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Diversity, Distribution and Uses of Wild Mammals of Jebel Al Dayer Biosphere Reserve

Mohmed A Abd El-Rahman[1], Zuheir N Mahmoud[2*] and Mohamed AA Salih[1]

[1]Department of Zoology, University of Khordofan, El-Obeid, Sudan

[2]Department of Zoology, University of Khartoum, Khartoum, Sudan

***Corresponding author:** Zuheir N Mahmoud, Department of Zoology, University of Khordofan, Khartoum, Sudan, Tel: 249911300333; E-mail: zuheirnm@hotmail.com

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Abstract

Jebel Al Dayer (3,715 km^2) richness and diversity in biota lead to its declaration as a national park in 2010. It became a UNESCO world biosphere reserves in 2017. Its wild mammals comprised 37 species, in 34 genera, 20 families and nine orders. Herbivorous wild mammals *Procava capensis, Chlorocebus aethiops, Hystrix cristata* and carnivorous ones caracal, *Hyaena hyaena* and *Canis aureus* are endangered by the residents who used it as bush meat, for trade in leather and in traditional medicine at the same time. Wildlife mammals attacking livestock (*Vulpus pallida* and *Felis silvestris lybica*) or crops (*Mellivora capensis* and *Lemnicomys striatus*) are always attacked by man. Most of the species are least concern and/or for which there are no identifiable risks. However, *Gazella dorcas* are vulnerable and *H. hyaenas* are threatened. The least signicant differences showed ($p>0.05$ to $p<0.05$) in number of wild mammals between seasons and elevations and between seasons and habitat.

Keywords: Biosphere; Mammalians; Wild; Conflicts; *H. hyaenas*

Introduction

Jebel Al Dayer Biosphere Reserve (JDBR) is one of the few areas with rich biodiversity in the semi-arid region of North Kordofan. It is composed of dry savannah woodland, forest ecosystems with five permanents and nine temporary streams. There are 16 major and 46 miner villages in JDBR. The climate of the biosphere is characterized by two extremes of dry and wet seasons. The rains start in early April and peaks in August. In the region it is in the range of 412.6 to 489 mm/year [1]. Over 112 plant species in JDBR have been recorded, including 95 species of medicinal and aromatic plants in different ecosystems. The vegetation in the biosphere is typical Sudanian woodland type. The major tree species in the biosphere is dominant by deciduous trees including *Boswellia papyrifera*, *Dichrostachys cinerea*, *Acacia tortilis*, *A. mellifera*, *A. etbaica*, *Anthephora hochstetteri*, *Combretum glutinosum*, *Terminalia* spp. and bamboos most of these plant species are not found elsewhere in North Kordofan. The habitat of the biosphere is classified into: Semi-arid mountain peaks woodland savannah urban area mountain forest/slope and agriculture plots [2].

The area was declared as a national park on 25th of July 2010 by the presidential decree no. 196. Its total surface area is 6,374 km^2 with a buffer zone of 987 km^2 and its transition area is 3,715 km^2. In 14 June 2017 it was added to UNESCO world network of biosphere reserves.

JDBR lies between 12°26' and 12°44'N and 30°39', 30°65'E in North Kordofan state (Map 1) [3]. According to Whiteman it is a volcanic rock mountain with different height peaks. It rises over 1,000 m above the surroundings train and 1,451 m.a.s.l.

According to list of mammals of Sudan at least there is about 230 species of mammal falling in 14 orders with rodentia and chiroptera being represented by 46 species each? Happold, et al. recorded 36 species of wild mammals from jebel mara and added 7 species to the region: *Mastomys natalensis*, *Hystrix cristata*, *Vulpes pallida*, *Ammotragus lervia*, *Sylvicapra grimmia* and *Herpestes* spp. [4].

Abdelhamid, reported *Papio cynocephalus* anubis, *Chlorocebus aethiops*, *Gazella dorcas*, *Tragelaphus strepsiceros*, *Mellivora capensis*, *Heterohyrax bruceei*, *Heliosciurus garianus*, *Ichneumia herpestes* and a *Lepus* sp., from JDBR. According to IFAD wild mammal of JDBR included *T. strepsiceros*, *Madoqua saltiana*, *Caracal*, *Felis silvestris*, *Crocuta crocuta*, *Genetta genetta*, *Papio anubis*, *Procavia capensis*, *Erythocebus patas* and *Cholorocebus aethiops*.

Tomor and Hashim, et al. assessed the status of some wild mammal species in dinder national park. El Khidir and Ali used a questionnaire to track 25 wildlife animal species in radom national park from 1974 to 2016. Recent studies on wild mammals in African included the work of Lavrenchenko, et al. which listed 28 species of shrews known from Ethiopia [5]. The wild mammals were studied in Uganda by Mills, et al. in Nepal Shuklaphanta national park by Poudyal, et al. and in Kafa biosphere reserve of Ethiopia by Yonas, et al.

This work aimed to study the dive rsity, distribution and threats to wild mammals other than bats in JDBR.

Materials and Methods

Collection of wild mammals

The wild mammals were seen or recognized by a binocular of the type (Bushnell 16 x 52 66 m 8000 m) [6]. Traps (28 iron meshed traps of different dimensions 18 x 32 x 18; 59 x 32 x 31; 23 x 15 x 12 and 108 x 78 x 78 cm) were baited and used to collect small wild mammals. A tranquilizer gun was used to immobilize large wild mammals (with permission from the authorities of JDBR). Collected wild mammals were photographed using a Samsung grand 2 mobile and a digital Canon camera fitted with a zoom lens 450 mm 800 mm.

Identification and documentation

Identification followed Tilde, 2008 and Jonathan, 2015. The captured specimens were released at site of collection [7]. The study started from 15/10/2021 to 20/10/2022 and covered winter, summer and autumn. The fieldwork extended for 40 days during each season. Wild mammals were counted on basis of season, elevation and habitat type.

Indigenous knowledge

Indigenous knowledge was used to generate a preliminary list of wild mammal species. After alerting the local community in JDBR with the objectives of the questionnaire, 47 forms were distributed randomly and recollected after being filled [8].

Statistical analysis

The Least Sigficance Difference (LSD) was used to compare the means following completely randomized block design analysis.

Results

A total of 1,874 wild mammals belonging to 37 species, 34 genera, 18 families and nine orders were encountered in JDBR (Figures 1-9).

Figure 1: *Papio cynocephalus* anubis.

Figure 2: *Chlorocebus aethiops*.

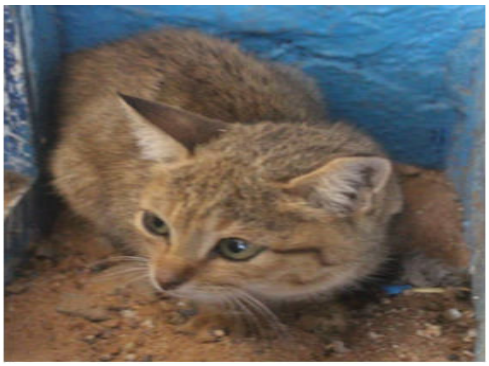

Figure 3: *Felis silvestris lybica*.

Figure 4: *Atelerix albiventris*.

Figure 5: *Rattus norvegicus*.

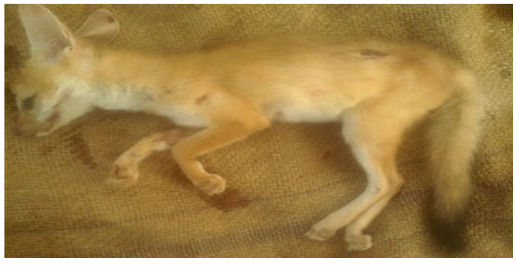

Figure 6: *Vulpes pallida*.

Figure 7: *Desmodiliscus braueri*.

Figure 8: *Mus* sp.

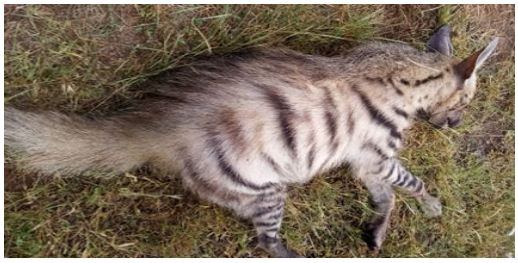

Figure 9: *Hyaena hyaena*.

Twenty six species were found in all seasons. *Leptailurus serval*, *E. patas*, *M. mungo*, *Atelerix* sp. and *G. microtis* were reported in autumn. Single specimens of *M. capensis* and of *O. afer* were encountered during winter. A single specimen of *L. microtis* was found during summer [9]. The highest number recorded for a wild mammal species was 429 for *D. braueri*. Wild mammals seen around villages of Sidrah were 82, near Kondukor were 58, close to Farla were 47, and around Negaiaa were 42 and 36 in the vicinity of El Eain as well as in Taiba. The highest recorded number of species was (30%) in the southern of JDBR.

It is apparent from Table 1 that eight species were found in all elevations, five species were observed only in <5 m elevation and 15 species are confined to >500 m elevations.

Procavia capensis and *M. natalensis* were found in all habitats. *Galago senegalensis* was observed only on mountain. *Papio cynocephalus anubis, C. aethiop. S. grimia, C. aureus* were confined to woodland savannah and agricultural plots. *Vulpes pallida* was observed in semi-arid zones and agricultural plots. *Mungos mungo, O. afer, L. microtis, G. micro is* and *M. capensis* were confined to woodland savannah (Table 1). The frequency of specimens of wild mammals sighted in mountain peaks were 94, semi-arid zones reached 549, woodland savannah were 336, urban areas were 164, mountain forest and slope was 321 and in agriculture plots were 347 [10].

Most of the species are at least concern and/or for which there are no identifiable risks. However, *G. dorcas* are vulnerable and *H. hyaena*s are near threatened.

Table 1: Distribution of wild mammals in JDBR according to season, elevation and habitat.

Species	Season			Elevation in m				Habitat					
	Winter	Summer	Autumn	0-5	>5-100	>100-500	>500-1200	SA	MP	WS	UA	MF	AG
Order: Tubulidentata, Family: Orycteropidae													
Orycter opusafer	1	0	0	-	-	-	+	0	0	1	0	0	0
Order: Hyracoidea, Family: Procaviidae													
Procavia capensis	15	13	35	+	+	+	+	6	9	2	11	11	24
Order: Primates, Family: Galagidae													
Galago senegalensis	3	2	5	+	+	+	+	2	0	0	0	8	0
Order: Primates, Family: Cercopithecidae													
Papio cynocephalus	51	17	56	+	+	+	+	13	0	0	0	83	28

anubis													
Chlorocebus aethiops	34	29	45	+	+	+	+	36	0	0	0	61	11
Erythrocebus patas	0	0	25	+	+	+	+	16	0	0	0	0	9
Order: Rodentia, Family: Hystricidae													
Hystrix cristata	9	3	2	+	+	+	+	2	0	3	0	9	0
Order: Rodentia, Family: Sciuridae													
Xeruser ythropus	43	27	9	+	+	-	-	0	43	27	0	0	9
Xerus rutilis	4	2	3	+	-	-	-	0	4	2	0	0	3
Order: Rodentia, Family: Gliridae													
Graphiurus microtis	0	0	1	-	-	+	+	0	0	1	0	0	0
Order: Rodentia, Family: Dipodidae													
Jaculus jaculus	10	4	7	-	-	-	+	0	10	4	0	0	7
Desmodiliscus braueri	123	119	87	-	-	-	+	0	123	119	2	0	85
Gerbillus gerbillus	25	12	3	-	-	-	+	0	25	12	0	0	3
Mastomys natalensis	134	94	111	-	+	+	+	33	101	41	53	39	72
Arvichanthis niloticus	176	30	49	-	-	-	+	0	81	28	2	91	53
Acomys cahirinus	4	1	0	-	-	-	+	0	4	1	0	0	0
Aethomys hindei	7	0	4	-	-	-	+	0	2	4	0	0	5
Lemnicomys striatus	11	0	4	-	-	-	+	0	11	0	0	0	4
Order: Lagomorpha, Family: Leporidae													

Lepus capensis	18	15	27	+	-	-	-	0	18	15	0	27	0
Lepus microtis	0	1	0	+	-	-	-	0	0	1	0	0	0
Order: Erinaceomorpha, Family: Erinaceidae													
Atelerix albiventris	9	7	15	+	-	-	-	9	0	7	0	15	0
Order: Soricomorpha, Family: Soricidae													
Crocidura spp.	6	5	11	+	-	-	-	0	6	5	0	10	1
Order: Carnivora, Family: Felidae													
Caracal caracal	1	8	2	+	+	+	+	1	0	8	0	2	0
Felis silvestris lybica	23	9	14	-	+	+	+	23	0	9	0	14	0
Leptailurus serval	0	0	2	-	+	+	-	0	0	0	0	2	0
Order: Carnivora, Family: Viverridae													
Genetta genetta	19	6	13	-	-	+	+	0	3	16	4	0	15
Order: Carnivora, Family: Herpestidae													
Herpestes sanguineus	3	1	3	-	-	-	+	3	0	1	0	3	0
Herpestes ichneumon	2	0	0	-	-	-	+	0	0	2	0	0	0
Ichneumia albicauda	7	3	2	-	-	-	+	7	0	2	0	3	0
Mungos mungo	0	0	6	-	-	-	+	0	0	6	0	0	0
Order: Carnivora, Family: Hyaenidae													
Crocuta crocuta	0	1	2	-	+	+	+	0	0	1	0	2	0
Hyaena hyaena	2	5	12	-	-	+	+	2	0	5	0	12	0
Order: Carnivora, Family: Canidae													
Vulpes pallida	9	7	9	-	-	+	+	0	9	0	0	0	16

Canis aureus	4	1	2	-	-	-	+	0	0	2	0	0	5
Order: Carnivora, Family: Mustelidae													
Ictonyx striatus	4	4	7	-	-	-	+	0	0	6	2	0	7
Mellivora capensis	1	0	0	-	-	-	+	0	0	1	0	0	0
Order: Artiodactyla, Family: Bovidae													
Tragelaphus strepsiceros	4	5	15	+	+	+	+	9	0	0	1	12	2
Sylvicapra grimmia	0	3	3	+	+	+	-	0	0	2	0	0	4
Note: Semi-Arid: SA; Mountain Peaks: MP; Woodland Savannah: WS; Urban Area: UA; Mountain Forest/slope: MF; Agriculture plots: Ag.													

The distribution of wild mammals according to season and elevation was assessed by LSD which showed ($p>0.05$ to $p<0.05$) in numbers between seasons and elevations, and between seasons and habitat (Table 2) [11].

Table 2: Distribution according to season and elevation.

Elevation in m	Season			Total	Mean
	Winter	Summer	Autumn		
0-5	709	359	477	1545	509^a
>5-100	73	27	49	149	49.67^b
>100-500	38	25	32	95	31.67^b
>500-1200	28	24	26	78	26^b
Total	848	435	584	1867	
Mean	212^a	108.75^c	146^b		
Note: Means with different superscripts in a raw and in a column are significantly ($p<0.05$) different.					

The distribution of wild mammals according to season and elevation was assessed by LSD which showed ($p>0.05$ to $p<0.05$) in numbers between seasons and elevations, and between seasons and habitat (Table 3).

Table 3: Distribution according to season and habitat.

Habitat*	Season			Total	Mean
	Winter	Summer	Autumn		
SA	233	131	177	541	135.25^a

MP	70	41	42	153	38.25[b]
WS	127	69	127	323	80.75[b]
UA	64	43	57	164	41.0[b]
MF	146	59	73	278	69.5[b]
Ag	208	92	108	408	102.0[a]
Total	848	435	584	1867	
Mean	169.6[a]	87[b]	116.8[ab]		

Note: *See legends of Table 1.
Means with different superscripts in a raw and in a column are significantly ($p<0.05$) different.

Wild mammals uses by residents of JDBR

Nine species of wildlife were used as food, in traditional medicine and decoration trade (Table 4) [12]. The total number of species used only as food, or in decoration or in traditional medicine were 21, 15 and 14, respectively.

Table 4: Wild mammal species of known uses by residents in JDBR.

Scientific name	**Exploited for**		
	Food	**Traditional medicine**	**Decoration**
Herbivores mammals			
Procava capensis	5	13	1
Erythrocebus patas	4	0	0
Chlorocebus aethiops	2	1	4
Papio. c. annubis	12	13	0
Hystrix cristata	18	28	2
Xerus rutilis	21	3	1
Xerus erythropus	1	0	0
Jaculus jaculus	1	0	0
Arvichanthis niloticus	4	0	0
Lepus capensis	14	7	3
Atelerix albiventris	3	0	0
Gazella dorcas	18	0	3
Tragelaphus strepsiceros	17	0	2
Sylvicapra grimmia	No record		
Carnivorous mammals			

Caracal caracal	3	3	1
Felis silvestris lypica	7	0	7
Genetta genetta	2	0	1
Leptailurus serval	0	0	3
Ichneumia albicauda	0	1	0
Crocuta crocuta	3	3	0
Hyaena hyaena	1	2	1
Vulpes pallida	3	0	0
Canis aureus	3	2	2
Mellivora capensis	0	3	0

Most risks stem from conflicts between man and wild mammals. These are: Bush meat of herbivorous like *P. capensis, C. aethiops, H. cristata* and carnivorous like *C. caracal, H. hyaena* and *C. aureus* wild mammals attacking livestock (*V. pallida* and *F. s. lybica*) or crops (*M. capeinsis* and *L. striatus*) led to destruction of burrows by the residents non-intention knock down by vehicles entail *J. jaculus, A. albiventris* and *D. braueri*. Unintentional fires represent unexpected risks to the flora and wildlife in JDBR [13]. The growing interest in building material increased burrow destruction rates due to mechanical deriding, as well as road accidents and bush meat exploitation (Table 3). The negative impacts on wild mammal's entails seven species attacking domestic animal in 44 accidents; 14 species share pasture and/or feed on crops in 177 accidents. Human impact included killing of 4 wild mammals to protect domestic animals in 4 accidents destruction of burrow of 12 species in 62 accidents in 10 road acidents 3 species were killed and 55 cases of bush meat involved 16 species (Table 5) [14].

Table 5: Conflicts of wildlife and man in JDBR.

Species	**Wildlife impact**				**Human impact**			
	ADA		**SPL**	**FFC**	**KM**	**DB**	**RA**	**IP**
Total of accidents	34	4		173	4	62	10	55
Total of species	7	2		12	4	12	3	16

Note: Attack Domestic Animal: ADA; Share Pasture with Livestock: SPL; Feed on Farm Crops FFC; Killed by Man: KM; Destruction of Burrow: DB; Road Accidents: RA; Illegal Poaching: IP.

The set questionnaire was intended to generate data on the attitude of the local names of wildlife and their consumptive uses, frequency of sighting wildlife by age groups, and the nature of conflicts outlined between man and wildlife [15].

The frequency of sighting wildlife in JDBR by age groups (5-15), (16-25) and (26-35) was more than age groups (36-45) and (>46). This might be attributed to differences in activity between these age groups.

Discussion

Jebel Al Dayer biosphere reserve is the richest biodiversity area in North Kordofan. Five permanent and 9 temporary streams run through it. Recorded over 112 plant species including 95 species of medicinal and aromatic plants in JDBR.

The present study collected 1,874 specimens of wild mammals. These belonged to 40 species, 36 genera, 20 families and? Orders in JDBR [16].

The IUCN recorded 188 wild mammal species in Sudan, of which three are critically endangered, ive are endangered, 11 are vulnerable and nine are near threatened [17]. This list needs to be updated a ter separation of Southern Sudan. Most of the mammalian species found in JDBR during this study like *G. gerbillus, Crocidura sp., M. natalensis, A. niloticus, C. aethiops, A. albiventris* and *C. pumil* are least concern and/or for which there

are no identifiable risks. However, *G. dorcas* is vulnerable and *H. hyaena* are near threatened.

The present study encountered? wild mammal species in JDBR. Abdelhamid, et al. reported *P. c. anubis, C. aethiops, G. dorcas, T. strepsiceros, M. capensis, H. bruceei, H. garianus, I. herpestes* and a *Lepus* sp. However, *H. bruceei* and *H. garianus* were not encountered during this study. On the other hand, *Ichneumia herpestes* does not exist as a species and probably it was a miss identification by Abdelhamid. According to Wozencraft the species *Albicauda* is the only member of the genus *Ichneumia*. IFAD encountered from JDBR *T. strepsiceros, M. saltiana, C. caracal, F. silvestris, C. crocuta, G. genetta, P. anubis, P. capensis, E. patas* and *C. aethiops*. The present study confirmed IFAD findings. Hashim and Mahgoub recorded *A. niloticus*, *Crocidura* sp., *I. albicauda, H. ichneumon, G. genetta, L. serval, M. capensis, G. senegalensis, H. cristata, X. erthropus, A. cahirinus, H. cristata* and *O. afer* in Dinder national park. Mahmoud found the following mammals from the six cataract area: *Herpestes ichneumon, G. gerbillus, Crocidura sp., M. musculu, A. niloticus* and *C. pumila*. These were also found in JDBR during this study.

Some wild mammals are difficult t o a ccess. F or e xample, *G. senegalensis* is a small nocturnal primate that can only be detected by a hand torch or a head torch [18]. The banded mongoose Mungo uses various types of shelters including termite mounds.

In the Dinder National Park (DNP) 60% of the mammals seen were *P. c. anubis* Tomor, et al. In DNP the most abundant small mammal was common genet and the least was the fox Hashim, et al. In JDBR the most abundant among wild mammals was R. microphylum, and the least abundant were *M. capensis, Atelerix* sp., *L. micro is, G. micro is, O. afer, C. afra* and *D. braueri. Desmodiliscus braueri* was found in Sahelian steppes on sandy or gravelly soils from Mauritania to Sudan, vicinity of Khartoum Jonathan, et al. *Xerus rutilus* and *L. striatus* were recorded in Southern Tanzania Nkwabi, et al. The least signicant differences showed ($p>0.05$ to $p<0.05$) in number of wild mammals between seasons and elevations, and between seasons and habitat.

Strong conflict was observed by Gataro and Tekalign between *P. c. anubis* and the people in southern Ethiopia [19]. Human settlement inside radom national park led to migration of some wildlife species due to loss of their habitats.

The present study identified the following pattern of conflicts between wildlife and man in JDBR. Seven species of wild carnivores attacked domestic animal in 34 accidents [20]. In 173 cases 12 species of wild herbivores were found feeding on crops. Four species were shot by man in 4 accidents to defend domestic animals. Destruction of burrow by man in 62 cases impacted 12 species ten road accidents entailed three species. Bush meat targeted 16 species in 55 cases.

In JDBR 9 species of wildlife were used as food, in traditional medicine and decoration trade [21]. The total number of species used only a food, or in decoration or in traditional medicine were 20, 15 and 14, respectively. On the other hand, 53 species were found to be of no known use.

Conclusion

This baseline study of wildlife mammal's species in JDBR concluded that: Most of the wildlife species found are least concern and/or for which there are no identifiable risks. *Gazella dorcas* is vulnerable and *P. regius, P. sebae* and *H. hyaena* are near threatened. Among non-flying mammals was *D. braueri* was the most abundant and *M. capensis, Atelerix* sp., *L. micro is, G. micro is, O. afer, C. afra* and *D. braueri* were the least abundant non-flying mammals in JDBR. Awareness among the residents of JDBR of the benefits that can be gained from protection of their wildlife is a priority.

Increase patrolling rates by employing modern techniques such as enough camera traps, camera drones and VHF radios to monitoring wildlife movement and risks.

Ethics Approval, Consent to Participate and Publish, Human and Animal Rights, Availability of Data and Materials

Not applicable.

Conflict of Interest

The authors declare no conflict of interest, financial or otherwise.

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