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Research Article

Ichthyofauna composition (Actinopterygii: Teleostei) caught by Jalisco's small-scale fisheries in the Mexican Central Pacific coast

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ABSTRACT. We present the composition of the ichthyofauna (Actinopterygii: Teleostei) caught by small-scale fisheries off the coast of Jalisco in the Mexican Central Pacific, which has 170 species grouped into 15 orders, 52 families, and 113 genera. The families with the highest species richness were Carangidae (14.7%), Haemulidae (10.0%), Sciaenidae (9.4%), Serranidae (8.2%), Lutjanidae (5.8%), and Scombridae (5.8%). The relative abundance analysis indicated 13 relevant species in the artisanal fisheries of the coast of Jalisco, with six being the most representative (*Lutjanus guttatus*, *L. peru*, *L. argentiiventris*, *Microlepidotus brevipinnis*, *Haemulon flaviguttatum*, and *Scomberomorus sierra*). Fishers use the gill net (43.3%), the hand line (33.4%), and the harpoon (10.1%) as the main fishing gear in the catch off the coast of Jalisco. The zoogeographical analysis revealed a high affinity with the Mexican Province (24.9%), followed by the Panamic Province (23.4%), the Cortez Province (23.4%), Californian-Peruvian Province (15.6%), and the Galapagos Province (12.6%). The composition of the ichthyofauna recorded in the Jalisco coast by artisanal fisheries was most likely linked to the heterogeneity of the continental shelf bottom, variation in primary productivity, temperature, salinity, and the dynamics of marine currents in the Mexican Central Pacific. Therefore, this information will serve as a basis for future comparisons with other studies that allow the sustainable management of fishery resources in Mexican Pacific coastal fisheries.

Keywords: artisanal fisheries; species richness; zoogeographic affinity; relative abundance

INTRODUCTION

Small-scale fisheries in Mexico are among the most important activities due to their role as a source of food for human consumption and as a generator of jobs for the fishing communities in each region (FAO 2020). This activity is not very technical and takes advantage of many species (Salas et al. 2011). The importance of this sector lies in the fact that it contributes approximately 65% of the production destined for direct human consumption, and 85% of national fishers and 90% of the more than 102,000 registered boats participate in it (Fernández et al. 2011). From the Mexican Pacific coastal states, 74% of production is obtained by artisanal fishing, and Jalisco contributes 2.16% of bony fishes (CONAPESCA 2018).

Fishing and other economic activities based solely on the extraction of renewable resources, such as hunting wild birds and mammals, cause alterations in their availability in the mid and long term, depending on the intensity of the activity and the vulnerability of the resource. One of the most notable effects has been the reduction in the richness and abundance of diverse species, even reaching levels of local extinction, particularly species with low mobility, slow growth, and reduced reproductive rates (Espino-Barr 2000). Artisanal fishing, although characterized by reduced production, its impact on the most important resources

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has led to the overexploitation of a few species, altering food webs, reproductive cycles, and interactions between species (Ibáñez-Aguirre & Gallardo-Cabello 1995, Arreguín-Sánchez & Arcos-Huitrón 2011). In addition, environmental fluctuations in coastal ecosystems cause strong pressures on populations and communities (Ault et al. 1998), aspects poorly documented in the fishes of the Mexican Central Pacific (MCP) (Espino et al. 2002).

The Mexican Pacific (MP) has approximately 1121 marine and estuarine fish species, with the Gulf of California having the highest number of species and endemism (Espinosa-Pérez 2014). On a smaller geographic scale, the MCP includes the coast of Nayarit, Jalisco, Colima, and Michoacán (Pantoja et al. 2012), presents unique oceanographic characteristics. For example, the influence of diverse marine surface currents (Wyrtki 1967, Kessler 2006, Pantoja et al. 2012), persistent thermo-hyaline conditions throughout the year (Filonov et al. 2000), geomorphology or continental shelf relief types (Salas et al. 2006), and the high chlorophyll-*a* values (Galicia-Pérez et al. 2006, López-Sandoval et al. 2009). All these aspects produce a dynamic zone of physical, chemical, and biological transition, directly affecting the diversity of interacting species, defining their structure and abundance.

The MCP presents around 50% (567 spp.) of the marine fish species of the MP (Aguilar-Palomino 2017). However, some reports suggest fewer species (Amezcua-Linares 1996, Castro-Aguirre et al. 2006), with similar percentages of 33% (380 and 373 spp., respectively). Others indicate higher numbers of species in specific areas of the MCP, such as in Banderas Bay, reporting 210 spp. (Moncayo-Estrada et al. 2006) and Chamela Bay, with 196 spp. (Galván-Villa et al. 2016). However, among the studies that have documented species richness in this area, specifically as a result of reports or support from commercial capture, are the studies by Espino-Barr et al. (1998, 2003, 2008), Espino-Barr (2000), Lucano-Ramírez et al. (2001) and Bravo-Olivas et al. (2014), with values ranging from 121 to 173 spp. There are still areas of the Jalisco coast where little or no information on the ichthyofauna present is available. Therefore, the purpose of this paper is to identify the ichthyofauna caught by artisanal fisheries off the coast of Jalisco, providing information on landing sites, fishing gear, and biogeographic affinity analysis of the species recorded.

MATERIALS AND METHODS

The coast of Jalisco has an extension of 350 km and is located between 19°10' and 20°45'N and 104°41' to 105°30' W, bordering Nayarit State on the Ameca River to the north and Colima State on the Cihuatlán River to the south (Fig. 1). It and its topographical characteristics can be divided into three zones: 1) Puerto Vallarta to Tehuamixtle, where the slope of the mountains forms cliffs in the sea. 2) Valley of Tomatlán to Punta Perula, with open beaches whose lowlands lagoons, small estuaries, and salt mines are located, and 3) Chamela to the mouth of the Cihuatlán River, where some bays present significant geographic accidents. The heterogeneity of the coastline creates a great variety of habitats of great natural value and biological diversity (INEGI 1995). The continental shelf in this region is very narrow, extending up to the 200 m isobath and at a distance from the coast of 7 to 10 km (Filonov et al. 2000). Where soft (sands, silts, and clays) and rocky (pebbles, boulders, rocky eminences, and rocky plains) bottoms alternate in shallow and intermediate-depth areas, not deeper than 80 m (Ríos-Jara et al. 2008).

The current pattern in the area consisting of three typical phases of circulation: the first is influenced by the California Current and is characterized by a cold water mass (February to April); the second is a transition stage where the California Current and North Equatorial Countercurrent converge, without either one dominating (May to June); and the third is a period influenced by the North Equatorial Countercurrent and characterized by a typically tropical water mass (August to January) (Wyrtki 1967). There is variation in climate along the coast due to the influence of winds and marine currents. At Bahía Banderas, there is greater humidity, and at the center and south of the coast, the climate becomes drier (Villalpando & García 1993). Annual rainfall is between 100 and 1500 mm (González-Ochoa 1997).

Monthly during one-week sampling was carried out in the landings of artisanal fishers along the coast of Jalisco between April 2002 and December 2017. Information was also obtained from the collection centers and from the leaders of 17 cooperative fisheries production societies, which consisted of data on the quantity and characteristics of fishing systems and vessels, the duration and particularities of the journey, the catch per total journey, and species. The samples focused on bony fish since cartilaginous fish are not part of the artisanal fishery because the catch permits are processed differently. The organisms caught were measured as recommended by the fisheries science 2 manual (Holden & Raitt 1975) and the fisheries biology manual (Espino-Barr et al. 2008). The measurements included the standard length in cm (ichthyometer with precision in mm) and gutted or whole weight in g (scale with an accuracy of 2 g) of the individuals caught.

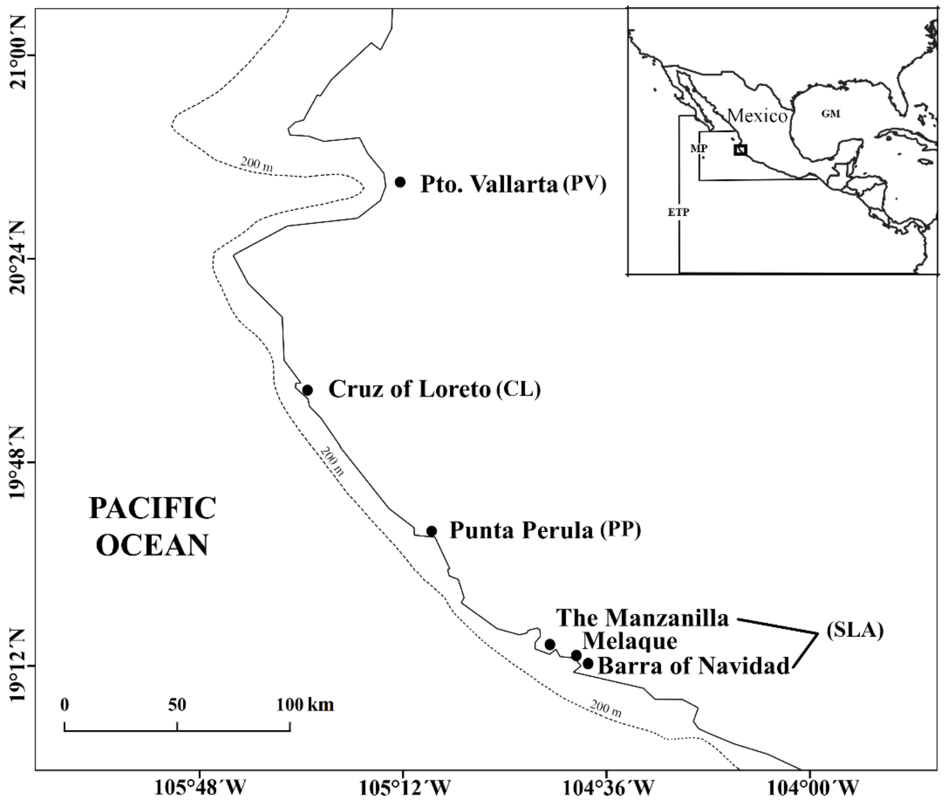

Figure 1. Map of artisanal fishing landing areas in the Mexican Central Pacific. Abbreviations, ETP: Eastern Tropical Pacific, MP: Mexican Province, GM: Gulf of Mexico, SLA: southern landing areas includes the sites of La Manzanilla, Melaque and Barra de Navidad.

Taxonomic identification was performed using keys, guides, and manuals of Ramírez-Hernández & González-Pagés (1976), Castro-Aguirre (1978), Thomson et al. (1979), Eschmeyer et al. (1983), Fisher et al. (1995) and Espino-Barr et al. (2004). The systematic updating of each species was done through Allen & Robertson (1994), Robertson & Allen (2002, 2015), and Fricke et al. (2020). Finally, we used Bussing & Lavenberg's (2003) systematic reviews and Fricke et al. (2020) to validate some species that expand their distribution. The systematic listing follows Nelson's (2006) scheme, and the arrangement of the genera and their respective species are presented in alphabetical order. The scientific name update was explored in Eschmeyer's catalog of fishes (Fricke et al. 2020). Additionally, the criterion of capture frequency (CF) was established taking into account the relative abundance (RA) by species, considering the number of individuals of a species (Ni), divided by the total number of all species (Nt), multiplied by 100 [% RA = (Ni / Nt) × 100] (Horn & Allen 1985, Ramírez & Rodríguez 1990) and following López-Martínez et al. (2010), species were grouped into four categories according to their RA: rare (<0.01%), common (0.01-0.99%), frequent (0.1-0.99%), and abundant (>1%).

The zoogeographic affinity analysis was established under the regions and provinces scheme of Robertson & Cramer (2009), considering the following divisions: Cortes Province (CP), Mexican Province (MP), Panamic Province (PP), Ocean Island Province (OIP) and Californian-Peruvian Province (CPP).

RESULTS

A total of 148,215 bony fish were analyzed, identifying 170 spp. belonging to 15 orders, 52 families, and 113 genera (Table 1). The order Perciformes was the best represented with 136 spp. (80.0%), followed by Pleuronectiformes and Tetraodontiformes, each with six spp. (3.5%); the rest presented between four and one spp. At the family level, the Carangidae had 14.7% of the species (25), followed by the Haemulidae with 14.7% (17), Sciaenidae 9.4% (16), Serranidae 8.2% (14), and 5.8% of Lutjanidae and Scombridae with an equal number of species (10). At the level of the genera,

Table 1. Taxonomic listing of ichthyofauna caught by artisanal fisheries on the coast of Jalisco, Mexican Central Pacific, between 2002 and 2017. Fishing gear, GN: gill net, HL: hand line, H: harpoon, At: atarraya, L: longline, Cu: currican, S: stealer, HLW: hand line with lure. Frequency of catch, R: rare species, C: common, F: frequent, A: abundant. Landing area, PV: Puerto Vallarta, CL: Cruz of Loreto, PP: Punta Perula, SLA: southern landing areas. Zoogeographic affinity, Ct: Circumtropical, Aa: Amphiameric, Ap: Amphipacific, CP: Cortes Province, MP: Mexican Province, PP: Panamic Province, OIP: Ocean Island Province, CPP: Californian-Peruvian Province. *E = exotic species.

Classification	Fishing gear	Frequency of catch	Landing area	Zoogeographic affinity
Phylum Chordata				
Class Actinopterygii				
Order Elopiformes				
Family Elopidae				
Elops affinis Regan, 1909	GN, HL, Cu	F	PV, CL, PP, SLA	CPP, CP, MP, PP
Order Albuliformes				
Suborder Albuloidei				
Family Albulidae				
Albula pacifica (Beebe, 1942)	GN, HL	C	PV, CL, PP, SLA	CPP, CP, MP, PP
Order Anguilliformes				
Suborder Muraenoidei				
Family Muraenidae				
Gymnothorax castaneus (Jordan & Gilbert, 1883)	GN, HL	R	PP, SLA	CPP, CP, MP, PP, OIP
Suborder Congroidei				
Family Ophichthidae				
Myrichthys tigrinus Girard, 1859	GN, HL	R	SLA	CP, MP, PP, OIP, CPP
Family Congridae				
Ariosoma gilberti Ogilby, 1898	GN, HL	R	SLA	CPP, CP, MP, PP, OIP
Bathycongrus macrurus Gilbert, 1891	GN, HL	R	SLA	CP, MP, PP
Order Clupeiformes				
Suborder Clupeoidei				
Family Pristigasteridae				
Pliosteostoma lutipinnis (Jordan & Gilbert, 1882)	At	C	SLA	MP, PP
Family Engraulidae				
Anchoa nasus (Kner & Steindachner, 1867)	GN, At	C	CL, SLA	CP, MP, PP, CPP
Family Clupeidae				
Opisthonema libertate Günther, 1867	GN, At	C	PV, CL, SLA	CP, MP, PP, OIP, CPP
Order Gonorynchiformes				
Suborder Chanoidei				
Family Chanidae				
Chanos chanos Fabricius, 1775	GN	F	PV, CL, PP, SLA	*E
Order Siluriformes				
Family Ariidae				
Ariopsis gilberti (Jordan & Williams, 1895)	GN, HL	F	PV, CL, SLA	CP, MP, PP
Bagre pinnimaculatus (Steindachner, 1876)	GN, HL	R	PV	CP, MP, PP
Order Ophidiiformes				
Suborder Ophidioidei				
Family Ophidiidae				
Brotula clarkae Hubbs, 1944	GN, HL, Cu	C	PV, SLA	CPP, CP, MP, PP
Order Mugiliformes				
Family Mugilidae				
Mugil cephalus Linnaeus, 1758	GN, At	F	PV, CL, SLA	Ct
Mugil setosus Gilbert, 1892	GN, At	A	PV, CL, PP, SLA	Aa
Order Beloniformes				
Suborder Belonoidei				

Continuation

Classification	Fishing gear	Frequency of catch	Landing area	Zoogeographic affinity
Family Exocoetidae				
Fodiator rostratus (Günther, 1866)	GN	R	PV	CPP, CP, MP, PP, OIP
Family Belonidae				
Ablennes hians (Valenciennes, 1846)	GN, Cu	R	PV, SLA	Ct
Strongylura exilis (Girard, 1854)	GN	C	PV, CL, SLA	CPP, CP, MP, PP, OIP
Order Beryciformes				
Suborder Holocentroidei				
Family Holocentridae				
Myripristis leiognathus Valenciennes, 1846	GN	R	PP	CPP, CP, MP, PP, OIP
Order Gasterosteiformes				
Suborder Syngnathoidei				
Family Fistulariidae				
Fistularia commersonii Rüppell, 1838	GN	R	SLA	Ap
Order Scorpaeniformes				
Suborder Scorpaenoidei				
Family Scorpaenidae				
Scorpaena mystes Jordan & Starks, 1895	GN, HL	C	PV, PP, SLA	CPP, CP, MP, PP, OIP
Suborder Platycephaloidei				
Familia Triglidae				
Prionotus horrens Richardson, 1844	GN	C	PV, PP, SLA	CPP, CP, MP, PP
Order Perciformes				
Suborder Percoidei				
Family Centropomidae				
Centropomus armatus Gill, 1863	GN, HL	C	CL, SLA	CP, MP, PP
Centropomus medius Günther, 1864	GN, At, HL, Cu	C	PV, CL, PP, SLA	CPP, CP, MP, PP
Centropomus nigrescens Günther, 1864	GN, HL, H, L	F	PV, CL, PP, SLA	CPP, CP, MP, PP
Centropomus robalito Jordan & Gilbert, 1882	At, HLW, GN	A	CL, PP, SLA	CP, MP, PP
Family Serranidae				
Alphestes immaculatus Breder, 1936	GN, HL, H	C	PV, SLA	CP, MP, PP, OIP
Cephalopholis panamensis (Steindachner, 1876)	GN, HL, H	F	PV, PP, SLA	CP, MP, PP, OIP
Diplectrum macropoma (Günther, 1864)	GN, HL	R	PV	CPP, CP, MP, PP
Epinephelus analogus Gill, 1863	GN, HL, H	C	PV, PP, SLA	CP, MP, PP, OIP, CPP
Epinephelus labriformis (Jenyns, 1840)	GN, HL, H	F	PV, PP, SLA	CP, MP, PP, OIP, CPP
Hyporthodus acanthistius (Gilbert, 1892)	GN, HL, H, L	C	PV, PP, SLA	CP, MP, PP, CPP
Hyporthodus cifuentesi Lavenberg & Grove, 1993	GN, HL, H	C	PV, PP, SLA	MP, PP, OIP
Hyporthodus niphobles (Gilbert & Starks, 1897)	GN, HL, H	C	PV, PP, SLA	CP, MP, PP, OIP, CPP
Mycteroperca prionura Rosenblatt & Zahuranec, 1967	GN, HL	R	PV, PP, SLA	CP, MP
Mycteroperca rosacea (Streets, 1877)	GN, HL, H	C	PV, PP, SLA	CPP, CP, MP
Paralabrax auroguttatus Walford, 1936	GN, HL, L	F	PV, PP, SLA	CPP, CP, MP
Paralabrax loro Walford, 1936	GN, HL, H	R	PP, SLA	CP, MP, PP, CPP
Paralabrax maculatofasciatus (Steindachner, 1868)	GN, HL	R	PV	CPP, CP, MP
Paranthias colonus (Valenciennes, 1846)	GN, HL	F	PV, PP, SLA	CP, MP, PP, OIP, CPP
Family Opistognathidae				
Opistognathus aff. *scops* (Jenkins & Evermann, 1889)	GN, HL, L	R	PV	PP, MP, CP, OIP, CPP
Family Priacanthidae				
Priacanthus alalaua Jordan & Evermann, 1903	GN	C	PV, PP, SLA	CPP, MP

Continuation

Classification	Fishing gear	Frequency of catch	Landing area	Zoogeographic affinity
Pristigenys serrula (Gilbert, 1891)	GN, HL	C	PV, PP, SLA	CP, MP, PP, OIP, CPP
Family Malacanthidae				
Aluterus monoceros (Linnaeus, 1758)	GN, HL, H	F	PV, SLA	Ct
Aluterus scriptus (Osbeck, 1765)	GN, HL	R	PV, PP, SLA	Ct
Caulolatilus affinis Gill, 1865	GN, HL, L, H	R	PV, PP	CP, MP, PP, OIP, CPP
Family Nematistiidae				
Nematistius pectoralis Gill, 1862	GN, HL, L	F	PV, PP, SLA	CP, MP, PP, OIP, CPP
Family Coryphaenidae				
Coryphaena hippurus Linnaeus, 1758	Cu, L	F	PV, PP, SLA	Ct
Family Carangidae				
Alectis ciliaris (Bloch, 1787)	GN, HL	C	PV, PP, SLA	Ct
Carangoides orthogrammus (Jordan & Gilbert, 1882)	GN, HL	R	PV, SLA	Ap
Carangoides otrynter (Jordan & Gilbert, 1883)	GN, HL	F	PV, PP, SLA	CPP, CP, MP, PP, OIP
Carangoides vinctus (Jordan & Gilbert, 1882)	GN	F	PV, PP, SLA	CPP, CP, MP, PP
Caranx caballus Günther, 1868	GN, HL	A	PV, PP, SLA	CPP, CP, MP, PP, OIP
Caranx caninus Günther, 1867	GN, HL, Cu	A	PV, CL, PP, SLA	CPP, CP, MP, PP, OIP
Caranx lugubris Poey, 1860	GN, HL, Cu	R	PV, SLA	Ct
Caranx melampygus Cuvier, 1833	GN, HL	R	PV, PP, SLA	Ap
Caranx sexfasciatus Quoy & Gaimard, 1825	GN, HL	A	PV, CL, PP, SLA	Ap
Chloroscombrus orqueta Jordan & Gilbert, 1883	GN, HL	C	PV, PP, SLA	CPP, CP, MP, PP, OIP
Decapterus muroadsi (Temminck & Schlegel, 1844)	GN, HL	C	PV, SLA	Ap
Elagatis bipinnulata (Quoy & Gaimard, 1825)	GN, HL, Cu	C	PV, PP, SLA	Ct
Gnathanodon speciosus (Forsskål, 1775)	GN, HL	C	PP	Ap
Hemicaranx leucurus (Günther, 1864)	GN	C	PV, PP, SLA	CP, MP, PP
Oligoplites altus (Günther, 1868)	GN, HL, At	F	PV, CL, PP, SLA	CP, MP, PP, CPP
Oligoplites refulgens Gilbert & Starks, 1904	GN, HL, At	R	PV, CL, SLA	CPP, CP, MP, PP
Selar crumenophthalmus (Bloch, 1793)	GN, S, At	C	PV, SLA	Ct
Selene brevoortii (Gill, 1863)	GN, HL	F	PV, CL, PP, SLA	CP, MP, PP, CPP
Selene orstedii Lütken, 1880	GN, HL	R	PV, SLA	CP, MP, PP
Selene peruviana (Guichenot, 1866)	GN, HL	A	PV, CL, PP, SLA	CP, MP, PP, OIP, CPP
Seriola peruana Steindachner, 1881	GN, HL	C	PV, PP, SLA	CP, MP, PP, OIP, CPP
Seriola rivoliana Valenciennes, 1833	GN, HL, H	F	PV, PP, SLA	Ct
Trachinotus kennedyi Steindachner, 1876	GN, HL	C	PV, CL, PP, SLA	CPP, CP, MP, PP
Trachinotus paitensis Cuvier, 1832	GN	C	PV, PP, SLA	CP, MP, PP, OIP, CPP
Trachinotus rhodopus Gill, 1863	GN, HL	A	PV, PP, SLA	CPP, CP, MP, PP, OIP
Family Lutjanidae				
Hoplopagrus guentherii Gill, 1862	GN, H	F	PV, CL, PP, SLA	CPP, CP, MP, PP, OIP
Lutjanus aratus (Günther, 1864)	GN, H	R	CL	CPP, CP, MP, PP, OIP
Lutjanus argentiventris (Peters, 1869)	GN, HL, L	A	PV, CL, PP, SLA	CPP, CP, MP, PP, OIP
Lutjanus colorado Jordan & Gilbert, 1882	L, HL, H	F	PV, CL, PP, SLA	CPP, CP, MP, PP
Lutjanus guttatus (Steindachner, 1869)	GN, HL, L, H	A	PV, CL, PP, SLA	CPP, CP, MP, PP, OIP
Lutjanus inermis (Peters, 1869)	GN, HL	A	PV, PP, SLA	CP, MP, PP
Lutjanus jordani (Gilbert, 1898)	GN, HL, L, H	F	PV, CL, PP, SLA	CP, MP, PP, OIP
Lutjanus novemfasciatus Gill, 1862	GN, HL, L	F	PV, CL, PP, SLA	CPP, CP, MP, PP, OIP
Lutjanus peru (Nichols & Murphy, 1922)	GN, HL, L	A	PV, CL, PP, SLA	CPP, CP, MP, PP, CPP
Lutjanus viridis (Valenciennes, 1846)	GN, HL	C	PV, PP, SLA	CP, MP, PP, OIP
Family Gerreidae				
Diapterus brevirostris (Sauvage, 1879)	GN, HL	A	PV, CL, PP, SLA	CPP, CP, MP, PP, OIP

Continuation

Classification	Fishing gear	Frequency of catch	Landing area	Zoogeographic affinity
Eucinostomus dowii (Gill, 1863)	GN, HL, At	F	PV, CL, SLA	CP, MP, PP, OIP
Eucinostomus currani Zahuranec, 1980	GN, At	F	PV, CL, SLA	CPP, CP, MP, PP
Eugerres lineatus (Humboldt, 1821)	GN, At	F	CL	CP, MP, PP, OIP
Gerres simillimus Regan, 1907	GN, HL, At	A	PV, CL, PP, SLA	CP, MP, PP, OIP
Family Haemulidae				
Anisotremus caesius (Jordan & Gilbert, 1882)	GN, HL, L, H	F	PV, PP, SLA	MP, PP
Anisotremus interruptus (Gill, 1862)	GN, HL, L	A	PV, PP, SLA	CPP, CP, MP, PP, OIP
Anisotremus taeniatus Gill, 1861	GN	C	PV, PP, SLA	CPP, CP, MP, PP
Genyatremus dovii (Günther, 1864)	GN	C	PV, PP, SLA	CP, MP, PP
Genyatremus pacifici (Günther 1864)	GN, L, HL	F	PV, PP, SLA	MP, PP
Genyatremus sp. Gill, 1862	GN, HL	C	PV, SLA	Ap
Haemulon flaviguttatum Gill, 1862	GN, L, HL	A	PV, PP, SLA	CPP, CP, MP, PP
Haemulon maculicauda (Gill, 1862)	GN, HL	F	PV, PP, SLA	CP, MP, PP, OIP
Haemulon scudderii Gill, 1862	GN, HL	F	PV, PP, SLA	CPP, CP, MP, PP, OIP
Haemulon sexfasciatum Gill, 1862	GN, HL	F	PV, PP, SLA	CPP, CP, MP, PP, OIP
Haemulon steindachneri (Jordan & Gilbert, 1882)	GN, HL	F	PV, PP, SLA	Aa
Haemulopsis elongatus (Steindachner, 1879)	GN	F	PV, CL, PP, SLA	CP, MP, PP
Microlepidotus brevipinnis (Steindachner, 1869)	GN, HL, L	A	PV, CL, PP, SLA	CP, MP, PP
Orthopristis chalcea (Günther, 1864)	RA, LM	F	PV, PP, SLA	CPP, CP, MP, PP, OIP
Rhencus panamensis (Steindachner, 1875)	GN, HL	F	PV, CL, PP, SLA	CP, MP, PP
Rhonciscus bayanus (Jordan & Evermann, 1898)	GN, At	C	PV, CL, SLA	CP, MP, PP
Xenichthys xanti Gill, 1863	GN, HL	F	PV, PP, SLA	CP, MP, PP, OIP
Family Sparidae				
Calamus brachysomus (Lockington, 1880)	GN, HL	F	PV, PP, SLA	CPP, CP, MP, PP, OIP
Family Polynemidae				
Polydactylus approximans (Lay & Bennett, 1839)	GN, At	F	PV, CL, PP, SLA	CPP, CP, MP, PP
Polydactylus opercularis (Gill, 1863)	GN	F	PV, CL, PP, SLA	CP, MP, PP, CPP
Family Sciaenidae				
Bairdiella ensifera (Jordan & Gilbert, 1882)	GN, HL	C	PV, PP, SLA	MP, PP
Corvula macrops (Steindachner, 1876)	GN, HL	C	PV, CL, PP, SLA	CP, MP, PP, OIP
Cynoscion reticulatus (Günther, 1864)	GN, L, HL	F	PV, PP, SLA	CP, MP, PP
Cynoscion stolzmanni (Steindachner, 1879)	GN, L, HL	R	PV, PP	CP, MP, PP
Cynoscion sp. Gill, 1861	GN, HL	R	SLA	Ap
Larimus acclivis Jordan & Bristol, 1898	GN, HL	F	PV, CL, PP, SLA	CP, MP, PP
Larimus argenteus (Gill, 1863)	GN, HL	C	PV, SLA	CPP, CP, MP, PP
Menticirrhus nasus (Günther, 1868)	GN, HL	R	PV	CPP, CP, MP, PP
Menticirrhus undulatus (Girard, 1854)	GN, HL	C	PV, PP, SLA	CPP, CP, MP
Micropogonias ectenes (Jordan & Gilbert, 1882)	GN, HL	F	PV, PP, SLA	CPP, CP, MP
Micropogonias megalops (Gilbert, 1890)	GN, HL	R	PV	CPP, CP, MP
Ophioscion vermicularis (Günther, 1867)	GN	C	PV, PP, SLA	CP, MP, PP
Pareques aff. *viola* (Gilbert, 1898)	GN, HL, H	R	PP, SLA	PP, OIP
Umbrina analis Günther, 1868	GN, HL	R	PP	CP, MP, PP
Umbrina bussingi López, 1980	GN, HL	A	PV, PP, SLA	MP, PP
Umbrina xanti Gill, 1862	GN, HL	F	PV, CL, PP, SLA	CPP, CP, MP, PP
Family Mullidae				
Mulloidichthys dentatus (Gill, 1862)	GN, HL, H	F	PV, PP, SLA	CPP, CP, MP, PP, OIP
Pseudupeneus grandisquamis (Gill, 1863)	GN, HL	C	PV, SLA	CP, MP, PP, OIP

Continuation

Classification	Fishing gear	Frequency of catch	Landing area	Zoogeographic affinity
Family Kyphosidae				
Kyphosus elegans (Peters, 1869)	GN, H	F	PV, PP, SLA	CP, MP, PP, OIP
Kyphosus ocyurus (Jordan & Gilbert, 1882)	GN	F	PV, PP, SLA	Ap
Kyphosus vaigiensis (Quoy & Gaimard, 1825)	GN, H	C	PP, SLA	Ap
Family Chaetodontidae				
Chaetodon humeralis Günther, 1860	H, HL, GN	R	PV, SLA	CPP, CP, MP, PP, OIP
Suborder Labroidei				
Family Cichlidae				
Cirrhitus rivulatus Valenciennes, 1846	H, HL, GN	C	PV, PP, SLA	CP, MP, PP, OIP
Family Pomacentridae				
Abudefduf troschelii (Gill, 1862)	GN, H	R	PP	CPP, CP, MP, PP, OIP
Family Labridae				
Bodianus diplotaenia (Gill,1862)	GN, H	C	PV, PP, SLA	CP, MP, PP, OIP, CPP
Halichoeres chierchiae Di Caporiacco, 1948	GN, H	R	PV, PP, SLA	CP, MP, PP, OIP
Iniistius pavo (Valenciennes, 1840)	GN, H	R	PP	Ap
Family Scaridae				
Nicholsina denticulata (Evermann & Radcliffe, 1917)	GN, HL, H	R	PV, SLA	CPP, CP, MP, PP, OIP
Scarus compressus (Osburn & Nichols, 1916)	GN, HL, H	R	SLA	CP, MP, PP, OIP
Scarus ghobban Fabricius, 1775	GN, HL, H	R	PV, SLA	Ap
Scarus perrico Jordan & Gilbert, 1882	GN, HL, H	C	PV, PP, SLA	CP, MP, PP, OIP
Suborder Trachinoidei				
Family Uranoscopidae				
Astroscopus zephyreus Gilbert & Starks, 1897	GN, HL	C	PV, SLA	CPP, CP, MP, PP
Suborder Gobioidei				
Family Eleotridae				
Eleotris aff. picta Kner 1863	At, HL	F	CL	PP, OIP
Suborder Acanthuroidei				
Family Ephippidae				
Chaetodipterus zonatus (Girard, 1858)	GN, H	F	PV, CL, PP, SLA	CPP, CP, MP, PP
Parapsettus panamensis (Steindachner, 1875)	GN, H	R	PV	CP, MP, PP
Family Acanthuridae				
Acanthurus xanthopterus Valenciennes, 1835	GN, H	C	PV, CL, PP, SLA	Ap
Prionurus laticlavius (Valenciennes, 1846)	GN, H	C	PV, PP, SLA	CP, MP, PP, OIP
Suborder Scombroidei				
Family Sphyraenidae				
Sphyraena ensis Jordan & Gilbert, 1882	GN, HL	F	PV, CL, PP, SLA	CP, MP, PP
Family Scombridae				
Auxis rochei eudorax Collette & Aadland, 1996	GN, HL	R	PV	CPP, CP, MP, PP, OIP
Auxis thazard brachydorax Collette & Aadland, 1996	GN, Cu	F	PV, SLA	CPP, CP, MP, PP, OIP, CPP
Euthynnus affinis (Cantor, 1849)	GN	C	PV	Ap
Euthynnus lineatus Kishinouye, 1920	Cu, GN, HL	F	PV, PP, SLA	CPP, CP, MP, PP, OIP
Katsuwonus pelamis (Linnaeus, 1758)	Cu, HL	R	PV	Ct
Sarda orientalis (Temminck & Schlegel, 1844)	Cu, GN, HL	F	PV, PP, SLA	Ap
Scomber japonicus Houttuyn, 1782	GN, HL, Cu	C	PV, SLA	Ap
Scomberomorus sierra Jordan & Starks, 1895	GN, Cu	A	PV, PP, SLA	CPP, CP, MP, PP, OIP, CPP
Thunnus alalunga (Bonnaterre, 1788)	Cu, HL	C	PV, SLA	Ct
Thunnus albacares (Bonnaterre, 1788)	Cu, HL	C	PV, SLA	Ct
Suborder Stromateoidei				
Family Stromateidae				
Peprilus medius (Peters, 1869)	GN, HL	R	PV	CP, MP, PP, OIP
Peprilus snyderi Gilbert & Starks, 1904	GN	F	PV, SLA	CP, MP, PP, CPP
Order Pleuronectiformes				
Suborder Pleuronectoidei				
Family Paralichthyidae				

Continuation

Classification	Fishing gear	Frequency of catch	Landing area	Zoogeographic affinity
Ancylopsetta dendritica Gilbert, 1890	GN, HL	R	PV, SLA	CP, MP, PP
Cyclopsetta panamensis (Steindachner, 1876)	GN, H, HL	A	PV, CL, PP, SLA	CP, MP, PP
Hippoglossina tetrophthalma (Gilbert, 1890)	GN, HL	R	PV, PP, SLA	CPP, MP, PP
Syacium latifrons (Jordan & Gilbert, 1882)	GN, HL	R	PV	CPP, CP, MP, PP, OIP
Family Achiridae				
Achirus mazatlanus (Steindachner, 1869)	GN, HL	R	PV	CPP, CP, MP, PP
Family Cynoglossidae				
Symphurus melasmatotheca Munroe & Nizinski, 1990	GN, HL	R	PV	MP, PP
Order Tetraodontiformes				
Suborder Balistoidei				
Family Balistidae				
Balistes polylepis Steindachner, 1876	HL, H	F	PV, CL, PP, SLA	AP, CPP, CP, MP, PP, OIP, CPP
Melichthys niger (Bloch, 1786)	GN, HL	R	SLA	Ct
Pseudobalistes naufragium (Jordan & Starks, 1895)	GN, HL	C	PV, CL, SLA	CPP, CP, MP, PP, OIP
Sufflamen verres (Gilbert & Starks, 1904)	GN, HL	C	PV, CL, PP, SLA	CPP, CP, MP, PP, OIP
Suborder Tetraodontoidei				
Family Tetraodontidae				
Sphoeroides annulatus (Jenyns, 1842)	GN, HL	C	PV, CL, SLA	CPP, CP, MP, PP, OIP
Family Diodontidae				
Diodon holocanthus Linnaeus, 1758	GN, HL	R	SLA	Ct

Lutjanus 9 (5.4%), *Caranx* 6 (3.6%), *Haemulon* 5 (3.0%), *Centropomus* 4 (2.4%), and *Anisotremus* 3 (1.8%) were the best represented.

The sites with the highest richness were Puerto Vallarta with 146 spp. and the southern landing zone; this includes La Manzanilla, Melaque, and Barra of Navidad sites with 145 spp., followed by Punta Perula with 109 spp. and Cruz de Loreto with 51 species, sharing only 26.6% (35 spp.) of the species between the four zones. Ichthyofauna was represented by abundant species 11.2% (19 spp.), rare species 27.0% (46 spp.), and mainly by common species 31.2% (53 spp.) and frequent species 30.6% (52 spp.), accounting for almost 62.0%. The RA analysis indicated 13 relevant species in the artisanal fisheries of the coast of Jalisco: *Lutjanus guttatus* (Steindachner, 1869), *Lutjanus peru* (Nichols & Murphy, 1922), *Microlepidotus brevipinnis* (Steindachner, 1869), *Haemulon flaviguttatum* Gill, 1862, *Scomberomorus sierra* Jordan & Starks, 1895, *Lutjanus argentiventris* (Peters, 1869), *Gerres simillimus* Regan, 1907, *Caranx caballus* Günther, 1868, *Caranx caninus* Günther, 1867, *Mugil setosus* Valenciennes, 1836 (before *Mugil curema* Valenciennes, 1836), *Selene peruviana* (Guichenot, 1866), *Trachinotus rhodopus* Gill, 1863 and *Umbrina bussingi* López, 1980.

Fishers use gill net (43.6%), hand line (33.2%), and harpoon (10.2%) as the main fishing gear. Other equipment, such as longline (4.7%), trolling (4.4%), rope (3.3%), stealing (0.3%), and hand line with jigging (0.3%), are also part of the repertoire in the artisanal fisheries. They caught up to 25 spp. in common with their essential fishing equipment, including the 13 spp, representatives of the area.

Of the recognized bonefish (Table 1), three spp. had an Amphiameric, a considerable number have a wide distribution (16 Amphipacific and 15 Circumtropical), and the rest are distributed in the eastern Pacific (135 spp.). Of the latter, 105 are endemic or restricted to the Tropical Eastern Pacific, of which 133 (24.7%) are shared in the Mexican Province, 127 (23.5%) in the Panamic Province, 125 (23.2%) in the Cortez Province, 84 (15.6%) in the Californian-Peruvian Province, and 70 (13.0%) in the Ocean Island Province. The climatic affinities, according to the provinces, were also documented. 75.3% of the species were cataloged as a tropical transition (distributed in CP, MP, PP, and OIP), 15.9% as tropical (their current distribution only includes the MP, PP, and OIP provinces), 7.2% as a peaceful transition (distributed in CPP, CP, MP, and OIP) and 1.4% as temperate distribution (CPP and CP).

DISCUSSION

The richness bony fish caught by artisanal fishermen on the coast of Jalisco was greater than the results of other research focused on ichthyological characterization in the MCP (Godínez-Domínguez et al. 2000, Ríos-Jara et al. 2001, Rojo-Vázquez et al. 2001, Espino-Barr et al. 2004, 2006, Saldaña-Millán 2010, Galván-Villa et al. 2011, Bravo-Olivas et al. 2014, García-Castiñeira et al. 2014, González-Sansón et al. 2014, Aguilar-Palomino 2017). Although with similar results to those reported by Lucano-Ramírez et al. (2001), Aguilar-Palomino et al. (2001), and Moncayo-Estrada et al. (2006). Some studies had more records because they include cartilaginous fish, cryptic species, species lists from other studies, and ecosystems rarely represented by artisanal or smaller-scale fisheries, Considering the number of species, genera, families, and orders. The applied catch effort may influence these differences in species richness, such as time, the number of sites, and fishing gear used (Moncayo-Estrada et al. 2006).

On the other hand, the number of species from our results were notoriously high compared to the ichthyological fauna of other areas of the MP such as Baja California (Ramírez & Rodríguez 1990, De la Cruz-Agüero et al. 1994, 1996, Rosales-Casián 1996, 2004, Rodríguez-Romero et al. 1998, 2011), Gulf of California (Rodríguez-Romero et al. 1994, López-Martínez et al. 2012, Herrera-Valdivia et al. 2016), Sonora (Grijalva-Chon et al. 1996), Sinaloa (Balart et al. 1992), Nayarit (Benítez-Valle et al. 2007, Ulloa-Ramírez et al. 2008, Valdez-Pineda 2015, Torrescano-Castro et al. 2016), Colima (Espino-Barr et al. 1998, 2003, 2008, Espino-Barr 2000, Castro-Aguirre et al. 2006), Michoacán (Castro-Aguirre et al. 2006, Sandoval-Huerta et al. 2014, García-Meraz 2019), and Guerrero (Gutiérrez-Zavala & Cabrera-Mancilla 2012, 2019). In contrast to other studies carried out in Baja California (Abitia-Cárdenas et al. 1994, Rodríguez-Romero et al. 2008), the Gulf of California (López-Martínez et al. 2010), Nayarit (Sánchez-González 2000, González-Díaz & Soria-Barreto 2013), Colima (González-Acosta et al. 2016), Michoacan (Madrid-Vera et al. 1997, 1998, Domínguez-Domínguez et al. 2014) and Oaxaca (Bastida-Zavala et al. 2013, Cerdenares-Ladrón de Guevara et al. 2014, Del Moral-Flores et al. 2016, Valencia-Méndez et al. 2021), where there is a large number of species. The differences in species richness of different study areas in the Mexican Pacific can be attributed to the systems of currents, upwelling, eddies, topography, and bathymetry, which together create a very dynamic ecosystem with a wide thermal regime and a great variety of habitats (López-Martínez et al. 2010).

When comparing species richness with the different landing areas, it was found that Puerto Vallarta (32.4%) and the Southern Landing Zone (32.0%) presented the highest number of species, in contrast to Cruz de Loreto (11.3%) and Punta Perula (24.3%) (Table 1). The above could be associated with the bottom heterogeneity of the capture areas (González-Sansón & Silva-Bátiz 2017). Punta Perula and Cruz de Loreto are characterized by extensive open beaches, coastal lagoons, estuaries, and marshes that form in the lowlands. On the other hand, the Banderas Bay coastline (Puerto Vallarta) and the Southern Landing Zone sites present greater substrate heterogeneity (pocket beaches interspersed with extensive facies and rocky points of greater complexity). They increase the supply of habitats for shelter and feeding (INEGI 1995, Espino-Barr et al. 2004).

In addition, the observed richness shows that the Jalisco coast is a transition zone, generating a great variety of habitats influenced by the convergence of three important marine currents: California Current, Costa Rican Coastal Current (Badan-Dangon 1997), and the Gulf of California Current (Carriquiry & Reyes-Bonilla 1997), which are seasonal and interact transporting heat, nutrients, and biomass from one ocean region to another (Fernández-Eguiarte et al. 1993). The area is also a transition zone between two zoogeographic provinces and, consequently, a zone of species mixing from the Gulf of California, tropical Pacific, and temperate regions (Robertson & Allen 2008). Another factor that influences the presence and absence of species is primary productivity; the coastal waters in which the state is located are considered very productive, with values of more than 300 gC m^{-2} yr^{-1} of primary production, due to the upwelling zones that occur in sometimes of the year (Zamudio et al. 2007, Wilkinson et al. 2009).

Of the total species (170), only 41.8% (71) were abundant and frequent, the other 58.2% (99) were within the category of common (53 spp.) and rare (46 spp.), presenting seasonal or monthly changes, a characteristic that stands out in tropical and subtropical fish (Rodríguez-Romero et al. 1998). Most of the rare species in this research correspond to pelagic and mesopelagic species caught as by-catch during different fishing operations (Robertson & Cramer 2009). On the other hand, 13 spp. are consistent in their frequency and RA, as they have been reported in other investigations from the coast of Jalisco (Godínez-Domínguez et al. 2000, Lucano-Ramírez et al. 2001, Aguilar-Palomino et al. 2001, Rojo-Vázquez et al. 2001, Espino-Barr et al. 2006, Saldaña-Millán 2010, García-Castiñeira et al. 2014, González-Sansón et al. 2014, Bravo-Olivas et al. 2014, Aguilar-Palomino 2017); in which the four spp. of the family Lutjanidae (*Lutjanus guttatus*, *L. peru*, *L. argentiventris*, *Microlepidotus brevipinnis*), two spp. of the family Carangidae (*Caranx caballus*, *C. caninus*) and the remaining seven spp. (*Haemulon flaviguttatum*, *Scomberomorus sierra*, *Gerres simillimus*, *Mugil* *curema*, *Selene peruviana*, *Trachinotus rhodopus*, *Umbrina bussingi*), represent the ichthyofauna caught by artisanal fisheries in the study area.

The analysis of the type of fishing gear used in the capture of bony fish in the region showed that eight gears are distinguished, of which the gill net (43.3%), the hand line (33.4%), and the harpoon (10.1%) are the most important. These results coincide with Espino-Barr et al. (2004, 2006) for the coast of Jalisco, although they report that the gill net and the harpoon are used more frequently than the hand line. In addition, the authors document that there are 970 fishing equipment: 340 gillnets, 50 handlines, 290 dive gear, 50 catfish, 240 hoop traps, pots, and lobsters. Fishing trips are daily, and the time taken depends on the fishing method and gear used: the handline is worked from 6 to 7 h in the morning, between 05:00 h and noon; the gillnet is set at 20:00 h and picked up the next day after 6:00 h, sometimes the net is checked at midnight. Diver's start fishing early in the morning (at 07:00 h) and return between noon and 15:00 h. Espino-Barr & Cruz-Romero (2006) for the south-central Pacific also recognize the importance of these gears in capturing coastal fisheries, highlighting the adaptations they have undergone. For this reason, the diversity in fishing gear is related to the species being caught and the season of the year in which it is fished (Espino-Barr et al. 2004), in addition to the vessel type, geomorphological characteristics of the region, and the economic capacity of coastal fishers (Ulloa-Ramírez et al. 2008).

Concerning the zoogeographical affinity of the ichthyofauna of the coast of Jalisco, a total of five divisions were presented, where PP and MP were the ones that recorded the greatest number of species. These results are consistent in some cases with Godínez-Domínguez et al. (2000), Aguilar-Palomino et al. (2001), Moncayo-Estrada et al. (2006) and Castro-Aguirre et al. (2006) for the Jalisco coast and with Rodríguez-Romero et al. (2008), López-Martínez et al. (2012), Valdez-Pineda (2015), González-Acosta et al. (2016) and Del Moral-Flores et al. (2016). The results, respecting the climate affinity are consistent with those reported by Sánchez-González (2000), who also recorded a high species richness in the climate affinity of tropical transition (63 spp.) and tropical affinity (54 spp.) and a low wealth in temperate affinity (7 spp.) and temperate transition (3 spp.). *Chanos chanos* has recently been recognised as an alien species in the Mexican Central Pacific (MCP) (Espinosa-Pérez & Ramírez, 2015).

The present investigation allows us to determine that the taxonomic composition of the ichthyofauna captured on the coast of Jalisco is rich and diverse, composed of 170 spp., five of which extend their range of geographical distribution. The zoogeographic analysis indicated an ichthyofauna typical of tropical waters, both of the Mexican and Panamica provinces. The fishing areas that landed in Puerto Vallarta and the three towns on the southern coast of Jalisco (La Manzanilla, Melaque, and Barra de Navidad) showed a greater number of species. It is undoubtedly related to the greater fishing effort, primary productivity, and other oceanographic conditions that define the habitats of each capture area. Therefore, this information will be used as a basis for future comparisons with other studies that allow for the sustainable management of fish resources from coastal fisheries in the MCP.

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