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LOW INFECTION PREVALENCE OF BLOOD PARASITES IN HOODED WARBLERS

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Abstract.—We quantified haematozoan infections in Hooded Warblers (*Wilsonia citrina*) sampled over two consecutive breeding seasons in northeastern Pennsylvania and during one season on the wintering grounds in Quintana Roo, Mexico. A total of 227 slides representing 89 individuals from the breeding grounds and 23 individuals from the wintering grounds were scored for parasite prevalence and intensity. Prevalences were very low for blood parasites identified, with 13% (15/112) of birds infected with *Leucocytozoon, Plasmodium, Haemoproteus* and microfilariae. Mean parasite intensity of all four types of parasites was 8.4 parasites/100 fields for combined age- and sex-classes. Our results indicate that Hooded Warblers have markedly low prevalence of blood parasites for reasons that are currently unknown.

BAJA INCIDENCIA DE PARÁSITOS SANGUÍNEOS EN INDIVIDUOS DE *WILSONIA CITRINA*

Sinopsis.—Cuantificamos las infecciones de hematoparásitos en individuos de *Wilsonia citrina* en muestras tomadas durante dos temporadas reproductivas en el noreste de Pennsylvania y una temporada invernal en Quintana Roo, Mexico. Un total de 227 laminillas, representando a 89 individuos de las áreas reproductivas y 23 de el lugar invernal, fueron examinadas para determinar la presencia de parásitos y su intensidad. La incidencia resultó baja con un 13% (15/112) de las aves infectadas con *Leucocytozoon, Plasmodium, Haemoproteus* y microfilarias. La intensidad parasítica promedio para los cuatro tipos de parásitos fue de 8.4 parásitos/100 campos para grupos combinados por edad y sexo. Los resultados indican que el ave estudiada tiene una baja incidencia de parásitos sanguíneos por razones que aún se desconocen.

Hooded Warblers (*Wilsonia citrina*) are hosts to the apicomplexan haemosporidians which include the genera *Haemoproteus, Leucocytozoon,* and *Plasmodium* and require biting fly vectors for the sexual stage and transmission from host to host. The vectors for the above three genera are ornithophilic species of ceratopogonids (genus *Culicoides*), simuliids (blackflies), and culicine mosquitoes respectively. In North America, these are the most common blood parasites in passerines (Bennett and Cameron 1974, Greiner et al. 1975, Atkinson and Van Riper III 1991).

Prevalence of blood parasites in passerines is typically high (e.g., Herman 1944, Levine and Campbell 1971). In this study we determine the prevalence and intensity of blood parasites in Hooded Warblers on the breeding and wintering grounds. Hooded Warblers are small (approximately 11 g), sexually dimorphic migratory songbirds that breed in the

eastern United States from April to late August or early September and winter anywhere from eastern and central Mexico to Panama during September to mid-March. We report very low prevalences of four different genera of blood parasites on both breeding and wintering grounds. To our knowledge this is the first study to document haematozoan prevalence in Hooded Warblers.

METHODS

Study site.—This study was conducted from 1 May–31 Aug. 1992 and 1993 in Crawford County, Pennsylvania (41°N, 79°W) and from 23 Sept.–10 Oct. 1992 in Quintana Roo, Mexico (20°N, 88°W). The breeding area consisted of a 200-ha selectively logged mixed-hardwood deciduous forest. Brushy fields, late successional shrubs, second-growth mature semi-evergreen forests, and deciduous forests comprise the wintering grounds (Stutchbury 1994). Each year, approximately 40 adult breeding pairs were captured with mist nets, banded with U.S. Fish and Wildlife bands, and uniquely marked with plastic colored leg bands to distinguish among individual birds. Rectrix shape (Pyle et al. 1987:3–20) was used to age males. Female age was determined from the degree of melanism on the head and throat (Lynch et al. 1985). We obtained two or three blood smears per adult from a drop of blood extracted from the brachial artery and tapped onto a clean glass slide. Slides were labelled, fixed in methanol, and stained to identify and quantify parasitemia.

Staining and scoring of slides.—Blood smears were stained using a technique similar to the Giemsa staining procedure (M. Siddall, pers. comm.) Slides were immersed into 1 g/L Xanthene dye, 100% PDC (Pure Dye Content), buffer, and sodium azide (0.01%) six times, each immersion lasting 1 s. Excess stain drained off slides before being immersed three times in 1.25 g/L Thiazine dye, 100% PDC (0.625 g/L Azure A and 0.625 g/L methylene blue) and buffer again for 1 s each. Excess was allowed to drain. Slides were thoroughly rinsed five times in distilled water and allowed to dry for 1 h before scoring.

Slides were scored by GFB at Memorial University of Newfoundland at the International Research Centre for Avian Haematozoa for parasite prevalence and intensity (no. of parasites/100 fields). Prevalence was defined as the percentage of infected birds sampled (see Allander and Bennett 1994). A total of 160 slides representing 89 individuals (57 in 1992; 32 in 1993) from the breeding grounds, and 67 slides representing 23 overwintering adults, were scored. Eight individuals were sampled in both years and 6/8 were consistently uninfected across both years; two birds were infected in 1993 only. Slides were scored using a 100× oil immersion objective with ×12 oculars at an enhanced magnification of 1.25 on the optivar. Infections were categorized according to the number of parasites per 100 fields. A 'low' level infection consisted of 0–100, 'moderate' 101–500, 'high' 501–1500, and slides with 1501–3000 parasites/100 fields were categorized as 'very high' infections (Allander and Bennett 1994).

RESULTS

Four different species of blood parasites were identified, *Plasmodium vaughani, Leucocytozoon paruli, Haemoproteus paruli* and a microfilariae of unknown species (microfilariae can only be identified to species when associated with the adult worms found in the hosts' tissues). We restricted our parasitemia evaluation to prevalence, intensity, and age- and sex-class patterns. Prevalence was extremely low, with 13% (15/112) of individuals infected (11% on the breeding grounds, 2% on the wintering grounds). The proportion of individuals harboring 'low' parasitemias ($n = 14$) was significantly higher than those with 'moderate' infections ($n = 1$) ($\chi^2 = 32.34$, df = 1, $P < 0.001$). No birds had 'high' or 'very high' parasitemias. Mean parasite intensity was 8.4 (range 5–12), for combined age- and sex-classes. *Haemoproteus paruli* occurred only in Mexico with 7 infected cells/100 fields. The proportion of ASY (after-second year) versus SY (second-year) infected birds at the breeding grounds was not significantly different ($\chi^2 = 0.36$, df = 1, $P > 0.05$) for combined sex classes. A significantly higher proportion of males ($n = 12$) than females ($n = 3$) was infected ($\chi^2 = 5.79$, df = 1, $P < 0.05$).

DISCUSSION

The key result of this study is the extremely low infection prevalence in Hooded Warblers, particularly of *Haemoproteus* spp. Why Hooded Warbler infection frequencies in our populations are so low remains unclear. Greiner et al. (1975) reported a high parasite prevalence in Parulidae (44%) and a mean prevalence of 53% (range 42%–69.9%) for passerines. His study suggested that small birds are highly susceptible to blood parasites. Low parasite prevalence may be explained by (1) a lack of host exposure to parasites at time of blood sampling (Weatherhead and Bennett 1991), (2) a lack of life cycle interaction between host and vector (Anderson and May 1979, Atkinson and Van Riper III 1991), (3) a lack of overlap between vector and avian habitats (Allander and Bennett 1994, Bennett 1960, Weatherhead and Bennett 1991) or (4) the presence of a physiological barrier impeding infection (Greiner et al. 1975). Additional explanations may include genetic resistance to parasites (Davidar and Morton 1993) or high mortality during migration of infected birds. The fact that some individuals were infected supports the absence of a physiological barrier to parasite infection.

Knowledge of parasite life cycles and the feeding behavior of vectors are necessary to estimate effectively the impact of blood parasites on any species in a given environment. Our study indicates that some passerines have remarkably low parasite prevalence. Why some species have substantially higher infections than others requires knowledge of parasite-host-vector relationships that researchers currently do not possess.

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