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Preliminary Report of *Haemoproteus tinnunculi* Infection in a Breeding Population of American Kestrels (*Falco sparverius*)

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ABSTRACT: A population of American kestrels breeding in southeastern Pennsylvania was examined for hematozoa. *Haemoproteus tinnunculi* infected 17 of 23 (74%) of the adults. Parasitemia ranged from two to 252, with a median of 32 infected erythrocytes per 10,000. Parasitemia and body weight of female kestrels were negatively correlated. This parasite was not observed in the six juvenile or 38 nestling kestrels examined. *Trypanosoma* sp. was detected by culture in three of seven (43%) adults, but not in the six juveniles and eight nestlings examined.

Key words: Hematozoa, *Haemoproteus tinnunculi*, *Trypanosoma* sp., American kestrels, *Falco sparverius*, prevalence, parasitemia, body weight.

Haemoproteus spp. infection is prevalent in American kestrels (*Falco sparverius*) throughout North America (Greiner et al., 1975). *Haemoproteus tinnunculi* has been reported recently in southern Quebec (Maloney et al., 1984) and New Jersey (Kirkpatrick and Lauer, 1985). Here, we report the occurrence of *H. tinnunculi* in southeastern Pennsylvania and describe the prevalence and intensity of infection in different sexes and age classes of a breeding kestrel population. Also, we note a correlation between body mass and parasitemia in infected birds.

A resident population of *F. sparverius* was studied near Hawk Mountain Sanctuary (Kempton, Pennsylvania; 40°30′N, 75°50′W). Kestrels readily nest in boxes, and details of the breeding biology of the population under study is described in Heintzelman and Nagy (1968). Nestlings were sampled weekly until fledging, while free-flying juveniles and adults were captured with a bal-chatri trap (Berger and Mueller, 1959). Sex and age classes were distinguished by plummage coloration (Parkes, 1955). Blood was taken by brachial venipuncture between 5 June and 24 August 1986. Nestlings were sampled close to fledging when their ages were between 20 and 30 days. Juveniles were sampled in mid-July when they were approximately 8 wk old. Adults were sampled throughout the study period and are considered to be ≥1 yr old. Body weights were measured with a 250-g Pesola spring scale accurate to ±2 g.

Thin blood smears were prepared as described in Kirkpatrick and Lauer (1985). Parasitemia represents the number of parasitized erythrocytes per 100 fields containing an estimated 100 blood cells. A count of cells in three fields from each of five randomly chosen slides yielded a mean of 103.7 ± 3.8 (SE) erythrocytes per field. Parasitemia was measured in triplicate in these five slides and yielded coefficients of variation of 6.1, 8.1, 9.9, 13.0 and 14.0%. Infection by *Trypanosoma* sp. was assessed by culture methods described in Kirkpatrick and Lauer (1985).

Haemoproteus tinnunculi was identified in adult kestrels (Fig. 1; Accession Nos. 97267–97271, International Reference Centre for Avian Hematozoa, Memorial University, St. John's, Newfoundland, Canada A1C 5S7). Gametocytes in various stages of development were observed in erythrocytes, as were multiple infections of immature forms.

Macrogametocytes stained blue with Giemsa, with a light pinkish, compact nucleus. Halteridial forms occasionally were pointed at one end and rounded at the other or were rounded at both ends. Their margins were entire or irregular. The host

cell nucleus was laterally displaced. Pigment granules appeared to be randomly distributed in the parasite cytoplasm. Mature forms encircled the host cell nucleus, leaving little trace of the host cell cytoplasm, and appeared to have the pigment granules concentrated in clusters. In these forms the host cell nucleus was not always laterally displaced. The number of pigment granules did not differ between macrogametocytes and microgametocytes and averaged 18.4 ± 0.28 per parasite (n = 179).

The cytoplasm of microgametocytes stained pale blue and the nucleus appeared diffuse and colorless. In halteridial forms, the pigment granules were occasionally clustered at the ends of the parasite cells. The shapes and margins of these forms were more difficult to discern, but appeared similar to those of macrogametocytes. Forms that encircled the host cell nucleus were observed but with some host cell cytoplasm still visible.

None of the 38 nestling kestrels examined were infected with hematozoa (Table 1), with the exception of a 22-day-old male nestling that showed a *Trypanosoma* sp. trypomastigote on one smear. The eight nestlings tested for *Trypanosoma* sp. infection were negative; unfortunately, the bird with a positive blood smear was not tested. Hematozoa were not detected in smears (Table 1) or cultures from juvenile kestrels.

The prepatent period for three well-studied *Haemoproteus* spp. ranges from 14 to 25 days (Fallis and Desser, 1977; Ahmed and Mohammed, 1978). It is thought that many hematozoan infections are acquired while the hosts are nestlings (Greiner et al., 1975). If kestrels are infected as nestlings, the juveniles and some of the nestlings examined here should have been patent. From the limited data, it does not appear that many kestrels acquire *H. tinnunculi* infections as nestlings.

At Cape May, New Jersey, 27 of 39 (69%) juvenile kestrels were found infected with *H. tinnunculi* while on migration during

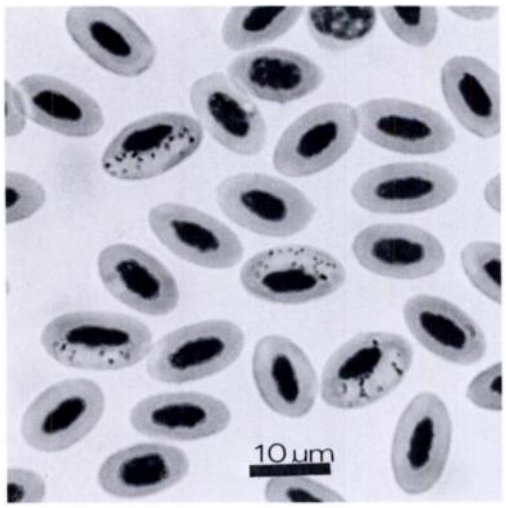

FIGURE 1. Typical halteridial gametocytes of *Haemoproteus tinnunculi* from an American kestrel (*Falco sparverius*).

September and October (Kirkpatrick and Lauer, 1985). These data show that *H. tinnunculi* infection becomes patent in juveniles before or during migration. Infection was not observed in juveniles during midsummer at Hawk Mountain. It is uncertain if these are two independent samples; it is possible that kestrels from the study area migrate past Cape May. The available evidence suggests that transmission of *H. tinnunculi* occurs after the nestling stage but before the fall migration of hatching-year birds. However, more work is required to test this hypothesis.

Of the 14 male and nine female adult kestrels examined, 17 (74%) were infected with *H. tinnunculi* (Table 1). Parasitemia ranged from two to 252, with a median of 32/10,000 erythrocytes. Neither sex-dependent differences in prevalence nor parasitemia were significant, using Fisher's exact test (P = 0.66) and the Mann-Whitney U-test (P = 0.091), respectively (SAS Institute Inc., 1985).

Adult body mass and parasitemia were negatively correlated in female kestrels. Parasitemia were log-transformed before analysis by the PROC GLM procedure of SAS (SAS Institute Inc., 1985). The regres-

TABLE 1. Prevalence and parasitemia of *Haemoproteus tinnunculi* infection in American kestrels by sex and age class.

Age class	Sex	Number examined	% Infected	Parasitemia (parasites/10,000 erythrocytes) Range	Median
Nestling (20–30 days)	M	21	0	—	—
	F	17	0	—	—
Juvenile (30–90 days)	M	4	0	—	—
	F	2	0	—	—
Adult (≥1 year)	M	14	71	2–201	23
	F	23	78	13–252	32

sion line can be expressed as: body weight (g) = 164 − 24.1•$\log_{10}$(number of infected erythrocytes per 10,000) and is significant (r^2 = 0.60 and P = 0.038). The regression of male body weight against log-transformed parasitemia is negative but not significant (r^2 = 0.22 and P = 0.16). It is not clear if parasitemia and female body weight are causally related, especially since the level of parasitemia appears to be modest. Unfortunately, morphometric covariates, such as wing chord or tarsus length, are not available.

In general, little is known about the effect of *Haemoproteus* spp. infections on their host. Raptors with hemoprotozoan infections (predominantly *Haemoproteus* spp.) averaged a longer recuperation period and a higher mortality rate in a rehabilitation center (Olsen and Gaunt, 1985). However, since this study was not case-controlled, the significance of the results are difficult to interpret. Measurements of migrant passerines failed to show a relationship between *Haemoproteus* sp. infection and body weight (Smith and Cox, 1972) or abdominal fat deposition (Ashford, 1971). There are conflicting reports of the effect of *Haemoproteus nettionis* on two species of waterfowl (Julian and Galt, 1980; Sibley and Werner, 1984), as well as dispute over the pathogenicity of *Haemoproteus columbae* in pigeons (*Columbia livia*; Markus and Oosthuizen, 1972).

Since the pathophysiology and epizootiology of hematozoa are poorly understood, we present this preliminary information to aid future studies of the effect of *Haemoproteus* spp. infections on their hosts.

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