

HISTORICAL AND ENVIRONMENTAL DISTRIBUTION OF ICHTHYOFAUNA IN THE TROPICAL WETLAND OF PANTANOS DE CENTLA, SOUTHERN GULF OF MEXICO

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Background. Thirty species were previously recorded for unstructured habitats (unvegetated soft substrates: USS) in Pantanos de Centla. However, a lack of information on the tropical ichthyofauna of the structured habitats such as marginal vegetation (MV), submerged macrophytes (SM) and coarse woody debris (CWD) emphasizes the importance of the aim of this paper that is the updating the records of the species distributed in these habitats, as they have been frequently reported as high biodiversity sites that are currently threatened by anthropogenic activities.

Materials and methods. Sampling was carried out in 30 shallow sites, each with unstructured habitats and the three structured habitats, in Pantanos de Centla, a Ramsar wetland, over a period of three years. Fish were collected with a dip net, a drop net and a Renfro beam net.

Results. A total of 6506 fish of 37 genera and 44 species were collected. Eleven species are new records for Pantanos de Centla, and the scientific name of 11 species was updated. The Poeciliidae and Cichlidae families are dominant with 10 and 13 species, respectively. Nine species of the genus *Cichlasoma* sensu lato were placed in six genera. Three species are new records for the Usumacinta Province. *Ctenogobius claytoni*, *Gobionellus oceanicus*, and *Rhamdia quelen* proved to be synonyms. Of all species, 84% were collected from USS, however, the number of species distributed in USS, MV, and SM was similar (CC_j 0.4736-0.5813).

Conclusion. Most of the species that were added to the previously recorded species list of Pantanos de Centla, inhabit structured habitats. This confirms the importance of including these habitats in surveys aimed at generating checklists, and of analysing the distribution of fish species in shallow tropical ecosystems.

Keywords: Ichthyofauna, submerged macrophytes, coarse woody debris, marginal vegetation, unvegetated soft substrates, diversity, tropical, wetland

INTRODUCTION

Freshwater ecosystems represent 0.8% of the world's surface and harbour 6% of the total diversity. However, the list of freshwater species is still incomplete and the rate of species loss is surely greater than has been estimated, particularly in tropical ecosystems (Revenga et al. 2005, Dudgeon et al. 2006). Approximately 2700 fish species have been recorded in Mexico (Contreras-Balderas et al. 2003, Espinosa-Pérez et al. 2008), and are found mostly in specialized publications, museum records, and collections (Miller et al. 2005). Of this total, only 495 are freshwater species (Miller et al. 2005), in marked contrast with the 662 native freshwater species that have been recorded exclusively for the southeastern USA (Warren et al. 2000).

Distributions associated with a particular habitat have been widely recorded for freshwater and estuarine fauna (Heck and Crowder 1991, Gilmore 1995, Hines and Ruiz 1995, Moksnes et al. 1997, Sánchez and Raz-Guzman 1997, Rozas and Minello 2006, Montalvo-Urgel et al. 2010). Freshwater fish are no exception, as they are markedly associated with specific habitats (Pelicice and Agostinho 2006, Sammons and Maceina 2006, Yamazaki et al. 2006). This type of distribution associated with a particular habitat, especially structured habitats, is subject to an increased risk caused by anthropogenic impact because habitat loss is one of the most important threats to biodiversity conservation (Warren et al. 2000, Dudgeon et al. 2006) due to the relative value of “in sensu” habitats, as stated by Minello and Zimmerman (1991).

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The drastic reduction or disappearance of areas with submerged macrophytes and marginal vegetation, the prevalence of eutrophic and hypereutrophic conditions, and changes in the flood pulses in the Biosphere Reserve of Pantanos de Centla (BRPC) (Sánchez et al. 2007, Ruiz-Carrera and Sánchez 2008) have been associated with fisheries over-exploitation, changes in the use of the land, inputs of cattle and human feces generated by the lack of municipal services, and the frequent and improvised construction of canals and dams above the high Grijalva watershed (Sánchez et al. 2007, Guerra and Ochoa 2008, Oswald-Spring 2008). This pressure on fish and habitats emphasizes the importance of updating the list of 30 fish species recorded by Reséndez-Medina and Salvadores (2000), who sampled only in unvegetated soft substrates (USS) with one sampling gear. The fact that these previous records were restricted to USS excluded species specifically distributed in other habitats, such as the three structured habitats of submerged macrophytes, coarse woody debris and marginal vegetation. Added to this, these three habitats have suffered a drastic reduction in cover area (Sánchez et al. 2007, Guerra and Ochoa 2008). This reduction is magnified in the case of submerged macrophytes and coarse woody debris that cover less than 1% of the total bottom area in the aquatic ecosystem (Sánchez et al. 2007). In spite of the anthropogenic pressures and habitat losses recorded in the BRPC, the number of fish species is expected to increase with the inclusion of the three structured habitats and other sampling gears. In addition, the name and number of the species may vary following the recent changes in the taxonomic identities of fish (Miller et al. 2005, Marceniuk and Menezes 2007, Marceniuk and Betancur-R. 2008, López-Fernández et al. 2010, McMahan et al. 2010). The updated fish catalogue provides a base line from which to develop future comparative studies in the Usumacinta Province, and emphasizes the necessity to include structured habitats in monitoring programmes to evaluate fish biodiversity in wetlands.

MATERIALS AND METHODS

Study area. The BRPC is located in the low basin of the rivers Usumacinta–Grijalva, on the coastal plain of the southern Gulf of Mexico (lat 17°57'53"–18°39'03"N, long 92°06'39"–92°47'58"W). The annual volume of water provided by both rivers (115 715 million m³) is second in the Gulf of Mexico after the Mississippi River (Velázquez 1994, Wetzel 2001).

The emergent macrophytes, arboreal hydrophytes and freely floating macrophytes confined to the margins of the aquatic ecosystems were grouped in this study as marginal vegetation. Among the emergent macrophytes, the dominant species include *Thalia geniculata* (bent alligator-flag), *Typha domingensis* (southern cattail), *Haematoxylon campechianum* (tinto), *Rhizophora mangle* (red mangrove), *Bucida buceras* (gregorywood), *Pachira aquatica* (pachira), *Tabebuia rosea* (pink trumpet-tree), and the fallow associations (Guadarrama and Ortíz 2000). The

arboreal hydrophytes are the main source of coarse woody debris and are found in the aquatic ecosystems. Another important group of marginal vegetation in the Reserve is that of the grasslands (Guadarrama and Ortíz 2000). The water hyacinth, *Eichhornia crassipes*, and the water lettuce, *Pistia stratiotes*, are the dominant freely floating macrophytes (Guadarrama and Ortíz 2000). The dominant submerged macrophytes are represented in the lagoons by the wild celery, *Vallisneria americana*, and the fanwort sargassum, *Cabomba palaeformis*.

The choice of the 30 sampled localities was based on the spatial distribution, as presence-absence, of the three structured habitats (marginal vegetation, submerged macrophytes, coarse woody debris), considering that unvegetated soft substrates are present throughout the aquatic ecosystem of the BRPC (Table 1) (Sánchez et al. 2007). Of the structured habitats, submerged vegetation and coarse woody debris each occupy less than 1% of the substrate, while marginal vegetation covers approximately 83% of the margins of the Reserve (Sánchez et al. 2007). Although all sampling sites included marginal vegetation, the areas with a dominance of exotic grassland were excluded from the study. The three structured habitats harbour a high faunistic diversity in other wetlands (Minello and Zimmerman 1991, Pelicice and Agostinho 2006, Rozas and Minello 2006, Cetra and Petrere 2007, Genkai-Kato 2007, Rozas and Minello 2010). A second criterium for the selection of sampling sites considered their location in the hydrologic basin and sub-basins (Table 1). The influence of the tidal currents, detected by salinity values (Practical Salinity Scale: PSS), was restricted to values below PSS 3 (Sánchez et al. 2007). The Usumacinta (U), Grijalva (G), and Tres Brazos (TB) sub-basins were re-named following the description of Velázquez (1994).

Sampling methods. Sampling was carried out from 2000 to 2010 during the minimum (April–March) and maximum (October–November) flooding seasons. Different sampling nets and methods were used to collect fish, considering the physical structure of each habitat. Dip nets with an area of 0.117 m² and 1-mm mesh size were operated for 10 min in the areas of marginal vegetation. A drop net (0.36 m²) was used over the submerged macrophytes. A Renfro beam net with a 1.8-m mouth and 0.8-mm mesh size (Renfro 1962) was used on the unvegetated soft substrates. The coarse woody debris was extracted manually and the fish were collected from the surface and from the galleries and holes in the trunks.

The identification of the fish species was based on the criteria established by Rauchenberger (1989), Castro-Aguirre et al. (1999), Carpenter (2002a, b), Miller et al. (2005), and Marceniuk and Betancur-R. (2008). The species are listed in the phylogenetic order proposed by Nelson (2006), and the updated species names were taken from the electronic FishBase web page (Froese and Pauly 2011).

The catalogue includes for each species the scientific name, the geographic distribution with emphasis on the basins of the rivers Tonalá, Grijalva, and Usumacinta, the local distribution in the BRPC, the habitat and notes.

The material examined includes the total number collected. This is included to indicate qualitative trends and not to carry out a quantitative analysis, considering that non-comparative sampling methods were used. The average and the range of total length (TL) are in cm. The geographic distribution of the species included in this list agrees with the records published by Reséndez-Medina (1980, 1981), Lozano-Vilano and Contreras-Balderas (1987), Gaspar-Dillanes (1996), Chávez et al. (1989), Reséndez-Medina and Kobelkowsky-Díaz (1991), Ayala-Pérez et al. (1998), Espinosa-Pérez et al. (1998), Schmitter-Soto (1998), Castro-Aguirre et al. (1999), Reséndez-Medina and Salvadores (2000), Avilés-Torres et al. (2001), Ayala-Pérez et al. (2003), Darrin et al. (2004), Chávez-López et al. (2005), Corona (2005), Espinosa-Pérez and Daza-Zepeda (2005), Miller et al. (2005), Rodiles-Hernández et al. (2005), Lozano-Vilano

et al. (2007), Pérez-León and Schmitter-Soto (2007), Soria-Barreto and Rodiles-Hernández (2008), López-López et al. (2009), Castillo-Domínguez et al. 2011, and Froese and Pauly (2011). The average temperature (°C) and PSS salinity for the locality of each species are included in the local distribution. The habitats are abbreviated as marginal vegetation (MV), submerged macrophytes (SM), coarse woody debris (CWD) and unvegetated soft substrates (USS). The notes include distinctive taxonomic characteristics to compare with similar congeneric species recorded for the Grijalva-Usumacinta Division (Minckley et al. 2005). The state of conservation considering the official Mexican Norm (Anonymous 2010a) and the Red List of Threatened Species (Anonymous 2011a) are mentioned in the notes as well.

The distribution of the species was analysed through a similarity analysis, which was based on comparative

Table 1
Location of the sites with respect to the hydrologic sub-basins defined by Velázquez (1994)

Locality	Geographical position (UTM)	Basin or sub-basin	Habitat				T	S
			MV	SV	CWD	USS		
Ribera Alta ¹ River	547995 – 2028872	U	+				28.3	0.4
San Pedrito Lagoon	542550 – 2030632	U	+	+	+	+	28.9	1.3
Punteada Lagoon	561812 – 2030260	U	+		+	+	28.4	0.6
El Guanal Lagoon	558711 – 2022995	U	+	+	+	+	28.3	0.9
San Isidro Lagoon	555330 – 2035112	U	+			+	28.3	0.4
El Coco Lagoon	532455 – 2043530	TB	+		+	+	29.1	0.8
Frontera bridge ¹	536851 – 2046906	TB	+				28.1	0.6
San Pedro y San Pablo bridge ¹	556200 – 2061000	U	+				28.9	2.0
El Cometa Lagoon	558134 – 2041912	U	+		+	+	28.7	2.5
Drain Narvéez Norte	582532 – 2039796	U	+				28.1	0.7
Narvéez Lagoon	581337 – 2036132	U	+				29.6	1.0
Drain Narvéez Sur	580726 – 2028665	U	+				29.8	1.1
El Viento Lagoon	536135 – 2015450	TB	+			+	29.9	0.2
Concepción Lagoon	580726 – 2028665	G	+			+	28.6	0.5
Larga Lagoon	541622 – 2012153	G	+			+	28.7	0.2
Grijalva Centro River	534754 – 2017974	TB	+				24.1	0.2
Los Ídolos Lagoon	538880 – 2021224	TB	+		+	+	28.9	0.5
River Bitzal 7th Section	554772 – 1997502	G	+				28.6	0.3
El Tintal Lagoon	541326 – 1999982	G	+			+	27.3	0.4
River Bitzal 5th Section	559779 – 1997322	G	+				28.7	0.2
Landeros Lagoon	559537 – 2002719	G	+			+	29.9	0.8
Sargazal Lagoon	567113 – 2003620	G	+		+	+	29.6	0.3
El Loncho Lagoon	565334 – 2001124	G	+			+	29.7	0.5
Chichicastle Lagoon	561616 – 2013710	U	+	+		+	28.7	0.3
El Sauzo Lagoon	567332 – 2013974	U	+	+		+	29.2	0.3
San Isidro El Jobo Lagoon	576193 – 2008687	U	+			+	28.3	0.3
Cantemoc Lagoon	569920 – 2015809	U	+			+	28.7	0.7
San Román channel	535300 – 2045675	TB	+				26.7	0.3
Arroyo Punteada	560135 – 2030981	U	+				28.0	0.5
Elpidio Sánchez ¹ River	581064 – 2017940	U	+				28.5	1.0

¹ Usumacinta River, U = Usumacinta, G = Grijalva, TB = Tres Brazos, T = annual average temperature [°C], S = annual average salinity (PSS); Habitats: MV = marginal vegetation, SM = submerged macrophytes, CWD = coarse woody debris, USS = unvegetated soft substrates.

tables of species presence and absence using the Jaccard coefficient (Brower and Zar 1981) for the four types of sampled habitats. The biological material was deposited in the National Fish Collection of the Instituto de Biología, UNAM, Mexico, under reference numbers CNPE-IBUNAM 16673 to CNPE-IBUNAM 16728.

Fish sampling were carried out according the General Law to Fish and Aquaculture Sustainable (Anonymous 2007).

RESULTS

A total of 6506 freshwater, estuarine, and marine fish were collected, of which 4286 specimens were identified to species level, representing 19 families, 37 genera, and 44 species. The 2220 unidentified fish included larvae of the families Loricariidae, Atherinopsidae, Poeciliidae, Gerreidae, Cichlidae, Eleotridae, and Gobiidae. The fish were classified ecologically as 32 freshwater-, four estuarine-, and eight marine species. The best represented families of freshwater fish were the Poeciliidae and Cichlidae with 10 and 13 species respectively. Eleven species, *Rhamdia quelen* (Quoy et Gaimard, 1824), *Amphilophus robertsoni* (Regan, 1905), *Parachromis friedrichsthalii* (Heckel, 1840), *Paraneetroplus synspilus* (Hubbs, 1935), *Rocio octofasciata* (Regan, 1903), *Theraps heterospilus* (Hubbs, 1936), *Thorichthys helleri* (Steindachner, 1864), *T. meeki* Brind, 1918, *T. pasionis* (Rivas, 1962), *Ctenogobius claytonii* (Meek, 1902), and *Gobionellus oceanicus* (Pallas, 1770) were reassigned in this study. Eleven species represented new records for the BRPC (Table 2).

The greatest similarity levels were obtained for the MV and USS ($CC_j = 0.5813$), followed by the MV and SM ($CC_j = 0.4857$), and the SM and USS ($CC_j = 0.4736$). The lowest similarity levels were recorded between the CWD and each of the other three habitats ($CC_j = 0.0909$, $CC_j = 0.0909$, $CC_j = 0.081$, respectively). Species collected in the four habitats were *Paraneetroplus synspilus* (Hubbs, 1935) and *Dormitator maculatus* (Bloch, 1792). In contrast, the poeciliids *Belonesox belizanus* Kner, 1860, *Heterandria bimaculata* (Heckel, 1848), *Poecilia petenensis* Günther, 1866, *Xiphophorus maculatus* (Günther, 1866), and *Cichlasoma pearsei* (Hubbs, 1936) were restricted to MV, and *Brycon guatemalensis* Regan, 1908, *Cathorops aguadulce* (Meek, 1904), *Diapterus auratus* Ranzani, 1842, *Bairdiella chrysoura* (L.), *Oreochromis niloticus* (L.), *Citharichthys spilopterus* Günther, 1862, and *Achirus lineatus* (L.) were found only on USS. All poeciliids (10 species) and eleotrids (three species) were collected in structured habitats (MV, SM, CWD). The other 77% of the species were distributed in two or three of the sampled habitats (Table 2).

CLASS ACTINOPTERYGII

ORDER CLUPEIFORMES

FAMILY ENGRAULIDAE

Anchoa parva (Meek et Hildebrand, 1923)

Material: Number of specimens: 109; TL: 1.7–3.5 cm; TL average: 2.5 cm.

Distribution: From the N and NE coast of Yucatán to Venezuela, including Cuba, Jamaica, and the Antilles along the Atlantic.

Table 2
Distribution of freshwater primary¹,
freshwater secondary², estuarine³, marine⁴,
and vicarious⁵ fish with respect to the four habitats
in the Biosphere Reserve of Pantanos de Centla

Species	MV	SM	USS	CWD
<i>Anchoa parva</i> ^{4 (a, b)}		107	2	
<i>Dorosoma petenense</i> ⁵		25	39	
<i>Astyanax aeneus</i> ¹	156	169	174	
<i>Brycon guatemalensis</i> ^{1 (b)}			1	
<i>Hyphessobrycon compressus</i> ¹	54	66	89	
<i>Cathorops aguadulce</i> ⁴			1	
<i>Rhamdia quelen</i> ¹	1	1	5	
<i>Atherinella alvarezii</i> ⁵	30	31	10	
<i>Hyporhamphus mexicanus</i> ⁵	5		1	
<i>Rivulus tenuis</i> ¹	9		4	
<i>Belonesox belizanus</i> ²	5			
<i>Carlhubbisia kidderi</i> ²	12	785	24	
<i>Gambusia sexradiata</i> ²	609		17	
<i>G. yucatanensis</i> ²	209	30	5	
<i>Heterandria bimaculata</i> ²	2			
<i>Heterophallus</i> aff. <i>rachovii</i> ^{2 (a, b)}	226	8	11	
<i>Phallichthys fairweatheri</i> ²	122		4	
<i>Poecilia mexicana</i> ²	20		3	
<i>P. petenensis</i> ²	2			
<i>Xiphophorus maculatus</i> ²	8			
<i>Microphis brachyurus</i> ^{4 (b)}	9		1	
<i>Ophisternon aenigmaticum</i> ^{1 (b)}	21		3	
<i>Diapterus auratus</i> ^{4 (b)}			7	
<i>Bairdiella chrysoura</i> ^{4 (b)}			1	
<i>Amphilophus robertsoni</i> ²	3	1	2	
<i>Cichlasoma pearsei</i> ²	1			
<i>C. salvini</i> ²	146	17	7	
<i>C. urophthalmum</i> ²	58	6	2	
<i>Oreochromis niloticus</i> ²			1	
<i>Parachromis friedrichsthalii</i> ²	2		1	
<i>Paraneetroplus synspilus</i> ²	33	3	1	1
<i>Petenia splendida</i> ²	16	7		
<i>Rocio octofasciata</i> ²	3		1	
<i>Theraps heterospilus</i> ²	16	4		
<i>Thorichthys helleri</i> ²	2	79	153	
<i>T. meeki</i> ²	3	19	166	
<i>T. pasionis</i> ²	2	26	93	
<i>Dormitator maculatus</i> ³	134	3	2	4
<i>Eleotris amblyopsis</i> ³	6			1
<i>Gobiomorus dormitor</i> ³	68		44	
<i>Ctenogobius claytonii</i> ^{3 (a, b)}			3	2
<i>Gobionellus oceanicus</i> ^{4 (b)}		5	10	
<i>Citharichthys spilopterus</i> ^{4 (b)}			2	
<i>Achirus lineatus</i> ^{4 (b)}			3	
No.	33	20	36	4

^a new records for the Usumacinta-Grijalva Division, ^b new records for Pantanos de Centla; No. = number of species per type of habitat; The number of each fish species is included by habitat; Habitats: MV = marginal vegetation, SM = submerged macrophytes, USS = unvegetated soft substrates, CWD = coarse woody debris.

Local distribution: San Pedrito and El Coco lagoons in 29°C and PSS 1, on average.

Habitat: 98% was collected from SM (*Vallisneria americana*) and 2% from USS.

Notes: This species differs from *A. mitchilli* (Valenciennes, 1848) as it is higher, and it has more gill rakers (24–27) and fewer anal rays (21–25) (Schmitter-Soto 1998, Castro-Aguirre et al. 1999, Miller et al. 2005). This is the first record of this species for the limnetic ecosystems of the Usumacinta Province and the BRPC, as it was previously recorded for shallow estuaries in Yucatán and Quintana Roo, Mexico, and for freshwater ecosystems in Guatemala and Panama (Castro-Aguirre et al. 1999).

FAMILY CLUPEIDAE

Dorosoma petenense (Günther, 1867)

Material: Number of specimens: 64; TL: 1.5–6.5 cm; TL average: 3.7 cm.

Distribution: Basin of the Mississippi River, from Ohio to southern Texas and Florida, USA. In Mexico, on the coastal plain of the Gulf of Mexico from Tamaulipas, basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, south to the Yucatán peninsula. NW Guatemala and Belize (Belize River) along the Atlantic.

Local distribution: El Sauzo, El Guanal, Concepción, El Viento, Cantemec, San Isidro and San Isidro-El Jobo lagoons in 28.8°C and PSS 0.5, on average.

Habitat: 61% was collected from SM and 39% from USS.

Notes: This species differs from *D. anale* Meek, 1904 by having a terminal mouth, a maxilla without a notch on the ventral border and a longer dorsal filamentous ray (Schmitter-Soto 1998, Miller et al. 2005). *D. anale* was not collected in this study, but was reported for the area by Reséndez-Medina and Salvadores (2000) and for the same ichthyofaunistic province by Minckley et al. (2005).

ORDER CHARACIFORMES

FAMILY CHARACIDAE

Astyanax aeneus (Günther, 1860)

Material: Number of specimens: 499; TL: 1.3–7.1 cm; TL average: 3.5 cm.

Distribution: From the Papaloapan River, Tonalá River basin, Grijalva River basin in Chiapas and Tabasco, Mexico south to Costa Rica along the Atlantic; From the Armería River, Mexico south to Colombia along the Pacific.

Local distribution: The Narvéez Norte and Narvéez Sur drains, the lagoons Cantemec, Chichicastle, Concepción, El Coco, El Cometa, El Guanal, El Loncho, El Sauzo, El Tintal, El Viento, Landeros, Larga, Los Ídolos, Narvéez, Punteada, San Isidro, San Isidro El Jobo, San Pedrito, Sargazal, Puente Frontera, the 5th and 7th section of the Bitzal River, Grijalva Centro River, and the 1st section of the Ribera Alta River (Usumacinta River) in 28.6°C and PSS 0.6, on average.

Habitat: 35% was collected from USS, 32% from MV and 33% from SM.

Notes: This species has two series of premaxillar teeth (Miller et al. 2005).

Brycon guatemalensis Regan, 1908

Material: Number of specimens: 1; TL: 4.5 cm.

Distribution: Basins of the Grijalva and Usumacinta rivers in Chiapas and Tabasco in Mexico, south to western Panama on the Atlantic and the Choluteca River in Honduras on the Pacific.

Local distribution: Laguna San Isidro in 26°C and PSS 0.1.

Habitat: This single specimen was collected from USS.

Notes: This is the only species of this genus that is distributed in the ichthyofaunistic province (Minckley et al. 2005). Its specimens are the largest of the genera *Astyanax* and *Hyphessobrycon*, and they are characterised by the upper mandible projecting further out than the lower mandible (Miller et al. 2005). It is a new record for the BRPC.

Hyphessobrycon compressus (Meek, 1904)

Material: Number of specimens: 209; TL: 1.8–6.3 cm; TL average: 3 cm.

Distribution: From the Papaloapan River, basin of the Tonalá River, basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco and the Hondo River, Quintana Roo in Mexico; Guatemala and north-western Belize on the Atlantic.

Local distribution: The lagoons of Cantemec, Chichicastle, Concepción, El Guanal, El Loncho, El Sauzo, Los Ídolos, San Isidro, San Isidro El Jobo and the 5th section of the Bitzal River in 28.7°C and PSS 0.5, on average.

Habitat: 43% was collected from USS, 31% from SM and 26% from MV.

Notes: This species is similar in shape and colour to *Astyanax*, but it is smaller and has a black spot on the anterobasal area of the dorsal fin (Schmitter-Soto 1998, Miller et al. 2005).

ORDER SILURIFORMES

FAMILY ARIIDAE

Cathorops aguadulce (Meek, 1904)

Material: Number of specimens: 1; TL: 22.5 cm.

Distribution: The Pánuco River basin in Tamaulipas, the Papaloapan River basin and the Coatzacoalcos and Tonalá rivers in Veracruz, basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, and Campeche, Mexico, south to the Polochic-Lago de Izabal in Guatemala on the Atlantic.

Local distribution: Laguna El Sauzo in 32°C and PSS 0.1.

Habitat: The species was collected from USS.

Notes: From a biogeographic point of view, the ariid recorded for the Grijalva-Usumacinta Division (Marceniuk and Betancur-R. 2008) is *Cathorops kailolae* Marceniuk et Betancur-R., 2008. However, the specimens collected in the BRPC were identified as *C. aguadulce* as they had a shorter snout (6.8–8.6 vs. 9.3%–11.6% SL) and a smaller distance from the tip of the snout to the origin of the dorsal-fin (33.1–38.0 vs. 39.0%–40.7% SL), which are the two characteristics that separate it from its more similar congeneric species (Marceniuk and Betancur-R. 2008).

FAMILY HEPTAPTERIDAE

Rhamdia quelen (Quoy et Gaimard, 1824)

Material: Number of specimens: 7; TL: 2–15.3 cm; TL average: 6.04 cm.

Distribution: From the Chachalacas River in Veracruz, basin of the Tonalá River; basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, Peninsula of Yucatán to Panama on the Atlantic, and on the Pacific from the Tehuantepec River in Chiapas to Central America.

Local distribution: El Sauzo and San Isidro El Jobo lagoons in 28.7°C and PSS 0.3, on average.

Habitat: 72% was collected from USS, 14% from MV and 14% from SM.

Notes: This species differs from *R. laticauda* (Kner, 1858) and *R. macuspanensis* Weber et Wilkens, 1998 as it has numerous serrae on the anterior and posterior edges of the pectoral spine (Schmitter-Soto 1998, Miller et al. 2005). The three species are distributed in the Usumacinta Province (Minckley et al. 2005). This species is in a status of special protection according to the NOM-059-SEMARNAT-2010 (Anonymous 2010a).

ORDER ATHERINIFORMES

FAMILY ATHERINOPSIDAE

Atherinella alvarezii (Díaz-Pardo, 1972)

Material: Number of specimens: 71; TL: 2.3–7.5 cm; TL average: 4.2 cm.

Distribution: From Sontecomapan, Veracruz, basin of the Tonalá River; basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, Champotón River in Campeche, south to the Caobas lagoon in Quintana Roo on the Atlantic.

Local distribution: The drains Narváez Norte and Narváez Sur, the lagoons of Cantemec, El Sauzo, Larga, Narváez, San Isidro and San Pedrito, the 7th section of the Bitzal River and Ribera Alta 1st section (Usumacinta River) in 28.8°C and PSS 0.6, on average.

Habitat: 44% was collected from SM, 42% from MV and 14% from USS.

Notes: This *Atherinella* was reported for the Usumacinta Province (Minckley et al. 2005) and differs from *A. schultzi* (Álvarez et Carranza, 1952) as the distal tips of the premaxilla and the maxilla do not extend further than the anterior margin of the orbit (Miller et al. 2005). Although *A. alvarezii* was recorded as endemic for the state of Tabasco by Espinosa-Pérez and Daza-Zepeda (2005), other authors recorded it for Veracruz, Campeche, Chiapas and Quintana Roo in Mexico, and for Guatemala (Reséndez-Medina 1981, Schmitter-Soto 1998, Willink et al. 2000, Rodiles-Hernández et al. 2005).

ORDER BELONIFORMES

FAMILY HEMIRAMPHIDAE

Hyporhamphus mexicanus Álvarez, 1959

Material: Number of specimens: 6; TL: 1.3–8.5 cm; TL average: 4 cm.

Distribution: Papaloapan River, basins of the rivers

Grijalva and Usumacinta in Chiapas and San Pedro River in Mexico, and Guatemala on the Atlantic.

Local distribution: Lagoon of San Pedrito and the 1st section of the Ribera Alta River (Usumacinta River) in 28.6°C and PSS 0.9, on average.

Habitat: Five specimens were collected from SM and one from USS.

Notes: This vicarious species has been collected in the adjacent neritic area. It is different from the marine species *H. roberti* (Valenciennes, 1847) as it lacks scales on the inter-radial membranes of the dorsal and anal fins, and it has fewer total gill rakers (19–21) on the first branchial arch, compared with *H. roberti* that has 28–31 (Castro-Aguirre et al. 1999).

ORDER CYPRINODONTIFORMES

FAMILY RIVULIDAE

Rivulus tenuis (Meek, 1904)

Material: Number of specimens: 13; TL: 1.4–4.1 cm; TL average: 2.3 cm.

Distribution: From the Antigua River, basin of the Tonalá River in Veracruz; basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, south to Quintana Roo in Mexico and Honduras on the Atlantic.

Local distribution: Lagoons of El Loncho, San Isidro El Jobo, Cantemec, El Tintal, Narváez and El Coco, and the 7th section of the Bitzal River in 28.8°C and PSS 0.6, on average.

Habitat: 69% was collected from MV and 31% from USS. **Notes:** *R. tenuis* differs from *Kryptolebias marmoratus* (Poey, 1880) by the presence of 35–41 scales on a lateral series, whereas *K. marmoratus* has 45–56 (Miller et al. 2005, Schmitter-Soto 1998). Also, *K. marmoratus* belongs to the ichthyofaunistic province of Yucatán (Minckley et al. 2005).

FAMILY POECILIIDAE

Belonesox belizanus Kner, 1860

Material: Number of specimens: 5; TL: 1.8–7.6 cm; TL average: 4.4 cm.

Distribution: From the Chachalacas River and the basin of the Tonalá River, Veracruz, basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, Mexico, to Costa Rica on the Atlantic.

Local distribution: Lagoons of Cantemec, Chichicastle, El Viento and San Pedrito in 29.5°C and PSS 0.6, on average.

Habitat: All specimens were collected from MV.

Notes: This species is unique for the family due to its size, strong teeth and beak-like jaws typical of predators. It also has various black points on the sides and a big spot at the base of the caudal fin (Schmitter-Soto 1998).

Carlhubbisia kidderi (Hubbs, 1936)

Material: Number of specimens: 821; TL: 0.8–5.9 cm; TL average: 2.7 cm.

Distribution: Basins of the Grijalva and Usumacinta rivers in Chiapas and Tabasco, and Champotón River in Campeche, Mexico; La Pasión and San Pedro rivers in Guatemala on the Atlantic.

Local distribution: The Narváz Norte and Narváz Sur drains, the lagoons Cantemoc, El Guanál, El Loncho, El Sauzo, El Tintal, San Isidro and Sargazal in 28.8°C and PSS 0.6, on average.

Habitat: 95% was collected from SM, 3% from USS and 2% from MV.

Notes: The body of this species is characteristically rhomboidal. The dorsal fin is triangular with a black spot (Schmitter-Soto 1998, Miller et al. 2005).

Gambusia sexradiata Hubbs, 1936

Material: Number of specimens: 626; TL: 1.15–3.4 cm; TL average: 2.1 cm.

Distribution: From northern Veracruz, basin of the Tonalá River; basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, and Peninsula of Yucatán in Mexico, south to Honduras on the Atlantic.

Local distribution: Arroyo Punteada, drains Narváz Norte and Narváz Sur, lagoons Cantemoc, Chichicastle, Concepción, El Guanál, El Loncho, El Sauzo, El Tintal, El Viento, Landeros, Larga, Los Ídolos, Narváz, Punteada, San Isidro, San Isidro El Jobo, San Pedrito, Sargazal, Puente Frontera, the 1st section of the Ribera Alta River (Usumacinta River) and Grijalva Centro in 28.6°C and PSS 0.6, on average.

Habitat: 97% was collected from MV and 3% from USS.

Notes: *G. sexradiata* differs from the sympatric species *G. yucatanensis* Regan, 1914 by its lateral lines of well aligned dots (Schmitter-Soto 1998, Miller et al. 2005).

Gambusia yucatanensis Regan, 1914

Material: Number of specimens: 244; TL: 1.2–3.5 cm; TL average: 2.3 cm.

Distribution: Basin of the Tonalá River in Veracruz; basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, Peninsula of Yucatán in Mexico; northwestern Guatemala and Belize on the Atlantic.

Local distribution: Arroyo Punteada, the drain Narváz Sur, the lagoons Cantemoc, Chichicastle, Concepción, El Coco, El Cometa, El Guanál, El Loncho, El Sauzo, El Tintal, Landeros, Larga, Los Ídolos, Narváz, Punteada, San Isidro, San Isidro El Jobo, San Pedrito, Sargazal, Puente Frontera, the 5th and 7th section of the Bitzal River, Bitzal, Elpidio Sánchez (Usumacinta River) and Grijalva Centro in 28.6°C and PSS 0.6, on average.

Habitat: 86% was collected from MV, 12% from SM and 2% from USS.

Notes: This *Gambusia* differs from *G. sexradiata* as the lines of dots at the sides of the body are scattered (Schmitter-Soto 1998, Miller et al. 2005).

Heterandria bimaculata (Heckel, 1848)

Material: Number of specimens: 2; TL: 1.5–3.9 cm; TL average: 2.7 cm.

Distribution: From the Misantla River in Veracruz, the Grijalva and Usumacinta rivers in Chiapas and Tabasco, Campeche, Yucatán, Quintana Roo in Mexico, to the Prinzapolka River in Nicaragua on the Atlantic.

Local distribution: The Narváz Sur drain in 31°C and PSS 0.

Habitat: The two specimens were collected from MV.

Notes: This species is the only of the genus *Heterandria* recorded for the División Grijalva-Usumacinta (Minckley et al. 2005). It differs from *H. jonesii* (Günther, 1874), its closer congener recorded for the División Papaloapan-Coatzacoalcos (Minckley et al. 2005), by having a greater number of rays in the dorsal fin (modally 14) than *H. jonesii* (modally 8–12) (Schmitter-Soto 1998, Miller et al. 2005).

Heterophallus aff. *rachovii*

Material: Number of specimens: 245; TL: 0.7–3.4 cm; TL average: 1.9 cm.

Distribution: *H. rachovii* Regan, 1914 has been recorded in the middle region of the Coatzacoalcos River in Veracruz.

Local distribution: The dredged canal San Román, the drains Narváz Norte and Narváz Sur, the lagoons El Cometa, Chichicastle, El Coco, El Guanál, El Loncho, El Sauzo, the 5th section of the Bitzal River and 1st section of the Ribera Alta River (Usumacinta River) in 28.7°C and PSS 0.7, on average.

Habitat: 92.2% was collected from MV, 4.5% from USS and 3.3% from SM.

Notes: The main characteristic of the specimens of *H. aff. rachovii* is a small perpendicular membranous hood on the point of the fourth ray, which is very prominent in *H. milleri* Radda, 1987 and *Gambusia echeagarayi* (Álvarez, 1952), two species that have been recorded for the basins of the rivers Grijalva and Usumacinta in Tabasco and Chiapas (Miller et al. 2005). Part of the material is being processed in the National Fish Collection, Instituto de Biología, Universidad Nacional Autónoma de México. This is a first record for the Usumacinta Province and the BRPC.

Phallichthys fairweatheri Rosen et Bailey, 1959

Material: Number of specimens: 126; TL: 1–3.8 cm; TL average: 2.6 cm.

Distribution: Basin of the Tonalá River; basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, southern Campeche and Quintana Roo in Mexico; northern Guatemala and Belize, basin of the Hondo River on the Atlantic.

Local distribution: The drain Narváz Sur, the lagoons Cantemoc, Chichicastle, Concepción, El Guanál, El Loncho, El Sauzo, El Tintal, Landeros, Los Ídolos, San Isidro, San Isidro El Jobo, Sargazal, Puente Frontera, and the 5th section of the Bitzal River in 28.8°C and PSS 0.5, on average.

Habitat: 97% was collected from MV and 3% from USS.

Notes: This species is the only one representing the genus *Phallichthys* in the División Grijalva-Usumacinta. It differs from *P. amates* (Miller, 1907), its closest congener, by having 10 rays in the dorsal fin and well defined dark vertical bars on the sides of the body, while *P. amates* has

nine rays in the dorsal fin and badly defined lateral bars on the sides of the body (Schmitter-Soto 1998, Miller et al. 2005). This is a new record for the study area.

Poecilia mexicana Steindachner, 1863

Material: Number of specimens: 23; TL: 1.3–6.8 cm; TL average: 2.9 cm.

Distribution: Coastal plain of the Gulf of Mexico from the San Juan River, Nuevo León, basin of the Tonalá River, basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, and the peninsula of Yucatán in Mexico, south to Guatemala on the Atlantic, upper stretch of the Choluteca River, Honduras on the Pacific.

Local distribution: Arroyo Punteada, the drains Narváez Norte and Narváez Sur, the lagoons El Loncho, El Sauzo, Landeros, San Isidro El Jobo, Sargazal, Puente Frontera, and the 5th section of the Bitzal River in 28.9°C and PSS 0.5, on average.

Habitat: 88% was collected from MV and 12% from USS.

Notes: This species differs from *P. petenensis* Günther, 1866, also recorded for Tabasco, by having fewer dorsal rays (9–10) in comparison with 12–14 (Schmitter-Soto 1998, Miller et al. 2005).

Poecilia petenensis Günther, 1866

Material: Number of specimens: 2; TL: 2.6–4.0 cm; TL average: 3.3 cm.

Distribution: Basin of the Tonalá River; basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco; Campeche and Quintana Roo in Mexico; northern Belize and Guatemala on the Atlantic.

Local distribution: Lagoon El Sauzo in 32°C and PSS 0.5.

Habitat: The specimens were collected from MV.

Xiphophorus maculatus (Günther, 1866)

Material: Number of specimens: 8; TL: 2.2–3.4 cm; TL average: 2.55 cm.

Distribution: Basins of the rivers Coatzacoalcos, Papaloapan and Tonalá in Veracruz; basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco; Campeche and Quintana Roo in Mexico, to Honduras on the Atlantic.

Local distribution: The lagoons of Los Ídolos and San Isidro El Jobo in 28.6°C and PSS 0.4, on average.

Habitat: The specimens were collected from MV.

Notes: This species differs from *Xiphophorus hellerii* Heckel, 1848 as the males lack a spade and the body is shorter and higher (Schmitter-Soto 1998, Miller et al. 2005). Both species have been recorded for the basins of the rivers Grijalva and Usumacinta in Tabasco and Chiapas (Lozano-Vilano and Contreras-Balderas 1987, Espinosa-Pérez and Daza-Zepeda 2005, Miller et al. 2005).

ORDER GASTEROSTEIFORMES

FAMILY SYNGNATHIDAE

Microphis brachyurus (Bleeker, 1854)

Material: Number of specimens: 10; TL: 1.5–12.1 cm; TL average: 9.0 cm.

Distribution: From North Carolina to Uruguay, Cuba, Antilles, coastal plain of the Gulf of Mexico, basin of the Tonalá River and basin of the Grijalva River in Tabasco, Mexico.

Local distribution: Arroyo Punteada, the dredged canal San Román, the lagoons of El Sauzo, Los Ídolos, San Pedrito, Puente Frontera, and the Grijalva Centro River in 27.7°C and PSS 0.6, on average.

Habitat: 90% was collected from MV and 10% from USS.

Notes: This is a marine species frequently distributed in the seagrass *Thalassia testudinum* and in reefs, which has invaded estuarine ecosystems, rivers, and other limnetic environments of the eastern Mexican coast (Castro-Aguirre et al. 1999). It is a new record for the BRPC.

ORDER SYNBRANCHIFORMES

FAMILY SYNBRANCHIDAE

Ophisternon aenigmaticum Rosen et

Greenwood, 1976

Material: Number of specimens: 24; TL: 3–19 cm; TL average: 6.5 cm.

Distribution: From the Chachalacas and Tonalá rivers in Veracruz, basins of the rivers Grijalva and Usumacinta in Tabasco and Chiapas, and the peninsula of Yucatán in Mexico, to the Motagua River basin, Guatemala and Honduras on the Atlantic; one record near Tapachula, Chiapas on the Pacific.

Local distribution: Arroyo Punteada, the Narváez Norte drain, the lagoons Cantemec, Chichicastle, El Coco, El Loncho, Sargazal, El Viento, Landeros, Larga, Los Ídolos and San Isidro El Jobo in 29°C and PSS 0.5, on average.

Habitat: 87% was collected from MV and 13% from USS. **Notes:** In this species, the gill opening is transversal and half moon shaped. This particular characteristic separates it from *Synbranchus marmoratus* Bloch, 1795 that presents it as a sunk pore between tissue folds (Schmitter-Soto 1998, Miller et al. 2005). It is a new record for the BRPC.

ORDER PERCIFORMES

FAMILY GERREIDAE

Diapterus auratus Ranzani, 1842

Material: Number of specimens: 7; TL: 1.6–4.8 cm; TL average: 4 cm.

Distribution: From North Carolina, USA, to Brazil; Antilles; coastal plain of the Gulf of Mexico from Laguna Madre, Tamaulipas, the basin of the Tonalá River, the basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, the peninsula of Yucatán in Mexico; Caribbean sea.

Local distribution: The lagoons of El Coco and El Cometa in 28.3°C and PSS 1.6, on average.

Habitat: These specimens were collected from USS.

Notes: This species has three spines and eight anal rays and 12–15 gill rakers on the first branchial arch in contrast with *D. rhombeus* (Cuvier, 1829) that has anal fin II, 9 and 16–18 gill rakers (Schmitter-Soto 1998, Miller et al. 2005). It is a new record for the BRPC.

FAMILY SCIAENIDAE

Bairdiella chrysoura (Lacepède, 1802)

Material: Number of specimens: 1; TL: 4.1 cm.

Distribution: From Massachusetts, USA, to Veracruz, and in the lagoon system of El Carmen-Machona-Redonda in Tabasco Mexico, on the Atlantic.

Local distribution: El Viento lagoon in 30.5°C and PSS 0.2.

Habitat: The only specimen of this species was collected from USS.

Notes: This species is a new record for the BRPC. It differs from *B. ronchus* (Cuvier, 1830) by having a shorter spine that does not reach the base of the caudal fin (Castro-Aguirre et al. 1999).

FAMILY CICHLIDAE

Amphilophus robertsoni (Regan, 1905)

Material: Number of specimens: 6; TL: 2.4–15.2 cm; TL average: 7.8 cm.

Distribution: Basins of the Coatzacoalcos River, the Tonalá River, and the Grijalva and Usumacinta rivers, also in Chiapas and Tabasco, Mexico, south to Honduras on the Atlantic.

Local distribution: The drain Narváez Sur, the lagoons El Guanál and San Isidro in 28.8°C and PSS 0.7, on average.

Habitat: 50% was collected from MV, 33% from USS and 17% from SM.

Notes: This species differs from the other cichlids on this list by having a robust body with a vivid yellowish green colour, a pattern of thin transversal bars and lips generally expanded or thickened with teeth sunk in the gums (Miller et al. 2005).

Cichlasoma pearsei (Hubbs, 1936)

Material: Number of specimens: 1; TL: 3.6 cm.

Distribution: Basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, also Campeche, Mexico, south to Petén, Guatemala, on the Atlantic.

Local distribution: The 5th section of the Bitzal River in 30°C and PSS 1.

Habitat: This single specimen was collected from MV.

Notes: This species differs from the other native cichlids recorded for the División Grijalva-Usumacinta, as its middle mandibular teeth of the external series are compressed and spatulate (Miller et al. 2005).

Cichlasoma salvini (Günther, 1862)

Material: Number of specimens: 170; TL: 1.6–10.7 cm; TL average: 4.1 cm.

Distribution: Basins of the rivers Papaloapan, Tonalá, Grijalva, and Usumacinta, in Chiapas and Tabasco, Mexico, south to Guatemala on the Atlantic.

Local distribution: Arroyo Punteada, the drains Narváez Norte and Narváez Sur, the lagoons Cantemec, Chichicastle, Concepción, El Guanál, El Loncho, Sargazal, El Sauzo, El Viento, Landeros, Larga, Los Ídolos, Narváez, Punteada, San Isidro, San Isidro El Jobo, San Pedrito, the 5th section of the Bitzal River, Elpidio Sánchez (Usumacinta River) and Grijalva Centro in 28.7°C and PSS 0.6, on average.

Habitat: 87% was collected from MV, 9% from SM and 4% from USS.

Notes: This *Cichlasoma* has a characteristic band-like dark spot that starts at the mouth and ends at the dorsal area of the caudal peduncle, passing through the eye. It does not bear spots on the caudal fin, which makes it easy to tell it apart from other species of the same group (Schmitter-Soto 1988, Miller et al. 2005).

Cichlasoma urophthalmum (Günther, 1862)

Material: Number of specimens: 66; TL: 1.7–17.5 cm; TL average: 4.3 cm.

Distribution: Basin of the Tonalá River; basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, Mexico to Nicaragua.

Local distribution: Arroyo Punteada, the drains Narváez Norte and Narváez Sur, the lagoons Cantemec, Chichicastle, Concepción, El Guanál, El Loncho, El Sauzo, El Tintal, Landeros, Los Ídolos, San Isidro, San Isidro El Jobo, Sargazal, the 7th section of the Bitzal River in 28.8°C and PSS 0.5, on average.

Habitat: 88% was collected from MV, 9% from SM and 3% from USS.

Notes: This species is different from the other species of the genus *Cichlasoma* as it has a caudal ocellus and 5–7 well defined dark vertical bands on the sides of the body (Schmitter-Soto 1998, Miller et al. 2005).

Oreochromis niloticus (L.)

Material: Number of specimens: 1; TL: 23.2 cm.

Distribution: Africa. Widely distributed as a result of being introduced for aquacultural purposes.

Local distribution: The 5th section of the Bitzal River in 29°C and PSS 0.1.

Habitat: This specimen was collected from USS.

Notes: Although *O. aureus* (Steindachner, 1864) and *O. mossambicus* (Peters, 1852) have not been reported for the study area, *O. niloticus* differs from both by presenting a pink-purple body, a dorsal black border and a caudal fin with defined vertical bars that follow a white-dark colour pattern. The species was introduced from Panama into Mexico in 1964 for aquacultural purposes (Morales 2003, Schmitter-Soto 2006).

Parachromis friedrichsthalii (Heckel, 1840)

Material: Number of specimens: 3; TL: 2.8–20.7 cm; TL average: 11.9 cm.

Distribution: Basins of the Tonalá and Coatzacoalcos rivers in Veracruz; basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, Mexico, south to Belize on the Atlantic.

Local distribution: Narváez, San Isidro and El Coco lagoons in 29°C and PSS 0.7, on average.

Habitat: 67% was collected from MV and 33% from USS. **Notes:** *P. friedrichsthalii* has four mandibular pores whereas *P. motaguensis* (Günther, 1867) has five. Also, *P. friedrichsthalii* has 8–13 gill rakers on the first branchial arch and *P. managuensis* (Günther, 1867) has 14–17. The species

P. managuensis and *P. motaguensis* were introduced for aquaculture into southern Mexico (Usumacinta River) (Schmitter-Soto 1998, Miller et al. 2005). *P. friedrichsthalii* was categorised by the IUCN as a “least concern species” (Snoeks et al. 2007).

Paraneetroplus synspilus (Hubbs, 1935)

Material: Number of specimens: 38; TL: 1.9–15 cm; TL average: 3.5 cm.

Distribution: Basin of the Tonalá River, basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, Quintana Roo, in Mexico; Petén, Guatemala and Belize, on the Atlantic.

Local distribution: Arroyo Punteada, the drain Narváez Sur, the lagoons Chichicastle, El Coco, El Loncho, El Sauzo, El Tintal, Landeros, Narváez, Punteada, San Isidro, San Pedrito, Sargazal, the 7th section of the Bitzal River and the 1st section of the Ribera Alta River (Usumacinta River) in 28.9°C and PSS 0.6, on average.

Habitat: 91% was collected from MV and 3% from each of SM, USS and CWD.

Notes: The presence of three or more joined spots on the posterior side, projected towards the front and upwards from the caudal base to the point of the pectoral fin, differ it from *Theraps heterospilus* (Hubbs, 1936) that has slightly defined bands at the body sides (Miller et al. 2005).

Petenia splendida Günther, 1862

Material: Number of specimens: 23; TL: 1.6–4.9 cm; TL average: 3.1 cm.

Distribution: Basin of the Tonalá River; basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco; Campeche and Quintana Roo in Mexico, south to Guatemala and Belize on the Atlantic.

Local distribution: Arroyo Punteada, the drains Narváez Norte and Narváez Sur, the lagoons Cantemoc, El Sauzo, Larga, San Isidro, San Isidro El Jobo, San Pedrito, Sargazal, and the Elpidio Sánchez River (Usumacinta River) in 28.7°C and PSS 0.6, on average.

Habitat: 76% was collected from MV and 24% from USS.

Notes: This cichlid differs from the other species of the family by having a yellowish elongate body with nine black rounded spots throughout the length of the body, and a big and markedly protrusible mouth (Schmitter-Soto 1998, Miller et al. 2005).

Rocio octofasciata (Regan, 1903)

Material: Number of specimens: 4; TL: 6.8–8.6 cm; TL average: 8.1 cm.

Distribution: Basin of the Tonalá River, basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco; Peninsula of Yucatán in Mexico, to Honduras on the Atlantic.

Local distribution: Arroyo Punteada, the lagoons of San Isidro El Jobo and El Guanal in 28.3°C and PSS 0.6, on average.

Habitat: 75% was collected from MV and 25% from USS.

Notes: This species has a short snout and a smallish mouth, the caudal, dorsal and anal fins are covered by

spots or small points, and it has a caudal ocellus and two dark lines between the eyes. *R. octofasciata* has a dark line similar to *Cichlasoma salvini*, but reaching only to mid body (Schmitter-Soto 1998, Miller et al. 2005).

Theraps heterospilus (Hubbs, 1936)

Material: Number of specimens: 20; TL: 2–11 cm; TL average: 3.6 cm.

Distribution: Basin of the Coatzacoalcos River, basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco in Mexico, to Guatemala on the Atlantic.

Local distribution: The lagoons Cantemoc, Chichicastle, El Coco, El Guanal, El Loncho, El Sauzo, El Tintal, Larga, San Pedrito, Puente Frontera, and the 5th section of the Bitzal River and Elpidio Sánchez (Usumacinta River) in 28.4°C and PSS 0.6, on average.

Habitat: 80% was collected from MV and 20% from SM.

Notes: This species differs from *Paraneetroplus synspilus* (Hubbs, 1935) by having irregular spots or a series of partial vertical bars and a big quadrangular spot at the centre of the base of the caudal peduncle (Miller et al. 2005).

Thorichthys helleri (Steindachner, 1864)

Material: Number of specimens: 234; TL: 1.5–16 cm; TL average: 4.7 cm.

Distribution: Basin of the Tonalá River, basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, northwestern Peninsula of Yucatán in Mexico, to the limits of Guatemala and Belize on the Atlantic.

Local distribution: The drain Narváez Sur, the lagoons Cantemoc, Chichicastle, Concepción, El Guanal, El Loncho, El Sauzo, El Tintal, Landeros, Larga, Los Ídolos, Punteada, San Isidro and San Isidro El Jobo in 28.8°C and PSS 0.5, on average.

Habitat: 74% was collected from USS, 25% from SM and 1% from MV.

Notes: It does not have a scaly sheath typical for *Thorichthys* group and also differs from the next two species by having a yellow anal fin and branchiostegal membranes that are not dark, while alive (Miller et al. 2005).

Thorichthys meeki Brind, 1918

Material: Number of specimens: 188; TL: 2.2–11.7 cm; TL average: 5.9 cm.

Distribution: Basin of the Tonalá River, basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, Peninsula of Yucatán, Mexico, and northern Belize on the Atlantic.

Local distribution: The drain Narváez Sur, the lagoons Chichicastle, El Guanal, El Loncho, El Sauzo, El Tintal, Landeros, Larga, Los Ídolos, Punteada, San Isidro, San Isidro El Jobo, San Pedrito and Sargazal in 29°C and PSS 0.6, on average.

Habitat: 89% was collected from USS, 10% from SM and 1% from MV.

Notes: This species is different from *T. helleri* and *T. passionis* (Rivas, 1962) due to the red color in the throat

and the abdomen, while alive (Schmitter-Soto 1998, Miller et al. 2005).

Thorichthys pasionis (Rivas, 1962)

Material: Number of specimens: 121; TL: 1.6–12 cm; TL average: 5.7 cm.

Distribution: Basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, southwestern Campeche in Mexico and Guatemala, on the Atlantic.

Local distribution: The drain Narv ez Sur, the lagoons Cantemoc, Chichicastle, Concepci n, El Guanual, El Loncho, El Sauzo, El Tintal, Landeros, Larga, Los  dolos, Punteada, San Isidro and San Isidro El Jobo in 28.8 C and PSS 0.5, on average.

Habitat: 78% was collected from USS, 20% from SM and 2% from MV.

Notes: This cichlid differs from *T. meeki* and *T. pasionis*, reported for the study area, by having a small dark spot on each scale of the upper lateral line and black branchiostegal membranes (Miller et al. 2005).

FAMILY ELEOTRIDAE

Dormitator maculatus (Bloch, 1792)

Material: Number of specimens: 143; TL: 0.7–18.9 cm; TL average: 2.9 cm.

Distribution: Along the Atlantic from North Carolina, USA, to Brazil; Bahamas; Antilles; on the coastal plain of the Gulf of Mexico in the basin of the Tonal  River; and the basins of the rivers Grijalva and Usumacinta in Tabasco, Mexico.

Local distribution: Arroyo Punteada, the dredged canal San Rom n, the drains Narv ez Norte and Narv ez Sur, the lagoons Cantemoc, Concepci n, El Coco, El Guanual, El Viento, Landeros, Larga, Los  dolos, Punteada, El Sauzo, San Isidro, San Isidro El Jobo, San Pedrito, the Grijalva Centro River and the 1st section of the Ribera Alta River (Usumacinta River) in 28.4 C and PSS 0.6, on average.

Habitat: 94% was collected from MV, 3% from CWD, 2% from SM and 1% from USS.

Notes: This genus differs from *Gobiomorus* and *Eleotris* by having 31–35 scales on the lateral series and a thin dark line from the anterior area of the eye to the posterior area of the mandible (Schmitter-Soto 1998, Miller et al. 2005).

Eleotris amblyopsis (Cope, 1871)

Material: Number of specimens: 7; TL: 1.8–4.2 cm; TL average: 3.2 cm.

Distribution: From central-northern Veracruz in the basin of the Tonal  River, Mexico to Surinam on the Atlantic.

Local distribution: El Coco lagoon, Puente Frontera and the 1st section of the Ribera Alta River (Usumacinta River) in 28.6 C and PSS 0.6, on average.

Habitat: 86% was collected from MV and 14% from CWD.

Notes: The presence of a small spine hidden in the angle of the preopercle, 50–56 scales on a lateral series of the body, and the pectoral fin reaching or passing the base of

the anal fin, make this species different from *Dormitator maculatus* and *Gobiomorus dormitor* (Miller et al. 2005).

Gobiomorus dormitor Lac pede, 1800

Material: Number of specimens: 112; TL: 1–3.4 cm; TL average: 2 cm.

Distribution: From southern Florida, USA, coastal plain of the Gulf of Mexico in the basin of the Tonal  River, and the basins of the rivers Grijalva and Usumacinta in Chiapas and Tabasco, Mexico to northern Brazil on the Atlantic.

Local distribution: Arroyo Punteada, the drains Narv ez Norte and Narv ez Sur, the lagoons El Cometa, El Coco, El Guanual, El Loncho, El Sauzo, El Tintal, El Viento, Los  dolos, Punteada, San Isidro, San Isidro El Jobo, San Pedrito, Puente San Pedro y San Pablo, the rivers Grijalva Centro and the 1st section of the Ribera Alta River (Usumacinta River) in 28.5 C and PSS 0.8, on average.

Habitat: 62% was collected from MV and 38% from USS.

Notes: The presence of 55–62 scales on a lateral series of the body, the sides of the body with a series of semicircular dark spots on the lateral line from the snout to the caudal peduncle, and a dark spot on the distal area of the first dorsal fin, make this species different from *Dormitator maculatus* and *Eleotris amblyopsis* (see Miller et al. 2005).

FAMILY GOBIIDAE

Ctenogobius claytonii (Meek, 1902)

Material: Number of specimens: 5; TL: 2–3.9 cm; TL average: 2.5 cm.

Distribution: From southern Texas, USA to Pajaritos Lagoon near Coatzacoalcos, Veracruz, Mexico on the Atlantic.

Local distribution: The lagoons El Coco, El Cometa, San Isidro and San Pedrito in 28.8 C and PSS 1.2, on average.

Habitat: 61% was collected from USS, 28% from SM, and 11% from CWD.

Notes: It is characteristic of this family for the pelvic fins to be joined forming an adhesive disc that allows them to remain attached to the bottom. The species present a spear shaped caudal fin and 30–40 scales on a lateral series (Miller et al. 2005). This species represents a new record for the Usumacinta Province and the BRPC.

Gobionellus oceanicus (Pallas, 1770)

Material: Number of specimens: 15; TL: 1.2–5.8 cm; TL average: 3.7 cm.

Distribution: From North Carolina, USA, to Campeche, Mexico including the basins of the rivers Tonal  and Grijalva in Tabasco on the Atlantic.

Local distribution: The lagoons El Coco, El Cometa, San Isidro and San Pedrito in 28.8 C and PSS 1.2, on average.

Habitat: 67% was collected from USS and 33% from MV.

Notes: This species represents a new record for the BRPC. The specimens were collected in oligohaline and limnetic environments, which partly agree with two other

records for oligohaline environments: Tampa, Fla. and Laguna de Alvarado, southern Gulf of Mexico. However, most specimens of this species have been recorded for brackish and marine environments, and some for hyperhaline areas (Castro-Aguirre et al. 1999).

ORDER PLEURONECTIFORMES
FAMILY PARALICHTHYIDAE

Citharichthys spilopterus Günther, 1862

Material: Number of specimens: 2; TL: 4.2–4.6 cm; TL average: 4.4 cm.

Distribution: From New Jersey to Florida and the Gulf of Mexico in the USA, through the Caribbean, to Brazil. On the coastal plain of the Gulf of Mexico in the basin of the Tonalá River and the basin of the Usumacinta River in Tabasco, Mexico.

Local distribution: El Coco Lagoon in 31°C and PSS 1.6.

Habitat: The specimens were collected from USS.

Notes: It represents a new record for the BRPC.

FAMILY ACHIRIDAE

Achirus lineatus (L.)

Material: Number of specimens: 3; TL: 1.5–1.6 cm; TL average: 1.53 cm.

Distribution: From Florida, USA to Uruguay; the basin of the Tonalá River in the Gulf of Mexico on the Atlantic.

Local distribution: El Cometa Lagoon in 31°C and PSS 2.5.

Habitat: All specimens were collected from USS.

Notes: It represents a new record for the BRPC.

DISCUSSION

The nomenclature of the 11 species was updated in this study. Nine species of native cichlids were relocated in six genera considering the proposals of Miller et al. (2005), Chakrabarty (2007), Schmitter-Soto (2007), López-Fernández et al. (2010) and McMahan et al. (2010). The cichlids that were reassigned were *Amphilophus robertsoni*, *Parachromis friedrichsthalii*, *Paraneetroplus synspilus*, *Rocio octofasciata*, *Theraps heterospilus*, *Thorichthys helleri*, *T. meeki*, and *T. pasionis*. Additionally, *Gobionellus claytonii* was found to be synonymous with *Ctenogobius claytonii*, as did *Gobionellus hastatus* with *G. oceanicus* (Carpenter 2002a, b; Nelson et al. 2004, McEachran and Feckhelm 2005). The pale catfish, *Rhamdia quelen*, previously in the Pimelodidae family, was placed by Bockmann and Guazzelli (2003) in the Heptapteridae family and is, at present, a synonym of *Rhamdia guatemalensis* (Ferraris 2007).

In México, the continental fish include about 495 freshwater species (Miller et al. 2005) which have been grouped in eight ichthyofaunistic provinces (Minckley et al. 2005) that mainly correspond to the great hydrographic basins. The BRPC is located in the Usumacinta Province, Grijalva-Usumacinta Division (Minckley et al. 2005), where the basins of the rivers Papaloapan, Coatzacoalcos, and Grijalva-Usumacinta, as well as the Peninsula of Yucatán, are located. More than 200 fish species have been recorded for the Usumacinta Province (Espinosa-Pérez et

al. 1998, Minckley et al. 2005, Anonymous 2010b), of which 44 were collected in this study. The Poeciliidae and Cichlidae were the most diverse families in the BRPC, coinciding with the data of Minckley et al. (2005) for the Usumacinta Province. Of the approximately 23 and 29 species of poeciliids and cichlids that are distributed in the Usumacinta Province (Lozano-Vilano and Contreras-Balderas 1987, Minckley et al. 2005), 10 and 13 were collected in this study. Of the 18 species of marine origin that have become permanent residents of the freshwater bodies in this province (Castro-Aguirre et al. 1999, Minckley et al. 2005), only *Hyporhamphus mexicanus* was recorded, and it is considered endemic to the basin of the high Grijalva and Usumacinta (Castro-Aguirre et al. 1999, Miller et al. 2005). Only 14 endemic species, of approximately 52 reported for the Usumacinta Province, were collected in the BRPC (de la Vega 2003, Minckley et al. 2005, Anonymous 2010b), and this is because the greatest endemism has been recorded for the high basins of the rivers Usumacinta and Grijalva (Lozano-Vilano and Contreras-Balderas 1987, Miller et al. 2005, Rodiles-Hernández et al. 2005). Of the species collected in this study, 86% and 70% were recorded previously for the Papaloapan-Coatzacoalcos and Yucatán Divisions, respectively (Miller et al. 2005, Minckley et al. 2005, Anonymous 2010b).

Of the 44 species collected in this study, the distribution of only the characids *Astyanax aeneus* and *Brycon guatemalensis*, the heptapterid *Rhamdia quelen*, and the introduced Nile tilapia, *Oreochromis niloticus*, was extended to the other two divisions of the Usumacinta Province. The occasional capture of *R. quelen* in the BRPC coincided with the low abundance it has presented in other limnetic ecosystems (Lozano-Vilano and Contreras-Balderas 1987, Gamboa-Pérez 1992, Gaspar-Dillanes 1996, Reséndez-Medina and Salvadores 2000, Chávez-López et al. 2005, Corona 2005, Rodiles-Hernández et al. 2005, Castillo-Domínguez et al. 2011). The Nile tilapia, *O. niloticus* was introduced into Mexico in 1964 for aquacultural purposes, and since then it has become one of the exotic species that has dispersed widely throughout the freshwater ecosystems of Mexico (Morales 2003, Schmitter-Soto 2006).

A total of 38% of the species included in this study have been recorded previously for the Grijalva-Usumacinta Division of the Usumacinta Province (Minckley et al. 2005). Of these species, 52% correspond to the secondary freshwater component, 18% to the marine component, 14% to the primary freshwater component, 9% to the estuarine component, and the other 7% to the vicarious component. The dominance of the freshwater ichthyofauna is explained by the restricted spatial influence of the tides in the BRPC (Sánchez et al. 2007). The presence of fish of the estuarine and marine components is mainly related to trophic migrations and to their osmoregulatory capacity (Castro-Aguirre et al. 1999). Vicarious species are important as they provide evidence of a marine ancestry (Castro-Aguirre et al. 1999).

The species *Anchoa parva*, *Heterophallus* aff. *rachovii*, and *Ctenogobius claytonii* are new records for the Usumacinta-Grijalva Division (Table 2). *Anchoa parva* is distributed in estuarine and marine ecosystems (Austin 1971, Castro-Aguirre et al. 1999, Sánchez and Rueda 1999, Caballero-Vázquez et al. 2005) of northern Yucatán and the Mexican Caribbean Sea, in the División Yucatán of the Usumacinta province (Schmitter-Soto 1998, Castro-Aguirre et al. 1999). In contrast, *H.* aff. *rachovii* and *C. claytonii* were confined to the Papaloapan-Coatzacoalcos Division (Castro-Aguirre et al. 1999, Espinosa-Pérez and Daza-Zepeda 2005, Miller et al. 2005, Anonymous 2010b). The little anchovy and the gobiid *C. claytonii* were mainly distributed in SV and MV (Table 2) in the Tres Brazos sub-basin, where the influence of the tides is present mainly during the season of minimum flooding (Sánchez et al. 2007). The poeciliid *H.* aff. *rachovii* has a wide distribution and a high abundance in the study area. These three species are mostly small omnivores (Parra et al. 1984, Schmitter-Soto 1998, Miller et al. 2005, Froese and Pauly 2011) with a distribution that is mainly associated with SM and MV, as is commonly recorded for similar species in coastal wetlands (Cetra and Petrere 2007, Montalvo-Urgel et al. 2010, Rozas and Minello 2010). The structure and function of shallow aquatic communities are regulated by the trophic dynamics of these species, as they are generally mesograzers or predators, as well as prey of top predators in shallow ecosystems (Warfe and Barmuta 2006, Jorgensen et al. 2007).

The BRPC is a high priority wetland in Mexico. It is included among the 174 Natural Protected Areas of Mexico (Anonymous 2010c), and is recognised by the Ramsar Convention (Anonymous 2011b). However, the inventory of fish was incomplete as, of the 44 fish species listed in this catalogue, only 25 agreed with the previously reported checklist for this area and the San Pedro River that joins the Reserve at its eastern margin (Chávez et al. 1989, Reséndez-Medina and Salvadores 2000, Castillo-Domínguez et al. 2011). Moreover, there were more similar species (31) with the lists published by Espinosa-Pérez and Daza-Zepeda (2005) and Miller et al. (2005), although they included the BRPC but did not represent it exclusively, as did the preliminary inventory published by Reséndez-Medina and Salvadores (2000). Only *Rhamdia quelen*, *Cichlasoma pearsei*, *Cichlasoma urophthalmum*, and *Petenia splendida* were recorded in this catalogue and the five previous studies. In contrast, *Anchoa parva*, *Heterophallus* aff. *rachovii*, *Microphis brachyurus*, *Diapterus auratus*, *Bairdiella chrysoura*, *Ctenogobius claytonii*, *Gobionellus oceanicus*, *Citharichthys spilopterus*, and *Achirus lineatus* are not in the five above-mentioned publications. Of these nine species, *A. parva*, *H.* aff. *rachovii*, *M. brachyurus*, and *C. claytonii* were collected mostly from one of the structured habitats (Table 2). The sciaenid *B. chrysoura* has been frequently cited for the coastal lagoons of the southern Gulf of Mexico and associated limnetic ecosystems (Reséndez-Medina 1980, 1981, Yáñez-Arancibia 1988, Reséndez-Medina and

Kobelkowsky-Díaz 1991, Ayala-Pérez et al. 1998), as it is a migratory euhaline marine species that tolerates salinities from PSS 0.5 to PSS 45.5 (Castro-Aguirre et al. 1999). The poeciliid *Phallichthys fairweatheri*, the syngnathid *Microphis brachyurus*, and the gerreid *Diapterus auratus* have been recorded for other aquatic environments of the Grijalva-Usumacinta Division and Usumacinta Province (Reséndez-Medina 1980, Lozano-Vilano and Contreras-Balderas 1987, Schmitter-Soto 1998, Espinosa-Pérez and Daza-Zepeda 2005, Miller et al. 2005, Rodiles-Hernández et al. 2005, Anonymous 2010b, Castillo-Domínguez et al. 2011), although not for the BRPC.

Papers published for the BRPC and the limnetic ecosystems of the Usumacinta-Grijalva basin have reported studies that were carried out with different sampling designs, mostly in USS (Chávez et al. 1989, Reséndez-Medina and Salvadores 2000, Castillo-Domínguez et al. 2011). Among these, Reséndez-Medina and Salvadores (2000) recorded 13 species that were not collected in this study, of which 31% belong to the estuarine component and the rest includes freshwater (23%), vicarious (23%), and primary (23%) components. Of the species listed by Reséndez-Medina and Salvadores (2000) and Castillo-Domínguez et al. 2011, the absence in this study of the pejelagarto *Atractosteus tropicus* Gill, 1863, the snooks *Centropomus parallelus* Poey, 1860 and *C. undecimalis* (Bloch, 1792), the jaguar capote *Parachromis managuensis* (Günther, 1867) and the grass carp *Ctenopharyngodon idella* (Valenciennes, 1844) are noteworthy. The pejelagarto and the snooks are commercial species with a high gastronomic value in the region (Espinosa-Pérez and Daza-Zepeda 2005). The jaguar capote and grass carp were introduced, the first to help local fisheries and the second for the biological control of invasive plants. At present, both species, are widely distributed in limnetic ecosystems of Mexico (Vera-Herrera et al. 1980, Espinosa-Pérez and Daza-Zepeda 2005)

In coastal wetlands, SM, MV and CWD are considered habitats with a high heterogeneity and structural complexity (Everet and Ruiz 1993, Rozas and Minello 2006, Sánchez et al. 2007, Montalvo-Urgel et al. 2010, Rozas and Minello 2010), that are important in the protection, feeding and reproduction of species (Minello and Zimmerman 1991, Pelicice and Agostinho 2006, Rozas and Minello 2006, Cetra and Petrere 2007, Genkai-Kato 2007). The smallest number of species was recorded for CWD and the greatest for USS, similar to the number of species collected in the other two structured habitats, MV and SM (Table 2). The low number of fish species (*Paraneotroplus synspilus*, *Dormitator maculatus*, *Eleotris amblyopsis*, and *Ctenogobius claytonii*) collected from CWD may be an underestimation caused by the manual sampling. Of these four species, the eleotrids *D. maculatus* and *E. amblyopsis*, and the cichlid *P. synspilus* were mainly collected from MV, whereas the gobiid *C. claytonii* was found mainly in CWD (Table 2). Both eleotrids were absent in the previous studies of the Grijalva-Usumacinta Division (Chávez et al. 1989, Reséndez-Medina and Salvadores 2000,

Castillo-Domínguez et al. 2011). The two eleotrids and the gobiid are omnivores that occasionally feed on insect larvae, while *P. synspilus* is a herbivore, all recorded frequently in vegetation (Schmitter-Soto 1998). Juveniles of *D. maculatus* are common in flooded areas covered by emergent rooted vegetation at the start of the maximum flooding season. The marked difference between this catalogue and the three previous studies cited before for the Grijalva-Usumacinta Division has been the increase to five poeciliid species (*Belonesox belizanus*, *Gambusia sexradiata*, *G. yucatanana*, *Heterandria bimaculata*, *Heterophallus* aff. *rachovii*, and *Xiphophorus maculatus*). This may also be related to the inclusion of structured habitats in the sampling, as the livebearers were collected mainly from MV where they feed mainly on insect larvae (Schmitter-Soto 1998, Miller et al. 2005).

In spite of the highest number of species collected in USS throughout this study, the different records for the BRPC corresponded to the structured habitats, which were not sampled systematically by Reséndez-Medina and Salvadores (2000). Therefore, the addition of species to the BRPC list is attributed to sampling in structured habitats and to the variety of sampling gears used, rather than to the recent taxonomic re-assignment of some fish species. In this context, the greater number of species and the similarity between the USS and the other two structured habitats respond to the fact that this unstructured habitat represents approximately 99% of the available substrate in the BRPC. Of special attention are the number of species and the similarity between the habitats of SM and MV, as the first one occupies less than 1% of the substrate in the Reserve and the second covers approximately 83% of the margins of the aquatic ecosystems in the BRPC. This contrast in cover area lays emphasis on the importance of generating programmes for the rehabilitation of submerged macrophytes (Ruíz-Carrera and Sánchez 2008) and marginal vegetation, which may take place together with the development of monitoring programmes in this tropical wetland.

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