

Pearlfish *Carapus bermudensis* from the sea cucumber *Holothuria mexicana* in Belize (Central America)

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Pearlfish (Carapidae) are specialised fishes that mainly live in the respiratory tree of sea cucumber hosts (Arnold 1956; Shen and Yeh 1987; Smith and Tyler 1969; Smith 1964) in a relationship that has generally been defined as commensalism (Parmentier et al. 2003; Van Den Spiegel and Jangoux 1989; Parmentier et al. 2016). However, some species such as *Encheliophis* spp. are known to feed off their host's gonad (Murdy and Cowan 1980; Parmentier et al. 2003; Parmentier and Vandewalle 2005; Parmentier et al. 2016).

The present article highlights the occurrence of the pearlfish *Carapus bermudensis* (Figure 1) inside the sea cucumber *Holothuria mexicana* in Belize. Adults of *H. mexicana* were collected from Buggle Caye (16°28.377' N: 88°21.77'W) on 14 July 2015 at a depth 1.2 m; at Frenchman Caye (16°06.347'N: 88°33.702'W) on 9 June 2014 at a depth of 10.7 m;

and from the Range (16°05.616'N: 88°42.827'W) on 12 February 2012 at a depth of 7.6 m. The latter two sites consisted of seagrass (*Thalassia testudinum*), sand and coral rubble and were within the Port Honduras Marine Reserve, while the former site consisted of patch coral, sand and *T. testudinum* (Figure 1).

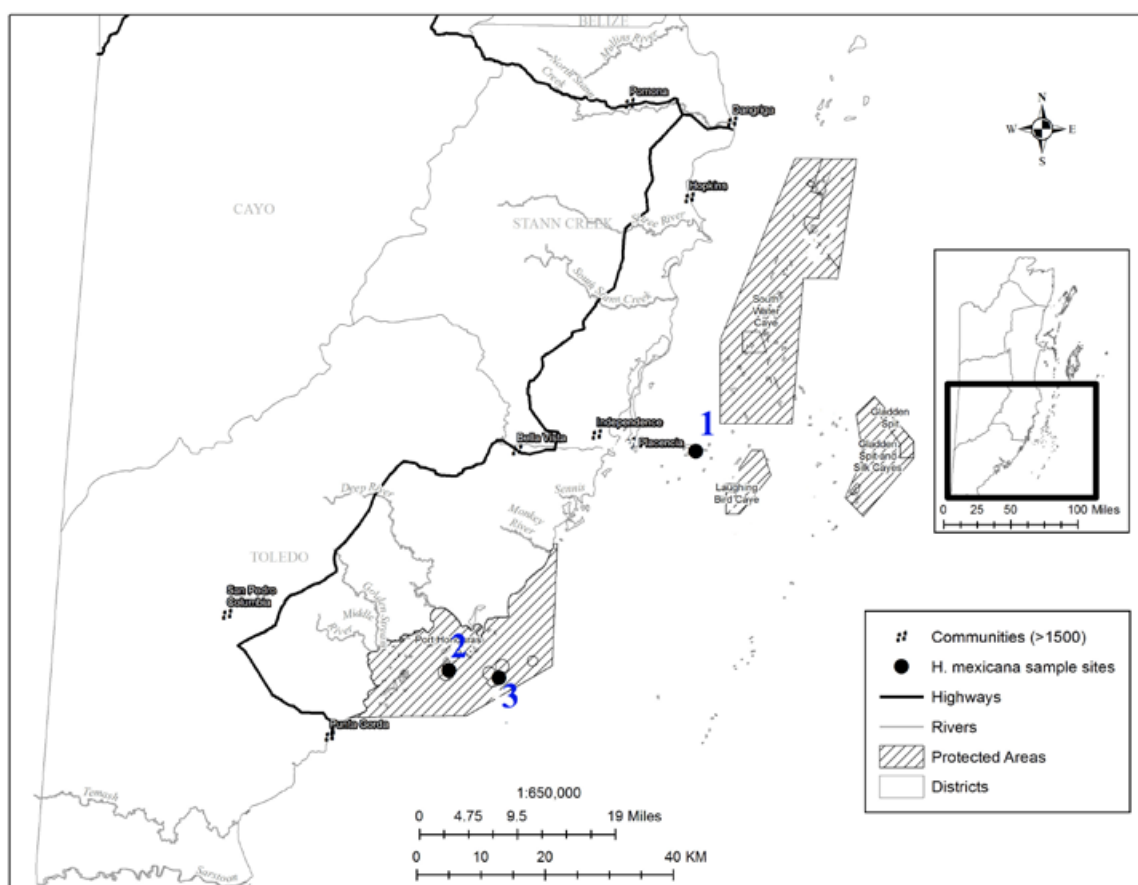


Figure 1. Locations where sea cucumbers (*H. mexicana*) hosting the pearlfish *C. bermudensis* were found. The map shows 1: Buggles Caye, 2: Frenchman Caye and 3: the Range (Port Honduras Marine Reserve). See Table 1 for details about samples.

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The distribution range of the sea cucumber *H. mexicana* primarily includes the Western Central Atlantic and the Caribbean Sea (Bruckner 2006); it is reported to occur in Florida (Engstrom 1980), the Yucatan Peninsula of Mexico (Fuente-Betancourt et al. 2001), Belize (Perez and Garcia 2012), Panama (Guzman and Guerverra 2002), Venezuela (Conde et al. 1991; Laboy-Nieves et al. 2001; Rodriguez-Milliet and Pauls 1998; Tagliafico et al. 2011), as well as in the Azores (Hansson 2001; Toral-Granda et al. 2013). The distribution of the pearlfish *C. bermudensis* centres in the Western Atlantic, including North Carolina, Bermuda, the Bahamas, the Gulf of Mexico from the Florida Keys (USA) to Cuba, throughout the Caribbean Sea, and along the South American coast to southern Brazil (Smith-Vaniz et al. 2015). Known sea cucumber hosts of *C. bermudensis* include *H. mexicana* (Smith and Tyler 1969; Trott 1970; Tyler et al. 1992; Hasbun and Lawrence 2002) *Actinopyga agassizi* (Arnold 1956; Van Meter and Ache 1974; Hasbun and Lawrence 2002), *Isostichopus badionotus* (Smith and Tyler 1969; Vergara et al. 2016); *Eostichopus arnesoni*, *Holothuria lentiginosa* (Miller and Pawson 1979; Valentine and Goeke, 1983), *Selenkothuria glaberrima*, *Theelothuria princeps* and *Thyone* sp. (Phyllophoridae, Dendrochirotida) (Smith et al. 1981; Trott 1970; Markle and Olney 1990; Tyler et al. 1992), *Astichopus multifidus* (Trott 1970); *Holothuria glaberrima* (Trott 1970) and *Holothuria princeps* (Dawson 1971).

In this study, a total of 12 individuals of *C. bermudensis* were found in seven out of 172 adult sea cucumbers that were examined (Table 1). All sea cucumbers containing pearlfish were strictly collected in seagrass (*T. testudinum*) between patch coral reefs or coral rubble and sand habitats. In two

cases, more than one pearlfish (Figure 2A) were found living in the same host (Figure 2B). One sea cucumber contained five pearlfishes, one contained two pearlfishes and the other five contained only one pearlfish each. Multiple pearlfish infestation has previously been described by Pamentier and Vandewalle (2005) where a total of six individuals of *C. homei* were found in one sea cucumber of the species *Bohadschia argus* and Meyer-Rochow (1977) found 15 individuals of *C. mourlani* in the sea cucumber *Bohadschia argus* (Jaeger) at Banda Island (Indonesia). Aronson and Mosher (1951) reported four individuals of *C. bermudensis* in a single host in the Bimini Lagoon (Bahamas) whereas other studies have reported only single individuals of this species occurring in the *H. mexicana* hosts in Belize (Tyler et al. 1992) and Honduras (Hasbun and Lawrence 2002).

No obvious side effect was noted in the hosts during the present study. The sea cucumbers hosting pearlfish ranged from 15–27 cm total length (relaxed) and the pearlfish ranged from 10–12.5 cm total length (Table 1). Pearlfishes were either found in the respiratory tree or in the coelomic cavity of *H. mexicana* (see table 1). Previous reports of *C. bermudensis* found in *H. mexicana* do not mention the location where they were found inside the host (Smith and Tyler 1969; Trott 1970; Tyler et al. 1992; Hasbun and Lawrence 2002). Five of the specimens were deposited at the ECOSUR museum in Chetumal, Mexico with sample number SCBZ001 and Field ID PHMR001. They were identified using genetic barcoding; the species had previously been identified by the Smithsonian Institute in Belize with sequences deposited in Gene Bank (accession: GU224746).

Table 1. Collection sites of the sea cucumber *H. mexicana* and the pearlfish *C. bermudensis* (see also Figure 1 for the map). The sea cucumbers' total length (relaxed) and the number of pearlfish per sea cucumber, with their sizes and location in the host.

<i>H. mexicana</i>	Collection sites (on fig. 1)	Sea cucumber total length (cm)	Number of pearlfish per sea cucumber	Pearlfish total length (cm)	Location of the pearlfish in host
1	1	15	1	10	Coelomic cavity
2	1	17	1	10.5	Coelomic cavity
3	1	21	1	10	Respiratory tree
4	1	23	1	12.5	Coelomic cavity
5	1	27	1	11.5	Respiratory tree
6	2	27	5	10; 10; 11.5; 12; 12.5	Coelomic cavity
7	3	23	2	11; 11	Coelomic cavity

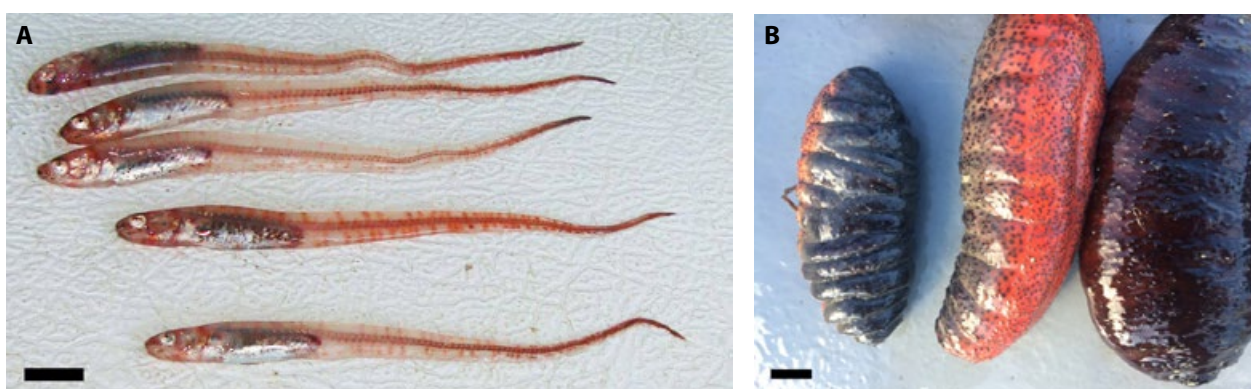


Figure 2. (A) Individuals of *Carapus bermudensis* found in (B) sea cucumbers *Holothuria mexicana* in Belize. Scale bar represents 2 cm in A and 3 cm in B.

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