
Novel Natural History and Ecological Information on Select Oklahoma Biota

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Abstract: In this contribution on the subject, we include noteworthy observations on the natural history and ecology of select biota of Oklahoma. Here, additional biological records on 15 species of invertebrates and vertebrates from the state are documented. Novel information is provided for an asellid isopod, three cambarid crayfishes, a stonefly, three fishes, one turtle, three snakes, one bird, and two mammals. Our purpose is to help complement and fill gaps in our limited biological knowledge of this biota that should help in future studies and observations conducted in the state.

Introduction

Oklahoma's biota is comprised of a very diverse group of organisms that inhabit the state's dynamic ecosystems. Therefore, when data on the natural history and ecology of the various taxa is noteworthy, it should be documented when available. Novel information has been provided by our previous community collaborative efforts (McAllister and Robison 2016, 2017; Robison et al. 2018) and, here, we continue that effort and provide new biological information on five invertebrates and nine vertebrates of the state.

Methods

Crayfishes were collected by hand or dipnet and preserved in 70% (v/v) isopropyl alcohol.

Fish were taken with gill nets or by bowhunting, measured for total length (TL), preserved in 10% formalin, and stored in 45% isopropanol; they were also examined for stomach contents. A turtle and three snakes, collected by hand, were measured for carapace length (CL) and snout-vent length (SVL), respectively. Feces from the rectum of snakes were collected and placed in a vial containing 2.5% (w/v) potassium dichromate ($K_2Cr_2O_7$) and, after flotation in Sheather's sugar solution (sp. gr. 1.30), examined for coccidians. A single bird, bat and bobcat each were found dead without necrosis on the road (DOR) and examined. The feathers of the bird was brushed vigorously over a white enamel tray to observe ectoparasites and those found were placed in individual vials of 70% (v/v) ethanol; selected specimens were cleared in 10% potassium hydroxide, dehydrated through an ethanol series, further cleared in xylene, and slide-mounted in Canada balsam (Price et al. 2003). Localities for

all sites herein are reported as GPS (latitude and longitude) coordinates.

Crayfish voucher specimens were deposited in the Southern Arkansas University (SAU) Collection, Magnolia, Arkansas. Photovouchers of fish and mammals were deposited in the Henderson State University (HSU) collection, Arkadelphia, Arkansas, and photovouchers of reptiles were deposited in the Arkansas State University Museum of Zoology (ASUMZ), Herpetological Collection, State University, Arkansas. The bird was deposited in the Eastern Oklahoma State University-Idabel collection, Idabel, Oklahoma. Voucher specimens of bird lice were deposited in the General Ectoparasite Collection in the Department of Biology at Georgia Southern University, Statesboro, Georgia, under an individual accession number. Voucher specimens of other parasites were deposited in the Harold W. Manter Laboratory of Parasitology (HWML), University of Nebraska, Lincoln, Nebraska.

We follow the Reptile Database for all common and scientific names of reptiles (Uetz et al. 2019), and/or Burbrink and Guiher (2014) who synonymized the copperhead subspecies *Agkistrodon contortrix contortrix*, *A. c. mokasen*, and *A. c. phaeogaster* (in part) into *A. contortrix*.

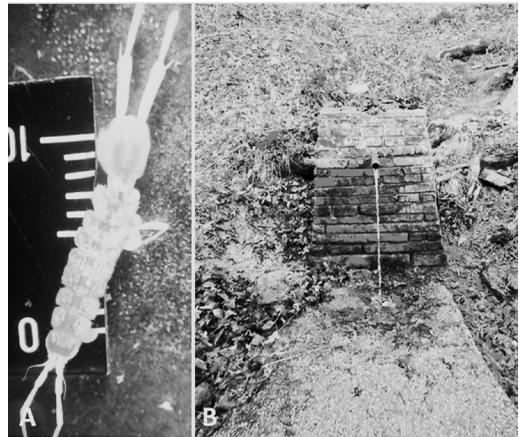
Results and Discussion

The collections described herein represent important records of geographic distribution or previously unknown observations of their natural history and ecology, and are reported below in an annotated format as follows.

Arthropoda: Crustacea: Malacostraca:

Isopoda: Asellidae

Caecidotea sp. – an unknown species of asellid isopod (Fig. 1A) was collected by aquatic dipnet on 29 December 2018 from Pipe Spring, 3.2 km N of Big Cedar off US 259, Le Flore County (34°41'53.35"N, 94°38'41.21"W) (Fig. 1B). It possessed small eyes and moderate pigmentation (Fig. 1A) and was determined to belong to the genus *Caecidotea*. There are at least 21 species of *Caecidotea* in Oklahoma



Figures 1A–B. Isopod from Le Flore County. (A) Specimen of *Caecidotea* sp. showing moderate pigmentation and without eyes; scale bar increments = 1 mm. (B) Pipe Spring study site looking south.

(Graening et al. 2007). Additional specimens will be required to provide a specific identity. However, *C. montana* (Mackin and Hubricht, 1938) has been reported by Graening et al. (2007) from a site just to the south of the collection locality above a “stream near Big Cedar.” The voucher was retained in the personal collection of Julian J. Lewis.

Decapoda: Cambaridae

Fallicambarus fodiens (Cottle, 1863) – **Digger Crayfish.** In Oklahoma, *F. fodiens* is known from only three localities in Le Flore and McCurtain counties, and from “one locality in north central portion of the state” that was not specified (Reimer 1968; Morehouse and Tobler 2013). This crayfish is a primary burrower, but constructs one of the least complex burrows of any species in its genus (Hobbs and Robison 1989). We document herein two new collection sites of *F. fodiens*. On 16 March 2000, a single form II male was collected from a roadside ditch at the jct. of US 70 and St. Hwy. 98, ca. 8 km E of Valliant, McCurtain County (33°59'27.4812"N, 95°02'6.6696"W). In addition, a female *F. fodiens* was collected from a simple burrow ca. 6.4 km E of Hugo on US 70, Choctaw County (33°59'52.674"N, 95°23'58.9416"W). The latter specimen represents a new county record of *F. fodiens* in the state and extends the range of this species westward to the Hugo area.

***Fallicambarus schusteri* Taylor and Robison, 2016 – Carmel Crayfish.** Recently, Taylor and Robison (2016) described *F. schusteri* from four locations in the flatlands draining south into the Red River from Idabel in southcentral McCurtain County to Ashdown, southcentral Little River County, Arkansas. These authors believed continued sampling of roadside ditches for burrowing crayfishes in this area would likely yield additional localities for this crayfish. In Oklahoma, only three localities are known for this species. We herein report a new collection site of *F. schusteri* in addition to the collection of a single ovigerous female captured on 17 March 2000 from a burrow in a roadside ditch along St. Hwy. 3 at Bokhoma, McCurtain County (33°49'20.73"N, 94°34'58.4256"W). This is the first report of *F. schusteri* with eggs; unfortunately, no egg counts were made. The specimen was dug from a burrow composed of a single shaft 10 cm deep within a low chimney.

***Procambarus clarkii* (Girard, 1852) – Red Swamp Crayfish.** This crayfish is a wide-ranging species which occurs naturally along the Gulf Coastal Plain from northeastern México to the Florida panhandle, extending northward into southeastern Missouri and southwestern Illinois (Page 1985; Pflieger 1996; Walls 2009). In Oklahoma, *P. clarkii* occurs naturally in the southeastern corner where the Gulf Coastal Plain enters the state (Morehouse and Tobler 2013). On 4 September 2000, a single ovigerous 83 mm TL female with 106 ova (1.0–1.4 mm in diameter, wet weight = 1.1 g) was collected from a flooded roadside ditch at the jct. of US 259 and co. rd. 2250 in Harris, McCurtain County (33°46'16.3632" N, 94°43'48.5328" W). In Louisiana, females with eggs have been collected in September (Penn, 1943). Page (1985) reported females with eggs from June through early September in Illinois. Morehouse and Tobler (2013) reviewed the distribution and natural history of *P. clarkii* in Oklahoma, but reported no ovigerous females were known from the state. The discovery of this female with eggs is the first report of an ovigerous *P. clarkii* taken in Oklahoma.

Insecta: Plecoptera: Leuctridae

***Zealeuctra claasseni* (Frison, 1929) – Common Needlefly.** A nymphal specimen of *Z. claasseni* was collected with an aquatic dipnet on 29 December 2018 from the same Pipe Spring site noted above. There are currently 12 species of *Zealeuctra* distributed in central and eastern North America (Grubbs et al. 2013; Verdone et al. 2019). *Zealeuctra claasseni* ranges widely and has been previously reported from Alabama, Arkansas, Illinois, Indiana, Kansas, Kentucky, Missouri, Oklahoma, Ohio, Tennessee, Texas, and West Virginia (DeWalt et al. 2019). In Oklahoma, *Z. claasseni* has been reported from Comanche, Johnston and Latimer counties (Grubbs et al. 2013). A voucher specimen was deposited in the C. P. Gillette Museum, Colorado State University, Fort Collins, Colorado. We document a new county record for this stonefly in Oklahoma.

Actinopterygii: Lepisosteiformes: Lepisosteidae

***Lepisosteus oculatus* Winchell, 1864 – Spotted Gar.** An adult female *L. oculatus* (670 mm TL) was collected by bowfishing on 28 October 2018 from a private lake (Little River drainage) on the Turner Ranch just north of Idabel, McCurtain County (33°55'56.93"N, 94°43' 43.22"W). Examination of the body revealed two fish lice, *Argulus americanus* C. B. Wilson, 1902 (HWML 111302, Fig. 2A). The genus *Argulus* (Crustacea: Branchiura) has a worldwide distribution and about 32 species and subspecies are considered valid (McLaughlin et al. 2005). However, relatively little is known of the distribution and species composition of the crustacean ectoparasite genus *Argulus* in Oklahoma. McAllister et al. (2016) reported *A. americanus* from Flathead Catfish (*Pylodictis olivaris*) and Largemouth Bass (*Micropterus salmoides*) from Broken Bow Lake (McCurtain County), ca. 32 km N of the current study site. The geographic distribution of records of this louse from Bowfin (*Amia calva*) and Longnose Gar (*Lepisosteus osseus*) include: Florida, Illinois, Indiana, Iowa, Louisiana, Michigan, Oklahoma, Wisconsin, and Québec, Canada (Wilson 1916; Meehan 1940; Shimura and Asai 1984; Poly 1998; McAllister et al. 2016). In

Arkansas, *L. oculatus* has been reported as a host of *A. nobilis* Thiele, 1904 (Hoffman 1999) and a specimen of *A. mississippiensis* Wilson, 1916, deposited in the United States National Museum (now National Museum of Natural History) as USNM 191113, was taken from a *L. oculatus* from Oates Creek at Bradford (White County), Arkansas. Branchiurans are primarily ectoparasites of fishes (Poly 2008) and these ectoparasites can be destructive due mainly to secondary fungal infections that attach at the puncture sites, and they can also transmit viral diseases and other fish parasites. This is the first report of *A. americanus* from a Spotted Gar from Oklahoma, and the second report of the parasite from the state.

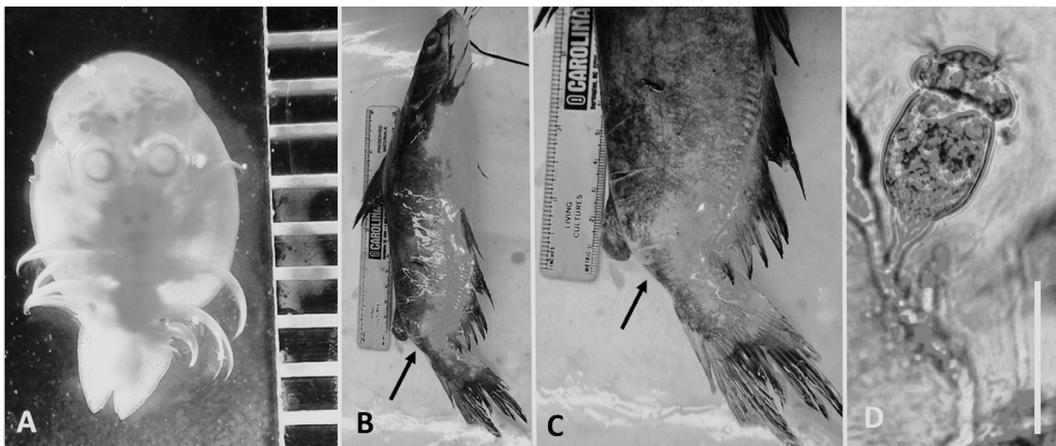
Hiodontiformes: Hiodontidae

Hiodon alosoides (Rafinesque, 1819) – **Goldeye**. The diet of the Goldeye is reported to be composed primarily of aquatic and terrestrial insects (Johnson 1963) and studies from Lake Texoma have supported this notion (Shelton 1969; Miller and Robison 2004). In addition, Tumilson et al. (2018) reported a *H. alosoides* that fed on cottonwood leaf beetles, *Chrysomela scripta* in the Mississippi River, Arkansas. To our knowledge, there are no reports of specific foods consumed by specimens of *H. alosoides* from Oklahoma. On 6 February 2018, an adult Goldeye (360 mm TL) was collected by gill net from the vicinity

of the Willis Bridge, Lake Texoma, Marshall County (33°52'31.9224"N, 96°50'01.2804"W). While it was being necropsied for parasites, the stomach was found to contain a menagerie of terrestrial insects as follows: a spider, stink bugs (Hemiptera), a carabid and a cerambycid beetle, and hymenopterans, but no aquatic taxa. This further supports *H. alosoides* food habit data that suggests this fish feeds on insects, terrestrial in origin, via frequent surface feeding in shallow water.

Siluriformes: Ictaluridae

Ictalurus punctatus (Rafinesque, 1818) – **Channel Catfish**. A 265 mm TL *I. punctatus* collected in a gill net on 10 June 2019 from a tributary of the Little River on the same Turner Ranch site above exhibited an unusual skeletal deformation that appeared to show the typical facies of kyphosis-scoliosis of the vertebral column (Fig. 2B–C). It is not known what caused this deformity but nutritional factors such as deficiencies in phosphorus and vitamins C and K, and hypervitaminosis A can lead to twisted neural and hemal spines, development of soft bones, decreased bone mass, vertebral fusion, lordosis, kyphosis, and scoliosis (Berillis 2015). Although this fish was a wild caught specimen, scoliosis has been observed in cultured Channel Catfish and is associated with severe vitamin C deficiency (Andrews and Murai 1975). In addition, Lim and Lovell (1978) reported that



Figures 2A–D. Fish louse, scoliosis, and commensal ciliate. (A) *Argulus americanus* from *Lepisosteus oculatus*; scale bar increments = 1 mm. (B) Scoliosis in *Ictalurus punctatus* (arrow); note ruler scale. (C) Close-up view of scoliosis (arrow) in *I. punctatus*. (D) *Epistylis* sp. from *Chelydra serpentina*; scale bar = 50 μ m.

I. punctatus with vitamin C deficiency had a decreased bone collagen content and developed vertebral column malformations (kyphosis, lordosis, scoliosis). We document the first report of scoliosis in a non-cultured Channel Catfish, including, to our knowledge, the initial specimen from Oklahoma afflicted with this skeletal disorder.

Reptilia: Testudines: Chelydridae

***Chelydra serpentina* (L., 1758) – Common Snapping Turtle.** An individual *C. serpentina* (CL = 265 mm) collected on 8 July 2018 from off US 259 in Hochatown, McCurtain County (34°09'53.2656"N, 94°45'20.2608"W) was found to be partially covered with ectocommensal *Epistylis* sp. (Fig. 2D) on its carapace. These ciliates are sessile peritrichous organisms often present as a branching colony with a short oral disc and collar, and non-contractile rigid stalk (Dias et al. 2006). *Epistylis* spp. have been reported on various turtles (Bishop and Jahn 1941; Bovee 1976) and from two species of emydid turtles from Arkansas (Tumblison and Clark 1996). This is the first report of an *Epistylis* sp. on *C. serpentina* from Oklahoma.

Ophidia: Colubridae

***Lampropeltis holbrooki* Stejneger, 1902 – Speckled Kingsnake.** On 16 July 2019, a juvenile male (425 mm SVL) *L. holbrooki* was collected by hand in Hochatown, McCurtain County (34°09'55.152"N, 94°45'35.8776"W), and held at room temperature. Within 12 hrs, it regurgitated a 215 mm SVL rough earth snake (*Haldea striatula*) (Fig. 3). Interestingly,

the prey item made up 51% of the SVL of the *L. holbrooki*. Speckled kingsnakes are reported to feed on a variety of vertebrate prey including small mammals, birds, venomous and nonvenomous snakes, lizards, turtles, frogs, as well as the eggs of birds and reptiles (Werler and Dixon 2000). Konvalina et al. (2015) documented an instance *L. holbrooki* eating a *H. striatula* in adjacent Arkansas. In addition, McAllister (2016) reported a *L. holbrooki* from the same Oklahoma locale above that had eaten both a flat-headed snake (*Tantilla gracilis*) and a smooth earthsnake (*Virginia valeriae elegans*). Here, we report a species of snake that has not previously been reported as prey of an Oklahoma *L. holbrooki*.

***Lampropeltis calligaster calligaster* (Harlan, 1827) – Prairie Kingsnake.** An adult *L. c. calligaster* (550 mm SVL) collected on 5 May 2018 from Smithville, McCurtain County (34°28'0.4794"N, 94°38'37.6794"W) was passing sporulated oocysts and sporocysts of a *Sarcocystis* sp. (HWML 216103) and sporulated oocysts of *Caryospora lampropeltis* Anderson, Duszynski, and Marquardt, 1968 (HWML 216104) in its feces. Sporocysts of the former (Fig. 4A) measured (L × W) 11 × 7 μm; the latter oocysts (Fig. 4B) measured ca. 22–25 μm in diameter with a single polar granule, and their sporocysts were 18–20 × 12–13 μm with a button-like Stieda body and a plump subStieda body, all fitting the description of *C. lampropeltis*. Anderson et al. (1968) reported a *Sarcocystis* (syn. *Cryptosporidium lampropeltis*) from *L. c. calligaster* from Illinois. In addition, the type



Figure 3. Speckled kingsnake (above) with rough earth snake prey (below). Note ruler scale.

host of *Ca. lampropeltis* is *L. c. calligaster* from Illinois (Anderson et al. 1968). McAllister et al. (2017) also reported the coccidian from *L. c. calligaster* from Arkansas. This is the second report of a *Sarcocystis* sp. in this host from the state (McAllister et al. 2013) and the first report of *Ca. lampropeltis* from Oklahoma.

Viperidae

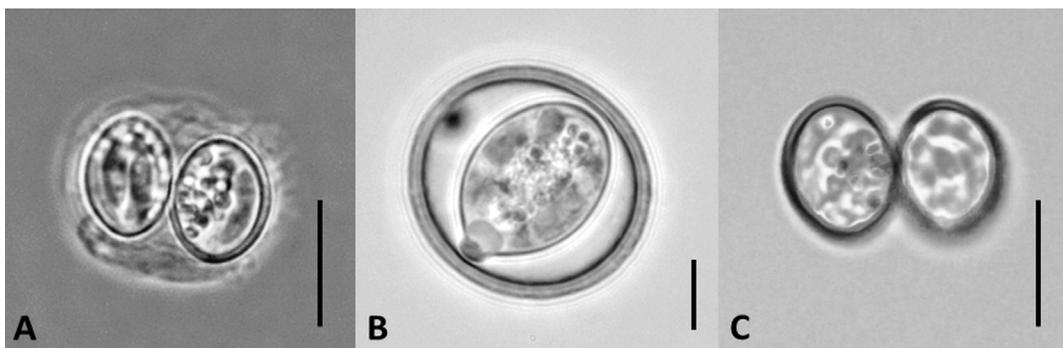
***Agkistrodon contortrix* (L., 1766) – Eastern Copperhead.** Although coccidian parasites are relatively common in snakes, copperheads in general have rarely been reported as hosts (Duszynski and Upton 2009). Wacha and Christiansen (1975) were the first to report an isosporan from eastern copperheads (formerly Osage copperheads, *A. contortrix phaeogaster*) in Iowa that was later determined to represent a *Sarcocystis* sp. Lindsay et al. (1991) and Robison et al. (2018) reported *Sarcocystis montanaensis* and a *Choleoimeria* sp., from *A. contortrix* from Arkansas and Oklahoma, respectively. A juvenile eastern copperhead (400 mm SVL) collected on 25 June 2019 from Hochatown, McCurtain County (34°09'55.152"N, 94°45'35.8776"W) was found to be passing sporulated oocysts and sporocysts (Fig. 4C) of a unknown *Sarcocystis* sp. (HWML 216105). Unfortunately, there were not enough sporocysts to attempt to establish experimental infections in rodents and therefore, a description of a new or previously known species using microscopy alone is not possible. This represents the third time *Sarcocystis* sp. has been reported from copperheads as well as the third species of snake (McAllister et al. 2013) harboring this coccidian genus in Oklahoma.

Aves: Passeriformes: Turdidae

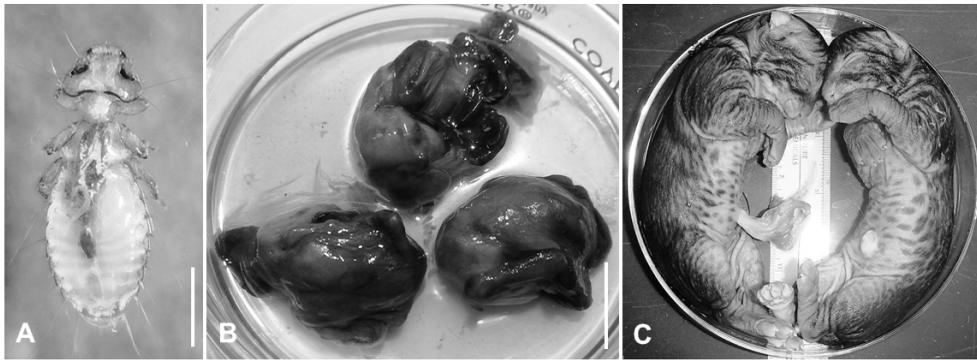
***Hylocichla mustelina* Baird, 1864 – Wood Thrush.** An adult *H. mustelina* found DOR on 14 May 2019 in Hochatown, McCurtain County (34°09'55.152"N, 94°45'35.8776"W) was found to be infested with one male, six females, and 11 nymphs of *M. eurysternus* (L3832) (Fig. 5A). *Menacanthus eurysternus* feeds on host blood obtained by piercing the quill of pin feathers and by gnawing through the epidermis (Agarwal 1983). Therefore, this louse could potentially be harmful to populations of wood thrushes. The host list for *M. eurysternus* is extensive, and includes at least 20 families, 70 genera, and 118 species (Price 1975). The wood thrush is included as a host by Price (1975) but; unfortunately, he did not specify the host locality (state) beyond USA. In addition, the louse was not listed by Emerson (1940) as occurring in Oklahoma. We document *M. eurysternus* for the first time in Oklahoma.

Mammalia: Chiroptera: Vespertilionidae

***Lasiurus borealis* Müller, 1776 – Eastern Red Bat.** A pregnant female *L. borealis* collected DOR on 1 June 2019 from off St. Hwy. 152 at Cerrogordo, McCurtain County (35°17'27.276"N, 98°43'0.7284" W) contained three fully-developed embryos (Fig. 5B) with crown-rump lengths of ca. 30 mm. Caire et al. (1989) and Ammerman et al. (2012) noted that *L. borealis* is one of the few bats that regularly give birth to more than two young (since they possess four teats), which enables the females to successfully raise three or four young. We document the first report of the young of *L. borealis* from



Figures 4A–B. Coccidians from snakes. (A) *Sarcocystis* sp. from *Lampropeltis calligaster calligaster*. (B) *Caryospora lampropeltis* from *L. c. calligaster*. (C) *Sarcocystis* sp. from *Agkistrodon contortrix*. Scale bars = 10 μ m.



Figures 5A–C. Bird louse and mammal reproduction. (A) *Menacanthus eurysternus* female. Scale bar = 500 μ m. (B) Three embryos of *Lasiurus borealis*. Scale bar = 15 mm. (C) Two fetuses of *Lynx rufus*. Note ruler scale.

Oklahoma.

Carnivora: Felidae

***Lynx rufus* Schreber, 1777 – Bobcat.** A pregnant female *L. rufus* collected DOR on 16 April 2019 in Idabel, McCurtain County (33°53'37.41"N, 94°51'09.8352" W) was found to contain two fetuses with crown-rump lengths of 135 and 145 mm (Fig. 5C). Given a gestation period of about 50 days, these young were near birth since their parents probably mated in January or February (Caire et al. 1989). In an unpublished thesis, Rolley (1983) reported that bobcats in Oklahoma give birth to two to four young with a mean *in utero* litter size of 2.25 for yearlings and 2.66 for adults. We document the first published report on an aspect of reproduction in a *L. rufus* from the state.

In summary, we provide additional information on the biology of five invertebrates and 10 vertebrates from Oklahoma. We suggest that future novel observations should be documented to help further our knowledge of the natural history and ecology of biota of the state.

Acknowledgments

The Oklahoma Department of Wildlife Conservation (ODWC) issued a Scientific Collecting Permit to CTM. We thank Matt Mauck, David Routledge, and Cliff Sager (ODWC) for assistance with collecting at Lake Texoma, Trevor K. Turner (Oklahoma State University) who donated the *L. oculatus* and

I. punctatus, Julian J. Lewis (Borden, IN) for identifying the isopod, Dr. Boris C. Kondratieff (Colorado State University, Colorado Springs, CO) who identified the stonefly nymph, and Dr. Lance A. Durden (Georgia Southern University, Statesboro, GA) for identifying the louse.

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Submitted October 11, 2019 Accepted December 13, 2019