

Research Note

Helminth Parasites of the Grotto Salamander, *Eurycea spelaea* (Caudata: Plethodontidae), from Northern Arkansas and Southern Missouri, U.S.A.

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ABSTRACT: Thirty-eight larval and adult *Eurycea* (= *Typhlotriton*) *spelaea* were borrowed from the Arkansas State University Museum Herpetological (ASUMZ) collection and examined for helminth parasites. These salamanders were collected at various times between 1936–1988 from locales in Independence, IZard, Sharp, and Stone counties, Arkansas, U.S.A., and Boone, Howell, and Taney counties, Missouri, U.S.A. In addition, 2 larval *E. spelaea* were collected more recently (March 2001 and May 2004) from Fulton and Madison counties, Arkansas, and 8 more larvae were collected (March 2003) from 2 caves in Shannon County, Missouri. Eight of the ASUMZ salamanders and 1 larvae from Madison County, Arkansas (9/40, 22.5%) harbored infections, including 1 (2.5%) with the trematode *Plagioporus gyrynophili* Catalano and Etges, 1981; 3 (7.5%) with the cestode *Bothriocephalus typhlotritonis* Reeves, 1949; 5 (12.5%) with the trichurid nematode *Amphibiocapillaria tritonispunctati* (Diesing, 1851) Moravec, 1982; 1 (2.5%) with the seuratoid nematode *Omeia papillocauda* Rankin, 1937, and 1 (2.5%) with the acanthocephalan *Fessisensis vancleavei* (Hughes and Moore, 1943) Nickol, 1972. In addition, all 8 larval *E. spelaea* from Shannon County, Missouri, harbored neascus type metacercariae of an undetermined strigeoid trematode in their gills and body tissues. *Plagioporus gyrynophili*, *O. papillocauda*, and *F. vancleavei* represent new helminth records for this host; new geographic distributional records are documented for *P. gyrynophili* and *B. typhlotritonis*.

KEY WORDS: Arkansas, Missouri, Trematoda, Cestoidea, Nematoda, Caudata, grotto salamander, neascus, Plethodontidae, metacercariae, *Eurycea spelaea*, *Plagioporus gyrynophili*, *Bothriocephalus typhlotritonis*, *Amphibiocapillaria tritonispunctati*, *Omeia papillocauda*, *Fessisensis vancleavei*.

The grotto salamander, *Eurycea* (formerly *Typhlotriton*) *spelaea* Stejneger, 1893, is a troglolithic

amphibian that resides in Ozark Plateau caves from southwestern Missouri, U.S.A., to extreme northeastern Kansas, U.S.A., and adjacent areas of northern Arkansas and northeastern Oklahoma, U.S.A. (Conant and Collins, 1998). We recognize this taxon as a member of the genus *Eurycea* following the taxonomy of Bonett and Chippendale (2004). Larval *E. spelaea* inhabit mountain brooks, springs, and cave entrances, whereas the blind adult is typically found in the twilight and dark zones of wet caves, underground streams, and sinkholes (Trauth et al., 2004). Little is known about the parasites of this enigmatic salamander (Smith, 1948; Reeves, 1949; Dyer, 1975; Ashley, 2004). The most exhaustive survey was by Dyer (1975), who examined 119 *E. spelaea* previously utilized in an ecological study by Brandon (1971), from Wet Cave, Shannon County, Missouri. Of the 119 salamanders, only 14 (12%) harbored 1 protozoan, 1 trematode, and 3 nematode taxa. Herein, we provide 3 new host and 2 new distributional records for endoparasites of *E. spelaea*.

Thirty-eight larval and adult *E. spelaea* were collected by hand or dip net in 1936, 1967–68, 1973–74, 1976, and 1988 from various locales in Independence, IZard, Sharp, and Stone counties, Arkansas, and Boone, Howell, and Taney counties, Missouri, U.S.A. These specimens had been deposited in the Arkansas State University Museum Herpetological Collection (ASUMZ) and were borrowed for this survey. In addition, 2 larval *E. spelaea* (1 male, 1 female, 43–44 mm snout–vent length [SVL]) were collected in March 2001 and May 2004 from Fulton (Richardson Cave near Glencoe, 36°17.4'N, 91°46.1'W) and Madison (3.2 km SE Clifty, 36°13.1'N, 93°46.1'W) counties, Arkansas, respectively, and 8 more larvae (4 males, 4 females, mean \pm 1 SD of SVL = 38.4 \pm 7.6, 30–48

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mm) were collected in March 2003 from 2 unnamed caves (vic. Akers at Lewis Hollow, 37°21.4'N, 91°32.2'W and NNE Devil's Well, 37°22.8'N, 91°29.7'W) in Shannon County, Missouri. Live specimens were placed in damp collection bags on ice and returned to the laboratory within 24 hr for processing. Salamanders were humanely killed with a dilute chloretone (chlorobutanol) solution, and the body cavity was opened by longitudinal incision beginning at the upper esophagus and ending at the cloaca. The entire gastrointestinal tract (including the liver and gallbladder) was removed, and each organ was opened longitudinally and placed in petri dishes. The lumens were examined for parasites under a stereomicroscope. The spleen, urinary bladder, reproductive organs, and coelomic cavity were also examined. Trematodes and cestodes were stained with Semichon's acetocarmine and mounted in Canada balsam. Nematodes and acanthocephalans were placed in a drop of glycerol on microscopic slides, and identifications were made from these temporary mounts. Tissues suspected of being infected with helminths were fixed in 10% neutral-buffered formalin, embedded in paraffin blocks, sectioned at 8 μ m, stained with hematoxylin and eosin counterstain, and mounted in Permount. Photomicrographs of live (sedated) salamanders with integumental lesions were taken with a Minolta X-370s SLR camera equipped with a macrolens via an aquarium photographic setup; photomicrographs of tissue sections were taken with an E-600 upright epifluorescent microscope and an SXM 1200 Nikon digital color camera.

All parasites were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, U.S.A. Selected host voucher specimens are deposited in the Arkansas State University Museum of Zoology, State University, Arkansas, U.S.A. (ASUMZ 6406, 8158, 9356, 9993, 10282, 18470, 18609, 18618, 18620, 19697, 20174, 24226, 25391, 25711–25712, 25724, 25728, 25732, 25873, 26698, 27780–27781, 27783, 27786–27787, 27789, 27794), the University of Louisiana at Monroe Museum of Natural History, Monroe, Louisiana, U.S.A. (ULM 36330, 38610, 53103), the Angelo State Natural History Collection, San Angelo, Texas, U.S.A. (ASNHC 14119), or the Museum of Vertebrate Zoology, University of California, Berkeley, California, U.S.A. (MVZ 249243).

***Eurycea spelaea* Stejneger, 1893**

Thirty-eight larval and adult (SVL = 49.1 \pm 5.6, range 37–61 mm) specimens of *E. spelaea* deposited

in the ASUMZ had been previously collected by hand from various cave and spring localities in Independence, Izard, Sharp, and Stone counties, Arkansas, and Boone, Howell, and Taney counties, Missouri. Two additional larval *E. spelaea* were collected in Fulton and Madison counties, Arkansas, and 8 more larvae were collected alive for examination of integumental and external gill lesions (see above).

Trematoda

Unidentified strigeoid metacercariae (Figs. 1–4)

Prevalence: 8 (100%) of 8 hosts infected with metacercariae too numerous to count; collected in March 2003 from 2 unnamed caves (vic. Akers at Lewis Hollow, 37°21.4'N, 91°32.2'W and NNE Devil's Well, 37°22.8'N, 91°29.7'W) in Shannon County, Missouri, U.S.A.

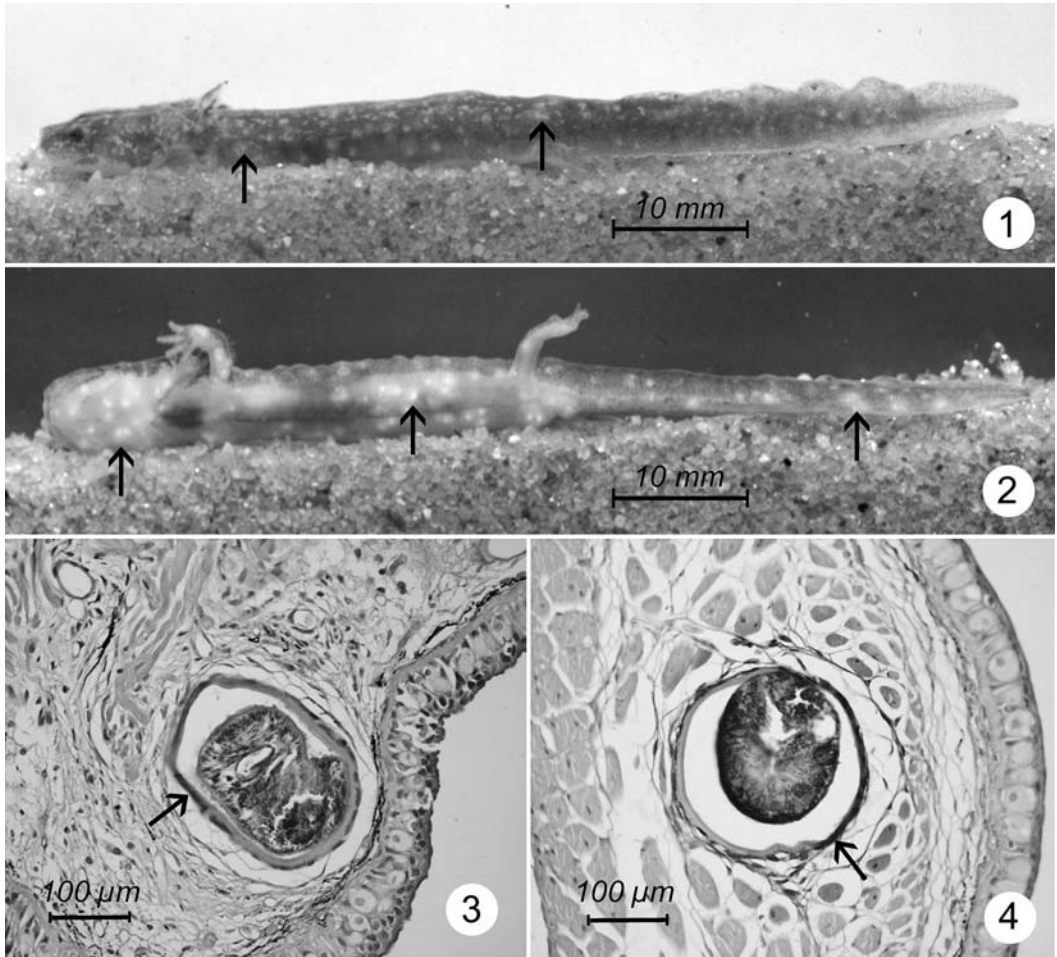
Distribution: Shannon County, Missouri, U.S.A., 4 males, 4 females, 38.4 \pm 7.6, 30–48 mm SVL.

Site of infection: Metacercariae were found encysted in the integument over most of the external surface of *E. spelaea* as well as the external gills.

Geographic range: Cosmopolitan.

Specimens deposited: USNPC 95512 (1 slide, teased metacercariae), 95559 (1 slide, tissue sections).

Remarks: Mature strigeoid trematodes are intestinal parasites of birds and mammals (Schell, 1970). Four metacercarial forms have been described—diplostomulum, tetracotyle, neascus, and prohemistomulum—and although these forms may be found throughout the bodies of their hosts, usually freshwater fish, the neascus form is found most often encysted in the integument (Hoffman, 1999). Metacercariae have been reported from the following salamander families and species: Ambystomatidae, northwestern salamander, *Ambystoma gracile*; Jefferson salamander, *Ambystoma jeffersonianum*; blue-spotted salamander, *Ambystoma laterale*; eastern tiger salamander, *Ambystoma tigrinum*; Plethodontidae, northern dusky salamander, *Desmognathus fuscus*; shovelnose salamander, *Desmognathus marmoratus*; blackbelly salamander, *Desmognathus quadramaculatus*; northern two-lined salamander, *Eurycea bislineata*; red salamander, *Pseudotriton ruber*; Salamandridae, eastern newt, *Notophthalmus viridescens* (Rankin, 1937a; Fischthal, 1955a; Lehmann, 1956; Dunbar and Moore, 1979; Coggins and Sajdak, 1982; Goater et al., 1987; Muzzall and Schindler, 1992). However, most of these reports involve metacercariae in tissue or body



Figures 1-4. 1. Infection of larval *Eurycea spelaea* with neascus-type metacercariae. 1. Lateral view of specimen (SVL = 42 mm) collected from Shannon County, Missouri, U.S.A. Arrows indicate metacercariae. 2. Ventral view. 3. Encapsulated metacercariae (arrow) in dermal tissue of *E. spelaea*, histological section. 4. Encapsulated metacercariae (arrow) in gill tissue of *E. spelaea*, histological section.

cavities. We are aware of only 1 previous report of metacercarial cysts in the integument of salamanders. Goater et al. (1987) reported finding metacercariae of 2 trematode species in *D. marmoratus* and *D. quadramaculatus*, 1 species in the body cavity, and 1 species in the integument, the latter in large numbers. Goater (1990) later noted that these 2 trematodes were *Metagonimoides oregonensis*, maturing in mink (*Mustela vison*) and raccoons (*Procyon lotor*), and the other, *Didelphodiplostomum desmognathi*, maturing in opossums (*Didelphis virginiana*). Whether our unknown metacercariae have a similar life cycle involving a mammalian definitive host species or represents a dead end that infects sympatric fishes is not known.

***Plagioporus gyrinophili*
Catalano and Etges, 1981**

Prevalence and intensity: 1 (2.6%) of 38 hosts infected with 4 worms; collected on 25 April 1973 from unknown locality in Boone County, Missouri, U.S.A.

Distribution: Boone County, Missouri, U.S.A., 1 male, 43 mm SVL.

Site of infection: small intestine.

Additional Missouri records: none.

Type host and type locality: Kentucky spring salamander, *Gyrinophilus porphyriticus duryi* (Weller, 1930) (Catalano and Etges, 1981); Ohio, U.S.A.

Other reported hosts: Red salamander, *P. ruber* (Latreille, 1801).

Geographic range: U.S.A.: Missouri (this report); Ohio (Catalano and Eges, 1981).

Specimens deposited: USNPC 95511 (1 slide).

Remarks: Missouri is a new geographic distribution record for *P. gyrinophilus*. Boone County is approximately 900 km (559 mi) southwest of the type locality.

Cestoidea

Bothriocephalus typhlotritonis Reeves, 1949

Prevalence and intensity: Hosts infected, 3 (7.5%) of 40; 2.3 ± 0.6 , 2–3.

Distribution: 3.2 km E Clifty, spring off County Rd. 42, Madison County, Eccle Ranch Cave, Sharp County, and Bergren Cave, vic. Calico Rock (36°7.3'N, 92°9.1'W), Stone County, Arkansas, U.S.A., 3 larval males, 43.3 ± 2.1 (40–46) mm SVL.

Site of infection: small intestine.

Additional Arkansas records: none.

Type host and type locality: Grotto salamander, *Eurycea spelaea* Stejneger, 1801 (Reeves, 1949), Grand Lake, near Disney, Mayes County, Oklahoma, U.S.A.

Other reported hosts: none.

Geographic range: Arkansas (this study), Oklahoma (Reeves, 1949).

Specimens deposited: USNPC 95513 (3 slides).

Remarks: Although some 70 species of *Bothriocephalus* are recognized (see Schmidt, 1986), only 3 species have been reported in North American salamanders, *Bothriocephalus euryciensis* Schaefer and Self, 1978, from the dark-sided salamander, *Eurycea longicauda melanopleura* in Adair County, Oklahoma (Schaefer and Self, 1978), *Bothriocephalus rarus* Thomas, 1937, from various salamanders and states (Thomas, 1937a; see McAllister and Bursey [2003] for host summary), and *B. typhlotritonis* (Reeves, 1949). These 3 species differ primarily in size; *B. rarus* is the largest species, and separation of each taxon is based on scolex shape: *B. rarus* and *B. typhlotritonis* have rectangular scoleces, while that of *B. euryciensis* is club-shaped. We have assigned our specimens to *B. typhlotritonis* because they are

small and possess rectangular scoleces. These 3 species should be reexamined and possibly synonymized. In *B. rarus* the proceroids develop in copepods and definitive hosts become infected by ingesting infected copepods (Thomas, 1937b).

Nematoda

Amphibiocapillaria tritonispunctati (Diesing, 1851) Moravec, 1982

(Syn: *Trichosomum tritonis punctati* Diesing, 1851; *Trichosomum tritonis* Solger, 1877, in part; *Trichosomum filiforme* Linstow, 1885; *Trichosomum tritonis* Linstow, 1909; *Capillaria tenua* Mueller, 1932; *Capillaria brachyauchenia* Walton, 1935; *Capillaria brevicollis* Walton, 1935; *Capillaria inequalis* Walton, 1935.)

Prevalence and intensity: Hosts infected, 5 of 40 (12.5%, 4.8 ± 2.7 , 2–9); 1 (14.3%) of 7 Independence County, Arkansas, U.S.A., 3 (50%) of 6 Eccle Ranch Cave, Sharp County, Arkansas, U.S.A., 1 (33%) of 3 Reed Springs (36°39.6'N, 94°1.6'W), Taney County, Missouri, U.S.A.

Distribution: Independence County, Arkansas, U.S.A., 1 male, 50 mm SVL; Sharp County, Arkansas, U.S.A., 1 male, 52 mm SVL, 2 females, 46 and 48 mm SVL; Taney County, Missouri, U.S.A., 1 male 50 mm SVL.

Site of infection: Small intestine.

Additional Arkansas records: Montgomery County, Arkansas, U.S.A. (McAllister et al., 1994).

Additional Missouri localities: Wet Cave, Shannon County, Missouri, U.S.A. (Dyer, 1975).

Type host and type locality: European newt, *Triturus vulgaris*, Germany (Diesing, 1851).

Other reported hosts: Spotted salamander, *Ambystoma maculatum*, marbled salamander, *Ambystoma opacum*, mole salamander, *Ambystoma talpoideum*, cave salamander, *Eurycea lucifuga*, *D. fuscus*, *D. marmoratus*, seal salamander, *Desmognathus monticola*, Allegheny dusky salamander, *Desmognathus ochrophaeus*, *D. quadramaculatus*, spring salamander, *Gyrinophilus porphyriticus*, *N. viridescens*, northern slimy salamander, *Plethodon glutinosus*, red salamander, *Pseudotriton ruber*, western lesser siren, *Siren intermedia nettingi*, Japanese fire-bellied newt, *Cynops pyrrhogaster*, Alpine newt, *Triturus alpestris*, northern crested newt, *Triturus cristatus*,

banded newt, *Triturus vittatus*, Caucasian salamander, *Mertensiella caucasica*, clouded salamander, *Hynobius nebulosus*, amber-colored salamander, *Hynobius stejnegeri*, Japanese clawed salamander, *Onychodactylus japonicus* (Holl, 1932; Mueller, 1932; Kelley, 1934; Walton, 1935; Rankin, 1937b, 1945; Fischthal, 1955a, b; Jackson and Beaudoin, 1967; Del Fosse and Whittaker, 1971; Dyer, 1975; Dyer and Peck, 1975; Dunbar and Moore, 1979; Catalano et al., 1982; Moravec, 1986; Castle et al., 1987; Goater et al., 1987; McAllister et al., 1994; Joy and Scott, 1997).

Geographic range: U.S.A.: Alabama (Dyer and Peck, 1975), Arkansas (McAllister et al., 1994; this report), Georgia (Dyer and Peck, 1975), Kentucky (Del Fosse and Whittaker, 1971; Dyer and Peck, 1975; Castle et al., 1987), Illinois, Massachusetts (Kelley, 1934; Rankin, 1945), Michigan (Kelley, 1934), Missouri (Dyer, 1975; this report), New York (Mueller, 1932; Fischthal, 1955a), North Carolina (Holl, 1932; Walton, 1935; Rankin, 1937b; Goater et al., 1987), Ohio (Kelley, 1934; Catalano et al., 1982), Pennsylvania (Kelley, 1934; Fischthal, 1955b; Jackson and Beaudoin, 1967), South Carolina (Kelley, 1934), Tennessee (Dyer and Peck, 1975; Dunbar and Moore, 1979), West Virginia (Joy and Scott, 1997). Europe: Austria, Czech Republic, Denmark, Great Britain, Hungary, western part of former Soviet Union (see Moravec [1986] for citations). Asia: Georgia, former Soviet Union and Japan (see Moravec [1986] for citations).

Specimen deposited: USNPC 95515 (1 vial).

Remarks: The majority of the salamander hosts listed above were originally reported to be infected with either *Capillaria* sp., *C. brevicollis*, *C. inequalis*, or *C. tenua*, which all have been subsequently synonymized with *A. tritonispunctati* (see Moravec, 1986). More recently, Moravec and Huffman (2000) described *A. texensis* from the related Texas blind salamander, *Eurycea* (= *Typhlomolge*) *rathbuni* from Hays County, Texas.

***Omeia papillocauda* Rankin, 1937**

(Syn: *Omeia chickasawi* Walton, 1940.)

Prevalence and intensity: 1 (2.5%) of 40 hosts infected with 14 worms (6 immature, 3 female, 5 male).

Distribution: 3.2 km E Clifty, spring off County Rd. 42, Madison County, Arkansas, U.S.A., male, 43 mm SVL.

Site of infection: Small and large intestines.

Additional Arkansas records: Polk County, Arkansas, U.S.A. (McAllister et al., 1995).

Type host and type locality: Northern dusky salamander, *Desmognathus fuscus* (Green, 1818), North Carolina (Rankin, 1937a).

Other reported hosts: Ouachita dusky salamander, *Desmognathus brimleyorum*, *D. marmoratus*, *D. monticola*, *D. ochrophaeus*, *D. quadramaculatus*, *E. bislineata*, *E. lucifuga*, and *G. porphyriticus* (Rankin, 1937a, b; Walton, 1940; Dyer and Peck, 1975; Dunbar and Moore, 1979; Catalano et al., 1982; Baker, 1987; Baker et al., 1987; Goater et al., 1987; Joy et al., 1993, McAllister et al., 1995).

Geographic range: U.S.A.: Alabama (Dyer and Peck, 1975), Arkansas (McAllister et al., 1995; this report), Kentucky, North Carolina (Rankin, 1937a, b; Baker, 1987; Goater et al., 1987; Ohio (Catalano et al., 1982), Tennessee (Walton, 1940; Dunbar and Moore, 1979), West Virginia (Joy et al., 1993).

Specimen deposited: USNPC 97077 (1 vial).

Remarks: Dunbar and Moore (1979) reported *O. chickasawi* Walton, 1940, from 4 plethodontid salamander hosts in Tennessee, namely *D. fuscus*, *D. monticola*, *D. quadramaculatus*, and *E. bislineata*; this species is regarded as a junior synonym of *O. papillocauda* Rankin, 1937.

Acanthocephala

Fessisentis vanleavei

(Hughes and Moore, 1943) Nickol, 1972

(Syn: *Acanthocephalus vanleavei* [Hughes and Moore, 1943].)

Prevalence and intensity: Hosts infected, 1 (2.5%) of 40, 3; 1 (100%) of 1, Bergren Cave, Calico Rock, Stone County, Arkansas, U.S.A.

Distribution: Stone County, Arkansas, U.S.A., 1 larval male, 40 mm SVL.

Site of infection: Small intestine.

Additional Arkansas records: Graybelly salamander, *Eurycea multiplicata griseogaster* (Cope, 1869) (Buckner and Nickol, 1978); Fleming Creek, 4.3 mi SSW St. Paul, Madison County, Arkansas, U.S.A.

Type host and type locality: Oklahoma salamander, *Eurycea tynerensis* Moore and Hughes, 1939

(Hughes and Moore, 1943); Pea Vine Creek, 13 mi NE Tahlequah, Cherokee County, Oklahoma, U.S.A.

Other reported hosts: *E. multiplicata* (Malewitz, 1956).

Geographic range: U.S.A.: Arkansas (Buckner and Nickol, 1978, 1979; this study); Oklahoma (Hughes and Moore, 1943; Malewitz, 1956).

Specimen deposited: USNPC 95514 (2 slides).

Remarks: The grotto salamander is a new host for this acanthocephalan. Interestingly, all previous salamanders reported as hosts of this worm belong to the family Plethodontidae and genus *Eurycea*.

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