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DIFFERENCES BETWEEN THE OUTER AND INNER STRUCTURE OF THE SHORT-TOED TREECREEPER'S (*CERTHIA BRACHYDACTYLA* BREHM, 1820) NEST IN AN URBAN AREA

RAPID COMMUNICATION

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Abstract. We reported the first available data on the fine-grained structure of the short-toed treecreeper's (*Certhia brachydactyla* Brehm, 1820) nest located in an urban park of Rome (central Italy). The outer structure was characterized by a high percentage of conifer (*Pinus pinea*) needles, which are significantly longer than other branches and twigs. Pine needles are widely available in urban parks, and being more flexible and easily detachable, may contribute to the support of the outer nest structure provided by other linear components (i.e., twigs/branches). Moreover, their aromatic terpenes may control nest parasites. In contrast, the internal cup lining was composed of a very light and heterogeneous set of components (bird feathers of at least one synanthropic bird species: *Streptopelia decaocto*), vegetable fluff, grass leaves, shrubs and trees, moss, sand, dust, and plant roots, i.e., all the materials largely used in bird nests because of their insulative qualities and thermoregulation functions. Although the internal cup lining was more heterogeneous in composition, the total weight of the outer nest was significantly heavier (>65% on the total nest weight).

INTRODUCTION

Although it has been recognized that bird nests are multifunctional structures fulfilling ecological, behavioural and evolutionary functions that are far more sophisticated than previously realized (Mainwaring et al. 2014; Deeming and Mainwaring 2015), studies on species-specific nest structures of some species in terms of fine-grained composition are still scanty (e.g., Winkler and Sheldon 1993; Hansell 2000; Merlino et al. 2018). As reported by Biddle et al. (2018a), nest size is known only for about 300 species, and the materials used for nest building have been quantified for less than 20 species (see also Deeming 2013; Deeming and Mainwaring 2015; Taberner Cerezo and Deeming 2016; Briggs and Deeming 2016; further examples at single species level in Navarro et al. 2010; Battisti and Fanelli 2021).

Treecreepers (*Certhia* spp.) represent a group of forest secondary cavity nesters (Newton 1994) preferring small tree holes excavated by woodpeckers or left by dead branches (Cramp 1988; Basile et al. 2016), and also occurring in nest boxes (e.g., Kuitunen and Aleknonis 1992; Robles et al. 2012; Deeming et al. 2017). However, excluding historical notes (e.g., Tyler 1914), analyses of the fine-grained structure and composition of the treecreeper's nests has been reported only in general terms (Cramp and Perrins 1993), as highlighted by Goodall et al. (2019).

The short-toed treecreeper (*Certhia brachydactyla* Brehm, 1820), a resident and specialist small Western Palearctic passerine species usually found in oak or mixed-deciduous forests (with prevalence of oaks, *Quercus* spp.), has recently colonised urban parks (Snell et al. 2020). This species frequently uses artificial nest boxes both during and outside the breeding season (Mainwaring 2011; for Italy: see Mascara et al. 2011). Thus, some authors (e.g., Harrap 1996) have provided a qualitative assessment of its nest composition specifying such materials as conifer needles, grass, bark, plant fibres, cloth, and paper, lined with feathers, hair, down rootlets, moss and lichens.

In this note we report a quantitative evaluation of the fine-grained structure and composition of a single nest of the short-toed treecreeper (*Certhia brachydactyla*) located in an urban park. To our knowledge, these are the first data on this topic available for this secondary hole-nesting species.

MATERIALS AND METHODS

We sampled the treecreeper's (*Certhia brachydactyla*) nest, which had been attributed to this species based on direct observations, in April, 2021. The nest was put in an artificial nest box (12 × 12 × 14 cm), which was placed on a non-native *Melia azedarach* tree (diameter at breast height: 46 cm) growing in a suburban residential park in the western sector of Rome (via dei Carafa, central Italy; 60 m a.s.l.; 41°51'51.0"N, 12°24'59.0"E) at a height of 3.5 m above ground. In the immediate surroundings of the nest tree, there was a large number of non-native ornamental coniferous (*Cedrus libani*, *C. atlantica, Pinus pinea*) and deciduous (*Ailanthus altissima*, *Celtis australis, Eucalyptus* sp., *Prunus* sp., *Malus* sp.) trees surrounded with hedges (*Laurus nobilis*, *Hedera helix*, *Pittosporum tobira*). The herbaceous layer was mainly composed of *Urtica membranacea, Geraniun molle, Perietaria judaica, Sonchus asper.* In the vicinity, there are two nature reserves ("Valle dei Casali" and "Tenuta dei Massimi") characterized by a typical landscape mosaic of Campagna Romana (*Quercus suber* wood fragments) with synanthropic and ecotonal habitats (see Fanelli 1998; Fanelli et al. 2007; Battisti and Mandolini 2018 for details).

To characterize the nest structure and composition, we distinguished two sectors: the internal cup lining (nest chamber) and the peripheral sector (the outer nest, surrounding the nest chamber). The entire nest was deconstructed and disassembled, different materials being separated in categories so as to determine the nest composition and weight (in grams; using a professional scale Sartorius analytic; error ± 0.00001 g). As to the outer nest, all linear components (woody branches and twigs vs. conifer needles) were also measured in length (in cm), using a professional calliper (Vernier LS PRO).

We obtained relative weight frequencies (Fr) for all material categories and compared the total material frequency for both the outer nest and the internal cup lining using an χ^2 test. The average length was compared between sectors using a Mann-Whitney U test (Dytham 2011). To test for difference in the frequency distribution of length measurements of both woody twigs and conifer needles, we used the Kolmogorov-Smirnov test. Alpha level was set at 0.05. We used the PAST 4.01 software for statistical analyses (Hammer et al. 2001).

RESULTS

The outer part of the nest was exclusively composed of linear components (branches/twigs of *Hedera helix* and Rosacea ind.; *Pinus pinea* needles). The internal cup consisted of (in decreasing order of weight) vegetable fluff, dust and sand, grass leaves (Graminaceae), bird feathers (probably, of *Streptopelia decaocto* and others undetermined), plant roots, leaves (*Quercus* sp., *Hedera helix*), grass sheaths (Graminaceae), and moss (*Rhynchostegium* cfr. *murale*; Table 1). Although the internal cup lining was more heterogeneous in composition, the total weight of the outer nest was significantly heavier (13.505 *vs*. 6.688 g; $\chi^2 = 7.18$, $p < 0.05$; Table 1).

As to linear components of the outer nest, we counted 234 items (mean length: 65.88 mm ± 32.30 (range: 12–192), 42 of which were conifer needles (17.9% of the total linear components; mean length: 88.24 mm ± 33.50; range: 17–182) and 192 woody twigs (60.99 mm ± 29.97; range: 12–192). Pine needles were significantly longer than twigs (pine needles *vs*. tree twigs: U = 2000, Z = 5.115, $p < 0.001$; U Mann-Whitney test; Figure 1). The abundance frequency distribution of pine needles *vs*. tree twigs/branches shows a significant difference (D = 0.44, $p > 0.01$, Kolmogorov-Smirnov test), with the modal class of pine needles being longer than that of twigs/branches (Figure 2).

DISCUSSION

In our exploratory study we observed a marked difference between the two sectors of the short-toed treecreeper's nest. The internal cup lining was lighter but more heterogeneous in composition than the outer nest, which represented the major part of the total nest weight (>65%).

Structural properties of different bird nest sectors vary according to their specific functions. Therefore, the nest-building materials used in the parts of the nest

Table 1. Composition of the Short-toed Treecreeper' nest in an urban park, subdivided into the outer nest and the internal cup lining. Weight (with frequency, in g) of all material categories is presented. (*) including twigs of *Hedera helix* and Rosacea ind.

	Components	Weight (g)	Fr
Outer nest	Linear components (branches/twigs* and *Pinus pinea* needles)	13.505	0.667
Internal cup lining	Vegetable fluff	2.518	0.124
	Dust and sand	1.949	0.096
	Leaves of grasses (Graminaceae)	0.911	0.045
	Bird feathers	0.505	0.025
	Roots	0.363	0.018
	Leaves (*Quercus* sp., *Hedera helix*)	0.317	0.016
	Sheaths of grasses (Graminaceae)	0.125	0.006
	Moss (*Rhynchostegium* cfr. *murale*)	0.052	0.003
	Total	20.193	1

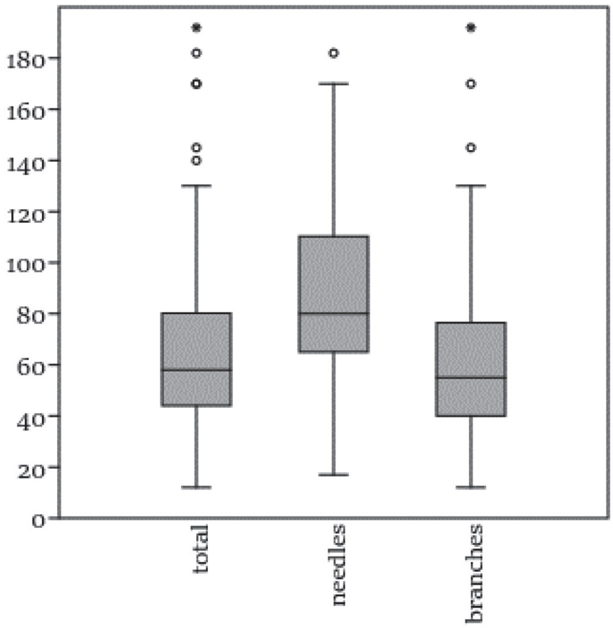

Figure 1. Mean length of linear components (box-whisker plot: total, N = 234; pine needles: N = 43; twigs and branches: N = 192) in the outer nest of the Short-toed Treecreeper (*Certhia brachydactyla*). For each sample, the 25–75 percent quartiles were drawn using a box. Horizontal line inside the box: median values. Short horizontal lines ("whiskers"): minimal and maximal values. Points represent the outliers.

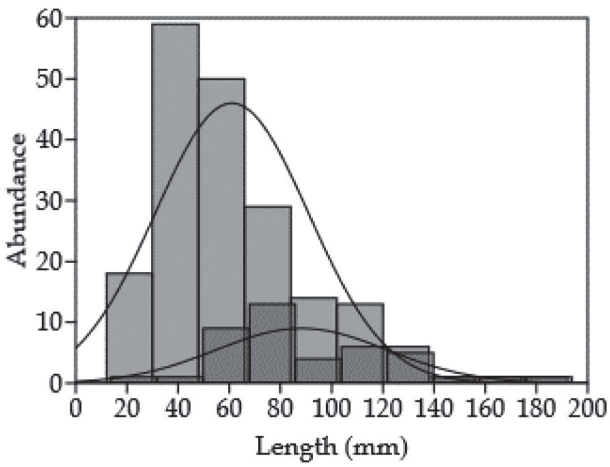

Figure 2. Frequency distribution in abundance (= n. items) for different length categories (in mm) and hump-shaped curves (Kolmogorov-Smirnov test for equal distributions). Light grey: branches and twigs; dark grey: pine (*Pinus pinea*) needles.

that need most support (the outer sector) are thicker and stronger than those used in the internal cup lining (see Biddle et al. 2018b). Here, in the outer nest, we recorded mainly twigs, branches and conifer (*Pinus pinea*) needles, which are widely used in bird nests (e.g., Erickson and Martinez-Vargas 1973; Csada and Brigham 1994; Quilodrán et al. 2012; Reynolds et al. 2019; for the congeneric *Certhia familiaris* Linnaeus, 1758: see Goodall et al. 2019; for other cavity nesters: Gelis and Martinez 2000). Due to their shape and size, pine needles are suitable for fulfilling the structural support function of the outer nest (Goodall et al. 2019), in addition to other linear components (i.e., twice and branches). Indeed, we found that conifer needles were significantly longer than the twigs. Moreover, they are more flexible and easily detachable from plants (for ductility and elasto-plastic properties of conifer needles, see Howard 1973; Jové-Sandoval et al. 2018). The additional function of pine needles as aromatic fragments can be inferred due to their richness in terpenes (Pires et al. 2012), such as limonene, a compound known to reduce fleas and ticks in domestic animals (Macchioni et al. 2002; Hinkle 2010).

In South European urban environments, conifer needles are readily available because these trees are widely cultivated for ornamental purposes. In addition, almost all components of the outer nest are from the ornamental plants grown in urban gardens (as Rosaceae ind. and *Hedera helix*), which is in line with the observations of other researchers stating that the composition of a bird nest may reflect the availability of resources, habitat types and species of plants growing in the vicinity (Lambrecths et al. 2017; Reynolds et al. 2019).

As opposed to the structural function of the external part, the internal cup lining appears to be very light and heterogeneous in composition, which includes feathers of at least one synanthropic bird species (*Streptopelia decaocto*), vegetable fluff, leaves of grass, shrubs and trees, moss, sand, dust, and roots, all the materials largely used in bird nests because of their insulation qualities and thermoregulation functions, as well as those used for the maintenance of stable temperatures in the incubation chamber (Lombardo et al. 1995; Hansell 2000; Goodfellow 2011).

To our knowledge, data about the fine-grained structure and composition of the short-toed treecreeper's nest have not been published previously. However, although the number of items analysed in our study was representatively large, this note reports only the data obtained from a focal nest in an urban context. Since this nest was located in a peculiar context (urban park with a high plant diversity), its structure cannot be considered to be representative of the entire species' nests. Therefore, to provide a more general overview of the short-toed treecreeper's nest structure, further research using a larger size sample has to be conducted.

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COMPETING INTEREST

The authors declare that they have no competing interest.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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