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Brief report

Blood parasites of juvenile Willow Tits *Parus montanus* during autumn migration in northern Finland

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1. Introduction

Haemosporidian blood parasites are intracellular protozoans that use the host's tissue and blood stream for asexual reproduction (Atkinson & van Riper III 1991). Parasites are transmitted by blood-sucking arthropod vectors, often dipteran insects (Ceratopogonidae, Culicidae and Simuliidae) that are intermediate hosts in the life cycle of the parasites (Fallis & Desser 1977). Hence, protozoans' life cycles include an infective stage during which sporozoites are transmitted to birds through vector salivary gland secretions during blood sucking. Simultaneously, dipterans become infected by parasite gametocytes through the blood meal (Atkinson & van Riper III 1991).

Bennett et al. (1994) found that only 6% of the 53 passerine bird families studied were free from blood parasites, indicating that blood parasites are common among passerines. Although blood parasite diversity is higher in tropical areas (Bennett 1993), the prevalence (proportion of infected individuals) seems to be highest in boreal areas (Bennett et al. 1991, Valkiûnas 1993a). The higher prevalences in the boreal region are presumably due to the high abundance of transmitting vectors in the short summer season, as well as the high species diversity of vectors specialised for birds or mammals (Simuliidae, Adler et al. 1999).

Seasonal variation in blood parasite prevalences and parasitaemias (the number of parasites in a sample) in blood samples is noticeable (Cheke et al. 1976), most likely depending on seasonal differences in parasite relapse from tissues into the blood. Higher prevalences commonly occur during the breeding season (Atkinson & van Riper III 1991) as compared to the migration period (Rintamäki et al. 1999). In this study we report on blood parasite prevalences and composition in Willow Tits (*Parus montanus*) in northern Finland and discuss our findings in relation to the

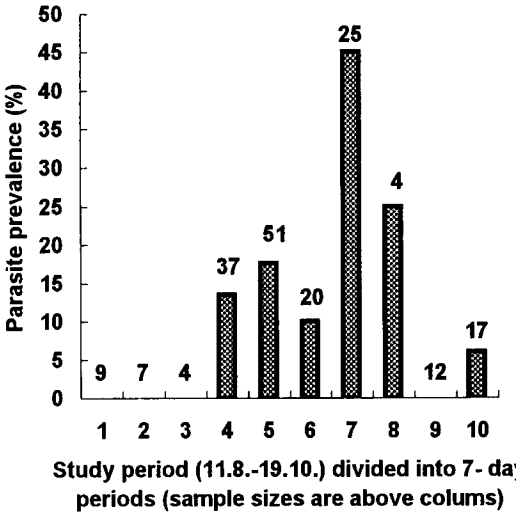

Fig. 1. Willow Tit parasite prevalences divided into 7-day periods along the migration route from mid-August to mid-October. Numbers above columns represent sample sizes.

seasonal occurrence of blood parasites in this species.

2. Material and methods

The study was conducted at Tauvo Observatory in northern Finland (64°48´N, 24°38´E) during the autumn of 1994. The study site is situated approximately 40 km north-east of the region where Rytkönen et al. (1996) obtained their Willow Tit samples. We collected blood samples daily during the main autumn dispersal period of the Willow Tits, i.e. from 16 August until 16 October. Willow Tits included in this study clearly were migratory (only about 5% of birds were recaptured on the next day or later). Birds were captured in mist-nets erected near the bird station (standardised net trapping of 11 × 6m and 12 × 9m birdnets), and included a total of 951 juvenile birds (for age determination, see Laaksonen & Lehikoinen 1976). From these Willow Tits, blood was taken from 186 individuals. The sex of the birds was not determined. The blood was taken from the brachial (basilic) wing vein and then smeared onto a glass slide. Smears were fixed with methanol and stained using Giemsa stain. Smears were screened under oil immersion (×1200 for *Haemoproteus* and *Plasmodium* and ×500 for *Leucocytozoon* and *Trypanosoma*) and parasites were enumerated from 100 fields by moving the slide to areas where blood cells formed a monolayer (for more details, see Godfrey et al. 1987, Bennett et al. 1995). Slides were screened by G. F. Bennett, Memorial University of Newfoundland, St. John's, Newfoundland, Canada; there was a good repeatability of blood parasite detection (see Sundberg 1995).

3. Results

Parasite prevalence was 14.5% (27/186). At the beginning of the study period, in middle and late August, sampled individuals were parasite free, while the highest prevalences occurred in late September and early October (Fig. 1). We found two parasite species, *Leucocytozoon major* (81% of infections, n = 22) and *Haemoproteus parus* (19% of infections, n = 5). When we used a conservative method (parasite count from 100 fields) to evaluate intensity of infection, the mean number of parasites in samples was 2.1 ± SD 1.4 for *Leucocytozoon* and 2.2 ± 1.8 for *Haemoproteus* (young parasites were excluded). The number of *Leucocytozoon* blood parasites increased with time although the relationship was not significant (r_s = 0.31, n.s.). The median occurrence of juvenile Willow Tits was on 11 September 1994 at Tauvo.

We compared the condition of parasite-infected and parasite-free individuals indirectly using the residuals from the linear regression of body mass on tarsus length (e.g. Rintamäki et al. 1998). We found no indication that parasitised birds were in poorer condition than those that were parasite free (Mann-Whitney *U* test: z = 0.41, n.s.). The result remained the same when we compared *Leucocytozoon* only (z = 1.20, n.s.).

4. Discussion

Juvenile Willow Tits were infected with two Haemosporidian protozoa, *Leucocytozoon major* and *Haemoproteus parus*, the former being the most common blood parasite. The blood parasite prevalence (14.5%) was relatively low as compared to breeding season studies of other passerine spe-

cies (e.g. Valkiûnas 1993a). Parasites were mainly found in samples from late September until early October.

Cheke et al. (1976) reported that, in England, seasonal variation in prevalences of blood parasites (*Haemoproteus*, *Leucocytozoon*, *Plasmodium* and *Trypanosoma*) differed, with the highest prevalences being found in May (15.9%). The English study included both non-migratory and migratory birds and, in addition to May, high parasite prevalences were also found in June, July and September (about 11.5%) as compared to February, March, October and December (about 4.5%). These data suggest that prevalences differ over time and that the highest prevalences are often found during the breeding season (see also Eide et al. 1969, Valkiûnas 1993a, Rintamäki et al. 1999).

The low blood parasite prevalence found by us conforms well with findings reported from England and Russia (for a summary, see Rytkönen et al. 1996). However, our results do not agree with what Eide et al. (1969) found among nine fledged Willow Tit juveniles and two adults in Norway. In a small sample taken from fledged juveniles (June to mid-August) they found prevalence as high as 81.8% (9 of 11 birds were parasitised by *Leucocytozoon* spp.). Rytkönen et al. (1996) recently reported a total absence of blood parasites both in adult and nestling Willow Tits in northern Finland. Their large sample consisted of adult birds (60) and nestlings (362), which were examined during the breeding season (June), and adult birds (21) caught in January–March. Interestedly, our study area was close (about 40 km to the south-southwest) to theirs, so the different results are noteworthy. As juvenile birds are expected to be more prone to parasite infection than older ones (e.g. Gabaldon & Ulloa 1980), and since all Willow Tits studied by us were juveniles, the birds in our study most likely became infected in their nests or close to them.

Clearly, different passerine bird populations often show differences in parasite prevalences, parasitaemias and parasite species composition (Bennett et al. 1995, Merilä et al. 1995, R. Dufva, personal communication). Thus, it seems relevant to discuss why our findings differ from those reported by Rytkönen et al. (1996) since the birds in both studies seem to be from the same population (Willow Tits' natal dispersal is mainly directed towards the south, and the distance travelled is usually no more than tens of kilometres, Ehrenroth 1973), but the sampling years are different. In their work, Rytkönen et al. (1996) pointed out the possibility that the absence of parasites may be due to the absence of vectors but also, alternatively, that Willow Tits may become infected after the young fledge from their nests. They did not collect blood samples during that time. Northern Scandinavia has a high abundance of potential transmitting vectors (Simuliidae, e.g. Adler et al. 1999); therefore, "the absence of vectors" hypothesis is, in general, an unlikely explanation for the absence of blood parasites in Willow Tits. However, it is possible that ornithophilic vectors have not yet emerged when Willow Tits breed in May–June and, therefore, we agree with the suggestion that birds may have been infected after fledging, or that infections are not seen in blood smears until nestlings have fledged.

Additionally it is possible that the latent period after infection is so long that the infection cannot be detected from nestling blood samples. Support for this comes from a study on the Chaffinch (*Fringilla coelebs*) by Valkiûnas (1993b). He collected uninfected blood samples from 10–12 day old nestlings. After this he placed nestlings in an inside enclosure with no possibility for infection by airborne insects. He continued blood sampling in captivity and found that *Haemoproteus fringillinarum* gametocytes first appeared in the samples when the birds were 23–25 days old, i.e. around 10 days after fledging. This study strongly suggests that, at least in this Chaffinch population, blood parasites cannot be found from blood smears until relatively long after infection (see also Garnham 1966). In addition, Rytkönen et al. (1996) suggested that infected birds may disperse or die before the following winter. This suggestion, however, does not explain why nestlings did not carry blood parasites in the nest (see Chaffinch above). In addition, we did not find evidence that parasitised birds were in poorer condition than parasite-free birds, which could be predicted if they suffer from higher mortality before winter.

To summarise, the results obtained from three Willow Tit studies suggest blood parasite prevalences to be higher among fledged juveniles (Eide

et al. 1969) and in the subsequent dispersal period (this study) than during the nestling period and in winter (Rytkönen et al. 1996). Assuming that blood parasites and vectors are abundant in the Oulu region, the reasons for the unexpected absence of blood parasites in winter and especially during the breeding season could be: (1) local absence of blood parasites and/or vectors, (2) absence of vectors during the Willow Tit nestling period, (3) impossibility to detect blood parasites from blood smears during the nestling period, and (4) juveniles are infected after fledging.

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Selostus: **Veriloisten esiintyminen nuorilla hömötiaisilla syysvaelluksen aikana Pohjois-Suomessa**

Veriloiset ovat alkueläimiä, jotka leviävät ja lisääntyvät hyönteisten (ns. vektorien, kuten hyttyset, mäkärät ja polttiaissääsket) ja selkärankaisten (esimerkiksi linnut ja nisäkkäät) avulla. Veressä suvuttomasti lisääntynyt loinen siirtyy vertaimevään hyönteiseen sen imiessä verta esimerkiksi linnusta ja samalla hyönteisessä olevat veriloiset siirtyvät lintuun. Veriloisia, joista tunnetuin on malariakuumetta aiheuttava veriloinen, on tavattu lähes kaikilta linnuilta ja ne puuttuvat tai ovat harvinaisia vain lajeilla, joiden elinympäristö on epäsuotuisa niitä levittäville hyönteisille (esimerkkinä merilinnut).

Tutkimme veriloisten esiintymistä vaeltavilla hömötiaisilla Siikajoen Tauvossa syksyllä 1994. Pyydystimme yhteensä 186 lintua, joista 27 oli loisittuja. Kahdesta löydetystä loislajista tavallisin oli *Leucocytozoon major* (22), kun taas *Haemoproteus parus* oli harvinaisempi (5). Veriloisia löytyi todennäköisimmin syyskuun lopussa ja lokakuun alussa verrattuna elokuuhun ja syyskuun alkuun.

Oulun seudulla aikaisemmin tehdyssä tutkimuksessa hömötiaisista ei talvella ja pesimäaikana löydetty veriloisia. Pohdimme todennäköisimpiä syitä loisten puuttumiseen talvella ja etenkin pesimäaikana verratuna syksyyn. Mielestämme loisia levittävien hyönteisten puuttuminen hömötiaisen pesimäaikana, veriloisten siirtyminen verenkiertoon vasta kun poikaset ovat lähteneet pesästä tai infektion saaminen vasta pesästä lähdön jälkeen ovat todennäköisimpiä syitä siihen, miksi hömötiaisen veriloisia havaitaan vasta loppukesällä ja syksyllä.

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