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VARIATION IN BLACKBIRD, *TURDUS MERULA* (PASSERIFORMES, TURDIDAE), NEST CHARACTERISTICS IN URBAN AND SUBURBAN LOCALITIES IN CRIMEA

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Variation in Common Blackbird, *Turdus merula* (Passeriformes, Turdidae), Nest Characteristics in Urban and Suburban Localities in Crimea. Kucherenko, V. M., Ivanovskaya, A. V. — Blackbird *Turdus merula* is a model species for studying the impact of environmental factors on the form and structure of nests. In the middle of XX, this species began to expand its range into the artificial forests of the Ukrainian steppe zone. This expansion may have led to changes in bird behaviour, including changes in nest construction choices (e.g., nest shape, size, location and building materials). In this study, we investigated Blackbird nest diversity (i. e., size, volume, and composition) in the park of Simferopol (a city in Crimea, South Ukraine) and in an artificial forest located nearby. We found a significant inverse relationship between nest placement height and external nest diameter. External nest depth was greater in the forest than in the park. This difference reflects the variation in plant life form between the sites. More specifically, nests in trees have significantly greater external depth than the nests located on shrubs. Most nests in both urban and suburban localities contained natural and anthropogenic materials; there was no significant difference in component types between sites. In general, the anthropogenic materials played a decorative role and also served as camouflage.
Key words: Blackbird, *Turdus merula*, nest morphology, size, Crimea.

Introduction

Nest building is a taxonomically widespread activity, with birds, mammals, reptiles, fish, and insects all constructing nests of some type in which to lay eggs or raise offspring (Hansell, 2000). Dawkins (1982) argues that just as there are specific genes for body form or eye colour, there must be genes whose phenotypic expression is apparent in the architecture of a nest or web. Even within taxa, there is a great deal of variation in nest design; in birds, nests range from the small but elaborate cup-shaped nests built by passerines to the huge mounds built by megapodes (Hansell, 2000). The shape and placement of nests are specific; that is, individuals can identify the nests of their own species based on those nests' morphological features.

Empirical studies examining the design and function of bird nests are not randomly distributed with respect to ecology; the vast majority of studies involve small hole-nesting passerines, which breed inside nestboxes (Mainwaring at al., 2014 a). Nonetheless, our understanding of the design and function of bird nests has increased considerably in recent years. In particular, evidence now suggests that nests have four functions that are not mutually exclusive. Moreover, bird nest designs are far more sophisticated than previously realized; nests are multifunctional structures that have important fitness consequences for the builders (Biddle et al., 2015; Mainwaring et al., 2014 a). The body of knowledge regarding the factors that affect nesting variables (e. g., nest placement, nesting duration, nest construction period, and clutch size) is still far from complete, especially for bird species that built open-cup nests (Mainwaring et al., 2014 b).

Blackbirds *Turdus merula* are a model species for studying the impact of environmental factors on the form and structure of nests because the species is widespread and common, and its nests are relatively easy to find. Blackbirds build open-cup nests that consist of a bulky cup of twigs, dry grasses, moss, stalks, and other vegetative material plastered on the inside with mud or muddy leaves. The nests are completed with a lining of fine grass, thin dead stems, or rootlets (Cramp, 1988; Mainwaring et al., 2014 b).

In the middle of XX *T. merula* began to expand its range into the artificial forests of the Ukrainian steppe zone (Tsvelykh, 2017). By the end of XX, Blackbird occupied the Simferopol (Crimea, South Ukraine) (Treschev & Kupsha, 1986). Range changes affect bird behaviour, including nest construction choices; birds may alter their nest size, shape, location, and building materials. These changes can be assessed not only by observation but also by studying nest construction. Thus, the aim of this study was to compare the diversity of blackbird nest designs between different urban and suburban localities and to assess the relationship between nest construction characteristics and environmental factors.

Material and methods

Our research was conducted from 2016 to 2018 at two study sites: the Salgirka City Park (44°56' N, 34°07' E) and the artificial forest on the Simferopol Reservoir (44°56' N, 34°09' E). Salgirka City Park (about 33 ha) is located in the southern part of Simferopol. It is constantly visited by people and surrounded by roads, streets, and buildings. The park's trees are mostly deciduous; however, 20 % are 50–70 year-old coniferous trees. A shrub layer consisting predominantly of *Rosa canina*, *Clematis* sp. covers about 20 % of the park. The artificial forest on the Simferopol Reservoir contains 60–70 year-old trees, of which about 80 % are coniferous and 20 % are deciduous. The shrub layer near the reservoir is very scant and consists of *Rosa canina* and *Prunus spinosa*. The distance between these two sites is about 3 km.

Blackbird nests were collected after nest abandonment at the end of the breeding season. Prior to analysis, the nests were stored for at least several months at approximately room temperature and humidity. We measured six aspects of nest morphology: external nest diameter, internal nest-cup diameter, external nest depth, internal nest-cup depth, volume, and weighed (Hansell, 2000; Mainwaring et al., 2014 b). The volume of the nest cup was determined by placing polyethylene under the nest-cup and filling it with water. After measuring, the samples were decomposed so that their structural components could be studied.

We identified three main nest regions: outer nest (loosely arranged, generally not interwoven), structural wall (sometimes interwoven, typically incorporating mud, cup-like shape) and cup lining (interwoven structure, cup-like shape) (Biddle et al., 2014). Each structural region was carefully deconstructed, taking particular care to avoid damaging any of the individual elements. We estimated the number of component types in each nest layers. T-tests and Wilcoxon tests were used to determine whether significant differences in nest morphology were between the two study sites. The normality of each variable's distribution was tested using the Shapiro-Wilk test. We carry out all analyses in R version 3.6.0 (R Core Team 2017).

Results and discussion

Previous studies have reported a relationship between nests placement height and nest predations rates. More specifically, nests located higher were more often attacked by avian predators; nest places near the ground were safer despite being greater risk from a range of mammalian predators (Piper & Catterall, 2004; Mainwaring et al., 2014 a). In our study, nest placement height not differed between the park and forest ($t = 0.02$, $p < 0.98$) likely because of the same variation in mammalian and avian predation rates in both places.

There was a significant inverse relationship between nest placement height and external nest diameter ($r = – 0.44$, $p < 0.05$) (fig. 1). According to Mainwaring & Hartley (2013), nest building is energetically expensive, and birds build smaller nests at greater heights above the ground in order to compensate for these costs. Two characteristic of nest construction (i. e., mass and volume) have a clear influence on energy costs. However, in our study, there were no significant correlations between nest height and nest volume, mass, external depth, or internal depth. Thus, the energy costs associated with nest construction did not affect placement height. On the other hand, nest size is determined by a nest's outer diameter. It can be concluded that birds tend to reduce the external nest diameter in order to decrease the visibility of nests located high above the ground. This hypothesis fits with the mammalian and avian predation pressure outlined above. The main predators of common blackbird nests at the study sites were Magpies (*Pica pica*) and Jays (*Garrulus glandarius*). Reduction in visibility make nests safer by diminishing the risk of attack from avian predators.

In addition, we determined that the external nest depth was grater in the forest than in the park ($t = 4.64$, $p < 0.01$, t-test) (table 1, fig. 2). This can be explained by differing composition of tree species that birds use to build nests in the park compared with the forest. It was also noted that nests in the forest were more often located on trees, while in the park they were more common on shrubs. In contrast to our research, urban and

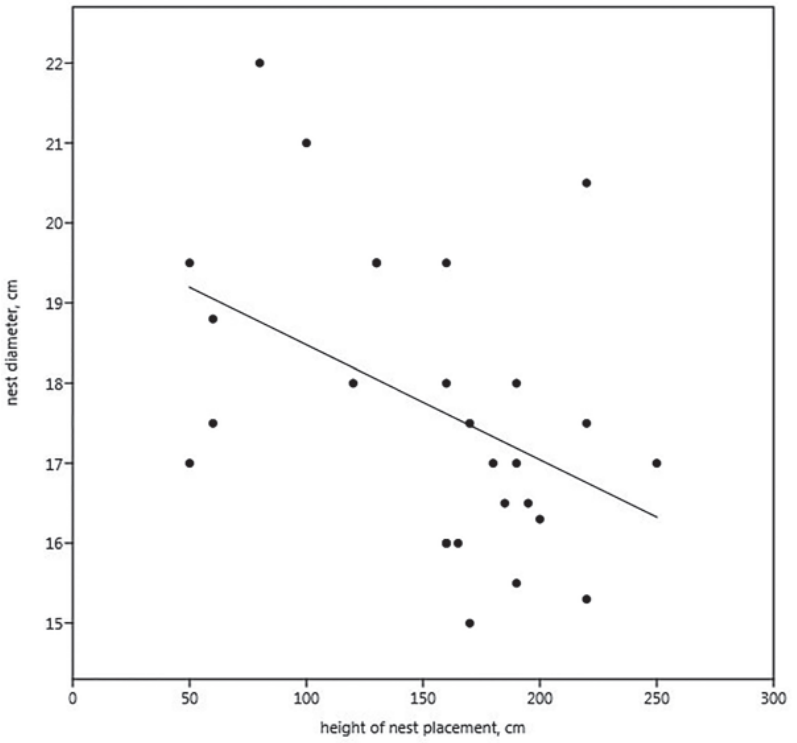

Fig. 1. The relation between external nest diameter and nest placement height (N = 27).

park-dwelling blackbird in Turkey are more likely to build nests in trees, and in forest they generally build on shrubs (Karakaya & Arikan, 2015).

We checked whether plant type affects external depth of the nest. We found that nests in trees had a significantly greater external depth than nests located on shrubs ($t = 3.198$, $p < 0.05$, t-test) (fig. 3). It appears that this occurs because nest location relative to the trunk varies with plant type. In trees, nests were more often located near the trunk, likely because placing the nest near the trunk increases the area of contact between the nest and its attachment site. When the nest lies on a shrub branch, the support is located below the nest, and this provides a secure mount that does not require additional design solutions. There were no significant differences in other nest size characteristics (i.e., volume, external diameter and internal diameter) between sites.

Three main cup-shaped regions were identified: outer nest (loosely arranged, generally not interwoven), structural wall (sometimes interwoven, typically incorporating mud, cup-like) and cup lining (interwoven structure, cup-like shape) (Biddle et al., 2015). The number of component types in each nest layer varied; there were 4–8 component types in the outer layer, 4–9 component types in the middle layer, and 2–6 component types in the inner layer (table 2, fig. 4, A–C).

We assumed that the environment in the city was more diverse; therefore, we further hypothesized that the number of component types in the nests at the park would be higher

Table 1. Blackbird nest characteristics in the park and in the forest

Site	Height placement, cm		External nest diameter, cm.		Internal nest diameter, cm		External nest depth, cm		Internal nest depth, cm		Nest cup volume, ml		Mass, g	
	N	X ± SE	N	X ± SE	N	X ± SE	N	X ± SE	N	X ± SE	N	X ± SE	N	X ± SE
Park	32	183.7 ± 10.2	15	17.9 ± 0.4	15	11.0 ± 0.3	15	9.9 ± 0.2	15	6.0 ± 0.2	10	227.2 ± 20.2	10	175.3 ± 19.9
Forest	29	169.1 ± 10.6	10	17.9 ± 0.4	10	10.4 ± 0.2	10	11.8 ± 0.3	10	5.9 ± 0.2	10	236.5 ± 15	10	171.2 ± 16.3

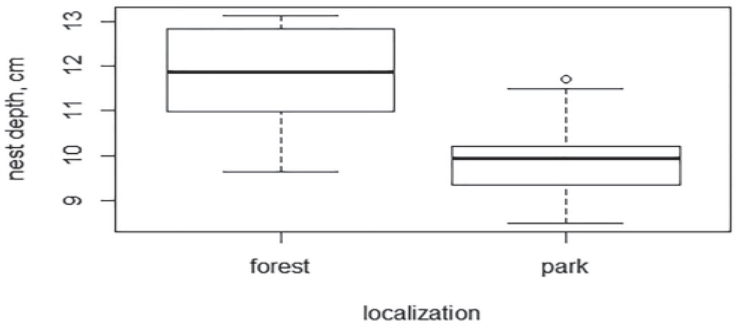

Fig. 2. The differences in external depth between Blackbird nests in the park (N = 15) and forest (N = 10)

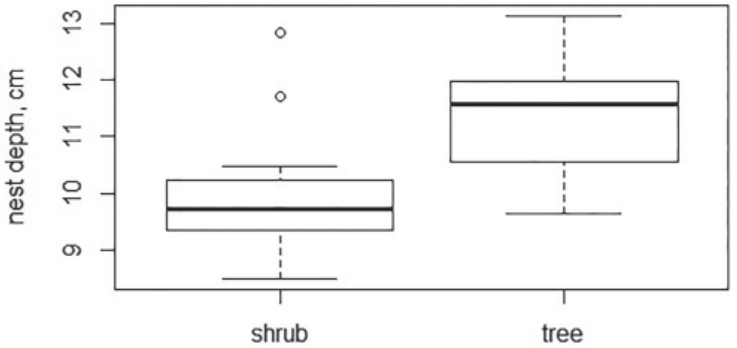

Fig. 3. The differences in external depth between Blackbird nest in tree (N = 12) and shrubs (N = 15).

than in nests in the forest. However, there was no significant difference in the number of component types in any layers between the park and forest (Wilcoxon test, $p > 0.05$). A previous study showed that the global pattern of debris incorporation in bird nests reflects anthropogenic pressure (Jagiello et al., 2019). In our survey, only 5 nests out of 21 did not contain anthropogenic materials; of those, four were located in a suburban area (forest), and one was located in an urban locality (park). Pieces of polyethylene, paper towels, and wet wipes were found in the nests. It is likely that these anthropogenic materials played a decorative role and helped better camouflage the nests. The outer layer of nests often contained moss, but in half of the nests from the park, moss was replaced by clematis stems (*Clematis* sp.).

Table 2. Types of components used in the structural layers of Blackbird nests in the park (N = 10) and in the forest (N = 10)

Types of components	Outer layer		Medium layer		Inner layer	
	park	forest	park	forest	park	forest
Moss	+	+	+	+	+	+
Lichen	-	+	–	–	–	–
Anthropogenic materials	+	+	+	+	+	+
Stems of perennial grasses	+	+	+	+	+	+
Stems of annual plants	+	+	+	+	+	+
Tree bark	+	+	+	+	+	+
Leaves	+	+	+	+	+	+
Roots	+	+	+	+	+	+
stems of shrubs and trees	+	+	+	+	+	+
Mud	–	–	+	+	+	+
Stones	–	–	+	+	–	–

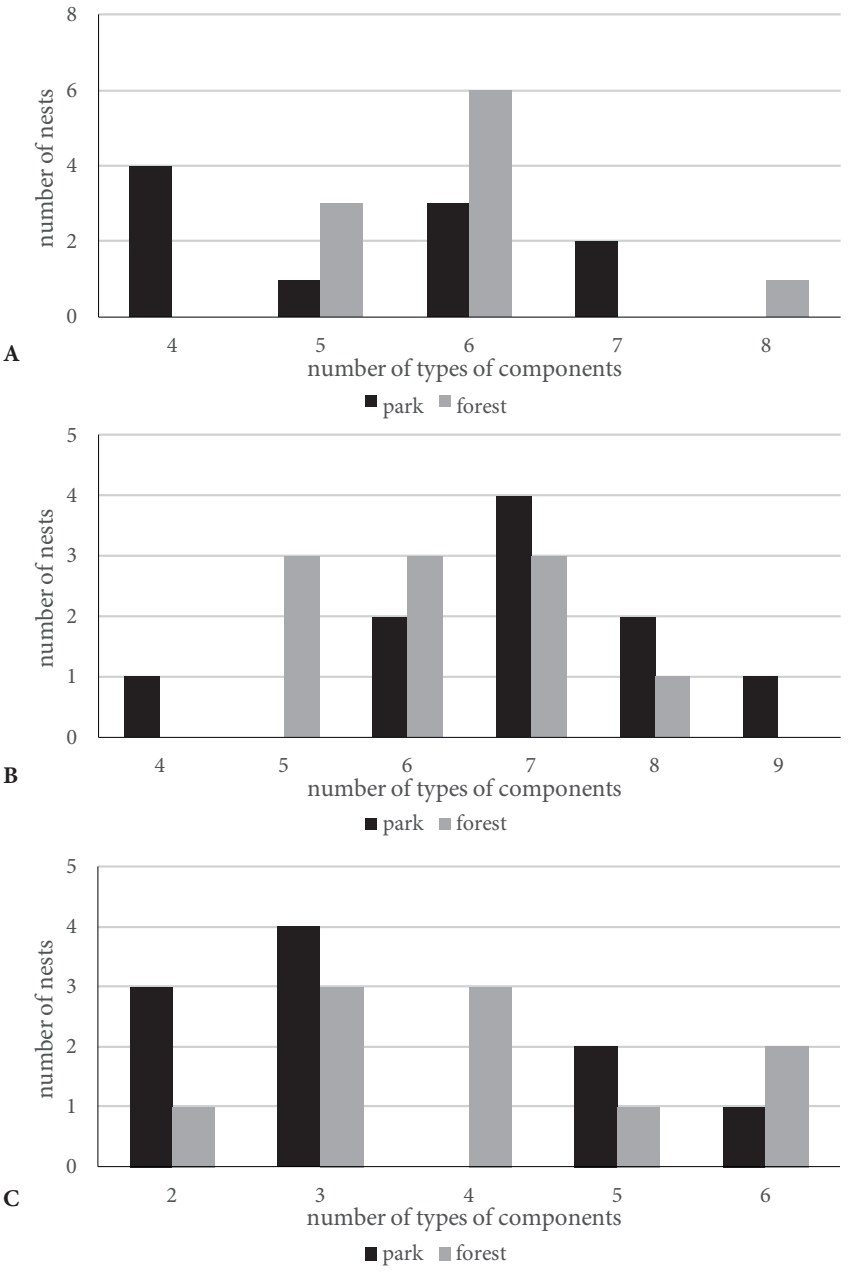

Fig. 4. Number of component types in each nest layer: A — Outer layer, B — Medium layer, C — inner layer.

Conclusion

Blackbird nest structure depends on various environmental conditions. This demonstrates the ecological plasticity of the species. We found a significant inverse relationship between nest placement height and external nest diameter. In contrast to the assumption that birds tend to reduce energy costs when building nests higher above the ground (Mainwaring & Hartley, 2013), in our opinion, birds tend to reduce the visual size of nests located high above the ground to avoid avian predators. Our data broadens the knowledge about the patterns of change in nest morphology. Previous study showed, open-cups nesting birds systematically vary the design of their nest to respond to large scale latitudinal variation of spring temperatures (Mainwaring et al., 2014 b). We found

that external nest depth was greater in the forest than in the park. This difference reflects the variation in plant life form between the sites. More specifically, nests in trees have significantly greater external depth than nests located on shrubs. Most nests in both urban and suburban localities contained natural and anthropogenic materials; there was no significant difference in component types between sites. In general, the anthropogenic materials played a decorative role and also served as camouflage.

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