FOOD HABITS OF COMMON BARN-OWLS ALONG AN ELEVATIONAL GRADIENT IN ANDEAN ARGENTINE PATAGONIA

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ABSTRACT.—We evaluated the diet of Common Barn-owls (*Tyto alba*) along an elevational gradient in Argentine Patagonia. Small mammals (mainly rodents) were the main prey accounting for 93.2% of total prey items. Consumption of rodents appeared to be dependent on their availability. Sizes of mammalian prey were variable but most ranged from 10–100 g in body mass. We concluded that the diet of these barn owls could be used as an index of cricetid rodent populations along the gradient.

KEY WORDS: *Common Barn-owl; Tyto alba; prey; Patagonia; selectivity; gradient.*

Dieta de la lechuza (*Tyto alba*) a lo largo de un gradiente altitudinal en la Patagonia Andina Argentina.

RESUMEN.—Se estudió la dieta de la lechuza (*Tyto alba*) y se la contrastó con la composición específica de la comunidad de micromamíferos a lo largo de un gradiente altitudinal en la Patagonia Argentina. La principal presa la constituyeron pequeños mamíferos (fundamentalmente roedores) alcanzando un 93.2% del total de presas consumidas. La masa corporal media de los mamíferos presa se concentró fuertemente en un rango comprendido entre 10 y 100 g. La dieta de la lechuza resultó ser un búen indicador de la composición de Cricetidos a lo largo del gradiente estudiado. El consumo de cada uno de los roedores presa dependió de su disponibilidad en el terreno.

[Traducción Autores]

Few of the many studies of Common Barn-owl (*Tyto alba*) food habits have examined dietary responses to elevational distribution of prey species (Herrera 1974, Brunet-Lecomte and Delibes 1984). In northwestern Patagonia, a steep elevational gradient (600–3000 m) occurs over just a few km. The abrupt change in elevation and the associated change in precipitation (300–3600 mm) causes a distinct shift in the vegetation from shrubsteppe to montaneous forest habitat within a few km. Pearson and Pearson (1982) qualitatively described the small mammal species composition along this gradient. They found six species of rodents (*Aconnaemys fuscus, Dromiciops australis, Notiomys macronyx, Notiomys valdivianus, Irenomys tarsalis* and *Akodon olivaceous*) occurred in the humid forest, while another seven rodent species (*Ctenomys haigi, Akodon xanthorrinus, Reithrodon auritus, Eligmodontia typus, Phyllotis darwini, Euneomys* sp, and a marsupial, *Lestodelphis halli*) were in the dry shrubsteppe. They also analyzed the diets of Common Barn-owls at three different localities at the forest-steppe transition and found that the proportions of species captured by traps and by owls were different.

Besides providing new information on the trophic niche of Common Barn-owls in Argentina, here we test the feasibility of using barn owl food habits to describe changes in composition and abundance of small mammals along an elevational-precipitation gradient. We considered the data provided by Pearson and Pearson (1982) as the ac-

tual representation of the small mammal community along this gradient and the barn owl prey as its descriptor. Additionally, Pearson (1986) provided data on relative abundance of cricetid species in eight different habitats ranging from steppe to forest over an 8-yr-period.

We made two comparisons between estimates of rodent availability and their occurrence in the diet of common barn owls: (1) on a broad scale, along the elevational-precipitation gradient, using data from Pearson and Pearson (1982), and (2) on a fine scale, along a segment of the complete gradient, using abundance estimates for rodent species given by Pearson (1986). We predicted that the barn owl diet would reflect gradient changes in rodent community composition (Herrera 1974, Pearson and Pearson 1982, Taylor 1994), but it would be less accurate in reflecting availability of prey at a fine scale (Jaksic and Yañez 1979).

STUDY AREA AND METHODS

Located in northwestern Patagonia (70°30′–71°30′W; 39°30′–40°20′S), the study area constitutes a portion of the Precordillera gradient and partially overlaps with the area studied by Pearson and Pearson (1982) and Pearson (1986). The greatest distance between our site and that of Pearson was under 150 km. The climate of the area is dry and cold with frost throughout most of the year and frequent snowfall in winter. Topographically, the area consists of plains from 800–900 m above sea level that are dissected by steep rugged valleys and large rivers. In general, the study area consists of lowland which coincides with river valleys and highland Piedmont with an intermediate area between them. Pearson (1986, 1987, 1988) has described five different habitats in intermediate and highland Piedmont: steppe or scattered bushes, usually <1 m tall, usually mixed with bunch grass, much of the ground is devoid of vegetation; bunchgrass or habitats with relatively pure stands of one or more species of bunchgrass; weeds or areas with dense weeds and grasses, usually growing in moist places; rocks or cliffs with tumbled rocks large enough to provide refuge for rodents; and bare ground or large areas not vegetated with a substrate of fine scree or rock and very few rocky shelters.

Barn owl pellets were collected from September-February 1991, 1992 and 1994–95. Pellets were collected at 32 isolated localities more than 2 km apart. On this basis, we assumed that barn owls at each locality were different individuals. Only fresh pellets were included in our samples in order to restrict our study to the spring season and avoid seasonal variation. All pellets were dissected using standard techniques (Yalden 1977). Small mammal remains were identified using taxonomic keys (Pearson 1986), reference specimens collected in the study area and museum collections. Small mammal biomass was derived from Pearson (1983, 1984) and Redford and Eisenberg (1992).

Following Herrera and Jaksic (1980), we characterized barn owl food habits by the following parameters: mean

mass of all small mammals (MWSM) in the diet; H′NGG, trophic diversity in relation to the number of individuals contributed by each higher taxonomic unit (mammals, birds, amphibians, invertebrates); H′NM, trophic diversity in relation to the small mammal component of the diet (rodents, lagomorphs, marsupials); and H′NR, trophic diversity in relation to the number of individuals contributed by each rodent species. The latter three parameters were computed by means of Shannon's information function (Ludwig and Reynolds 1988). Corresponding values of evenness (J = H′/H′max) were also calculated.

The use of the barn owl food habits to detect and describe changes in the composition and abundance of small mammals along a gradient was explored using correspondence analysis (SAS 1987). This is a multivariate ordination method (Digby and Kempton 1987, Pielou 1984), applied on a data matrix that included frequencies of appearance (%) of several prey categories for each barn owl locality. This type of analysis permits one to plot points for both rows and columns (here localities and small mammal prey categories) on the same plane. Correspondence analysis is especially appropriate for matrices with numerical frequencies (Cuadras 1980) and does not normally require previous transformation of data (Digby and Kempton 1987). We used this analysis to verify if the pattern in rodent species distribution derived from barn owl diets was similar to that described by Pearson and Pearson (1982) along both the elevational and precipitation gradients. For this analysis, we restricted ourselves to those localities ($N = 23$) with >30 identified prey items.

Selection among potential prey species was studied only in intermediate and highland Piedmont. Barn owl selectivity was evaluated by comparing the species' rank for each cricetid rodent in the barn owl diet with the species' abundance in the field as estimated by Pearson (1986). We used a Spearman Rank Correlation Coefficient (Siegel and Castellan 1988) for this analysis. It was calculated from the sum of the ranks obtained for each species in each of the five habitats considered. Comparison was restricted to cricetids because these were the rodent species for which Pearson (1983) estimated relative abundance.

RESULTS

A total of 2447 prey items were identified from barn owl pellets. Small mammals were the main prey in northwestern Patagonia, accounting for 93.2% of the total. Birds, amphibians and invertebrates made up the remaining 6.8% (Table 1). Calculated from a random sample of 71 pellets, the mean number of prey/pellet was 1.85 (SD = 1.09, range 1–6).

Among mammals, rodents most frequently occurred in the diet, representing the 98.9% of the total (Table 1). The MWSM was 54.2 g (SD = 36.7, range 17.5 g for *Calomys musculinus*, 286.1 g for *Microcavia australis*) but most small mammals were between 10–100 g (Fig. 1).

Table 1. Composition of the Common Barn-owl in the lowland, midland, and highland piedmont, northwestern Argentine Patagonia.

PREY TYPE	LOWLAND PIEDMONT (%)	MIDLAND PIEDMONT (%)	HIGHLAND PIEDMONT (%)	TOTAL	
				N	%
MAMMALS					
Rodents					
Hystricognath					
Ctenomys haigi	13.1	3.1	3.0	134	5.5
Galea musteloides	1.7	0.3	0.0	13	0.5
Microcavia australis	0.3	0.0	0.0	2	0.1
Cricetids					
Akodon spp	9.6	21.4	25.0	484	19.8
Auliscomys micropus	0.2	6.3	18.7	226	9.2
Chelemys macronix	0.0	1.0	3.1	37	1.5
Eligmodontia typus	31.6	13.1	6.7	374	15.3
Euneomys sp	0.0	0.1	2.8	25	1.0
Geoxus valdivianus	0.2	0.3	1.0	13	0.5
Irenomys tarsalis	0.0	0.1	0.5	5	0.2
Oryzomys longicaudatus	6.6	8.2	6.0	171	7.0
Phyllotis darwini	4.0	12.8	5.6	198	8.1
Reithrodon auritus	23.0	16.9	24.4	522	21.3
Calomys musculinus	5.4	1.9	0.0	51	2.1
Marsupials					
Marmosa pusilla	1.8	1.1	0.0	22	1.0
Lagomorphs					
Oryctolagus cuniculus	0.0	0.2	0.1	3	0.1
Birds	1.3	0.8	0.3	19	0.8
AMPHIBIANS	0.0	0.5	0.0	5	0.2
INSECTS	0.3	11.9	2.8	143	5.8
TOTAL PREY	(595)	(980)	(872)	(2447)	
H'NGG				0.28	
JNGG				0.20	
H'NM				0.06	
JNM				0.05	
H'NR				2.06	
JNR				0.78	

These barn owls had a relatively narrow diet as shown by the H'NGG value (Table 1). The low evenness index was largely due to their concentration on mammal prey (Table 1). The diversity and evenness of the small mammal component (H'NM) showed that the diet was based upon a small number of small mammal species, most of which were rodents. Among rodents, H'NR (2.06) and evenness (0.78) reached the highest values, denoting both the high number of rodent prey species consumed ($N = 14$, 82% of total present in the area) and their overall even representation in the diet.

Two axes generated by the correspondence anal-

ysis accounted for 49.5% of the variance in the diet (Fig. 2). Representation of localities and prey categories on the plane defined by the two axes clearly segregated the dry, lowland Piedmont localities (which tended to the positive zone of Axis I and negative zone of Axis II) from the rest of localities (which occupied all the space defined by Axis I and the positive zone of Axis II). Prey in the lowland Piedmont localities included *Ctenomys haigi*, *Microcavia australis*, *Galea musteloides*, *Eligmodontia typus* and *Calomys musculinus*. Prey in most of the other localities, included in mid- and high Piedmonts were *Akodon* sp, *Auliscomys micropus*, *Chelemys*
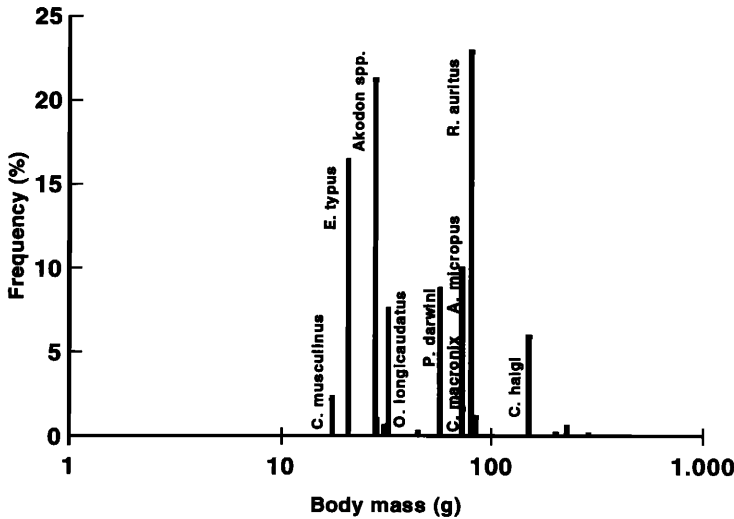
Figure 1. Relative frequencies (%) of small mammal prey in the diet of Common Barn-owls in northwestern Argentine Patagonia, ordered along a logarithmic axis of body weights.

macronix and *Geoxus valdivianus.* In a few localities, *Phyllotis darwini* and *Euneomys* sp. also occurred.

The similarity between the expected and observed rank order in cricetid species in the diet
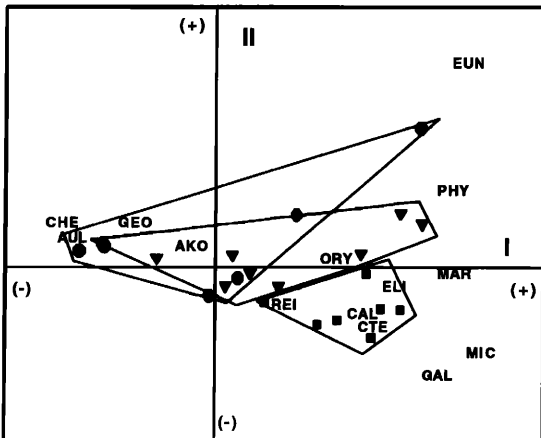

Figure 2. Variation in the taxonomic composition of the diet of the Common Barn-owl in northwestern Argentine Patagonia. Plot of the Correspondence Analysis, areas of each delimited by minimum poligon. See Table 2 for most species abbreviations. MAR, *Marmosa pusilla*; CAL, *Calomys musculinus*; GAL, *Galea musteloides*; CTE, *Ctenomys haigi.* Circles correspond to highland Piedmont, quadrats to lowland Piedmont and triangles to intermediate Piedmont.

(Table 2) indicated that barn owls fed on prey according to their availability in intermediate and highland Piedmont areas ($r_s = 0.91$, $P < 0.01$). The most important difference was the greater importance of *Reithrodon auritus* and the overall absence of *Akodon* sp. in the diet.

DISCUSSION

Barn owls in our study preyed almost exclusively on rodents, as found in most other studies (Smith and Cole 1989, Bellocq 1990, Iriarte et al. 1990, De Santis et al. 1994, Taylor 1994). This suggests that these barns owls do not behave as opportunistic, nonselective predators as suggested by Mikkola (1983). Taking this into account, care should be taken when interpreting the unusually high predation on birds reported by Noriega et al. (1993) in the Patagonian zoogeographic domain (Ringuelet 1961). Their data may reflect individual differences of individual barn owls.

Our mean body mass estimate of small mammals in the diet (56.2 g) was intermediate between that reported in Spain (21.2 g) and Chile (70.7 g) (Herrera and Jaksic 1980). Because the largest prey taken in the three areas was the European rabbit, (*Oryctolagus cuniculus*), the smaller MWSM in Argentina when compared with Chile was a consequence of both the high concentration of smaller prey than in Chile (30–500), and the greater consumption of smaller rodents than in Chile. In Argentine Patagonia, only one of the three available rodent species weighing more than 150 g (*Ctenomys haigi*) was readily consumed by owls, while in Chile three of four such species were consumed in amounts similar to that of our *C. haigi* (Herrera and Jaksic 1980).

H'NGG diversity and evenness indexes were similar to

Table 2. Expected composition of Common Barn-owl diet expressed as a percentage for five habitats, based on Pearson (1983, 1986).

SPECIES[1]	STEPPE	BUNCH GRASS	WEEDS	ROCKS	BARE	OWL DIET	OWL DIET	FIELD RANK
AKO	42.0	76.0	49.0	41.0	36.0	27.0	AKO	AKO
AUL	2.0	12.0	16.0	2.0	23.0	12.0	REI	ELI
CHE	0.0	0.0	1.0	0.0	10.0	1.9	ELI	AUL
ELI	43.0	12.0	2.0	3.0	3.0	13.0	AUL	ORY
EUN	0.0	0.0	0.0	1.0	15.0	2.8	PHY	REI
GEO	0.0	0.0	2.0	0.0	2.0	1.0	ORY	PHY
IRE	0.0	0.0	0.0	1.0	0.0	0.3	EUN	EUN
ORY	4.0	0.0	19.0	2.0	8.0	10.0	CHE	CHE
PHY	4.0	0.0	0.0	48.0	1.0	11.0	GEO	GEO
REI	5.0	0.0	11.0	2.0	2.0	21.0	IRE	IRE

[1] AKO, *Akodon* sp.; AUL, *Auliscomys micropus*; CHE, *Chelemys macronix*; ELI, *Eligmodontia typus*; EUN, *Euneomys* sp.; GEO, *Geoxus valdivianus*; IRE, *Irenomys tarsalis*; ORY, *Oryzomys longicaudatus*; PHY, *Phyllotis darwini*; REI, *Reithrodon auritus*.

those found by Herrera and Jaksic (1980) for Chilean barn owls. The inclusion of amphibians and the absence of reptiles by the Argentine owls were the main reasons for these differences.

Among mammals, the preponderance of rodents among the diets of Argentine owls made the H'NM diversity and evenness indices very low compared to those obtained for Chilean owls (Herrera and Jaksic 1980), which were more equally represented. In Chile, Spain and Argentina, the low consumption of the European rabbit is likely related to its large body size.

The correspondence analysis results concurred with results obtained by Pearson and Pearson (1982) and our prediction with respect to the gradient with which cricetid rodents are associated. Both species and localities were segregated by an aridity gradient.

Irenomys tarsalis occurred in the barn owl diet only near the *Nothophagus* forest. *Auliscomys micropus* was eaten only in forest or dense cover habitats but *Oryzomys longicaudatus* was eaten in all the habitats considered for this analysis. *Eligmodontia typus* occurred in the diet of owls only in open habitats with bare soil and scattered desert shrubs, *Ctenomys haigi* occurred in the diet in open areas with sandy soils, and *Calomys musculinus* and *Reithrodon auritus* occurred in the diet of birds associated with the arid portion of our gradient.

Observed consumption of *Reithrodon auritus* was, both in percent frequency and rank order, higher than expected. A similar situation was observed by Jaksic and Rau (1986) for the Great Horned Owl (*Bubo virginianus*) in a Chilean Patagonian steppe with about the same mammalian composition that we report. As in Europe and North America, comparison of the abundance of small mammal species is often susceptible to problems of differential trapability. On the other hand, *Akodon* sp. was consumed less than expected by chance in all five habitats. Perhaps their more diurnal activity period and small body weight contributed to these results (Taylor 1994). Based on our knowledge, the ecology of *Reithrodon auritus* and *Akodon* sp. resembles that of voles and mice described in North America and Europe (Marti 1974, Col-

vin 1984). There, barn owls frequently select voles in the presence of other prey, probably because the former are heavier and easier to catch (Taylor 1994). Three factors provide a plausible explanation. First, *R. auritus* (80.4 g) is 3 times heavier than *Akodon* sp. (28.0 g), even a bigger difference to that found between voles and mice (Marti 1974, Colvin 1984). Second, *Akodon* sp. shows greater activity during the daytime (Rau et al. 1981). The opposite is true for *R. auritus* which is a typical nocturnal species (Pearson 1988), thus overlapping its activity period with that of the barn owl. Finally, *R. auritus* feeds in open grassy habitat where it may be more exposed to owl predation, while *Akodon* sp. prefers dense bushes in the steppe (Pearson and Pearson 1982), perhaps gaining protection against owl predation.

LITERATURE CITED

BELLOCQ, M.S. 1990. Composicion y variacion temporal de la dieta de *Tyto alba* en ecosistemas agrarios Pampeanos, Argentina. *Vida Silvestre Neotropical* 2:32–35.

BRUNET-LECOMTE, P. AND M. DELIBES. 1984. Alimentacion de la lechuza comun *Tyto alba* en la cuenca del Duero, España. *Doñana, Acta Vertebrata* 11:213–229.

COLVIN, B.A. 1984. Barn owl foraging behaviour and secondary poisoning hazard from rodenticide use on farms. Ph.D. dissertation, Bowling Green State Univ., Bowling Green, OH U.S.A.

DE SANTIS, L.J.M., N.G. BASSO, J.I. NORIEGA AND M.F. GROSSMAN. 1994. Explotacion del recurso trofico por la lechuza de los campanarios (*Tyto alba*) en el oeste de Chubut, Argentina. *Stu. Neotrop. Fauna. Envir.* 29: 43–47.

DIGBY, P.G.N. AND R.A. KEMPTON. 1987. Multivariate analysis of ecological communities. Chapman and Hall, London, UK.

HERRERA, C.M. 1974. Trophic diversity of the barn owl *Tyto alba* in continental western Europe. *Ornis Scand.* 5:181–191.

——— AND F.M. JAKSIC. 1980. Feeding ecology of the barn owl in central Chile and southern Spain: a comparative study. *Auk* 97:760–767.

IRIARTE, J.A., W.L. FRANKLIN AND W.E. JOHNSON. 1990. Diets of sympatric raptors in southern Chile. *J. Raptor Res.* 24:41–46.

JAKSIC, F.M. AND J.L. YAÑEZ. 1979. The diet of the barn owl and its relation to the availability of prey. *Auk* 96: 619–621.

——— AND J.R. RAU. 1986. Prey and trophic ecology of Great Horned Owls in western South America: an indication of latitudinal trends. *J. Raptor Res.* 20:113–116.

LUDWIG, J.A. AND J.F. REYNOLDS. 1988. Statistical ecology, a primer on methods and computing. Wiley, New York, NY U.S.A.

MARTI, C.D. 1974. Feeding ecology of four sympatric owls. *Condor* 76:45–61.

MIKKOLA, H. 1983. Owls of Europe. T. & A.D. Poyser, Carlton, UK.

NORIEGA, J.I., R.M. ARAMBURÚ, E.R. JUSTO AND L.J.M. DE SANTIS. 1993. Birds present in pellets of *Tyto alba* (Strigiformes, Tytonidae) from Casa de Piedra, Argentina. *J. Raptor Res.* 27:37–38.

PEARSON, O.P. AND A.K. PEARSON. 1982. Ecology and biogeography of the southern rainforest of Argentina. Pages 129–142 *in* A.M. Mares and H.H. Genoways [Eds.], Mammalian biology of South America. Spec. Publ. Ser. 6. Pymatuning Lab. Ecol., Pittsburg, PA U.S.A.

PEARSON, O.P. 1983. Characteristics of mammalian fauna from forests in Patagonia, southern Argentina. *J. Mamm.* 64:476–492.

———. 1984. Taxonomy and natural history of some fossorial rodents of Patagonia, southern Argentina. *J. Zool.* 202:225–237.

———. 1986. Annotated keys identifying small mammals living in or near Nahuel Huapi National Park and Lanin National Park, southern Argentina. Unpubl. Manuscript.

———. 1987. Mice and the postglacial history of the Traful valley of Argentina. *J. Mamm.* 68:469–478.

———. 1988. Biology and feeding dynamics of a South American herbivorous rodent, *Reithrodon. Stud. Neotrop. Fauna Environ.* 23:25–39.

PIELOU, E.C. 1984. The interpretation of ecological data. Wiley, New York, NY U.S.A.

RAU, J., R. MURUA AND M. ROSEMANN. 1981. Bioenergetics and food preferences in sympatric southern Chilean rodents. *Oecologia* 50:205–209.

REDFORD, K.H. AND J.F. EISENBERG. 1992. Mammals of the Neotropics, the southern cone, Vol 2. Univ. of Chicago Press, Chicago, IL U.S.A.

RINGUELET, R.A. 1961. Rasgos fundamentales de la zoogeografía de la Argentina. *Physis* 22:151–170.

SAS. 1987. SAS/STAT Users guide version 6. SAS Inst. Inc. Cary, NC U.S.A.

SIEGEL, S. AND N.J. CASTELLAN. 1988. Nonparametric statistics for the behavioral sciences. McGraw-Hill. New York, NY U.S.A.

SMITH, J.D.B. AND J. COLE. 1989. Diet of the barn owl, *Tyto alba,* in the Tanami Desert, Northern Territory. *Aust. Wildl. Res.* 16:611–624.

TAYLOR, I. 1994. Barn owls, predator-prey relationships and conservation. Cambridge Univ. Press, Cambridge, U.K.

YALDEN, D.W. 1977. The identification of remains in owl pellets. Occas. Publ. Mammal. Soc., London, UK.