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HABITAT USE AND DIET OF THE EURASIAN SCOPS OWL *OTUS SCOPS* IN THE BREEDING AND WINTERING PERIODS IN CENTRAL ITALY

USO DEL HÁBITAT Y DIETA DEL AUTILLO EUROPEO *OTUS SCOPS* DURANTE LOS PERÍODOS DE REPRODUCCIÓN E INVERNADA EN ITALIA CENTRAL

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Summary.—The Eurasian scops owl is one of the least known European nocturnal raptors. The species is declining throughout its distributional range, thus giving concern for its conservation status. We investigated seasonal shifts in its habitat use and diet in central Italy, where scops owl is a resident species in Central Tuscany. The owls used grasslands and human settlements during the breeding period, while woodlands were mainly used during the winter. The main prey species in the diet during the warm period were grasshoppers (Orthoptera, Tettigoniidae), whereas shrews (Soricomorpha) constituted the main prey during the winter. Thus, protecting extensive grassland would not suffice to conserve resident populations of Eurasian scops owls and preservation of mature deciduous woodlands with trunk cavities is also recommended.

Resumen.—El autillo europeo es una de las rapaces nocturnas europeas menos conocidas. Es una especie de interés para la conservación, ya que está disminuyendo en toda su área de distribución. El autillo anida en Italia y también algunos individuos pasan el invierno en la Toscana Central. Se investigaron los cambios estacionales en el uso del hábitat y la dieta de una población residente en el centro de Italia. Los autillos usaron las praderas y los asentamientos humanos durante el período de reproducción, mientras que los bosques fueron utilizados principalmente durante los meses fríos. Los saltamontes (Orthoptera, Tettigoniidae) fueron la principal especie de presa en el período reproductor, mientras que durante los meses fríos las musarañas constituyeron la mayor parte de la dieta. Por lo tanto, el favorecimiento de pastos extensivos no parece suficiente para preservar los autillos, siendo recomendable también la preservación de viejos robledales con cavidades en el tronco.

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Habitat loss due to agricultural alteration may lead to the decline of local animal populations (Sala *et al*., 2000; Thorbek and Bilde, 2004). Birds represent reliable bioindicators of this phenomenon (Temple and Wiens, 1989): in particular, raptors play a pivotal role for ecological conservation, as their occurrence is strictly correlated with biodiversity richness (Sergio *et al*., 2005). Among those, the Eurasian scops owl *Otus scops* Linnaeus 1758 (Aves: Strigidae) is a small, mainly insectivorous, nocturnal raptor. It breeds mainly in Mediterranean areas, as well as in parts of Asia (Cramp, 1985; Del Hoyo *et al*., 1999). It is a trans-Saharan migrant but there are a number of resident or wintering populations in southern Europe (BirdLife International, 2012). This owl is typical of traditional agro-pastoral systems and orchards. Thus its conservation would benefit other birds of conservation interest and several bat species (Cramp and Simmons, 1980; Treggiari *et al*., 2013). This species is declining in Italy, as well as in the rest of the western Palearctic (Cramp and Simmons, 1980; Marchesi and Sergio, 2005) mainly because of the recent intensification of agricultural practices (Arlettaz, 1990; Bavoux *et al*., 1997). On the other hand, its current abundance is not well estimated and refers only to breeding populations (Marchesi and Sergio, 2005). Its winter distribution in Italy is incompletely known: it mainly includes the southern regions (Brichetti and Fracasso, 2006), with scattered observations in North (Spina and Volponi, 2008) and Central Italy (Laurenti, 1987; Cignini and Zapparoli, 1996; Tellini Florenzano *et al*., 1997). Some wintering individuals have also been recorded in the Metalliferous hills (southern Tuscany; Mori *et al*., 2014), where Eurasian scops owls have long been recorded breeding (Vannini *et al*., 2013).

This species shows marked territorial behaviour during the breeding season (Galeotti and Sacchi, 2002), with a home range of about 30 hectares around the nest for each breeding pair (Cramp and Simmons, 1985; Mikkola, 1983). Territoriality has not been confirmed during the winter when calls are only occasionally recorded (Mori *et al*., 2014). In this study, we performed a two-year auditory survey in the Metalliferous hills to detect the presence of scops owls. We used points of occurrence to assess differences in habitat use between the breeding and winter seasons. Preliminary data of a shift in seasonal diet, based on collected pellets, are also shown.

The survey was carried out at "Poggi di Prata", a Site of Community Importance at Grosseto, Southern Tuscany. The elevation ranged from 474 to 938 m a.s.l. Habitat types included mixed deciduous woods (69.31%), fallows (12.55%), agricultural areas (5.45%), coniferous woodlands (3.12%), human settlements (1.86%) and scrub (7.71%) (cf. Cantini *et al*., 2013). During the survey, the ambient temperature ranged from -2.7°C to 26.6°C (median = 13.9°C, Q_1-Q_3 = 7.9°C-19.0°C: Mori *et al*., 2014).

The field study was carried out between March 2011 and February 2013. A 27 km route was driven by car, one night per week, every month and during any weather conditions to avoid artefacts (N = 104 total visits). The same 18 listening stations, about 1.5 km apart, were visited in the same order throughout the study period, starting after dusk and finishing not later than 23:30. Previous work with this population has shown that the probability of hearing a scops owl hooting was the same from dusk to midnight, without any significant peak (cf. Mori *et al*., 2014). Thus, bias due to different sampling periods at each station was unlikely. Observers remained at each station for two minutes in silence, to detect spontaneous calls and/or direct observations of the target species. Song playback was not used since broadcast calls may force individuals to move from their natural position, thus affecting their spatial behaviour. Four habitat categories (human settlements, fields, woodlands and scrub) were defined according to the main habitat types; we included fallows and agri-

cultural areas within the macro-category "field", and pinewoods and deciduous woodlands within "woodlands". Habitat categories were assigned to each owl location, by using a buffer zone of about 100 m in diameter. We performed a test based on the habitat types of the points of occurrence detected during a whole year, to assess differences in habitat use between the breeding and wintering periods (cf. McDonald, 2009). If the species was detected at the same station during different transects, only one contact was considered for the analysis within the same three months (*i.e.* the maximum duration of a defended territory for breeding scops owls: Scortecci, 1953), to avoid pseudo-replications.

Scops owl pellets were collected under perches or nest sites. They were softened in hot water, and then in 100% ethanol, to separate prey remains, *i.e.* bones and chitinous residues. These were identified to the lowest taxon possible, using taxonomic keys (mammals: Nappi, 2001; invertebrates: Roberts, 1999; Chinery, 2007), as well as private reference collections. Seasonal food choices were defined through the frequency of occurrence (Ni% = number of prey of each taxonomic group/total number of collected prey × 100) and relative biomass (B% = number of individuals of a taxonomic group × body mass of the same group/total biomass × 100).

The mean weight of each prey taxon was estimated by using data from Mediterranean areas (cf. Manganaro *et al*., 2000; Bertolino *et al*., 2001) or our own local sampling of Coleoptera, Arachnida and Sauria. *G*-tests of independence were applied to the number of prey items that appeared in the pellets, to study seasonal variation of the main items found in the diet (cf. Rocha *et al*., 2005). The Bonferroni correction for multiple testing was applied (Simes, 1986).

The number of scops owls breeding in the study area was impossible to determine with certainty. According to the number of observed nests, we assumed that at least 24 adult individuals may have been present during the breeding period. Given the mean home range sizes for this species in the Mediterranean area (Martínez *et al*., 2007), we also considered that a minimum of 5-7 individuals wintered within the study area, as they were detected at a minimum distance of 9 km apart (cf. Galeotti and Sacchi, 2002). The maximum number of different individuals detected at a single station during the same transect was four, during the breeding season. Habitat use was calculated for 116 contacts (N = 82 during the breeding period, 38 in the first year of survey, 44 in the second; N = 24 outside the breeding period, 10 in the first year of survey, 14 in the second). Significant differences were detected between the two periods ($\chi^2 = 71.48$, df = 1, $P < 0.001$), with human settlements ($\chi^2 = 38.29$, df = 1, $P < 0.001$) and fields ($\chi^2 = 36.29$, df = 1, $P < 0.001$) being the most used during the breeding period. Twelve nest sites were observed, seven of them within the village of Prata and the other five in cavities of isolated trees surrounded by fields. Woodlands represented the most used habitat types during the winter ($\chi^2 = 64.37$, df = 1, $P < 0.001$). Scops owls were never detected in scrub (fig. 1).

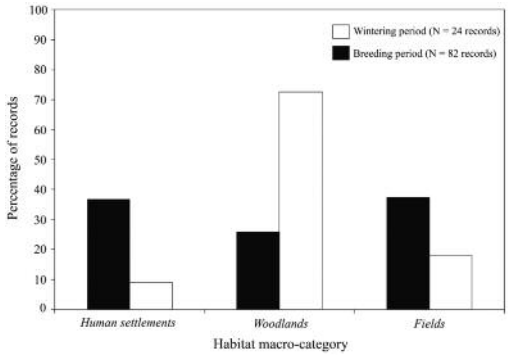

FIG. 1.—Percentages of use of habitat categories during the breeding and wintering periods.
[Porcentajes de uso de las categorías de hábitat durante los períodos de reproducción e invernada.]

A total of 39 pellets were collected, 31 during the breeding season (May-June, at 27 locations) and eight in winter (December-February, at 7 locations). The mean number of prey items per pellet was 1.86 ± 1.21. The diet substantially changed between breeding and non-breeding periods (table 1). Orthopterans were the staple diet during the breeding period (in 83.87% of pellets), followed by Coleopterans (in 77.42% of pellets). In winter, small mammals predominated in the diet (in 85.71% of pellets: table 1). Some broken seeds of *Oryza sativa* were also found in a winter pellet: these are likely to have consumed originally by a rodent.

TABLE 1

Diet composition of Eurasian scops owls: N, number of prey; Ni%, percentage of occurrence; B%, relative biomass. *G*-test with Bonferroni correction was applied to Ni% to assess seasonal diet variations: * significant *P*-values (< 0.05); ** highly significant *P*-values (< 0.01); NA, not applicable (number of records < 10% in at least one period).
*[Composición de la dieta del autillo europeo: N, número de presas; Ni%, porcentaje de ocurrencia; B%, biomasa relativa. Se aplicó la prueba estadística G con la corrección de Bonferroni a Ni% para valorar las estacionales en la dieta: * valores de P significativos (< 0,05); ** valores de P altamente significativos (< 0,01); NA, no aplicable (número de registros < 10% en al menos uno de los períodos).]*

			Body mass	**Breeding period**		**Wintering period**		***G*-test**
			(g)	N (Ni%)	B%	N (Ni%)	B%	
INSECTA	**Orthoptera**	Tettigonidae	1.3	**26 (83.87)**	**50.00**	**2 (25.00)**	**5.19**	**63.61****
	Coleoptera			**24 (77.42)**	**36.68**	**1 (12.50)**	**2.00**	**89.90****
		Carabidae	1	12 (38.71)	17.75	1 (12.50)	2.00	43.28*
		Geotrupidae	1.2	8 (25.81)	14.20	–	–	NA
		Tenebrionidae	0.8	4 (12.90)	4.73	–	–	NA
ARACHNIDA			**0.5**	**8 (25.81)**	**5.92**	**3 (37.50)**	**2.99**	**5.75***
REPTILIA	**Sauria**			**1 (3.23)**	**7.40**	**–**	**–**	**NA**
		Podarcis cf. *siculus*	5	1 (3.23)	7.40	–	–	NA
MAMMALIA	**Soricomorpha**			**–**	**–**	**6 (75.00)**	**47.90**	**NA**
		Suncus etruscus	2	–	–	1 (12.50)	3.99	NA
		Crocidura suaveolens	4	–	–	4 (50.00)	31.94	NA
		Unidentified shrews	7	–	–	1 (12.50)	13.97	NA
	Rodentia			**–**	**–**	**1 (12.50)**	**41.91**	**NA**
		Myodes glareolus	21	–	–	1 (12.50)	41.91	NA
Total number of prey				**59**		**13**		
Total biomass (g)					**67.60**		**50.10**	

The scientific literature describes the Eurasian scops owl as a nocturnal raptor typical of open, often grassy areas, with scattered trees (*e.g.* Cramp and Simmons, 1980; Marchesi and Sergio, 2005; Treggiari *et al.*, 2013), but no information on the ecology of European wintering populations was available before the present work. Although our small sample size does not allow us to draw general conclusions, most observations within our study area occurred in fields during the breeding period, thus confirming results by Treggiari *et al.* (2013) for Northern Italy. Thus, extensive grassland management practices represent one of the major conservation strategies for the target species during the breeding season (cf. Sergio *et al.*, 2009; Treggiari *et al.*, 2013). Scops owls living at altitudes above 500 m a.s.l., often choose to nest within human settlements, possibly because of the heat released by stone walls during the night (Marchesi and Sergio, 2005). Accordingly, in our study area, human settlements accommodated most of the nests found (70.59%), although they covered a negligible fraction of the study area (1.86%). Open habitats (*i.e.* fields) provide scops owls with an abundance of Orthopterans, which are the staple component of the summer diet of this species both in terms of frequency of occurrence and relative biomass. The substantial drop in temperature and thus of Orthopteran densities in winter may force owls to search for other food resources in secluded, warm environments (Robbins, 1983). This shift may also reflect an antipredatory strategy; during winter human settlements may attract predators (*e.g.* feral cats and stone martens *Martes foina*) due to the milder temperatures, thus posing an increased threat for scops owls, which may instead shelter in hollow logs of deciduous woodlands. Although an analysis of just eight pellets only allows very limited conclusions, preliminary data on winter feeding ecology suggest that shrews (Soricomorpha) represent the bulk of the diet during the cold months, both in frequency of occurrence and relative biomass. Consumption of Orthopterans fall from 83.87% during the warm months to 28.57% during cold ones, when the availability of this prey category reaches its annual minimum (Wolda, 1988). The presence of typical woodland species in the winter diet confirms that scops owls use woodlands not only to shelter during daytime but also as feeding sites during the cold months.

Eurasian scops owls were not individually recognisable so a more detailed study on habitat selection was not possible: a project involving ringing and/or radiotracking of some individuals may be useful to provide further support to our hypotheses.

The conservation of the Eurasian scops owl is a priority according to the European Birds Directive (Directive 79/409/EEC) and BirdLife International. Our results complement those of Sergio *et al.* (2009) and Treggiari *et al.* (2013), suggesting that careful management only of grasslands and open fields would not be sufficient to ensure long-term survival for the scops owl, at least among resident populations.

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