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The mammalian fauna of the salt licks in the savanna zone of Mont Sangbé National Park, western Côte d'Ivoire

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ABSTRACT: Medium and large-sized mammals worldwide are facing a critical survival challenge due to human activities. In Mont Sangbé National Park (MSNP) in western Côte d'Ivoire, medium and large-sized mammals are frequently sighted in the natural salt licks of the savanna zone, yet there is limited knowledge regarding this fauna. This study seeks to assess the diversity of mammals in the park's natural salt licks and evaluate potential threats posed by human activities. We employed camera trapping and reconnaissance walks at these natural salt licks to collect data. During reconnaissance walks, 58 signs of medium and large mammals were observed, including feces, footprints, feeding remnants et burrows. A total of 19 species of medium and large-sized mammals, distributed across six (06) orders and 11 families, were identified. Among these species, six (06) were directly observed during reconnaissance walks, and 16 were observed with camera traps. Fifteen of the observed species are classified as least concerned, one is near threatened and three are vulnerable according to the International Union for Conservation of Nature. Furthermore, we documented evidence of human activities near the salt licks, underscoring significant anthropogenic threats to these species. Comprehensive research covering all MSNP natural salt licks and accounting for seasonal variations is essential for gaining a deeper understanding of the ecology of mammals frequenting these areas and ensuring their preservation.

KEYWORDS: Salt lick mammal, Specific Diversity, anthropogenic threat, Mont Sangbé National Park, Côte d'Ivoire.

1 INTRODUCTION

The escalating human demand for it well-being has significantly intensified the pressure on natural habitats, subjecting them to various anthropogenic activities, including extensive agriculture, logging, mining and industrialization ([1], [2]). Many animal species face the threat of extinction due to these human activities, depleting natural resources [3], with the potential to lead to a sixth mass extinction if left unaddressed ([4], [5]). This fauna biodiversity threat is exacerbated by the rampant practice of illegal hunting, which spares not even protected areas, particularly in Africa [6].

In Côte d'Ivoire, illegal hunting is observed within the network of protected areas ([7], [8]). Poachers in this country often employ rudimentary or traditional traps and weapons, with a particular focus on large animals that are relatively easy to target. This is especially true for medium and large mammals, which are easily detectable due to their body size and are highly sought after by local populations [9]. This situation significantly escalates the threat to the medium and large-sized mammals of Côte d'Ivoire. It is, therefore, crucial to take action to ensure the conservation of these animal species, which are now subjected to trafficking in the country.

Despite experiencing a drastic loss of its forest cover over the last six decades ([10], [11]), protected areas in Côte d'Ivoire harbor a significant biodiversity. This is notably true for Mont Sangbé National Park (MSNP), which, due to its unique location

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in a mountainous region with both forest and savanna ecosystems, including salt licks, hosts an exceptional fauna likely thanks to its habitat diversity [12], [13]. Indeed, the salt licks in the savanna zone are frequented by medium and large-sized mammals from the MSNP, possibly for mineral supplementation, especially salt [14]. However according to the Ivorian Office of Park and Reserves (2016 unpublished), most of the salt licks in the MSNP are situated in the savanna zone from the northern areas of the park where, to our knowledge, there is a lack of information regarding the fauna present or the anthropogenic activities taking place. Acquiring this information would be an asset in defining an effective management strategy for the MSNP and the conservation of the animal species residing there. Therefore, this study aims to enhance our understanding of the mammalian fauna in the MSNP and the anthropogenic threats these animals encounter.

2 Material And Methods

2.1 Study Site

This study was conducted around five salt licks located in the savanna zone to the north of the MSNP (Figure 1). The MSNP is situated in western Côte d'Ivoire between latitudes 7°51' and 8°10' North and longitudes 7°03' and 7°23' West, covering an area of 97,000 hectares [12]. This park lies in a transitional zone between subequatorial and tropical climates, marked by the transition from a bimodal rainfall pattern (two rainy seasons) to a unimodal pattern (one rainy season). The rainy season spans from April to October, with the heaviest rainfall occurring in September. The extended dry season lasts for five to six months and is characterized by two to three months of harmattan winds. The Mont Sangbé region also features an average annual temperature of 25°C, with local variations related to altitude. The average annual rainfall is approximately 1200mm, with a mean annual relative humidity of 75% (Ivorian Office of Park and Reserves 2014 unpublished). The park's vegetation consists mainly of forest habitats, represented by forest islands and the Sassandra gallery forest. These habitats are associated with a semi-deciduous humid forest and savanna portions characterized by woody stands and a shrub layer. The unique habitat offered by the MSNP attracts a diverse range of animal species, including mammals, birds, and reptiles (Ivorian Office of Park and Reserves 2000, 2014 unpublished).

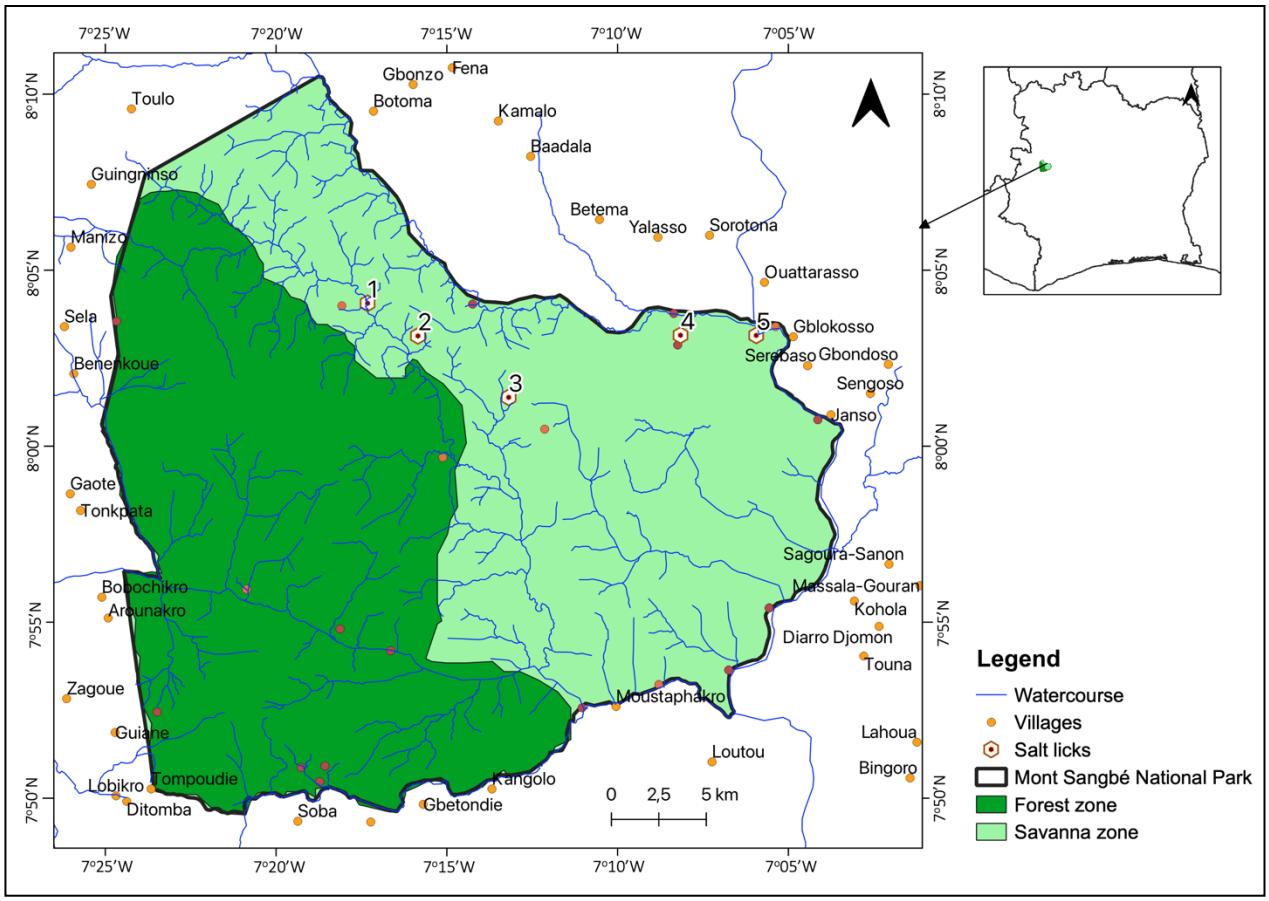

Fig. 1. Localization of the study area

2.2 DATA COLLECTION

The study was conducted during the dry season from December 2019 to February 2020 in five salt licks located in the savanna zone of MSNP (Figure 1), which is known for having a higher number of salt licks according to the Ivorian Office of Park and Reserves (2018 unpublished). The selected salt licks were chosen based on their size (greater than 50m2) and accessibility (approximately 4 km between consecutive sites with established tracks). Medium-sized mammals were defined as those weighing between 1 and 15 kg, except for mongooses, which can sometimes weigh less. Species weighing more than 15 kg were categorized as large mammals [15].

2.2.1 RECONNAISSANCE WALKS

During the reconnaissance walks (recce surveys), we followed pre-determined routes while deviating less than 40 degrees to deviate obstacles and utilizing paths of least resistance to navigate in the study area more swiftly and cover a larger area in a shorter timeframe while minimizing our environmental impact [16]. The recce method was chosen over line transects, as it is better suited for challenging and inaccessible environments, as suggested by some authors ([16], [17]). Accompanied by a local guide during the recce surveys, we actively searched for animals and their signs of presence, as well as traces of human activities, typically within an average radius of 100 meters around the salt licks, following straight lines. For each animal sign observation, we meticulously recorded geographical coordinates, the type of sign (vocalization, droppings, tracks, etc.), the quantity of signs, the distance covered, and the name of the observed animal species. Additionally, certain signs of animal presence and human activity were collected or photographed to facilitate a more in-depth identification process.

2.2.2 CAMERA TRAPPING

Fourteen camera traps were installed to capture both diurnal and nocturnal animals, with the purpose of observing rare and cryptic species ([6], [18]). To maximize the field of view at each salt lick and increase the chances of capturing visiting animals, we strategically placed two camera traps per salt lick. These camera traps were positioned approximately 50 cm above the ground, pointing either north or south to minimize the impact of direct sunlight. Potential obstacles were cleared to enhance visibility and prevent false triggers caused by moving branches or leaves. Two consecutive trapping phases, each without interruption, were conducted at each site. The initial phase lasted for three weeks after the camera traps were set up, covering all five salt licks sampled in this study. This phase allowed us to identify the salt licks most frequented by animals for the second trapping phase, which took place at salt licks S1, S2, and S5, lasting for an additional three weeks. The camera traps were set in video mode (hybrid) with recording sequences of one minute (60 seconds) each, separated by 30-second intervals. To determine the operational duration of the camera traps, we meticulously recorded the time and date of each camera's installation at the site.

2.3 DATA ANALYSIS

We calculated the Shannon diversity index (H) to assess the diversity of medium and large mammals on the salt licks and Piélou's equity index (E) to evaluate the level of dominance of these species using the software PAST (version 3.10).

The Shannon diversity index, ranging from values 0 to 5, was calculated using the following formula:

$$H = -\Sigma\, pi \times \log(pi)$$

Where pi represents the relative abundance of species

The equity index, which varies between 0 (dominance of a single species) and 1 (even distribution of individuals among species), was calculated using the following formula:

$$E = H'/\log(S)$$

Where H is the Shannon diversity index

S represents species richness

We identified the species captured by camera trapping and confirmed the identification of the observed species using the illustrated Guide to the Mammals of Africa of Kingdon (1995). The videos and images from the camera traps were collected

and organized, excluding negative captures, which were those that did not show any animal species, or displayed species that were difficult to identify, or showed species other than mammals. A capture was considered positive when the captured animal species was clearly identifiable as a mammal.

3 RESULTS

During the reconnaissance walks, a total of 58 signs of medium and large mammals were observed, including feces, footprints, feeding remnants, or burrows. Among these, six species were clearly identified. These identified species include traces and direct observation of the African forest buffalo (*Syncerus caffer nanus*), the hartebeest (*Alcelaphus buselaphus*), the defassa waterbuck (*Kobus defassa*), the spotted hyena (*Crocuta crocuta*), the bushpig (*Potamochoerus porcus*) and the aardvark (*Orycteropus afer*) (Table 1). The other observed signs of animal presence did not allow us to identify them at the species level but could potentially be signs of species such as duikers or medium carnivores like mongooses or servals.

From the camera traps, we identified five species of medium-sized mammals (Figure 2): the Gambian mongoose (*Mungos gambianus*), the marsh mongoose (*Atilax paludinosus*), the Crested Porcupine (*Hystrix cristata*), the patas monkey (*Erythrocebus patas*), and the green monkey (*Cercopithecus aethiops sabaeus*). Out of the 333 positive captures from the camera traps, 27 were captures of medium-sized mammals, accounting for 7.5% of the captures. The Cercopithecidae family was the most frequently captured with 11 captures, followed by the Hystricidae family with 4 captures (Table 1). In total, we identified ten species of medium-sized mammals from both the reconnaissance walks and camera trapping, distributed evenly across salt licks S1, S2, S3, and S5 (Figure 3).

Almost 95% of the positive videos, specifically 315 out of 333, featured captures of large mammals. These camera trap captures allowed us to identify 11 species of large mammals (Figure 4). These species include the Leopard (*Panthera pardus*), Olive Baboon (*Papio anubis*), Bushbuck (*Tragelaphus scriptus*), Common Eland (*Hippotragus equinus koba*), Hartebeest (*Alcelaphus buselaphus major*), Buffon's Kob (*Kobus kob*), Defassa Waterbuck (*Kobus defassa unctuosus*), Yellow-backed Duiker (*Cephalophus sivicultor*), Common Hippopotamus (*Hippopotamus amphibius*), Warthog (*Phacochoerus africanus*), and Bushpig (*Potamochoerus porcus*). The Bovidae and Cercopithecidae families were the most represented on the study site, with 258 captures for Bovidae and 46 captures for Cercopithecidae by the camera traps (Table 1). The Felidae family was the least represented, with only 2 captures. In total we identified 13 species of large-sized mammals through reconnaissance walks and camera trapping, distributed evenly across salt licks S1, S2, S3, and S5, with a single species observed in the salt lick S4 (Figure 5). The specific diversity of medium and large mammals in the sampled salt licks was relatively low (H' = 1.54). Additionally, no species demonstrated dominance among the salt licks (E = 0.83).

During the reconnaissance walks, various signs of human activities were documented in the vicinity of the salt licks. These signs included cooked food remnants, hearth traces for cooking, and remnants of bushfires.

4 DISCUSSION

The study has provided valuable insights into the diversity of medium and large-sized mammals on the salt lick sites in the savanna zone of MSNP, based on data obtained from reconnaissance walks and camera trapping. The results have revealed that these salt lick sites harbor a wide array of medium and large sized mammals, ranging from species as small as mongooses to larger mammals like leopards and hippos, including both diurnal, nocturnal, and cathemeral species. The presence of such a diverse array of animal species on these salt licks can be justified by the fact that salt licks are areas that naturally attract wildlife and can even be considered as hotspots in their own right ([19] – [21]). Our observation of the African forest buffalo in the savannah zone might illustrates the attraction that salt lick exert on wild animals. However, this may be a coincidence, given that we only had one direct observation.

The allure that salt licks hold for wild animals, particularly mammals, has also been confirmed through the installation of artificial salt licks in protected areas in Malaysia [22]. Among the mammals, certain species are very frequently observed on the salt lick sites, especially herbivorous ungulates and primates. These herbivorous species regularly visit the salt lick areas in search of salt to supplement their daily plant-based diet ([14], [23]).

The frequent observation of primate and ungulate species, represented by the Cercopithecidae and Bovidae families, respectively, on our study site can be attributed to the attraction of these salt licks to these animals. Nevertheless, despite the diversity of medium and large-sized mammals, we have determined a relatively low diversity index and an absence of species dominance. These findings may be explained by the relatively small size of the sampling site and the relatively short duration of the study, which only covered the dry season. These results provide a foundation for guiding more comprehensive, long-term studies of these salt licks. Given that seasonal variations can influence the utilization of salt licks by animal species, it

would be beneficial to expand this study to cover all seasons of the year to gain a more comprehensive understanding of the mammalian fauna frequenting the salt licks in the savanna zone of MSNP [24].

Despite the relatively short study period, the presence of signs of anthropogenic activities near some salt licks, such as remnants of food cooked over a fire, hearth traces from cooking, and remnants of bushfires, has been observed. These indicators suggest the presence of poachers around the salt licks, which have been repeatedly proven as high-activity zones for wildlife ([19] – [21]). Poachers are attracted to hotspots within protected areas ([25], [26]) where the congregation of animals makes them easy prey. Consequently, these activities can have a detrimental impact on local wildlife by disrupting natural habitats, as hunting ranks among the most destructive factors for biodiversity survival ([27], [28]). It is, therefore, crucial to consider the potential presence of poachers at salt lick sites, as observed in our study, for the management and conservation of MSNP's wildlife. Given that there are mammal species that visit the salt licks both day and night, steps should be taken by the park's authorities to address the threat of poaching at any time of the day.

Table 1. Specific diversity of medium and large sized mammals on the salt lick of the MSNP

	Order	Familly	Species		Number of observation		UICN red list (2023)
			Common name	Scientific Name	Camera trapping (Individual)	Recce* (sign)	
Medium-sized mammals	Carnivora	Viverridae	Gambian mongoose	*Mungos gambianus*	1	1	LC
			Marsh mongoose	*Alliax paludinosus*	1	0	LC
		Felidae	Serval	*Leptailurus serval*	0	1	LC
	Rodentia	Hystricidae	Crested porcupine	*Hystrix cristata*	5	6	LC
		Thryonomyidae	Greater Cane Rat	*Thryonomys swinderianus*	0	1	LC
	Primates	Cercopithecidae	Patas monkey	*Erythrocebus patas*	6	0	LC
			Green monkey	*Cercopithecus aethiops*	5	0	LC
	Artiodactyla	Bovidae	Red-flanked duiker	*Cephalophus rufilatus*	0	1	LC
	Lagomorpha	Leporidae	Africa savanna hare	*Lepus victoriae*	0	1	LC
	Tubulidentata	Orycteropodidae	Aardvark	*Orycteropus afer*	0	1#	LC
Large mammals	Carnivora	Canidae	Spotted hyena	*Crocuta crocuta*	0	1#	LC
		Felidae	Leopard	*Panthera pardus*	2	0	VU
	Primates	Cercopithecidae	Olive aboon	*Papio anubis*	46	0	LC
	Artiodactyla	Bovidae	Hartebeest	*Alcelaphus buselaphus*	1	7#	LC
			Kob	*Kobus kob*	19	2	LC
			Defassa waterbuck	*Kobus defassa*	23	13#	NT
			Yellow-backed duiker	*Cephalophus silvicultor*	2	0	LC
			Bushbuck	*Tragelaphus scriptus*	197	3	LC
			Roan antelope	*Hippotragus equinus*	16	0	VU
			Buffalo	*Syncerus caffer*	0	1#	LC
		Hippopotamidae	Common hippopotamus	*Hippopotamus amphibius*	1	4	VU
		Suidae	Warthog	*Phacochoerus africanus*	3	1	LC
			Bushpig	*Potamochoerus porcus*	5	15#	LC

LC, least concern; NT, near threatened; VU, vulnerable;
**The identification of species presence indicators during recce remains subjective; precision is achieved at the family level;*
#Clearly identified species.

Gambian mongoose (Mungos gambianus)

Crested porcupine (Hystrix cristata)

Patas monkey (Erythrocebus patas)

Green monkey (Cercopithecus aethiops)

Fig. 2. Camera trap pictures of four medium-sized mammal species clearly identified in the salt licks of the MSNP

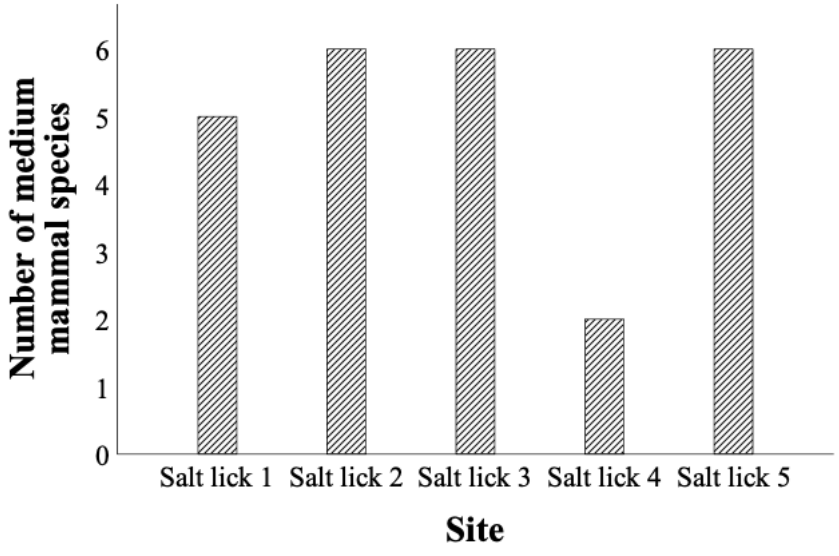

Fig. 3. Specific species richness of the medium mammals observed in the salt licks of the MSNP

Olive baboon (Papio anubis) Yellow-backed duiker (Cephalophus silvicultor)

Bushpig (Potamochoerus porcus) Hartebeest (Alcelaphus buselaphus)

Defassa waterbuck (Kobus defassa unctuosus) Roan antelope (Hippotragus equinus)

Leopard (Panthera pardus) Bushbuck (Tragelaphus scriptus)

Fig. 4. Camera trap pictures of eight large mammal species clearly identified in the salt licks of the MSNP

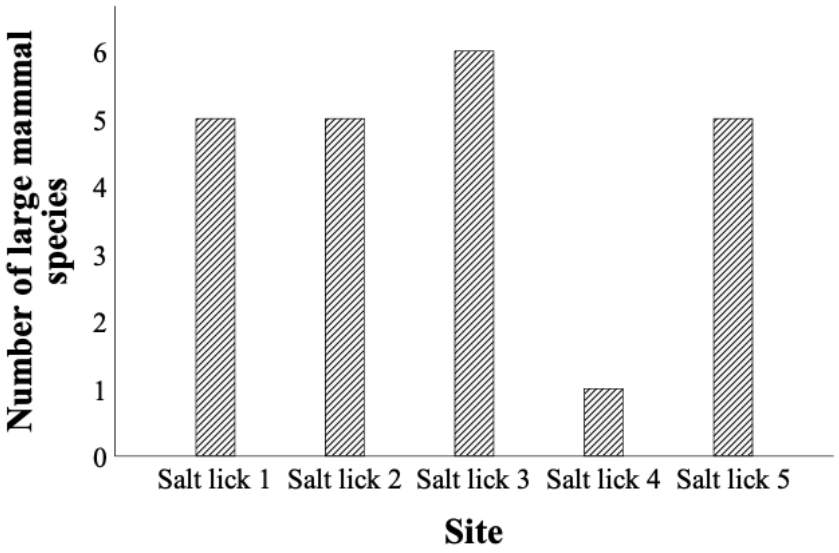

Fig. 5. Specific species richness of the large mammals observed in the salt licks of the MSNP

5 CONCLUSION

This study provides valuable insights into the mammalian fauna of the savanna zone within the Mont Sangbé National Park in Côte d'Ivoire. The results highlight the richness of mammalian wildlife in the salt licks of the savanna zone of the park and their implication eco-touristic activities, as well as the potential threats posed by human activities. These findings can be used to guide future research and develop more effective conservation and management strategies to preserve the biodiversity of this area.

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