



10-28-2002

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Recommended Citation

Goldberg, Stephen R. and Bursey, Charles R. (2002) "Helminths of the plains spadefoot, *Spea bombifrons*, the western spadefoot, *Spea hammondi*, and the Great Basin spadefoot, *Spea intermontana* (Pelobatidae)," *Western North American Naturalist*: Vol. 62 : No. 4 , Article 13.
Available at: <https://scholarsarchive.byu.edu/wnan/vol62/iss4/13>

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HELMINTHS OF THE PLAINS SPADEFOOT, *SPEA BOMBIFRONS*,
THE WESTERN SPADEFOOT, *SPEA HAMMONDII*,
AND THE GREAT BASIN SPADEFOOT, *SPEA INTERMONTANA*
(PELOBATIDAE)

Stephen R. Goldberg¹ and Charles R. Bursey²

Key words: *Spea bombifrons*, *Spea hammondii*, *Spea intermontana*, *helminths*, *Trematoda*, *Cestoda*, *Nematoda*.

The plains spadefoot, *Spea bombifrons* (Cope, 1863), occurs from southern Alberta, Saskatchewan, and Manitoba to eastern Arizona and northeastern Texas south to Chihuahua, Mexico; the western spadefoot, *Spea hammondii* (Baird, 1859), occurs from the Great Valley of California and Coast Ranges south of San Francisco Bay, California, into northwestern Baja California, mainly below 910 m; the Great Basin spadefoot, *Spea intermontana* (Cope, 1883), ranges from southern British Columbia through the Great Basin to northwestern Arizona (Stebbins 1985). The 3 species are allopatric throughout their ranges. Taxonomy is according to Crother (2000): *Spea* = *Scaphiopus* in part.

There are 2 reports of helminths (Rodgers 1941, Brooks 1976) for *S. bombifrons*; but, to our knowledge, there are no reports of helminths for *S. hammondii* or *S. intermontana*, although the biology of *S. intermontana* has been summarized (Hall 1998). The purpose of this paper is to add to the helminth list of *S. bombifrons* and to provide the initial account of helminths for *S. hammondii* and *S. intermontana*.

Thirty-five adult specimens (19 female, 16 male) of *Spea bombifrons* collected 1953–1962, 31 adult specimens (9 female, 22 male) of *S. hammondii* collected 1938–1975, and 34 adult specimens (11 female, 23 male) of *S. intermontana* collected 1937–1964 were borrowed from museum collections. All *S. bombifrons* were from Arizona (snout-vent length, SVL = 46 mm \pm 3 s, range = 38–53 mm). All *S. hammondii* were from California (SVL = 46 mm \pm 7 s, range = 31–58 mm). Twelve *S. intermontana* were from Arizona (SVL = 57

mm \pm 2 s, range = 54–61 mm), 8 from Nevada (SVL = 50 mm \pm 3 s, range = 47–55 mm), and 14 from Utah (SVL = 57 mm \pm 6 s, range = 44–67 mm). Museum accession numbers and counties of collection are given in the Appendix. For each toad the body cavity was opened and the lungs, esophagus, stomach, small intestine, large intestine, bladder, and body cavity were searched for helminths. Each nematode was placed in a drop of glycerol on a glass slide, allowed to clear, and then identified. Cestodes and trematodes were stained in hematoxylin, dehydrated in a graded series of ethanol, cleared in xylene, and mounted in balsam for identification. Representative samples were deposited in the United States National Parasite Collection, Beltsville, Maryland (Appendix).

Five (14%) of 35 *Spea bombifrons* were found to harbor helminths: 1 male with immature individuals of the trematode *Polystoma nearcticum* (Paul, 1935); 1 male with gravid individuals of the nematode *Aplectana incerta* Caballero, 1949; 1 female and 1 male with gravid individuals of the nematode *Aplectana itzocanensis* Bravo Hollis, 1943; and 1 female with 1 larva of *Physaloptera* sp. (Nematoda). Infection rates are too low for comparative (female, male) statistical analyses; helminth numbers, site of infection, prevalence (percentage of infected toads), mean intensity (mean number of helminths per infected toad) \pm 1 s, and range (low to high number of helminths per infected toads) are presented in Table 1. *Spea bombifrons* represents a new host record for *Polystoma nearcticum*, *Aplectana incerta*, and *A. itzocanensis*.

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TABLE 1. Number of helminths, prevalence, mean intensity $\pm 1 s$, range, and infection site for 35 *Spea bombifrons* from Arizona.

Helminth Site of infection	Number helminths	Prevalence (%)	Mean intensity	Range
TREMATODA				
<i>Polystoma nearcticum</i> lung	3	3	3.0	0
NEMATODA				
<i>Aplectana incerta</i> Large intestine	29	6	14.5 \pm 19.0	1–28
<i>Aplectana itzocanensis</i> Large intestine	1	3	1.0	0
<i>Physaloptera</i> sp. Stomach	1	3	1.0	0

Five of 31 *S. hammondi* were found to harbor gravid females of *Aplectana incerta* (large intestine of 3 male and 2 female toads, prevalence = 16%, mean intensity = $3.6 \pm 1.7 s$, range 1–5). *Spea hammondi* is a new host record for *Aplectana incerta*.

Sixteen (47%) of 34 *S. intermontana* were found to harbor helminths: 3 females and 11 males with gravid individuals of the trematode *Polystoma nearcticum*; 2 males with gravid individuals of the cestode *Distoichometra bufonis* Dickey, 1921; 6 males with gravid individuals of *Aplectana incerta*; 1 male with 5 larvae of an unidentified species of an acuariid nematode; and 1 male with 2 larvae of *Physaloptera* sp. There was no statistical difference for infection by *Polystoma nearcticum* in female and male toads ($\chi^2 = 0.57$, 1 df, $P > 0.05$); infection rates by the other species of helminths are too low for comparative statistical analyses. We report the presence of *Aplectana incerta* only in male hosts because only male toads comprised the Nevada subsample. Helminth numbers, site of infection, prevalence, mean $\pm 1 s$, and range by location are presented in Table 2. *Spea intermontana* represents a new host record for *Polystoma nearcticum*, *Distoichometra bufonis*, and *Aplectana incerta*.

The monogenean *Polystoma nearcticum* was originally described from *Hyla versicolor* collected in New England and *H. cinerea* from Florida (Paul 1935). Examination of the life cycle has revealed the presence of a rapidly maturing brachial form (22 days) and a more slowly maturing (3 years) bladder form (Paul 1938). Only brachial forms were found in *S. bombifrons*; both brachial and bladder forms were found in *S. intermontana*. It should be noted that Rodgers (1941) described the mono-

genean *Neodiplorchis scaphiopodis* (= *Diplorchis scaphiopodis*) from *S. bombifrons* collected in Oklahoma and that Brooks (1976) reported it from the same host collected in Nebraska. In the original descriptions, immature forms of these 2 species were reported to have different numbers of hooks between the anterior suckers of the opisthaptor: *N. scaphiopodis* with 6, *P. nearcticum* with 8. Because immature trematodes collected from *S. bombifrons* in this study possessed 8 hooks between the anterior suckers, we have assigned them to *P. nearcticum*.

Distoichometra bufonis was originally described from *Bufo terrestris* collected in Georgia (Dickey 1921). *Distoichometra kozloffii* was placed in synonymy with *D. bufonis* by Jones (1987); thus, only a single species of *Distoichometra* is recognized for North America. This species is a common cestode of North American anurans and, in addition to *B. terrestris*, has been reported from *Bufo americanus*, *B. boreas*, *B. cognatus*, *B. debilis*, *B. microscaphus*, *B. punctatus*, *B. retiformis*, *B. woodhousii*, *Pseudacris regilla*, *Pternohyala fodiens*, *Scaphiopus couchii*, *S. holbrookii*, and *Spea multiplicata* (Brandt 1936, Odlaug 1954, Douglas 1958, Koller and Gaudin 1977, Goldberg and Bursey 1991a, 1991b, Goldberg et al. 1996a, 1996b, 1999). Although *D. bufonis* was found only in Nevada in this study, it has been reported from Arizona and Utah (Parry and Grundmann 1965, Goldberg and Bursey 1991a).

Aplectana incerta was originally described from *Bufo marinus* collected in Mexico (Caballero 1949) and has been reported from toads of Arizona and New Mexico, namely, *Bufo debilis*, *B. microscaphus*, *B. retiformis*, *B. woodhousii*, *Gastrophryne olivacea*, *Scaphiopus*

TABLE 2. Number of helminths, prevalence, mean intensity $\pm 1 s$, range, and infection site for 34 *Spea intermontana* from Arizona, Nevada and Utah.

Helminth Site of infection	Arizona			Nevada			Utah					
	Number helminths	Prevalence (%)	Mean intensity	Range	Number helminths	Prevalence (%)	Mean intensity	Range	Number helminths	Prevalence (%)	Mean intensity	Range
Trematoda		(n = 12)	(n = 8)	(n = 14)								
<i>Polystoma nearcticum</i>	13	33	3.3 \pm 2.1	1-5	13	75	2.2 \pm 1.5	1-5	42	29	10.5 \pm 7.3	2-18
Lung and bladder												
Cestoda												
<i>Distoichometra bufonis</i>	—	—	—	—	4	13	4.0	0	—	—	—	—
Small intestine												
Nematoda												
<i>Aplectana incerta</i>	—	—	—	—	90	50	22.5 \pm 23.7	2-44	4	14	2.0 \pm 1.4	1-3
Small and large intestines												
<i>Physaloptera</i> sp. (larvae)	1	8	1.0	0	—	—	—	—	—	—	—	—
Stomach												
Acuariidea gen. sp. (larvae)	—	—	—	—	—	—	—	—	5	7	5.0	0
In cysts on stomach wall												

couchii, and *Spea multiplicata* (Goldberg et al. 1998). This study extends the range of *A. incerta*, previously considered a middle-American species (see Goldberg et al. 1998), into the Great Basin of western North America as well as California.

Aplectana itzocanensis was originally described from *Spea multiplicata* (= *Scaphiopus multiplicatus*) from Puebla, Mexico, by Bravo Hollis (1943) and was also found in *S. multiplicata* from New Mexico by Goldberg et al. (1995). It has been reported from the following toads of Arizona and New Mexico: *Bufo albivarius*, *B. cognatus*, *B. debilis*, *B. microscaphus*, *B. punctatus*, *B. retiformis*, *B. woodhousii*, *Gastrophryne olivacea*, *Scaphiopus couchii*, and *Spea multiplicata* (Goldberg et al. 1998). Additional examinations of Great Basin anurans will be required to determine if, like *A. incerta*, the range of *A. itzocanensis* extends north of Arizona and New Mexico.

Third stage larvae of *Physaloptera* sp. (but not adults) are known from a variety of amphibians and reptiles (see Goldberg et al. 1993). Members of the Physalopteridae require insect intermediate hosts (Anderson 2000). They enter amphibians or reptiles in insect prey, no further development occurs, and they subsequently pass from the body with feces. Species of the Acuariidae are bird parasites requiring arthropod intermediate hosts (Anderson 2000). They also enter with prey and then migrate to tissue where they are found in cysts; no further development occurs.

Four species of *Spea* occur in North America: *S. bombifrons*, *S. hammondi*, *S. intermontana*, and *S. multiplicata* (Crother 2000). Prior to this study, Rodgers (1941) and Brooks (1976) reported the trematode *Neodiplorchis scaphiopodis* (= *Diplorchis scaphiopodis*) from *S. bombifrons* collected in Oklahoma and Nebraska, respectively; Lamothe-Argumedo (1973) found *N. scaphiopodis* in *S. multiplicata* from Mexico; and Goldberg et al. (1995) reported *Distoichometra bufonis*, *Aplectana incerta*, and *A. itzocanensis* from *S. multiplicata* collected in New Mexico. Although these helminths are generalist parasites (occurring in 2 or more host species) of anurans, they have been encountered infrequently in species of *Spea*. However, these helminths are now known to occur in at least 2 species of *Spea*: *Neodiplorchis scaphiopodis* in *S. bombifrons* and *S. multiplicata*; *Polystoma nearcticum* in *S. bombifrons*

and *S. intermontana*; *Distoichometra bufonis* in *S. intermontana* and *S. multiplicata*; *Aplectana incerta* in *S. bombifrons*, *S. hammondii*, *S. intermontana*, and *S. multiplicata*; *Aplectana itzacanensis* in *S. bombifrons* and *S. multiplicata*. Further examination of species of *Spea* as well as *Scaphiopus* will be required before the number of shared helminth species within the genus and the family Pelobatidae can be known.

Spea bombifrons were loaned to us by Charles H. Lowe (University of Arizona), David B. Wake (Museum of Vertebrate Zoology, University of California, Berkeley), Bradford D. Hollingsworth (San Diego Natural History Museum), and David A. Kizirian (Natural History Museum of Los Angeles County) loaned the *S. hammondii*. Michael E. Douglas (formerly of Arizona State University), Jack W. Sites, Jr. (Brigham Young University), David A. Kizirian, and Charles H. Lowe allowed us to examine *S. intermontana*.

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Received 3 December 2000

Accepted 16 August 2001

APPENDIX

LOCALITIES AND MUSEUM NUMBERS
FOR SPECIMENS EXAMINED

Spea bombifrons: University of Arizona (UAZ) ARIZONA (Cochise County) 7378, 7379, 7381, 7386, 7388, 7389, 7391, 7392, 7364–7366, 7368, 7395, 7399–7408, 7410–7412, 7414–7418, 7420, 7421, 7423, 7425.

Spea hammondi: Natural History Museum of Los Angeles County (LACM) CALIFORNIA (Madera County) 147873; Museum of Vertebrate Zoology (MVZ) (Madera County) 25963, 31874, 54046–54049, 54202, 54203, 55519, 56734, 60284–60291, 60983, 76003; San Diego

Natural History Museum (SDSNH) (San Diego County) 55335–55337, 55518–55524.

Spea intermontana: Arizona State University (ASU) NEVADA (Lincoln County) 21290, 21291, 21293, 21297–21299, 21301, 21302; Brigham Young University (BYU) UTAH (Garfield County) 1970, 1973, 1977, 2772, (Carbon County) 2058, 2800, (Daggett County) 14180, (Tooele County) 14789, 14791; Natural History Museum of Los Angeles County (LACM) UTAH (Carbon County) 90959–90963; University of Arizona (UAZ) ARIZONA (Mohave County) 14668, 14670, 14672, 14674, 14676, 14679, 14680, 14683–14685, 14688, 14690.

* * * * *

Accession numbers for helminths in the U.S. National Parasite Collection (USNPC):

Spea bombifrons: *Polystoma nearcticum* (91240); *Aplectana incerta* (91241); *Aplectana itzacanensis* (91242); *Physaloptera* sp. (91243). *Spea hammondi*: *Aplectana incerta* (92015). *Spea intermontana*: *Polystoma nearcticum* (90903, 90906); *Distoichometra bufonis* (90904); *Aplectana incerta* (90905, 90907); *Physaloptera* sp. (90902); acuariid larvae (90908).