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## Comparative Study of Helminth Parasites of the Many-Ribbed Salamander, *Eurycea multiplicata* and Oklahoma Salamander, *Eurycea tynnerensis* (Caudata: Plethodontidae), from Arkansas and Oklahoma, A

C. T. McAllister

*Eastern Oklahoma State College, cmcallister@se.edu*

M. B. Connior

*South Arkansas Community College*

C. R. Bursey

*Pennsylvania State University*

H. W. Robison

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# A Comparative Study of Helminth Parasites of the Many-Ribbed Salamander, *Eurycea multiplicata* and Oklahoma Salamander, *Eurycea tynerensis* (Caudata: Plethodontidae), from Arkansas and Oklahoma

C.T. McAllister<sup>1\*</sup>, M.B. Connior<sup>2</sup>, C.R. Bursey<sup>3</sup>, and H.W. Robison<sup>4</sup>

<sup>1</sup>Division of Science and Mathematics, Eastern Oklahoma State College, Idabel, OK 74745  
<sup>2</sup>Health and Natural Sciences, South Arkansas Community College, El Dorado, AR 71730  
<sup>3</sup>Department of Biology, Pennsylvania State University, Shenango Campus, Sharon, PA 16146  
<sup>4</sup>9717 Wild Mountain Drive, Sherwood, AR 72120

\*Correspondence: cmcallister@se.edu

Running Head: Helminths of *Eurycea* spp.

## Abstract

Ninety many-ribbed salamanders, *Eurycea multiplicata* and 135 Oklahoma salamanders, *Eurycea tynerensis* were collected between April 2010 and April 2014 from 14 counties of Arkansas and McCurtain County, Oklahoma (*E. multiplicata* only) and examined for helminth parasites. Twelve (13%) *E. multiplicata* were infected, including two (2%) each with *Brachycoelium salamandrae*, *Bothriocephalus rarus*, *Batracholandros magnavulvaris*, *Cosmocercoides variabilis*, and *Omeia papillocauda*, and one (1%) each with an oligacanthorhynchid cystacanth and *Fessisentis vanacleavei*. Forty-one (30%) of the *E. tynerensis* were infected, including seven (5%) with *Gorgoderina tenua*, two (1%) each with *Phyllodistomum solidum* and cyclophyllidean tapeworm cysticerci, one (0.7%) with *Cylindrotaenia americana*, six (3%) with *B. rarus*, eight (12%) with *Desmognathinema nantahalaensis*, 10 (7%) with *O. papillocauda*, two (1%) with *Amphibiocapillaria tritonipunctata* and six (4%) with *F. vanacleavei*. We document 13 new host and two new distributional records for helminths of these salamanders. In addition, a summary of the endoparasites of *E. multiplicata* and *E. tynerensis* is provided.

## Introduction

The many-ribbed salamander, *Eurycea multiplicata* ranges south of the Arkansas River and throughout the Ouachita Mountains of west-central Arkansas and adjacent southeastern Oklahoma (Trauth et al. 2004, Sievert and Sievert 2011). It is a metamorphic surface-dwelling plethodontid that frequents aquatic sites including abandoned mine shafts and spring seeps and can also be found under

damp rocks and logs in deciduous forest. Although much has been published on the ecology of *E. multiplicata* (Dundee 1965, Trauth and Dundee 2005), little is published about its helminth parasites. McAllister and Bursey (2010) examined 66 *E. multiplicata* from Arkansas and Oklahoma and reported three species of nematodes.

The Oklahoma salamander, *Eurycea tynerensis* (Ozark gray-belly salamanders, *Eurycea multiplicata griseogaster* Moore and Hughes 1941 = *E. tynerensis* [sensu Bonett and Chippendale 2004]) ranges north of the Arkansas River in the state throughout the Ozark Highlands and westward to northeastern Oklahoma where it is found in cool springs, spring-fed creeks with cherty gravel bottoms and cave streams (Trauth et al. 2004). Likewise, a great deal has been published on the biology of this salamander (Dundee 1965, Ireland 1976, Cline et al. 1989, 1997, 2001, Tumblison et al. 1990a, b, Tumblison and Cline 2003, Bonett 2005, Emel and Bonett 2011, Martin et al. 2012, Connior et al. 2014) but less is available on its helminths. However, most studies are of a fragmentary nature including: Hughes and Moore (1943a,b) who described an acanthocephalan (*Fessisentis vanacleavei*) and a monogenean (*Sphyranura euryceae*) from *E. tynerensis* from Cherokee County, Oklahoma; Malewitz (1956) reported *F. vanacleavei* from specimens from Cherokee County; Buckner and Nickol (1978) provided a redescription of *Fessisentis vanacleavei* (Acanthocephala) from *E. tynerensis* from Oklahoma; McAllister et al. (1991) reported *S. euryceae* from *E. tynerensis* from Arkansas; Bonett et al. (2011) reported on *Clinostomum marginatum* in *E. tynerensis* from Oklahoma; and McAllister et al. (2011) provided a study of *S. euryceae* from *E. tynerensis* from northeastern Oklahoma. In the most thorough survey to date, McAllister et al. (1995b) reported trematode,

nematode, and acanthocephalan parasites from *E. tynerensis* (= *E. m. griseogaster*) from seven counties of the Arkansas River Valley. There have also been several unpublished theses on parasites of this salamander from Arkansas and Oklahoma, and while not mentioned specifically herein, they are referenced in McAllister et al. (1995b, 2011).

Here, we provide 13 new host and two new distribution records for some helminth parasites of *E. multiplicata* and *E. tynerensis*. In addition, a summary of their endoparasites is reported.

## Materials and Methods

Between April 2010 and April 2014, 90 larval and adult *E. multiplicata* (mean  $\pm$  snout-vent length [SVL] =  $35.2 \pm 6.6$ , 19-48 mm) were collected by hand or aquatic dip-net from (sample sizes in parentheses) Clark (4), Conway (21), Garland (1), Montgomery (21), Polk (1) and Saline (40) counties, Arkansas, and McCurtain (2) County, Oklahoma; 135 larval, paedomorphic and adult *E. tynerensis* ([SVL] =  $41.5 \pm 5.3$ , 23-53 mm) were collected in the same manner from Benton (3), Carroll (5), Cleburne (8), Franklin (5), Johnson (9), Marion (36), Searcy (68) and Washington (1) counties (Fig. 1).

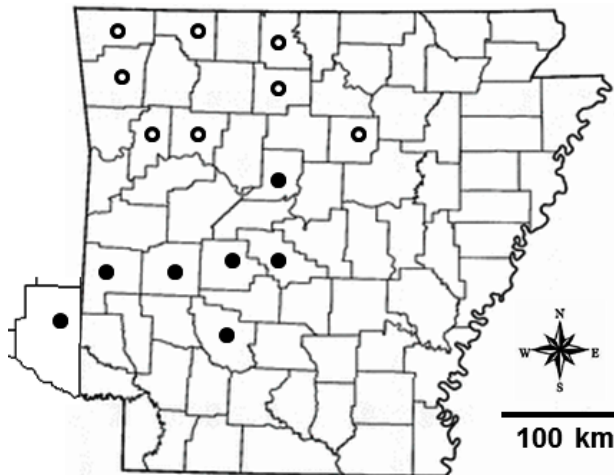


Figure 1. Arkansas and se corner of Oklahoma. Solid dots mark counties where *Eurycea multiplicata* were collected on the Ouachita Plateau/Arkansas River Valley; open dots mark counties where *Eurycea tynerensis* were collected on the Ozark Plateau.

Specimens were placed in habitat water on ice and taken to the laboratory for necropsy. Salamanders were killed by prolonged immersion in a dilute chloretone® (chlorobutanol) solution. If gills were present, they were examined for monogeneans under a stereomicroscope. A mid-ventral incision was made to

expose the viscera and the entire gastrointestinal tract, liver, gall bladder, spleen, urinary bladder and gonads were examined for helminths. Trematodes and cestodes were stained with acetocarmine and mounted in Canada balsam, and nematodes and acanthocephalans were placed on a glass slide in a drop of undiluted glycerol for identification. Prevalence, mean intensity, and range of infection are provided and are in accordance with terminology given in Bush et al. (1997). Helminth voucher specimens were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland. Host voucher specimens were deposited in the Arkansas State University Museum of Zoology, Herpetological Collection (ASUMZ) as ASUMZ 32605-32611 and 32616.

## Results and Discussion

We found 13 helminths, including three trematodes, three cestodes, five nematodes, and two acanthocephalans. Six helminths were found in *E. multiplicata* and 10 helminths were harbored by *E. tynerensis*; four helminths were shared by both species. Twelve (13%) of the *E. multiplicata* and 41 (30%) of the *E. tynerensis* harbored at least one helminth. A detailed annotated list of the helminths recovered from *E. multiplicata* and *E. tynerensis* is presented below, with a Table summarizing all helminths reported from these two hosts.

### TREMATODA

#### Digenea: Brachycoeliidae

*Brachycoelium* cf. *salamandrae* (Frölich, 1789) Dujardin, 1845. – We tentatively document *B. salamandrae* (Fig. 2) in three (3%) *E. multiplicata*. A larval specimen (35 mm SVL) from Cox Spring off St. Hwy. 8, Montgomery County (34.456421°N, 93.845254°W) had six worms and two adults (34, 38 mm SVL) from Shannon Hills, Saline County (34.60996°N, 92.43227°W) possessed two and three worms in their small intestine, respectively. McAllister et al. (1995) reported *B. salamandrae* from *E. tynerensis* from Conway County. Other hosts from Arkansas include six salamanders, four frogs/toads and a skink (McAllister 2013c, 2014). Interestingly, McAllister et al. (2014) recently noted they had serious doubts about Old World and New World *B. salamandrae* being conspecific (see summary by Bursey et al. 2012), and suggested caution with their former conclusions (McAllister et al. 2013d) and until a molecular approach was completed (V.V. Tkach,

## Helminths of *Eurycea* spp.

*pers. comm.*). However, regardless what species is eventually verified, this is a new host record for the genus *Brachycoelium*.

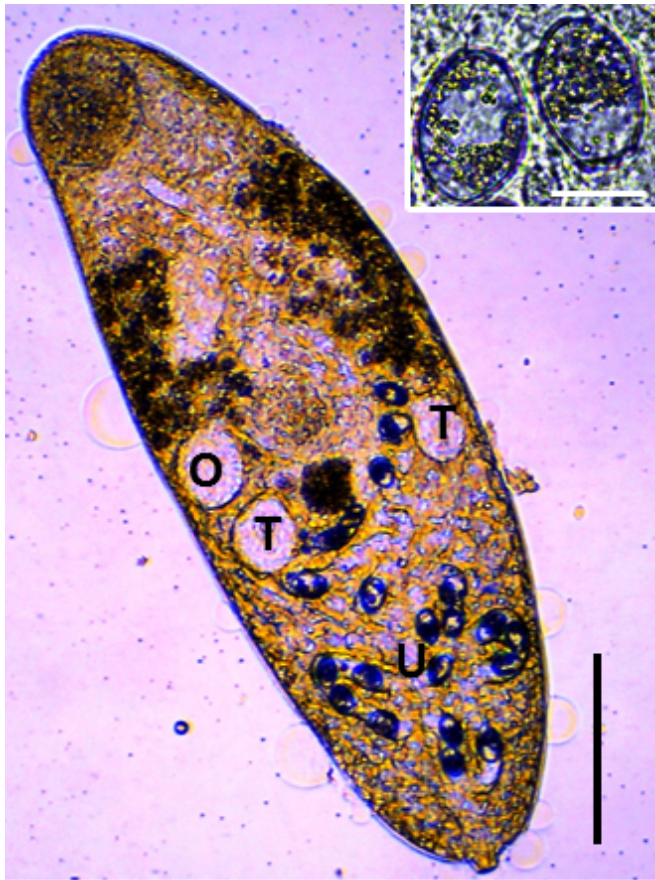


Figure 2. *Brachycoelium* cf. *salamandrae* from *Eurycea multiplicata*, Saline County, Arkansas. Note uterus (U) with ova; scale bar = 200  $\mu$ m. Abbreviations: O (ovary); T (testes). Inset: two ova; scale bar = 25  $\mu$ m.

### Gorgoderidae

*Phyllodistomum solidum* Rankin, 1937. –Two (3%) *E. tynerensis* from 3 km S of Mull off Ramblewood Trail, Searcy County (36.059975°N, 92.59847°W) were infected with three and one *P. solidum*, respectively. Interestingly, the specimens (USNPC 108057) came from the intestinal tract of these salamanders, not the urinary bladder. This digenean has been previously reported from northern dusky salamander, *Desmognathus fuscus* from Illinois (Dyer 1986), New York (Goodchild 1943 [experimental infection]), North Carolina (Rankin 1937a, b) and Ohio (Groves 1945) and northern two-lined salamander, *Eurycea bislineata* from Ohio (Groves 1945). The life cycle involves fingernail clams (*Pisidium* sp.) as first intermediate hosts and dragonfly nymphs as second intermediate hosts

(Goodchild 1943). Thus, we document a new host and a significant new geographic record for *P. solidum*.

*Gorgoderina tenua* Rankin, 1937 – Seven *E. tynerensis* ( $42.9 \pm 3.3$ , 36–46 mm SVL) from 3 km S of Mull off Ramblewood Trail, Searcy County (36.059975°N, 92.59847°W) were infected with one to four (mean intensity =  $1.4 \pm 1.1$ ) *G. tenua*. Rankin (1937a) described *G. tenua* from three-lined salamander (*Eurycea guttolineata*) from North Carolina. There are currently at least 52 recognized species of *Gorgoderina* Looss, 1902 with five from North American salamanders (*Ambystoma*, *Eurycea*, *Desmognathus*, *Pseudotriton*, *Necturus*, *Notophthalmus* spp.) (Mata-López et al. 2005). Rosen and Manis (1976) reported *Gorgoderina attenuata* (Stafford, 1902) Stafford 1905 and *Gorgoderina schistorchis* Steelman, 1938 from American bullfrog (*Lithobates catesbeianus*) and Red River mudpuppy (*Necturus maculosus louisianensis*) from Arkansas, respectively. This is only the second report of *G. tenua* since the original description and we document a new host and geographic record. Molecular analysis of the ITS2/28S region is ongoing (T.J. Fayton, *pers. comm.*).

## CESTOIDEA

### Cyclophyllidea

Two *E. tynerensis* (3%) from Panther Creek at Mull, Marion County (36.082643°N, 92.594726°W) harbored unknown cyclophyllidean tapeworm cysticerci in the mesenteries. Cysticerci were spheroidal to ovoidal and possessed calcareous corpuscles (USNPC 107940, Fig. 3). This is the first time cyclophyllidean tapeworm cysticerci have been reported from this salamander.

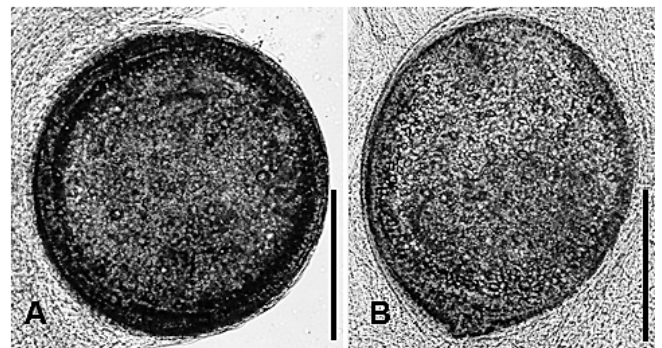


Figure 3. Unknown tapeworm cysticerci from *Eurycea tynerensis*, Marion County, Arkansas. (A) Spheroidal shape (B) Ovoidal shape. Scale bars = 25  $\mu$ m.

**Cyclophyllidea: Cyndrotaeniidae**

*Cyndrotaenia americana* Jewell, 1916. – One (2%) *E. tynerensis* (40 mm SVL) from a spring seep S of Oark off St. Hwy. 103, Johnson County (35.5929°N, 93.584011°W) had nine immature cyclophyllidean tapeworms (USNPC 107961) in the small intestine that match the description of *C. americana* (Jewell 1916). Previous hosts from Arkansas include Ouachita dusky salamander, *Desmognathus brimleyorum*, western slimy salamander, *Plethodon albagula*, Ozark zig-zag salamander, *Plethodon angusticlavius* and bird-voiced treefrog, *Hyla avivoca* (see McAllister et al. 2013c). There are many other amphibian hosts of *C. americana* and its geographic range stretches north to south from Alberta, Canada to Uruguay, including 18 U.S. states, two provinces of Canada, Trinidad, Costa Rica, Mexico, and seven South American countries (see McAllister et al. 2013c). We document a new host record and the first report of this tapeworm in salamanders of the genus *Eurycea*.

**Pseudophyllidea: Bothriocephalidae**

*Bothriocephalus rarus* Thomas, 1937. – Two (2%) *E. multiplicata* (37, 38 mm SVL) collected from Shannon Hills, Saline County (34.60996°N, 92.43227°W) each harbored one worm, and six (4%) *E. tynerensis*, one (30 mm SVL) from Spavinaw Creek, Benton County (36.353059°N, 94.552347°W) and five (35.1 ± 4.5, 29-45 mm SVL) from 3 km S of Mull, Searcy County (36.059975°N, 92.59847°W) were infected with *B. rarus* (USNPC 107958, 107960) (Fig. 4) in their small intestines. Intensity of infection was 1.5 ± 0.9, 1-3 worms. This tapeworm has been previously reported from the dwarf salamander, *Eurycea quadridigitata* and dark-sided salamander, *Eurycea longicauda melanopleura* from Arkansas (McAllister and Bursey 2003, 2004) as well as several other salamanders from California, Kentucky, Michigan, Missouri, New Hampshire, Ohio, Pennsylvania, Tennessee, and West Virginia (see McAllister et al. 2013b). We document two new host records for *B. rarus*.

**NEMATODA****Seuratoidea: Quimperiiidae**

*Desmognathinema nantahalaensis* Baker, Goater, and Esch, 1987. – Eight (12%) *E. tynerensis* (39.2 ± 5.6, range 28-47 mm SVL) harbored a total of 17 (mean intensity = 2.2 ± 1.9, range 1-6) *D. nantahalaensis* (USNPC 107937, 107941) in their small intestines. One salamander came from S of Oark off St. Hwy. 103, Johnson County (35.5929°N,

93.584011°W), one was collected from 3.2 km S of Cass off St. Hwy. 23, Franklin County (35.646329°N, 93.839612°W), one came from a wellhouse off St. Hwy. 59 N of Gentry, Benton County (36.299061°N, 94.450533°W), three were collected from Panther Creek at Mull, Marion County (36.082643°N, 92.594726°W) and two were taken 3 km S Mull, Searcy County (36.059975°N, 92.59847°W). The Oklahoma salamander (as *E. m. griseogaster*) and cave salamander, *Eurycea lucifuga* from Arkansas have previously been reported as hosts of this nematode (McAllister and Bursey 2004, McAllister et al. 1995a). In addition, *E. multiplicata* from Oklahoma is a host (McAllister and Bursey 2010) as well as *Desmognathus quadramaculatus* (type host) and *Desmognathus monticula* from North Carolina (Baker et al. 1987). Interestingly, the disjunct range of *D. nantahalaensis* includes only three states, Arkansas, North Carolina, and Oklahoma.

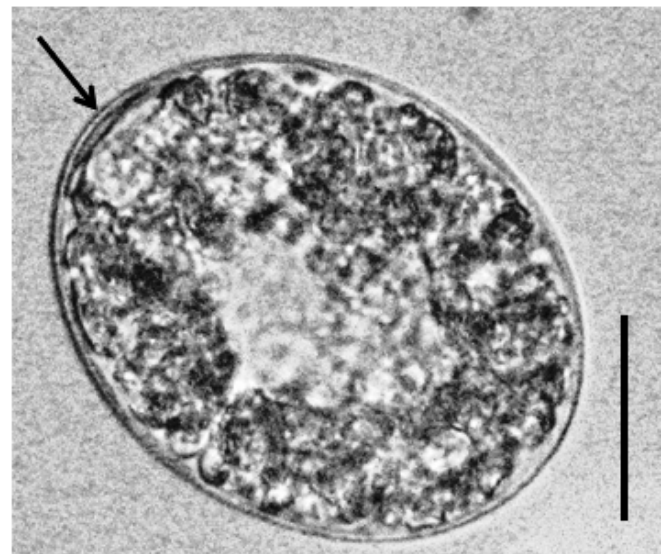


Figure 4. Ovum of *Bothriocephalus rarus* from *Eurycea multiplicata*, Saline County, Arkansas. Note operculum (arrow). Scale bar = 50 µm.

*Omeia papillocauda* Rankin, 1937. – Two (2%) *E. multiplicata* were infected, a single (35 mm SVL) specimen from Tanyard Springs, Conway County (35.115908°N, 92.916619°W) had one larval worm and one (32 mm SVL) salamander from 4 km NW of Caddo Valley and 1 km W of St. Hwy. 7, Clark County (34.215204°N, 93.095655°W) had one larval and two male *O. papillocauda*. In addition, 10 (7%) *E. tynerensis*, three (41-43 mm SVL) from Panther Creek at Mull, Marion County (36.082643°N, 92.594726°W) and seven (40.6 ± 7.2, 34-52 mm SVL) from 3 km S

**Helminths of *Eurycea* spp.**

Mull, Searcy County (36.059975°N, 92.59847°W) possessed a total of 26 ( $2.6 \pm 3.1$ , 1-11) *O. papillocauda* (Fig. 5, USNPC 107938) in their stomachs. Many-ribbed salamanders from Arkansas have been previously reported as hosts of *O. papillocauda* (McAllister and Bursey 2010). It has also been reported from *D. brimleyorum* (McAllister et al. 1995d) and *D. monticola* from Arkansas (Connior et al. 2013). This nematode has also been reported from several other members of the genus *Eurycea* as well as *Desmognathus* and *Gyrinophilus* from Alabama, North Carolina, Ohio, and Tennessee (see McAllister and Bursey 2010). We document a new host record for *O. papillocauda* in *E. tynerensis*.

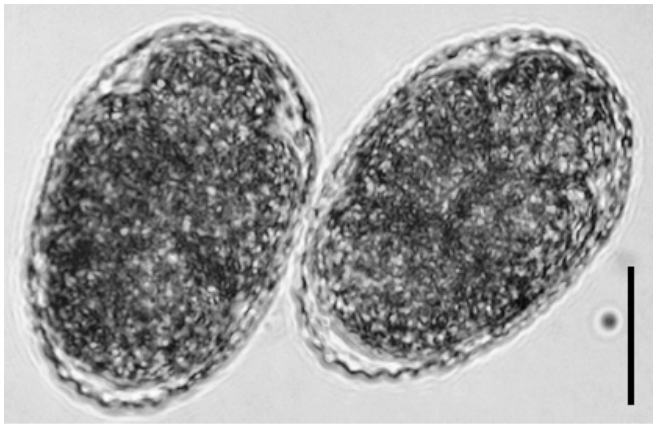


Figure 5. Embryonated ova of *Omeia papillocauda* from *Eurycea tynerensis*, Marion County, Arkansas. Note outer rugose shell. Scale bar = 25  $\mu$ m.

**Oxyurida: Pharyngodonidae**

*Batracholandros magnavulvaris* (Rankin, 1937) Petter and Quentin, 1976. – Two (2%) *E. multiplicata* (43, 45 mm SVL) from Petit Jean State Park, Conway County (35.114642°N, 92.943574°W) each harbored one female pinworm (USNPC 107942) in its rectum. In addition, a single (3%) *E. tynerensis* (30 mm SVL) from Spavinaw Creek, Benton County (36.353059°N, 94.552347°W) had three female *B. magnavulvaris* (USNPC 107959) in the rectum. McAllister et al. (2013c) recently summarized records of *B. magnavulvaris* in caudate amphibians, including seven species of salamanders from Arkansas. There are four other members of the genus *Eurycea* reported as hosts of this oxyurid from Alabama, Michigan, North Carolina and Tennessee (see McAllister et al. 2013c). The many-ribbed and Oklahoma salamander are new hosts of *B. magnavulvaris*, which exhibits a direct life cycle (Anderson 2000).

**Enoplida: Capillaridae**

*Amphibiocapillaria tritonispunctati* (Diesing, 1851) Moravec, 1982. – Two (1%) *E. tynerensis*, one (43 mm SVL) from Lake Leatherwood, Carroll County (36.442033°N, 93.756562°W) and the other (30 mm larvae) from Savoy Cave, Washington County (36.109846°N, 94.340588°W) possessed six and one *A. tritonispunctati* (USNPC 107936) in their small intestine (Fig. 6). This nematode was previously reported from Arkansas in *E. spelaea* (McAllister et al. 2006) and *P. angusticlavius* (McAllister et al. 2013c). In addition, McAllister et al. (2013c) provided a summation of records of *A. tritonispunctati* in Nearctic and Palearctic amphibians of the world; only two members of the genus *Eurycea* have been previously reported as hosts of this worm and we add one more.

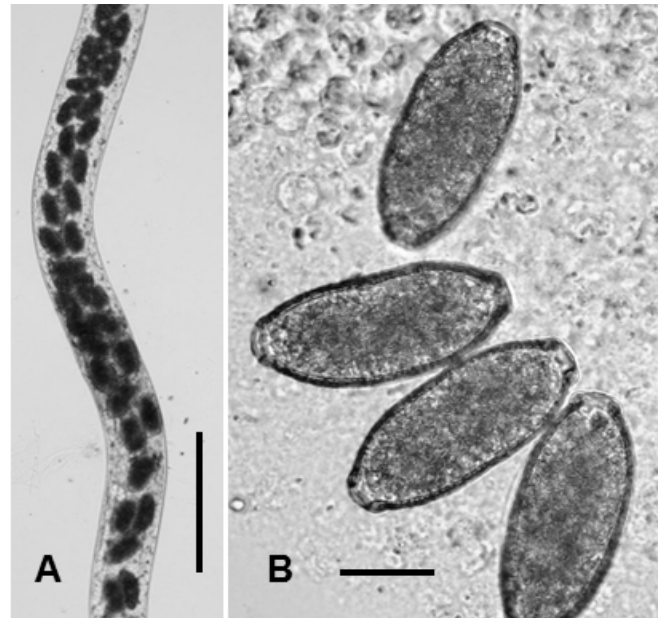


Figure 6. *Amphibiocapillaria tritonispunctati* from *Eurycea tynerensis*, Carroll County, Arkansas. (A) Gravid female showing numerous ova; scale bar = 100  $\mu$ m. (B) Higher magnification of four individual ova from same showing typical capillariid morphology; scale bar = 25  $\mu$ m.

**Ascarida: Cosmocercidae**

*Cosmocercoides variabilis* (Harwood, 1930) Travassos, 1931. – Two (2%) *E. multiplicata* (34, 37 mm SVL) from Shannon Hills, Saline County (34.60996°N, 92.43227°W) harbored one female and two male *C. variabilis* (USNPC 107939) in the large intestine, respectively. Previously, only female *Cosmocercoides* sp. was reported from this same host species and same population by McAllister and Bursey (2010); since only females were found it was not possible to assign their specimens to species. In

Arkansas, *C. variabilis* has been reported from ringed salamander, *Ambystoma annulatum*, *E. l. melanopleura*, *E. lucifuga*, Caddo Mountain salamander, *Plethodon caddoensis*, Rich Mountain salamander, *Plethodon ouachitae*, pickerel frog, *Lithobates palustris* and Cajun chorus frog, *Pseudacris fouquettei* (see McAllister et al. 2013a). Nematodes of this genus/species are common in both amphibians and reptiles and its range includes at least 24 U.S. states, four provinces of Canada, Mexico, Costa Rica and Panama (summarized by Bursey et al. 2012, McAllister et al. 2013d). We document a new host record for *C. variabilis*.

## ACANTHOCEPHALA

### Oligacanthorhynchidae (cystacanth)

An unknown oligacanthorhynchid cystacanth (USNPC 107944) was found in one (1%) *E. multiplicata* (39 mm SVL) from Petit Jean State Park, Conway County (35.114642°N, 92.943574°W). There is only one previous report of this parasite from an Arkansas salamander, the western slimy salamander, *Plethodon albagula* (McAllister et al. 1993). Juvenile stages of oligacanthorhynchid acanthocephalans have been found in other amphibians (Moore 1946, McAlpine 1996), reptiles (Elkins and Nickol 1983) and mammals (Radomski 1991). However, Elkins and Nickol (1983) and Bolette (1997) consider reptiles in these instances to be paratenic hosts and we believe salamanders are accidental or transport hosts acting as a trophic bridge between intermediate and definitive hosts. For those acanthocephalans parasitic in terrestrial animals, the intermediate hosts are usually insects (Nickol 1985). Salamanders are known to eat insects (Trauth et al. 2004) and thus, might be expected to become infected. We document a new host record.

### Echinorhynchida: Fessisentidae

*Fessisentis vancleavei* (Hughes and Moore, 1943) Nickol, 1972 – Six (4%) *E. tynerensis* (47.3 ± 5.9, 40-55 mm SVL), one collected from S of Oark off St. Hwy. 103, Johnson County (35.5929°N, 93.584011°W), another from 3.2 km S of Cass off St. Hwy. 23, Franklin County (35.646329°N, 93.839612°W) and four from JFK Park, Little Red River, Cleburne County (35.512919°N, 91.997125°W) was found to harbor a total of 18 (3.1 ± 2.4, 1-7) *F. vancleavei* (USNPC 107962). In addition, one of two (50% [overall prevalence = 1%]) larval *E. multiplicata* (30 mm SVL) from Beavers Bend State Park off St. Hwy. 259A, McCurtain County, Oklahoma (34.113292°N, 94.708729°W) had a single

acanthocephalan (USNPC 107943). *Fessisentis vancleavei* has been previously reported from *E. tynerensis* in Arkansas (Buckner and Nickol 1978, McAllister et al. 1995b) and Oklahoma (Hughes and Moore 1943a, Malewitz 1956). The life cycle of *Fessisentis* spp. involves aquatic isopods as intermediate hosts (Buckner and Nickol 1979). *Eurycea multiplicata* is a new host of *F. vancleavei*.

This paper represents the second report of endoparasites of *E. multiplicata* and only the second thorough survey of *E. tynerensis* for helminths. We document 13 new host records for *E. multiplicata* and *E. tynerensis* and new distributional records for *P. solidum* and *G. tenua*. As noted by McAllister and Bursey (2010), the number of parasite species in *E. multiplicata* should increase with further study, and they did here by 50%, from three to six with our additional survey. Where comparisons are made, helminths shared by both salamanders include a trematode (*B. salamandrae*), a tapeworm (*B. rarus*), three nematodes (*B. magnavulvaris*, *D. nantahalaensis*, *O. papillocauda*) and an acanthocephalan (*F. vancleavei*), with most exhibiting prevalences < 5% (Table 1). Therefore, studies on these salamanders lend support to Aho's (1990) contention that caudate species are among the most depauperate hosts of all vertebrates. We suggest that future studies should include a larger sample size of *E. multiplicata* and *E. tynerensis* from a variety of localities in Oklahoma. In addition, if samples of the recently described and related Ouachita streambed salamander, *Eurycea subfluvicola* (Steffen et al. 2014) from Arkansas become available for study, it will be interesting to see if its helminth parasites are shared with *E. multiplicata* and *E. tynerensis*, particularly in areas of sympatry with the former.

### Acknowledgments

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**Helminths of *Eurycea* spp.**Table 1. Summary of helminth parasites of *Eurycea multiplicata* and *Eurycea tynereensis*.

Helminth	State	Prevalence*	Reference
<b><i>Eurycea multiplicata</i></b>			
<b>Trematoda</b>			
<i>Brachycoelium</i> cf. <i>salamandrae</i> †	Arkansas	2/88 (2%)	This study
<b>Cestoidea</b>			
<i>Bothriocephalus rarus</i> †	Arkansas	2/88 (2%)	This study
<b>Nematoda</b>			
<i>Batracholandros magnavulvaris</i> †	Arkansas	2/88 (2%)	This study
<i>Cosmocercoides</i> sp.‡	Arkansas	3/61 (5%)	McAllister and Bursey (2010)
<i>Cosmocercoides variabilis</i> †	Arkansas	2/88 (2%)	This study
<i>Desmognathinema nantahalaensis</i>	Oklahoma	3/5 (60%)	McAllister and Bursey (2010)
<i>Omeia papillocauda</i>	Arkansas	1/61 (2%)	McAllister and Bursey (2010)
		2/88 (2%)	This study
<b>Acanthocephala</b>			
<i>Fessisentis vanleavei</i> †	Oklahoma	1/2 (50%)	This study
Oligacanthorhynchid cystacanth†	Arkansas	1/88 (1%)	This study
<b><i>Eurycea tynereensis</i></b>			
<b>Trematoda</b>			
<i>Brachycoelium</i> cf. <i>salamandrae</i>	Arkansas	1/50 (2%)	McAllister et al. (1995)
<i>Clinostomum marginatum</i>	Oklahoma	9/74 (12%)	Bonett et al. (2011)
<i>Phyllodistomum solidum</i> †	Arkansas	2/135 (1%)	This study
<i>Gorgoderina tenua</i> †	Arkansas	7/135 (5%)	This study
<i>Sphyranura euryceae</i>	Arkansas	10/10 (100%)	McAllister et al. (1991)
		37/74 (50%)	McAllister et al. (2011)
	Oklahoma	45/90 (50%)	Moore and Hughes (1943b)
<b>Cestoidea</b>			
<i>Bothriocephalus rarus</i> †	Arkansas	6/135 (4%)	This study
<i>Cylindrotaenia americana</i> †	Arkansas	1/135 (0.7%)	This study
Unknown cysticerci	Arkansas	2/135 (1%)	This study
<b>Nematoda</b>			
<i>Amphibiocapillaria tritonipunctati</i> †	Arkansas	2/135 (1%)	This study
<i>Batracholandros magnavulvaris</i> †	Arkansas	1/135 (0.7%)	This study
<i>Desmognathinema nantahalaensis</i>	Arkansas	3/50 (6%)	McAllister et al. (1995)
		8/135 (6%)	This study
<i>Omeia papillocauda</i> †	Arkansas	10/135 (7%)	This study
<b>Acanthocephala</b>			
<i>Fessisentis vanleavei</i>	Arkansas	not given	Buckner and Nickol (1978)
		2/50 (4%)	McAllister et al. (1995)
		6/135 (4%)	This study
	Oklahoma	10/73 (14%)	Moore and Hughes (1943a)
		8/19 (42%)	Malewitz (1956)

\*Prevalence = number infected/number examined (%). †New host record. ‡Only females; specific identity not possible. ‡New distributional record.



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