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Hematozoa from the Spotted Owl

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ABSTRACT: One hundred five spotted owls (*Strix occidentalis*) from seven populations and three subspecies were examined for hematozoa. *Haemoproteus noctuae*, *H. syrnii*, *Leucocytozoon ziemanni*, *Trypanosoma avium*, *Atoxoplasma* sp. and unidentified microfilariae were recorded. All northern (*S. occidentalis caurina*), California (*S. occidentalis occidentalis*) and Mexican (*S. occidentalis lucida*) spotted owls were infected with at least one hematozoan; 79% had multiple infections. Twenty-two percent of the owls were infected with as many as four species of parasites. There were significant differences in the prevalence of these species of parasites occurring among the five populations of northern and California spotted owls sampled in California. *Haemoproteus noctuae*, *H. syrnii* and *Atoxoplasma* sp. represented new host records for this host species.

Key words: *Strix occidentalis*, spotted owl, hematozoa, *Haemoproteus* spp., *Leucocytozoon ziemanni*, *Trypanosoma avium*, *Atoxoplasma* sp., microfilariae, parasitemia, survey.

The spotted owl (*Strix occidentalis*) occurs as three recognized subspecies in western North America ranging from British Columbia to Central Mexico (American Ornithologists' Union, 1957). The northern spotted owl (*S. occidentalis caurina*) is the center of an expanding controversy because of its decline in the Pacific Northwest (USA) as a consequence of old-growth logging (Heinrichs, 1983; Simberloff, 1987; United States Department of Agriculture Forest Service, 1988). As a candidate endangered species, the status of the northern spotted owl must be evaluated by the United States Fish and Wildlife Service with respect to a number of criteria including the effect of diseases and parasites on the population (Gore et al., 1987). Although the spotted owl has been intensively studied (Gutiérrez, 1985), little is known of the occurrence, distribution and etiology of diseases and parasites in spotted owls (Gore et al., 1987). Accordingly, I surveyed hematozoa in blood smears taken from all three spotted owl subspecies; northern, California (*S. occidentalis occidentalis*) and Mexican (*S. occidentalis lucida*).

Spotted owls were surveyed from five populations in California and two in New Mexico (USA) between April and August, 1987 to 1988 (Table 1). The samples from New Mexico (Black Range and Sacramento Mountains) were combined because of the low sample size from each of these populations. Owls were captured with mist nets, noose poles, and pan traps (Forsman, 1983; Franklin et al., 1989). All birds were sampled and released unharmed within 20 min of initial capture. No birds were resampled, although many color banded individuals were later resighted. Most captured birds were adults; however, when young were sampled they were always >1-mo-old.

Thin blood smears were made (opportunistically) from spotted owl blood drawn from a brachial vein (using a 25 gauge needle and 1 cc syringe) for genetic analysis; EDTA was used as an anticoagulant and was required by the genetic study. Since my primary goal was to elucidate genetic variation, in general, I did not collect blood from siblings or related birds. Smears were air dried (5 min), fixed (2 to 4 min) in 100% methanol and later stained with buffered Giemsa (pH 6.4 phosphate buffer).

All smears were first completely scanned at low magnification (100×) of a bright field microscope for a minimum of 10 min in order to detect metazoans. Following this scan all smears were examined for a minimum of 20 min using oil immersion (1,000×) for protozoans. Smears were then rescanned under low power for 5 min and 10 min using oil immersion to assess the accuracy of the original screening proce-

TABLE 1. Occurrence of Hematozoa from three subspecies of spotted owls in the United States.

Owl subspecies	Location	n[a]	%[b]	Percent infection by group				
				H[c]	L	M	T	A
1[d]	SBCA[e]	22	100	91 (20)[f]	100 (22)	82 (18)	91 (20)	0
1	SJCA	29	100	83 (24)	93 (27)	24 (7)	17 (5)	3 (1)
1	PMCA	9	100	100 (9)	100 (9)	11 (1)	44 (4)	0
1	SNCA	16	100	86 (14)	81 (13)	13 (2)	56 (9)	0
2	BSNM	7	100	43 (3)	57 (4)	14 (1)	43 (3)	0
3	NWCA	22	100	50 (11)	95 (21)	9 (2)	9 (2)	0
Total[g]		105	100	77 (81)	91 (96)	30 (31)	41 (43)	<1 (1)

[a] Number of owls sampled.

[b] Percent positive infection for all parasites.

[c] H, *Haemoproteus* sp.; L, *Leucocytozoon ziemanni*; M, microfilaria; T, *Trypanosoma avium*; A, *Atoxoplasma* sp.

[d] 1, *Strix occidentalis occidentalis*; 2, *S. occidentalis lucida*; 3, *S. occidentalis caurina*.

[e] SBCA, San Bernardino Mountains, California (34°20'N, 116°56'W to 34°1'N, 116°45'W and 34°11'N, 116°43'W to 34°17'N, 117°25'W); SJCA, San Jacinto Mountains, California (33°51'N, 116°45'W to 33°36'N, 116°40'W and 33°47'N, 116°38'W to 33°48'N, 116°49'W); PMCA, Palomar Mountain, California (33°27'N, 116°59'W to 33°15'N, 116°48'W and 33°17'N, 116°46'W to 33°26'N, 117°2'W); SNCA, Sierra Nevada, California (39°7'N, 120°22'W to 38°55'N, 120°33'W and 39°0'N, 120°22'W to 39°0'N, 120°44'W); BSNM includes owls from both the Black Range (32°54'N, 107°48'W) and Sacramento Mountains (33°28'N, 105°50'W to 32°37'N, 105°37'W and 32°55'N, 105°29'W to 32°48'N, 105°51'W), New Mexico; NWCA, Northwestern California (41°57'N, 123°37'W to 40°42'N, 123°37'W and 40°45'N, 123°30'W to 40°52'N, 123°42'W).

[f] (*n*) = sample size for each category.

[g] Total number of owls sampled and percentage for each category.

dure. Only five additional parasites were discovered on the smears following the second screening.

I surveyed 105 spotted owls, from seven populations and three subspecies, for hematozoa. All spotted owls were infected with at least one parasite (Table 1). Reference slides representing each parasite species found were deposited in the International Reference Centre for Avian Haematozoa (Memorial University of Newfoundland, St. John's, Newfoundland, Canada A1B 3X9; accession numbers IRCAH 103466–103471).

Leucocytozoon ziemanni was the most frequently encountered parasite, followed by *Haemoproteus* spp., *Trypanosoma avium*, microfilariae, and *Atoxoplasma* sp. (Table 1). Since the EDTA allowed some of the parasites to leave the blood cells prior to drying, not all infections of *Haemoproteus* spp. could be identified to species. However, two species were positively identified: *H. noctuae* and *H. syrnii*.

The prevalence of parasite species found among different owl populations was significantly different ($\chi^2 = 30.02$, df = 12, $P < 0.05$). I excluded the seven owls from New Mexico because there was insufficient data from each population for analysis. However, if these seven owls are combined as one group, the frequency of parasites found among all populations was still significantly different ($\chi^2 = 30.08$, df = 15, $P < 0.05$). However, there was no significant differences among the three subspecies ($\chi^2 = 10.1$, df = 6, $P > 0.05$). These results suggested that differences were the result of population differences and not subspecific differences. For example the

TABLE 2. Number of spotted owls infected with multiple species of blood parasites.

Location	n[b]	Percent infected[a]			
		1	2	3	4
SBCA[c]	22	0	18	46	36
SJCA	29	21	52	17	10
PMCA	9	0	23	67	0
SNCA	16	12	44	38	6
BSNM	7	57	29	14	0
NWCA	22	50	40	5	5
Total[d]	105	22	38	28	12

[a] Percent infected by 1, 2, 3 or 4 species of blood parasites.
[b] Number of owls surveyed.
[c] SBCA, San Bernardino Mountains, California; SJCA, San Jacinto Mountains, California; PMCA, Palomar Mountain, California; SNCA, Sierra Nevada, California; BSNM, includes owls from both the Black Range and Sacramento Mountains, New Mexico; NWCA, Northwestern California.
[d] Total number of owls sampled and percentage for each category.

San Bernardino populations had a higher prevalence of large hematozoa than any other population (Table 1). These differences could have been a function of survey technique, sampling design (failure to account for parasite periodicity) or real differences in parasite distribution and abundance. Because each smear was surveyed completely for metazoans and extensively for protozoans, the differences among the host populations were probably not due to screening techniques. This was particularly evident when considering the low numbers of large parasites (i.e., easily detected) observed in all the host populations except in the San Bernardino Mountains (Table 1). Owls were captured opportunistically. Therefore, I did not account for possible parasite periodicity in the sampling design. The differences recorded probably did not reflect differences in parasite distribution because all populations contained all species (except *Atoxoplasma* sp.). However, I could not reject the hypothesis that differences in prevalences were real.

All subspecies of spotted owls had a higher prevalence of blood parasites than typically found in other species of owls (Stabler and Holt, 1965; Greiner et al., 1975). Stabler and Holt (1965) reported 69% of a sample of 36 owls, representing nine species, from Colorado (USA) were infected with hematozoans; however, 14 (78%) of the 18 great horned owls (*Bubo virginianus*) were infected with blood parasites. Greiner et al. (1975) summarized the literature and reported that 49% of 117 individuals from 14 species of Strigidae were infected with hematozoans. The occurrence of *Haemoproteus noctuae*, *H. syrnii*, and *Atoxoplasma* sp. represent new host records for *Strix occidentalis*. Only one California spotted owl had been surveyed previous to this study; it was infected with *Haemoproteus* sp., *Trypanosoma* sp. and microfilariae (Wood and Herman, 1943).

Multiple infections of blood parasites were common in spotted owls (Table 2). Eighty-three of 105 birds were infected with at least two species whereas 24 of 105 owls were infected by at least four species of parasites (Table 2). Although I did not determine the vectors of these parasites, multiple infections indicated that there must be at least two species of vectors responsible for transmitting these hematozoans (Fallis et al., 1974; Bennett and Peirce, 1986).

The effect of these parasites on the owls was not determined. In general, the effect of hematozoa on wildlife has not been well documented. Some research has indicated little deleterious effect of hematozoans on their hosts. For example, Bennett et al. (1988) noted no difference in body mass between infected and uninfected passerine birds. Rand et al. (1983) suggested a balanced relationship between the lizard (*Anolis limifrons*) and its blood parasites. Blood parasites apparently had little effect on growth and reproduction in the lizard, but high levels of parasitemia did result in anemia. However, Atkinson et al. (1988) did attribute deleterious effects of *Haemoproteus meleagridis* on experimentally infected domestic turkeys (*Meleagris gallopavo*). Lizards (*Sceloporus occidentalis*) infected with *Plasmodium mexicanum* had impaired physiological performance,

lower clutch size and lower levels of social interaction which may affect an individual's lifetime reproductive performance (Schall et al., 1982; Schall, 1983; Schall and Sarni, 1987, respectively). Hayworth et al. (1987) demonstrated that canaries (*Serinus canarius*) experimentally infected with *Plasmodium relictum* showed decreased metabolic rate. Other authors also have correlated negative effects of *Haemoproteus* spp. on California quail (*Callipepla californica*), pigeons (*Columba livia*), and wild turkeys (e.g., O'Roke, 1930; Markus and Oosthuizen, 1972; Atkinson and Forrester, 1987, respectively).

Spotted owls are territorial, nocturnal predators that have large home ranges (Gutiérrez, 1985). Adult owls are usually sedentary while juveniles can disperse widely (Gutiérrez et al., 1985). Prior to dispersal, juveniles are dependent on the adults for food for up to 3 mo after leaving the nest. Adults and juveniles almost always roost in close proximity. The northern and California subspecies are distributed as continuous populations from southern British Columbia to southern California; whereas the Mexican subspecies is geographically distinct and consists of many disjunct populations throughout the southwestern United States. Both the northern and California subspecies attain similar densities throughout their range (Franklin et al., 1990; R. J. Gutiérrez, unpubl. data). Furthermore, spotted owls are long lived birds (Forsman et al., 1984; A. B. Franklin, unpubl. data). Thus, the ecology of spotted owls may explain the distribution of its hematozoa and its high rate of infection by these parasites. An owl's large home range spans several habitat types within the old growth forest ecosystem which could facilitate its contact with potential vectors. The species' continuous distribution (at least in the west coast forms) would explain the occurrence of all species of parasites at all sites. The close association of parents and offspring would permit rapid infection of the juveniles (all juveniles that I sampled in the study were infected). Finally, the birds longevity would predict a high prevalence of infection in the populations if there is annual parasite recrudescence. Because the effects of these parasites on the spotted owls are unknown they should be studied since the bird is the object of widespread environmental concern.

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