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Role of ivy in determining the attractiveness of the Blackbird *Turdus merula* territory

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Abstract – The quality of the territories of breeding bird species is often analyzed by considering the reproductive success of breeding pairs. In this study we propose an approach that examines not the territorial quality, but what is interpreted as attractive by Blackbird *Turdus merula* in its territory. This aspect was studied using territorial songs as indicators of territorial-index, considering the importance that songs have in terms of female attraction and male genetic quality. Through a multiple regression model, the relationship between this parameter and some structural features and types of the vegetation is studied: the only variable which is significantly and strongly related to the average number of songs is the abundance of ivy on trunks. This result is discussed considering the ecological role that ivy plays in determining the highest attractivity in Blackbird territory.

Key-words: mapping method, territorial-index, ivy.

INTRODUCTION

If bird song is important for female attraction it is expected that females use features like repertoire size (Howard 1974, Catchepole 1980, Yasukawa *et al*. 1980, McGregor *et al*. 1981, Searcy 1984) or song rate (Gottlander 1987, Radesäter *et al*. 1987, Reid and Weatherhead 1990) as cues to select among potential mates (Hoi-Leitner 1995). These cues may provide to females the information about the quality of a territory (Møller 1983, Radesäter & Jacobsson 1899), the male's propensity or ability to invest in offspring (Searcy & Yasukawa 1981, Greig-Smith 1982) or the male's genetic quality (Andersson 1982, Kodric-Brown & Brown 1984).

Indeed, there is some evidence that food abundance influences song output in some bird species (Searcy 1979, Wilhelm *et al*. 1980, Morton 1982, Pflumm *et al*. 1984, Davies & Lundberg 1985, Gottlander 1987, Reid 1987). Moreover, other studies underline how male song quality is positively related to a high reproductive success (Levin 1996).

Hesler *et al*. (2012b) found a positive correlations between repertoire size in Eurasian Blackbirds and some measures of body size, meaning that larger males had larger repertoires. Larger males may have better fighting abilities and, thus, advantages in territorial defence: larger structural body size may also reflect better conditions during early development. This is in accordance with the general assumption that repertoire size represents an honest signal in Eurasian Blackbirds that has evolved in response to sexual selection.

However, the same authors (Hesler *et al*. 2012a), in a study performed by using Blackbirds in captivity, found no evidence for the hypothesis, that male Blackbirds use repertoire sizes to assess a rival's fighting ability. However, the interpretation of negative results is difficult. Possibly a ceiling effect lead to indifferent responses to the different repertoire sizes. Also, it is possible that males use repertoire sizes for quality assessment in other contexts than territory intrusion, such as listening to song outside their territory.

For all these reasons, song rate and repertoire could be considered as an honest general signal of male attributes and territory quality (Hoi-Leitner 1995). Territoriality is expressed on the borders of the territory itself mainly by males, especially in the reproductive period, but also

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by females, generally against same-sex individuals (Snow 1958).

In this paper, we consider European Blackbird *Turdus merula*, a common breeding bird all over Europe, except for northern Scandinavia. Its population is generally stable, with peaks in Bulgaria, Croatia, Spain and Italy (Tucker & Heath 1994); non-urban populations prefer habitats in dense forests with multiple layers, but rely on marginal groundcover because they feed on soil organisms such as earthworms; however Blackbirds easily adapt to different environments (Glutz von Blotzheim & Bauer 1982). Formerly known as only a forest inhabitant, Blackbirds now are frequenting urban areas such as hedges, parks, cemeteries and even avenues (Schmid *et al*. 1998, von dem Bussche 2008). For this reasons, Blackbird thus appears to be a generalist species, not having special requirements concerning its habitat and in Italy it is a relatively widespread species (Fornasari *et al*. 2010). This paper aims at analyzing a population of Blackbirds in order to understand which characteristics of vegetation Blackbird considers potentially favorable elements in its territory.

Usually, when analyzing the quality of a territory or a couple, we consider the reproductive success (Weatherhead & Robertson 1977, Ens *et al*.1992). However, the number of chicks fledged represents the final stage of the reproductive process, which begins at the moment of choosing and defence of the territory by the couple who decide to occupy it. Definitely, the most reliable method to determine the final quality of an area is to consider the reproductive success, which increases the fitness of the individuals that occupy it; but in this way you have a synthetic results about the territorial quality and it becomes difficult to identify which parameters determine the attractiveness of the territory before the period of hatching. The purpose of this study is to analyze the factors that can be interpreted by Blackbird as potential signals of environmental quality, which can determine a greater reproductive success (but that can be strongly influenced also by numerous other phenomena and factors that may occur after the choice of the territory) and affect the attractiveness of a specific territory in respect of the species.

We proposed to use the number of territorial songs as an index, in order to classify and analyze the territory of Blackbird, so to investigate which parameters of the vegetation Blackbird interprets as favourable elements in its territory.

Therefore in every territory, we investigate the relationship between song rate and several vegetation parameters. Additionally, an analysis of the surface area of the territory of each individual can provide further information about the characterization of the microhabitat of the species.

MATERIALS AND METHODS

Study area

This study was carried out in central-eastern Italy, at the foothills of the Apennine Mountains, in the north of Marche region (43.765440°N, 12.652728°E), consisting of a coppice of hornbeam (Catorci 2007) and of about 40 acres, surrounded by cultivated fields and gullies.

The climate in Central Italy is generally temperate (Tomaselli *et al*. 1972) and characterized by high temperatures in spring and summer and by a marked summer drought period.

Identification of territories and territorial-index

The activity of the Blackbird is not solely conducted within the borders of its territory. Blackbirds frequently feed in areas occupied by other individuals (Hatchwell 1996). For this reason, in order to delineate the territories in the study area, only territorial songs were considered (especially contemporary ones).

This study was conducted in the latter part of the breeding season, during the second or third brood (Myres 1954): presumably, at that time, it is more likely that territorial boundaries are established and pairs are defined.

The identification of the territories was carried out by means of the mapping method (Bibby *et al*. 1993). Within the study area, we positioned 15 survey stations, approximately 100 m apart from one another. In each station, 250 min of observation were made, divided in 10 visits of 25 min each distributed in 10 time zones: five in the morning (6:00-6:30; 6:30-7:00; 7:00-7:30; 7:30-8:00; 8:00-8:30) and five in the late afternoon (16:30-17:00; 17:00-17:30; 17:30-18:00; 18:00-18:30), so that each station is monitored one time for each time slot.

A sketch map of the area surrounding the survey stations was made and all observed activities of every single Blackbird were recorded. For each Blackbird, its position, the type of its activities and the exact time they occurred were schematically noted on the map. After collecting data, a complete map of the study area was drawn, where all observations made about Blackbirds were reported. By doing so, it was possible to identify clusters of activity concentrated in particular areas and, by focusing on territorial songs, especially contemporary ones, to identify the different territories (Bibby *et al*. 1993). Furthermore, it was possible to associate each recorded sighting (lasting at least 30 seconds) with an exact individual which occupies a definite territory.

Obviously, inner territories of the study area were intercepted by the survey stations more than the outer ones and thus showing a total of more songs. Therefore, the ra-

tio of the total number of songs in each territory divided by the number of survey stations from which contacts were registered, was used as a territorial-index.

Analysis of vegetation

Parameters of vegetation were studied to take into account both the type of vegetation and its structure, in order to investigate if song rate can be influenced by the stages of development of the vegetation and by its shape.

The physiognomic-structural features of vegetation considered are: diameters of the trunks of trees (trees lower than 8 m and those equal or greater than 8 m) and abundance of ivy *Hedera helix* (thickness from the trunk of the tree used as a support to the outer surface of the ivy).

The average value of the diameters of the trunks for the two tree types was obtained by averaging 20 random measurements within each territory. Similarly, the abundance of ivy was calculated considering 20 random trunks in each territory (McCall 1982).

The qualitative features of the vegetation (land cover) were obtained by calculating the relative percentages identified through photo-interpretation of aerial photographs at a 1:500 scale, by using GIS software. All the environmental variables considered in this study are shown in Table 1.

Statistical analysis

The nature and strength of relationships between the parameters of vegetation and the territorial-index were examined using multiple regression (McCullagh & Nelder 1989). The index was not transformed as suggested by the Box-Cox plot ($\lambda = 0.94$, near to 1) (Box & Cox 1964).

In order to avoid multi-colinearity among independent variables, variables with the strongest correlation between them were eliminated (> 0.8). A stepwise backward procedure was followed in order to select the best predictors using the AIC criterion (Akaike 1974, Anon 1999). The best model was selected using the lowest AIC.

The goodness of fit of the best model, which describes how well it fits into a set of observations, was evaluated using R^2 adjusted. All tests were performed with R program (R Development Core Team, 2011).

RESULTS

19 territories uniformly distributed in the study area were identified. The mean size of each territory was about 1500 m^2, according to Snow (1958). The average value of the territorial-index examined through song rate is 10.8 (SD 4.6).

The only important variable related to the territorial-index was the abundance of ivy; in fact comparing entire model with the best model, where only ivy included, the total variance of the data source is equal $c^2 = 1.19$, df = 11, $p = 0.99$).

The selected model, with only abundance of ivy as independent variable, shows a value of AIC lower than the one of the initial model which included all variables (Table 2). The slope estimated for Abundance of ivy = 0.02 ($p < 0.001$); i.e. for an average enlargement of 3 cm of thickness of ivy, the territorial quality index increases by unity.

Moreover, the goodness of fit (R^2 adjusted) who describes the discrepancy between the observed values and the expected values, is, in the best model, 89.4%, a relatively high value which confirms the effectiveness of the model.

Table 1. Environmental parameters used to describe the vegetation features of the Blackbird territory.

Parameters type	Parameters	Abbreviation	Details
physiognomic-structural	Diameters of the trunks of lower trees	dtl	Diameters of the trunks, cm
	Diameters of the trunks of high trees	dth	Diameters of the trunks, cm
	Ivy	divy	Thickness of ivy on the trunks, cm
land cover	Blackthorn shrub	shrub	%
	Wood of hornbeam and black locust	fcar	%
	Riparian forest	frip	%
	Forest of oak and black locust	frov	%
	Alfalfa	for	%
	Stream	wat	%
	Meadows	gra	%
	Blackberry and elderberry shrub	shr2	%
	Total breeding territory area	sur	m^2

Table 2. Initial model and selected model ranked according to AIC, used to select the best model explaining the increasing territory-index in relation to vegetation variables.

Model variables	N° variables	Parameters type	AIC
dtl+dth+divy+shrub+fcar+frip+ frov+for+wat+gra+shr2+sur	12	physiognomic-structural and land cover	106.85
divy	1	physiognomic-structural	85.88

DISCUSSION

The study area has proved to be a good habitat for the species, in fact, identified territories of Blackbirds are relatively numerous and well distributed (Snow 1958).

However, a detailed analysis reveal that some environmental parameters can be considered by the species as favorable, such as the presence of ivy. The study of the relationship between the manifestations of individuals within each territory shows that there is a strong correlation between the average abundance of ivy and the average number of territorial songs.

The relationship between ivy and song rate is quite high and significant. We think this can be due to the important ecological role that this creeper plays in favor of many bird species, just as Blackbird. Ivy acts as a physical support for the Blackbird's nest (Hatchwell et al. 1996) and its fruits can be eaten (Hernández 2005).

Moreover the microenvironment which originates close to the ivy may be a favorable habitat for the development of a whole range of insects and other invertebrates which, in turn, are potential food for the Blackbird (Williams 2006).

One should also consider that where ivy is more abundant, it generates a shadow zone in the ground around the trunks, where other trees or shrubs can't grow. In these areas without vegetation, the litter can be accumulated and it can become an optimal substrate where Blackbirds can eat invertebrates.

The results, though they refer to a local study, show how the abundance of ivy may affect how Blackbird interprets its territory. The attractiveness of territory was measured through the intensity of song rate expressed within each territory. Very often, the quality of the territories is estimated on the basis of the reproductive success of individual pairs (Hatchwell *et al*. 1996). In many populations, processes such as competitive territory defense, longevity, site-fidelity, and variation in breeding density and territory size over time have the potential to limit the degree to which individual and habitat quality will be positively related in nature (Germain & Arcese 2014). For this reasons, in our study we considered something different: we aims to investigate what the Blackbird interprets as favorable factors, that not perforce determines an increasing of fitness. The approach used in this study not depend on what happens during the period going from the hatching of eggs to the fledging of chicks, but it takes into account only those aspects that the Blackbird "reads" as potentially favorable. By doing so, the aspects of the habitat that are interpreted and considered as important by the species are highlighted. This is in line with the notion of Ecofield (Farina & Belgrano 2004) and it allows to analyze how the species actually interprets the landscape, so as to obtain useful information that doesn't depend on external factors which can affect the reproductive success of individuals.

At this stage, it becomes interesting and it may be the future goal of study, to investigate if what is interpreted by the Blackbird as attractive within its territory, then also determines a greater reproductive success.

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