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A pilot study to survey the carnivore community in the hyper-arid environment of South Sinai mountains

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ABSTRACT

Carnivores are one of the taxa most affected by habitat fragmentation and human persecution; as a result, most carnivore species are declining; for this reason monitoring changes in carnivore population is paramount to plan effective conservation programs. Despite being one of the most threatened habitat, arid environment are often neglected and the carnivore species living in this environment are generally poorly studied.

We conducted a pilot study to survey the carnivore guild in the St Katherine Protectorate, the largest Egyptian national park and a hotspot for biodiversity and conservation in an arid environments. Three species were detected using both camera trapping and morphological identification of scats: Red fox, Striped hyena and Arabian wolf, while through genetic analysis we were able to confirm the presence of Blandford fox as well. Arabian wolf appeared to be the most elusive and rarer species and should be a conservation priority.

We also provide guidelines for a monitoring program: we estimated that a survey period of 8–10 weeks would be enough to detect foxes and hyenas with a 95% probability, but it would take at least 26 weeks to detect the presence of wolves. This is the first comprehensive carnivore survey in South Sinai and provides an important baseline for future studies in this unique hyper-arid environment at the conjunction between the African and Eurasian continents.

1. Introduction

Many carnivore species have recently experienced a drastic declines, due principally to anthropogenic pressure and habitat fragmentation, so that long-term monitoring is essential to support effective conservation plans. Large carnivores tend to be particularly vulnerable given their generally low population density, slow population growth rate and large area requirements (Dalerum et al., 2009); for the same reasons, they are also difficult to study (Minta et al., 1999; Gese, 2001). A deep understanding of the ecology and distribution of carnivores and the way they interact with other species is essential to plan effective conservation programmes (Naves et al., 2003). However, the costs of large-scale monitoring programmes can be prohibitively high. Pilot surveys can provide information that can be used to plan more effective long-term monitoring and conservation studies (Long and Zielinski, 2008), in order to optimise effort and reduce costs.

Unfortunately, many pilot studies do not include detectability, and this means that they can only report observed occupancy (O'Connell et al., 2006), which is likely to vary across site, time and detection methods (Bailey et al., 2004; O'Connell et al., 2006). Including occupancy and detectability is an effective way to provide an estimation of the proportion of area occupied by (Pollock et al., 2002; Bailey et al., 2004) and therefore the abundance of the species. Presence-absence data utilised for the estimation of these parameters are relatively easy to obtain, allowing this kind of

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analysis within most studies; incorporating detection probability in pilot studies can help obtaining more accurate estimates of site occupancy, and provides the foundation stone for effective survey and monitoring programmes (O'Connell et al., 2006).

The St Katherine Protectorate is located in South Sinai, Egypt, and covers an area of about 4350 km^2. It was created in 1996 in order to protect the environment and the high biodiversity of the area (Grainger and Gilbert, 2008). The importance of the Protectorate derives mainly from its peculiar geographical position and the region's unusual microclimate, due to its prominent mountain formation (Guenther et al., 2010). This reflects in the structure of the carnivore community of this area: species from both African and Eurasian continents coexist. For a desert environment, an exceptionally high number of carnivore species have historically been recorded (Osborn and Helmy, 1980). Three species of foxes are present in the protectorate: Blanford's fox (*Vulpes cana*) and Rüppell's sand fox (*Vulpes rueppellii*), are native to South Sinai (Osborn and Helmy, 1980), while the Red fox (*Vulpes vulpes*) is not a native species (Osborn and Helmy, 1980) and colonised Sinai following the Israeli invasion in 1967 (cf. Ginsberg, 2001). The Arabian leopard (*Panthera pardus nimr*), has been hunted to extinction and has not been recorded in Sinai since the 1960s (Al-Johany, 2007). Arabian wolf (*Canis lupus arabs,* Gaubert et al., 2012), Golden jackal (*Canis aureus*) and Striped hyena (*Hyaena hyaena,* Osborn and Helmy, 1980) are considered to be still present in the Protectorate. Caracal (*Caracal caracal*) has been considered locally extinct for many years but recently, signs of the presence of a medium-sized feline compatible with a Caracal have been recorded (A. Soultan, pers.comm.). Finally, wild cats (*Felis silvestris lybica*) live in the southern part of the Protectorate (El Alqamy et al., 2002).

We undertook a preliminary survey of the carnivore community of the St Katherine Protectorate, as such our work can be considered as a first step in the direction of a continuous programme of carnivore monitoring within the Protectorate. We also provide detectability estimates in order to maximise the amount of data about carnivores in the study area. We hope this may result in a carefully planned long-term monitoring project and to optimise carnivore conservation programs in this area.

2. Methods

Given the lack of previous data on the carnivore community of the protectorate, we used two commonly used non-invasive techniques, camera trapping and scat collection, to carry out a pilot study surveying the carnivore community of the St Katherine protectorate. Integrating multiple methods is useful as it increases the probability of detection and reduces bias of derived population estimates (Campbell et al., 2008). In this case it seemed to be particularly advantageous since this was a pilot study conducted to assess the presence of multiple species (Gompper et al., 2006; Long, 2006). Fieldwork was conducted within the boundaries of the St Katherine Protectorate, within a radius of 20 km from the town of St. Katherine (28°34′30.6″N, 33°59′45.9″E). The survey period was over three months, between May and July 2012.

Scent and food lures were used at every site and sampling occasion to maximise the probability of detecting target species. Although we recognise that this has probably positively biased our estimates of detectability and occupancy (Garrote et al., 2012), we judged it necessary to use attractants to achieve our objectives (Garrote et al., 2012), given our limited survey period, the large area to be sampled and the lack of available biological data for the study area.

2.1. Study area

We selected two desert regions: the Blue Desert (five sampling sites) and Sheikh Awad (six sampling sites), each covering about 100 km^2, and an urban region surrounding St. Katherine (four sampling sites) with an area of about 25 km^2 to assess the presence of carnivores in urban areas (Fig. 1). The survey area of the two desert regions was chosen to be larger (Long and Zielinski, 2008) than the likely home range of the two largest species expected to be found in Sinai, the Arabian wolf and the Striped hyena, which have territory sizes up to 60–70 km^2 (Hefner and Geffen, 1999; Wagner et al., 2008).

2.2. Camera-trapping survey

We used a total of 14 cameras for our survey. Eleven were equipped with infra-red flash (nine Bushnell Trophy Cam Trail Cameras, Bushnell, USA; two Reconix HC600 Hyperfire cameras, Reconix, USA) providing lower-quality pictures but with minimal impact on wildlife (Schipper, 2007). These were used in the desert regions where we expected animals to be less tolerant of anthropogenic disturbance. Three devices (Cuddeback Attack cameras, Cuddeback, USA) had a white flash which produced high-quality pictures at night, although the potential for disturbance was high. This kind of devices can cause avoidance behaviours in wild animals (Schipper, 2007), for this reason these cameras were only used in urban sites, where animals are more habituated to disturbance.

Overheating is a common issue in the desert and can cause malfunction in the cameras, for this reason we made sure the cameras were always properly shaded, sometimes building a shelter around the camera with rocks and other material found on site. Heat can also shorten battery life; to prevent this, we used external 12-V batteries and cables that we placed under rocks to make them inaccessible to wild animals.

2.3. Scat survey

We selected five transects according to each region's habitat features, trying to represent different environments evenly. According to this principle we selected two transects in the urban and Sheikh Awad region respectively, while only one was selected for the Blue Desert, given the more uniform nature of this region. The two transects in the urban region were walked once per week, while the three transects in the desert regions were walked every two weeks. In addition we also collected scats opportunistically (e.g. at camera trap sites) in order to maximise the amount of samples collected.

We performed a species identification in the field of every scat found, based on its size and morphology. As morphological identification is frequently not accurate (Davison et al., 2002; Prugh et al., 2005), we also performed a genetic species identification on a subset of the better-preserved of scats to determine their origin to species level.

DNA material was extracted using the QIAmp™ stool kit (Qiagen, Germany), following the manufacturer's protocols. In order to monitor any contamination, each group of 12 extractions included a negative control (Waits and Paetkau, 2005). Two different primer pairs were used for PCR, both specific for the 3′ ending flanking domain of the regulatory D-loop region: LRCB 1/MARDH (Davison et al., 2002) and KFSpid F/KFSpid R (Bozarth et al., 2010). The PCR mastermix contained 1 μl of each primer solution (10 mM), 1.6 μl of dNTPs solution (200 μM), 2 μl reaction buffer, 1.2 μl $MgCl_2$ solution (25 mM), and 0.5 units of *Amplitaq Gold* (Perkin Elmer, USA) in a 20 μl reaction volume with 1 μl of DNA extract. The reaction profile was the same for both primers: 95 °C for 10 min, followed by 35 cycles of 95 °C for 30 s, 50 °C (annealing temperature) for 30 s and 72 °C for 1min; and a final extension at 72 °C for 5 min. Following electrophoresis on a 1.5% agarose gel, clean PCR products (54