



Original investigation

Spatial and temporal variability in the distribution, daily activity and diet of fennec fox (*Vulpes zerda*), red fox (*Vulpes vulpes*) and African golden wolf (*Canis anthus*) in southern Tunisia



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ARTICLE INFO

Article history:

Received 24 April 2018

Accepted 12 February 2019

Available online 13 February 2019

Handled by Rena Rebecca Ray

Keywords:

Sympatric carnivores

Niche separation

Trophic niche overlap

Coexistence

Southern Tunisia

ABSTRACT

In this study, we investigated the habitat, the daily activity and the trophic niche overlap of three carnivores found in southern Tunisia, namely the fennec fox (*Vulpes zerda*), the red fox (*Vulpes vulpes*) and the African golden wolf (*Canis anthus*) over seasons. To achieve this goal, we surveyed 300-meter transects in Sidi Toui National Park (N=29) and in Oued Dekouk Natural Reserve (N=24) over a year. Using information provided by camera trap photos and scats analysis; we determined daily activities and diets of the three canids. African golden wolves and red foxes shared most of their habitat in the two areas, especially in Sidi Toui National Park, while fennec foxes were restricted to the sandy area in Oued Dekouk Natural Reserve. Based on 729 photos produced by camera trap, we observed that the African golden wolf had a continuous activity through the day and the year, while the red fox and the fennec fox were active also through the year but mainly during twilight. We were able to identify food items from 504 scats, which included fruits, invertebrates, rodents, lagomorphs, birds, reptiles and livestock. Our results showed a significant variation in the diets between the species, seasons and sites. Rodents and livestock represented, respectively, 11.7% and 19.2% of the biomass consumed by the African golden wolf over the year. Both foxes ate invertebrates and rodents with different frequency during the seasons. The trophic niche overlap was very high between the two foxes ($O_{jk} > 0.95$) and partial between each fox species and the wolves ($O_{jk} < 0.65$). The knowledge of the habitat and the trophic niche overlap of these three carnivores increases our understanding of factors responsible for their coexistence, which may help to improve management and conservation actions.

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Introduction

Identifying factors affecting species distributions and uncovering mechanisms responsible for animal population dynamics and coexistence of competing species have a great importance in conservation and management (Barrull et al., 2014; Johnson et al., 2001). The primary factor determining species organisation, coexistence or exclusion is often the availability of resources used (Schoener, 2009; Brashares et al., 2010). Previous studies suggested that aggregation of weak competitors promote coexistence

(Monzeglio and Stoll, 2005; Hart and Marshall, 2009). Following Guthrie and Moorhead (2002), coexistence is possible for species shifting to different diets, selecting different habitats or carrying out different patterns of activity, while cohabitation of species at the same trophic level is favoured when they follow different selective behaviour (Pimm and Rosenzweig, 1981). One way to understand community organisations is to measure overlap in resources used among the different species (Krebs, 1989). The most common resources measured to evaluate species overlap are food and habitat (Chesson, 2000).

Large and medium-sized mammalian carnivores influence ecosystem structure through predation and intra-guild competition (MacDonald et al., 2004; Ripple et al., 2014). Moreover, it is clear that interaction between carnivores occupying similar ecolog-

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