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Rapid Communication

First record of South American suckermouth armored catfishes (Loricariidae, *Pterygoplichthys* spp.) in the Chumpan River system, southeast Mexico

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Abstract

Non-native South American suckermouth armored catfishes brackish waters of the genus *Pterygoplichthys* are reported in the Chumpan River in the Southeastern Mexico. The *Pterygoplichthys* in the Chumpan likely dispersed from populations from the drainage of nearby coastal rivers where they were already established. These catfish tolerate estuarine conditions and probably dispersed from the Grijalva-Usumacinta basin through the brackish waters of Laguna de Términos and then ultimately entered the Chumpan River system. One juvenile and seven adult *Pterygoplichthys* were collected in the Chumpan River system in December 2014 from a river lagoon some 15 km upstream from Laguna de Términos. Non-native catfish were not detected in the nearby Candelaria River. Based on their ventral color patterns, the captured adult catfish were identified as a mix of *Pterygoplichthys pardalis* and hybrid *Pterygoplichthys disjunctivus* × *pardalis*. The detection of these invasive catfish in the Chumpan River highlights the urgent need to generate an awareness program to reduce any adverse effects of this invasive species in the basin, and raises concerns that they may disperse to other basins via an oligohaline passageway in Laguna de Términos.

Key words: invasive species, dispersion, oligohaline, fluvio-lagoons, Laguna de Términos

Introduction

South American suckermouth armored catfishes of the genus *Pterygoplichthys* are firmly established in parts of southeastern Mexico. Researchers have documented the existence of as many as two different *Pterygoplichthys* species in the Grijalva and Usumacinta basin (Wakida-Kusunoki et al. 2007; Wakida-Kusunoki and Amador-del Ángel 2008; Capps et al. 2011; Sánchez et al. 2012a, 2012b; Ayala-Pérez et al. 2014; Barba-Macías and Cano-Salgado 2014; Barba-Macías et al. 2014). There are also confirmed reports of these non-native catfishes in the Palizada River and Este-Palizada fluvio-lagoon (Wakida-Kusunoki and Amador-del Ángel 2008; Ayala-Pérez et al. 2014), as well as in the Pom-Atasta fluvio-lagoon (Ayala-Pérez et al. 2014). The freshwater inflow in Laguna de Términos also means that tributaries feeding into that estuarine lagoon are at risk of invasion. The changing salinities of coastal areas, such as in the southern portion of Laguna de Términos, are not an impediment to their dispersal given that recent experiments demonstrated that *Pterygoplichthys* are able to survive in salinities above 8 ‰ (Capps et al. 2011). The spread of non-native fauna has been almost inevitable worldwide (Cucherousset and Olden 2011), and the successful dispersal of *Pterygoplichthys* through Laguna de Términos is very probable.

Methods

Study area

The region of focus was an area of southwestern Mexico, where numerous rivers and lagoons are in contact with coastal estuarine habitats along the Gulf of Mexico. The major rivers in the area are the Candelaria-Mamantel, Chumpan, Palizada, and San Pedro-San Pablo. All of them drain into

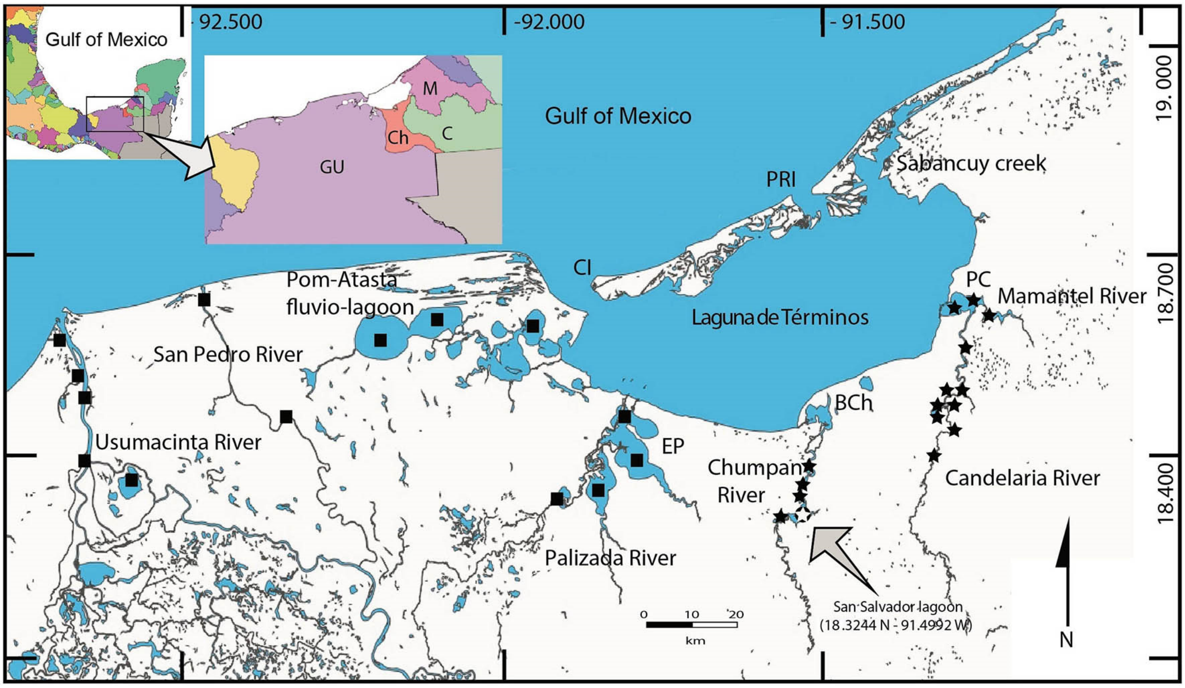

Figure 1. *Pterygoplichthys* records in the river basins of Laguna de Términos; ■ = documented record (Wakida-Kusunoki et al. 2007; Wakida-Kusunoki and Amador-del Ángel 2008; Capps et al. 2011; Ayala-Pérez et al. 2014); ★ = sampled sites; ✪= new record (18.3244 N; -91.4992 W); GU = Grijalva-Usumacinta basin, Ch = Chumpan Basin, C = Candelaria Basin, M = Mamantel Basin, EP = Este-Palizada fluvio-lagoon, BCH = Balchacah-Chumpan fluvio-lagoon, PC = Panlao-Candelaria fluvio-lagoon, CI = Carmen Inlet, and PRI = Puerto Real Inlet. For details see supplementary material in Table S1.

Laguna de Términos, which is the largest fluvio-estuarine ecosystem, with a size of 705,016 ha (Figure 1).

The Chumpan basin has a drainage area of 3,005 km^2 (SNIA 2012), and is a transboundary basin that is partially in Guatemala (Cuevas et al. 2010). The Chumpan River undergoes a monthly average variation from 10.5 to 24.4 m^{3}seg^{-1} (Ayala-Pérez 2010). The river drains into the southern extreme of Laguna de Términos through the Balchacah-Chumpan fluvio-lagoon (Figure 1), which has an area of 13.1 km^2 and a depth of 1.5 m (Ayala-Pérez 2010). The ample variation in the salinity, from 9 to 28 ‰ (Amezcua and Yañez-Arancibia 1980; Ayala-Pérez et al. 1995), is tied to the contrasting conditions between the dry and rainy seasons. The dominant species in the Balchacah-Chumpan fluvio-lagoon are *Cathorops melanopus* (Günther, 1864), *Gerres cinereus* (Walbaum, 1792), *Diapterus rhombeus* (Jordan and Gilbert, 1882), *Eugerres plumieri* (Cuvier, 1830), *Eucinostomus gula* (Quoy and Gaimard, 1824), and *Bairdiella ronchus* (Cuvier, 1830) (Ayala-Pérez et al. 2014), but the number of small-bodied fishes has been underestimated due to the types of fishing gear used in previous surveys (Álvarez-Pliego et al. 2015).

The Candelaria and Mamantel Basins have drainage areas of 10,525 and 5,451 km^2, respectively (SNIA 2012). The Candelaria Basin is also classed as transboundary, because it begins in Petén, Guatemala. From 2000 to 2011, the monthly average discharge of the Candelaria and Mamantel Rivers fluctuated from 13.19–288.14 and 0.3–18.21 m^{3}seg^{-1}, respectively. These ranges were estimated from the Banco Nacional de Datos de Aguas Superficiales (BANDAS) government database (http://www.conagua.gob.mx/CONAGUA07/Contenido/Documentos/Portada%20BANDAS.htm). Both rivers run into Laguna de Términos through the Panlao-Candelaria fluvio-lagoon, and Mamantel River then merges with the Candelaria River 7.3 km upstream from the lagoon (Figure 1). Among the 50 fish species recorded, *Cathorops melanopus*, *Diapterus rhombeus*, *Anchoa mitchilli* (Valenciennes, 1848), and *Sphoeroides testudineus* (Linnaeus, 1758) are dominant in the Panlao-Candelaria fluvio-lagoon, which has an area of 14 km^2 (Ayala-Pérez

Table 1. Morphometric and meristic data of the eight *Pterygoplichthys* specimens collected in the Chumpan River (TL: total length; SL: standard length; HL: head length; S: snout length).

	Adults with spotted ventral pattern n = 3			Adults with vermiculated ventral pattern n = 4				Juvenile n = 1
TL (mm)	350	360	345	295	310	287	290	17
SL (mm)	270	265	257	214	235	215	214	13
HL (mm)	50	45	43	35	41	46	45	2.4
S (mm)	35	30	30	25	28	28	27	1.6
Dorsal fin rays	11	12	12	12	11	12	12	12
Anal fin rays	4	4	4	4	4	4	4	4
Pectoral fin rays	5	6	6	6	6	6	6	6
Pelvic fin rays	5	5	5	5	5	5	5	5
Weight (g)	321	301	248	216	208	209	188	0.04

2010) and is in the southeastern extreme of Laguna de Términos (Figure 1).

The Palizada and San Pedro-San Pablo Rivers are distributaries of the Usumacinta River. Both are in the Grijalva-Usumacinta Basin (SNIA 2012), and drain into Laguna de Términos through the Este-Palizada and Pom-Atasta fluvio-lagoons, which are located near the western extreme of the lagoon (Figure 1). The monthly freshwater flow of the Palizada River varies from 61.85 to 702.14 m^3seg^{-1}. This range was estimated for the 2000–2011 period using the data in the BANDAS database.

Laguna de Términos is connected with the Gulf of Mexico through the Carmen and Puerto Real inlets, its freshwater inflow is from the Palizada, Chumpan, and Candelaria-Mamantel Rivers. This lagoon includes four fluvio-lagoons near its western and southern extremes. In addition, Sabancuy Creek is located in the northeast (Figure 1). The spatial arrangement of the main inlets and rivers, the dominant and frequent winds, and the northeastward tidal water transport in the southern portion and southwestward tidal water transport in the north of the lagoon, can explain the northward salinity gradient and the distributions of aquatic fauna (Mancilla-Peraza and Vargas-Flores 1980; Yañez-Arancibia et al. 1983; Sánchez and Raz-Guzman 1997; Contreras-Ruiz Esparza et al. 2014). The lagoon supports the greatest faunal biodiversity of any of the estuarine systems in the south of the Gulf of Mexico (García-Cubas 1981; Sánchez et al. 1996; Raz-Guzman et al. 2004; Sirot et al. 2015), and the aquatic diversity could increase with detailed studies the secondary associated ecosystems (e.g., the four fluvio-lagoons, rivers, and adjacent creek).

Sampling and laboratory methods

In September and December 2014, sampling was conducted at 16 sites in the Chumpan, Candelaria, and Mamantel Rivers, and the Panlao-Candelaria fluvio-lagoon (supplementary Table S1). In the rivers, sites were chosen mainly in low-energy areas, such as shallows and interconnected lagoons and creeks. Water temperature (ºC) and electrical conductivity (μScm^{-1}) were measured at each site using a Hach sensION 156 portable multimeter (± 0.1°C and ± 0.01 μScm^{-1}). Fish were collected during both day and night with 40-cm-diameter dip nets with a 1 mm mesh and 50-m-long set gillnets with a 5 cm mesh.

Specimens were identified as *Pterygoplichthys* due to the presence of a long dorsal fin with nine or more dorsal fin rays in agreement with Armbruster and Page (2006). Each fish was weighed (g) and its total (TL) and standard (SL) length in mm was measured (Table 1). Moreover, seven meristic and morphological measures were made to support identification to the genus level (Table 1). The ventral patterns of dark spots and vermiculations, proposed by Armbruster and Page (2006), were used for identification to the species level. All loricariids were registered in the Colección Nacional de Peces, Instituto de Biología-UNAM, catalog numbers CNPE-IBUNAM 19823 to 19825.

Results

One juvenile of 17 mm TL and seven adult *Pterygoplichthys* from 287 to 360 mm and 188 to 321 g were collected in San Salvador Lagoon (18.319863N, -91.545287W). This lagoon is permanently connected to the Chumpan River, and

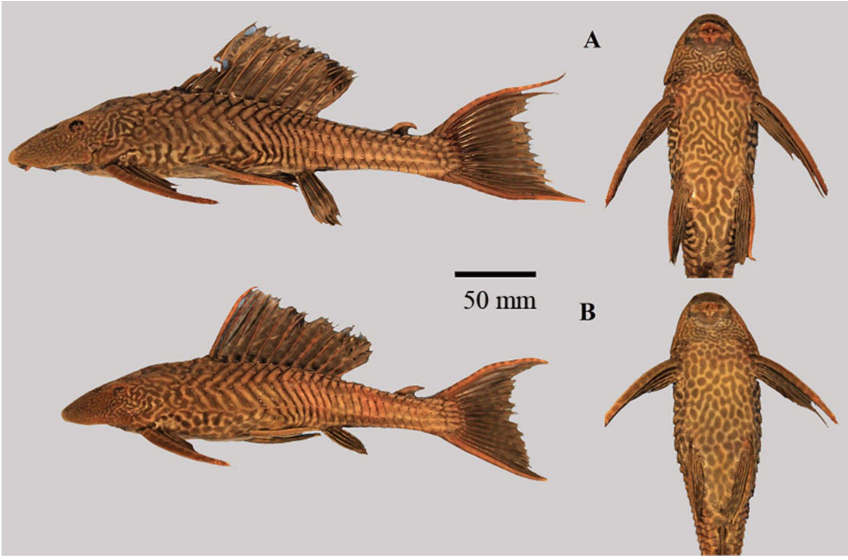

Figure 2. Two of the eight *Pterygoplichthys* specimens collected in the Chumpan River (18.319863N, -91.545287W) showing: A) an individual with a ventral pattern with many large vermiculations and a few spots, which is a pattern characteristic of *P. pardalis** (CNPE-IBUNAM 19824); and B) an individual with a ventral pattern consisting of a mix of coalesced spots and a few small vermiculations, which is a pattern presumed to be that of a hybrid (CNPE-IBUNAM 19825). Photographs by Álvarez-Pliego.

is located 15 km upstream from Laguna de Términos (Figure 1). Two patterns of ventral spots were identified on the abdomens of the seven adult fish caught: 1) three specimens had large vermiculations and spots, and 2) four fish had a coalescence of spots and some small vermicu-lations (Figure 2). The juvenile specimen could not be identified to the species level because the ventral pattern of small *Pterygoplichthys* is not species specific. Water temperatures ranged from 23 to 31.6ºC. Most of the sites had limnetic conditions (< 1020 µScm^{-1} at 25 ºC); however, oligohaline conditions were also observed in the Panlao-Candelaria fluvio-lagoon (Table S1).

Discussion

The wide variety of the ventral patterns among the seven adult *Pterygoplichthys* obtained during this study, defined as *Pterygoplichthys pardalis* and *P. disjunctivus* by Armbruster and Page (2006), agreed with the hypotheses of Wu et al. (2011) regarding the hybridization or synonymy of both species. Considerable variability in the color patterns of *Pterygoplichthys* has also been reported for introduced populations in Taiwan (Wu et al. 2011), Florida USA (Nico et al. 2012), and the Grijalva-Usumacinta basin in Mexico (Sánchez et al. 2015). Indeed, Nico et al. (2012) noted that some introduced *Pterygoplichthys* populations show such extensive variation that they might best be referred to as "hybrid swarms". The situation in Mexico highlights the need to determine if the hybrid *Pterygoplichthys disjunctivus* × *pardalis* has a fitness advantage over non-hybrids as Wu et al. (2011) speculated.

Evidence for the apparent successful dispersion and reproduction of *Pterygoplichthys* in the Chumpan River is based on our observations that both small juvenile and adult individuals are present in the system. The lengths and weights of the seven adults collected correspond to those of females in the IV mature stage from the Grijalva-Usumacinta Basin (Ayala-Pérez et al. 2014) and mature and spawning females reported for Florida (Nico et al. 2012). To date, nest burrows of these catfish were not observed in the Chumpan River system (see Nico et al. 2009).

Natural dispersal of *Pterygoplichthys* from the Grijalva-Usumacinta Basin is the most likely origin of the *Pterygoplichthys* observed in multiple river and lagoon systems that feed into Laguna de Términos. For instance, specimens of the genus were found in the Palizada River and the Este-Palizada and Pom-Atasta fluvio-lagoons during the period 2007 to 2009 (Wakida-Kusunoki and Amador-del Ángel 2008; Capps et al. 2011; Ayala-Pérez et al. 2014). Those systems are inside the Grijalva-Usumacinta Basin (Figure 1). The current study is the first to report presence of these catfish in two additional Laguna de Términos tributaries, the Chumpan and Candelaria systems, both more distant from the Grijalva-Usumacinta Basin. In this context, the presence of *Pterygoplichthys* in the Chumpan River might be related to either release by aquarium hobbyists or dispersion across the Laguna de Términos. Introductions via aquarium releases are more common in areas with large human populations (Leprieur et al. 2011), which do not happen even in the Chumpan Basin. Natural dispersal is also a feasible explanation since *Pterygoplichthys* can survive in brackish waters (Capps et al. 2011). The survival of hybrid *Pterygoplichthys* suggests that they are dispersing via an oligohaline passageway located in the extreme south of Laguna de Términos. The salinities and faunal distribution data agree with this scenario because the freshwater river inflow keeps the brackish environment below 5 ‰, mainly during the rainy season in the southern extreme of Laguna de Términos, as well as in the Balchacah-Chumpan and Panlao-Candelaria fluvio-lagoons (Amezcua and Yañez-Arancibia 1980; Ayala-Pérez et al. 1995; Ayala-Pérez et al. 1998; Sirot et al. 2015). Moreover, the salinity conditions have produced an ecological area (Yañez-Arancibia et al. 1983), where the numerically dominant crustaceans or fish tolerate low salinities (Yañez-Arancibia et al. 1983; Sánchez and Raz-Guzman, 1997).

If *Pterygoplichthys* are dispersing through the oligohaline zone in Laguna de Términos, then the spread of loricariid into the Candelaria and Mamantel systems is probably only a matter of time. This route is feasible due to 1) the oligohaline conditions measured in the Panlao-Candelaria fluvio-lagoon in this study and previously (Ayala-Pérez et al. 1998), and 2) their localization in the southern extreme of Laguna de Términos. In conclusion, our capture of *Pterygoplichthys* in the Chumpan River during December 2014 should be used to develop a short-term warning system, to reduce adverse effects in the Chumpan system, and avoid further dispersal into the Candelaria and Mamantel systems. Finally, the ample variety of the morphological traits of *Pterygoplichthys* seen in this survey supports the need to confirm the taxonomic identity of the various species and the possible presence of *Pterygoplichthys disjunctivus* × *pardalis*.

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Supplementary material

The following supplementary material is available for this article:

Table S1. Geographic localization of sampling sites of *Pterygoplichthys*.

This material is available as part of online article from:
http://www.reabic.net/journals/bir/2015/Supplements/BIR_2015_AlvarezPliego_etal_Supplement.xls