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A Survey of Parasites Identified in the Feces of Eastern Spotted Skunks (*Spilogale putorius*) in Western Arkansas

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ABSTRACT: The endoparasite community of the eastern spotted skunk (*Spilogale putorius*) is poorly known. We surveyed parasites found in the feces of 29 eastern spotted skunks captured between March 2005 and January 2007 from a population in west-central Arkansas as part of a broader study of the ecology of the species. We identified 13 species (nine nematodes, four protozoa) from 82 fecal samples. Mean (±SD) number of species per individual skunk was 4.1±2.1, although this is likely an underestimate because some individuals were sampled more intensively than others. Most of the identified parasite species were also found in other skunk species or in other small carnivore species.

Key words: Arkansas, carnivore, eastern spotted skunk, Ouachita National Forest, parasites, *Spilogale putorius*, survey.

The eastern spotted skunk (*Spilogale putorius*) was once an abundant member of the small carnivore community of the midwestern and southeastern United States and was heavily harvested for the fur trade (Gompper and Hackett, 2005). Beginning in the mid-1900s, however, population sizes of the species began to decline steadily. The species has now been extirpated in large portions of its historic distribution, and it is currently listed by many state wildlife agencies as endangered, threatened, or of conservation concern (Gompper and Hackett, 2005; Sasse and Gompper, 2006). The cause of this decline is unclear because fundamental natural history and ecology studies of the species are lacking. For instance, there has never been a population-level survey of the parasites of the eastern spotted skunk, and only a handful of endoparasites have been described for the species (Hill, 1939; Peery, 1939; Chandler, 1952; Levine and Ivens, 1964; Layne and Winegarner, 1971).

We undertook a survey of the parasites of a population of eastern spotted skunks from west-central Arkansas to enhance baseline information on the parasitology of the species. This study was conducted in the Poteau Ranger District (96,755 ha) portion of the Ouachita National Forest (ONF; 690,000 ha) in Scott County, Arkansas (34°48.29′N, 94°20.54′W) as part of a broader telemetry-based study examining the ecology of the species (Lesmeister, 2007). The specific 8,784-ha study site within the ONF where animals were captured and sampled is heavily forested and dominated (by approximately 89%) by shortleaf pine (*Pinus echinata*) and hardwoods (*Quercus* spp. and *Carya* spp.). We conducted all capture and telemetry-based work from March 2005 to January 2007. All work was carried out under the University of Missouri Animal Care and Use Committee protocol no. 4039 and an Arkansas Game and Fish Commission scientific collection permit no. 111520042.

Detailed handling methodology is given in Lesmeister (2007). In brief, we trapped eastern spotted skunks with Tomahawk no. 103 box traps (Tomahawk Live-Trap Co., Tomahawk, Wisconsin, USA) baited with various canned fish and commercial fruit-scented paste lures (Wildlife Damage Control, Charleston, West Virginia, USA). Most skunks were captured between late fall and early spring, when the species is most easily trapped (Hackett et al., 2007). Captured animals were anesthetized with an intramuscular injection of ketamine hydrochloride (10 mg/kg; Fort Dodge Laboratories, Fort Dodge, Iowa, USA) and xylazine (1 mg/kg; Vedco, Inc., St Joseph, Missouri, USA). They were then classified as adult (>7 mo) or juvenile

(<7 mo), sexed, and ear-tagged. We fitted each eastern spotted skunk with a 12-g radio transmitter (ca. 2–3% of adult body mass) prior to release at the capture site. Feces collected from traps were immediately preserved in 10% formalin until laboratory analyses. Radio-collared skunks were tracked to den sites throughout the year. When a den was located, the site was examined for feces. Eastern spotted skunks rarely communally denned at the study site, and den site reuse was rare (Lesmeister, 2007), indicating that all fecal samples collected at den sites were likely defecated when the animal entered the den the previous night. In total, we collected 82 fecal samples from 29 individuals (mean±SD=2.8±2.0; median=2; range 1–7).

Fecal samples were prepared for microscopy using standard sugar (specific gravity [sp. gr.] 1.33) and zinc sulfate (sp. gr. 1.2) centrifugation concentration-flotation techniques (Georgi and Georgi, 1990) at the Animal Health Diagnostic Center, Cornell University, New York, USA. Samples were centrifuged for 10 min at 616-760 × G. Ova, oocysts, and larvae were identified to taxon by comparing morphologic characteristics and linear measurements with those reported in the literature on skunk and other carnivore parasites. In cases where the parasite species could not be identified, the taxa were reported at the genus level. For each taxon, prevalence was calculated as the ratio of the number of hosts infected to the total number examined. Infracommunity species richness was the number of species identified for an individual host when combining all fecal samples collected for the individual. Only one or two fecal samples were available for many individual skunks, however, so we also calculated the mean number of species identified per sample for each individual.

Eleven species of endoparasites were identified from the 29 eastern spotted skunks, including nine nematode species and four protozoan species (Table 1). Prevalence of specific species in feces varied from virtual ubiquity (e.g. *Molineus* sp., which was identified in 25 individuals) to apparent rarity (e.g. *Baylisascaris columnaris* and *Capillaria aerophila*, which were identified in one individual each). Across all parasites combined there was no significant difference in prevalence as a function of sex (Mann–Whitney $U=85.00$; $P=0.98$; $n=13$), and no individual parasitic species differed in prevalence as a function of host sex (Fisher exact tests; $P>0.05$). Adults had marginally higher prevalence relative to juveniles (Mann–Whitney $U=123.00$; $P=0.05$; $n=29$) across all species combined, and although the sample size of surveyed juveniles was small ($n=5$), prevalence of one nematode species (*Capillaria putorii*) differed significantly by age (Fisher exact test; $P=0.01$). No other species differed as a function of host age ($P>0.05$).

Of the 78 possible pairwise cross-species comparisons for the 13 species, three showed potentially nonrandom patterns of infection with respect to one another, and these involved just three taxa: *C. putorii*, *Isospora spilogales*, and *Sarcocystis* sp. Each of the five *Sarcocystis*-positive individuals were also positive for *C. putorii* (Fisher exact test; $P=0.05$), as were eight of nine *I. spilogales*-positive animals ($P=0.02$). Four of five *Sarcocystis*-positive individuals were also positive for *I. spilogales*, while only one of 19 *Sarcocystis*-negative animals was positive for *I. spilogales* ($P=0.02$).

Mean (±SD) infracommunity richness was 4.10 (SD=2.1; range=0–8; mode=3) species, with only one adult lacking parasites. Species richness did not differ by sex (Mann–Whitney $U=104$; $P=1.00$) or age ($U=90.5$; $P=0.07$). However, this value likely underestimates the true infracommunity richness for these 13 parasitic species because: 1) these analyses were fecal-based rather than based on direct examination of hosts; 2) fewer fecal samples were available for some individuals (especially juveniles) than others; and

TABLE 1. Species richness and prevalence (%) of nematode and protozoan species identified from 82 fecal samples collected from 29 eastern spotted skunks in west-central Arkansas.

	Overall (n=29)	Females (n=13)	Males (n=16)	Adults (n=24)	Juveniles (n=5)
	Mean (±SD) species richness				
	4.10 (2.14)	4.08 (2.40)	4.13 (2.00)	4.42 (2.22)	2.60 (0.55)
Nematodes	Prevalence (%)				
Baylisascaris columnaris	3	0	6	4	0
Capillaria aerophila	3	8	0	4	0
Capillaria putorii	55	46	63	67	0
Capillaria procyonis	10	15	6	13	0
Crenosoma sp.	45	31	56	46	40
Molineus sp.	86	85	88	83	100
Physaloptera sp.	17	15	13	17	0
Placoconus lotoris	17	8	25	17	20
Skrjabingylus sp.	21	31	13	25	0
Protozoa					
Eimeria mephitidis	76	85	69	79	60
Isospora sengeri	31	38	25	29	40
Isospora spilogales	31	31	31	38	0
Sarcocystis sp.	17	5	19	21	0

3) there was a strong correlation between the number of fecal samples examined and the number of identified endoparasitic species (r^2=0.54; P<0.01). When infracommunity species richness was corrected for sampling effort, however, there was again no significant difference due to sex (U=101.5; P=0.91) or age (U=46.5; P=0.43).

Several species identified from the ONF have been previously reported from eastern spotted skunks (*I. sengeri*, *I. spilogales*; Levine and Ivens 1964; *Skrjabingylus chitwoodorum*; Hill 1939; *B. columnaris*, *Physaloptera maxillaries*; Erickson, 1946) or from the western spotted skunk, *S. gracilis* (*P. maxillaries*; Erickson, 1946; Tiner, 1946; Neiswenter et al., 2006; *S. chitwoodorum*; Hobmaier, 1941; Erickson, 1946; Mead, 1963). Cranial damage, presumably caused by *Skrjabingylus* spp., has also been documented in several other North American skunk species (Kirkland and Kirkland, 1983; Kirkland and Maldonado, 1988). The remainder of the parasitic species, however, represent new records for the genus *Spilogale*. With the exception of the two *Isospora* spp., however, all taxa identified in this survey also occur in striped skunks (*Mephitis mephitis*) or raccoons (*Procyon lotor*; Rankin, 1946; Mead, 1963; Dyer, 1969; Richardson et al., 1992; Dubey et al., 2002; Mitchell et al., 2002; Wright and Gompper, 2005). Data for western spotted skunks in Texas (Neiswenter et al., 2006) and for eastern spotted skunks in Minnesota (Erickson, 1946) show a similar pattern; all identified endoparasitic species also occurred in one or more sympatric skunk or mustelid species (in Texas: striped skunk and hog-nosed skunk, *Conepatus leuconotus*; and in Minnesota: striped skunk; short-tailed weasel, *Mustela erminea*; long-tailed weasel, *Mustela frenata*; mink, *Mustela vison*; and badger, *Taxidea taxus*).

The parasite community identified from the feces of eastern spotted skunks in the ONF is relatively species rich. This contrasts with results reported by Neiswenter et al. (2006), who identified the presence of four helminth species from nine western spotted skunks collected in Texas and describe the component community as relatively pauperate (mean species richness per host=1.7) compared to sympatric hog-nosed skunks and striped skunks. Given that the current study was fecal-based, which tends to underestimate

prevalence rates, and the fact that some individuals were not intensively sampled, infracommunity richness of eastern spotted skunks from the ONF is likely quite high.

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