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Short communication

Recent declines in urban Italian Sparrow *Passer* (*domesticus*) *italiae* populations in northern Italy

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During the last quarter of the 20th century, the House Sparrow *Passer domesticus* declined greatly in numbers throughout its western European breeding range (Summers-Smith 1988, BirdLife International 2004). This followed an increase during the 19th century that matched the expansion of human settlements (Holloway 1996). Population declines have occurred in both urban and rural areas, but have been more severe in the former, raising considerable public concern (Summers-Smith 2003, Robinson *et al.* 2005). The reasons for this decline have been investigated in detail on British farmland, where complex source–sink dynamics of local populations were identified (Hole *et al.* 2002). Food supplementation experiments showed that the decline could be related to a reduction in winter food supplies (Hole *et al.* 2002), due to the progressive shift from spring to autumn sowing of cereals (Chamberlain *et al.* 2000, Robinson & Sutherland 2002). In addition, the recent introduction of hygiene regulations and the increased efficiency of harvesting machines has led to a marked reduction of spilt grains and seeds available to granivorous farmland birds, including sparrows (Robinson & Sutherland 2002, Robinson *et al.* 2005). Factors affecting the decline of urban populations are less well understood (Summers-Smith 2003, Robinson *et al.* 2005). In Britain, urban populations declined by 60% between 1970 and 2000, although with some geographical variation (Robinson *et al.* 2005). Among the possible causes, a reduction of nest-site availability due to improvements in quality and insulation of rooftops and a reduction of food availability due to loss of weedy corners from urban areas have both been suggested as likely explanations, as was an increased transmission of epidemic diseases (Summers-Smith 2003, Robinson *et al.* 2005).

The status of European populations of the House Sparrow is variable, although widespread recent declines in western countries have prompted its current evaluation to the SPEC 3 (poor conservation status) category from a previously non-SPEC (secure) designation (BirdLife International 2004). However, in the same assessment Italian populations were wrongly classified as 'stable', as an unrealistically small estimate of 50–100 000 pairs of *Passer domesticus* (which lives only in the Alps and along the northeast and northwest borders of Italy) was taken to represent the total Italian population (BirdLife International 2004), thus excluding the much larger *italiae* population (5–10 million pairs: Brichetti & Gariboldi 1997) from the evaluation (Massa 2006).

In this study we analysed population trends of the Italian Sparrow *Passer* (*domesticus*) *italiae* in six urban areas of northern Italy from 1996 to 2006, by undertaking a detailed survey of breeding adults at 85 buildings in 1996, 1998 and 2006, and describing between-year variation in population size.

The taxonomic status of the Italian Sparrow has been widely debated. According to the most recent review (Töpfer 2006), the phenotypically distinctive form *italiae*, which occurs from the Alps southwards to parts of North Africa, deserves full species rank (*P. italiae*), of which the closely related Spanish Sparrow should be regarded as a subspecies (*P. i. hispaniolensis*), both being clearly separated from *P. domesticus*. Earlier views pointed towards *P. italiae* being a stable hybrid between *P. hispaniolensis* and *P. domesticus* (reviewed in Töpfer 2006). However, later analyses (Fulgione & Milone 1998, Milone *et al.* 2002; but see Allende *et al.* 2001) showed a distinct character breach between *italiae* and *domesticus* in the Alps and a clinal transition to *hispaniolensis* in southern Italy, both at the genotypic and at the phenotypic levels. The authors therefore concluded that *italiae* derived from an ancestral *hispaniolensis* form and is therefore not the result of hybrid stabilization (Milone *et al.* 2002), for which there is no empirical evidence in birds (Helbig *et al.* 2002).

METHODS

Birds were counted at six sampling sites (four towns and two cities) in Lombardy, northern Italy (Fig. 1), at altitudes ranging between 42 and 262 m asl. At each sampling site, a single observer recorded the number of adult Sparrows along a road transect of 1.8–2.3 km, in each city (Brescia and Busto Arsizio) from the outskirts to the centre, and in each town from the outskirts, through the centre and out to the outskirts on the other side. Each transect was walked twice (at 7–14-day intervals, in the morning) during the breeding seasons (April to mid May, therefore excluding

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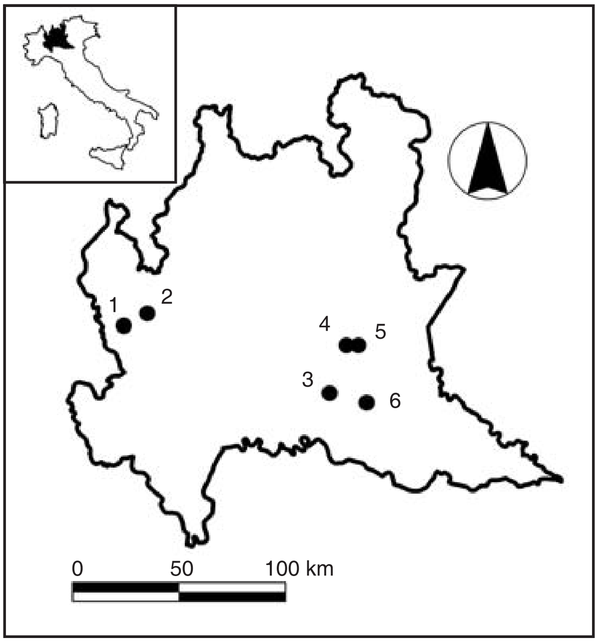

Figure 1. Map of the Lombardy region showing the six sampling sites where Italian Sparrow censuses were carried out (numbered from west to east: 1, Busto Arsizio, 45°36′N, 08°50′E; 2, Cislago, 45°39′N, 08°58′E; 3, Verolavecchia, 45°19′N, 10°03′E; 4, Roncadelle, 45°31′N, 10°09′E; 5, Brescia, 45°31′N, 10°13′E; 6, Gottolengo, 45°17′N, 10°16′E). Inset: location of Lombardy within the Italian peninsula.

the occurrence of newly fledged birds) of 1996, 1998 and 2006. The maximum number of birds counted within each season was used in the analyses. Along each transect, at an approximately even spacing, we selected 12–17 buildings with differing characteristics (see below; $n = 87$, mean per transect = 14.5) where we counted the number of breeding Sparrows (if any). Focal buildings were selected according to ease of counting, regardless of the occurrence of Sparrows on them. Between 1998 and 2006, two of the 87 buildings underwent extensive renovation and were thus excluded from the analyses. Censuses along transects were repeated by the same observer walking at a slow pace following the same route each year. The observer stopped for 5 min at each of the selected buildings and counted the maximum number of adult individuals on it. The total number of individuals recorded along a given transect included also all the individuals counted on focal buildings along that transect. Clearly, an unknown proportion of individuals may not have been observed along transects or on buildings during the count. Nevertheless, our census method is likely to have provided a reasonably accurate estimate of overall abundance, as repeated counts carried out five times over 15 days at one of our sampling sites (Gottolengo) detected only a 20% difference between maximum and minimum counts along transects (including building counts) (P. Brichetti unpubl. data). At Verolavecchia, we also estimated the sex ratio, and this averaged eight males per female. Therefore, the counts included mostly males, and could be regarded as a rough estimate of the number of breeding pairs, although the focus of this study was examining between-year changes rather than obtaining accurate census figures.

In order to assess the effect of building characteristics on Sparrow abundance, we recorded for each building the following variables: location (as 'old town', usually including historical buildings, 'urban areas', the residential belt, or 'suburban areas', the outer belt), building type ('agricultural-industrial', 'residential' or 'non-residential'), rooftop type ('flat tile covering', 'angled tile covering', 'other'), building age ('pre-1950' or 'post-1950') and estimated building height (m).

Due to the small sample size ($n = 6$ sampling sites × 3 years), the between-year variation in Sparrow counts on transects (expressed as individuals/km) was assessed by a non-parametric repeated-measures test (Friedman test), where yearly counts of each sampling site were regarded as replicates.

Between-year variation in building counts was assessed by means of a repeated-measures generalized linear model assuming a negative binomial error distribution and a log link function, fitted by means of the SAS (ver. 9.0) GENMOD procedure. The negative binomial error distribution, a natural extension of the Poisson distribution, was adopted instead of the Poisson distribution because its greater flexibility allowed us to control for Poisson overdispersion in our models (SAS Institute 1999, Hoffman 2003). The correlations between the counts in different years were modelled as autoregressive correlations, although other covariance structures yielded qualitatively identical results. In this model, individual buildings (nested within sampling site) were regarded as subjects, while sampling site, year, location, building type, rooftop type and building age were included as between-subject effects, and estimated building height was included as a covariate. All two-way interactions between factors and year were included in the initial model, which was subjected to a stepdown simplification procedure, following Crawley (1993), until a minimal adequate model, including only significant ($P < 0.05$) predictors, was obtained. Hypothesis testing was carried out by means of the generalized score statistic, which approximates the χ^2 distribution (SAS Institute 1999).

RESULTS AND DISCUSSION

Across all transect counts, we recorded a mean abundance of 60.9 individuals/km (95% CL 39.2–82.5, $n = 18$ counts). Road transect abundance varied significantly between the study years (Friedman test, $\chi^2 = 12$, $df = 2$, $P = 0.002$), with an average 49% (95% CL 34–63%, $n = 6$ sites) decline between 1996 and 2006 across all sampling sites (Fig. 2).

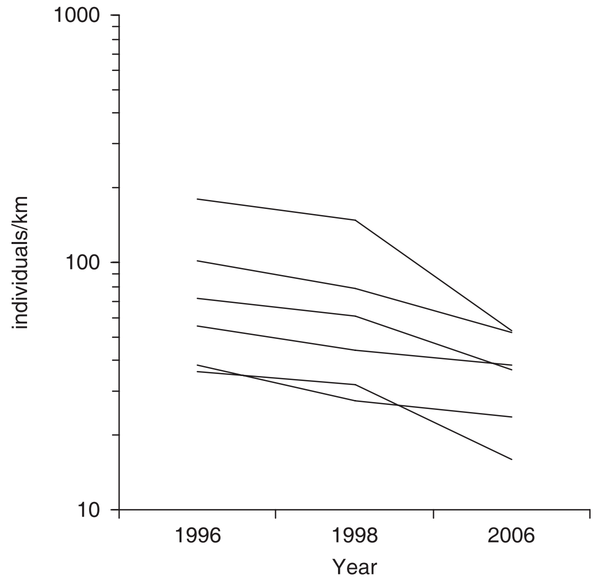

Figure 2. Road transect abundance (individuals/km; note the logarithmic *y*-axis scale) of Italian Sparrows at six urban sampling sites in northern Italy between 1996 and 2006.

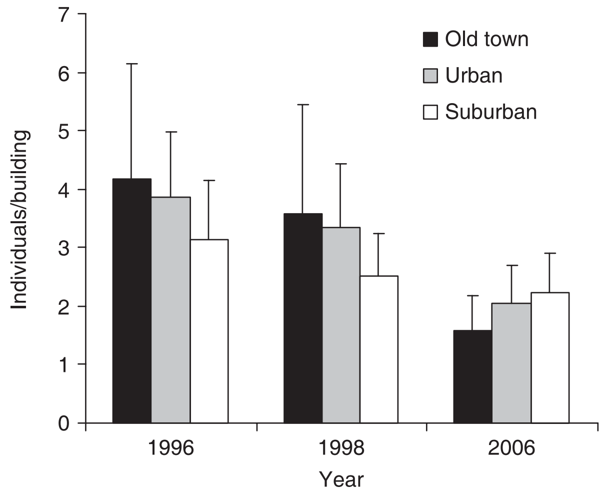

Figure 3. Abundance of Sparrows on focal buildings in old town, urban and suburban areas at six urban sampling sites in northern Italy between 1996 and 2006. Bars represent mean and 95% CL. Sample size for each year was 24, 34 and 27 buildings for old town, urban and suburban areas, respectively. *Post-hoc* contrast analyses from the repeated-measures general linear model of count data (see Methods) showed that there were significant differences between all years (1996 vs. 1998, $\chi^2 = 9.22$, $df = 1$, $P = 0.002$; 1996 vs. 2006, $\chi^2 = 22.1$, $df = 1$, $P < 0.0001$; 1998 vs. 2006, $\chi^2 = 14.2$, $df = 1$, $P = 0.0002$; significance tests based on the generalized score statistic, see Methods).

On focal buildings, between 1996 and 2006 there were five colonizations (6% of buildings) and 15 extinctions (18% of buildings), a significant difference (binomial test, $P = 0.041$). Of the focal buildings, 12 in 1996, 11 in 1998 and 21 in 2006 held no Sparrows. The mean abundance was 2.95 individuals per building (95% CL 2.58–3.32, $n = 255$ counts). The minimal adequate model showed that the between-year change was highly significant ($\chi^2 = 22.4$, $df = 2$, $P < 0.0001$) (Fig. 3). The decrease from 1996 to 2006 was 62% for old town buildings, 46.6% for urban buildings and 29.4% for suburban buildings and was statistically significant for all three locations (Wilcoxon matched-pairs test, old town, $P = 0.003$; urban, $P < 0.0001$; suburban, $P = 0.042$) (Fig. 3). However, there were no significant differences in the rate of decline among different locations in the repeated-measures model due to large variance in counts, especially in the earlier years (see CL of Fig. 3; location × year interaction, $\chi^2 = 7.50$, $df = 4$, $P = 0.11$), and there was no effect of location *per se* ($\chi^2 = 0.57$, $df = 2$, $P = 0.75$). The other variables and their interactions had no significant influence on Sparrow counts on buildings (details not shown).

Our data, although limited to a few areas of northern Italy, suggested that urban Italian Sparrow populations have undergone a significant decline in recent years, which may amount to a reduction of 50% of the breeding population within 10 years. In our study areas, such decline appears to have been continuous. For example, in Verolavecchia, where we had additional data for 2000 and 2003, the mean numbers of individuals per building were 6.05, 5.35, 4.35, 2.82 and 2.40 for the years 1996, 1998, 2000, 2003 and 2006, respectively (figures for transects were similar). The decline was more pronounced in urban than in suburban areas, and particularly marked in old towns, although this difference did not reach statistical significance in our model. This pattern matches studies of House Sparrows in Great Britain, where urban populations declined by 60% from 1970 to 2000, whereas rural ones declined by 47% (Robinson *et al.* 2005).

The census method, involving repeated counts on the same buildings in successive years, is likely to provide a very accurate picture of the local population status, as it is not confounded by variation in quality of breeding sites or renovations. Indeed, none of the recorded characteristics of buildings nor their location affected our counts of breeding Sparrows, which appeared to be distributed rather homogeneously across the urban areas we censused. This suggests that some of the previously proposed explanations for the decline of urban House Sparrows in Britain, such as the improved insulation and quality of rooftops, may not hold for the Italian Sparrow, despite a similar rate of decline (Robinson *et al.* 2005). In fact, it appears that the availability of suitable nest-sites did not change in our focal buildings over the study period, as we excluded from the analyses the few buildings subjected to renovation (see Methods). Moreover, Sparrows were not more abundant on historical buildings (which potentially have a greater availability of nest-sites) than on more recent ones.

Thus, causes of decline of Italian Sparrows may include a reduction of year-round food supplies, possibly from reduced refuse along roads, more efficient street cleaning, a reduction of 'weedy' areas in both private and public gardens, or a reduction of private, small-scale poultry farming practices in rural areas. Moreover, the progressive shift of cereal cultivations from wheat to maize and changes in livestock farming practices, which led to reducing the traditional hay storing/feeding practices (leaving many herb seeds available as sparrow food) in favour of other composite cattle foods, may have also played a role (for discussions, see Summers-Smith 2003, Robinson *et al.* 2005, Wilkinson 2006).

The generality of our findings is corroborated by a report from the recently established Italian national common bird monitoring scheme, MItO2000 (Fornasari *et al.* 2002, 2004). These data revealed a countrywide 27% decline of the abundance of the Italian Sparrow from 2000 to 2005, with an estimated average yearly rate of decline equal to 6.1% (FaunaViva 2006), which fits well with the decline we documented in the present study, the overall average yearly rate of decline between 1996 and 2006 being 4.88% (95% CL 3.44–6.33%) or 4.25% (95% CL 2.26–6.25%) ($n = 6$ sampling sites, for transect and building counts, respectively). As the MItO2000 counts are not restricted to urban areas, but rather cover the whole Italian territory (Fornasari *et al.* 2002, 2004), it is highly likely that farmland populations are declining as well as urban ones, which nonetheless constitute the stronghold of the total population (for UK House Sparrow estimates, see Robinson *et al.* 2005). Similar generalized declines may have taken place also among the Italian population of the Spanish Sparrow, which occurs mostly in Sardinia (–38.5% change in abundance from 2000 to 2005, FaunaViva 2006). Therefore, both our data and the MItO data suggest that Italy is not an exception in the generalized decline of synanthropic sparrows in western Europe (BirdLife International 2004).

In conclusion, the rate of change in urban areas of northern Italy is alarming, and urgent conservation measures need to be implemented in the coming years. For example, the hunting of sparrows, which has occurred in some Italian regions under derogation from the EU Birds Directive in recent years (Brunner & Gustin 2004), should be banned as soon as possible. Moreover, we suggest that future conservation plans and status assessments, either at the national or at the international level, should be carried out separately for House, Spanish and Italian Sparrows: these taxa should be regarded as 'designatable units' (*sensu* Green 2005), irrespective of their actual taxonomic position, due to their separate phylogeographical histories, range specificity and taxonomic distinctiveness.

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