Blood Parasites of Wintering Birds of Prey in South Carolina

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Introduction

The effects of blood parasites on birds of prey can be subtle and difficult to detect. The field ornithologist is limited to observation and collection of data in wild birds, without the advantage of experimental manipulation of blood parasite loads (Dawson *et al.* 2000). However, important observational studies in nesting American Kestrels have shown reduction in fitness, survival, and return rates for migrating American Kestrels (Dawson and Bortolotti 2000). Migration increases exposure to biting insects, which serve as vectors for transmission of blood parasites to avian hosts (Tella *et al.* 1999).

While raptorial hematozoa have been well studied during the breeding season and migration, little data on hematozoa prevalence in wintering birds of prey is available. South Carolina provides suitable winter habitat, and its population consists of both resident and migrant birds of prey. We surveyed five common species of wintering birds of prey over a 2 year period from coastal, midlands, and western Piedmont locations in the state. These five species (see Methods) are most conducive to capture with *Bal chatri* noose traps. Prevalence of blood parasites (hematozoa), relationship to body weight, and inter-regional differences in hematozoa species were evaluated. We compared our findings with published blood parasite surveys from other Atlantic states.

Methods

Bal chatri noose traps were employed to capture wintering birds of prey in South Carolina from January 2000 through February 2002. Study months were November, December, January and February. We trapped in Greenwood, Abbeville, Saluda, Newberry, Clarendon, Williamsburg, and Georgetown Counties. Four species of Falconiformes were studied: American Kestrel, Red-shouldered Hawk, Cooper's Hawk, and Red-tailed Hawk. The Passeriforme studied was Loggerhead Shrike. Common house mice (*Mus musculus*) live-

trapped at a local roller mill (Bub 1991; deMent and deMent 2001) were used as lures. We attempted to capture all birds of prey that we sighted in the study area.

Upon capture, birds of prey were banded, aged (HY = hatch year; AHY = after hatch year), sexed (2 species), weighed to the nearest 0.1 gram, non-flattened wing cord measured to the nearest millimeter, and birds condition recorded according to guidelines (North American Bird Banding Manual 1991, 1997). Location, time, and date of capture were also recorded in the field. Examination for external parasites was undertaken. Blood was collected from a superficial vein between the hallux and first toe with a sterile 23 gauge needle. A thin blood film was smeared on a clean glass slide labeled with the band number assigned to the bird (deMent *et al.* 1986; deMent and deMent 2001). All studies were performed in compliance with Master Banding Permit 22771. Air-dried, thin blood films were stored at room temperature and then hand-stained with Wright/Giemsa stain. Glass slides were batch-mailed to The Johns Hopkins School of Public Health for qualitative blood parasite identification (blinded to sex and species). We did not prepare buffy coat, thick blood films or quantify hematozoa. Each slide was studied for a minimum of 10 minutes by a single, expert observer (Dr. Graczyk).

Unpaired student t tests compared body weight, date of capture (American Kestrel), and age of bird for infected vs. non-infected birds of prey. Contingency table Fisher's exact test was used to evaluate proportions. Linear regression with wing cord as the independent variable and body weight as the dependent variable was also performed in American Kestrels, with residuals analyzed. Some groups' sample sizes were too small for statistical comparisons.

Results

Eighty-seven thin blood films were evaluated from 84 birds of prey. Three recaptures of previously studied American Kestrels made up the additional 3 blood films studied. Of the 3 recaptures, 2 showed the same parasite, while the third was negative on restudy. There was 1 foreign band encounter (band placed by another bander), an American Kestrel first banded near Syracuse, NY, approximately 4 years prior to recapture in South Carolina. The overall prevalence of blood parasites in the 84 birds of prey was 42%. In American Kestrel, 45% were positive for hematozoa. Loggerhead Shrike had a prevalence of 30%, Red-shouldered Hawk 33%, and Cooper's Hawk 50%. One Red-tailed Hawk was studied, which was negative for hematozoa. Flat flies were identified in 1 Red-shouldered Hawk and 1 Cooper's Hawk.

Two genera of hematozoa were identified: *Haemoproteus spp.* (see Figure 1), *Plasmodium elongatum*, and *Plasmodium reticulum*. American Kestrels and Cooper's Hawks were sexed. Male American Kestrels outnumbered females in total numbers captured. Overall, 60% of female American Kestrels were parasitized compared to 35% of the males (P = 0.07, Fisher's exact). Both

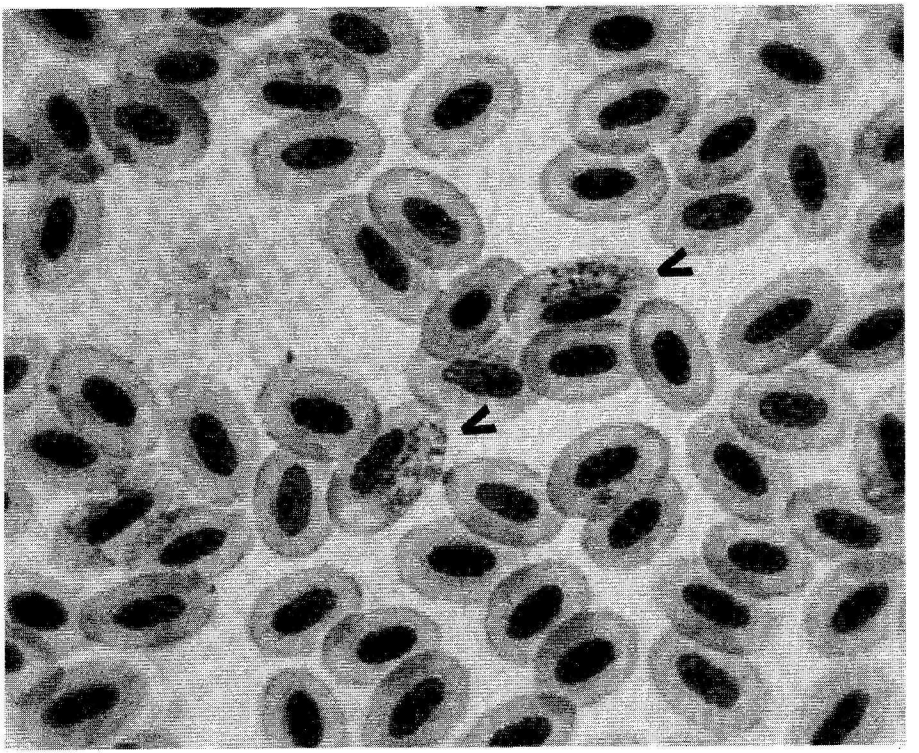
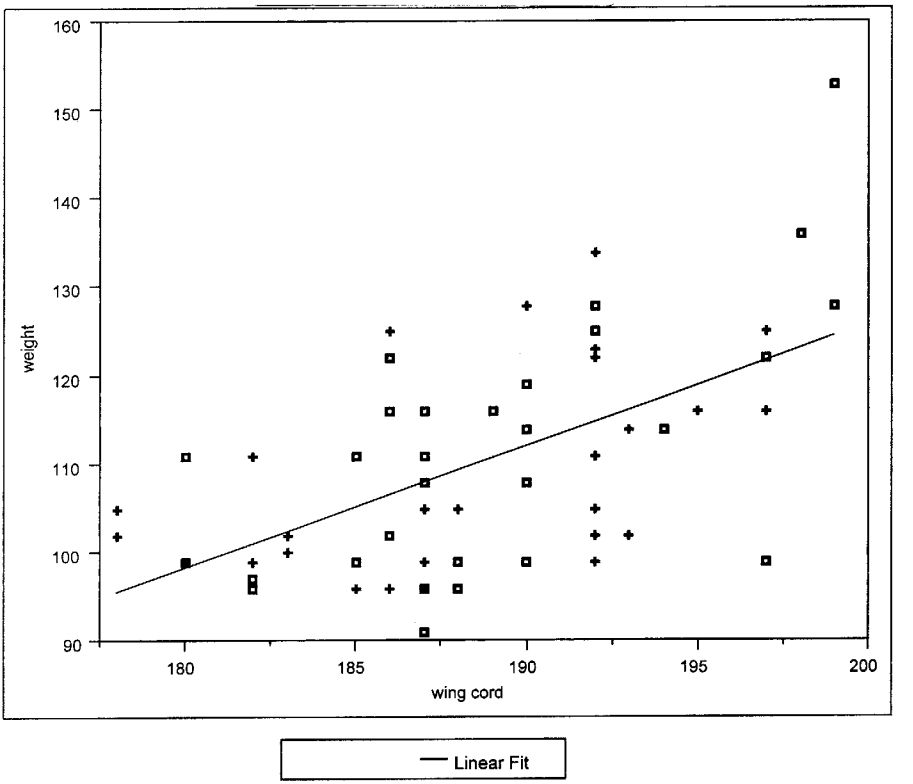


Figure 1. *Haemoproteus spp.* (arrows) located within avian nucleated red blood cells.

Cooper's Hawks captured were females. One was positive for *P. reticulum*. Neither *Leucocytozoon* nor *Trympanosoma spp.* was identified in any bird. Statistical analysis for body weight differences in parasitized vs. non-parasitized birds was not significant ($P > 0.05$). Linear regression analysis of wing cord (independent variable) vs. body weight (dependent variable) for infected vs. non-infected American Kestrels was also performed (see Table). Residuals analyzed showed more negative residuals distribution for infected birds compared to non-infected birds, but statistical significance was not achieved. Location of capture (coastal, midlands, or western Piedmont) did not show statistical difference for prevalence or for species of hematozoa. When data were stratified for month of capture, statistical difference ($P = 0.02$) was observed for the number of parasitized birds captured in February (18 out of 30 positive) compared to combined November, December and January (10 out of 32 positive).



Data. Weight by Wing Cord. American Kestrels, + = infected.

Discussion

Tella *et al.* (1991) determined that migrating birds of prey more often harbored hematozoa than residents. Biting insects, the vectors for blood parasite transmission to avian hosts, are frequently encountered along warmer migration routes and at wintering grounds. Although only 1 migrant was confirmed in this study based on banding data, a considerable proportion of the American Kestrels captured would be predicted to be migrants based on reduced field identifications of this species during the summer months in the study area. The aforementioned migrant American Kestrel was negative for hematozoa. More sophisticated studies like stable isotope analysis may help distinguish resident vs. migrant birds of prey in South Carolina and allow for further stratification of the data. The effects of blood parasites on reproductive success, migration return rates, and growth have been detailed in breeding American Kestrels (Dawson and Bortolotti 2000). Female American Kestrels are larger than males and therefore can better allocate energy to tolerate parasite burden (Dawson and Bortolotti 2001). This finding may explain why one female American Kestrel in our study was negative for hematozoa on recapture 11 months after first

studied. Fedynich *et al.* (1995) attributed such discrepancies to host immune response, host-parasite interactions or sampling error.

Kirkpatrick and Lauer (1985) reported that male American Kestrels were more often parasitized with hematozoa than females in a study of mid-Atlantic raptors. Our study suggests the opposite. Kirkpatrick and Lauer (1985) also identified *Leucocytozoon spp.* in their study, but species that most often harbor this parasite (accipiters and Red-tailed Hawks) totaled only 3 of our study population. Apanius and Kirkpatrick (1988) inversely correlated body weight with parasite burden in American Kestrel, but they quantified hematozoa. In addition, their study was conducted during the breeding season, which places an additional drain on body energy reserves, and when combined with parasite burden, may account for statistical differences reported in body weights for parasitized vs. non-parasitized birds of prey. We performed linear regression analysis for wing cord (independent variable) vs. body weight (dependent variable) for infected vs. non-infected American Kestrels. Residuals analyzed showed a more negative (left) shift of distribution for infected birds compared to non-infected birds, but did not attain statistical significance. Hematozoa would be expected to have a negative effect on body weight.

Our overall prevalence for hematozoa in Falconiformes was 43%, compared to 33% for Florida, and 59% for mid-Altantic raptors (Forrester *et al.* 1994; Kirkpatrick and Lauer 1985). Phalen *et al.* (1995) showed seasonal variation in prevalence of hematozoa, with accipiters captured in late spring more likely to harbor hematozoa than those captured in early spring. We report similar findings in the 62 American Kestrels studied, suggesting spring recrudescence of patent parasite infections. We do not find hematozoa data on Loggerhead Shrikes in the literature and therefore believe this data will be an important addition to the literature for this species in apparent decline. Field observations in our study area suggest that most Red-shouldered Hawks are residents. In addition, stable isotope studies on Loggerhead Shrikes in adjacent Georgia have determined that species to be residents (Hobson and Wassenaar 2001).

Conclusion

This blood parasite survey not only reports prevalence data for South Atlantic region birds of prey, but also includes prevalence of blood parasites in wintering birds of prey. With more international travel among humans, population growth, and increased potential for introduction of exotic diseases (*e.g.* West Nile virus recently), identification and monitoring of avian hematozoa is essential. Comparison of avian hematozoa data with other banding sites may help detect regional differences in hematozoa prevalence and better explain reduced return rates of migrating birds of prey to their breeding grounds. The possible potentiation effect of introduced diseases (*e.g.*, West Nile virus) with native diseases like hematozoa remains to be determined.

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