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Rapid Communication

First report of the invasive red lionfish *Pterois volitans* (Linnaeus, 1758) (Scorpaenidae) on the coast of Tamaulipas, Mexico

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Abstract

This paper documents the spread of the non-native, invasive, red lionfish (*Pterois volitans*), to the coast of Tamaulipas, Mexico, a state without coral reefs. Six specimens were collected from a breakwater in the town of La Pesca, municipality of Soto la Marina, in October 2016. The specimens had an average total length of 157 mm and were immature individuals with empty stomachs. We hypothesize that the presence of this species is due to larval dispersal by currents of the Gulf of Mexico.

Key words: non-native species, red lionfish, *Pterois volitans*, Gulf of Mexico

Introduction

Introduced species are a major threat to ecosystem health and can negatively affect biodiversity (Mack et al. 2000). One of the most notorious examples of invasive marine fishes is the lionfishes *Pterois volitans* (Linnaeus, 1758) and *Pterois miles* (Bennett, 1828) which are tropical and subtropical species of the Indo-Pacific region that have expanded their distributions globally due to human activities.

Red lionfish (*P. volitans*) are native to the Red Sea, Indian Ocean, and Western Pacific (Schultz 1986). Among other important characteristics, they have a high reproductive and growth rates (Morris and Whitfield 2009), they are efficient competitors (for food with native fishes; Raymond et al. 2015), and they are effective predators (Côté et al. 2013). Albins and Hixon (2008) evaluated the effects of *P. volitans* on a reef in the Bahamas and reported this species is capable of reducing recruitment of juvenile fish by up to 79% in only five weeks. This could eventually extinguish native species, generating changes in the structure and function of communities and even lead to economic losses in tourism and commercial fishing (Albins 2013; Green et al. 2012; Whitfield et al. 2002).

The introduction of red lionfish is probably the result of releases from the ornamental aquarium industry, which plays a leading role in relation to introductions (Semmens et al. 2004). The first reports of red lionfish in the Atlantic were in South Florida from the mid-1980s to the early 1990s (Semmens et al. 2004). In 2000, it expanded northward along the east coast of the United States and to Bermuda (Whitfield et al. 2002). The red lionfish was recently reported in the Bahamas, the north and center of the Caribbean Sea, throughout the Greater Antilles, Belize, Honduras, San Andrés and the islands of Old Providence east of Nicaragua (Colombian territory), Costa Rica, Panama, and the coast of Brazilian (Chevalier et al. 2008; Ferreira et al., 2015; Guerrero and Franco 2008; Snyder and Burgess 2007). In Mexico, its presence has been reported in the Caribbean and the southern area of the Gulf of Mexico (2009 and 2010, respectively; Aguilar-Perera and Tuz-Sulub 2010; Santander-Monsalvo et al. 2012; Wakida-Kusunoki and Amador del Angel 2015), but always related to coral reefs.

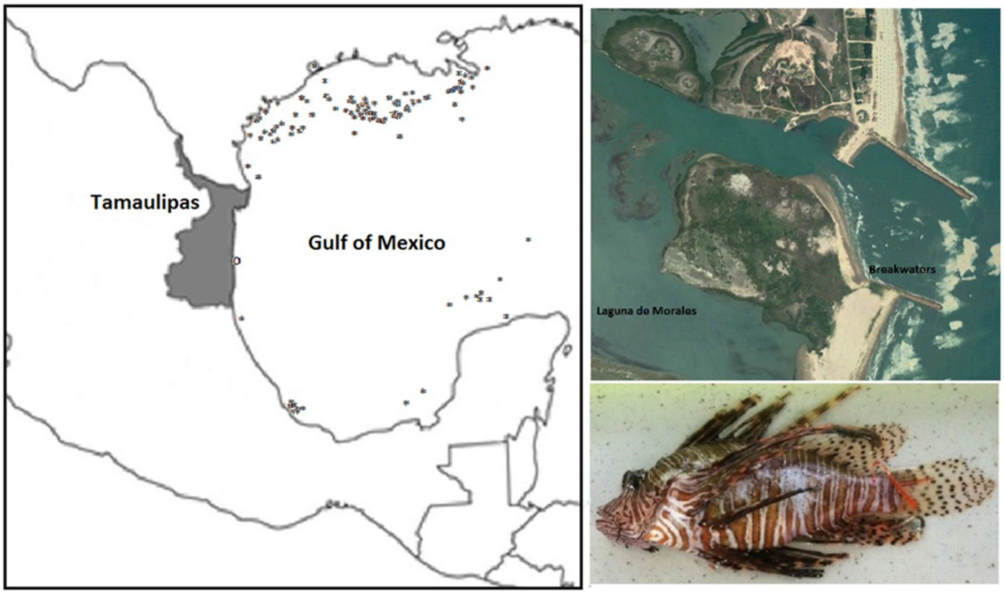

Figure 1. Location of La Pesca and the breakwaters in the connection area Laguna de Morales-Gulf of Mexico, in the central area of the state of Tamaulipas and one of specimens of *Pterois volitans*, about 16 cm total length. (*) Sites where red lionfish had been caught previously, USGS Data (Schofield, 2017); (o) New observation, this study. Photo by Arellano-Méndez.

Table 1. Meristic data of the red lionfish (*Pterois volitans*) collected in La Pesca (Tamaulipas, Mexico).

Identification number	Total length (mm)	Standard length (mm)	Total weight (g)	Dorsal fin	Anal fin
1	162	137	218.23	XII-12	III-8
2	159	138	210.11	XII-12	III-8
3	158	138	209.58	XII-12	III-8
4	157	137	210.26	XII-12	III-8
5	155	136	208.42	XII-12	III-8
6	151	129	207.95	XII-12	III-8

Material and methods

In February 2016, we held discussions with fishermen from the Tamaulipan coast about the presence of invasive species, such as the red lionfish in the Gulf of Mexico. In these meetings, we showed pictures of specimens that were captured at other sites. The fishermen recognized the fish and mentioned that individuals have been seen locally. We hypothesized that these red lionfish were coming from Veracruz by the currents, which are warm currents and transparent waters. We asked the fishermen to capture specimens and then report to us. In October 2016, a local fisherman (José Colorado Dapa) from the port of La Pesca (municipality of Soto la Marina) captured six juvenile red lionfish. They were caught in water < 3 m deep on the breakwater (22º29′32.42″N; 97º50′23.10″W), an area with low visibility (Figure 1). The specimens were frozen until transported to the Institute of Applied Ecology of the Autonomous University of Tamaulipas. Collected specimens were examined following the two main meristic identification characteristics (spines on dorsal and anal fins). Subsequently the body cavity was inspected to identify stomach contents and determine the gonadal state.

Results

The captured specimens were identified as juvenile organisms of *Pterois volitans* (dorsal fin-12, anal fin-8 spines), with an average total length of 157 ± 1.53 mm and average weight of 210.76 ± 3.77 g (Table 1). The stomachs were empty and the gonads were immature.

Discussion

The six specimens likely were the same age based on their narrow length range. These individuals were approximately the same size as those previously recorded in the Gulf of Mexico (Table 2), where the red lionfish invasion is now well-advanced, with the presence of

Table 2. Comparative meristic data of red lionfish *Pterois volitans* from several localities where they have been reported as invasive, as well as Indo-Pacific (reference values), and emphasizing reports for México.

Study site	Total length (mm)	Dorsal fin	Anal fin	Reference
Indo-Pacific	82–235	XII-10,12	III-5,8	Schultz 1986
North Carolina	100–120	XII-11	III-7	Whitfield et al. 2002
Florida	134–378	XII-11,13	III-7,8	Ruíz-Carus et al. 2006
México (Tamaulipas)	151–162	XIII-12	III-8	This study
México (Veracruz)	185	XIII-12	III-8	Santander-Monsalvo et al. 2012
México (Tabasco)	245–250	XIII-11	III-7	Wakida-Kusunoki and Amador del Ángel 2015
México (Campeche)	390	XIII-11	III-7	Aguilar-Perera et al. 2012
México (Yucatán)	137	XII-11	III-8	Aguilar-Perera and Tuz-Sulub 2010
Venezuela	127–215	XII-12	III-8	Lasso-Alcalá and Posada 2010
Colombia	96–157	XII-11,12	III-7,8	González et al. 2009
Brasil	250	XII-11	III-7	Ferreira et al. 2015

large mature individuals, mainly in the reef areas of Veracruz (Parque Nacional Sistema Arrecifal Veracruzano and Isla de Lobos-Tuxpan).

Our record is consistent with the hypothesis larvae are being widely dispersed by Gulf of Mexico currents (Aguilar-Perera and Tuz-Sulub 2010; Santander-Monsalvo et al. 2012). Locally, the Yucatan current flows through the Yucatan Channel into the Gulf of Mexico and is later part of the Loop Current (Ochoa et al. 2001). It is very possible that larvae of *P. volitans* have dispersed throughout the Caribbean, then to the Yucatan Current that passes through the Yucatan Channel and ended up being transported by the Loop Current.

Although the red lionfish typically inhabits reefs, they are habitat generalists and have also been reported from mangroves, seagrass meadows, mud bottoms, and estuaries (Claydon et al. 2012; Jud and Layman 2012). This is evident in the state of Tamaulipas, where natural coral reefs do not occur. However, there is an artificial reef (Usumacinta Ship E-20), located in the port of Tampico at a depth of 35 meters, and could provide suitable habitat for red lionfish (Aguilar-Perera and Tuz-Sulub 2010; Aguilar-Perera et al. 2012; Whitfield et al. 2002). This artificial reef may function as a biological corridor for fish, in their quest to colonize more northern territories. The presence of lionfish in arrival buoys, where vessels are moored before passing to the shipyards, has also been reported. The fixed buoys serve as shade for many fish, which in turn become prey for red lionfish (personal observation). Additional sightings have been made around sunken vessels (for example, a dredging vessel at the entrance to the Laguna de Morales system), which may serve as a refuge for red lionfish.

Another factor that may help red lionfish spread is the winds. It has been observed that the Tamaulipas continental platform, influenced by the Texas platform, generates eddies that interact with the slope. This causes upwelling areas in the summer. In autumn and winter, cold-water advection processes provide increased nutrients (contributions from the Mississippi River and other estuarine systems in Texas and Louisiana). This makes it a relevant area because it acts as a biological corridor for the transport of nutrients, larvae, and organisms, as well as serves as a connection between the different coastal lagoon systems (Zavala-Hidalgo et al. 2003).

The discharge of the Pánuco River plume, however, does not seem to restrict red lionfish distribution. The discharge of fresh water, which contains a high sediment load, has not represented a substantial barrier, unlike the Orinoco and Amazon Rivers (Ferreira et al. 2015). For example, fishermen of La Pesca mentioned that the red lionfish has been observed in the Laguna de Morales (estuarine, shallow and turbid conditions). The presence of this species in environments with low salinity, such as estuaries, has already been reported (Jud et al. 2015), which indicates that this is not a limitation to its distribution. In addition, this species continues to adapt to a diversity of conditions, perhaps in search for food (Morris and Atkins 2009). Additional research must be conducted to confirm this by the collection and dissection of organisms that are trapped within the lagoon.

The severe ecological and economic damage by red lionfish in the Caribbean and Gulf States (Albins and Hixon 2008; Claydon et al. 2012; Côté et al. 2013; Morris and Whitfield 2009; Raymond et al. 2015) must alert the authorities to monitor the presence of red lionfish in the Tamaulipas state. As demonstrated here, contact and communication with local stakeholders (citizen scientists) may provide an effective mechanism for the early detection of invasive species in a new area (e.g., Scyphers et al. 2012). Efforts should also be made to build coherent databases to track progress in the region. Additional information should be provided to coastal decision makers on the biology and morphology of red lionfish as an aid to control invasion.

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Author Contributions

Analysis of samples LUAM, ERM. All authors contributed to the writing, process and approved the manuscript LUAM, AMO, CZT, ERM.

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