J. Helminthol. Soc. Wash.
65(1), 1998 pp. 98–102

Research Note

Helminth Parasites of the Spotted Salamander *Ambystoma maculatum* and Red-backed Salamander *Plethodon c. cinereus* from Northwestern Wisconsin

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ABSTRACT: Twenty spotted salamanders *Ambystoma maculatum* and 20 red-backed salamanders *Plethodon c. cinereus* were collected from NW Wisconsin in May 1996 and examined for helminth parasites. Two species of helminths infected the spotted salamanders, while 3 species infected the red-backed salamanders. The nematode *Batracholandros magnavulvaris* had the higest prevalence in spotted salamanders (45%), while the nematode *Rhabdias* sp. had the highest prevalence in red-backed salamanders (30%). The trematode *Brachycoelium salamandrae* had the highest mean intensity in both hosts, 3.3 in *A. maculatum* and 2.0 in *P. c. cinereus*. This is the first report of *B. magnavulvaris* from *Ambystoma maculatum* as well as the first report of it from Wisconsin.

KEY WORDS: *Ambystoma maculatum, Plethodon c. cinereus, Brachycoelium salamandrae, Batracholandros magnavulvaris, Rhabdias* sp., Wisconsin.

The spotted salamander *Ambystoma maculatum* Shaw, 1802, is a large, robust species of mole salamander reported from south-central Ontario to Nova Scotia, south to Georgia and eastern Texas (Vogt, 1981). The red-backed salamander *Plethodon c. cinereus* Green, 1818, is one of the smallest woodland species of lungless salamanders that occurs throughout the northeastern United States and southeastern Canada, with populations in Ontario, Minnesota, Missouri, Arkansas, Oklahoma, Louisiana, and Georgia (Vogt, 1981). Both species inhabit mesic forests throughout northern Wisconsin. Although parasites of the spotted salamander, *Ambystoma maculatum*, and the red-backed salamander, *Plethodon c. cinereus*, have been studied by several

Table 1. Prevalence, abundance, and mean intensity of helminths of *Ambystoma maculatum* and *Plethodon c. cinereus*.

	Ambystoma maculatum			*Plethodon c. cinereus*			
	Prevalence*	Abundance ±1 SD	Mean intensity ±1 SD (range)	Prevalence*	Abundance ±1 SD	Mean intensity ±1 SD (range)	Location
Brachycoelium salamandrae	3 (15)	0.5 ± 1.3	3.3 ± 1.5 (2–5)	2 (10)	0.2 ± 0.6	2 (2)	Small and large intestine
Batracholandros magnavulvaris	9 (45)	0.8 ± 1.1	1.7 ± 1.1 (1–4)	1 (5)	0.05 ± 0.2	1 (1)	Small and large intestine
Rhabdias sp.	—	—	—	6 (30)	0.4 ± 0.8	1.3 ± 0.8 (1–3)	Body cavity

* Number infected (percent infected).

authors (Chitwood, 1933; Rankin, 1937a, b, 1938, 1945; Rankin and Hughes, 1937; Fischthal, 1955a, b; Cheng, 1958, 1960; Cheng and Chase, 1960; Ernst, 1974; Rosen and Manis, 1976; Dunbar and Moore, 1979; Bursey and Schibli, 1995), few studies are known from the Great Lakes area (Meserve, 1943; Coggins and Sajdak, 1982; Muzzall, 1990). Here we present new information on the parasites of Wisconsin salamanders.

Twenty adult red-backed salamanders (15 males and 5 females) were collected by overturning rocks and logs during the day, and 20 breeding spotted salamanders (15 males and 5 females) were collected by dip-net at an ephemeral pond in Bayfield County, Wisconsin, in May 1996. Animals were killed in MS 222 (ethyl m-aminobenzoate methane sulfonic acid) within 48 hours of capture. Snout-vent length and wet weight were recorded for each individual. The mean Snout-vent length ±1 SD (range) of spotted salamanders was 76 mm ± 8.8 (63–93). The mean Snout-vent length of red-backed salamanders was 44 mm ± 7 (30–52). At necropsy, the digestive tract, limb and body wall musculature, and internal organs were examined for helminths. Trematodes were preserved in 10% neutral buffered formalin, stained with aceto-carmine, dehydrated through ethanol, and mounted in Canada balsam. Nematodes were preserved in 10% neutral buffered formalin, dehydrated to 70% ethanol, cleared in glycerol, and identified as temporary mounts. Prevalence is the percentage of infected salamanders in a sample, mean intensity is the mean number of worms per infected salamander, and abundance is the mean number of individuals of a particular parasite species per host examined. Voucher specimens have been deposited in the Harold W. Manter Laboratory, University of Nebraska State Museum, Lincoln (accession numbers HWML 39248—*Brachycoelium salamandrae* from red-backed salamander; 39249—*Brachycoelium salamandrae* from spotted salamander; 39250—*Rhabdias* sp.; 39251—*Batracholondros magnavulvaris*).

Eleven of 20 (55%) spotted salamanders were infected with helminths. Mean helminth abundance in spotted salamanders was 1.25 ± 1.60. Nine (45%) were infected with *Batracholandros magnavulvaris* Rankin, 1937, while 3 (15%) were infected with *Brachycoelium salamandrae* Frolich, 1789. Only one spotted salamander (5%) was concurrently infected with *B. magnavulvaris* and *B. salamandrae*. Eight of 20 (40%) red-backed salamanders were infected with 1 or more *B. magnavulvaris, B. salamandrae,* and *Rhabdias* sp.. Mean helminth abundance in red-backed salamanders was 0.65 ± 0.99. Only one red-backed salamander (5%) was concurrently infected with *B. magnavulvaris* and *B. salamandrae*. *Batracholandros magnavulvaris* had the highest prevalence in spotted salamanders, *Rhabdias* sp. had the highest prevalence in red-backed salamanders, and *B. salamandrae* had the highest mean intensity in both hosts (Table 1). There was no statistically significant correlation between helminth abundance and either weight or length for spotted salamanders ($r = -0.228$, $r = -0.111$) or red-backed salamanders ($r = 0.027$, $r = -0.096$). Because of the skewed sex ratio toward males, neither prevalence nor mean intensity was compared between the sexes in either host species.

Batracholandros magnavulvaris exhibits little host specificity, infecting plethodontids (Rankin, 1937b; Schad, 1960, 1963; Dyer et al., 1980; Goater et al., 1987; Muzzall, 1990; Joy et al.,

1993; McAllister et al., 1995; Bursey and Schibli, 1995) as well as salamandrids (Rankin, 1937b; Baker, 1987) and ambystomids (Muzzall and Schinderle, 1992). In this study, 16 gravid female *B. magnavulvaris* were recovered from both salamander species, 15 from spotted salamanders and 1 from red-backed salamanders. All female nematode populations in salamanders has been reported by other investigators (Rankin, 1937b; Walton, 1940; Fischthal, 1955a; Joy et al., 1993). The spotted salamander is a new host record for *B. magnavulvaris,* and Wisconsin is a new locality record for this nematode in red-backed salamanders. Although both species of salamanders in this study are considered terrestrial, only the spotted salamander returns to water during its reproductive season. The red-backed salamander is totally terrestrial, with reproduction and development occurring on land (Vogt, 1981). Our prevalence data of *B. magnavulvaris* in spotted salamanders (45%) and red-backed salamanders (5%) agree with reports by Dunbar and Moore (1979) and Joy et al. (1993) that more aquatic salamanders are more likely to be infected with this nematode than are terrestrial species of salamanders. Although the differences observed in the present report may be due to chance, because of the small number of salamanders examined, Muzzall (1990) found 48 (28%) of 171 red-backed salamanders infected with this nematode, while Ernst (1974) found a 50% prevalence (6/12) in Virginia red-backed salamanders.

The 4 specimens of *Brachycoelium salamandrae* from red-backed salamanders and 10 specimens from spotted salamanders exhibited morphological variation. A statistically significant difference existed between the mean length, in millimeters ± 1 SD (range), of trematodes recovered from spotted salamanders, 2.82 mm ± 0.30 (2.28–3.30), and red-backed salamanders, 1.26 mm ± 0.47 (0.85–1.93) (one-tailed *t*-test, $P < 0.05$), while no such difference existed in mean width of trematodes from spotted salamanders, 0.40 mm ± 0.07 (0.28–0.50), and red-backed salamanders, 0.34 mm ± 0.12 (0.25–0.52) (one-tailed *t*-test, $P > 0.05$). Other apparent differences existed in body shape, position of testes, and distribution of vitellaria. *Brachycoelium* spp. are common parasites of salamanders (Dyer et al., 1980; Goater et al., 1987; Muzzall, 1990; McAllister et al., 1995; Bursey and Schibli, 1995), but controversy surrounds the assignment of species to this genus. Rankin (1938) reduced all known species to *B. salamandrae.* He concluded that heavy infections produce many small flukes, whereas light infections were usually made up of larger specimens. Other investigators (Parker, 1941; Cheng, 1958, 1960; Cheng and Chase, 1960; Couch, 1966) disagreed and described 13 species based on such morphological characteristics as body length and shape, length of esophagus, position of testes, and distribution of vitellaria. Although the trematodes we collected from spotted salamanders and red-backed salamanders exhibited morphological variation, we have adopted the conservative approach suggested by McAllister et al. (1995) to report *B. salamandrae* from North American salamanders.

Rhabdias sp. was the most frequently found parasite in red-backed salamanders. Six red-backed salamanders (30%) were found to be infected, with a total of 8 specimens recovered from the body cavity. *Rhabdias spp.* have been reported previously from a wide variety of salamander species (Chitwood, 1933; Walton, 1938, 1940; Lehmann, 1954; Landewe, 1963; Dyer and Peck, 1975; Price and St. John, 1980; Coggins and Sajdak, 1982; Muzzall and Schinderle, 1992). However, the finding of this nematode in the red-backed salamander was unexpected, since it is a lungless salamander and should not be expected to harbor lung parasites. The study of Baker (1979) on *Rhabdias* revealed that subadult nematodes must invade the lungs if they are to mature and produce eggs, but numerous subadults can be found in the body cavity. All nematodes recovered in the present study were nongravid subadults from the body cavity and are probably accidental infections in this host.

Results of the current survey support previous work on salamander helminths, indicating that they are not strongly host-specific; rather, their distribution can be correlated with habitat preference and diet of the host (Fischthal, 1955a, b; Dunbar and Moore, 1979; Coggins and Sajdak, 1982; Goater et al., 1987). Recently, Kleeberger and Werner (1982, 1983) showed that in a northern hardwood forest, similar to the present study area, spotted salamanders spent 72% of their time underground, 21% under decaying logs, and 7% under wet leaf litter, while red-backed salamanders in the same area spent 61% of their time above the soil, primarily in the litter layers

and decaying logs. Thus, the differences in parasite prevalence and species found in the two hosts may be due to differences in host habitat utilization. Parasites may encounter only a limited number of potential hosts under natural conditions, giving the appearance of a much narrower host specificity (Kennedy, 1975). To our knowledge, the spotted salamander is a new host record for *B. magnavulvaris,* and Wisconsin is a new locality record for this nematode in either of the salamander species.

We thank H. R. Yoder, University of Wisconsin–Milwaukee, and Dr. H. Gene Drecktrah, University of Wisconsin–Oshkosh, for help in collecting salamanders. We also thank two anonymous reviewers for improvements on an earlier draft of the manuscript.

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