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Abundance and Diet of Alexander's Kestrel (*Falco tinnunculus alexandri*) on Boavista Island (Archipelago of Cape Verde)

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Alexander's Kestrel (*Falco tinnunculus alexandri*) is an endemic resident subspecies of the Common Kestrel residing on Cape Verde archipelago, characterized by heavily marked upper parts and a barred tail in all plumages (Hazevoet 1995), which occurs only on the eastern and southern islands (Sal, Boavista, Maio, Santiago, Fogo, and Brava). The geographical distribution of the subspecies in the archipelago is explained by the effect of the last glaciation, which split the kestrel population into two distinct island groups, with Alexander's Kestrel to the south and Neglectus Kestrel (*Falco tinnunculus neglectus*) to the north (Hazevoet 1995). This circumstance caused morphological and ecological differences between the two subspecies of raptors (Hille and Winkler 2000), which are endemic birds scarcely known at present.

Alexander's Kestrel is common on the islands, occupying all habitats from sea level up to the highest mountains, but information on its biology is lacking. Only its taxonomy, distribution, and breeding dates have been reported (Bourne 1955, De Naurois and Bonnaffoux 1969, Stresemann and Amadon 1979, De Naurois 1987, Hazevoet 1995), but no data are available on its abundance or food habits in the archipelago.

Islands offer divergent environments with geographically separated animal populations that are subject to several evolutionary forces such as genetic bottle-necks, drift, gene flow, and selection driven by local conditions. In this way, the conservation needs of island fauna, and especially of raptors, are generally more urgent than those of continental species, except where limited distributions on continents mimic island-like isolation (Virani 1995, Virani and Watson 1998). Therefore, knowledge of an endemic and restricted species such as Alexander's Kestrel is key to their conservation.

In this paper, I present the first data on the relative abundance and diet composition of Alexander's Kestrel on an island (Boavista), which represents 23.5% of the distribution area of the subspecies in the world.

Study Area and Methods

The Cape Verde Islands are situated in the eastern Atlantic, between 14°48′–17°22′N and 22°44′–25°22′W, 460–830 km west of Senegal (Fig. 1). The archipelago is comprised of 10 islands and several islets. Boavista Island extends 620 km^2, with ca. 116 km of perimeter, being the third largest island of the archipelago in surface area. Its topography is generally flat; the highest elevation (Monte Estância) is 387 m. The climate is very dry (mean annual rainfall = 91 mm; Kasper 1987) and the presence of goats causes continued desertification of the land. Therefore, the landscape of the island consists mainly of large areas covered with sand, forming mobile dunes and barren-stony plains, but in the interior there are oases with palms (Sena-Martins et al. 1986). Because the moderating influence of the surrounding ocean temperatures are relatively constant, the amplitude of mean temperatures in different months seldom exceed 6°C.

To estimate the abundance of Alexander's Kestrels on Boavista Island, a driver and an observer performed seven line transects (one transect/d) in a vehicle during July 1999, on days of good visibility, travelling at ca. 40 km/hr, counting (with 10×40 binoculars) all individuals perched or flying closer than 300 m on either side of the road. Transect lengths varied, ranging from 9–55 km (total length = 226 km) according to the availability of adequate roads. All censuses were performed on unpaved roads, far from the few existing power lines (potential hunting perches) of the island, these being located in villages; therefore, the data are not biased by this circumstance. Counting raptors from a vehicle along roads in a flat landscape with scarce vegetation (the case for Boavista Island) is a widely used method (Johnson 1978, Fuller and Mosher 1981, Byby et al. 2000), particularly for kestrels (Tella and Forero 2000). It provides an abundance index that is sensitive to the behaviour of the species involved, the habitat surveyed, speed of the vehicle, meteorological conditions, hour, season, and number and experience of observers. In the presence of the observer, the animal response varies according to different factors (Eberhardt 1978, Burnham et al. 1980). Therefore, in the censuses I considered the detection distance and angle of individuals. Boavista Island has a homogeneous landscape (desert with some oases), and the length of the line transects were distributed proportionally over the surface of these habitats. I estimated the density of Alexander's Kestrel on the island with the program DISTANCE 4.1 (Thomas et al. 1998) and empirically calculated the variance.

Also, I studied the food habits of this raptor in July, analyzing 44 pellets collected under eight different roosting sites. Due to the scarce number of bird species on the island (see Discussion), avian prey were identified from feather remains when possible, reptiles from skulls and mandibles collected from the study area, mammals from hair remains (Teering 1991), and insects from head capsules and mandibles. The biomass contribution of each species in the total biomass was estimated following

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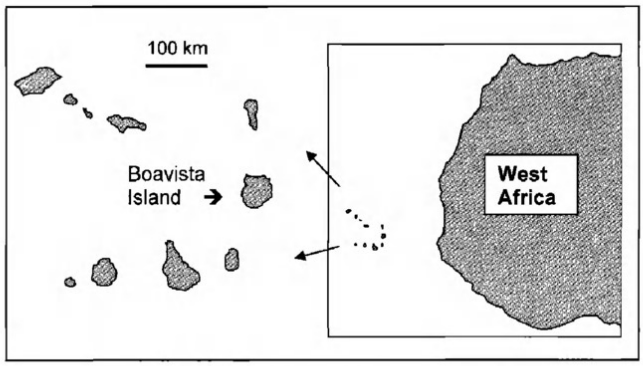

Figure 1. Map of Cape Verde Islands, and their position relative to West Africa.

Marti (1987), assigning the biomass of birds from Cramp (1998), and using mass data from individuals of the study area for other prey.

RESULTS AND DISCUSSION

Analysis of the data collected with program DISTANCE showed a mean density of 0.125 Alexander's Kestrels/km^2 (95% C.I. = 0.045–0.348 kestrels/km^2), implying an estimated population of 77 individuals (95% C.I. = 28–216 kestrels) of Alexander's Kestrel for Boavista Island. However, I only detected seven kestrels (one male and six females), thus the estimated density must be considered as a very course estimate. Burnham et al. (1980) suggested that at least 40 detections were required to determine adequate density estimates using line transects techniques.

Most young Alexander's Kestrels leave their nests in April (Hazevoet 1995), 3 mo before the censuses were performed (July). Therefore, the young were likely uniformly distributed throughout the island. Thus, the total breeding population might be lower than the numbers estimated during my surveys. Nevertheless, the limited sample size of this study requires caution in the interpretation of results.

Although Boavista Island is topographically flat and practically deforested (Diniz and Matos 1988), the kestrels were invariably located in areas with trees, buildings or small cliffs, and were never found in areas without perch and roost habitat. The availability of elevated perches could favour prey detection, especially small ground-dwelling lizards.

In fact, based on the pellet analysis an endemic skink, *Mabuya spinalis salensis,* accounted for the 84.7% of the biomass consumed by Alexander's Kestrel. This small lizard has a mean mass of 11.8 g (J.A. Mateo pers. comm), close to the mean biomass (10.6 g) of 72 total prey items found in the pellets (Table 1). These results agree with other studies that have reported 12.01 g as a mean biomass of prey caught by Common Kestrels (Piatella et al. 1999). Boavista Island has a homogeneous semiarid climate throughout the year (Kasper 1987) and the lizards are active all year. Thus, this prey item may be important in other seasons, as well as in July when I collected pellets.

Several factors can explain the stenophagy of Alexander's Kestrel on the Mabuya Skink on Boavista Island. (1) Only between 17–23 species of birds breed on the island (Hazevoet 1995), nine of which are smaller than Alexander's Kestrel, thus being potential prey. (2) Among reptiles, only two species of marine turtles and four lizards are present on the island (López-Jurado et al. 1999), but three of the lizards are nocturnal (*Tarentola* and *Hemidactylus*) and only the skink is diurnal, and may be the primary prey of the kestrel. (3) As expected for an oceanic island, no indigenous terrestrial mammals inhabit the Cape Verde Archipelago, and only the exotic *Mus musculus* and *Rattus* spp. are present (Hazevoet 1995),

Table 1. Dietary composition of the Alexander's Kestrel on Boavista Island (Cape Verde).

PREY	FREQUENCY *N* (%)	BIOMASS g (%)
Aves		
Bar-tailed Desert Lark (*Ammomanes cincturus*)	2 (2.8)	34.8 (4.5)
Unidentified passerines	3 (4.2)	45 (5.9)
Reptilia		
Skink (*Mabuya spinalis salensis*)	55 (76.4)	649 (84.7)
Mammalia		
House mouse (*Mus musculus*)	1 (1.5)	21 (2.7)
Insecta		
Grasshopper (*Heteracris* sp.)	10 (13.9)	15 (2)
Unidentified Coleoptera	1 (1.5)	1 (0.1)
Total prey	72	

but quite scarce in a sparsely human populated area such as Boavista. (4) Finally, the sparse vegetation of the island does not support great numbers of invertebrates, which therefore barely appear in the diet of the kestrel. Consequently, the only prey species on Boavista Island that is largely abundant, a ground dweller, appropriate in size, and exhibits diurnal activity is the skink. The pellet data clearly supports that the skink is the most common prey of the Alexander's Kestrel in July (Table 1). Nevertheless, the more easily digested prey, such as invertebrates, are often underrepresented in pellets (Mersmann et al. 1992, Whalen et al. 2000) and therefore may be underrepresented in my results as well.

Many ecomorphological studies have shown the close relationship between habitat and behaviour of birds (Leisler et al. 1989, Gamauf et al. 1998, Hille and Winkler 2000), and as ground-level vegetation can affect the ability to detect prey, this factor may influence the success of particular foraging behaviours (Bechard 1982, Janes 1985). Therefore, the broad deforestation of Boavista Island and the absence of alternative prey could account for the high kestrel use of this swift, but abundant, skink. Despite the limited sample size of this study, no other studies on food habits of Alexander's Kestrels in Cape Verde archipelago are available. Except for the results of this study, lizards have been reported as scarce prey in the diet of the Common Kestrel throughout the western Palearctic (Cramp 1998).

These results contradict the prediction of Hille and Winkler (2000), who found that the larger bill and longer wing of Alexander's Kestrel may indicate frequent aerial hunting of larger prey items than those sought by the Neglectus Kestrel. Nevertheless, aerial hunting is more energetically expensive and is employed in areas where climatic and topographic conditions are conducive to such foraging, or when prey availability is high enough to yield a positive energy budget (Barnard 1986, van Zyl 1993). In support of this hypothesis, a comparison of the diet of kestrels between South Africa and Europe showed that the African population consumed mostly invertebrates and lizards and only few mammals and birds, rather than the opposite as observed in Europe (van Zyl 1994).

The Cape Verde Islands are oceanic islands with a recent volcanic origin, and consequently have flora and fauna derived from elsewhere. Oceanic islands are often isolated laboratories on which their populations gave rise to a marked radiation of different species. Contrary to other islands widely studied, such as the Galapagos archipelago, the avifauna of Cape Verde is poorly known. The lack of study is especially troubling, because the occurrence of Palearctic taxa in the Cape Verde is of considerable interest. These are the southernmost and most isolated breeding populations of some Palearctic species, being some 2000 km from their nearest congeners in North Africa and Southern Europe (Hazevoet 1995). For almost 40 yr, scientists and naturalists have called for measures to preserve the rapidly declining populations of seabirds and endemic land birds of Cape Verde Islands (e.g., De Naurois 1964, Nørrevang and Hartog 1984, Hartog 1990, Donald et al. 2003). The stenophagy of the Alexander's Kestrel, the scarcity of elevated perches and roosts, and the progressive deforestation of Boavista Island, could affect the current status of this subspecies on Boavista Island.

ABUNDANCIA Y DIETA DE *FALCO TINNUNCULUS ALEXANDRI* EN ISLA BOAVISTA (ARCHIPIÉLAGO DE CABO VERDE)

RESUMEN.—El cernícalo *Falco tinnunculus alexandri* es una subespecie de cernícalo común, endémica del Archipiélago de Cabo Verde y escasamente conocida. En este artículo se presentan los primeros datos sobre abundancia y alimentación de la rapaz en el archipiélago, concretamente de la población de la Isla de Boavista. Para su estudio se han recorrido un total de 226 km de transectos lineales, cifrándose la población de la especie en Boavista en 0.125 individuos/km^2 (95% I.C. = 0.045–0.348 individuos/km^2), unos 77 individuos, si bien hay que tomar la cifra con precaución ante lo reducido de la muestra obtenida. En la dieta de la rapaz únicamente se encontraron seis tipos de presas distintas, debido probablemente a la deforestación general de la isla y escasa disponibilidad de recursos tróficos. Su dieta se basó fundamentalmente en el consumo de *Mabuya spinalis salensis*, un escíncido endémico de la isla que representó hasta el 84.7% de la biomasa consumida por el cernícalo. La acusada estenofagia de esta especie y la creciente escasez de perchas en la isla, podrían ser una amenaza para el futuro de la población del cernícalo *F. tinnunculus alexandri* en esta isla.

[Traducción de los autores]

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