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THE RELATIONSHIP OF FORAGING HABITAT TO THE DIET OF BARN OWLS (*TYTO ALBA*) FROM CENTRAL CHILE

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KEY WORDS: *Barn Owl;* Tyto alba; *diet; Chile; feeding ecology; anthropogenic disturbance.*

Several studies on the diet of the Barn Owl (*Tyto alba*) related to broader investigations of predator-prey relationships have been conducted in Chile, most of which involved data collected in the semi-arid north-central zone of this country (e.g., Schamberger and Fulk 1974, Jaksić et al. 1992, 1993b). The majority of these studies dealt with predator-prey interactions, and little attention was paid to human influences on the Barn Owl's diet (e.g., Schlatter et al. 1980, Simeone 1995). Indeed, most of these studies were conducted in areas of reduced human activities such as the Fray Jorge National Park (Schamberger and Fulk 1974, Fulk 1976, Jaksić et al. 1993b), the Chinchilla National Reserve (Jaksić et al 1992), or the Atacama Desert (Jaksić et al. 1999). Disturbances of hunting habitats by human activities such as agriculture or pollution may differentially affect the occurrence or abundance of small mammals, and thus, the diet of the Barn Owl.

In this study, I examine the diet of Barn Owls occupying two ecologically-dissimilar study areas. Although both sites are affected by humans, their extent of disturbance differs. One study site (El Alamo), located in the south of central Chile, consisted mainly of meadows and was only slightly influenced by human settlement. In contrast, the second habitat (Los Maitenes) appeared to be noticeably polluted by the copper-processing industry as indicated by substantially reduced vegetative cover. Furthermore, the polluted habitat lies within the geograph-

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ical range of previous diet studies (Jaksić and Yáñez 1979, Herrera and Jaksić 1980), and thus, allows comparisons between data sets.

MATERIALS AND METHODS

Owl pellets were collected from two localities in central Chile (El Alamo and Los Maitenes) during field studies conducted in January and March 1998. At both localities, Barn Owls were observed using the roosts from which the pellets were collected. The study site at El Alamo (36°11'S, 72°24'W) comprised mainly open vegetation (meadows grazed by cattle, goats, and sheep) with many shrubs and relatively complete vegetation cover (80–100%) and scattered fields. The landscape was interspersed with forest fragments (<20%). A total of 318 pellets were collected in abandoned barns at six sites near settlements within an area of ca. 80 km^2.

At Los Maitenes (32°46'S, 71°27'W), 239 pellets were collected in and nearby roosts that were located in the walls of a gorge, ca. 3 km from the nearest village. The five sampling sites were located within a radius of ca. 5 km. This area was contaminated by sulphur dioxide and arsenic emitted by an adjacent copper-processing refinery (J. Bustamente, Empresa Nacional de Minera Ventanas, pers. comm.) ca. 6 km from the sampling site. The vegetation was poorly developed with only a few shrubs, a reduced vegetative ground cover (<20%), and the soil did not contain geophytes (Begall and Gallardo 2000). The land has not been used for agriculture for at least two decades.

I dissected pellets after soaking them in water, and mammalian skulls were identified using the key by Reise (1973). In the case of uncertainty, skulls (especially teeth) were compared with specifications and drawings by Osgood (1943) and for cricetine rodents with an online key (Huiña-pukios Limitada 2002). Scientific nomenclature followed Jaksić (1997) for vertebrates.

Prey per pellet was estimated by summing up the numbers of identified individual prey animals divided by the total number of pellets analyzed. Calculations of the minimum number of specimens per pellet were derived from the maximum number of either left or right elements of cranial and postcranial bones (Lyman et al. 2003).

Diet breadth (B_{obs}) was calculated using the term $(\Sigma_{i=1}^{n} p_i^2)^{-1}$ with p_i being the fraction of prey category i (Levins 1968). This index can yield values ranging between 1–3 (according to N = three prey categories: mammals, birds, and insects). In addition, I calculated standard niche breadths according to the equation $B_{st} = (B_{obs} - B_{min})/(B_{max} - B_{min})$ (Colwell and Futuyma 1971). Geometric mean weight of prey (GMWP) was calculated using the formula GMWP = antilog $(\Sigma_{i=1}^{n} p_i \log m_i)$ where p_i is defined as above and m_i is the mass of prey category i. Data on body mass of mammalian prey were obtained from Begall et al. (1999) for *Spalacopus cyanus*, from Redford and Eisenberg (1992) for *Auliscomys micropus* and *Octodon* sp., and from Herrera and Jaksić (1980) for the remaining taxa. Means are given as $\bar{x} \pm$ SD (standard deviation), and mean prey sizes were compared using t-test.

RESULTS

Altogether 689 individual prey were identified from skulls found in 557 owl pellets, resulting in 1.24 prey per pellet. However, estimates of the minimal number of specimens based on cranial and postcranial bones accounted for 1.81 animals per pellet. The Barn Owl fed mainly on mammals (98.1%), or more precisely on rodents (96.4%); the remaining 3.6% consisted of marsupials (1.15%), lagomorphs (0.6%), birds (1.15%), and insects (0.7%). A total of 12 mammal species was identified, of which 10 were rodents (Table 1). Furthermore, remains of eight birds, and elytra and chitin shells of five beetles (Coleoptera) were found in the prey. Diet breadths calculated for the broad prey categories mammals, birds, and insects were comparable for both study sites (B_{obs} = 1.05 and 1.04 for El Alamo and Los Maitenes, respectively), and thus, yielded low standard niche breadths (B_{st} = 0.026 and 0.021 for El Alamo and Los Maitenes, respectively).

Mammalian prey composition differed between the two localities (Table 1). Differences in the consumed prey across the respective rodent families were significant (χ^2-test; $P < 0.001$). Whereas the cricetine rodents (*Auliscomys micropus, Oligoryzomys longicaudatus,* and *Phyllotis darwini*) were more abundant in the owl's diet from Los Maitenes than in pellets originating from El Alamo, the reverse was true for *Abrothrix longipilis* (Table 1). Because the body mass of the respective species ranged between 30–70 g, the distribution of prey according to body mass (Fig. 1) shows a slightly higher amount of medium-sized prey (<70 g) for Los Maitenes. Barn Owls from El Alamo seemed to take heavier prey like *Rattus rattus* or *Octodon bridgesi,* with the latter being absent in Los Maitenes. The fossorial coruro (*Spalacopus cyanus*) was found more often in pellets from Los Maitenes (7.8%) than in the southern locality El Alamo (2.0%). The differences of mammalian prey composition in the diet of the Barn Owl resulted in significantly lower GMWP at Los Maitenes (54.4 ± 25.3 g) in comparison to El Alamo (66.1 ± 36.4, $P < 0.001$).

DISCUSSION

One of the sampling localities (Los Maitenes) lies within the geographical range of sampling localities of two previous studies addressing the diet of the Barn Owl in central Chile (Jaksić and Yáñez 1979, Herrera and Jaksić 1980). In these studies, a slightly different Barn Owl prey spectrum was found compared to the present findings Nevertheless, both this study and the previous ones revealed that the most important prey (>50%) consisted of *Phyllotis darwini* and *Oligoryzomys longicaudatus.* While Herrera and Jaksić (1980) found *Abrocoma bennetti* and *Octodon degus* in the diet of Chilean Barn Owls with proportions of 4% and 3%, respectively, these rather large octodontoids (body mass of adults > 200 g) were absent in pellets that I had analyzed. Also chiropteran skulls, that Herrera and Jaksić (1980) found in low frequencies

Table 1. Prey of Barn Owls at two study sites from central Chile (El Alamo and Los Maitenes). Data on body mass of mammals were taken from Begall et al. (1999) for *Spalacopus cyanus*, from Redford and Eisenberg (1992) for *Auliscomys micropus* and *Octodon* sp., and from Herrera and Jaksić (1980) for the remaining taxa.

SPECIES	BODY MASS (g)	EL ALAMO N (%)	LOS MAITENES N (%)
Thylamys elegans (elegant fat-tailed opossum)	40	7 (2.0)	1 (0.3)
Oryctolagus cuniculus (juv.) (old-world rabbit)	180	3 (0.8)	1 (0.3)
Mus musculus (house mouse)	17	6 (1.7)	16 (4.8)
Rattus rattus (black rat)	158	34 (9.6)	3 (0.9)
Abrothrix longipilis (long-haired grass mouse)	76	39 (11.0)	2 (0.6)
Abrothrix olivaceus (olive-grass mouse)	40	38 (10.7)	23 (6.8)
Auliscomys micropus (southern big-eared mouse)	73	2 (0.6)	18 (5.4)
Oligoryzomys longicaudatus (long-tailed rice rat)	45	78 (22.0)	120 (35.8)
Phyllotis darwini (Darwin's leaf-eared mouse)	66	72 (20.3)	113 (33.7)
Octodon bridgesi (bridge's degu)	93	60 (17.0)	0 (0.0)
Octodon lunatus (moon-toothed degu)	233	0 (0.0)	2 (0.6)
Spalacopus cyanus (coruro)	90	7 (2.0)	26 (7.8)
(Rodents, unidentified)		2 (0.6)	3 (0.9)
(Birds, unidentified)		4 (1.1)	4 (1.2)
(Insects, unidentified)		2 (0.6)	3 (0.9)
Total		354	335

(<1%) were not present in the samples from El Alamo or Los Maitenes, a difference which may be related to a larger sample size in the earlier study. On the other hand, the cricetid rodent *Auliscomys micropus* was present at Los Maitenes (5.4%) as well as at El Alamo (0.6%), yet absent in previous studies (Jaksić and Yáñez 1979, Herrera and Jaksić 1980).

The differences between prey compositions found at El Alamo and Los Maitenes may be due to differences in

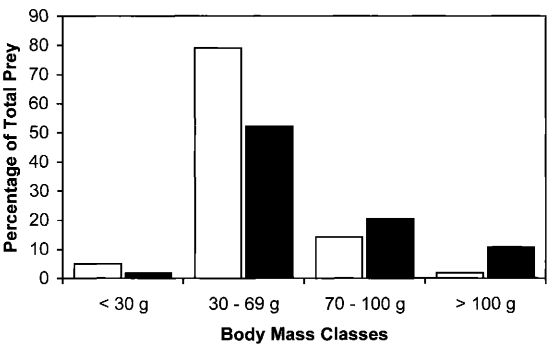

Figure 1. Percentage of prey in body mass taken by Barn Owls from two localities from central Chile (white bars represent samples from Los Maitenes, black bars samples from El Alamo). Data on body mass were taken from Begall et al. (1999) for *Spalacopus cyanus*, from Redford and Eisenberg (1992) for *Auliscomys micropus* and *Octodon* sp., and from Herrera and Jaksić (1980) for the remaining taxa.

prey availability. However, I did not assess availability of prey by trapping except for *Spalacopus cyanus* (Begall and Gallardo 2000; see below). Nevertheless, different frequencies of *Oligoryzomys longicaudatus, Phyllotis darwini,* and *Abrothrix olivaceus* found in the pellets from the two study sites may be related to prey availability. Rodent outbreaks in the above mentioned species occur at regular intervals and may depend on bamboo flowering, rainfall peaks, but also on density-dependent factors (Gallardo and Mercado 1999, Lima and Jaksić 1999, Jaksić and Lima 2003).

Other striking differences between the two sampling localities were found with *Octodon bridgesi* (El Alamo: 17.0%; Los Maitenes: 0%) and *Abrothrix longipilis* (11.0% versus 0.6%). While *Octodon bridgesi* is absent at Los Maitenes (and the surrounding area), *Abrothrix longipilis* is most common in moister areas (like El Alamo) with a high proportion of shrub and litter cover (Redford and Eisenberg 1992)—conditions that are absent at Los Maitenes. Furthermore, *Abrothrix longipilis* was also reported to exhibit cyclic populations (Murúa et al. 2003) that may have contributed to differing frequencies of this species between the study sites. Higher amounts of *Rattus rattus* remains in pellets from El Alamo (9.6% versus 0.9%) certainly indicated the close association of the rat with humans.

Skulls of *Spalacopus cyanus* in pellets analyzed by Herrera and Jaksić (1980) accounted for 0.8% of the Barn Owl diet even a smaller fraction than at El Alamo (2%) during the current study. In contrast to these findings, *Spalacopus cyanus* accounted for 7.8% of the Barn Owl diet at Los Maitenes. This pattern was surprising because at both study sites (Los Maitenes and El Alamo), at least five colonies of *Spalacopus cyanus* were found in immediate vicinity (<2 km) of sampled roosts. Furthermore, mean colony sizes were similar at both localities (Begall et al. 1999, Begall and Gallardo 2000) suggesting similar population densities. Perhaps low vegetation cover and absence of geophytes at Los Maitenes force *Spalacopus* to forage above ground (on leaves of *Convolvulus arvensis*) more frequently, and thus, exposing them to greater predation pressure. In contrast, at El Alamo *Spalacopus cyanus* spent most time underground foraging on bulbs of the geophyte *Dioscorea longipes* (Begall and Gallardo 2000). Despite the absent underground-food resource at Los Maitenes, *Spalacopus cyanus* maintains its typical complex burrow network presumably to avoid even higher levels of predation.

Although there were several noticeable differences between the two foraging habitats, Barn Owls seemed to be equally abundant in both areas and exploited a similar mammalian-prey-based diet with comparable diet breadths. This finding indicated that sufficient mammalian prey was also available at the disturbed area of Los Maitenes for Barn Owls and corroborates that this species specializes on mammalian prey. Long-term studies by Jaksić et al. (1992, 1993a) revealed that if mammalian prey decreases, Barn Owls tend to abandon the area rather than shift toward non-mammalian prey as seen in some other predator species (e.g., Bednarz and Dinsmore 1985, Selas 2001).

The results of this study showed that Chilean Barn Owls took prey of medium body mass. Even the mean value calculated for the study site at Los Maitenes (GMWP = 54.4 g) was almost twice as high as the value calculated for prey of Barn Owls from Chilean Patagonia (Iriarte et al. 1990). Higher abundances of large animals like *Rattus rattus* and *Octodon bridgesi* at El Alamo may have led to significantly higher mean prey mass at this locality (GMWP = 66.1 g). Studies of White-tailed Kites (*Elanus leucurus*) in central Chile revealed a similar pattern (Schlatter et al. 1980). They found that prey taken in the undisturbed habitat was significantly heavier than prey taken at the disturbed area. Schlatter and colleages related the higher proposed that kites from anthropogenically-disturbed areas may have had access to more prey due to greater prey abundance or higher prey vulnerability. Whereas, I suggest there was not higher prey abundance in Los Maitenes due to lower habitat quality. Rather, I assume that higher prey vulnerability at Los Maitenes may be supporting the current Barn Owl population.

ECOLOGÍA DE ALIMENTACIÓN DE *TYTO ALBA* EN EL CENTRO DE CHILE Y SU RELACIÓN CON EL HÁBITAT DE CAZA

RESUMEN.—Se comparó la composición de la dieta de *Tyto alba* en dos localidades de la región central de Chile (El Alamo y Los Maitenes), relacionándose posteriormente los resultados obtenidos con las características de ambos hábitats. La región de El Alamo consistió principalmente en campos cultivados y prados, mientras que la región de Los Maitenes se caracterizó por presentar una cubierta vegetal escasa, encontrándose fuertemente afectada por la polución generada por la presencia de industrias de cobre en las cercanías. En ambas áreas de estudio, *T. alba* mostró una amplitud de dieta estrecha, representando los mamíferos un 98% del total de presas. Sin embargo, la composición de la dieta varió marcadamente entre los dos sitios de estudio, encontrándose una mayor frecuencia de roedores fosoriales de gran tamaño en áreas alteradas que en aquellas áreas que presentaban una cubierta vegetal densa. Finalmente, los tamaños de las presas en la región de Los Maitenes fueron menores que los obtenidos en la región de El Alamo.

[Traducción de los autores]

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