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Biogeographical affinities of fish associated to the shrimp trawl fishery in the Gulf of Tehuantepec, Mexico

Marco A. Martínez-Muñoz[1], Domènec Lloris[2], Adolfo Gracia[1], Ricardo Ramírez-Murillo[3], Saul Sarmiento-Nafáte[4], Sebastián Ramos-Cruz[4] & Felipe Fernández[5]

1. Unidad Académica de Ecología Marina, Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México, PO Box 70-305, México, D.F., 04510; marcoam@unam.mx, gracia@unam.mx
2. Institut de Ciències del Mar (CMIMA-CSIC), Pasage Marítim de la Barceloneta 37-49 Barcelona, Spain; ictios@gmail.com
3. Instituto de Educación Media Superior del Distrito Federal (IEMS-DF). Plantel Tlalpan I. Av. División del Norte # 906, Col. Narvarte Poniente, 03020, Del. Benito Juárez México, D.F.; hippoglossina@hotmail.com
4. Instituto Nacional de Pesca, Centro Regional de Investigación Pesquera (CRIP) Salina Cruz, Prol. Playa Abierta S/N, Col. Miramar, 70680. Salina Cruz, Oaxaca, México; nafatess@yahoo.com.mx, ramoscruz@yahoo.com
5. Departament d'Ecologia, Facultat de Biologia, Universitat de Barcelona, Diagonal 645, 08028 Barcelona, Spain; ffernandez@ub.edu

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Abstract: Fish by-catch of shrimp fishery from the Gulf of Tehuantepec is composed of several species that are mainly discarded. In this study, fish by-catch species composition, distribution and biogeographical affinities were analyzed. For this, a total of 15 cruises were carried out on the continental shelf, at depths from 15 to 64 m, during 2003, 2004, 2005 and 2013. Results showed that fish by-catch was represented by 58 families, 129 genera and 242 species. The families Haemulidae, Sciaenidae, Paralichthyidae, Gerreidae and Carangidae accounted for > 70 % of the catch. *Haemulopsis axillaris*, *Syacium ovale*, *Selene peruviana*, *Diapterus peruvianus*, *Larimus acclivins* and *Stellifer erycimba* were the most frequent species at < 40 m depth (inner shelf), and *Prionotus stephanophrys*, *Scorpaena russula*, *Porichthys analis* and *Synodus scituliceps* were dominant at 40-60 m depth (outer shelf). Analysis of biogeographical affinities showed that 36.1 % of species had a wide distribution, from San Diego Province to the Panamic Province, while 13.2 % had a restricted distribution in the Mexican and Panamic Provinces. The ichthyofaunal composition was markedly influenced by the local environment and seasonal conditions. Rev. Biol. Trop. 64 (2): 683-700. Epub 2016 June 01.

Key words: biogeography, ichthyofauna, shrimp, fisheries, by-catch, Gulf of Tehuantepec.

The Gulf of Tehuantepec is influenced by an array of environmental factors like the current pattern, seasonal wind regimes, seasonal upwellings, rivers runoff and extensive coastal lagoon systems, that makes this region a very productive one in terms of fisheries (Tapia-García, 1998).

A valuable trawl shrimp fishery is conducted in this area mainly based on four species: *Litopenaeus vannamei* (White shrimp), *Farfantepenaeus californiensis* (Yellowleg shrimp), *Litopenaeus stylirostris* (Blue shrimp) and *Farfantepenaeus brevirostris* (Crystal shrimp) (Cervantes-Hernández, Gallardo-Berumen, Ramos-Cruz, Gómez-Ponce & Gracia, 2008). Gulf of Tehuantepec shrimp catch contributes nearly 5 % (1 880 m) to the total annual catch of the Mexican Pacific (37 600 m). Brown and white shrimp are the most important species as they represent 90 % of the total shrimp catch in the area.

Shrimp is the target species in trawling operations, but is associated with a highly diverse fish fauna, which is usually discarded. Both, the large catches discarded and the high ichthyofaunal diversity have caused concern

and prompted attempts to improve its use and management (Allsop, 1985; Andrew & Pepperell, 1992; Hendrickson & Griffin, 1993; Griffiths, Larson, & Courtney, 2004; Sarmiento-Náfate, Gil-López, & Arroyo, 2007; Stobutzki, Miller, Jones, & Salini, 2001).

Studies on the Gulf of Tehuantepec demersal community caught in trawl nets include that of Acal & Arias (1990), who pointed out the high diversity in fish communities in the region. Bianchi (1991) studied the demersal faunal assemblages (fish, crustaceans and cephalopods) of the shelf and upper slope in a wide area of the Gulf of Tehuantepec. Tapia-García, García-Abad, González-Medina, Macuitl-Montes, and Cerdenares-Ladrón de Guevara (1994) recorded composition and abundance of fish reporting 178 species, with the greatest diversity located in front of the lagoon-estuarine systems of Oaxaca and Chiapas coasts. The dominant species were: *Syacium latifrons*, *S. ovale*, *Eucinostomus gracilis*, *Bothus constellatus*, *Orthopristis chalceus* and *Pomadasys nitidus*. Siqueiros-Beltrones and De la Cruz-Agüero (2004) stood out the importance of taxonomic lists and the analysis of biogeographical distribution as essential tools for fishery management. According to this, several studies have recently assumed increased interest in the Southeastern Mexican Pacific Ocean (Aguilar-Palomino, Mariscal, Gonzalez, & Rodríguez, 1996; Madrid-Vera, Ruiz, & Rosado, 1998; Moncayo-Estrada, Castro-Aguirre, & De la Cruz-Agüero, 2006). In spite of the ecological and fisheries importance of the Gulf of Tehuantepec, there are only a few by-catch studies on the demersal species from shrimp trawl fishery in this region (Tapia-García, 1998; Tapia-García & García-Abad, 1998).

Up to now, studies are scarce, spatially and temporally scattered with little comprehensive integration and mainly focused on the fishery perspective. This study presents an updated systematic list of by-catch fishes from shrimp fishery, its abundance and analyzes of their biogeographical relationships.

MATERIALS AND METHODS

By-catch sampling was carried out during the shrimp closed seasons (April-August) in the Southern Pacific region of Mexico. A total of 15 exploratory cruises were developed during 2003 (five), 2004 (two), 2005 (four) and then resumed in 2013 (four) in a wide section of the continental shelf of the Gulf of Tehuantepec between Punta Chipehua (Oaxaca) and Puerto Madero (Chiapas) (14°43'-16°01' N - 92°53'-95°22' W). A sampling design of 62 stations was established for all cruises based on previous studies done in the area (Reyna Cabrera & Ramos-Cruz, 1998). Total number of locations sometimes varied due to weather conditions; however, this number was never above 25 % (Fig. 1).

Samples were obtained day and night with twin shrimp nets (24.4 mm horizontal mouth opening, 40.0 mm stretched mesh body, 38.1 mm stretched mesh cod-end) towed at each side of the vessel. The net had a turtle excluder device (TED) fitted in front of the codend. Each trawl had one-hour duration at an average speed of 1.5-2.5 knots; 344 hauls were done in a 15-64 m depth range; 206 hauls (60 %) were made during the day and 138 (40 %) at night; 234 hauls (68 %) were made below 40 m depth and 110 trawls (32 %) were carried above 40 m depth.

The catch from each trawl was cast on deck, and total weigth per trawl was estimated filling crates or boxes of 40 kg. A sample of 20 kg was taken; previous analysis sowed that this was enough to reflect adequately the species composition. Each sample was kept in the freezer at -30º C.

The biological material was identified and processed in the laboratories of the Regional Centre of Fisheries Research, Salina Cruz (CRIP-SC). The standard length of each fish was measured with a standard icthyometer of 50 cm length and a precision of 0.05 cm. Large individual fish were weighted with a scale (25 g of precision) and small fishes were weighted with an OHAUS digital scale of 2.6 kg of capacity and a precision of 0.05 g. In the

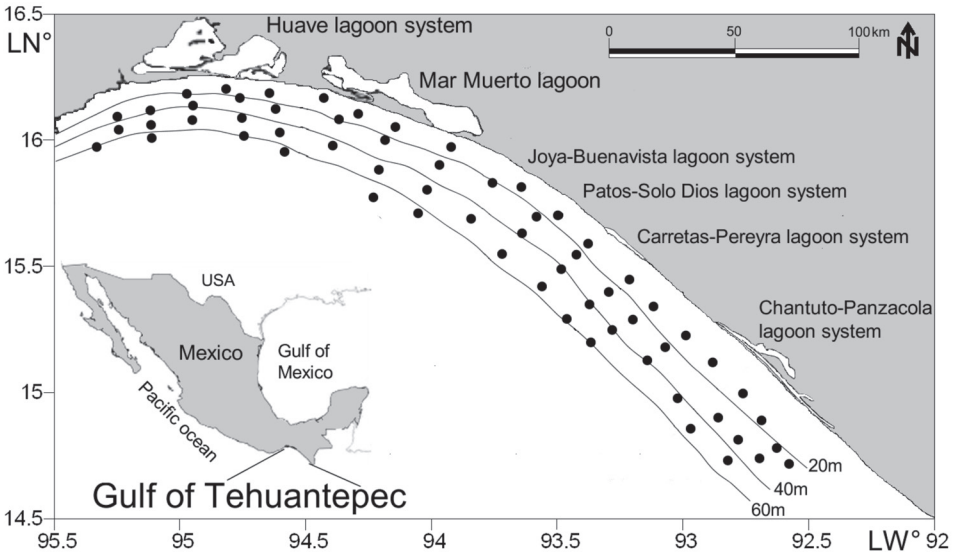

Fig. 1. Study area and sampling stations in the Gulf of Tehuantepec, Mexico.
Fig. 1. Área de estudio y estaciones de muestreo en el Golfo de Tehuantepec, México.

laboratory, fish were separated, washed, relabelled and stored in 70 % isopropyl alcohol.

Fish identification followed the keys of Castro-Aguirre (1978) Eschmeyer (1998), Bussing and López (1993), Fischer, Krupp, Schneider, Sommer, Carpenter and Niem (1995), Robertson and Allen (2002), and Amezcua-Linares (1996). Specialized literature for some specific groups was also consulted: rays, Castro-Aguirre and Espinosa-Pérez (1996); sharks, Espinosa-Pérez, Castro-Aguirre and Huidobro-Campos (2004); Sciaenidae, McPhail (1958); Pleuronectiformes, Norman (1934), and Ginsburg (1958); *Diplectrum*, Rosemblatt and Johnson (1974); and *Porichthys*, Walter and Rosemblatt (1988).

Systematic ordination followed the criteria of Nelson (2006). Genera and their species are presented in alphabetical order. Common names were taken from Robertson and Allen (2002); Nelson et al. (2004); and Love, Mecklenburg, Mecklenburg and Thorsteinson (2005).

The relative abundance of each species was estimated from the number of individuals within the total of individuals sampled. The species were grouped in four categories: (A) Abundant, relative abundance > 1 %; (F) Frequent, 0.1-0.99 %; (C) Common, 0.01-0.099 %; and (R) Rare, < 0.01 %. Differences in biomass values between day and night as well as the depth intervals were calculated through variance analysis (ANOVA) and t-test (Zar, 1999).

Analysis of zoogeographic affinities followed the basic scheme of Briggs (1974, 1995) and Walker (1960), with modifications proposed by Boschi (2000), Galván-Magaña, Gutiérrez-Sánchez, Abitia-Cárdenas and Rodríguez-Romero (2000), Hastings (2000), Robertson & Allen (2002), Robertson, Grove and McCoster (2004), and Horn, Allen and Lea (2006), considering the following provinces: A) Oregonian: from Puget Sound to Punta Concepción in California. The Southern section is considered a transition zone between this province and that of San Diego. B) San Diego: from Punta Concepción to Bahía Magdalena in the South of Baja California, with temperate-warm waters. C) Cortés: Southern Bahía Magdalena and the Gulf of California. D) Mexican: from Mazatlán, Sinaloa to Tehuantepec (Mexico). E) Panamic: from the South of Salvador to Cabo Blanco (Peru). F) Tropical Eastern Pacific: includes the West coast of the American

continent between 25° N in the Southern part of Bahía Magdalena and 5 °S at Cabo Blanco, Northern Peru. Differences in species biogeographic affinities between the years 2003 and 2013 were calculated by analysis of variance (ANOVA) (Zar, 1999).

The analysis also considered species with wide biogeographic distribution, such as the Circumtropical, Trans-Pacific and amphi-American species of the Central American Isthmus, the Tropical Eastern Pacific and the Western Atlantic.

Classification of the abundant, frequent, common and rare species used the Olmstead-Tukey method modified by Sokal and Rohlf (1995). The data matrices were expressed as frequency of occurrence within each sampling period. Then the frequency of occurrence per cruise was calculated (mean ± standard deviation). Richness was considered as the number of fish species in the study area.

RESULTS

The total number of samplings from all cruises was 344, with a total weight of 2 818 kg. The 66 908 individual fishes represented two Classes, 20 Orders, 58 families, 129 genera and 242 species (Table 1). Previous studies in the area showed a lower number of demersal

TABLE 1
Fishes of the Gulf of Tehuantepec, Mexico

CUADRO 1
Peces del Golfo de Tehuantepec, México

Species	A	B	C	D
Phylum Chordata				
Class Chondrichthyes				
Subclass Elasmobranchii				
Subdivision Selachii				
Order Carcharhiniformes				
Family Triakidae				
Mustelus lunulatus Jordan & Gilbert, 1883	Sicklefin smooth-hound	94-108	R	PS-PP
Family Carcharhinidae				
Rhizoprionodon longurio (Jordan & Gilbert 1882)	Pacific sharpnose shark	230	R	PS-PP
Family Sphyrnidae				
Sphyrna lewini (Griffith & Smith, 1834)	Scalloped hammerhead	176-350	R	CT
Sphyrna tiburo (Linnaeus, 1758)	Bonnethead	260	R	PS-PP
Subdivision Batoidea				
Order Torpediniformes				
Family Narcinidae				
Narcine entemedor Jordan & Starks, 1895	Giant electric ray	40-399	C	PC-PP
Narcine vermiculatus Breder, 1928	Vermiculate electric ray	44-444	F	POT
Order Rajiformes				
Family Rhinobatidae				
Rhinobatos glaucostigma Jordan & Gilbert, 1883	Speckled guitarfish	60-335	F	POT
Rhinobatos leucorhynchus Günther, 1867	Whitesnout guitarfish	68-571	C	PC-PP
Zapteryx exasperata (Jordan & Gilbert, 1880)	Banded guitarfish	95-230	C	PS-PP
Zapteryx xyster Jordan & Evermann, 1896	Witch guitarfish	406	R	PC-PP
Order Myliobatiformes				
Family Urolophidae				
Urolophus halleri Cooper, 1863	Haller's round ray	170	R	POT

TABLE 1 (Continued) / CUADRO 1 (Continuación)

Species	A	B	C	D
Urolophus maculatus (Garman, 1913)	Spotted round ray	110-125	R	PS-PC
Urotrygon aspidura (Jordan & Gilbert, 1882)	Spiny-tail round ray	41-395	F	PM-PP
Urotrygon chilensis (Günther, 1872)	Chilean round ray	35-364	A	PC-PP
Urotrygon munda Gill, 1863	Munda round ray	42-230	F	PM-PP
Urotrygon nana Miyake & McEachran, 1988	Dwarf round ray	30-235	F	PM-PP
Urotrygon reticulata Miyake & McEachran, 1988	Reticulate round ray	90-151	R	PM-PP
Urotrygon rogersi (Jordan & Starks, 1895)	Roger's round ray	64-411	C	PC-PP
Family Dasyatidae				
Dasyatis brevis (Garman, 1880)	Whiptail stingray	146	R	PO-PP
Dasyatis longa (Garman, 1880)	Longtail stingray	118-227	R	PO-PP
Family Gymnuridae				
Gymnura marmorata (Cooper,1864)	California butterfly ray	200-326	C	PS-PP
Family Myliobatidae				
Aetobatus narinari (Euphrasen, 1790)	Spotted eagle ray	165-195	C	CT
Rhinoptera steindachneri Evermann & Jenkins, 1891	Pacific cownose ray	175-406	R	PS-PP
Class Actinopterygii				
Subclass Neopterygii				
Division Teleostei				
Order Albuliformes				
Family Albulidae				
Albula nemoptera (Fowler, 1911)	Threadfin bonefish	134-276	C	POT
Albula vulpes (Linnaeus, 1758)	Bonefish	175-231	C	POT
Order Anguilliformes				
Suborder Muraenoidei				
Family Muraenidae				
Gymnothorax equatorialis (Hildenbrand,1946)	Spotted-tail moray	213-681	C	PC-PP
Gymnothorax panamensis (Steindachner, 1876)	Panamic moray	531-569	C	PS-PP
Suborder Congroidei				
Family Ophichthidae				
Myrophis vafer Jordan & Gilbert, 1883	Pacific worm eel	247	R	PS-PP
Ophichthus zophochir Jordan & Gilbert, 1882	Yellow snake eel	205-580	C	PS-PP
Pseudomyrophis micropinna Wade, 1946	Smallfin worm eel	169	R	PM-PP
Family Congridae				
Ariosoma gilberti (Ogilby, 1898)	Gilbert's garden eel	109-165	C	PC
Paraconger californiensis Kanazawa, 1961	California conger	483	R	PS-PP
Order Clupeiformes				
Suborder Clupeoidei				
Family Engraulidae				
Anchoa argentivittata (Regan, 1904)	Regan's anchovy	50-65	R	PC-PP
Anchoa helleri (Hubbs, 1921)	Heller's anchovy	38-109	C	PC-PM
Anchoa ischana (Jordan & Gilbert, 1882)	Slender anchovy	40-119	F	PC-PP
Anchoa lucida (Jordan & Gilbert, 1882)	Bright anchovy	46-193	F	PC-PP
Anchoa mundeola (Gilbert & Pierson, 1898)	False Panama anchovy	50-72	C	PC-PP
Anchoa nasus (Kner & Steindachner, 1867)	Longnose anchovy	60-119	C	PC-PP
Anchoa starksi (Gilbert & Pierson, 1898)	Black-tail anchovy	84	R	PP
Anchoa walkeri Baldwin & Chang, 1970	Walker's anchovy	40-145	C	PC-PP
Anchovia macrolepidota (Kner, 1863)	Bigscale anchovy	47-177	F	PC-PM

TABLE 1 (Continued) / CUADRO 1 (Continuación)

Species	A	B	C	D
Cetengraulis mysticetus (Günther, 1867)	Pacific anchoveta	36-134	C	PS-PP
Family Clupeidae				
Harengula thrissina Jordan & Gilbert, 1882	Pacific flatiron herring	117-180	C	PC-PP
Lile gracilis Castro-Aguirre & Vivero, 1990	Graceful piquitinga	80-190	C	PC-PP
Lile stolifera (Jordan & Gilbert, 1882)	Pacific piquitinga	118	R	PC-PP
Opisthonema libertate (Günther, 1867)	Pacific thread herring	73-195	F	PS-PP
Opisthonema medirastre Berry & Barrett,1963	Middling thread herring	118-166	C	PC-PP
Sardinops sagax (Jenyns, 1842)	South American pilchard	207	R	PA-PC
Family Pristigasteridae				
Opisthopterus dovii (Günther, 1868)	Dove's longfin herring	59-180	F	PS-PP
Pliosteostoma lutipinnis (Jordan & Gilbert, 1882)	Yellowfin herring	45-482	F	PM-PP
Order Siluriformes				
Family Ariidae				
Ariopsis guatemalensis (Günther, 1864)	Blue sea catfish	66-195	F	PC-PP
Ariopsis seemanni (Günther, 1864)	Tete sea catfish	41-236	F	PC-PP
Bagre panamensis (Gill, 1863)	Chilhuil sea catfish	64-410	F	PC-PP
Bagre pinnimaculatus (Steindachner, 1876)	Red sea catfish	152-325	R	PC-PP
Cathorops dasycephalus (Günther, 1864)	Big-bellied sea catfish	38-172	C	PM
Cathorops fuerthii (Steindachner, 1876)	Congo sea catfish	40-205	F	PC-PP
Cathorops steindachneri (Gilbert & Starks,1904)	Steindachner's sea catfish	119-191	C	PM-PP
Cathorops taylori (Hildebrand, 1925)	Sea catfish	176-213	R	PP
Galeichthys peruvianus Lütken, 1874	Peruvian sea catfish	140-241	C	PM-PP
Notarius kessleri (Steindachner, 1876)	Sculptured sea catfish	70-255	C	PM-PP
Notarius planiceps (Steindachner, 1876)	Flathead sea catfish	68-247	C	PM-PP
Notarius troschelii (Gill, 1863)	Chili sea catfish	28-275	F	PM-PP
Occidentarius platypogon (Günther, 1864)	Cominate sea catfish	57-290	F	PC-PP
Sciades dowii (Gill, 1863)	Brown sea catfish	170-190	R	PP
Order Aulopiformes				
Suborder Synodontoidei				
Family Synodontidae				
Synodus evermanni Jordan & Bollman, 1890	Inotted lizardfish	84-312	F	PS-PP
Synodus scituliceps Jordan & Gilbert, 1882	Shorthead lizardfish	91-420	F	PS-PP
Order Gadiformes				
Family Merluccidae				
Merluccius angustimanus Garman, 1899	Panama hake	68-155	C	PS-PP
Merluccius productus (Ayres, 1855)	North Pacific hake	46-180	C	PS-PP
Order Ophidiiformes				
Suborder Ophidioidei				
Family Ophidiidae				
Brotula clarkae Hubbs, 1944	Pacific bearded brotula	154-315	C	PC-PP
Chilara taylori (Girard,1858)	Spotted cusk-eel	178	R	PO-PP
Lepophidium pardale (Gilbert, 1890)	Leopard cusk eel	120-169	R	POT
Lepophidium prorates (Jordan & Bollman, 1890)	Prowspine cusk eel	60-254	C	POT
Ophidion galeoides (Gilbert, 1890)	Striped cusk eel	175	R	PM-PP
Otophidium indefatigabile Jordan & Bollman, 1890	Bighead cusk eel	169	R	PS-PP
Order Batrachoidiformes				
Family Batrachoididae				
Batrachoides boulengeri Gilbert & Starks,1904	Boulenger's toadfish	87-210	C	PM-PP

TABLE 1 (Continued) / CUADRO 1 (Continuación)

Species	A	B	C	D
Batrachoides waltersi Collette & Russo, 1981	Walter's toadfish	40-292	F	PM-PP
Porichthys analis Hubbs & Schultz, 1939	Darkedge midshipman	10-174	A	PS-PP
Porichthys margaritatus (Richardson, 1844)	Daisy midshipman	52-160	F	POT
Suborder Antennariidae				
Family Antennariidae				
Fowlerichthys avalonis (Jordan & Starks, 1907)	Roughbar frogfish	50-156	C	PS-PP
Order Mugiliformes				
Family Mugilidae				
Mugil cephalus Linnaeus, 1758	Flathead grey mullet	167-188	R	PS-PP
Mugil curema Valenciennens, 1836	White mullet	160-210	C	PC-PP
Mugil setosus Gilbert, 1892	Liseta mullet	155	R	PC-PP
Suborder Belonoidei				
Family Exocoetidae				
Cheilopogon papilio (Clark,1936)	Butterfly flyingfish	117-127	R	PM-PP
Order Beloniformes				
Family Hemiramphidae				
Cypselurus callopterus (Günther, 1866)	Ornamented flyingfish	185	R	PS-PP
Hemiramphus saltator Gilbert & Starks,1904	Longfin halfbeak	240-250	R	PS-PP
Suborder Cyprinodontoidei				
Order Cyprinodontiformes				
Family Poeciliidae				
Poecilia butleri Jordan, 1889	Pacific molly	55	R	PM
Poeciliopsis fasciata (Meek, 1904)	San Jeronimo livebearer	52	R	PS-PP
Order Gasterosteifomes				
Suborder Sygnathoidei				
Family Syngnathidae				
Hippocampus ingens Girard, 1858	Pacific seahorse	117-197	R	PO-PP
Family Fistularidae				
Fistularia commersonii Rüppell, 1838	Bluespotted cornetfish	170	R	PC-PP
Fistularia corneta Gilbert & Starks, 1904	Pacific cornetfish	164-381	C	PO-PP
Order Scorpaeniformes				
Suborder Scorpaenoidei				
Family Scorpaenidae				
Pontinus sierra (Gilbert, 1890)	Speckled scorpionfish	67	R	PC-PM
Scorpaena histrio Jenyns, 1840	Player scorpionfish	35-88	F	PS-PP
Scorpaena mystes Jordan & Starks, 1895	Pacific spotted scorpionfish	92-145	R	PS-PP
Scorpaena russula Jordan & Bollman, 1890	Reddish scorpionfish	27-130	A	PS-PP
Suborder Platycephaloidei				
Family Triglidae				
Bellator gymnostethus (Gilbert, 1892)	Naked-belly searobin	35-239	R	PC-PP
Bellator loxias (Jordan, 1897)	Barred searobin	65-277	C	POT
Bellator xenisma (Jordan & Bollman, 1889)	Splitnose searobin	32-282	F	PS-PP
Prionotus albirostris Jordan & Bollman, 1890	Whitesnout searobin	39-110	C	PC-PP
Prionotus birostratus Richardson, 1844	Two-beaked searobin	55-198	C	PC-PP
Prionotus horrens Richardson, 1844	Bristly searobin	30-125	F	POT
Prionotus ruscarius Gilbert & Starks, 1904	Common searobin	53-245	F	PS-PP
Prionotus stephanophrys Lockington, 1881	Lumptail searobin	30-200	A	PM-PP

TABLE 1 (Continued) / CUADRO 1 (Continuación)

Species	A	B	C	D
Order Perciformes				
Suborder Percodei				
Family Centropomidae				
Centropomus armatus Gill, 1863	Armed snook	170	R	PM-PP
Centropomus medius Günther, 1864	Blackfin snook	93-140	C	PS-PP
Centropomus robalito Jordan & Gilbert, 1882	Yellowfin snook	58-190	F	PC-PP
Centropomus unionensis Bocourt, 1868	Union snook	69-162	C	PM-PP
Family Serranidae				
Alphestes immaculatus Breder, 1936	Pacific mutton hamlet	65-110	C	PC-PP
Alphestes multiguttatus (Günther, 1867)	Rivulated mutton hamlet	72-172	C	PC-PP
Cephalopholis panamensis (Steindachner, 1876)	Pacific graysby	180	R	PC-PP
Diplectrum eumelum Rosemblatt &Johnson, 1974	Orange-spotted sand perch	50-162	F	POT
Diplectrum euryplectrum Jordan & Bollman, 1890	Bighead sand perch	59-155	F	PC-PP
Diplectrum labarum Rosemblatt & Johnson, 1974	Highfin sand perch	60-158	F	PS-PP
Diplectrum macropoma (Günther, 1864)	Mexican sand perch	65-140	C	POT
Diplectrum pacificum Meek & Hildebrand, 1925	Inshore sand perch	43-195	F	PS-PP
Epinephelus analogus Gill, 1863	Spotted grouper	90-308	C	PS-PP
Epinephelus labriformis (Jenyns, 1840)	Starry grouper	104-104	R	PC-PP
Hyporthodus acanthistius (Gilbert, 1892)	Rooster hind	74-510	C	PS-PP
Hyporthodus exsul (Fowler, 1944)	Tenspine grouper	200-570	C	PC-PP
Hyporthodus niphobles (Gilbert & Starks, 1897)	Star-studded grouper	61-138	C	PS-PP
Rypticus nigripinnis Gill, 1861	Blackfin soapfish	98-160	C	PS-PP
Family Priacanthidae				
Pristigenys serrula (Gilbert, 1891)	Popeye catalufa	45-128	F	PO-PP
Family Carangidae				
Carangoides otrynter (Jordan & Gilbert, 1883)	Threadfin jack	36-468	C	PS-PP
Caranx caballus Günther, 1868	Green jack	132-190	R	PS-PP
Caranx vinctus Jordan & Gilbert, 1882	Cocinero	32-175	F	PS-PP
Caranx caninus Günther, 1867	Pacific crevalle jack	91-118	R	PS-PP
Chloroscombrus orqueta Jordan & Gilbert, 1883	Pacific bumper	48-325	A	PS-PP
Decapterus macarellus (Cuvier, 1833)	Mackerel scad	165-184	R	CT
Decapterus macrosoma Bleeker, 1851	Shortfin scad	92-192	C	CT
Decapterus muroadsi (Temminck & Schlengel, 1844)	Amberstripe scad	115-325	R	CT
Hemicaranx leucurus (Günther, 1864)	Yellowfin jack	56-190	C	POT
Hemicaranx zelotes Gilbert, 1898	Blackfin jack	39-195	F	PC-PP
Oligoplites refulgens Gilbert & Starks,1904	Shortjaw leatherjack	113	R	PM-PP
Oligoplites saurus (Bloch & Schneider, 1801)	Leatherjack	144	R	PC-PP
Selar crumenophthalmus (Bloch, 1793)	Bigeye scad	54-195	C	PC-PP
Selene brevoortii (Gill, 1863)	Mexican lookdown	40-205	F	PC-PP
Selene orstedii Lutken, 1880	Mexican moonfish	42-78	C	PC-PP
Selene peruviana (Guichenot, 1866)	Pacific moonfish	31-238	A	PS-PP
Family Lutjanidae				
Lutjanus argentiventris (Peters, 1869)	Yellow snapper	70	R	PS-PP
Lutjanus guttatus (Steindachner, 1869)	Spotted rose snapper	42-405	F	PC-PP
Lutjanus peru (Nichols & Murphy, 1922)	Pacific red snapper	39-295	F	PC-PP
Family Gerreidae				
Diapterus aureolus Jordan & Gilbert 1882	Golden mojarra	52-157	F	PC-PP

TABLE 1 (Continued) / CUADRO 1 (Continuación)

Species	A	B	C	D
Diapterus peruvianus (Cuvier, 1830)	Peruvian mojarra	10-222	A	PC-PP
Eucinostomus argenteus Baird & Girard, 1855	Silver mojarra	78-109	R	PS-PP
Eucinostomus currani Zahuranec, 1980	Pacific flagfin mojarra	51-194	A	PC-PP
Eucinostomus dowii (Gill, 1863)	Dow's mojarra	80-145	R	PC-PP
Eucinostomus entomelas Zahuranec, 1980	Dark-spot mojarra	72-145	C	PC-PP
Eucinostomus gracilis (Gill, 1862)	Graceful mojarra	48-170	A	PC-PP
Gerres cinereus (Walbaum,1792)	Yellow fin mojarra	72-92	R	PC-PP
Family Haemulidae				
Anisotremus interruptus (Gill, 1862)	Burrito grunt	132	R	PC-PP
Conodon serrifer Jordan & Gilbert, 1882	Armed grunt	64-165	F	PS-PP
Haemulon scudderii Gill, 1862	Grey grunt	42-200	A	PC-PP
Haemulon steindachneri (Jordan & Gilbert, 1882)	Chere-chere grunt	82-205	C	POT
Haemulopsis axillaris (Steindachner, 1869)	Yellowstripe grunt	31-297	A	PC-PP
Haemulopsis elongatus (Steindachner, 1879)	Elongate grunt	132	R	PM-PP
Haemulopsis leuciscus (Günther, 1864)	White grunt	31-252	F	PS-PP
Haemulopsis nitidus (Steindachner, 1869)	Shining grunt	47-285	F	PC-PP
Microlepidotus brevipinnis (Steindachner, 1869)	Humpback grunt	115	R	PC-PP
Orthopristis chalceus (Günther, 1864)	Brassy grunt	72-215	F	PM
Orthopristis reddingi Jordan & Richardson, 1895	Bronze-striped grunt	98-148	C	PC-PP
Pomadasys bayanus Jordan & Evermann, 1898	Purplemouth grunt	55-176	C	PC-PP
Pomadasys branickii (Steindachner, 1879)	Sand grunt	111-182	C	PC-PP
Pomadasys panamensis (Steindachner, 1876)	Panama grunt	32-314	F	PC-PP
Xenichthys xanti Gill, 1863	Longfin salema	64-176	F	PS-PP
Xenistius californiensis (Steindachner, 1876)	Californian salema	102-130	R	PS-PP
Family Polynemidae				
Polydactylus approximans (Lay & Bennet, 1839)	Blue bobo	56-207	A	PS-PP
Polydactylus opercularis (Gill, 1863)	Yellow bobo	70-260	F	PC-PP
Family Sciaenidae				
Aplodinotus grunniens Rafinesque, 1819	Freshwater drum	95-199	C	PM
Bairdiella armata Gill,1863	Armed croaker	68-185	C	PC-PP
Bairdiella ensifera (Jordan & Gilbert, 1862)	Swordspine croaker	130-156	C	PM-PP
Cynoscion phoxocephalus Jordan & Gilbert, 1882	Cachema weakfish	108	R	PC-PP
Cynoscion reticulatus (Günther, 1864)	Striped weakfish	160-205	R	PC-PP
Cynoscion stolzmanni (Steindachner, 1879)	Stolzmann's weakfish	83-184	R	PC-PP
Elattarchus archidium (Jordan & Gilbert 1882)	Bluestreak drum	110-155	C	PC-PP
Isopisthus remifer Jordan & Gilbert, 1882	Silver weakfish	50-215	F	PS-PP
Larimus acclivis Jordan & Bristol, 1898	Steeplined drum	34-211	A	PC-PP
Larimus argenteus (Gill, 1863)	Silver drum	37-195	A	PC-PP
Larimus effulgens Gilbert, 1898	Shining drum	68-170	F	PC-PP
Larimus pacificus Jordan & Bollman, 1890	Pacific drum	39-155	F	POT
Menticirrhus elongatus (Günther, 1864)	Pacific kingcroaker	85-280	C	PC-PP
Menticirrhus nasus (Günther, 1868)	Highfin kingcroaker	74-215	F	PC-PP
Menticirrhus panamensis (Steindachner, 1876)	Panama kingcroaker	54-192	C	PC-PP
Menticirrhus undulatus (Girard,1854)	California kingcroaker	87-185	C	PC-PP
Micropogonias altipinnis (Günther, 1864)	Tallfin croaker	59-280	F	PC-PP
Micropogonias ectenes (Jordan & Gilbert 1882)	Slender croaker	189-190	R	PS-PM
Nebris occidentalis Vaillant, 1897	Pacific smalleye croaker	54-240	F	PM-PP

TABLE 1 (Continued) / CUADRO 1 (Continuación)

Species	A	B	C	D
Ophioscion imiceps (Jordan & Gilbert 1882)	Blinkard croaker	50-194	F	PC-PP
Ophioscion strabo Gilbert, 1897	Squint-eyed croaker	69-178	C	PM-PP
Ophioscion typicus Gill,1863	Point-nosed croaker	70-475	C	PS-PP
Paralonchurus goodei Gilbert, 1898	Goode croaker	100-182	C	PM-PP
Paralonchurus rathbuni (Jordan & Bollman 1890)	Bearded banded croaker	112-201	C	PM-PP
Stellifer chrysoleuca (Günther, 1867)	Shortnose stardrum	44-246	C	PS-PM
Stellifer ericymba (Jordan & Gilbert, 1882)	Hollow stardrum	40-300	A	PS-PM
Stellifer fuerthii (Steindachner, 1876)	White stardrum	54-186	F	PP
Stellifer illecebrosus Gilbert, 1898	Silver stardrum	59-185	F	PS-PP
Umbrina xanti Gill, 1862	Polla drum	45-313	F	PM-PP
Family Mullidae				
Pseudupeneus grandisquamis (Gill, 1863)	Bigscale goatfish	56-172	A	PS-PP
Family Chaetodontidae				
Chaetodon humeralis Günther, 1860	Threebanded butterflyfish	37-112	F	PS-PP
Suborder Labroidei				
Family Labridae				
Halichoeres chierchiae Di Caporiacco, 1948	Wounded wrasse	128-152	R	PC-PP
Suborder Trachinoidei				
Family Ephippidae				
Chaetodipterus zonatus (Girard, 1858)	Pacific sleeper	125-140	R	PC-PP
Parapsettus panamensis (Steindachner, 1876)	Pennant goby	59-90	C	PC-PM
Family Uranoscopidae				
Astroscopus zephyreus Gilbert & Starks 1897	Pacific stargazer	193	R	PS-PP
Suborder Gobioidei				
Family Eleotridae				
Gobiomorus maculatus (Günther, 1859)	Tailspot goby	66-72	R	PC-PP
Family Gobiidae				
Bollmannia ocellata Gilbert, 1892	Pacific spadefish	32-176	F	PC-PP
Bollmannia stigmatura Gilbert, 1892	Panama spadefish	33-286	F	POT
Suborder Scombroidei				
Family Trichiuridae				
Lepidopus fitchi Rosenblatt & Wilson, 1987	Pacific scabbardfish	400	R	PO-PP
Trichiurus lepturus Linnaeus, 1758	Largehead hairtail	436	C	CT
Family Scombridae				
Scomberomorus sierra Jordan & Starks, 1895	Pacific sierra	135-290	C	PS-PP
Family Sphyraenidae				
Sphyraena ensis Jordan & Gilbert, 1882	Mexican barracuda	16-304	F	PC-PP
Suborder Stromateoidei				
Family Stromateidae				
Peprilus medius (Peters, 1869)	Pacific harvestfish	110-222	C	POT
Peprilus ovatus Horn, 1970	Shining butterfish	115-157	R	PS-PP
Peprilus snyderi Gilbert & Starks, 1904	Salema butterfish	49-179	C	PM-PP
Order Pleuronectiformes				
Suborder Pleuronectoidei				
Family Paralichthyidae				
Ancylopsetta dendritica Gilbert, 1890	Three-spot flounder	105-222	R	PM-PP
Citharichthys platophrys Gilbert, 1891	Small sandab	33-124	F	PM-PP

TABLE 1 (Continued) / CUADRO 1 (Continuación)

Species	A	B	C	D
Cyclopsetta panamensis (Steindachner, 1876)	God's flounder	45-306	A	PC-PP
Cyclopsetta querna (Jordan & Bollman, 1890)	Toothed flounder	56-385	F	PC-PP
Etropus crossotus Jordan & Gilbert, 1882	Fringed flounder	89-170	F	PS-PP
Paralichthys woolmani Jordan & Williams, 1897	Speckled flounder	225-290	R	PC-PP
Syacium latifrons (Jordan & Gilbert, 1882)	Beach flounder	40-237	A	POT
Syacium longidorsale Murakami & Amaoka, 1992	Longfin flounder	96	R	PM-PP
Syacium ovale (Günther, 1864)	Oval flounder	88-128	A	POT
Family Bothidae				
Bothus constellatus (Jordan, 1889)	Pacific eyed flounder	35-303	A	PS-PP
Engyophrys sanctilaurentii Jordan & Bollman, 1890	Speckled-tail flounder	88-90	R	PC-PP
Monolene asaedai Clark, 1936	Asaedae flounder	39-107	F	PS-PP
Family Cynoglossidae				
Symphurus atramentatus Jordan & Bollman, 1890	Inkspot tonguefish	130-135	R	PC-PP
Symphurus atricaudus (Jordan & Gilbert, 1880)	California tonguefish	126-164	C	PO-PP
Symphurus elongatus (Günther, 1868)	Elongate tonguefish	72-266	F	PM-PP
Symphurus melanurus Clark, 1936	Drab tonguefish	135	R	POT
Family Achiridae				
Achirus mazatlanus (Steindachner, 1869)	Mazatlan sole	34-146	C	PS-PP
Achirus scutum (Günther, 1862)	Network sole	51-205	F	PM
Achirus zebrinus Clark, 1936	Tehuantepec sole	50-182	F	PS-PP
Trinectes fimbriatus (Günther, 1862)	Fringed sole	57-75	R	PS-PP
Trinectes fonsecensis (Günther, 1862)	Spottedfin sole	58-190	C	PS-PP
Order Tetraodontiformes				
Suborder Balistoidei				
Family Balistidae				
Balistes polylepis Steindachner, 1876	Finescale triggerfish	45-350	C	PO-PP
Pseudobalistes naufragium (Jordan & Starks, 1895)	Stone triggerfish	39-65	C	PS-PP
Family Monacanthidae				
Aluterus monoceros (Linnaeus, 1758)	Unicorn leatherjacket filefish	280-441	R	CT
Suborder Tetraodontoidei				
Family Tetraodontidae				
Sphoeroides annulatus (Jenyns, 1842)	Bullseye puffer	30-264	F	PM-PP
Sphoeroides kendalli Meek & Hildebrand, 1928	Slick puffer	65-87	F	PS-PP
Sphoeroides lobatus (Steindachner, 1870)	Longnose puffer	46-210	R	PO-PP
Sphoeroides sechurae Hildebrand, 1946	Peruvian puffer	44-169	F	POT
Family Diodontidae				
Chilomycterus reticulatus (Linnaeus, 1758)	Spotfin burrfish	60-190	F	CT
Diodon holocanthus Linnaeus, 1758	Long-spine porcupinefish	109-275	R	CT
Diodon hystrix Linnaeus, 1758	Spot-fin porcupinefish	70-290	C	CT

A: Common Name in English; B: Size range (standard length, mm); C: Relative abundance; D: Province and biogeographical region (PO, Oregonian; PS, San Diego Province; PC, Cortés Province; PM, Mexican Province; PP, Panamic Province; POT, Tropical Eastern Pacific; CT, Circumtropical species; T, Trans-Pacific species). Species abundance: (A) abundant; (F) frequent; (C) common; (R) rare. Systematic arrangement according to Nelson (2006). Revision of species according to Eschmeyer (1998) and Froese & Pauly (2013).

A: Nombre común en inglés, B: Intervalo de tallas (longitud estándar, mm), C: Abundancia relativa, D: Provincias y regiones biogeográficas (PO: Provincia Oregoniana, PS: Provincia de San Diego, PC: Provincia de Cortés, PM: Provincia Mexicana, PP: Provincia Panámica, POT: Pacífico Oriental Tropical, CT: Especies Circumtropicales, y T: Especies Transpacíficas). Especie abundante (A), especie frecuente (F), especie común (C) y especie rara (R). Clasificación sistemática según Nelson (2006). Revisión de especies según Eschmeyer (1998), Froese y Pauly (2013).

TABLE 2
Comparison of previous studies regarding demersal fish lists in the continental shelf of the Gulf of Tehuantepec

CUADRO 2
Comparación de estudios anteriores con respecto a las listas de peces demersales en la plataforma continental del Golfo de Tehuantepec

Author	Cruises	Year	Nº of Trawls	Depth Range (m)	Nº of Families	Nº of Genus	Nº of Species
Secretaria de Marina (1978)	1	1977	11	27-60	32	49	61
Acal-Arias (1990)	4	1987	161	15-200	53	115	195
Tapia-García (1998)	5	1989-1990	85	15-80	56	123	173
Present study	15	2003-2005, 2013	344	15-64	58	129	242

fish species with respect to this study (Table 2). The Order Perciformes was the most diverse, with 20 families, 55 genera and 110 species, which is typical of the ichthyofaunal groups in the intertropical regions. The families best represented in terms of number of species were: Sciaenidae (29), Haemulidae (16), Carangidae (16), and Serranidae (14). The main genera were: *Anchoa, Eucinostomus*, *Epinephelus* and *Urotrygon*, each with six species, followed by *Prionotus* and *Diplectrum,* each with five species. Sizes ranged from 27 mm in the reddish scorpionfish (*Scorpaena russula*) to 681 mm in the Spotted-tail moray (*Gymnothorax equatorialis*). The species with the highest relative abundance were: *Haemulopsis axillaris* (Steindachner, 1869), *Syacium ovale* (Günther, 1864), *Selene peruviana* (Guichenot, 1866), *Bothus constellatus* (Jordan, 1889), *Diapterus peruvianus* (Cuvier and Valenciennes, 1830), *Syacium latifrons* (Jordan and Gilbert, 1882), *Scorpaena russula* (Jordan and Bollman, 1889), *Eucinostomus currani* (Zauranec, 1967), *Haemulon scudderii* (Gill, 1863), *Prionotus stephanophrys* (Lockington, 1881), and *Larimus acclivis* (Jordan and Bristol, 1898). *H. axillaris*, *S. ovale*, *S. peruviana*, *D. peruvianus*, *L. acclivins* and *Stellifer erycimba* were the most frequent species in the inner shelf (< 40 m depth), whereas *P. stephanophrys*, *S. russula*, *Porichthys analis* and *Synodus scituliceps* were dominant in the outer shelf (40-60 m depth).

Individual fish size and weight showed a similar general pattern along the four years. Most of the fishes (40 %) presented a standard length range of 75 to 107 mm with a mean of 103 ± 31.8. Individual weight including 70 % of the fishes varied between 1.25 to 32.5 g with a mean of 32.5 ± 32.7. Large fishes (> 50 cm SL and 2 000 g) were also found in shrimp by-catch, although their abundance may be underestimated due to reduced catchability related to trawl speed and net selectivity. Most of these fishes were elasmobranch of commercial interest like *Narcine vermiculatus, Gymnura marmorata* and *Rhinobathos glaucostigma*, and teleosts like *Epinephelus multiguttatus, Hyporthodus exsul, H. acanthisthius, Ophioscion typicus, Carangoides otrynter, Lutjanus guttatus, L. peru, Paralichthys woolmani, Cyclopsetta querna, Trichiurus lepturus*, *Centropomus robalito*, *Micropogonias altipinnis* and *Cynoscion phoxocephalus*, which represented 25 % of the biomass. Fish catches during day and night showed significant differences (t-test = 1.93, $P < 0.05$). Also catches recorded below 40 m depth presented a significant difference (t-test = -5.67, $P < 0.05$) with those obtained deeper than 40 m.

The community was composed mainly by species with subtropical and tropical affinities (Table 1). Subtropical and tropical fish represented 34.4 % of the catch with a wide geographical distribution from the Cortés to the Panamic Province; 27.0 % were eurythermic species from the San Diego to the Panamic Province, 13.3 % were restricted to the Mexican and Panamic Provinces, and 9.3 % were species with a distribution in the Eastern Tropical Pacific (Fig. 2). The fish community

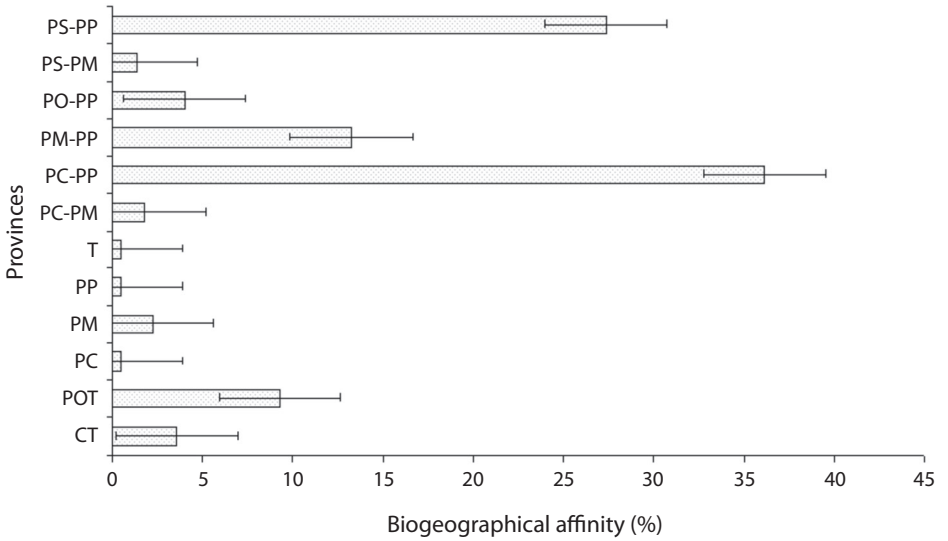

Fig. 2. Ichthyogeographic affinities (%) in Provinces along the Eastern Pacific coast (PO, Oregonian; PS, San Diego; PC, Cortés; PM, Mexican; PP, Panamic; POT, Tropical Eastern Pacific; CT, Circumtropical species; T, Trans-Pacific species).
Fig. 2. Afinidad ictiogeográfica (%) en las provincias a lo largo de la costa oeste del Pacífico (PO: Provincia Oregoniana, PS: Provincia de San Diego, PC: Provincia de Cortés, PM: Provincia Mexicana, PP: Provincia Panámica, POT: Pacífico Oriental Tropical, CT: Especies Circumtropicales, y T: Especies Transpacíficas).

was constituted by 32.8 % of common species, whereas 28.6 % are frequent species, 30.3 % are rare species and the remaining 8.3 % were abundant.

New records for the area were: *Notarius planiceps, Ophioscion typicus, Mugil setosus, Alphestes immaculatus, Chilara taylori*, *Decapterus muroadsi, Lepidopus fitchi* and *Stellifer chrysoleuca.* The recorded distribution within the area was extended for *Urotrygon reticulata*, *Anchoa helleri*, *Cathorops steindachneri*, *Bollmannia stigmatura* and *Sphoeroides kendalli.*

In terms of abundance, the most important families were Haemulidae, Sciaenidae, Carangidae, Ariidae and Serranidae, which also contributed with the greatest number of species and abundance. These species are central to the understanding of the structure and function of the community of demersal fishes of the area. Its euryhaline capacity explains its abundance in front of the lagoons of the Huave, Mar Muerto, La Joya-Buenavista, Carretas-Pereyra and Chantuto-Panzacola systems.

Of the 242 species recorded, 70 (30 %) made incursions into the coastal lagoons for various purposes such as spawning and feeding. Notable for their abundance were those in the Huave (Oaxaca) and Chantuto Panzacola (Chiapas) systems: *Lile stolifera, L. gracilis, Diapterus peruvianus, Micropogonias altipinnis, Achirus zebrinus, A. scutum, Anchoa nasus, A. mundeola, Centropomus robalito, Cathorops fuerthii, Eucinostomus currani* and *Cyclopsetta panamensis*.

Three species (1.3 %) were typically freshwater species: *Poecilia butleri, Poecilopsis fasciata* and *Gobiomorus maculatus*. They were caught near the outlet of the Mar Muerto lagoon at 16-18 m depth, possibly due to the influence of a plume of brackish water intruding the continental shelf.

The total number of species registered in 2003 (131) was higher than the one found in 2013 (116), whereas species biogeographical affinities did not present a significant difference ($F_{12,9} = 4.41$, d.f. = 21.0, $P > 0.447$) among 2003 and 2013.

DISCUSSION

The species richness of demersal fishes recorded as by-catch from the shrimp fishery in the Gulf of Tehuantepec, with 242 species, is typical of the Eastern Pacific (Robertson & Cramer, 2009). Only 34 species (15 %) were frequent or abundant while the others were common and rare. Some of the rare species are epipelagic species (*Opisthonema libertate, Scomberomorus sierra, Decapterus macarellus* and *Cypselurus callopterus*), which probably may have been caught while the net was being recovered.

Fish by-catch individual size and weight were consistently small, with 92 % under 50 g weight and 20 cm SL, respectively. A similar composition has been previously reported for the Gulf of California (Pérez Mellado & Findley, 1985). These authors pointed out that about 1 % were fishes weighting more than 100 g whereas in this study the percentage was remarkably higher (3.4 %). These fishes, usually higher than 350 g, were frequent in by-catch and are mainly used for human consumption.

On previously compiled lists of species for the demersal fishery on the continental shelf in the Gulf of Tehuantepec, recorded 32 families, 49 genera and 61 species (Secretaria de Marina, 1978). Acal and Arias (1990) registered 292 species, but that list contained 97 inconsistencies; 50 species were not identified but simply assigned to genus, 24 others were only assigned to family, six constituted synonyms within the list, and others were clearly out of context since they were species recorded for the Atlantic Ocean; the record has accordingly been adjusted.

Of the species in previous lists from the Gulf of Tehuantepec, 167 (74 %) were also found in the present study but 99 were not. Compiling these studies we obtained a total of 331 species, which supports the fact that recorded fish species in the Mexican South Pacific are higher than those for the Western shelf of Baja California Sur, the Gulf of California, the Jalisco and Colima shelf, and the shelves of Nayarit, Michoacán and Guerrero. This number may be greater if species that belong to the rocky, pelagic and slope zones, and to the lagoons and estuaries, are considered.

From a biogeographical point of view, the assignment of this ichthyofauna to the classical faunistic provinces (Cortés, Panamic and Mexican) presents difficulties, particularly because it is constituted by species with tropical affinities that overlap with others with subtropical or temperate affinities. In addition, it must be considered that the conjuction of provinces (Cortés-Panamic) corresponds to 12 zoogeographic divisions. This marks a distinct change in association, frequency and diversity of species from South to North, reflecting the great variety of habitats.

In the Northern area, the species were temperate ones: *Bellator xenisma, Diplectrum pacificum, Epinephelus analogus, Sphoeroides lobatus, Synodus evermanni, G. marmorata, Ophidion galeoides, Opisthonema medirastre* and *Merluccius productus*. To the South, the predominant species are typical of the Tropical Eastern Pacific, such as *Bellator loxias, Porichthys analis, Ancylopsetta dendritica, Aluterus monoceros, Trinectes fimbriatus, Diplectrum macropoma, Urotrygon munda* and *Paralonchurus rathbuni*. Horn et al. (2006) and Rodríguez-Romero, Hernández-Vázquez and López-Martínez (2009) noted similar tendencies.

The high diversity recorded in the Gulf of Tehuantepec, while demonstrating the importance and uniqueness of the area, reflects the concurrence of a series of environmental factors that interact, characterizing the region as a dynamic frontier or transition ecosystem with a broad thermic regime and a variety of habitats (Díaz-Ruiz, Cano-Quiroga, Aguirre-León, & Ortega-Bernal, 2004; Tapia-García, García-Abad, Carranza-Edwards & Vázquez-Gutiérrez, 2007; Velázquez-Velázquez, Vega-Cendejas & Navarro-Alberto, 2008). This uniqueness is supported not only by its geographic position with tropical and temperate characteristics, but also by: 1) the contribution of river runoff, 2) the presence of extensive coastal lagoon systems with high productivity,

3) the prevailing winds and seasonal rainfall from land to the sea, and 4) a wide continental shelf influenced by a complex oceanic current system (the sub-surface equatorial, the North-equatorial countercurrent, the California current, and the South-equatorial or coastal current of Costa Rica that flows northwards and favors the presence of important upwellings) (Galván-Magaña et al., 2000; López-Martínez, Herrera-Valdivia, Rodríguez-Romero, & Hernández-Vázquez, 2010; Mora & Robertson, 2005; Rodríguez-Romero et al. 1998; Rodríguez-Romero, Palacios-Salgado, López-Martínez, Hernández-Vázquez, & Ponce-Díaz, 2008; Zapata & Robertson, 2007).

In addition, the species of the Tropical Eastern Pacific receive strong immigration on its coasts, particularly during events such as ENSO (El Niño - Southern Oscillation), which reach the East Pacific coasts when it is of great magnitude and intensity (Lea & Rosenblatt, 2000). Their periodicity and magnitude contribute significantly to dispersion, since most fishes have life cycles with pelagic larval stages (Auster, 1988; Caddy & Sharp, 1986; Galzin & Legendre, 1987; Grossman, Freeman, Moyle, & Whitaker, 1985), which affect the distribution patterns since long time. It is considered that changes in abundance and composition of the fish community frequently occur as a result of migratory movements between neighbouring geographic areas driven by climatic and oceanographic processes of medium or long-term duration (Safran, 1990), as well as other factors such as changes in the rates of hatching and mortality, owing to abiotic environmental factors (temperature, oxygen) or biotic factors (predation, competition, food availability).

The results show the uniqueness and importance of the region in relation to the fish species richness of great value for industrial and artisanal fisheries. In this context, it would be important to include, in the actual local policies, rules that could regulate the technical aspects of the fishing methods used in the Gulf of Tehuantepec in order to preserve this ecosystem richness. Consequently, scientific research appropriate to the particular needs of this area of the Tropical Eastern Pacific should increase, so long as the information is scarce and temporarily discontinuous.

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RESUMEN

En la pesquería del camarón del Golfo de Tehuantepec un gran número de especies de peces se capturan como fauna de acompañamiento y son descartadas. La composición, distribución y afinidades biogeográficas de la ictiofauna acompañante del camarón fue analizada mediante 15 cruceros desarrollados en la plataforma continental entre 15-64 m de profundidad durante 2003, 2004, 2005 y 2013. La ictiofauna descartada estuvo representada por 58 familias, 129 géneros y 242 especies. Las familias, Haemulidae, Sciaenidae, Paralichthyidae, Gerreidae y Carangidae aportaron más del 70 % de la captura. *Haemulopsis axillaris*, *Syacium ovale*, *Selene peruviana*, *Diapterus peruvianus*, *Larimus acclivins* y *Stellifer erycimba* fueron las especies más frecuentes en profundidades menores de 40 m (plataforma interna), mientras que *Prionotus stephanophrys*, *Scorpaena russula*, *Porichthys analis* y *Synodus scituliceps*, fueron dominantes entre 40-60 m de profundidad

(plataforma externa). El análisis de las afinidades biogeográficas mostró que el 36.1 % de las especies son de amplia distribución desde la provincia de San Diego a la Panámica, mientras que el 13.2 %, presentó una distribución restringida entre la provincia Mexicana y la Panámica. La composición de la ictiofauna estuvo marcadamente influenciada por las condiciones ambientales locales y sus variaciones estacionales.

Palabras clave: biogeografía, ictiofauna, camarón, pesca, fauna de acompañamiento, Golfo de Tehuantepec.

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