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Camera trapping in assessing diversity of mammals in Jabal Moussa Biosphere Reserve, Lebanon

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> Abstract

Thirteen species of mammals were documented using camera trapping in Jabal Moussa Biosphere Reserve in Lebanon. The presence of seven carnivores and most interestingly the Rock Hyrax, *Procavia capensis*, was confirmed. Data on annual activity were also included for all species reported.

> Key words

Lebanon, mammals, camera trapping, Insectivora, Carnivora, Hyracoidea, Jabal Moussa.

Introduction

The mammals of Lebanon were studied over the past five decades. The earliest detailed studies on the mammals of Lebanon were carried out by Lewis & Harrison (1962) on the bats, Lewis *et al*. (1967) on the rodents and lagomorphs and Lewis *et al*. (1968) on the carnivores, artiodactyls and Hyracoidea.

Atallah (1977 & 1978) included records from Lebanon, mainly reported by Lewis *et al*. (1967 & 1968). Other publications included further records of the Lebanese mammals such as Von Lehman (1965) and Tohmé & Tohmé (1985). Recent studies addressed the conservation of large carnivores such as the Striped Hyena, *Hyaena hyaena* (Abi-Said & Marrouche-Abi-Said, 2007). All these studies were entirely based on cage traps and other traditional methods.

With current advances in sampling and recording mammalian species, non-conventional or non-invasive techniques have been developed, mainly to reduce disturbance, and have documentation for some trap-shy and rare species. Camera trapping proved to be a useful method for baseline data assessment as well as a measure for species richness. Camera traps have been very successful and widely used in wildlife ecology, inventory, population dynamics, species richness, population density, habitat use, activity pattern, behavioral ecology and even studies on animal damage (Carthew & Slater, 1991, Cutler & Swann, 1999, Varma *et al.*, 2006; Lyra-Jorge *et al*., 2008; Maffei *et al*., 2007; Arispe *et al*., 2008; Tobler *et al*., 2009; Marnewick *et al*., 2008; Trolle & Kery, 2005; Rios-Uzeda *et al.*, 2007; Rowcliffe *et al*., 2008) which are important information for evaluation of conservation efforts (Balme *et al*., 2009; McCarthy *et al*., 2008). Besides, camera trapping is very beneficial in inventorying mammal in various habitat (Kinnaird *et al*., 2003; Silveira *et al*., 2003; Yasuda, 2004; Tobler *et al*. 2008), can be implemented in various climatic conditions and can give crucial informative data on secretive species that else will be difficult to obtain using other field techniques (Rowcliffe *et al*., 2008).

The first study to employ non-invasive methods to study the Lebanese mammals was carried out by Nader *et al*. (2011). They conducted a rapid assessment of mammalian richness in Ehden Nature Reserve using three non-invasive techniques based on the transect-quadrat survey scheme (droppings, foot prints and photo). They recorded 12 medium and large sized species.

The present study is the first attempt to document the mammalian fauna of Jabal Moussa Biosphere Reserve in Lebanon, employing camera trap method.

Materials and Methods

Study site

Jabal Moussa Biosphere Reserve (JMBR) is located in Keserwan-Jbeil area of Lebanon. It covers an area of 6500 with a core area of 1250 ha. JMBR is characterized by its different topography and elevations ranging from 350 m above sea level (asl) in the west to 1700 m asl in the east. JMBR is a typical Mediterranean scrubland characterized by its untouched steep and fertile mountain sides. Vegetation cover is relatively dense mainly by *Juniperus drupacea, Pinus brutia, Quercus calliprinos, Quercus cerris* and *Quercus infectoria.*

Camera Traps

Twelve digital pre-baited active and passive remote camera traps (Bushnell TrailScout Pro 2.1mp), triggered by both heat and motion, were set from March 8, 2008 to May 24, 2009 a total of 443 days (10608 hours). The cameras were tied to a tree 40–60 cm above the ground. The cameras were programmed to shoot photographs for 24hours/day, with a 2-minute interval between photos, and to record date and time on each photograph. Power was supplied by 4 alkaline D batteries which lasted approximately one month. The bait consisted of butchery leftovers, apples, carrots and corn seeds. Sites chosen to install the camera traps were selected randomly to cover the whole reserve and marked using Global Positioning System (GPS). Broken or stolen cameras were replaced. Each site was visited twice weekly at the first two months, to check on the suitability of the selected site and to verify that the cameras are working normally, to check on the bait and add on the bait when needed besides down loading the photos, and later once per week. Photos from the camera traps were downloaded on a laptop in the field on weekly bases. The identification of small mammals like rodents was difficult when based solely on photographs.

Data analysis

Photos taken by the camera traps were sorted and empty frames and such including humans, birds were eliminated to obtain suitable data for analysis. Moreover, data analysis from camera trapping data are often difficult to interpret when a series of photographs portray the same species which leads to issue of self-dependence and inappropriateness for statistical analysis (O'Brein *et al*., 2003; Yasuda, 2004). Hence to minimize this self-dependence is to consider a series of photographs of the same species taken within a certain period of time as single event (Otani, 2001; O'Brien *et al*., 2003). In this study, we treated a picture as indicating a single visit by a given species if that picture was taken >30 minutes after the previous picture of that species (O'Brein *et al*., 2003, Yasuda, 2004, Bowkett *et al*., 2007). Moreover this study aimed to investigate the presence of mammal species and factors affecting their conservation. Hence the data that were obtained from camera traps were used to answer the following questions: 1) species diversity, 2) species richness, and 3) seasonal differences.

Results

The camera traps revealed the richness of Jabal Moussa Biosphere Reserve in mammal diversity which could be correlated to the richness of flora species and the heterogeneity of the landscape. Thirteen species of mammals belonging to five orders and 12 families were discovered, identified and documented. In addition to wild mammals, domestic mammals like goats, dogs and cats were also photographed (Table 1).

The Southern White-breasted Hedgehog, *Erinaceus concolor,* was the only extant species of the order Insectivora that was encountered in Jabal Moussa. It was photographed in 21 incidences, representing 0.51% of all photos by the camera trap (Fig. 1A). It was more common during summer (15 encounters out of 21) and with no activities during winter.

The carnivores were represented by seven species, accounting for more than half of the recorded species. Order Carnivora is represented in Jabal Moussa by four families (Canidae, Felidae, Hyaenidae, and Mustelidae). The Red Fox *Vulpus vulpus,* was the second most common species (Fig. 2B). It was most active during the spring (49.8%), with more or less similar activity pattern during the rest of the seasons (Table 1). On the other hand, wolves were the least photographed (0.68%). A lactating female was photographed for two consecutive years (Fig. 2A), while a couple was photographed in two incidences.

The Stone Martin, *Martes foina,* was the most photographed species (667 frames) accounting for 16.2% of the total photographs (Fig. 2C). It was most active during the summer (34.2%) and spring (29.5%), declined in the fall and recovered during the winter

Table 1. Species captured by camera traps, number of photos, percentage of the total incidences, and percent of photos per season

Scientific name	Location	No. of photos	% of total photos	Number and percentage of photos per season							
				Spring		Summer		Fall		Winter	
				N	%	N	%	N	%	N	%
Order Insectivora											
Erinaceus concolor	Oak forest	21	0.51	2	9.5	15	71.4	4	19.0	0	0.0
Order Carnivora											
Canis lupus	Oak forest	28	0.68	11	39.3	3	10.7	0	0.0	14	50.0
Vulpus vulpus	All over the reserve	647	15.80	322	49.8	99	15.3	120	18.5	106	16.4
Martes foina	All over the reserve	667	16.28	197	29.5	228	34.2	87	13.0	155	23.2
Mustela nivalis	Open rocky area	3	0.07	1	33.3	2	66.7	0	0.0	0	0.0
Meles meles	Oak forest	2	0.05	1	50.0	1	50.0	0	0.0	0	0.0
Hyaena hyaena	All over the reserve	220	5.37	119	54.1	26	11.8	41	18.6	34	15.5
Felis silvestris	Oak forest	21	0.51	8	38.1	7	33.3	3	14.3	3	14.3
Order Hyracoidea											
Procavia capenis	Open rocky area	22	0.54	3	13.6	18	81.8	1	4.5	0	0.0
Order Artiodactyla		199	4.86	51	25.6	120	60.3	27	13.6	1	0.5
Sus scrofa	All over the reserve	199	4.86	51	25.6	120	60.3	27	13.6	1	0.5
Order Rodentia		105	2.56	26	24.8	45	42.9	33	31.4	1	1.0
Sciurus anomalus	All over the reserve	105	2.56	26	24.8	45	42.9	33	31.4	1	1.0
Hystrix indica	All over the reserve	1619	39.53	468	28.9	394	24.3	478	29.5	279	17.2
Apodemus mystacinus	All over the reserve	542	13.23	273	50.4	154	28.4	73	13.5	42	7.7
Total		4096	100	1482		1112		867		635	

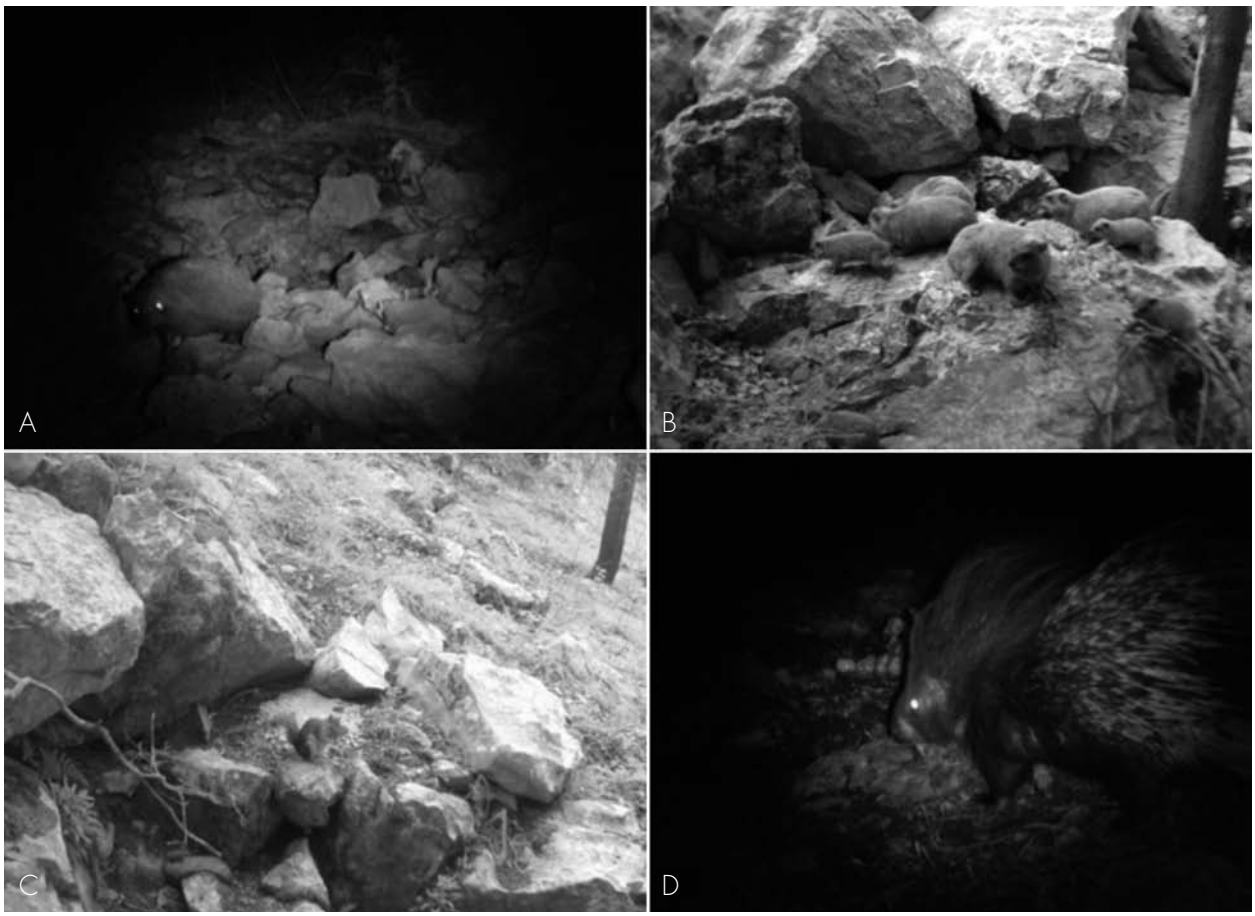

Fig. 1. A. The Southern White-breasted Hedgehog, *Erinaceus concolor.* **B.** A colony of the Rock Hyrax, *Procavia capenis* in JMBR. **C.** The Persian Squirrel, *Sciurus anomalus.* **D.** The Indian Porcupine, *Hystrix indica.*

Fig. 2. A. The Wolf, *Canis lupus.* B. The Red Fox, *Vulpus vulpus.* C. The Stone Martin, *Martes foina.* D. Least Weasel, *Mustela nivalis.* E. The European Badger, *Meles meles.* F. A couple of striped hyenas caught by the camera before sunset in JMBR. Least weasel is very difficult to spot in print. [This is the best photo that the weasel could be clearly seen since it was only photo trapped 3 times.]

(Table 1). The Least Weasel, *Mustela nivalis* and the European Badger, *Meles meles,* were least photographed, 0.07% and 0.05% of all photos respectively (Fig. 2D and 2E). Both species showed activity during spring and summer, with virtually no signs in fall and winter.

The Striped Hyena, *Hyaena hyaena,* was the third common carnivore during this study. It was recorded in 220 incidences representing (5.4%), also it was photographed before sunset (10%). In one incidence, a couple was photographed (Fig. 2F). The Striped Hyena was most active during spring, with declining activity thereafter. The Wild Cat, *Felis silvestris tristrami*, was among the least common carnivores. It was photo-trapped 21 times (Table 1).

Surprisingly, a viable population of the Rock Hyrax, *Procavia capenis,* inhabits the reserve. A total of 22 photos were recorded by the camera traps that were

installed at the steep rocky mountain in the reserve (Table 1). Moreover, in 41% of the incidences small colonies ranging between 3–9 individuals were photographed (Fig. 1B). In one occasion, four adults and four juvenile were photographed in the first week of July.

Even though 199 photos representing 4.8% of all photos were taken of the Wild Boar, *Sus scrofa*, these photos were taken of males and probably even the same two males, with none of the photos showing any female.

Order Rodentia was represented by three families: Sciuridae, Hystricidae and Muridae and three species (Table 1). One hundred and five photos were taken of the Persian Squirrel, *Sciurus anomalus,* 33% with more than one individual in the same photo. The Persian Squirrel was active all year round except in winter, with peak activity during summer (Table 1). The Indian Porcupine, *Hystrix indica,* was the most photographed rodent. A total of 1619 photos were taken representing 39.3% of the total frames. Porcupines were photographed in the camera traps all year round with varying incidences. More than one individual (28% two individuals and 1.6% with three or more individuals) in the same photo were recorded. Moreover, the Broad-toothed Field Mouse, *Apodemus mystacinus,* was photographed in 542 incidences (15.7%) of all photos, and in 5.3% of the incidences between 2–3 individual were observed in the same photo.

Discussion

The present study reveals the mammalian diversity in this poorly known protected area in Lebanon. Five species of carnivores has been reported in the present study. In addition, the presence of the Hyrax adds more to the geographical range of this noteworthy species.

In a hard and difficult terrain like Jabal Moussa Biosphere Reserve the camera traps proved their effectiveness in detecting, documenting and surveying mammals. This study added to the effectiveness of camera trapping in different landscape as it was documented in several surveys on mammals (Rovero & Marshall, 2009; Trolle & Kerry, 2005; Jiménez *et al*., 2010; Treves *et al*., 2010). For instance, the hedgehogs *Erinaceus concolor* were photographed 21 times in the reserve at an elevation above 1500m asl could be missed in transects surveys.

The Red Fox, *Vulpes vulpes*, and the Stone Marten, *Martes foina,* are very common in Lebanon (Harrison & Bates 1991; Lewis *et al*., 1968; Tohmé & Tohmé, 1985). The camera traps results confirmed their abundance. Their widespread status and relatively high populations could be attributed to the absence of large carnivores to compete with. Elmhagen *et al*. (2010) and Johnson (2010) stated that the re-colonization by Lynx (*Lynx lynx*) and subsequent increase in its population has suppressed the Red Fox population. But the spread of garbage dumps provide food all year round that affected the Red Fox population positively as has been shown for Poland (Goldyn *et al*., 2003) and Palestine (Bino *et al*., 2010).

Mustela nivalis is a secretive animal with few records in Lebanon. This weasel is heavily persecuted by farmers and became at the verge of local extinction. It is hardly possible to detect this species with other means than camera traps. The low number of photos of this weasel reflects it rarity. This species was known from a specimen collected from Kammouha at an altitude of 1385 m (Lewis *et al*., 1961) and another from Sanine Mountain photographed by Dr. R. Sadek from the American University of Beirut in the 1996. Hence, this is an additional new record for the species distribution in Lebanon.

During the rapid survey in 2007, local informants in Jabal Moussa region claimed that Striped Hyena appeared in high numbers. Camera traps confirmed the locals' claim. The Striped Hyena is very abundant in JMBR and was photographed on a monthly bases by all camera traps. However, this species is fairly abundant in Lebanon (Abi-Said & Marrouche-Abi-Said, 2007, Tohmé & Tohmé, 1985). In addition camera traps provided additional information on the ecological behavior of Striped Hyena. It was reported that members of feeding groups are larger than one member in the same group, most likely a mother with her offspring roam together (MacDonald, 1978; Rieger, 1979; Bouskila, 1984). A photo by the camera traps showed a couple of Striped Hyaena *Hyaena hyaena,* male and a female that were distinguished by head size roaming together in the reserve.

Rovero & Marshall (2009) concluded that the use of camera traps is promising as an index for species abundance; since as density increase the chances of more encounters of photos between individuals and cameras would be expected to increase. In this study, the importance of camera trapping in revealing the richness, abundance and distribution of mammals in JMBR is well documented. Several photos from different locations showed more than two porcupines, squirrels, or rock hyraxes in one frame each. Similar observations were recorded by camera traps on the extended range of Jackson's Mongoose (*Bdeogale jacksoni*) in Tanzania (De Luca & Rovero, 2006).

Foxes, stone martins and striped hyaenas were active before darkness. It was reported by Lucherini *et al*. (1995) that foxes were strongly nocturnal in high human activity areas. In addition, finding on striped hyaenas in Lebanon revealed that they were not ac-

tive before darkness in rural and urban sites due to human disturbance (Abi-Said, 2006). Furthermore, the presence of a pregnant female wolf and later with her cubs in JMBR during day time reflects the undisturbed status, and the peaceful environment in the reserve. A large scale disturbance gradient in southern Africa had affected the number and distribution of large and medium herbivore (Wallgren *et al*., 2009). Moreover, Bennette (2009) reported that in less disturbed areas by humans, the Yellow-headed Black Bird (*Xanthocephalus xanthocephalus*) and the Barbastelle Bat (*Barbastella barbastellus*) had better successful breeding areas. In contrast to the prevailing situation of the abundance of wild boar in Lebanon, from the photos taken for wild boars which were probably from a male revealed that the reserve is not overpopulated with wild boars most likely due to the presence of their predator. This reflects the healthy status of the mammals in the reserve. Hence, camera trapping could be a useful tool in assessing habitat disturbance and the status of its biodiversity.

The presence of domestic dogs and cats could have a negative effect due to hybridization with domestic species (O'Brien *et al*., 2009; Randi, 2008; Young *et al*., 2011) or affecting wildlife populations and has to be managed in particular from the conservation point of view. The effect of domestic dogs on wildlife communities was described by Lenth *et al*. (2008) who gave some management recommendation for natural areas. In addition, Galetti & Sazima (2006) showed the great impact of feral dogs on wildlife in the Atlantic forest. Moreover, feral cats have a strong impact on predation of birds and were the main cause of bird decline in several areas worldwide (Read & Bowen, 2001; Nogales *et al*., 2004). Furthermore, feral cats and dogs carry infectious diseases such as rabies and toxoplasmosis (Deem *et al*., 2001; Schoegel *et al*., 2005)

The biodiversity of JMBR faces several threats due to logging, quarries, forest fires, hunting and animal poisoning. Shepherds practice poisoning to kill predators that attack their domestic animals. An accident happened during the survey where poisonous baits were spread in different parts of the reserve that might have affected some carnivores. Disturbance by visitors, camping, camp fires, music, singing etc., can also affect the wild animals in JMBR. This was evident during the Cross Holiday. Cameras were put around the camping areas beside the Cross two days before the holiday and left for three weeks after. No animals were photographed in these places even though a lot were photographed before the holiday.

Disturbance in the reserve is still minimal as this occasion happens only once a year, besides the difficult landscape and topography of the reserve make accessibility very difficult.

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