

**INSIGHTS INTO THE NATURAL HISTORY OF THE LITTLE
KNOWN MANED RAT *LOPHIOMYS IMHAUSI* THROUGH
EXAMINATION OF OWL PELLETS AND PREY REMAINS**

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ABSTRACT

Maned rat *Lophiomys imhausi* is a highly unusual, but very little known rodent that is endemic to East Africa. A population from the highlands of central Kenya was studied through analysis of owl pellets and prey remains, including one incidental observation. Over 28 months, 40 individual rats were documented, of which two were juveniles. The mean length of time between discovery of rat remains in any one owl territory was once every 5.3 months, and the maximum number of rats found in any single owl territory over one year was five. Maned rat density was low and was estimated at 1 rat/km². Their lower altitudinal limit in Kenya is *c.* 1900 m, and eagle owls and humans are important predators. Maned rats are not uncommon in highly altered habitats and they may require poisonous plants in addition to *Acokanthera* spp. for anti-predator defense.

Keywords: maned rat, crested rat, poisonous plant, owl pellet, Mackinder's eagle owl, anti-predator defense

INTRODUCTION

The maned (or crested) rat *Lophiomys imhausi* Milne-Edwards, 1867 is arguably one of Africa's least known rodents and is the only species in the subfamily Lophiomyinae. It most closely resembles a porcupine due to its large size (adults weigh between 500–1000 g), long hair, bushy tail and black-and-white colouration. Since its discovery in the mid-19th century, it has been described as 'very remarkable' (Giglioli, 1880) and 'extraordinary' (Kingdon, 1974) in reference to a number of its unusual features. It was long suspected of harbouring poisonous properties that were recently confirmed and it is the first known placental mammal to acquire potentially lethal toxicity from a poisonous plant (Kingdon *et al.*, 2012). The maned rat chews the roots and bark of *Acokanthera schimperi* (A.DC.) Schweinf., the poison arrow tree, which it smears onto highly specialized hairs that wick up the poison (Kingdon *et al.*, 2012). The poison contains ouabain, a cardiac glycoside best known for its use among elephant hunters, which is transferred to a predator whenever the rat is bitten or mouthed

(Kingdon *et al.*, 2012). Other anti-predation adaptations include unusually dense and tough skin, an elongated vertebral column that is exceptionally robust and flexible, unusually large salivary glands possibly in relation to its self-application of ouabain, and an extraordinary skull that is roofed over with bone such that the cranium resembles that of a turtle (Kingdon, 1974; Kingdon *et al.*, 2012).

Apart from accounts by Kingdon (1974), Kingdon *et al.* (2012) and Monadjem *et al.* (2015), and two notes about its occurrence, one in southwest Ethiopia (De Beenhouwer *et al.*, 2016) and the other in southwest Djibouti (Kock & Künzel, 1999), there is little further information concerning its distribution or natural history. Based on these accounts, the maned rat is a scarce, nocturnal resident of varied habitats including montane forest and dry lowland woodland from sea level to over 3000 m throughout East Africa (Kingdon, 1974; Kock & Künzel 1999; Carleton & Musser, 2013). It is often found in rocky areas and lies up in hollow trunks or holes on the edge of ravines or in bushy banks. Its diet is said to include leaves, fruits and shoots. It is usually seen alone, but pairs have been seen as well as females with young. There is no information on its home range size, factors limiting its range, or predators other than dogs (Kingdon, 1974; Kingdon *et al.*, 2012).

In Kenya the majority of records have come from the highlands of Mau Forest, Uasin Gishu and Laikipia plateaus, Naivasha escarpment, and the Aberdare, Mount Kenya and Matthews ranges (Kock & Künzel, 1999). De Beenhouwer *et al.* (2016) captured it on a camera trap in Afromontane rainforest at 2076 m in southwest Ethiopia.

As part of a larger study focused on the ecology of Mackinder's eagle owl *Bubo capensis mackinderi* Sharpe 1899 a largely East African-occurring subspecies of the Cape eagle owl *Bubo capensis* Smith, 1834 (Ogada & Kibuthu, 2008, 2009, 2012), I report on a population of maned rats in the highlands of central Kenya that was discovered through analysis of owl pellets and prey remains, and supplemented by one incidental observation.

MATERIALS AND METHODS

The study area was located in the foothills of the Aberdare Mountain range in central Kenya (00°11'S, 036°47'E) between 1990–2600 m, just below the protected (fenced) section of the forest. Mean annual rainfall was 752 mm at the lowest elevation (*ca.* 1990 m), but noticeably increased with elevation. The topography consisted of steep valleys separated by plateaus inhabited by small-scale farmers. Due to the dense human population, the valleys have been largely deforested and their steep slopes increasingly cultivated, while permanent settlement within the valleys is growing (figure 1). Within the valleys, the owls nest on scattered rocky cliffs that are well exposed due to deforestation.

Owl pellets and other prey remains were collected monthly between June 2004 and October 2006, from a total of 16 territories. However, only seven owl territories were known in 2004 with additional territories located over the following two years. Skeletal remains from the maned rat were initially confirmed by visual comparison with reference skeletons in the collection of the National Museums of Kenya, Osteology Department (accession numbers OM6444, OM7891, OM7892). Once confirmed, their peculiar skulls, in particular, were easily recognizable.

Rainfall was measured daily from January 2001 through December 2006 at nearby Solio Ranch.



Figure 1. Typical deforested and cultivated habitat found in Kiawara village, Nyeri county, part of the study area. Photo D. Ogada

RESULTS AND DISCUSSION

A total of 1388 individual prey items were identified from owl pellets and prey remains. The majority (87%) were from mammals ($n=1136$). A total of 21 mammal species or species groups (*e.g.* galago, genet) were represented and maned rats accounted for 3.4% of all mammal specimens identified.

Forty individual maned rats were documented, 37 were identified from owl pellets or prey remains, two were found as fresh carcasses, and one dead rat was found inside a farm, presumably killed by a farmer. Of the 16 owl territories, two were excluded from further analyses because they had <20 prey items each. Maned rat remains were found in 11 of the remaining 14 owl territories. Based on the size of the skulls and skeletal remains, only two of the 40 individuals appeared to be juveniles.

Remains of 39 rats, not including the rat found dead in a farm, were found during 10 different months of the year (figure 2).

The average length of time between the discovery of rat remains in any single owl territory was once every 5.3 months (range 1–14 months). The highest number of individual rats that were found in consecutive months in the same territory was four and this consisted of three adults and one juvenile. The largest number of individual rats found as prey in any one territory over the course of one-year was five, consisting of four adults and one juvenile.

Because the generation length of maned rats is not known, it is impossible to know if the four adults may have been related, *i.e.* grown offspring. Despite this uncertainty, this indicates that there were approximately four maned rats per one owl territory. Owl density was 0.24 pairs/km² (Ogada & Kibuthu, 2012) and based on this, maned rat density could be a maximum of 0.96 rats/km², or about 1 rat per km², reinforcing the notion that maned rats exist at low density in this habitat. Based on these findings, maned rats are likely to be solitary and have a slow reproductive cycle relative to other rodents. They probably live at low densities.

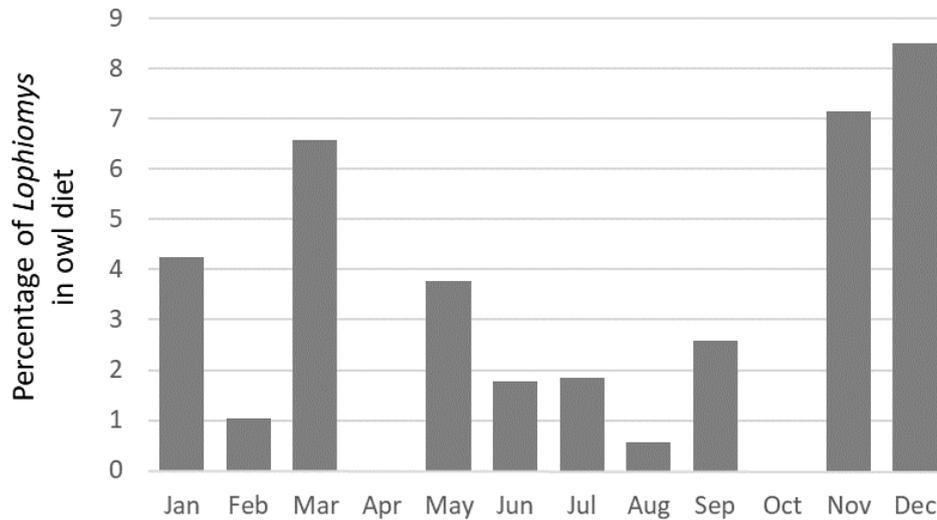


Figure 2. Proportional abundance of maned rats in the diet of Mackinder's eagle owls as a percentage of all prey items per month, as assessed by owl pellets and prey remains.

The use of owl pellets to estimate the proportion of prey available in the field depends on two assumptions: 1) owls hunt at random, and 2) pellets represent a random sample of their catch (Yom-Tov & Wool, 1997). Mackinder's eagle owl is a large, territorial, high altitude generalist predator that has been shown to randomly hunt small mammals (<120 g) in a previous study (see Ogada & Kibuthu, 2009). Whether the owls randomly hunt larger mammals, the size of maned rats, is not known and therefore our results should be interpreted with caution on this point. However, their pellets likely represent a random sample of their catch, particularly for prey the size of maned rats, because: 1) eagle owls are large and able to carry relatively large mammals back to their nests, 2) both eagle owls and maned rats are nocturnal, and 3) eagle owls, like rats, were found in similar open habitats where they hunted primarily for ground-dwelling species.

Remains were not found in territories below 2089 m (n=4) and in one territory at high elevation (2546 m; figure 3). The majority of maned rat remains were collected between 2300–2500 m (figure 3). Based on this study and Kock & Künzel (1999) *ca.* 1900 m is the lower altitudinal limit for maned rats in Kenya.

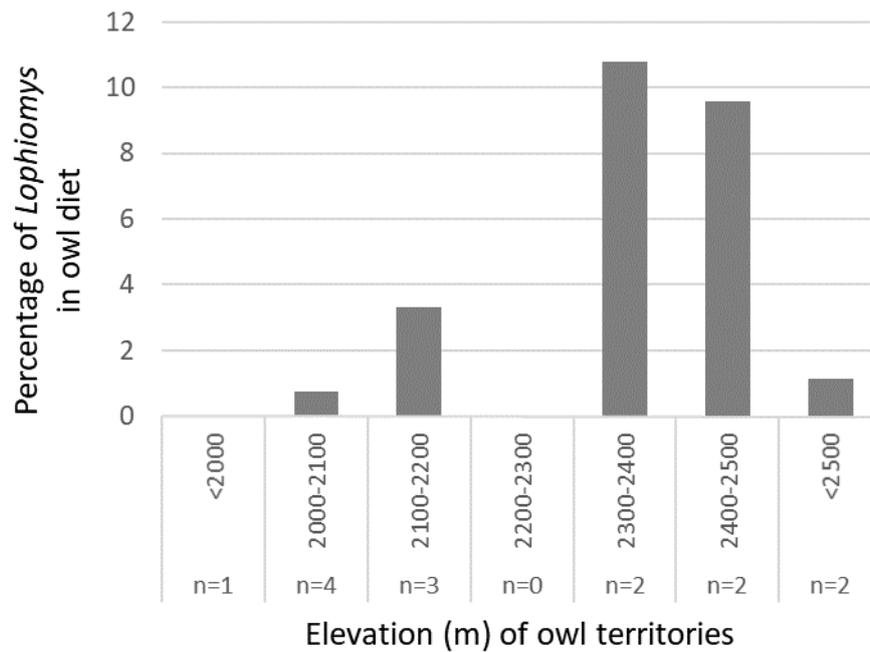


Figure 3. Proportional abundance of maned rats in the diet of Mackinder's eagle owls as a percentage of all prey items and based on owl territory elevation (m). Only owl territories where >20 prey remains were collected, were included (n=14 territories). The number of territories in each elevation range is included on the x-axis.

Of the three carcass remains, one was found half eaten inside an owl nest. The second consisted of only the digestive tract and fur, and was found in a farmer's field below an active owl nest. A farmer living on site confirmed that an owl had killed and eaten the rat the previous night. The third carcass was a juvenile, and was found intact at the edge of an active farm. A farmer explained that they intentionally kill maned rats because they damage crops. Despite the deadly defensive strategy employed by this rodent (Kingdon *et al.*, 2012), at least one additional predator (other than humans) can now be confirmed. Eagle owls are well known for effectively handling difficult and well-armed prey species, including hedgehogs, snakes and scorpions (*e.g.* Demeter, 1981; Marchesi *et al.*, 2002; Shehab, 2004).

An additional finding of this study is that maned rats are not uncommon in highly altered habitats, and in many cases were found where tree cover was sparse or reduced to shrubs and bushes (figure 1). Given that maned rats use *Acokanthera schimperi* for predator defense their persistence in highly degraded habitats would appear surprising. This led to a one-day plant survey in June 2017 to determine the remaining extent of *Acokanthera* spp. in owl territories where maned rats were documented. We focused on two of the three owl territories where maned rat carcasses were previously found at 2410 m and 2546 m, respectively. With assistance from P. Muriithi and K. Ndung'u, we re-visited these two territories (a third territory has since been rendered difficult to access due to human development). Although our survey was incomplete, we could not locate *A. schimperi* within either territory and none of the five local inhabitants whom we spoke to were familiar with

the tree at those elevations. Locals knew the tree from below *ca.* 2100 m, where we easily located it. Yet, 76% of maned rat remains were found above this altitude, at 2100–2600 m. We did not detect, nor were locals familiar with, the other *Acokanthera* species known from central Kenya, *A. oppositifolia* (Lam.) Codd. While our brief survey cannot confirm if there is an absence of overlap between *Acokanthera* spp. and maned rats above 2100 m at our study site, it does highlight the possibility that maned rats utilize other poisonous plants in addition to *Acokanthera* spp. for predator defense and this may be of interest for future studies even if it remains speculative at this time.

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