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FEEDING HABITS OF THE BARN OWL (*TYTO ALBA*) ALONG A LONGITUDINAL-LATITUDINAL GRADIENT IN CENTRAL ARGENTINA

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Resumen. – Dieta de la Lechuza de Campanario (*Tyto alba*) a lo largo de un gradiente longitudinal-latitudinal en Argentina Central. – Se analizó la dieta de la Lechuza de Campanario (*Tyto alba*) basada en muestras provenientes de nueve localidades a lo largo de un gradiente ambiental de 5º de latitud y 5º de longitud, sobre 500 km en dirección N-S y E-O, en la provincia de Buenos Aires (Argentina). Se identificaron 3251 items presa, principalmente roedores sigmodontinos nativos. *Oligoryzomys flavescens* fue la presa predominante hacia el noreste del gradiente, mientras que *Calomys* spp. fueron las presas más comunes hacia el sudoeste. La diversidad y riqueza de presas fue mayor hacia el sur. Los ensambles de roedores consumidos por la Lechuza de Campanario mostraron diferencias significativas entre aquellas localidades ubicadas en los extremos del gradiente, correspondientes a diferentes unidades fitogeográficas.

Abstract. – We studied the food habits of the Barn Owl (*Tyto alba*) based on samples from nine coastal localities along an environmental gradient of 5º of latitude and 5º of longitude, about 500 km N-S and E-W, in the Buenos Aires Province (Argentina). We identified 3251 prey items, mainly native sigmodontine rodents. *Oligoryzomys flavescens* was the predominant prey species in the diet of the owls in the northeastern part of the gradient, while *Calomys* spp. were the most common prey species toward the southwestward. Prey diversity and total vertebrate prey richness were greater towards the south. The rodent assemblages consumed by Barn Owls showed significant differences among the localities settled at the opposite extremes of the gradient, corresponding to different phytogeographic units. *Accepted 21 January 2006.*

Key words: *Tyto alba,* diet, environmental gradient, regional scale, latitudinal and longitudinal variation, Argentina.

INTRODUCTION

Habitat structure and environmental and geographical factors frequently affect the distribution and abundance of small mammals (e.g., Delibes 1985, Real *et al.* 2003). Small mammals studies based on raptor pellet analysis are valid tools to obtain new data on species presence, on population features in relation to climate and vegetation, and biogeographic information (e.g., Brunet-Lecomte & Delibes 1984, Marti 1988, Andrews 1990, Love *et al.* 2000, Pardiñas *et al.* 2003). Barn Owls (*Tyto alba*) inhabit open

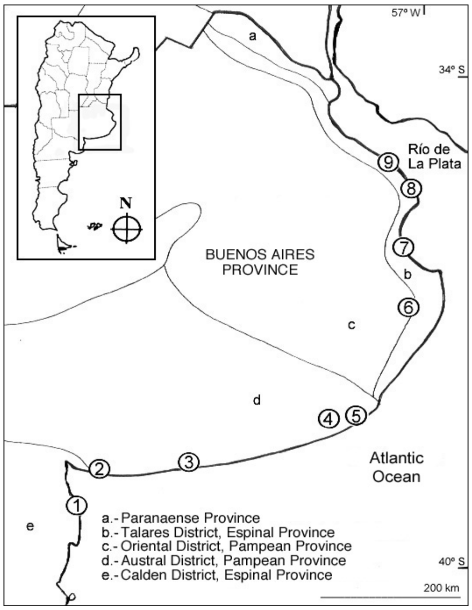

FIG. 1. Location of study sites in the Buenos Aires Province: 1) Puesto El Chara, 2) Balneario Pehuen-co, 3) Lin Calel, 4) Pieres, 5) Centinela del Mar, 6) General Juan de Madariaga, 7) Puesto El Plátano, 8) Punta Indio, and 9) Punta Lara.

landscapes and are opportunistic and generalist predators feeding mainly on small mammals as a function of their availability (Taylor 1994). Studies on geographical variation in the diet of Barn Owls revealed that it can reflect changes in the distribution of their prey (Alegre *et al.* 1989, Barbosa *et al.* 1992, Travaini *et al.* 1997, Bellocq 2000, Torre *et al.* 2004).

Food habits of Barn Owls have been extensively studied in different regions of southern South America (Jaksic 1996 and references therein, Pardiñas & Cirignoli 2002 and references therein). Based on published papers, Bellocq (2000) reviewed the principal characteristics of the trophic ecology of this owl in Argentina. Information about the diet of Barn Owls for the Argentinean pampas is particularly abundant (e.g., Massoia 1983, 1989; Bargo 1987, Faverín 1987, Amela García *et al.* 1990, Bellocq 1988, 1990; Bellocq & Kravetz 1994, Kittlein 1994). However, prior to this study, the geographical variation in the diet of the species at a regional scale had not been explored.

Species richness and diversity of small mammals in the littoral fringe of Buenos Aires Province vary spatially in response to different phytogeographic units (see Bilenca 1993, Galliari *et al.* 1991, Pardiñas 1999, for a synthesis of the distribution of sigmodontine rodents in Buenos Aires Province). In addition to providing new information on the trophic ecology of Barn Owls in the Pampean Region, here we test the feasibility of using Barn Owl food habits to describe changes in the composition and abundance of small mammals in the coastal region of the Buenos Aires Province. If Barn Owls demonstrate an opportunistic hunting behavior, some degree of variation would be expected in their diet along an environmental gradient. To analyze this, we explored different dietary parameters of Barn Owls in nine localities along an environmental gradient of the littoral fringe of Buenos Aires Province.

METHODS

Pellets were collected in the following localities (Fig. 1): 1) Puesto El Chara (39º26'17''S, 62º04'53''W), 2) Balneario Pehuen-co (38º-59'59''S, 61º37'07''W), 3) Lin Calel (38º-42'43''S, 60º15'03''W), 4) Pieres (38º24'08'S, 58º40'07''W), 5) Centinela del Mar (38º-26'04''S, 58º13'09''W), 6) General Juan de Madariaga (36º59'41''S, 57º08'41''W), 7) Puesto El Plátano (35º57'55''S, 57º27'11''W), 8) Punta Indio (35º16'33''S, 57º15'51''W), and 9) Punta Lara (34º49'25''S, 57º59'20''W) . All localities are situated at < 30 m elevation. We collected fresh pellets, mainly during 1999

TABLE 1. Prey frequency (%), total percent biomass (%B) and dietary parameters for pellets of Barn Owls from nine localities of the Buenos Aires Province, Argentina. W = mean prey weight; NS < 0.1%; N = number of prey.

Prey		Punta Lara		Punta Indio		Puesto El Plátano		Gral. J. Madariaga		Pieres		Centinela del Mar		Lin Calel		Balneario Pehuen-co		Puesto El Chara	
	W	%	%B	%	%B	%	%B	%	%B	%	%B	%	%B	%	%B	%	%B	%	%B
MAMMALIA																			
RODENTIA																			
Akodon azarae	28	35.0	35.4	18.0	18.5	63.0	57.2	25.0	34.9	5.0	7.5	28.0	35.3	12.0	18.8	6.0	6.5	24.0	32.7
Akodon molinae	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.0	3.1
Calomys spp.	14	10.0	5.1	NS	0.2	7.0	3.0	37.0	26.2	64.0	52.2	39.0	24.7	66.0	51.1	21.0	11.8	56.0	38.2
Cavia aperea	525	1.0	20.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ctenomys talarum	175	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.0	21.9	-	-
Eligmodontia typus	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52.0	43.8	1.0	1.2
Graomys griseoflavus	62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	2.6
Holochilus brasiliensis	326	-	-	2.0	27.4	2.0	19.3	-	-	-	-	1.0	8.0	NS	5.4	-	-	-	-
Mus domesticus	14	-	-	-	-	-	-	-	-	28.0	22.7	2.0	1.4	5.0	3.9	-	-	-	-
Necromys benefactus	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.0	5.9	-	-
Necromys obscurus	43	-	-	-	-	-	-	-	-	-	-	NS	0.5	-	-	-	-	-	-
Oligoryzomys flavescens	19	52.0	34.9	78.0	52.1	26.0	15.6	37.0	34.5	NS	0.4	29.0	24.7	15.0	15.7	13.0	9.5	-	-
Oligoryzomys longicaudatus	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.0	19.9
Oxymycterus rufus	76	1.0	1.5	NS	1.3	-	-	NS	0.8	-	-	1.0	3.7	-	-	-	-	-	-
Rattus sp.	160	-	-	-	-	-	-	NS	1.6	1.0	12.1	-	-	-	-	-	-	-	-
Reithrodon auritus	82	-	-	-	-	1.0	2.6	NS	1.7	1.0	4.6	NS	1.0	1.0	4.1	-	-	-	-
Scapteromys aquaticus	112	1,0	2,2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DIDELPHIMORPHIA																			
Monodelphis dimidiata	25	-	-	-	-	-	-	-	-	-	-	NS	0.6	-	-	-	-	-	-
Thylamys sp.	20	-	-	-	-	-	-	-	-	-	-	1.0	NS	-	-	-	-	NS	2.4
CHIROPTERA	20	-	-	-	-	NS	0.1	-	-	-	-	-	-	-	-	-	-	3.0	NS
BIRDS	31	-	-	NS	0.5	NS	2.2	NS	0.3	NS	0.6	-	-	NS	1.0	NS	0.6	-	-

TABLE 1. Continued.

Prey		Punta Lara		Punta Indio		Puesto El Plátano		Gral. J. Madariaga		Pieres		Centinela del Mar		Lin Calel		Balneario Pehuen-co		Puesto El Chara	
	W	%	%B	%	%B	%	%B	%	%B	%	%B	%	%B	%	%B	%	%B	%	%B
Total (N)		178		211		598		491		366		304		330		191		582	
Richness		6		6		7		7		7		9		7		7		7	
Richness (all rodent species)		6		5		5		6		6		8		6		6		6	
Richness (only exotic rodents)		0		0		0		1		2		1		1		0		0	
GMPW		28.28		28.22		31.03		20.17		17.45		22.15		18.27		25.11		25.11	
Shannon H' Log Base 10		0.455		0.292		0.449		0.496		0.401		0.566		0.461		0.596		0.596	
FNB		2.45		1.57		2.16		2.97		2.02		3.24		2.11		2.94		2.94	
FNBsta		0.29		0.11		0.19		0.33		0.17		0.28		0.19		0.32		0.32	

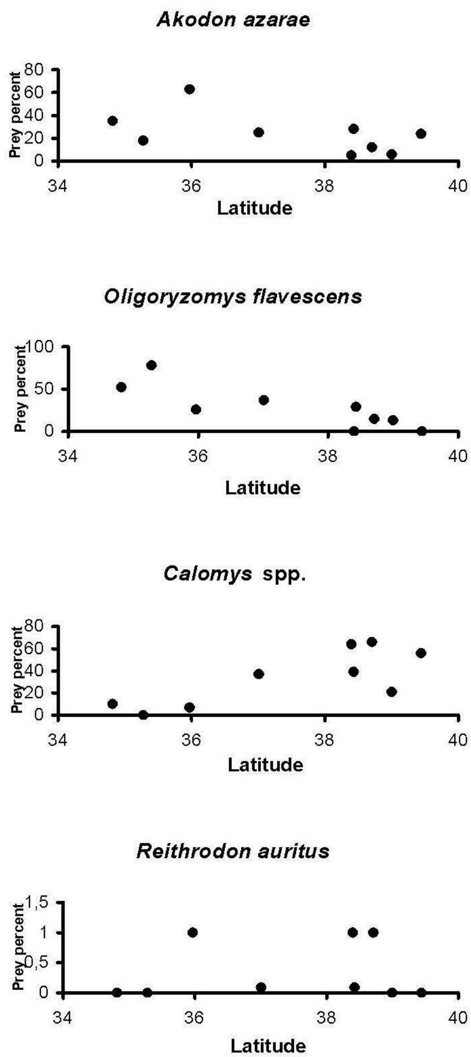

FIG. 2. Percent frequency of prey consumed by Barn Owls in > 50% of the localities studied, along a latitudinal gradient in the Buenos Aires Province, Argentina.

and 2000 breeding seasons, eliminating pellet fragments and debris.

Following the phytogeographic scheme of Cabrera (1968), localities 1 and 2 (Fig. 1) were positioned on an ecotonal area between the scattered remnants of xerophilous woodlands (Calden District, Espinal Province) and grasslands (Austral District, Pampean Province). Localities 3, 4, and 5 were located in the Austral District of the Pampean Region. Finally, localities 6, 7, 8 and 9 were located in the xerophilous woodlands of the Talares District in the Espinal Province. These four localities, from north to south, are in ecotonal situations with the riparian forests of the Paranaense Region (locality 9) and the grasslands of the Oriental District of the Pampean Region (localities 6, 7, and 8). Native grasslands through most of the Pampean Region have gradually been converted to agriculture over the last two centuries. Primary uses of the land are for cereal crops and livestock breeding.

Along the study gradient, mean annual precipitation decreases from 1400 mm (NE) to 400 mm (SW). The mean annual temperatures shows a similar trend, with values between 23ºC (NE) and 21ºC (SW) for January, and 10ºC (NE) and 7ºC (SW) for July (Burgos 1968). The thermal amplitude in the littoral fringe is regulated by the moderate action of the Atlantic Ocean (Burgos 1968).

Prey were identified and quantified on the basis of skulls and mandible pairs using reference collections of the Museum of La Plata (Buenos Aires, Argentina). Prey weights were obtained from literature (e.g., Reig 1965) and data we collected in the field. Invertebrate prey were not considered due to their very low number in pellets.

For each sample were calculated the following dietary parameters (Marti 1987): richness, diversity (Shannon's index; see Odum 1982), food niche breadth, standardized food niche breadth, geometric mean of prey weight, and trophic overlap (Pianka's index).

To evaluate potential differences between the small mammal assemblages of different phytogeographic units, we compare the trophic overlap index between localities of

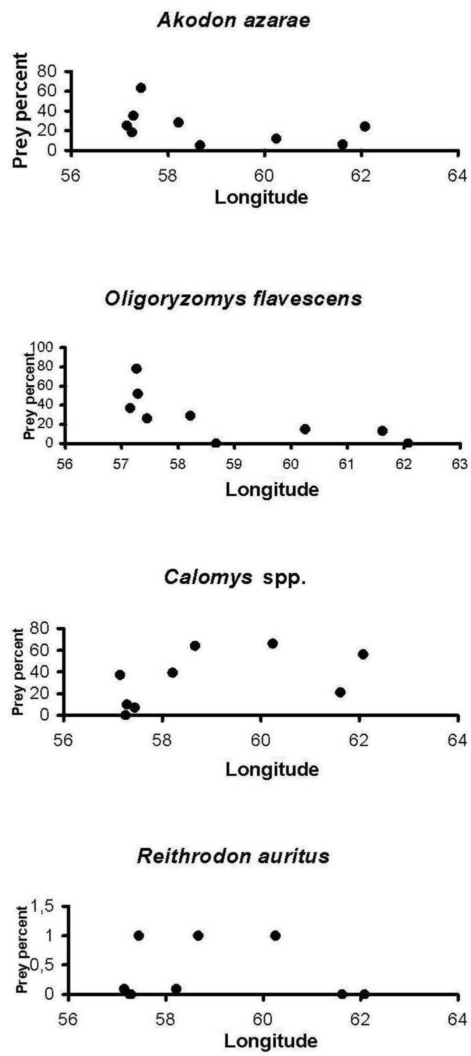

FIG. 3. Percent frequency of prey consumed by Barn Owls in > 50% of the localities studied, along a longitudinal gradient in the Buenos Aires Province, Argentina.

the same phytogeographic unit and between localities of different units. We expected that overlap index would be higher between localities of the same phytogeographic unit than between those of different phytogeographic units. To test this hypothesis, we used the Kolmogorov-Smirnov test (Zar 1999).

RESULTS

A total of 3251 prey items were identified, mostly native sigmodontine rodents. Frequencies of marsupials, bats, and birds were mostly negligible (Table 1). More than 60% of prey consumed in each locality were represented by one (four localities) or two taxa (five localities). *Akodon azarae*, *Calomys* spp. (including *C. laucha* and *C. musculinus*), *Oligoryzomys flavescens*, and *Reithrodon auritus* were registered in more than 50% of the studied localities. Frequency of *Calomys* spp. was correlated positively with latitude (r_s = 0.67, P < 0.05; Fig. 2), whereas frequency of *O. flavescens* was negatively correlated with latitude (r_s = -0.82, P < 0.01; Fig. 2). *A. azarae* and *R. auritus* did not follow any trend (r_s = -0.48, P > 0.10; r_s = 0.00, P = 1, respectively; Fig. 2). Regarding longitude, *O. flavescens* was negatively correlated (r_s = -0.88, P < 0.001; Fig. 3), while *Calomys* spp. followed an opposite trend (r_s = 0.58, P < 0.10; Fig. 3). Both *A. azarae* and *R. auritus* were not significantly related to longitude (r_s = 0.47 and -0.02, P > 0.10, respectively; Fig. 3). Exotic rodents like *Mus domesticus* and *Rattus* spp. were registered in four of the nine localities studied, with a high frequency in Pieres (28%) (Table 1).

The geometric mean of prey weight values varied between 17.45 and 28.28 and the food niche breath fluctuated between 1.57 and 3.24. Prey diversity and richness were positively related with latitude (r_s = 0.76; P < 0.05; r_s = 0.63; P < 0.10, respectively). Others dietary parameters did not follow any trend with respect to latitude. No trend was observed between dietary parameters and longitude.

The degree of trophic overlap between localities of the Austral District of the Pampean Region and the localities of the other

TABLE 2. Trophic overlap values for Barn Owl pellets from nine localities of the Buenos Aires Province, Argentina.

	Punta Indio[a]	Puesto El Plátano[a]	Gral. J. Madariaga[a]	Centinela del Mar[b]	Pieres[b]	Lin Calel[b]	Balneario Pehuen-co[c]	Puesto El Chara[c]
Punta Lara[a]	0.92	0.83	0.86	0.81	0.18	0.43	0.29	0.36
Punta Indio[a]	-	0.58	0.72	0.63	0.03	0.26	0.23	0.09
Puesto El Plátano[a]	-	-	0.69	0.72	0.15	0.34	0.21	0.44
Gral. Madariaga[a]	-	-	-	0.99	0.62	0.83	0.41	0.74
Centinela del Mar[b]	-	-	-	-	0.68	0.87	0.41	0.81
Pieres[b]	-	-	-	-	-	0.92	0.34	0.85
Lin Calel[b]	-	-	-	-	-	-	0.41	0.93
Balneario Pehuen-co[c]	-	-	-	-	-	-	-	0.38

[a]Talares District of the Espinal Province (northeastern of Buenos Aires Province).
[b]Austral District of the Pampean Province (east-central Buenos Aires Province).
[c]Caldén District of the Espinal Province (southwestern of Buenos Aires Province).

two districts was not significantly higher than that obtained between the localities within each district (Kolmogorov-Smirnov test, $P > 0.05$; Table 2). Rodent assemblages located in the district of the middle of the gradient were mostly similar to those of neighboring districts. On the other hand, the trophic overlaps between localities in the northeastern and southwestern districts were lower than those registered in localities within each district (Kolmogorov-Smirnov test, $P < 0.05$; Table 2). These results indicate that the rodent assemblages consumed by Barn Owls in the phytogeographic units located in the opposite extremes of the gradient were significantly different.

DISCUSSION

The trophic habits of Barn Owls along this environmental gradient are similar to those reported in other studies conducted in Argentina where the main prey items were rodents of the subfamily Sigmodontinae (e.g., Bellocq 2000). Two of the four sigmodontines rodents preyed by Barn Owls were differently consumed along the gradient. *Calomys* spp. was the main prey item of the owls toward the southwestern region, whereas *O. flavescens* was the predominant prey toward the northeastern sector. High frequencies of *Calomys* spp. in southern assemblages coincide with the more intensive agricultural use of lands in the Austral District of the Pampean Region (see Pardiñas 1999). Bilenca and Kravetz (1995) associated *Calomys* spp. with intensification of the agriculture in the Pampean Region. At the opposite extreme of the gradient, narrowly associated with the woodlands and wetlands of the La Plata River, small mammal communities are characterized by high frequencies of *O. flavescens* and *A. azarae* and by the presence of species with subtropical affinities (e.g., *Scapteromys aquaticus*, *Holochilus brasiliensis*). Other sigmodontine rodents such as *Necromys* spp., *Oxymycterus rufus* or *R. auritus* occupy natural grasslands and edges of agrosystems (Reig 1965) and, in some cases, present fragmentary distributions along the coastal fringe of the Buenos Aires Province which coincide with their discontinuous representation in owl pellet assemblages. Finally, small mammal assemblages at the southwestern extreme of the gradient are dominated by species adapted to moderate or dry climates and xerophyllous vegetation (*e.g., Akodon molinae*, *Eligmodontia* *typus*, *Graomys griseoflavus*, *Oligoryzomys longicaudatus*).

In Argentina, exotic rodents such as *M. domesticus* and *Rattus* spp. represent an important proportion in the diet of Barn Owls near urban and suburban areas (e.g., Massoia 1989, Nores & Gutiérrez 1990). The high proportion of *M. domesticus* in Pieres could be related to the neighboring regional cereal harbor of Quequén and the existence of numerous grain deposits in the area. As in our study, Kittlein (1994) found high predation of owls on *M. domesticus* near the harbor of Quequén. Apparently, Barn Owls have adapted their behavior to use these new resources (Jaksic 1998).

Geometric mean of prey weight in this study was lower than the 45.1 g reported by Marti *et al.* (1993) for temperate latitudes of South America. According to Bellocq (2000), the mean weight of the dominant prey species in the Pampean Region varies from 12.6 g (*C. laucha*) to 32.0 g (*A. molinae*).

The value of food niche breath (FNB) and standardized food niche breath (FNBsta) in this study were lower than those reported by Marti *et al.* (1993) for temperate latitudes of South America (FNB = 4.28; FNBsta = 0.18), and Bellocq (2000) for the Pampean Region (FNBsta = 0.35 ± 0.19). We did not find any obvious trend as a function of latitude or longitude. Coincidentally, Bellocq (2000) did not find a significant correlation between latitude and food niche breath at a national scale for Argentina. These patterns agree with Vasquez & Stevens (2004) who refuted the hypothesis that niche breadth would increase in direction of the tropics. On other hand, Jaksic *et al.* (1986) reported a decline of the food niche breath with latitude by studying the diet of Great Horned Owls (*Bubo virginianus*) in Chile.

Prey diversity had an opposite pattern than that found by Bellocq (2000) for species richness in Argentina, increasing toward the southwest. These differences could be related to the scale of the study. Bellocq (2000) worked at a national scale, while our study was conducted at a regional scale. The pattern that we found contradicts the prediction of a negative correlation between species diversity and latitude (Rohde 1992). This is an interesting result, because small mammal diversity and habitat heterogeneity increase toward the northeast (Bilenca 1993, Cueto & Lopez de Casenave 1999, Pardiñas 1999), indicating that Barn Owl prey diversity is apparently not related to habitat diversity, selecting the hunting habitat (Alegre *et al.* 1989, Barbosa *et al.* 1992). Moreover, in habitats where rodent diversity is high, Barn Owls can be more specialized and prey on larger animals (Varuzza *et al.* 2001). On other hand, Baker (1991) found a negative relationship between small mammal richness and latitude by studying the diet of Barn Owls along 575 km of the Texas Gulf Coastal Plain (United States).

In spite of some limitations and biases imposed by the trophic ecology of this owls (see Andrews 1990), the study of pellet assemblages has been successfully used in southern South America to study patterns of small mammal distributions along elevation and latitude gradients (e.g., Travaini *et al.* 1997, Pardiñas *et al.* 2003). Our results indicate that, in the littoral fringe of Buenos Aires Province, dietary parameters and trophic overlap were strongly influenced by the composition of rodent assemblages in the different phytogeographic units. In fact, at a regional scale, assemblages of sigmodontine rodents in owl pellet samples were consistent with the small mammal distribution in different vegetational units.

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