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CHANGES IN THE HABITAT AND NEST SITE DISTRIBUTION FOR TWO *LANIUS* SPECIES IN KARST POLJES (BOSNIA AND HERZEGOVINA)

SUMMARY

This study presents the first comparative analysis for the selection of nesting sites of two shrike species in habitats that were changed after total emigration of the human population. In this area, two shrike species are present (Red-backed Shrike - *Lanius collurio* and Lesser Grey Shrike - *Lanius minor*). The selection of nesting sites of two shrike species (breeding population) between two periods was compared: before and after the Balkan civil conflict in three karst poljes (karst fields), municipality of Bosansko Grahovo. Data was collected in 1974–1991 and in 2001–2022 in three karst poljes at Bosansko Grahovo. In total 998 nests of Red-backed Shrikes and Lesser Grey Shrikes (822 and 176 nests respectively) were analysed. The vast majority (67.0% in first and 40.2% in second period) of nests of Red-backed Shrikes were located on the *Crataegus monogyna* (total 17 species of plants). The Lesser Grey Shrike had the maximum number of nests (over 40%) placed on the two trees/shrubs (*C. monogyna* and *Prunus domesticus*) in the first period, and additionally in *Sambucus nigra* (17.9% of nests) in the second period. Significant differences were found in the selection of nesting sites between these two species and between two periods. Only five trees of nest locations for both species were registered. The Red-backed Shrike prefers lower shrubs (0.8–2.8 m) and Lesser Grey Shrike 3.5–10 m high shrubs/trees. It was confirmed that the presence of suitable nest sites is one of the most important limiting factors determining the distribution of two species in karst poljes.

Keywords: nest site distribution, Red-backed Shrike, Lesser Grey Shrike, karst poljes, Bosnia and Herzegovina

INTRODUCTION

Abandonment of the village and thus arable land leads to changes in the natural environment resulting in varying habitats, many of which are extreme for birds, for example *Emberiza citrinella* or *Passer domesticus*, however, for some

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species this had a favourable effect (Marić 2022b). Some of the species whose abundance increased after the mass emigration of the human population (during the war in Bosnia and Herzegovina - Nikolić 2021) are *Lanius* spp. In addition to villages, the number of these species increased in other habitats where they had suitable places for nesting (Marić 2022b, pers. obs.) However, shrike species have been showing a marked decline in their breeding population for the last third of the last century in almost all of Europe (Yosef 1994, Krištín *et al*. 2000, Brambilla *et al.* 2009). According to the European regulations, they are protected due to their declining across the breeding range (Tucker *et al*. 1994, Brambilla *et al.* 2009, Sfougaris *et al*. 2014, etc.). Generally, farmland bird species are in decline across the whole of Europe (Tucker and Evans 1997, Gregory *et al.* 2008, Sutcliffe *et al.* 2015). Among the bird species which depend on agriculture management are Shrikes and it represents an important group of farmland bird species which inhabit open habitats.

According to Marić (2022a) *L. collurio* inhabits six different habitat types, and *L. minor* three in the Grahovo's poljes. According to Cramp (1994) and Yosef (2008) *L. minor* inhabits open habitat with plenty of scattered or grouped trees, and fewer bushes, requires presence of features offering perches, shade and accessible food. Breeding habitats in Europe included extensively managed orchards, as well as vineyards and meadows, tall trees necessary for nesting. Prefers open or disturbed lowland and hilly areas to 700 m, rarely to 900 m in C. Europe. Need for drier and sunnier conditions than those tolerated by other European shrikes possibly connected with more specialized diet or large insects. Red-backed Shrikes (*L. collurio*) have favoured shrubby cattle grazed pastures or other habitats with sustained low vegetation allowing good visibility of ground living beetles (Brandl *et al.* 1986, Olsson 1995a). The majority of the population breeds in semi-open habitats created or maintained by human activities (Lefranc and Worfolk 1997). The Red-backed Shrike is breeding in most parts of Europe. According to Block and Brennan (1993) the breeding habitat is selected based on nesting requirements, whereas the non-breeding habitat use is strongly associated with food abundance. Red-backed Shrikes are particularly sensitive to both agricultural intensification and land abandonment (Brambilla *et al*. 2007). Both shrike species occur in the karst poljes (karst fields) of Bosnia and Herzegovina (Obratil 1984, 1987, 2006, Kotrošan *et al*. 2013, Puzović *et al.* 2019). Scarce data on biology of shrike species can be found scattered in the literature. Studying the reproductive performance of bird species in Bosnian karst poljes with different management regimes is urgently needed to understand their impact on avian populations.

In the present study, analysed nest site distribution in the two *Lanius* spp. in three karst poljes in the Western part of Bosnia and Herzegovina. In the present study, analysed nest site distribution in the two *Lanius* spp. in three karst poljes in the Western part of Bosnia and Herzegovina. In this paper, research was done on which changes in the vegetation influenced the choice of nesting sites of these species. The comparative analysis is between the period 1974–1991 (there were no significant population movements) and the period 2001–2022, five years after the total emigration of the human population. To the best of our knowledge, no

study has considered shrike nesting in in the area of karst poljes. Nest site selection is generally considered an important component of habitat selection by birds (e.g. Hildén 1965). Some of the most commonly used parameters are tree species, the height of the tree, the nest's height above the ground (Marić 2023).

MATERIAL AND METHODS

Study area

The study area, three karst poljes are situated in the central part of the municipality of Bosansko Grahovo (=B. Grahovo). B. Grahovo is situated in the west part of Bosnia and Herzegovina (B&H) (Figure 1) and it covers 780 km^2. This area is characterized by high diversity of habitats (for detailed information and habitat description see Marić 2022a). There are 4 karst poljes: Livanjsko polje and three Grahovo poljes (790–860 m a.s.l., 29 km length and width 2–4 km=80 km²). They are situated between 16°18'00" and 16°27'00" of eastern geographical longitude and 44°08'00" and 44°18'00" of northern geographical latitude. The area holds one of the most representative traditional and low-intensity agricultural systems in the karst poljes.

The main habitats of this area are agricultural land, meadows and pastures. Arable fields cover less than 20% of total land cover, and are situated only in central part of poljes. The slopes of the hills, around poljes, are covered with pastures and various succession stages of forestation. The afforestation of the rocky hills and the pasture around karst poljes was done with pine (*Pinus* sp.) and covers an area of about 10 km^2 (pers. obs.). Also, the marginal parts of karst poljes are naturally overgrown with pines and several deciduous species. Arable lands are small sized arable fields (mainly fodder and cereals, including wheat and oat).

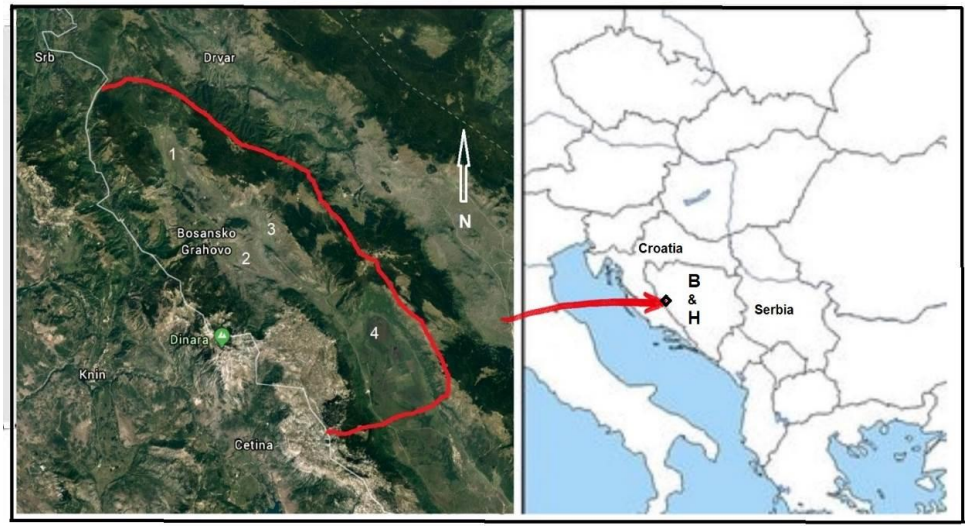

Figure 1. The area of the municipality of Bosansko Grahovo, red line border between the municipalities and white line borders between the states. B&H=Bosnia and Herzegovina, 1) Resenovačko polje, 2) Pašića polje, 3) Marinkovci polje, 4) Livanjsko polje

Arable fields recently abandoned cultivations and pastures progressively covered by shrubs and small trees. There are broadleaved forests (secondary woods derived from tree recovery over abandoned land), then forests along the banks of creeks and rivers, habitat type is similar to 91E0, according to Natura 2000 code. These forests (small groves of alder, willows and poplar) are along the banks of sinking rivers (the Struga and the Korana). Around poljes there are rocky habitats, orchards and small villages. Fruit species are dominated by plums, apples, pears and cherries (deciduous fruit trees), and in the village grow trees, such as *Tilia* spp., and shrubs such as *Cornus mas*, *Rosa* spp., *Crataegus monogyna*, *Sambucus nigra*, *Prunus spinosa*, etc. (see Marić 2022a, 2022b).

Nesting of *L. collurio* was found in 6 types of habitats: 1) forests along the banks of creeks and rivers, 2) high shrub deciduous and evergreen bushes (up to 7-10m) or forests with large clearings, degraded forests in different degradation stages, 3) deciduous bushes: bushes, shrubs of low trees and shrubs (mostly up to 3m high) with large clearings (20-70%), 4) dry calcareous grasslands, from karst poljes to the montane zone, (in habitats 3 and 4, afforestation has been carried out in the last 20 years), 5) meadow and agricultural land (arable fields, grasslands and wet meadows of karst poljes), 6) settlements (villages and town) with orchards.

Nesting of *L. minor* was found in three types of habitats: 1) forests along the banks of creeks and rivers, 2) meadow and agricultural land (arable fields, grasslands and wet meadows of karst poljes), 3) settlements (villages and town) with orchards (details see in Marić, 2022 a).

Field methods, sampling strategy

Our study was carried out at three karst poljes, at B. Grahovo, in the Pašića, Marinkovci and Resanovačko polje, during the two periods: first period before the Balkans civil conflict (1974–1991), and second period, 5 years after the Balkans civil conflict (2001–2022). Studies of the shrikes in this area of the period 1992–2000, was not possible due to Civil War and post-war instability. The size of the study area was approximately 80 square kilometers. *Lanius* spp. were censused at six habitats characterized by different land-use (see Marić 2022a) and representing the main landscape types found in the area. All these habitats were included in our study plots, in proportion to their relative extension in the study area.

Two methods were used in bird surveying: first method - line transect or point counts (see Marić 2022b), second method - systematically searched for nests across each habitat (localities), using visual and auditory cues (Martin and Geupel 1993). Both methods are well suited to monitoring shrikes, as they are sedentary, conspicuous and mono-territorial during the breeding season. Transects were carried out in the mornings and the targeted search for nests was

carried out throughout the day. For each habitat, the nests were counted along transects (see Marić 2022b) or systematic search of nests. After the identification of *Lanius* species, their nests were detected by observing the birds heading towards their nests i.e. adults carrying food and nest material or exhibiting behaviours typically elicited when predators are near nests. Nests were discovered at various developmental stages, including nest building, incubation and brood rearing. Most nests were found during nest building or egg laying periods. A 15 cm diameter mirror mounted on a telescopic pole was used to estimate eggs or chickens, but also to measure the height of nests, only in the second period (measurement error=circa 10cm).

Nests were discovered during the morning hours (between 6 and 12 o'clock) and in the afternoon (between 4 and 7 o'clock). Fieldwork took place between 20th May and the the end of July, i.e. bird surveys were conducted during the breeding season. The localities were surveyed under favourable weather conditions (without heavy rain, mist and strong wind). Censuses were not carried out in wet or strong windy (> Force 5 on the Beaufort scale) weather.

Statistical analysis

Descriptive statistics were carried out and number of nests were tested (number or %). In order to test differences between periods the z-test was conducted for all tree species separately, i.e. share of the total number of nests %. The differences between periods for all tree species (in total) was calculated from the hypothetical ratio (50:50) and were tested by means of test - χ^2 (Sokal and Rohlf 1981). All statistical tests were independent and two-tailed. The statistical analyses were performed using STATISTICA software package. Results are considered significant if $P \leq 0.05$.

RESULTS

During the research period, 15 to 20 pairs of *L. minor* and over 150 pairs of *L. collurio* were registered as nesting in the research area (three karst fields) during one year. A total of 998 nests were located for these two species during 40 breeding seasons, 822 nests of *L. collurio* and 176 of *L. minor* were observed during the present work. The analysis of nest site distribution of two shrike species' observations in period 1974–1991 and 2001–2022 from three karst poljes from the municipality of B. Grahovo are shown in Table 1. More than 20 tree species are commonly selected by *Lanius* spp. for nesting (a total of 25 species). Red-backed Shrike used 17, and Lesser Grey Shrike 14 tree species (Table 1) as nest sites in three Grahovo karst poljes. No significant differences (χ^2) were found in the total number of nests and selected trees between the studied periods ($P>0.05$).

Table 1. Tree and bush species used as *Lanius* nest sites in the six habitats in Grahovska polja. Given are number of nests N, share of the total number of nests-percentage (%), z-test and significance differences (ns – no significant, P<0.05 #, 0.01 ##, 0.001 ###)

Species	*Lanius collurio*			*Lanius minor*		
	Periods			Periods		
	1974–1991 N (%)	2001–2022 N (%)	*z*	1974–1991 N (%)	2001–2022 N (%)	*z*
Acer sp.	-	-	-	2	1	ns
Alnus glutinosa	-	-	-	1	3	ns
Amelanchier ovalis	-	3	-	-	-	-
Carpinus betulus	1	3	ns	1	3	ns
Corilus avelana	24	21	ns	-	-	-
Cornus mas	12	27	5.8#	-	-	-
Cornus sanguinea	5	24	6.2	-	-	-
Crataegus monogyna	246 (67.0)	188 (41.3)	7.8###	26 (35.1)	21 (19.8)	ns ns
Fraxinus sp.	1	2	ns	1	2	-
Malus sylvestris	2	18	12.8###	-	-	-
Malus pumila	-	-	-	3	5	ns
Ostria carpinifolia	7	14	ns	-	-	-
Pinus niger	-	3	-	-	-	-
Pirus communis	-	-	-	1	7	ns
Populus sp.	-	-	-	2	2	ns
Prunus cerasus	-	-	-	3	1	ns
Prunus domesticus	4	23	13.4###	16 (21.6)	21 (19.8)	ns
Prunus mahaleb	3	4	ns	-	-	-
Prunus spinosa	33 (9.0)	47 (10.3)	ns	3	8	-
Rhamus frangila	2	2	ns	-	-	ns
Robinia pseudacacia	-	-	-	6	9	ns
Rosa spp	21	24	ns	-	-	-
Salix alba	-	-	-	4	3	ns
Salix purpurea	2	15	9.9##	-	-	-
Sambucus nigra	4	36 (7,9)	4.4###	2	19 (17.9)	3.04##
Total	**367**	**455**		**71**	**105**	

DISCUSSION

In recent decades, changes in the structure of the landscape at the local and regional scale in many areas of Bosnia and Herzegovina have been observed. In general, such changes have influenced the composition of biodiversity in those/such habitats then changes in ecology, phenology and diversity of species assemblages (e.g. Chamberlain *et al.* 2000, Marić 2022b, etc.). According to Baur *et al.* (2006) and Queiroz *et al.* (2014) the effects of land abandonment on biodiversity are complex and can vary regionally and between taxa. Also, results show contrasted responses for diff erent bird groups, with "loser" and "winner" species (Phalan *et al.* 2011, Teillard *et al.* 2015). Abandonment of the villages in

some karst poljes in Bosnia and Herzegovina led to changes in bird populations, some have left (disappeared) the area, some have reduced abundance, for example *Emberiza citrinella* or *Passer domesticus*, and some had a favourable effect (Marić 2022b). Some of the species whose abundance increased after the mass emigration of the human population are *Lanius* spp. In addition to villages, the number of these species increased in other habitats where they had suitable places for nesting (pers. obs.).

In this paper, the focus is on two species of birds typical of agricultural landscapes, *L. collurio* and *L. minor*. Habitat and nest site preferences of shrikes have not yet been studied in karst poljes in Bosnia and Herzegovina. This study presents the first comparative analysis of the selection of nesting sites of both shrikes in habitats that were changed after the total emigration of the human population. It therefore provides basic indications for the conservation of this species in this important part of its distribution range, i.e. in karst poljes. Results showed that both species of shrikes react positively to changes in the habitat.

The biggest changes are evident in the settlements and orchards habitats, this is because this type of habitat in many villages is now without human population, and thus without domestic animals. The lack of people affected the orchards because they are not cultivated, and the disappearance of the sheep resulted in intensive growth of bushes and an increase in the presence of some plants as black elder. Black elders also appear inside demolished buildings. The lack of domestic livestock, primarily sheep, enabled the intensive growth of various types of shrubs in all habitats, especially in the deciduous bushes habitat. If we add to this that intensive afforestation was carried out, it is clear that the changes in the habitats of these two species are evident and permanent.

The Red-backed Shrike inhabits the most habitat types of all species registered in the research area and are significantly more numerous in sympatry than *L. minor* (Marić 2022a). Also, according to Marić (2022b), both species of shrikes significantly increased in abundance in the three studied habitats in the Pašića poljes after the exodus of people. This paper shows how these changes influenced the selection of nesting sites for these species in three karst fields in the municipality of B. Grahovo. The nests of Red Backed Shrikes were recorded in six observation habitats while the Lesser Grey Shrike in only three observation habitats. Nest-site selection is a key component of habitat selection by birds (Hildén 1965), with important consequences for survival and reproduction of individuals (Cody 1985).

Lesser Grey Shrike - *Lanius minor*

An analysis of 176 records of nest sites used by Lesser Grey Shrikes from 1974 to 2022 showed that *Crataegus* and tree fruits were the most preferred species in both periods, followed by *S. nigra*. The analysis also showed that this species did not nest in underbushes and forest clearings and pastures. Contrary to this, according to Ajder and Baltag (2017) the Lesser Grey Shrikes select also pastures for breeding. The same preference of trees was recorded also in Greece (Sfougaris *et al*. 2014), Hungary (Lovászi *et al*. 2000), Romania (Moga *et al.* 2010) and Slovakia (Krištín 1995).

(A) Natural succession of pastures after the exodus of people

(B) Pastures after forestation

(C) A village with many black elders

(D) Black elders sprouted from the collapsed buildings

(E) A nest in a black elder bush at a 0.8 m height

(F) *L. collurio*, nest in *Salix purpurea*

(G) Settlements with electric wires are a habitat for *L. minor*

(H) *L. minor*, nest in a solitary tree in the karst field

Figure 2. Panoramic view on the studied area of karst poljes and selected habitats

In this area, the deciduous trees on the pastures are still of small height, so this is probably the main reason for the absence of this species on the pastures. Tall pines appeared in part of the pasture, either naturally or afforestation with those species was carried out. Only *L. collurio* nests in them, but not *L. minor*, although these trees have grown to the optimal heights preferred by this species (4–10 m in this study). The increase in the occupancy of fruit species is the result of these fruit species not being pruned and cultivated (absence of people), and the increase in *S. nigra* due to the increase in its abundance also due to the lack of people and domestic animals. From each collapsed object (house or building) black elders emerged, which grew up to 7 m at the end of the studied period (Figure 2 C, D pers. obs.). The increase in numbers and growth of black elder is significant in the second period. This provided many potential nesting places preferred by the Lesser Grey Shrike. There are many orchards which are the main breeding place of Lesser Grey Shrikes and *Prunus domesticus* mostly preferred (ca. 20.0%). This is explained by the fact that branches of *P. domesticus* are most favourable for nest location. In addition, this tree species is the most common in the villages in this area (more than 70% of all tree species). The structure of these trees offers better conditions for nesting than others. Other species also nest on the most abundant trees (Sakhvon and Kövér 2020, Marić 2023).

More than 10 tree species are commonly selected by *L. minor* for nesting, *C. monogyna* (26.6%), *P. domesticus* (22.5%) are mostly preferred in the first period, and *C. monogyna* (19,8%), *P. domesticus* (19.8%), *S. nigra* (17.9%) in the second period. *S. nigra* rapidly increased in number after the village was abandoned and this provided many potential nesting places preferred by the *Lanius* spp.

Finally, the electric poles and wires, which serve as hunting perches in the breeding area, might be another factor effecting their habitat preferences and tree selection near electric poles. The pattern found in this study is not confirmed by other studies from Europe.

The predominant use of poplars for nest building was noted also by Horváth (1959) and Lovászi *et al*. (2000). In the study conducted by Lovászi *et al.* (2000), beside poplars, four other species were also used in nest building, but to a lesser degree. Krištín (1995) noted that 97% of the observed nests were built in fruit trees and similarly noted Wirtitsch *et al.* (2001), in a study from central Slovakia. The authors did not record a clear preference for one kind of fruit tree, some of the species (i.e. apple) were used according to their availability while others not. Our results and the above-mentioned studies suggest that *L. minor* may show a wide preference for microhabitats. These differences are probably due to the specificity of the vegetation of karst poljes.

L. minor nests on tall trees up to 20 m (Peterson *et al.* 1968), and according to Krištín (1995) at heights of 5 to 24 m – average 8.53 m. According to the data of this paper, this species nests at much lower heights (4–10 m) because there are no tall trees in the habitats it inhabits, except for Linden. Also, according to the data of the aforementioned authors, this species was not selected for nesting,

which indicates that it is not suitable for building nests, and Magpies in the Zeta river valley did not build nests on Linden trees (Marić 2023).

Red Backed Shrike - *Lanius collurio*

The Red-backed Shrike inhabits the most habitat types of all species registered in the study area and are significantly more numerous in sympatry than *L. minor*. The Red-backed Shrike preferred shrubs and open areas e.g. pasture or agricultural land i.e. habitats with low vegetation and a low concentration of shrubs in (Marić 2022a). This species used 17 types of trees for nesting. According to Kosiński (2001) this variability may be explained by the species capacity to build a nest in different nesting conditions and to adapt nest placement to the structure of available sites. This plasticity of nest placement was previously observed in *L. collurio* (Lislevand 2012) but in other passerines (Wilson and Cooper 1998, Marques *et al*. 2002, Lomáscolo *et al*. 2010) and in Columbiformes (Hanane 2012, 2014a).

Bushes presenting good perches for insect hunting nearly always also provide good nesting sites. In the study area, mostly nests this species were found in thorny shrubs and clearly preferred hawthorns. Over 2/3 of all nests in the first period and over 40 in the second were found in these shrubs. Some other authors also pointed to the Red-backed Shrike's preference for thorny or prickly species, such as hawthorn, plum tree (*Prunus* sp.) or blackberry (*Rubus* sp.) (Kuźniak 1991, Nikolov 2000, Baláž 2007). In these studies, nests were not found in blackberry (*Rubus* sp.), which some authors state as a suitable place for nesting (e.g. Svendsen *et al*. 2015). In the researched area, this species is rare and grows low, usually up to 50 cm, which is a possible reason that *L. collurio* does not nest in it. In addition to hawthorn, a considerable number of nests were found in Rosa spp. and *Prunus spinosa* in both periods. Hawthorn and these two species make up over 80% of nesting hosts in the first period, and over 56% in the second. According to Olsson (1995b) about half of all nests (50.2%) were built in dog rose *Rosa canina*, blackthorn *Prunus spinosus* and blackberry *Rubus fruticosus*. Also and other authors (Olsson 1995b, Farkas *et al.* 1997, Campos and Lizarraga 2000, Söderström 2001) found that Red-backed Shrike uses spiny scrub as nest sites. Large, dense, thorny, species with dense leaf cover often make nests invisible to, and unapproachable by, humans and possibly other visually oriented nest predators. Choice of such bush type can be an adaptation, since it reduces the possibility of penetrating the inner bush by potential predators destroying broods (Polak 2012).

This is contrary to other studies which found that Red-backed Shrikes does not selectively choose specific plant species, but simply use the dominant plant species in the breeding area (Holan 1995, Söderström 2001). Goławski (2007) found the preferences of this species for nesting in pear trees (*Pyrus communis*) and black elder, which were relatively rare in his research area. Nesting in black elder is reported by Kuźniak (1991) and Horváth *et al.* (2000). In this study the Red-backed Shrike in three karst poljes frequenlently used black elder only in second period. The more significant use of this species in the second period than the first (z=4.4) is due to the significantly higher abundance of this species in

abandoned villages. The black elder is present in all demolished houses, barns, etc. (Figure 2C, D), and it is much more numerous around gardens and orchards in the second period. This provided many potential nesting places preferred by the *Lanius* spp. A high plasticity of shrikes in nest site selection was noted by Jakober and Stauber (1981), who emphasized that nest site selection is influenced by local habitat conditions. The specific selection of trees in this area is due to the specificity of the vegetation of karst fields.

The Red-backed Shrike also used fruit species (plum and wild apple) in considerable numbers, significantly more in the second period ($z \approx 13$). Selection of fruit species for nesting is reported by Žolner (1983) and Goławski (2007). The preponderance of nests in this type of trees (plum tree) is partly explained by it being the most common fruit species in the area (more than 80%, pers. obs.). Also, another difference is that the Red-backed Shrike used *Pinus* spp. for nesting in the second period (not in the first). The use of conifers for nesting is mentioned by several authors (Kuźniak 1991, Olsson 1995b, Pedersen *et al*. 2011), but mainly for the area of Northern Europe. *Pinus* spp. was a common tree species planted in the 21th century in many sites, ie. on abandoned pastures. In the next 10 to 20 years, these afforestations will allow an increase in the number of *L. collurio*, but with the increase of *Pinus* spp. a forest will be created, so this species will lose large areas for nesting, and thus for survival. According to Zhang *et al.* (1994) breeding is the most important part of bird life, since a success of breeding can directly affect population dynamics and the continuity of species.

Average height of nests from the ground was higher than that of certain other European populations (Olsson 1995b, Nikolov 2000, Tryjanowski and Sparks 2001, Lislevand 2012). Elsewhere, Red-backed Shrikes placed their nests higher than found in the current study (eg. Denac 2003 or Baláž 2007). The height of nests in the study area mostly did not differ from that reported by other authors in Central Europe (Kuźniak 1991, Goławski and Mitrus 2000, Pedersen *et al*. 2011, Polak 2012, etc). Also, the highest nests in the study area did not differ from that reported by many authors (eg. Olsson 1995b, Baláž 2007, Lislevand 2012, Arslan Şahin *et al*. 2016 etc). Only in a few populations the nest height was 3.5 to 4 m (Pedersen *et al*. 2011, Polak 2012). According to Kuźniak (1991) the highest nests were built in pines at heights of 3.5 to 4 m but the majority of nests (73.2%) were built at a height of 0.7 to 1.8 m. The height of nests variability in different populations may be due to habitat type or tree differences in breeding areas.

CONCLUSIONS

To fill the gap in our knowledge on srikes' nesting places, in this paper the nests of two species nesting in karst fields were characterized. In addition to fulfilling these descriptive purposes, the species' nesting site preferences were assessed for the first time in six habitats, which differ in vegetation structure and the availability of different nesting niches. Differences in patterns observed between these habitats are discussed and results compared with other studies.

Generally, the results showed that the species-habitat relationships observed in our study were similar to those reported in the literature.

The selection of nest sites of two species of birds between two periods was compared: before and after Balkans civil conflict in thre karst poljes, the municipality of Bosansko Grahovo. In both species, differences were found between the two studied periods. This might relate to the less intensive agriculture and reduced anthropogenic disturbance generally found in second period in our study area.

Further studies on the consequences of choosing different nest sites in the area of karst poljes and characteristics of nest site choice in different habitats and their impact on the daily survival rates and thus the reproductive success are required to enhance our understanding of the processes influencing selection of nest placement by the Shrikes in the agricultural man-made environment when it is completely abandoned.

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