ACTA ORNITHOLOGICA
Vol. 45 (2010) No. 2

Ringing procedure can reduce the burden of feather lice in Barn Swallows *Hirundo rustica*

Zoltán VAS[1,2]* & Tibor István FUISZ[1]

[1]Hungarian Natural History Museum, Department of Zoology, Bird Collection, Budapest, 1088, Baross u. 13., HUNGARY
[2]Szent István University, Faculty of Veterinary Science, Department of Biomathematics and Informatics, Budapest, 1078, István u. 2, HUNGARY
*Corresponding author, e-mail: vas.zoltan@gmail.com

Vas Z., Fuisz T. I. 2010. Ringing procedure can reduce the burden of feather lice in Barn Swallows *Hirundo rustica*. Acta Ornithol. 45: 203–207. DOI 10.3161/000164510X551345

Abstract. Chewing lice (Insecta: Phthiraptera) are the most widespread obligate ectoparasites living in the plumage of birds. Lice have to cope with unusual mechanical effects during ringing, and they could fall off their hosts. We assumed that trapping birds in nets, taking measurements and estimating condition could reduce their louse burdens. Lousiness affects life expectancy and reproductive success, so if ringing causes remarkable louse loss, the fitness of ringed birds could be altered. Lice are usually collected at ringing sites, and ringing precedes parasite sampling. This may therefore lead to an underestimation of louse prevalence and intensity. Here we tested whether ringing reduces the louse burden. We allocated Barn Swallows *Hirundo rustica* in the breeding season to two experimental groups — the birds were subject to either a standard ringing procedure (recording biometry, fat and other condition scores, feather hole counts), or a reduced one (only feather hole counts). We used feather holes (traces of louse chewing) as a measure of louse loads. Holes were recounted after a month. Significantly more new holes appeared in the reduced ringing procedure group, indicating that the usual ringing procedures effectively reduce louse loads. We believe this is the first evidence that bird ringing affects ectoparasite infestations.

Key words: Barn Swallow, lice, bird ringing, handling of birds, louse collection, louse sampling, fitness alteration, ectoparasites, feather holes, Amblycera, Ischnocera

Received — July 2010, accepted — Nov. 2010

INTRODUCTION

Bird ringing is a more than 100 years old method in ornithology. It was originally developed for studying bird migration; however it can be used — especially if combined with colour-banding — in other ornithological investigations as well. Bird ringing is applied in population biology, behavioural studies, breeding biology, conservation biology, faunistic studies and even in avian parasitology. Thanks to the co-operation of international organisations (e.g. EURING) the procedures including capture methods, handling of birds and the taking of measurements are standardised and used almost in the same way by every ringer (Svensson 1992). Strict rules are implemented to avoid negative effects on birds caused by catching and ringing. Hereafter the term 'ringing' means the whole ringing procedure from catching with mist nets until releasing.

Birds act as habitat islands for other animals, such as ectoparasitic lice (Insecta: Phthiraptera: Amblycera, Ischnocera). Lice are the most widespread ectoparasites of birds, and the only parasitic insects that complete their entire life cycle on the body surface of birds (Clayton & Tompkins 1994, 1995). Ischnoceran lice (Phthiraptera: Ischnocera) live and feed on feathers, while Amblyceran lice (Phthiraptera: Amblycera) partly feed on feathers and partly also on living tissues (Johnson & Clayton 2003, Rózsa 2003, Mey et al. 2007). A number of influential papers showed that lice affect both life expectancy and reproductive success of hosts (Clayton 1990, Booth et al. 1993, Brown et al. 1995, Clayton et al. 1999, Kose & Møller 1999, Kose et al. 1999, Barbosa et al. 2002). In this paper we test whether ringing procedures reduce louse burdens.

We assumed that catching birds with mist nets, handling and taking measurements can reduce louse burdens on birds, because lice have to cope with unusual mechanical effects and they can fall off the feathers. If this is a significant louse loss, it may influence certain aspects of host life history. Furthermore, this phenomenon can have a serious outcome in louse biology. Nowadays, the most evident chance to handle wild birds to collect their lice is offered by ringing sites. When a bird is caught, first a ring is placed on it, then biometrical measurements are taken and its body condition is assessed (Svensson 1992). During this process the feathers are blown apart to view the fat reserves, the brood patch, and, in addition feathers are spread out on the wings to score moult and to check emarginations and notches. Consequently, ectoparasites living on feathers might be affected. These procedures are usually carried out prior to parasitological sampling. If the ectoparasites fall off the feathers, it may lead to underestimation of lousiness measures.

Møller (1991) described characteristic feather holes found on the rectrices and remiges of the Barn Swallow *Hirundo rustica*. He found that hole counts are highly repeatable, and also showed a positive correlation between the number of holes and the intensity of louse infestation. Hence he suggested that these holes are feeding traces of lice. In some small passerines, including the Barn Swallow, *Brueelia* Kéler, 1936 lice are likely to be causative agents of feather holes (Vas et al. 2008). It was also shown that the number of holes increases on the remiges and rectrices of both male and female adult Barn Swallows with the progress of the breeding season (Vas et al. 2008). As Barn Swallows do not moult remiges and rectrices during spring and summer (Svensson 1992), the observed increase of hole counts can be attributed to the activity of lice. Hereafter we also use hole counts to quantify lousiness in Barn Swallows.

In this paper we compare two experimental groups — one subjected to a standard ringing procedure and another to a reduced ringing procedure (both in terms of handling and measurements taken) — to assess the effect of handling on the number of feather holes of recaptured birds.

MATERIALS AND METHODS

Our study was carried out in a Barn Swallow breeding colony at a cattle farm in Világospuszta (Fejér County, Hungary) in 2009–2010. The birds were caught with mist nets in the stables. All swallows were immediately picked from mist nets and stored in linen bags for a maximum of 15 minutes. We stored each bird separately in sterilised bags to avoid louse transmission. All birds were marked with aluminium rings and sexed by tail length and presence of brood patch (Svensson 1992).

On first capture (30–31 May 2009, 29–30 May 2010) we randomly assigned all adult birds either into the standard or to the reduced ringing procedure group.

Standard ringing procedures included ringing, measuring 3rd primary length, wing length, tail length (all on the left side of the bird) and tail fork length as suggested by Svensson (1992). Abdominal plumage was blown apart to check subcutan fat and the condition of flying muscles. Moult and abrasion of remiges were also scored. We quantified feather holes on remiges of both wings and on rectrices. We counted the holes on each primaries (18 feathers), secondaries (12 feathers) and tertials (6 feathers) and on each tail feathers (12 feathers). In the analyses each bird was represented by the sum of the holes counted on its tail feathers.

Reduced ringing procedures consisted of marking the bird with an aluminium ring and counting the feather holes on the rectrices only. Feather holes can be counted faster and more reliably on rectrices than on remiges (Z. Vas own data) thus we could collect valuable data on lousiness within a shorter handling period. On recapture (7–8 July 2009, 2–3 July 2010) feather holes were recounted. The counter was the same person (Z. Vas) on both occasion, however, at the 2nd count he did not know which group the birds were assigned to previously to avoid observer bias.

Hole counts were compared by t-tests. According to quantile-comparsion plots the assumptions of t-test were satisfied. Potential confounders were checked by Kendall's tau correlation coefficient, because this method treats every concordant and discordant data point with the same weight (Reiczigel et al. 2007). Statistical analyses were carried out with R 2.10.1 (R Development Core Team 2009), and a figure was drawn with Statistica (Statsoft 2009). Values are presented as mean ± SD.

RESULTS

We counted the feather holes on the rectrices of captured (n = 60 in 2009 and n = 27 in 2010) and recaptured Barn Swallows (n = 19 in 2009 and n = 15 in 2010). As there was no significant year effect in the increase of feather holes between capture and recapture (mean ± SD: 2009 — 2.3 ± 1.5, n = 19, 2010 — 3.5 ± 3.0, n = 15; Welch two sample t-test, two-tailed p = 0.1702), we pooled the data of the two years in further analyses. Individuals included in the experiment in 2009 were excluded from the experiment in 2010. The number of holes increased on rectrices in both groups during the observation period (standard ringing procedure: hole numbers at 1st count: 15.5 ± 12.4, hole numbers at 2nd count: 17.2 ± 13.0, n = 16; paired t-test, two-tailed p = 0.0001; reduced ringing procedure: hole numbers at 1st count: 12.9 ± 8.3, hole numbers at 2nd count: 16.8 ± 9.5, n = 18; paired t-test, two-tailed p < 0.0001).

We compared the differences in the increase of hole numbers on rectrices during the observation period between the two experimental groups, and we found a significant difference (Welch two sample t-test, two-tailed p = 0.0040, Fig. 1).

The lengths of tail feathers varied from 89 mm to 125 mm in our sample. We checked whether tail length differences affect our result (e.g. on longer feathers more holes could be found). In addition, according to Svensson (1992) males have longer outermost tail feathers than females (in our sample: males: 111.8 ± 8.5, n = 13, females: 97.1 ± 5.8, n = 9; Welch two sample t-test, two-tailed p < 0.0001), therefore we could check the effect of sex by including the outermost tail feather length in the analysis. We found no significant correlation between tail length and the increase of hole numbers (Kendall's tau = -0.1694, p = 0.3057, n = 22). We also repeated this analysis by excluding all females because the outermost tail feather length in males act as a sexually selected signal indicating higher parasite resistance (Møller 1991). However, no significant correlation was found (Kendall's tau = 0.0857, p = 0.7037, n = 13). Thus we conclude that tail length and sex did not affect our results.

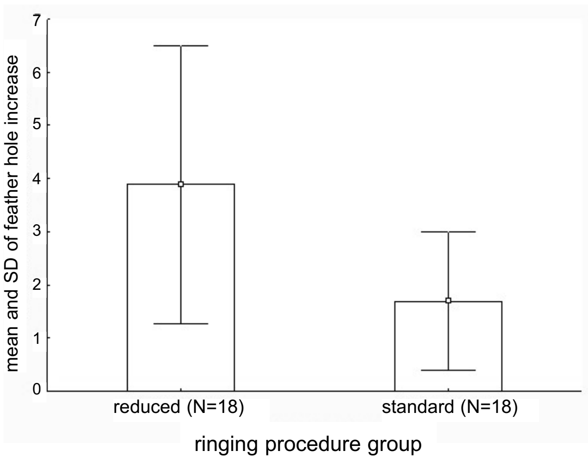

Fig. 1. Feather hole increase in the two experimental groups between capture and recapture.

DISCUSSION

The significant difference in the increase of feather holes in the two experimental groups suggests that ringing (catching, taking measurements and estimating body condition) can cause a measurable louse loss on Barn Swallows. Higher intensity of louse infestations has far-reaching effects on birds. In several species life expectancy of infested birds is lower (Brown et al. 1995, Clayton et al. 1999). Reduced insulation is balanced by higher metabolism rates in feral Rock Doves *Columba livia* (Booth et al. 1993). In Barn Swallows life history parameters and various individual traits are affected by the presence and intensity of ectoparasites. By chewing feather holes lice may facilitate feather breakage and hence reduce flight capability (Kose & Møller 1999, Barbosa et al. 2002). Papp et al. (2005) showed that female Barn Swallows exhibiting more feather holes are less likely to return next year to their breeding grounds, suggesting that feather holes cause higher mortality during migration, the period characterised by highest mortality in fledged swallows. Birds arriving later in the spring were also characterised by a higher number of feather holes. These birds find pairs later and hence have a reduced chance for producing a second clutch (Kose & Møller 1999, Kose et al. 1999, Møller et al. 2004, Papp et al. 2005). Males having fewer feather holes posses longer tail feathers, a trait strongly preferred by females (Møller 1991). Another sexually selected trait, song is also negatively correlated with the number of feather holes (Garamszegi et al. 2005). Both sexual selection and natural selection favours birds with lower louse burdens, and thus researchers through ringing may unconsciously alter the fitness of ringed birds.

Besides effects on the host, bird ringing may also affect population processes of the parasite. The specimens of a louse species inhabiting the same host individual form an infrapopulation. Ringing may act as a stochastic disturbance for louse infrapopulations and may affect transmission chances as well.

As ringing methods are highly standardised, the reduction of louse burdens through ringing can occur not only in *Brueelia* lice of Barn Swallows, but in other bird species and their ectoparasites as well. *Brueelia* spp. is relatively less mobile Ischnoceran lice. In the case of the more mobile Amblyceran lice (Johnson & Clayton 2003) one can presume that ringing influences louse burdens differently. Amblycerans often run from the bird to the hand of the ringer during ringing and measuring (Z. Vas own data). We never observed Ischnocerans doing this, as expected, because Ischnocerans can move only on feathers.

Louse loss due to ringing can have a serious methodological outcome. Most of the lice collected for faunistical studies originate from birds captured for ringing. There are a lot of bird ringing centres, where ringers catch thousands of birds from hundreds of species every year. These camps offer good opportunities for collecting parasitological data. However, as our results suggest, the whole ringing procedure can cause a bias in louse prevalence and intensity of infestation. It may lead to the underestimation of these measures and even an underestimation of parasite species richness. As most phthirapterists collect lice in ringing camps, it may influence results of the louse faunistical literature. Thus it is advisable that birds should be analysed by phthirapterists before the ringing procedure itself to get more reliable data about louse burden. However, it is possible that birds can get lice from other bird specimens, and maybe from other bird species, if the bird ringers store many bird in the same bag without sterilising it. This effect can easily be avoided by using sterilised bags and storing only one specimen in a bag.

Several authors have already showed the side-effects of marking techniques on birds (Marion & Shamis 1977, Fuisz 1995, Söhle et al. 2000, Ritchie et al. 2010). However, to our best knowledge, this is the first report to show that bird ringing — the most widespread marking technique — affects ectoparasite infestations. Though our results refer only to Barn Swallows and their *Brueelia* lice, the methods of capture and handling are widespread and highly standardised, so this phenomenon should be tested with other bird species and their lice, including also Amblycerans.

Our study might imply that researchers dealing with feather holes should take into account that ringing and condition measuring of the studied birds might seriously affect their ectoparasite burden. Therefore they are advised to take into account and also publish capture and handling methods. If the phenomenon would prove widespread among other avian and lice taxa, we hypothesise that the widespread use of colour ringing as individual identification method in avian behavioural ecology studies might well use birds whose ectoparasite load was considerably affected. Parasitologists also should treat their data carefully, and the description of the collecting method of feather lice should detail the extent of handling of hosts.

ACKNOWLEDGEMENTS

We thank Lajos Rózsa of the Animal Ecology Research Group of the Hungarian Academy of Sciences for his advice on the style of the manuscript. We are especially grateful to Jenő Reiczigel, Head of Department of Biomathematics and Informatics at Faculty of Veterinary Science, Szent István University, for his help in statistical analyses. We are grateful to an anonymous reviewer for the valuable comments on the manuscript. We thank Ricardo L. Palma (Museum of New Zealand Te Papa Tongarewa, Curator of insects) for his help in finding relevant references. We would also like to express our gratitude to Ágnes Varga, the director and the staff (especially László Mulady) of the Világospuszta Cattle Farm (Mezőfalvai Mg. Zrt. Világospusztai Tehenészeti Telep) for allowing us to work on their premises during the field work.

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STRESZCZENIE

[Czynności związane z obrączkowaniem mogą zmniejszać poziom zapasożycenia wszołami u dymówki]

Wszoły są ektopasożytami żyjącymi w upierzeniu ptaków. Podczas obrączkowania, oraz towarzyszących mu pomiarów biometrycznych, otłuszczenia czy formuły skrzydła, pasożyty te narażone są na działania, które mogą powodować ich odpadnięcie z piór. W ten sposób obrączkowanie mogłoby w sposób niezamierzony wpływać pośrednio np. na średnią długość życia, czy sukces lęgowy ptaków, gdyż stwierdzono, że wszoły mogą negatywnie wpływać na właśnie te parametry. Ponadto analizy parazytologiczne związane z wszołami, bardzo często wykonywane są na ptakach łapanych podczas akcji obrączkowania. Jeśli więc czynności związane z obrączkowaniem mogą powodować, że część wszołów odpada z piór (a najczęściej analizy parazytologiczne wykonywane są po zaobrączkowaniu ptaka), to wyniki w ten sposób zbierane mogą być obarczone dużym błędem. W pracy zbadano, czy czynności związane z obrączkowaniem oraz pomiarami biometrycznymi i otłuszczenia mogą wpływać na wszoły występujące na ptakach. Do oceny liczebności tych pasożytów na poszczególnych osobnikach wykorzystano liczbę otworów w piórach, gdyż uznaje się, że mogą one być śladami ich żerowania.

Podczas sezonu lęgowego chwytano dorosłe dymówki, które przypisywano do dwóch grup. W pierwszej grupie ptaki obrączkowano, poddawano pomiarom biometrycznym i otłuszczenia oraz zliczano otwory w piórach we wszystkich lotkach i sterówkach. Natomiast w drugiej grupie ptaki były tylko obrączkowane i poddane zliczeniu otworów w piórach wyłącznie na sterówkach.

Po miesiącu ptaki ponownie schwytano w celu zliczenia otworów w piórach. W ten sposób oceniono wzrost liczby otworów w grupie ptaków o standardowej i zredukowanej procedurze obrączkowania. W analizach brano pod uwagę łączną liczbę otworów we wszystkich sterówkach, oraz płeć ptaków i długość badanych sterówek. Stwierdzono, że wzrost liczby otworów w piórach był istotnie większy w grupie ptaków poddanych zredukowanej procedurze obrączkowania (Fig. 1). Autorzy przedstawili wnioski płynące z tych danych zarówno dla ornitologów, jak i parazytologów badających wszoły występujące na ptakach.