

ENDOPARASITISM AND FIBROSIS IN *CROTALUS TOTONACUS* (VIPERIDAE) FROM SIERRA GORDA DE QUERÉTARO, MEXICO

ENDOPARASITISMO Y FIBROSIS EN *CROTALUS TOTONACUS* (VIPERIDAE) DE LA SIERRA GORDA DE QUERÉTARO, MÉXICO

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Resumen.— A pesar de que recientemente se han realizado algunas revisiones parasitológicas en algunos grupos como serpientes y lagartijas, el conocimiento actual sobre la parasitofauna y patologías asociadas en reptiles es incompleto y escaso. Por lo tanto, aquí presentamos el primer informe para el estado de Querétaro, México del pentastómido *Porocephalus crotali* y el primer informe del nemátodo *Kalicephalus inermis* parasitando a un ejemplar de *C. totonacus*.

Palabras claves.— Fibrosis, histopatología, nemátodo, pentastómido, *Porocephalus crotali*, Querétaro, serpiente.

Abstract.— Even though some parasitological reviews have recently been made in some groups of reptiles, such as snakes and lizards, the current knowledge about the parasitofauna and associated pathologies in reptiles is incomplete and scarce. Therefore, here we present the first report for the state of Querétaro, Mexico of the pentastomid *Porocephalus crotali* and the first record of the nematode *Kalicephalus inermis* parasitizing a specimen of *Crotalus totonacus*, as well as a fibrous mass in the mesentery.

Key words.— Fibrosis, histopathology, nematode, pentastomid, *Porocephalus crotali*, Querétaro, snake.

Reptiles are one of the most diverse groups of vertebrates in Mexico, with approximately 981 species of the 11,440 (8.6%) registered worldwide (Uetz et al., 2021). During the last decades, taxonomic analysis in many groups of squamates has promoted great advances in the knowledge of Mexican herpetofauna. However, the knowledge of parasite communities associated with reptiles is scarce and incomplete. Pit vipers of the genus *Crotalus*, also known as rattlesnakes, are venomous snakes distributed throughout the Americas, from Canada to Argentina (Campbell & Lammar, 2004), and includes approximately 42 species (Blair & Sánchez-Ramírez, 2016), while near 80% of the total diversity of the genus is distributed in Mexico.

Crotalus totonacus (Gloyd & Kauffeld, 1940) is a snake with a relatively restricted distribution in central and northeastern Mexico. This species extends from Hidalgo and Querétaro to

Tamaulipas on the Atlantic versant through the Sierra Madre Oriental (Dixon & Lemos, 2010). The objective of this study was to provide new records of parasitism by one species of pentastomid and one species of nematode in *C. totonacus* from the state of Querétaro, as well as a neoplasm in the mesentery.

Clinic case

On August 10th, 2015, at 11:23 we collected an adult female *C. totonacus* at the locality of San Juan de Los Durán (21.498 ° N, 99.176 ° W, WGS84; 1142 m elev.), Jalpan de Serra, Querétaro, under the scientific collection permit issued by SEMARNAT to Oscar Flores Villela (FAUT-0015). The snake had a total length of 1565 mm. The specimen was euthanized following NOM-033 (2014), and Mader (2006) using the overdose method with an anesthetic derived from barbituric acid commonly used by veterinarians.



Figura 1. Pentastómido *Porocephalus crotali* encontrado en *Crotalus totonacus*. A) Región caudal de *P. crotali*, B) Región cefálica de *P. crotali* mostrando los distintivos ganchos de quitina.

Figure 1. Pentastomid *Porocephalus crotali* found in *Crotalus totonacus*. A) Tail region from *P. crotali*, B) Cephalic region of *P. crotali* showing the distinctive chitinous hooks.

Necropsy

We performed the necropsy following Martínez-Acevedo (2012). We found two pentastomids identified as *Porocephalus crotali* (Humboldt, 1808) attached to the outside of the digestive tract,

and 24 nematodes identified as *Kalicephalus inermis* (Molin, 1861) in the coelomic cavity. Additionally, we found a beige nodular mass attached to the intestine, with well-defined edges of firm consistency without neovascularization. At the time of the

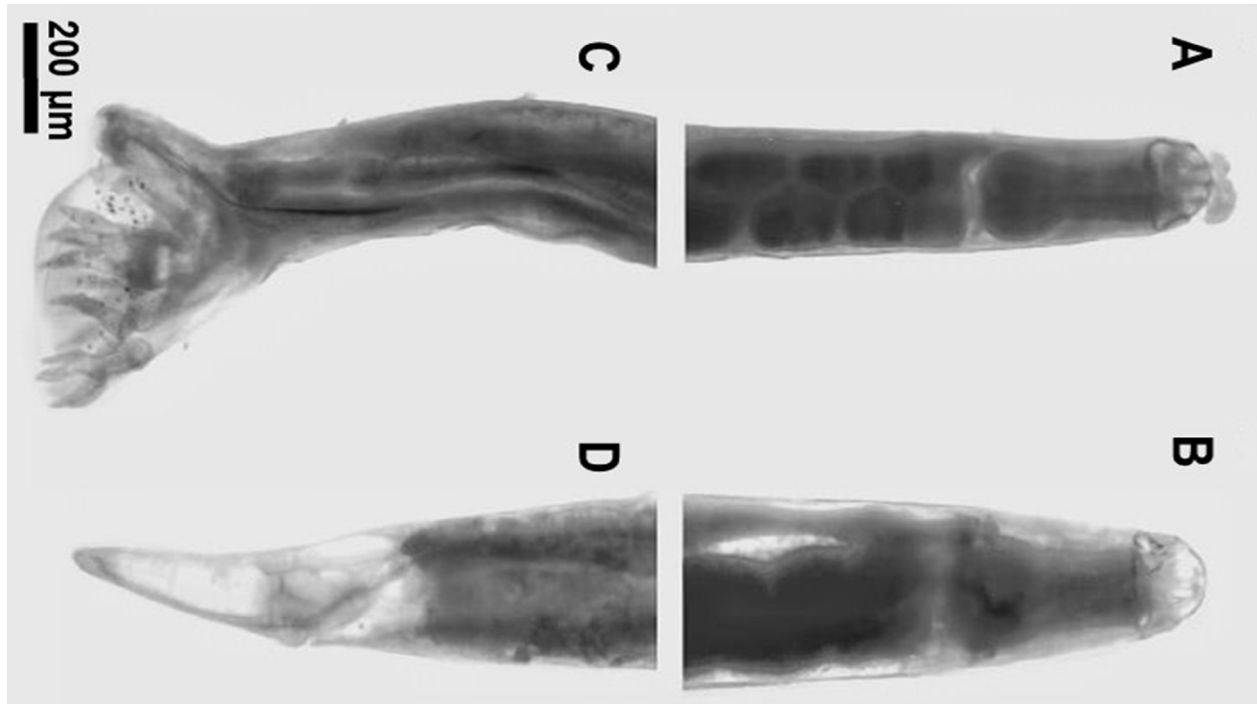


Figura 2. Nematodo *Kalicephalus inermis* encontrado en *Crotalus totonacus*. A) Región cefálica de un macho en posición ventral, B) Región cefálica de una hembra en posición ventral, C) Bursa del macho en vista lateral, D) Región caudal de una hembra en vista lateral

Figure 2. Nematodes *Kalicephalus inermis* found in *Crotalus totonacus*. A) Male cephalic region in ventral view, B) Female cephalic region in ventral view, C) Male bursa in lateral view, D) Female caudal region in lateral view.

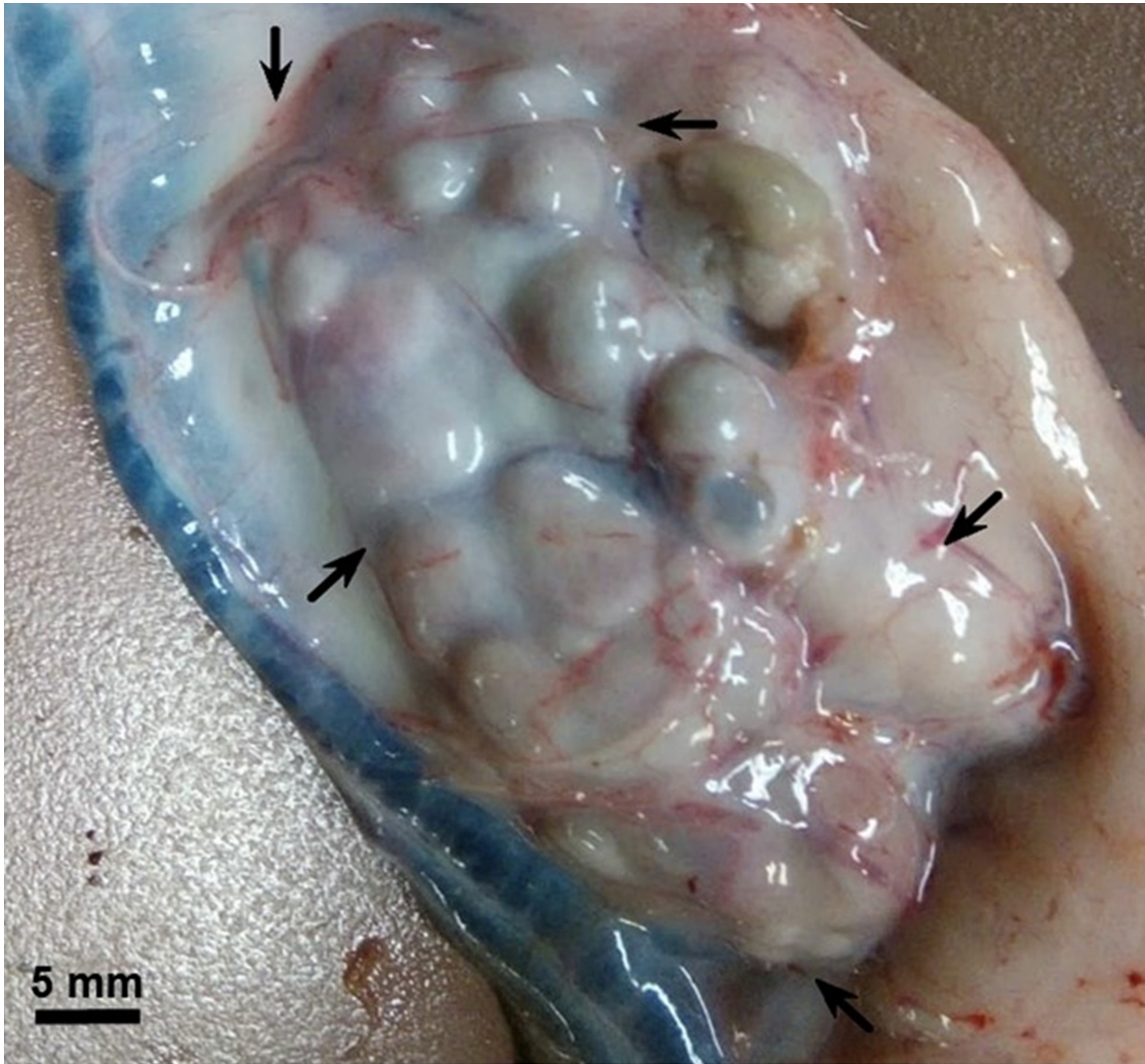


Figura 3. Nódulos removidos del mesenterio de *C. totonacus*. Las flechas negras indican los nódulos y la delimitación de la fibrosis.

Figure 3. Nodules removed from the mesentery of *C. totonacus*. Black arrows indicate nodules and delimitation of the fibrosis.

necropsy, the mass had a length of 6.11 cm measuring the longest portion of the mass, the nodules had a mean size of 0.6 cm (SD \pm 0.15 cm), and an approximate polygonal area of 15.7 cm.

We determined the parasite species using morphological characterization. The pentastomids presented the following morphological characteristics that are diagnostic of *P. crotali*: the number of annuli in the body (74-80), body length (63-71 mm), and a characteristic keyhole-shaped mouth (Fig. 1; Riley & Self 1979; 1980; Lagunas-Calvo et al., 2020). The nematodes presented the following morphological characteristics that are diagnostic of *K. inermis*: absent teeth, males with equal and slender spicules, broad and oblique copulatory bursa with dorsal rays close to each other with “V” shape pattern at the extremities,

females amphidelphic with salient lips on the vulva, and an elongated tail with a rounded tip (Fig. 2; Schad, 1962; Pinto et al. 2010). Specimens collected were deposited in the Colección Nacional de Helmintos (CNHE) and Colección Nacional de Invertebrados of the Universidad Nacional Autónoma de México (UNAM), under catalog numbers CNHE-11449 and CNINV-170, for nematodes and pentastomids, respectively. These parasites are commonly found in many reptile species including snakes (Fieldsen et al., 2021), and poses zoonotic potential (Walden et al., 2020; Rataj et al., 2011; Oliveira et al., 2008).

To determine the nature of the mass we performed histological analysis in the Histopathology laboratory in the Facultad de Ciencias Naturales at Universidad Autónoma de Querétaro by

M. en C. María de Jesús Guerrero Pérez. The diagnostic was an advanced process of fibrosis at the mesentery adhered to the intestine serous.

Porocephalus crotali parasitizing *C. totonacus* in Querétaro represents the southernmost record of the interaction between these species according to previous reports from Nuevo León and Tamaulipas (Peláez & Julia, 1983; Paredes-León et al., 2008). *Porocephalus crotali* is probably present in *C. totonacus* along with its distribution, and the absence of records in other localities of San Luis Potosí or Veracruz may be due to the lack of studies regarding paristofauna in reptiles, as well as the misallocation of the parasite in similar species of the southeastern region of its distribution due to the recently taxonomic changes (Carbajal-Márquez et al., 2020).

Kalicephalus inermis represents the first record of parasitism of this nematode in *C. totonacus*, but it has been reported for other species of rattlesnakes with nearctic and neotropical affinities such as *C. atrox*, *C. molossus*, *C. pusillus*, *C. scutulatus*, *C. triseriatus*, *C. tzabcan*, *C. viridis* and *Sistrurus* sp. (Comroe 1948; Schad, 1962; Paredes-León et al., 2008; Carbajal-Márquez et al., 2018a). Unlike the amount of information available for *P. crotali*, there is little recent information about the prevalence of this species in rattlesnakes and, in Mexico, these reports are restricted to Mexico City and Michoacán (Carbajal-Márquez et al., 2018a). However, some authors suggest that helminths infections in rattlesnakes present low prevalence and mean values for abundance and intensity (Carbajal-Márquez et al., 2018a). These values may be associated with many factors such as ontogenetic changes in feeding preferences (Carbajal-Márquez et al., 2018b).

Porocephalus crotali is commonly found in the respiratory tract of vertebrates (Paré, 2008). However, in this case, the parasites were found in the coelomic cavity attached to the upper portion of the gastrointestinal tract. The parasites can generate very common lesions due to the migration of the primary larvae which are specially adapted to penetrate and trespass tissues due to their numerous spines and stylets in the dorsum of the cephalothorax (Keegan, 1943). This larvae migration can cause primary lesions such as asymptomatic chronic fibrosis process adhered to the intestine serous without neovascularization (Oliveira et al., 2008), as well as secondary lesions including blood or lymphatic system obstruction, respiratory lesions (pneumonia and obstruction of other parenchymatous organs) or multiple eyes injuries (iritis, secondary glaucoma, and conjunctivitis; Oliveira et al., 2008). However, we did not find any secondary lesions. Neoplasm of some groups of vertebrates receives less attention than other groups, especially in possible

viral and parasite etiology (Orr et al., 1972). Nevertheless, we did not find conclusive evidence regarding the cause of the fibrosis, or the limitation of essential processes for the snake such as feeding or breathing by the parasites or the tumor, as previously observed in other snake species (Martin et al., 1994).

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