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Feather lice (Mallophaga) of the Irish Dipper *Cinclus cinclus hibernicus*

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Forty Dippers *Cinclus cinclus hibernicus* were caught and deloused in southwest Ireland in 2003. Two species of lice (Mallophaga) were recorded; *Philopterus cincli* and *Myrsidea franciscoloi*. Both these species are known ectoparasites of the Dipper, yet these records were the first for Ireland. The incidence and infestation rates reported in this study were significantly greater than those recorded in Dippers from two studies in Wales and Germany.

Ectoparasites play an important role in the lives of birds. As with other biotic interactions, such as predation and competition, parasitism has far reaching implications for the ecology and evolution of a species. Indeed, the study of bird-ectoparasite associations has provided many influential examples of parasite-mediated ecology and evolution (Proctor & Owens 2000). In recent years, parasitism has received much attention from a conservation perspective. For example, Loye & Carroll (1995) detail how a parasitic fly has determined the fate of the endangered Puerto Rican Parrot *Amazona vittata*. Therefore, studies of bird-ectoparasite associations, such as this one, provide valuable scientific information.

This paper describes aspects of the population of feather lice (Mallophaga) collected from 40 Irish Dippers *Cinclus cinclus hibernicus*. In keeping with standard usage (Margolis *et al* 1982) we refer to host specificity as the species of lice associated with the host, the incidence rate as the proportion of hosts which are infested, and the infestation rate as the average number of parasites per host. The aim of this study was to examine the occurrence and distribution of Mallophaga on Dippers from Ireland. We also compare our findings to those recorded for Dipper populations in Wales (*C c gularis*, Fowler & Hodson 1991) and Germany (*C c aquaticus*, Spitznagel 1985).

METHODS

Between September and December 2003, 40 Dippers were captured using mist nets set by day on various rivers in east Cork and west Waterford, southwest Ireland. Each bird was fitted with a British Trust for Ornithology numbered ring and a coloured ring to indicate sex and age class. Each bird was aged and sexed using criteria outlined in Svensson (1992), Ormerod *et al* (1986) and O'Halloran *et al* (1992). Birds were weighed to the nearest 0.1 g using a digital balance. Wing lengths (maximum flattened chord) were measured to the nearest 0.5 mm using a stopped ruler, and tarsus measurements were taken to the nearest 0.1 mm using vernier callipers.

Collection of Mallophaga

Following a number of trials, a quantitative collection of feather lice was carried out using a 120 mm diameter Kilner preserving jar with a modified plastic cap, the middle of which had been replaced with a diaphragm of stiff rubber. A 15 mm diameter hole was cut in the diaphragm to form a collar. The rubber collar was split, which allowed it to be fitted around the bird's neck, rather than being pulled over the head. To fit the collar, the two ends were overlapped and stapled together. The collar could be adjusted to fit each bird individually by varying the size of the overlap. Trials showed the birds to be very active while in the jar, and many were able to 'claw' the top of the jar with their feet. To prevent damage to the bird, the feet were temporarily, individually bound with a piece of cotton cloth and tape.

Following the method of Fowler & Cohen (1983), the birds were placed in the delousing jar for 15 minutes. A few drops of chloroform were added to a piece of cotton wool that was placed at the bottom of the jar. The jar was held on its side, thus allowing the bird to adopt a natural standing position. It was found that

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birds struggled less when the jar was in this position, as opposed to the recommended upright position. During delousing, each bird was monitored carefully by two people for signs of stress. Delousing was conducted outdoors to allow the dispersal of any vapours that may have leaked around the collar. A maximum handling time of 30 minutes was placed on the procedure from catching to release and in no case was this time exceeded. No birds showed signs of significant stress during the procedure and all were released successfully following delousing.

Anaesthetised lice fell from the birds and were collected on filter paper. Upon removing the bird from the jar the feathers were carefully ruffled to dislodge any lice still attached to the plumage. All lice were preserved in 70% ethanol in labelled tubes. These were subsequently cleared and mounted on microscope slides in Canada balsam for examination and identification (Marshall 1981). All specimens were identified using Blagovetschenskii (1967) and Séguy (1944).

Statistical analysis

The frequency distribution of the lice collected was calculated using the sample mean (x) and variance (s^2) and an exponent, k, estimated from $k = x^2/(s^2 - x)$. Chi-square and Kruskal-Wallis tests were used to examine the relationships between the occurrence and abundance of lice with the following parameters; sex, age, month and river. A Kruskal-Wallis test was also used to examine differences between the body condition (weight/wing length) of infested and non-infested birds.

RESULTS

Frequency and abundance

Of the 40 Dippers deloused, 80% (32 birds) yielded lice. A total of 435 lice were collected. The mean (x) infestation rate (ie average number of parasites per host) was 10.85 +/- 1.96, the variance (s^2) 154.16, median 5.5 and range 0-53. Two species of feather lice (Mallophaga) were collected, the Ischnocera *Philopterus cincli* and the Amblycera *Myrsidea franciscoloi*.

P cincli was collected from all 32 birds that yielded lice; these included male and female, as well as first-year and older birds. Four specimens of *M franciscoloi* were collected from only one bird; an adult male examined in September 2003, and *P cincli* was also present on this bird. Figure 1 shows the frequency distribution of *P cincli* is aggregated and is significantly different from that predicted from a Poisson (random) distribution, $\chi^2 = 6$, $p<0.001$. The frequency distribution is more in agreement with that predicted

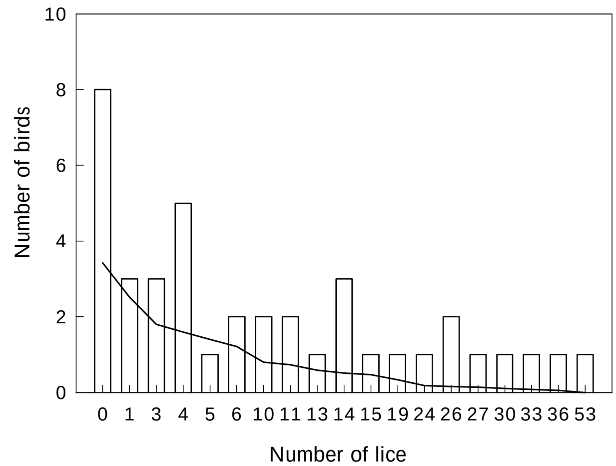

Figure 1. The frequency distribution of *Philopterus cincli* on 40 Dippers deloused in southwest Ireland. The line shows the expected frequencies of a negative binomial distribution estimated from the sample statistics.

Table 1: Relationship between the occurrence/abundance of Mallophaga on Dippers with regard to sex, age, month and river.

	Occurrence of Mallophaga on Dippers	Abundance of Mallophaga on Dippers
Sex	$\chi^2 = 2.5$, P<0.05	H = 3.23, P = 0.072*
Age	$\chi^2 = 12.53$, P>0.05	H = 3.21, P = 0.073
Month	$\chi^2_3 = 0.625$, P<0.05	H = 8.95, P = 0.030
River	$\chi^2_5 = 20.489$, P>0.05	H = 9.10, P = 0.221

*(significant difference at P<0.05-0.1 where we believe it to be ecologically meaningful).

by a negative binomial model estimated from the sample statistics x = 10.85, $s^2 = 154.16$, and k = 0.79 (Fig 1).

Infestation versus sex, age class, month and river

We found significantly more Mallophaga on male than female Dippers (male median = 6, female median = 4; Table 1). The occurrence of Mallophaga did not differ significantly between juveniles and adults, although their abundance on adults (median = 8) was greater than on juveniles (median = 2). Both the occurrence and abundance of Mallophaga on Dippers varied significantly across months, with November being the month with the greatest infestation rate (median = 19). There was no significant difference in the abundance and occurrence of Mallophaga between rivers (Table 1).

Body condition (weight/wing length) did not vary significantly between birds that were infested with Mallophaga and those that were not (H = 1.17, P = 0.279). Table 2 compares characteristics of Dippers from the present study with those of Dippers from studies in Wales and Germany. The incidence of Mallophaga on Dippers in Ireland was higher than that reported from the Welsh and German studies.

DISCUSSION

Two species of Mallophaga were collected from the Irish Dipper during this study; the Ishnocera *P cincli* and the Amblycera *M franciscoloi*. These are the first records of these two species for Ireland (Butler & O'Connor 1994, Doyle *et al* 2004). It is clear from this work that *P cincli* is common and probably widespread on Dippers in Ireland. The lack of records until now is simply due to the fact that researchers have not looked for feather lice in recent years.

Both *P cincli* and *M franciscoloi* are known ectoparasites of Dippers and were recorded in similar studies on Dipper populations in Wales (Fowler & Hodson 1991) and Germany (Spitznagel 1985). The incidence of lice recorded in the present study is considerably greater than those recorded by Fowler & Hodson (1991) and Spitznagel (1985), and the infestation rates of Dippers in Ireland was higher than that of the species in Wales. One possible explanation for the relatively high infestation and incidence rates in this study could be due to the time of the year when the sampling was carried out. Fowler & Price (1987) report that lice populations are at a minimum in July, which coincides with the hosts' moult, but recover through the latter part of the calendar year. The delousing period of this study (September to December) would therefore coincide with a time when parasite populations were approaching their peak. The study of Fowler & Hodson (1991) was carried out over a two-day period in mid-September, and it is possible that parasite numbers were still at a low following the birds' moult. Spitznagel (1985) reported the heaviest infestation during the time preceding the breeding season. This synchronization of life cycles is likely to be an adaptation, in the lice, to maximise their opportunities to transfer from adult hosts to chicks. Foster (1969) noted that, in the case of the Mallophaga of the Orange-crowned Warbler *Vermivora celata*, the maximum breeding period of the Mallophaga was timed so that maximum population numbers occurred before the hatching of the host's egg. Although the exact time of transfer from adults to chicks is not accurately known, Van Den Broek (1967) reported Mallophaga on Black-headed Gull *Larus ridibundus* chicks that were only a few hours old. This does not, however, explain why the incidence and infestation rates recorded in Spitznagel's study were less than those reported here, as his study was carried out over the course of a full year.

It has been suggested that the different behaviours and habitats of the hosts affect their Mallophaga burden (Eveleigh & Threlfall 1976). Post & Enders (1970) compared the Mallophaga infestation of Seaside Sparrow *Ammospiza maritima* and Sharp-tailed Sparrow *Ammospiza caudacuta* occupying the same habitat, noting that the species favouring the wetter parts of a marsh and feeding closer to the ground had a higher incidence and intensity of infestation. While the habitats occupied by the three populations of Dipper are very similar, it is possible that subtle differences exist in their habits. For example, many (but not all) Irish Dippers roost under bridges where the temperature

Table 2: Summary table comparing the findings of the present study with those carried out on two other populations of Dipper.

	Irish Dipper (Present Study)	Welsh Dipper (Fowler & Hodson 1991)	German Dipper (Spitznagel 1985)
Host Specificity	*Philopterus cincli* *Myrsidea franciscoloi*	*Philopterus cincli* *Myrsidea franciscoloi*	*Philopterus cincli* *Myrsidea franciscoloi*
Incidence Rate	80% (32 of 40)	54% (27 of 50)	43.7% (69 of 160)
Infestation Rate	Mean 10.8 per bird, range 0-53	Mean 1.86 per bird, range 0-17	*
Occurrence / Abundance of Mallophaga with regard to sex & age	Males > Females Adults >Juv	Sex - NS Age - NS	Males > Females Fledged >Nestlings
Frequency Distribution of *Philopterus cincli*	Probably Negative binomial, k = 0.79	Negative binomial, k = 0.314	*

* Data not available.

is a few degrees warmer than outside the bridge (Smiddy & O'Halloran 2004). As Mallophaga are known to be sensitive to temperature and have a narrow range of preference (Ash 1960), differences in roosting temperatures may affect the breeding survival of nymphs and in turn the parasite load found on the host. Also, communal roosting may facilitate the transfer of Mallophaga. Differences between the proportions of birds that roost communally in the three populations may help explain the difference found in their Mallophaga burden. This is speculative however, and a detailed comparative study between the three populations would be necessary to confirm if any such differences in habits actually occur.

A third possible explanation for the high rate of infestation and incidence of lice found in this study could be methodological differences. For example, on ruffling the birds' feathers after removal from the jar we almost invariably dislodged several more lice. We are unable to quantify the effect of this on overall numbers since the behaviour of birds in the jar varied and those that flapped a lot would be expected to shed more lice than those that remained still. However, Clayton & Walther (1997) reported that this technique greatly increases the number of lice yielded. Ruffling of feathers was not mentioned in the methods outlined by Fowler & Hodson (1991) and Spitznagel (1985).

The aggregated distribution of *P cincli* on the Irish Dipper is similar to that previously reported by Fowler & Hodson (1991) for Welsh Dippers. The frequency distribution, in which most hosts have few parasites and in which large numbers of parasites are found on a few hosts, seems to follow that of a negative binomial (Fig 1). This is supported by the fact that the variance is greater than the mean. The reasons why ectoparasites are so distributed among their hosts have been discussed and reviewed by Crofton (1971), Randolph (1975) and Fowler & Williams (1985) and have been summarised by Fowler & Price (1987). Such factors include seasonal variation in infestation rates, non-random spatial distribution of hosts, resistance to re-infestation by previously infested hosts and non-random differences in behaviour or physiology (eg moult) related to different age classes within the host population. Why the frequency should conform to a negative binomial distribution model rather than to some other distribution is not so easily explained (Fowler & Price 1987). Anderson & May (1978) suggest that the value of the binomial exponent, k, is a measure of the destabilising effect of the parasite on the host population, and is related to the relative reproductive rates of the parasite and host. Negative binomial distributions have been observed in feather lice (Mallophaga) and feather mites (Acari) in many bird species, for example the Fulmar *Fulmarus glacialis* and Storm Petrel *Hydrobates pelagicus* (Fowler & Miller 1984), the Puffin *Fratercula arctica* (Eveleigh & Threlfall 1976) and the Reed Bunting *Emberiza schoeniclus* (Fowler & Williams 1985).

The present study found male Dippers to have a higher rate of infestation than females (Table 1). Similarly, Spitznagel (1985) found male Dippers to be more heavily infested (46.7%) than females (38.6%); a trend common across parasitism of bird and mammal species (Poulin 1996, Schalk & Forbes 1997). Why male birds should have a greater infestation rate is not easily explained. Mallophaga never leave the living host unless they come in contact with another warm surface such as another bird, nesting material or eggs. Therefore, most intraspecific dispersal takes place during copulation, incubation and brooding. While believed to be largely monogamous, polygamy is known to occur in Dippers, with the male fathering and tending to as many as three broods simultaneously (Tyler & Ormerod 1994). Such behaviour greatly facilitates the dispersal and transfer of Mallophaga and offers one possible explanation why male Dippers are reported to have greater infestation rates than females. Furthermore, as male Dippers are the territory holders and defend it against intruding males, they are further subject to increased risks of physical contact and in turn the transfer of Mallophaga. Alternatively, there is some evidence to suggest that it is not sex differences in parasite transmission which are important, but differences in the immune function of male and female hosts (Wilson *et al* 2002). Further work is clearly needed on sex-biased parasitism.

In conclusion, we found the incidence and infestation rate of Mallophaga to vary across three different populations of Dipper (Table 2) and have discussed possible explanations for this. The incidence and infestation rate reported in this study appears comparatively high, and is above that cited by Rothschild & Clay (1952) for small passerines that usually bear fewer than 10 lice, and rarely exceed 20. However, it is important to bear in mind that parasitism can have a great diversity of effects on the host (Loye & Carroll 1995). Our data suggest that even the comparatively high rates of infestation have little or no impact on the host's physical well being. A thorough examination of feathers from different body parts of the Dipper showed no evidence of damage from Mallophaga (Doyle *et al* unpublished). Furthermore, no significant difference was found between the body condition of infested and non-infested birds, although experimental studies are needed to confirm the potential effects.

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REFERENCES

Anderson, R.M. & May, R.M. (1978) Regulation and stability of host-parasite interactions. I Regulatory processes. *Journal of Animal Ecology* **5**, 219-242.

Ash, J.S. (1960) A study of the Mallophaga of birds with particular reference to their ecology. *Ibis* **102**, 93-110.

Blagovetschenskii, D.I. (1967) Mallophaga. In *Key to the Insects of the European USSR.* (eds Bei-Bienko, G.Ya.) **1**, pp 385-403. Israel Programme for Scientific Translation. Oldbourne Press, London.

Butler, F.T. & O'Connor, J.P. (1994) A review of Irish Ischnocera and Amblycera (Phthiraptera). *Irish Naturalists' Journal* **24**, 449-457.

Clayton, D.H. & Walther, B.A. (1997) Collection and quantification of arthropod parasites of birds. In *Host-parasite Co-evolution: General principals and avian models* (eds Clayton, D.H. & Moore, J.) pp 419-440. Oxford University Press, Oxford.

Crofton, H.D. (1971) A model of host-parasite relationships. *Parasitology* **63**, 343-364.

Doyle, Ú., O'Halloran, J. & Smiddy, P. (2004) Records of the feather lice (Mallophaga) *Philopterus cincli* (Denny) and *Myrsidea franciscoloi* (Conci), two species new to Ireland. *Irish Naturalists' Journal* **27**, 440.

Eveleigh, E.S. & Threlfall, W. (1976) Population dynamics of lice (Mallophaga) on auks (Alcidae) from Newfoundland. *Canadian Journal of Zoology* **54**, 1694-1711.

Foster, M. (1969) Synchronized life cycles of the Orange-crowned Warbler and its mallophagan parasites. *Ecology* **50**, 315-323.

Fowler, J.A. & Cohen, S. (1983) A method for the quantitative collection of ectoparasites from birds. *Ringing & Migration* **4**, 185-189.

Fowler, J.A. & Hodson, D.P. (1991) Feather lice (Mallophaga) of the Dipper *Cinclus cinclus* in Central Wales. *Ringing & Migration* **12**, 43-45.

Fowler, J.A. & Miller, C.J. (1984) Non-haematophagus ectoparasite populations of Procellariiform birds in Shetland, Scotland. *Seabird* **7,** 23-30.

Fowler, J.A. & Price, R.A. (1987) A comparative study of the Ischnoceran Mallophaga of Wilson's Petrel *Oceanites oceanicus* and British Storm Petrel *Hydrobates pelagicus*. *Seabird* **10**, 43-49.

Fowler, J.A. & Williams, L.R. (1985) Population dynamics of Mallophaga and Acari on Reed Buntings occupying a communal winter roost. *Ecological Entomology* **10**, 377-383.

Loye, J. & Carroll, S. (1995) Birds, bugs and blood: avian parasitism and conservation. *Trends in Ecology and Evolution* **10**, 232-235.

Margolis, L., Esch, G.W., Holmes, J.C., Kuris, A.M. & Schad, G.A. (1982) The use of ecological terms in parasitology. *Journal of Parasitology* **68**, 131-133.

Marshall, A.G. (1981) *The Ecology of Ectoparasitic Insects*. Academic Press, London.

O'Halloran, J., Smiddy, P. & O'Mahony, B. (1992) Biometrics, growth and sex ratios amongst Irish Dippers *Cinclus cinclus hibernicus*. *Ringing & Migration* **13**, 152-161.

Ormerod, S.J., Tyler, S.J., & Lewis, J.M.S. (1986) Biometrics, growth and sex ratios amongst Welsh Dippers *Cinclus cinclus*. *Ringing & Migration* **7**, 61-70.

Poulin, R. (1996) Sexual inequalities in Helminth infections: a cost of being male? *The American Naturalist* **147**, 287-295.

Proctor, H. & Owens, I. (2000) Mites and birds: diversity, parasitism and coevolution. *Trends in Ecology and Evolution* **15**, 358-364.

Randolph, S.E. (1975) Seasonal dynamics of a host-parasite system: *Ixodes trianguliceps* (Acarina: Ixodidae) and its small mammal hosts. *Journal of Animal Ecology* **44**, 451-474.

Rothschild, M. & Clay, T. (1952) *Fleas, Flukes and Cuckoos*. Collins, London.

Schalk, G. & Forbes, M.R. (1997) Male biases in parasitism of mammals: effects of study type, host age, and parasite taxon. *Oikos* **78**, 67-74.

Séguy, E. (1944) Insectes Ectoparasites. *Faune de France* **43**.

Smiddy, P. & O'Halloran, J. (2004) The ecology of river bridges: their use by birds and mammals. In *The Effects of Human Transport on Ecosystems: cars and planes, boats and trains* (eds Davenport, J. & Davenport, J.L.) pp 83-97. Royal Irish Academy, Dublin.

Spitznagel, A. (1985) Untersuchungen über den Befall der Wasseramsel (*Cinclus c. aquaticus*) mit Federlingen (*Phthiraptera: Mallophaga*). *Okogie der Vogel* **7**, 409-420.

Svensson, L. (1992) *Identification Guide to European Passerines*. 4th edition. Svensson, Stockholm.

Tyler, S.J. & Ormerod, S.J. (1994) *The Dippers*. T & A.D. Poyser, London.

Van Den Broek, E. (1967) Observations on the infestation of young gulls by Mallophaga. *Ardea* **55**, 112-114.

Wilson, K., Bjornstad, O.N., Dobson, A.P., Merler, S., Poglayen, G., Randolph, S.E., Read, A.F. & Skorping, A. (2002) Heterogeneities in macroparasite infections: patterns and processes. In *The Ecology of Wildlife Diseases*. (eds Hudson, P.J., Rizzoli, A., Grenfell, B.T, Heesterbeek, H. & Dobson, A.P.) Pp 6-44 . Oxford University Press, Oxford.

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