Latin American Journal of Aquatic Research, 47(4): 694-698, 2019
DOI: 10.3856/vol47-issue4-fulltext-11

Short Communication

Occurrence of *Panulirus meripurpuratus* and *Panulirus laevicauda* (Decapoda: Achelata: Palinuridae) in Bahía de la Ascensión, México

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ABSTRACT. The Caribbean spiny lobster *Panulirus argus* (Latreille, 1804), previously considered to range from North Carolina, USA, to Rio de Janeiro, Brazil, and throughout the wider Caribbean region, was recently divided into two species based on morphology and coloration: *Panulirus meripurpuratus* Giraldes & Smyth, 2016 in Brazil, and *P. argus* north of the Amazon-Orinoco River plume. Here we report on the presence of two individuals of *P. meripurpuratus* and four of *Panulirus laevicauda* (Latreille, 1804), another species typical of Brazil, in Bahía de la Ascensión, Mexico. This bay is located in the area where the Caribbean current - the main route by which South Atlantic water can reach this coast after entering the Caribbean basin through the Lesser Antillean passages - impinges the Mexican Caribbean coast before turning north to give rise to the Yucatan Current. The potential for larval retention is increased in this area, potentially explaining the episodic occurrence of Brazilian spiny lobster species in Bahía de la Ascensión.

Keywords: Palinuridae; spiny lobsters; connectivity; dispersal; Caribbean Current; Mexican Caribbean

Spiny lobsters (Crustacea: Decapoda: Achelata: Palinuridae) are marine megacrustaceans that constitute valuable fishing resources and play important roles as mesopredators in all tropical and subtropical ecosystems in which they dwell (Phillips *et al*., 2013).

Until recently, the spiny lobster genus *Panulirus* was thought to be represented by four species in the western Atlantic region. *Panulirus laevicauda*, occurring from Florida to Brazil but present only in sufficient numbers to support a long-term fishery in Brazil, *Panulirus echinatus*, confined to the northeast of Brazil and the mid-Atlantic islands, *P. guttatus*, an obligate reef-dweller mainly distributed in the wider Caribbean region north from Florida to Venezuela-Surinam, and *P. argus*, presumably with the broadest latitudinal range, from Bermuda and North Carolina, USA, to Rio de Janeiro, Brazil (Holthuis, 1991). Since the late 1990s, however, several studies argued for the splitting of *P. argus* into two distinct subspecies or species based on genetic evidence (*e.g*., Sarver *et al.*, 1998, 2000; Naro-Maciel *et al*., 2011; Tourinho *et al*., 2012). *Panulirus argus westonii*, a provisional name proposed by Sarver *et al.* (1998) for the Brazilian subspecies, remained a *nomen nudum* (Chan, 2010; WoRMS, 2018a). More recently, Giraldes & Smyth (2016) divided *P. argus* into two separate species based on morphology and patterns of coloration: *P. argus* north of the Amazon-Orinoco River plume, and *Panulirus meripurpuratus* in Brazil. This new species has been recognized (WoRMS, 2018b).

Bahía de la Ascensión is a large, shallow bay located on the eastern margin of the Yucatan Peninsula, Caribbean coast of Mexico, where an important fishery for *P. argus* is based on the extensive use of "casitas" (Briones-Fourzán *et al.*, 2000). Casitas are large, low-lying artificial shelters that can harbor multiple lobsters and are deployed on seagrass, sandy or hard bottoms within the bay (Briones-Fourzán *et al.*, 2000). *Panulirus guttatus* occurs on the coral reefs along the mouth of the bay, but this obligate reef-dweller does not

Corresponding editor: Ingo Wehrtmann

Figure 1. Individual lobsters collected in Bahía de la Ascensión, Mexico. From left to right: *Panulirus meripurpuratus*, *P. argus*, and *P. laevicauda*.

Table 1. Summary of information on two *Panulirus meripurpuratus* and four *P. laevicauda* specimens collected in Bahía de la Ascensión, Mexico. Lobsters sampled at the landing site were captured by commercial fishers, which allowed us to inspect and measure the specimens, and provided information on the collection site (CL: carapace length, in mm; F: female, M: male).

Species	Sex	CL	Bottom type	Date	Sampling remarks
P. laevicauda	F	40.0	Coarse sand/seagrass	13-11-2008	Sharing a casita with 23 *P. argus*
P. meripurpuratus	F	76.6	Hard bottom	10-07-2009	Sampled at the landing site
P. laevicauda	M	68.3	Sand/seagrass/algae	13-07-2009	Sampled at the landing site
P. laevicauda	F	82.7	Sand/seagrass/algae	03-07-2010	Sampled at the landing site
P. laevicauda	M	71.3	Hard bottom	03-07-2010	Sampled at the landing site
P. meripurpuratus	F	80.4	Seagrass	14-05-2017	Sampled at the landing site

occupy casitas given its habitat specialization. On several occasions, between 2008 and 2017, thousands of *P. argus* were sampled in this bay for various research purposes, obtaining also four individuals of *P. laevicauda* (two females and two males) as well as two female lobsters that fit the description of *P. meripurpuratus* provided by Giraldes & Smyth (2016) (Fig. 1).

These two female lobsters of *P. meripurpuratus* have the meri of pereiopods of a solid purple color; abdominal somites 2-5 with a shallow and incomplete transverse groove; a line of very small white spots (not a continuous line as in *P. argus*) along the posterior region of each abdominal somite, and the membranous part of the greenish tail fan with two black transverse bands located distally and proximally, and a brownish central band (Fig. 1). One specimen of *P. laevicauda* was extracted directly from a casita in the bay and the other lobsters were collected at the landing site, where individual fishers allowed us to measure and sex the lobsters upon landing their catch and provided information on the fishing site and type of habitat in which the casitas with the lobsters were located (Table 1). Figure 2 depicts the location of Bahía de la Ascensión with the indication of the casitas where these lobsters were found.

Spiny lobsters have a high potential for dispersal because of their protracted larval phase with multiple planktonic stages (phyllosomata) which, in the genus *Panulirus*, can last for five to nine months (Phillips *et al.*, 2013). Here, the first record of *P. meripurpuratus* from the Caribbean region, after the recognition of these two species, is presented. Sarver *et al.* (2000) reported a greater genetic affinity to "*P. argus westonii*" in preserved tissue samples from three individuals previously caught by Silberman *et al.* (1994), two off Miami (USA) and one off Venezuela, but did not provide a description of the specimens. In eastern Africa, Marchal (1968) and Freitas & Castro (2005) reported the presence of adult individuals of *P. argus*, which according to Giraldes & Smyth (2016) exhibited the characteristics of *P. meripurpuratus*, although it is unclear whether these specimens arrived there as larvae or via anthropogenic transport (Tourinho *et al.*, 2012).

As far as it is known, there are no established adult populations of *P. laevicauda* in the wider Caribbean,

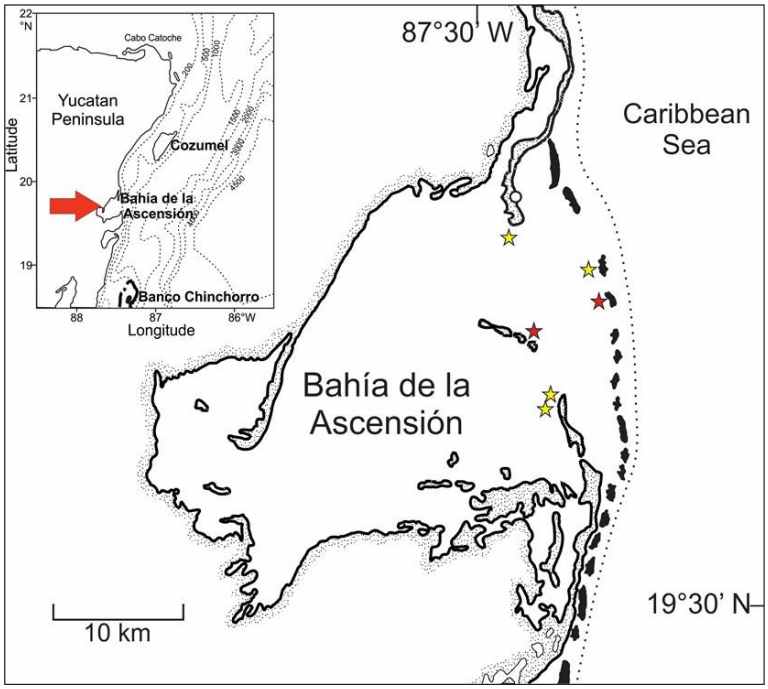

Figure 2. Schematic map of Bahía de la Ascensión, Mexico, showing the approximate location of casitas in which, the lobsters were found: *Panulirus meripurpuratus* (red stars) and *P. laevicauda* (yellow stars). The series of black patches along the mouth of the bay denotes the coral reef tract, where *P. guttatus* occurs. The dotted line indicates the 200 m isobath. The inset shows the location of Bahía de la Ascensión (red arrow) on the Caribbean coast of Mexico (Yucatan Peninsula).

although there are recurrent reports of individuals of this species in this region. For example, Boone (1922) reported on two specimens of *P. laevicauda* found in Key West, USA, and Moore (1962) observed several individuals in Palm Beach, Florida, but commented that its occurrence was very rare. Out of 3,549 lobster tails sampled from commercial catches at Puerto Morelos, Mexico, five (0.14%) were of *P. laevicauda* (Padilla-Ramos & Briones-Fourzán, 1997). Baisre & Ruiz de Quevedo (1982) described two phyllosoma stages of *P. laevicauda* from plankton samples taken near Cuba, but mentioned the absence of adult populations in the Caribbean region. More recently, out of 2,280 mid-to-late stage palinurid phyllosomata collected in oceanic waters off the Mexican Caribbean coast, three were identified as *P. laevicauda* (Muñoz de Cote-Hernández, 2016), and out of nearly 1,500 early to mid-stage palinurid phyllosomata, also collected off this coast by Canto-García *et al.* (2016), none were *P. laevicauda.* Interestingly, these authors, however, reported using three adult *P. laevicauda* from Bahía de la Ascensión (no collection dates were provided) as references for DNA barcoding of their larvae.

Episodic recruitment events, which have been invoked as an explanation for the rare occurrences of *P. laevicauda* in the Caribbean region (Moore, 1962; Sarver *et al.*, 2000), could also explain the presence of *P. meripurpuratus* along the Mexican Caribbean coast. For example, a hydrographic model revealed that a small percentage of phyllosomata originated outside the Caribbean basin could arrive at the Mexican Caribbean coast within the larval duration of *P. argus* (Briones-Fourzán *et al.*, 2008). Moreover, and as evidenced by the trajectories of several satellite-tracked drifters, particles can pass close to the Mexican Caribbean coast within five to nine months after being released outside the Lesser Antilles (Fig. 3). The Caribbean Current is the major route by which South Atlantic water (via the north Brazil/Guiana Current) can reach the coast of Mexico after entering the Caribbean basin through the Lesser Antillean passages (Richardson, 2005). It has been postulated as a plausible transport pathway for the pelagic macroalga *Sargassum* from the Equatorial Atlantic into the Caribbean Sea, where large strandings of this alga have accumulated on the beaches (Putman *et al.*, 2018). The Caribbean current flows west across the Caribbean and Cayman basins before turning northwards off the Mexican coast, giving rise to the swift Yucatan Current (Cetina *et al.*, 2006). The latitude at which the Caribbean current meets the coast fluctuates over time between the Mexico-Belize border and Cozumel Island (Badan *et al.*, 2005; Carrillo *et al.*, 2015) (see Fig. 2). This variability modulates the currents near the coast,

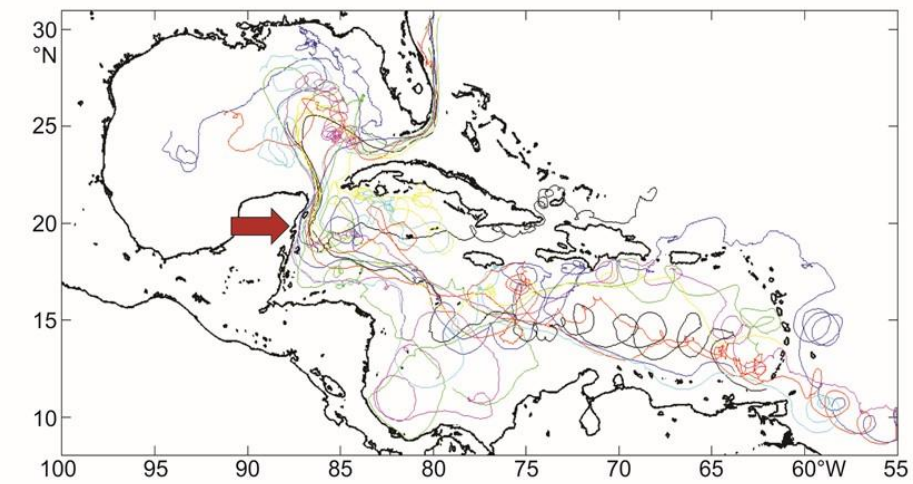

Figure 3. Trajectories of several satellite-tracked drifters that passed close to the Mexican Caribbean coast within five to nine months (the typical larval duration of *Panulirus* spp.) after being released. Some of these drifters were released close to the northern Brazilian coast, illustrating the potential for larvae originating in Brazil to enter into the Caribbean. The red arrow denotes the location of Bahía de la Ascensión.

increasing the potential for larval advection north of the impingement area, and for larval retention in the area over which the current impacts the coast (Carrillo *et al*., 2015), *i.e.*, where Bahía de la Ascensión (with a virtually non-existent continental shelf, see Fig. 2) is located.

Given the occasional reports of individuals of *P. laevicauda* in the Caribbean region, as well as the finding of individuals of *P. meripurpuratus* in Bahía de la Ascensión, more records of both species in the wider Caribbean region are likely to ensue. However, as is the case for *P. laevicauda*, persistent populations of adult *P. meripurpuratus* are unlikely to occur in this region, as this would require that enough individuals not only survive, but also reproduce. Nevertheless, it would be interesting to investigate how co-occurring individuals of the three species interact.

ACKNOWLEDGMENTS

We thank the members of the Fishing Cooperative "Pescadores de Vigía Chico" for allowing us to sample their catches and fishing grounds. Julio Candela (CICESE-Ensenada, México) provided Figure 3. The lobsters were collected while conducting research projects funded by CONACYT (project 82724-Q, granted to E.L.A.) and by UNAM-DGAPA-PAPIIT (project IN206117, granted to P.B.F.).

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Received: 8 October 2018; Accepted: 7 March 2019

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