

Protozoan, Helminth, and Arthropod Parasites of the Spotted Chorus Frog, *Pseudacris clarkii* (Anura: Hylidae), from North-central Texas

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ABSTRACT: Thirty-nine juvenile and adult spotted chorus frogs, *Pseudacris clarkii*, were collected from 3 counties of north-central Texas and examined for parasites. Thirty-three (85%) of the *P. clarkii* were found to be infected with 1 or more parasites, including *Hexamita intestinalis* Dujardin, 1841, *Tritrichomonas augusta* Alexeieff, 1911, *Opalina* sp. Purkinje and Valentin, 1840, *Nyctotherus cordiformis* Ehrenberg, 1838, *Myxidium serotinum* Kudo and Sprague, 1940, *Cylindrotaenia americana* Jewell, 1916, *Cosmocercoides variabilis* (Harwood, 1930) Travassos, 1931, and *Hannemania* sp. Oudemans, 1911. All represent new host records for the respective parasites. In addition, a summary of the 36 species of amphibians and reptiles reported to be hosts of *Cylindrotaenia americana* is presented.

KEY WORDS: Anura, *Cosmocercoides variabilis*, *Cylindrotaenia americana*, *Hannemania* sp., *Hexamita intestinalis*, Hylidae, intensity, *Myxidium serotinum*, *Nyctotherus cordiformis*, *Opalina* sp., prevalence, *Pseudacris clarkii*, spotted chorus frog, survey, *Tritrichomonas augusta*.

The spotted chorus frog, *Pseudacris clarkii* (Baird, 1854), is a small, secretive, hylid anuran that ranges from north-central Kansas southward through central Oklahoma and Texas to northeastern Tamaulipas, Mexico (Conant, 1975). The species inhabits marshy areas of open prairie grasslands and edges of woodland. Little information is available on the ecology and natural history of *P. clarkii* (Pierce and Whitehurst, 1990), and even less is known about its parasites. Kuntz and Self (1944) examined 3 *P. clarkii* from Comanche County, Oklahoma, for helminth parasites and reported *Glythelmins quieta* (Stafford, 1900) Stafford, 1905, in a single frog. To my knowledge, nothing else has been published regarding either ecto- or endoparasites of this frog. The purposes of this paper are to report the identity, prevalence, and intensity of parasites infecting *P. clarkii* in north-central Texas, and to provide a summary of the amphibians and reptiles of the world known to be hosts of *Cylindrotaenia americana*.

Materials and Methods

Between May 1986 and April 1988, and again during March 1990, 39 juvenile and adult *P. clarkii* (24 males, 15 females; $\bar{x} \pm$ SE snout-vent length [SVL] = 28.7 \pm 0.4, range = 24–33 mm) were collected from Dallas ($N = 14$), Hood ($N = 12$), and Somervell ($N = 13$) counties of north-central Texas and examined for parasites. Specimens were either taken by hand by overturning limestone rocks or were captured with dipnets in temporary ponds during spring breeding activities. Frogs were placed in plastic freezer bags on ice and trans-

ported to the laboratory where they were killed with an overdose of Nembutal®. Necropsy and parasite techniques are identical to the methods of McAllister (1987) and McAllister and Upton (1987a, b), except that cestodes were stained with Semichon's acetocarmine and larval chiggers were fixed in situ with 10% formalin, sectioned at 7 μ m, and stained with hematoxylin and eosin counterstain. Voucher specimens of frogs have been deposited in the Arkansas State University Museum of Zoology (ASUMZ 5948, 5966, 5969, 5977–5979, 6015–6016, 7069–7072, 8515, 8578, 8628–8634, 8637, 8683–8688, 8691). Parasites have been deposited in the U.S. National Parasite Collection, USDA, Beltsville, Maryland 20705 as follows: *Hexamita intestinalis* (USNM 81062), *Tritrichomonas augusta* (USNM 81063), *Opalina* sp. (USNM 81059), *Nyctotherus cordiformis* (USNM 81060), *Myxidium serotinum* (USNM 81061), *Cylindrotaenia americana* (USNM 81057–81058), *Cosmocercoides variabilis* (USNM 81065), *Hannemania* sp. (USNM 81064).

Results and Discussion

Thirty-three (85%) of the *P. clarkii* harbored 1 or more parasites (Table 1); all are new host records. None of the *P. clarkii* was found to be infected with coccidial parasites in the feces and the blood was negative for intraerythrocytic or trypanosomal hematozoa. Of frogs from the 3 separate county locations, 14 (100%) from Dallas, 11 (92%) from Hood, and 8 (62%) from Somervell counties were infected.

The cosmopolitan flagellates, *Hexamita intestinalis* Dujardin, 1841, and *Tritrichomonas augusta* Alexeieff, 1911, were the most common parasites of *P. clarkii*. Both species have been reported previously from a number of amphib-

Table 1. Parasites found in *Pseudacris clarkii* from north-central Texas.

Parasite	Site of infection*	Prevalence†
Protozoa		
Mastigophora		
<i>Hexamita intestinalis</i>	CO, RE	33/39 (85%)
<i>Tritrichomonas augusta</i>	CO, RE	33/39 (85%)
Opalinata		
<i>Opalina</i> sp.	CO	17/39 (44%)
Ciliophora		
<i>Nyctotherus cordiformis</i>	CO	2/39 (5%)
Myxozoa		
<i>Myxidium serotinum</i>	GB	23/39 (59%)
Platyhelminthes		
Cestoidea		
<i>Cylindrotaenia americana</i>	SI	3/39 (8%)
Nematoda		
<i>Cosmocercoides variabilis</i>	RE	2/39 (5%)
Acari		
<i>Hannemania</i> sp. (larvae)	DE	11/39 (28%)

* Abbreviations: CO, colon; DE, dermis; GB, gall bladder; RE, rectum; SI, small intestine.

† Number infected/number examined (Margolis et al., 1982).

ians (Buttrey, 1954; Frank, 1984), including Brimley's chorus frogs, *P. brimleyi*, from North Carolina (Brandt, 1936) and western chorus frogs, *P. triseriata triseriata*, from Ohio (Odlaug, 1954).

The endocommensal *Opalina* sp. Purkinje and Valentin, 1840, was found in nearly half of the frogs examined. McAllister (1987) reported that 51 of 52 (98%) Strecker's chorus frogs, *P. streckeri streckeri*, from Dallas County, Texas, were infected with *Opalina* sp. Interestingly, the opalinids noted herein were morphologically indistinguishable from those of sympatric *P. s. streckeri*. However, as noted by McAllister (1987), specific identification was not possible.

Only 5% of the *P. clarkii* were found to be infected with *Nyctotherus cordiformis* Ehrenberg, 1838. However, a 10-fold higher prevalence of *N. cordiformis* was reported for *P. s. streckeri* (McAllister, 1987), as 54% were infected. This ciliate has been reported from other *Pseudacris* spp. (Walton, 1964).

Spores and trophozoites of *Myxidium serotinum* Kudo and Sprague, 1940, were found in more than half of the frogs. A moderately high prevalence of this myxozoan was also reported for *P. s. streckeri* (McAllister, 1987). Additional amphibians from north-central Texas have been reported previously to harbor *M. serotinum*, including smallmouth salamanders, *Ambystoma texanum* (McAllister and Upton, 1987b), and 3

species of toads, *Bufo* spp. (McAllister et al., 1989).

Adult nematotaeniid tapeworms, *Cylindrotaenia americana* Jewell, 1916, were found in 3 frogs, 1 each collected on 16 March and 10 April 1987 and on 22 June 1986 from Dallas (30 mm SVL male, ASUMZ 8684), Hood (25 mm SVL male, ASUMZ 7071), and Somervell (30 mm SVL male, ASUMZ 6016) counties, respectively. The mean intensity was 2.7 (range = 1–6) worms per host. This cestode has been reported previously from *Gastrophryne olivacea* (McAllister and Upton, 1987b) and *Ambystoma texanum* (McAllister and Upton, 1987a) from north-central Texas. None of the *P. s. streckeri* examined by McAllister (1987) was found to be infected with *C. americana*, although sympatric salamanders and other frogs harbored the parasite. *Cylindrotaenia americana* has been reported from other amphibians and 2 reptiles from North and South America, Europe, and Asia, including 9 species of salamanders, 25 species of frogs and toads, 1 skink, and 1 snake (Table 2).

Joyeux (1924) reported *C. americana* from the puddle frog, *Phrynobatrachus* (syn. *Arthroleptis*) *ogoensis* Boulenger, 1906, and mascarene grass frog, *Ptychadena mascareniensis* (syn. *Rana aequiplicata*) Werner, 1898, from Mozambique, Africa. Harwood (1932) questioned the identity of Joyeux's material and Joyeux (*in* Baer, 1933)

Table 2. Amphibians and reptiles of the world reported to be hosts of *Cylindrotaenia americana* Jewell, 1916.

Host	Locality	Reference
Amphibia		
Caudata		
Ambystomatidae		
<i>Ambystoma texanum</i>	Texas	McAllister and Upton, 1987b
Plethodontidae		
<i>Desmognathus fuscus</i>	North Carolina	Mann, 1932
	New York	Fischthal, 1955
<i>D. monticola</i>	Tennessee	Dunbar and Moore, 1979
	North Carolina	Goater et al., 1987
<i>D. quadramaculata</i>	North Carolina	Goater et al., 1987
<i>D. ochrophaeus</i>	Tennessee	Dunbar and Moore, 1979
	North Carolina	Goater et al., 1987
<i>Plethodon cinereus</i>	Tennessee	Dunbar and Moore, 1979
<i>P. glutinosus</i>	Tennessee	Dunbar and Moore, 1979
<i>P. jordani</i>	North Carolina	Dyer, 1983
<i>P. richmondi</i>	Tennessee	Dunbar and Moore, 1979
Anura		
Pelobatidae		
<i>Scaphiopus multiplicatus</i>	Mexico	Walton, 1940
Leptodactylidae		
<i>Leptodactylus ocellatus</i>	Argentina, Brazil	Savazzini, 1929
Hylidae		
<i>Acris crepitans</i>	Illinois, Michigan	Jewell, 1916
	Nebraska	Brooks, 1976a
	Iowa	Ulmer and James, 1976
	Texas	McAllister and Upton, 1987a
<i>A. gryllus</i>	Texas	Harwood, 1932
	Oklahoma	Trowbridge and Hefley, 1934
<i>Hyla arborea</i>	Czechoslovakia	Prokopic, 1957
<i>H. arenicolor</i>	Utah	Parry and Grundmann, 1965
<i>H. squirella</i>	Texas	Harwood, 1932
<i>Pseudacris clarkii</i>	Texas	McAllister, this study
<i>P. triseriata</i>	Texas	Harwood, 1932
Bufonidae		
<i>Bufo americanus</i>	Iowa	Ulmer and James, 1976
<i>B. canorus</i>	California	Ingles, 1936; Walton, 1941
<i>B. compactilis</i>	Mexico	Walton, 1940
<i>B. ictericus</i>	Brazil	Stumpf, 1981/1982a, 1981/1982b
<i>B. marinus</i>	Colombia	Brooks, 1976b
	Ecuador	Dyer, 1986
<i>B. microscaphus</i>	Utah	Parry and Grundmann, 1965
<i>B. terrestris</i>	SE United States	Jewell, 1916
<i>B. typhonius</i>	Ecuador	Dyer, 1986
<i>B. woodhousii</i>	Virginia	Campbell, 1968
<i>Melanophryniscus stelzneri</i>	Uruguay	Mane-Garzon and Gonzalez, 1978
Ranidae		
<i>Rana aurora</i>	Oregon, Washington	Lehmann, 1965
<i>R. catesbeiana</i>	Massachusetts	Rankin, 1945
	Virginia	Campbell, 1968
<i>R. pipiens</i>	Illinois, Michigan, Nebraska	Jewell, 1916
	Oregon, Washington	Lehmann, 1965
	Iowa	Ulmer and James, 1976
<i>R. pretiosa</i>	Oregon, Washington	Lehmann, 1965
<i>R. septentrionalis</i>	Maine	Bouchard, 1951
Microhylidae		
<i>Gastrophryne olivacea</i>	Texas	McAllister and Upton, 1987a
Reptilia		
Sauria		
Scincidae		
<i>Scincella lateralis</i>	Texas	Harwood, 1932
	Florida	Brooks, 1972
Serpentes		
Colubridae		
<i>Ptyas mucosus</i>	Burma	Meggitt, 1931

synonymized it with *Barietta jaegerskioeldi* (Janicki, 1928) Hsü, 1935. However, Mettrick (1953) assigned Joyeux's specimens to *B. janicki* (Hilmy, 1936) Douglas, 1958 (see also Fischthal and Asres, 1970). Nevertheless, Yamaguti (1959) recognizes them as *B. jaegerskioeldi*, while Schmidt (1986) lists *Arthroleptis* as a host of *C. americana*. Dyer (1986) was apparently unaware of this confusion although he did suggest that the identity of the Joyeux's African form of *C. americana* with the American form seemed unlikely. In view of this controversy over Joyeux's material, neither of the above hosts is listed in Table 2.

Two nematodes, *Cosmocercoides variabilis* (Harwood, 1930) Travassos, 1931, were each found in 2 *P. clarkii* (26 mm SVL male, ASUMZ 8691; 28 mm SVL female, uncatalogued) collected on 7 March 1987 and 18 March 1990 in Somervell and Hood counties, respectively. *Pseudacris clarkii* could represent an accidental host since other sympatric anurans (i.e., *Bufo* spp. and *G. olivacea*) have been reported to have a higher prevalence of *C. variabilis* (McAllister and Upton, 1987a; McAllister et al., 1989), whereas the more closely related *P. s. streckeri* has not been found to be infected (McAllister, 1987).

Larval intradermal mites, *Hannemania* sp. Oudemans, 1911, infested 8 (57%) *P. clarkii* from Dallas, 1 (8%) from Hood, and 2 (15%) from Somervell counties. It is not known why there is such a great disparity in prevalence among the 3 localities. Unengorged or partially engorged larvae were encapsulated by host dermal connective tissue. The majority of capsules was found on the undersides of legs, on the venters, and near the cloacal openings of frogs. Because only larvae were found, it was not possible to determine specific identity. However, *H. multifemorala* Loomis, 1956, has been reported previously from neighboring Erath County on Great Plains narrowmouth toads, *Gastrophryne olivacea*, *H. dumni* Sambon, 1928, is known from eastern Texas on dusky salamanders, *Desmognathus auricularis* and *G. olivacea*, and *H. eltoni* (syn. *H. penetrans* Ewing, 1931) has been reported from Bexar County on southern leopard frogs, *Rana sphenoccephala* (Loomis, 1956). In addition, Kuntz and Self (1944) reported *H. eltoni* on *G. olivacea* from Comanche County, Oklahoma, and Duszynski and Jones (1973) reported 9 species of frogs and toads from New Mexico harboring *Hannemania* sp.

In conclusion, most of the protozoan parasites of *P. clarkii* are shared with sympatric *P. s. streckeri*, while neither the helminth nor arthropod parasites are shared. Furthermore, a common helminth of the region in other anurans (*Cylindrotaenia americana*) is reported to have a low prevalence in *P. clarkii* but apparently is not harbored by *P. s. streckeri*. An ecological explanation for these comparative data is elusive at present; however, it is similar to that reported by Upton and McAllister (1988) who noted that several *Eimeria* spp. infect *P. s. streckeri* but not *P. clarkii* from the same aquatic environment.

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Literature Cited

- Baer, J. G. 1933. Contribution à l'étude de la faune helminthologique africaine. Revue Suisse de Zoologie 40:31-84.
- Bouchard, J. L. 1951. The platyhelminths 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 6:490-532.
- Brooks, D. R. 1976a. Parasites of amphibians of the Great Plains. Part 2. Platyhelminths of amphibians in Nebraska. Bulletin of the University of Nebraska State Museum 10:65-92.
- . 1976b. Five species of platyhelminths from *Bufo marinus* L. (Anura: Bufonidae) in Colombia with descriptions of *Creptotrema lynchi* sp. n. (Digenea: Allocrediidae) and *Glyptelminis robustus* sp. n. (Digenea: Macroderoididae). Journal of Parasitology 62:429-433.
- Brooks, G. R. 1972. Intestinal parasites of the lizard *Lygosoma laterale*. Quarterly Journal of the Florida Academy of Sciences 35:8-14.
- Buttrey, B. W. 1954. Morphological variations in *Tritrichomonas augusta* (Alexeieff) from Amphibia. Journal of Morphology 94:125-164.
- Campbell, R. J. 1968. A comparative study of the parasites of certain Salientia from Pocahontas State Park, Virginia. Virginia Journal of Science 19:13-20.
- Conant, R. 1975. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin, Boston. 429 pp.
- Dunbar, J. R., and J. D. Moore. 1979. Correlations of host specificity with host habitat in helminths parasitizing the plethodontids of Washington

- County, Tennessee. *Journal of the Tennessee Academy of Science* 54:106-109.
- Duszynski, D. W., and K. L. Jones.** 1973. The occurrence of intradermal mites, *Hannemania* spp. (Acarina: Trombiculidae), in anurans in New Mexico with a histological description of the tissue capsule. *International Journal for Parasitology* 3: 531-538.
- Dyer, W. G.** 1983. A comparison of the helminth fauna of two *Plethodon jordani* populations from different altitudes in North Carolina. *Proceedings of the Helminthological Society of Washington* 50: 257-260.
- . 1986. Cestodes of some Ecuadorian amphibians and reptiles. *Proceedings of the Helminthological Society of Washington* 53:182-183.
- Fischthal, J. H.** 1955. Ecology of worm parasites in southcentral New York salamanders. *American Midland Naturalist* 53:176-183.
- , and **M. Asres.** 1970. Two cestodes of amphibians from Ethiopia. *Proceedings of the Helminthological Society of Washington* 37:203-204.
- Frank, W.** 1984. Non-hemoparasitic protozoans. Pages 259-384 in G. L. Hoff, F. L. Frye, and E. R. Jacobson, eds. *Diseases of Amphibians and Reptiles*. Plenum Publishing Corporation, New York.
- Goater, T. M., G. W. Esch, and A. O. Bush.** 1987. Helminth parasites of sympatric salamanders: ecological concepts at infracommunity, component and compound community levels. *American Midland Naturalist* 118:289-300.
- Harwood, P. D.** 1932. The helminths parasitic in the Amphibia and Reptilia of Houston, Texas and vicinity. *Proceedings of the United States National Museum* 81:1-74.
- Ingles, L. G.** 1936. Worm parasites of California amphibians. *Transactions of the American Microscopical Society* 55:73-92.
- Jewell, M. E.** 1916. *Cylindrotaenia americana* nov. sp. from the cricket frog. *Journal of Parasitology* 2:181-192.
- Joyeux, C.** 1924. Recherches sur le cycle évolutif des *Cylindrotaenia*. *Annales de Parasitologie Humaine et Comparée* 2:74-81.
- Kuntz, R. E., and J. T. Self.** 1944. An ecological study of the metazoan parasites of the Salientia of Comanche County, Oklahoma. *Proceedings of the Oklahoma Academy of Sciences* 25:35-38.
- Lehmann, D. L.** 1965. Intestinal parasites of northwestern amphibians. *Yearbook of the American Philosophical Society* 1965:284-285.
- Loomis, R. B.** 1956. The chigger mites of Kansas. *University of Kansas Science Bulletin* 37:1195-1443.
- Mane-Garzon, F., and L. E. Gonzalez.** 1978. *Gorgoderina darwini* n. sp. Digenea parasito de la vejiga urinaria del sapito de Darwin *Melanophryniscus stelzneri* (Weyenbergh). *Revista de Biología del Uruguay* 6:39-43.
- Mann, D. R.** 1932. The ecology of some North Carolina salamanders with special reference to their parasites. Unpublished M.S. Thesis, Duke University, Durham, North Carolina. 50 pp.
- Margolis, L., G. W. Esch, J. C. Holmes, A. M. Kuris, and G. A. Schad.** 1982. The use of ecological terms in parasitology (report of an ad hoc committee of the American Society of Parasitologists). *Journal of Parasitology* 68:131-133.
- McAllister, C. T.** 1987. Protozoan and metazoan parasites of Strecker's chorus frog, *Pseudacris streckeri streckeri* (Anura: Hylidae), from north-central Texas. *Proceedings of the Helminthological Society of Washington* 54:271-274.
- , and **S. J. Upton.** 1987a. Parasites of the Great Plains narrowmouth toad (*Gastrophryne olivacea*) from northern Texas. *Journal of Wildlife Diseases* 23:686-688.
- , and ———. 1987b. Endoparasites of the smallmouth salamander, *Ambystoma texanum* (Caudata: Ambystomatidae) from Dallas County, Texas. *Proceedings of the Helminthological Society of Washington* 54:258-261.
- , ———, and **D. B. Conn.** 1989. A comparative study of endoparasites in three species of sympatric *Bufo* (Anura: Bufonidae), from Texas. *Proceedings of the Helminthological Society of Washington* 56:162-167.
- Meggitt, F. J.** 1931. On cestodes collected in Burma. Part II. *Parasitology* 23:250-253.
- Mettrick, D. F.** 1953. Some cestodes of reptiles and amphibians from the Rhodesias. *Proceedings of the Zoological Society of London* 141:239-250.
- Odlaug, T. O.** 1954. Parasites of some Ohio Amphibia. *Ohio Journal of Science* 54:126-128.
- Parry, J. E., and A. W. Grundmann.** 1965. Species composition and distribution of the parasites of some common amphibians of Iron and Washington counties, Utah. *Proceedings of the Utah Academy of Sciences, Arts and Letters* 42:271-279.
- Pierce, B. A., and P. H. Whitehurst.** 1990. *Pseudacris clarkii*. Pages 458.1-458.3 in D. M. Hillis, ed. *Catalogue of American Amphibians and Reptiles. Society for the Study of Amphibians and Reptiles, American Museum of Natural History, New York.*
- Prokopic, J. K.** 1957. Helminthofauna nasich zab. *Ceskoslovenska Parasitologie* 4:249-262.
- 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.
- Savazzini, L. A.** 1929. La *Cylindrotaenia americana* en nuestro *Leptodactylus ocellatus*. *Semana Médica* 36:868-870.
- Schmidt, G. D.** 1986. *CRC Handbook of Tapeworm Identification*. CRC Press, Inc., Boca Raton, Florida. 675 pp.
- Stumpf, I. V. K.** 1981/1982a. Evolutionary cycle of *Cylindrotaenia americana* Jewell, 1916 (Cyclophyllidean: Nematotaeniid) in *Bufo ictericus*, Spix, 1824. *Acta Biologica Paranaense* 10-11:31-40.
- . 1981/1982b. Biological aspects of *Cylindrotaenia americana* Jewell, 1916 (Cyclophyllidean: Nematotaeniid) in *Bufo ictericus*, Spix, 1824. *Acta Biologica Paranaense* 10-11:41-52.
- Trowbridge, A. H., and H. M. Hefley.** 1934. Preliminary studies on the parasitic fauna of Oklahoma anurans. *Proceedings of the Oklahoma Academy of Sciences* 14:16-19.
- Ulmer, M. J., and H. A. James.** 1976. Studies on the helminth fauna of Iowa II. Cestodes of amphibians

- ans. Proceedings of the Helminthological Society of Washington 43:191-200.
- Upton, S. J., and C. T. McAllister.** 1988. The coccidia (Apicomplexa: Eimeriidae) of Anura, with descriptions of four new species. Canadian Journal of Zoology 66:1822-1830.
- Walton, A. C.** 1940. Notes on amphibian parasites. Proceedings of the Helminthological Society of Washington 7:87-91.
- . 1941. Notes on some helminths from California Amphibia. Transactions of the American Microscopical Society 60:53-57.
- . 1964. The parasites of Amphibia. Wildlife Disease WD-63-4, on microcard. 28 pp.
- Yamaguti, S.** 1959. Systema Helminthum. II. The Cestodes of Vertebrates. Interscience Publishers, New York. 860 pp.

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