Inter-relationships between composition, insulation and water-proofing of domed nests constructed by the long-tailed tit (*Aegithalos caudatus*)

INTRODUCTION

Bird nests are where eggs are incubated and chicks are reared; they may also offer some protection from the weather and predation. Significant diversity is found among birds in nest size, shape and composition, but the extent to which this relates to function is not fully understood. In many species, nest mass and material proportions relate to nest water-proofing abilities and insulatory properties (Biddle *et al*., 2019; Deeming *et al*., 2020).

Long-tailed tits build elaborate domed nests of moss and lichen, woven with silk and filled with feathers. How their nest structure impacts incubation or withstands environmental pressures, such as rainfall, is unknown. Exploring how nest composition relates to function in this and other species will provide understanding of the evolutionary drivers of nest design and how climate change may impact avian reproduction.

METHODOLOGY

Photo by Charles Deeming

15 nests were collected during 2021 and donated by Professor Ben Hatchwell of the University of Sheffield.

Insulatory values were calculated using temperature loggers (iButtons) which were heated and then placed inside and outside of nests. Readings were taken every minute until they had cooled. This was repeated 3 times per nest (see Deeming *et al*. 2020).

To simulate rainfall, 250ml of water was poured over each nest through a sieve. Nests were left to drain and the amount of water absorbed was calculated. Repeated weighs allowed for calculation of the time it would take the nest to fully dry (Biddle *et al*. 2019).

Using forceps, nests were carefully deconstructed. This provided data on the mass of the various materials used in the inner lining and the outer nest, as materials from each region were individually bagged and weighed.

RESULTS

The outer nest contained the highest number of materials, with the lining dominated by feathers and the outer nest mainly consisting of moss and lichen (Figure 1A).

Most of the insulatory values were below 0.045 and did not show a strong relationship with feather mass (Figure 1B). There seemed to be a good positive relationship between mass of moss and the amount of water absorbed by the nest (Figure 1C). There was a positive relationship between the minutes to dry and nest mass (Figure 1D).

However, correlation analyses showed that there were no significant relationships between any of the nest materials and the nests' insulatory values, water absorbed, or time taken to dry (Table 1).

Variable	Insulatory value	Water absorbed	Minutes to dry
Insulatory value	-	-	-
Water absorbed	*rho* = 0.300 (0.277)	-	-
Minutes to dry	*rho* = 0.411 (0.130)	*rho* = 0.186 (0.507)	-
Nest mass	*r* = 0.021 (0.941)	*rho* = 0.318 (0.248)	***rho* = 0.382 (0.161)**
Lining mass	*r* = 0.096 (0.733)	*rho* = 0.161 (0.567)	*rho* = 0.396 (0.145)
Outer wall mass	*rho* = 0.129 (0.648)	*rho* = 0.289 (0.295)	*rho* = 0.293 (0.289)
Proportion lining	*r* = 0.011 (0.970)	*rho* = 0.1 (0.724)	*rho* = 0.164 (0.558)
Feathers	***r* = 0.095 (0.736)**	*rho* = 0.193 (0.490)	*rho* = 0.45 (0.094)
Hair	*rho* = -0.047 (0.869)	*rho* = 0.249 (0.371)	*rho* = -0.036 (0.899)
Moss	*r* = 0.170 (0.545)	***rho* = 0.371 (0.174)**	*rho* = 0.207 (0.458)
Lichen	*r* = 0.030 (0.914)	*rho* = 0.104 (0.714)	*rho* = 0.268 (0.333)
Grass	*rho* = -0.168 (0.548)	*rho* = -0.007 (0.980)	*rho* = -0.036 (0.899)
Stems	*rho* = -0.130 (0.645)	*rho* = 0.234 (0.401)	*rho* = -0.324 (0.239)
Silk	*rho* = -0.218 (0.434)	*rho* = -0.225 (0.419)	*rho* = 0.186 (0.507)
Woody stems	*rho* = -0.118 (0.675)	*rho* = 0.043 (0.879)	*rho* = 0.068 (0.810)

Table 1. Results of correlation analyses to test the relationships between insulatory value, water absorbed, and minutes to dry with each other and with the masses of the nest and its components. Values are test statistics, *r* for Pearson's tests and *rho* for Spearman's tests, with p-value in parentheses; DF = 13 in all cases.

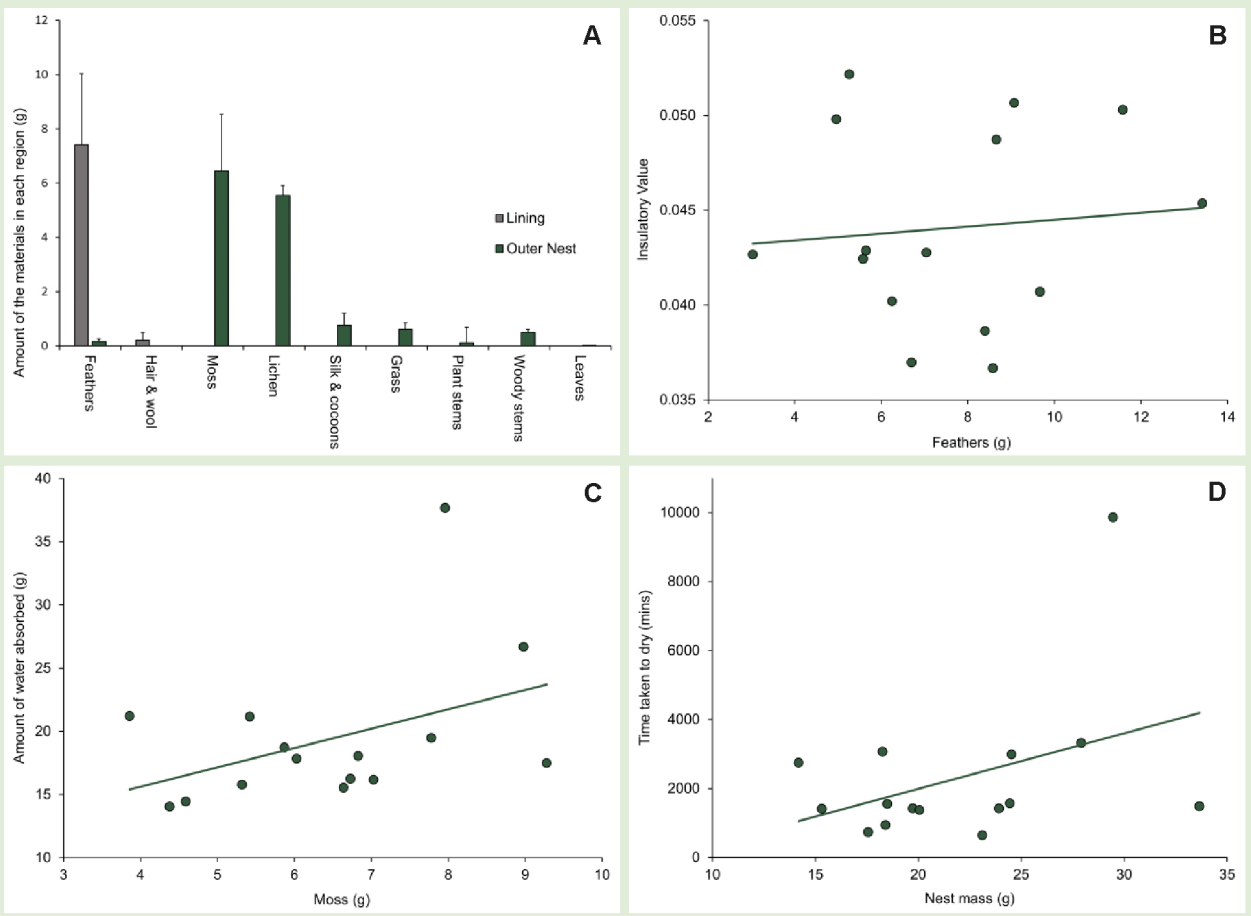

Figure 1. (A) Outer nest and inner lining composition shown as the mean (+ SD) material mass found in each region. (B) The relationship between insulatory values and feathers (C) the amount of water absorbed and moss mass and (D) the time taken to dry and nest mass (n = 15). Trendlines through the data points generated by Excel.

DISCUSSION

Long-tailed tit nests show clear demarcation in materials used in the lining and outer nest, with feathers comprising a substantial part of the overall nest mass. These results were similar to those previously reported (McGowan *et al*., 2004).

Nest size and composition did not affect the insulatory properties of the nests, the amount of water they absorbed, or how long they took to dry. This suggests that in long-tailed tits, material choice and nest construction is not influenced by external factors, such as temperature or rainfall. This result was different from previous studies where there were correlations between nest size and insulatory values (Gray and Deeming, 2017).

Other studies have shown that there are significant relationships between the materials used and the amount of water absorbed by a nest, or the time taken to dry (Biddle et al., 2019). It is unclear why long-tailed tit nests differ.

The domed structure of the nest, and the materials used, may reflect a means of avoiding predation. In particular, lichen use may be related to concealment through background matching (Hansell, 1996).

In other songbirds, variability in material choice and nest design appears to be related to environmental conditions. This plastic response may reflect species-specific effects, e.g. breeding location (Deeming and Mainwaring, 2015). Comparatively, all of the nests in this study came from one location; this could have impacted results.

Future study should be directed towards sampling nests from a range of geographical locations to establish whether greater variation exists in response to different or more challenging weather conditions. It would also be interesting to examine other species with domed nests, e.g. wood warblers (*Phylloscopus sibilatrix*), to compare nest composition and function with long-tailed tits.

References:

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