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SELECTIVE PREDATION BY NORTHERN SHRIKES ON SMALL MAMMALS IN A NATURAL ENVIRONMENT

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Abstract.—Selective predation by Northern Shrikes (*Lanius excubitor*) on small mammals was studied in northwestern Spain. Northern Shrikes preferred semi-open habitats and, as a consequence, preferred as prey the small mammal species associated with forest edges, farmland, scrubland, and other open areas with scattered shrubs and trees. Small mammal species related to other habitats were avoided. Northern Shrikes did not discriminate among the sizes and ages of small species of shrews, mice and voles, but did prefer smaller and younger individuals of medium-sized species.

DEPREDACIÓN SELECTIVA SOBRE MICROMAMÍFEROS POR *LANIUS EXCUBITOR* EN CONDICIONES NATURALES

Sinopsis.—Se ha estudiado la depredación selectiva de Alcaudones Reales (*Lanius excubitor*) sobre micromamíferos en el noroeste de España, mediante la comparación de datos sobre su dieta con datos sobre la disponibilidad de presas. Como consecuencia de la selección de hábitats semiabiertos por los Alcaudones Reales, las especies de micromamíferos discriminadas positivamente están asociadas a bordes de bosque o a zonas despejadas con cultivos, matorral, y arbustos y árboles dispersos. Por otra parte, las especies de micromamíferos vinculadas a otros tipos de hábitat fueron seleccionadas negativamente. Las aves seleccionaron positivamente tamaños pequeños e individuos jóvenes de especies medianas de múridos y arvicólidos, y no seleccionaron tallas o edades de las especies más pequeñas de sorícidos, múridos y arvicólidos.

True shrikes (Passeriformes, Laniidae) are principally insectivorous birds of medium or small size that are able to capture small vertebrates (reviews by Ali and Ripley 1987, Bent 1950, Cramp and Perrins 1993, Harris and Arnott 1988). Laboratory experiments have demonstrated that shrikes selectively capture small mammals within certain size classes, avoiding bigger ones that might provide a larger quantity of food but lower rates of net energy gain (Cade 1967 for *Lanius excubitor*; Craig 1978, Slack 1975 for *L. ludovicianus*; Carlson 1985 for *L. collurio*). Olsson (1984a) observed free-ranging Northern Shrikes killing shrews almost instantly, but taking about 1 min to kill larger voles.

To date, however, the patterns of selective predation by shrikes on small mammals have not been investigated in natural conditions. In this study, I present the taxonomic variety of small mammals captured by Northern Shrikes in southwestern Europe. I also compare their diet with prey availability, to determine whether selective predation on small mammals by Northern Shrikes occurs in this region.

STUDY AREA AND METHODS

The study area is located in the province of León, in the northwest of the Iberian Peninsula (42°35′–42°45′N, 5°25′–5°32′E; 800–1100 m above

sea level). Northern Shrikes are resident in the study area. The climax vegetation consists of deciduous oak (*Quercus pyrenaica*) with a few clusters of holm oak (*Q. rotundifolia*) (Rivas Martínez 1987). The landscape is composed of cereal cropland, woodland, scrubland, irrigable meadows and hedges. Shrike pellet collection was conducted in three habitat types: Ruiforco (scrub-deciduous oak), Sobarriba (cereal-fallow-scrub-deciduous oak) and Castrillino (scrub-holm oak). Small mammal trapping, however, occurred within the former two habitat types only.

I conducted this study during 1987–1989. I defined winter as December–March; spring as April–June; summer as July–August; and autumn as September–November. Diet of the Northern Shrike was studied through pellet analysis which, in this species, is considered a reliable qualitative and quantitative measure of small mammals eaten (Cade 1967, Olsson 1986). Pellets were obtained under perches regularly used by Northern Shrikes. I included for analysis a maximum of 10 pellets collected from any single perch site. The osseous remains of small mammals found in pellets were identified following determination keys and characteristics described by Darviche and Orsini (1982), Dueñas and Peris (1985), Nores (1978), and using a personal reference collection composed of small mammal species which inhabit the study area.

Availability of small mammals was determined using Hayne's (1949) method, which estimates their population density. Following the variant of this method suggested by Pelikán (1971), 64 trapping points, each separated by 15 m, were arranged in an 8 point × 8 point square, with two snap traps at each point. Zones visited frequently by Northern Shrikes were chosen for study. Bread, saturated with olive oil used previously for frying meat, was utilized as bait. Small mammals were baited at the trapping points, but not captured, during 6 d prior to trapping. After that, continuous sampling for 4 d was carried out in Ruiforco (scrub-forest) during February and for 3 d in Sobarriba (scrub-cereal) during February–March. Captured small mammals were collected at dawn each day. In Sobarriba, the traps were examined, but small mammals not collected, during the day to check for diurnal activity. The percentage of cover was estimated from both the shrublike stratum (0.5–2 m in height) and the arboreal cover (more than 2 m in height) within a 10-m radius of each trapping point.

To supplement the prey availability data, Barn Owl (*Tyto alba*) pellets were collected and analyzed in different habitats of the study area, taking into account the usefulness of this species diet composition as an indicator of the presence of small mammal species (Mikkola 1983, Saint Girons and Spitz 1966). Northern Shrikes and Barn Owls hunt mainly in open lowlands (Cramp 1985, Hernández 1994).

To evaluate interspecific selection, I used Jacobs's (1974) index:

$$D_{mi} = (r_{mi} - p_{mi})/(r_{mi} + p_{mi} - 2r_{mi}p_{mi}),$$

where r is the relative abundance in the diet and p the relative abundance in the samplings (trapping) of the species m in location i. This index

TABLE 1. Small mammal population densities (individuals/ha) in León, Spain, in winter, based on methodology by Hayne (1949) and Pelikán (1971). Number of trapped small mammals is in parentheses.

	Ruiforco Scrubland-Forest	Sobarriba Farmland mosaic
Crocidura russula	8 (9)	15 (16)
Apodemus sylvaticus	34 (37)	2 (2)
Mus spretus	—	1 (1)
Microtus arvalis	35 (22)	34 (36)
Estimated total density	65	52

varies between −1 (maximum negative selection) and 1 (maximum positive selection), with 0 value if there is no selection.

The selection of sizes and ages of each mammal species was studied by comparing biometric data and the deterioration of dentition of individuals captured by Northern Shrikes with data of the same type from trapped individuals or those found in pellets of Barn Owls, within the same season. Small mammal species found in the diet of Northern Shrikes were considered non-selected species in relation to their age (size) by the Barn Owl (Saint Girons 1973), which has been proved in this study in all cases it was possible (see results). I used Barn Owl data only if trapping data were lacking. I calculated allometric equations relating to osseous measures and body mass of small mammals (Morris 1979, Pagels and Blem 1984) using bones from pellets of owls as well as from trapped specimens. To study intraspecific selective predation by the shrikes and to calculate the allometric equations, I used owl pellets I collected in the study area.

Mice (*Apodemus sylvaticus* and *Mus* spp.) were classified into five age classes according to the deterioration of the molar cusps (Felten 1952, Saint Girons 1973): newborn (untouched molars), young (M^3 worn away), older young (M^3 and M^2 worn away), adult (M^3, M^2 and M^1 worn away) and older adult (M^3, M^2 and M^1 very worn away).

I used two-tailed *t*-test and contingency table (*G*-test; chi-squared if there was any 0 value) to verify statistical significance of analyses (Fowler and Cohen 1986, Sokal and Rohlf 1984).

RESULTS

Small mammal community.—The estimated total density of small mammals in winter was higher in Ruiforco (scrub-forest) than in Sobarriba (scrub-farmland) (Table 1), and the mammalian community in both places was significantly different ($\chi^2 = 27.79$, df = 3, $P < 0.001$). The average percentage of shrublike and arboreal cover at trapping points was 6.8% (SD = 9.42, $n = 64$) and 6.3% (SD = 11.42, $n = 64$), respectively, in Ruiforco, and 4.1% (SD = 5.20, $n = 64$) and 0.5% (SD = 2.31, $n = 64$), respectively, in Sobarriba. Shrubs appeared in 62.5% of the trapping points in Ruiforco and in Sobarriba, whereas trees appeared at 34.4% of

the Ruiforco trap points and 4.7% of the Sobarriba ones. On the basis of that, *Apodemus sylvaticus* showed preference for wooded zones, *Crocidura russula* and *Mus spretus* for zones with scrub and farmland, respectively, and *Microtus arvalis* occurred with equal regularity in both trapping places. The occurrence of those mammals in the diet of the Barn Owl in the different habitats was similar to that shown by trapping; moreover, the diet of the Barn Owl also produced data about other species of small mammals, indicating that *Sorex coronatus, Microtus agrestis* and *Microtus lusitanicus* occupied mainly hedges and scrubland-forest (Table 2). In a sample of 133 *Mus* individuals found in pellets of Barn Owls, *M. spretus* represented 95.5% and *M. musculus* 4.5%. In Sobarriba, 49.1% of trapped small mammals were captured at night, 25.5% in the morning, and 25.5% in the afternoon (n = 55 individuals). Thus, *C. russula* and *M. arvalis* were apparently partly diurnal, but the activity patterns of *A. sylvaticus* and *M. spretus* could not be determined from my trapping results.

Small mammals in the diet of Northern Shrikes.—In total, 466 vertebrate prey were identified. Significant interhabitat differences in small mammals were observed in winter diet (G = 24.72, df = 2, $P < 0.001$); thus, the relative frequency of insectivores in the shrike's diet was greater in places with increased shrublike and arboreal cover (i.e., Ruiforco and Castrillino) (Table 3). Considering only rodent families, no significant differences among habitats in diet were found (G = 2.30, df = 2, $P > 0.05$), with voles predominating in all cases. *S. coronatus* and *M. agrestis* were only captured by shrikes in zones of scrub with some arboreal cover (Ruiforco and Castrillino). *M. spretus* appeared in the pellets gathered in areas of farmland mosaic (Sobarriba). The remaining species (*C. russula, A. sylvaticus, M. arvalis* and *M. lusitanicus*) contributed to the diet of Northern Shrikes in all habitat types. No significant seasonal differences existed in their feeding, both in Ruiforco and in Sobarriba, and not only taking into account orders of small mammals (they always predominated the rodents), but also rodent families (they always predominated the voles) (G = 3.13, df = 3, $P > 0.05$, for orders of small mammals in Ruiforco; χ^2 = 6.33, df = 3, $P > 0.05$, for rodent families in Ruiforco; χ^2 = 0.31, df = 2, $P > 0.05$, for orders of small mammals in Sobarriba [no summer data were available]; χ^2 = 3.41, df = 1, $P > 0.05$, for rodent families in Sobarriba [no summer and autumn data were available]).

Interspecific selective predation.—A significant difference between the winter diet of Northern Shrikes and the availability of prey was observed in Ruiforco, both for small mammals in general (G = 19.74, df = 1, $P < 0.001$) and rodents in particular (G = 15.90, df = 1, $P < 0.001$); I found the percentages of insectivores and voles were comparatively higher in the diet than were available. In the winter data for Sobarriba, no significant differences existed between diet and overall small mammal availability (G = 0.58, df = 1, $P > 0.05$), but significant differences were found for rodents (G = 5.96, df = 1, $P < 0.05$), because the percentage of mice was comparatively larger in the diet than those species were available.

TABLE 2. Importance of small mammal species in the diet of *Tyto alba* in different localities and habitats of León, Spain, as determined by pellet analysis.

Habitat	Season	# small mammals	Abundance rank 1	2	3	4
Forest-Scrubland	Summer	320	*Crocidura russula*	*Apodemus sylvaticus*	*Microtus lusitanicus*	*Microtus arvalis*
Forest-Scrubland	Winter	188	*Crocidura russula*	*Microtus arvalis*	*Apodemus sylvaticus*	*Microtus lusitanicus*
Cereal cropland	Winter–Spring	464	*Mus* sp.	*Crocidura russula*	*Microtus arvalis*	*Apodemus sylvaticus*
Cereal cropland	Winter	37	*Mus* sp.	*Crocidura russula*	*Microtus arvalis*	*Apodemus sylvaticus*
Hedges-Meadowland	Autumn	195	*Crocidura russula*	*Microtus lusitanicus*	*Apodemus sylvaticus*	*Microtus agrestis*
Hedges-Meadowland	Summer	135	*Crocidura russula*	*Microtus lusitanicus*	*Apodemus sylvaticus*	*Sorex coronatus*
Hedges-Meadowland	Winter	100	*Crocidura russula*	*Microtus lusitanicus*	*Microtus arvalis*	*Apodemus sylvaticus*
Hedges-Meadowland	Winter–Spring	437	*Crocidura russula*	*Microtus arvalis*	*Apodemus sylvaticus*	*Mus* sp.
Hedges-Meadowland	Winter	71	*Crocidura russula*	*Microtus arvalis*	*Mus* sp.	*Apodemus sylvaticus*

TABLE 3. Percentage of small mammals in the diet of *Lanius excubitor* in León, Spain, as determined by pellet analysis.

	Ruiforco Scrubland-Forest				Sobarriba Farmland mosaic			Castrillino Scrubland-Forest
	Winter	Spring	Summer	Autumn	Winter	Spring	Autumn	Winter
Insectivora	34.9	66.7	52.0	37.5	22.8	19.1	—	59.0
Soricidae	34.9	66.7	52.0	37.5	22.8	19.1	—	59.0
Crocidura russula	24.9	33.3	20.0	18.8	18.1	14.3	—	52.5
Sorex coronatus	1.2	—	—	—	—	—	—	3.3
Undetermined Soricidae	8.9	33.3	32.0	18.8	4.7	4.8	—	3.3
Rodentia	60.9	33.3	48.0	62.5	74.5	64.3	100.0	39.3
Muridae	5.3	—	4.0	18.8	14.1	—	—	6.6
Apodemus sylvaticus	5.3	—	4.0	18.8	5.4	—	—	6.6
Mus spretus	—	—	—	—	6.7	—	—	—
Mus sp.	—	—	—	—	2.0	—	—	—
Arvicolidae	27.8	33.3	28.0	12.5	38.9	33.3	—	18.0
Microtus arvalis	8.3	—	24.0	6.3	28.2	14.3	—	6.6
Microtus agrestis	3.0	33.3	4.0	—	—	—	—	3.3
Microtus lusitanicus	7.1	—	—	6.3	6.7	2.4	—	3.3
Microtus sp.	9.5	—	—	—	4.0	16.7	—	4.9
Undetermined Rodentia	27.8	—	16.0	31.3	21.5	31.0	100.0	14.8
Undetermined small mammals	4.1	—	—	—	2.7	16.7	—	1.6
Total # small mammals	169	3	25	16	149	42	1	61

TABLE 4. Index of selective predation (Jacobs 1974) by *Lanius excubitor* on small mammals during winter at León, Spain.

	Ruiforco Scrubland-Forest	Sobarriba Farmland mosaic	BM[1]	BM[2]
Crocidura russula	0.80	−0.02	9.04 ± 0.97, n = 25	8.75 (1)
Sorex coronatus	1.00	—	—	—
Apodemus sylvaticus	−0.73	0.38	20.83 ± 2.93, n = 39	—
Mus spretus	—	0.70	—	—
Microtus arvalis	−0.60	−0.42	23.93 ± 6.76, n = 58	19.62 (3) (2)
Microtus agrestis	1.00	—	—	18.89 (4) (2)
Microtus lusitanicus	1.00	1.00	—	8.96 (5) (2)

[1] Average body masses (g) for trapped individuals.

[2] Body masses (g) for individuals captured by *L. excubitor* determined using allometric equations (numbers in parentheses correspond to equations in the text).

Values of the selection index indicate that Northern Shrikes in Ruiforco disproportionately selected *C. russula, S. coronatus, M. agrestis* and *M. lusitanicus,* and avoided *A. sylvaticus* and *M. arvalis* (Table 4). In Sobarriba, I found a strong preference for *M. spretus* and *M. lusitanicus,* moderate preference for *A. sylvaticus,* moderate avoidance of *M. arvalis,* and no apparent selection for *C. russula.*

Intraspecific Selective Predation

Allometric equations.—The correlation between the length of the lower mandible (ML, mm) and body mass (W, g) of trapped individuals was positive and significant in *C. russula* (1) and *M. arvalis* (2): (1) $W = 2.77ML - 18.62$, product moment correlation coefficient $r = 0.90$, df = 23, $P < 0.001$; (2) $W = 7.30ML - 86.16$, $r = 0.90$, df = 56, $P < 0.001$. There was a positive and significant correlation between the height of the first inferior molar (hM_1, mm) measured in the rear part and ML of *M. arvalis* (3), *M. agrestis* (4) and *M. lusitanicus* (5) from pellets of Barn Owls, Long-eared Owls (*Asio otus*) and Tawny Owls (*Strix aluco*): (3) $ML = 2.68hM_1 + 4.98$, $r = 0.86$, df = 72, $P < 0.001$; (4) $ML = 3.03hM_1 + 3.88$, $r = 0.85$, df = 28, $P < 0.001$; (5) $ML = 2.38hM_1 + 5.22$, $r = 0.75$, df = 23, $P < 0.001$. Average body masses for trapped individuals and estimated body masses for individuals captured by Northern Shrikes are presented in Table 4. I used equation 2 for voles of the genus *Microtus.*

Crocidura russula.—No significant differences existed between the mean ML found in pellets of Northern Shrikes (9.88 mm) and that of trapped individuals (9.98 mm) ($t = 1.55$, df = 103, $P > 0.05$; winter data). Thus, the Northern Shrike did not selectively prey upon particular size classes in this insectivore. Not enough data were available to analyze for *S. coronatus,* but its similarity in size to *C. russula* could mean that shrikes also did not select size classes in this species.

Apodemus sylvaticus.—The difference between the mean ML found in pellets of Barn Owls (13.82 mm) and that of trapped individuals (13.85 mm) was not significant ($t = 0.35$, df = 103, $P > 0.05$). This implies that the Barn Owl did not select for size in this rodent. In contrast, significant differences were observed among the age class frequencies found in pellets of Northern Shrikes and the age class frequencies in pellets of Barn Owls ($G = 15.48$, df = 3, $P < 0.005$; summer, autumn and winter data; Table 5), and illustrate that Northern Shrikes appear to catch younger *A. sylvaticus* preferentially.

Mus spretus.—Significant differences were not observed among the age class frequencies found in pellets of Northern Shrikes and of Barn Owls ($\chi^2 = 1.48$, df = 3, $P > 0.05$; winter data; Table 5). Therefore, the Northern Shrike did not select ages in this rodent, if we assume that Barn Owls did not select ages either.

Microtus arvalis.—The difference between the mean hM_1 of this rodent in pellets of Northern Shrikes (3.55 mm) and of Barn Owls (3.77 mm) was significant ($t = 3.38$, df = 123, $P = 0.001$; winter data). It thus appears that Northern Shrikes preferred to capture small sizes, if we assume that

TABLE 5. Percentages of the age classes of *Apodemus sylvaticus* and *Mus spretus* (Felten 1952, Saint Girons 1973) in the diet of *Lanius excubitor* and *Tyto alba* in León, Spain, as determined by pellet analysis for winter, summer and autumn data.

	Apodemus sylvaticus		*Mus spretus*	
	Lanius excubitor	*Tyto alba*	*Lanius excubitor*	*Tyto alba*
Age class				
Newborn	0.0	0.0	0.0	0.0
Young	21.7	4.8	0.0	8.9
Older young	47.8	19.4	71.4	58.2
Adult	21.7	61.3	28.6	24.1
Older adult	8.7	14.5	0.0	8.9
Total # individuals	23	62	7	79

Barn Owls did not select for size. The latter seems to be true, because the mean ML of *M. arvalis* in pellets of Barn Owls (15.09 mm) and in trappings (15.08 mm) did not differ significantly ($t = 0.06$, df = 138, $P > 0.05$).

Microtus agrestis.—The mean hM_1 in pellets of Northern Shrikes, 3.47 mm, was less than that in Barn Owl pellets, 3.70 mm, although the difference was not significant ($t = 1.96$, df = 18, $P > 0.05$; winter data). The sample size is small, however, and considering that *M. agrestis* is similar in size to *M. arvalis,* it is logical that Northern Shrikes also select small sizes in this case (note the lack of size selection by Barn Owls on *M. agrestis* is uncertain, since no trapping data were available).

Microtus lusitanicus.—There were no significant differences between the mean hM_1 of this rodent in pellets of Northern Shrikes (3.28 mm) and of Barn Owls (3.31 mm) ($t = 0.48$, df = 44, $P > 0.05$; winter data), indicating that shrikes may not select for size in this vole.

DISCUSSION

In the study area, Northern Shrikes occupied habitats characterized by the presence of shrubs and trees, which are necessary as nesting sites, night roosts and hunting perches. They also shelter against predators and aid in caching food. Nevertheless, shrikes were observed to forage in areas that had more than 80% of the surface covered exclusively by grassland (Hernández 1993, 1994). This habitat selection allowed them to capture selectively small mammal species associated with forest edges or open zones with farmland, scrubland, and scattered shrubs and trees. Similarly, Olsson (1984b) in a study carried out in Sweden during the winter pointed out the dependence of Northern Shrikes on semi-open habitats rich in *M. agrestis.* In Idaho, the majority of the rodents eaten by wintering Northern Shrikes were voles (*Microtus* spp.) (Atkinson and Cade 1993). The moderate preference for *A. sylvaticus* observed in Sobarriba was probably due to the lack of arboreal cover in the area chosen for small

mammal trapping rather than an actual positive selection of this species by shrikes. On the other hand, Northern Shrikes avoided *M. arvalis*, perhaps due to a lack of balance between the total availability of this rodent (very high) and that of preferred sizes.

Other insectivores and rodents which I found to inhabit the study area (i.e., *Erinaceus europaeus, Galemys pyrenaicus, Talpa* sp., *Neomys anomalus, Sciurus vulgaris, Eliomys quercinus, Arvicola sapidus, Arvicola terrestris*) did not appear in the diet of Northern Shrikes, presumably due to their excessive size and/or due to the woody, aquatic, or hypogeous habitats and microhabitats in which they occur. Bats, which are nocturnal, were not captured either. However, some of the aforementioned mammals are found occasionally as food of shrikes (e.g., moles in the diet of Northern Shrikes, bats in that of Red-backed Shrikes) (see Cramp and Perrins 1993). The partly diurnal activity of insectivores and rodents favors their capture by Northern Shrikes; nevertheless, a more thorough knowledge of the pattern of daily activity of each prey species would improve our knowledge about the trophic ecology of shrikes.

Northern Shrikes did not discriminate among the sizes of the smallest species of their prey (*C. russula, M. spretus* and *M. lusitanicus*), but selectively captured individuals under 20 g and the juveniles of larger species (*A. sylvaticus, M. arvalis* and *M. agrestis*). In Alaska, this shrike species ate more adult voles (40 g) than young ones (20 g), even during the period of greater availability of juveniles (Cade 1967). Cade also pointed out the low diversity and availability of more easily captured prey (e.g., insects) in that region, which may place a premium upon foraging for the largest individuals. At the same time, the larger size of Northern Shrikes in higher latitudes (reviews by Cramp and Perrins 1993, Olivier 1944) probably also favors the capture of big rodents.

The results I obtained corroborate the selection of species, sizes and ages of small mammals by shrikes in natural conditions. Other studies have demonstrated that several different bird species which feed on vertebrates are selective in their capture of prey (e.g., Donázar and Ceballos 1989, Morris 1979, Zamorano et al. 1986). These birds discriminate among the different population segments in their foraging habits, thus constituting another element of the trophic strategy developed by predators.

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LITERATURE CITED

Ali, S., and S. D. Ripley. 1987. Compact handbook of the birds of India and Pakistan. Second edition. Oxford University Press, Delhi, India. 737 pp.

Atkinson, E. C., and T. J. Cade. 1993. Winter foraging and diet composition of Northern Shrikes in Idaho. Condor 95:528–535.

BENT, A. C. 1950. Life histories of North American wagtails, shrikes, vireos, and their allies. Smithsonian Institution, Washington, D.C. 411 pp.

CADE, T. J. 1967. Ecological and behavioral aspects of predation by the Northern Shrike. Living Bird 6:43–86.

CARLSON, A. 1985. Central place food caching: a field experiment with red-backed shrikes (*Lanius collurio* L.). Behav. Ecol. Sociobiol. 16:317–322.

CRAIG, R. B. 1978. An analysis of the predatory behavior of the Loggerhead Shrike. Auk 95: 221–234.

CRAMP, S. (Ed.). 1985. The birds of the western Palearctic. Vol. 4. Oxford University Press, Oxford, United Kingdom. 960 pp.

———, AND C. M. PERRINS (Eds.). 1993. The birds of the western Palearctic. Vol. 7. Oxford University Press, Oxford, United Kingdom. 577 pp.

DARVICHE, D., AND P. ORSINI. 1982. Critères de différenciation morphologique et biométrique de deux espèces de souris sympatriques: *Mus spretus* et *Mus musculus domesticus*. Mammalia 46:205–217.

DONÁZAR, J. A., AND O. CEBALLOS. 1989. Selective predation by Eagle Owls on rabbits *Oryctolagus cuniculus*: age and sex preferences. Ornis Scand. 20:117–122.

DUEÑAS, M. E., AND S. J. PERIS. 1985. Clave para los micromamíferos (Insectivora y Rodentia) del centro y sur de la Península Ibérica. Ediciones Universidad de Salamanca, Salamanca, España. 38 pp.

FELTEN, H. 1952. Untersuchungen zur Ökologie und Morphologie der Waldmaus (*Apodemus sylvaticus* L.) und der Gelbhalsmaus (*Apodemus flavicollis* Melchior) in Rhein-Main-Gebiet. Bonn. Zool. Beitr. 3:187–206.

FOWLER, J., AND L. COHEN. 1986. Statistics for ornithologists. British Trust for Ornithology, Tring, United Kingdom. 175 pp.

HARRIS, T., AND G. ARNOTT. 1988. Shrikes of Southern Africa. Struik Winchester, Cape Town, South Africa. 224 pp.

HAYNE, D. W. 1949. Two methods of estimating populations from trapping records. J. Mammal. 30:399–411.

HERNÁNDEZ, A. 1993. Biología de la familia Laniidae (alcaudón real *Lanius excubitor* L., alcaudón dorsirrojo *Lanius collurio* L., y alcaudón común *Lanius senator* L.) en la cuenca de río Torío, provincia de León. Ph.D. thesis. León Univ., España.

———. 1994. Selección de hábitat en tres especies simpátricas de alcaudones (real *Lanius excubitor* L., dorsirrojo *Lanius collurio* L., y común *Lanius senator* L.): segregación interespecífica. Ecología 8, in press.

JACOBS, J. 1974. Quantitative measurement of food selection. A modification of the forage ratio and Ivlev's electivity index. Oecologia 14:413–417.

MIKKOLA, H. 1983. Owls of Europe. Poyser, Calton, United Kingdom. 397 pp.

MORRIS, P. 1979. Rats in the diet of the Barn Owl (*Tyto alba*). J. Zool. 189:540–545.

NORES, C. 1978. Clave para la identificación de cráneos de mamíferos ibéricos (excluidos los marinos). Universidad de Oviedo, Oviedo, España. 71 pp.

OLIVIER, G. 1944. Monographie des Pies-grièches du genre *Lanius*. Lecerf, Rouen, France. 326 pp.

OLSSON, V. 1984a. [The winter habits of the Great Grey Shrike *Lanius excubitor*. 3. Hunting methods.] In Swedish with English summary. Vår Fågelvärld 43:405–414.

———. 1984b. [The winter habits of the Great Grey Shrike *Lanius excubitor*. 1. Habitat.] In Swedish with English summary. Vår Fågelvärld 43:113–124.

———. 1986. [The winter habits of the Great Grey Shrike *Lanius excubitor*. 5. Choice of prey.] In Swedish with English summary. Vår Fågelvärld 45:19–31.

PAGELS, J. F., AND C. R. BLEM. 1984. Prediction of body weights of small mammals from skull measurements. Acta Theriol. 29:367–381.

PELIKÁN, J. 1971. Calculated densities of small mammals in relation to quadrat size. Ann. Zool. Fennici 8:3–6.

RIVAS MARTÍNEZ, S. 1987. Memoria del mapa de series de vegetación de España. ICONA, Madrid, España. 268 pp.

SAINT GIRONS, M. C. 1973. L'âge des micromammifères dans le régime de deux rapaces nocturnes, *Tyto alba* et *Asio otus*. Mammalia 37:439–456.

———, AND F. SPITZ. 1966. A propos de l'étude des micromammifères par l'analyse des pelotes de rapaces. Intérêt et limites de la méthode. Terre Vie 113:3–18.

SLACK, R. S. 1975. Effects of prey size on Loggerhead Shrike predation. Auk 92:812–814.

SOKAL, R. R., AND F. J. ROHLF. 1984. Introducción a la Bioestadística (Spanish translation from the original English edition). Reverté, Barcelona, España. 362 pp.

ZAMORANO, E., L. J. PALOMO, A. ANTÚNEZ, AND J. M. VARGAS. 1986. Criterios de predación selectiva de *Bubo bubo* y *Tyto alba* sobre *Rattus*. Ardeola 33:3–9.

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MEETINGS OF INTEREST

International Conference on Holarctic Birds of Prey, 17–22 April 1995, Badajoz, Spain

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Hawk Migration Association of North America Conference VII, 4–7 May 1995, Ramada Inn, Windsor, ON, Canada.

Address inquiries to: Robert C. Petit, HMANA Conference Chairperson, Monroe County Community College, 1555 South Raisinville Road, Monroe, MI 48161.

9th Annual Meeting of the Society for Conservation Biology, 7–11 June 1995, Colorado State University, Fort Collins, CO.

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V Neotropical Ornithological Congress, 5–11 August 1995, Asuncion, Paraguay.

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