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Learedius learedi Price, 1934 (Trematoda: Spirorchiidae), in Black Turtle (*Chelonia mydas agassizii*) Hearts from Magdalena Bay, Baja California Sur, Mexico

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ABSTRACT: *Learedius learedi* Price, 1934, is redescribed using specimens obtained from the hearts of 3 black turtles, *Chelonia mydas agassizii*, from Magdalena Bay, Baja California Sur, Mexico. The redescription is consistent with the original description but provides an unreported range of variation in testes shape and position and adds new information about the reproductive systems, such as the presence of a papilla in the pore of Laurer's Canal and the presence of an external seminal vesicle instead of a preovarian seminal receptacle. Of 4 turtle hearts examined, only 1 was free of parasites (75% prevalence). In all, 128 parasites were found, a mean intensity of 43 worms per heart. This is the first record of the occurrence of *L. learedi* in *C. m. agassizii* in Mexico, expanding the known range of the parasite to the Baja California Peninsula.

KEY WORDS: *Learedius learedi*, spirorchiid, Trematoda, Spirorchiidae, *Chelonia mydas agassizii*, black turtle, Reptilia, Cheloniidae, redescription, Magdalena Bay, Baja California Sur, Mexico.

The family Spirorchiidae contains 18 genera of digeneans reported from the vascular system of marine and freshwater turtles (Platt, 2002). Nine genera and 17 species of spirorchiid parasites have been recorded from hearts and blood vessels of the green turtle, *Chelonia mydas* (see Glazebrook et al. [1989] and Smith [1997]). Single infections by *Learedius*, *Hapalotrema*, and *Neospirorchis* (see Rand and Wiles [1985] and Dailey et al. [1992]) and mixed infections by *Learedius* and *Hapalotrema* (see Glazebrook et al. [1989] and Dailey et al. [1992]) or *Learedius* and *Neospirorchis* (see Rand and Wiles [1985]) have been reported in *C. mydas*, but spirorchiids have never been recorded in black turtles, *Chelonia mydas agassizii*.

Chelonia mydas agassizii, the black turtle or Eastern Pacific green turtle, is distributed from San Diego to the Galapagos Islands. Trematode infections in black turtles are probably acquired in feeding areas with large populations of gastropods. The life cycle of these marine spirorchiids remains unknown but cercariae probably develop in mollusks, particularly gastropods (Smith, 1972). This report contains the first parasite study in the black turtle and constitutes the first report of the parasite *Learedius learedi* Price, 1934, in Mexico.

MATERIALS AND METHODS

During March and May 2002, as part of a larger project studying sea turtle biology, 4 specimens of *C. m. agassizii* were obtained after death in the course of incidental fishing in Magdalena Bay, Baja California Sur, Mexico (24–25°N; 111–112°W). The straight carapace length of the turtles ranged from 40 to 60 cm. All specimens were necropsied and examined for parasites. Necropsies followed the methods of Work (2000). Hearts were collected and refrigerated until examination. Trematodes were fixed in alcohol–formalin–acetic acid solution for 24 hr and stored in 70% ethanol. Specimens were stained in Gomori trichromic, cleared in methyl salicylate, and mounted in synthetic resin. Measurements were taken with an image analyzer (Image Pro Plus 4 [Media Cybernetics, L.P., Silver Spring, Maryland, U.S.A.]). Drawings were made with the aid of a drawing tube. Specimens for histology were embedded in paraffin, sectioned at 3-μm thickness, and stained with hematoxylin and eosin.

Taxonomic description

Learedius learedi Price, 1934 (Figs. 1–3)

(Syn. *Learedius orientalis* Mehra, 1939)

Description

Morphometric measurements are presented in Table 1. Body elongate, flattened with rounded extremes, constricted at the level of the ventral sucker. Minute tegumental spines present over entire body. Oral sucker terminal, cup shaped; prepharynx and pharynx absent; esophagus long, slightly sinuous, surrounded by glandular cells; esophageal bulb present at junction of esophagus and intestinal ceca; intestinal ceca bifurcate anterior to ventral sucker; cecae loop anteriad and terminate near posterior end of body. Ventral sucker pedunculate, circular with

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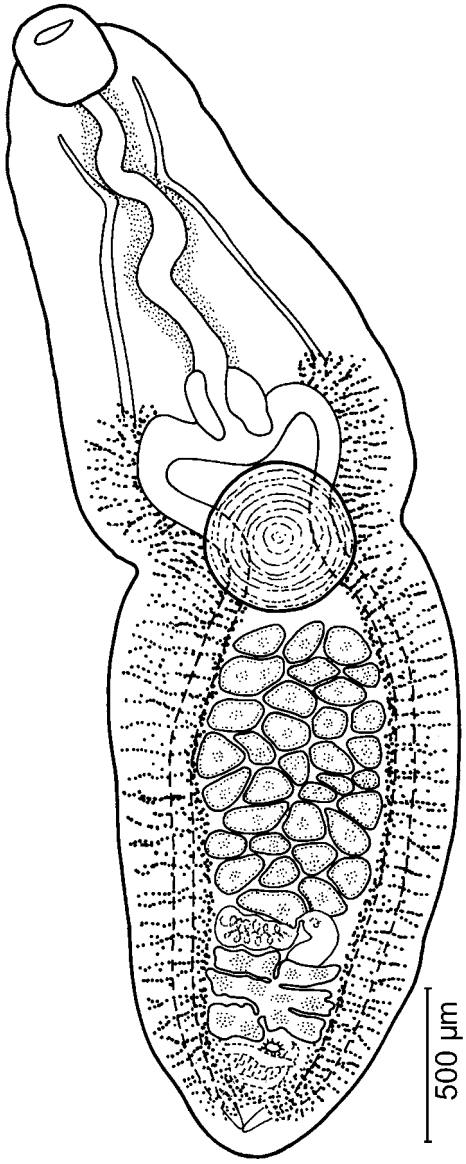

Figure 1. *Learedius learedi*, adult, ventral view.

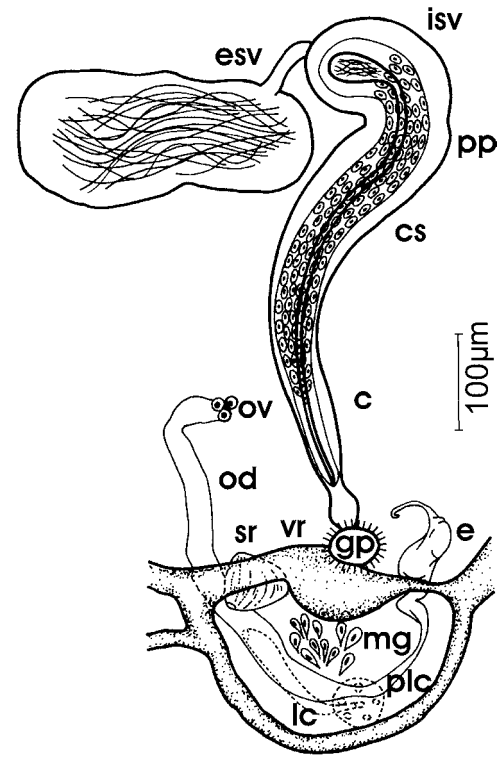

Figure 2. *Learedius learedi*, terminal genitalia, ventral view. c, cirrus; cs, cirrus sac; e, egg; esv, external seminal vesicle; gp, genital pore; isv, internal seminal vesicle; lc, Laurer's canal; mg, Mehlis' gland; od, oviduct; ov, ovary; plc, papilla of the Laurer's canal; pp, pars prostatica; sr, seminal receptacle; vr, vitelline reservoir.

minute spines on margin, in the middle of the body. Numerous testes, shape variable with rounded to flattened margins, confluent or separate. External seminal vesicle elongated transversely with lobed margins, located dextral between testes and ovary. Cirrus sac well developed with a small internal seminal vesicle, pars prostatica, and long ejaculatory duct. Common genital pore medial and ventral, between ovary and vitelline reservoir. Ovary large, deeply lobed, posterior; oviduct issuing from right side of ovary, passing posteriorly and receiving the opening of ovoid seminal receptacle dextrolateral to vitelline reservoir, continuing posteriorly and producing Laurer's canal with a distinct papilla displayed in the dorsal pore. Duct from vitelline reservoir not observed. Mehlis' gland behind vitelline reservoir. Uterus short, passing anteriorly, directed to common genital pore at postovarian level, with a single egg. Egg fusiform with unequal bipolar processes. Vitelline reservoir small, immediately posterior to ovary. Vitelline follicles granular, beginning slightly anterior to cecal bifurcation, terminating near cecal ends. Excretory vesicle Y shaped.

Taxonomic summary

Host: Chelonia mydas agassizii (Cheloniidae).

Locality and collection date: Magdalena Bay, Baja California Sur, Mexico (24–25°N; 111–112°W). March and May 2002.

Site of infection: Heart.

Prevalence and intensity of infection: Three of 4 hosts (75%). Mean intensity, 43; range, 18–79.

Specimens deposited: Coleccion Parasitologica del Museo de Historia Natural, Universidad Autonoma de Baja California Sur, La Paz, B.C.S., Mexico (CPMHN-UABCS 222), and Coleccion Nacional de Helmintos, Universidad Nacional Autonoma de Mexico, Mexico, D.F. (CNHE 4654).

Records: Chelonia mydas in National Zoological Park, Washington, D.C., U.S.A. (Price, 1934); Panama (Caballero et al., 1955); Puerto Rico (Dyer et al., 1991); Grand Cayman, British West Indies (Greiner et al., 1980); Bermuda (Rand and Wiles, 1985); Hawaii, U.S.A. (Dailey et al., 1992, 1993); Australia (Blair, 1979 *in* Smith, 1997). *Eretmochelys imbricata imbricata* in Puerto Rico (Dyer et al., 1995a).

Remarks

Smith (1997) reported 5 species of *Learedius* in marine turtles: *L. learedi* Price, 1934; *Learedius similis* Price, 1934; *Learedius europaeus* Price, 1934; *L. orientalis* Mehra, 1939; and *Learedius loochooensis* Takeuti, 1942.

Learedius similis was transferred to *Monticellius* by Mehra (1939). *Learedius europaeus* was poorly described by Leared (1862), and Price (1934) thought it synonymous with *L. learedi*. *Learedius loochooensis* is similar to *L. learedi*, but the taxa are clearly distinguished by differential reproductive morphology: *L. loochooensis* possesses a liver shape ovary and a conical cirrus sac, but *L. learedi* possesses a dendritic ovary and a sigmoid cirrus sac (Takeuti, 1942).

The 23 specimens that we examined (Table 1) coincide with the morphological characteristics and measurements based on a single specimen of *L. learedi* described by Price (1934) and an unspecified number of specimens described by Caballero et al. (1955).

Dyer et al. (1995a, b) suggested *L. learedi* and *L. orientalis* could be synonymous because the only major difference among them is the form and position of the testes: flattened and confluent in *L. orientalis* and rounded and separated in *L. learedi*. Our observations across 18 specimens reveal substantial variation in testis morphology: 9 specimens possessed oblong testes with flat margins, 6 specimens possessed round testes, and 3 specimens possessed both testes types. The testes were clearly separate in 10 specimens, but their margins were confluent in the remaining 8 specimens. This variability indicates that testes shape and confluence are not stable diagnostic characters for species within *Learedius*. Thus, we recognize *L. orientalis* as a junior synonym of *L. learedi* as suggested by Dyer et al. (1995a, b).

Figure 3. *Learedius learedi*, transversal histological section at Laurer's canal pore level, showing the distinctive papilla on dorsal surface (arrow).

A relevant feature in *L. learedi* is a structure similar to an external seminal vesicle, located anterior to the ovary that Caballero et al. (1955) considered a seminal receptacle. We have observed a channel along this structure on the base of the cirrus sac and conclude that it represents an external seminal vesicle

Table 1. Measurements (μm) of *Learedius learedi* Price, 1934 from the hearts of green turtles, *Chelonia mydas*, and black turtles, *Chelonia mydas agassizii*.

	Price (1934)	Caballero et al. (1955)	This study
Sample size (*n*)	1	Not reported	23
Body length (mm)	3.4	3.768–4.449	3.359–5.088 (4.142)
Body width (mm)	0.690	0.966–1.179	0.692–1.087 (0.924)
Tegumental spine length		4–8	4–7 (6)
Oral sucker length	280	198–205	246–344 (312)
Oral sucker width	240	277–288	234–344 (296)
Ventral sucker length	340	315–531	443–517 (481)
Ventral sucker width	340	361–531	467–541 (503)
Suckers ratio length		1.5–2.6	1.4–1.8 (1.6)
Sucker ratio width		1.2–1.8	1.5–1.9 (1.7)
Esophagus length	1,020	1,232–1,292	984–1,550 (1,258)
Esophagus width		53–95	55–141 (101)
Esophagic bulb length		258–266	212–413 (279)
Esophagic bulb width		190–266	125–266 (200)
Distance genital pore to posterior end	360	342–426	300–509 (391)
Testes count	28	31–42	26–40 (33)
Testes length		72–194	68–166 (121)
Testes width		160–167	74–333 (161)
Cirrus sac length		475–574	400–567 (495)
Cirrus sac width		65–91	72–110 (90)
External seminal vesicle length	144	133–372	242–349 (303)
External seminal vesicle width	60	61–171	83–155 (127)
Lobes ovary	7	7–9	6–7 (7)
Ovary length	240	349–365	260–403 (327)
Ovary width	240	332–465	315–551 (430)
Egg with bipolar process length	210	228–247	279–350 (308)*
Egg with bipolar process width	28	30	38–60 (50)*
Host	*Chelonia mydas*	*Chelonia mydas*	*Chelonia mydas agassizii*
Site	Circulatory system	Heart	Heart
Locality	National Zoological Park, Washington, D.C., U.S.A.	Panama Bay, Panama	Magdalena Bay, Mexico

* Eggs free in the heart.

as suggested by Price (1934). The union channel was observed with difficulty in only 3 of the 23 specimens. Another important characteristic in our specimens is a papilla present in the pore of Laurer's canal, a structure not previously described in *L. learedi* (Fig. 3).

We found 79 adult *L. learedi* in the heart of 1 black turtle, a higher intensity than ever reported from a green turtle heart: 43 in Dailey et al. (1992), 53 in Rand and Wiles (1985), and 49 in Greiner et al. (1980). Prevalence of *L. learedi* is also high in *C. m. agassizii* from Magdalena Bay. Although direct helminth examination indicates a prevalence of 75%, spirorchid eggs have been found in the organs and tissues of 25 of 26 black turtles (96%) surveyed over time. Reported prevalence of *L. learedi* in *C. mydas* is typically lower: 55% in Rand and Wiles (1985), 40% in Greiner et al. (1980) and Dailey et al. (1992), and 22% in Glazebrook (1989). This study provides the first record in Mexico of *C. m. agassizii* infection by *L. learedi* and establishes Baja California Sur as a new locality in the broad distribution of this parasite in the Pacific.

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