

RESEARCH NOTE

A review of recent sightings and reports of the giant tiger shrimp *Penaeus monodon* (Decapoda: Penaeidae) on the Mexican coast of the Gulf of Mexico (2012-2019)

Revisión de avistamientos y reportes recientes de camarón tigre gigante *Penaeus monodon* (Decapoda: Penaeidae) en la costa mexicana del Golfo de México (2012-2019)

Armando T. Wakida-Kusunoki^{1*}, José Luís Cruz-Sánchez¹ and Norma Angélica López-Téllez²

¹Centro Regional de Investigación Pesquera de Yucalpetén, Instituto Nacional de Pesca y Acuicultura, Boulevard del Pescador s/n esquina Antigua Carretera a Chelem 97320, Yucalpetén, Yucatán, México

²Centro Regional de Investigación Pesquera de Lerma, Instituto Nacional de Pesca y Acuicultura, Kilómetro 5 Carretera Campeche - Lerma # 200, 24500 Campeche, Campeche, México

*Corresponding author: armandowakida@yahoo.com.mx

Abstract. This work shows an update of the sightings and reports of tiger shrimp *Penaeus monodon* on the Mexican coast of the Gulf of Mexico recorded from 2012 to 2019 and reports the smallest specimen found in the western Atlantic. The results show an increase of almost 300% in sightings and reports since the first report. The zone with most sightings and reports was the coast of Campeche and Yucatán. The wide range of size and distribution of the captured specimens, including the smallest specimen found in the western Atlantic and the presence of females at an advanced stage of gonadal maturity, indicates that *P. monodon* has established itself in the area. The possible negative effects of such establishment make necessary the proposal of measures based on scientific evidence.

Key words: Crustacean, invasive species, Peninsula of Yucatán

INTRODUCTION

The Asian tiger shrimp, *Penaeus monodon* Fabricius, 1798, is a penaeid widely distributed throughout most of the Indo-West Pacific region, however, its fishing grounds are mostly located in tropical countries, particularly in Indonesia, Malaysia and the Philippines (Motoh 1981) and it is an invasive species in the Eastern Mediterranean (Khafage *et al.* 2019) and West Africa (Clotilde-Ba *et al.* 1997). In the western Atlantic, it has been detected since the end of the 1980s, when Fausto-Filho (1987) first recorded the species in the littoral zone of Maranhão, Brazil. Later it was registered in 1988 in the Carolinas, Georgia, and Florida, USA (Fuller *et al.* 2014), Venezuela (Altuve *et al.* 2008), Colombia (Gómez-Lemos & Hernando-Campos 2008), Puerto Rico (Knott *et al.* 2021), Cuba (Giménez *et al.* 2014), Costa Rica (Alfaro-Montoya *et al.* 2015) and Guatemala (Avalos 2015). The first report of this species in the Gulf of Mexico was in 2006 (Knott *et al.* 2021) when one male was captured in Mississippi, USA.

On the Mexican coast of the Gulf of Mexico, first reports were made in the northwest (Tamaulipas) and southeast (Campeche and Tabasco) areas (Wakida-Kusunoki *et al.* 2013); and it has since been reported in other places, such as Veracruz (Morán-Silva *et al.* 2014) and the Yucatán Peninsula (Wakida-Kusunoki *et al.* 2016a, b).

Fuller *et al.* (2014) suggest that the most likely introduction routes into the southeastern US were escapement from aquaculture facilities following flooding by storms and hurricanes, or through migration from areas where tiger shrimp have previously established in the wild. The route of introduction of *P. monodon* on the Mexican coasts may be the result of migration of post larvae and juveniles from areas where this species was already established, probably from the northern Gulf of Mexico or the Caribbean area.

Some authors describe an exotic species as being established when a population perpetuates itself without the need for new introductions and successful breeding exists (Williamson 1996, Colautti & MacIsaac 2004).

This work provides updated information on reported sightings of *P. monodon* on the Mexican coast of the Gulf of Mexico and reports the smallest specimen found in the western Atlantic.

MATERIALS AND METHODS

Collected data of *P. monodon* sightings and reports on the Mexican Coast of the Gulf of Mexico were compiled by two procedures; the first was an Internet survey where scientific papers, newspapers, biodiversity database (iNaturalista 2021¹, Global Biodiversity Information Facility, GBIF²) and Scientific Collections (Portal de Datos Abiertos UNAM³, BDMY⁴) were revised. The information from newspapers was used only when it presented photos where the species could be clearly identified. The second procedure was by consulting the reported data from the invasive species campaign by the National Aquaculture and Fisheries Institute (INAPESCA, Mexico). This campaign consisted of gathering data and invasive specimens through a series of posters and social networking events to report and deliver captured specimens, such as tiger shrimp and the lionfish *Pterois volitans* (Linnaeus, 1758).

Each donor who delivered a specimen and gave information about the catch (the catch area and fishing gear used, geographic position and depth) received a reward. The total length (TL) of donated specimens was measured from the base of the rostrum to the end of the telson using a ictiometer (± 0.1 cm) and the carapace length (CL) with a caliper (± 0.1 mm). Total weight (TW) was determined using a scale (0.1 g accuracy).

The size distribution by sex of the donated shrimp was determined; the shrimp were also divided by the mean size at first maturity by sex estimated by Motoh (1985) to differentiate recruits from reproductive adults.

RESULTS AND DISCUSSION

A total of 63 specimens were collected or reported between 2012 and 2019 with the largest number of reports made in 2019. The states with the most reports are Yucatán and Campeche (Table 1).

Most of the reports were from the INAPESCA's invasive species reporting campaign (67%) and scientific publications (27%). Biodiversity database and newspaper reports accounted for 3% each. The information found in the scientific collection corresponded to specimens deposited and cited by the scientific publications.

Table 1. Number of tiger shrimp *Penaeus monodon* obtained from sightings and reports by Mexican states in the Gulf of Mexico (2012-2019) from the invasive species detection campaign by the National Aquaculture and Fisheries Institute (INAPESCA, Mexico) and other sources [Wakida-Kusunoki *et al.* (2013), Moran-Silva *et al.* (2014), Wakida-Kusunoki *et al.* (2016a, b), Gómez-Ponce *et al.* (2020), Gaxiola-Cortés (2020)⁵; Data base: iNaturalista¹ and GBIF²; Newspaper: *Diario de Xalapa*⁶, *Milenio*⁷] / Número de camarones tigres *Penaeus monodon* obtenidos de avistamientos y reportes de los estados mexicanos en el Golfo de México (2012-2019) por la campaña de detección de especies invasoras del Instituto Nacional de Pesca y Acuicultura y otras fuentes

Year	States					Total
	Tamaulipas	Veracruz	Tabasco	Campeche	Yucatán	
2012	3	-	1	5	-	9
2013	-	-	-	1	-	1
2014	1	2	-	-	3	6
2015	-	2	-	1	2	5
2016	-	1	-	-	-	1
2017	-	3	-	-	1	4
2018	2	1	-	5	3	11
2019	4	3	4	5	10	26
Total	10	12	5	17	19	63

¹iNaturalista. 2021. Observaciones *Penaeus monodon*. Red iNaturalist, California Academy of Sciences y National Geographic Society. <https://www.naturalista.mx/observations?place_id=6793&taxon_id=209120>

²Global Biodiversity Information Facility. GBIF -Infraestructura Mundial de Información en Biodiversidad, Copenhagen. <<https://www.gbif.org/es/occurrence/search?q=Penaeus%20monodon&country=MX>>

³Dirección General de Repositorios Universitarios, Universidad Nacional Autónoma de México. Portal de Datos Abiertos UNAM, Colecciones Universitarias, Colecciones Universitarias, Colecciones Biológicas. Universidad Nacional Autónoma de México, México. <<https://datosabiertos.unam.mx/biodiversidad/>>

⁴Crustáceos de la Península de Yucatán, Biodiversidad Marina de Yucatán - Base de datos, BioDiversidad Marina de Yucatán (BDMY), Facultad de Ciencias de la UNAM, México <<https://www.bdmymex.org/datasets/bdmymex>>

⁵Gaxiola-Cortés MG. 2020. La llegada del camarón tigre a México: efecto de las actividades antropogénicas en la biodiversidad de camarones peneidos del Atlántico Americano, número III. <<https://scme.mx/la-llegada-del-camaron-tigre-a-mexico-efecto-de-las-actividades-antropogencias-en-la-biodiversidad-de-camarones-peneidos-del-atlantico-americano>>

⁶Periódico Diario de Xalapa, 26 de abril 2019. <<https://www.diariodexalapa.com.mx/local/capturan-camaron-tigre-de-33-cm-especie-en-peligro-de-extincion-en-tecolutla-3370918.html>>

⁷Periódico Milenio <<https://www.milenio.com/estados/pescan-camaron-20-cm-laguna-tamiahua>>

The spatial distribution of the tiger shrimp reported in this study (Fig. 1) matches the potential prediction models in the Mexican Gulf based on environmental variables and reports (Petatán-Ramírez *et al.* 2020), except that the Yucatán and Campeche areas have the highest number of recorded sightings. This may be a result of the limited sighting information used in the models or the fact that the effort to detect tiger shrimp has been greater in this area than others.

Another aspect in the distribution and number of tiger shrimp reports could be their diel behavior. The tiger shrimp is nocturnal (Motoh 1981, Primavera & Leбата 1995), therefore its catchability is higher at night.

In the lagoons and littoral zones of Campeche, Tabasco and Veracruz, the target species of the shrimp fisheries are white shrimp *Penaeus setiferus* and the seabob shrimp *Xiphopenaeus kroyeri*, which are captured during daylight hours (Wakida-Kusunoki *et al.* 2006); this could explain the few reports and sightings of tiger shrimp in this area. On the other hand, in Yucatán, shrimp fishing takes place during night hours since the target species is the pink shrimp

Penaeus duorarum Burkenroad, 1939 and *P. brasiliensis* Latreille, 1817 (Wakida-Kusunoki *et al.* 2016c), which could be the cause of the larger number of reports in this area.

The size distribution ranged between 43 and 345 mm TL, where 67% were female and 33% male (Fig. 2). The spatial distribution of the lengths matches that reported by Motoh (1985), small sizes (< 168 mm TL) being found in the lagoon and inner and outer littoral zones and the large sizes in the outer littoral zone (> 168 mm TL).

Among the organisms reported, a juvenile tiger shrimp collected on 23 December 2019 in Celestun Lagoon in the Yucatán Peninsula was the smallest reported for the Atlantic American coast (Zink *et al.* 2018, Aguirre-Guzmán & López-Acevedo 2020). This specimen weighed 4 g and measured 43 mm TL and 10.5 mm CL, a difference of 4 mm TL and 2 mm CL smaller than the previous smallest specimen captured in Southern Biscayne Bay and reported by Zink *et al.* (2018).

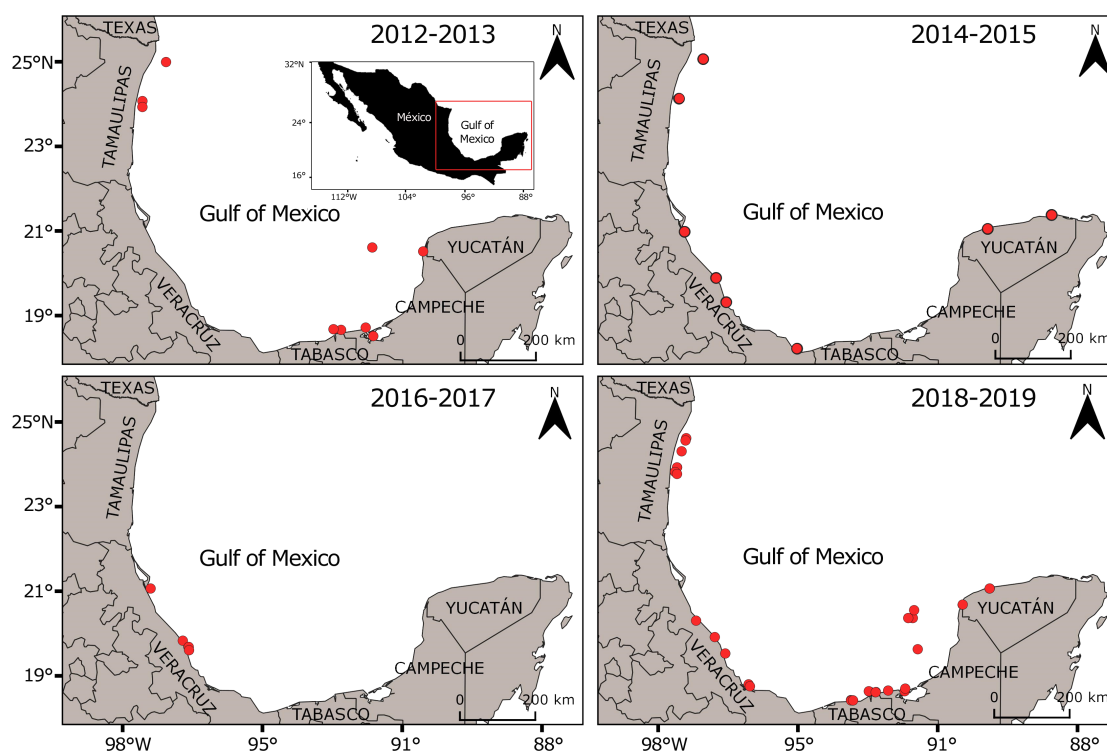


Figure 1. Distribution of the reports of giant tiger shrimp *Penaeus monodon* in the Mexican Gulf of Mexico every two years (2012-2019) / Distribución de los reportes de camarón tigre gigante *Penaeus monodon* en las costas mexicanas del Golfo de México de forma bianual (2012-2019)

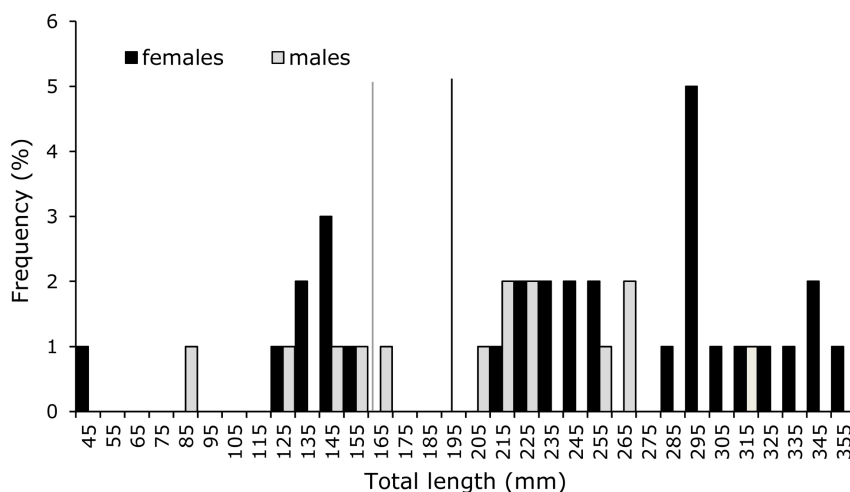


Figure 2. Size distribution of the reported specimens of giant tiger shrimp *Penaeus monodon*. The vertical lines represent the minimum gonadic maturity size by sex reported by Motosh (1985) (gray line= male, black line= female) / Distribución de tallas de los organismos reportados de camarón tigre gigante *Penaeus monodon*. Las líneas verticales representan el tamaño mínimo de madurez gonádica por sexo reportada por Motosh (1985) (línea gris= macho, línea negra= hembra)

The identification of this small specimen was based on its dark coloration, rostrum with six dorsal and three ventral spines (Motosh 1985), lack of prominent adrostral sulci of the carapace and dorsolateral sulci of the 6th abdominal segment. These last morphological characteristics are the main means to differentiate tiger shrimp from the common species of penaeid shrimp in the area (*P. duorarum* and *P. brasiliensis*) (Zink *et al.* 2018).

The specimen was deposited in the Crustacean Collection of Yucatán, UNAM-Sisal (catalog number YUC-CC-255-11-006771).

The presence of the smallest specimen in the western Atlantic and a breeding female on the coast of Campeche (Gómez-Ponce *et al.* 2020), as well as reports of juveniles and mature females throughout the Mexican coast of the Gulf of Mexico, suggests that there are already reproductive populations in this region (Fuller *et al.* 2014).

Petatán-Ramírez *et al.* (2020), using a potential distribution model of *P. monodon* based on environmental information of native and invaded distribution zones, mentioned that the countries where tiger shrimp could become established are Mexico and Cuba.

The information on number and geographical distribution from the reports and sightings indicates that tiger shrimp populations are established at stage IVa. This stage of establishment of an invasive species is defined when the reports of presence are widespread but rare (Colautti & MacIsaac 2004).

The ecological effects of the establishment of this species in the Mexican area of the Gulf of Mexico have not been estimated, but it is known that juveniles of *P. monodon* are effective zooplankton predators (Chen & Chen 1992) and that adults are more aggressive predators of soft-bodied invertebrate benthic organisms than other native shrimp species (Marte 1980, Motosh 1981), and may be potential predators of native shrimp species (Knott *et al.* 2021). Moreover, the giant tiger shrimp is able to compete for food and space with other species, interfering with the breeding success of native shrimp species (Wakida-Kusunoki *et al.* 2016a). The pink shrimp *P. duorarum* is the main species captured in the area with the highest number of reports. Its stock is considered over-exploited (DOF 2012)⁸, a situation which could be aggravated by the presence of the invasive tiger shrimp.

⁸DOF. 2012. Acuerdo por el que se da a conocer la Actualización de la Carta Nacional Pesquera. Diario Oficial de la Federación, Ciudad de México, 24 de agosto del 2012. <<https://www.gob.mx/inapesca/documentos/actualizacion-carta-nacional-pesquera-2012>>

Another possible effect could be the introduction of pathogens. Although no viruses have currently been detected in the captured organisms, the tiger shrimp is known to be the carrier of several important viral diseases such as white spot syndrome virus (WSSV) (De la Peña *et al.* 2007, Fuller *et al.* 2014, Sandoval *et al.* 2014).

The possible negative effects associated with the presence of tiger shrimp on the ecosystem and the importance of shrimp fisheries in the area highlight the need for control measures based on the scientific evidence.

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