NATURAL HISTORY OF LEPIDOPTERA ASSOCIATED WITH BIRD NESTS IN MID-WALES

D. H. Boyes

Bridge Cottage, Middletown, Welshpool, Powys, SY21 8DG.
(E-mail: info@douglasboyes.co.uk)

Abstract

Bird nests can support diverse communities of invertebrates, including moths (Lepidoptera). However, the understanding of the natural history of these species is incomplete. For this study, 224 nests, from 16 bird species, were collected and the adult moths that emerged were recorded. The majority of nests contained moths, with 4,657 individuals of ten species recorded. Observations are made on the natural history of each species and some novel findings are reported. The absence of certain species is discussed. To gain deeper insights into the life histories of these species, it would be useful to document the feeding habits of the larvae in isolation.
Keywords: Commensal, detritivore, fleas, moths, Tineidae.

Introduction

Bird nests represent concentrated pockets of organic resources (including dead plant matter, feathers, faeces and other detritus) and can support a diverse invertebrate fauna. A global checklist compiled by Hicks (1959; 1962; 1971) lists eighteen insect orders associated with bird nests, and a study in England identified over 120 insect species, spanning eight orders (Woodroffe, 1953).

Moths are particularly frequent occupants of bird nests, but large gaps in knowledge and some misapprehensions remain. For example, *Tineola bisselliella* (Hummel, 1823) was widely thought to infest human habitations via bird nests, which acted as natural population reservoirs. However, it has recently been discovered that this non-native species seldom occurs in rural bird nests and can be regarded as wholly synanthropic in Europe, where it was introduced from Africa around the turn of the 19th century (Plarre & Krüger-Carstensen, 2011; Plarre, 2014).

In October 2013, I collected several old bird nests from my garden (near Welshpool, Montgomeryshire) to see if they contained any moths. The following spring, I was surprised by the emergence of several *Nemapogon koenigi* Câpuse, 1967, a scarce species associated with dead wood fungi (Langmaid, Palmer & Young, 2018). It remains unclear why this species was present in bird nest material. Intrigued, I identified the moths of bird nests as a worthy topic for my final year research project (part of my undergraduate degree in Biological Sciences). Keen to ensure an adequate sample size, I had initially intended to obtain over 500 bird nests but rapidly ran out of storage space. Fortunately, the majority of the 224 bird nests I collected yielded moths.

In this paper, I document the species that emerged and my observations on their natural history. As part of the project, my supervisor and I also quantitatively explored the ecology of the system, particularly the factors structuring moth communities; this aspect is not covered here and is reported in Boyes & Lewis (2018).

Methods

Nests were collected from seven sites in Montgomeryshire (Vice-county 47) (Fig. 1) in January 2016. Five of the sites are nature reserves, managed by Montgomeryshire Wildlife Trust, while the remaining two are on privately-owned land. The sites are predominately mature oak woodland and are between 70-300m in elevation.

Most nests (206 of 224) came from nest boxes installed for the benefit of breeding birds. Nest boxes were all fixed to mature tree trunks roughly 1.4m above ground, facing northeast. To reduce avian parasites, the contents of these boxes are removed after the breeding season each autumn or winter (most recently in the autumn and winter of 2014/2015). In addition to the nest boxes, 18 other nests were collected; these were either nests found in undergrowth (n=15) or in a sheltered location (wren nest in a tractor cab, robin nest from a wood shed, and stock dove nest in an owl box). All the nests had been monitored for the British Trust for Ornithology (BTO) breeding bird survey, providing data on occupancy and breeding outcome. Nests from the undergrowth were classified as 'open' and those built within other structures were defined as 'closed'. Table 1 summarises the bird nests collected from each site.

Nest contents were collected in paper bags for transportation and later transferred to plastic takeaway boxes with dimensions approximately 18cm x 13cm x 7cm, with bulkier nests split between multiple containers. The central part of the lid of each box was cut away to form a window, and the lid was then used to secure a sheet of muslin, providing ventilation while preventing insects from escaping. The boxes were kept out of direct sunlight and stored in an unheated shed (Plate 1). They were inspected every few days from the start of May until the end of July 2016, and any emerging moths were counted and removed. The contents of each container were then searched for any dead adults. Many of the species can be identified without close examination; however, if there was any doubt over the identification, specimens were collected. Difficult species were dissected for genitalia determination. The moths were identified using Heath & Emmet (1985) and Bengtsson & Johansson (2011). For families other than Tineidae, Emmet & Langmaid (2002), Riley & Prior (2003) and Sterling, Parsons & Lewington (2012) were consulted.

To assess sampling completeness, a species accumulation curve was drawn using the vegan package (Oksanen et al., 2016) in *R* 3.3.1 (R Core Team, 2016).

Results

Most nests contained moths (172 of 224; 78%) and a total of 4,657 adults emerged, comprising ten species (Table 2).

As well as Lepidoptera, other groups noted included Dermaptera, Diptera, Hymenoptera, Coleoptera, Araneae and mites. Most conspicuous were the many thousands of bird fleas (Siphonaptera).

Natural history notes and observations

Tineidae

***Nemapogon cloacella* (Haworth, 1828).** Found in nest boxes at two different sites in very low numbers, with adults emerging over a two-week period in mid-June. As far as I am aware, this is the first recorded occurrence of the species in bird nests. Bracket fungi is the preferred pabulum, however, it may sometimes feed on stored vegetable products (Heath & Emmet, 1985; Langmaid, Palmer & Young, 2018). The species is very common across the county and it seems possible it may utilise bird nests occasionally when occurring at high density. It is unclear what the larvae fed on within the nests.

***Tinea semifulvella* Haworth, 1828**. Usually occurred in low numbers, although 36 emerged from a single great tit nest. Adults emerged from mid-May until the end of June. The species had significantly higher occurrence and abundance in open nests compared to closed nests (Boyes & Lewis, 2018), which agrees with Heath & Emmet's (1985) assessment that the species is found within "birds' nests of various species in the open". This was the only species to be positively associated with open nests; it is plausible *T. semifulvella* has specialised to avoid interspecific competition. The species can also be found on dead sheep and bits of wool (Sterling, Parsons & Lewington, 2012), suggesting it is keratinophagous.

***Tinea trinotella* Thunberg, 1794**. A singleton emerged from a great tit nest at the end of May. Hinton (1956) states it is an obligate commensal of nesting birds. As the species is common at light across the study sites, it seems probable nest boxes are not the principal resource for the species in mid-Wales. Like the previous species, it is plausible *T. trinotella* prefers open nests, and thus was simply under-recorded in this study. In Poland, the species occurs in high density in shrike nests (Tryjanowski et al., 2001).

***Niditinea striolella* (Matsumura, 1931).** Common across a wide range of sites but mostly from a small selection of nests. A maximum of 57 individuals were reared from a single blue tit nest. The moths appeared from mid-May until the end of July. The species has a scattered distribution and is considered elusive. Heath & Emmet (1985) state it has been reared exclusively from cavity nests and my findings do not contradict this (no individuals emerged from open

Table 1: The bird species investigated in the project and their representation at each study site.

Species	BTO species code	Number of observations							
		Beares	Coed Y Dinas	Cwy y wydden	Dolforwyn	Glan Hafren	Hill	Pendugwm	***Totals:***
Closed nests									
Blue tit, *Cyanistes caeruleus*	BT	35	13	0	31	12	17	4	*112*
Great tit, *Parus major*	GT	20	0	0	15	5	9	7	*56*
Pied flycatcher, *Ficedula hypoleuca*	PF	13	0	0	7	2	0	7	*29*
Redstart, *Phoenicurus phoenicurus*	RT	6	0	0	0	0	1	0	*7*
Coal tit, *Periparus ater*	CT	0	0	0	0	1	0	0	*1*
Nuthatch, *Sitta europaea*	NH	0	0	0	0	0	1	0	*1*
Robin, *Erithacus rubecula*	R.	0	0	0	0	0	1	0	*1*
Wren, *Troglodytes troglodytes*	WR	0	0	0	0	0	1	0	*1*
Stock dove, *Columba oenas*	SD	0	0	0	1	0	0	0	*1*
Open nests									
Blackbird, *Turdus merula*	B.	0	1	0	0	1	4	0	*6*
Blackcap, *Sylvia atricapilla*	BC	0	0	0	3	0	0	0	*3*
Wood warbler, *Phylloscopus sibilatrix*	WO	0	0	2	0	0	0	0	*2*
Garden warbler, *Sylvia borin*	GW	0	0	0	0	0	1	0	*1*
Chiffchaff, *Phylloscopus collybita*	CC	0	0	0	1	0	0	0	*1*
Goldcrest, *Regulus regulus*	GC	0	0	1	0	0	0	0	*1*
Goldfinch, *Carduelis carduelis*	GO	0	0	0	0	0	1	0	*1*
	Totals:	*74*	*14*	*3*	*58*	*21*	*36*	*18*	*224*

TABLE 2. Moth species recorded. The fourth column indicates associations with bird species (bird species codes are given in Table 1).

Species	Total abundance	Total nests occupied (% of nests)	Bird species (BTO codes)*
Endrosis sarcitrella	1907	128 (57%)	BT, GT, PF, R., CT, NH, B., GW, CC
Monopis laevigella	1871	87 (39%)	BT, GT, PF, R., CT, NH, B.
Hofmannophila pseudospretella	509	52 (23%)	BT, GT, PF, R., CT, R., B., WR, SD
Niditinea striolella	138	11 (5%)	BT, GT, PF, CT,
Tinea semifulvella	57	7 (3%)	BT, GT, B., WO
Eupithecia vulgata	3	3 (1%)	BT, GT
Nemapogon cloacella	4	2 (<1%)	BT
Aphomia sociella	166	2 (<1%)	BT
Tinea trinotella	1	1 (<1%)	GT
Agonopterix heracliana	1	1 (<1%)	BT

nests). Incidentally, *N. striolella* exhibited atypical behaviour; it was mostly sedentary, tending to remain amongst the nest material, where it was exceptionally well camouflaged. Conversely, most species were active during the day, often resting conspicuously near the top of the containers. It seems likely that *N. striolella* spends most of its time within bird nest cavities and is reluctant to disperse. Over the course of nine years, I have regularly recorded every other species detailed here from light traps. But not once have I encountered *N. striolella* at light, despite previous rearing exercises proving the species is common in my garden. The perceived scarcity of this species is probably merely an artefact of its behaviour.

***Monopis laevigella* ([Denis & Schiffermüller], 1775).** Emerged from most closed nests but was rarely seen in open nests. When present, it was seldom found in single figures and was sometimes hugely abundant; highest counts came from great tit nests (107, 137 and 191 individuals). The majority emerged in May or June, with occasional emergences throughout July.

Oecophoridae

***Endrosis sarcitrella* (Linnaeus, 1758)**. Occurred extensively and abundantly in many closed, and some open, nests. A single great tit nest produced over 260 moths. Adults appeared from early May until the end of July, with the vast majority emerging before July. The larvae feed on a wide range of organic debris, including dead plant matter, natural fibres and dead insects (Emmet & Langmaid, 2002; Meyrick, 1928). Woodroffe (1953) suggests the species is

Fig. 1. The location of the seven study sites; the number of nests sampled from each is given in parenthses. Map image © 2018 Google.

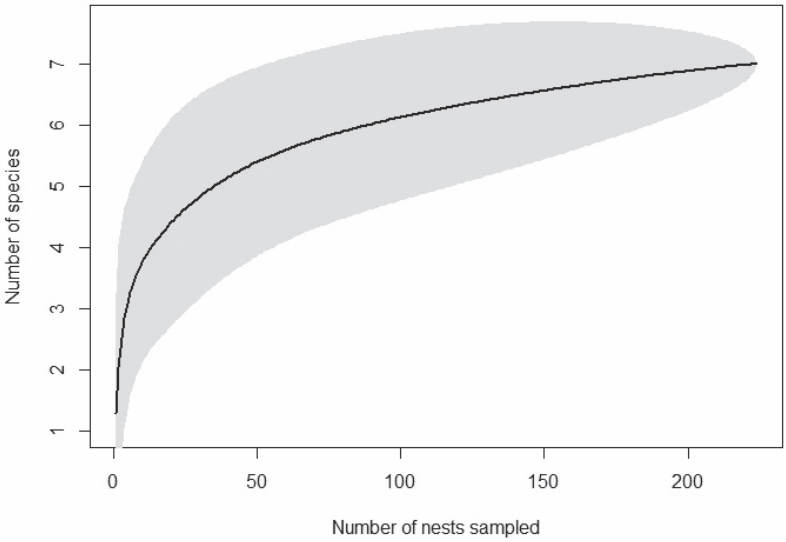

Fig. 2. Species accumulation curve showing the number of moth species expected when sampling a given number of bird nests. The grey area provides the 95% confidence intervals. Excludes the three species not intrinsically associated with bird nests.

Plate 1. The shed used to store the nests. May 2016, John Krebs Field Station, Wytham, Oxfordshire.

abundant in nests containing moss, which was a principle constituent of the tit nests. In the literature, the wingspan is given as 13-21mm (Emmet & Langmaid, 2002). In this project, multiple individuals had wingspans as small as 9mm. Large groups of undersized individuals would tend to emerge from a single nest, potentially indicating stunted larval development as a result of substantial intraspecific competition.

***Hofmannophila pseudospretella* (Stainton, 1849).** Fairly common, occasionally abundant, in the nests of a wide range of birds. It appeared notably later than other species: individuals were not seen until June and the emergence peaked in mid-July. This species appears to prefer sheltered and relatively dry nests; its abundance was negatively associated with nest moisture (Boyes & Lewis, 2018). Like the previous species, the larvae are generalist, feeding on a wide range of animal and plant material (Woodroffe, 1951; Emmet & Langmaid, 2002).

Depressariidae

***Agonopterix heracliana* (Linnaeus, 1758).** A single individual was found shortly after collection. The overwintering life stage is the adult (Emmet & Langmaid, 2002) and it can be assumed this moth was simply hibernating in the shelter of the nest.

Pyralidae

***Aphomia sociella* (Linnaeus, 1758).** Large numbers emerged in late May from two nest boxes, where the large silky mass of cocoons was stuck to the interior walls. The species is sexually dimorphic. Males outnumbered females by a factor of two to one and females did not appear until late in the emergence. The larvae feed on the honeycomb within bee and wasp nests (Sterling, Parsons & Lewington, 2012). There was no obvious evidence of hymenopterous nests in either of the boxes. Pupal masses have been found in nest boxes before; Hasenfuss (1999) suggested the larvae gained nourishment from dead insects dropped by birds. I consider it more plausible that the larvae only moved into the box immediately prior to pupation.

Geometridae

***Eupithecia vulgata* (Haworth, 1809).** Singletons in three nests. The caterpillars are strictly herbivorous (Riley & Prior, 2003), so the species is highly unlikely to breed within bird nests. It is probable the larvae sought shelter as they were descending the tree to pupate.

Discussion

This study represents the first systematic investigation of the moth communities associated with bird nests in the UK since the 1950s. Ten species of moth were recorded; however, not all the species would have bred within the nests. The occurrence of at least three species should be classed as incidental (*Agonopterix heracliana, Aphomia sociella, Eupithecia vulgata;* perhaps also *Nemapogon cloacella*). The slope of the species accumulation curve becomes relatively shallow (Fig. 2), implying the sampling was sufficient to detect the majority of the species present in the system.

Some species were conspicuous by their absence. Plarre (2014) states that *Tinea pellionella* Linnaeus, 1758, occurs commonly in bird nests. This species was not found in the nests, despite being recorded recently at three of the study sites. More work is needed to assess the prevalence of *T. pellionella* in rural bird nests (relative to its occurrence in nests near human habitations). *Niditinea fuscella* (Linnaeus, 1758) was also not seen in this study. The species occurs in the county and is associated with bird nests (Heath & Emmet, 1985), with Plarre (2014) suggesting it is most common in rural bird nests. At least one *Niditinea* emerging from each new nest was dissected (approximately one third in total), so I consider it improbable *N. fuscella* was overlooked due to misidentification. The *Monopis laevigella* were also checked carefully as *M. weaverella* (Scott, 1858) is present in the county.

The assemblage reported here is quite unlike the one reported in the previous investigation of moths in British bird nests (Woodroffe, 1953), with only three

species common to both studies (the generalist detritivores *Monopis laevigella*, *Endrosis sarcitrella* and *Hofmannophila pseudospretella*). This difference could be down to a number of factors. Woodroffe principally examined pigeon and sparrow nests in an urban setting, which probably support a different set of moths to the box-dwelling woodland passerines examined here. Furthermore, the urban nests are more likely to contain pest species, which are often absent from nests in rural areas. Woodroffe identified moisture content as an important determiner of moth communities, stating that most of his nests were dry. In contrast, the nests in this study were often wet. Finally, moth communities may have changed significantly over the last 60 years.

The bias towards box-dwelling birds in this study reflects the relative ease of locating large numbers of these nests. A larger sample size of open nests and exploration of different bird guilds would provide variation in nest microhabitat structure, resources and abiotic conditions and consequently, a different invertebrate fauna might be expected. For example, nests of birds of prey could host a unique community of detritivores feeding on animal remains; *Monopis fenestratella* (Heyden, 1863) is thought to be a specialist of these nests (Jaworski, Gryz, & Buszko, 2011). It would also be interesting to examine the moth communities found in natural cavity nests (e.g. tree hollows), which have a more stable microclimate (Maziarz, Broughton & Wesołowski, 2017) and higher rates of organic material decomposition (Hebda, Kandziora, & Mitrus, 2017) compared to artificial nest boxes.

As well as the relatively narrow selection of nest types considered, this study was conducted in one area of mid-Wales. It is worth emphasising that conclusions drawn from these data may not be applicable to other parts of the UK.

Due to time constraints, I only documented the natural history of the adults. It would be interesting to examine the larvae to determine the exact diet of each species. In owl nests in Japan, it has been suggested that *Monopis* spp. (including the species discussed here, *M. laevigella*) are predominately keratinophagous (eating feathers, fur, hair, etc) and *Niditinea* spp., including *N. striolella,* are chitinophagous (eating fragments of arthropod exoskeletons) (Nasu et al., 2012). It is unclear how transferable these findings are to other parts of the world. To further unravel the natural history of the British bird nest-dwelling Tineidae, it will be necessary to examine individual larvae within nest materials, documenting the pabulum and feeding behaviour of the different species.

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