

**Befriending the Critically Endangered Nguru Spiny Pygmy Chameleon
(*Rhampholeon acuminatus*): Assessing the Abundance, Distribution and
Threats to its Conservation**



**Project Report
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Abstract

The Nguru spiny pygmy chameleon (*Rampholeon acuminatus*) is a critically endangered dwarf chameleon species endemic to the Nguru mountains in Tanzania. Its population is declining and is currently categorized as critically endangered by the International Union for Conservation of Nature (IUCN) due to habitat loss caused by human activities such as cultivation of shade crops. For the successful conservation of this rare chameleon species, information on its current population status as well as the habitat conditions in the Nguru mountains is crucial. To achieve this, the project conducted an intensive field work during the rainy season from March to May 2023 in order to assess the population size, distribution and habitat quality of the Mkingu Nature Forest Reserve (MNFR) which is part of the Nguru mountains. The findings showed that the population is small (57 individuals sighted during the field work) and confined to a small geographic range. These findings highlight the vulnerability of this highly specialized chameleon to the ongoing human activities and habitat degradation. The project recommends urgent measures to help protect and conserve the Nguru mountains so as to safeguard and rescue the remaining *Rampholeon acuminatus* population from further declining to extinction.

1.0 Introduction

Tanzania is a country in East Africa famously known for tourism due to its diverse flora and fauna. The forests cover 39.9% of the land in the country with the population density of 48 persons/km² (Worldometers, 2022). The biggest threat to forests in Tanzania is deforestation for agriculture and settlement of the rapidly growing population. Moreover, rural communities which consist of more than 75% of the country's population, depend on the resources from the forest such as timber, firewood, poles etc. This increase pressure on the natural resources causing further deterioration which in turns affects the biodiversity that's depend on forests for survival. The Nguru mountains are part of the Eastern Arc mountains, which are the chains of mountains covering both Tanzania and Kenya (Burgess et al., 2007). The Nguru mountains specifically are found in Morogoro region in Tanzania, and are predominantly covered with rainforest at lower elevations and montane forests at higher elevations. The difference in climate as well as isolation of each mountain range has led to diverse flora and fauna with higher degree of endemism including the Nguru spiny pygmy chameleon (*Rhampholeon acuminatus*) thus making these mountains a conservation priority (Newmark, 2002).

The *Rhampholeon acuminatus* is the species of small chameleon inhabiting the tropical montane forest of the Nguru mountains in Morogoro, Tanzania (Tilbury, 2018). The species is categorized as Critically Endangered by the IUCN, making it a global importance for conservation (Tolley et al., 2014). The chameleon is endemic to Nguru mountains, inhabit the remaining patches of less than 28km² of this fragmented habitat (Tilbury, 2018). Although portion of the forest is protected as a reserve i.e. Mkingu Nature Forest Reserve (MNFR), activities such cultivation of shade crops puts a lot of challenge in the conservation of this species as they disturb the forest floor which is the primary habitat for *Rhampholeon acuminatus*. Despite the fact that the forest receive protection from the government, ongoing human activities that pose less harm to other species, cause further declines in the quality of this microhabitat, and potentially drive the chameleon to extinction in the wild. In addition to that, the illegal harvesting of the *Rhampholeon acuminatus* for pet trade also threaten its long-term survival in the forest, since the species is already in the Critically Endangered category, its removals from the wild could have negative effects to its population in the Nguru mountains.

2.0 Objectives

The main objective of this project was to collect population and geographic information on the endemic and critically endangered *Rhampholeon acuminatus*. We specifically aim to address some recently expressed concerns about the species' continued existence and any related IUCN Red List data gaps (Tolley et al., 2014). Specifically, the project aimed to gather the research data listed in the Table 1 below:

Table 1: Project objectives and activities implemented in the MNFR

Project Objectives		Notes
1. Research	1.1 Population size, distribution & trends	- A quick survey is needed to determine the population size, distribution, and trends of this species as well as to determine how much of its original habitat still exists.
	1.2 Threats	- The habitat quality of the Nguru mountain remain supportive for the survival for Nguru spiny pygmy chameleon (<i>Rhampholeon acuminatus</i>) for the present and near future.
2. Conservation planning	2.1. Species action/ Recovery plan	- If any individuals are left in the original population, translocation and/or in situ programs should be considered.
	2.2. Area-based management plans	- The remaining forest should be preserved, and forest restoration should be taken into account.
3. Monitoring	3.1. Population trends	- The current number of <i>Rhampholeon acuminatus</i> compared to the previous data.
	3.2. Habitat trends	- To determine the rate at which the forest is being lost, additional habitat loss should be quantified.
4. Conservation education & Public awareness	4.1. Training	- Any actions taken to recover or restore a species must involve the local community.

3.0 Data collection and results

3.1 Study design and field protocols

Data were collected during day and night for three consecutive months i.e. from March to May 2023. A total of 9 sampling sites were established (Table 2), and their selection was primarily based on elevation, vegetation type, land use and prior information about the citing of the *Rhampholeon acuminatus*. Other factors known to influence reptile abundance and distribution including the amount of leaf litter, canopy cover, air temperature, air humidity and understory cover etc. were also considered. The study area (MNFR) was divided into three zones i.e. low land forest

(< 700 MASL), sub-montane forest (700 - 1400 MASL) and montane forest (> 1400 MASL) following Shangali et al. (1998) and Zilihona et al. (1998) with some slight modifications. Each zone consisted of three sampling sites, each with a radius of 1 km, and placed at least 1 km apart. Several methods (night transects, time constrained searches and opportunistic searches) were used following Howell (2002) and McDiarmid et al. (2012) in order to maximize captures. Nine plots of 1 km x 1 km were established using ropes, and all chameleons within the plot were surveyed at night by four researchers with strong head torches. The plot was surveyed in four parallel lines to avoid disturbance with an average of 45 - 60 minutes search time. All the chameleons were counted and communicated to avoid double counting. Chameleons were also classified in age categories based on length: juveniles (< 2 cm Snout Vent Length or SVL), sub adults (2 - 4 cm SVL) and adults (> 4 cm SVL).

Table 2. Overview of the specific *Rhampholeon acuminatus* plots established across its known distribution area

Site	GPS coordinate	Condition	Elevation (MASL)	Survey (min)
1	06°02.504'S, 037°29.269'E	Wet	1884	180
2	06°02.429'S, 037°29.301'E	Wet	1733	180
3	06°02.390'S, 037°30.322'E	Rainy	1623	180
4	06°02.538'S, 037°30.948'E	Rainy	1435	180
5	06°02.046'S, 037°29.995'E	Wet	1594	180
6	06°02.281'S, 037°29.237'E	Rainy	1674	180
7	06°03.498'S, 037°31.743'E	Rainy	1149	180
8	06°03.919'S, 037°33.264'E	Wet	731	180
9	06°01.991'S, 037°31.592'E	Rainy	656	180

3.2 Results

3.2.1 Habitat conditions

The MNFR is an exceptional ecosystem, known for its rich biodiversity and unique species including a dwarf chameleon species that is critically endangered known as the *Rhampholeon acuminatus*. This project explored the distribution patterns of *Rhampholeon acuminatus* within the MNFR and examined the factors that influence its population dynamics. To accomplish this, extensive field surveys were carried out in various locations within the study area for a period of 3 months i.e. March to May 2023. The presence and abundance of *Rhampholeon acuminatus* were recorded, and multiple environmental variables were measured, including elevation, air humidity, temperature, and understory and canopy cover. To reduce bias and ensure representative data collection, then systematic sampling techniques were employed. The analysis of our data revealed intriguing patterns with respect to the distribution of *Rhampholeon acuminatus* within the MNFR which could be linked to several key environmental factors (Figure 1). There was a significant association between the presence of *Rhampholeon acuminatus* and the extent of canopy cover i.e. the species was consistently more abundant in areas with denser canopy cover as compared to other areas with less denser canopy cover. These findings can be attributed to the role of the canopy cover in providing essential microhabitats and shelter for *Rhampholeon acuminatus*. The dense vegetations could offer protection from predators, creating suitable foraging opportunities as well as microclimate that is conducive for their survival. Elevation was also

found to play a crucial role in the distribution patterns of *Rhampholeon acuminatus* as it was observed that the species was more abundant at higher elevations in the MNFR. This could be attributed to cooler temperatures at higher elevations, along with the associated changes in vegetation and microclimate that create more favorable conditions for the *Rhampholeon acuminatus* survival and reproduction. Moreover, the MNFR offered other unique environmental conditions for the *Rhampholeon acuminatus* as the findings from this project showed that the air humidity had a positive correlation with its population. The species seemed to thrive in areas characterized by higher levels of humidity. The availability of moisture in these environments likely supports the chameleon's physiological functions, including skin hydration, respiration, and overall well-being. Temperature on the other hand had a negative correlation with the abundance and distribution of *Rhampholeon acuminatus* in the MNFR, as it was observed that areas with higher temperature had fewer to no individuals. This observation suggests that *Rhampholeon acuminatus* might be sensitive to temperature fluctuations and may experience physiological stress when exposed to higher temperature or extreme heat. The project also explored the influence of understory cover on the abundance and distribution of *Rhampholeon acuminatus* and it was found that understory covers i.e. the vegetation layer below the canopy negatively influence the presence of this chameleon species in the MNFR. The species appeared to be less abundant in areas with dense understory vegetation possibly because it hinders the chameleon's movement, foraging opportunities, or access to suitable microhabitats, leading to reduced population numbers.

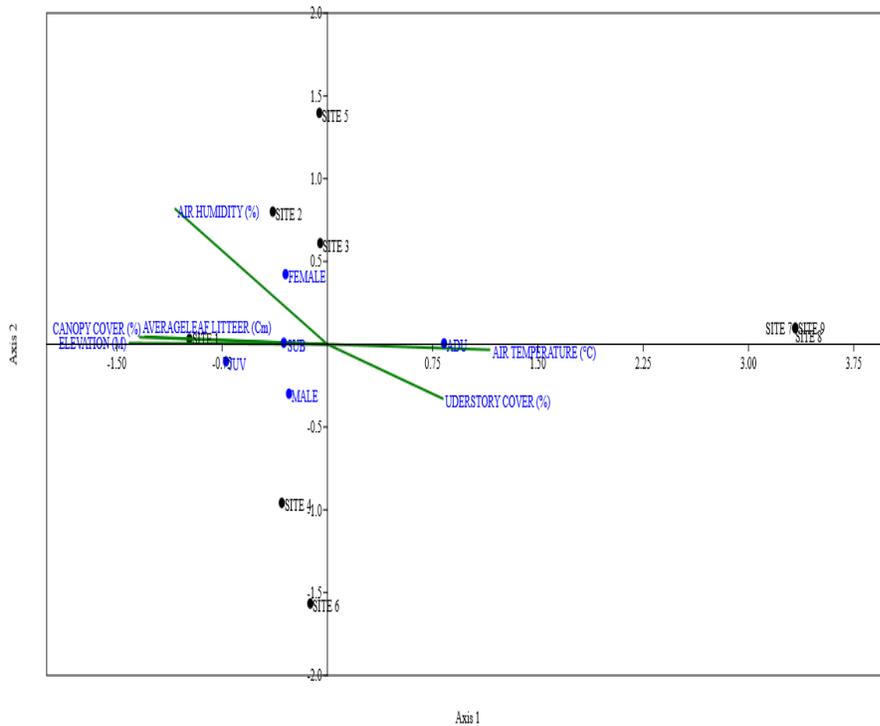


Figure 1: Canonical correspondence analysis diagram showing the influence of environmental factors on distribution and abundance of *Rhampholeon acuminatus* species in MNFR. Lines represent environmental variables (elevation, undergrowth, temperature, canopy, humidity and leaf litter).

3.2.2 Population size and composition

During the three months of assessing the population demographics of *Rampholeon acuminatus*, a total of 57 individuals were recorded (Table 3). Out of those, 23 were females and 34 were male. The age class category was as follow; 1 juvenile, 37 sub-adults and 19 adults. The most abundant age group was the sub-adult followed by the adult. The presence of only fewer juvenile suggests potential challenges in the survival of young individuals which might pose challenges in the reproductive success of *Rampholeon acuminatus* in the MNFR.

Table 3. *Rampholeon acuminatus* observed in the study area

Sex	SVL (cm)	TL (cm)	Age categories	Height of tree chameleon found (m)
Male	1.8	0.8	Juvenile	4
Male	3.7	1.7	Sub adult	1.4
Male	3.8	1.8	Sub adult	5
Male	3.4	1.5	Sub adult	6
Male	3.6	1.7	Sub adult	6.5
Male	3.8	1.7	Sub adult	8
Male	3.8	1.6	Sub adult	7
Male	3.9	1.7	Sub adult	4
Male	3.9	1.7	Sub adult	2
Male	3.5	1.3	Sub adult	2.5
Male	3.4	1.4	Sub adult	1.8
Male	3.8	1.6	Sub adult	5.6
Male	3.9	1.6	Sub adult	5.5
Male	3.3	1.2	Sub adult	3.5
Male	3.8	1.5	Sub adult	10
Male	3.9	1.4	Sub adult	7.7
Male	3.7	1.5	Sub adult	1.8
Male	3.6	1.4	Sub adult	1
Male	4.2	1.9	Adult	4
Male	4.5	2.1	Adult	1.5
Male	4.3	1.9	Adult	6
Male	5.1	2.1	Adult	1.6
Male	4.9	2	Adult	2.7
Male	4.2	1.9	Adult	2
Male	5.4	1.7	Adult	3
Male	4.4	1.6	Adult	5.2
Male	4.8	1.4	Adult	1.5
Female	2.3	1.1	Sub adult	0
Female	3.5	1.5	Sub adult	0
Female	3.4	1.5	Sub adult	3
Female	3.4	1.5	Sub adult	6
Female	3.6	1.3	Sub adult	6
Female	3.9	1.7	Sub adult	8
Female	4	1.6	Sub adult	4.2
Female	3.6	1.5	Sub adult	4.6
Female	3.5	1.4	Sub adult	4.25
Female	3.6	1.5	Sub adult	12
Female	3.7	1.5	Sub adult	4
Female	3.9	1.6	Sub adult	1.5
Female	3.6	1.6	Sub adult	5
Female	4.1	1.7	Adult	2

Female	4.4	1.8	Adult	3
Female	4.7	1.9	Adult	2
Female	5.3	1.8	Adult	4.5
Female	5.3	1.4	Adult	1.8
Female	5.1	1.9	Adult	0
Female	4.8	2.1	Adult	2
Female	5.8	1.4	Adult	4.8
Female	4.2	1.6	Adult	2
Female	5.2	1.8	Adult	2.5



Figure 2. Nguru spiny pygmy chameleon (*Rampholeon acuminatus*) photographed on a night survey in the Mkingu Nature Forest Reserve (MNFR)

3.2.3 Population distribution and trends

The observed distribution patterns of *Rhampholeon acuminatus* within the MNFR provide interesting insights into the preferences, requirements as well as ecological factors influencing the presence or absence of this chameleon species in different habitats

- (i) **Montane Forest:** The high number of *Rhampholeon acuminatus* individuals (50) was observed in the montane forests. This suggests that this chameleon species prefer higher elevations that are characterized by cooler temperatures, cloud and canopy cover and unique vegetation community. The cooler temperatures found in montane forests are more favorable for *Rhampholeon acuminatus*, as they potentially provide a more suitable thermal environment for the species. The chameleons are more adapted to lower temperatures and may struggle to thrive in warmer lowland habitats. In addition, the cloud cover in montane forests can contribute to higher humidity levels, which is an important factor for the survival and well-being of *Rhampholeon acuminatus*, as indicated by the positive correlation between air humidity and population numbers. Furthermore, montane forests often exhibit a more complex

vegetation structure with a well-developed canopy and understory, providing a variety of microhabitats, suitable perches, and ample prey resources for the chameleon species. The dense and diverse vegetation in montane forests offer multiple foraging opportunities for the chameleons, allowing them to meet their nutritional needs more effectively.

- (ii) **Sub-Montane Forest:** In contrast to the montane forest, the sub-montane forest had significantly lower number (7) of *Rhampholeon acuminatus* individuals. The decline in population as the habitat shifts from montane to sub-montane areas might be caused by several factors such as lower elevations as a result experience relatively higher temperatures compared to the montane forest. The preferences of *Rhampholeon acuminatus* for cooler temperatures explain the lower abundance observed in this sub-montane forest. The warmer conditions could lead to physiological stress, reduced activity, and potential impacts on reproductive success for the chameleon species. Additionally, the differences in vegetation structure between montane and sub-montane forests may have influence in the distribution of *Rhampholeon acuminatus*. Sub-montane forests typically exhibit a less dense and less diverse vegetation structure compared to montane forests thus less available microhabitats, suitable perches, and prey resources for the chameleons, contributing to the lower population numbers observed in this forest zone.
- (iii) **Lowland Forest:** The absence of *Rhampholeon acuminatus* in the lowland forests within the MNFR raises intriguing questions about the species' tolerance to warmer and potentially drier conditions found in these habitats. Lowland forests generally experience higher temperatures and reduced cloud cover compared to higher elevation forests. This discrepancy in environmental conditions may explain the lack of *Rhampholeon acuminatus* sightings in lowland areas during the 3-month field survey. The absence of suitable thermal and humidity conditions and potential physiological stress caused by increased temperatures could be among the factors that prevent *Rhampholeon acuminatus* from surviving and colonizing the lowland forests.

Furthermore, the Bray-Curtis similarity index (Figure 3) was used to show the ratio of similarity in *Rhampholeon acuminatus* abundance within the three forest zones. The results showed that, the lowland zone is the most discordant zone, and the sub-montane and montane zones being more similar in species composition. Sub montane and montane zones contained more forest dependent species compared to the lowland zone.

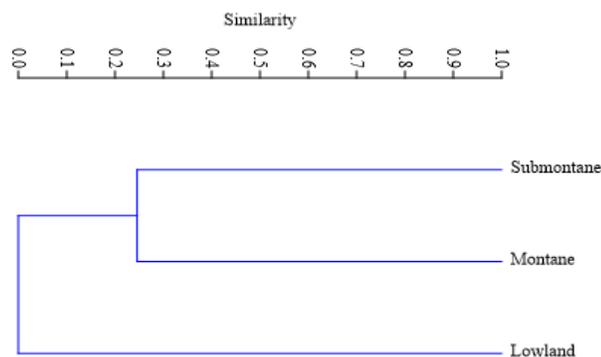


Figure 3. Bray-Curtis similarity index for the three forest zones in the MNFR

The Bray-Curtis similarity index further showed that sites in the lowland zone (abbreviated as low in Figure 4) were similar to no *Rhampholeon acuminatus*, and dissimilar to sites in sub montane and montane zone i.e. the similarity index of Low 1 vs Low 2 vs Low 3 = 1. The sub-montane sites (abbreviated as Sub) on the other hand, showed 100% similar number of *Rhampholeon acuminatus* as Sub 1 vs Sub 2 = 0.857, Sub 1 vs Sub 3 = 0.72 and Sub 2 vs Sub 3 = 0.9565. Also, as expected, sites close to each other were more similar in species composition than distant sites i.e. Mon 3 vs Sub 1 (Montane abbreviated as Mon), while distant sites showed no similarity i.e. Mon 2 vs Mon 3. Some of the sites in sub-montane forest showed great similarity with those of montane forest i.e. Mon 3 vs Sub 2. Similarly, sites in the same elevation zone where more related compared to sites in other zones i.e. sites in Mon 1 vs Mon 2 and sites in Mon 3 vs Sub 2.

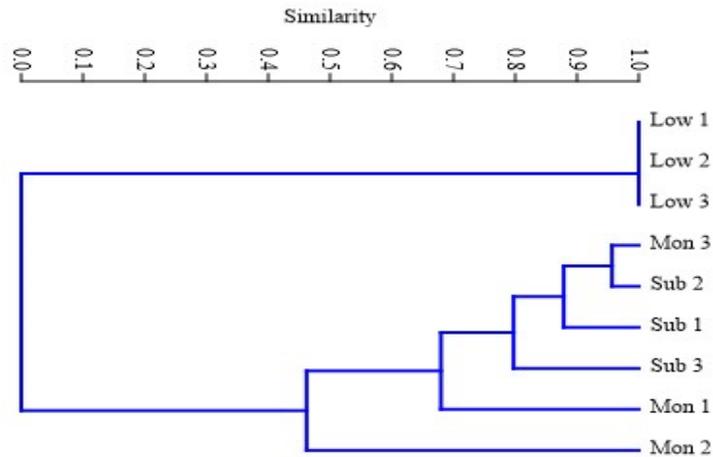


Figure 4: A dendrogram based on Bray-Curtis species similarity index (Single Average Link) for *Rhampholeon acuminatus* from the 9 sites surveyed from March to May 2023 in the MNFR

3.3 Threats to the conservation of the *Rhampholeon acuminatus* in Nguru mountains

The project assessed the habitat conditions and activities that threatens the conservation of the *Rhampholeon acuminatus* in the Nguru mountains and discovered human encroachment in the forest reserve for the cultivation of banana, yam, cocoa, cardamom and beans particularly in the south of Nguru mountains (Figure 5). Most of the newly and rapidly established farms observed during the habitat survey were cardamom farms. Cardamon is a seasoning spice with huge market in Asian countries that was initially cultivated in the East Usambara mountains and now cultivation has expanded to the south of Nguru mountains. Bananas and yams are commonly grown alongside the cardamom. The project team also noticed that, clearing of the forest's understory is a necessary step in the cultivation of cardamom. This could have seriously implication in the conservation of *Rhampholeon acuminatus* since forest floor is the primary habitat this rare and endemic chameleon species.



Figure 5. Farming activities inside the MNFR, (a) cardamom and (b) yams

3.4 Action plan for the *Rhampholeon acuminatus* conservation

To conserve the remaining habitat in MNFR and to address the threats that threatens long-term survival of the *Rhampholeon acuminatus*, it is very important to develop a comprehensive action plan. To achieve this, the project engaged the local communities and other conservation stakeholders in the Nguru mountains. The project team and stakeholders agreed to develop a detailed action plan that will guide the conservation of the *Rhampholeon acuminatus* in Nguru mountains. The following topics were proposed to be considered;

- (i) Strengthen the law enforcement: Enhance efforts to combat illegal activities such as deforestation and the illegal harvesting of species like *Rhampholeon acuminatus* for pet trade. This include increasing patrols, establishing surveillance systems, and imposing stricter penalties for offenders.
- (ii) Public awareness and conservation education: Public awareness campaigns to educate the local communities, especially farmers on the importance of forest conservation. Promote sustainable land use practices and alternative livelihood options that will reduce pressure on forest resources including encroachment for farming, firewood, poles, timber etc.
- (iii) Community involvement and participation: To engage the local communities, in the conservation initiatives including active participation in forest management and to provide incentives for sustainable practices.

- (iv) Sustainable natural resources management: To implement sustainable practices and established guidelines for responsible use of forest resources, including clear regulations for logging, agriculture, and livestock grazing.
- (v) Habitat restoration and protection: To establish measures that will help restore degraded areas of the Nguru mountains. The PAMS foundation will help with the restoration activities outside the forest reserve i.e. in communal lands and around environmentally sensitive areas such as water catchment areas so as to minimize external threats.
- (vi) Collaboration and partnerships: To form collaboration between government agencies, non-profit organizations and local communities so as to combine resources, expertise, and efforts in the successful conservation of the forests in the Nguru mountains.
- (vii) Monitoring and evaluation: To establish robust and regular monitoring and evaluation strategies that will help to track deforestation rates, species populations and the overall health of the forest ecosystem.

4.0 Conclusion

The distribution patterns of *Rhampholeon acuminatus* within the Mkingu Nature Forest Reserve suggest strong preferences and requirements of this chameleon species in relation to different forest types. The high abundance of *Rhampholeon acuminatus* observed in montane forests, the lower numbers in sub-montane forests, and the absence in lowland forests highlight the species' sensitivity to environmental conditions and their specific adaptations. Montane forests, characterized by lower temperatures, dense cloud cover, and a complex vegetation structure, appear to provide ideal conditions for *Rhampholeon acuminatus*. The cooler temperatures in montane forests likely create a more suitable thermal environment for the species, while the cloud cover contributes to higher humidity levels. The diverse vegetation structure of montane forests offers a range of microhabitats and ample prey resources, supporting the chameleons' survival and population growth. The decline in *Rhampholeon acuminatus* abundance observed in sub-montane forests suggests a potential response to the warmer temperatures in these areas. The chameleons' affinity for cooler temperatures may explain their reduced occurrence in sub-montane forests. The less dense and diverse vegetation structure of sub-montane forests may also affect access to suitable microhabitats and prey resources, further influencing population numbers. The absence of *Rhampholeon acuminatus* in lowland forests raises questions about the species' tolerance to warmer and potentially drier conditions found in these habitats. The lack of suitable thermal and humidity conditions, coupled with a potential scarcity of essential microhabitats and prey resources, explain the complete absence of *Rhampholeon acuminatus* in lowland forests within the reserve. The observed distribution patterns have important conservation implications for *Rhampholeon acuminatus* and its habitat within the MNFR. Thus, it is very important for the responsible authorities, conservation partners, researchers and local communities at large to actively participate in the conservation and management of montane forests of the MNFR so as to continue support the remaining population of the *Rhampholeon acuminatus*.

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