FEATHERING THE NEST

Dr Charles Deeming explores the subtle factors that will determine the size and shape of individual bird nests this spring

Bird nests range from simple scrapes on the ground to complex woven hanging structures. The role of a bird's nest is usually seen as a receptacle for the eggs or chicks, but recent research is considering the functional characteristics of nests in order to better understand their role in bird reproduction.

In general, bird nests tend to be characteristic of the species that built them in terms of location, shape and construction materials[1,2]. Nests can be located on rock ledges, within vegetation, on or above the ground, or within cavities in trees or the ground. But variation in nests built by the same individual bird was shown recently to be considerably greater than first thought[3].

We have little quantitative data on just how much of a particular nest material, such as grass or moss, is used in a nest of any particular species and whether this should be considered as a defining characteristic of that species.

Much to learn

After 30 years working on incubation and embryonic development in birds and reptiles in a laboratory context, I came to realise just how little I knew about how bird nests worked. Having established a small population of great tits (*Parus major*) and blue tits (*Cyanistes caeruleus*) breeding in nest boxes at Riseholme Park, University of Lincoln, I decided to investigate how these particular nests were built and how they functioned. General observations suggested that the nests of these familiar birds varied in size but it was unclear why.

A nest is much larger than the bird (Fig. 1), which suggests that the time and physical effort to collect all this material is energetically demanding (nest mass is a function of female body size[4], and food supplementation can shorten the period of nest construction[5]), and we have no idea of how or why such a variety of materials are chosen.

In this article I relate studies that my colleagues and I have undertaken to try to answer these questions with the emphasis on a better understanding of how the environment affects nest construction and function. We study species of tits largely because they are common and conveniently nest in artificial boxes, which are easy to find and monitor.

Nest building in blue and great tits

Great tits and blue tits take around 14 days to construct a nest within a nestbox[5]. During the seven days leading up to clutch initiation, lining materials are added and the bird moulds and lines a cup at the end furthest away from the entrance hole (Fig. 1).

At Riseholme Park, blue tits weighed around 10g, yet they built nests that averaged 26g (range = 16–43g). Larger great tits (18g) were also producing 26g nests[6]. This similarity implied that size of the box

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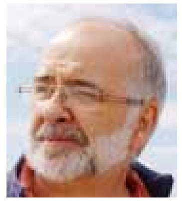

Dr Charles Deeming CBiol FSB has been studying various aspects of incubation and development in birds, particularly ostriches, and reptiles for over 30 years. A senior lecturer in the School of Life Sciences, University of Lincoln, Charles won an Ig Nobel Prize in 2002 for his work looking at ostrich courtship behaviour directed towards humans.

“Birds building in early warm periods are likely to construct a light, poorly insulated nest”

A blue tit feeding its chicks in a tree hole nest.

CHARLES DEEMING

Fig. 1. A typical blue tit nest with the bird *in situ*. Note that the base of the nestbox is filled with moss and plant stems and a cup has been moulded by the bird in the corner of the box furthest away from the entrance hole [not shown]. Note how the bird sits within the cup with its back in line with the nest layer, rather than sitting on top of the nest.

(which did not vary) in part determines the mass of the nest. These data were in line with other reports showing that nest mass is variable within a population[4,7,8].

For instance, blue tit nests built around Lancaster were also variable in size although around 50% heavier than those in Lincoln[4,7]. This view is supported by my unpublished data which shows that blue tits provided with nestboxes that are 30% or 80% larger than normal construct heavier nests that fill the base of the box.

At Riseholme my student, Jennifer Britt, showed that the composition of the nests of these species varied significantly (Fig. 2)[6]. In both species moss was approximately half of the total nest mass, but blue tits preferred grass and feathers compared with the great tits' penchant for twigs (used to line the base of the nest), hair and fur (used to line the nest cup).

In Spain, Elena Álvarez and colleagues[9] have shown that great tits nesting in an orange grove constructed nests with a high proportion of sticks. Moss was relatively rare in nests, but its presence was positively correlated with nesting success in this population. In other woodland locations moss was more prevalent in nests, but animal derived materials were relatively uncommon[9]. Overall, nests built by Spanish great tits were only around 60% of the mass of Lincoln nests.

Easy pickings

Nest materials surrounding the cup are important because of their different thermal properties. At Riseholme, in 2008, wool was freely available from a sheep flock in a nearby field and it was regularly found in tit nests. During 2009, the sheep flock was much further away and wool was rarely found in nests[6].

Further insight into how birds decide upon the materials used in their nests came from a study by the Treswell Wood Ringers Group in Nottinghamshire, which provided coloured artificial materials in dispensers distributed around the wood[10].

The amount of artificial nest material used by tit species varied – blue tits and coal tits (*Periparus ater*) used relatively little of this material. By contrast, it was more common in the nests of great tits and marsh tits (*Poecile palustris*). Use of the material was not influenced by its colour, but rather seemed to depend on the ease of its availability in the wood. For instance, in great tits more material was used the closer it was to the nestbox. It seemed that these tit species were very opportunistic in their use of nesting materials[10].

The effect of the environment

These data prompt the question: why is there such variation in the amount of nest material within one breeding season? At Riseholme, when compared to the date of clutch initiation for blue tits and great tits, early nests were heavier than late nests[6].

It is possible that birds breeding later had less time to build a heavy nest, but between years the mass of a nest was unrelated to the actual dates of the start of breeding. Compared to 2008, nesting started 15 days earlier in 2009, so light, late nests were being completed on the same date as heavy, early nests a year before.

By contrast, when the temperature during the nest lining phase was considered, nests built during colder temperatures (irrespective of when they were built) were heavier than nests built when the weather was warmer[6]. This result implied that the birds were constructing nests that reflected the temperature conditions during the construction phase, and so perhaps better reflected the thermal needs of the bird, rather than building a nest to simply house their potential eggs or chicks[6].

Of course, a better insulated nest will mean that an incubating bird would lose less heat through the nest wall and so presumably would have lower energy costs during incubation. It is interesting to note that the pied flycatcher (*Ficedula hypoleuca*) also nests in artificial boxes and exhibits considerable variation in nest mass (~18–58g)[8]. Nest attentiveness during incubation is lower in the heavier nests (~60%) than in lighter nests (~80%) implying that nest construction does impact on the incubation process in this species, but it is unclear how.

If the nest is being built by the female for her thermal needs during incubation then this should be observed more generally. In 2010, nests were collected from blue tits and great tits nesting from Cornwall to Edinburgh (~560 km and 5° latitude) to test the hypothesis that nest characteristics would correlate with latitude[11].

In line with predictions, dry nest cup mass, comprised mainly of animal-derived materials used for insulation, was inversely correlated with mean spring temperatures (mid-February to mid-May), which correlated well with latitude. Birds in the warmer south built nests that had less material in the lining of the nest cup. Temperature recorders placed in these cups cooled more quickly than those in nests from further north, proving that their insulation was poorer.

Similar latitude and temperature effects on nest thickness have been demonstrated for birds in Canada and the US[12,13]. Further analysis of the British data showed that irrespective of latitude, nest mass and the mass of material lining the cup was significantly negatively correlated with mean temperature for the seven days leading up to clutch initiation (Fig. 3)[14].

To date the means by which the birds achieve better insulation has yet to be ascertained. It is hoped that deconstruction of these nests will start soon, allowing us to understand whether these tit species just use more insulating materials in the north or whether they actually use different materials.

Great tit pulli in a nestbox.

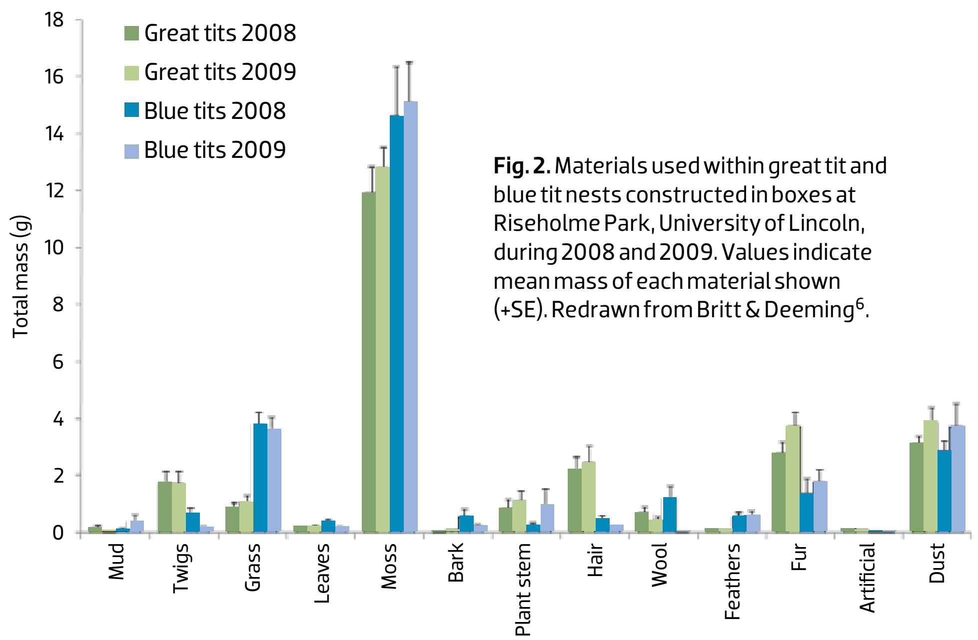

Fig. 2. Materials used within great tit and blue tit nests constructed in boxes at Riseholme Park, University of Lincoln, during 2008 and 2009. Values indicate mean mass of each material shown (+SE). Redrawn from Britt & Deeming[6].

Climatic variation and change

The effect of climate change, and therefore general and localised spring temperatures on nest construction, could be important. It is well known that the date of clutch initiation has become progressively earlier over the past 30 to 40 years[15] but being able to predict when the first egg will be laid in any year has become very difficult (Fig. 4).

Climate change could cause localised extinction of species of plants that are key to nest construction in certain species. We cannot easily assess the impact of this because we do not know how adaptable birds are in their use of nest materials.

Moreover, weather patterns are unpredictable – spells of warm, dry weather characterised the early springs of 2011 and 2012 in many parts of Great Britain but temperatures turned cooler and, in 2012, much wetter. At Riseholme, this seems to have had devastating effects on reproductive success measured as numbers of pulli (young birds or chicks) fledged (Fig. 5). Birds building in these early warm periods are likely to construct a light, poorly insulated nest – after all, why expend energy doing more nest construction when it is so warm? If the weather subsequently turns cooler, having a poorly insulated nest will be a disadvantage and may have an adverse effect on their reproductive success.

It is interesting to note that in 2010 all of the breeding season was relatively cold at Riseholme and most nest visits revealed birds sitting tight on their nests. Fledging rates were very high during this year (Fig. 5), which probably reflected the high attentiveness of the parents.

The impact of the experience of the female constructing the nest and its consequences for nest building, incubation and chick rearing, have yet to be investigated. It is appreciated that there are many factors that contribute to the variation in fledging success but, to date, variation in nest mass has only rarely been considered. In Poland, nest mass and the proportion of moss in great tit nests significantly affected fledging

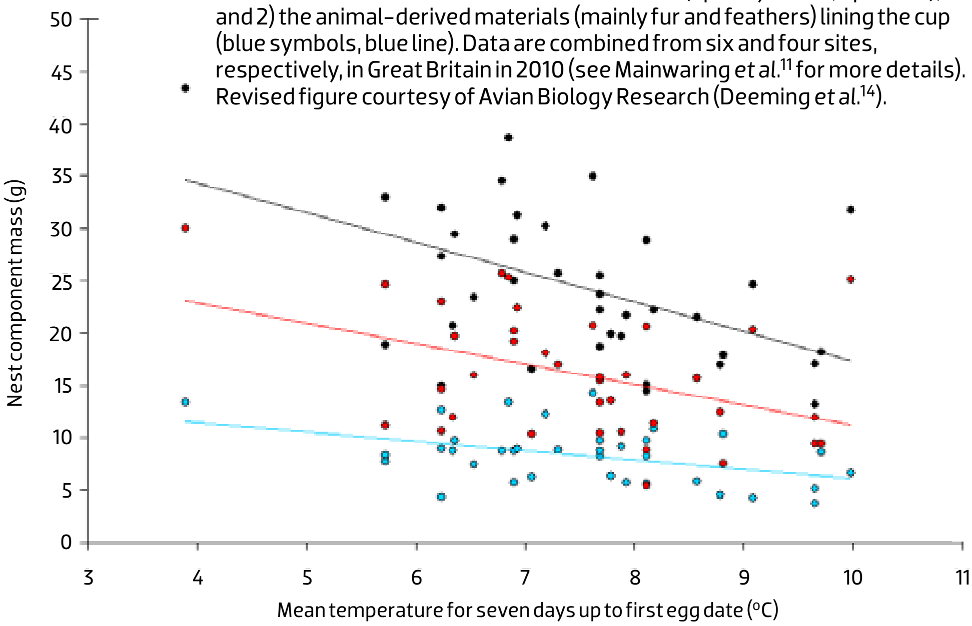

Fig. 3. Relationships for great tits between the mean temperature in the seven days preceding and including the date of clutch initiation and the mass of the whole nest (black symbols, black line), and separated into 1) the plant-derived materials that form the bulk of the nest (open symbols, open line), and 2) the animal-derived materials (mainly fur and feathers) lining the cup (blue symbols, blue line). Data are combined from six and four sites, respectively, in Great Britain in 2010 (see Mainwaring *et al.*[11] for more details). Revised figure courtesy of Avian Biology Research (Deeming *et al.*[14]).

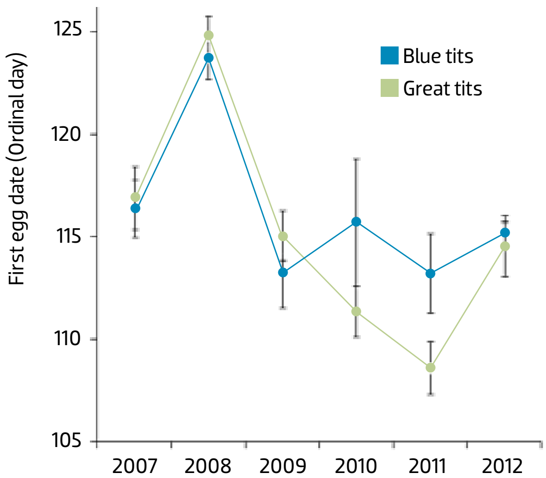

Fig. 4 (right). Nest initiation dates recorded as the presence of the first egg recorded in nestboxes for great tits and blue tits breeding in woodland at Riseholme Park, University of Lincoln (Deeming, unpublished data). Error bars indicate standard deviations.

success[16]. Investigating how nest mass impacts on either hatching or fledging success are key aims of further studies.

In conclusion

Over the past few years scientific interest in nests has increased. Research ranges from my own interest in nest composition through to construction behaviour[17,18], their thermal properties[19,20], and the use of nests as potential signals to mates during reproduction[21,22].

Now that we are studying nests in greater detail, the factors affecting their construction are proving to be more complex than ever considered previously. Much more research is needed to determine how local climate impacts on nest construction in tits and whether this is widespread in other species.

So, if this spring you have blue tits nesting in your garden bird box, how well their nest is insulated will depend on where you live and the temperature outside when the nest was built.

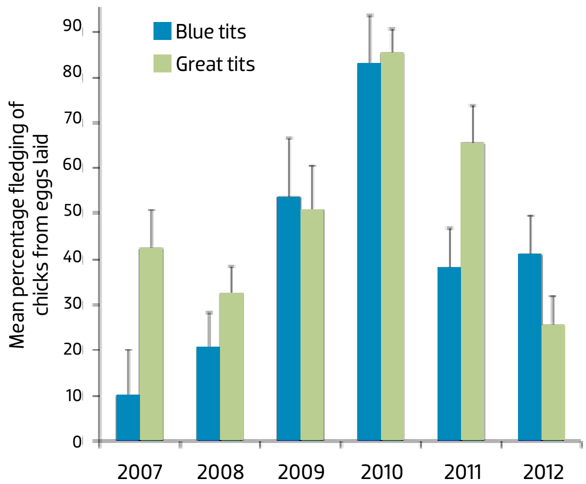

Fig. 5. Fledging success rates recorded as percentage of eggs laid in nestboxes by great tits and blue tits breeding in woodland at Riseholme Park, University of Lincoln (Deeming, unpublished data). Error bars indicate standard deviations.

REFERENCES

1 Hansell, M. *Bird Nests and Construction Behaviour*. Cambridge University Press, Cambridge (2005).

2 Ferguson-Lees, J. *et al. A Field Guide to Monitoring Nests*. BTO, Thetford (2011).

3 Walsh, P. T. *et al.* Repeatability of nest morphology in African weaver birds. *Biol. Lett.* **6**(2), 149-151 (2010).

4 Mainwaring, M. C. *et al.* The weight of female-built nests correlates with female but not male quality in the Blue tit *Cyanistes caeruleus*. *Acta Ornithol.* **43**(1), 43-48 (2008).

5 Smith, J. A. *et al.* Feathering the nest: food supplementation influences nest construction by Blue (*Cyanistes caeruleus*) and Great Tits (*Parus major*). *Avian Biol. Res.* **6**(1), in press (2013).

6 Britt, J. *et al.* First-egg date and air temperature affect nest construction in Blue Tits *Cyanistes caeruleus* but not in Great Tits *Parus major*. *Bird Study* **58**(1), 78-89 (2011).

7 Mainwaring, M. C. *et al.* Seasonal adjustments in nest cup lining in Blue Tits *Cyanistes caeruleus*. *Ardea* **96**(2), 278–282 (2008).

8 Moreno J. *et al.* Nest construction costs affect nestling growth: a field experiment in a cavity-nesting passerine. *Acta Ornithol.* **45**(2), 139–145 (2010).

9 Álvarez, E. *et al.* Plasticity in Great tit nest weight and composition and its breeding consequences: a comparative study in four Mediterranean habitats. *Avian Biol. Res.* **6**(1), in press (2013).

10 Surgey, J. *et al.* Opportunistic use of a wool-like artificial material as lining of Tit (Paridae) nests. *Condor* **114**(2), 385-392 (2012).

11 Mainwaring, M. C. *et al.* Latitudinal variation in blue tit and great tit nest characteristics indicates environmental adaptation. *J. Biogeog.* **39**(9), 1669-1677 (2012).

12 Kern, M. *et al.* Altitudinal variations in nests of the Hawaiian honeycreeper *Hemignathus virens virens*. *Condor* **86**(4), 443-454 (1984).

13 Crossman, C. A. *et al.* Variation in the structure of bird nests between Northern Manitoba and Southeastern Ontario. *PLoS ONE* **6**(4), e19086 (2011).

14 Deeming, C. *et al.* Local temperature and not latitude determines the design of Blue tit and Great tit nests. *Avian Biol. Res.* **5**(4), 203-208 (2012).

15 Deeming, C. *et al.* Long term patterns in egg mortality during incubation and chick mortality during rearing in three species of tits in an English woodland. *Bird Study* **58**(3), 278-290 (2011).

16 Alabrudzińska, J. *et al.* Effects of nest characteristics on breeding success of Great Tits *Parus major*. *Acta Ornithol.* **38**(2), 151–154 (2003).

17 Walsh, P. *et al.* Individuality in nest building: do southern masked weaver (*Ploceus velatus*) males vary in their nest-building behaviour? *Behav. Process.* **88**(1), 1-6 (2011).

18 Muth, F. *et al.* Zebra finches build nests that do not resemble their natal nest. *Avian Biol. Res.* **5**(4), 218-226 (2012).

19 Heenan, C. B. *et al.* Structural support, not insulation, is the primary driver for avian cup-shaped nest design. *Proc.R.Soc.London.B.* **278**, 2924-2929 (2011).

20 Heenan, C. B. *et al.* The effect of wind on the rate of heat loss from avian cup-shaped nests. *PLOS One* **7**, e32252 (2011).

21 Sergio, F. *et al.* Raptor nest decorations are a reliable threat against conspecifics. *Science* **331**, 327-330 (2011).

22 Moreno, J. Avian nests and nest-building as signals. *Avian Biol. Res.* **5**(4), 238-251 (2012).