Journal of Wildlife Diseases, 44(2), 2008, pp. 469–474

Blood Parasites of House Finches (*Carpodacus mexicanus*) from Georgia and New York

Barry K. Hartup,[1,4] Allison Oberc,[1] Briana Stott-Messick,[1] Andrew K. Davis,[2] and Elliott C. H. Swarthout[3]
[1] School of Veterinary Medicine, University of Wisconsin, 2015 Linden Drive, Madison, Wisconsin 53706, USA;
[2] Department of Environmental Studies, Emory University, 400 Dowman Drive, Atlanta, Georgia 30322, USA;
[3] Laboratory of Ornithology, Cornell University, 159 Sapsucker Woods Road, Ithaca, New York 14850, USA;
[4] Corresponding author (email: hartup@savingcranes.org)

ABSTRACT: This study investigated the ecology of hematozoan parasites in two eastern populations of House Finch (*Carpodacus mexicanus*). Blood smears were obtained from birds captured in Georgia during 2001–2003 ($n=757$) and New York during 2001 ($n=282$) and evaluated for the presence of hematozoans. Low-density infections of *Haemoproteus fringillae* and *Plasmodium relictum* were confirmed at each location. Infections were observed year-round in Georgia, but primarily between June and November in New York. Overall, hematozoa were more prevalent in House Finches from Georgia than New York ($P \leq 0.01$). The prevalence of infection was similar between finches of different age, sex, and reproductive status in Georgia. The low density of the infections observed suggests there is limited influence on host mortality.

Key words: Blood parasites, *Carpodacus mexicanus*, *Haemoproteus fringillae*, hematozoa, House Finch, *Plasmodium relictum*.

The study of hematozoan parasites has become a focus of avian disease ecologists since Hamilton and Zuk (1982) first hypothesized that parasites play a role in sexual selection (Clayton and Moore, 1997). Despite numerous studies among various host species, incomplete and inconsistent information exists on the geographic and seasonal variation of hematozoan infections, as well as parasite prevalence differences in birds of different ages and sex (Dawson and Bortolotti, 1999). Documenting this variation is essential to understanding host-parasite interactions and the effects of parasites on host population dynamics (van Riper et al., 1986).

No single large-scale survey of blood parasites has been conducted in eastern populations of House Finches (*Carpodacus mexicanus*) since their introduction from native western populations in the early 1940s (Hill, 1993). A recent limited survey showed low prevalence of *Plasmodium relictum* infections in House Finches from Wisconsin (Hartup et al., 2004). Kirkpatrick and Suthers (1988) identified a *Haemoproteus* sp. and *Trypanosoma* sp. infection from a small opportunistic sample of House Finches in New Jersey. A meta-analysis based on data from various geographic locations in North America showed approximately 15% of House Finches were infected by *Plasmodium, Haemoproteus, Leucocytozoon, Trypanosoma,* and microfiliarial organisms (Greiner et al., 1975).

The objectives of this study were to determine the species of hematozoan parasites infecting House Finches in two widely separated locales in the eastern United States and to describe sex and age distribution of patent infections and seasonal variation in parasite prevalence.

House Finches were sampled within 20 km of Emory University in Atlanta, Georgia, USA (33°47′N, 84°19′W) or within 3 km of Cornell University in Ithaca, New York, USA (42°27′N, 76°28′W) for this study. In Georgia birds were sampled from five sites between August 2001 and September 2003 (26 mo); in New York, birds were sampled from 22 sites between March 2001 and December 2001 (10 mo). At all sites birds were captured using mist nets, wire mesh cages placed around feeders, or various trap devices such as Potter traps (Bub,

TABLE 1. Comparison of hematozoan parasite prevalence in House Finches from Georgia and New York.

	Georgia No. infected/no. tested (%)	New York No. infected/no. tested (%)
Haemoproteus fringillae	61/757 (8)**	8/282 (3)**
Plasmodium relictum	40/757 (5)*	5/282 (2)*
Unknown spp.	22/757 (3)	5/282 (2)

* $P<0.05$, ** $P<0.01$.

1991). All techniques were approved by the respective Animal Care and Use Committee at each institution. All birds were banded with unique numbered aluminum leg bands under a valid federal permit.

The age of each bird was determined through plumage characteristics (Hill, 1993) and extent of skull ossification, and classified as either a hatch-year juvenile or an after-hatch-year adult according to date and status determined from previous captures (Pyle, 1997). Birds were sexed based on plumage characteristics. Females in breeding condition were determined by the presence of one of the following between either March–August (Georgia) or April–July (New York): a brood patch, palpable egg, or cloacal protuberance. The breeding condition of males was determined by presence or absence of a cloacal protuberance between February and July (Georgia) or March and July (New York; Hartup et al., 2001).

Blood was collected from the cutaneous ulnar vein into heparinized microhematocrit tubes following venipuncture with a 27 ga needle. Blood smears were made immediately onto glass slides, air dried, and later fixed and stained with a commercial Wright-Giemsa kit (similar to Dip Quick stain J-322-3, Jorgensen Laboratories Inc., Loveland, Colorado, USA). Once stained, the slides were examined for 10 min at 1,000× or until 25,000 erythrocytes per slide were examined (van Riper et al., 1986). Infection was determined by detection of intraerythrocytic schizonts or gametocyte stage parasites (Greiner et al., 1975; Burry-Caines and Bennett, 1992). Immature trophozoite stages of unknown species were also noted. Representative slides were deposited in the US National Parasite Collection (Beltsville, Maryland, USA; accession numbers 94688–94).

Prevalence was defined as the percentage of infected individuals among all birds sampled. No recapture or repeat blood sample data were included to minimize bias from potential chronic infections, and no attempt was made to estimate parasite density due to the low number of infected cells observed. The prevalence data were stratified by location (Georgia or New York) and parasite type and assessed using a chi-square test. Data from Georgia were then evaluated using logistic regression analysis to evaluate the potential associations of age, sex, and reproductive status with the occurrence of *Haemoproteus fringillae* or *P. relictum* infections (Hosmer and Lemeshow, 1989). The low prevalence of hematozoan infections in New York precluded a similar analysis. Statistical analyses were conducted using EpiInfo v. 3.3.2 (Centers for Disease Control and Prevention, Atlanta, Georgia, USA) and Statview v. 5.0.1 (SAS Institute Inc., Cary, North Carolina, USA) software. Significance was established at $P<0.05$.

Haemoproteus fringillae, P. relictum, and unknown intraerythrocytic trophozoite-stage parasite infections were observed in birds from both locations surveyed (Table 1). All cases consisted of single-species infections, and all infections were of extremely low density (1–5 infected cells per 25,000 erythrocytes or ≤0.02%). Infections involving each species were observed in most calendar months in

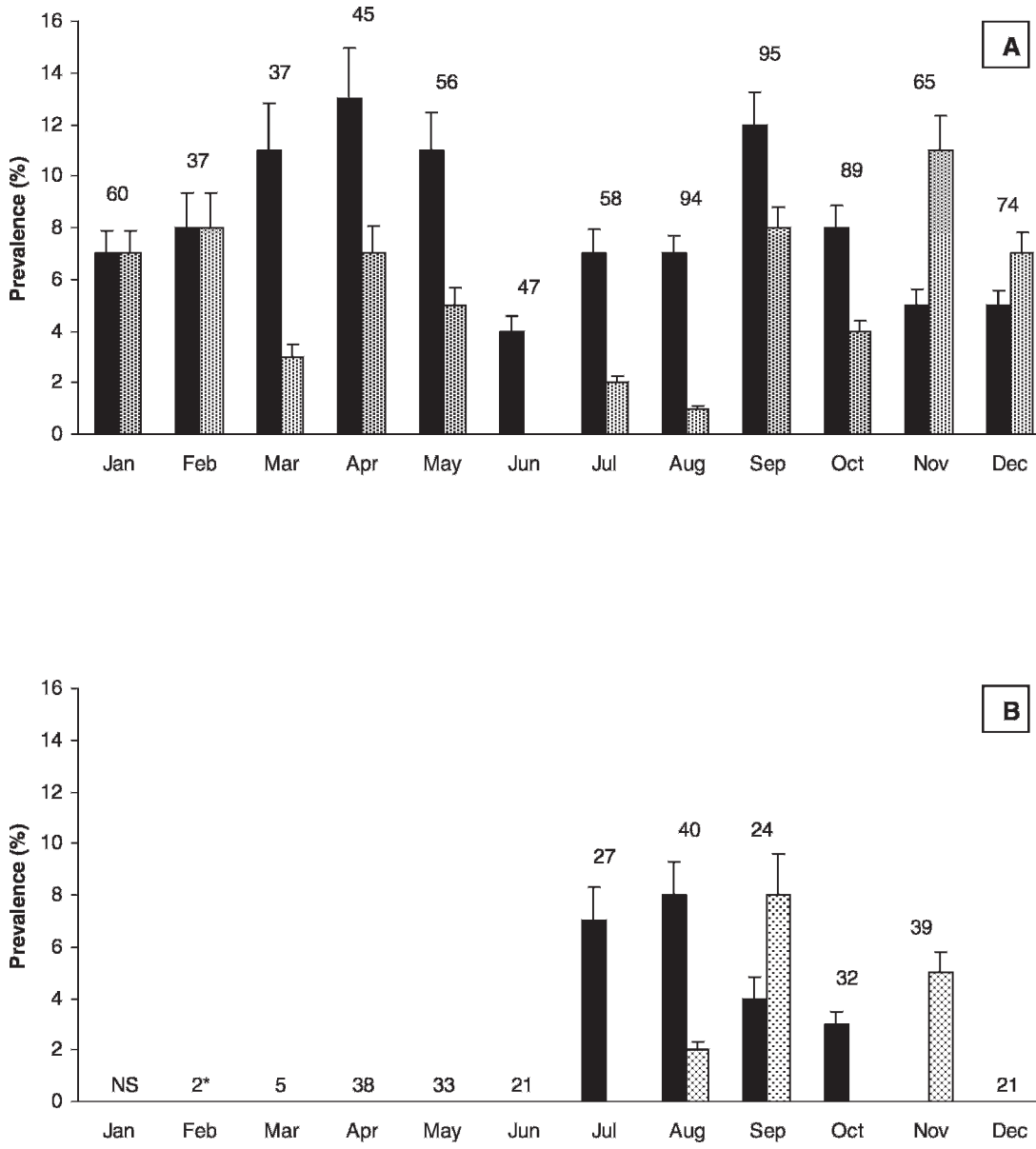

FIGURE 1. Prevalence of *Haemoproteus fringillae* (■), *Plasmodium relictum* (▦) infections in House Finches by calendar month from (A) Georgia and (B) New York. The number above each prevalence estimate is the sample size (NS = no samples; * = one positive for *H. fringillae*). Error bars denote the 95% confidence limit of the estimates.

Georgia (Fig. 1A). The prevalence of infections with *H. fringillae* showed an approximately bimodal annual fluctuation, with peaks in spring and late summer/early fall, whereas *P. relictum* prevalence showed a nadir during early summer followed by an increase lasting from fall through spring. In New York infections with *H. fringillae* were observed predominantly between July and October (with one infection detected in February), and infections with *P. relictum* were observed during August, September, and November (Fig. 1B). No hematozoan infections were

TABLE 2. Hematozoan parasite prevalence among House Finch subgroups from Georgia and New York.

	Georgia No. infected/no. tested (%)	New York No. infected/no. tested (%)
Age:		
Juvenile		
Haemoproteus fringillae	21/298 (7)	6/152 (4)
Plasmodium relictum	15/298 (5)	5/152 (3)
Unknown spp.	10/298 (3)	3/152 (2)
Adult		
H. fringillae	32/330 (10)	2/80 (3)
P. relictum	17/330 (5)	0/80 (0)
Unknown spp.	10/330 (3)	1/80 (1)
Sex:		
Male		
H. fringillae	26/322 (8)	1/143 (1)
P. relictum	21/322 (7)	3/143 (2)
Unknown spp.	10/322 (3)	1/143 (1)
Female		
H. fringillae	26/260 (10)	2/72 (3)
P. relictum	16/260 (6)	1/72 (1)
Unknown spp.	7/260 (3)	1/72 (1)
Reproductive status (adults):		
Breeding		
H. fringillae	10/96 (10)	1/58 (2)
P. relictum	5/96 (5)	0/58 (0)
Unknown spp.	3/96 (3)	1/58 (2)
Nonbreeding		
H. fringillae	8/57 (14)	0/17 (0)
P. relictum	4/57 (7)	0/17 (0)
Unknown spp.	2/57 (4)	0/17 (0)

detected from House Finches in New York in spring or early summer. Infections with unknown hematozoan parasites not shown in Figure 1 were observed each calendar month in Georgia except November (range 1.1–5.6%), but were observed only during July, August, and October in New York (range 3.1–7.4%).

Overall, infections with *H. fringillae* ($\chi^2_1=9.0$, $P<0.01$) and *P. relictum* ($\chi^2_1=6.1$, $P=0.01$) were more prevalent in House Finches from Georgia than those from New York (Table 1). The prevalence of hematozoan infections was similar between birds of different age, sex, and reproductive status in both Georgia and New York (Table 2). The logistic regression analysis did not identify any statistically significant associations between these variables and the presence of either *H. fringillae* or *P. relictum* infections in House Finches in Georgia.

We observed distinct latitudinal effects on the seasonality and prevalence of hematozoan infections in House Finches. In New York infections were detected primarily between July and November, whereas infections were detected year-round in House Finches from Georgia. Similar large-scale temporal and geographic variation in blood parasite prevalence has been documented in birds, most often reflecting climate differences and the abundance and activity of vector populations during an annual cycle (Atkinson and van Riper, 1991; Allander and Bennett, 1994; Merilä et al., 1995; Yezerinac and Weatherhead, 1995; Bensch and Akesson, 2003). The abbreviated seasonal appearance of blood parasite infections we

observed in New York suggested that transmission resulted from seasonal population increases of *Culicoides* (*H. fringillae*) and *Culex* (*P. relictum*) vectors during the warmer summer months (Atkinson, 1991; Atkinson and van Riper, 1991). Climatic conditions conducive to vector reproduction and development may be effectively sustained year-round in Georgia. Our study did not sample potential vector populations to confirm this hypothesis.

We found no gender or breeding bird predilection for hematozoan infection similar to studies in American Kestrels (*Falco sparverius*; Dawson and Bortolotti, 1999) and Pied Flycatchers (*Ficedula hypoleuca*; Bennett et al., 1995). Alternatively, other studies have suggested changes in parasite prevalence in Red-winged Blackbirds (*Agelaius phoeniceus*; Weatherhead and Bennett, 1991), Gray Catbirds (*Dumatella carolinensis*; Garvin et al., 2003) and Dark-eyed Juncos (*Junco hyemalis*; Deviche et al., 2001) were due to seasonal hormonal shifts that altered host immune status, resulting in recrudescence of latent infections, often in males.

The late summer and fall increases of parasite prevalence from both locations were primarily among infected juveniles. The timing of the increases may reflect variation in the dispersal of newly infected juveniles into the population or migration influx of infected juvenile and adult birds at each location (Hill, 1993). In New York, the infections we detected generally preceded periods of migration and likely resulted from an increased sample of dispersing juveniles (Belthoff and Gauthreaux, 1991). Other factors, such as host habitat utilization, behavioral and physiological traits that promote exposure of hosts to vectors, and vector feeding preferences may influence local variation in blood parasite prevalence as well (Atkinson and van Riper, 1991). Such complementary data were unavailable for this study.

The absence of high-density infections in our study suggests there may be little influence from *H. fringillae* and *P. relictum* on House Finch mortality at the population level. Density of hematozoan infections has been correlated with decreased survivorship in birds, as pathogenic effects such as vascular compromise or anemia most often occur when parasite densities are high (Dawson and Bortolotti, 2000; Sol et al., 2003). The techniques we employed to capture free-flying House Finches (mist nets, etc.), however, may have biased our results by undersampling heavily parasitized, nonflying hosts (Valkiunas, 1998).

We thank E. C. Greiner, Department of Pathobiology, College of Veterinary Medicine, University of Florida, for assistance with hematozoan identification. This study was supported by the National Science Foundation under grant DEB-0094456 to A. Dhondt. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

LITERATURE CITED

ALLANDER, K., AND G. F. BENNETT. 1994. Prevalence and intensity of haematozoan infection in a population of great tits *Parus major* from Gotland, Sweden. Journal of Avian Biology 25: 69–74.

ATKINSON, C. T. 1991. Vectors, epizootiology, and pathogenicity of avian species of *Haemoproteus* (Haemosporina: Haemoproteidae). Bulletin of the Society for Vector Ecology 16: 109–126.

———, AND C. VAN RIPER. 1991. Pathogenicity and epizootiology of avian haematozoa: *Plasmodium, Leucocytozoon,* and *Haemoproteus*. *In* Bird-parasite interactions, J. E. Loye and M. Zuk (eds.). Oxford University Press, Oxford, UK, pp. 19–48.

BELTHOFF, J. R., AND S. A. GAUTHREAUX. 1991. Partial migration and differential winter distribution of House Finches in the eastern United States. Condor 93: 374–382.

BENNETT, G. F., D. SQUIRES-PARSONS, P. SIIKAMÄKI, E. HUHTA, K. ALLANDER, AND L. HILLSTRÖM. 1995. A comparison of the blood parasite of three Fenno-Scandian populations of the pied flycatcher *Ficedula hypoleuca*. Journal of Avian Biology 26: 33–38.

BENSCH, S., AND S. AKESSON. 2003. Temporal and

spatial variation of hematozoans in Scandinavian willow warblers. Journal of Parasitology 89: 388–391.

BUB, H. 1991. Bird trapping and bird banding. Cornell University Press, Ithaca, New York, 330 pp.

BURRY-CAINES, J. R., AND G. F. BENNETT. 1992. The Haemoproteidae (Apicomplexa: Haemosporina) of the avian families Fringillidae and Emberizidae s.l. Canadian Journal of Zoology 70: 1149–1160.

CLAYTON, D. H., AND J. MOORE. 1997. Host-parasite evolution: General principles and avian models. Oxford University Press, Oxford, UK, pp. 473.

DAWSON, R. D., AND G. R. BORTOLOTTI. 1999. Prevalence and intensity of hematozoan infections in a population of American kestrels. Canadian Journal of Zoology 77: 162–170.

———, AND ———. 2000. Effects of hematozoan parasites on condition and return rates of American kestrels. The Auk 117: 373–380.

DEVICHE, P., E. C. GREINER, AND X. MANTECA. 2001. Seasonal and age-related changes in blood parasite prevalence in dark-eyed juncos (*Junco hyemalis*, Aves, Passeriformes). Journal of Experimental Zoology 289: 456–466.

GARVIN, M. C., J. P. BASBAUM, R. M. DUCORE, AND K. E. BELL. 2003. Patterns of *Haemoproteus beckeri* parasitism in the gray catbird (*Dumatella carolinensis*) during the breeding season. Journal of Wildlife Diseases 39: 582–587.

GREINER, E. C., G. F. BENNETT, E. M. WHITE, AND R. F. COOMBS. 1975. Distribution of avian hematozoa of North America. Canadian Journal of Zoology 53: 1762–1787.

HAMILTON, W. D., AND M. ZUK. 1982. Heritable true fitness and bright birds: A role for parasites? Science 218: 384–387.

HARTUP, B. K., J. M. BICKAL, A. A. DHONDT, D. H. LEY, AND G. V. KOLLIAS. 2001. Dynamics of conjunctivitis and *Mycoplasma gallisepticum* infections in House Finches. The Auk 118: 327–333.

———, B. STOTT-MESSICK, M. GUZY, AND D. H. LEY. 2004. Health survey of House Finches (*Carpodacus mexicanus*) from Wisconsin. Avian Diseases 48: 84–90.

HILL, G. E. 1993. House finch (*Carpodacus mexicanus*). *In* The birds of North America, no. 46, A. Poole and F. Gill (eds.). Academy of Natural Sciences, Philadelphia, Pennsylvania, and American Ornithologists' Union, Washington, D.C., pp. 1–24.

HOSMER, D. W., AND S. LEMESHOW. 1989. Applied logistic regression. John Wiley and Sons, New York, New York, 307 pp.

KIRKPATRICK, C. E., AND H. B. SUTHERS. 1988. Epizootiology of blood parasite infections in passerine birds from central New Jersey. Canadian Journal of Zoology 66: 2374–2382.

MERILÄ, J., M. BJÖRKLUND, AND G. F. BENNETT. 1995. Geographic and individual variation in hematozoan infections in the greenfinch. Canadian Journal of Zoology 73: 1798–1804.

PYLE, P. 1997. Indentification guide to North American birds, part I. Slater Creek Press, Bolinas, California, 732 pp.

SOL, D., R. JOVANI, AND J. TORRES. 2003. Parasite mediated mortality and host immune response explain age-related differences in blood parasitism in birds. Oecologia 135: 542–547.

VALKIUNAS, G. 1998. Haematozoa of wild birds: Peculiarities in their distribution and pathogenicity. Bulletin of Scandinavian Society of Parasitology 8: 39–46.

VAN RIPER, C., S. G. VAN RIPER, M. L. GOFF, AND M. LAIRD. 1986. The epizootiology and ecological significance of malaria in Hawaiian land birds. Ecological Monographs 56: 327–344.

WEATHERHEAD, P. J., AND G. F. BENNETT. 1991. Ecology of red-winged blackbird parasitism by haemotozoa. Canadian Journal of Zoology 69: 2352–2359.

YEZERINAC, S. M., AND P. J. WEATHERHEAD. 1995. Plumage coloration, differential attraction of vectors and haemotozoa infections in birds. Journal of Animal Ecology 64: 528–537.

Received for publication 11 October 2004.