread and relatively abundant species. However, the fruit bat Myonycteris is represented by an endemic taxon *M. angolensis goliath* that is restricted to central Mozambique and the neighbouring highlands of eastern Zimbabwe (Monadjem et al., 2020); whether the Mt Mabu specimens refer to this taxon is not yet

clear. The taxonomy and proper identification of the remaining five species are unresolved and will require further examination of specimens and molecular analysis to sort out.

Table 1. List of the 8 species of bats (Chiroptera), 3 rodents (Rodentia) and 1 (2?) shrews (Eulipotyphla) captured (or recorded by bat detector) during the survey of Mount Mabu, Mozambique, during an intensive small mammal survey conducted 30 May – 10 June 2024. IUCN list refers to the global status of each species (IUCN, 2019); LC = Least Concern; NT = Near Threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered, DD = data deficient, NE = not evaluated. See Appendix 1 for English names. Ac = only recorded on the bat detector

Order/Family	Genus	Species	IUCN red list	Numbers captured
Chiroptera				
Pteropodidae	*Myonycteris*	*Angolensis*	LC	1
	Rousettus	*Aegyptiacus*	LC	3
Rhinolophidae	*Rhinolophus*	*Blasii*	LC	3
	Rhinolophus	*Clivosus*	LC	2
	Rhinolophus	cf. *rhodesiae*		1
	Rhinolophus	cf. *darlingi*		2
Miniopteridae	*Miniopterus*	*Wilsoni*	NE	6
Vespertilionidae	*Afronycteris*	*Nana*	LC	Ac
Rodentia				
Muridae	*Lophuromys*	*Machangui*	DD	22
	Montemys	*Delectorum*	LC	46
Nesomyidae	*Beamys*	cf. *major*	LC	12
Eulipotyphla				
Soricidae	*Crocidura*	*Luna*	LC	1
	Crocidura	*luna?*		1
Total captures				**100**

Most of the rodent species (as currently recognized) recorded at Mt Mabu have relatively restricted distributions, although two of them are abundant in appropriate forested habitat (*Lophuromys machangui* and *Montemys delectorum*). The latter species is a close endemic, being restricted to northern Mozambique and the extreme south of Malawi (Bryja et al., 2014). Recent research (not yet published) as shown that *Beamys major* is a synonym of *B. hindei*.

Crocidura luna occurs widely in mid-elevation forests in the region, as observed in this study where we captured multiple individuals in all our pitfall traps. However, a single specimen is far smaller than the others and may represent a different species, hence our assignment of it to *Crocidura luna*?.

Unfortunately we did not capture any additional species of the cryptic and mysterious C. cf. *denti* that was captured on the 2022 survey, and that probably represents a new species to science.

Conclusion and recommendations

The current survey has expanded our knowledge of the mammals on Mt Mabu, which harbours a distinct community of small mammals, quite different from those inhabiting the savannas around the base of the mountain. As such, these species are essentially trapped on the mountain. Since at least some of these species are regional endemics, this means that Mt Mabu is vital to the longer-term persistence of small mammal biodiversity in northern Mozambique. This observation was also noted previously (e.g. see Bayliss et al., 2014).

It is important to note that this survey was conducted in the central parts of the forest, and mostly at higher elevations. Hence, this survey contrasts with previous studies that emphasised the far eastern portion of the forest (e.g. Bayliss et al., 2014; Monadjem et al., 2022; Bayliss et al., 2023). The fact that we captured the same species here as were previously captured in the eastern parts, suggests that the diversity of small mammals is similar across the forest. This has important conservation implications in that the forest could potentially be considered as a single unit as far as small mammals as concerned. One important exception are the species that are restricted to the summit peaks covered in grassland. The only small mammal species that was only captured in this highly restricted habitat was *Otomys angoniensis* (captured only on the 2022 survey, although we did confirm the presence of this species during this survey by its characteristic runways and faeces).

Another point to consider is the type of traps and numbers of traps deployed. For example, we used a small harp trap, the dimensions of which were probably inappropriately small for the vegetation structure at Mt Mabu. A large, 3-bank Austbat Harp trap is highly recommended for such a forested site. Indeed, it has recently been demonstrated that bat diversity in African forests have been severely under-represented because of the lack of harp traps (Tanshi et al., 2022). A canopy mist net system is probably also essential and should be a priority, although it would probably only be possible to deploy such a system at the base of the mountain (due to logistical constraints).

Although trap success was extremely relatively high (well over 30%) in the Sherman traps, these were dominated by just three species: *Montemys delectorum*, *Lophuromys machangui*, and *Beamys hindei*. This may have prevented or dissuaded other rodent species from entering the traps.

It is very likely that cold weather inhibited bat activity (especially at the main camp at 1270 m). Bat activity was relatively low at the satellite camp (at about 970 m), but it was virtually absent at the main camp. In a typical 20 min period immediately after sunset (which is prime time for bat activity), we only ever recorded one or two species per night, and never more than three separate echolocation calls. By contrast, at the satellite camp, we were recording hundreds of calls (of up to four species) during the same period. In addition, *Rhinolophus clivosus* (which was only captured at the main camp) was collected while hibernating, supporting this statement.

Herpetology (Reptiles and Amphibians)

Ruben Foquet and Tim Brammer

Background

The reptiles and amphibians of Mabu forest have been surveyed on several occasions previously resulting in the discovery of two news species of snake (*Atheris mabuensis* and *Dipsadoboa montisilva*) and two new species of chameleon (*Rhampholeon maspictus* and *Nadzikambia baylissi*) for Mabu forest. There are currently no known endemic amphibian species for Mabu forest although the specimens of *Arthroleptis aff. francei* from Mabu forest are suspected to be new to science.

Methodologies

Opportunistic Sampling

To survey the reptiles and amphibians of Mabu forest both daytime and nocturnal opportunistic sampling took place, to provide an overview of species encountered. Amphibians and reptiles were looked for using different methods. In each of the sites, we performed visual encounter surveys during the night, focusing on forest edge, forest streams and forest interior, mostly within primary forests. Further visual and acoustic searches were carried out opportunistically during the day. These mostly were carried out in the morning and late afternoon to increase our chances of recording diurnal and crepuscular species. The surveys were aimed at providing baseline semi-quantitative data on species occurrences across the focal habitats. Amphibians were handled using nitrile gloves, and where appropriate, sampling bags were not reused between individuals and localities to prevent the transmission of pathogens. All specimens listed in the account below were photographed, GPS coordinates were taken and digital records are available on the online platform iNaturalist.

Sequencing

Where DNA or voucher samples were collected, the following methods were used. DNA samples, consisting of tail and toe clips, were stored in 99% ethanol immediately after extraction. Reptile vouchers were euthanized by means of orally administered 20% benzocaine gel. Amphibians were euthanized by topical application of 20% benzocaine gel to the ventrum. Vouchers were fixed by means of injecting all fleshy parts with 99% ethanol using a hypodermic syringe and then submerging the entire specimen in 99% ethanol. Vouchers of amphibians were transferred to a 70% ethanol and 30% distilled water solution after 24 - 48 hrs depending on the size of the specimen. We await analysis for which results will be added to this report on a running basis.

Pygmy chameleon density survey methodology

To estimate the population density of pygmy chameleons, various methods could be used including a distance sampling approach or a plot approach. We opted for the plot approach. Density estimates were carried out in Mabu focused on the Mount Mabu Pygmy Chameleon. Plots were placed randomly in the forest. Each plot was visited once, at night. All chameleons were counted in each plot by meticulously scanning the whole plot with two observers (always the same avoiding observer bias), slowly moving up and down in a systematic manner through the plot.

Plot size

Based on an earlier density assessment by the same authors on the Chapman's Pygmy chameleon (*Rhampholeon chapmanorum*) in the Malawi hills (De Beenhouwer et al. in prep.), it was suggested to downscale the plot size from 400 m2 to 100 m2 to allow for more plots to be sampled within a limited time whilst maintaining accuracy. Each plot was square and measured 20 by 20 metres in size on Mt.

Mabu. The choice of plot size was adjusted based on, among others, the chameleon density; lower densities required larger plot sizes to remain relevant. If conducted by two observers, the size is limited by the upward limit since observation accuracy is expected to decrease with larger plots, as the attention span of each observer decreases.

Plot parameters

For each plot, the following categorical parameters were recorded:

- Slope (No incline, Slight incline, Steep incline)
- Habitat type (Riverine, Forest Interior)
- Undergrowth density (Very open, Open, Medium, Very dense)
- Leaf litter (Very little, Little, Medium, Thick), with four readings of leaf litter depth, one for each plot corner point

Fauna parameters

For each individual pygmy chameleon detected, the following parameters were recorded: snout vent length and sex (if possible). For Mount Mabu, all other reptiles and amphibians encountered within the plots were also identified and counted.

Results

Mt. Mabu Pygmy Chameleon

Between the 1st and the 10th of June 2024, 21 plots of each 400 m2 were established, where a total of 38 Mount Mabu Pygmy Chameleons were discovered (Figure 3). Here a slightly different approach was followed. Due to the wide altitudinal range on which suitable forest can still be found, the team intentionally defined seven altitude intervals spanning 100m each. Within each of these intervals, three plots were chosen at random. The intervals spanned from 900 up until 1600 m.a.s.l. All plots were located within the main major forest block that constitutes the core of Mount Mabu. Higher numbers were encountered for the 900-1000 altitude interval and 1000-1100 altitude interval, with a gradual decreasing abundance towards the higher altitudes. Although no chameleons were encountered in the plots above 1500 m.a.s.l., presence within this altitude interval was confirmed opportunistically, albeit at low density.

Figure 3. Mount Mabu Pygmy Chameleon (*Rhampholeon maspictus*). Photograph by Christophe Bernier.

Notable reptile observations

- Mt. Mabu Bush Vipers (*Atheris mabuensis* - Endangered). Two very dark, almost pattern less Mt. Mabu Bush Vipers were observed at an approximate altitude of 1300 m.a.s.l.. Local hunters who knew the species by name, claimed that it was also present at our survey sites located between 1500 m.as.l. and 1600 m.a.s.l.. Previously, on Mt. Mabu, this species was only recorded from the lower lying forest at 1000 m.a.s.l.. (Branch & Bayliss 2009). These records increase the altitudinal range for the species on Mt. Mabu by 200 m. The species has also been recorded from Mt. Namuli where a single specimen was found at an altitude of 1550 m.a.s.l.. At the time of that publication, it was thought that the presence of this species at such high altitudes was due to the destruction of the low lying forests of Mt. Namuli which might have forced the species to migrate higher up. Our findings suggest that this is most likely still part of the species natural habitat and suggests that the species might cover a wider altitudinal range than previously assumed (record available on iNaturalist).
- Montane Tree Snakes (*Dipsadoboa montisilva* - Near Threatened) Two Montane Tree Snakes were observed. One was found dead; it appeared to have been killed by an animal (available on iNaturalist) and a second was found foraging at night on the forest floor in one of the sampling plots prior to heavy rain (available on iNaturalist). The altitudes at which they were found were respectively 1300 m.a.s.l. and 1146 m.a.s.l.. The second specimen was the largest of the two, measuring 901 mm from snout to vent and 1181 mm in total length. This is a new length record for the species, measuring 97 mm longer than the previous longest recorded specimen which measured 1084 mm in total length (Branch et al. 2019).
- Mount Mabu chameleon (*Nadzikambia baylissi* – Near Threatened). Several individuals were found at night, whilst scanning the mid-canopy of the evergreen forest.

- Mount Mabu Pygmy Chameleon (*Rhampholeon maspictus* – Near Threatened). A systematic population density estimate was conducted through plot counts on this species, across the altitudinal range of the evergreen forest on Mount Mabu. The species was encountered across the altitudinal range, yet with differing densities.

Notable amphibian observations

- *Arthroleptis* aff. *francei.* Several specimens of *Arthroleptis* aff. *francei* were encountered on the forest floor. This species complex was already known from Mt. Mabu, hence our records confirm their presence on the mountain.
- Spiny-throated Reed Frog (*Hyperolius* cf. *spinigularis* - Vulnerable)

We note that colleagues including Dr. Julian Bayliss observed and photographed *Hyperolius cf. spinigularis* (Figure 4) in the centre of Mount Mabu in December 2023, in preparation of the June 2024 expedition. We did not encounter this species, underlining the limitations of dry season sampling.

Figure 4. *Hyperolius spinigularis* from the centre of Mabu forest in December 2023. Photograph by Christophe Bernier.

Birds

Claire Spotiswoode and Callan Cohen

We are awaiting report but the main result was the re-discovery of the Namuli Apalis (*Apalis thoracica lynesi*) – Mozambique's only endemic bird (Figure 5), previously only know from the forests of Mt Namuli which are highly threatened, and therefore Mt Mabu forest represents a crucial refuge population and raises the importance of Mabu forest even more.

Figure 5. The Namuli Apalis (*Apalis thoracica lynesi*) - photograph by Ross Gallardy (Copyright)

Fish

Erica Tovela

We are awaiting the taxonomic report from Dr Erica Tovela. However, according to Dr Tovela, at least one species of freshwater fish new to science has been collected on this last expedition to Mabu forest. These specimens have now been delivered to experts in south Africa for DNA sequencing which will hopefully confirm this result.

Orthoptera (Bush Crickets/Katydids)

Piotr Naskrecki

We are awaiting the taxonomic report from Dr Piotr Naskrecki. However, according to Dr Naskrecki several species of Bush Cricket new to science have been collected on the last two expeditions to Mabu forest.

Odonata (Dragonflies), Weather, and Terrestrial and Instream Habitat

Gerhard J Diedericks

Background

To date, 158 adult Odonata species have been recorded in Mozambique (Odonata Database of Africa, Dijkstra & Clausnitzer 2005; Dijkstra K. -D. 2016; Jocque et al. 2018; Bernard & Barowski 2020; iNaturalist 2024; ADU Virtual Museum 2024). Previous surveys in the eastern mountain ranges of Mozambique with Afromontane Forest have thus far been restricted to Mount Sanga, Mount Chitigal, Njesi Plateau (Jocque et al. 2018), and some citizen scientists posting photographic records from across the country which may include mountainous areas. Thus far, 32 species (20%) out of the 158 countrywide have been recorded in Afromontane Forest regions in Mozambique. Odonata species associated with Afromontane Forests are generally tolerant to colder climates and shade, with low insolation and interspecific competition considered the key factors segregating forest and non-forest species (Dijkstra & Clausnitzer 2005).

The survey in the forests of Mount Mabu in May-June 2024 focused on adult and larvae of Odonata in the watery habitats in the forest. Weather conditions during May-June are generally considered cooler (low flow, winter) and therefore late for most southern African adult Odonata. Odonata larvae therefore provide insight into which genus or species successfully copulated, oviposited and emerged from eggs in the available habitats, even though they might not be on the wing at the time. In addition, with aquatic ecosystems globally being one of the most threatened (Dudgeon et al. 2006). The aquatic stream community present provides insight into dominant stream functional feeding groups and ecological drivers of these systems draining the forest. This report therefore presents the results of the May-June 2024 Odonata field survey.

Study Area

The Mount Mabu Mountainous area is in the north-eastern part of Mozambique, in the Zambezia Province. The area was accessed by foot from the Limbue village, located south-southeast of the forest to the central portions of Mount Mabu Forests (Figure 1). The elevational range of the area covered by foot during the study ranged from 364 m a.s.l at the Limbuè village to 1,537 m a.s.l at the summit on one of the exposed granite inselbergs.

The area covered at lower elevations (prior to entering the forest) drains the Muladi stream towards the Munduzi River. The catchment of the Mgupya streams formed most of the catchment area accessed in the forest, with both camp sites located along the Muavani stream, a tributary of the Mgupya. Both the Mgupya and Muladi are tributaries of the Munduzi River. The Munduzi merges with the Lugela, which merges with the Licungo in the city of Mocuba (Figure 6).

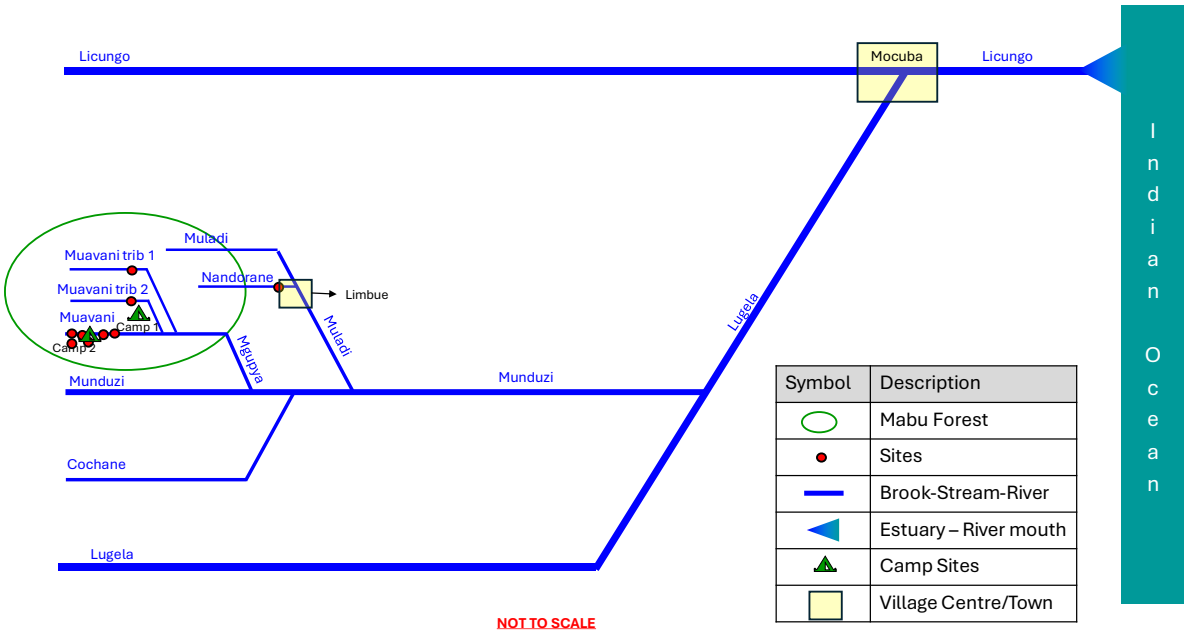


Figure 6. Schematic sketch of main drainage (Brooks-Streams-Rivers) in the study area and its link to the main catchment basin (Rio de Licungo). The sketch is not to scale.

Methods

Terrestrial and Instream Habitat

Ecological information gathered at each site were guided by elevation-forest type, habitat type, Hydraulic type, and spot measurements of in situ water quality measurement. Key terms used to categorise spot measurements of water temperature, pH, electrical conductivity, and descriptions of trophic levels are listed below.

Weather

Weather conditions, specifically ambient temperature and relative humidity are main drivers of the presence and activity levels of adult Odonata. To assist with some of the information three ambient temperature and relative humidity loggers were stationed at:

- a stream close to the 1st camp (S 16.296377 E 36.358007; 948 m a.s.l.),
- the Muavani stream at the 2nd camp (S 16.280768 E 36.358025; 1,263 m a.s.l.), and
- the summit close to the source of the Muavani (S 16.274460 E 36.345230; 1,535 m a.s.l.).

Data from these loggers are summarised and presented.

Aquatic Macro-invertebrates

While searching for Odonata larvae, other aquatic macroinvertebrates encountered, and the habitats they were associated with were also recorded. Some of the nymphs, larvae, and adults of the following

taxa were collected, with the aim of supplying these specimens to specialists currently working on them:

- Plecoptera: Perlidae
- Ephemeroptera: Caenidae, Dicercomyzidae, Prosopistomatidae, and Tricorythidae
- Coleoptera: Elmidae, Gyrinidae, Dytiscidae

Other aquatic taxa collected were for the Maputo Museum, or to microscopically verify genus and or species. The stream community composition also provides a brief window into the ecology of the stream systems during the May-June site visit.

Odonata

Adult Odonata encountered hiking from Limbuè village (29th May 2024) into the forest and back (10th June 2024) were recorded. Adult Odonata were captured with a sweep net and photographed in hand. Species observed but not captured with a net were identified using 10x42 binoculars. Larvae were collected sampling different depositional and erosional habitats in seeps, brooks, creeks and streams within the study area. All specimens collected were identified to genus level, with species level identification to be attempted at a later stage (dependant on budget) through linking DNA of the larvae with those of known adults.

Results

Terrestrial and Instream Habitat

Most of the survey fell within the medium-altitude rain forest, followed by records at higher elevations along brooks, creeks and streams (moister Afromontane Forest), and then records before entering the forest (cultivated woodland). Ephemeral or intermittent streams with numerous brooks, creeks and streams drain the area visited, with the Muavani the dominant stream system visited during the study. Close to the source (granite domes or inselbergs) subsurface seeps maintains shallow pools (depth <50 cm) in drainage areas, with boulders, sand and organic material (leaf litter) dominant. Brooks and streams are dominated by boulders, sand, silt, and detritus in depositional areas, with boulders, cobble, bedrock, gravel and sand dominant in erosional areas. Leaf-litter as expected was ever present, either in depositional areas or trapped between cobble in riffle areas.

Based on spot measurements during the survey, stream water was generally categorised as cold (<19°C), ranging from 13.8 to 17.8°C [16.0°C]. Waters draining from the study area during this survey was therefore categorised as cold. The spot measurements of water pH ranged from 5.7 to 6.9 [6.0], categorised as weakly acidic to neutral. Lower pH values were mostly measured in smaller streams at higher elevations, and 'higher' pH levels further downstream in bigger streams. Water conductivity measured ranged from 8.0 to 15 µS/cm [10.6 µS/cm), categorised as very low in dissolved ion concentrations. Based on the high organic loads (leaf litter) and low ion contents, the flowing waters draining the study area was categorised as dystrophic. The waters were "soft" (soapy feeling after washing), generally indicative of waters with low ion concentrations, specifically of calcium and magnesium, with potentially higher levels of bicarbonate (forest leaf litter).

Weather

A table summarising ambient temperature, relative humidity, dewpoint, and vapour pressure deficit are included for loggers at the three different locations. A graph illustrating the ambient temperature differences are also included.

Table 2. Summary of weather conditions measured in Mount Mabu Forest, 30th May to 10th June 2024.

Logger	Elevation (M a.s.l.)	No. of days	No. of records (1 min interval)	Ambient Temperature (°C) – min-max [avg]	Relative Humidity (%) – min-max [avg]	Dewpoint (°C) – min-max [avg]	Vapour Pressure Deficit (kPa) – min-max [avg]
1: 1st camp	948	11	16,078	13.6-21.5 [16.9]	63-99 [94]	12.8-19.2 [15.9]	0.02-0.95 [0.12]
2: 2nd camp	1,263	9	12,524	10.6-20.1 [15.0]	70-99 [93]	8.9-17.4 [13.8]	0.02-0.65 [0.13]
3: Summit	1,535	4	5,434	12.3-26.8 [17.3]	26-99 [62]	2.8-14.7 [9.0]	0.01-2.43 [0.84]

Ambient temperature in the forest, as expected, is cooler than outside the forest. On average, the ambient temperature logged at the summit (Logger 3) was higher than at a lower elevation in the centre of the forest (Logger 2). Adult Odonata are less active when ambient temperatures are lower, especially within shaded habitats (i.e., forest).

Stream Community: Aquatic Macroinvertebrates

Predators and shredders dominated depositional areas in stream communities, while filtering and gathering collectors dominated erosional areas. Clingers, sprawlers and climbers dominated the stream community, with burrowers and sprawlers dominating depositional areas, and climbers and clingers dominating erosional areas.

Odonata

Table 3. A list of Odonata adults and larvae encountered inside the forest are listed, as well as those encountered in the lower lying cultivated areas outside of the forest.

Family - Species	Common Name	Abundance in forest[1]	Notes
Calopterygidae			
Umma declivium Förster, 1906	Green-banded Sparklewing	Rare	During site visit adults only encountered at the 1st camp, restricted to sunny spots on Brooks. No larvae encountered.
Chlorocyphidae			
Chlorocypha consueta (Karsch, 1899)	Ruby jewel	Common	Commonly encountered in the forest during site visit. Uncommon but present at Limbuè. Larvae common in root wads.
Platycypha caligata (Selys, 1853)	Dancing Jewel	Uncommon	Abundant at lower elevations (Limbuè) on streams outside of the forest, and only once encountered in the forest at site visited regularly.
Coenagrionidae			
Pseudagrion (A) *hageni* Karsch, 1893	Painted Sprite	Uncommon	Encountered inside and outside of the forests, at elevations ranging from 370 to 1 460 m a.s.l.
Pseudagrion (A) *kersteni* (Gerstäcker, 1869)	Powder-faced Sprite	Absent	Only recorded on the smaller streams-brooks outside the forest.
Pseudagrion (A) *spernatum* Selys, 1881	Upland Sprite	Common	Present on bigger streams with open sunny spots.
Platycnemididae			

Allocnemis Selys, 1863	Yellowwings	Rare	Only larvae encountered in seep pools close to the summit.
Elattoneura Cowley, 1935	Threadtail	Absent	Only one adult female encountered on stream at Limbuè.
Aeshnidae			
Anax speratus Hagen, 1867	Orange Emperor	Rare	During site visit one adult spotted[2] at the summit, one patrolling sunlit pools upstream from 2nd camp[3], and one in the cultivated terrestrial area close to a stream at Limbue[4].
Zosteraeschna usambarica (Förster, 1906)	Forest Hawker	Common	Adults regularly encountered in the forest, while larvae were less commonly encountered in pools with root wads over undercut banks.
Gomphidae			
Nepogomphoides stuhlmanni (Karsch, 1899)	Eastern Horntail	Rare	One photographic record by Julian Bayliss during a previous survey.
otogomphus Selys, 1858	Longlegs	Common	Larvae regularly encountered in depositional parts of stream with silt-detritus over sand.
Onychogomphus Selys, 1854	Claspertails	Common	Only larvae encountered, mostly in depositional areas of streams with cobble-sand.
Paragomphus Cowley, 1934	Hooktails	Abundant	Only larvae encountered in depositional areas dominated by sand at nearly all sites sampled.
Libellulidae			
Aethiothemis/Diplacodes		Absent	One female encountered (not collected) in terrestrial area (shrub-herbaceous thicket) on the way up to the forest
Crocothemis Brauer, 1868	Scarlets	Rare	One larvae encountered in stagnant pool (connected with trickle-seep) close to camp 2.
Crocothemis sanguinolenta (Burmeister, 1839)	Little Scarlet	Rare	One female adult sunning on granite dome near summit, and one female adult in cultivated terrestrial habitats outside of the forest.
Notiothemis jonesi Ris, 1919	Eastern Forest Watcher	Common	Adults regularly encountered at long pool area upstream from camp 2.
Orthetrum Newman, 1833	Skimmers	Common	Larvae regularly encountered in depositional areas of streams and brooks with an abundance of fine detritus. Potentially *O. julia*.
Orthetrum julia Kirby, 1900	Julia Skimmer	Common	Adults regularly encountered at stagnant waters adjacent streams and brooks. One "old" female in dry seep on summit.
Orthetrum machadoi Longfield, 1955	Highland Skimmer	Absent	One female encountered in terrestrial area close to a bog or slow flowing wetland channel, outside of the forest.
Trithemis aconita Lieftinck, 1969	Halfshade Dropwing	Uncommon	Adults encountered at sunny pool areas in the forest, but more abundant along the stream at Limbuè (outside forest).
Trithemis furva Karsch, 1899	Navy Dropwing	Uncommon	Adults encountered at sunny pool areas in the forest, but more abundant along the stream at Limbuè (outside forest).
Trithemis pluvialis Förster, 1906	Russet Dropwing	Absent	Adults common outside the forest, with females up to 700 m from their larval habitat.
Zygonyx Hagen, 1867	Cascaders	Rare	Only larvae encountered in small brook close to the summit.
Macromiidae			

Phyllomacromia Selys, 1878	Cruisers	Absent	Larvae abundant in depositional areas of streams, brooks and creeks.

Discussion

Terrestrial and Instream Habitat

The terrestrial and instream habitats in Mount Mabu forest visited in May-June 2024 are mainly undisturbed by direct human influence. Water for domestic use during the field visit was used by everyone (>25 people) as drinking water without any immediate side effects. The water colour was predominantly clear, becoming slightly murky (cloudy) only during high rainfall runoff. During the high rainfall event (8th to 9th June 2024), small brooks was dominant throughout the forest, with all ephemeral drainage lines transporting water downstream. The runoff is rapid, with the mainstream in front of Camp 2 subsiding soon after rain dissipated.

Weather

Weather conditions for adult Odonata was not ideal, with several species present in larvae stage not encountered as adults.

Aquatic macroinvertebrates

Taxa regarded as highly sensitive dominated the stream community (e.g., Dicercomyzidae, Heptageniidae, Leptophlebiidae, Prosopistomatidae, Tricorythidae, etc.). Taxa considered sensitive were encountered in erosional as well as depositional areas. The dominance of predators and abundance of taxa in depositional areas suggests “unpolluted” food sources, dominated by forest leaf litter rather than anthropogenic sources.

Odonata

A total of 24 species have been encountered during this survey, of which 9 was restricted to the forest, 6 species only outside of the forest, and 9 was encountered both inside and outside of the forest. A total of 18 imago’s were encountered, and 11 different larvae. No adult Gomphidae were encountered, which is likely due to the cooler conditions experienced during the field visit. Odonata adults were mostly encountered at sunny spots during warmer parts of the day, which shifted with the earth’s rotation throughout the day. Often when an adult is disturbed, its flight is high up into the forest canopy. Early morning, some adults were observed slowly working their way down towards the stream from the upper canopy.

Julian Bayliss photographed an adult male of Gomphidae: Nepogomphoides stuhlmanni (Karsch, 1899) in 2017. This brings the total number of Odonata species in the forest and vicinity to 25. The Eastern Horntail (N. stuhlmanni) species is described as preferring faster rocky sections of streams (Dijkstra (2024). No larvae of Gomphidae were encountered in the fast-flowing areas of streams sampled in May-June 2024.

A survey during the warmer months following the rainy season (Dec-Jan) should reveal more adult Odonata for Mount Mabu forest and its surrounding landscape.

Beetles

Gimo Daniel

Background

Dung beetles are one of the dominant invertebrates in tropical forests. These beetles primarily feed on the faeces of mammals and, in doing so, perform a series of essential ecological functions and environmental services, including dung removal, nutrient recycling, soil fertility enhancement, secondary seed dispersal, and suppression of other insects or parasites. These ecosystem services are vital not only to other creatures but also to humans (Nichols et al., 2008), making dung beetles an important subject for investigation.

Methods

During the 2024 expedition, we established transects in the following altitudinal gradients: 800–1000 m, 1100–1300 m, and 1300–1535 m (Table 4; Figure 7). Within each altitudinal range, multiple transects were established for sampling. Each transect consisted of five standard pitfall traps spaced 50 m apart. The pitfall traps were five-litre plastic buckets, approximately 17 cm in height and 23 cm in diameter, baited with 250 ml of human faeces, and left in the field for 48 hours. Voucher specimens are currently housed at the Natural History Museum, Maputo, Mozambique and await formal identification.

Results

As a result of the 2024 scientific expedition at least two new species of dung beetle were collected on this expedition, which add to those previously collected from Mabu in 2022. These are *Onthophagus* sp nov group 19 and *Pseudocopris* sp. nov.

Table 4. List of transects where dung beetles were sampled in 2024 trip.

Sites	Coordinates
Site 1	-16.296377; 36.358007
Site 2	-16.280768; 36.358025
Site 3	-16.274460; 36.345230

Figure 7. Dung beetle collecting sites on the 2024 scientific expedition.

Discussion

While the June 2024 trip recorded relatively low dung beetle diversity, likely due to the cold season and the reduced activity of insects, it still managed to collect an additional two species new to science. The two new species to science collected on the 2024 Mabu expedition can be added to the 15 new species previously collected from Mabu in 2022. This equals approximately 30 species of dung beetle collected from Mabu forest, half of which were new to science, with several representing new records for the country. Most notably, many of the dung beetle species collected appeared to be endemic to the Mabu region (Daniel, 2023; Daniel et al., 2023a, b; 2024a, b). This research has increased the number of currently recognized dung beetle species in Mozambique to 330, which is still considered far less than half of the country's estimated total diversity (Daniel & Génier, 2019).

Botany

Background

This report aims to present the methods used to setup long-term vegetation monitoring plots in Mount Mabu, Mozambique, in June 2024. It also attempts to show the reasoning behind the actions taken. Plant collecting trips to the forest were undertaken by various researchers in previous expeditions - e.g. 2005 and 2008 - and recorded 18 species of interest, (Timberlake et al., 2012), with most. Only a small part of the forest has been botanically explored to date, hence more effort is required (Bayliss et al., 2014). For this expedition it was decided that it was time to start working towards understanding the forest dynamics to aid conservation effort and to monitor the impact of any conservation efforts being implemented. Long-term monitoring plots are a great way of doing this. In Any case, considering that most of the plants had finished flowering and fruiting, specimen collecting was not going to yield much. Nevertheless, Joao Elias Belto collected all fertile plant specimens in addition to the ones collected by the team as part of the plot establishment. More detailed descriptions of Mt Mabu have been published before and are available. These include Timberlake & Bayliss, (2016), Bayliss et al., (2014), and Timberlake et al., (2012). The botany team members were Noe dos Santos Ananias Hofico, Papin Aurelio Mucaleque, Belto Elias Joao, Fernando Macia, Custodio Ndimande, and Anthony Mapaura. Lucia Manhique joined for a day. The local hunter Mr Agua was with the team for a day before being replaced by Estevao Enriques for the rest of the expedition.

Methods

Rationale

This section gives details of the permanent plots that were setup in Mt Mabu, Mozambique.

The original plan was to setup two 100 m x 100 m plots, one close to the edge of the forest and another one close to the centre of the forest. However, this proved to be over ambitious due to several reasons which include:

1. Setting up plots in the forest proved to be time consuming due to high tree densities making it difficult to move around. It would have been impossible to finish even a single plot given the limited time.

2. It was not possible to find a continuous area to setup a plot with those dimensions due to the numerous streams and cliffs in the mountain.

Location of permanent plots

The team therefore, decided to use 20 m x 20 m plots which are commonly used in other parts of the world. A decision was made to strive to have a minimum of a quarter a hectare in total at each site. The right angles at each corner were set using the Pythagorean theorem (3-4-5 method) and every side was checked to make sure it was 20 m long. Yellow and orange strings were used to mark the boundaries of the plot before measuring the trees. For each plot, coordinates were taken approximately at the centre of the plot.

Data recording

Data was captured using a datasheet drawn up for the study. For each tree in the plots, the following parameters were measured: species identification, circumference at breast Height (CBH), (using a tape measure), tree heights, (using a height rod), tree vigour and health, bore quality, position of the canopy in relation to light, and actual position of the individual using a GPS. Bore quality, position of the canopy in relation to light, tree health, and vigour were assessed according to the classes defined in Tables 1

to 4 in the Appendix. This follows the Mozambiquan manual on setting up permanent forest plots (Fernandes et al., 2020). Only trees with a CBH of 16 cm were measured. A plant was considered a tree when it was free standing (with a self-supporting stem - not a liana), woody, and with a clear stem.

Results

Tree identification proved particularly challenging since most trees were not fruiting and the leaves were not easy to see, especially canopy trees. However, identification was made possible through our local guides who had extensive knowledge of the flora, the use of binoculars, slashing the stem and observe the sap and slash colour (Figure 8), and collecting specimens for identification. Collected specimens were dried in the field using a field drier (Figure 9). This enabled us to reduce the weight of material to be carried down at the end of the expedition and also ensured that all collected material was not lost to mould.

Figure 8. Examples of slash colours and their sap. A. *Tabenaemontana* slash showing the milky sap, and B. *Garcinia* slash showing the yellow sap. Photo: A. Mapaura.

Figure 9. The field drier. Photo: A. Mapaura.

Each individual tree had a numbered metal plate nailed to it, at a height of 10 cm above the point where CBH was measured. All the labels were made in the field, and indicated the Plot number, subplot number and tree number (Figure 10). All the subplots near the edge of the forest were designated Plot 1 (P1) and those near the forest centre were Plot 2 (P2) (Figure 11). For P1, subplots ranged from S1 to S7, while P2 had subplots ranging from S1 to S13.

Figure 10. Making metal tree tags A, and tree tag nailed on a tree B, P2S2 16 (Plot 2, subplot 2, tree number 16). Photo: A. Mapaura.

The following tables give details of the classes used for bore quality, position of the canopy in relation to light, tree health, and vigour. For a more detailed descriptions of the classes with pictorial illustrations please see Fernandes et al., (2020).

Table 5. Bore quality

This considers the shape of the shaft, presence of branches and their position along the stem, and defects of tree trunk.

Class	Description
4	Straight, cylindrical shaft without apparent defects, at a Height of 4 m and branching positioned less than 1/3 of the top of the tree

3	Straight and cylindrical stem, with branching 1/3 of the top of the tree, but with lower height at 4 m; or slightly crooked cylindrical shaft, devoid of branches, but with height greater than 4 m; or tree with wavy or fluted bole
2	Shaft with strong tortuosity; or forked half of your He:
1	Shaft with several tortuosities; or spiral-shaped, presence of tumors and cavities, broken shaft, cracked in any position; or stump with shoots:

Table 6. Position of the canopy in relation to light

Refers to the position of the individual's crown in relation to the light.

Class	Description
4	Emergent (without neighbouring canopies) receiving direct light all day:
3	Every canopy with direct light incident only from above:
2	The entire canopy receiving some (diffuse) light from above or from the sides:
1	The entire canopy without direct light

Table 7. Tree health

This considers the condition of the tree and the possibility of rot or mortality due to damage caused by animals, insects, fungi, diseases and the presence of fire.

Class	Description
4	Completely healthy
3	Damaged by lightning, fire or animal action, with possibility of recovery
2	Damaged by human action (extraction of the bark to manufacture beehives, canoes and other uses), existence of cavities (human or natural action), and possible strangulation by lianas and/or epiphytes, with low possibilities of recovery
1	Dead (standing or lying down) due to various causes

Table 8. Vigour

This deals with the shape of the crown and its asymmetry in relation to the trunk.

Class	Description
4	Crown forming a complete circle and symmetrical projection around the shaft
3	Incomplete circle and distinctively asymmetrical canopy

2	Severely damaged crown with few branches and signs of mortality, with its circle occupying less than half the projection of a normal canopy
1	Dead or apparently dead crown, but the individual remains standing

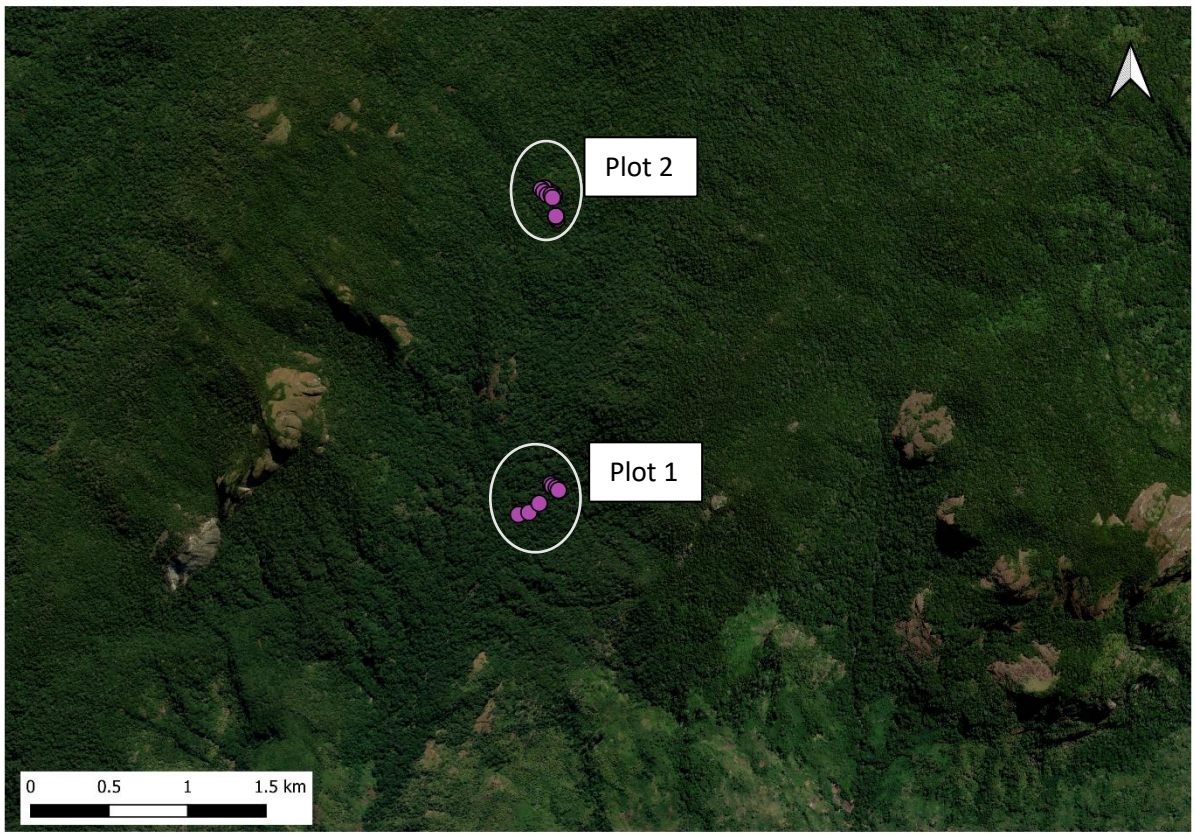


Figure 11. Position of the plots in the forest. Plot 1 is near the forest edge while Plot 2 is near the centre of the forest.

Discussion

Data is still being captured and specimens being identified. It is expected that data capturing and specimen identification will be done by the end of August and data analysis will start. Basic information is given here while detailed results are awaited. A total of seven plots were done near the edge of the forest (2800 m^2), and 13 subplots near the centre of the forest (5200 m^2). This gives just over a quarter hectare and slightly over half a hectare respectively. A total of nine hundred and fifteen (915) individual stems were measured, with 261 stems in Plot 1, (an average of 932 stems/ha), and 654 in Plot 2 (an average of 1258 stems/ha). These numbers are comparable to earlier research in the forest Timberlake & Bayliss, (2016). More results will be available once data capture is done.

EXPEDITION CONCLUSIONS

- This expedition resulted in several news species to science to be added to the Mabu endemic species list. It is becoming evident that the new species to science are now to be found in the taxonomic groups which have not been surveyed in detail before, such as the invertebrate groups. Most of the vertebrate groups have now probably been surveyed sufficiently. However, it is thought that the plant species list is still far from complete and further botanical collection is still a good idea.
- The two botanical permanent sampling plots that were established on the forest edge and in the centre of Mabu forest will form part of a future forest monitoring system to assess forest condition and health.
- There is considerable hunting using gin traps throughout Mabu forest. Approximately half of males in the local communities are hunters inside Mabu forest. This is a recognised form of livelihood, however there seems to be high levels of hunting. Interestingly, on the camera traps that were out for 1 year and several out for 6 months at a time, not a single bushbuck was recorded. This is alarming and probably as a result of hunting. The method of hunting (gin traps) is also not traditional and highly destructive trapping anything that steps on it.

PROJECT RECOMMENDATIONS

- Future expeditions should concentrate on the small mammals, the botany, and the invertebrate groups to find more species new to science at Mabu forest.
- The two botanical sampling plots can now be used by forest researchers from national institutions and research students to help monitor forest health and condition at Mabu forest.
- The level of hunting needs to be assessed across the whole of Mabu forest. We have found that hunters are active in the very centre of the forest and throughout, it is widespread throughout the forest. An alternative source of meat through domestic livestock needs to be invested in the local communities to reduce the hunting pressure on the forest. Alternative methods of hunting needs to be promoted instead of the use of gin trapping which is indiscriminate and very cruel (and not traditional).
- Nature-based tourism now needs to be promoted strongly to ensure that local communities benefit from forest conservation.
- A website needs to be developed to help promote and market Mabu as a nature-based tourism destination.

Figure 12. Images of the team following the expedition.

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