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Helminth Communities in the Northern Spring Peeper, *Pseudacris c. crucifer* Wied, and the Wood Frog, *Rana sylvatica* Le Conte, from Southeastern Wisconsin

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ABSTRACT: Fifteen spring peepers and 20 wood frogs were collected in April 1993 from 2 temporary ponds in southeastern Wisconsin. Five species of adult and larval nematodes, 4 species of adult and larval trematodes, and 1 larval cestode infected wood frogs. Spring peepers harbored 1 adult and 1 larval nematode species as well as 1 adult and 5 larval trematode species. Sixteen of 20 (80%) wood frogs were infected with helminths. Mean species richness and mean helminth abundance were 2.15 and 4.90, respectively. Eight of 15 (53%) spring peepers were infected. Only 1 individual was infected by more than 1 helminth species and only 1 parasite species infected more than 1 spring peeper. Low prevalence and intensities of helminths as well as low diversity within infracommunities suggest depauperate, isolationist helminth communities in these 2 populations of anurans. This work represents new records for 5 helminth species in Wisconsin wood frogs and 3 helminth species in Wisconsin spring peepers.

KEY WORDS: *Rana sylvatica, Pseudacris crucifer, Oswaldocruzia pipiens, Cosmocercoides dukae, Rhabdias ranae, Glypthelmins pennsylvaniensis, Hematoloechus varioplexus, Fibricola texensis, Alaria mustelae,* diplostomula, mesocercaria, Wisconsin.

Rana sylvatica Le Conte is found from New Brunswick to eastern Manitoba and south to Georgia and eastern Texas (Vogt, 1981). The range of *Pseudacris crucifer* Wied extends from Alaska to Labrador and from northeastern Georgia to northeastern North Dakota in the south (Vogt, 1981). Both inhabit woodland areas throughout Wisconsin (Vogt, 1981), yet relatively little work has been done on the helminth communities of these anurans (Harwood, 1930; Walton, 1931; Brandt, 1936; Rankin, 1945; Bouchard, 1951; Odlaug, 1954; Najarian, 1955; Ashton and Rabalais, 1978; Adamson, 1980; Williams and Taft, 1980; Coggins and Sajdak, 1982; Muzzall and Peebles, 1991; McAllister et al., 1995). Of the aforementioned studies, only 2 were concerned with Wisconsin amphibians. Williams and Taft (1980) included 5 wood frogs in their study. Coggins and Sajdak (1982) sampled, among several other amphibian species, 2 spring peepers and 1 wood frog. The present study reports 5 new species of helminth parasites from Wisconsin wood frogs and 3 new species from Wisconsin spring peepers.

Materials and Methods

Twenty wood frogs and 15 spring peepers were collected by dip-net from 2 temporary ponds adjacent to the University of Wisconsin–Milwaukee field station in Ozaukee County, Wisconsin, during April 1993. Frogs were transported to the laboratory, where they were euthanized in MS-222. Snout–vent length (SVL) and wet weight (g) were recorded. The external surfaces as well as the mouth and eustachian tubes, the internal organs, including the brain, and the musculature of the limbs were examined for the presence of helminth parasites. Trematodes were relaxed and fixed in hot formalin alcohol acetic acid, whereas nematodes were killed and preserved in 70% ethanol. Voucher specimens have been sent to the H. Manter Helminth Collection, University of Nebraska, Lincoln (HWML 38396–38405). Prevalence and mean intensity were calculated for helminth species, and Brillouin's index of diversity (Pielou, 1977) was calculated for wood frog infracommunities. Brillouin's index is recommended by Pielou (1977) for fully censused communities and includes both richness and evenness of species.

Results

Sixteen of 20 (80%) wood frogs were infected with helminths. Mean helminth abundance in *R. sylvatica* was 4.90 (SD = 6.94). Mean species richness was 2.15 species per host individual (SD = 1.66, range = 0–6). No significant correlation was found between SVL and abundance ($r = -0.32$) or wet weight and abundance ($r = -0.32$). No correlation was found between these 2 host parameters and species richness ($r = -0.12$, $r = -0.14$).

Five nematode species, 4 trematode species, and 1 cestode species were found within the component community of *R. sylvatica. Oswaldocruzia pipiens* Walton, 1929, was found most frequently in wood frogs with 40% prevalence and mean intensity of 2.75 (SD = 4.2, range = 1–13).

Table 1. Prevalence and mean intensity of helminths of *Rana sylvatica* and *Pseudacris crucifer*.

	Rana sylvatica		*Pseudacris crucifer*		
	Prevalence %	Mean intensity (range)	Prevalence	Intensity	Location
Nematoda					
Oswaldocruzia pipiens	40	2.75 (1–13)	a†		Stomach, small intestine, and large intestine
Cosmocercoides dukae	15	1.67 (1–3)	a		Adults in rectum, larvae in lungs and small intestine
Rhabdias ranae	20	3.0 (1–7)	6.67	1	Lungs
Immature nematodes	10	*	a		Rectum and large intestine
Encysted nematodes	5	*	6.67	*	Small intestine mesentery
Trematoda					
Glypthelmins pennsylvaniensis	a		6.67	2	Small intestine
Haematoloechus varioplexus	25	2.4 (1–4)	a		Lungs
Fibricola texensis (Diplostomula)	35	3.57 (1–8)‡	6.67	4	Musculature and body cavity
Alaria mustelae (Mesocercariae)	5	5	13.33	3	Body cavity and rectal area
Unidentified metacercariae	30	1.67 (1–3)	6.67	21	Liver and leg muscles
Unidentified mesocercariae	a		6.67	5	Leg muscles
Unidentified immature trematode	a		6.67	1	Lung
Cestoda					
Unidentified cestode cysts	5	*	a		Organ mesentery

* Too numerous to count accurately.
† Absent in this host.
‡ Number actually recovered and most probably an underestimate.

Diplostomula of *Fibricola texensis* Chandler, 1942, were found with the highest mean intensity (3.57, SD = 3.05, range = 1–8). These latter values are probably underestimates, as these small, white larvae are difficult to find in the muscles. Values of prevalence and mean intensity for all parasites are summarized in Table 1.

Brillouin's index of diversity (Pielou, 1977) was calculated for all wood frog infracommunities using natural logarithms and included all helminth species that could be accurately counted. Mean Brillouin's diversity (H) was 0.379 (SD = 0.346, range = 0–1.15).

Eight of 15 spring peepers (53%) were infected with 1 or more helminth species. Mean abundance and mean species richness were 2.67 (SD = 5.72) and 0.6 (SD = 0.63), respectively. Only 2 adult worms were found in this component community: the nematode *Rhabdias ranae* Walton, 1929, and the digenetic trematode *Glypthelmins pennsylvaniensis* Cheng, 1961. These were found in only 1 host individual, both with an intensity of 1 worm per frog. All other helminths harbored by spring peepers were larval forms. Only the mesocercariae of *Alaria mustelae* Bosma, 1931, were found in more than 1 host individual. Only 1 spring peeper harbored more than 1 species of helminth, both larval forms. Consequently, it was unnecessary to calculate Brillouin's index for these infracommunities. Dip-net sampling during the breeding season proved to be biased toward males, as only 1 female of each species was taken. Consequently, no analysis was carried out on the basis of host sex.

Discussion

In this system, *R. sylvatica* harbored a variety of adult and larval helminths whereas *P. crucifer* seemed to serve most often as an intermediate host for helminth parasites. Additionally, the number of parasite species in the compound community, species richness at the infracommunity level, prevalence of parasites, and, with 1 exception, intensities were low in *P. crucifer* as compared to *R. sylvatica.* There exist several potential explanations for these results. First, spring peepers are considered to be tree frogs (Vogt, 1981) and are more arboreal in habit than wood frogs. This would limit their contact with soil and possibly skin-penetrating nematodes such as *R. ranae* and *O. pipiens* during most of the year. Thus, the breeding migration and emergence period would be especially important as windows of transmission in spring peepers. Aho (1990) found the helminth communities of arboreal anurans to consist of fewer species than the communities of terrestrial anurans. Baker (1978, 1979b) found both *R. ranae* and *O. pipiens* to be most prevalent in Ontario wood frogs during late summer and fall and suggested that most transmission occurred during this time when young frogs were emerging from ponds. Additionally, there exist differences in body and gape size between these 2 anurans. Although no analysis of size-based differences in infection parameters was carried out between species, these factors may be important in terms of the probability of penetration by skin penetrators and the range of intermediate hosts ingested. These factors should be inspected more carefully in future studies. Finally, some of the helminths in this study infect both anuran species as well as other amphibia in the system. Host specificity and the assemblage of parasites at the compound community level are most likely important factors in structuring helminth infracommunities.

Although the component community of *R. sylvatica* contains species that infect similar regions of the frog body, it was rare in this study to observe more than 1 species of helminth in the same location within a given host. This would make interaction between species unlikely. In the present survey, only 3 wood frogs provided exceptions. Two of these cases involved the diplostomula of *F. texensis* and an unidentified metacercaria in the leg muscles. The third case was an unusually heavily infected wood frog that harbored 13 *O. pipiens* in its anterior small intestine along with 3 adult nematodes that could not be positively identified. These may have been damaged specimens of *O. pipiens,* but this can not be stated with certainty. One frog harbored both *Haematoloechus varioplexus* Stafford, 1902, and *R. ranae,* both of which infect the lung. In this frog, however, only 1 individual of each helminth species was recovered, and they were occupying different lungs. Within this system, it seems that the lungs of *R. sylvatica* are areas of potential interaction between these 2 helminth species. The mean intensities of each were found to be greater than 1, both were found in relatively high prevalence, and adults of both species are large relative to the frog lungs they inhabit. Baker (1979a) observed many more subadult *R. ranae* in the body cavity than adults in the lung, and Anderson (1992) suggested that this species may utilize some mechanism for avoiding intraspecific competition. Although no definitive conclusion can be reached from the present study, it is reasonable to suggest that some active avoidance of interaction between these 2 species is a possibility in those, apparently rare, situations in which both species infect a single host. Furthermore, this possibility is worthy of closer examination in future work.

Although the component communities of both anurans contain a variety of helminth taxa, prevalence, intensity, and species diversity are quite low at the infracommunity level. These values are indicative of depauperate, isolationist helminth communities. The assemblage of parasites in the component community of wood frogs in this study is similar to the findings of Muzzall and Peebles (1991), as are the relative orders of prevalence and intensity values. Muzzall and Peebles (1991) recovered *Spiroxys* sp., which was not found in our study. They reported *Haematoloechus parviplexus* Irwin, 1929, which Kennedy (1981) considers a synonym for *H. varioplexus* Stafford, 1902. Also recovered in this study were 4 larval forms not found in Michigan by Muzzall and Peebles (1991); *Fibricola texensis,* whose definitive host is the raccoon (Chandler, 1942), and *Alaria mustelae,* which utilizes mustelids, felids, and canids as definitive hosts (Pearson, 1956; Johnson, 1970). Additionally, an unidentified encysted nematode and an unidentified cestode cyst were recovered. To our knowledge, this is a new locality record for *F. texensis.*

Muzzall and Peebles (1991) found *O. pipiens* and *Cosmocercoides* sp. in spring peepers in relatively low prevalence, but these helminths were not recovered from *P. crucifer* in the present study. Due to their presence in wood frogs, these worms are known to be a part of the compound community, and failure to recover them from *P. crucifer* may be a function of low sample size.

The hypothesis that spring peepers and wood frogs in the Great Lakes region harbor depauperate, isolationist helminth communities is supported by this study. To our knowledge, this is the first report of *O. pipiens, C. dukae, H. varioplexus, F. texensis,* and *A. mustelae* in Wisconsin wood frogs and the first report of *R. ranae, F. texensis,* and *A. mustelae* in Wisconsin spring peepers.

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Literature Cited

Adamson, M. L. 1980. *Gyrinicola batrachiensis* (Walton, 1929) n.comb. (Oxyuroidea; Nematoda) from tadpoles in eastern and central Canada. Canadian Journal of Zoology 59:1344–1350.

Aho, J. M. 1990. Helminth communities of amphibians and reptiles: comparative approaches to understanding patterns and processes. Pages 157–195 *in* G. W. Esch, A. O. Bush, and J. M. Aho, eds. Parasite Communities: Patterns and Process. Chapman and Hall, New York.

Anderson, R. C. 1992. Nematode Parasites of Vertebrates: Their Development and Transmission. C.A.B. International, Wallingford, U.K. 578 pp.

Ashton, A. D. and F. C. Rabalais. 1978. Helminth parasites of some anurans of northwestern Ohio. Proceedings of the Helminthological Society of Washington 45:141–142.

Baker, M. R. 1978. Development and transmission of *Oswaldocruzia pipiens* Walton, 1929 (Nematoda: Trichostrongylidae) in amphibians. Canadian Journal of Zoology 56:1026–1031.

———. 1979a. The free living and parasitic development of *Rhabdias* spp. (Nematoda: Rhabdiasidae) in amphibians. Canadian Journal of Zoology 57:161–167.

———. 1979b. Seasonal population changes in *Rhabdias ranae* Walton, 1929 (Nematoda: Rhabdiasidae) in *Rana sylvatica* of Ontario. Canadian Journal of Zoology 57:179–183.

Bouchard, J. L. 1951. The Platyhelminthes parasitizing some northern Maine Amphibia. Transactions of the American Microscopical Society 70: 245–250.

Brandt, B. B. 1936. Parasites of certain North Carolina Salientia. Ecological Monographs 6:491–532.

Chandler, A. 1942. The morphology and life cycle of a new Strigeid, *Fibricola texensis* parasitic in raccoons. Transactions of the American Microscopical Society 61:156–167.

Coggins, J. R. and R. A. Sajdak. 1982. A survey of helminth parasites in the salamanders and certain anurans from Wisconsin. Proceedings of the Helminthological Society of Washington 49:99–102.

Harwood, P. D. 1930. A new species of *Oxysomatium* (Nematoda) with some remarks on the genera *Oxysomatium* and *Aplectana* and observations on the life history. Journal of Parasitology 17:61–73.

Johnson, A. D. 1970. *Alaria mustelae:* description of mesocercaria and key to related species. Transactions of the American Microscopical Society 89: 250–253.

Kennedy, M. J. 1981. A revision of the species *Haematoloechus* Looss, 1899 (Trematoda: Haematoloechidae) from Canada and the United States. Canadian Journal of Zoology 59:1836–1846.

McAllister, C. T., S. J. Upton, S. E. Trauth, and C. R. Bursey. 1995. Parasites of wood frogs, *Rana sylvatica* (Ranidae), from Arkansas, with a description of a new species of *Eimeria* (Apicomplexa: Eimeriidae). Journal of the Helminthological Society of Washington 62:143–149.

Muzzall, P. M. and C. R. Peebles. 1991. Helminths of the wood frog, *Rana sylvatica,* and spring peeper, *Pseudacris c. crucifer,* from southern Michigan. Journal of the Helminthological Society of Washington 58:263–265.

Najarian, H. N. 1955. Trematodes parasitic in the salientia in the vicinity of Ann Arbor, Michigan. The American Midland Naturalist 53:195–197.

Odlaug, T. O. 1954. Parasites of some Ohio Amphibia. Ohio Journal of Science 54:126–128.

Pearson, J. C. 1956. Studies on the life cycles and morphology of the larval stages of *Alaria arisaemoides* Augustine and Uribe, 1927 and *Alaria canis* LaRue and Fallis, 1936 (Trematoda: Diplostomidae). Canadian Journal of Zoology 34:295–387.

Pielou, E. C. 1977. Mathematical Ecology. John Wiley and Sons, New York. 385 pp.

Rankin, J. S., Jr. 1945. An ecological study of the helminth parasites of amphibians and reptiles of western Massachusetts and vicinity. Journal of Parasitology 31:142–150.

Vogt, R. C. 1981. Natural History of Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum and Friends of the Museum, Milwaukee. 205 pp.

Walton, A. C. 1931. Note on some larval nematodes found in frogs. Journal of Parasitology 7:228–229.

Williams, D. D. and S. J. Taft. 1980. Helminths of anurans from NW Wisconsin. Proceedings of the Helminthological Society of Washington 47:278.