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Trematode Parasites (Digenea) of the Slender Madtom *Noturus exilis* and Black River Madtom *Noturus maydeni* (Siluriformes: Ictaluridae) from Arkansas, U.S.A.

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**ABSTRACT:** Between June 2012 and July 2013, 43 slender madtoms (*Noturus exilis*) and 21 Black River madtoms (*Noturus maydeni*) were collected from 4 counties of northern Arkansas and examined for helminths. Eleven (26%) slender madtoms were infected with digenean trematodes, including 3 (7%) with metacercaria of *Posthodiplostomum minimum*, 3 (7%) with *Alloglossidium* sp., and 7 (16%) with *Plagioporus* sp.; a single (5%) Black River madtom was infected with *Caecincola* sp. We document new host records for each of these 4 helminths. Notable among these new host records are new distributional records for *Caecincola* sp. To our knowledge this represents the first report of any helminth from *N. exilis* and *N. maydeni*.

**KEY WORDS:** Arkansas, Ictaluridae, Trematoda, Digenea, *Noturus exilis*, *Noturus maydeni*, *Alloglossidium* sp., *Caecincola* sp., *Plagioporus* sp., *Posthodiplostomum minimum*.

The slender madtom, *Noturus exilis* Nelson, is a long, slender brownish ictalurid of clear creeks and small rivers of the upper Mississippi River basin ranging from southern Wisconsin and Minnesota to the Ouachita uplift of Arkansas, Kansas, and Oklahoma; a disjunct population occurs in the Cumberland, Green, and Tennessee river drainages (Page and Burr, 2011). In Arkansas, *N. exilis* occurs widely throughout the White and Arkansas river systems, as well as the Red River drainage in the Mountain Fork River (Robison and Buchanan, 1988). The Slender madtom inhabits small to moderately sized, permanent, clear spring-fed streams with rock and gravel bottoms where it feeds on aquatic insect larvae, crustaceans, nematodes, and gastropods (Robison and Buchanan, 1988). The Black River madtom, *Noturus maydeni* Egge, which is genetically and karyotypically distinct from the Ozark madtom (*Noturus albater*), is found in the upper Black and St. Francis river systems in Arkansas and Missouri where it is locally common (Egge and Simons, 2006; Page and Burr, 2011). The Black River madtom inhabits riffles and rocky pools of clear, cool, high-gradient creeks and small to medium-sized rivers (Burr and Mayden, 1984; Pfieger, 1997) where it feeds on similar food items as *N. exilis*.

Although both madtoms are fairly well studied freshwater fishes (see citations in Rohde, 1980; Burr and Mayden, 1984; Pfieger, 1997), to our knowledge there is nothing known about their helminth parasites. Herein, we report 4 new hosts and a new distributional record for helminths of *N. exilis* from Arkansas.

Between July 2012 and July 2013, 43 slender madtoms (mean ± 1 SD total length [TL] = 83.0 ± 14.9, range 52–137 mm) and 21 Black River madtoms (73.4 ± 9.6, range 49–88 mm) were collected using a backpack electroshocker or by overturning rocks and capturing fish with a dip net. Collections were from 5 localities in 4 counties of the state, including Benton (n = 9), Fulton (n = 21), *N. maydeni* only), Marion (n = 32), and Searcy (n = 2) counties. Specimens were placed in containers with cool aerated habitat water and examined postmortem within 24 hr. We followed accepted guidelines for the
use of fish in research (AFS, 2004). Specimens were overdosed with a concentrated chloroform solution, and a midventral incision was made to expose the gastrointestinal tract and internal viscera. Fish were examined for helminths, but their gills/gill filaments were not examined for monogeneans. Trematodes were fixed in hot tap water without coverslip pressure, transferred to 70–95% ethanol, stained with acetocarmine, and mounted in Canada balsam or Kleermount®. Voucher specimens of parasites were deposited in the U.S. National Parasite Collection (USNPC), Beltsville, Maryland, U.S.A. Host voucher specimens were deposited in the Henderson State University Museum (HSU), Arkadelphia, Arkansas, U.S.A., as HSU 3512, 3514, and 3516. Prevalence, mean intensity, and range of infection are provided and are in accordance with terminology given in Bush et al. (1997).

Of the 43 slender madtoms examined, 11 (26%) were infected with digenean trematodes, including 3 (7%) with metacercaria of Posthodiplostomum minimum, 3 (7%) with Alloglossidium sp., and 7 (16%) with Plagioporus sp.: a single (5%) Black River madtom was infected with Caecincola sp. Seven of 9 (78%) of the slender madtoms from the Illinois River drainage in Benton County were infected; 6 of 33 (18%) slender madtoms from the White River drainage in Marion and Searcy counties were infected.

**Trematoda: Digenea**

**Strigeatida: Diplostomidae**

*Posthodiplostomum minimum* (MacCallum, 1921)

*Hosts and localities:* 3 slender madtoms (74, 80, 85 mm TL) collected on 25 July 2013 from Kelly’s Slab at Yellville, Marion County (36°15’9.9”N; 94°26’25.8”W).

*Prevalence:* 3/43 (7%) overall; 3/32 (9%) Marion County.

*Intensity:* 2.3 ± 1.2 (1–3) metacercaria.

*Site of infection:* Mesenteries.

*Other reported hosts:* White grub has been reported from many genera of North American fishes, including ictalurids such as black bullhead, *Ameiurus melas*; yellow bullhead, *Ameiurus natalis*; brown bullhead, *Ameiurus nebulosus*; blue catfish, *Ictalurus furcatus*; channel catfish, *Ictalurus punctatus*; and tadpole madtom, *Noturus gyrinus* (see Hoffman, 1999).


**Specimens deposited:** USNPC 107266 (slide).

**Remarks**

Our specimens are presumed to be *P. minimum* because many metacercariae cannot be identified to species unless they are fed to a definitive host, and adult worms are obtained that can be identified to species on the basis of morphology. Additionally, some species of *Posthodiplostomum*, including *P. minimum*, have a high intraspecific morphological variability (see Ritossa et al., 2013). Indeed, natural infections of *Posthodiplostomum* have been found in a variety of vertebrates, mainly fish-eating birds of the Order Ciconiiformes and, to a lesser extent, Charadriiformes and Pelecaniformes (Dubois, 1970). This digenean has been experimentally (and to some extent naturally) transmitted in a wide range of birds and mammals, and even reptiles and amphibians have been shown to be suitable hosts. Physid snails (*Physa halei*) serve as first intermediate hosts (Bedinger and Meade, 1967).

**Plagiorchiida: Macrodoroididae**

*Alloglossidium* sp. Simer, 1929

**(Fig. 1)**

**Hosts and localities:** 2 slender madtoms (74, 85 mm TL) collected on 25 July 2013 from Kelly’s Slab at Yellville, Marion County (36°15’9.9”N; 94°26’25.8”W); 1 slender madtom (137 mm TL) collected on 15 August 2012 from Water Creek at Mull, Searcy County (36°03’0.9”N; 92°35’42.4”W).

*Prevalence:* 3/43 (7%) overall; 2/32 (6%) Marion County; 1/2 (50%) Searcy County.

*Intensity:* 2.0 ± 1.7 (1–4) worms.

*Site of infection:* Small intestine.

*Other reported hosts:* Of the 16 recognized species of *Alloglossidium*, 5 species of have been reported from fishes (mainly ictalurids), including *Ameiurus*

**Geographic range:** Five species have been reported from fishes in various states, including Arkansas, California, Florida, Georgia, Kansas, Kentucky, Idaho, Indiana, Louisiana, Maine, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New York, Ohio, Oklahoma, North Dakota, Texas, Virginia, and Wisconsin, as well as from Ontario, Canada (Carney and Brooks, 1991; Hoffman, 1999; Tkach and Mills, 2011; Kasl et al., 2014).

**Additional Arkansas records:** *Alloglossidium corti* (Lamont, 1921) Van Cleave and Mueller, 1932 has been reported in *A. natalis*, *I. punctatus* (Becker and Houghton, 1969), and Ouachita madtom, *Noturus 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.

**Specimens deposited:** USNPC 107258 (slide).

**Remarks**

The recent publications of Tkach and Mills (2011) and Kasl et al. (2014) note that the subtle morphological variations within and among species in this genus

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**Figures 1, 2.** *Alloglossidium* sp. and *Plagioporus* sp. from *Noturus exilis*. 1. *Alloglossidium* sp. showing ovary (O) and testes (T). 2. *Plagioporus* sp. showing testis (T).
make species delimitation difficult. Thus, we feel it is premature to label these specimens with a species name based on morphology alone. Ongoing work in our labs is using molecular markers to elucidate the biogeography of species in the genus Alloglossidium. A more comprehensive biogeographic, morphologic, and genetic analysis that includes these specimens is in preparation and will be submitted in the near future. This is the first time the genus has been reported from *N. exilis.*

**Opecoelidae**

*Plagioporus sp. Stafford, 1904*  
(Fig. 2)

*Hosts and localities:* 7 slender madtoms (72, 86, 87, 95, 96, 102 [2] mm TL); 3 collected on 16–17 June 2013 from Flint Creek off Fairmont Road at Springtown, Benton County (36°15′9.9"N; 94°26′25.8"W) and 4 collected on 16–17 June 2013 from Flint Creek south of Gentry off US 59, Benton County (36°14′33.8"N; 94°29′14.5"W).  

*Prevalence:* 7/43 (16%) overall; 7/9 (78%) Benton County.  
*Intensity:* 3.0 ± 1.8 (1–6) worms.  
*Site of infection:* Small intestine.  

*Other reported hosts:* See McAllister et al. (2014).  

*Geographic range of genus in North America:* See McAllister et al. (2014).  

*Additional Arkansas records:* Banded sculpin, *Cottus carolinae* (McAllister et al., 2014).  

*Specimens deposited:* USNPC 107257 (slide).

**Remarks**

Our specimens of *Plagioporus* sp. cannot be distinguished from those recently reported by McAllister et al. (2014) from *C. carolinae* within the same Benton County localities. It shares morphological affinities with plagioporid species distributed east of the Rocky Mountains and is most morphologically similar to *Plagioporus sinitsini* Mueller, 1934, which was described from the gall bladder of white sucker, *Catostomus commersonii* from Oneida Lake, New York (Mueller, 1934), and subsequently redescribed from the gall bladder of cyprinid and catostomid hosts from the Huron River, Michigan (Dobrovolny, 1939). The type material of *P. sinitsini* was fixed under coverslip pressure (Mueller, 1934) preventing meaningful morphometric comparisons with our specimens of *Plagioporus* sp., which were not flattened before fixation. *Plagioporus* sp. is similar to Dobrovolny’s (1939) specimens of *P. sinitsini* with respect to oral and ventral sucker shape and ratios, body length, and egg size (length and width), along with the possession of a spindle-shaped body, short excretory vesicle, and testis, the latter of which cluster together near the posterior end of the body. *Plagioporus* sp. can be differentiated from *P. sinitsini* by its more narrow body and larger testis, and by having a more anterior posterior extent of the vitellarium at the anterior margin of the posterior testis (as opposed to the posterior end of the body in *P. sinitsini*). Additionally, *Plagioporus serratus* Miller, 1940, is not considered here; its specific status is problematic, in that the only characters that distinguish it from *P. sinitsini*, with which it occurs sympatrically in the St. Lawrence River (Quebec), are a smaller body size and parasitism of mooneye, *Hiodon tergisus* (Miller, 1940). *Plagioporus* sp. is the first species of its genus to be reported from a madtom in the eastern Nearctic and the second to be reported from an ictalurid (*A. melas*) in North America (Harms, 1959). It is most likely a new species; DNA analyses are ongoing, and it will be described in a forthcoming publication.

**Opisthorchiida: Cryptogonimidae**

*Caecincola sp.*  
*Marshall and Gilbert, 1905*  
(Figs. 3–4)

*Hosts and localities:* 1 Black River madtom (84 mm TL) collected on 27 July 2013 from the Spring River at Many Islands, Fulton County (36°23′14.3"N; 91°31′46.9"W).  

*Prevalence:* 1/21 (5%).  
*Intensity:* 2 immature worms.  
*Site of infection:* Small intestine.  


*Geographic range of genus:* U.S.A.: Arkansas (this report), Florida (Premvati, 1967), Georgia (Howard and Aliff, 1980), Illinois (Robinson and Jahn, 1980), Louisiana (Greer and Corkum, 1979, 1980), Michigan
Five species of *Caecincola* have been described from North American fishes, including *Caecincola autumnae* Barger, 2010; *Caecincola latostoma* Greer and Corkum, 1979; *Caecincola longiscens* Curran and Overstreet, 2009; *Caecincola parvulus* Marshall and Gilbert, 1905; and *Caecincola wakullata* Premvati, 1967. Unfortunately, our 2 specimens were immature (Fig. 3) and could not be identified beyond genus. However, this is the first time *Caecincola* sp. has been reported from *N. maydeni*, as well as, in so far as we know, the first time from Arkansas. Additionally, *N. maydeni* is only the second ictalurid host reported for *Caecincola* sp., as most fishes previously reported as hosts are centrarchids (see other reported hosts above).

Of the approximately 200 nongame fish species reported from Arkansas (Robison and Buchanan, 1988), we are aware of only 4 species that have been surveyed for helminth parasites in general (Cloutman, 1976; Fiorillo et al., 1999; McAllister et al., 2014), whereas others are descriptions of monogenes from shiners (see Cloutman, 1994, 1995, 2011), a report of white grub in a minnow (Mitchell et al., 1982), and a study of black-spot disease in various fishes (McAllister et al., 2013). Therefore, as recently noted by Scholz and Choudhury (2014) and reiterated by McAllister et al. (2014), studies on freshwater fish parasites are mostly lacking, with an obvious paucity of reports on helminth parasites of fishes of Arkansas. As additional nongame fishes from the state are surveyed for helminth parasites, we expect additional new host and distributional records as well as new species will be reported, thus extending our knowledge of this important fauna.

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**Figures 3, 4.** *Caecincola* sp. (unstained) from *Noturus maydeni*. 4. View of entire specimen showing “eye spots” (ES). 5. Higher magnification of cup-shaped oral sucker.
ment of Agriculture Forest Service (Ozark region) provided Scientific Collecting Permits to C.T.M., M.B.C., and H.W.R.

LITERATURE CITED


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