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Leucocytozoonosis and Trypanosomiasis in Redstarts in Finland

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ABSTRACT: *Leucocytozoon* spp. and *Trypanosoma* spp. blood parasites in the redstart (*Phoenicurus phoenicurus*) were studied during spring migration 1994 in southern Finland (53 individuals) and the breeding season 1992–1994 in northern Finland (69). Parasite prevalence was higher during the breeding season (48%) than during the migration period (13%), with no age or sex differences in the breeding site birds. In both periods, redstarts were infected by the same blood parasites *Leucocytozoon shaartusicum* (46% prevalence at the breeding site and 71% during the migration period) and *Trypanosoma avium* complex (58% and 43%, respectively). One individual at the breeding site had contracted *L. dubreuili* and one at the stop-over site had *T. everetti.* Our results may support the assumption that tissue-hidden parasites relapse during the breeding season when birds may have diminished immune response related to egg production and brood rearing. Another explanation could be that the high abundance of ornithophilic vectors enhance parasite transmission during breeding season in northern Finland.

Key words: Breeding season, *Leucocytozoon* spp., migration, *Phoenicurus phoenicurus,* redstart, seasonal variation, *Trypanosoma avium.*

Parasite relapses resulting from their movement into blood circulation from tissues in birds occur mainly during the breeding season (Atkinson and van Riper III, 1991). The mechanism behind this occurrence is thought to be an ineffective immunological defense towards parasites when birds start their breeding cycle (Applegate and Beaudoin, 1970; Wedekind, 1992). Alternatively, higher parasitemias at breeding time also may be due to increased transmission by vectors. Both of these hypotheses could explain increase in prevalences of parasites in peripheral blood of birds during the breeding season as compared with the non-breeding period.

Prevalences and species composition in the host have seldom been compared between migration and breeding seasons. Here, we describe blood parasites and their prevalences during the spring migration and breeding season in the redstart (*Phoenicurus phoenicurus*).

The redstart is a small (18–20 g) Eurasian passerine bird that breeds in Europe in forests where nest holes are available (von Haartman et al., 1963–72). The density of breeding birds is highest in the northern parts of Fenno-Scandia (Hagemeijer and Blair, 1997). The redstart is a long distance southwestern migrant and overwinters in tropical subSaharan West Africa (Cramp, 1992). Blood samples from migrating redstarts were collected between 11 and 24 May 1994 at Lågskär Bird Observatory (59°50′N, 19°56′E), a small (64 hectares) and isolated (15 km from the mainland Åland) island in the southwestern archipelago of Finland. Redstarts do not breed at Lågskär and their median spring arrival date to the study site is 19th May (Rintamäki et al., 1997). In addition, their short stop-over normally lasts from few hours to <1 day on Lågskär. Therefore, parasite infections detected from migrants were likely to have been contracted elsewhere. The data from the breeding site were collected between 20 June and 6 July 1992–94 close to Meltaus Game Research Station in northern Finland (67°00′N, 25°20′E). The distance between the study sites is approximately 800 km.

Birds were captured using mist nets at Lågskär. The data set consisted of 53 in-

dividuals (n = 22 males, n = 31 females); all males were 1-yr-old while the age of females was unknown (Svensson, 1992). Birds at the breeding site were captured during the late breeding period (i.e., when nestlings were ≥1-wk-old), and included 69 birds (20 from 1992, 26 from 1993, 23 from 1994; n = 28 males, n = 41 females) captured by nest-box traps. The data from the breeding site comprised 51 adults and 17 1-yr-old redstarts. For analyses, we pooled the data obtained from different years at the breeding site since we could not find significant differences by chi-square analysis in prevalences in three consecutive years (55% in 1992, n = 20; 35% in 1993, n = 26; 57% in 1994, n = 23; χ^2 = 2.93, df = 2, P = 0.23). The abundance of ornithophilic vectors is high in the Meltaus area during redstart breeding season (O. Rätti and U. Ojanen, pers. comm.; see also Adler et al., 1999). At both study sites, blood samples were taken immediately after capture.

Comparison of parasite prevalences between migrants and breeders may be most interesting if they belong to the same or close populations. To investigate this possible relationship, we checked Finnish redstart ringing recovery data accumulated from 1974–95 from latitudes 59° to 68° (i.e., latitudes between study sites). We noted migration directions of redstarts that had been found dead or re-captured at least 300 km distant from the banding location in the Finnish southern and southwestern coastlines or archipelago. All recoveries (18) indicated that redstarts continue their spring migration towards the north and northeast, i.e., towards the areas we collected the breeding site data. In addition, four redstart recoveries were taken relatively close (<100 km) distance from our breeding study site. Thus, we consider that our samples represent birds originating from the population breeding in Fenno-Scandia, although data may not consist of the same individuals and some of the birds captured during the migration may breed elsewhere in southern Finland.

Blood was collected from the basilic and tarsometatarsal veins using sterilized needles and microcapillary tubes. Blood was sampled from two locations, but according to studies in domestic turkeys (*Meleagris gallopavo*) by Noblet and Noblet (1976), circulating blood parasites do not vary in different body locations. Every bird was sampled once. Blood was smeared onto a glass slide, air dried, fixed in 100% methanol or ethanol, and stained with Giemsa stain. Slides were screened for *Leucocytozoon* spp. and *Trypanosoma* spp. at 200× using a Zeiss Ultraphot II microscope (Carl Zeiss, Oberkochen, Germany), while *Haemoproteus* spp., *Hepatozoon* spp. and *Plasmodium* spp. were screened for at a magnification of 800 to 1,000×. Each smear was screened for 10 to 15 min. We followed recent suggestion for use of parasitological terms (Bush et al., 1997), so that prevalence is the proportion of infected individuals in the host population. Slides also were screened by a record individual (G. F. Bennett, Memorial University of Newfoundland, St. John's, Newfoundland, Canada); there was good repeatability of blood parasite detection (Allander and Bennett, 1994; Sundberg, 1995). Nomenclature for parasite species or described morphological forms follows Bennett et al. (1994) for the genus *Leucocytozoon* and Baker (1976) for the genus *Trypanosoma.* Statistical analyses were performed using the chi-square test (Sokal and Rohlf, 1995). Representative specimens are deposited in the International Reference Centre for Avian Haematozoa (Queensland Museum, South Brisbane, Queensland, Australia). Registration numbers for five respective samples from Meltaus in 1992 are 121464, and 121467 for *T. avium,* 121475, and 121478 for *L. shaartusicum,* and 121506 for *L. shaartusicum* and *T. avium.* For Lågskär they are G462642, G462644, G462645, G462646, and G462647 for *L. shaartusicum,* G462641, G462643, and G462648 for *T. avium,* and G462649 for *T. everetti.*

The blood parasite fauna of redstarts

TABLE 1. Blood parasites of migratory and breeding redstarts in Finland.

Parasite	Time period			
	Migration (n = 53)		Breeding (n = 69)	
	Number infected	%	Number infected	%
Leucocytozoon shaartusicum	5	9	15	22
Leucocytozoon dubreuili	0	0	1	1
Trypanosoma avium complex	3	6	19	28
Trypanosoma everetti	1	2	0	0
Total parasite infections	9	17	35	51
Total infected birds	7	13	33	48

was similar in both study sites, with birds infected by mainly *L. shaartusicum* or *T. avium* (Table 1). In addition, one bird at the migratory stop-over site was infected with *T. everetti*, one bird at the breeding site with *L. dubreuili* and two birds both at the breeding and migratory site with *L. shaartusicum* and *T. avium*. Therefore, the total number of infections (44) recorded is greater than the number of infected birds (40) (Table 1). Migrating redstarts were less often infected (13%, n = 53) compared to the breeding birds (48%, n = 69; χ^2 = 16.3, df = 1, $P < 0.001$). We also compared prevalences between the birds for which we have information of sex and age from both study sites, i.e., yearling males. There were no significant differences (χ^2 = 2.6, df = 1, P = 0.11). The same pattern occurred when we separately compared *Leucocytozoon* spp. and *Trypanosoma* spp. prevalences using pooled data. For *Leucocytozoon* spp. there was 9% (n = 5) at the migratory site versus 23% (n = 16) at the breeding site (χ^2 = 4.0, df = 1, $P < 0.05$) and for *Trypanosoma* spp. there was 8% (n = 4) and 28% (n = 19), respectively (χ^2 = 7.8, df = 1, $P < 0.005$). At the breeding site, there were no significant differences in prevalence between sexes. Males had 57% (n = 28) and females had 42% (n = 41) (χ^2 = 1.64, df = 1, P = 0.20). Between age groups the 1-yr-old birds had 35% (n = 17) and adults had 50% (n = 51) (χ^2 = 1.26, df = 1, P = 0.26). The small sample size of birds from the migratory stop-over site precluded comparisons between sexes. At the breeding site, prevalences did not differ between male and female age classes (χ^2 analyses $P > 0.10$ in both cases).

Previous studies of passerine blood parasites at breeding sites have shown geographical differences in prevalence and parasite species composition (Bennett et al., 1995; Merilä et al., 1995). Consequently, several studies have reported spring relapses of parasites prior to the breeding season (Applegate and Beaudoin, 1970; Kirkpatrick and Suthers, 1988) and found moderate or high prevalences during the breeding season (Valkiûnas, 1993; Allander and Sundberg, 1997). In contrast, studies outside the breeding period have encountered low or even absent prevalences of blood parasites in resident or migratory passerines (Cheke et al., 1976; Rytkönen et al., 1996; Rintamäki et al., 1997).

In our study, the prevalence in redstarts was higher at the breeding site than at the stop-over site suggesting that blood parasites were more likely to be present in peripheral blood during the summer breeding period in the northern hemisphere. We suggest three possible explanations for the observed increase in prevalence during the breeding period. First, parasites relapse in the breeding season due to reduced immunological resistance of the host bird. This implies that hormonal activity (i.e., increase in gonadotropin and corticosterone) in the host decreases the immunological response towards parasites during the breeding season (Applegate and Beaudoin, 1970; Folstad and Karter, 1992; Wedekind, 1992). In fact, the rela-

tionship between onset of breeding and parasite relapse was recently confirmed by Allander and Sundberg (1997) who found a peak in intensity of infection in indoor captive yellowhammer (*Emberiza citrinella*) males at breeding time when vector exposure was apparently absent. Secondly, parasites also may increase their activity during the breeding season when the probability to be transferred to new host by emerging vectors is presumably highest. Finally, concomitant emergence of transmitting vectors at the breeding time undoubtedly increases the risk of infection. Unfortunately, there are no published data on bird vector species, their emergence or activity in the Meltaus area. However, a study in northern Sweden revealed that 40% of blackfly species (total $n = 61$) are ornithophilic and that the number of bird feeding species increases with latitude (Adler et al., 1999). In addition, studies on adult and young black grouse (*Tetrao tetrix*) exposed to ornithophilic vectors indicate that several species of potential vectors emerge at Meltaus at the same time redstarts breed (O. Rätti and U. Ojanen, pers. comm.). Since infections with *Leucocytozoon* spp. are possible to detect on smears at 5 to 6 days and *Trypanosoma* spp. at 1 to 2 days after infection (G. F. Bennett, pers. comm.; Olsen, 1974), our blood samples from the breeding site may include new infections. Consequently, it is possible that the increase in prevalence observed in the breeding area may be in part coming from new infections acquired during the breeding season.

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