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ORIGINAL PAPER

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Patterns in the distribution of avian lice (Phthiraptera: Amblycera, Ischnocera) living on the great grey shrike *Lanius excubitor*

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Abstract The lice parasite community of great grey shrike *Lanius excubitor* collected in NE Slovakia during 1962–1974 was quantitatively studied. Lice fauna comprised of three species: *Docophorulus coarctatus*, *Bruelia cruciata* (Ischnocera) and *Lanicanthus camelinus* (Amblycera). All these species were previously indicated as characteristic for that host. The prevalence of lice was high—lice were recovered from 96.3% (n=108) host specimens. Distributions of lice on the great grey shrike, a strictly territorial bird, were aggregated, indicating substantial variation in the abundance of lice. Sex ratios of lice were biased towards females and not correlated with the subpopulation size of lice on individual hosts.

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Introduction

Lice (Phthiraptera) are obligate ectoparasites. These are the only parasitic insects that complete all of their life cycle on a single host by feeding on the host's tissues (such a blood, feathers, fur or skin debris). However, it has been suggested that lice occurrence on birds show low levels of pathogenicity (Clayton and Tompkins 1994). On the other hand, lice influence major aspects of avian life history traits such as flight performance, metabolism, life expectancy and sexual selection (e.g. Barbosa et al. 2002; Kose and Møller 1999). Therefore, it still seems likely that other parasites have imposed more important selection pressures on birds than lice (for a detailed discussion of this point of view and references, see Møller and Rózsa 2005).

Recently, some aspects connected with life of lice on avian body were tested even on a multispecies level (Rózsa et al. 1996; Rékási et al. 1997; Clayton and Walther 2001; Møller and Rózsa 2005). To date however, knowledge of common parasites infecting birds is sometimes limited. This inhibits more detailed analysis and, hence, more data are still necessary (Lindell et al. 2002; Valera et al. 2006).

In this paper, we present information on the prevalence, intensity, species richness of avian-chewing lice on a passerine bird species, the great grey shrike *Lanius excubitor*. We chose to analyse this bird host species these reasons: First, to our knowledge, these are the first quantitative data on louse fauna for this host species. Secondly, we had the chance to analyse data on lice obtained from probably the biggest collection of the great grey shrike skins in the world (Hromada et al. 2003a,b); therefore, we could avoid problems connected with limitation of size of data sets (Rózsa et al. 2000). Thirdly, it was recently known that existing and emerging parasites and pathogens pose unusual challenges for conservation measures because of their potential to change the numerical abundance and even genetic composition of wild host populations (Alitzer et al. 2003). Therefore, because the species shows a decline in population size and geographical range (Lefranc and Worfolk 1997; Antczak et al. 2004), the study may have conservation implications (cf. Valera et al. 2006).

Table 1 Prevalence and intensity of three lice species on *Lanius excubitor*

Lice	Prevalence (%)	Mean intensity±SE	Intensity range	Sex ratio	*P*
Docophorulus coarctatus	93.5	34.6±4.0	1–215	0.12	0.001
Bruelia crucata	14.8	4.5±1.9	1–151	0.18	0.013
Lanicanthus camelinus	11.1	0.6±0.2	1–14	0.10	0.021

The sex ratio was the fraction of males. *P* Probability. This refers to a binominal test of sex ration skewness (comparison of the actual ratio to an equal sex ratio)

Additionally, because we possess a large data set, we also try to focus on sex ratio problem in lice inhabiting great grey shrikes plumage. We present the male to female ratio and test results for sex distribution. We also discuss briefly the problem of sampling bias, which was suggested to be an important problem for sex ratio studies on lice (Marshall 1981; Rózsa et al. 1996).

Materials and methods

Great grey shrike *Lanius excubitor* is a medium-sized (body mass about 60–70 g), socially monogamous, territorial passerine bird with lack of conspicuous sexual dichromatism widely distributed throughout Europe. Individuals differ by migration strategy; generally males are more sedentary than females (Antczak et al. 2004). Recently, the species declines over distribution range, but a couple of decades ago it was relatively common. Sometimes because it is a predator, it was even treated as a pest and was shot by hunters (Hromada et al. 2003a,b).

Host specimens were collected between 1962 and 1974 in the region of NE Slovakia (49°3′N–49°27′N; 20°30′E–20°34′E) and after they were shot, the specimens were immediately transported to the Šarišské Museum Bardejov, Slovakia (Hromada et al. 2003a,b). Although 665 great grey shrikes were caught, parasites were obtained only from a part (108) of individuals (Hromada et al. 2003a,b). T. Weisz and/or the taxidermists collected lice from fresh dead birds by direct inspection for ectoparasites occurrence, without using special methods such as fumigation. All lice were preserved in 75% ethyl alcohol (more details in Hromada et al. 2003a,b). The lice were subsequently cleared and mounted on microscope slides for examination and identification. All specimens were identified by following (Złotorzycka 1980, 1997).

The prevalence, mean intensity, intensity of infestation and mean abundance were determined for all species of lice collected (*sensu* Bush et al. 1997). The frequency distribution of the lice collected was calculated using the sample mean (x) and variance (s^2) and an exponent k, estimated from $k=x^2/(s^2-x)$. The significance of the difference between the observed frequency distribution was determined by a chi-square test (Rózsa et al. 1996; Rékási et al. 1997). Statistics were performed using SPSS for Windows following Zar (1999).

Results

Of the 108 great grey shrikes deloused, 96.3% (104 birds) yielded lice. A total of 2,722 lice were collected. Three species of feather lice were recorded, the Ischnocera *D. coarctatus*, *B. cruciata* and the Amblycera *L. camelinus* (Table 1).

Species richness The average number of louse species was 1.19 (SD=0.53) on individual shrikes; there were 23 (21.3%) shrikes harbouring two or three species of lice (Fig. 1). We found no relationships between the abundance of Amblycera and Ischnocera (even if log-transformed before analysis; all tests with $P>0.27$)

Frequency distributions of all species together and of each louse species separately indicated an aggregated distribution pattern (Fig. 2). Distributions of all species significantly differed from that predicted from a Poisson (random) distribution (for k values and statistical significance see Fig. 2).

Sex ratios of three collected lice species were biased towards females (Table 1). Sex ratio in all three species was not correlated with subpopulation size of lice on individual hosts ($P>0.54$ in all cases).

Discussion

Three species of feather lice were collected from the great grey shrikes during this study. All three species found, *B.*

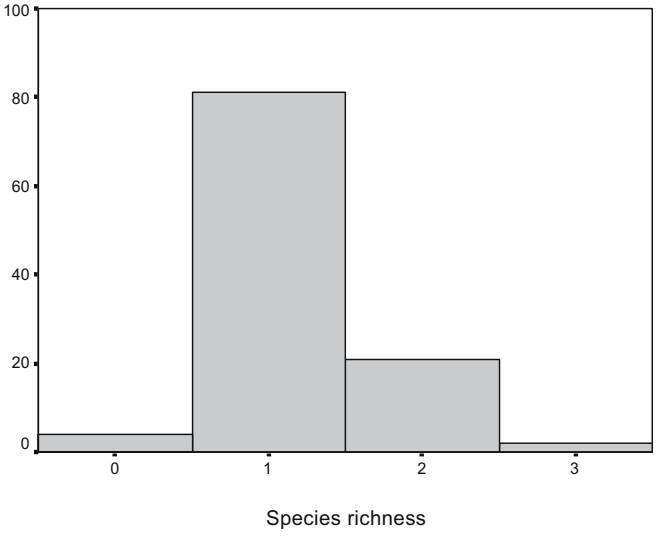

Fig. 1 Louse species richness on the great grey shrikes (n=108 birds)

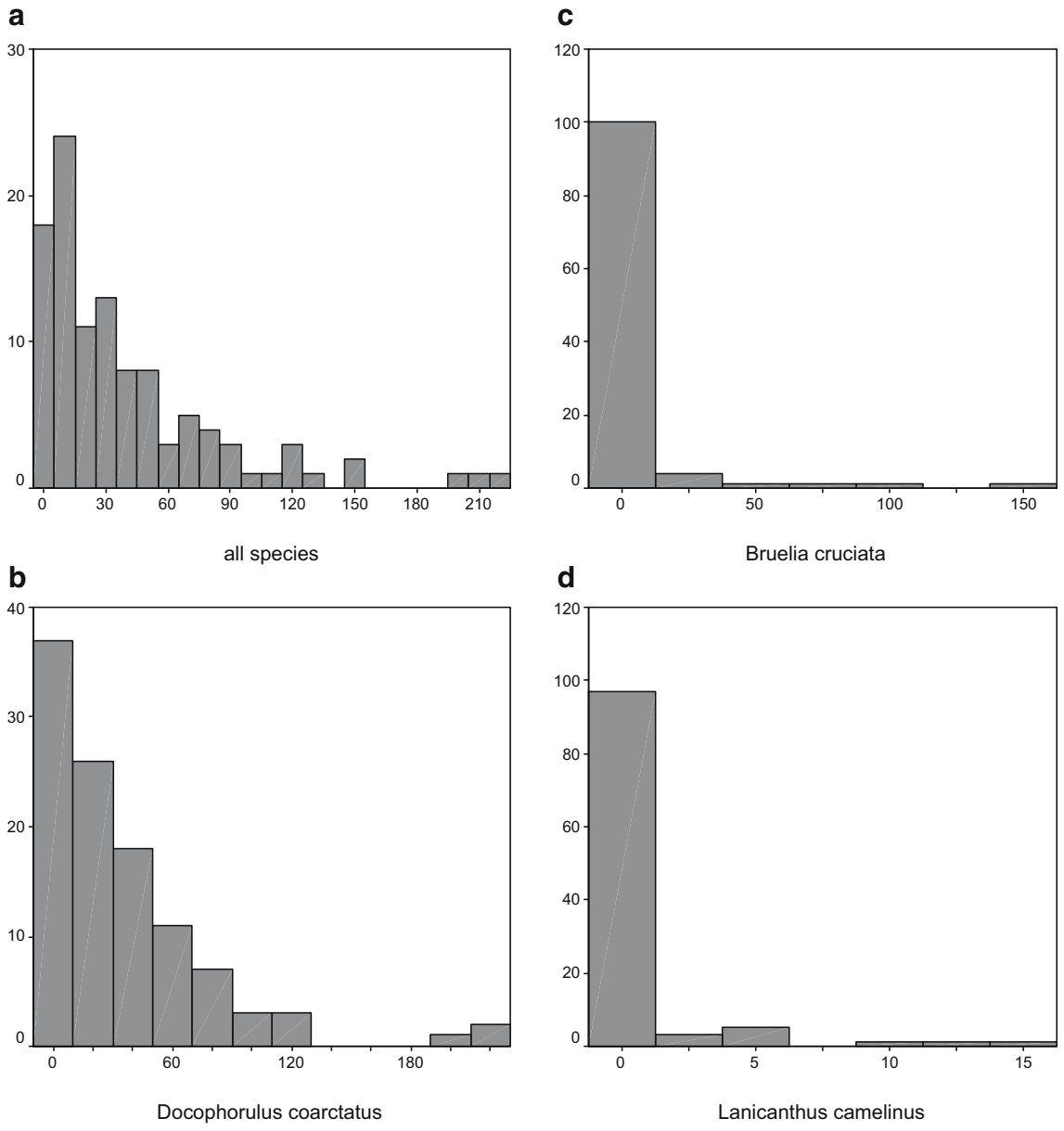

Fig. 2 Frequency distribution of number of all lice species together **a** (k=0.0004, Z=5.20, P<0.001) and separate panels for **b** *Docophorulus coarctatus* (k=0.0004, Z=5.24, P<0.001), **c** *Bruelia crucata* (k=0.0001, Z=8.81, P<0.001) and **d** *Lanicanthus camelinus* (k=0.017, Z=3.65, P<0.001)

cruciata, *D. coarctatus* (Ischnocera) and *L. camelinus* (Amblycera), are known ectoparasites of great grey shrike and were recorded during parasitological investigations in Poland (Złotorzycka 1990, 1994) and Hungary (Rékási 1993). For a discussion on their diagnostic and taxonomical problems, see Złotorzycka (1994). However, discussion on prevalence, intensity and patterns in the abundance and distribution in comparison to mentioned studies is impossible because those studies are not quantitative in character.

However, we may discuss obtained findings with more general predictions from multi-analysis on a multi-species level (Rózsa 1997; Møller and Rózsa 2005). First, in comparison to other studies on lice occurrence in passerine birds, we should note really high prevalence (cf. Rékási et al. 1997), as well as the abundance (cf. Rózsa 1997; Møller and Rózsa 2005). The abundance was higher, about three standard deviation values, than predicted by regression models of lice abundance on host size (Rózsa 1997; Møller and Rózsa 2005), as well as by data collected for other shrike species such as the lesser grey shrike *Lanius minor*. Here, recorded occurrence of lice *Menacanthus camelinus* was 17.6% (Valera et al. 2005). It is interesting because great grey shrike is a strictly territorial bird species; hence, potential colonialism does not explain high prevalence and abundance levels (Rózsa et al. 1996; Rózsa 1997). We suspect that higher lice prevalence and abundance recorded in our studies may be an effect of really intensive searching of lice individuals, without time limitations in many classical ectoparasitological studies on living wild birds

(e.g. Lindell et al. 2002; Valera et al. 2005). Therefore, probability of lice recording could be essentially higher (see also Złotorzycka 1990 and Clayton and Drown 2001).

In comparison to others parasites living into shrike plumage, the noted prealence of Acarina mites living in the feather quills of the great grey shrike, *Syringophiloidus weiszii*, was only 3.5% (Skoracki et al. 2001, based on data obtained from the same great grey shrike collection).

Louse distributions of all three species and whole louse communities were aggregated or clustered as results of statistical tests showed, and confirmed by classical statistical procedures (variance/mean>1) (Zar 1999). Aggregated distributions have been reported frequently for macroparasites (review in Loye and Zuk 1991), including feather lice (Lindell et al. 2002). This pattern of distribution reflects on many hosts with low parasite intensities and a few hosts with high parasite intensities.

Our findings showed that both Amlycera and Ischnocera lice exhibited the same ratio pattern, biased towards females, which agrees with Rózsa et al. (1996). We do not think that it is connected with potential sampling error, as suggested by Marshall (1981), because data were collected with birds shot with no time limitation to lice collection, and the same pattern occur in three louse species, independent of their body size.

Although our study does not focus on birds from currently live population, we hope that obtained findings may support future conservation project on shrikes to protect this endangered species. Although the effect of parasites on other disease agents on shrikes has been scarcely documented (Lefranc and Worfolk 1997; but see Valera et al. 2006), the available information are mainly records of parasite occurrence and taxonomic works (Hromada et al. 2000; Skoracki et al. 2001, 2002; Votypka et al. 2003). We suggested that future studies on feather lice fauna should be done on wild, living birds and to link lice abundance with the shrikes' health status (for one exceptional example, see Valera at al. 2006).

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