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# Blood parasites found in three passerine species during spring migration

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Blood samples from three common passerine bird species, Robin, Redstart and Lesser Whitethroat, were collected during spring migration in the south-western archipelago of Finland. A total of 10 parasitic haemosporidian and trypanosomid species were recorded. The proportion of parasited samples of all three bird species was 18.0%, with no significant differences between them. Furthermore, the prevalence of parasites did not differ between the sexes in Redstarts and between age classes in Robins and Lesser Whitethroats. Instead, species that belong to the same family (Turdidae: Redstart and Robin) were partly infected with the same parasite species. The Lesser Whitethroat, belonging to the family Sylviidae, was infected with different blood parasite species compared with the Turdids. Our results indicate that during migration, the prevalence of blood parasites is rather low and that the taxonomic relationships of bird species is related to their parasitic fauna.

## 1. Introduction

Avian blood parasites include: (1) intracellular protozoans belonging to the families of Haemoproteidae, Leucocytozoidae and Plasmodiidae; (2) flagellated trypanosomes; and (3) juvenile filarial worms. They use the avian bloodstream as a habitat for growth and asexual reproduction and are transmitted by bloodsucking arthropod vectors, often dipteran insects (Ceratopogonidae, Simuliidae and Culicidae), which are intermediate hosts in their life cycle (Fallis & Desser 1977, Seed & Manwell 1977). Insect to bird transmission occurs through vector salivary gland secretions during bloodsucking (see Atkinson & van Riper III 1991).

Avian blood parasites have usually been found wherever birds are tested, with sub-Saharan Africa containing nearly 75% of all avian blood parasites described so far (Bennett 1993a). The prevalence of parasites in birds seems to be highest in the Northern hemisphere where suitable habitats for vectors may be especially abundant (Bennett 1993b). It has also been found that, even among adjacent geographical areas, parasite species, prevalence and intensity may differ remarkably, suggesting differences between bird populations in terms of susceptibility to parasitism (Weatherhead & Bennett 1991, 1992, Bennett et al. 1995, Merilä et al. 1995).

Blood parasites are believed to be transmitted to birds mainly during the breeding season when nestlings are susceptible to infection (Herman et al. 1975, Gabaldon & Ulloa 1980, G. F. Bennett pers. comm.). However, birds may become infected in the wintering areas (Peirce & Mead 1978,

Valkiûnas 1993) and, in addition, the stress of migration may cause a relapse, that is, parasites increase in number in the bloodstream (Peirce & Mead 1978). It is also possible the prevalence of parasites may vary in different age and sex classes within bird species, as well as the species of parasites. In this study, we examined the prevalence of parasites (proportion of samples infected) and the species of parasites in three common migratory passerine bird species captured at a stop-over site during spring migration.

## 2. Material and methods

### 2.1. Study area and birds

The birds were captured on 11–24 May 1994, at the Lågskär bird observatory in the south-western archipelago of Finland (lat. 59°50′N, long. 19°56′E). The bird species included in our study were selected because they are common breeding species in Fenno-Scandia and have somewhat different breeding habitats and dissimilar wintering areas. The three bird species studied were Redstarts (*Phoenicurus phoenicurus*), Robins (*Erithacus rubecula*) and Lesser Whitethroats (*Sylvia curruca*), which do not breed at the study site. Birds were captured by using mist nets. At our study site, Redstarts and Lesser Whitethroats arrive in May (arrival medians being 19 May and 26 May, respectively, n = 16 years), while the median arrival date for Robins is in late April (median 29 April, n = 15 years). Birds were aged as one-year-old or older and sexed by following the guidelines presented by Svensson (1992). We were able to determine sex and age (only males) for Redstarts and age only for Robins and Lesser Whitethroats. All three species belong to the taxon Passeriformes: the Robin and Redstart to the family Turdidae and the Lesser Whitethroat to the family Sylviidae (Howard & Moore 1991).

The total number of birds sampled was 122, of which 53 (43.5%) were Redstarts, 42 Lesser Whitethroats (34.4%) and 27 (22.1%) Robins (Table 1). Redstart samples were taken from both males (42.3%) and females (57.7%); all males being one-year-old, while the age of the females was unknown. Samples of Lesser Whitethroats consisted of approximately equal numbers of one-year-olds (46.4%) and adult birds (53.6%). Robin samples contained mainly one-year-old birds (88%) because the migration of older birds had peaked by the time we took the samples. Some of the individuals, specially in Lesser Whitethroats, could not be age-determined with certainty and

Table 1. Sampling dates in May and parasite samples taken (all three species) during the migratory season in May 1994. Symbols: LW = Lesser Whitethroat, ER = Robin, PP = Redstart. NI = Number of infected samples, NE = Number of examined samples.

| | Total | | % | LW | | ER | | PP | |
|---|---|---|---|---|---|---|---|---|---|
| Date | NI | NE | | NI | NE | NI | NE | NI | NE |
| 11 | 4 | 6 | 66.7 | 1 | 2 | 2 | 3 | 1 | 1 |
| 12 | – | – | – | – | – | – | – | – | – |
| 13 | 1 | 4 | 25.0 | 0 | 1 | – | – | 1 | 3 |
| 14 | 5 | 20 | 25.0 | 3 | 9 | 2 | 7 | 0 | 4 |
| 15 | 0 | 9 | 0.0 | 0 | 8 | – | – | 0 | 1 |
| 16 | 2 | 3 | 66.7 | 2 | 3 | – | – | – | – |
| 17 | 2 | 16 | 12.5 | 1 | 3 | 0 | 8 | 1 | 5 |
| 18 | 0 | 6 | 0.0 | 0 | 1 | 0 | 3 | 0 | 2 |
| 19 | 1 | 9 | 11.1 | – | – | 1 | 2 | 0 | 7 |
| 20 | 2 | 20 | 10.0 | 1 | 3 | 0 | 1 | 1 | 16 |
| 21 | 0 | 3 | 0.0 | – | – | – | – | 0 | 3 |
| 22 | 0 | 2 | 0.0 | – | – | – | – | 0 | 2 |
| 23 | 4 | 17 | 23.5 | 2 | 9 | 0 | 2 | 2 | 6 |
| 24 | 1 | 7 | 14.3 | 0 | 3 | 0 | 1 | 1 | 3 |
| Total | 22 | 122 | | 10 | 42 | 5 | 27 | 7 | 53 |
| % infected | 18.0 | | | 23.8 | | 18.5 | | 13.2 | |

are thus not included in the age analyses. Sex was determinable only in Redstarts, a species in which the sexes have a distinguishable plumage coloration (Svensson 1992). The numbers of samples taken each day are presented in Table 1.

### 2.2. Breeding habitats and wintering areas

The species we took blood samples from are common breeding birds in Finland, but do not breed at the capture site, appearing as migrants only. During the breeding season, Robins prefer spruce (*Picea abies*) forests with rather thick undercover vegetation. Redstarts breed in more open, mixed coniferous–deciduous forests where nest holes are available. Lesser Whitethroats favour more open areas, such as grass fields with juniper (*Juniper communis*) and young or stunted spruce trees (von Haartman et al. 1967, Ojanen 1983, Solonen 1983a, b). Because available breeding habitat overlaps in space, birds may be exposed to similar vectors during the breeding season.

The Robin mainly overwinters in North Africa (Algeria, Morocco, Tunisia) but also in central and southern parts of Europe (France, Italy, Spain). Redstarts overwinter primarily in tropical West Africa, while the winter habitats of Lesser Whitethroats are situated in the eastern part of the sub-Saharan area, around latitude 10° (Cramp 1992).

### 2.3. Blood samples

Blood samples were taken from the brachial vein into heparinized microcapillary tubes, and a drop of blood was smeared onto a glass slide, fixed in 100% (absolute) methanol and stained with Giemsa. Slides were screened for parasites under a magnification of × 200 for the presence of *Leucocytozoon* and *Trypanosoma* and × 800 for the *Plasmodium* and *Haemoproteus*. The presence of parasites was estimated by counting 100 fields under oil immersion in an area where blood cells formed a monolayer (Godfrey et al. 1987, Bennett et al. 1995). Parasites were identified as to species or forms according to descriptions by Gordon F. Bennett, Memorial University of Newfoundland (see checklists Bennett et al. 1993a, 1994 for references on genera *Haemoproteus*, *Leucytozoon* and *Plasmodium* and Baker 1976 for genera *Trypanosoma*). Data were analysed by using non-parametric Spearman rank order correlation, the Mann-Whitney U-test and the Chi-square test.

## 3. Results

In the samples studied, the overall proportion of infected samples was 18.0%. Among haemosporidians, the prevalence was highest in the genera *Haemoproteus* and *Leucocytozoon* (44.4% and 50.0% respectively; total 77% of observed infections), while the prevalence of trypanosomes was less (18% of infections). The haemosporidian parasite, *Plasmodium vaughani* was rare (5.6% of haemosporidian infections). The prevalence of parasites in different bird species was comparable and rather low, without significant differences between species: Lesser Whitethroats 23.8%, Robins 18.5% and Redstarts 13.2% ($\chi^2 = 1.8$, df = 2, P = 0.41, Table 1). The bird species studied differed in the species of parasites they carried (Table 2). Two out of five species of parasites were found in Robins and Redstarts, while none of the species of parasites found in Robins and Redstarts were found in Lesser Whitethroats. The prevalences of parasites in all three bird species were comparable although the species of

Table 2. Prevalence of blood parasites in samples of migrant passerines. % = percentage of observed species seen in relation to total number of sampled individuals. Bird species: 1 = Lesser Whitethroat, 2 = Robin and 3 = Redstart.

| Parasite species | No. of infected indiv. 1 | 2 | 3 | % |
|---|---|---|---|---|
| *Haemoproteus belopolskyi* * | 3 | 0 | 0 | 2.5 |
| *Haemoproteus fallisi* | 0 | 1 | 0 | 0.8 |
| *Haemoproteus nesseri* | 0 | 2 | 0 | 1.6 |
| *Haemoproteus sylvae* | 2 | 0 | 0 | 1.6 |
| *Leucocytozoon shaartusicum* | 0 | 1 | 5 | 4.9 |
| *Leucocytozoon phylloscopus* | 3 | 0 | 0 | 2.5 |
| *Plasmodium vaughani* | 1 | 0 | 0 | 0.8 |
| *Trypanosoma everetti* | 0 | 0 | 1 | 0.8 |
| *Trypanosoma avium* | 0 | 1 | 1 | 1.6 |
| *Trypanosoma paddae* | 1 | 0 | 0 | 0.8 |

* One sample includes both *H. belopolskyi* and *H. sylvae*.

blood parasites were different. Lesser Whitethroats were infected with a total of five blood parasite species of which 80% were Haemosporidans and 20% Trypanosoma, Robins four (75% vs. 25%) and Redstarts three (66.7% vs. 33.3%). All cases, except one Lesser Whitethroat sample, contained only one parasite species (Table 2).

We also checked whether there was any differences in the prevalence of parasites between the sexes or between age groups. The proportion of parasitised birds did not differ between the sexes in Redstarts (Mann-Whitney U-test; $z_{22,30} = 0.49$, $P = 0.63$) nor between different age-classes of Lesser Whitethroats ($z_{15,13} = 0.2$, $P = 0.87$) or Robins ($z_{22,3} = 1.4$, $P = 0.16$).

## 4. Discussion

Most parasite surveys are carried out during the breeding season of birds, when blood parasites are active in the blood and thus easier to detect. Studies in the boreal region showed that the prevalence of parasites was higher during the breeding season (e.g. Bennett 1993b, Bennett et al. 1995), while our study showed that during spring migration the prevalence was lower. This difference may be due to parasites truly being rare in our study species or the parasites live in other organs and the numbers circulating in the blood were below the detection limit. In another study, the prevalence of blood parasites was high in some sub-Saharan migratory passerines (Icterine warbler, *Hippolais icterina* 97.6%, Pied Flycatcher, *Ficedula hypoleuca* 34.3%, Blackcap, *Sylvia atricapilla* 100% and Willow Warbler, *Phylloscopus trochilus* 29.5%) just after spring migration on the Curonian Spit in the south-eastern part of the Baltic Sea (Valkiûnas 1993). In addition, in an around-the-year study in England, the prevalence of parasites was higher in May than in other months of the year (Cheke et al. 1976). These results suggest that a relapse may occur during migration and/or when birds prepare to start breeding.

Birds are most susceptible to infections as nestlings (see Gabaldon & Ulloa 1980), which may partly be due to an immature immune system (Bennett & Fallis 1960). With this in mind, we may assume that the prevalence of parasites is different in one-year-old and older birds, which we did not find. The simplest explanation for this may be that once infected (e.g. in the nest), birds are never rid of the parasites. In the species for which we could determine the sex accurately, i.e. the Redstart, the sexes did not show any difference in the prevalence of parasites, which suggests that infection should occur unselectively between sexes.

All bird species studied showed a similar pattern of blood parasite infections; haemosporidian blood parasites being more abundant compared with trypanosomes. However, our results may be misleading since our technique for blood smears favours haemosporidians over trypanosomes. A major finding in our observations was that the bird species studied differed in the types of blood parasites infecting them. The more closely related Robins and Redstarts were infected with more similar parasite species or morphological forms, while Lesser Whitethroats were infected with a totally different species. One explanation for the difference is that, at the family level, blood parasites may be family adapted and, thus, show family specificity. Another explanation is that blood parasites are considered to be different species (or morphological forms) if found in birds from different families (Atkinson & van Riper III 1991). However, since birds may be infected not only at their breeding site, but also at the overwintering areas (Bennett et al. 1974, Peirce & Mead 1978, Valkiûnas 1993), it is possible that some of the differences in parasite species found among the birds we studied could be explained by differences at the breeding and overwintering areas. Valkiûnas (1993) was able to re-take blood samples from several of the sub-Saharan migrants mentioned earlier, thus obtaining valuable information on the species of parasites found in the same birds as juveniles and after the overwintering period. His results suggest that *Leucocytozoon* infections are more likely obtained in breeding areas while *Haemoproteus* and *Plasmodium* are transmitted during wintering in the sub-Saharan area. This fits well with the results reported by Bennett and coworkers, who also reported *Leucocytozoon*, and trypanosomas, being more common in the north during the breeding season (Bennett et al. 1995). *Leucocytozoon* infections very likely are transmitted by simuliids, which are abundant in fresh,

moving water in northern Fenno-Scandia (see Bennett et al. 1995). Furthermore, among the species studied, particularly the Lesser Whitethroat overwinters in a different area than the other species (Cramp 1992), suggesting that it may be exposed to different vectors and blood parasites. Therefore, differences in breeding habitats together with differences in overwintering areas may partly explain the differences in the species of parasites found.

In conclusion, it appears that the variations in the types of parasites infecting different bird species can be a result of the different habitats used by birds, both at breeding and especially at overwintering sites. In addition, infections by dissimilar species of parasites may occur because of taxonomic differences among bird species. This interpretation, however, is circular reasoning since parasite taxonomy is partly based on bird species taxonomy. The prevalences of parasites was approximately the same among the species we studied, but lower than what has been found in studies made during the breeding season (Bennett 1993b, Valkiûnas 1993, Bennett et al. 1995), which may suggest that a relapse occurs when birds reach their breeding grounds.

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## Selostus: **Veriloisten esiintyminen kolmella varpuslintulajilla kevätmuuton aikana**

Lintujen veriloiset ovat alkueläimiä, jotka tarvitsevat lintujen verenkiertoa lisääntyäkseen. Linnun verenkiertoon loiset pääsevät kaksisiipisten vertaimevien hyönteisten, niin kutsuttujen väli-isäntien avulla (etenkin erityiset lintuihin erikoistuneet hyttys-, polttiaissääski- ja mäkärälajit). Monimutkainen loisen lisääntymiskierto edellyttää loisen esiasteen pääsyä hyönteisestä linnun verenkiertoon hyönteisen sylkirauhasten kautta. Imetyn veren mukana linnussa olevat nuoret, suvuttomasti lisääntyneet loiset siirtyvät verta imevään hyönteiseen lisääntyäkseen päästessään uudelleen linnun verenkiertoon. Veriloisia on löydetty useimmilta tutkituilta lintulajeilta, joiden elinympäristössä esiintyy lintujen veriloisia levittäviä hyönteislajeja. Erilaisten veriloislajien tai niiden muotojen runsaus on monipuolisin troppisilla seuduilla, mutta prevalenssi (loisittujen lintuyksilöiden osuus kaikista tutkituista lintuyksilöistä) on suurin pohjoisella vyöhykkeellä.

Tutkimme Lågskärin lintuasemalla toukokuun jälkipuoliskolla 1994 erovatko punarinnan, leppälinnun ja hernekertun veriloiset toisistaan ja onko loisisuudessa eroa iän ja sukupuolen perusteella. Yhteensä 18% tutkituista 122 näytteestä oli loisittuja edustaen 10 veriloislajia tai kuvattua muotoa. Prevalenssit olivat alhaisia kaikilla kolmella lajilla verrattuna pesimäaikaisiin tutkimuksiin varpuslinnuilla ja siksi on mahdollista, että linnut saavat pesimäaikana uusia loistartuntoja ja/tai kudoksissa piilevät loiset näkyvät verenkierrossa vasta lintujen lisääntymisaikana. Emme havainneet eroja loisten esiintymisessä eri sukupuolilla (leppälintu) tai ikäluokissa (hernekerttu ja punarinta). Eri sukupuolten välinen tulosten eroamattomuus viittaa siihen, että loisia välittävät hyönteiset eivät valikoi lintuja ja ikäluokkien prevalenssien samankaltaisuus siihen, että linnut kantavat veriloisia eliniän infektion saatuaan. Läheisempää sukua toisilleen olevalla punarinnalla ja leppälinnulla oli useammin samoja loisia kuin hernekertulla, jolla tavatut loiset olivat erilaisia verrattuna leppälintuun ja punarintaan. Loislajien erilaisuus voi johtua lajien pesimä- ja talvehtimisalueiden erilaisuudesta, mutta myös siitä, että eri linturyhmissä on kehittynyt erilaisia loislajeja tai morfologialtaan eroavia muotoja. Se miksi loiset eroavat punarinnalla ja leppälinnulla verratuna hernekerttuun voi johtua myös siitä, että loislajeja tai niiden muotoja luokitellaan lintulajin perusteella.

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