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Miscellaneous Fish Helminth Parasite (Trematoda, Cestoidea, Nematoda, Acanthocephala) Records from Arkansas

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Running Title: Fish Helminth Parasite Records

Abstract

Between June 2012 and January 2014, 147 fishes (10 species) within five families were collected from watersheds in 8 counties of Arkansas and examined for helminth parasites. Almost every fish species examined harbored at least one or more helminth parasite, including 5 trematodes (*Alloglossidium* sp., *Plagioporus* sp., *Crepidostomum* sp., *Clinostomum marginatum* and unknown metacercaria), 2 cestodes (unknown cyclophyllidean cysticerci and *Corallotaenia parva*), 3 nematodes (*Spiroxys* sp., *Capillaria catostomi*, and *Eustrongylides* sp.), and 3 acanthocephalans (unknown cystacanths, *Neoechinorhynchus* sp., and *Leptorhynchoides* sp.). We document 16 new host and 2 new distributional records for these helminths. In addition, this is the first time any helminth has been reported from the Blackspot Shiner, *Notropis atrocaudalis* and Caddo Madtom, *Noturus taylori*.

Introduction

Reports on helminth parasites of non-game fishes are mostly lacking in North America (Scholz and Choudbury 2014), with an obvious paucity of reports from Arkansas. Of the approximately 200 non-game fishes reported from the state (Robison and Buchanan 1988), we are aware of only 6 species that have been surveyed for helminth parasites in general (Cloutman 1976, Fiorello et al. 1999, McAllister et al. 2014a, b). Although there are fragmentary studies reporting monogenes from Speckled and Rainbow Darters, *Etheostoma* spp. (Wellborn 1967, Wellborn and Rogers 1967), a comparative study on stonerollers, *Campostoma* spp. (Cloutman 1976), one of white grub

in a minnow (Mitchell et al. 1982), descriptions of monogenes from shiners (see Cloutman 1994, 1995, 2011), reports of acanthocephalans and tapeworm in Pirate Perches, *Aphredoderus sayanus* (McAllister and Amin 2008, McAllister et al. 2012, respectively), a study of black-spot disease in various fishes (McAllister et al. 2013), and helminths of Banded Sculpins, *Cottus carolinae* and madtoms, *Noturus* spp. (McAllister et al. 2014, 2015, respectively), studies on freshwater fish parasites in Arkansas are lacking. Here we report some new host and distributional records for helminth parasites of select fishes of the state.

Materials and Methods

Between June 2012 and January 2014 the following 147 fishes were collected from watersheds in eight counties of Arkansas (Fig. 1) and examined for helminth parasites (sample sizes in parentheses): **APHREDODERIDAE**: *A. sayanus* (21); **CYPRINIDAE**: *N. atrocaudalis* (10); **ICTALURIDAE**: Black Bullhead, *Ameiurus melas* (11), Yellow Bullhead, *Ameiurus natalis* (31), Ozark Madtom, *Noturus albater* (6), Tadpole Madtom, *Noturus gyrinus* (7), Ouachita Madtom, *Noturus lachneri* (20), *N. taylori* (16); **ELASSOMATIDAE**: Pygmy Sunfish, *Elassoma zonatum* (5); **COTTIDAE**: Knobfin sculpin, *Cottus immaculatus* (20). Fishes were collected with backpack electrofishers, dipnets or seines. They were placed in habitat water and necropsied within 24 h. We followed accepted guidelines for the use of fish in research (AFS 2004) and specimens were overdosed with a concentrated Chloretone solution, measured for total length (TL) and a mid-ventral incision from anus to stomach was made to expose the gastrointestinal tract and other

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internal viscera (including gallbladder) which was removed and placed in a Petri dish containing 0.6% w/v saline. Their gills/gill filaments were not examined for monogenes. Trematodes and cestodes were stained with acetocarmine and mounted in Canada balsam or Kleermount®. Nematodes and Acanthocephalans were placed on a slide with glycerol and studied as temporary mounts. Voucher specimens of parasites were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland or Harold W. Manter Collection (HWML), University of Nebraska, Lincoln. Host voucher specimens preserved in 10% v/v formalin, transferred to 40% v/v ethanol, and deposited in the Henderson State University Museum (HSU), Arkadelphia, Arkansas as HSU 3540-3543, 3545, 3555-3556. Prevalence, mean intensity, and range of infection are provided and are in accordance with terminology given in Bush et al. (1997).

Figure 1. Localities (dots) in eight counties of the state where fish were collected. Abbreviations: Fulton (F), Garland (G), Izard (I), Little River (L), Marion (Ma), Miller (Mi), Montgomery (Mo), Sevier (S).

Results and Discussion

Every fish species examined, except 20 *C. immaculatus* (Spring River, Fulton County), harbored at least one or more helminth parasite. Seventy-three of 141 (52%) of the fishes examined were infected. The following is an annotated list of data as follows: host and total length (TL), prevalence, intensity, total length of host, collection site, collection date, USNPC accession number.

PLATYHELMINTHES: TREMATODA

Digenea: Plagiorchiida: Macroderoididae

Alloglossidium sp. (Fig. 2)

Noturus gyrinus, 60 mm TL, 1/7 (14%), 5 worms, Sevier Co., Rolling Fork River, 24 Oct. 2013.

Ameiurus natalis, 103 mm TL, 1/6 (17%) 2 worms, Sevier Co., Rolling Fork River, 24 Oct. 2013.

Figure 2. Gravid *Alloglossidium* sp. (unstained) with expelled ova from *Noturus gyrinus*; inset shows single ovum with operculum (arrow).

Six (35%) of the 17 recognized species of *Alloglossidium* have been reported from fishes (mainly ictalurids), including *Ameiurus* spp., *Ictalurus* spp., and *Noturus* spp. (see Smythe and Font 2001, Tkach and Mills 2011, Tkach et al. 2013). In addition, Kasl et al. (2014) recently reported *A. floridense* from *N. gyrinus* from Florida.

Species of *Alloglossidium* from fishes have been reported from Arkansas, California, Colorado, Florida,

Georgia, Kansas, Kentucky, Idaho, Illinois, Indiana, Louisiana, Maine, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New York, North Dakota, Ohio, Oklahoma, North Dakota, Texas, Virginia, and Wisconsin and Ontario, Canada (Hoffman 1999; Tkach and Mills 2011, Kasl et al. 2014, McAllister et al. 2015).

Alloglossidium corti (Lamont, 1921) Van Cleave and Mueller, 1932 has been reported in *A. natalis*, channel catfish, *Ictalurus punctatus* (Becker and Houghton 1969) and *N. lachneri* (Fiorillo et al. 1999), with metacercaria in the antennal gland of some crayfishes from the state (McAllister et al. 2011). As yet, there are no additional species of *Alloglossidium* reported from Arkansas. Our specimens do not fit any previous description of *Alloglossidium* and is most likely a new species that we are investigating in an ongoing morphological and molecular study (V.V. Tkach, pers. comm.).

Opecoelidae, *Plagioporus* sp. (Fig. 3)

Noturus lachneri, 60.9 ± 11.2 , 43-82 mm TL, 17/20 (85%), 2.0 ± 0.9 , range 1-4 worms, Garland Co., Hot Springs, Middle Branch Gulpha Creek off E Grand Avenue (34.5092°N, 93.009039°W). 26 Oct. 2013.

Figure 3. *Plagioporus* sp. (unstained) from *Noturus lachneri*; abbreviations: testes (T), ovary (O).

McAllister et al. (2014, 2015) recently reported *Plagioporus* sp. from *C. carolinae* and Slender Madtoms, *Noturus exilis* from Arkansas, respectively. Interestingly, except for the report by Harms (1959) of

Plagioporus sp. in Black Bullheads, *Ameiurus melas* from Kansas, our specimens reported herein from *N. lachneri* and those of McAllister et al. (2015) from *N. exilis* are the only other specimens of the genus reported from North American ictalurids and are likely a new species; DNA and morphological analyses are ongoing (T.J. Fayton, pers. comm.).

Allocreadiidae, *Crepidostomum* sp. (Fig. 4)

Aphredoderus sayanus, 59.6 ± 5.2 , range 53-67 mm TL, 5/9 (56%), 3.4 ± 1.5 , range 1-5 worms, Sevier Co., Rolling Fork River (34.064667°N, 94.380023°W), 24 Oct. 2013.

Figure 4. *Crepidostomum* sp. from *Aphredoderus sayanus*. Abbreviations: oral sucker (O), ventral sucker (V).

To date, 3 species of *Crepidostomum* have been reported from *A. sayanus*: *C. farionis* (Müller, 1784) Nicoll, 1909, *C. isostomum* Hopkins, 1931, and an unidentified immature *Crepidostomum* sp. (see

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Hoffman 1999). In addition, *Crepidostomum* sp. has been reported from *A. natalis* and *I. punctatus* from Lake Fort Smith, Arkansas (Becker and Houghton 1969). Further, at least 25 other genera of fishes have been reported as hosts of this digene from Alabama, Arkansas, Georgia, Illinois, Kentucky, Louisiana, Maine, Massachusetts, Michigan, Mississippi, New York, North Carolina, North Dakota, Oklahoma, Ohio, Pennsylvania, Oregon, Tennessee, Texas and Wisconsin and Ontario and Quebec, Canada (Hoffman 1999, Muzzall and Whelan 2011, summarized by McAllister et al. 2014). McAllister et al. (2014) recently reported *C. cooperi* from *C. carolinae* from Arkansas. Our specimens will be identified following DNA analyses (V.V. Tkach, pers. comm.).

Strigeidida: Clinostomidae***Clinostomum marginatum* Rudolphi, 1819 (metacercaria) (Fig. 5)**

Noturus albater, 74 mm TL, 1/6 (17%), 1 worm, Marion Co., Crooked Creek at Kelly's Slab (36.245207°N, 92.715611°W), 26 Jul. 2013.

Noturus taylori, 67 and 74 mm TL, 2/16 (13%), 2 and 6 worms, Montgomery Co., Caddo River, 26 Oct. 2013. USNPC 107670.

Clinostomum marginatum is a very common trematode that is cosmopolitan in distribution and, according to Hoffman (1999), it is "likely capable of infecting any species of freshwater fish." Indeed, yellow grub has been commonly reported primarily from Arkansas game fishes (*Micropterus* spp.), including those from Crooked Creek (Daly et al. 2002) and the Caddo River (Daly et al. 1999). However, this is the first time *C. marginatum* metacercaria have been reported from *N. albater* and *N. taylori*.

Unknown digene metacercaria (Fig. 6)

Aphredoderus sayanus, 57 mm TL, 1/9 (11%), Sevier Co., Rolling Fork River (34.064667°N, 94.380023°W), 24 Oct. 2013.

Unknown metacercaria of a digene trematode was found in the mesenteries of *A. sayanus*. Numerous metacercaria were found as spheroidal to ovoidal cysts (Fig. 6). This is the first time metacercaria have been reported from *A. sayanus*.

Figure 5. Metacercaria of *Clinostomum marginatum* from *Noturus taylori*. (A) Lateral side of madtom showing two encysted metacercaria (arrows) in dermis; scale bar = 10 mm. (B) Unstained metacercaria extracted from cyst showing typical morphology; scale bar = 1 mm.

CESTOIDEA**Cyclophyllidae: unidentified cysticerci (Fig. 7)**

Ameiurus melas, 55 mm TL, 1/11 (9%), too numerous to count, Little River Co., Little River oxbow (33.908447°N, 94.396119°W), 24 Oct. 2013.

Noturus lachneri, 48, 59, and 64 mm TL, too numerous to count, 3/20 (15%), Garland Co., Hot Springs, Middle Branch Gulpha Creek off E Grand Avenue (34.5092°N, 93.009039°W), 26 Oct. 2013. USNPC 107690.

Noturus taylori, 71 mm TL, 1/16 (6%), 6 worms, Montgomery Co., Caddo River (34.455676°N, 93.714543°W), 26 Oct. 2013.

Notropis atrocaudalis, 55, 59, 66 mm TL, 3/10 (30%), too numerous to count, Miller Co., Nix Creek at Texarkana (33.444116°N, 94.016049°W), 3 Jan. 2014.

Elassoma zonatum, 5/5 (100%), too numerous to count, Miller Co., Nix Creek at Texarkana (33.444116°N, 94.016049°W), 3 Jan. 2014.

Cyclophyllidean tapeworms have not been previously reported from any of these hosts (above);

Figure 6. Unknown digenean metacercaria from *Aphredoderus sayanus*; scale bar = 50 μ m.

Figure 7. Tapeworm cysticerci from Arkansas fishes. (A) Specimen from *Noturus lachneri*. (B) Specimen from *Noturus taylori*. (C) Specimen from *Notropis atrocaudalis*. (D) Specimen from *Ellassoma zonatum*.

therefore, we document 5 new host records for these cyclophyllidean cysticerci.

Proteocephalidea: Proteocephalidae

Corallotaenia parva (Larsh, 1941) Frese, 1965

Ameiurus melas, 58, 58 and 62 mm TL, 3/11 (27%), Little River Co., Little River oxbow (33.908447°N, 94.396119°W), 24 Oct. 2013, USNPC 107688-107689.

McAllister and Bursey (2011) recently reported *C. parva* from *A. melas* from Oklahoma. Other hosts include the brown bullhead, *Ameiurus nebulosus* and channel catfish, *Ictalurus punctatus* (Hoffman 1999). The range includes Colorado, Illinois, Maine, Michigan and Oklahoma (Hoffman 1999, McAllister and Bursey 2011), and now Arkansas (this report). We document a new distributional record for *C. parva* in the state.

NEMATODA

Spirurida: Gnathostomatidae, *Spiroxys* sp. (larvae) (Fig. 8)

Aphredoderus sayanus, 67 mm TL, 1/9 (11%), Sevier Co., Rolling Fork River (34.064667°N, 94.380023°W), 24 Oct. 2013. USNPC 107687.

Ameiurus natalis, 41.9 $\pm$ 14.8, range 30-75 mm TL, 13/23 (56%), Miller Co., Nix Creek at Texarkana (33.444116°N, 94.016049°W), 29 Jun. 2012. 6 Jul. 2012, 29 Sept. 2012.

Noturus lachneri, 59 mm TL, 1/20 (5%) with five worms, Garland Co., Hot Springs, Middle Branch Gulpha Creek off E Grand Avenue (34.5092°N, 93.009039°W), 26 Oct. 2013.

Noturus taylori, 55 mm TL, 1/16 (6%) Montgomery Co., Caddo River (34.455676°N, 93.714543°W), 26 Oct. 2013, USNPC 107671.

Species of *Spiroxys* from North American fishes have been reported from Arkansas (McAllister et al. 2014a), California, New York, North Dakota, Pennsylvania, West Virginia, Wisconsin, and Wyoming (see Hoffman 1999). The larval *Spiroxys* sp. that we found in intestinal mesenteries possessed the distinctly trilobed lips and triangular appearing anterior end (see Hedrick 1935, his figs. 2-6, our fig. 8B). Hoffman (1999) noted that *Spiroxys* sp. to be "very common in pond-reared fishes" (unidentified species) in Arkansas. In the experimental life cycle, the first intermediate host of *Spiroxys* was reported to be the crustacean, *Cyclops* sp. (Hedrick 1935). Larval *Spiroxys* sp. has been previously reported from *A.*

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natalis (Hoffman 1999); however, we document 3 new host records and the first nematode, to our knowledge, ever reported from *A. sayanus*.

Figure 8. *Spiroxys* sp. larvae from intestinal mesenteries of madtoms. (A) Whole specimen from *Noturus lachneri*. (B) Whole specimen from *Noturus taylori* and anterior end of worm showing lips (inset, arrow).

Trichuroidea: Capillaridae, *Capillaria catostomi* Pearse, 1924

Aphredoderus sayanus, 78 mm TL, 1/3 (33%), 1 worm, Little River Co., Little River oxbow (33.908447°N, 94.396119°W). USNPC 107685.

Capillaria catostomi has been reported from suckers (*Catostomus* spp.) and carp *Cyprinus carpio* from Florida and Wisconsin and Ontario, Canada (Hoffman 1999). In addition, Hoffman (1999) further noted “from 1962 to 1985, I saw *C. catostomi* from *Ctenopharyngodon idella*, *Lepomis cyanellus*, *L. macrochirus*, *Notemigonus chryssoleucus* and *Pimephales promelas* from West Virginia and Arkansas.” However, we document a new host and the first genuine voucher of *C. catostomi* from Arkansas.

**Diectophymatoidea: Diectophymatidae
Eustrongylides sp.**

Aphredoderus sayanus, 67 mm TL, 1/9 (11%), 1 worm, Sevier Co., Rolling Fork River (34.064667°N, 94.380023°W), 24 Oct. 2013, USNPC 107686.

Nematodes of the genus *Eustrongylides* are found as adults in the proventriculus of piscivorous birds with larvae encysted in the body cavity and musculature of fishes (Hoffman 1999). Early larval development occurs in oligochaetes (Lichtenfels and Stroup 1985). Specific identification of *Eustrongylides* requires

rearing larvae in an avian host and our study did not include this experimental transmission. However, we document a new host record for this nematode and the first report of the genus from Arkansas.

ACANTHOCEPHALA

Unidentified cystacanth (Fig. 9)

Notropis atrocaudalis, 56, 60 mm TL, 2/10 (20%), too numerous to count, Miller Co., Nix Creek at Texarkana (33.444116°N, 94.016049°W), 3 Jan. 2014.

Ameiurus natalis, 46.1 ± 20.6, range 30-75 mm TL, 6/23 (26%), too numerous to count, Miller Co., Nix Creek at Texarkana (33.444116°N, 94.016049°W), 29 Jun. 2012, 6 Jul. 2012, 29 Sept. 2012.

Figure 9. Acanthocephalan cystacanths from intestinal mesenteries of *Notropis atrocaudalis* and *Ameiurus natalis*. (A) View showing entire specimen from *N. atrocaudalis*. (B) Higher magnification of same showing proboscis and hook arrangement. (C) Entire specimen from *A. natalis*. (D) Higher magnification of same showing proboscis and hook arrangement (arrows).

The black-spot shiner and yellow bullhead are new hosts of acanthocephalan cystacanths and more importantly, we document the first helminth, to our knowledge, ever reported from *N. atrocaudalis*. Several genera of acanthocephalans have been

previously reported from *A. natalis*, including *Leptorhynchoides*, *Neoechinorhynchus*, *Pilum*, and *Pomphorhynchus* (Hoffman 1999). Unfortunately, it is not possible to place our cystacanths within any genera.

**Eoacanthocephala: Neoechinorhynchida:
Neoechinorhynchidae, *Neoechinorhynchus* sp.**

Aphredoderus sayanus, 4 worms, 61 and 67 mm TL; 2/9 (22%) Sevier Co., Rolling Fork River, (34.064667°N, 94.380023°W), 24 Oct. 2013, HWML 49932.

Two male and 2 immature female *Neoechinorhynchus* sp. were found in the intestinal tract of *A. sayanus*. There are no previous reports of this genus from Pirate Perches although *Neoechinorhynchus cylindratus* (Van Cleave, 1913) Van Cleave, 1919 has been reported from other Arkansas fishes (Hoffman 1999). Additional specimens are needed to determine a species identity. However, we document a new host record for the genus *Neoechinorhynchus*.

**Palaeacanthocephala: Echinorhynchida:
Rhadinorhynchidae, *Leptorhynchoides* sp.**

Aphredoderus sayanus, 60 mm TL, 4 worms, 1/9 (11%), Sevier Co., Rolling Fork River (34.064667°N, 94.380023°W), 24 Oct. 2013, HWML 49931.

Leptorhynchoides aphredoderi was described by Buckner and Buckner (1976) from *A. sayanus* from Louisiana. In addition, *Leptorhynchoides thecatus* (Linton, 1891) Kostylew, 1924 was reported from basses (*Micropterus* spp.) from Arkansas (Becker et al. 1966). The lemnisci of *L. aphredoderi* is described as being "short, equal" (see Amin et al. 2013, their Table 1), a view consistent with our specimens. However, because we lack enough mature specimens, we cannot make a confident species diagnosis at this time. Therefore, additional specimens are needed to determine a species identity.

McAllister and Amin (2008) reported the acanthocephalans *Pomphyrhynchus lucyi* and *Aspersentis* sp. from *A. sayanus* from the Caddo River, Arkansas. We report 2 new host records for 2 acanthocephalans from *A. sayanus*.

In summary, we document 16 new host and 2 new distributional records for some helminth parasites of non-game fishes of the state. Most importantly, we have only begun to realize the diversity of fish

helminths in Arkansas and future studies will undoubtedly report additional records, including descriptions of new taxa.

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