

***Aethycteron moorei* (Monogenoidea: Dactylogyrida: Ancyrocephalidae) from the Fantail Darter, *Etheostoma flabellare* (Perciformes: Percidae): New distributional records for Arkansas and Oklahoma**

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Little is known about monogenean parasites of fishes in Oklahoma (see McAllister et al. 2015). Members of the ancyrocephalid genus *Aethycteron* Suriano and Beverley-Burton, 1982, have been reported on the gills of various darters (*Ammocrypta*, *Etheostoma*, and *Percina* spp.) from Alabama, Arkansas, Mississippi, New York, North Dakota, Tennessee, and Ontario, Canada (see Hoffman 1999; Hanson and Stallsmith 2013; Cloutman and McAllister 2017). To our knowledge, nothing has been published on any species of *Aethycteron* in Oklahoma, and a single species, *A. robisoni*, was only recently described from Arkansas (Cloutman and McAllister 2017).

Here, we report new distributional records for a species of *Aethycteron* from the Fantail Darter, *Etheostoma flabellare* Rafinesque, in Arkansas and Oklahoma. *Etheostoma flabellare* is a morphologically variable species of the subgenus *Catonotus* which some authors suggest is a complex of species (Blanton and Schuster 2008). Page and Burr (2011) consider *E. flabellare* to comprise three subspecies. *Etheostoma flabellare* is widely distributed in

rocky riffles of small and medium streams in eastern North America from Atlantic, Great Lakes, and Mississippi River basins from southern Quebec to Minnesota, and south to the Pee Dee basin in northern South Carolina, northern Alabama, and northeastern Oklahoma (Page and Burr 2011).

Between June 2013 and June 2015, 28 *E. flabellare* were collected by seine (3.7 m, 1.6 mm mesh) or backpack electrofisher from: **ARKANSAS:** Benton Co., Flint Creek at Gentry, 36°14'33.8"N, 94°29'14.5"W ($n = 1$) and Flint Creek at Springtown, 34°15'9.9"N, 94°26'25.8"W ($n = 1$); Franklin Co., N. Fork White Oak Creek, 35°33'20"N, 93°51'44"W ($n = 10$) and Spirits Creek, 35°38'17.65"N, 93°56'16.84"W ($n = 4$); Johnson Co., Washita Creek, 35°39'16.80"N, 93°35'37.16"W ($n = 2$); Izard Co., Little Strawberry River, 36°19'27.31"N, 91°51'27.98"W ($n = 4$); Randolph Co., Eassis Creek at St. Hwy 90, 36°20'30.77"N, 91°08'46.87"W ($n = 1$); **OKLAHOMA:** Mayes Co., Snake Creek, 36°09'51.90"N, 95°09'25.61"W ($n = 5$). Fish were placed in containers with cool aerated

water from their collection site, measured for total length (TL) and necropsied, excepting the gills, within 24 hr. We followed accepted guidelines for the use of fish in research (AFS, 2004); specimens were overdosed by immersion in a concentrated chloretone (chlorobutanol) solution and preserved in 10% formalin. The preserved gills of all the fish were examined under a stereomicroscope for monogeneans, and when found, they were picked with minuten nadeln directly from the gills. Monogeneans were mounted in Gray and Wess medium stained with Gomori's trichrome (Kritsky et al. 1978). Measurements of haptoral sclerites, in micrometers (μm), were made as presented by Beverley-Burton and Suriano (1980) and Suriano and Beverley-Burton (1982); means \pm 1SD are followed by ranges in parentheses. The curved male copulatory organ was measured as a straight line extending between the two most distant points of such structures (Harrises and Vickery 1970). Voucher specimens were deposited in the Harold W. Manter Laboratory of Parasitology (HWML), Lincoln, Nebraska. Host voucher specimens were deposited in the Henderson State University Collection (HSU), Arkadelphia, Arkansas.

Seven of 28 (25%) of the *E. flabellare* were found to be infected with a species of

monogenean identifiable as *A. moorei* (Mizelle, 1940), Suriano and Beverley-Burton, 1982 (Figs. 1 and 2). These included two of four (50%, mean \pm 1SD intensity = 1.5 ± 0.7 , range 1–2) from Spirits Creek, Franklin Co., Arkansas, $35^{\circ}38'17.65''\text{N}$, $93^{\circ}56'16.84''\text{W}$ (HWML 102073, 2 specimens), and five of five (100%, 6.4 ± 5.5 , range 1–13) from Snake Creek, Mayes Co., Oklahoma, $36^{\circ}09'51.90''\text{N}$, $95^{\circ}09'25.61''\text{W}$ (HWML 102074, 3 specimens). Host mean total length was 43.8 ± 3.8 , range 40–49 mm and 42.6 ± 2.8 , 38–45 mm, respectively. Measurements of the sclerites of the five specimens above of *A. moorei* are: dorsal anchor length 39 (34–44); dorsal bar length 48 (43–54); ventral anchor length 44 (43–47); marginal hooks 15 (14–16); male reproductive organ 40 (36–44); accessory piece 16 (14–17). The distal portion of the male reproductive organ of *A. moorei* is flexible and often strongly curves back on itself as shown in our Fig. 1B and in Fig. 29 in the original description by Mizelle (1940), or appears as a shepherd's hook as shown in our Fig. 2 and in Fig. 14 in a redescription by Suriano and Beverley-Burton (1982).

Aethycteron moorei has previously been reported on two species of darters: Rainbow Darter, *Etheostoma caeruleum* Storer, and *E. flabellare* (Table 1). Based on the typically

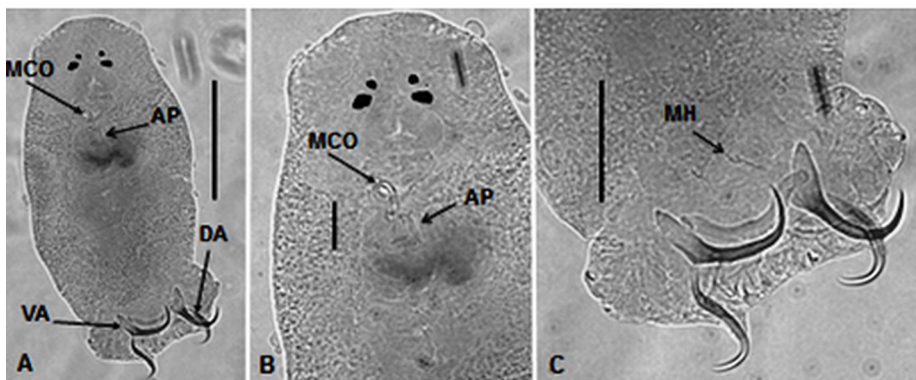


Figure 1. *Aethycteron moorei* (HWML 102074, slide DGC 7212-4) from *Etheostoma flabellare*. A. Entire specimen showing male copulatory organ (MCO) and accessory piece (AP); dorsal anchor and dorsal bar (DA); ventral anchor and ventral bar (VA). Scale bar = 100 μm . B. View showing close-up of male copulatory organ (MCO) and accessory piece (AP). Scale bar = 30 μm . C. Closer view showing marginal hooks (MH). Scale bar = 40 μm .

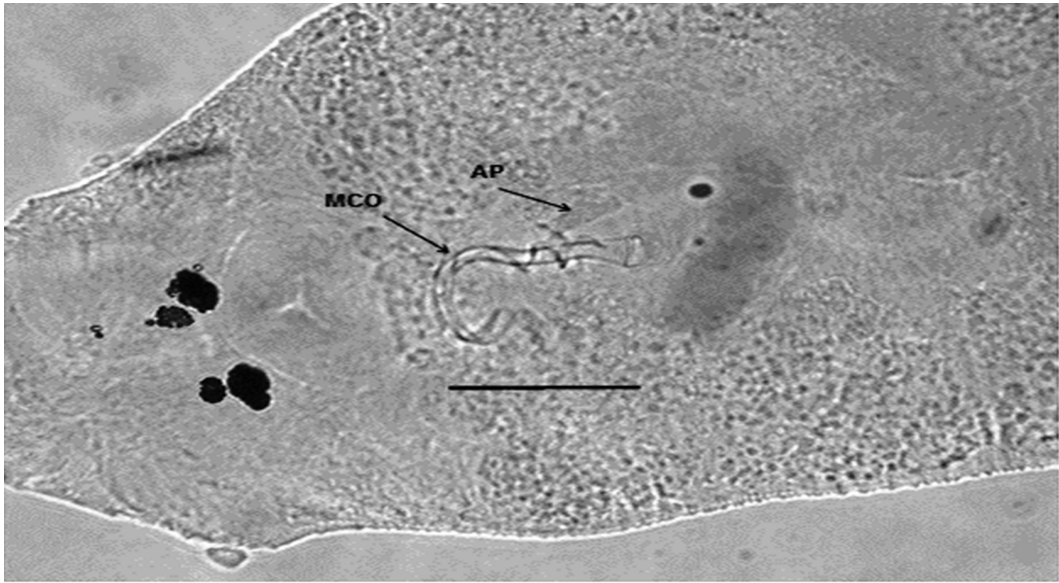


Figure 2. Male copulatory organ (MCO) and accessory piece (AP) of *Aethycteron moorei* (HWML 102074, slide DGC 7212-7) from *Etheostoma flabellare*. Scale bar = 30 μm .

high host specificity suggested by Suriano and Beverley-Burton (1982) for species of *Aethycteron*, we suspect that the record of *A. moorei* from *E. caeruleum* (no voucher specimens are available for examination) by Kozel and Whitaker (1982) represents *A. caerulei* Suriano and Beverley-Burton, 1982. Kozel and Whitaker (1982) reported this record (as *Urocleidus moorei*) almost simultaneously with Suriano and Beverley-Burton's (1982) original description of the genus *Aethycteron* and of *A. caerulei*. We suspect that both pairs of authors were unaware of the others' work, as neither cited the others' papers. Furthermore, Kozel and Whitaker (1982) used the genus *Urocleidus*, which was standard taxonomic practice until Suriano and Beverley-Burton (1982) partially synonymized *Urocleidus* (from darters) with *Aethycteron*. *Aethycteron caerulei* and *A. moorei* are morphologically very similar (Suriano and Beverley-Burton 1982; Cloutman and McAllister 2017); in fact, Suriano and Beverley-Burton (1982) compared the two species in their original description of *A. caerulei*. Thus, it is understandable that Kozel and Whitaker (1982) identified the monogenean on *E. caeruleum* as *Urocleidus moorei*.

Excluding the report of *A. moorei* from *E. caeruleum* discussed above, all records of *A. moorei* (Table 1) are from *E. flabellare*, and based on geographic distribution (Page and Burr 2011), the subspecies *E. f. flabellare* Rafinesque, in particular. The specimens reported herein extend the range of this widely distributed parasite into the far western portion of the range of *E. flabellare* (Page and Burr 2011) and represent the first records of *A. moorei* from west of the Mississippi River and from Arkansas and Oklahoma.

Numerous species of *Etheostoma* (including several in the subgenus *Catonotus*) have been described in recent decades, largely the result of splitting what were previously considered to be widely distributed species (including *E. flabellare*). Robins et al. (1980), Robins et al. (1991), Nelson et al. (2004), and Page et al. (2013) provide an overview and references of these taxonomic developments. Research concerning monogeneans on darters is in its infancy (Cloutman and McAllister 2017), as studies of parasites have not kept pace with those of their hosts. As a prime example, *E. flabellare* is only one of two of the 24 described species of *Catonotus* (Page and Burr 2011, Martin and

Table 1. Reports of hosts and localities of *Aethycteron moorei*.

Host	Locality	Reference
<i>Etheostoma caeruleum</i>	Tennessee	Kozel and Whitaker 1982*
<i>Etheostoma flabellare</i>	Tennessee	Mizelle 1940†
	Ontario, Canada	Suriano and Beverley-Burton 1982
	Arkansas‡, Oklahoma‡	This study

*Most likely represents *A. caerulei* (see text for discussion).

†Reported as *Urocleidus moorei*, a synonym of *A. moorei*.

‡New distributional records.

Page 2015) to have a monogenean reported from it (Hoffman 1999; Hanson and Stallsmith 2013). Hanson and Stallsmith (2013) reported an unidentified species of *Aethycteron* from the Stripetail Darter, *Etheostoma kennecotti* (Putnam) in Alabama. Much research is needed to determine the species diversity, host specificity, geographic distribution, intensity, prevalence, and harmfulness of monogenes on species of *Catonotus*, including the other two subspecies of *E. flabellare* not yet studied. Moreover, the same can be said for numerous other species of darters.

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Natural History Notes on Select Fauna (Decapoda, Actinopterygii) from Southeastern Oklahoma

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Abstract: Oklahoma is rich in biodiversity, mostly due to the vast differences in the various eco- and physiographic regions of the state that support that fauna. In particular are the distinctive fish assemblages found in the southeastern corner of the state in the coastal plain and upland streams of the Ouachita highlands in Le Flore and McCurtain counties. However, our knowledge of their ecology and natural history, as well as the geographic distribution of many species, is still not well understood. Here, we report some new information on select aspects of the natural history of a crayfish and several native fishes of the state. ©2016 Oklahoma Academy of Science

Introduction

Although there have been seminal publications on various fauna of Oklahoma, including those on crayfishes (Creaser and Ortenburger 1933; Reimer 1968; Morehouse and Tobler 2013), and fishes (Miller and Robison 2004), our knowledge of the geographic distribution, ecology and natural history of many of these organisms in the state is not well documented. A series of articles on the natural history of Arkansas' crayfishes and fishes have been reported over the last decade (Tumlison et al. 2016 and references therein). Here, in a similar manner, we provide a noteworthy report on aspects of the natural history of a crayfish and several native fishes of Oklahoma.

Methods

A single crayfish was collected by hand and preserved in 70% (v/v) ethanol. Fishes were taken with 3.1×1.8 m or 6.1×1.8 m seines (3.2 mm mesh) and/or with a backpack electrofisher, preserved in 10% formalin and stored in 45%

(v/v) isopropanol. Total length (TL) of fishes was also measured and all specimens examined for reproductive characters. Observations were made on specimens from Cherokee, Delaware, Le Flore, and McCurtain counties with specific localities reported as GPS (latitude and longitude) coordinates. Voucher specimens are deposited in the Henderson State University (HSU) Collection, Arkadelphia, Arkansas.

Results and Discussion

The collections described herein represent important records of geographic distribution or previously unknown observations of their natural history and are reported below in an annotated format as follows.

Decapoda: Cambaridae (cambarid crayfishes)

Orconectes neglectus neglectus (Faxon, 1885) – ringed crayfish. On 2 April 2016, a female *O. n. neglectus* “in berry” with 129 ova (1.2–1.5 mm in diameter, wet weight = 0.9 g) was collected from the outflow of an unnamed cave off county road 660 in vicinity of Flint, Delaware County (36°12'27.83"N, 94°42'15.78"W). Creaser and Ortenburger (1933) and Reimer (1968) did not

report on reproduction of *O. neglectus* in the state nor did Williams (1954) in adjacent Arkansas. However, a female in berry was reported in late April from a subterranean stream in January-Stansberry Cave, Delaware County, but the number of eggs were not reported (Fenolio et al. 2013). In Arkansas, 15 females in berry were collected by Reimer (1963, *unpublished thesis*) in May from burrows near the edge of a clear, fast-moving stream. Also, females in berry have been reported in March and April from introduced populations in the Spring River drainage of Arkansas and Missouri (Magoulick and DiStefano 2007; Larson and Magoulick 2008). Pflieger (1996) reported females in berry in Missouri from March through June with 18 females carrying 54 to 505 eggs (mean 245). This is the first time ova have been quantified from an *O. n. neglectus* in Oklahoma.

**Actinopterygii: Petromyzontiformes:
Petromyzontidae (lampreys)**

Ichthyomyzon gagei Hubbs and Trautman, 1937 – Southern Brook Lamprey. A gravid female *I. gagei* (164 mm TL) was collected by CTM on 31 January 2016 from Yashau Creek off the US 70 bridge, just S of Broken Bow, McCurtain County (33° 59' 14.3952"N, 94° 44' 36.6174"W). This specimen was taken using a backpack electrofisher near the upper end of a riffle in gravel and sandy substrate. It contained ~6,000 ova (wet weight = 3.0 g); however, unyolked eggs were not considered in this count and some may regress before spawning, thus reducing the count. In an Alabama population of *I. gagei*, number of oocytes ranged from 820 to 2,485 (William and Beamish 1982). In addition, Beamish et al. (1994) noted that females produce on average about 1,500 eggs and Etnier and Starnes (1993) reported from 800–2,500 eggs. Nothing has been previously reported on reproduction of *I. gagei* in Oklahoma (Miller and Robison 2004).

The Southern Brook Lamprey is listed as vulnerable (S3) in Oklahoma (NatureServe 2015). This current specimen is also important as it represents a new distribution record. Miller and Robison (2004, p. 47) shade the distribution just north of the current locale in the Ouachita

uplift so we extend the distribution southward into the Little River drainage.

Ichthyomyzon castaneus Girard, 1858 – Chestnut Lamprey. In Oklahoma, spawning of *I. castaneus* has been observed by HWR in the upper Mountain Fork River, Le Flore County, over a nest in coarse gravel substrate. Five individuals (two males and three females) were observed spawning approximately 1.2 m from shore in swift water, 0.5 m deep, over a large excavated gravel nest ca. 0.61 m long × 0.15 m wide on a coarse gravel bottom 0.15 m deep on 23 April 1984. Water temperature was 17.8°C.

An adult (139 mm TL) *I. castaneus* was collected by a local fisherman (Michael Hill) on 2 April 2016 attached to an adult Walleye (*Sander vitreus*) at Broken Bow Lake, McCurtain County (34° 10' 49.8612"N, 94° 41' 29.5722"W). Although there are unpublished and anecdotal accounts of infestation of “lampreys” from the Great Lakes on Walleye (although most of these appear to be from Silver Lampreys, *Ichthyomyzon unicupis*), this is the first time, to our knowledge, *I. castaneus* has been documented from a Walleye with a representative voucher specimen.

Cypriniformes: Cyprinidae (carps and minnows)

Campostoma spadiceum (Girard, 1856) – Highland Stoneroller. Populations representing this species in Oklahoma were formerly assigned to *Campostoma anomalum pullum* with *C. spadiceum* recognized as a distinct species and redescribed by Cashner et al. (2010). Two gravid *C. spadiceum* (116, 119 mm TL) were collected by CTM on 13 February 2016 from Yashau Creek off US 70 bridge, just S of Broken Bow, McCurtain County (33° 59' 14.3952"N, 94° 44' 36.6174"W). Nothing has been reported previously on reproduction in Oklahoma *C. spadiceum*.

Lythrurus snelsoni (Robison, 1985) – Ouachita Mountain Shiner. Miller and Robison (2004) reported spawning of *L. snelsoni* occurred from late May to mid-July in Oklahoma. Robison and Buchanan (1988) quoted field notes taken

by Drs. George A. Moore and Frank B. Cross on 30 May 1948 of the reproduction of *L. snelsoni* below the dam on Mountain Fork River, McCurtain County. We report observations of *L. snelsoni* spawning from four different years: namely 14 May 1982, 27 May 1985, 3 June 1990, and 15 June 1994 in the upper Mountain Fork River at Smithville, Le Flore County (34° 27' 40.6008"N, 94° 38' 9.4452"W). Observations by HWR while snorkeling revealed that the Ouachita Mountain Shiner is a midwater, schooling species that feeds from the surface and the water column. Feeding from the surface was observed numerous times. In each of the four years observed (1982, 1985, 1990, and 1994), tuberculate males and gravid females were present at the Smithville site. Breeding males developed red coloration dorsally on the head from the top of the snout to the occiput, and on the chin, and the anterior third of the gular area (Robison 1985). Our observations of courtship were similar to those of Moore and Cross in that females and males swam together in schools in pools where water depth was approximately 0.9–1.2 m just off beds of water willow (*Justicia americana*). Water temperature in the pools ranged from 18.3–25°C. Courtship began when a male would pursue a female and appeared to nudge or bump her side. Aggressive tendencies were shown by males if another male came close to the area of interaction as the first male would dart out and drive the other male away. After these brief encounters, the first male would always return to the side of the original female he seemed to be guarding. Such behavior was repeated numerous times. Unfortunately, actual

spawning was not observed and no eggs were ever collected. Tuberculate males have been taken by HWR as early as 10 May from the Smithville locality and gravid females have been collected there into early July.

Siluriformes: Ictaluridae (catfishes)

Ameiurus natalis (Lesueur, 1819) – Yellow Bullhead. An adult *A. natalis* was collected on 10 October 2015 from the Little River at Cow Creek Crossing, McCurtain County (33° 56' 38.2122"N, 94° 37' 53.7342"W). This specimen was found to have an unusual forked maxillary barbel (Fig. 1). The barbel might have been injured or split which resulted in the abnormal growth. Forked barbels have been previously reported in other catfishes (Rao and Reddy 1984); however, to our knowledge, this is the first report in a North American Yellow Bullhead.

Noturus exilis Nelson, 1876 – Slender Madtom. One of seven (14%) *N. exilis* (female with eggs, 60 mm TL) collected on 5 June 2015 from a tributary of the Illinois River, Cherokee County (36° 07' 16.2006"N, 94° 48' 21.3732"W) was found to have a leech in its stomach. *Noturus exilis* usually feeds on aquatic insect larvae, crustaceans, nematodes, and gastropods (Curd 1960; Mayden and Burr 1981). There is no previous report of leeches eaten by this madtom.

Esociformes: Esocidae (pikes)

Esox americanus vermiculatus Lesueur, 1846 – Grass Pickerel. On 13 February 2016, a 90



Figure 1. Yellow Bullhead from Little River with forked maxillary barbel (arrow).

mm TL female *E. a. vermiculatus* with eggs was collected by CTM from Yashau Creek at Airline Drive, McCurtain County (34° 01' 8.0184"N, 94° 45' 24.2634"W). This fish was previously known to spawn from late February through early March in Oklahoma (Miller and Robison 2004).

Perciformes: Aphredoderidae (pirate perches)

Aphredoderus sayanus (Gilliams, 1824) – Pirate Perch. A gravid *A. sayanus* (75 mm TL) was collected by CTM on 13 February 2016 from Yashau Creek at Airline Drive, McCurtain County (34° 01' 8.0184"N, 94° 45' 24.2634"W). Two additional *A. sayanus* (93 and 105 mm TL) with eggs were collected on 28 February 2016 from the same locale. In Arkansas, Tumlison et al. (2015) reported collecting a male running milt on 6 April 2014 from Floyd, White County. Tiemann (2004) reported that two sizes of eggs were present in ovaries (mature and immature) of *A. sayanus*, with a mean of 78 and 124 eggs, respectively. In Oklahoma spawning occurs in spring (Miller and Robison 2004).

Percidae (perches)

Etheostoma artesia (O. P. Hay, 1881) – Red-spot Darter. An adult male (64 mm TL) *E. artesia* was found in breeding color (with bands of blue, white, and red [proximally] on its median fins) on 13 February 2016 at Yashau Creek at the US Hwy 70 bridge just S of Broken Bow, McCurtain County (33° 59' 14.3952"N, 94° 44' 36.6174"W). In addition, a female (71 mm TL) with eggs was collected at the same site on the same date. Miller and Robison (2004) reported that *E. artesia* spawned in the spring but little else is known about its biology in Oklahoma.

Etheostoma squamosum (Distler, 1968) – Plateau Darter. Four of nine (44%) female *E. squamosum* (42–53 mm TL) were found with eggs as well as two adult males (47, 55 mm TL) in breeding color (with 8-9 brilliant bars on their sides with more or less bright orange between them) collected on 2 April 2016 from Flint Creek, Delaware County (36° 11' 55.734"N, 94° 42' 27.0504"W). Spawning of *E. squamosum* (formerly *E. spectabile squamosum*) in Oklahoma occurs from late February to May

(Miller and Robison 2004).

In summary, Oklahoma contains a tremendous variety of fauna, including 30 species of crayfishes (Morehouse and Tobler 2011) and 180+ species of fishes (Miller and Robison 2004). Much can be gained by reporting novel natural history information on both invertebrates and vertebrates of the state. Here, we report reproductive information on a crayfish and several fishes from Oklahoma, as well as other natural history data. Additional documentation of similar natural history is warranted.

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