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Factors Influencing Numbers of Syntopic House Sparrows and Eurasian Tree Sparrows on Farms

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The House Sparrow (*Passer domesticus*) and the Eurasian Tree Sparrow (*P. montanus*) show differences in habitat use. The former is predominantly an urban and suburban species, while the Eurasian Tree Sparrow is more rural (Summers-Smith 1963, Pinowski 1967, Lack 1971, Cody 1974, Dyer et al. 1977). However, they often coexist along suburban-rural gradients (Cody 1974), where extensive diet overlap (Anderson 1978, 1984) and nest-site segregation (Anderson 1978, Cordero and Rodriguez-Teijeiro 1990) have been found. Some ecological (Pinowski 1967, Anderson 1978) and geographical (Summers-Smith 1963, 1988) evidence suggests that habitat differences, in part, may be modeled by competitive interactions during which the House Sparrow is dominant. Assuming that Eurasian Tree Sparrows are nest-site limited (Anderson 1978), I have analyzed the habitat characteristics of House and Eurasian Tree sparrows on farms where nest boxes were introduced to increase the available nest sites.

My objective was to determine the effects of different habitat variables on the breeding numbers of both House and Eurasian Tree sparrows on farms and at rural residences. I have examined the relationships between variables related to food, nest site, and the number of individuals of each species, both in natural holes and introduced nest boxes.

I studied 14 farms or houses in rural areas of Barcelona Province in northeastern Spain. All sites were used by man and were isolated, surrounded by cultivated fields or forest. Other hole-nesting species were absent except for a few pairs of European Starlings (*Sturnus vulgaris*) at one of the farms. I put up 10 to 131 nest boxes (Table 1) on buildings or on the nearest trees adjacent to them. In the breeding season I searched intensively for occupied nests (as in Cordero and Rodriguez-Teijeiro 1990) and checked nest boxes at three- to four-day intervals to determine whether they contained completed clutches. The number of sparrows was determined based on the total number of nest sites occupied and for which there was evidence of breeding. Also, cavities potentially available for nesting were noted.

Variables associated with food availability were related to vegetation cover and livestock (Dyer et al. 1977, Lowther 1983). The vegetational cover in the 100 m around each plot was measured, assuming that, normally, foraging trips were within that distance (Summers-Smith 1963, pers. observ.). The vegetation

was mapped and classified into agricultural land, including: (FORAGE) orchards, cereals and associated natural vegetation where sparrows foraged; (FOR-EST) woodlands, including Mediterranean oak, pine forest and Mediterranean scrub; and (GARDEN) gardens, including groves of several tree species and ornamental shrubs where the sparrows did not forage. Open fields supported agricultural activities, mostly intensive vegetable growing (89%), with the rest in alfalfa, wheat, barley and maize.

To evaluate livestock I considered cattle equivalents of domestic animal biomass (LIVESIND; Table 1). To obtain this, total mass was evaluated using the following estimated values: 0.325 kg for a domestic pigeon (*Columba livia*); 2.5 kg for a domestic fowl; 3.5 kg for a rabbit; 27 kg for a dog; 100 kg for a pig; 450 kg for a cow or bull; and 850 kg for a horse. Livestock except pigeons, dogs, and occasionally domestic fowl were in enclosed buildings; with the presence of livestock, an abundant food supply was provided for the sparrows (both vegetables and insects; Dyer et al. 1977, Lowther 1983).

I used the possible predictor variables summarized in Table 1. Other possible variables, such as year of investigation in the plot (in which nest boxes were introduced), elevation, distance to coast, distance to nearest farm or rural house, nest box support (tree or wall), and climatic features were excluded because the range of variation was minimal, or earlier descriptive analyses indicated that the variable was not important for this analysis.

Linear-multiple-regression analyses (Norusis 1985) were used to determine which of the factors best explained the observed numbers of House Sparrows and Eurasian Tree Sparrows in the plots. Before the analyses, I transformed the variables logarithmically (log) so that they were normally distributed and had homoscedastic variances (e.g. Zar 1984). The factors that could affect the numbers of birds (Table 1) were entered into the analyses with forward stepwise inclusion of variables (Norusis 1985). Four regression models were developed. In two, the dependent variables were the total number of House Sparrow nests (ALL-HS) and the total number of Eurasian Tree Sparrow nests (ALL-ETS). In the other two models, the dependent variables were the number of House Sparrow nests in nest boxes (HSBOX) and the number of Eurasian Tree Sparrow nests in nest boxes (ETS-BOX). For each final equation, the regression residuals

TABLE 1. Designation and description for variables included in multiple-regression analyses, with means, standard deviations and ranges observed at 14 sites.

Code	Description	$\bar{x} \pm SD$	Range
FORAGE	Percent cultivated land and associated vegetation cover	62.43 \pm 22.72	30-99
FOREST	Percent forest + scrub cover	29.28 \pm 24.25	0-60
GARDEN	Percent grove and scrub garden cover	4.29 \pm 7.28	0-20
TREES	Percent FOREST + GARDEN	33.57 \pm 22.57	0-60
LIVESIND	Livestock index ^a	11.86 \pm 26.93	0-98
CAVITY	No natural cavities	22.00 \pm 21.72	3-70
BOXES	No nest boxes	31.21 \pm 29.47	10-131
HSCAV	No House Sparrow nests in natural cavities	12.71 \pm 15.05	0-43
ETSCAV	No Eurasian Tree Sparrow nest in natural cavities	1.14 \pm 1.23	0-4
HSBOX	No House Sparrow nests in nest boxes	3.78 \pm 6.09	0-22
ETSBOX	No Eurasian Tree Sparrow nests in nest boxes	5.35 \pm 7.99	0-31
RHSCAV.	Ratio HSCAV/CAVITY	0.45 \pm 0.76	0.0-0.9
RETSCAV	Ratio ETSCAV/CAVITY	0.13 \pm 0.17	0.0-0.5
RPSCAV	Ratio (HSCAV + ETSCAV)/CAVITY	0.57 \pm 0.23	0.0-0.9
ALL-HS	No House Sparrow nests ^b	18.00 \pm 18.34	0-50
ALL-ETS	No Eurasian Tree Sparrow nests ^b	6.71 \pm 9.23	0-36

^a Cattle equivalents of domestic animal biomass calculated as the sum of estimated mean mass and total numbers of all domestic animal species in plot divided by estimated mean mass of cattle (450 kg).

^b Nests included that were in open (i.e. not in cavities or nest boxes).

met the assumptions for linear-multiple-regression analysis (e.g. Norusis 1985). Results are given as $\bar{X} \pm SD$.

Both House and Eurasian Tree sparrows occurred in 12 (86%) of the plots ($n = 14$), but the House Sparrow was more numerous than the Eurasian Tree Sparrow (Table 1; Wilcoxon matched-pair signed-ranks test, $z = -2.118$, two tailed, $P = 0.034$). The number of available natural cavities (CAVITY) was the most important factor affecting the total number of breeding House Sparrows (ALL-HS) explaining 54% of the variation (Table 2). Variables related to food availability (i.e. livestock index, percent of foraging areas) were not determinants for ALL-HS or, at least, they were not so within the range of variation found in the plots investigated (Table 1). LIVESIND, although approaching significance, did not enter in the regression equation. Although the relationship between the House Sparrow and presence of livestock is well documented due to the additional food supplies (e.g. Summers-Smith 1963, Dyer et al. 1977, Lowther 1983), agricultural land also supported high densities of sparrows. The sparrows concentrated in isolated buildings amid orchards and croplands; old roofs (with pottery tiles) in these areas provided numerous nest sites.

The total number of Eurasian Tree Sparrows (ALL-ETS) was positively related to the number of available nest boxes (BOXES) and negatively to the percent of total tree and scrub cover (TREES), which together

explained 57% of total variance (Table 2). The negative association with TREES is related to food availability. Food overlap between House and Eurasian Tree sparrows may be considerable in the breeding season (Anderson 1984). However, some differences in foraging ecology (a consequence of greater attachment of House Sparrows to humans) should exist between the two species. The House Sparrow could obtain food both from agricultural areas (including associated natural vegetation) and from areas close to human dwellings (e.g. food waste, livestock), while the Eurasian Tree Sparrow may obtain most of its food from agricultural areas in open fields where natural vegetation is common. An increase of woodland and gardens with tree plantation reduces the potential foraging areas ($r = -0.99$, $P < 0.001$), and this may limit the carrying capacity of the habitat for the Eurasian Tree Sparrow. This result does not contradict the findings of another study on habitat selection by the Eurasian Tree Sparrow, in which forests represented a secondary breeding area for the species (Pinowski 1967). In Pinowski's study, nest boxes were put up in villages and forests, while in mine the nest boxes were placed only near buildings. In both situations, Eurasian Tree Sparrows needed to increase foraging distance from the nests when forest coverage was extensive.

Although the numbers of nest boxes occupied by the two species were similar (Wilcoxon test, $z = -1.27$, two tailed, $P = 0.20$), proportionally, the Eurasian Tree

TABLE 2. Coefficients for multiple-regression equations used to predict total numbers of occupied nests and numbers of occupied nest boxes by the two species of sparrows. For total numbers of occupied nests, independent variables entered in the analyses were: BOXES, CAVITY, FORAGE, FOREST, GARDEN, TREES, and LIVESIND; also ALL-HS and ALL-ETS used as independent variables for analysis of the other species. For numbers of occupied nest boxes by the two species, independent variables were: BOXES, CAVITY, HSCAV, ETSCAV, RHSCAV, RETSCAV, RPSCAV, FORAGE, FOREST, GARDEN, TREES, and LIVESIND; also HSBOX and ETSBOX used for analyses of other species. Variable codes as in Table 1.

Dependent variable	Independent variable or intercept	Regression coefficient (b)	Significance level (two-tailed)	Cumulative adjusted R ²
ALL-HS	CAVITY	0.158	0.006	0.54
	Intercept	0.705	0.001	
ALL-ETS	BOXES	0.012	0.003	0.32
	TREES	-0.012	0.029	
	Intercept	0.704	0.002	
HSBOX	RPSCAV	1.895	0.002	0.63
	BOXES	0.005	0.044	
	Intercept	0.641	0.001	
ETSBOX	BOXES	0.187	0.000	0.79
	ETSCAV	1.825	0.003	
	FOREST	-0.087	0.007	
	HSCAV	0.103	0.027	
	Intercept	-1.880	0.088	

Sparrows used more nest boxes (75 of 94 total nest sites; 80%) than House Sparrows (53 of 252; 21%; $X^2 = 101.2$, $P < 0.0001$). The number of House Sparrow nests in nest boxes (HSBOX) was affected by the ratio of natural cavities occupied by both sparrow species (RPSCAV) and by the number of available nest boxes (BOXES), which together explained most of the variation (79%; Table 2). This I interpreted to be the result of nest-site preference and the dynamics of nest-site occupation. The House Sparrow does not readily occupy nest boxes when natural cavities are available; however, when natural cavities are scarce or the resource is saturated, nest-box occupation increases if nest boxes are abundant.

Occupation of nest boxes by Eurasian Tree Sparrows (ETSBOX), was related to the number of available nest boxes (BOXES), the number of Eurasian Tree Sparrow nests in natural cavities (ETSCAV), the percent of forest cover (FOREST; negative relationship), and the number of House Sparrow nests in natural cavities (HSCAV). Together, these explained 94% of the variation (Table 2). Nest boxes were a limiting factor for the Eurasian Tree Sparrow in the plots colonized mostly by House Sparrows. Although the number of Eurasian Tree Sparrow nests in natural

cavities (ETSCAV) was small (Table 1), nonbreeding individuals also were around; they readily occupied nest boxes when they were put up. House Sparrow nests in natural cavities (HSCAV) also could affect the number of Eurasian Tree Sparrow nests in nest boxes by competitive displacement and differential nest-site preference.

In rural areas, where the building of open nests is uncommon (e.g. Cordero and Rodriguez-Teijeiro 1990), numbers of breeding House and Eurasian Tree sparrows on farms are primarily limited by the presence of the available nest sites (e.g. Kendeigh 1934, MacKenzie 1946, von Haartman 1971). I did not find a negative relationship between the numbers of the two species. Notice, however, that the aim of my study was not to investigate interspecific competition between the species under conditions of abundant nest sites; such a study would require a quite different approach.

Some additional and unexplained variation in the number of House and Eurasian Tree sparrows may be due to uncontrolled variables. Certain cultural factors and/or local predation rates may influence whether sparrows occupy available nests sites on farms or rural houses supplied with nest boxes.

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Song Differences Between North American and European White-winged Crossbills (*Loxia leucoptera*)

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According to my experience, the song of the White-winged Crossbill (*Loxia leucoptera*; referred to as the Two-barred Crossbill in Europe) in eastern Canada is distinctly different from that of Fennoscandian birds. I heard about 20 singing individuals in New Brunswick, Canada, in August 1991. They all had a song similar to that generally described in North American field guides. This song includes a long series of loud trills on different pitches, each trill being monotonous and reminiscent, for example, of a singing Greenfinch (*Carduelis chloris*), a calling Common Redpoll (*Acanthis flammea*), or a singing Arctic Warbler (*Phylloscopus borealis*). Four recordings of singing White-winged Crossbills from Ohio and Maine, supplied by the Cornell Laboratory of Ornithology, all feature the same song type.

In contrast, the White-winged Crossbills that I have heard in Sweden and Finland (June-October) all have had a very different song. It is rich and varied, consisting mainly of clear (metallic) and slurred whistles, but also of chatters and wheezes. This song is frequently interspersed with any of the three basic flight calls (Elmberg 1991). This song type, thus, is reminiscent of the song of the Red Crossbill (*L. curvirostra*) or the Parrot Crossbill (*L. pytyopsittacus*). Note that the recording of a singing White-winged Crossbill on *All the Bird Songs of Europe* (Roché 1990) is also a Canadian bird (Jean C. Roché pers. comm.).

Recent suggestions of the occurrence of cryptic species in the Red Crossbill (Groth 1988) highlights the importance of knowing whether the song of the White-winged Crossbill differs consistently between the Palearctic and the Nearctic. In comparison with its closest relatives (see Knox 1990, Tyrberg 1991), the taxonomy and phylogeny of the White-winged Cross-

bill have received little attention (cf. Griscom 1937). Thus, better knowledge of the song (and other vocalizations) of the White-winged Crossbill is needed from all parts of its range. I especially urge birders and professional zoologists to record and describe singing White-winged Crossbills from eastern Russia, western North America, and Hispaniola, where the geographically isolated *L. l. megaplaga* occurs.

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