

Journal of the Arkansas Academy of Science

Volume 68

Article 28

2014

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Recommended Citation

McAllister, C. T.; Burse, C. R.; Robison, H. W.; Connior, M. B.; and Barger, M. A. (2014) "Haemogregarina sp. (Apicomplexa: Haemogregarinidae), *Telorchis attenuata* (Digenea: Telorchidae) and *Neoechinorhynchus emydis* (Acanthocephala: Neoechinorhynchidae) from Map Turtles (*Graptemys* spp.), in Northcentral Arkansas," *Journal of the Arkansas Academy of Science*: Vol. 68 , Article 28.

Available at: <http://scholarworks.uark.edu/jaas/vol68/iss1/28>

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***Haemogregarina* sp. (Apicomplexa: Haemogregarinidae), *Telorchis attenuata* (Digenea: Telorchidae) and *Neoechinorhynchus emydis* (Acanthocephala: Neoechinorhynchidae) from Map Turtles (*Graptemys* spp.), in Northcentral Arkansas**

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Running Title: Haemogregarine, Trematode and Acanthocephalan Records

Little is known about the hematozoa and helminths of turtles of Arkansas. McAllister and King (1980) and McAllister et al. (1995) reported haemogregarines from the red-eared slider, *Trachemys scripta elegans* and alligator snapping turtle, *Macrochelys temminckii*, respectively. Fragmentary information is available on acanthocephalans (Ward and Hopkins 1931, Cable and Fisher 1957, Fisher 1960) and a nematode (McAllister et al. 1995). However, the only complete endoparasite survey to date on turtles of the state is that of Rosen and Marquardt (1976) on *T. s. elegans*. It is obvious that more turtles need to be surveyed for hemoparasites and helminths. Here we report new geographic and host records for a haemogregarine, a digene trematode and an acanthocephalan in map turtles, *Graptemys* spp. from the state.

On 25 May 2013, a juvenile Ouachita map turtle, *Graptemys ouachitensis* (carapace length [cl] = 57 mm, ASUMZ 33041) was collected by dipnet from the Lakeview Boat Dock, Baxter County (36.370576°N, 92.554544°W). On 25 July 2013, an adult male common map turtle, *Graptemys geographica* (cl = 125 mm, ASUMZ 33042) was collected by hand from Crooked Creek, Marion County (36.245225°N, 92.715755°W). Both turtles were killed with an intraperitoneal injection of concentrated Chloretone and their plastrons were removed with a bone saw to expose visceral contents. Thin smears were made of blood samples taken from the heart, fixed in absolute methanol, stained with Wright's stain, rinsed in neutral buffer and examined by light microscopy for hematozoa. The entire gastrointestinal tract from the cloaca to esophagus and urinary bladder was removed, washed in 0.6% w/v saline, split longitudinally, and examined for helminths under a stereomicroscope. Trematodes were stained with acetocarmine and

mounted in Canada balsam. Acanthocephalans were placed on slides with a drop of glycerol and studied as temporary mounts. Voucher specimens of hosts are deposited in the Arkansas State University Museum of Zoology (ASUMZ) Herpetological Collection, State University. Voucher specimens of parasites were deposited in the United States National Parasite Collection, Beltsville, Maryland. Scientific and common names of turtles follow the TIGR Reptile Database (Uetz and Hošek 2013).

A digene trematode was found in the *G. ouachitensis* while a haemogregarine and an acanthocephalan were recovered from the *G. geographica*. Data is presented below in annotated format.

Apicomplexa: Adeleorina: Haemogregarinidae

Haemogregarina sp. Danilewsky, 1885 – About 2% of the red blood cells of *G. geographica* contained an intraerythrocytic hematozoan thought to belong to the genus *Haemogregarina* (USNPC 107976). Banana-shaped immature gamonts were most often observed (Fig. 1). They were very similar to the “type IV” morphological type reported from Lonoke County *T. s. elegans* by McAllister and King (1980). McAllister et al. (1995, Fig. 3) also reported large immature gamonts from *M. temminckii* from Ouachita County similar of those from *G. geographica*. In addition, Acholonu (1974) reported *Haemogregarina pseudemydis* in Mississippi map turtle, *Graptemys pseudogeographic kohnii* (syn. *Graptemys kohnii*) from Louisiana. Haemogregarines are most commonly reported from aquatic turtles with leeches serving as the only known invertebrate hosts and vectors (Telford 2009). We document a new host record for a haemogregarine in *G. geographica*.

Haemogregarine, Trematode and Acanthocephalan Records

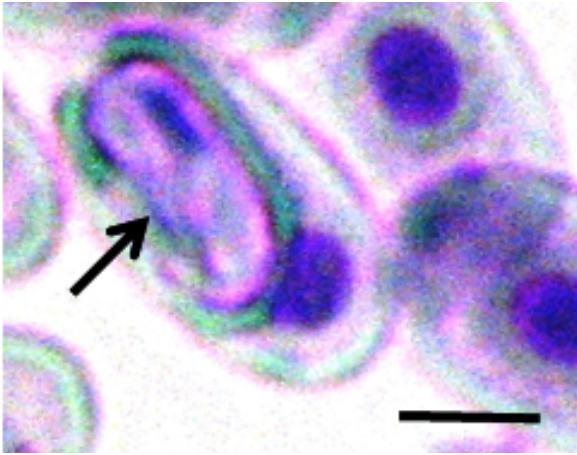


Figure 1. Gamont (arrow) of hematozoan from *Graptemys geographica*. Scale bar = 10 μ m.

Trematoda: Digenea: Plagiorchiida: Telorchiiidae

Telorchis attenuata Goldberger, 1911 – Numerous (> 100) digene specimens fitting the description of *T. attenuata* (Fig. 2, USNPC 107963) and confirmed using the key to North American species of *Telorchis* provided by MacDonald and Brooks (1989) were found in the intestine of *G. ouachitensis*. This trematode was previously reported in common snapping turtles, *Chelydra serpentina* from Ohio (Rausch 1947) and painted turtles, *Chrysemys picta* from Indiana (Goldberger 1911), Iowa, Maryland (MacDonald and Brooks 1989), Michigan (Esch and Gibbons 1967), Nebraska (Brooks and Mayes 1975), Ohio (Rausch 1947, Platt 1977), Wisconsin (Guilford 1959) and British Columbia, Canada (MacDonald and Brooks 1989), and *T. scripta* from Mexico (Moravec and Vargas-Vásquez, 1998) and Spain (Cardells et al. 2013). Previously in the state,

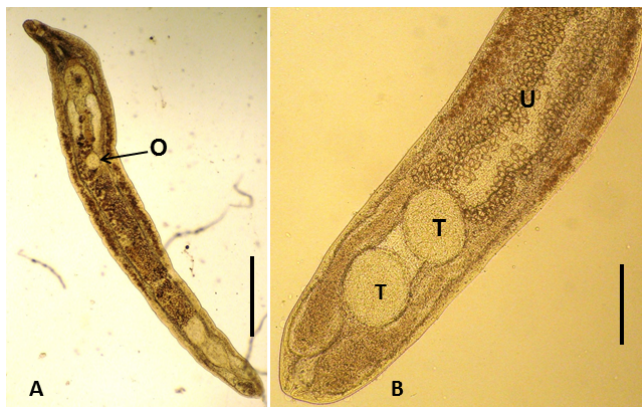


Figure 2. *Telorchis attenuata* (unstained) from *Graptemys geographica*. (A) Entire worm showing ovary (O); scale bar = 100 μ m. (B) Lower half of worm showing tandem testes (T) and uterus (U) with ova; scale bar = 25 μ m.

Rosen and Manis (1976) reported *Telorchis stunkardi* Chandler, 1923 from the three-toed amphiuma, *Amphiuma tridactylum* and Rosen and Marquardt (1978) reported *Telorchis corti* Stunkard, 1915 and *Telorchis singularis* (Bennett, 1935) Wharton, 1940 from *T. scripta* from Lake Conway (see MacDonald and Brooks 1989). Brooks and Mayes (1976) previously reported *Telorchis chelopi* MacCallum, 1919 (syn. *Telorchis gutturosi* Brooks and Mayes, 1976) from false map turtle, *Graptemys pseudogeographica pseudogeographica* from Nebraska. We document a new host and new geographic record for *T. attenuata*.

Acanthocephala:

Eoacanthocephala:

Neoechinorhynchida: Neoechinorhynchidae

Neoechinorhynchus emydis (Leidy, 1851) Van Cleave, 1916 – Of the acanthocephalans we examined from the intestinal tract of *G. geographica* that included immatures and both sexes, every gravid female (USNPC 107211) represented *N. emydis* (Fig. 3), confirmed by the anatomy of the eggs and posterior ends (Barger and Nickol 2004). There were more than 200 individual worms in this host (Fig. 3A). Previous hosts of *N. emydis* include *G. geographica*, *G. pseudogeographica*, Texas map turtle, *Graptemys*

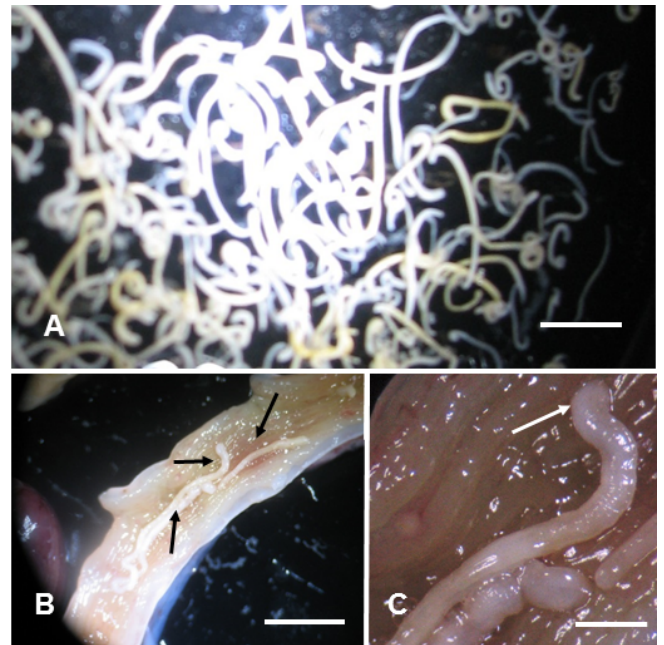


Figure 3. *Neoechinorhynchus emydis*. A. Gross view of acanthocephalans removed from intestinal tract showing intensity of infection. Scale bar = 1 mm. B. In situ view showing three worms in intestine (arrows). Scale bar = 10 mm. C. Closer view of worm with proboscis embedded in intestinal mucosa (arrow). Scale bar = 2 mm.

versa, *C. serpentina*, river cooter, *Pseudemys concinna*, *T. scripta*, spotted turtle, *Clemmys guttata*, wood turtle, *Glyptemys insulpta*, and Blanding's turtle, *Emydoidea blandingii* (Hopp 1954, Ernst and Ernst 1977, Barger 2004). This acanthocephalan has been reported most often from the eastern half of the upper Mississippi River drainage, including Illinois, Indiana, Mississippi, Ohio, Oklahoma and Texas (Williams 1953, Everhart 1958, Barger 2004), and now Arkansas. In addition, Rosen and Marquardt (1978) reported four species of *Neoechinorhynchus* (but not *N. emydis*) from *T. s. elegans* from the state. Thus, we document a new distributional record for *N. emydis* in the Arkansas.

Turtles are hosts of numerous described and undescribed hematozoans and helminths (Ernst and Ernst 1977, 1979, Telford 2009). Because Arkansas supports 19 species and subspecies of turtles within four families (Trauth et al. 2004), we suggest additional surveys on larger samples of turtles from the state as several species remain to be examined for hematozoans and endoparasites. The inclusion of DNA sequence analysis would be particularly helpful to identify some parasite species which have limited morphological traits (i.e., haemogregarines). As such, we predict additional new host and distributional records, including the possibility of discovery of new species.

We thank P.R. Pilitt (USNPC) and Dr. S.E. Trauth (ASUMZ) for expert curatorial assistance. The Arkansas Game & Fish Commission provided Scientific Collecting Permits to CTM and MBC.

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