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A New Species of *Caecincola* (Trematoda: Cryptogonimidae) from White Crappie (*Pomoxis annularis*) in Southeastern Texas, U.S.A.

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ABSTRACT: *Caecincola cookorum* n. sp. is described from the intestine of white crappie (*Pomoxis annularis*) collected from B. A. Steinhagen Reservoir in Tyler County, Texas, U.S.A. Worms of the new species possess ceca that extend past the posterior testis, whereas members of the other species in the genus (*Caecincola autumnae*, *Caecincola latostoma*, *Caecincola longiscens*, *Caecincola parvulus*, and *Caecincola wakullata*) have ceca that terminate before the end of the posterior testis. This is the second species of *Caecincola* described from white crappie from rivers draining into the Gulf of Mexico (*C. longiscens* from Mississippi being the other), and it is possible that a large fraction of the species-level diversity in this genus remains to be discovered.

KEY WORDS: *Caecincola cookorum*, *Pomoxis annularis*, white crappie, Big Thicket National Preserve, Texas.

Five species of *Caecincola* (Trematoda: Cryptogonimidae) have been described thus far: *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, all from centrarchid fishes in North America. The taxonomic history and affinities of the genus have been discussed by Gibson (1996), Miller and Cribb (2008), and Curran and Overstreet (2009a). Curran and Overstreet (2009a) detailed the difficulty of distinguishing between *Caecincola* Marshall and Gilbert, 1905, and *Cryptogonimus* Osborn, 1903, in their description of *C. longiscens* and decided to emphasize the lack of a gonotyl, a trilobed ovary, and an oral sucker that is wider than long when placing that taxon.

During a survey of the parasites of fishes as part of an All Taxon Biodiversity Inventory in the Big Thicket National Preserve of southeastern Texas, U.S.A., specimens of a previously undescribed species of cryptogonimid trematode were collected from white crappie, *Pomoxis annularis*. Like *C. longiscens*, members of the new species share some characteristics with both *Cryptogonimus* and *Caecincola*. The large length-to-width ratio of the body and the extent of the ceca (into the posttesticular space) are consistent with *Cryptogonimus*, but the absence of a gonotyl, the dimensions of the oral sucker (wider than long), the distribution of the vitellaria in the forebody, and the possession of a bipartite seminal vesicle and trilobed ovary argue for

inclusion in *Caecincola*. The new species is described as a member of the latter genus.

MATERIALS AND METHODS

White crappie were collected by gill net from B. A. Steinhagen Reservoir in Tyler County, Texas, U.S.A., in July 2014 and March 2015. Sixty-seven gravid specimens of a new species of *Caecincola* were collected from 2 white crappie. Worms were killed in hot water, fixed, and stored in 70% ethanol, stained in carmalum, dehydrated in an ethanol series, cleared in xylene, and mounted on glass slides in damar balsam. Mounted worms were examined with bright-field and differential interference contrast microscopy on an Olympus BX 53 compound microscope. Line drawings of individual structures were made from high-resolution photographs taken in series at adjacent focal planes with an Olympus DP-73 camera, and drawings were then assembled in Adobe Photoshop CS software (Adobe Systems Inc., San Jose, California, U.S.A.) to produce composite line drawings. Measurements are presented in micrometers as the range followed by the mean parenthetically. Names of shapes follow the recommendations of Clopton (2004).

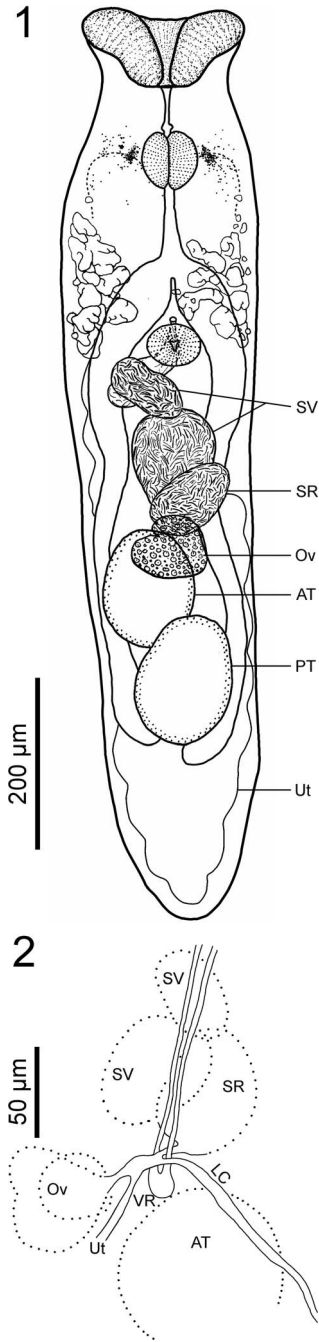
RESULTS

Caecincola cookorum n. sp. (Figs. 1–2)

Description

Based on observations of 179 specimens and measurements of 67 gravid specimens. Adult worms very narrowly to narrowly obpanduriform, 884–1,379 (1,098) long, 182–320 (251) wide at widest point; ratio of body length to width 3.7–6.0. Very small (<5), spines cover entire body surface. Mouth terminal, surrounded by large, shallowly obpanduriform

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Figures 1, 2. Line drawings of *Caecincola cookorum*. **1.** Holotype, dorsal view. Eggs omitted; outline of space occupied by uterus shown only. **2.** Details of genitalia, sinistral view (ventral to the left), composite drawing from multiple specimens; structures in stippled outline are those visible on holotype above. AT, anterior testis; LC, Laurer's canal; Ov, ovary; PT, posterior testis; SR, seminal receptacle; SV, seminal vesicle; Ut, uterus; VR, vitelline reservoir.

oral sucker; oral sucker 58–182 (118) long, 65–233 (179) wide. Prepharynx, 23–76 (48) long, usually slightly curved and directed dorsally. Pharynx 48–67 (58) long, 50–78 (62) wide. Esophagus 62–117 (80) long; bifurcation 234–365 (286) from anterior end, anterior to ventral sucker. Ceca lateral, in dorsal half of worm, extending to beyond the posterior testis, 146–306 (226) from posterior end. In 64 specimens the ceca terminate 4–93 (40) beyond the posterior testis. In 2 specimens, the posteriormost cecum terminates 17 before the posterior of the posterior testis, and in 1 specimen it terminates at the posterior edge of the posterior testis. Ventral sucker 42–60 (52) long, 49–66 (58) wide, enclosed within ventrogenital sac, in anterior half of body; anterior edge of ventral sucker posterior to bifurcation of intestinal caeca, 309–480 (362) from anterior end of worm. Excretory bladder with 2 large branches that reach level of pharynx; excretory pore terminal. Pigmented cells present as diffuse eyespots at level of pharynx. Testes oblique, both elliptical to ovoid, edges not scalloped or lobed. Anterior testis 242–684 (565) from anterior end, 91–191 (142) long, 77–168 (113) wide; posterior testis larger, 103–219 (161) long, 87–180 (121) wide. Vasa efferentia extend anteriorly and contact posterior seminal vesicle without uniting; no vas deferens detected. Cirrus sac lacking. Bipartite seminal vesicle naked, occupying medial position, anterior portion of seminal vesicle sometimes overlapping posterior margin of ventral sucker, 39–101 (69) along long axis, 30–61 (45) along perpendicular axis; posterior portion 58–183 (109) along long axis, 42–116 (78) along perpendicular axis. Anterior portion of seminal vesicle leads to elongated pyriform bulb that narrows anterior to ventral sucker and unites with uterus to form short common genital duct; genital pore immediately anterior to ventral sucker. Ovary with 3 distinct lobes, ventral to testes, overlapping anterior testis substantially; total space occupied by ovary, 57–148 (83) long, 65–149 (101) wide. Oviduct seen in few specimens, short, leading dorsally and anteriorly to common union with duct from seminal receptacle and Laurer's canal; union with duct from vitelline reservoir not observed. Seminal receptacle medial, 54–132 (89) along long axis, 36–84 (56) along perpendicular axis; sperm abundant. Laurer's canal extends dorsally and posteriorly from origin, terminates at small pore on dorsal surface at level of midpoint of anterior testis. No distinct Mehlis gland observed. Vitelline follicles mostly extracecal, digitate, and broadly interconnected, with single vitelline duct on each side

extending posteriorly and medially to level of ovary, forming small vitelline reservoir. Vitelline follicles extend from posterior of pharynx to mid-to-posterior level of ventral sucker. Uterus largely ventral, occupying most of the space posterior of the ventral sucker and completely filling space posterior of testes. Eggs numerous, 20–31 (24.4) long, 9–14 (11.5) wide, as measured through body wall, lacking abopercular knob (eggs somewhat deformed in permanent mounts).

Taxonomic summary

Type host: White crappie, *Pomoxis annularis* Rafinesque, 1818.

Type locality: B. A. Steinhagen Reservoir, Tyler County, Texas, U.S.A., 30°51'22.449"N, 94°12'39.135"W.

Dates of collection: 17 July 2014 and 11 March 2015.

Site of infection: Small intestine.

Specimens deposited: Holotype and paratypes on 67 slides, each with single specimen. All slides deposited in Harold W. Manter Laboratory of Parasitology (HWML), Nebraska State Museum, Lincoln, Nebraska, HWML 102026 (holotype, BITH-17282) and 102027 (paratypes; BITH-17283). BITH numbers are National Park Service reference numbers.

Etymology: The epithet *cookorum* recognizes the contributions of the Cook family of Huntsville, Texas, and Sam Houston State University, Drs. Tamara and Jerry Cook and Siera, who have been indispensable to the work conducted in the Big Thicket National Preserve.

Remarks

The termination of the ceca past the posterior testis distinguishes *C. cookorum* n. sp. from the other 5 species in the genus. The ceca of all 5 other species of *Caecincola* terminate before the posterior edge of the posterior testis. Additionally, the body of *C. parvulus* is elliptical, the anterior portion of the seminal vesicle lies behind the ventral sucker, and the arrangement of the testes is oblique to opposite (Marshall and Gilbert, 1905); *C. wakullata* has a seminal vesicle that extends anterior to the ventral sucker, a bean-shaped body not found in other species of *Caecincola*, testes in the posterior quarter of the body, no prepharynx, and an oral sucker that occupies about a quarter of the body (Premvati, 1967); *C. longiscens* is somewhat longer (~1.5 mm), has a very elongate body form, testes in

tandem, vitelline follicles that are few, large, and confined to the hindbody, and seminal vesicle that is tubular and convoluted (Curran and Overstreet, 2009a); *C. latostoma* is smaller (~656 µm), has a seminal vesicle that extends anterior to the ventral sucker, cecal bifurcation that occurs near the level of the ventral sucker, and seminal receptacle that is smaller than an ovarian lobe (Greer and Corkum, 1979).

Caecincola cookorum n. sp. most closely resembles *C. autumnae*. The vitelline follicles are similar in position and arrangement, the seminal receptacle is similar in size in relation to the other reproductive organs, the cecal bifurcation occurs before the ventral sucker, and the position of all the organs are very similar. However, the ovary of *C. autumnae* consists of 4 lobes vs. 3 lobes in *C. cookorum* n. sp., the overall body size of *C. autumnae* is considerably smaller (530–630 µm), the ceca are shorter, the body is more broadly obpan-duriform (length-to-width ratio = 3.0–3.9:1, as measured on type series and vouchers) than *C. cookorum* n. sp. (3.7–6.0:1), the body narrows to a greater extent toward the posterior, the eggs are smaller (17.5–20 × 7.5–8.8 µm vs. 20–31 × 9–14 µm), and possess a small abopercular knob.

Curran and Overstreet (2009a) considered 6 characteristics (Miller and Cribb, 2008) that distinguish between *Cryptogonimus* and *Caecincola*, noting that Gibson (1996) used only the presence of a gonotyl in *Cryptogonimus* to distinguish it from *Caecincola*. According to this analysis, members of the new species share in common with *Caecincola* the absence of a gonotyl, an oral sucker that is wider than long, a bipartite seminal vesicle, and vitelline follicles that are largely confined to the forebody; also, members of the new species have a trilobed ovary, similar to most other *Caecincola* species. A more elongate body and intestinal ceca that extend into the posttesticular space make members of the new species similar to species of *Cryptogonimus*. Although it defines *Caecincola* based on the absence of a character, we emphasized the lack of a gonotyl in our decision because this character is unambiguous and not subject to artifacts introduced by differing methods of relaxing, killing, and fixing worms.

Three new species of *Caecincola* have been described since 2009, *C. longiscens* from white crappie in Mississippi, *C. autumnae* from spotted bass in Texas, and *C. cookorum* n. sp. from white crappie in Texas. As noted by Curran and Overstreet (2009b), the fishes of the Gulf Coast drainages and surrounding areas probably harbor a large fauna of undiscovered

species of trematode parasites, and it is likely that situation is repeated for other parasite groups as well. Given the number of new species discovered and described in the last decade from the area (Curran et al., 2006, 2007; Steinauer et al., 2007; Tkach et al., 2008; Amin and Heckmann, 2009; Curran and Overstreet, 2009a, b; Barger, 2010a, b, 2014; Tkach et al., 2010; Tkach and Kinsella, 2011; Dutton and Barger, 2014; Barger and Wellenstein, 2015; Steinauer and Nickol, 2015), this opinion no longer seems conjectural.

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