ACTA ICHTHYOLOGICA ET PISCATORIA (2012) 42 (3): 153–164 DOI: 10.3750/AIP2011.42.3.01

ENDEMIC FISHES OF THE CORTEZ BIOGEOGRAPHIC PROVINCE (EASTERN PACIFIC OCEAN)

Deivis S. PALACIOS-SALGADO [1, 2*], Luis A. BURNES-ROMO [2, 3], José J. TAVERA [4], and Arturo RAMÍREZ-VALDEZ [5, 6]

[1] *Escuela Nacional de Ingeniería Pesquera, Universidad Autónoma de Nayarit, Bahía de Matanchén, San Blas Nayarit, México*

[2] *IIK'KAKNAB A.C.* Bahía Asunción *181, Col. Fovissste, 23060, La Paz, Baja California Sur, Mexico*

[3] *Secretaria de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (SAGARPA).*

[4] *Centro de Investigaciones Biológicas del Noroeste, S.C. (CIBNOR), Mexico*

[5] *Facultad de Ciencias Marinas, Universidad Autónoma de Baja California (UABC), Ensenada, Baja California, Mexico*

[6] *Instituto de Investigaciones Oceanológicas (IIO), UABC, Ensenada, Baja California, Mexico*

Palacios-Salgado D.S., Burnes-Romo L.A., Tavera J.J., Ramírez-Valdez A. 2012. Endemic fishes of the Cortez Biogeographic Province (eastern Pacific Ocean). Acta Ichthyol. Piscat. 42 (3): 153–164.

Background. The Cortez Province (CP) is located in the transitional warm-temperate/subtropical region that allows the ichthyological component inhabiting it to be a mixture of elements of different biogeographic affinities. Since the first systematic analysis of the fish fauna of the Gulf of California in the 1960's a major portion of the endemic species was recognized. Subsequently, a total of 31 new endemic species have been described in the CP. This study constitutes an amendment of the fish component of the CP, including the most relevant ecological attributes of the species, along with an updated taxonomic list.

Materials and methods. A comprehensive literature review was made, considering current biological knowledge, and taxonomic status of the endemic species from the CP. Those fish species with restricted distribution ranges, falling within the limits of this province, were considered endemic. Additionally, and to recognize the dominant ecological attributes of the CP endemic species, the preferential habitat, bathymetric distribution, the reproduction strategy, and the maximum total length (TL) were recorded.

Results. Seventy-nine endemic species were recognized and grouped in 13 orders, 29 families, and 59 genera. Gobiidae (12), Chaenopsidae (8), and Labrisomidae (7) are the families with the highest species richness, and *Sebastes* (6 species), the most diverse genus. Forty-five percent of the species are associated with coral and rocky reefs, with 35% distributed within the first 10 m depth layer. The dominant reproduction strategies are: oviparous with benthic eggs and pelagic larval phase (48.7%), and oviparous with pelagic eggs (25.6%). More than half of the species (52%) are shorter than 10 cm (total length).

Conclusion. The list of endemic species presented in this study is not conclusive, still undescribed species have not been included, detected differences (morphologic and/or genetic) in several species with disjunct populations may increase the diversity of this province.

Keywords: Gulf of California, endemic species, biogeography, Gobiidae

INTRODUCTION

The Gulf of California (GC) represents one of the world's most productive sea areas including an important diversity of marine environments (e.g., rocky- and coraline reefs, oceanic trenches, lagoons, and wetlands) (Thomson et al. 2000, Thomson and Gilligan 2002, Brusca et al. 2005). The GC oceanographic conditions, geographic location, and geological history have deeply influenced speciation processes and species accumulation, which may explain why this area includes the second highest peak in species richness within the Tropical Eastern Pacific (TEP) (Mora and Robertson 2005, Robertson and Allen, 2008). Its location in the transitional warm-temperate and subtropical biogeographic region allows the fishes inhabiting to be a mixture of elements from different affinities: tropical, subtropical, temperate,

* Correspondence: Dr. Deivis S. Palacios Salgado, Escuela Nacional de Ingeniería Pesquera, Colección ictiológica, Apartado Postal 10, San Blas, Nayarit. México 63740, phone: (+323) 231-21-20, e-mail: palaciossalgado@gmail.com.

and arctic-boreal or warm-temperate (Walker 1960, Castro-Aguirre et al. 1995, Hastings et al. 2010).

Given the high number of reported endemisms from different taxonomic groups, Briggs (1974) recognized the inner sea of the Baja California Peninsula as a biogeographic province different from the San Diegan and Mexican Provinces, naming it the Cortez Province (CP). The latter author determined the southern limits to be at La Paz Bay on the west coast of the Gulf of California, and Topolobampo Bay on the east coast. This province together with the San Diegan Province constitutes the warm-temperate Californian region. Currently, the northern limit of the CP is known to be located at Bahía Magdalena, Baja California Sur, and the southern boundary in the Topolobampo region, Sinaloa (Fig. 1) (Hastings 2000, Robertson and Cramer 2009). This province is delimited to the north by strong temperature gradients (Robertson et al. 2004, Mora and Robertson 2005) and to the south by the Sinaloa gap, a coastline of 370 km, which includes wide extensions of sandy and muddy bottoms, with estuarine lagoons and wide mangrove areas that separate it from the Mexican Province (Springer 1959, Dawson 1975, Hastings 2000). This gap has been considered a 'faunistic filter' given that it does not have the same isolation effects for all fish elements (Castro-Aguirre et al. 1995).

Walker (1960) made the first evaluation of the endemic fishes of the Gulf of California reporting 92 species. In subsequent studies, Findley et al. (1996a, b, 1997, 1999) initially recognized the existence of 77, and ended up with 86, endemic species. Castro-Aguirre et al. (2005a) evaluated fish species from the Gulf of California with amphipacific, boreal, endemic, and amphipeninsular distributions and reported 50 endemic species. Nevertheless, despite these studies mention endemic species of the GC, none of them present a complete systematic list. Our study presents an amendment of the fish component from the CP, including the most relevant ecological attributes of species, plus an updated taxonomic list.

MATERIAL AND METHODS

A comprehensive literature review was made, considering current biological knowledge and taxonomic status of the endemic species from the Cortez Province (CP) (*sensu* Hastings 2000). Those fish species with restricted distribution ranges, falling within the limits of this province, were considered endemic. An updated systematic list is presented excluding species being a subject of any stage of taxonomic review. Family designations and higher hierarchical ranks follow Nelson (2006). Genera and their respective species are presented alphabetically. The spelling of scientific and common names is based on FishBase (Froese and Pauly 2012).

Additionally, and to recognize the dominant ecological attributes of CP endemic species, the preferential habitat, bathymetric distribution, reproduction strategy, and the maximum total length (TL) were recorded. According to their habitat, species were classified as follows: reef species (R); soft bottom demersal (SBD); mixed bottom demersal (MBD); pelagic-demersal (PD), species that being demersal also break-into the water column; neritic-pelagic (NP), those species associated to the upper part of the water column by the coastal zone; mesopelagic (MP); and bathybenthic (BB). Classification in bathymetric distribution was made using minimum and maximum depth limits in which species are distributed.

Reproductive strategies for each species were grouped according to Balon (1989) and Elliot and Dewailly (1995), as following: viviparous (V), those species who give birth to complete juveniles and whose embryos obtain nutrients from yolk or directly from their mother; ovoviviparous (W), those with internal fertilization, embryonic development is produced inside the ovary until larvae are formed, and nutrition of embryo does not depend on the mother but on egg yolk; and oviparous, in those fishes, eggs are spawned directly to the environment and fertilization is external although in some uncommon instances internal fertilization events may occur before spawning. Within the oviparous group, a sub-classification was considered: oviparous with pelagic eggs (OP), oviparous with benthic eggs and pelagic phase (OBPP), oviparous with benthic eggs without pelagic phase (OBWPP), oviparous with oral gestation (OOG), and oviparous with gestation in the vascularized ventral sac (OGVVS).

Regarding size, species were classified by 10 cm length intervals. Biological information was obtained from specific published sources (e.g., Thomson et al. 2000, Robertson and Allen 2008).

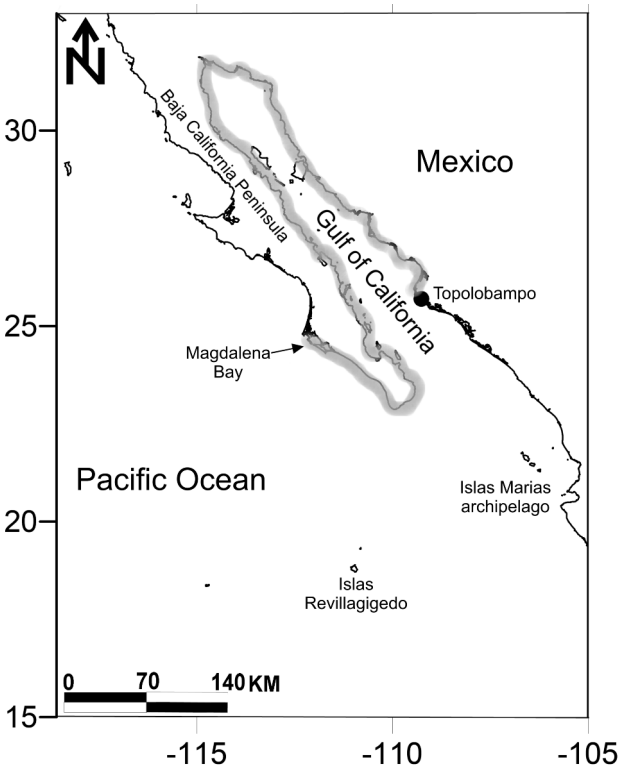

Fig. 1. Study area, the biogeographic province of Cortez (PC) (shaded grey) (*sensu* Hastings 2000)

RESULTS

Seventy-nine endemic species were recognized and grouped into 29 families, and 59 genera (Table 1). A total of 75 species belong to the class Actinopterygii (94.9%), three to the class Chondrichthyes (3.8%), and one to the class Myxini (1.3%). Gobiidae, Chaenopsidae, and Labrisomidae were the best represented families in terms of number of species with 12, 8, and 7, respectively. On the other hand, *Sebastes* and *Ogilbia* (with six and four species, respectively) were the genera with the highest richness. From the overall taxonomic composition, five genera appeared to be endemic to the CP (*Colpichthys*, *Totoaba*, *Crocodilichthys*, *Xenomedea*, and *Aruma*).

Fishes associated to coralline- and rocky reef systems were the dominant group with 36 species (45.6%). Nineteen (24.05%) species were grouped in the soft bottom demersal group; the demersal-pelagic and demersal-neritic groups were represented by eight species each (Fig. 2). Twenty-seven species (35.5%) can be found within the first 10-m depth layer of water (Fig. 3). Six species reach depths > 200 m, of which, only two exceed 1000 m. The dominant reproduction strategies were oviparous with benthic eggs and pelagic phase (38 species, 48.7%), and oviparous species with pelagic eggs (20 species, 25.6%) (Fig. 4). Regarding adult length, more than half of the endemic species (39 species, 52%) are between 1 and 10 cm total length (TL) and only six exceed 50 cm of TL (Fig. 5).

DISCUSSION

The 79 endemic species considered in this study constitute 8.67% of the total fish fauna reported for the Gulf of California (911 species; Hastings et al. 2010) and 6.14% of the total shore species of the Tropical Eastern Pacific (1285 species) (Robertson and Allen 2008). The number of reported endemic fish species has not drastically changed within the past 50 years, from the 92 species documented by Walker (1960), or the 77–86 found by Findley et al. (1996a,b, 1997, 1999). However, the taxonomic list of species that take part of this endemic assemblage has indeed been modified. Since 1960, a total of 31 endemic new species have been described as species new to science in the CP. Ten of these new species were described after Findley et al. (1996a, b, 1997 and 1999): *Elacatinus limbaughi** (Gobiidae); *Stellifer wintersteenorum* (Sciaenidae); *Opistognathus fossoris* and *O. walkeri* (Opistognathidae); *Mustelus albipinnis* (Triakidae); *Ogilbia davidsmithi*, *O. nigromarginata*, *O. nudiceps* (Bythitidae); *Etropus ciadi* (Paralichthyidae); and *Acanthemblemaria hastingsi* (Chaenopsidae).

The greatest percentage of endemic species corresponded to the families Gobiidae (13 species), Chaenopsidae (8 species), Labrisomidae (7 species), Scorpaenidae (6 species), Gobiesocidae (5 species), Sciaenidae (5 species), Bythitidae (4 species), and Dactyloscopidae (3 species). Highly diversified families in the Tropical Eastern Pacific such as Serranidae (56 species), Ophichthidae (41 species), Haemulidae (37 species), Labridae (36 species), Carangidae (35 species), and Muraenidae (33 species), do not have endemic representatives in the CP and/or are poorly represented. The same pattern can be identified at a genus level; e.g., anchovies (*Anchoa*: 19 species), tonguefishes (*Symphurus*: 18 species), wrasses and moray eels (*Halichoeres* and *Gymnothorax,* respectively; both with 12 autochthonous species), among others.

Walker (1960) recognized four endemic genera from the CP, while Findley et al. (1997) only found two (*Totoaba* and *Xenomedea*). According to the presently reported study, five genera, four of them currently monotypic, are endemic to the CP (*Colpichthys*, *Totoaba*, *Crocodilichthys*, *Xenomedea*, and *Aruma*).

From the endemic species, three belong to the family Atherinopsidae: the false grunion, *Colpichthys regis*, a common species in the Sonora coastal hypersaline (values > pss 50) lagoons; and *Colpichthys hubbsi* and *Leuresthes sardine,* both autochthonous to the northern part of the Gulf of California, and restricted to the delta and mouth of the Colorado River, Sonora (Castro-Aguirre and Espinosa-Pérez 2006). The Panamic flashlightfish, *Phthanophaneron harveyi*, is the only species of the family Anomalopidae present in the Tropical Eastern Pacific and it is endemic to the CP (Thomson et al. 2000).

Some species of this endemic component support or even keep supporting important fishery pressure. The Gulf weakfish, *Cynoscion othonopterus*, forms reproductive aggregations from February to May; a period during which it is captured in great numbers. In 2009, the Gulf weakfish capture reached a profit of more than 30 million Mexican pesos (Paredes et al. 2010). The Gulf croaker, *Micropogonias megalops*, represents almost 27% of the total fish capture in the Upper Gulf of California (Aragón-Noriega et al. 2009). The totoaba, *Totoaba macdonaldi*, supported one of the most important fisheries in the region; nevertheless, uncontrolled fisheries and the decrease of Colorado River flow and thus spawning, breeding, and reproduction of this species brought this fishery to collapse (Cisneros-Mata et al. 1995). Currently, the totoaba is included in NOM-059-SEMARNAT-2010 regulation in the category of risk of extinct, and as Critically Endangered by the IUCN red list of threatened Species. According to Berdegue (1955), during the 1950s, totoaba fisheries at San Felipe were composed of 25 shrimp fishing ships, each capturing an average of five to six tons of totoaba weekly.

Many other endemic species are part of multi-specific fisheries (e.g., *Diplectrum sciurus*, *Paralichthys aestuarius*, *Stellifer wintersteenorum*, and *Umbrina wintersteeni*). In addition, some small reef species, at least four (*Malacoctenus hubbsi*, *Emblemaria hypacanthus*, *E. walkeri*, and *Gobiosoma chiquita*), are exploited for the aquarium trade (Piña-Espallargas, unpublished**).

The number of endemic species presented in this study may vary given that there are non-validated records, such as the spiny guitarfish, *Rhinobatos spinosus*, that was described from a 26 cm total length specimen, and considered

* Full species names featuring the authority and the year are privided in Tables 1 and 2.

** Piña-Espallargas R. 2005. La pesquería de especies marinas con fines de ornato en México. El parque marino de Loreto, B.C.S., como estudio de caso. MSc Thesis. Centro Interdisciplinario de Ciencias Marinas, Instituto Politécnico Nacional (CICIMAR-IPN). La Paz, México.

Table 1

Taxonomic list of the endemic fishes from Cortez Province (Eastern Pacific Ocean)

Class, family, and species	Common name	Habitat	Depth [m]	TL [cm]	RS
CLASS MYXINI					
FAMILY MYXINIDAE					
Eptatretus sinus Wisner et McMillan, 1990	Cortez hagfish	G	708	48	OBWPP
CLASS CHONDRICHTHYES					
FAMILY SCYLIORHINIDAE					
Galeus piperatus Springer et Wagner, 1966	Peppered catshark	F	400–1330	30	OBWPP
FAMILY TRIAKIDAE					
Mustelus albipinnis Castro-Aguirre, Antuna-Mendiola, González-Acosta et De la Cruz-Agüero, 2005		E	103–281	118	V
FAMILY RHINOBATIDAE					
Rhinobatos spinosus Günther, 1870	Spiny guitarfish	B	—	26	V
CLASS ACTINOPTERYGII					
FAMILY OPHICHTHIDAE					
Apterichtus gymnocelus (Böhlke, 1953)		B	30	24	OP
Ethadophis byrnei Rosenblatt et McCosker, 1970	Ordinary eel	B	3	51	OP
FAMILY CONGRIDAE					
Heteroconger canabus (Cowan et Rosenblatt, 1974)	White-ring garden eel	B	20	80	OP
FAMILY ENGRAULIDAE					
Anchoa analis (Miller, 1945)	Longfin Pacific anchovy	E	10	14	OP
Anchoa helleri (Hubbs, 1921)	Heller's anchovy	E	10	10	OP
Anchoviella parri (Hildebrand, 1943)	Mystery anchovy	E	—	—	OP
FAMILY OPHIDIIDAE					
Ophidion iris Breder, 1936	Rainbow cusk-eel	B	85	26	OP
FAMILY BYTHITIDAE					
Ogilbia davidsmithi Möller, Schwarzhans et Nielsen, 2005	Smith's coralbrotula	A	3	11	V
Ogilbia nigromarginata Möller, Schwarzhans et Nielsen, 2005	Darkfinned coralbrotula	A	33	8	V
Ogilbia nudiceps Möller, Schwarzhans et Nielsen, 2005	Naked-headed coralbrotula	A	30	8.5	V
Ogilbia ventralis (Gill, 1863)	Gulf cuskeel	A	10	9	V
FAMILY BATRACHOIDIDAE					
Porichthys mimeticus Walker et Rosenblatt, 1988	Mimetic midshipman	B	185	21.5	OBWPP
FAMILY ATHERINOPSIDAE					
Colpichthys hubbsi Crabtree, 1989	Delta silverside	E	4	15	OBPP
Colpichthys regis (Jenkins et Evermann, 1889)	False grunion	E	4	20	OBPP
Leuresthes sardina (Jenkins et Evermann, 1889)	Gulf grunion	E	5	25	OBPP
FAMILY ANOMALOPIDAE					
Phthanophaneron harveyi (Rosenblatt et Montgomery, 1976)	Gulf flashlightfish	A	100	26	OP
FAMILY SYNGNATHIDAE					
Syngnathus carinatus (Gilbert, 1892)	Cortez pipefish	B	33	21	OGVVS
FAMILY SEBASTIDAE					
Sebastes cortezi (Beebe et Tee-Van, 1938)	Cortez rockfish	F	1100	25.5	W
Sebastes exsul Chen, 1971	Buccaneer rockfish	D	200	31	W
Sebastes peduncularis Chen, 1975	Gulf rockfish	F	440–450	4.7 AJ	W

Table 1 (cont.)

Class, family, and species	Common name	Habitat	Depth [m]	TL [cm]	RS
Sebastes sinensis (Gilbert, 1890)	Blackmouth rockfish	F	670	15.2	W
Sebastes spinorbis Chen, 1975	Spinyeye rockfish	D	200	34.4	W
Sebastes varispinis Chen, 1975	Hidden rockfish	F	500	5.6 AJ	W
FAMILY PERISTEDIIDAE					
Peristedion paucibarbiger Castro-Aguirre et García-Domínguez, 1984	Cortez searobin	B	60	8	OP
FAMILY SERRANIDAE					
Diplectrum sciurus Gilbert, 1892	Gulf squirrelfish	B	100	17	OP
FAMILY OPISTOGNATHIDAE					
Opistognathus fossoris Bussing et Lavenberg, 2003	Barred jawfish	C	32	11	OOG
Opistognathus walkeri Bussing et Lavenberg, 2003		C	90	13.5	OOG
FAMILY SCIAENIDAE					
Cynoscion othonopterus Jordan et Gilbert, 1882	Gulf weakfish	D	30	70	OP
Micropogonias megalops (Gilbert, 1890)	Gulf croaker	D	30	40	OP
Totoaba macdonaldi (Gilbert, 1890)	Totoaba	D	25	200	OP
Stellifer wintersteenorum Chao, 2001	Amigo stardrum	D	20	21	OP
Umbrina wintersteeni Walker et Radford, 1992	Wintersteen drum	D	15	35	OP
FAMILY KYPHOSIDAE					
Girella simplicidens Osburn et Nichols, 1916	Gulf opal eye	A	15	46	OP
FAMILY LABRIDAE					
Pseudojuloides inornatus (Gilbert, 1890)	Cape wrasse	D	57	9	OP
FAMILY TRIPTERYGIIDAE					
Axoclinus nigricaudus Allen et Robertson, 1991	Cortez triplefin	A	5	5	OBPP
Crocodilichthys gracilis Allen et Robertson, 1991	Lizard triplefin	A	40	8	OBPP
FAMILY DACTYLOSCOPIDAE					
Dactyloscopus pectoralis Gill, 1861	Whitesaddle stargazer	B	45	5	OBPP
Gillellus ornatus Gilbert, 1892	Ornate stargazer	B	55	6	OBPP
Myxodagnus opercularis Gill, 1861	Dart stargazer	B	20	9	OBPP
FAMILY LABRISOMIDAE					
Cryptotrema seftoni Hubbs, 1954	Hidden blenny	A	10	3.5	—
Malacoctenus gigas Springer, 1959	Sonora blenny	A	5	13	OBPP
Malacoctenus hubbsi Springer, 1959	Redside blenny	A	6	9	OBPP
Paraclinus altivelis (Lockington, 1881)	Topgallant blenny	A	40	6	OBPP
Paraclinus magdalenae Rosenblatt et Parr, 1969	Magdalena blenny	A	21	4.5	OBPP
Starksia cremnobates (Gilbert, 1890)	Fugitive blenny	A	60	4	W
Xenomedea rhodopyga Rosenblatt et Taylor, 1971	Redrump blenny	A	33	6.5	W
FAMILY CHAENOPSIDAE					
Acanthemblemaria crockeri Beebe et Tee-Van, 1938	Browncheek blenny	A	60	6	OBPP
Acanthemblemaria hastingsi Lin et Galland, 2010	Cortez barnacle blenny	A	10	5.5	OBPP
Chaenopsis coheni Böhlke, 1957	Cortez pikeblenny	A	40	7.2	OBPP
Coralliozetus micropes (Beebe et Tee-Van, 1938)	Scarletfin blenny	A	5	4	OBPP
Coralliozetus rosenblatti Stephens, 1963	Spikefin blenny	A	9	3.5	OBPP
Emblemaria hypacanthus (Jenkins et Evermann, 1889)	Gulf signal blenny	A	10	5	OBPP
Emblemaria walkeri Stephens, 1963	Elusive signal blenny	A	20	6.5	OBPP
Stathmonotus sinuscalifornici (Chabanaud, 1942)	California worm blenny	A	5	6.5	OBPP

Table 1 (cont.)

Class, family, and species	Common name	Habitat	Depth [m]	TL [cm]	RS
FAMILY GOBIESOCIDAE					
Gobiesox pinniger Gilbert, 1890	Tadpole clingfish	A	5	13	OBPP
Gobiesox schultzi Briggs, 1951	Smoothlip clingfish	A	5	7.8	OBPP
Pherallodiscus funebris (Gilbert, 1890)	Northern fraildisc clingfish	A	5	12.5	OBPP
Tomicodon boehlkei Briggs, 1955	Cortez clingfish	A	12	7.5	OBPP
Tomicodon humeralis (Gilbert, 1890)	Sonora clingfish	A	5	10	OBPP
FAMILY GOBIIDAE					
Aruma histrio (Jordan, 1884)	Slow goby	A	15	6.5	OBPP
Barbulifer pantherinus (Pellegrin, 1901)	Panther goby	A	32	5.2	OBPP
Chriolepis minutillus Gilbert, 1892	Rubble goby	A	45	3.2	OBPP
Chriolepis zebra Ginsburg, 1938	Gecko goby	A	30	4.4	OBPP
Elacatinus limbaughi Hoese et Reader, 2001	Widebanded cleaning goby	A	30	3.4	OBPP
Evermannia longipinnis (Steindachner, 1879)	Enigmatic goby	B	3	3.8	OBPP
Gillichthys detrusus Gilbert et Scofield, 1898	Delta mudsucker	B	10	11.1	OBPP
Gillichthys seta (Ginsburg, 1938)	Shortjaw mudsucker	A	2	6	OBPP
Gobiosoma chiquita (Jenkins et Evermann, 1889)	Sonora goby	A	10	7.5	OBPP
Ilypnus luculentus (Ginsburg, 1938)	Bright goby	B	3	5.3	OBPP
Pycnomma semisquamatum Rutter, 1904	Secret goby	A	20	6.3	OBPP
Quietula guaymasiae Jenkins et Evermann, 1889	Guaymas goby	B	5	8.5	OBPP
FAMILY STROMATEIDAE					
Peprilus ovatus Horn, 1970	Shining butterfish	E	27	13	OP
FAMILY PARALICHTHYIDAE					
Etropus ciadi van der Heiden et Plascencia González, 2005		B	40	11.5	OP
Paralichthys aestuarius Gilbert et Scofield, 1898	Cortez flounder	B	45	58	OP
FAMILY PLEURONECTIDAE					
Pleuronichthys ocellatus Starks et Thompson, 1910	Ocellated turbot	B	140	24	OP

Common names follow those in FishBase (Froese and Pauly 2012); Habitat: A = reef species, B = soft bottom demersal, C = mixed bottom demersal, D = pelagic–demersal (species that being demersal also break-into the water column), E = neritic–pelagic (those associated to the upper part of the water column by the coastal zone), F = mesopelagic, G = bathybenthic; Depth (minimum and maximum depth limits in which species are distributed); TL = maximum total length, (AJ = all juveniles); RS = reproduction strategy (V = viviparous, W = ovoviviparous, OP = oviparous with pelagic eggs, OBPP = oviparous with benthic eggs and pelagic phase, OBWPP = oviparous with benthic eggs without pelagic phase, OOG = oviparous with oral gestation, OGVVS = oviparous with gestation in the vascularized ventral sac).

as a possible juvenile of a different species by Compagno (2005). However, Castro-Aguirre and Espinosa-Pérez (1996) collected and confirmed the existence of this species off the La Paz Bay. A similar situation is that of the mystery anchovy, *Anchoviella parri*, described from specimens collected in 1926 on board of the Pawnee research cruise off San Felipe. Based on morphological characters Whitehead et al. (1988) proposed that *Anchoviella parri* might instead be the Upper Gulf of California *Anchoa lucida*. Similarly, the Gulf rockfish, *Sebastes peduncularis*, is only known from two juvenile specimens collected with midwater trawls between the southern end of Tiburon Island and Angel de la Guarda Island, at 440–450 m depths (Chen 1975). However, given the overlapping characters with the Cortez rockfish, *S. cortezi*, Chen (1975) himself discussed the option of this species being a junior synonym of the Cortez rockfish or even of any other species of *Sebastes* (see Chen 1975, Love et al. 2002).

Additionally, three species were described and are currently known only from their holotypes. The ordinary eel, *Ethadophis byrnei,* was sampled during low tide at Puertecitos, western coast of the Gulf of California. The Cortez searobin, *Peristedion paucibarbiger*, was collected by bottom trawling at 60 m depth north of La Paz bay, BCS. Lastly, the cape wrasse, *Pseudojuloides inornatus*, is known only from a juvenile collected near Cabo San Lucas, BCS.

A smoothhound shark, *Mustelus albipinnis*, was described from six captured specimens in 2000, at Puerto Adolfo Lopez Mateos, BCS. The same species was also described, in the same year, under the name *M. hacat*, from 36 collected specimens across the Gulf of California; nevertheless, *M. albipinnis* is considered as the valid name according to priority principle (Anonymous 1999). Considering both descriptions, the distribution range of this species comprises the inner parts of the Gulf of California: from north of Isla Angel de la Guarda, to the south-western coast of the Gulf of California including Santa Cruz and Monserrat Islands, and La Ventana Bay, and the Western coast of BCS on the shelf in front of Bahía Magdalena (Castro-Aguirre et al. 2005b, Perez-Jimenez et al. 2005). This species can be kept as an endemic component of CP; however, according to Perez-Jimenez et al. (2005), it is possible that *M. albipinnis* distribution extends southward to the coasts of Ecuador including Galapagos Islands.

Bussing and Lavenberg (2003), in a review of the genus *Opistognathus*, concluded that *Opistognathus mexicanus* Allen et Robertson, 1991, considered endemic to the Gulf of California, was instead a juvenile of *O. punctatus* Peters, 1869, which has a wide distribution across the Tropical Eastern Pacific. An opposite case is that of delta mudsucker, *Gillichthys detrusus* (Gobiidae), this species was erroneously placed in the synonymy of *G. mirabilis* Cooper, 1864, in 1907 (see Swift et al. 2011).

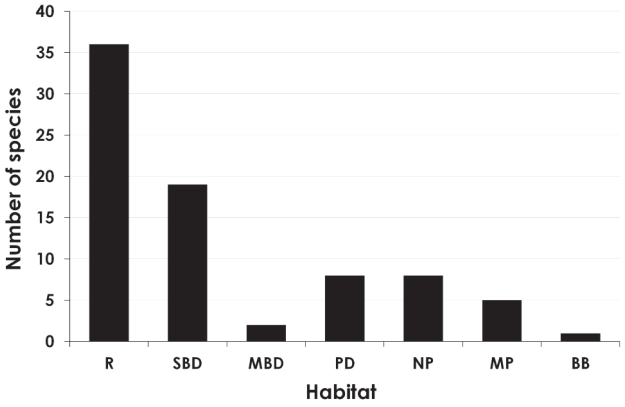

Fig. 2. Endemic fishes from the Cortez Province by preferential habitat; R = reef, SBD = soft bottom demersal, MBD = mixed bottom demersal, PD = pelagic–demersal, NP = neritic–pelagic, MP = mesopelagic, BB = bathybenthic

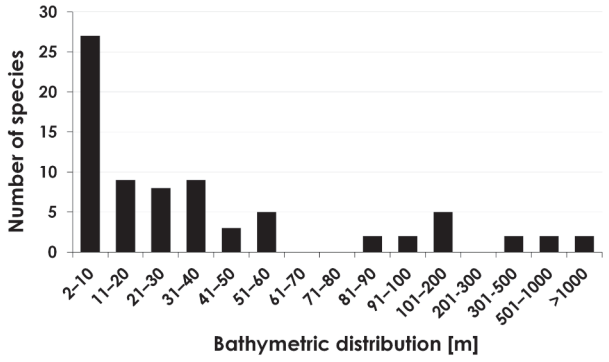

Fig. 3. Bathymetric distribution of endemic fishes from the Cortez Province

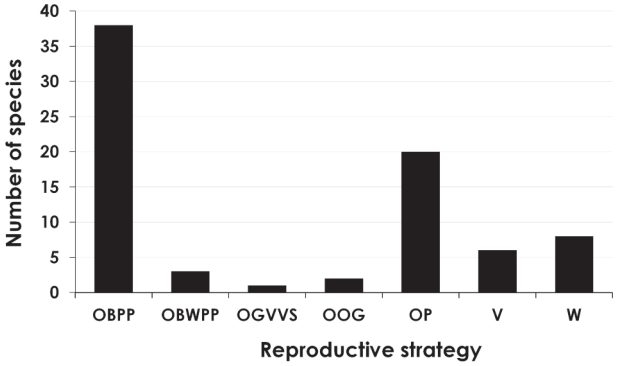

Fig. 4. Reproductive strategies of endemic fishes from the Cortez Province: OBPP = oviparous with benthic eggs and pelagic phase, OBWPP = oviparous with benthic eggs without pelagic phase, OGVVS = oviparous with gestation in the vascularized ventral sac, OOG = oviparous with oral gestation, OP = oviparous with pelagic eggs, V = viviparous, W = ovoviviparous

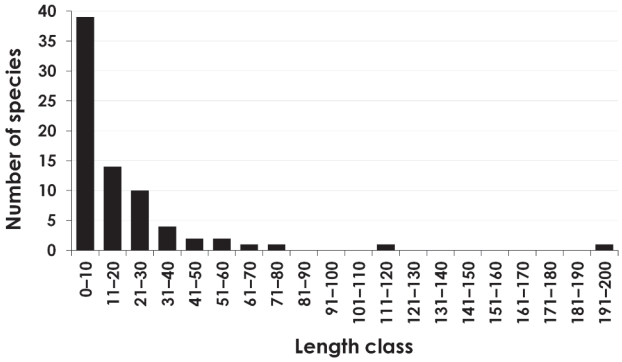

Fig. 5. Endemic fishes from the Cortez Province; Length-class distribution (maximum total length; Length classes [cm]

A study on several species complexes done by Hastings and Springer (2009), resulted in recognition of existing morphological differences among subspecies of *Dactyloscopus pectoralis* (*fallax*, *insulatus*, and *pectoralis*) and *Malacoctenus hubbsi* (*hubbsi* and *polyporosus*) evidence used to guarantee at least the existence of *D. pectoralis* and *M. hubbsi* as endemic species to the CP. Similar studies were made by Rosenblatt and Parr (1967, 1969) for the genus *Paraclinus*; Stepien and Rosenblatt (1991) for *Gibbonsia* and *Heterostichus*; and Bath (2008) for the genus *Parablennius*, where some subspecies were raised to species and some others were recognized as synonyms (Hastings and Springer 2009). Nonetheless, the use of additional tools is required (e.g., geometric morphometrics and genetic or molecular analyses) to come to any further conclusions on these particular cases.

Additionally, 21 species described as endemics of the Gulf of California have been found outside the CP expanding their distribution ranges (e.g., Castro-Aguirre et al. 2006). Those species are: *Raja cortezensis*

Table 2

Genetic divergence in disjunct fish species

Species	Molecular marker	Divergence [%]	Reference
Anisotremus davidsonii (Steindachner, 1876)	Cytochrome B	0.40	Bernardi and Lape 2005
	Cytochrome B	1.34	Bernardi et al. 2003
	S7	0	Bernardi and Lape 2005
Chaenopsis alepidota (Gilbert, 1890)	Control region	1.87	Bernardi et al. 2003
Gillichthys mirabilis Cooper, 1864	Cytochrome B	2.21	Huang and Bernardi 2001
Girella nigricans (Ayres, 1860)	Control region	8.49	Bernardi et al. 2003
	Control region	3.3	Terry et al. 2000
Gymnura marmorata Cooper, 1864	NADH2	<0.01	SCRO
Halichoeres semicinctus (Ayres, 1859)	Control region	0.79	Bernardi et al. 2003
Hermosilla azurea Jenkins et Evermann, 1889	Control region	2.30	Bernardi et al. 2003
Hypsoblennius jenkinsi (Jordan et Evermann, 1896)	Control region	7.87	Bernardi et al. 2003
Hypsopsetta guttulata (Girard, 1856)	Control region	0.1211	Schinske et al. 2010
	S7	0.0029	Schinske et al. 2010
Lythrypnus dalli (Gilbert, 1890)	Cytochrome B	0.20	Bernardi et al. 2003
Myliobatis californica Gill, 1865	NADH2	0.3	SCRO
Narcine entemedor Jordan et Starks, 1895	NADH2	0	SCRO
Paralabrax maculatofasciatus (Steindachner, 1868)	Control region	1.06	Stepien et al. 2001
Rhinobatos productus Ayres, 1854	Control region	2.47	SCRO
	NADH2	1.2	SCRO
Rhinoptera steindachneri Evermann et Jenkins, 1891	NADH2	10	Sandoval-Castillo and Rocha-Olivares 2011
Sebastes macdonaldi (Eigenmann et Beeson, 1893)	Control region	0.64	Bernardi et al. 2003
Semicossyphus pulcher (Ayres, 1854)	Control region	0.84	Bernardi et al. 2003

SCRO = Sandoval-Castillo and Rocha-Olivares, unpublished data in: Sandoval-Castillo and Rocha-Olivares (2011).

McEachran et Miyake, 1988 (Rajidae), *Urobatis concentricus* Osburn et Nichols, 1916 (Urotrygonidae), *Urolophus maculatus* (Garman, 1913) (Urolophidae), *Gymnothorax eurygnathos* Böhlke, 2001 (Muraenidae), *Herpetoichthys fossatus* (Myers et Wade, 1941) (Ophichthidae), *Heteroconger digueti* (Pellegrin, 1923) (Congridae), *Anchoa mundeoloides* (Breder, 1928) (Engraulidae), *Porichthys analis* Hubbs et Schultz, 1939 (Batrachoididae), *Scorpaena sonorae* Jenkins et Evermann, 1889 (Scorpaenidae), *Mycteroperca prionura* Rosenblatt et Zahuranec, 1967, *M. rosacea* (Streets, 1877) (Serranidae), *Opistognathus rosenblatti* Allen et Robertson, 1991 (Opistognathidae), *Orthopristis reddingi* Jordan et Richardson, 1895 (Haemulidae), *Chromis limbaughi* Greenfield et Woods, 1980, *Stegastes rectifraenum* (Gill, 1862) (Pomacentridae), *Enneanectes reticulatus* Allen et Robertson, 1991 (Tripterygiidae), *Labrisomus xanti* Gill, 1860 (Labrisomidae), *Cirriemblemaria lucasana* (Stephens, 1963) (Chaenopsidae), *Bollmannia macropoma* Gilbert, 1892, *B. ocellata* Gilbert, 1892 (Gobiidae), and *Citharichthys gordae* Beebe et Tee-Van, 1938 (Paralichthyidae). The record of *Paralichthys aestuarius* from Laguna Ojo de Liebre (Arellano-Martinez et al. 1997) is erroneous; this specimen was examined and allowed us to confidently identify it as *P. californicus* (Ayres, 1859).

On the other hand, ecological characteristics of the CP endemic species revealed that the component associated with coralline and rocky reef systems is dominant, mainly represented by small fishes from the families Gobiidae, Chaenopsidae, Labrisomidae, Gobiesocidae, and Bythitidae, among others. These groups are common off the islands of the Gulf of California, and in the central and south-western coasts of it (Thomson et al. 2000, Thomson and Gilligan 2002). Demersal, demersal-pelagic, and neritic-pelagic species from the families Paralichthyidae, Sciaenidae, Engraulidae, and Atherinopsidae are related mainly to soft bottom ecosystems in the eastern coast and Upper Gulf of California (Hastings and Findley 2007, Robertson and Allen 2008). Concerning deep-water ichthyofauna from the Gulf of California, Castro-Aguirre and Balart (1996) denoted the importance of further studies on the great basins, trenches, and ocean depressions from where specimens like the Cortez hagfish, *Eptatretus sinus*, were obtained. Robertson and Cramer (2009) without counting this deep-water component validated the existence of only 62 fish species endemic to the PC.

From the endemic ichthyofauna, 12 species reach a maximum length of 5 cm, 39 are shorter than 10 cm, and only the totoaba reaches a total length exceeding 2 m. Small-sized species belong mainly to the families Gobiidae, Chaenopsidae, Labrisomidae, Gobiesocidae, Dactyloscopidae, and Tripterygiidae. The dominant reproduction strategy of these families is oviparous with benthic eggs and pelagic phase. These families are considered primary residents given the limited movility of larvae and adults (Thomson and Gilligan 2002). Eggs are relatively large and fixed to the substratum, while adults have a short lifetime (one or two years of generation time), becoming

territorial and therefore limiting genetic flow and favouring species fragmentation (Rosenblatt 1963, Thomson and Gilligan 2002). TEP biogeographic gaps (e.g., Sinaloa and Central America) have a considerable impact on these families. Conversely oviparous species with pelagic eggs and long planktonic larval stage (secondary residents) have great potential for dispersal, which is enhanced by the currents (Leis and McCormick 2002), keeping species genetic homogeneity. In the TEP just 30% of species are oviparous with benthic eggs and pelagic phase, most of the species are oviparous with pelagic eggs (56%) (Robertson and Allen 2008).

Some models have demonstrated that ecological differences may cause partial or total reproductive barriers in just hundreds of generations (Hendry et al. 2007). Reproductive isolation may evolve rapidly when populations are settled and adapted to ecologically different environments (Palumbi 1994). In the presently reported study, 26 species with disjunct population distribution have been detected; these species are found on the Pacific Coast and in the northern part of the Gulf of California, but are absent from the southern (Cabo San Lucas) region (Walker 1960, Castro-Aguirre et al. 2005a, Hastings et al. 2010). These species are: *Hydrolagus colliei* (Lay et Bennett, 1839) (Chimaeridae), *Raja binoculata* Girard, 1855, *R. inornata* Jordan et Gilbert, 1881, *R. rhina* Jordan et Gilbert, 1880 (Rajidae), *Platyrhinoidis triseriata* (Jordan et Gilbert, 1880) (Platyrhinidae), *Atherinops affinis* (Ayres, 1860) (Atherinopsidae), *Scorpaena guttata* Girard, 1854 (Scorpaenidae), *Sebastes macdonaldi* (Sebastidae), *Zaniolepis frenata* Eigenmann et Eigenmann, 1889 (Hexagrammidae), *Anisotremus davidsonii* (Haemulidae), *Atractoscion nobilis* (Ayres, 1860), *Cheilotrema saturnum* (Girard, 1858) (Sciaenidae), *Girella nigricans* (Kyphosidae), *Zalembius rosaceus* (Jordan et Gilbert, 1880) (Embiotocidae), *Halichoeres semicinctus*, *Semicossyphus pulcher* (Labridae), *Hypsoblennius gentilis* (Girard, 1854), *H. jenkinsi* (Blenniidae), *Exerpes asper* (Jenkins et Evermann, 1889) (Labrisomidae), *Chaenopsis alepidota* (Chaenopsidae), *Gillichthys mirabilis* (Gobiidae), *Scomberomorus concolor* (Lockington, 1879) (Scombridae), *Paralichthys californicus* (Paralichthyidae), *Pleuronichthys guttulatus* (Girard, 1856), *P. ocellatus* Starks et Thompson, 1910, and *P. verticalis* Jordan et Gilbert, 1880 (Pleuronectidae).

Some studies (e.g., Bernardi et al. 2003, Sandoval-Castillo and Rocha-Olivares 2011) have detected subtle morphological differences and, in some species, significant genetic distance (Table 2), which in turn could be derived in increasing ichthyodiversity endemism in this province. In addition, according to Robertson and Allen (2008), three species (*Chriolepis* (2) and *Enneanectes* (1)) have not yet been described in the Gulf of California.

There is a general consensus that the limits of biogeographic provinces are identified by the occurrence of species distribution and that these limits generally correspond with the existence of environmental discontinuities. Established limits for the CP have been extensively discussed (e.g., Hendrickx 1992, Hastings 2000, Erisman et al. 2011). Based on geological evidence several authors (Thomson et al. 2000, Brusca and Findley 2005, Brusca et al. 2005, Hendrickx et al. 2005, 2007, and Hastings et al. 2010) have included in the limits of the Gulf of California an extended fringe from the Baja California Peninsula towards the Mexican mainland territory, in other words from Cabo San Lucas, BCS towards Cabo Corriente, Jalisco. The southern CP limit extension allows the inclusion of three endemic species from Islas Marías: the scaly-belly blenny, *Starksia lepidogaster* Rosenblatt et Taylor, 1971, described from 11 specimens collected at Cleopatra Island; the leastfoot blenny, *Paraclinus ditrichus* Rosenblatt et Parr, 1969, known only from three specimens; and the lonely clingfish, *Gobiesox marijeanae* Briggs, 1960, known from eleven specimens. The latter two species were sampled at San Juanito Island. This addendum would increase endemic species number to 82.

A great number of studies have pointed out the importance of the CP in terms of conservation, and although recent meaningful efforts for its conservation have been developed (e.g., World heritage Islands and protected areas of the Gulf of California, Natural protected areas: Biosphere reserves of the Upper Gulf of California and Colorado River delta; San Pedro Martir Island; Bahia de los Angeles, Ballenas and Salsipuedes Channels; Gulf of California islands; and Cabo San Lucas; National parks of Loreto bay, Cabo Pulmo, Espiritu Santo Archipelago, and San Lorenzo Archipelago), over the past two decades the existence of a complex web of threats to this large marine ecosystem have being noted (Sala et al. 2004, Enríquez-Andrade et al. 2005, Sáenz-Arroyo et al. 2005, Cudney-Bueno et al. 2009, Hastings et al. 2010, Erisman et al. 2011).

It is generally known that nomenclature ambiguity, and incomplete diversity lists may represent a problem for species and therefore area conservation (Rojas 1992, Hey et al. 2003, Isaac et al. 2004, Mace 2004). Hence, the importance of clarifying species taxonomic status and updating the knowledge of endemism might help in the development of objective conservation strategies (Kerr 1997).

ACKNOWLEDGEMENTS

This work was funded by the IIK´KAKNAB, A.C. We thank to Alfredo Zayas, Norma Sánchez, Pablo Castro, Luis Mejía, Carlos Felix, and Linda Barranco for their contribution to this study. D.S.P.S. wishes to thank CONACyT´s program: 'Complementary Support for the Institutional Strengthening Working Groups: Retention'. Thanks to Melba De Jesús Huerta and Mariana Santana for their help in language editing.

REFERENCES

Anonymous 1999. International code of zoological nomenclature. Fourth edition. International Commission of Zoological Nomenclature. The International Trust for Zoological Nomenclature, c/o Natural History Museum, London.

Aragón-Noriega E.A., Valenzuela-Quiñones W., Esparza-Leal H., Ortega-Rubio A., Rodríguez-Quiroz G. 2009.

Analysis of management options for artisanal fishing of the Bigeye Croaker *Micropogonias megalops* (Gilbert, 1890) in the Upper Gulf of California. International Journal of Biodiversity Science and Management **5** (4): 208–214. DOI: 10.1080/17451591003709371

Arellano-Martínez M., De La Cruz-Agüero J., Cota-Gómez V.M. 1997. New records and range extensions of fishes on the Pacific Coast of Mexico. Revista Biología Tropical **45** (2): 936.

Balon E.K. 1989. Patterns in the evolution of reproductive styles in fishes. Pp. 35–51. *In*: Potts G.W., Wootton R.J. (eds.). Fish reproduction strategies and tactics. Academic Press, London.

Bath H. 2008. Review of the genus *Parablennius* Miranda-Ribeiro from Australia and New Caledonia (Pisces: Blenniidae: Salariinae). Stuttgarter Beiträge zur Naturkunde A, Neue Serie **1**: 77–94.

Berdegue J. 1955. La pesquería de la totoaba (*Cynoscion macdonaldi* Gilbert) en San Felipe, Baja California. Revista de la Sociedad Mexicana de Historia Natural **16** (1–4): 45–78.

Bernardi G., Findley L.T., Rocha-Olivares A. 2003. Vicariance and dispersal across Baja California in disjunct marine fish populations. Evolution **57** (7): 1599–1609.

Bernardi G., Lape J. 2005. Tempo and mode of speciation in the Baja California disjunct fish species *Anisotremus davidsonii*. Molecular Ecology **14** (13): 4085–4096. DOI: 10.1111/j.1365-294X.2005.02729.x

Briggs J.C. 1974. Marine zoogeography. McGraw-Hill, New York, NY, USA.

Brusca R.C., Findley L.T. 2005. El Mar de Cortés. Pp: 1–32. *In*: Hendrickx M.E., Brusca C.R., Findley L.T. (eds.) Listado y Distribución de la Macrofauna del Golfo de California, México. Part I. Invertebrados. Arizona–Sonora Desert Museum/Conservation International, Tucson, AZ, USA.

Brusca R.C., Findley L.T., Hastings P.A., Hendrickx M.E., Torre Cosio J., van der Heiden A.M. 2005. Macrofaunal biodiversity in the Gulf of California. Pp. 179–203. *In*: Cartron J.L.E., Ceballos G., Felger R. (eds.) Biodiversity, ecosystems, and conservation in Northern Mexico. Oxford University Press, New York, NY, USA.

Bussing W.A., Lavenberg R.J. 2003. Four new species of eastern tropical Pacific jawfishes (*Opistognathus*: Opistognathidae). Revista Biología Tropical **51** (2): 529–550.

Castro-Aguirre J.L., Antuna-Mendiola A., González-Acosta A.F., De la Cruz-Agüero J. 2005a. *Mustelus albipinnis* sp. nov. (Chondrichthyes: Carcharhiniformes: Triakidae) de la costa suroccidental de Baja California Sur, México. Hidrobiológica **15** (2): 123–130.

Castro-Aguirre J.L., Balart E.F. 1996. Contribución al conocimiento del origen y las relaciones de la ictiofauna de aguas profundas del Golfo de California, México. Hidrobiológica **6** (1–2): 67–76.

Castro-Aguirre J.L., Balart E.F., Arvizu-Martínez J. 1995. Contribución al conocimiento del origen y distribución de la ictiofauna del Golfo de California, Mexico. Hidrobiológica **5** (1–2): 57–78.

Castro-Aguirre J.L., Espinosa-Pérez H. 1996. Listados faunísticos de México. VII. Catalogo sistemático de las rayas y especies afines de México (Chondrichthyes: Elasmobranchii: Rajiformes: Batoideiomorpha). Instituto de Biología, UNAM, Mexico.

Castro-Aguirre J.L., Espinosa-Pérez H. 2006. Los peces de la familia Atherinopsidae (Teleostei: Atheriniformes) de las lagunas costeras neutras e hipersalinas de México. Hidrobiológica **16** (1): 89–101.

Castro-Aguirre J.L., Gonzalez-Acosta A.F., De la Cruz-Agüero J. 2005b. Lista anotada de las especies ícticas anfipacificas, de afinidad boreal, endémicas y anfipeninsulares del Golfo de California, México. Universidad y Ciencia **21** (42): 85–106.

Castro-Aguirre J.L., González-Acosta A.F., De la Cruz-Agüero J., Moncayo-Estrada R. 2006. Ictiofauna marina-costera del Pacífico central mexicano: análisis preliminar de su riqueza y relaciones biogeográficas. Pp: 149–166. *In*: Jiménez-Quiroz M.C., Espino-Barr E. (eds.) Los recursos pesqueros y acuícolas de Jalisco, Colima y Michoacán. Instituto Nacional de Pesca, SAGARPA, Mexico.

Chen L.C. 1975. The rockfishes, genus *Sebastes* (Scorpaenidae), of the Gulf of California, including three new species with a discussion of their origin. Proceedings of the California Academia of Sciences Ser. 4, **40** (6): 109–141.

Cisneros-Mata M.A., Montemayor-López G., Román-Rodríguez M.J. 1995. Life history and conservation of *Totoaba macdonaldi*. Conservation Biology **9** (4): 806–814. DOI: 10.1046/j.1523-1739.1995.09040806.x

Compagno L.J.V. 2005. Checklist of living Elasmobranchs. Pp. 503–548. *In*: Hamlett W.C. (ed.) Reproductive biology and phylogeny of Chondrichthyes: sharks, batoids, and chimaeras. Science Publishers, Enfield, NH, USA.

Cudney-Bueno R., Bourillón L., Sáenz-Arroyo A., Torre-Cosío J., Turk-Boyer P., Shaw W.W. 2009. Governance and effects of marine reserves in the Gulf of California, Mexico. Ocean and Coastal Management **52** (3–4): 207–218. DOI: 10.1016/j.ocecoaman.2008.12.005

Dawson C.E. 1975. Studies on the eastern Pacific sand stargazers (Pisces: Dactyloscopidae) 2. Genus *Dactyloscopus*, with descriptions of new species and subspecies. Natural History Museum of Los Angeles County, Scientific Bulletin **22** (1): 1–61.

Elliott M., Dewailly F. 1995. The structure and components of European estuarine fish assemblages. Netherlands Journal of Aquatic Ecology **29** (3–4): 397–417. DOI: 10.1007/BF02084239

Enríquez-Andrade R., Anaya-Reyna G., Barrera-Guevara J.C., Carvajal-Moreno M.A., Martínez-Delgado M.E., Vaca-Rodríguez J., Valdés-Casillas C. 2005. An analysis of critical areas for biodiversity conservation in the Gulf of California region. Ocean and Coastal Management **48** (1): 31–50. DOI: 10.1016/j.ocecoaman.2004.11.002

Erisman B.E., Paredes G.A., Plomozo-Lugo T., Cota-Nieto J.J., Hastings P.A., Aburto-Oropeza O. 2011. Spatial structure of commercial marine fisheries in Northwest Mexico. ICES Journal of Marine Science **68** (3): 564–571. DOI: 10.1093/icesjms/fsq179

Findley L.T., Hastings P.A., van der Heiden A.M., Güereca R., Torre J., Thomson D.A. 1997. Distribution of endemic

fishes of the Gulf of California, Mexico. Pp. 130. *In*: Abstracts, 77th Annual Meeting of the American Society of Ichthyologists and Herpetologists, Seattle, WA, USA.

Findley L.T., Hastings P.A., van der Heiden A.M., Güereca R., Torre J., Thomson D.A. 1999. Distribution of endemic ichthyofauna of the Sea of Cortes. Pp. 51. *In*: Abstracts, VII Congreso de la Asociación de Investigadores del Mar de Cortés, A.C. and Simposium Internacional sobre el Mar de Cortés. 25–28, Mayo 1999. Universidad de Sonora. Hermosillo, Sonora, Mexico.

Findley L.T., Torre J., Hastings P.A., van der Heiden A.M., Nava J.M. 1996a. Diversity and endemicity of the fish fauna of the Gulf of California, Mexico. Pp. 10–13. *In*: Program and Abstracts. The phylogeny of life and the accomplishments of phylogenetic biology. A symposium at the University of Arizona Tucson, AZ, USA.

Findley L.T., Torre J., Nava J.M., van der Heiden A.M., Hastings P.A. 1996b. Preliminary ichthyofaunal analysis from a macrofaunal database on the Gulf of California, México. P. 138. *In*: Abstracts, 76th Annual Meeting of the American Society of Ichthyologists and Herpetologists, New Orleans, LA, USA.

Froese R., Pauly D. (eds.) 2012. FishBase. [version 06/2012] http://www.fishbase.org.

Hastings P.A. 2000. Biogeography of the Tropical Eastern Pacific: distribution and phylogeny of chaenopsid fishes. Zoological Journal of the Linnean Society **128** (3): 319–335. DOI: 10.1006/zjls.1998.0196

Hastings P.A., Findley L.T. 2007. Marine fishes of the Biosphere Reserve, Northern Gulf of California. Pp. 364–382. *In*: Felger R., Broyles W. (eds.) Dry borders: Great natural areas of the Gran Desierto and Upper Gulf of California. University Utah Press, Salt Lake City, UT, USA.

Hastings P.A., Findley L.T., Van der Heiden A.M. 2010. Fishes of the Gulf of California. Pp: 96–118. *In*: Brusca R. (ed.). The Gulf of California. Biodiversity and Conservation. University Arizona Press. Tucson, AZ, USA.

Hastings P.A., Springer V.G. 2009. Recognizing diversity in blennioid fish nomenclature (Teleostei: Blennioidei). Zootaxa **2009** (2120): 3–14.

Hendrickx M.E. 1992 Distribution and zoogeographic affinities of decapods crustaceans of the Gulf of California, Mexico. Proceedings of the San Diego Society of Natural History **20** (1): 1–11.

Hendrickx M.E., Brusca R.C., Cordero M., Ramírez R.G. 2007. Marine and brackish-water molluscan biodiversity in the Gulf of California, Mexico. Scientia Marina **71** (4): 637–647. DOI: 10.3989/scimar.2007.71n4637

Hendrickx M.E., Brusca R.C., Findley L.T. (eds.) 2005. A Distributional checklist of the macrofauna of the Gulf of California, Mexico. Part I. Invertebrates. Arizona-Sonora Desert Museum and Conservation International.

Hendry A.P., Nosil P., Rieseberg L.H. 2007. The speed of ecological speciation. Functional Ecology **21** (3): 455–464. DOI: 10.1111/j.1365-2435.2007.01240.x

Hey J., Waples R.S., Arnold M.L., Butlin R.K., Harrison R.G. 2003. Understanding and confronting species uncertainty in biology and conservation. Trends in Ecology and Evolution **18** (11): 597–603. DOI: 10.1016/j.tree.2003.08.014

Hildebrand S.F. 1943. A review of the American anchovies (family Engraulidae). Bulletin of the Bingham Oceanographic Collection Yale University **8**: 1–165.

Huang D., Bernardi G. 2001. Disjunct Sea of Cortez—Pacific Ocean *Gillichthys mirabilis* populations and the evolutionary origin of their Sea of Cortez endemic relative, *Gillichthys seta*. Marine Biology **138** (2): 421–428. DOI: 10.1007/s002270000454

Isaac N.J.B., Mallet J., Mace G.M. 2004. Taxonomic inflation: its influence on macroecology and conservation. Trends in Ecology and Evolution **19** (9): 464–469. DOI: 10.1016/j.tree.2004.06.004

Kerr J.T. 1997. Species richness, endemism, and the choice of areas for conservation. Conservation Biology **11** (5): 1094–1100. DOI: 10.1046/j.1523-1739.1997.96089.x

Leis J.M., McCormick M.I. 2002. The biology, behavior, and ecology of the pelagic, larval stage of coral reef fishes. Pp 171–199. *In*: Sale P.F. (ed.) Coral reef fishes dynamics and diversity in a complex ecosystem. Academic Press, London.

Love M.S., Yoklavich M., Thorsteinson L. 2002. The rockfishes of the Northeast Pacific. University of California Press, Berkeley, CA, USA.

Mace G.M. 2004. The role of taxonomy in species conservation. Philosophical Transactions of the Royal Society of London B **359** (1444): 711–719. DOI: 10.1098/rstb.2003.1454

Mora C., Robertson D.R. 2005. Factors shaping the range-size frequency distribution of the endemic fish fauna of the Tropical Eastern Pacific. Journal of Biogeography **32** (2): 277–286. DOI: 10.1111/j.1365-2699.2004.01155.x

Nelson J.S. 2006. Fishes of the world. 4th edn. John Wiley and Sons, Hoboken, NJ, USA.

Palumbi S.R. 1994. Genetic divergence, reproductive isolation, and marine speciation. Annual Review of Ecology and Systematics **25**: 547–572. DOI: 10.1146/annurev.es.25.110194.002555.

Paredes G.A., Erisman B., Mascareñas-Osorio I., Cota-Nieto J., Gherard K., Aburto-Oropeza O. 2010. La curvina golfina: Biologia, pesqueria y su gente. CONABIO. Biodiversitas **2010** (91): 1–5.

Pérez Jiménez J.C., Sosa Nishizaki O., Castillo Geniz J.L. 2005. A new eastern north Pacific smoothhound shark (genus *Mustelus*, family Triakidae) from the Gulf of California. Copeia **2005** (4): 834–845. DOI: 10.1643/0045-8511(2005)005[0834:ANENPS]2.0.CO;2

Robertson D.R., Cramer K.L. 2009. Shore fishes and biogeographic subdivisions of the tropical eastern Pacific. Marine Ecology Progress Series **380**: 1–17. DOI: 10.3354/meps07925

Robertson D.R., Allen G.R. 2008. Peces costeros del Pacífico oriental tropical: Sistema de informacion en linea. Version 1.0 (2008). Instituto Smithsonian de Investigaciones Tropicales, Balboa, Republica de Panama. www.neotropicalfishes.org/sftep.

Robertson D.R., Grove J.S., McCosker J.E. 2004. Tropical transpacific shore fishes. Pacific Science **58** (4): 507–565. DOI: 10.1353/psc.2004.0041

Rojas M. 1992. The species problem and conservation: What are we protecting? Conservation Biology **6** (2): 170–178. DOI: 10.1046/j.1523-1739.1992.620170.x

Rosenblatt R.H. 1963. Some aspects of speciation in marine shore fishes. Pp. 171–180. *In*: Harding J.P., Tebble N.B. (eds.) Speciation in the sea. Publications of the Systematics Association, London, No. 5.

Rosenblatt R.H, Parr T.D. 1967. The identity of the blenny *Paraclinus altivelis* (Lockington) and the status of *P. sinus* Hubbs. Copeia **1967** (3): 675–677.

Rosenblatt R.H., Parr T.D. 1969. The Pacific species of the clinid fish genus *Paraclinu*s. Copeia **1969** (1): 1–20.

Sáenz-Arroyo A., Roberts C.M., Torre J., Cariño-Olvera M., Enríquez-Andrade R.R. 2005. Rapidly shifting environmental baselines among fishers of the Gulf of California. Proceedings of the Royal Society of London B **272** (1575): 1957–1962.
DOI: 10.1098/rspb.2005.3175

Sala E., Aburto-Oropeza O., Reza M., Paredes G., López-Lemuse L.G. 2004. Fishing down coastal food webs in the Gulf of California. Fisheries **29** (3): 19–25. DOI: 10.1577/1548-8446(2004)29[19:fdcfwi]2.0.co;2

Sandoval-Castillo J.R., Rocha-Olivares A. 2011. Deep mitochondrial divergence in Baja California populations of an aquilopelagic elasmobranch: the golden cownose ray. Journal of Heredity **102** (3): 269–274.
DOI: 10.1093/jhered/esr004

Schinske J.N., Bernardi G., Jacobs D.K., Routman E.J. 2010. Phylogeography of the diamond turbot (*Hypsopsetta guttulata*) across the Baja California Peninsula. Marine Biology **157** (1): 123–134.
DOI: 10.1007/s00227-009-1302-2

Springer V.G. 1959. Systematics and zoogeography of the clinid fishes of the subtribe Labrisomini Hubbs. Publications of the Institute of Marine Science, University of Texas **5**: 417–492.

Stepien C., Rosenblatt R.H. 1991. Patterns of gene flow and genetic divergence in the northeastern Pacific Clinidae (Teleostei: Blennioidei), based on allozyme and morphological data. Copeia **1991** (4): 873–896.
DOI: 10.2307/1446084

Stepien C.A., Rosenblatt R.H., Bargmeyer B.A. 2001. Phylogeography of the spotted sand bass, *Paralabrax maculatofasciatus*: divergence of Gulf of California and Pacific coast populations. Evolution **55** (9): 1852–1862. DOI: 10.1111/j.0014-3820.2001.tb00834.x

Swift C.C., Findley L.T., Ellingson R.A., Flessa K.W., Jacobs D.K. 2011. The delta mudsucker, *Gillichthys detrusus*, a valid species (Teleostei: Gobiidae) endemic to the Colorado River delta, northernmost Gulf of California, México. Copeia **2011** (1): 93–102.
DOI: 10.1643/CI-09-123

Terry A., Bucciarelli G., Bernardi G. 2000. Restricted gene flow and incipient speciation in disjunct Pacific Ocean and Sea of Cortez populations of a reef fish species, *Girella nigricans*. Evolution **54** (2): 652–659.
DOI: 10.1111/j.0014-3820.2000.tb00066.x

Thomson D.A., Findley L.T., Kerstitch A.N. 2000. Reef Fishes of the Sea of Cortez: The Rocky-Shore Fishes of the Gulf of California. University of Texas Press, Austin, TX, USA.

Thomson D.A., Gilligan M. 2002. Rocky-shore fishes. Pp: 154–180. *In*: Case T.J., Cody M.L., Ezcurra E. (eds.) A new island biogeography in the Sea of Cortes. Oxford University Press, Oxford.

Walker B.W. 1960. The distribution and affinities of the marine fish fauna of the Gulf of California. Symposium: The Biogeography of Baja California and adjacent Seas. System Zoology **9** (3): 123–133.

Whitehead P.J.P., Nelson G.J., Wongratana T. 1988. FAO Species Catalogue. Clupeoid fishes of the world (Suborder Clupeoidei). An annotated and illustrated catalogue of the herrings, sardines, pilchards, sprats, shads, anchovies and wolfherrings. Vol. 7. Part 2. Engraulididae. FAO Fish Synopsis 125.

Received: 5 May 2012
Accepted: 22 June 2012
Published electronically: 30 September 2012