Eimeria dericksoni Roudabush, 1937 (Apicomplexa: Eimeriidae) from the Pallid Spiny Softshell, *Apalone spinifera pallida* (Reptilia: Testudines: Trionychidae): Initial Report from Oklahoma and a Summary of the Coccidia from North American Softshell Turtles

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The pallid spiny softshell, *Apalone spinifera pallida* (Webb, 1962) is a large turtle that ranges from southern Arkansas and westcentral Oklahoma south to the eastern coast of Texas (Powell et al. 2016). In Arkansas, *A. s. pallida* occurs primarily in the Gulf Coastal Plain of the extreme southwestern part of the state (Trauth et al. 2004), and in Oklahoma, it is found in the southern one-third of the state in the Red River drainage (Sievert and Sievert 2011). It prefers sites with sandy or soft substrates such as rivers, streams, lakes, and ponds where it feeds on a variety of invertebrates (crayfish, insects, mollusks, earthworms) and vertebrates (fish, amphibians), and even carrion.

Five species of coccidian parasites (Apicomplexa) have been reported from this turtle, including *Eimeria amydae* Roudabush, 1937, *E. dericksoni* Roudabush, 1937, *E. pallidus* McAllister, Upton, and McCaskill, 1990, and *E. spinifera* McAllister, Upton, and McCaskill, 1990 from Texas, and *E. apalone* McAllister, Upton, and McCaskill, 1990, from Arkansas and Texas (see Duszynski and Morrow 2014). There are no previous reports of any coccidians from softshell turtles from Oklahoma. Here we document a new distributional record for an eimerian from *A. s. pallida* from the state and provide a summation of the eimerians from North American softshell turtles (Trionychidae).

During April 2013 and April 2017, two adult (150, 155 mm carapace length [CL]) eastern spiny softshells, *A. s. spinifera* (Le Sueur, 1827) were collected by hand from Anderson's Minnow Farm, Lonoke County, Arkansas (34° 45' 36.3954"N, 91° 57' 14.1114"W), and Crow Creek at Madison, St. Francis County, Arkansas (35° 00' 45.144"N, 90° 44' 16.8246"W), respectively; a single adult (360 mm CL) *A. s. pallida* was collected in a similar manner in September 2017 from Yashau Creek, McCurtain County, Oklahoma. Fresh fecal samples from captive turtles were placed in individual vials containing 2.5% (w/v) aqueous potassium dichromate ($K_2Cr_2O_7$). Samples were examined for coccidia by brightfield microscopy first after flotation in Sheather's sugar solution (specific gravity = 1.30). Measurements were taken on 10 sporulated oocysts from a single turtle using a calibrated ocular micrometer and reported in micrometers (μm) with the means followed by the ranges in parentheses; photographs were taken using brightfield optics. Oocysts were 20 days old when measured and photographed. A host

photovoucher was accessioned into the Arkansas State University Museum of Zoology (ASUMZ) Herpetological Collection, State University, Arkansas as ASUMZ 33744. Photovouchers of sporulated oocysts were accessioned into the Harold W. Manter Laboratory of Parasitology (HWML), University of Nebraska, Lincoln, Nebraska.

Oocysts of a coccidian matching the description of *E. dericksoni* (Roudabush 1937) were found in one turtle and are described below.

Apicomplexa: Eimeriidae

***Eimeria dericksoni* Roudabush, 1937 (Figs. 1-2)**

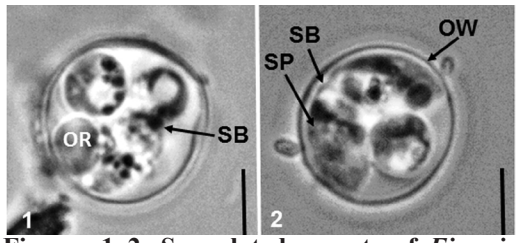
Oocysts subspheroidal, 12.4 × 11.2 (11–14 × 10–12) with smooth, thin wall prone to collapsing in sucrose solution; shape index (L/W) 1.1 (1.1–1.2). Micropyle absent but oocyst residuum 3.6 × 3.4 (3–4 × 3–4; n = 5) present; a polar granule was present in 3 of 10 (30%) sporulated oocysts. Sporocysts ellipsoidal, 8.3 × 5.2 (7–10 × 4–6); L/W 1.6 (1.3–1.8). Stieda body present, substieda and parastieda bodies absent. Sporocyst residuum scattered within the sporocyst. Each sporozoite (not measured) contains a spheroidal posterior refractile body. Nucleus not evident.

Host: Pallid spiny softshell, *Apalone spinifera pallida* (Webb, 1962) (Reptilia: Testudines: Trionychidae) (adult female, collected 23 September 2017).

New locality: Yashau Creek off West Sherry Lane, Broken Bow, McCurtain County, Oklahoma (34° 2’ 27.0018”N, 94° 45’ 21.8046”W).

Type-host and locality: *A. s. spinifera* (Le Sueur, 1827), Ames, Story County, Iowa (Roudabush, 1937).

Other hosts and localities: Western spiny softshell, *A. s. hartwegi* (Conant and Goin, 1948), Iowa (Wacha and Christiansen 1977); *A. s. pallida*, Dallas and Johnson counties, Texas (McAllister et al. 1994).



Figures 1–2. Sporulated oocysts of *Eimeria dericksoni* from *Apalone spinifera pallida* from Oklahoma. Abbreviations: OR (oocyst residuum); OW (oocyst wall); SB (Stieda body); SP (sporocyst). Scale bars = 5µm.

Material deposited: Photovoucher of sporulated oocyst deposited in the HWML 102962.

Prevalence: In 1 of 3 (33%) overall; 1 of 1 (100%) *A. s. pallida*.

Sporulation time: Exogenous. All oocysts were passed unsporulated or partially sporulated and fully sporulated within five days at ca. 23°C.

Site of infection: Unknown; oocysts passed in feces.

Remarks

A total of seven eimerians have been reported from two subspecies of *A. spinifera* from Arkansas, Iowa, Oklahoma, and Texas (Table 1). Oocysts of our isolate of *E. dericksoni* are smaller than those reported in the original description (14.6 × 12.9 µm, L/W = 1.1) (Roudabush 1937); sporocyst measurements were not given in the original description. However, in a redescription of *E. dericksoni* by Wacha and Christiansen (1977), measurements of oocysts and sporocysts were provided, respectively, as follows: 10.8 × 10.0 µm, L/W = 1.1 and 6.8 × 4.0 µm, L/W = 1.7. These authors, in the same report, also included measurements of the oocysts and sporocysts from a different isolate of *E. dericksoni* as follows: 13.0 × 12.0 µm, L/W = 1.1 and 8.4 × 5.2 µm, L/W = 1.6. Taken together, the mensural data of Roudabush (1937) and Wacha and Christiansen (1977) suggest that the oocysts and sporocysts of *E. dericksoni* can vary somewhat in size. The dimensions of the oocysts and sporocysts of

Table 1. Summary of coccidian parasites of North American trionychid turtles.

Eimeria spp.	Host	Locality	Prevalence*	Reference
E. amydae	*Apalone spinifera pallida*	Texas	1/9 (11%)	McAllister et al. (1990)
	A. s. spinifera	Iowa	1/1 (100%)	Roudabush (1937)
E. apalone	*A. s. pallida*	Texas	5/9 (56%)	McAllister et al. (1990)
			5/10 (50%)	McAllister et al. (1994)
	A. s. spinifera†	Arkansas	1/3 (33%)	McAllister et al. (1994)
E. dericksoni	*A. s. pallida*	Texas	3/7 (43%)	McAllister et al. (1990)
			3/10 (30%)	McAllister et al. (1994)
		Oklahoma	1/1 (100%)	This report
	A. s. spinifera	Iowa	1/1 (100%)	Roudabush (1937)
E. mascoutini	*A. s. pallida*	Texas	3/10 (30%)	McAllister et al. (1994)
	A. s. spinifera	Iowa	2/5 (40%)	Wacha and Christiansen (1976)
			1/1 (100%)	Wacha and Christiansen (1977)
E. pallidus	*A. s. pallida*	Texas	4/9 (44%)	McAllister et al. (1990)
			4/10 (40%)	McAllister et al. (1994)
E. spinifera	*A. s. pallida*	Texas	3/9 (33%)	McAllister et al. (1990)
			3/10 (30%)	McAllister et al. (1994)
E. vesticostieda	*A. s. spinifera*	Iowa	not given	Wacha and Christiansen (1977)

*Prevalence = number infected/number examined (%).

†Host originally reported as *A. s. hartwegi* from Conway County, Arkansas (McAllister et al. 1994); only *A. s. spinifera* occurs in central Arkansas.

our isolate are similar to those reported for *E. dericksoni* by Wacha and Christiansen (1977). In addition, the morphological characters of our isolate (smooth, thin oocyst wall prone to collapsing in Sheather's solution, presence of oocyst residuum and polar granule) match those of Wacha and Christiansen's (1977) specimens. Consequently, we consider the coccidian described herein to be *E. dericksoni*.

In summary, we provide the first report of *E. dericksoni* documented from a trionychid turtle from Oklahoma. This also represents only the third report of a coccidian from any turtle in the state (McAllister et al. 2015; McAllister and Hnida 2016). Since the midland smooth softshell, *A. mutica* (Le Sueur, 1827) also occurs in the state (Sievert and Sievert 2011), and in adjacent Arkansas (Trauth et al. 2004) and Texas (Dixon 2013), it should also be examined for coccidia as the species has never been reported as a host (Duszynski and Morrow 2014). Indeed, finding any coccidian would result in a new host record and possibly geographic records.

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(1921–2016), former curator of the Stovall Museum, OU faculty member (1952–1982), and herpetologist extraordinaire of Oklahoma and beyond.

References

Dixon JR. 2013. Amphibians and reptiles of Texas: With keys, taxonomic synopses, bibliography, and distribution maps. Third ed., revised and updated. College Station (TX): Texas A&M University Press. 447 p.

Duszynski DW, Morrow JJ. 2014. The biology and identification of the coccidia (Apicomplexa) of turtles of the world. San Diego (CA): Academic Press. 210 p.

McAllister CT, Hnida JA. 2016. *Eimeria chelydrae* Ernst, Stewart, Sampson, and Fincher, 1969 (Apicomplexa: Eimeriidae) from the common snapping turtle, *Chelydra serpentina* (Reptilia: Testudines: Chelydridae): First report from Oklahoma. Proc. Okla. Acad. Sci. 70:73–75.

McAllister, C. T., Motriuk-Smith D, Seville RS, Hudson C, Connior MB, Robison HW. 2015. Coccidia (Apicomplexa: Eimeriidae) of three-toed box turtles, *Terrapene carolina triunguis* (Reptilia: Testudines), from Arkansas and Oklahoma. J. Ark. Acad. Sci. 69:74–77.

McAllister CT, Upton SJ, McCaskill LD. 1990. Three new species of *Eimeria* (Apicomplexa: Eimeriidae) from *Apalone spinifera pallidus* (Testudines: Trionychidae) in Texas, with a redescription of *E. amydae*. J. Parasitol. 76:481–486.

McAllister CT, Upton SJ, Trauth SE. 1994. New host and geographic records for coccidia (Apicomplexa: Eimeriidae) from North American turtles. J. Parasitol. 80:1045–1049.

Roudabush RL. 1937. Some coccidia of reptiles found in North America. J. Parasitol. 23: 354–359.

Sievert G, Sievert L. 2011. A field guide to Oklahoma's amphibians and reptiles. Oklahoma City (OK): Oklahoma Department of Wildlife Conservation. 211 p.

Trauth SE, Robison, HW, Plummer MV. 2004. The amphibians and reptiles of Arkansas. Fayetteville (AR): University of Arkansas Press. 421 p.

Wacha RS, Christiansen JL. 1976. Coccidian parasites from Iowa turtles: Systematics and prevalence. J. Protozool. 23:57–63.

Wacha RS, Christiansen JL. 1977. Additional notes on the coccidian parasites of the soft-shell turtle, *Trionyx spiniferus* Le Sueur, in Iowa, with a description of *Eimeria vesicostieda* sp. n. J. Protozool. 24:357–359.

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