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Abundance and distribution of carnivorous mammals in a protected area : preliminary study in the Mount Nimba Integral Nature Reserve (West, Côte d'Ivoire)

Abstract

Carnivores are at the top of the trophic system and are important in the functioning and dynamics of ecosystems. However, due to their cryptic behavior and low density, information on carnivore abundance and distribution is rarely available in many sites, including protected areas. The present study aims to determine the diversity of carnivore species and their distribution in the Mount Nimba Strict Nature Reserve, in western Côte d'Ivoire. Data were collected from 2020 to 2024, using line transect counting and camera trapping methods. Five (05) carnivore species were identified. These are the golden cat (Caracal aurata), the African civet (*Civettictis civetta*), the African genet (*Genetta genetta*), the marsh mongoose (*Atilax paludinosus*), and the brown mongoose (Crossarchus obscurus). The Viverridae family was the most inventoried with an observation rate of 66.67%. The distribution of carnivores is almost spread over the entire extent of the reserve. However, they are more abundant in the south and north in the reserve. The five (05) species of carnivores were inventoried in four types of habitats. These are dense lowland forests, dense montane forests, gallery and secondary forests. This preliminary information on carnivores deserves to be reinforced by other work on the spectrum of their prey and their periods of activity in order to contribute to a good understanding of the dynamics of the mammalian fauna, the functioning of the ecosystem and the sustainable conservation of the reserve.

Key words:*Abundance, camera, carnivores, distribution, reserve.*

INTRODUCTION

In Africa, wildlife is a key natural resource in developing rural areas (Veron, 2013 ; OIPR, 2017). Unfortunately, the survival of these wild animals is threatened mainly by various human activities including habitat fragmentation and destruction, hunting, poaching and environmental pollution (Ritchie et al., 2012 ; Béné et al., 2015). Among this wildlife are carnivores whose diet is mainly based on the consumption of flesh or tissues of other living or dead animals (Ordeñana et al., 2016). Wild carnivores thus play a crucial role in the ecosystem by regulating prey populations while maintaining ecological balance (Jones et al., 2015 ; Smith et al., 2018). However, approximately 25% of carnivore species are threatened with extinction worldwide. In Côte d'Ivoire, wild carnivore populations are essentially confined to protected areas (Lauginie, 2007 ; Beda, 2018). Unfortunately, these protected areas are subject to strong anthropogenic pressures (Akpatou et al., 2018). The Mount Nimba Strict Nature Reserve (RNIMN) is no exception to this reality.The general objective of this study is to contribute to a better understanding of the fauna of the RNIMN in order to improve the conservation and management of the protected area. More specifically, at the level of the RNIMN, it is a question of (i) determining the diversity of carnivorous mammals (ii) establishing distribution maps of carnivorous mammals.

Methodology

Study site

The Mount Nimba massif, part of the Guinean Ridge, marks the borders between Liberia, Guinea and Côte d'Ivoire. The Mount Nimba Strict Nature Reserve reaches an altitude of 1,752 m and is located at approximately 7°30' north latitude and 8°30' west longitude

(Lauginie, 2007). Its slopes, covered with dense forest at the foot of grassy mountain pastures, are home to a particularly rich flora and fauna, including endemic species.

Material

The biological material used for this study is represented by all carnivorous mammals in the RNIMN. The technical equipment used for data collection during this study is represented by (i) a data collection sheet to provide information in the field (ii) a pair of binoculars for observations in the canopy and/or distant animals (iii) a guide for the recognition of carnivores and their presence index (Kingdon et al 2015; Christ & Stuart, 2021) (iv) a compass and GPS (Global Positioning System) for navigation, and for marking presence indices (direct or indirect) during pedestrian surveys (v) a digital camera for taking pictures of animals or carnivore presence indices (Bitty et al., 2015).

Collecte des données

Line transect method

The linear transect method is recognized as one of the effective methods for estimating the abundance of animals, but also for determining their distribution areas (Walsh & White, 1999). The system established for this study includes a total of 16 linear transects for the entire reserve. During the linear transect routes, once an indication of the presence of carnivorous mammals is observed, the following information is recorded. This is the time, date, location, transect number, type of indication, number of indications and geographical coordinates of the observation (Figure 1).

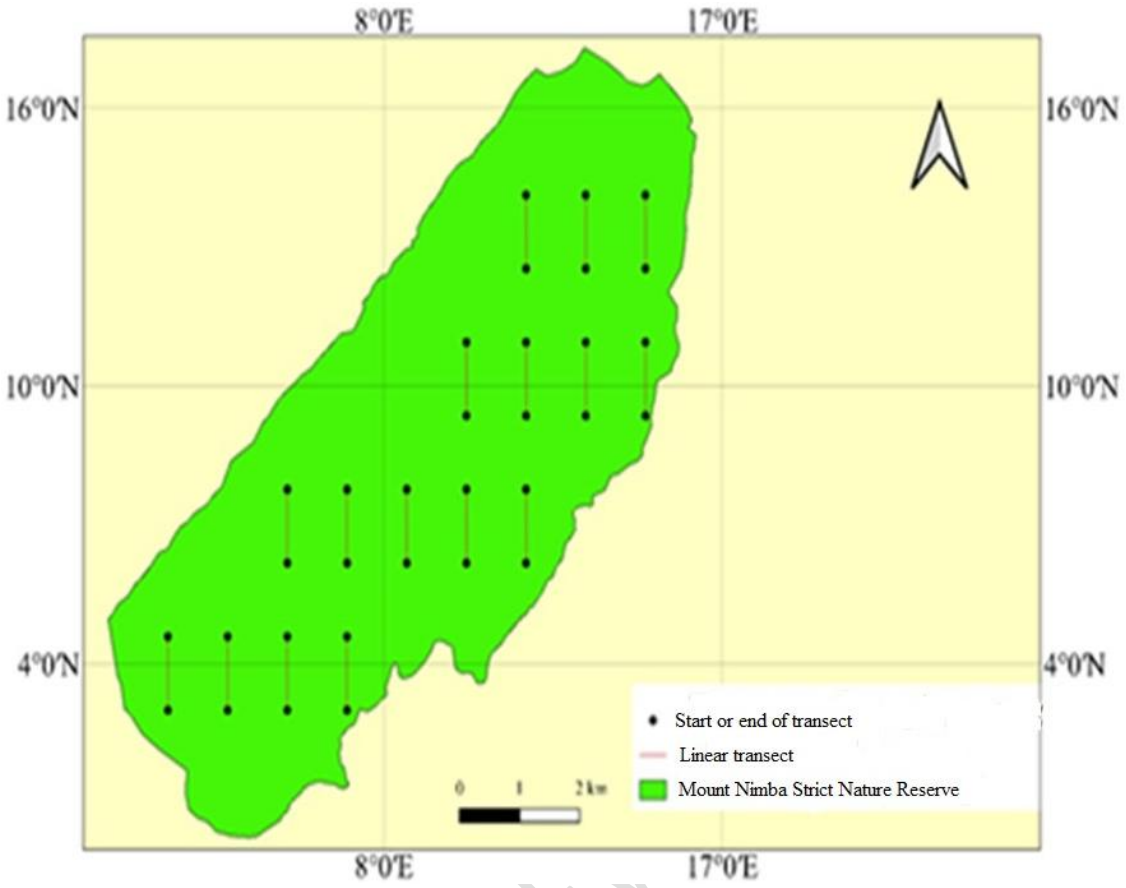

Figure 1 :Distribution of transects in the Mount Nimba Strict Nature Reserve

Camera trapping

This method was applied by OIPR, by installing five (05) cameras or camera traps in the RNIMN. It was necessary to first identify the areas potentially visited or frequented by carnivorous mammals, before determining the location of the camera traps. When the suitable area was identified, the camera trap was securely attached to a tree using cables to avoid any unwanted movement. The objective of the camera trap was oriented towards the place where there was a greater probability of carnivorous mammals passing, while taking into account the distance and the angle of view. The duration of trapping for this study was one month. The memory card of each camera is collected at the end of the trapping period for analysis to identify individuals of carnivorous mammals (Carlos et al., 2010)

Data analysis

Two software programs (PAST 3.10 and QGIS 3.10) were used for data analysis. PAST (3.10) software was used to perform statistical tests on frequency differences, calculation of numerical abundance, Shannon index values and equitability. QGIS 3.10 software was used to produce maps of the spatial distribution of carnivorous mammals inventoried in the RNIMN.

RESULTS

Diversity of Carnivorous Mammals in the Mount Nimba Strict Nature Reserve

Using the line transect method, two carnivorous mammal species were inventoried in the RNIMN in 2021. These are *Crossarchus obscurus* and *Caracal aurata*. In 2020, only the species *Crossarchus obscurus* was observed. No carnivorous mammal species were

inventoried in the RNIMN in 2024. Using the camera trapping method, only *Genetta genetta* was inventoried in 2023 (Table I).

Table I :Specific richness of carnivorous mammals in the RNIMN

Family	Species	Linear Transect		Trapping				
		2020	2021	2024	2020	2021	2023	2024
Viverridae	*Civettictiscivetta*	-	-	-	-	-	-	-
	Atilaxpaludinosus	+	+	-	-	-	-	-
	Genettagenetta	-	-	-	-	-	+	-
Herpestidae	*Crossarchusobscurus*	+	+	-	-	-	-	-
Felidae	*Caracalaurata*	-	+	-	-	-	-	-

Species observed (+) ; Species not observed (-)

Carnivore Mammal Diversity Index

The diversity of carnivore mammal species in the NMRNP was assessed using the Shannon index and Pielou's Equitability index values. The highest Shannon index value was observed using the line transect method (H = 0.84), while camera trapping yielded a zero value (H = 0). The Piélou Equitability index was 0.77 for the line transect method and (H = 0) for the camera trapping method (Table II).

Table II :Diversity indices of carnivorous mammals in the RNIMN from 2020 to 2024

	Linear Transect	Photo Trap	Total
Number of individuals	S=9	S=1	
Shannon index (H)	H=8,84	H=0	Total = 16
Equitability (J)	J=0,77	J=0	

Distribution of carnivorous mammals in the RNIMN from 2020 to 2024

From 2020-2024, carnivorous mammal species were observed throughout the reserve but were more abundant in the northwest, south and center of the reserve. This distribution concerns five carnivore species. *Crossarchus obscurus* is the most observed species. It is present in the south, center and northwest of the reserve. The species *Genetta genetta* was observed in the center and southeast of the reserve. The *Caracal aurata* was only observed in the south of the reserve not far from the peripheral zone. The Atilax paludinosus and the *Civettictis civetta* were observed in the southeast and northwest of the reserve respectively (Figure 2). Carnivorous mammals (five species) were inventoried in different types of habitats in the RNIMN from 2020 to 2024 with a strong presence of these species in the lowland dense forests. All five species were observed in lowland dense forests except *Atilax paludinosus*. *Atilax paludinosus* was observed in all habitat types except lowland dense forests. Crossarchus obscurus was recorded in lowland dense forests and montane dense forests (Table III).

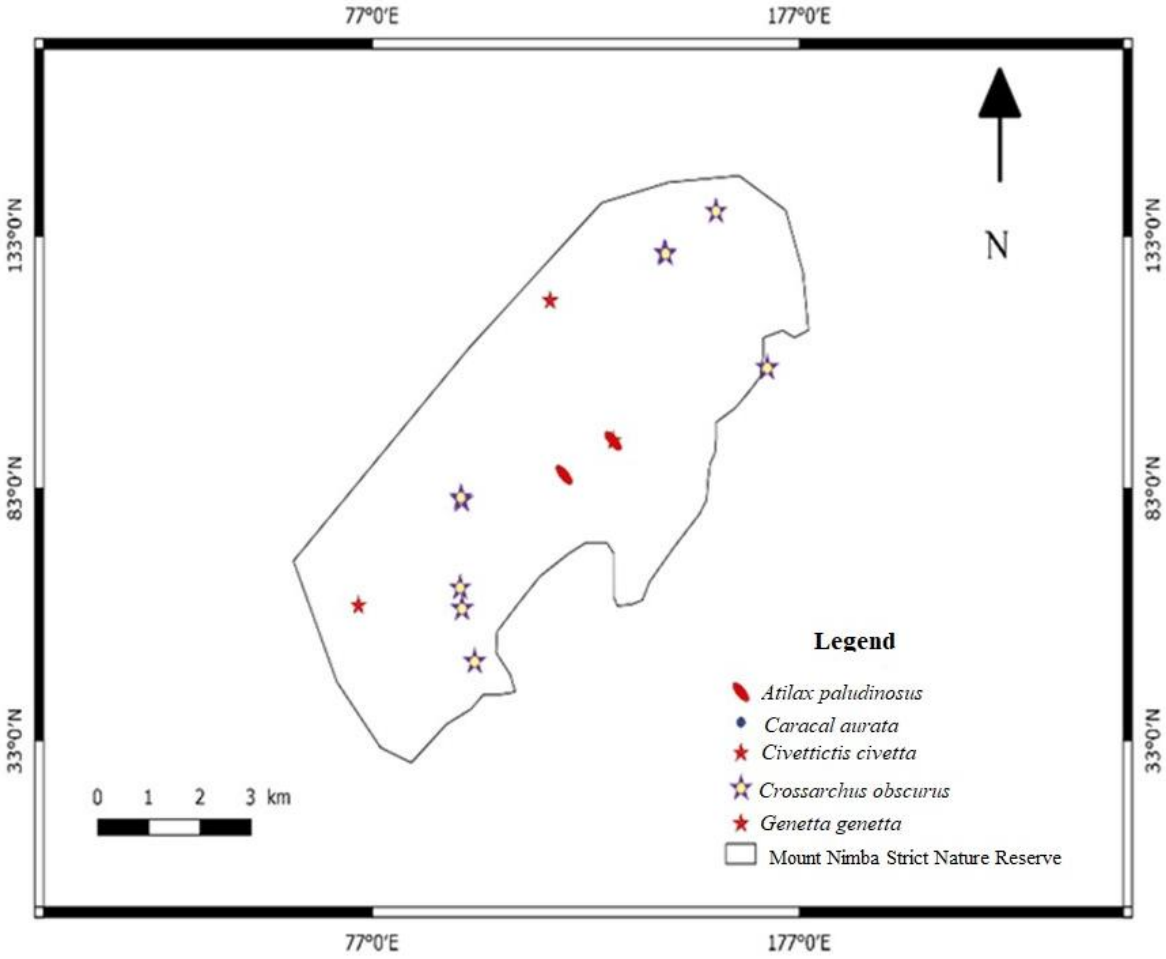

Figure 2 : Distribution of carnivores in the RNMN from 2020 to 2024

Table III : Distribution of carnivorous mammals according to habitats in the RNIMN from 2020 to 2024

Carnivore species	Types of habitats			
	Dense lowland forests	Dense mountain forests	Gallery forests	Secondary forests
Civettictis civetta	+	-	-	-
Crossarchus obscurus	+	+	-	-
Caracal aurata	+	-	-	-
Genetta genetta	+	-	-	-
Atilax paludinosus	-	+	+	+

Species observed (+) ; Species not observed (-)

Discussion

The diversity of carnivorous mammals was assessed during this study through the determination of the observed specific richness and diversity indices. In total, five (05) species belonging to three (03) families (Viverridae, Herpestidae, Felidae) of carnivorous mammals were inventoried in the RNIMN. This number of species detected is lower than that obtained by Chatelain et al. (2001) based on a bibliographic compilation of a study conducted in Tai National Park, where the presence of 13 species of carnivorous mammals was confirmed, including 12 species of small and medium-sized carnivorous mammals. This difference in specific richness could be due to the use of camera traps in limited number (five) in the present study. Furthermore, given that carnivorous mammals are secretive and often nocturnal species, they can only be detected in large numbers by a large number of camera traps (Dramane et al. (2024). However, the species richness observed during this study is higher than that obtained by N'Goran et al. (2020) at the PNT. Indeed, during their studies carried out around the PNT research center on mammals by camera trap, they detected 4 species of small and medium-sized carnivorous mammals. This low number could be explained by the fact that they used a single sampling method, which is the camera trap method Ancrenaz et al. (2012).

For Shannon diversity indices, the line transect method has the highest Shannon index (H = 0.84). The Shannon index value is zero according to the camera trap method. This could be due to the fact that during the present study a limited number of Camera traps were used. Some studies have shown that camera traps are best suited for studying carnivorous mammals (Dramane et al., 2024).

From 2020 to 2024, carnivorous mammal species were generally found in four different habitat types. Among the five carnivorous mammal species, with the exception of the *Atilax paludinosus* species, all other species were observed in dense lowland forests. These habitats, which determine the high presence of these species, could correspond to sites with high wildlife attraction where the physical and environmental characteristics would favor the development of these carnivore species (Veron, 2013). The *Atilax paludinosus* species was observed in all habitat types except dense lowland forests. This could be related to its ability to adapt quickly in different forest types (Macdonald et al., 2013; Assui et al., 2022).

CONCLUSION

This study made it possible to identify in the Mount Nimba Integral Nature Reserve, five (05) species of carnivores (*Caracal aurata*, *Civettictis civetta*, *Genetta genetta*, *Atilax paludinosus*, and *Crossarchus obscurus*) belonging to three (03) taxonomic families : Viverridae, Herpestidae, Felidae. Viverridae represent the most observed family of carnivores. In terms of species, Crossarchus obscurus which is a species of Herpestidae was the most observed. The distribution of these carnivores is almost spread over the entire extent of the reserve but more abundant in the south and north than in other areas of the reserve. The five (05) species of carnivores were inventoried in four types of habitats : dense lowland forests, dense montane forests, gallery forests and secondary forests.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest for this article.

AUTHORS' CONTRIBUTION

KONE NIBA collected the data, KONE NIBA and BAMBA KRAMOKO performed the data processing, statistical analysis, and manuscript writing. The other co-authors contributed to proofreading and improving the article.

ACKNOWLEDGEMENT

We would like to sincerely thank the Ivorian Office of Parks and Reserves (OIPR) for providing the various permits and facilitating access to the Mount Nimba Strict Nature Reserve. We also thank Colonel Assui Wa Kassi N'Guessan Dawy, Deputy Director of the Western Zone (DZO-OIPR), for his material and technical support, which enabled data collection. We particularly thank Colonel Assari Koffi, Chief of the Nimba Sector, for his cooperation during data collection. We extend a special thank you to the village assistants who helped collect data in the field. Finally, we thank everyone who assisted in setting up the database.

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