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Taxonomy and systematics

The fish fauna of three lagoon-estuarine systems in the northeastern Gulf of Tehuantepec, Mexican south Pacific

Peces de tres sistemas estuarino lagunares en el noreste del golfo de Tehuantepec, Pacífico sur mexicano

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Abstract

A checklist of fishes recorded from Mar Muerto, La Joya-Buenavista, and Los Patos-Solo Dios lagoon-estuarine systems, northeastern Gulf of Tehuantepec, Mexico is presented. Fish samples were collected through 34 stations using several kinds of fishing gear, between April 2007 and May 2016. The checklist includes 2 classes, 19 orders, 52 families, 87 genera, and 120 species. The best-represented families are Carangidae (9 species), Gerreidae (7), and Engraulidae (6). The Mar Muerto system had 89 species, followed by La Joya-Buenavista with 76; in Los Patos-Solo Dios, only 41 species were recorded, perhaps due to a lower marine influence. Based on their ecological affinities, 43% of the fishes belong to marine stenohaline component, 42% to the marine euryhaline component, 11% are of freshwater derivation, and 5% are estuarine residents. The ichthyofauna showed high affinities to the Panamic province (80.7%) followed by Mexican (79.8%) and Cortés (73.1%) provinces. Nine species (8 native and 1 exotic) are added to the known continental fish fauna of the state of Chiapas.

Keywords: Ichthyofauna; Mar Muerto; La Joya-Buenavista; Los Patos-Solo Dios; Chiapas; Coastal lagoons; Ecogeographical affinity

Resumen

Se presenta una lista sistemática de los peces registrados en los sistemas estuarino lagunares Mar Muerto, La Joya-Buenavista y Los Patos-Solo Dios, en el noreste del golfo de Tehuantepec, México. Las muestras se obtuvieron en 34 estaciones utilizando varias artes de pesca, entre abril 2007 y mayo 2016. La lista incluye 2 clases, 19 órdenes, 52 familias, 87 géneros y 120 especies. Las familias mejor representadas son Carangidae (9 especies), Gerreidae (7)

y Engraulidae (6). El sistema Mar Muerto tuvo 89 especies, seguido de La Joya-Buenavista con 76. En el sistema Los Patos-Solo Dios únicamente se registraron 41 especies, debido quizá a una baja influencia marina. Según la afinidad ecogeográfica, 43% del total fueron especies marinas estenohalinas, 42% marinas eurihalinas, 11% dulceacuícolas y 5% residentes estuarinas. La ictiofauna mostró una alta afinidad a la provincia Panámica (80.7%), seguida por las provincias Mexicana (79.8%) y Cortés (73.1%). Nueve especies (8 nativas y 1 exótica) se adicionan a la ictiofauna continental conocida de Chiapas.

Palabras clave: Ictiofauna; Mar Muerto; La Joya-Buenavista; Los Patos-Solo Dios; Chiapas; Lagunas costeras; Afinidad ecogeográfica

Introduction

The Gulf of Tehuantepec (GT; 14°30'–16°13' N, 96°07'–92°14' W), southern Mexico, is one of the most important marine coastal regions in the Middle American Pacific. The peculiarity of its environmental processes, such as upwelling, current patterns, winds, and freshwater discharges, leads to high productivity that supports artisanal and industrial fisheries (Tapia-García, 1998; Wilkinson et al., 2009). The GT is also recognized as an ecoregion of the Tropical Eastern Pacific, with confluence of 2 coastal marine zoogeographical provinces: Mexican and Panamic (Briggs, 1974; Lara-Lara et al., 2008).

Although the demersal fish fauna in the GT is relatively well characterized (Bianchi, 1991; Martínez-Muñoz et al., 2016; Núñez-Orozco et al., 2013; Tapia-García, 1998), studies focused on coastal lagoons are rather scarce, despite their importance as nurseries and feeding sites for many commercial species (Contreras, 2010). The information available on the composition of estuarine ichthyofauna in the GT is restricted to some inventories in the northern region (Chávez, 1979; Tapia-García et al., 1998) and the Biosphere Reserve “La Encrucijada” (Díaz-Ruiz et al., 2006; Gómez-González et al., 2012).

In recent decades, the problems of siltation, eutrophication, mangrove deforestation, and collapse of fisheries have increased in the lagoon estuarine systems of the GT (Rivera-Velázquez et al., 2009; Tovilla-Hernández, 2004). Fish are a key ecological component in tropical coastal lagoons. They have a wide range of species at several trophic levels, so their use as an indicator group of biotic integrity of coastal ecosystems is feasible (Pérez-Domínguez et al., 2012; Xu et al., 2011). In this context, checklists represent an indispensable tool for understanding the structure of fish assemblages, ecosystem modeling, and development of strategies for biodiversity management.

In this work, we carried out an inventory of fish species present in 3 lagoon-estuarine systems in the northeast region of the GT. The list includes notes on its ecogeographical and biogeographical affinities as well as its conservation status.

Material and methods

Sampling was conducted in the lagoon-estuarine systems Mar Muerto (MM; 15°58'–16°17' N, 93°50'–94°25' W), La Joya-Buenavista (JB; 15°48'–56' N, 93°32'–47' W), and Los Patos-Solo Dios (PSD; 15°31'–40' N, 93°15'–25' W) (Fig. 1). These are shallow coastal lagoons with a sandy barrier class of III-A (Contreras, 2010; Lankford, 1977). The tides are mixed, predominantly semidiurnal, with a mean range of 1 m. Climate is tropical wet-dry, with 2 distinct seasons: rainy (June–October) and dry (November–May). The distribution of annual precipitation increases west to east from below 1,000 mm to over 1,600 mm. The mean temperature is about 28 °C. Mangroves (*Avicennia germinans*, *Rhizophora mangle*), marshes (*Batis maritima*, *Sporobolus virginicus*), and agricultural and semiurban areas surround the systems. The main rivers (e.g., Tapanatepec, Lagartero, Los Horcones, San Isidro) have reduced their flow in recent decades, limiting the freshwater input to coastal lagoons (Tovilla-Hernández, 2004). The northeastern GT groups 3 priority marine regions of Mexico (Arriaga-Cabrera et al., 1998), a Ramsar site, and the federal protected area “Santuario Playa de Puerto Arista” (Conanp, 2016).

Mar Muerto, shared between the states of Oaxaca and Chiapas, is one of the most extensive coastal lagoons in the Mexican Pacific (c. 720 km²). At its southeastern end, the system is connected to the sea through a 1.3-km-long inlet (Boca de Tonalá). Its depth varies between 1 and 3.6 m, with the deepest area in the inlet. During the early dry season, the southward wind events generate surface currents, which affect depth and temperature. The limited supply of seasonal streams generates hyperhaline conditions (salinity up to 55 psu) during the dry season (Contreras-Espinosa et al., 1994; Tapia-García et al., 2011). We established 10 sampling sites in this system (#MM 1–10; Fig. 1A). All of the samples in this system were collected between October 2014 and May 2016, with additional material collected in April 2007, February 2008, and April 2010 only from the sampling stations 2, 3, 4, and 10.

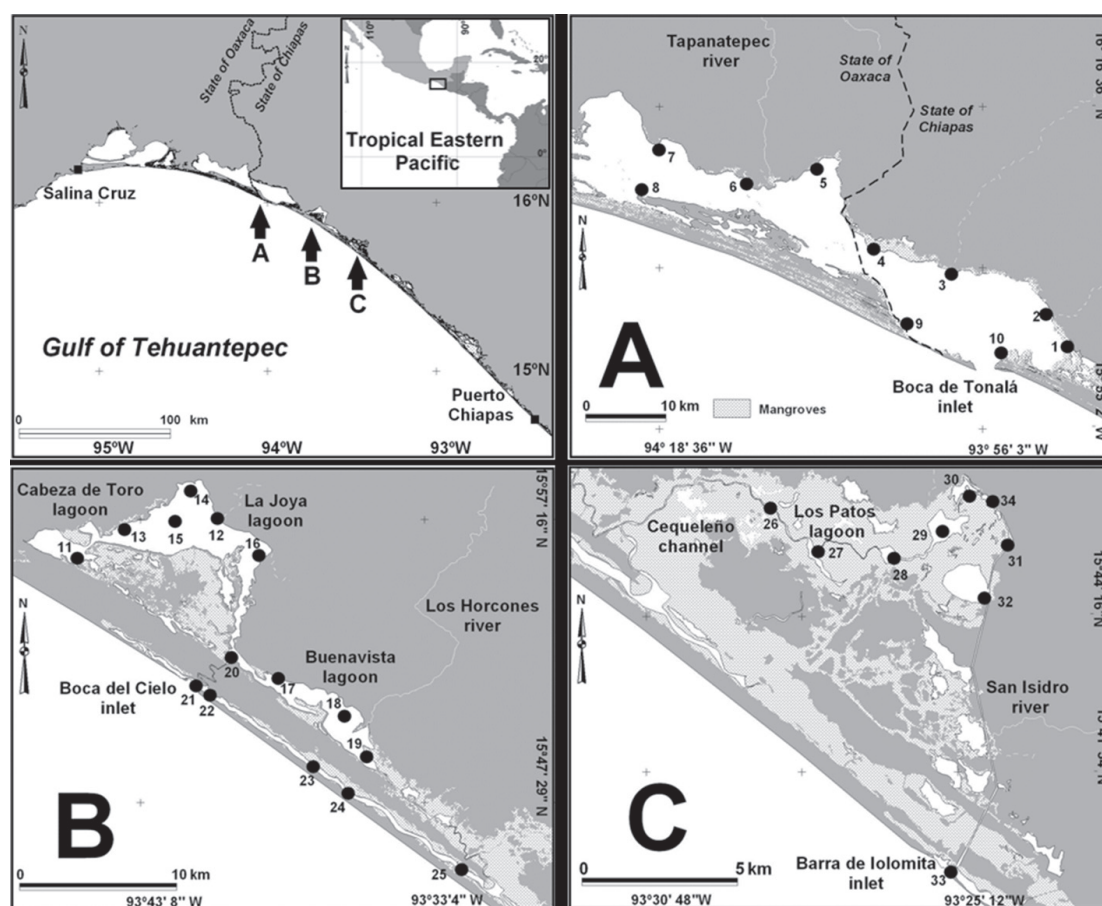


Figure 1. Maps of the Gulf of Tehuantepec (upper left), Mar Muerto (A), La Joya-Buenavista (B) and Los Patos-Solo Dios (C) lagoon-estuarine systems, with sampling sites of the fish fauna.

La Joya-Buenavista (47.5 km²) is a shallow and seasonally polyhaline system with restricted oceanic exchange. Interconnected lagoons (La Joya, Cabeza de Toro, Buenavista) communicate with the GT through a dredged channel 2.4 km long (San Marcos) that leads into the inlet of the estuarine channel (Boca del Cielo). The system shows a high concentration of nutrients; therefore, it is considered one of the most productive coastal lagoons in the Mexican Pacific (Contreras, 2010; Contreras-Espinosa & Zabalegui-Medina, 1991). Here, we established 15 sampling sites (#11-25; Fig. 1B). The samples were collected between May 2013 and June 2016.

Los Patos-Solo Dios (113 km²) comprises several small and shallow lagoons (Los Patos, El Mosquito, La Balona, Pampita) interconnected by narrow channels, and connected to the GT through the dredged channel Joaquín Amaro (12 km). A greater number of ephemeral streams drain into the system, so mesohaline conditions prevail seasonally. Because the Barra de Santiago-Iolomita inlet

is closed, the main tidal influence occurs through channels that are connected to adjacent systems. Nine sampling sites (#26-34) were established (Fig. 1C). In this system, collections were made between August 2014 and October 2015.

Fish were collected with a 20-m long by 2-m deep and 56-mm-mesh-size gill net, a 4-m diameter and 15 mm-mesh-size casting net, a 5- and 10-m long by 2-m deep and 5 mm-mesh-size seine nets, spoon net, cod-end net, harpoon, and some complementary samples from local fishermen. At most sampling events, salinity at mid-water was measured with a refractometer or a multiprobe meter (to the nearest 0.1 psu). The fish specimens were fixed in a 10% formalin solution during 1 week, then washed in water during 1 day, and finally preserved in 70% ethanol. Then they were deposited in the fish collection (CHIS-PEC-210-03-09) of the Museum of Zoology, Instituto de Ciencias Biológicas, Universidad de Ciencias y Artes de Chiapas (UNICACH, Tuxtla

Gutiérrez, Chiapas, Mexico; see museum vouchers in Appendix).

Fish were identified to species level with the taxonomic keys of Bussing and López (2011), Castro-Aguirre et al. (1999), Fischer et al. (1995), and Miller et al. (2009), original descriptions, and recent systematic reviews. The systematic checklist was arranged by order and family following the classification of Nelson (2006); genera and species within families were arranged in alphabetical order. Nomenclature of taxonomic units follows Eschmeyer et al. (2016). For a general description of the fish community structure, the species recorded between 2013 and 2015 through standardized sampling (with cast net, gill net, and seine net) were classified by their residency status in lagoon-estuarine systems using the relative frequency of occurrence as: Permanent resident (> 80%), Seasonal/Recurrent visitor (50-80%), Transient/Occasional visitor (20-49%), and Rare (< 19%).

The ecogeographical affinity classification according to salinity tolerance was based on criteria of Castro-Aguirre et al. (1999), Miller (1966), and Myers (1949). The species were classified into 4 groups: estuarine resident, euryhaline, stenohaline, and freshwater (primary or secondary). The biogeographical affinities and distributional ranges of the species were based on Briggs (1974, 1995), Castro-Aguirre et al. (2006), and Robertson and Cramer (2009), using the following categories: San Diegan Province, Cortés Province, Mexican Province, Panamic Province, Circumtropical, Amphi-Pacific, Amphi-American, and Freshwater. The global conservation status and risk categories were based on the IUCN Red list (IUCN, 2016) and Mexican law NOM-059-SEMARNAT-2010 (Semarnat, 2010).

Results

This study recorded 120 species belonging to 87 genera, 52 families, 19 orders and 2 classes. The order Perciformes is the most diverse, with 66 species, representing 56% of the total recorded species. The most speciose families were Carangidae (9 spp.), Gerreidae (7), and Engraulidae (6), whereas Poeciliidae, Lutjanidae, Haemulidae, Sciaenidae, and Gobiidae had 5 species each. Twenty-six families had only 1 species. The checklist (Table 1) shows the presence of species in each system.

The most frequent species in the studied systems were *Gerres simillimus* (62% of the sampling stations), *Astatheros macracanthus* (62%), *Diapterus brevirostris* (59%), *Eucinostomus currani* (56%), *Centropomus robalito* (56%), *Lile gracilis* (53%), and *Gobionellus microdon* (50%). Fifty-three percent of the species were recorded using the standardized methods. The structure of the fish assemblages based on the residency status is

characterized mainly by rare species (82%). Only 1 species is categorized as permanent resident: *L. gracilis*. Another 3 species are categorized as seasonal or recurrent visitors: *A. macracanthus*, *C. robalito*, and *Mugil curema*; 7 are classified as transient or occasional visitors.

Values and ranges of salinity are presented here for 97 species collected at sites with conditions ranging from limnetic (0.6 psu) to hyperhaline (45 psu) in all 3 systems. The specific richness according to ecological affinity based on salinity tolerance is shown in Figure 2.

Zoogeographically, the ichthyofauna was mainly related to 3 provinces: Panamic (80.7%), Mexican (79.8%), and Cortés (73.1%). A few fish are related to Circumtropical (3.4%), Amphi-Pacific (1.7%), or Amphi-American (0.8%) distributional patterns. The Freshwater component is represented by families Lepisosteidae (*Atractosteus tropicus*), Characidae (*Astyanax aeneus*), Anablepidae (*Anableps dowei*), Poeciliidae (*Poecilia nelsoni*, *Poecilia sphenops*, *Poeciliopsis fasciata*, *P. pleurospilus*, *P. turrubarensis*), and Cichlidae (*Amphilophus trimaculatus*, *Astatheros macracanthus*). The only exotic component is the cichlid *Oreochromis niloticus*. Four species were recorded with some national or international risk category (Table 1).

Discussion

The fish composition recorded in this study is similar to that reported in other coastal lagoons in the GT (Gómez-González et al., 2012; Tapia-García et al., 1998). This represents 21.7% of the continental components (548 spp.) and 8.6% of all the shore-fish fauna (1,358 spp.) known for the Tropical Eastern Pacific (Robertson &

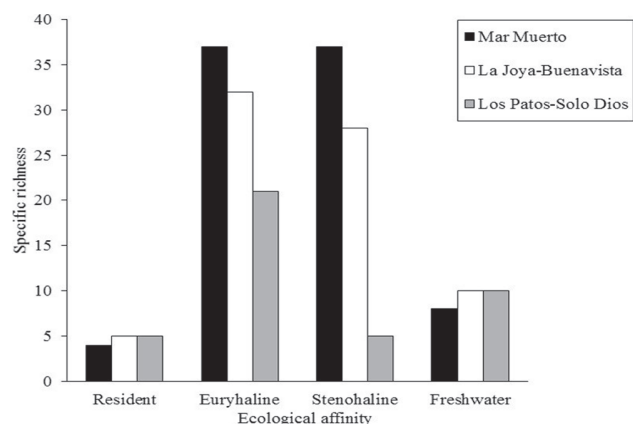


Figure 2. Fish fauna specific richness in Mar Muerto, La Joya-Buenavista, and Los Patos-Solo Dios lagoon-estuarine systems.

Table 1

Systematic checklist of fishes of 3 lagoon-estuarine systems in the northeastern Gulf of Tehuantepec. (*) New records for inland environments in Chiapas. Risk categories are according to the NOM-059-SEMARNAT-2010: (^{PR}) Subject to special protection; and the IUCN Red list of threatened species: (^{LC}) least concern, (^{NT}) near threatened, (^{VU}) vulnerable.

The “+” indicates the presence of the species in the lagoon-estuarine systems. Residency status: (P) permanent resident, (S/R) seasonal / recurrent visitor, (T/O) transient /occasional visitor, (R) rare. Ecological affinity: (ER): estuarine resident, (EU) euryhaline, (ST) stenohaline, (PF) primary freshwater, (SF) secondary freshwater. Biogeographical provinces and distribution: (SP) San Diegan, (CP) Cortés, (MP) Mexican, (PP) Panamic, (CT) Circumtropical, (AP) Amphi-Pacific, (AA) Amphi-American, (F) Freshwater, (E) Exotic. -: No data available.

Taxon	Mar Muerto	La Joya-Buenavista	Los Patos-Solo Dios	Residency status	Salinity range (PSU)	Ecological affinity	Biogeographical provinces and distribution
Class Chondrichthyes							
Order Myliobatiformes							
Family Urotrygonidae. American round stingrays.							
<i>Urotrygon chilensis</i> (Günther, 1872)	+			-	-	ST	SP, CP, MP, PP
<i>Urotrygon nana</i> Miyake & McEachran, 1988	+			-	-	ST	MP, PP
Family Potamotrygonidae. River stingrays.							
<i>Styracura pacifica</i> (Beebe & Tee-Van, 1941)	+	+		R	29.1-33.6	ST	MP, PP
Family Myliobatidae. Eagle rays							
^{NT} <i>Rhinoptera steindachneri</i> Evermann & Jenkins, 1981	+			-	31.7	ST	SP, CP, MP, PP
Class Actinopterygii							
Order Lepisosteiformes							
Family Lepisosteidae. Gars.							
<i>Atractosteus tropicus</i> Gill, 1863			+	-	4.2	SF	F
Order Elopiformes							
Family Elopidae. Tenpounders.							
<i>Elops affinis</i> Regan, 1909	+	+		-	22.4-35	EU	SP, CP, MP, PP
Order Albuliformes							
Family Albulidae. Bonefishes.							
^{LC} <i>Albula esuncula</i> (Garman, 1899)	+	+		R	30-31.9	ST	SP, CP, MP, PP
Order Anguilliformes							
Family Ophichthidae. Snake eels and worm eels.							
^{LC} <i>Ophichthus zophochir</i> Jordan & Gilbert, 1882	+			-	-	EU	CP, MP, PP
Order Clupeiformes							
Family Engraulidae. Anchovies.							
^{LC} <i>Anchoa curta</i> (Jordan & Gilbert, 1882)	+			-	-	EU	SP, CP, MP, PP
^{LC} <i>Anchoa ischana</i> (Jordan & Gilbert, 1882)			+	R	28.7	EU	CP, MP, PP
^{LC} <i>Anchoa lucida</i> (Jordan & Gilbert, 1882)	+	+	+	R	9.8-24.4	EU	SP, CP, MP
^{LC} <i>Anchoa mundeola</i> (Gilbert & Pierson, 1898)	+	+	+	R	5.9-23.7	EU	CP, MP
^{LC} <i>Anchoa starksii</i> (Gilbert & Pierson, 1898)			+	R	20.7	EU	PP
^{LC} <i>Anchoa macrolepidota</i> (Kner, 1863)	+	+	+	R	23.7-30.1	ST	SP, CP, MP, PP

Table 1

Continuación.

Taxon	Mar Muerto	La Joya-Buenavista	Los Patos-Solo Dios	Residency status	Salinity range (PSU)	Ecological affinity	Biogeographical provinces and distribution
Family Clupeidae. Herrings.							
^{LC} <i>Lile gracilis</i> Castro-Aguirre & Vivero, 1990	+	+	+	P	3.7-34.6	ER	CP, MP, PP
^{LC} <i>Lile nigrofasciata</i> Castro-Aguirre, Ruiz-Campos & Balart, 2002		+		-	-	ER	CP, MP, PP
^{LC} <i>Opisthonema libertate</i> (Günther, 1867)	+	+		R	31.9	ST	SP, CP, MP, PP
Order Gonorynchiformes							
Family Chanidae. Milkfishes							
<i>Chanos chanos</i> (Forsskål, 1775)	+			-	-	ST	CT
Order Characiformes							
Family Characidae. Characins.							
<i>Astyanax aeneus</i> (Günther, 1860)		+	+	R	1.5-6.4	PF	F
Order Siluriformes							
Family Ariidae. Sea catfishes.							
^{LC} <i>Sciades guatemalensis</i> (Günther, 1864)	+	+	+	R	4.3-15.7	EU	CP, MP, PP
^{LC} <i>Sciades seemanni</i> (Günther, 1864)	+	+	+	R	24.2	EU	CP, MP, PP
<i>Cathorops liropus</i> (Bristol, 1897)	+	+	+	R	4.3-15.7	EU	CP, MP, PP
<i>Cathorops steindachneri</i> (Gilbert & Starks, 1904)	+	+	+	R	7.2-16.5	EU	MP, PP
Order Aulopiformes							
Family Synodontidae. Lizardfishes.							
^{LC} <i>Synodus scituliceps</i> Jordan & Gilbert, 1882	+			-	-	ST	SP, CP, MP, PP
Order Batrachoidiformes							
Family Batrachoididae. Toadfishes.							
^{VU} <i>Batrachoides boulengeri</i> Gilbert & Starks, 1904	+			R	27.6	EU	MP, PP
^{LC} <i>Batrachoides waltersi</i> Collette & Russo, 1981	+			-	30	EU	MP, PP
Order Mugiliformes							
Family Mugilidae. Mulletts.							
^{LC} <i>Mugil cephalus</i> Linnaeus, 1758		+	+	R	23.7-34.3	EU	CT
^{LC} <i>Mugil curema</i> Valenciennes, 1836	+	+	+	S/R	8.7-23.6	EU	CT
^{LC} <i>Mugil hospes</i> Jordan & Culver, 1895	+	+		R	9.8-29.1	EU	AA
Order Atheriniformes							
Family Atherinopsidae. New World silversides.							
^{LC} <i>Atherinella guatemalensis</i> (Günther, 1864)	+	+	+	R	5.9-32.9	ER	PP
* ^{LC} <i>Atherinella panamensis</i> Steindachner, 1875	+			R	33.6	ST	PP
^{LC} <i>Membras gilberti</i> (Jordan & Bollman, 1890)	+	+		R	31.9-33.5	ST	CP, MP, PP
Order Beloniformes							
Family Hemiramphidae. Halfbeaks.							
^{LC} <i>Hyporhamphus naos</i> Banford & Collette, 2001	+	+		R	28.7-31.9	EU	SP, CP, MP, PP

Table 1

Continuación.

Taxon	Mar Muerto	La Joya-Buenavista	Los Patos-Solo Dios	Residency status	Salinity range (PSU)	Ecological affinity	Biogeographical provinces and distribution
^{LC} <i>Hyporhamphus rosae</i> (Jordan & Gilbert, 1880)	+			-	-	EU	PP
Family Belonidae. Needlefishes.							
^{LC} <i>Strongylura exilis</i> (Girard, 1854)	+			R	26.7	ST	SP, CP, MP, PP
Order Cyprinodontiformes							
Family Anablepidae. Four eyed fishes.							
<i>Anableps dowei</i> Gill, 1861	+	+	+	R	5.1-7.2	SF	F
Family Poeciliidae. Livebearers.							
<i>Poecilia nelsoni</i> (Meek, 1904)	+	+	+	T/O	0.6-20	SF	F
<i>Poecilia sphenops</i> Valenciennes, 1846	+	+	+	R	0.7-7.8	SF	F
^{NT} <i>Poeciliopsis fasciata</i> (Meek, 1904)	+	+	+	R	1.5-9.1	SF	F
<i>Poeciliopsis pleurospilus</i> (Günther, 1866)	+	+	+	R	3.1-5.9	SF	F
^{LC} <i>Poeciliopsis turrubarensis</i> (Meek, 1912)	+	+	+	T/O	6.8-15.7	SF	F
Order Gasterosteiformes							
Family Syngnathidae. Pipefishes and seahorses.							
<i>Pseudophallus starksi</i> (Jordan & Culver, 1895)	+			R	26.7	ER	CP, MP, PP
^{PR, VU} <i>Hippocampus ingens</i> Girard, 1858		+		-	-	ST	SP, CP, MP, PP
Family Fistulariidae. Cornetfishes.							
* <i>Fistularia commersonii</i> Rüppell, 1838		+		-	-	ST	AP
Order Perciformes							
Family Centropomidae. Snooks.							
^{LC} <i>Centropomus armatus</i> Gill, 1863		+		R	20.7-33.4	EU	CP, MP, PP
^{LC} <i>Centropomus nigrescens</i> Günther, 1864		+	+	R	16.1	EU	CP, MP, PP
^{LC} <i>Centropomus robalito</i> Jordan & Gilbert, 1882	+	+	+	S/R	7.1-34.2	EU	CP, MP, PP
^{LC} <i>Centropomus viridis</i> Lockington, 1877	+	+	+	R	12.1-19	EU	SP, CP, MP, PP
Family Serranidae. Sea basses.							
^{LC} <i>Alphestes multiguttatus</i> (Günther, 1867)	+			-	35	ST	CP, MP, PP
* ^{LC} <i>Epinephelus labriformis</i> (Jenyns, 1840)		+		-	34.3	ST	SP, CP, MP, PP
Family Nematistiidae. Roosterfishes							
<i>Nematistius pectoralis</i> Gill, 1862	+			-	-	ST	SP, CP, MP, PP
Family Carangidae. Jacks and pompanos.							
^{LC} <i>Caranx caninus</i> Günther, 1867	+	+	+	R	16.1-34.2	EU	SP, CP, MP, PP
^{LC} <i>Chloroscombrus orqueta</i> Jordan & Gilbert, 1883	+			-	-	EU	SP, CP, MP, PP
^{LC} <i>Hemicaranx zelotes</i> Gilbert, 1898	+			-	-	ST	CP, MP, PP
^{LC} <i>Oligoplites altus</i> (Günther, 1868)	+	+	+	R	6.6-24.5	EU	CP, MP, PP
^{LC} <i>Oligoplites saurus</i> (Bloch & Schneider, 1801)	+	+	+	R	20.7-29.1	EU	SP, CP, MP, PP
^{LC} <i>Selene orstedii</i> Lütken, 1880	+			-	30	ST	CP, MP, PP

Continuación.

Taxon	Mar Muerto	La Joya-Buenavista	Los Patos-Solo Dios	Residency status	Salinity range (PSU)	Ecological affinity	Biogeographical provinces and distribution
^{LC} <i>Selene peruviana</i> (Guichenot, 1866)	+			-	30	ST	SP, CP, MP, PP
^{LC} <i>Trachinotus kennedyi</i> Steindachner, 1876	+			-	-	ST	SP, CP, MP, PP
^{LC} <i>Trachinotus rhodopus</i> Gill, 1863	+	+		R	34.1	ST	SP, CP, MP, PP
Family Lutjanidae. Snappers.							
^{LC} <i>Hoplopagrus guentherii</i> Gill, 1862	+	+		-	23.6	ST	SP, CP, MP, PP
^{LC} <i>Lutjanus argentiventris</i> (Peters, 1869)	+	+	+	R	21.3-31.9	ST	SP, CP, MP, PP
^{LC} <i>Lutjanus colorado</i> Jordan & Gilbert, 1882	+	+		R	17.3-37	ST	SP, CP, MP, PP
^{LC} <i>Lutjanus guttatus</i> (Steindachner, 1869)	+			-	31.9	ST	CP, MP, PP
^{LC} <i>Lutjanus novemfasciatus</i> Gill, 1862	+	+		R	17.3-29.9	EU	SP, CP, MP, PP
Family Gerreidae. Mojarras.							
^{LC} <i>Diapterus brevirostris</i> (Sauvage, 1879)	+	+	+	T/O	3.1-34.5	EU	SP, CP, MP, PP
^{LC} <i>Eucinostomus currani</i> Zauranec, 1980	+	+	+	T/O	5.9-33.6	EU	SP, CP, MP, PP
^{LC} <i>Eucinostomus dowii</i> (Gill, 1863)	+	+		R	34.1	EU	SP, CP, MP, PP
^{LC} <i>Eucinostomus gracilis</i> (Gill, 1862)	+			-	-	EU	SP, CP, MP, PP
^{LC} <i>Gerres simillimus</i> Regan, 1907	+	+	+	T/O	6.3-33.4	EU	SP, CP, MP, PP
^{LC} <i>Eugerres axillaris</i> (Günther, 1864)		+		R	23.7-30.1	ST	CP, MP, PP
^{LC} <i>Eugerres lineatus</i> (Humboldt, 1821)	+	+	+	R	20.1-34.6	ST	CP, MP, PP
Family Haemulidae. Grunts.							
^{LC} <i>Genyatremus pacifici</i> (Günther, 1864)	+			-	-	ST	PP
^{LC} <i>Pomadasys macracanthus</i> (Günther, 1864)	+			R	26.7-45	EU	CP, MP, PP
^{LC} <i>Haemulopsis leuciscus</i> (Günther, 1864)	+			-	-	ST	CP, MP, PP
^{LC} <i>Haemulopsis axillaris</i> (Steindachner, 1869)		+		R	34.3	ST	CP, MP, PP
^{LC} <i>Orthopristis chalceus</i> (Günther, 1864)		+		R	34.3	ST	CP, MP, PP
Family Polynemidae. Threadfins.							
^{LC} <i>Polydactylus approximans</i> (Lay & Bennett, 1839)	+	+		-	34.3-35	ST	SP, CP, MP, PP
^{LC} <i>Polydactylus opercularis</i> (Gill, 1863)	+			-	35	ST	CP, MP, PP
Family Sciaenidae. Drums.							
^{LC} <i>Bairdiella armata</i> Gill, 1863	+			-	30	ST	CP, MP, PP
<i>Cynoscion albus</i> (Günther, 1864)	+			-	30	EU	CP, MP, PP
<i>Menticirrhus nasus</i> (Günther 1868)		+		-	-	ST	SP, CP, MP, PP
^{LC} <i>Micropogonias altipinnis</i> (Günther, 1864)	+			-	30	EU	SP, CP, MP, PP
^{LC} <i>Paralonchurus goodei</i> Gilbert, 1898	+			-	30	ST	MP, PP
Family Mullidae. Goatfishes.							
* ^{LC} <i>Pseudupeneus grandisquamis</i> (Gill, 1863)	+			-	37	ST	CP, MP, PP
Family Kyphosidae. Sea chubs.							

Table 1

Continuación.

Taxon	Mar Muerto	La Joya-Buena Vista	Los Patos-Solo Dios	Residency status	Salinity range (PSU)	Ecological affinity	Biogeographical provinces and distribution
^{LC} <i>Kyphosus analogus</i> (Gill, 1862)	+			-	30	ST	SP, CP, MP, PP
Family Chaetodontidae. Butterflyfishes.							
^{LC} <i>Chaetodon humeralis</i> Günther, 1860	+	+		-	31.9-34.3	ST	CP, MP, PP
Family Cichlidae. Cichlids.							
<i>Amphilophus trimaculatus</i> (Günther, 1867)	+	+	+	T/O	3.1-33.4	SF	F
<i>Astatheros macracanthus</i> (Günther, 1864)	+	+	+	S/R	0.7-33.4	SF	F
<i>Oreochromis niloticus</i> (Linnaeus, 1758)		+		R	1.5	SF	E
Family Pomacentridae. Damselfishes.							
^{LC} <i>Abudefduf troschelii</i> (Gill, 1862)		+		-	34.3	ST	SP, CP, MP, PP
* ^{LC} <i>Stegastes flavilatus</i> (Gill, 1862)		+		-	34.3	ST	SP, CP, MP, PP
Family Labridae. Wrasses							
* ^{LC} <i>Halichoeres dispilus</i> (Günther, 1864)		+		-	34.3	ST	SP, CP, MP, PP
Family Scaridae. Parrotfishes.							
* ^{LC} <i>Nicholsina denticulata</i> (Evermann & Radcliffe, 1917)		+		-	-	ST	SP, CP, MP, PP
Family Dactyloscopidae. Sand stargazers.							
^{LC} <i>Dactyloscopus amnis</i> Miller & Briggs, 1962			+	-	25.3	ST	SP, CP, MP, PP
^{LC} <i>Dactyloscopus lunaticus</i> Gilbert, 1890	+			-	-	ST	SP, CP, MP, PP
Family Eleotridae. Sleepers.							
^{LC} <i>Dormitator latifrons</i> (Richardson, 1844)		+	+	T/O	3.1-18.9	ER	SP, CP, MP, PP
^{LC} <i>Eleotris picta</i> Kner, 1863		+	+	R	6.3-29.1	ER	SP, CP, MP, PP
<i>Erotelis armiger</i> (Jordan & Richardson, 1895)			+	-	16.4	EU	CP, MP, PP
^{LC} <i>Gobiomorus maculatus</i> (Günther, 1859)	+	+	+	R	11.6-24	ER	SP, CP, MP, PP
Family Gobiidae. Gobies.							
<i>Aboma etheostoma</i> Jordan & Starks, 1895		+		R	20.1-32.6	EU	CP, MP, PP
<i>Awaous transandeanus</i> (Günther, 1861)	+			-	-	C	SP, CP, MP, PP
^{LC} <i>Bathygobius andrei</i> (Sauvage, 1880)		+		-	34.3	ST	PP
^{LC} <i>Ctenogobius sagittula</i> (Günther, 1861)		+		-	34.3	EU	SP, CP, MP, PP
^{LC} <i>Gobionellus microdon</i> (Gilbert, 1892)	+	+	+	R	5.9-32.6	ER	SP, CP, MP, PP
Family Microdesmidae. Wormfishes.							
<i>Microdesmus dorsipunctatus</i> Dawson, 1968		+		-	34.3	EU	SP, CP, MP, PP
Family Ehippidae. Spadefishes.							
^{LC} <i>Chaetodipterus zonatus</i> (Girard, 1858)	+			R	30-45	ST	SP, CP, MP, PP
Family Acanthuridae. Surgeonfishes.							
* ^{LC} <i>Acanthurus xanthopterus</i> Valenciennes, 1835	+	+		-	34.3	ST	AP
Family Sphyrnidae. Barracudas.							
* ^{LC} <i>Sphyrna ensis</i> Jordan & Gilbert, 1882		+		-	34.1	ST	SP, CP, MP, PP

Table 1

Continuación.

Taxon	Mar Muerto	La Joya-Buena Vista	Los Patos-Solo Dios	Residency status	Salinity range (PSU)	Ecological affinity	Biogeographical provinces and distribution
Family Scombridae. Mackerels and tunas.							
^{LC} <i>Scomberomorus sierra</i> Jordan & Starks, 1895	+			-	43	ST	SP, CP, MP, PP
ORDER PLEURONECTIFORMES							
Family Paralichthyidae. Sand flounders.							
^{LC} <i>Citharichthys gilberti</i> Jenkins & Everman, 1889	+	+		R	17.3-29.9	EU	SP, CP, MP, PP
^{LC} <i>Cyclopsetta panamensis</i> (Steindachner, 1876)	+			-	35	EU	CP, MP, PP
^{LC} <i>Etropus crossotus</i> Jordan & Gilbert, 1882	+			R	31.7	EU	SP, CP, MP, PP
Family Achiridae. American soles.							
^{LC} <i>Achirus mazatlanus</i> (Steindachner, 1869)	+	+	+	R	22.6-34.3	EU	SP, CP, MP, PP
^{LC} <i>Achirus scutum</i> (Günther, 1862)	+	+		-	34.1	ST	MP
Family Cynoglossidae. Tonguefishes							
^{LC} <i>Symphurus elongatus</i> (Günther, 1862)	+			-	-	ST	MP, PP
Order Tetraodontiformes							
Family Balistidae. Triggerfishes.							
^{LC} <i>Pseudobalistes naufragium</i> (Jordan & Starks, 1895)	+	+		-	25-35	ST	SP, CP, MP, PP
Family Tetraodontidae. Puffers.							
^{LC} <i>Sphoeroides annulatus</i> (Jenyns, 1842)	+	+		R	34.3	EU	SP, CP, MP, PP
^{LC} <i>Sphoeroides rosenblatti</i> Bussing, 1996		+		-	-	EU	MP, PP
Family Diodontidae. Porcupinefishes.							
^{LC} <i>Diodon hystrix</i> Linnaeus, 1758		+		-	34.1	EU	CT

Allen, 2015). Likewise, the checklist contains 66% of continental fishes recorded in the coastal basins of Chiapas (165 spp.; Pacific Subprovince; Velázquez-Velázquez et al., 2013). Additionally, this study reports 10 species that had not been previously recorded in inland waters of Chiapas: *Atherinella panamensis*, *Fistularia commersonii*, *Epinephelus labriformis*, *Pseudupeneus grandisquamis*, *Stegastes flavilatus*, *Halichoeres dispilus*, *Nicholsina denticulata*, and *Acanthurus xanthopterus*.

Differences in species richness among the 3 systems may be associated with factors such as seasonal pattern, rainfall, diversity of habitats, lagoon area, width and dynamics of inlets, substrate, and mangrove cover (González-Acosta et al., 2005; Mendoza et al., 2009; Raz-Guzmán & Huidobro, 2002). The highest richness was found in the MM system with 89 species, which is higher than the 66 reported by Tapia-García et al. (1998) in the same locality, although

in our study fewer stations were sampled. This system has the highest diversity of euryhaline and stenohaline marine components, reflecting a strong marine influence. Lower richness and diversity of marine species in PSD are due to a limited oceanic exchange, because the main inlet of the system remained closed during the sampling period. Checklists for the JB and PSD systems are documented for the first time here.

Species richness in both MM and JB systems was higher than reported for other coastal lagoons of the GT, such as Superior-Inferior (47 spp.; Tapia-García & Mendoza-Rodríguez, 2005), Oriental-Occidental (72 spp.; Chávez, 1979), or Carretas-Pereyra (67 spp.; Gómez-González et al., 2012). At a regional scale, the area of the lagoon-estuarine system and the width of the adjacent continental shelf may be critical to determine the fish richness (Passos et al., 2012; Vasconcelos et al., 2015). Area partly explains

the high richness in MM, which is more extensive (720 km²) than other South Pacific estuarine systems with fewer species: Carretas-Pereyra (36 km²), Chacahua (6 km²; Mendoza et al., 2009), Chautengo (34 km²), and Tres Palos (50 km²; Yáñez-Arancibia, 1978). However, this variable is not sufficient to explain the high richness of systems, which are small in surface, but display great environmental heterogeneity, e.g., Chantuto-Panzacola (143 spp., 180 km²; Gómez-González et al., 2012). Also, a part of such differences among ichthyofaunas may be due to incomplete sampling in all the diversity of estuarine habitats, and a lack of standardization in the use of fishing gear for surveys (Blaber, 2002).

In this study, elasmobranchs were represented by order Myliobatiformes, with 4 species. Castro-Aguirre et al. (1999) mentioned unpublished records of 18 species (8 families) with presence in MM at the locality of Paredón. Most species of elasmobranchs are stenohaline, and their incursion into brackish waters can be associated with high salinity during the dry season.

The high diversity of Engraulidae, Carangidae, and Gerreidae is commonly found in coastal lagoons of the GT (e.g., Tapia-García et al., 1998; Tapia-García & Mendoza-Rodríguez, 2005; Gómez-González et al., 2012). The euryhaline capacity of many species in these families is key to explain the structure of demersal fish communities, related to the heterogeneity of intertidal environments (Martínez-Muñoz et al., 2016).

Marine ichthyofauna in estuarine-lagoons of the GT is composed of many species widely distributed between the provinces Cortés and Panamic, dominating species of tropical derivation over those of temperate origin. Although the GT is located at a critical point of the Central American gap, this has a limited effect on the fish fauna at the regional level in the Mexican tropical Pacific (Palacios-Salgado et al., 2014; Robertson & Cramer, 2009). From the standpoint of the continental biogeography, the Pacific slope provinces in northern and nuclear Central America are characterized by a low representation of primary derivation species (Cichlidae and Poeciliidae are the most speciose families), dominating components of marine and neotropical origin (Lozano-Vilano & Contreras-Balderas, 1987; Matamoros et al., 2015; Myers, 1966).

The exotic cichlid *O. niloticus* was found in JB; this is its third record in estuarine localities in Chiapas (Gómez-González et al., 2012). Although the species is not widely distributed in these environments, their presence implies a potential impact on native communities, considering the constant release of organisms, deliberate or incidental, as part of public policies for aquaculture development.

This work provides a data set relevant for assessing the composition of estuarine fish fauna in a poorly studied

region. While the high number of species found reflects the extent of the inventoried area and the sampling effort with multiple fishing gears, it is also due to the complexity of their coastal lagoons. The list may be increased by sampling in other habitats, such as mangroves, marshes, and swamps. Intertidal environments in the GT could be among the most diverse in the Mexican Pacific (Gómez-González et al., 2012). Although it has been suggested that the Tropical Eastern Pacific fish fauna is well studied (Allen & Robertson, 1998; Robertson & Allen, 2015), information specific to most coastal lagoons is still scant. Increased knowledge of the fish fauna can generate inputs for a more precise regionalization of coastal areas. Annotated checklists represent an essential component for the development of management strategies in a priority region for artisanal fisheries and coastal ecosystems conservation.

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Appendix. Museum vouchers of specimens from 3 lagoon-estuarine systems in the northeastern Gulf of Tehuantepec, deposited in the ichthyological collection at the Museo de Zoología of the Universidad de Ciencias y Artes de Chiapas (#MZ-P-UNICACH). Numbers in parentheses indicate the number of sampling station where the specimen was collected (see Fig. 1). Species are arranged in alphabetical order.

Aboma etheostoma: 5462(14), 5730(11), 6940(24); *Abudefduf troschelli*: 7108(22); *Acanthurus xanthopterus*: 7103(22), 7110(10); *Achirus mazatlanus*: 5460(19), 5476(21), 5483(24), 6055(25), 6115(27), 6117(28), 6126(30), 6144(31), 6155(33), 6168(34), 6170(1), 6780(3), 6785(4), 7088(9); *Achirus scutum*:

- 3352(10), 5488(21); *Albula esuncula*: 3324(4), 6041(22); *Alphestes multiguttatus*: 6093(4); *Amphilophus trimaculatus*: 5250(11), 5731(14), 5774(15), 5787(18), 5794(23), 5815(26), 5853(27), 5860(30), 5867(31), 6059(32), 6095(33), 6164(34), 6193(2), 6996(4), 7015(7); *Anableps dowei*: 5254(17), 5461(19), 5793(21), 5891(27), 6047(31), 6066(33), 6150(1); *Anchoa curta*: 6986(4); *Anchoa ischana*: 6161(33); *Anchoa lucida*: 5219(13), 5463(18), 5766(19), 5898(20), 6143(31), 6965(3); *Anchoa mundeola*: 5225(14), 5468(12), 5720(13), 5742(11), 5744(15), 5749(16), 5803(26), 5825(27), 5852(28), 5859(29), 5886(2), 6173(3), 6177(7), 6774(8); *Anchoa starksii*: 6232(33); *Anchovia macrolepidota*: 5224(14), 5265(15), 6050(28), 6114(31), 6771(32), 6773(34), 6939(4); *Astatheros macracanthus*: 5036(11), 5216(13), 5230(14), 5253(15), 5258(16), 5470(17), 5471(18), 5723(19), 5734(23), 5776(24), 5780(27), 5785(28), 5796(29), 5822(30), 5850(31), 5896(32), 6057(33), 6122(34), 6172(4), 6969(6), 6974(7); *Astyanax aeneus*: 5777(12), 6189(33), 6795(29); *Atherinella guatemalensis*: 5261(11), 5733(12), 5750(17), 5812(18), 5858(26), 5871(30), 5892(31), 6068(1), 6154(2), 6190(7), 6779(8); *Atherinella panamensis*: 6227(1); *Atractosteus tropicus*: 5789(31), 6800(34); *Awaous trasandeanus*: 6044(1); *Bairdiella armata*: 7030(2); *Bathygobius andrei*: 6181(22), 7105(21), 7107(24); *Batrachoides boulengeri*: 3332(1); *Batrachoides waltersi*: 3333(2), 6231(1); *Caranx caninus*: 5257(13), 5485(16), 5758(17), 5820(21), 5864(22), 6054(27), 6128(1), 6153(3), 6978(4), 7033(10); *Cathorops liropus*: 5740(19), 5849(31), 5875(33), 6051(34), 6163(4); *Cathorops steindachneri*: 5259(17), 5851(19), 5874(31), 6165(33), 6963(34), 7031(7); *Centropomus armatus*: 5843(23); *Centropomus nigrescens*: 5255(17), 5835(23), 5842(24), 5846(28), 5897(31), 6069(34); *Centropomus robalito*: 5037(11), 5228(14), 5264(17), 5472(18), 5728(19), 5775(23), 5795(24), 5837(26), 5841(27), 5847(28), 5857(29), 5869(30), 5895(31), 6063(32), 6141(33), 6174(34), 6176(2), 6995(3), 7003(5); *Centropomus viridis*: 5479(18), 5762(19), 5879(28), 6121(4); *Chaetodipterus zonatus*: 7029(2), 7097(4); *Chaetodon humeralis*: 6180(10), 7100(22), 7114(21); *Chanos chanos*: 7091(2); *Chloroscombrus orqueta*: 6097(4); *Citharichthys gilberti*: 5243(21), 5475(22), 6111(10); *Ctenogobius sagittula*: 6941(21); *Cyclopsetta panamensis*: 6160(4); *Cynoscion albus*: 6132(2); *Dactyloscopus amnis*: 6810(32); *Dactyloscopus lunaticus*: 6187(10); *Diapterus brevirostris*: 5215(11), 5242(13), 5738(14), 5739(15), 5751(16), 5798(17), 5799(18), 5863(19), 6116(25), 6129(26), 6137(27), 6184(31), 6775(33), 6783(34), 6957(1), 6960(3), 6973(4), 6976(5), 6983(5), 7006(7); *Diodon hystrix*: 5477(22); *Dormitator latifrons*: 5227(11), 5480(12), 5732(19), 5755(23), 5772(24), 5790(26), 5887(27), 6065(30), 6112(31), 6782(32), 6788(33), 6798(34); *Eleotris picta*: 5724(21), 5873(22), 6166(25), 7112(31), 7113(34); *Elops affinis*: 5725(11), 6099(4), 6188(21), 6943(22); *Epinephelus labriformis*: 6102(22), 7012(21); *Erotelis armiger*: 5877(34); *Etropus crossotus*: 6151(1); *Eucinostomus currani*: 5229(11), 5241(13), 5251(14), 5490(15), 5759(16), 5764(17), 5801(18), 5813(19), 5824(22), 5832(23), 5833(25), 5838(32), 6064(33), 6109(34), 6139(1), 6140(3), 6159(5), 6778(8), 7000(10); *Eucinostomus dowii*: 5233(3), 6984(22); *Eucinostomus gracilis*: 6228(5); *Eugerres axillaris*: 5034(11), 5260(12), 5718(13), 5721(14), 5746(15), 5767(16), 5817(17); *Eugerres lineatus*: 5469(13), 5482(14), 5781(18), 5810(19), 6106(4), 6961(5), 7008(33); *Fistularia commersonii*: 5894(21); *Genyatremus pacifici*: 6101(2), 6135(4); *Gerres simillimus*: 5040(11), 5214(12), 5220(13), 5252(14), 5473(15), 5491(16), 5805(17), 5809(18), 5836(19), 5840(22), 5865(23), 5870(30), 6052(33), 6110(1), 6113(2), 6157(3), 6959(4), 6970(5), 6975(6), 7002(7), 7034(10); *Gobiomorus maculatus*: 5226(23), 5783(24), 5829(26), 5855(28), 5861(29), 6049(30), 6060(31), 6169(32), 6171(33), 6175(1), 6967(6), 6992(7); *Gobionellus microdon*: 5018(11), 5035(13), 5039(15), 5717(16), 5747(17), 5839(19), 6125(25), 6136(26), 6149(27), 6167(29), 6178(30), 6185(31), 6229(32), 6781(34), 6786(1), 6794(2), 7090(5); *Haemulopsis axillaris*: 5223(21); *Haemulopsis leuciscus*: 6124(2); *Halichoeres dispilus*: 7101(22); *Hemicaranx zelotes*: 6226(10); *Hippocampus ingens*: 7092(22); *Hoplopagrus guentherii*: 4632(4), 7098(25); *Hyporhamphus naos*: 3387(10), 5757(22), 6956(8), 7016(9); *Hyporhamphus rosae*: 6100(10); *Kyphosus analogus*: 6120(10); *Lile gracilis*: 5221(11), 5467(12), 5716(13), 5722(14), 5743(15), 5760(16), 5768(17), 5779(18), 5788(19), 5816(29), 5823(30), 5845(31), 6162(32), 6770(33), 6772(34), 6977(7), 6979(10), 7024(1); *Lile nigrofasciata*: 5756(22); *Lutjanus argentiventris*: 4633(20), 5474(21), 5792(22), 5802(25), 5808(32), 6972(4), 7085(7); *Lutjanus colorado*: 4631(4), 5806(21), 6158(2); *Lutjanus guttatus*: 6105(2); *Lutjanus novemfasciatus*: 4634(18), 5763(21), 5834(23), 5868(4), 6966(6), 7104(22); *Membras gilberti*: 5240(21), 5459(22), 6108(10); *Menticirrhus nasus*: 7096(25); *Microdesmus dorsipunctatus*: 5263(22), 7094(21); *Micropogonias altipinnis*: 6230(2); *Mugil cephalus*: 5489(12), 5804(15), 5827(16), 5828(18), 7109(31); *Mugil curema*: 5212(11), 5262(12), 5466(13), 5486(16), 5769(17), 5800(18), 5811(19), 5814(21), 5821(22), 5824(26), 5899(27), 6067(31), 6119(32), 6131(34), 6138(1), 6142(3), 6152(6), 6182(10); *Mugil hospes*: 5232(21), 5245(22), 5807(15), 5807(18), 6043(2), 7001(5); *Nematistius pectoralis*: 7093(2); *Nicholsina denticulata*: 5244(22); *Oligoplites altus*: 5038(13), 5217(14), 5266(15), 5478(16), 5819(19), 5830(22), 6045(27), 6094(28), 6127(4), 6183(5), 6969(6), 6971(7), 7004(8), 7014(10); *Oligoplites saurus*: 5487(19), 5791(20), 5831(21), 5854(22), 5862(26), 6118(33), 6186(5), 7007(10); *Ophichthus zophochir*: 0081(2); *Opisthonema libertate*: 5484(4), 6053(2), 6103(21), 6179(22), 6980(10); *Orthopristis chalcus*: 5222(21); *Oreochromis niloticus*: 5481(12); *Paralonchurus goodei*: 7028(2); *Poecilia nelsoni*: 5231(11), 5256(12), 5736(17), 5784(23), 5797(27), 5893(28), 6061(31), 6146(32), 6148(33), 6191(34), 6789(1), 6797(2), 6994(6), 7020(7); *Poecilia sphenops*: 5773(12), 5876(27), 6058(28), 6062(30), 6156(31), 6787(33), 6791(34), 6799(1), 6998(2); *Poeciliopsis fasciata*: 5735(11), 5771(12), 6790(28), 6793(33), 7018(7), 7025(8); *Poeciliopsis pleurospilus*: 5737(11), 5888(26), 6769(27), 6777(28), 6792(31), 6988(33), 7023(7); *Poeciliopsis turrubarensis*: 5463(19), 5786(20), 5872(27), 5890(31), 6147(32), 6776(33), 6964(34), 6991(1), 6993(6), 7019(7), 7021(8); *Polydactylus approximans*: 6225(21), 6945(10); *Polydactylus opercularis*: 6133(2); *Pomadasys macracanthus*: 6145(3), 7005(4), 7027(5), 7035(7), 7099(9); *Pseudobalistes naufragium*: 7111(10), 7164(22);

Pseudophallus starksi: 6192(7), 7012(8); *Pseudupeneus grandisquamis*: 6130(2); *Rhinoptera steindachneri*: 7116(10); *Sciades guatemalensis*: 5465(13), 5818(16), 5844(18), 5848(19), 5889(27), 6167(31), 6962(33), 6989(3); *Sciades seemanni*: 5782(21), 6042(26), 6134(33), 6981(4); *Scomberomorus sierra*: 6096(4); *Selene orstedii*: 6123(2); *Selene peruviana*: 6104(2); *Sphoeroides annulatus*: 5213(21), 6046(10), 7106(22); *Sphoeroides rosenblatti*: 6098(22); *Sphyræna ensis*: 7117(22); *Stegastes flavilatus*: 7095(22); *Strongylura exilis*: 7009(8); *Styracura pacifica*: 6942(21), 7163(1); *Symphurus elongatus*: 7165(1); *Synodus scituliceps*: 7118(9); *Trachinotus kennedyi*: 6056(4); *Trachinotus rhodopus*: 6946(10), 7032(21); *Urotrygon chilensis*: 6944(10); *Urotrygon nana*: 6048(10).

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