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DO THE WINTER DIETS OF SYMPATRIC BURROWING OWL AND SHORT-EARED OWL OVERLAP IN WEST-CENTRAL MEXICO?

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Abstract. Burrowing Owl (*Athene cunicularia*) and Short-eared Owl (*Asio flammeus*) are widely distributed but uncommon species during winter in Mexico. Information about their winter ecology is limited, particularly in areas where both species are present. Knowledge of their diet is an important component to understand the nocturnal raptors' habitat requirements. We analyzed 179 pellets of Burrowing Owl and 354 pellets of Short-eared Owl collected in 2002-2003, at the Military Airbase of Zapopan, Jalisco. The owls shared three main prey categories: invertebrates, small mammals, and birds. Small mammals provided the highest proportion of biomass in the Short-eared Owl diet and invertebrates in the Burrowing Owl diet. Food-niche breadth was lower in Short-eared than in Burrowing Owl reflecting the diversity of invertebrates in the Burrowing Owl's diet. The dietary overlap included items of relative low mass such as Northern Pigmy Mouse (*Baiomys taylori*) and the Gray Bird Grasshopper (*Schistocerca nitiens*). Zapopan Airbase is important for these two species and others adjacent to a large metropolitan city and should be managed as wildlife habitat that is compatible with its function for military training.

Key Words: Burrowing owl, Short eared-owl, central Mexico, winter diet, feeding strategies.

¿SE TRASLAPAN LAS DIETAS DE DOS SPECIES SIMPÁTRICAS DE BUHOS (*ATHENE CUNICULARIA* Y *ASIO FLAMMEUS*) EN EL OESTE DE MÉXICO?

Resumen. El Tecolote Llanero (*Athene cunicularia*) y el Búho Cuerno Corto (*Asio flammeus*) se distribuyen ampliamente durante el invierno en México. La información sobre su ecología invernal es limitada, particularmente en áreas donde ambas especies están presentes. El conocimiento de su dieta es un componente importante para entender los requerimientos de hábitat de las rapaces nocturnas. Analizamos 179 regurgitados de Tecolote Llanero, y 354 regurgitados Búho Cuerno Corto colectados en el invierno 2002-2003, en la Base Aérea Militar de Zapopan, Jalisco. Los tecolotes compartieron tres principales categorías de presas: invertebrados, pequeños mamíferos, y aves. Los pequeños mamíferos aportaron la porción más alta de biomasa en la dieta del Búho Cuerno Corto, e invertebrados en la dieta del Tecolote Llanero. La amplitud de nicho alimentario fue más bajo en Búho Cuerno Corto, que en Tecolote Llanero, reflejando la diversidad de invertebrados en la dieta del Tecolote Llanero. El traslape de dietas incluyó elementos con masa relativamente baja como el Ratón de Campo (*Baiomys taylori*), y la Langosta (*Schistocerca nitiens*). La Base Aérea de Zapopan es importante para estas y otras especies de tecolotes, adyacentes a la extensa metrópoli, y debería ser manejada como hábitat de vida silvestre que es compatible con su función de entrenamiento militar.

INTRODUCTION

Migratory Burrowing Owls (*Athene cunicularia*) and Short-eared Owls (*Asio flammeus*), both species of conservation concern in Mexico, are widely distributed in desert, grasslands and open woodlands during the winter in Mexico (Enriquez-Rocha 1997, Wiggins 2004). Extensive data for these species are available in northern latitudes; however, information about their winter ecology in Mexico is limited (Holroyd et al. 2001, Valdez 2003). The Short eared-Owls' nomadic habits are attributed to the numerical fluctuations of its prey (Clark 1975, Holt and Leasure 1993) which limits studies about seasonal interactions between the two species. In the winter 2002–2003 we found both species co-existing in the same mixed grassland habitat

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in west-central Mexico. We collected and analyzed Burrowing Owl and Short-eared Owl pellets over the winter 2002–2003, to compare not only the diet but measures of foraging ecology of these owls which are thought to utilize taxonomically similar food items, but with season differences in terms of size and frequency (Haug et al. 1993, Holt and Leasure 1993). Burrowing Owl consumes mainly invertebrates in the winter (Thomsen 1971, Valdez 2003, Woodin et al. 2007), while small mammals define the primarily diet of Short-eared Owl over the non breeding period (Holt 1993, Munyear 1966). More importantly, by understanding the ecological significance of mutually exploited prey, future management practices can be better formulated and implemented in their wintering grounds. In this paper we report food niche breadth and overlap at ordinal level prey identification of foraging ecology of these sympatric species in one winter. We also discuss shared prey items at species level. This comparison provides preliminary insights into the winter prey habits of these owls utilizing a shared resource.

METHODS

The airbase in the municipality of Zapopan, is located in the northwest portion of Guadalajara City within the Valley of Tesistan (20°44′–20°46′N; 103°26′–103°29′W), in west-central Mexico. The airbase has a mean elevation of 1625 m.a.s.l. This military airport comprises 1127 hectares of mixed grasslands dominant by *Paspalum* sp., *Sporobolus* sp., *Andropogon* spp., and *Rhynchelytrum repens*; other elements of secondary vegetation combine *Acacia pennatula*, *Verbesina greenmanii, Rizinus comunis*, and *Otatea glauca*, among others (Lopez-Coronado and Guerrero-Nuño 2004). The climate includes a dry season from October to May and a rainy season from June to September. The annual mean temperature is 20°C (min. –2°C, max. 32°C) and mean precipitation of 769 mm. (INEGI 2002). West of the Airbase are poultry farms and seasonal crops of sugar cane and maize. The other three sides are bordered by residential developments.

Pellet Collection

Pellets and prey remains (only feathers) were collected at Burrowing Owl diurnal roosts that were located in a small quarry, in a shallow arroyo, in ditches and under bunch grasses between October 2002 and March 2003. Pellets from Short-eared Owls were collected from January to March 2003 at a communal roost in grasslands that had been cut short adjacent to a runway. Owl roosts were visited twice a month to collect pellets. From unpublished telemetry data we know that these owls foraged primarily only on the airbase. These pellets were soaked in a NaOH solution to dissolve fur, hair and feathers prior to analysis (Marti et al. 2007).

Prey Categorization

The accuracy of pellet analysis will always be determined by the ability of the researcher to identify prey structures as well as access to representative collections of local fauna, particularly in latitudes where prey diversity is high.

Shared prey distributed in several orders were identified to family. The rest of the items are grouped into ordinal level. Although this criterion standardizes the taxonomy of prey reported, niche breadth and overlap is sensitive to level of prey identification (Greene and Jaksic 1983). The mass of shared prey were obtained from specimens directly trapped in the field. Mass reported for orders are based on the mean mass of individual prey obtained from zoological collections at Centro de Estudios en Zoología, Universidad de Guadalajara; Instituto de Ciencias Agricolas, Universidad de Guanajuato; and Colección Nacional de Aves, Instituto de Biología, UNAM.

Data Analysis

Prey diversity and food-niche breadth were estimated using the Shannon (H′) and Levine (B_A) indexes (Begon et al. 1990). Levin's index $B_A = (B - 1) / (n - 1)$, where n is the number of items, $B = 1 / \Sigma p^2 i$, and pi is the frequency of the ith item of the total sample. Values of B_A close to 1.0 indicate that the prey categories are used in similar frequencies, while diets concentrated in one or a few categories will generate B_A values close to 0. Equitability was calculated as J′ = H′/H′max., where H′max. equals natural logarithm (ln) of the total prey categories. The Pianka index (Krebs 1998) to measure diet overlap between both species of owls (O_{12}) is given as:

$$O_{12} = O_{21} = \frac{\sum_i^n - 1 p_{2i} p_{1i}}{\sqrt{\sum_i^n - 1 (p_{2i}^2)(p_{1i}^2)}}$$

where pi is the frequency of the ith item in the diet. Values close to 1.0 indicate equal use of prey categories and values of 0 indicate totally different resource use. The significance of the overlap was tested using randomization procedures in ECOSIM 7.0 (Gotelli and Entsminger 2001). We compared the overlap of their diets using frequency of prey consumed.

TABLE 1. NUMBERS AND PROPORTIONS OF PREY ITEMS IN PELLETS OF BURROWING OWL AND SHORT-EARED OWL IN THE AIRBASE OF ZAPOPAN JALISCO.

	Burrowing Owl	Short-eared Owl
Number of pellets	179	354
Total prey	5583	1058
Mean prey / pellet ± S.D.	31.18 ± 10.77	2.98 ± 1.77
H′	1.59	1.21
J	0.55	0.42
B_A	0.17	0.09

RESULTS

A total of 6641 prey items grouped into 18 orders were identified from 533 pellets. The number of prey per pellet differed between the two owl species (Table 1). A total of 179 Burrowing Owl pellets contained on average 31.18 preys per pellet (S.D. 10.77), while 354 Short-eared Owl pellets from the roost with at least 19 owls contained only 2.98 prey per pellet (S.D. 1.77). The primary reason for this difference is the large number of invertebrates present in the Burrowing Owl's diet compared to the number of small mammals contained in the Short-eared Owl's diet (Table 1). Short-eared Owls most frequently consumed small mammals and did not consume any reptiles, while the Burrowing Owls consumed primarily invertebrates, reptiles, and only one bird (Table 2).

The Burrowing Owl diet was dominated numerically and in biomass by invertebrates, specifically Lepidoptera, Arachnida and Orthoptera. The diet of Short-eared Owl was dominated numerically by Rodentia, where *Baiomys taylori* was an important source of biomass. Out of 15 orders consumed by Burrowing Owl and 13 orders consumed by Short-eared Owl, 14 prey categories are mutually exploited, including one species of bird (*Spizella pallida*); 5 small mammal species plus one prey category (*Criptotis parva*, *Baiomys taylori*, *Baiomys musculus*, *Mus musculus*, *Reithrodontomys megalotis*, Unidentified rodent); and 8 families of three orders of invertebrates included by Spiders (*Licosidae*); Beetles (*Carabidae*, *Histeridae*, *Tenebrionidae*); and Orthoptera (*Cyrtacanthacrididae*, *Gryllidae*, *Gryllotalpidae*, *Tettigoniidae*). The Levin's index (B_A) for Burrowing Owl = 0.17, was higher than for Short-eared Owl, B_A= 0.09. The Niche overlap for the 18 orders using % frequency was (O_{12}, O_{21}) = 0.16. The Type 1 error in these estimates obtained from 1000 iterations in ECOSIM was 0.02.

DISCUSSION

Comparing the diets of two or more species of raptors co-existing in a specific area is necessary and productive in poorly known parts of the world (Bednarz 2007). Although the literature on the diet of Burrowing Owls and Short-eared Owls is extensive (Millsap et al. 1997, Holt and Leasure 1993), most of the substantive studies of their ecology have taken place in Canada and the United States and few of them emphasize the winter ecology of these owls (Thomsen 1971, Woodin et al. 2007). This lack of information may hide important adaptations driven by geographical and seasonal changes, necessary to understand their winter survival at more southerly latitudes.

Woodin et al. (2007) studied the winter diet of migrant Burrowing Owls in south Texas over four winters. The diet, using the number of prey items, was 98% invertebrates, only 2% small mammals, and 0.2% birds, very similar to the diet in our study. These winter diets are dominated by invertebrates more than in summer. At Mapimi Biosphere Reserve in northern Mexico the Burrowing Owls' summer diet had 84% invertebrates by number and but more than 50% small mammals by biomass (Rodriguez-Estrella 1997).

The diet of Short-eared Owl in our study was similar to that reported in other studies, with small mammals dominating the diet and with few birds (Holt and Leasure 1993). The diet in our study was different in that the dominant small mammals were not voles as reported in several studies (Holt 1993, Korpimaki and Norrdhal 1991, Sissons 2003, Village 1997, Wellicome 2000) but were Northern Pygmy Mouse (*Baiomys taylori*). This rodent may replace voles in the food niche that voles occupy in the north, becoming a key species not only for Short-eared Owls but for Burrowing Owls as well.

Both species took advantage of swarms of Gray Bird Grasshopper (*Schistocerca nitiens*), that invaded the airbase and surrounding region in mid-December 2002 through late April 2003, when regional drought reduced the availability of green vegetation. This grasshopper (Cyrtacanthacrididae) comprised 20% of the prey items taken by both species indicating both owls were able to opportunistically take advantage of this abundant prey.

TABLE 2. Numerical proportions of prey orders found in the diet of Burrowing Owl (BUOW) and Short-eared Owl (SEOW) at the Military Base in Zapopan, Jalisco, Mexico during the winter 2002–2003. %B equals percentage of the total ingested biomass in grams. Mean mass of prey (M.M.) in grams.

	Order / Shared prey (M.M.g)	BUOW	% B	SEOW	%B
Reptiles	Squamata (19)	0.1	2.6	0	0
Birds	Galliformes (60)	0	0	0.1	0.2
	Columbiformes (26)	0	0	0.2	0.2
	Passeriformes (23)			13.0	7.40.7
	Spizella pallida (15)	0.0	0.4	1.3	
Mammals	Soricomorpha				0.9
	Criptotis parva (6)	0.1	0.9	4.6	
	Rodentia (47)	1.2	20.9	58.8	90.51
	Baiomys taylori (8)	0.6	6.1	39.2	0.30
	Baiomys musculus (12)	0.1	1.5	1.9	72.9
	Mus musculus (16)	0.4	9.5	5.6	20.1
	Reithrodontomys megalotis (14)	0.1	1.4	0.5	
	Unidentified rodent (15)	0.1	1.5	0.3	
	Chiroptera (11)	0.0	0.3	0	0
Invertebrates	Amphipoda (0.1)	0	0	0.1	0.0
	Araneae				
	Licosidae (0.5)	27.9	19.3	0.4	0.0
	Solifugae (0.6)	1.0	0.8	0	0
	Glomerida (0.2)	0.4	0.1	0	0
	Coleoptera (0.5)	8.1	5.8	0.7	0.0
	Carabidae (0.3)	2.0	0.8	0.1	0.0
	Histeridae (0.3)	0.1	0.0	0.2	0.0
	Tenebrionidae (0.3)	0.7	0.2	0.1	0.0
	Diptera (0.3)	1.7	1.0	0	0
	Hymenoptera (0.2)	1.3	0.2	1.1	0.0
	Lepidoptera (0.4)	36.3	20.6	0.3	0.0
	Hemiptera (0.4)	0.2	0.1	0.2	0.0
	Orthoptera (1.0)	20.2	26.8	20.4	0.8
	Cyrtacanthacrididae (1.4)	3.2	6.1	15.2	0.7
	Gryllidae (0.7)	6.8	6.6	3.6	0.1
	Gryllotalpidae (1.2)	4.7	7.9	0.8	0.0
	Tettigoniidae (0.6)	0.9	0.7	0.9	0.0
	Dermaptera (0.4)	1.1	0.7	0.1	0.0

Level prey identification (LPI) affects the food-niche breadth and overlap used to measure foraging and community ecology (Greene and Jaksic 1983). As LPI reach high taxonomic resolution, overlap values will decrease while niche breadth values increase. These proportions need to be considered when comparing prey items grouped either at the same or at different taxonomic categories. Our results suggest that differences observed on food-niche breadth (SEOW B_A = 0.09; BUOW B_A = 0.17), and overlap (O_{12}, O_{21} = 0.16) are proportionally consistent with richness and equitability. Burrowing Owl diet included more orders (H′ = 1.59) than Short-eared Owl diet (H′ = 1.21). Individual prey uniformity is slightly more consistent for the Burrowing Owl (J = 0.55) than Short-eared Owl (J = 0.42). Levine's index may be explained by the strong predation of Short-eared Owl on rodents.

Particularly interesting is the fact that shared prey were within the mass range of 0.4–19 g. Regardless that some mean prey mass of prey (Table 2), exceed this range, Burrowing Owl predation is limited by mass. On the opposite scale, it is hard to determine whether extremely low mass invertebrates are directly consumed by the owls. Overall the Burrowing Owl can be classified as an insectivore in winter, while the Short-eared Owl diet is a microtine-size specialist year round.

The Military Airbase of Zapopan comprises 1127 hectares of mixed grassland. Together with the surrounding agricultural fields it provides suitable habitat where species of migrant owls interact. Other diurnal raptors such as Red-shoulder Hawk, Red-tailed Hawk, Swainson's Hawk and White-tailed Hawk, have been observed foraging actively in this airport. The area is also utilized by Northern Harriers and White-tailed Kite as nocturnal roosting site. The high value of the land and the fast growing mixed-use urban developments of Guadalajara near the Airbase may compromise its continuity

as wildlife habitat. It is important that wildlife agencies recognize the base's importance and work together to preserve this remnant grassland refuge.

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