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Research Note

***Bothriocephalus* sp. (Cestoidea: Bothriocephalidae) from the Georgia Blind Salamander, *Eurycea wallacei* (Caudata: Plethodontidae), in Georgia, U.S.A.: First Definitive Report of a Parasite from This Host**

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ABSTRACT: One of 4 Georgia blind salamanders (25%), *Eurycea wallacei* from Dougherty County, Georgia, U.S.A., were found to be infected in its small intestine with a *Bothriocephalus* sp. tapeworm; a single *E. wallacei* from Jackson County, Florida, U.S.A., was negative. Because the internal anatomy of this worm was immature, species identity was not possible. This is the first definitive report of any parasite from this G2 ranked (globally imperiled) host and a new distribution record for the genus.

KEY WORDS: Georgia blind salamander, *Eurycea wallacei*, *Bothriocephalus* sp., Cestoidea, Bothriocephalidae, Georgia, Caudata, Plethodontidae.

The Georgia Blind Salamander, *Eurycea wallacei* (Carr 1939), is a paedomorphic caudate restricted to subterranean waters of the Florida Aquifer of the Marianna Lowlands–Dougherty Plain of southwestern Georgia and northwestern Florida (Brandon, 1967; Conant and Collins, 1998). Within this region, *E. wallacei* has been reported at just 7 localities in Decatur and Dougherty counties in Georgia, U.S.A., and 28 localities in Calhoun, Jackson, and Washington counties of Florida, U.S.A., which include wells, sinkholes, vadose caves, and partially or completely submerged carbonate cave systems (Means, 1977, 1992, 2005, 2008). This species is at risk from several anthropogenic threats, including groundwater pollution and the overharvesting of groundwater (Means, 2005, 2008). Consequently, *E. wallacei* is listed as “Vulnerable” on the International Union for Conservation of Nature (IUCN) Red List (Hammerman, 2004) and globally “Imperiled” (G2) by NatureServe (NatureServe, 2012); it is ranked S1 (critically imperiled) in Georgia, U.S.A., and S2 (imperiled) in Florida, U.S.A. (NatureServe, 2012).

Little is known about the biology of *E. wallacei* (Brandon, 1967; Means, 2005), and even less is known regarding its parasites. Lee (1969) reported “transient parasitic nematodes” in the stomach of 3 of 32 individuals (9%) from a cave in the Marianna Lowlands; another individual that died in captivity had “large numbers of live nematodes protruding from the body wall.” Unfortunately, these specimens were not identified, and their disposition is unknown. Herein, we provide the first definitive report of a parasite from *E. wallacei*, with deposition of genuine voucher specimens of both host and parasite.

On 12 February 2012, 4 juvenile *E. wallacei* (mean \pm 1 standard deviation [SD] snout–vent length [SVL] = 16.8 ± 2.1 ; range, 15–19 mm) were collected using slurp guns by divers at Radium Springs, Dougherty County, Georgia, U.S.A., whereas a single adult female (SVL = 33 mm) was collected on 13 February 2012 from Jackson Blue Spring, at Merritt's Mill Pond, Jackson County, Florida, U.S.A. Unfortunately, these specimens died and were fixed in vials containing 10% formalin and transferred to 70% ethanol. They were subsequently sent to the senior author (C.T.M.) for examination and a midventral incision was made to expose the entire gastrointestinal tract, which was removed and placed in a petri dish containing distilled water, split longitudinally, and examined under a stereomicroscope. A single tapeworm was removed from the small intestine and transferred to clean 70% ethanol. It was photographed using a Canon PowerShot S3 IS digital camera fitted with a Canon conversion lens (LA-DC58E) and Martin Microscope Company (Easley, South Carolina, U.S.A.) adapters (MM99, S/N 5282) mounted on a stereomicroscope. The specimen was subsequently stained with hematoxylin, dehydrated through graded ethanols, cleared in xylene, and

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mounted in its entirety in Canada balsam. A description follows; measurements are given in micrometers unless otherwise stated. The immature cestode was deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, U.S.A. The host was deposited in the Yale Peabody Museum of Natural History, Herpetological Collection, New Haven, Connecticut, U.S.A. as YPM HERA 013625.

PLATYHELMINTHES

Cestoidea: Bothriocephalidae *Bothriocephalus* sp. (Figs. 1–3)

Description

One immature specimen, scolex with 10 proglottids, 3.7 mm in length. Unarmed elongate scolex, 460 in length, 204 broad in midregion, no neck; bothria shallow, 408 in length, noncrenulated margins; rectangular apical disc, 153 μ m wide. Strobila immediately behind scolex, segmentation distinct. Proglottids immediately behind scolex 153 long by 204 wide, terminal proglottid 485 long by 383 wide. Genital primordium first appearing as dark staining mass in proglottid 6; 42 testes in proglottid 9; anteriomedian uterine pore, uterus (as a straight tube), posteriomedian compact bilobular ovary (38 broad by 178 long) visible in terminal proglottid; cirrus sac, vas deferens, and genital pore indistinct; vitelline follicles in 2 lateral fields. Irregular calcareous bodies scattered throughout strobila.

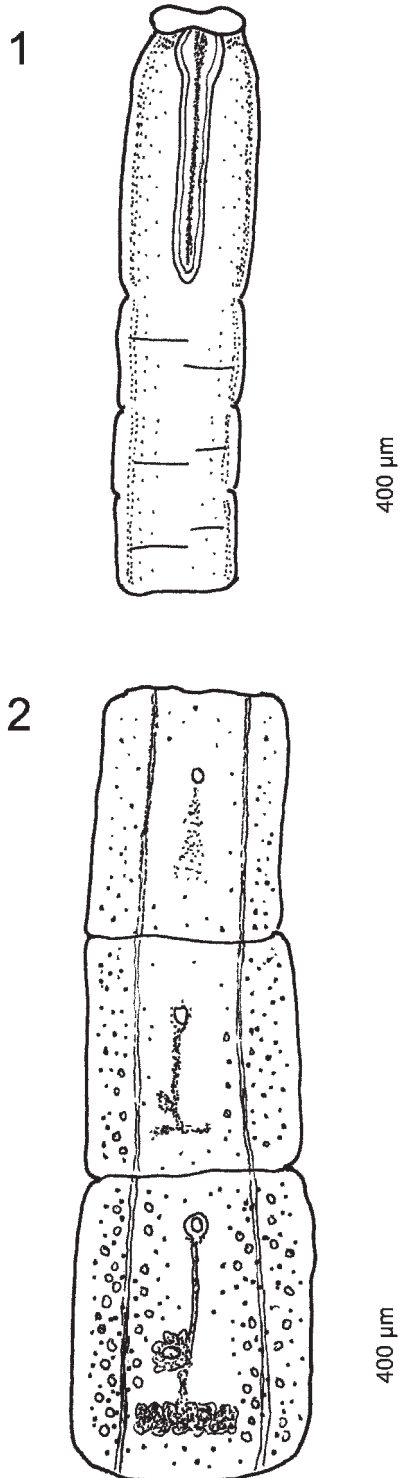
Host and locality: Georgia blind salamander, *Eurycea wallacei* (Carr, 1939), SVL = 18 mm (juvenile, sex unknown), collected on 12 February 2012 from Radium Springs, Dougherty County, Albany, Georgia, U.S.A. (31°31'34.63"N; 84°08'07.59"W).

Prevalence and intensity: 1/5 (20%) overall; 1/4 (25%) Dougherty County, Georgia, U.S.A.; 0/1 (0%) Jackson County, Florida, U.S.A.

Site of infection: Small intestine.

Type species: *Bothriocephalus scorpii* (Müller, 1776) Rudolphi, 1808 (Syn. *Taenia scorpii* Mueller, 1776; *Bothriocephalus punctatus* Rudolphi, 1802; *Bothriocephalus bipunctatus* (Zeder) Lühe, 1899).

Type host and locality: Shorthorn sculpin, *Myoxocephalus* (= *Cottus*) *scorpius* (Linnaeus, 1758), Denmark (Müller, 1788).



Figures 1–2. Composite line drawings of *Bothriocephalus* sp. from *Eurycea wallacei*. **1.** Scolex. **2.** Terminus.

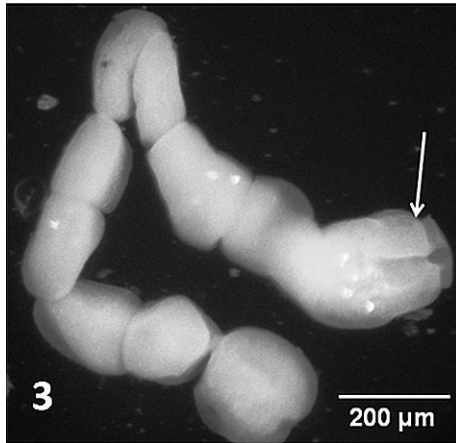


Figure 3. Photomicrograph of *Bothriocephalus* sp. from *Eurycea wallacei* showing individual proglottids and bothrium (arrow).

Additional Georgia records: None.

Reported amphibian hosts with Bothriocephalus spp.: ***Bothriocephalus* sp.:** American bullfrog, *Lithobates catesbeianus* (McAlpine and Burt, 1998). ***Bothriocephalus euryciensis* Schaefer and Self, 1978:** dark-sided salamander, *Eurycea longicauda melanopleura* (Schaefer and Self, 1978). ***Bothriocephalus rarus* Thomas, 1937:** northern dusky salamander, *Desmognathus fuscus* (Muzzall et al., 1997); common blackbelly salamander, *Desmognathus quadramaculatus* (Dunbar and Moore, 1979); northern two-lined salamander, *Eurycea bislineata* (Fischthal, 1955; Muzzall et al., 1997); *E. l. melanopleura* (McAllister and Bursey, 2004); *Eurycea lucifuga* (O'Brien, 1979: unpublished thesis, University of Cincinnati, Cincinnati, Ohio, U.S.A.); coastal plain dwarf salamander, *Eurycea quadridigitata* (McAllister and Bursey, 2003); spring salamander, *Gyrinophilus porphyriticus* (Catalano et al., 1982); eastern newt, *Notophthalmus viridescens* (Kelley, 1934; Thomas 1937a, b; Rankin, 1945; Fischthal, 1955; Jackson and Beaudoin, 1967; Del Fosse and Whitaker, 1971; Jarroll, 1979, 1980; Muzzall, 1991); red salamander, *Pseudotriton ruber* (Catalano et al., 1982); California newt, *Taricha torosa* (Lehmann, 1960). ***Bothriocephalus typhlotritonis* Reeves, 1949:** *E. l. melanopleura* (Saltarelli, 1977: unpublished thesis, University of Arkansas, Fayetteville, Arkansas, U.S.A.); *E. lucifuga* (Saltarelli, 1977: unpublished thesis, University of Arkansas, Fayetteville, Arkansas, U.S.A.); grotto salamander, *Eurycea spelaea* (Reeves, 1949; McAllister et al., 2006).

Geographic range: United States: Arkansas (Saltarelli, 1977: unpublished thesis, University of Arkansas, Fayetteville, Arkansas, U.S.A.; McAllister and Bursey, 2003, 2004); California (Lehmann, 1960); Georgia (this report); Kentucky (Del Fosse and Whitaker, 1971; O'Brien, 1979: unpublished thesis, University of Cincinnati, Cincinnati, Ohio, U.S.A.); Michigan (Kelly, 1934; Thomas, 1937a; Muzzall, 1991); Missouri (McAllister et al., 2006); New Hampshire (Muzzall et al., 1997); New York (Fischthal, 1955); Ohio (Catalano et al., 1982); Oklahoma (Reeves, 1949; Schaefer and Self, 1978); Pennsylvania (Kelley, 1934; Thomas, 1937b; Jackson and Beaudoin, 1967); South Carolina (Kelley, 1934; Thomas, 1937b); Tennessee (Dunbar and Moore, 1979); and West Virginia (Jarroll, 1979, 1980). Canada: New Brunswick (McAlpine and Burt, 1998).

Specimens deposited: USNPC 105884 (slide).

Remarks: Because our specimen was immature, we have not assigned it to a species. However, of the 3 species reported to infect amphibians (above), the scolex of our specimen is rectangular, as in *B. rarus*, rather than claviform as in *B. euryciensis* and *B. typhlotritonis*. In a similar fashion, our specimen differs from species reported from American freshwater fishes, the scolex of which varies from heart-shaped to claviform (Scholz, 1997). The life cycle of *B. rarus* involves a first intermediate host (cyclopoid copepod, *Megacyclops viridis*) ingested by definitive host salamanders (Thomas, 1937b; Jarroll, 1979, 1980). At the study site, the Hobbs cave isopod *Caecidotea hobbsi* is present, as is the Dougherty Plain Cave crayfish *Cambarus cryptodytes*. This is the first report of a tapeworm from *E. wallacei* and the first definitive report of any parasite from the species. We also document a new geographic record (Georgia) for the genus *Bothriocephalus*.

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