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BREEDING DISTRIBUTION OF EUROPEAN TURTLE DOVE (*STREPTOPELIA TURTUR*) IN SARNENA SREDNA GORA MOUNTAIN, CENTRAL SOUTH BULGARIA

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Abstract

We monitored the abundance of European Turtle dove in 6 forest habitats. The present study identifies two variables that can affect the breeding distribution of European Turtle dove in Sarnena Sredna Gora Mountain. The arable land adjacent to the breeding habitats is a significant factor influencing its breeding distribution in the study area. The abundance is significantly higher in forest habitats adjacent to cereal, sunflower and sunflower/cereal crops. Second environmental variable which determines its breeding distribution is elevation. The study shows differences between the preferences of breeding sites of Turtle doves in Sarnena Sredna Gora and those found in lowland open habitats in Bulgaria. These results suggest that different approaches to habitat management need to be chosen for different parts of the breeding area of the species in Bulgaria.

Key words: abundance index, agricultural crops, breeding habitats, food source, habitat variables.

Introduction

European Turtle dove (*Streptopelia turtur* (Linnaeus, 1758)) is one of the most rapidly declining species in Europe. It falls under the category of vulnerable species (BirdLife International 2019). Threats in Europe include fragmentation and reduction of breeding habitats (Browne et al. 2004; Dunn and Morris 2012; Kleemann and Quillfeldt 2014), and changes in agricultural practices leading to a decrease in food availability (Browne and Aebisher 2003, 2004; Baptista et al. 2020).

In Bulgaria, the species was common and widespread at the end of the 20th century (Patev 1950; Simeonov 1971; Simeonov and Petrov 1977; Petrov 1981; Nankinov 1981, 1994). The species has been subject to several ornithological studies, some of which indicate a decrease in the population trend indices (Hristov and Petkov 2013, Spasov et al. 2017, Gruychev and Mihaylov 2019).

The distribution pattern of Turtle doves in Europe suggests that their breeding dis-

tribution is determined by latitude as well as the mean annual and monthly temperature during the entire breeding season (Keller et al. 2020). Similar results have been obtained in Germany but in relation to forest cover (Marx and Quillfeldt 2018). In many European regions, hedges and various coniferous and deciduous trees are of major significance for its breeding distribution (Browne and Aebisher 2005, Bakaloudis et al. 2009, Sáenz de Buruaga et al. 2012, Kleemann and Quillfeldt 2014). In some Mediterranean countries, Turtle dove nesting locations can also be found in olive, orange, eucalyptus and other plantations (Pina 1989, Peiro 1990, Boukhemza et al. 2008, Hanane and Baamal 2011). Although the primary breeding habitats of the species are various forest, shrub and plantation landscapes, it mainly feeds on seeds found in open areas (Browne and Aebisher 2003). The migratory specifics of Turtle doves, the large variety of breeding habitats, and the dependence of the birds on food availability often create a set of relationships difficult to comprehend.

The aim of this study is to provide data on the distribution and impact of certain habitat characteristics on European Turtle doves in Sarnena Sredna Gora Mountain.

Material and Methods

Study area

The studied area is Sarnena Sredna Gora Mountain (Fig. 1). It is part of Sredna Gora Mountain, situated in the central part of Bulgaria (Petrova 2020). Its area is 2280 km^2, mean altitude is 416 m a.s.l., and its highest peak is Bratan (1235.8 m) located in the western part of the mountain (Georgiev 2020). The terrain is mountainous hilly, the annual rainfall is between 550–700 mm, and the mean annual temperature is above 0 °C (Petrova 2020). The vegetation in the study area is comprised of forest and open habitats, which provide breeding and feeding sites for European

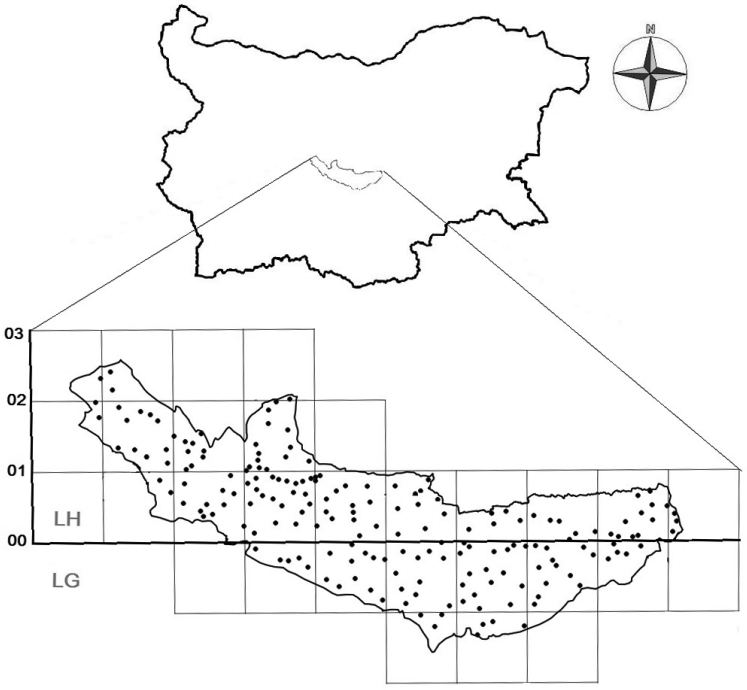

Fig. 1. Study area and distribution of points to determination of Turtle dove abundance index.

Note: the study area falls into quadrants LH and LG of 35T Universal Transverse Mercator, UTM.

Turtle doves. Based on the tree composition, forest habitats have been divided into the following species: broadleaf forest: includes Oriental hornbeam (*Carpinus orientalis* Mill.), Sessile oak (*Querqus petraea* (Matt.) Liebl.), Turkey oak (*Querqus cerris* L.), Hungarian oak (*Quercus frainetto* Ten.), Downy oak (*Quercus pubescens* Willd.), and oak of Virgil (*Querqus virgiliana* (Ten.) Ten.); oak forest (comprised only of oak species): includes Sessile oak, Turkey oak, Hungarian oak, Downy oak, and oak of Virgil (Bondev 1991); mixed oak/European beech forest: mixed forest comprised of various oak species and up to 50 % of European beech (*Fagus sylvatica* L.), with single Common hornbeam (*Carpinus betulus* L.) and European hop-hornbeam (*Ostrya carpinifolia* Scop.) trees; riparian forest: comprised of willows and poplars, and covering a small area around water within the study area; human-made Scots pine (*Pinus silvestris* L.) plantations which were planted 40–45 years ago; mixed broadleaf and coniferous forest comprised of deciduous trees and mostly artificially-planted conifers.

The open habitats in the southern part of the study area are occupied by arable lands mostly with cereal and oilseed crops, and small areas of alfalfa, vineyards and orchards. To the north, open areas at a higher altitude are occupied by grasslands, including pastures with occurrence of Bulbous bluegrass (*Poa bulbosa* L.), Perennial ryegrass (*Lolium perenne* L.), and Couch grass (*Cynodon dactylon* (L.) Pers.), Bothriochloa (*Dichantium ischaemum* (L.) Roberty), Chrysopogon (*Chrysopogon gryllus* (L.) Trin.) (Bondev 1991).

Field methods

In the period between 2018–2020 we monitored the presence of European Turtle dove in 6 forest habitats: broadleaf forest – 83 points; oak forest – 40; mixed oak/European beech – 5; Scots pine (*Pinus sylvestris* L.) plantations – 23; mixed broad-leaved/coniferous forest – 20; riparian forest – 21; a total of 192 points across 1084.1 km^2 (Fig. 1). The number of singing male birds within 100 m of the centre of each point was recorded twice a year (first report: 1–25 May; second report: 1–25 June). All the data was collected in quiet weather, no rainfall, between 04:30 and 08:30 am. The number of singing Turtle doves was reported over the course of 10 min, after a 2-min wait on the part of the observer before the onset of the measurement of each point. We calculated the abundance index as the average number of singing birds in each point by year (total number of singing birds in each point/number of observations per year). The following parameters were determined at each point in the 100-m radius: average tree height (m); elevation (m); distance to water sources (m); distance to road (m); distance to arable land (m); distance to villages (m); tree cover (%); shrub cover (%); type of arable land in the open area around the points. All distances were recorded as the shortest distances from each point to the point of beginning of the respective territory. We determined three main types of arable land: cereal crops; sunflower crops; pastures, and combination of sunflower/cereal, cereal/pastures, or sunflower/pastures. The remaining arable land was planted mainly with potatoes, alfalfa, orchards, and Damask rose (*Rosa damascena* Mill.) but as the latter occupied a very small area (several decares), it was not reported. A total of 1152 reports were made for the entire study period at 192 points with different types of arable land around them (Table 1).

Table 1. Distribution of observations during 2018–2020 by type of arable land.

Arable land around the point	Number of reports
cereal	286
sunf./cereal	137
pastures	312
sunflower	152
cereal/pastures	164
sunfl./pastures	101
Total	1152

Statistical methods

We used ANOVA main effects to examine the relationships between breeding habitats, type of arable land in the open area over every point every year, and abundance of Turtle doves within every fixed radius of points. Then we tested the significant categorical variable with other continuous predictors (tree height, elevation distance to water sources, etc.) using generalized linear models with log-link function and Poisson error distribution. Turtle dove abundance within the fixed radius was a dependent variable, the type of arable land in open areas over every point was the categorical variable, and all other variables measured were continuous predictors. All statistical analyses were performed with Statistica 10 StatSoft, Inc (2011).

Results

At 28 out of 192 points, Turtle doves were not reported for the entire study period. At 144 points the abundance index was between 0.1 and 0.4, and at 20 points it was higher than 0.4 (Fig. 2).

ANOVA analysis shows a high degree of significance of our model. It determines that the arable land adjacent to the breeding habitats is a significant factor influencing Turtle dove breeding distribution in the study area (Table 2).

The abundance of Turtle doves within the fixed radius is significantly higher in forest habitats adjacent to cereal, than in the other five types of open area surrounding the breeding sites (Table 3, Fig. 3).

Two environmental variables deter-

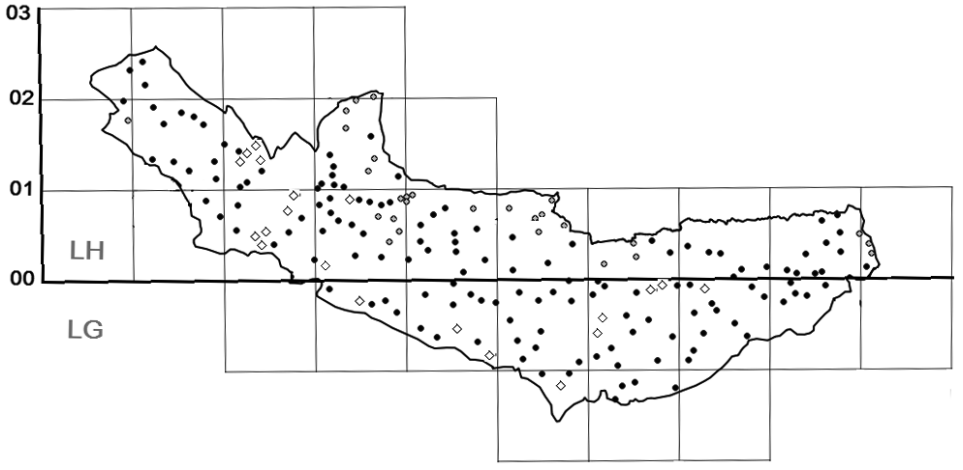

Fig. 2. Distribution of points in study area by abundance index, ○ – no reported birds; ● – points with abundance 0.1 – 0.4; ◊ – points with abundance higher than 0.4.

Table 2. Results from univariate test of significance for distribution of Turtle dove dependence two categorical predictors.

Variables	Sum of squares	Degree of freedom	Mean square	F	*p*
Intercept	**1.906**	**1.000**	**1.906**	**14.867**	**0.000**
Habitats	1.358	5.000	0.272	2.118	0.062
Arable land around point	**7.499**	**5.000**	**1.500**	**11.698**	**0.000**
Error	50.130	391.000	0.128		

Note: in bold are significant results.

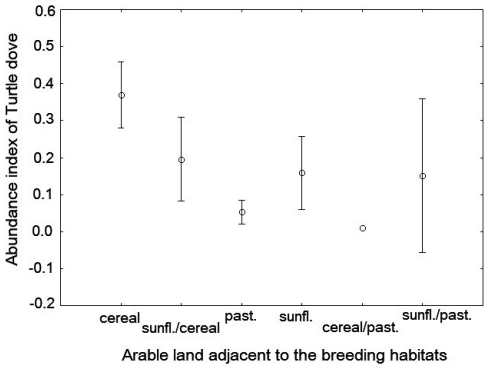

Fig. 3. Abundance index of Turtle dove in fixed radius by type of arable land around the counting point, mean (min-max).

mine Turtle dove breeding distribution in Sarnena Sredna Gora Mountain: type of arable land around the breeding sites, and elevation (Table 4).

Although the abundance index of Turtle doves decreases with increasing altitude, the significance of this variable is close to the limit value, unlike the other variable which has a high degree of significance (Table 4).

Discussion

The present study identifies two variables that can affect the breeding distribution of European Turtle dove in Sarnena Sredna Gora Mountain: elevation, and type of open areas around the breeding sites. Although the differences in altitude are not very large (381.5 m min-max 210-840 m), the number of singing birds decreases with increasing altitude. The distribution of European breeding population of Turtle doves is associated with higher temperatures and lower latitudes (Marx and Quillfeldt 2018, Keller et al. 2020). Probably the higher minimum temperatures in January determine the availability of food resources at the beginning of the breeding season (Marx and Quillfeldt 2018). In addition, with the increase of altitude, the forest cover also increases, and the share of open areas which Turtle doves can use for food decreases. Some studies (Sáenz de Buruaga et al. 2012) have found a decrease in Turtle dove abundance with the increase of forest cover. Therefore, altitude is the second probable reason for the decrease of Turtle doves.

The second factor that is significant for the breeding distribution in this study is type of open areas around the breeding sites. Although previous studies in other regions of Bulgaria (Gruychev and Mihaylov 2019, Gruychev 2020) found variations in breeding density associated with the type of breeding habitats, they did not test the significance of arable land in open areas around the breeding sites. In contrast to Sakar Mountain, where habitat heterogeneity is greater (Gruychev and Mihaylov 2019), in Sredna Gora Mountain there is a clearly marked differentiation

Table 3. Results from univariate test of significance for abundance of Turtle dove dependence type of arable land around the counting point.

Variables	Presence parameter	Standard error	*t*	*p*	-95.00% Cnf. Lmt	+95.00% Cnf. Lmt	β	Standard error	-95.00% Cnf. Lmt	+95.00% Cnf. Lmt
Intercept	**0.161**	**0.065**	**2.491**	**0.013**	**0.034**	**0.288**				
Cereal	**0.215**	**0.067**	**3.213**	**0.001**	**0.083**	**0.346**	**0.289**	**0.090**	**0.112**	**0.466**
Sunfl./cereal	0.065	0.075	0.869	0.386	-0.082	0.213	0.065	0.075	-0.082	0.212
Pastures	-0.119	0.066	-1.788	0.075	-0.249	0.012	-0.171	0.096	-0.359	0.017
Sunflower	0.022	0.074	0.299	0.765	-0.123	0.168	0.023	0.077	-0.128	0.174
Cereal/past.	-0.174	0.164	-1.059	0.290	-0.497	0.149	-0.096	0.090	-0.273	0.082
Sunfl./past.	-0.032	0.312	-0.103	0.918	-0.645	0.581	-0.016	0.156	-0.322	0.290

Note: in bold are significant results.

Table 4. Results from generalized linear model summary of all effects.

Variables	Degree of freedom	Wald-statistics	Log- likelihood	*p*
Intercept	**1.000**	**9.363**		**0.002**
Tree height	1.000	0.438	-175.670	0.508
Elevation	**1.000**	**4.029**	**-177.416**	**0.045**
Distance to water	1.000	0.182	-175.537	0.670
Distance to road	1.000	0.223	-175.551	0.637
Distance to food	1.000	0.290	-175.609	0.590
Distance to villages	1.000	0.940	-175.903	0.332
Tree cover	1.000	0.831	-175.772	0.362
Shrub cover	1.000	1.405	-176.167	0.236
Type of food	**5.000**	**33.231**	**-196.839**	**0.000**

Note: in bold are significance level.

between points in large forest complexes surrounded by pastures and points near arable land. No clear relationship to food resources in Sakar can be found due to the availability of food resources in close proximity to nearly all counting points, which is not the case in Sarnena Sredna Gora Mountain.

Variation in breeding density is associated with the type of breeding habitat. According to a number of studies (Simeonov et al. 1990, Nankinov 1994, Browne et al. 2004, Sáenz de Buruaga et al. 2012, Gruychev 2020), breeding density is high in the riparian and oak forests as well as in similar forest types; however, breeding density seems to depend to a large extent on the type of habitats found which provide the main food resources. In Europe, Turtle doves feed on large amounts of seeds, most of which occur naturally in the environment (Dunn et al. 2018). Studies of the food spectrum in Spain have recently reported a higher share of wild seeds, in contrast to older studies (Gutiérrez-Galán and Alonso 2016). In the United Kingdom, it has been found that it mainly uses grasslands as feeding habitats (Dunn et al. 2021). Nevertheless, our model shows a greater presence of Turtle doves in breeding habitats of the study area surrounded by open areas occupied by cereal and sunflower crops, and low presence around pastures, pastures and cereal crops combined. Two possible explanations of these results can be suggested: 1) pastures are located in high parts of the study area, with high forest cover and lower temperatures, which is why birds avoid these areas; 2) weed strips, which are often formed in arable land planted with wheat crops, could possibly provide food for Turtle doves at the beginning of their breeding season. In addition, the size of arable land in the study area is between 0.2 and 0.5 km^2, which probably contributes to increasing the diversity of food supply (Fig. 4).

Fig. 4. Arable land around the breeding sites of European turtle dove (*Streptopelia turtur*) in the lower part of the studied area (Foto Gradimir Gruychev, 17.05.2018).

Although Turtle doves can travel up to 10 km to feeding sites (Browne and Aebisher 2003, Gutiérrez-Galán and Alonso 2016, Vreugdenhil-Rowlands 2020), they also often feed near breeding sites (Browne et al. 2004, Fisher et al. 2018, Moreno-Zárate et al. 2020). During the second half of the breeding season, Turtle doves often use cereal and rapeseed crops as food resources (Browne and Aebisher 2003), which is likely to link the presence of Turtle doves in the present study to the availability of cereal crops. The relationship between Turtle dove occurrence and areas with sunflower crops might be due to the fact that at the beginning of the breeding season, areas occupied by these crops abound in numerous early-flowering weed species that the birds may feed on, but additional studies are needed in order to confirm this hypothesis.

The present study did not examine the species composition or the quantitative indicators of the potential feeding grounds; therefore, we have been unable to ascertain any definitive relationships between Turtle dove breeding distribution and these variables.

The study shows differences between the preferences of breeding sites of Turtle doves in Sarnena Sredna Gora and those found in lowland open habitats in Bulgaria. These results suggest that different approaches to habitat management need to be chosen for different parts of the breeding area of the species in Bulgaria, taking into account the food availability in early breeding season.

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