Z. Säugetierkunde **62** (1997) 86–92

ZEITSCHRIFT FÜR SÄUGETIERKUNDE
INTERNATIONAL JOURNAL OF MAMMALIAN BIOLOGY

Bat predation by small carnivores in a central African rainforest

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Receipt of Ms. 04. 04. 1996
Acceptance of Ms. 22. 06. 1996

Abstract

Fragments of four species of bats (*Mops* cf. *spurrelli*, *Nycteris arge*, *Hipposideros cyclops*, *H. ruber*) were identified in scats of small carnivores collected in a tropical rainforest of Central African Republic. For all four species the Dzanga forest constitutes the second locality record in this country. Genets (*Genetta servalina*) and long-nosed mongoose (*Herpestes naso*) were identified as the predator species. Bats occurred in only 0.4% of the scats analyzed. The few examples refer to bat species which roost solitarily or in small groups. Their presence in the scats can be attributed to chance encounters. Large bat colonies seem to be rare or inaccessible in the study area.

Introduction

Bats are rarely common food items in the diets of mammals, with the exception of other bats such as false vampires (*Megaderma* in Asia, *Macroderma* in Australia, *Vampyrum* in South America) which are known to prey upon the smaller members of their order (Hill and Smith 1984). Other mammals, such as opossums, lorises, and a number of carnivores, probably take live bats only when captured in chance encounters or when found on the floor of caves and other roosts (Hill and Smith 1984). Although mammalian carnivores are assumed to be predators of bats (Rosevear 1965; Gilette and Kimbrough 1970; Bekker and Mostert 1991), there has been little evidence of this in the literature, apart from anecdotal observations. Very little is known about predation of bats by carnivores in tropical Africa. In this study we document four cases where bat remains were found in the scats of genets and mongooses in a central African rainforest. In addition, we discuss the ecological conditions that may lead to encounters between bats and small carnivores.

Material and methods

Small carnivores were studied by JCR from 1992–1994 in the Dzanga-Sangha Reserve of south-western Central African Republic. The species studied include *Genetta servalina*, *Herpestes naso*, *Atilax paludinosus*, *Bdeogale nigripes*, *Nandinia binotata*, *Civettictis civetta*, and *Profelis aurata*. The 35 km^2 study area (Dzanga) is located in the extreme south-western corner of the Central African Republic, between the borders of Cameroon and Congo (Ray 1995, 1996). The base camp, in the Dzanga-Sangha Special Dense Forest Reserve and Dzanga-Ndoki National Park, was 35 km from the village of Bayanga. Human population in the area is low with less than one person/km^2.

The study area was a mosaic of five principal habitat types: mixed-species semi-deciduous unlogged forest, selectively logged forest, second-growth forest along secondary logging roads, mono-dominant

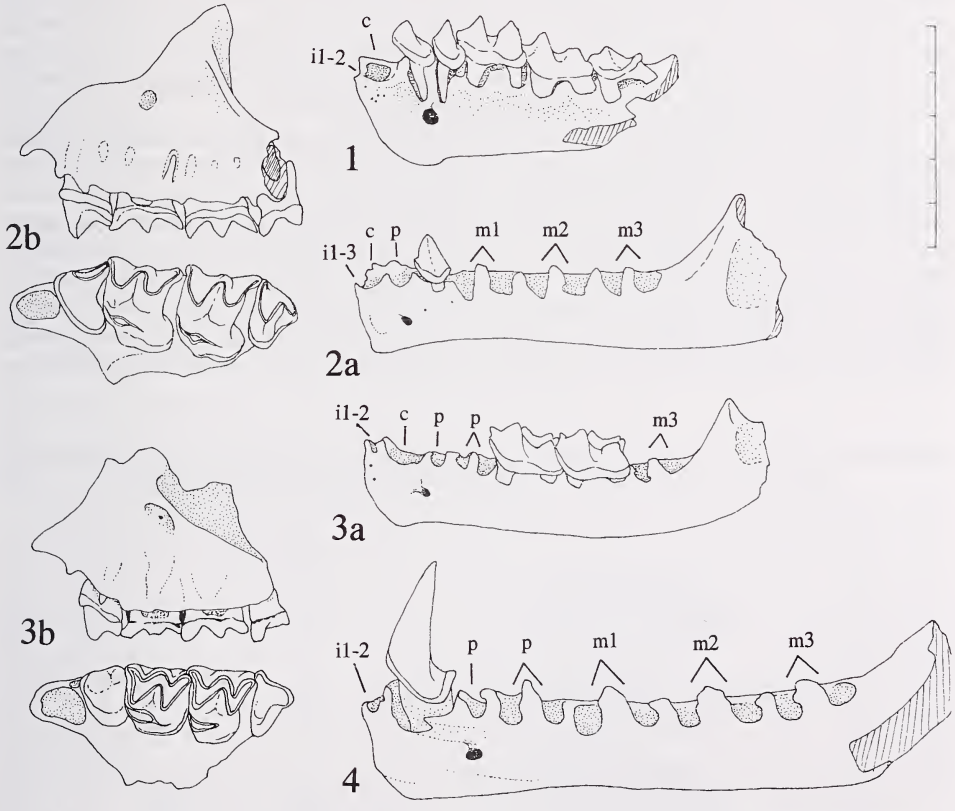
Gilbertiodendron dewevrei forest, and a thin ribbon of swamp forest bordering the Kongana stream that bisected the study area. For further details see Ray and Hutterer (1996).

Approximately 45 km of logging roads, trails, and streambeds were walked regularly by one to four individuals during a 25-month period, whereby carnivore scats were collected opportunistically. Scat identifications were made based on diameter, field signs, hair ingested while grooming, and thin layer chromatography of bile acids (Ray 1996).

Scats were washed in a fine-meshed sieve, dried in the sun or over a fire, and stored in plastic bags. Jaws and jaw fragments were identified by RH. Identification was aided by extensive comparisons with properly identified specimens in the collections of the Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn (ZFMK). The nomenclature of bats follows Koopman (1993).

Results

Out of a total of 904 carnivore scats analyzed, only four contained fragments of bats (0.4%). Each yielded remains of only one individual, representing three different families and genera and four species of bats. We identified them as *Mops* cf. *spurelli* (Dollman, 1911) (scat no. 75: fragment of left mandible), *Nycteris arge* Thomas, 1903 (scat no. 436: fragments of left mandible and maxillary), *Hipposideros ruber* (Noack, 1893) (scat



Figs. 1–4. Skull fragments of bats found in small carnivore scats collected in the Dzanga area, C.A.R. 1: *Mops* cf. *spurelli* (left lower mandible), 2 a, b: *Nycteris arge* (left lower mandible, left maxillary with P4-M3), 3 a, b: *Hipposideros ruber* (left lower mandible, left maxillary with P4-M3), 4: *Hipposideros cyclops* (right lower mandible, reversed). Corresponding teeth are noted for the alveoli of the mandible. Scale is 5 mm.

no. 438: left and right mandibles, 2 maxillary fragments), and *Hipposideros cyclops* (Temminck, 1853) (scat no. 843: left and right mandibles, 1 upper canine).

Mops cf. *spurrelli* (Molossidae) was identified by the short and stout mandible and by the broad and heavy dentition (Fig. 1), and by comparison with figures and measurements provided by Freeman (1981). It must be noted, however, that *Mops nanulus* is very similar, if not conspecific (Koopman 1989), and that a discrimination between the two forms on the basis of a mandibular fragment may not be possible. The latter species, however, has not yet been recorded from C.A.R. The bat was probably taken by a genet (*Genetta servalina*); the scat also contained traces of arthropods and remains of blue duiker (*Cephalophus monticola*) and porcupine (*Atherurus africanus*). In Central African Republic this molossid bat was first collected by Schlitter et al. (1982) north of M'Baiki. Our specimen is the second locality record for the country.

Nycteris arge (Nycteridae) was identified on the basis of both upper and lower skull fragments (Fig. 2). The anterior-lateral ridge of the skull (Fig. 2 b) is typical of a nycterid bat. The large size of the lower premolar (Fig. 2 a) groups it into the *Nycteris arge* group as defined by Van Cakenberghe and De Vree (1985). The group also includes *N. intermedia*, *N. nana*, and *N. major.* From these *N. arge* differs in size, the first two species being considerably smaller and the latter being larger. The Dzanga fragment fits well with specimens of *N. arge* from Cameroon and with the measurements provided by Van Cakenberghe and De Vree (1985) (Tab. 1). The carnivore species which took *Nycteris arge* could not be determined. The scat also contained arthropod remains. *N. arge* was first recorded from Salo, C.A.R., by Schlitter et al. (1982). The Dzanga specimen represents the second locality record for the Central African Republic.

The identity of *Hipposideros ruber* (Hipposideridae) was settled on the basis of tooth formula, shape of the maxillary fragment and molars (Fig. 3 b), and size and shape of the mandible (Fig. 3 a, Tab.1). Skull fragments of this species are easily mistaken for *H. beatus* or *Rhinolophus landeri*, among others. The similar-sized *Hipposideros caffer* has much smaller molars and is readily separated. A comparison of toothrow measurements (Tab. 1) shows that the fragments very likely represent *H. ruber.* However, the relations of this and other small species such as *H. lamottei* and *H. guineensis* have still to be investigated (Koopman et al. 1995). The bat was taken by a long-nosed mongoose (*Herpestes naso*); the scat also contained remains of 5 shrews (*Crocidura ludia*, 2 *C. nigrofusca*, *Suncus re-*

Table 1. Comparison of the alveolus length (mm) of upper and lower toothrow of the Dzanga bat fragments with measurements taken from museum specimens and from the literature.

	C-M3	c-m3
Mops spurrelli		
Freeman (1981) (n = 1)	5.50	6.50
Dzanga, C.A.R. (n = 1)	–	6.77
Nycteris arge		
Van Cakenberghe and De Vree (1985) (n = 134)	6.39	7.18
Dzanga, C.A.R. (n = 1)	6.54	7.07
Hipposideros ruber		
Cameroon (ZFMK, n = 7)	6.02	7.08
Dzanga, C.A.R. (n = 1)	5.93	7.12
Hipposideros cyclops		
Cameroon (ZFMK, n = 3)	9.41	10.33
Dzanga, C.A.R. (n = 1)	–	10.39

myi, *Sylvisorex ollula*; see Ray and Hutterer 1996) and some arthropods. Schlitter et al. (1982) published the first record of this species from Central African Republic (near N'dele). The Dzanga fragment therefore constitutes the second locality record for the country.

Hipposideros cyclops is documented only by mandible fragments (Fig. 4) and by an isolated upper canine. These remains indicate a very large bat, which at first sight was mistaken for *Rhinolophus maclaudi*, but the tooth formula points to genus *Hipposideros*. The specimen was probably taken by a genet; the scat in which it was found also contained a shrew (*Suncus remyi*). Only recently Hill (1983) recorded a specimen of this large bat from Bamingui-Bangoran National Park, C.A.R.; the Dzanga record therefore is the second for the country.

Discussion

Raptors are generally the most significant predators of bats (Ruprecht 1979; Tuttle and Stevenson 1982; Fenton et al. 1994), and many bats engage in energetically expensive behaviors apparently in order to avoid this threat (Krzanowski 1973; see also Tuttle and Stevenson 1982). The few accounts of predation on bats by mammalian carnivores are incidences when a regular and predictable source was available in the form of a large roost. In southern Africa, Carpenter (1970) observed a genet waiting by an opening of a house roof for the emergence of bats (*Eptesicus* and *Scotophilus* spp.) and over a five-night period the individual averaged six bats per night. On another occasion, the same author discovered a genet preying upon *Rhinolophus simulator* that were nesting in a shallow cave. Urbancyk (1981) reported a case of predation on bats by stone marten (*Martes foina*) in a wintering cave in Poland. Remains of more than 100 *Barbastella barbastellus* and 10 *Myotis myotis* (both known to roost in large assemblages) were found inside the cave, while marten faeces containing bat remains were located in the vicinity.

The predictable emergence of large colonies of bats from their roosts can provide a regular food source to opportunistic predators whose home ranges occupy the same area (Fenton et al. 1994). Given the low proportion of bats in the diet of Dzanga carnivores and the generalized nature of the food habits of most (Ray 1996), this may indicate that such large colonies were unavailable within the home ranges of animals represented by the scats collected in this study, perhaps because suitable roost sites were either absent or inaccessible. Indeed, the four bats found in carnivore scats were representatives of genera that do not tend to occur in large colonies.

Hipposideros cyclops is a large bat (mean body mass 32.2 g, n = 3, Cameroon) that roosts singly or in small groups within the cavities of hollow standing trees (Eisentraut 1942; Verschuren 1957; Brosset 1966, 1969). Members of this species are found in cavities high above the ground, which they sometimes share with flying squirrels (Anomaluridae). Roosting sites can be used continuously for many years (Brosset 1966). Although little is known about the smaller *H. ruber* (mean body mass 10.1 g, n = 10, Cameroon) and other species in the genus, it is reasonable to suggest that they have similar roost ecologies. According to Kunz (1982), small groups of *Nycteris arge*, *N. grandis*, *N. major*, and *N. nana* typically roost in trees with entrances located near the base. Verschuren (1957) found *Nycteris intermedia* and other species within cavities in trees in the Garamba National Park (Zaire). During the day, they also rest in twigs close to the ground, in ravines, and in other hidden places (Fig. 5).

Experiments have shown that roosting in large colonies decreases the risk of predator attack to any one individual (Fenton et al. 1994). This is no longer the case for bats in smaller colonies, which must utilize different behaviours such as roost switching and unpredictable and burst emergences (Morrison 1980; Fenton et al. 1985; Speakman et al.

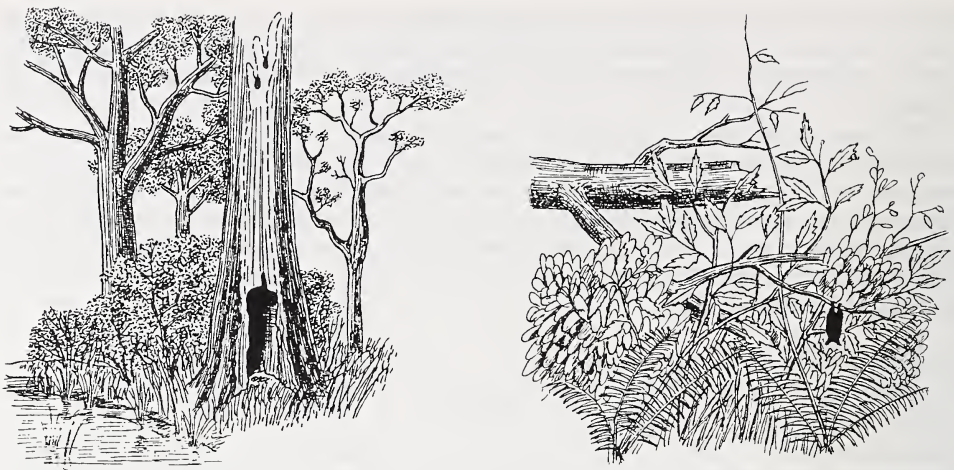


Fig. 5. Roost sites of *Hipposideros cylops* (left) and *Nycteris* sp. (right) in the Garamba National Park, Zaire; modified after Verschuren (1957).

1992; Fenton et al. 1994). Therefore, predators are less able to predictably encounter small colonies and encounter rates will probably depend on the degree of overlap of the microhabitats where the carnivores forage and the bats roost.

A genet, *Genetta servalina*, and a mongoose, *Herpestes naso*, were positively identified as predators of bats in this study. The former is a largely arboreal and nocturnal species (Rahm 1972; Rosevear 1974), although it is known to sleep and hunt on or near the ground (Rosevear 1974; Wemmer 1977). During the day, genets find shelter in hollow trees or logs, holes in tree trunks or in the ground, or even in dense vegetation (Smithers 1971; Rosevear 1974). The long-nosed mongoose is strictly terrestrial and is active only during the day (Ray 1996). In the Dzanga forest the principal prey of both carnivores were arthropods, rodents, and shrews; however, the genet was somewhat less insectivorous (Ray 1996; Ray and Hutterer 1996).

Genets may encounter bats in hollow logs or standing trees, a microhabitat that both animals utilize as daytime rest-sites. The diurnal and terrestrial long-nosed mongoose may encounter bats resting in fallen logs or in holes on the ground. Judging from scats, the favored foraging microhabitat of this forest mongoose is in areas characterized by dense understory, among leaf litter and fallen timber. As such, it may also encounter bats like *Nycteris* spp. in dense thickets that are resting on twigs close to the ground (Fig. 5). A further possibility is that these carnivores scavenged bat carcasses.

In conclusion, predation on bats by mammalian carnivores was a rare phenomenon in this central African rainforest. The few examples that we recorded can be attributed to chance encounters and are probably indicative of the paucity or inaccessibility of large bat colonies in the study area.

Acknowledgements

Field work of JCR was supported by a Fulbright scholarship and grants from the Wildlife Conservation Society and the Conservation, Food and Health Foundation. Maka Sylvestre, Bokombi Franco, Mokonzo Etienne, Mokoko Marc, Etubu Gaston, Singale Jerome, and Balayona Joseph assisted in the field. The support of Le Ministere des Eaux et Fôrets, Chasse, Peche et Tourisme and the World

Wildlife Fund R.C.A./U.S. in the Central African Republic was also invaluable. Many thanks also for the generous support of University of Florida's Center for African Studies and the Program for Tropical Conservation and Development. Jay Malcolm, Gustav Peters and Henning Vierhaus read drafts of the manuscript; we are grateful for their critical comments and valuable suggestions.

Zusammenfassung

Fledermäuse als Nahrung kleiner Raubtiere in einem zentralafrikanischen Regenwald

In Kotproben von Kleinraubtieren, die in einem tropischen Regenwald der Zentralafrikanischen Republik gesammelt worden waren, wurden Fragmente von vier Fledermausarten (*Mops* cf. *spurrelli*, *Nycteris arge*, *Hipposideros cyclops*, *H. ruber*) nachgewiesen. Der Dzanga-Regenwald ist für alle vier Fledermausarten der zweite Fundort in der Zentralafrikanischen Republik. Schleichkatzen (*Genetta servalina*) und Langnasenmanguste (*Herpestes naso*) wurde als zugehörige Prädatoren bestimmt. Fledermausreste fanden sich in nur 0.4% der untersuchten Proben. Die wenigen Fälle betreffen sämtlich Arten, die keine großen Kolonien bilden; ihre Erbeutung wird auf Zufallsbegegnungen zwischen Fledermäusen und Carnivoren zurückgeführt. Große Fledermauskolonien fehlen offenbar im Untersuchungsgebiet oder sind für Prädatoren unerreichbar.

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