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Original Article

Diet composition of the Pharaoh eagle owl, *Bubo ascalaphus*, across agricultural and natural areas in Saudi Arabia

Composição da dieta da coruja bufo-real, *Bubo ascalaphus*, em áreas agrícolas e naturais em Arábia Saudita

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Abstract

The diet of the Pharaoh eagle owl, *Bubo ascalaphus,* inhabiting agricultural and natural areas in Saudi Arabia, was studied. Pellet analysis for *B. ascalaphus* in the agricultural area contained a high percentage (61.3%) of the house mouse, *Mus musculus,* while pellets collected from natural habitats were void of *M. musculus,* however, with a high proportion of wild rodents (*Meriones crassus* (28.6%) and *Jaculus loftusi* (41.6%). This suggests the importance of this owl as a biological control agent in agricultural areas.

Keywords: owls, biological control, feeding behaviour, Saudi Arabia.

Resumo

Foi estudada a dieta da coruja bufo-real, Bubo *ascalaphus*, que habita áreas agrícolas e naturais em Arábia Saudita. A análise de *pellets* para a B. *ascalaphus* na área agrícola continha uma alta porcentagem (61,3%) de camundongos domésticos Mus *musculus*, enquanto os *pellets* coletados em habitats naturais não continham M. *musculus,* apresentando, no entanto, uma alta proporção de roedores selvagens (28,6% de *Meriones crassus* e 41,6% de *Jaculus loftusi*), o que sugere a importância desta coruja como agente de controle biológico em áreas agrícolas.

Palavras-chave: corujas, controle biológico, comportamento alimentar, Arábia Saudita.

1. Introduction

Feeding behaviour and diet composition of owls in agricultural and natural areas were investigated in several parts of the world. Saufi et al. (2020) compared the diet of the Barn Owl, *Tyto alba javanica,* in urban and agricultural areas in Malaysia. They showed that *Rattus norvegicus* and *Rattus argentiventer* were the most consumed prey items in urban and agricultural areas respectively. Diet of the Barn Owl in agricultural landscapes in Greece included *Mus domesticus* (26.3%) and *Rattus* spp. (11%), whereas rats constituted the highest biomass (Bontzorlos et al., 2005).

In central South Africa, Stenkewitz et al. (2010) showed that small mammals constituted most of the biomass in the diet of *Tyto alba* in both natural and agricultural areas. Analysis of pellets of western Burrowing Owls (*Athene cunicularia hypugaea*) in Idaho, USA, inhabiting agricultural areas showed greater species richness, while pellets from non-agricultural areas showed greater species evenness and broader food-niche breadths (Moulton et al., 2005). The Ural owl, *Strix uralensis,* reduced populations of voles in orchards by 63% compared to other natural habitats (Murano et al., 2019).

In the Middle East, the role of owls in controlling pest rodents in agricultural areas was studied in Syria. Both *Mus musculus* and *Rattus rattus* were found among the main prey items of *Tyto alba* (Shehab et al., 2004). Very little is known about the role of the Pharaoh eagle owl, *Bubo ascalaphus,* in controlling rodent pests in Saudi Arabia. Abi Said et al. (2020) showed that this owl diet consisted of 11.82% of *R. rattus* and 1.48% *M. musculus* in an urban area around Riyadh. In Qatar, Mohedano et al. (2014) showed that the diet of *B. ascalaphus* was mainly comprised (89.7% and 97.7% in frequency and biomass of wild rodents *Jaculus jaculus* and *Meriones crassus* respectively)

Other studies on the diet composition of *B. ascalaphus* in natural habitats showed that this owl fed on a variety of wild small and medium-sized mammals, reptiles, birds, and arthropods (Rifai et al., 2000; Al Ghamdi et al., 2023).

To this end, this is the first comparative study on the prey selection of the Pharaoh eagle owl, *Bubo ascalaphus,* in agricultural and natural habitats in Saudi Arabia to assess its role as a biological control agent.

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2. Materials and Methods

2.1. Study sites

A total of 106 regurgitated pellets for the Pharaoh eagle owl were collected from two sites; 40 from Bsitah in Al Jouf Province (30° 44' 20.4" N 38° 31' 1.5" E), and 66 from Al Daba'ah in Tabuk Province (28° 44' 03" N, 37° 58' 23" E) during December of 2022 and March 2023. Two *B. ascalaphus* were observed in Bsitah perching on a eucalyptus tree (Figure 1).

2.2. Pellets processing

The length and width of the collected 39 (19 from Bsitah and 20 from Al Daba'ah) intact pellets were measured by a digital caliper. Each pellet was soaked in warm water and teased using a pair of forceps and a needle to separate prey remains for identification. Recovered items from each pellet were placed in a Petri dish. For each species, the lower and upper jaws were cleaned and preserved. Prey remains were identified using distinctive morphological characteristics of body and/or skull parts (e.g. mandibles and maxillae) described based on previous collections from the region (Amr, 2012) as well as Iyad Nader small mammals collection kept at the NCW. Arthropod remains were identified up to the family level.

Figure 1. Two individuals of *B. ascalaphus* perching on a Eucalyptus tree in Bsitah site.

2.3. Data analysis

Diet composition was expressed by the number of individuals (minimum number of individuals, MNI) and percentage (number of individuals divided by the total number of prey individuals). The total number of prey individuals in a pellet was determined using the total number of mandibles and/or skulls found (Yalden and Morris, 1990). Dietary composition was estimated in terms of diversity using Simpson's diversity index (Simpson, 1949):

Pi is the relative representation of the "i" the prey category in the sample. To test for differences in diet composition between the two sites, we conducted a chi-square test of independence using the number of prey items consumed from every prey category.

3. Results

Pellets collected from both sites were cylindrical with an average of 56.36± 9.98 mm (mean ± standard deviation) in length (ranging from 32.43 and 75.2 mm in length), and 27.22± 2.62 mm in width (ranging from 22.38 and 38.29 mm in width) for Bsitah pellets, and 52.21± 15.33 mm in length (ranging from 37.44 and 86.6 mm in length), and 24.72±2.23 mm in width (18.57 and 21.04 mm in width) for Al Daba'ah pellets.

A total of 80 prey items were recovered from Bsitah pellets. The House Mouse, *Mus musculus* was the most dominant prey item (61.3%), followed by birds (16.3%). Prey items found in pellets from Al Daba'ah included remains of 84 individuals, with the Arabian Jerboa, *Jaculus loftusi,* being the most common accounting for 41.6% of the total prey items, followed by Sundevall's Jird, *Meriones crassus* (28.6%).

By species number, seven and nine species were found in Bsitah and Al Daba'ah pellets respectively. Animals recovered from Al Daba'ah pellets contained five native rodent species (*Acomys dimidiatus, Meriones crassus, Jaculus loftusi, Gerbillus dasyurus,* and *Gerbillus* sp.), while those from Bsitah included five species, one invasive (*M. musculus*), and four native species (*Meriones crassus, Jaculus loftusi, Gerbillus* sp. and *Paraechinus aethiopicus*). Furthermore, diet composition was more diverse in the Al Daba'ah site (3.62) compared to Bsitah (2.5) based on Simpson's diversity estimates (Table 1). The diet composition of the owls from the two sites appeared to be independent in terms of the dietary composition as suggested by the significant value of the chi-square test (χ^2 = 136.4; df 13; P < 0.05).

4. Discussion

The Pharaoh eagle owl is the most common species of owls in Saudi Arabia (Jennings, 2010). It was found to inhabit a wide range of habitats of arid rocky deserts. Recently, we conducted studies on the feeding behavior of this species (Al Ghamdi et al., 2023) along with other owls (Al Ahmary et al., 2023). *B. ascalaphus*, is an opportunistic species that has a wide range of prey items depending on

Table 1. Food composition of the Pharaoh eagle owl, *Bubo ascalaphus* in terms of frequencies and percentages of prey items from Bsitah and Al Daba'ah.

	Bsitah (N= 40)		Al Daba'ah (N= 66)	
	No.	**%**	**No.**	**%**
Mammals				
Acomys dimidiatus	0	0	7	8.3
Meriones crassus	2	2.5	24	28.6
Mus musculus	49	61.3	0	0
Jaculus loftusi	2	2.5	35	41.6
Gerbillus dasyurus	0	0	9	10.7
Gerbillus sp.	3	3.7	1	1.2
Paraechinus aethiopicus	4	5	0	0
Unidentified Rodents	3	3.7	3	3.6
Birds				
Galerida cristata	4	5	0	0
Unidentified Birds	9	11.3	1	1.2
Reptiles				
Uromastyx aeagptia	0	0	1	1.2
Ptyodactylus sp.	0	0	1	1.2
Arthropoda				
Solifugae	4	5	0	0
Tenebrionidae	0	0	2	2.4
Total No. of Individuals	**80**	**100**	**84**	**100**
Total No. of Prey	**9**		**10**	
D = Sum P^2	**0.40**		**0.28**	
Simpson's Diversity (1/D)	**2.50**		**3.62**	

their availability in a particular habitat. For instance, it was found to feed on *R. rattus* and *M. musculus* in urban areas around Riyadh (Abi Said et al., 2020) and six species of wild rodents in Ara'ar region (Al Ghamdi et al., 2023).

Elsewhere, Saufi et al. (2020) showed that the Barn Owl, *T. a. javanica* fed on *R. norvegicus* in urban areas, while hunted *R. argentiventer* in agricultural areas in Malaysia. Reduction of damage in palm plantations in Malaysia was observed after the introduction of the Barn Owl, where 98% of its diet consisted of rats (Duckett, 1991). Owl boxes for the Barn Owl were used in agricultural areas in the Jordan Valley to increase its population as a mean of biological control (Meyrom et al., 2009).

The results demonstrated that the *B. ascalaphus* owls have varied niche breadths and limited food-niche overlap between the two areas, suggesting opportunistic feeding habits that are likely influenced by prey availability, in the agricultural area of Bsitah, the owls fed more often on *M. musculus* which is small and thus required more than one individual to satisfy its nutritional needs hence more than one item per pellet were found, whereas in Al Daba'ah, high proportion of larger, wild rodents were eaten (*M. crassus* and *J. loftusi*), resulting mostly in one item per pellet (Figure 2).

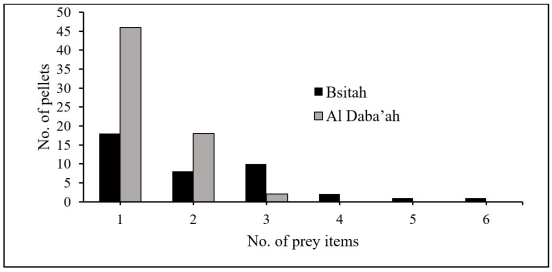

Figure 2. Number of prey items per pellet from the two sites.

The house mouse was the most abundant prey item within the agricultural area of Bsitah. It is a commensal and invasive species that can establish colonies in remote agricultural areas in the desert. Previous studies have reported this mouse as the most frequent food item of the Barn Owl in the Middle East (Nader, 1968; Abu Baker et al., 2005). Its high occurrence as the main prey item strongly suggests that owls have the potential to be an effective biological control agent against commensal small mammal pest populations therefore providing valuable pest control services in these areas. In the

Bethlehem, the Palestinian Territories, *Rattus rattus* constituted 37% of the diet of the Eurasian Eagle Owl, *Bubo bubo* (Amr et al., 2016). Abi Said et al. (2020) showed that the Pharaoh Eagle Owl diet consisted of 11.82% *R. rattus* and 1.48% *M. musculus* in an urban area around Riyadh, thus a good candidate as a biological control agent. The same observation was made in suburbs of Hurghada, Egypt, whereas *B. ascalaphus* consumed a large proportion of both adults and juveniles of *Rattus norvegicus* by both number of consumed individuals (66.1%) and by biomass (89.1%), and *M. musculus* (Moldován and Sándor, 2009).

This study suggests the use of owl's nest boxes for small-sized owls in agricultural areas in Saudi Arabia as an environmentally friendly method to reduce pest rodents in both open agricultural areas and palm plantations.

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