Bonn zoological Bulletin 68 (1): 13–19
2019 · Ntoungwa Ebague G.M. et al.
https://doi.org/10.20363/BZB-2019.68.1.013

ISSN 2190–7307
http://www.zoologicalbulletin.de

Research article
urn:lsid:zoobank.org:pub: D8C8DAAF-4F7A-4BB4-97A1-384C6E3D889D

Terrestrial small mammal assemblage from pellets of three sympatric owl species in the Mount Oku area (Northwest Cameroon), with implications for conservation

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Abstract. Mount Oku is well known for its exceptional species diversity for both animals and plants. A total number of 27 species of rodents and six species of shrews are reported from the area. Ten of these species are endemic at local or regional level and are considered as endangered or vulnerable, with a decreasing population trend. They are thus considered as having a high conservation importance. We sampled terrestrial small mammals from owl pellets during a period of 22 months in different areas near the village Oku, in order to assess the importance of these taxa in the diet of owl species present in the area. The 236 pellets attributed to three sympatric owl species (Barn owl, *Tyto alba*, the African wood owl, *Strix woodfordii*, Northern white-faced owl, *Ptilopsis leucotis*), yielded a total number of 543 specimens of rodents and shrews, belonging to 22 species (16 species of rodents and six species of shrews). They represented respectively 69.06% and 30.94% of the total assemblage, the species *Dasymys* sp., with a final score of 18.23%, having the highest relative abundance. Of the ten species with a high conservation importance, only *Lemniscomys mittendorfi* was missing. All constituted about 27.62% of all specimens collected, with a relative abundance of 4.23% for species strictly restricted to Mount Oku. This study confirms the position of Mount Oku as an important conservation area for rodents and shrews, and highlights the evidence that terrestrial small mammal predation by owls cannot be considered a threat to species of conservation concern at Mount Oku.

Key words. Mount Oku, owl pellets, rodents, shrews, owls, conservation.

INTRODUCTION

The montane forests of the Cameroon Highlands' region are considered as priority conservation areas at a global scale (Oates et al. 2004) and are one of the most important centres of endemism on the African continent (Zimkus & Gvoždík 2013). The Kilum-Ijim forest in the massif of Mount Oku (3100 m asl), the second highest mountain after Mount Cameroon, is relatively well-studied for many taxa including animals and plants (Cheek et al. 2000; Doherty-Bones & Gvozdik 2017; Ineich et al. 2015; Momo 2017). It represents the largest remaining part of afromontane forest in West Africa (Cheek et al. 2000). Several studies have been carried out on small mammals of Mount Oku, most of them using trapping methods, which enabled the publication of an updated list of 27 species of rodents (24 terrestrial and three arboreal) and six species of shrews (Maisels et al. 2001; Denys et al. 2014).

It has been recently demonstrated that the use of owl pellets is a more effective alternative to conventional trapping for broad-scale studies of small mammals' communities (Heisler et al. 2016). However, very little attention has been focussed on the study of small mammal communities using owl pellets in tropical Africa. Indeed, most of data available are from the northern part of the continent, mainly from the country Algeria (Baziz et al. 2002, 2005; Sekour et al. 2010, 2011, 2014; Alia et al. 2012; Hadjoudj et al. 2012; Idouhar-Saadi et al. 2014; Tergou et al. 2014; Souttou et al. 2015; Bounaceur et al. 2016;

Received: 15.01.2019
Accepted: 24.01.2019

Corresponding editor: J. Decher
Published: 30.01.2019

Djilali et al. 2016; Ouarab & Doumandji 2017); few are from Morocco (Rihane et al. 2015), Tunisia (Leonardi & Del-Arte 2006) and Egypt (Sándor & Moldován 2012). For tropical Africa, some studies were made in the South African region, including the countries Malawi (Happold & Happold 1986; Ngonda 1991; Denys et al. 1999), Botswana (Denys 1985) and South Africa (Grindley et al. 1973; Dean & Dowsett 1986; Mendelsohn 1989; Avery 1992; Avery et al. 2005). The few data available for West Africa are mainly from Senegal (Bâ et al. 2000; Thiam et al. 2008), Mauritania (Bruderer & Denys 1999) and Nigeria (Lekunze et al. 2001). Previous works in the East African region include the two countries Ethiopia (Demeter 1982) and Tanzania (Andrews 1990). In Central Africa, only one study from the area of Bambilli (NW Cameroon), based on the diet of the African grass owl (*Tyto capensis*) and the spotted eagle owl (*Bubo africanus*) is known from the literature (Riegert et al. 2007). However, Denys et al. (2014) used owl pellets collected by O. Fülling in 1990 and 1991 in the lake Oku cave and for the first time verified the presence of *Mylomys dybowskii* at Oku.

Of the 27 species of rodents reported from Mount Oku (Denys et al. 2014), four are known as strictly endemic (*Lamottemys okuensis*, *Hylomyscus grandis*, *Lophuromys dieterleni* and *Lemniscomys mittendorfi*) to the mountain, and three others (*Praomys hartwigi*, *Hybomys eisentrauti* and *Otomys occidentalis*) have a distribution range that is limited to the Banso-Bamenda Highlands. Two of the six species of shrews reported from Oku (*Myosorex okuensis* and *Sylvisorex camerunensis*) are restricted to the Banso-Bamenda Highlands and one (*Sylvisorex isabella*) extends to the southern part of Cameroon Highlands in Bioko. All these species are considered as endangered or vulnerable on the IUCN Red List, with a decreasing population trend (IUCN 2016). Mount Oku is thus an important area for the conservation of terrestrial small mammals. The effect of owl predation on small mammal populations' abundance has already been reported and their importance in rodent pest species management has been repeatedly highlighted (Baleiauskiene 2005; Previtali et al. 2009; Sekour et al. 2014), suggesting a possible influence on rodent population dynamics at the local level. From 2015 to 2016 we conducted opportunistic sampling of pellets in areas near the village Oku, from 2000 up to 2900 m asl, in order to assess the importance of species with high conservation value in the diet of owl species present in the area. This paper reports data on small mammal assemblages sampled from three owl species (Barn owl, *Tyto alba*, the African wood owl, *Strix woodfordii*, and the Northern white-faced owl, *Ptilopsis leucotis*), with an emphasis on the conservation of rodent species endemic to Mount Oku or to the whole Banso-Bamenda Highland region.

MATERIAL & METHODS

Study area

Belonging to Banso-Bamenda Highlands within the Cameroon Highlands' region, Mount Oku (Fig. 1) is

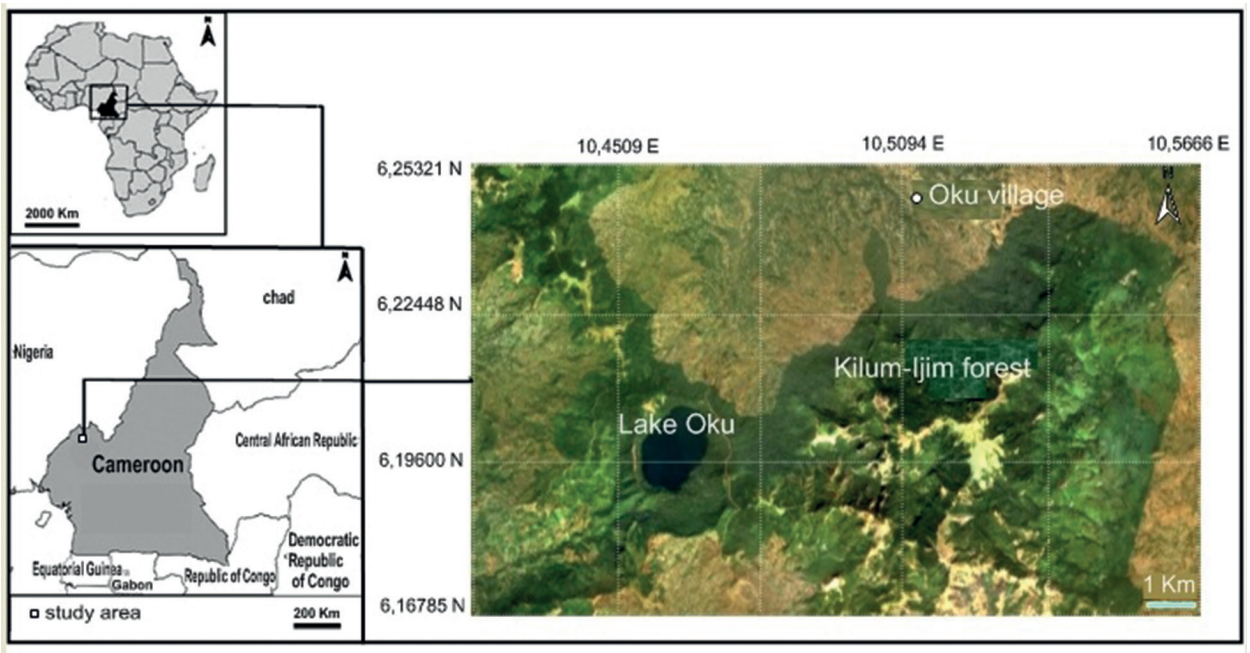

Fig. 1. Map showing the location of the study area.

covered by a small montane forest, the Kilum Ijim forest massif which extends from 2200 m to 2800 m asl (Maisels et al. 2001). It is dominated by *Carapa grandiflora* (Meliaceae), *Nuxia congesta* (Loganiaceae), *Syzygium staudtii* (Myrtaceae) and *Arundinaria alpina* (Poaceae). An afroalpine vegetation is found from 2800 m up to the summit (3011 m), and mostly constitutes of the grass species *Gnidia glauca, Hypericum revolutum* and *Erica mannii* (Momo 2017). Lower altitudes (below 2200 m asl) are widely used for agriculture. The Oku village is situated at about 2000 m asl in Mount Oku, close to the Kilum forest. Mount Oku is dominated by equatorial climate, characterised by a wet season of seven to eight months and a dry season of four to five months; months of August and March being respectively the most wet and dry. The average annual rainfall is about 2427 mm and the temperature ranges between about 10 °C and 25–28 °C (Forboseh & Ikfuingei 2001).

Owl pellet sampling

From March 2015 to December 2016, opportunistic sampling of pellets (97 complete and about 139 damaged) was done in different habitats near the village Oku (6°24' N–10°50' E), including montane forests, montane grasslands and crop plantations. The sampling was done between 2000 m and 2900 m asl. On each occasion, the samples collected were kept together in a dry plastic bag. They were later attributed to three owl species known from the area, the Barn owl (*Tyto alba*), the African wood owl (*Strix woodfordii*), and the Northern white-faced owl (*Ptilopsis leucotis*), based on direct observations and feather remains, following the field guide by Borrow & Demey (2008).

Owl pellet treatment and small mammal species identification

In the laboratory, each pellet was softened in hot water during five to ten minutes and disinfected later in a 10% diluted solution of chlorinated water. Pellets were then opened and the bones were cleaned using a pair of forceps. After rinsing with water and drying, skulls and other remaining bones were placed in separate tubes for further observations.

Species identifications of rodents and shrews were mostly based on the mandibles, the upper molar row and skull morphology, following the criteria provided in Denys et al. (2014) as well as reference collections housed at the MNHN. We also followed identification keys of Monadjem et al. (2015). For shrews, we also used cranio-dental characters, and followed character descriptions reported in Heim de Balsac (1968, 1975), Meester & Setzer (1971) and Hutterer & Happold (1983). In two cases (rodents and shrews), morphological characters of teeth were checked by using a Pierron® binocular magnifier at 10x. All specimens are currently housed at the Zoology Unit of the Laboratory of Biology and Physiology of Animal Organisms, Faculty of Science, University Douala.

Small mammal relative abundance estimates

As skulls were not present in all pellets collected, the total number of small mammals was estimated in each pellet based on a tally of paired mandibles as proposed by Bueno & Motta-Junior (2008). After pairing, unpaired mandibles were counted as additional individuals. The same approach was also used to evaluate the total number of individuals in the whole sample, and finally for an estimation of the relative abundance.

RESULTS

The entire sample examined yielded a total number of 543 specimens of rodents (Order Rodentia) and shrews (Order Soricomorpha), belonging to 22 species, 18 genera and three families (Table 1). Rodents were represented by 16 species from 14 genera and two families. Shrews included six species belonging to four genera and one family. Rodents represented 69.06% of the small mammal assemblage, while shrews constituted 30.94% of the entire sample. The Shaggy rat (*Dasymys* sp.) was the most abundant species found (18.23%), followed by the Hun shrew (*Crocidura attila* Dollman, 1915), with 12.34% of the total assemblage. The less represented species of our sample were the Mount Oku *Hylomyscus*, *Hylomyscus grandis* Eisentraut, 1969 (0.55%), the Roof rat, *Rattus rattus* (Linnaeus, 1758) and the Mount Oku rat, *Lamottemys okuensis* Petter, 1986 (each with 1.1 %). Of the ten species with a high conservation importance, only one species, *Lemniscomys mittendorfi*, was missing. The nine other species represented together a total number of 150 specimens, out of the 543 individuals counted, corresponding to a relative abundance of about 27.62%. From the whole sample, the relative abundance of each of these species varied from 0.55% (three specimens of *Hylomyscus grandis*) to 7.18% (33 individuals of *Otomys occidentalis*).

DISCUSSION

With a total number of 236 pellets collected in the study area, our sample represents important material, which can help to complement our knowledge on small mammal diversity from the Oku area. Of the 543 specimens counted from the pellets, 22 species of terrestrial small mammals, including 16 species of rodents and six species of shrews were finally identified. All of these newly

Table 1. Relative abundance (RA) of rodent and shrew species found in owl pellets collected in Oku (N: Number of specimens).

Orders	Families	Subfamilies	Species	N	RA
Rodentia	Nesomyidae	Dendromurinae	*Dendromus sp.*	13	2.39
	Muridae	Deomyinae	*Lophuromys dieterleni* Verheyen, Hulselmans, Colyn & Hutterer, 1997	14	2.58
		Murinae	*Dasymys* sp.	99	18.23
			Grammomys poensis Eisentraut, 1965	8	1.47
			Hybomys rufocanus (Tulberg, 1893)	7	1.29
			Hylomyscus grandis Eisentraut, 1969	3	0.55
			Lamottemys okuensis Petter, 1986	6	1.10
			Lemniscomys striatus (Linnaeus, 1758)	29	5.34
			Mastomys sp.	36	6.63
			Mus musculus Linnaeus, 1758	11	2.03
			Mus setulosus Peters, 1876	19	3.50
			Mus sp.	22	4.05
			Oenomys hypoxanthus Eisentraut, 1968	9	1.66
			Otomys occidentalis Dieterlen & Van der Straeten, 1992	39	7.18
			Praomys hartwigi Eisentraut, 1968	22	4.05
			Praomys jacksoni (de Winton, 1897)	19	3.50
			Rattus rattus Linnaeus, 1758	6	1.10
			Undetermined murines	13	2.39
			Total Rodents	**375**	**69.06**
Soricomorpha	Soricidae	Crocidurinae	*Crocidura attila* Dollman, 1915	67	12.34
			Crocidura olivieri Lesson, 1827	15	2.76
			Suncus megalura Jentink, 1888	16	2.95
			Sylvisorex camerunensis Heim de Balsac, 1968	14	2.58
			Sylvisorex isabellae Heim de Balsac, 1968	10	1.84
		Myosoricinae	*Myosorex okuensis* Heim de Balsac, 1968	35	6.45
			Undetermined shrews	11	2.03
			Total Shrews	**168**	**30.94**
			Total general	**543**	**100**

collected species of rodents were previously sampled at Oku (Eisentraut 1968, 1969; Bowden 1986; Hutterer & Fülling 1994; Maisels et al. 2001; Denys et al. 2014), as well as the six species of shrews found in our sample (Maisels et al. 2001). Of the 24 species of terrestrial rodents reported by Denys et al. (2014), eight were missing from our sample. Some of these taxa are known by only a low number of specimens from Oku (*H. alleni* cf. *montis*, *H. walterverheyeni*, *Lemniscomys mittendorfi*, *Mylomys dybowskii*, *Gerbilliscus kempi*). The others are members of genera currently under revision, in which the identification solely using morphology is not obvious (*Grammomys* sp., *L. sikapusi*). Moreover, species of the genus *Cricetomys*, with a mean weight of 500 grams (Monadjem et al. 2015) are likely not suitable prey in the diet of the three species of owls involved in this study.

The predominance of rodents, compared to shrews, in small mammal assemblages using owl pellets has been previously reported from different areas of the African continent (Demeter 1982; Dean & Dowsett 1986; Mendelsohn 1989; Ngonda 1991; Riegert et al. 2007; Sándor & Moldován 2010; Hadjoudj et al. 2011; Alia et al., 2012; Sekour et al. 2014; Ouarab & Doumandji 2017). However, some studies documented the abundance of birds (Hamani et al. 2011), amphibians (Tergou et al. 2014) or insects (Doumandji et al. 1997). With pellets of the African grass owl, Riegert et al. (2007) reported more shrew specimens (about 70.41% of the total prey items), compared to rodents. Data from other areas also suggest-

ed an abundance of shrew items in the diet of *Tyto alba* (Love et al. 2000; Mahmood-Ul-Hassan et al. 2007). Many studies have highlighted the evidence of a seasonal variation in the diet composition of different owl species (Bosè & Guidali, 2000; Mahmood-Ul-Hassan et al. 2007; Sekour et al. 2011). Other works suggested the existence of a shift in the trophic habits of these birds, depending on prey availability (Bueno & Motta-Junior 2008; Sandor & Moldovan, 2010). In this study, we used specimens collected from pellets from a period of 22 months, suggesting that we report here a general trend in the predation of small mammals by owls at Oku. In Bambili, less than 50 km from Oku, Riegert et al. (2007) reported a dominance of *Dasymys* (with about 27% of rodent and shrew samples), *Otomys occidentalis* (15%) and *Mastomys* sp. (12%) specimens in the diet of the Spotted eagle owl, which is very close to our findings.

Our study confirms the presence of nearly all the species with a high conservation importance at Oku, except *Lemniscomys mittendorfi*. All represented about 27.62% of the total small mammal assemblage. The three species *Lamottemys okuensis* (1.10%), *Hylomyscus grandis* (0.55%) and *Lophuromys dieterleni* (2.58%), that are restricted to Oku, together constituted only 4.23% of all the specimens identified. Using both Sherman, snap and traditional traps, specimens of *Lamottemys okuensis* represented about 18.66% of all the rodents trapped (Denys et al. 2014). Thus, the abundance of this species as revealed by owl pellets is not representative of its population size in the study area. Otherwise, from our final sample of species with high conservation importance, the three taxa having a high abundance, *Otomys occidentalis* (7.18%), *Myosorex okuensis* (6.45%), *Praomys hartwigi* (4.05%), are widely distributed in the whole area of the Banso-Bamenda highlands. Riegert et al. (2007) obtained between 2.0% (*Myosorex okuensis*) and 11.4% (*Otomys occidentalis*) of total prey items in their study. All these findings together highlight the fact that (i) terrestrial small mammal species with high conservation importance do not constitute the main diet of owl species in the Oku area, (ii) those with a predation rate that can be considered as relatively high (eg. *Otomys occidentalis*: from 3.0 to 11.4% depending on the owl species) are widely distributed in Banso-Bamenda Highlands, suggesting a lower pressure at the level of their entire area of distribution. In conclusion, terrestrial small mammal predation by owls cannot be considered a threat to their conservation at Mount Oku. Many other threats, mainly relating to high human pressure on natural environments of Mount Oku have been reported before, with a particular emphasis on local rodent trapping levels (Denys et al. 2014; Maisels et al. 2001). With nine of the ten small mammal species having a high conservation importance, this study confirms the place of Mount Oku as an important conservation area for rodents and shrews.

Acknowledgments. The authors would like to express their gratitude to local people of Oku that helped for pellets sampling during the study period. They are also grateful to authorities of the University of Douala for the deliverance of a research certificate to G.M. Ntoungwa Ebague (Ref. LBPOA/05/2015), as part of its PhD project, and for the specimen transportation certificate delivered to A.D. Missoup (Ref. LBPOA/01/2018) that was used to export specimens at the MNHN in Paris in March 2018. The authors would finally like to thank the reviewers who improved the earlier draft of this manuscript.

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