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Cover Page Footnote

The Arkansas Game and Fish Commission issued a Scientific Collecting Permit to CTM. We thank Drs. S.L. Gardner and G. Racz (HWML) for expert curatorial assistance, and J.M. Kinsella (Missoula, MT) for assistance with helminth identifications.

Ecto- and Endoparasites of the Texas Deermouse, *Peromyscus attwateri* and Eastern Woodrat, *Neotoma floridana* (Rodentia: Cricetidae) from Polk County, Arkansas

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Running Title: Parasites of Texas Deermice and Eastern Woodrats

Abstract

In Arkansas, the Texas deermouse (*Peromyscus attwateri*) occurs in the western part of the state where it is restricted to the uplands of the Interior Highlands. The eastern woodrat (*Neotoma floridana*) is found statewide but is less common in the Gulf Coastal Plain. Very little is known about the parasites of either rodent in Arkansas, especially helminths from *P. attwateri* at any locality within its range. Found in/on *P. attwateri* were a coccidian (*Eimeria langbarteli*), a tapeworm (*Catenotaenia peromysci*), a nematode (*Syphacia peromysci*), 2 ticks (*Dermacentor variabilis* and *Ixodes scapularis*), and 2 mites (*Androlaelaps fahrenheitsi* and *Leptotrombidium peromysci*). Eastern woodrats harbored 3 nematodes (*Eucoelus* sp., *Longistriata neotoma*, and *Trichurus neotomae*), a larval bot fly (*Cuterebra americana*), and a flea (*Orchopeas pennsylvanicus*). We document 6 new host and 5 new distributional records for these parasites.

Introduction

Arkansas supports at least 27 species of rodents (Sealander and Heidt 1990). One of these, the Texas deermouse, *Peromyscus attwateri* J. A. Allen, 1895, is a semiarboreal, small cricetid rodent that occurs in the western part of the state within the Ouachita and Ozark uplands. It also inhabits rocky portions of northern and central Texas, northward into Oklahoma and extends into southern Kansas, and Missouri (Reid 2006). This mouse prefers rocky areas including crevices along cliffs and limestone outcropping with woody vegetation.

Another rodent, the eastern woodrat, *Neotoma floridana* (Ord, 1818), is found statewide in Arkansas and also ranges from the swamplands along the lower Mississippi River, through forested uplands to southern

North Carolina, west to the arid plains of eastern Colorado and Nebraska, and south to eastern Texas and Florida.

Little is known about the parasites of *P. attwateri*. Duszynski and McAllister (1995) and McAllister and Kessler (2002) reported the coccidian, *Eimeria langbarteli* from *P. attwateri* from Texas and Arkansas, respectively. Tumilson *et al.* (2015) and McAllister *et al.* (2017) reported fleas from *P. attwateri* from Arkansas. No helminth parasites, to date, are known from *P. attwateri* from any part of its range.

Moderate information is available on the parasites of *N. floridana* in Oklahoma (Murphy 1952; Boren *et al.* 1993) and Arkansas (McAllister *et al.* 2017), including a recent description by McAllister and Hnida (2020) of a new coccidian from *N. floridana* from Arkansas (incorporating 6 specimens from the current study). Fleas have only been reported from *N. floridana* nests (McAllister *et al.* 2017) and several ticks have been reported from eastern woodrats from the state (McAllister *et al.* 2016). Nothing else, however, has been published on parasites of *N. floridana* in Arkansas. Here, we document some additional parasites from *P. attwateri* and *N. floridana* from the state.

Materials and Methods

Between March and October 2019, and again during March 2020, 6 *P. attwateri* and 6 *N. floridana* were collected with Sherman live traps (H. B. Sherman Traps, Tallahassee, FL) from a limestone escarpment located ca. 4.8 km N of Mena off St. Hwy. 88 at Blue Haze Vista, Polk County (34°37'40.17"N, -94°14'44.4228"W). In addition, a single *N. floridana* was collected on 13 March 2020 from off St. Hwy. 8 at Big Fork, Polk County (34°29'07.89"N, -93°58'03.99"W).

Rodents were killed by cervical dislocation following accepted guidelines (Sikes *et al.* 2011) and their pelage was brushed for ectoparasites. Those found were placed in a vial of 70% (v/v) ethanol; fleas and ticks were cleared in 10% potassium hydroxide, dehydrated through an ethanol series, further cleared in xylene, and slide-mounted in Canada balsam. A mid-ventral incision was made to expose the viscera and the gastrointestinal (GI) tract from the throat to anus was removed, rinsed in 0.9% saline, and organs (including heart, liver, lungs, spleen, and kidneys) were placed in individual Petri dishes. Several sections of the GI tract were cut, split lengthwise, and examined under a stereomicroscope for endoparasites. Feces from the rectum was collected from *P. attwateri* and a single *N. floridana* (from Big Fork site) and placed in 2.5% potassium dichromate. Fecal flotations were accomplished with Sheather's sugar solution (sp. gr. 1.30). Tapeworms were fixed in near boiling tap water without coverslip pressure, transferred to DNA grade ethanol, stained with acetocarmine, and mounted in Canada balsam. Nematodes were examined as temporary mounts in glycerol.

Hosts were deposited in the Henderson State University (HSU) collection, Arkadelphia, Arkansas. Voucher specimens of ectoparasites were deposited in the General Ectoparasite Collection in the Department of Biology at Georgia Southern University, Statesboro, Georgia. Endoparasites were deposited as photovouchers in the Harold W. Manter Laboratory (HWML) of Parasitology, University of Nebraska, Lincoln, Nebraska, or samples were retained for molecular analyses. Prevalence, mean intensity \pm 1SD, and range of infection are provided in accordance with terminology given in Bush *et al.* (1997).

Results and Discussion

An eimerian coccidian was found to be passing in *P. attwateri* feces, a species of cyclophyllidean tapeworm and a nematode were found in the gut, and 2 mites and 2 ticks, each, occurred on the pelage. Woodrats harbored 3 species of nematodes, 1 species of flea, and a third instar bot fly larva; a single *N. floridana* was not passing coccidia. Data are presented below in annotated format.

APICOMPLEXA: EIMERIIDAE

Eimeria langebarteli Ivens, Kruidenier, & Levine, 1959. – Oocysts of *E. langebarteli* (HWML 216346; Fig. 1) were passing in the feces of 4 of 6 (67%) *P. attwateri*. Oocysts were ellipsoidal, $19.8 \times$

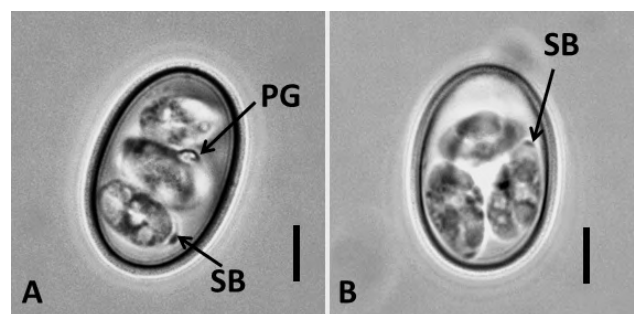


Figure 1. Coccidian from *Peromyscus attwateri*. (A) Sporulated oocyst of *Eimeria langebarteli* showing polar granule (PG) and Stieda body (SB). (B) Another sporulated oocyst of *E. langebarteli* showing SB. Scale bars = 5 μ m.

13.4 (18– 22 \times 13–14) μ m with a length/width ratio (L/W) of 1.5 (1.4–1.7). A micropyle and oocyst residuum was absent but 1–2 polar granules were present. Sporocysts were ovoidal-ellipsoidal, (L \times W) 9.2 \times 5.4 (8–10 \times 5–6) μ m with a L/W ratio of 1.7 (1.5–2.0). A knob-like Stieda body was present but subStieda and paraStieda bodies were absent. The sporocyst residuum was composed of various granules forming either a small, compact sphere or as dispersed mass located between and across the sporozoites. An ellipsoidal posterior refractile body occurred in the sporozoites. This is the first report of measurements and accompanying photomicrographs of *E. langebarteli* from an Arkansas host.

McAllister and Kessler (2002) reported *E. langebarteli* from 1 of 4 (25%) *P. attwateri* from the same collection site herein; however, no mensural data or photomicrographs were provided. In the present study, it is most interesting that this rodent population has hosts passing the same coccidian species that has persisted nearly 2 decades. Duszynski and McAllister (1995) also reported *E. langebarteli* from *P. attwateri* and white-ankled mice (*Peromyscus pectoralis*) from Texas. This coccidian has now been reported from at least 6 species of cricetid rodents, including *Peromyscus* and *Reithrodontomys* from the southwestern United States and México (McAllister and Kessler 2002). Zhao and Duszynski (2001) using plastid ORF470 and nuclear 18S rDNA sequences found that *E. langebarteli* belonged in a lineage B that included eimerians in *Mus*, *Onychomys*, *Rattus*, and *Reithrodontomys*, and which lacked an oocyst residuum.

CESTODA: CYCLOPHYLLIDEA: CATENOTAENIIDAE

Catenotaenia peromysci Smith, 1954. – Two specimens were found in the small intestine of 2 of 6 (33%) *P. attwateri*. Nineteen species of *Catenotaenia*

Parasites of Texas Deermice and Eastern Woodrats

have been described from 22 species of rodents from both Palearctic and Nearctic realms (Haukisalml *et al.* 2010). The type host and type locality is the deer mouse (*Peromyscus maniculatus*) collected from New Mexico (Smith 1954). The geographic range of *C. peromysci* also includes Colorado, Utah, Wyoming, and Alberta and British Columbia, Canada (Smith 1954; Lubinsky 1957; Grundmann *et al.* 1976; Hwang *et al.* 2007). Other hosts include red backed voles (*Myodes gapperi*) from British Columbia, Canada (Erickson 1938). We document a new host and the southeasternmost geographic record for this tapeworm. Vouchers are being retained for molecular analyses.

NEMATODA: RHABDITIDA: TRICHOSTRONGYLIDAE

***Longistriata neotoma* Murphy, 1952.** – Several *L. neotoma* (HWML 216347; Fig. 2) were found in the small intestine of 2/7 (29%) *N. floridana* collected on 17 August and 20 October 2019. This nematode has been previously reported from *N. floridana* from Oklahoma (Murphy 1952; Boren *et al.* 1993). We document this nematode in a host from Arkansas for the first time.

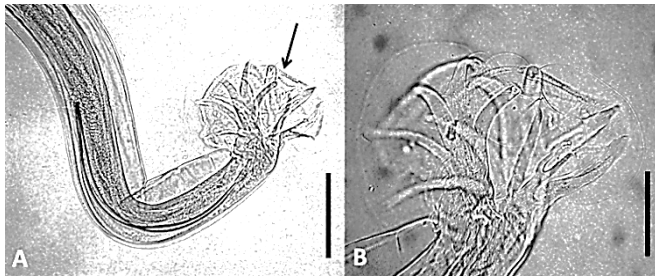


Figure 2. *Longistriata neotoma* from *Neotoma floridana*. (A) View showing posterior end of worm and copulatory bursa (arrow). Scale bar = 100 μ m. (B) Close-up showing copulatory bursa and dorsal rays. Scale bar = 50 μ m.

ENOPLIDA: TRICHOCEPHALIDA: TRICHURIDAE

***Eucoelus* sp.** – Species of the genus *Eucoelus* Dujardin, 1845 are primarily parasites of the esophagus and stomach of birds and mammals. The specimen (gravid female) recovered here in 1 of 7 (14%) *N. floridana* collected on 20 October 2019 was found in the small intestine and is probably undescribed. Bechtel *et al.* (2015) reported *Eucoelus* sp. from dusky-footed woodrat (*Neotoma fuscipes*) and big-eared woodrat (*Neotoma macrotis*) in California. However, their identification was made from capillariid eggs in the feces and it is impossible to reliably determine such eggs to genus, although our own record may lend weight to the possibility. The

only record, to date, of *Eucoelus* specimens in North American rodents appears to be that of *E. gastricus* from the marsh rice rat (*Oryzomys palustris*) in Florida by Kinsella (1988), but that species only occurs in tunnels within the stomach lining. We here document this nematode from *N. floridana* and Arkansas for the first time. Vouchers are being retained for molecular analyses.

***Trichurus neotomae* Chandler, 1945.** – Two female *T. neotomae* (HWML 216348; Fig. 3) were taken from the cecum of 1 of 7 (14%) *N. floridana* collected on 17 August 2019. Both Boren *et al.* (1993) and McAllister *et al.* (2017) reported *T. muris* from *N. floridana* from Oklahoma but we believe this to be a misidentification and actually represent *T. neotomae*. This nematode was originally described from *N. fuscipes* from California (Chandler 1945). It has also been reported from southern plains woodrat (*Neotoma micropus*) from Texas (Charles *et al.* 2012). We report *T. neotomae* in Arkansas for the first time.

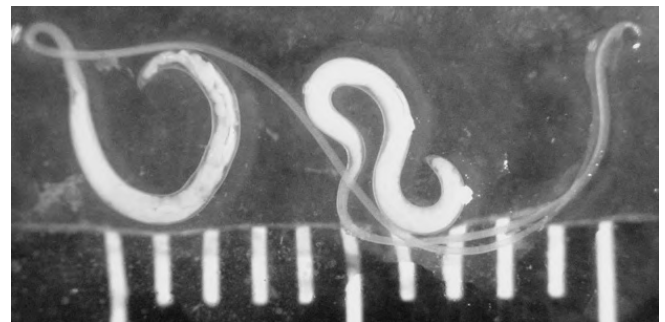


Figure 3. Stereoscopic view of 2 *Trichurus neotomae* from *Neotoma floridana*. Each scale interval = 1 mm.

OXYURIDA: SYPHACIIDAE

***Syphacia (Seuratoxyuris) peromysci* Harkema, 1936.** – Two immature female specimens were found in the small intestine of 1 (17%) *P. attwateri* collected on 15 March 2020. This nematode has been previously reported from *Peromyscus* spp. (*P. gossypinus*, *P. leucopus*, *P. maniculatus*, and *P. polionotus*), western harvest mouse (*Reithrodontomy megalotis*), and spotted ground squirrel (*Xerospermophilus spilosoma*) from Arizona, Minnesota, New Mexico, North Carolina, Utah, Wisconsin, and Québec, Canada and México (Kruidenier *et al.* 1961; Pulido-Flores *et al.* 2005; Falcón-Ordaz *et al.* 2016). The life cycle is direct with hosts being infected via perianal contact with ova. This is the first time *S. peromysci* has been reported from *P. attwateri* and Arkansas is also a new

geographic locality. Vouchers are being retained for molecular analyses.

ACARI: TROMBICULIDAE

***Leptotrombidium peromysci* Vercammen-Grandjean & Langston, 1976.** – One larval *L. peromysci* (L3843) was collected from a single (17%) *P. attwateri* collected on 15 March 2020. This chigger has been reported from several species of small and medium-sized mammals in the eastern U.S. and South Dakota (Walters *et al.* 2011), including white-footed mouse (*Peromyscus leucopus*) from Arkansas (Connior *et al.* 2017). This represents the second record of this species from Arkansas as well as a new host record for this chigger mite.

LAELAPIDAE

***Androlaelaps fahrenheitzi* (Berlese, 1911).** A single nymphal *A. fahrenheitzi* (L3843) was found on 1 of 6 (17%) *P. attwateri* collected on 15 March 2020. This is a widespread and common Nearctic ectoparasite that has been previously reported from various rodents in other states (Whitaker *et al.* 2007), including woodland vole (*Microtus pinetorum*), hispid pocket mouse (*Sigmodon hispidus*), golden mouse (*Ochrotomys nuttalli*), and *N. floridana* from Arkansas (Tumlison *et al.* 2015; Connior *et al.* 2017). We document a new host record for *A. fahrenheitzi*.

IXODIDA: IXODIDAE

***Dermacentor variabilis* (Say, 1821).** – Two larval American dog ticks (L3843) were collected from a single (17%) *P. attwateri* collected on 20 March 2020. This is a commonly collected tick from a variety of mammalian hosts, including several rodents (Cricetidae, Sciuridae) from Arkansas (McAllister *et al.* 2016). There are several records of *D. variabilis* from domestic dogs and cats from Polk County (McAllister *et al.* 2016). This is, however, the first time *D. variabilis* has been reported from *P. attwateri*.

***Ixodes scapularis* Say, 1821.** – A single larval *I. scapularis* (L3843) was taken from a *P. attwateri* collected on 20 March 2020; this same host also co-harbored the *D. variabilis* above. The blacklegged tick is a common species in Arkansas on a wide variety of hosts, including medium to large-sized mammals as adults but immatures are often found infesting the same hosts as well as small mammals, birds, and reptiles, especially lizards (see McAllister *et al.* 2016). We document *I. scapularis* from *P. attwateri* for the first time.

INSECTA: SIPHONAPTERA: CERATOPHYLLIDAE

***Orchopeas pennsylvanicus* (Jordan, 1928).** – Three of 7 (43%) eastern woodrats, collected on 15 March and 20 October 2019, harbored 1 male (L3828) and 2 female (L3837) *O. pennsylvanicus* (Fig. 4) from the Blue Haze Vista site respectively, and another *N. floridana* collected on 13 March 2020 was infested with 18 (9 male and 9 female, L3843) *O. pennsylvanicus* from the Big Fork site. This flea was previously reported by Schiefer and Lancaster (1970) from woodrat “nests” from northwestern Arkansas. The eastern woodrat hosts a variety of generalist flea parasites (Durden *et al.* 1997) and *O. pennsylvanicus* occurs in eastern North America as an ectoparasite of woodrats (Lewis 2000); it has no known medical-veterinary importance. We document the first report of this flea (with genuine voucher specimens) on eastern woodrats from Arkansas.



Figure 4. Female *Orchopeas pennsylvanicus* (L3837) from *Neotoma floridana*. Scale bar = 500 μ m.

DIPTERA: OESTRIDAE

***Cuterebra americana* (Fabricius, 1775).** – A single third-instar larval woodrat bot fly, *C. americana* (L3836; Figs. 5A–B) was found on the subcutis of the throat region of 1 of 7 (14%) *N. floridana* collected on 19 October 2019. The host of preference for *C. americana* is the eastern woodrat (Beamer *et al.* 1943; Sabrosky 1986). Eggs of cuterebrids are typically laid on sticks, rocks or other surfaces at or near the entrance to woodrat nests (Beamer *et al.* 1943). Flies of the genus *Cuterebra* are common in most temperate and tropical regions in the Western Hemisphere (Sabrosky 1986; Colwell *et al.* 2005). Larvae of these flies infest lagomorphs and rodents (Colwell *et al.* 2005).

Parasites of Texas Deermice and Eastern Woodrats

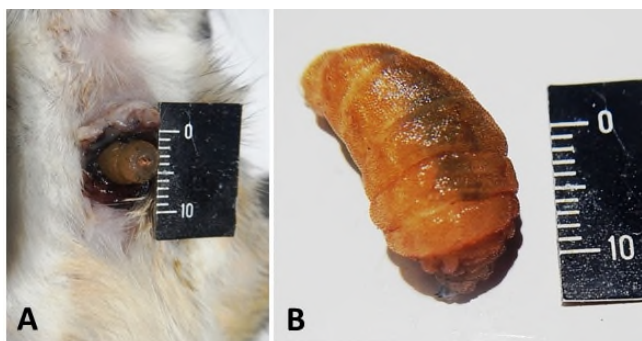


Figure 5. *Cuterebra americana* from *Neotoma floridana*. (A) View showing bot *in situ*. (B) Extracted specimen. Scale intervals = 1 mm.

Although botflies are relatively large compared to their hosts, they rarely cause mortality from myiasis. This appears to be the first report of a *N. floridana* from Arkansas to be infested with larval *C. americana*. Sabrosky (1986) documented adult *C. americana* from Baxter and Washington counties in northern Arkansas.

In summary, we have provided novel ecological information on 2 rodents from Arkansas by documenting 6 new host and 5 new distributional records for their parasites. As Arkansas supports at least 27 species of rodents (Sealander and Heidt 1990), additional surveys are warranted to identify and report their parasites in the state.

Acknowledgments

The Arkansas Game and Fish Commission issued a Scientific Collecting Permit to CTM. We thank Drs. S.L. Gardner and G. Racz (HWML) for expert curatorial assistance, and J.M. Kinsella (Missoula, MT) for assistance with helminth identifications.

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