

First Report of *Sarcocystis* sp. (Apicomplexa: Sarcocystidae) from Oklahoma Snakes (Ophidia: Colubridae)

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Coccidia of the genus *Sarcocystis* exhibit an obligate predator/prey or scavenger/prey life cycle. In a snake definitive host, sexual reproduction occurs in the epithelial cells of the small intestine and oocysts and free sporocysts are passed in feces; in the intermediate host (often a rodent), asexual development takes place, usually as cyst (sarcocyst) stages in skeletal musculature (Duszynski and Upton 2009). In order to adequately identify *Sarcocystis* species, it is necessary to examine their life cycle through experimental transmission studies. Indeed, McAllister et al. (1996) stated, "tissue stages recovered in the intermediate host are necessary for species identification."

Duszynski and Upton (2009) provide the most recent summation of *Sarcocystis* spp. from snakes of the world. In the family Colubridae, only 10 species of *Sarcocystis* have been adequately described. Of these, four species are known from North America as follows: *Sarcocystis lampropeltis* Duszynski and Upton, 2009, formerly *Sarcocystis montanaensis* Dubey, 1983 from a speckled kingsnake (*Lampropeltis holbrookii*) from Arkansas (see Lindsay et al., 1992), *S. montanaensis* from a southern copperhead (*Agkistrodon contortrix contortrix*) from Arkansas (Lindsay et al., 1991), *Sarcocystis idahoensis* Bledsoe, 1980 from Great Basin gopher snakes (*Pituophis catenifer deserticola*) from Idaho, and *Sarcocystis roundabushi* (Pellérdy, 1974)

Levine and Tadros, 1980 from bullsnakes (*P. c. sayi*) from Iowa (Roudabush 1937; Bledsoe 1980; Duszynski and Upton 2009). We know of no previous reports of *Sarcocystis* sp. in any reptile from Oklahoma. Here we provide the first report of *Sarcocystis* sp. in two common snakes from the state.

Between September 2002 and September 2013, we collected by hand, snake tongue, or from fresh specimens found dead on the road (DOR), 42 colubrid and five viperid snakes from five counties (Figure 1) of southeastern Oklahoma (Atoka, Choctaw, LeFlore, McCurtain, Pushmataha), including: two *A. c. contortrix*, one western cottonmouth (*Agkistrodon piscivorus leucostoma*), two black racers (*Coluber constrictor priapus*), two timber rattlesnakes (*Crotalus horridus*), five prairie ring neck snakes (*Diadophis punctatus arnyi*), one western mud snake (*Farancia abacura reinwardtii*), two eastern hognose snakes (*Heterodon platirhinos*), four prairie king snakes (*Lampropeltis calligaster calligaster*), one blotched water snake (*Nerodia erythrogaster transversa*), one broad-banded water snake (*Nerodia fasciata confluens*), 11 diamondback water snakes (*Nerodia rhombifer*), 13 western rat snakes (*Pantherophis obsoletus obsoletus*), one midland brown snake (*Storeria dekayi wrightorum*), one flathead snake (*Tantilla gracilis*), and one western ribbon snake (*Thamnophis proximus proximus*). Fresh fecal samples were col-

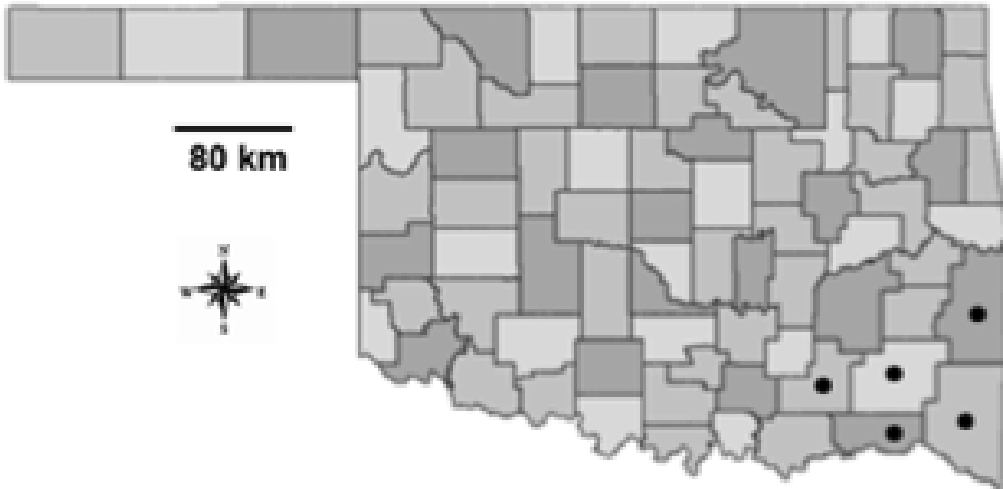


Figure 1. Five Oklahoma counties where snakes were collected and surveyed for *Sarcocystis* spp.

lected from the rectum of each individual for examination of coccidia and placed in individual vials containing 2.5% (w/v) aqueous potassium dichromate ($K_2Cr_2O_7$). They were examined by light microscopy after flotation in Sheather's sugar solution (specific gravity = 1.30). Measurements were taken on 10 sporocysts using a calibrated ocular micrometer and reported in micrometers with means followed by the ranges in parentheses. Photographs were taken using Nomarski interference-contrast (DIC) optics. Photovouchers of the parasites are deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland. Host vouchers are deposited in the Arkansas State University Museum of Zoology (ASUMZ) Herpetological Collection, State University, Arkansas. Snake taxonomy follows the TIGR reptile database (Uetz 2013). Four of 47 (9%) of the snakes were found to be passing fully sporulated oocysts and free sporocysts of *Sarcocystis* sp. (Figures 2A-C) in feces as follows: two of 13 (15%) *P. o. obsoletus*, an adult male (snout-vent length [SVL] = 1,230 mm, ASUMZ 32765) collected on 23 May 2013 from the vicinity of Three Sticks National Forest Monument off US 259, Le Flore County (34.730637°N,

95.042542°W) and another adult male (1,135 mm SVL, ASUMZ 32766) collected on 9 August 2013 from off US 271, S of Talihina, Le Flore County (34.623603°N, 94.652138°W); and two of four (50%) *L. c. calligaster* (adult males, 850 and 745 mm SVL, ASUMZ 32766, uncatalogued-DOR) collected on 21 July 2013 and 19 September 2013 from 1.6 km W of Broken Bow off St. Hwy. 3, McCurtain County (34.032217°N, 94.756866°W) and 3.2 km SE of Smithville off St. Hwy. 4, McCurtain County (34.450335°N, 94.6271°W). Sporocysts from *P. o. obsoletus* (ASUMZ 32765) measured L × W (mean [range]) = 11.2 × 9.0 (10–12 × 8–10) with a shape index of 1.3 (1.2–1.4); the sporocyst wall was ca. 0.5 thick, lacked a Stieda body, and enclosed four sporozoites and a granular sporocyst residuum. These measurements accord well with those previously reported from *L. holbrookii* from Arkansas and originally reported as *Sarcocystis montanaensis* (Lindsay et al. 1992) but now referred to as *Sarcocystis lampropeltii* (see Duszynski and Upton 2009). 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.

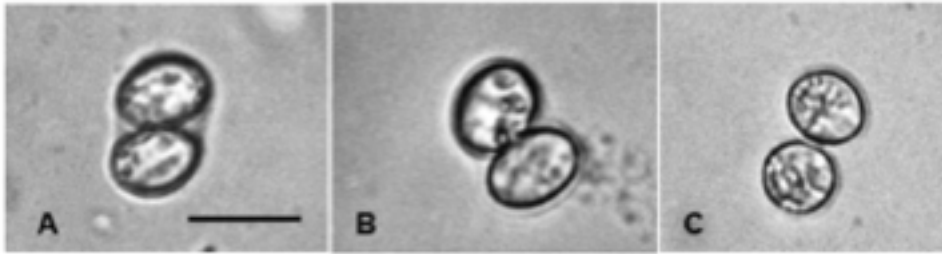


Figure 2. Photomicrographs of oocysts of three isolates of *Sarcocystis* sp. from Oklahoma snakes. **A.** Oocyst (USNPC 107154) from *Pantherophis obsoletus obsoletus*, Le Flore County, Three Sticks National Forest Monument. **B.** Oocyst (USNPC 107155) from *P. o. obsoletus*, Le Flore County, Talihina. **C.** Oocyst (USNPC 107156) from *Lampropeltis calligaster calligaster*, McCurtain County, Broken Bow. Oocyst from other *L. c. calligaster*, McCurtain County, Smithville, not shown. Bar = 10 μ m for all figs.

This is not the first time that a western rat snake or prairie king snake has been reported to harbor *Sarcocystis* sp. McAllister et al. (1995) reported a *Sarcocystis* sp. from one of 13 (8%) *P. o. obsoletus* and a single *L. c. calligaster* from Arkansas. In addition, a *Sarcocystis* sp. (termed *Sarcocystis* sp. 2, formerly *S. roudabushi*, see Duszynski and Upton 2009) and *S. cleithrionomyelapis* (Matuschka 1986) have been previously reported from *P. obsoletus* and a *Sarcocystis* sp. (syn. *Cryptosporidium lampropeltis*) was reported by Anderson et al. (1968) from *L. c. calligaster* from Illinois. However, we document the initial report of *Sarcocystis* sp. from two species of Oklahoma reptiles.

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