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Short Communication

First record of a sea spider (Pycnogonida) from an anchialine habitat

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ABSTRACT. The anchialine fauna from the Yucatan Peninsula has been extensively studied since the 1980´s. "Sea spiders" or Pycnogonida, have never been found in these systems before. A record for *Anoplodactylus batangensis* (Helfer, 1938) from a cenote (sinkhole) in the Yucatan Peninsula, Mexico is presented herein. The pycnogonid was found in waters of the cenote Nohoch Nah Chich, part of the Sac Actun anchialine system, in the State of Quintana Roo. This species was already reported from the northeastern shore of the Yucatan Peninsula, however the record we present herein constitutes the first time a pycnogonid is reported from an anchialine habitat. A brief description of the female *A. batangensis* is presented for the first time.

Keywords: *Anoplodactylus batangensis***,** anchialine, sinkhole, cenote, cave, Quintana Roo.

Studies of the anchialine fauna in the Yucatan Peninsula (YP) began more than 25 years ago, with the explorations of the Nohoch Nah Chich and Sac Actun systems in Quintana Roo (Kambensis & Coke, 2016; Bauer-Gottwein *et al.*, 2011), since then several publications have summarized the records of the fauna (Alvarez & Iliffe, 2008; Alvarez *et al*., 2015); most of them involving mainly crustacean species. Recently, other groups such as mollusks, echinoderms, and annelids have been found in these systems (Solís-Marín & Laguarda-Figueras, 2010; Frontana-Uribe & Solis-Weiss, 2011; Rubio *et al*., 2015); however, pycnogonids have never been found. Pycnogonida is a relatively small, exclusively marine group of invertebrates that includes more than 1,300 species (Bamber *et al*., 2017); living from shallow shores to deep abyssal trenches, and found in both marine and estuarine habitats, but not known from freshwater (Child, 1992).

Most pycnogonids are small, with leg spans of less than one centimeter, in some species just a few millimeters, but some deep-sea species have leg spans of up to 60 cm (Arnaud & Bamber, 1987). Although their phylogeny until now is not clearly resolved, pycnogonids are currently considered to be a sister group of the rest of the Chelicerata (Dunlop & Arango, 2005; Regier *et al*., 2010; Giribet & Edgecombe, 2012).

Reports of pycnogonids from Mexico have been sporadic. The first species (*Nymphon pixellae* Scott, 1912) was cited by Hilton (1942); and later Hedgpeth (1948), Stock (1955), and Arnaud (1978) mentioned other pycnogonids from Mexican coasts. Child (1979) listed 21 species from the Mexican Pacific coast. Munilla (2002) summarized the information for the group, recording 42 species in 17 genera across six families. The latest contributions to the knowledge of Mexican pycnogonids reported two species from a rocky intertidal shore in southern Veracruz (Vassallo *et al*., 2014) and five epibenthic species collected from the giant lion's-paw scallop *Nodipecten subnodosus* (Sowerby) (De León-Espinosa & De León-González, 2015). The Pycnogonida of the YP has the most records within Mexico (Child, 1979; Munilla, 2002). Nevertheless, faunal studies focusing on pycnogonids in anchialine waters are unknown locally, and throughout the world.

We present herein a new record of the pycnogonid, *Anoplodactylus batangensis*, from Cenote Nohoch Nah Chich, which is located in Rancho San Felipe (20°17.92'N, 87°24.22'W), 6 km north of the town of Tulum, and 3.8 km from Casa Cenote, the site where the Sac Actun system connects with the Caribbean Sea (Fig. 1a). Cenote Nohoch Nah Chich is one of the many entrances to a flooded cave system that extends some 8 km inland from the coast inland (Alvarez *et al*., 2015).

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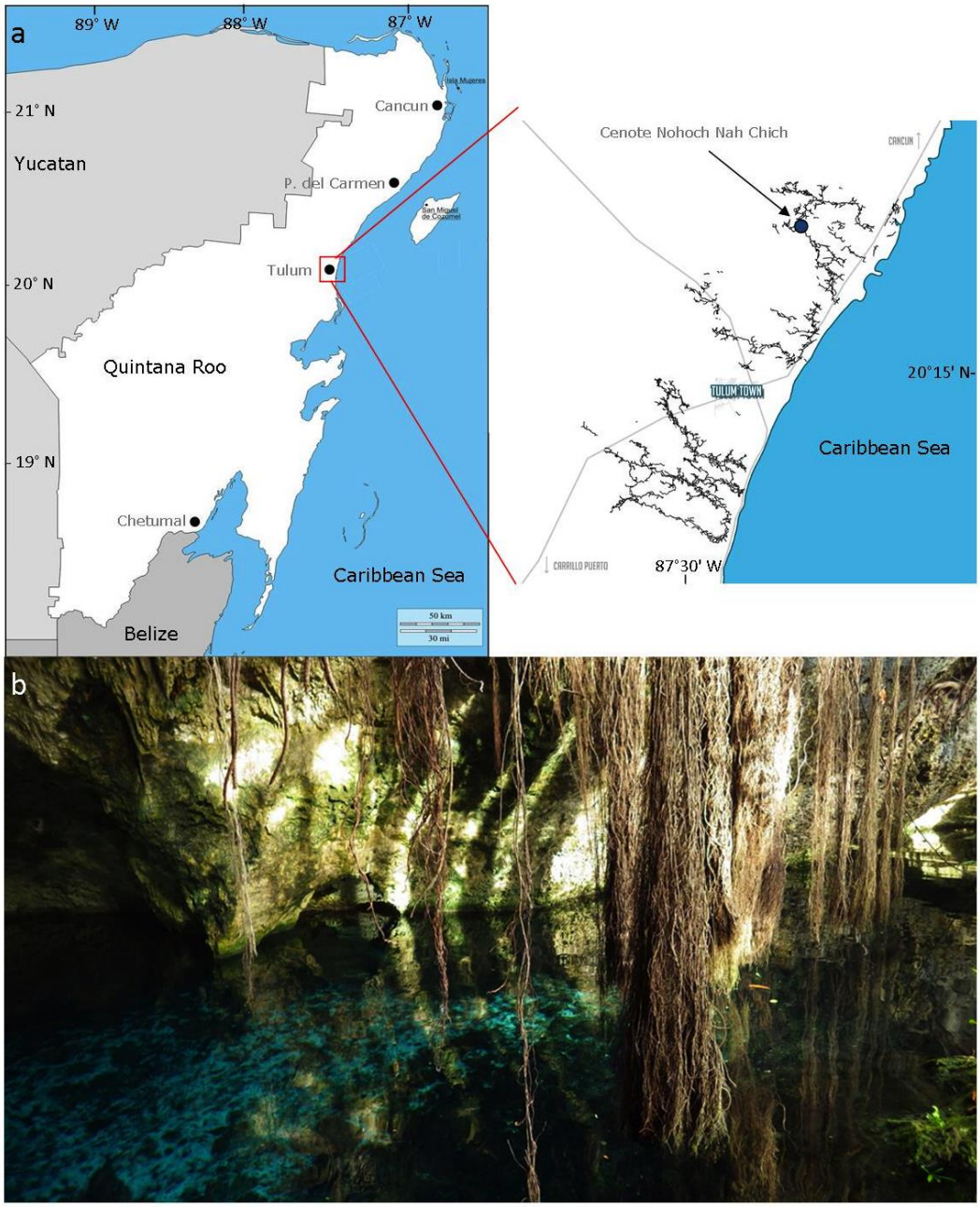

Figure 1. Cenote Nohoch Nah Chich, Quintana Roo, Mexico. a) Map showing location within the Yucatan Peninsula, b) site of collection.

Samples were obtained with a 300 µm mesh net from the aquatic vegetation present in the surface waters at the entrance of the cenote (Fig. 1b). The samples were preserved in 70% ethanol. A DS5X Hydrolab multiparameter sonde was used to obtain temperature, salinity, pH and dissolved oxygen concentration profiles.

All collected organisms were sorted under a stereoscopic microscope, cleaned, and individually preserved in vials with 80% ethanol. The illustrations and measurements were made using a Nikon Optiphot-2 phase contrast microscope. Microphotographs were obtained with an AxioCam MRC5 camera using a Carl Zeiss AxioZoom V16 microscope. All specimens were collected under the scientific collector's license issued to F. Alvarez (FAUT 0104) by the Mexican environmental authority (SEMARNAT). The single specimen was deposited in the National Crustacean Collection

(CNCR) of the Institute of Biology, Universidad Nacional Autónoma de México, Mexico City, with catalog number CNCR 31997. A systematic account of the species is presented following the classification proposed by Bamber (2007) and a new complementary description with details and illustrations of the female are presented.

Phylum Arthropoda Siebold & Stannius, 1845
Subphylum Cheliceriformes Schram, 1978
Class Pycnogonida Latreille, 1810
Order Pantopoda Gerstäcker, 1863
Family Phoxichilidiidae Sars, 1891
Genus *Anoplodactylus* Wilson, 1878
Anoplodactylus batangensis (Helfer, 1938)
Anoplodactylus intermedius Hilton, 1942
Anoplodactylus stylirostris Hedgpeth, 1948
Anoplodactylus tenuirostris Lebour, 1949
Pycnosomia batangense Helfer, 1938

Members of the family Phoxichilidiidae are well known from tropical habitats around the world. In particular, *Anoplodactylus* is one of the most numerous genera of Pycnogonida, with more than 180 species widely distributed and very common in shallow waters.

Diagnosis

Trunk triangular, anterior lateral processes broader than posterior pairs. Proboscis, tapering gradually from broad base to narrow distal section; mouth minute, curved ventrally in proximal half. Legs short; tibia short, with setose bulges, auxiliary claws minute, sometimes absent (Child, 1992).

Description of the female. Trunk length 0.6 mm, width 0.19 mm; segmentation lines visible in dorsal and ventral views (Figs. 2c-2d); body compact, crurigers or lateral processes separated by about half their diameter. Ocular tubercle inclined forward, rounded tip, eyes well pigmented (Fig. 2b); proboscis slender, styliform, upturned, tapering distally (Fig. 2d). Abdomen (0.18 mm) erect, almost same height as ocular tubercle (0.14 mm) (Figs. 2b-2c). Palps absent. Chelifore scape 1-jointed, smooth, touching each other, palm with scattered short setae, fingers in front of the mouth, in downward diagonal position (Figs. 2a, 2c). Ovigers absent. Legs robust, margins irregular, femora swelled, single dorsodistal long spine on femur and tibiae (Figs. 2a, 2g); propodus large, curved, robust, strong heel, 2 heel spines, 5-6 sole spines and propodal lamina; no auxiliary claws visible (Figs. 2e-2f). Cement gland not present.

Measurements

Proboscis, ventral length 0.51 mm, width 0.17 mm. Body, 0.83 mm long from anterior end of the cephalic segment to end of fourth lateral processes, width between the second pair of lateral processes 0.19 mm. Leg 1, 3.42 mm long from coxa I to the tip of main claw. Coxa I, 0.18 mm; coxa II, 0.78 mm; coxa III, 0.19 mm; femur, 0.16 mm; tibia I, 0.56 mm; tibia II, 0.54 mm; tarsus, 0.3 mm; propodus, 0.45 mm; claw, 0.26 mm.

Material examined

Mexico: Quintana Roo, Tulum, Cenote Nohoch Nah Chich (20°17.92'N, 87°24.22'W), associated to surface vegetation; 1 female, CNCR 31997; 28/06/2015.

Distribution

Anoplodactylus batangensis has been reported in the YP in Mexico (Child, 1992; Munilla, 2002). It is considered a pantropical species in coastal waters at shallow depths (Bourdillon, 1955; Bamber, 2007), and a frequently reported species from Colombia (Müller & Krapp, 2009), Brazil (Lucena *et al*., 2015) and Mexico (Child, 1992; Munilla, 2002).

Remarks

The record of a single *A. batangensis* female collected associated to the vegetation in the pool of cenote Nohoch Nah Chich, Quintana Roo, Mexico, represents the first occurrence of a pycnogonid in an anchialine habitat. Females of *A. batangensis* are easily recognizable due to their upturned, tapering proboscis, without tubercles or alar processes ventrally; these characters are used to distinguish them from all other shallow-water *Anoplodactylus* species. Our specimen shows slight variations relative to the reports made by Child (1982), namely: a pale brown cuticle (Figs. 2a-2b), and segmentation lines that are visible ventrally and dorsally. Arango (2003) observed also slight differences in specimens from Australia. Future studies should evaluate if the amount of geographic variation observed warrants the description of several species.

The presence of this pycnogonid in cenote Nohoch Nah Chich, 3.8 km from the coastline, following the map of the submerged cave, shows that coastal marine organisms can be transported inland through the conduits or passageways of anchialine systems, since there are no superficial bodies of water in the YP, expanding their distribution ranges. Three other coastal species from the Mexican Caribbean have been reported from cenotes: the halacarid mite *Limnohalacarus cultellatus* Viets, 1940 (Ojeda *et al.*, 2016), the atyid shrimp *Jonga serrei* (Bouvier, 1909) (Alvarez *et al*.,

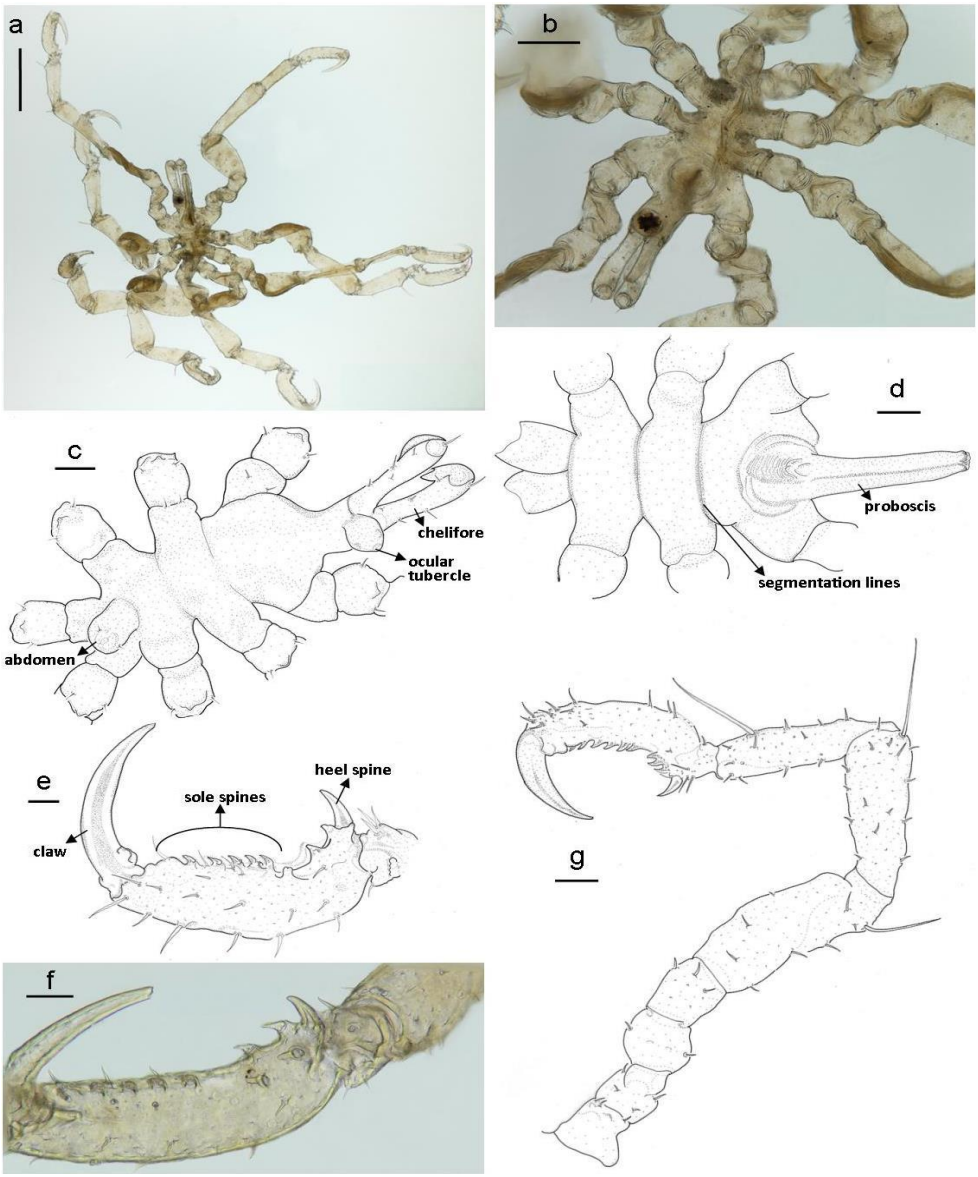

Figure 2. *Anoplodactylus batangensis* (Helfer, 1938) from Cenote Nohoch Nah Chich. a) Habitus, ventral view, b) trunk, dorsal view, c) trunk, dorsal view, d) trunk, ventral view, e, f) propodus and dactyl of leg 3; leg 3, entire. Scale bars represent a) 0.5 mm, b) 0.2 mm, c-d) 0.01 mm, e-g) 0.05 mm.

2015), the hippolytid shrimp *Barbouria cubensis* (Von Martens, 1872) (Alvarez & Iliffe, 2008); and there are unpublished records of the palaemonid shrimp *Macrobrachium acanthurus* (Wiegman, 1836) from several cenotes (CNCR 26033, 26035, 26037, 26040, 26042, 26046). With these findings, a pattern is emerging that shows a high degree of connectivity operating in the anchialine systems of the eastern portion of Quintana Roo, that allows coastal marine species to live in cenotes kilometers away from the coast. The pycnogonid was collected live in the first 20 cm of water at a salinity of 1.63, temperature of 25.8ºC, pH of 6.94, and 1.49 mg L^{-1} of dissolved oxygen, at the entrance of the cenote, and no halocline was recorded in the first 12 m. Hence, this shallow-water marine species, once it has penetrated into the anchialine system, seems to be capable of adjusting to these particular conditions. The few available observations on the tolerance of pycnogonids to salinity variations show that some species can occur regularly in brackish waters at salinities as low as 11, including two species of *Anoplodatylus*, *A. petiolatus* (Kröyer, 1884) and *A. pygmaeus* (Hodge, 1864) (Wolff, 1976; El-Hawawi & King, 1978).

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