

# Fish larvae from the Gulf of California to Colima, Mexico: An update

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**ABSTRACT:** An updated taxonomic list of marine fish larvae from the Gulf of California to Colima, Mexico is presented. A total of 579 taxa belonging to 119 families, 256 genera, and 423 species were recorded. The list was compiled using 14 publications on fish larvae research (1974-2012), and the fish larvae identified from 315 samples collected with Bongo nets during 10 oceanographic cruises made from the Gulf of California to Bahía de Banderas, Mexico, from 2003 to 2007 (this study). The most important families in this study were the Myctophidae (28.3%), Engraulidae (25.0%), and Clupeidae (15.4%). The most abundant species were *Cetengraulis mysticetus* (18.2%), *Benthoosema panamense* (13.9%), and *Opisthonema libertate* (12.7%). The compiled taxonomic list shows the addition of 296 new taxa to the previous list published 10 years ago, and also the need of an increase in the effort on the taxonomy of fish larvae forms not identified to species level.

## INTRODUCTION

Ichthyoplankton studies in the Gulf of California began almost 40 years ago when Moser *et al.* (1974) collected plankton during six oceanographic cruises made during 1956-1957 and published the first list of the occurrence and abundance of marine fish larvae. Moser (1996) provided the most important taxonomic tool for the identification of the early stages of fish larvae in the California Current, which account for an important number of species in the Gulf of California, while Aceves-Medina *et al.* (2003) contributed with the first and most extensive systematic list to that date. Many other early ichthyoplanktonic studies targeted only the main commercial species such as the Pacific sardine and the northern anchovy (Hamman *et al.* 1988; Green-Ruiz and Hinojosa-Corona 1997).

More recently, ichthyoplanktonic research related to the study of fish larvae abundance, distribution, and their relationship to environmental factors and mesoscale processes was conducted throughout several areas from the Gulf of California to the oceanic area in front of Colima (Franco-Gordo *et al.* 1999; 2003; Ávalos-García *et al.* 2003; Sala *et al.* 2003; Sánchez-Velasco *et al.* 2004; 2007; González-Armas *et al.* 2008; Peguero-Icaza *et al.* 2008; Silva-Segundo *et al.* 2008; Avendaño-Ibarra *et al.* 2009; León-Chávez *et al.* 2010; Contreras-Catala *et al.* 2012; Avendaño-Ibarra *et al.* 2013). Some of these included taxonomic lists of the fish larvae identified. At the same time, a strong sampling effort (10 oceanographic cruises from 2003 to 2007) directed to identify fish larvae communities and other zooplankton components and their relationship to the pelagic environment, provided the clues to determine a change in the status of our knowledge of the diversity in the Mexican Pacific area.

The main objective of our study was to incorporate all the new taxa we recognized during the 2003-2007 study, and those from the last 10 years of published fish larvae studies, into an updated taxonomic list of the larval fish communities present in the area from the Gulf of California to Colima, Mexico.

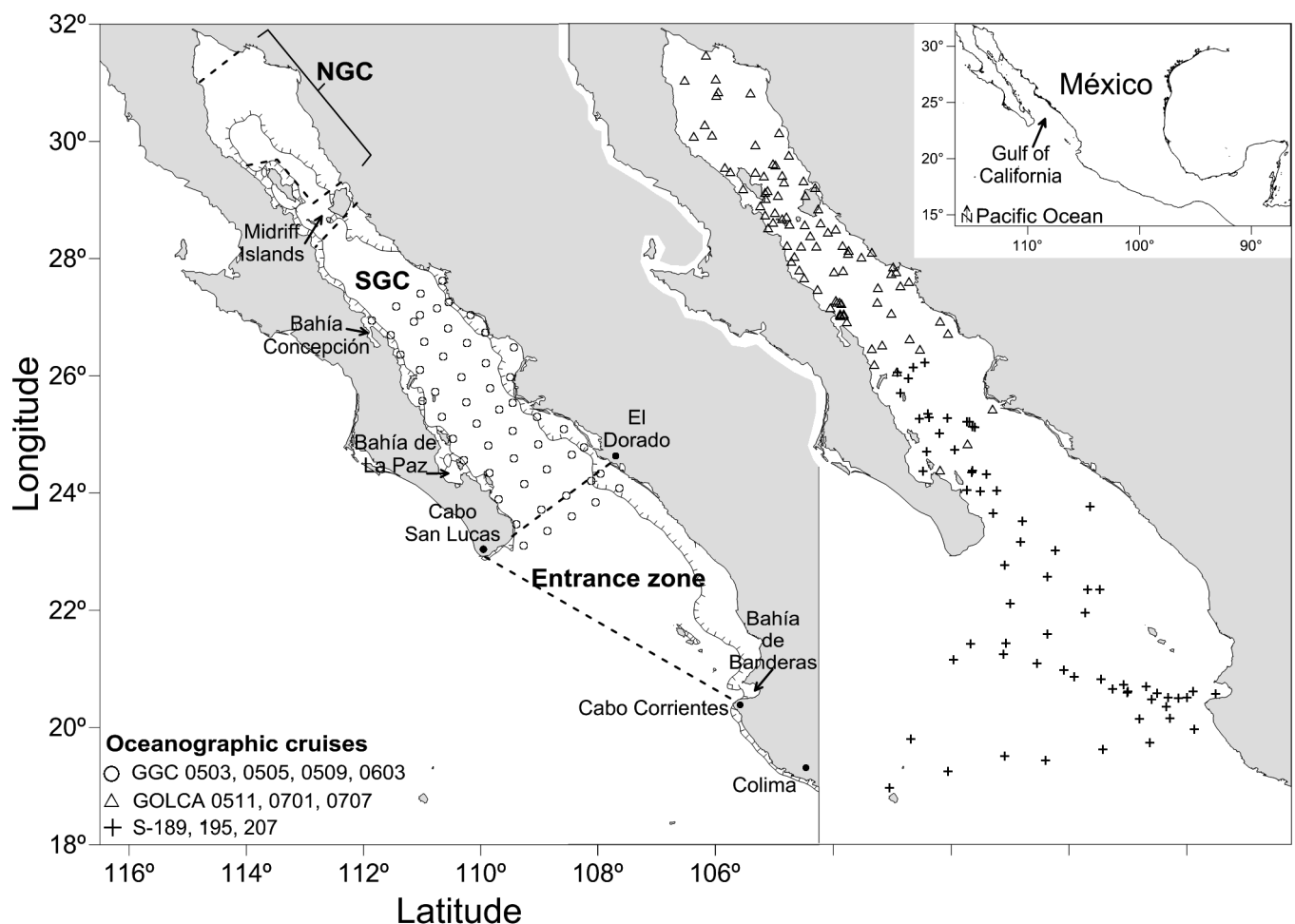
## MATERIALS AND METHODS

The study area includes two biogeographic provinces: the Mexican and the Cortez provinces; and it is located at the northernmost region of the Eastern tropical Pacific in front of Mexico (Figure 1) comprising from 32° N to 20° N and from 116° W to 105.5° W. The Gulf of California is a semi-enclosed dynamic sea where strong changes in temperature, salinity, and currents are related to the seasonal flux of the Gulf of California and Tropical Surface Water masses, which cause latitudinal and coastal-oceanic gradients in the physical, chemical, and biological characteristics (Gaxiola-Castro *et al.* 1999). This area provides a unique environment where the southern tropical, subtropical, and northern temperate marine biota develops (Castro-Aguirre 1995; Aceves-Medina *et al.* 2003). Based on bottom topography and physical processes, five contrasting regions have been described in the Gulf of California (Lavín *et al.* 1997; Lavín and Marinone 2003). The Northern Gulf of California region (NGC), located to the north of the archipelago of the large islands, has an anticyclonic circulation most of the year, while in June and September it reverses to a cyclonic gyre (Jiménez *et al.* 2005). In this area, the ichthyofauna is primarily of temperate affinity (Castro-Aguirre 1995). The archipelago zone (area around Isla Tiburón, Ángel de la Guarda, and San Esteban), represents a boundary between

the northern and southern gulf (Figure 1), with thermal fronts induced by vertical mixing at the sills ( $\approx 400\text{--}600$  m depth) of the archipelago that maintain low temperatures (Lavín *et al.* 1997; Soto-Mardones *et al.* 1999) and high chlorophyll concentrations throughout the year (Pegau *et al.* 2002; Espinosa-Carreón and Valdéz-Holguín 2007). The Southern Gulf of California (SGC) is located from the lower limit of the archipelago through Cabo San Lucas at the tip of the Baja California peninsula, and it is characterized by, among other features, strong upwelling and oceanic fronts particularly during winter-spring, deep basins with depths that range from 1000–3000 m, and warm sea surface temperature with small variations throughout the year (Soto-Mardones *et al.* 1999; Lavín and Marinone 2003). This area presents a mixture of tropical and temperate species. The continental coast of the gulf is characterized by a broad continental shelf and mostly sandy beaches, while the peninsular side has a narrow continental shelf and rocky beaches. The Entrance Zone of the gulf (from the tip of the Baja California peninsula and El Dorado, Sinaloa to Cabo Corrientes, Jalisco) is located in the Eastern Tropical Pacific (ETP) in front of Mexico. It is a transitional ocean region associated with the seasonal confluence of tropical water brought to the area by the poleward Mexican Coastal Current (Kessler 2006; Lavín *et al.* 2006), and subarctic water from a branch of the California Current System which, instead of flowing westward to join the North Equatorial Current, flows equatorward parallel to the coast of Mexico

(Kessler 2006). In this area, submarine canyons, a narrow continental coast, an intense mesoscale activity consisting of fronts between the California Current, Gulf of California, and Tropical Surface Water masses, and eddies and filaments (related to wind originated coastal upwelling) are observed year-round (Torres-Orozco *et al.* 2005; Zamudio *et al.* 2007). The presence of all these features, and also of a number of islands, may promote and enhance a wide variety of habitats linked to a complex and diverse ichthyoplanktonic community. The oceanographic region from Jalisco to Colima presents a narrow continental shelf (Filonov *et al.* 2000). It is influenced by the poleward flow of the Costa Rica Coastal Current (CRCC) almost all the year, which is more or less intense according to the change of position of the intertropical convergence zone, and plays an important role carrying tropical and subtropical biota to northern latitudes. The variability in this region is influenced by interannual, interseasonal (equatorially generated), and higher frequency (storm-induced) signals (*e.g.* coastally trapped Kelvin waves) (Zamudio *et al.* 2001; 2008).

A total of 315 plankton samples were collected during ten oceanographic cruises from November 2003 to August 2007 (this study). These included three transects made in the gulf from Bahía de La Paz, Baja California Sur to Bahía de Banderas (Figure 1). The cruises included the following months: November 2003, 2004, 2005, and 2006 (S-189, S-195, GOLCA0511, and S-207); March,



**FIGURE 1.** Study area and sampling grid stations covered during the 10 oceanographic cruises made from the Gulf of California to Colima, Mexico, from 2003–2007. NGC = Northern Gulf of California, SGC = Southern Gulf of California. Dashed line indicates the 200 m depth isoline.

May, and September 2005, and March 2006 (CGC0503, CGC0505, CGC0509, and CGC0603); and January and July 2007 (GOLCA0701 and GOLCA0707). Cruises were made on board the B/O H05 *Altair* and B/O H03 *Alejandro de Humboldt* of the Secretaría de Marina, Armada de México; on the B/O *El Puma* of the Universidad Nacional Autónoma de México; and on the sailing vessel SSV *Robert C. Seamans* of the Sea Education Association, Woods Hole Laboratory, Massachusetts, U.S.A. For the six cruises (CGC0503, CGC0505, GOLCA0511, CGC0603, GOLCA0701, GOLCA0707), plankton samples were obtained from oblique tows by means of standard Bongo net tows (Smith and Richardson 1979), or with a conical 1 m diameter net (S-195 and S-207 cruises, 505 µm pore size) that was towed using the same Bongo nets methodology. During the September 2005 cruises (CGC0509), plankton samples were collected using only a surface conical net. Additional Neuston surface tows (345 µm pore size) were made during the cruises S-189, S-195, and S-207. In all cases the nets were fitted with calibrated flow meters. After collection, samples were drained and immediately fixed in 96% ethyl alcohol, followed by a full change of preservation fluids 24 hours later. In the laboratory, the ichthyoplankton was sorted from the entire zooplankton samples. In the case of bongo samples, only the larvae from the 505-µm mesh net were analyzed. Fish larvae were identified to the lowest possible taxonomic level, mainly using Moser *et al.* (1984), Moser (1996), Beltrán-León and Ríos (2000a, b), and Richards (2006a, b), and preserved in 96% alcohol. The number of larvae was standardized to 10 m<sup>2</sup> of sea surface (Smith and Richardson 1979). No samples were taken for DNA analysis. The taxa list follows the Eschmeyer, W. N. Catalog of Fishes electronic version (updated 04/01/13) (Eschmeyer 2013), and the updated species names, faunistic affinity, and habitat, follow the Fish Base (updated 12/2012) (Froese and Pauly 2012) web pages. The genera and their respective species are presented in alphabetical order. Voucher specimens were cataloged and deposited in the Ichthyoplankton Collection of the Mexican North Pacific (acronym ICTIOPLANCTON) at CICIMAR in La Paz, BCS, Mexico (catalog number SEMARNAT B.C.S.-INV-196-06-07). Some larvae were not identified to species level because of the lack of larval descriptions of species inhabiting the area or due to damaged larvae. These were distinguished with the genera name plus the notation “sp.” followed by a number to denote the number of different morphological forms in each recognized taxa.

The list of species presented in this paper, comprises not only the results of the identified larvae from the ten oceanographic cruises made in this study, but also the compilation of 14 species lists of fish larvae of several areas located from the Gulf of California to the coasts of Jalisco-Colima published in oceanographic or ecological studies between 1974 and 2012. When compiling the list, we noted that different formats for species level were used by different authors in their published lists, *e. g.* (“*Diplectrum* type 1, *Diplectrum* T1, *Diplectrum* sp. A, or *Diplectrum* sp.”). As a result, we adjusted them to fit the “*Diplectrum* sp. n” format in which “n” represents a number to denote the number of morphological forms reported per author. The same was observed at family level. In this case, we only mentioned the family in the list and included a table where

the number of forms registered per family, per author is presented. Lists of species from bays or coastal lagoons in the study area were not included.

The species list presented by Aceves-Medina *et al.* (2003) was used as baseline to determine the historical addition of new taxa in each of the 14 lists and in this study. Our study represents the most recent addition to the list, and to our knowledge, the additional taxa we found were never registered before by the former authors.

## RESULTS

A total of 28,066 specimens belonging to 378 taxa were identified from November 2003 to July 2007 in this study. These taxa were identified two to order level, 77 to family level, two to subfamily level, 99 to genera, and 198 taxa to species level. The most important families during this study were the Myctophidae (28.3%), Engraulidae (25.0%), Clupeidae (15.4%), Phosichthyidae (10.4%), Bathylagidae (4.4%), Scombridae (3.3%), Carangidae (1.6%), Paralichthyidae (1.4%), and Gobiidae (1.3), which altogether comprised >90% of the total larval abundance. Twenty species (Table 1) from 11 families were the most abundant in the studied area. Most of the species were of tropical affinity.

**TABLE 1.** Relative abundance (Ab) of the most important taxa collected in the Gulf of California to Colima, Mexico, during this study (November 2003 to July 2007). Faunistic affinity (Aff): tropical (tr), subtropical (st), and temperate (tm). Habitat (Hab): shallow demersal (sd), coastal pelagic (cp), ocean epipelagic (op), and mesopelagic (mp).

TAXA	Ab (%)	Aff	Hab
<i>Cetengraulis mysticetus</i> (Günther, 1867)	18.2	st	cp
<i>Benthoosema panamense</i> (Tåning 1932)	13.9	tr	sd
<i>Opisthonema libertate</i> (Günther, 1867)	12.7	tr	cp
<i>Vinciguerria lucetia</i> (Garman, 1899)	10.4	tr-st	mp
<i>Diogenichthys laternatus</i> (Garman, 1899)	7.7	st	mp
<i>Engraulis mordax</i> Girard, 1854	6.8	st	cp
<i>Triphoturus mexicanus</i> (Gilbert, 1890)	5.8	st	mp
<i>Leuroglossus stilbius</i> Gilbert, 1890	4.3	tm-st	mp
<i>Sardinops sagax</i> (Jenyns, 1842)	1.8	st	cp
Gobiidae	1.2		
<i>Scomber japonicus</i> Houttuyn, 1782	1.0	st	cp
<i>Citharichthys fragilis</i> Gilbert, 1890	0.8	st	sd
Sciaenidae	0.8		
<i>Hygophum atratum</i> (Garman, 1899)	0.8	tr-st	bp
<i>Oligoplites saurus inornatus</i> (Bloch & Schneider, 1801)	0.7	st	cp
<i>Auxis thazard thazard</i> (Lacepède, 1800)	0.7	tr	op
<i>Scomberomorus sierra</i> Jordan & Starks, 1895	0.7	tr	cp
<i>Thunnus</i> sp. 1	0.6		
<i>Etrumeus teres</i> (DeKay, 1842)	0.6	st	cp
<i>Eucinostomus dowii</i> (Gill, 1863)	0.6	tr	sd

In this study, the Myctophidae, Phosichthyidae, Engraulidae, and Clupeidae families were the most important in the Gulf of California accounting for 79.0% of total larval abundance. Similar results were found by Moser *et al.* (1974) and Aceves-Medina *et al.* (2003) that recorded 71.8% and 82.4% respectively (Table 2). The slight differences in the relative abundance by family were the result of the collection of less myctophyds, but more Engraulidae and Clupeidae fish larvae in our study, compared to the relative abundance of these families in

the collections of Moser *et al.* (1974) and Aceves-Medina *et al.* (2003) (Table 2). These authors also recorded that the main characteristic of the larval fish community of the gulf was the dominance of the mesopelagic and coastal pelagic taxa. In this study, mesopelagic and coastal pelagic taxa contributed almost in the same proportion to the total larval abundance (43.3 and 43.9% respectively), very similar to the records of Moser *et al.* (1974) (Table 2).

**TABLE 2.** Comparative relative abundance (%) of the most important taxa by family and habitat, collected in the Gulf of California to Colima and Eastern Tropical Pacific. (A) Aceves-Medina *et al.* 2003; (B) Moser *et al.* 1974; (C) Brogan 1994; (D) Acal 1991; (E) Ahlstrom 1971.

	A	B	C	D	E	This study
<b>FAMILY</b>						
Myctophidae	45.3	33.5		16.2	49.7	28.3
Engraulidae	20.1	1.4	0.9	2.2	0.2	25.0
Clupeidae	10.2	14.1	21.7	1.7	0.1	15.4
Phosichthyidae	6.8	22.8	1.9	8.9	20.7	10.4
<b>HABITAT</b>						
Mesopelagic	55.0	41.9	3.1	18.5	78.0	43.3
Coastal pelagic	34.0	43.2	27.0	72.4	2.7	43.9
Shallow demersal	9.5	9.3	64.6		1.8	9.2

## DISCUSSION

In our study, we found that extremely high abundances of *Cetengraulis mysticetus* (40,149 Larvae/10 m<sup>2</sup>) not recorded by Moser *et al.* (1974) or Aceves-Medina *et al.* (2003), and of *Opisthonema libertate* (24,252 Larvae/10 m<sup>2</sup>) collected in two sampling stations very close to each other located in the northern gulf, indicated an spawning event produced by the coupling of reproductive strategies of the species to mesoscale processes in that area (Avendaño-Ibarra *et al.*, 2013). Consequently, these high abundances influenced the relative abundance of the entire community. Excluding the abundance of these two stations from the analysis, the aforementioned mesopelagic families accounted for 60.2%; coastal pelagic families reached only 19.8%, while a decrease in the shallow demersal (8.1%) was observed.

Sampling directed to reef fish larvae communities inside the gulf only showed presence of coastal pelagic (27.0%), and dominance (64.6%) of shallow demersal taxa over all previous reports (Brogan 1994) (Table 2). To the southeast of our study area, in the Mexican Central Pacific, Acal (1991) reported also a different species community, with dominant coastal pelagic (72.4%), followed by mesopelagic species (18.5%). In contrast, in the Eastern Tropical Pacific, Ahlstrom (1971) reported dominance of mesopelagic species.

The compiled taxonomic list of taxa registered from the Gulf of California to the Colima area since 1974 to 2012 (including the results of this study) indicates a total of 579 taxa. From these, 306 were identified to species, 173 to genera, 94 to family, four to subfamily, and two taxa to order level (Table 3). These numbers indicate an addition of 296 new taxa since the most complete systematic list published ten years ago by Aceves-Medina *et al.* (2003) (283 taxa and 173 species), sampled from the north area of the Gulf of

California to Bahía de La Paz. The taxa increment reported in our compiled list resulted from a continuous sampling effort through time and on the entire extension of the sampling area. In the Gulf of California, Moser *et al.* (1974) reported 27 different taxa not included by Aceves-Medina *et al.* (2003) (Table 4). Several studies conducted inside the gulf added 95 additional taxa. These studies covered from the north to the center of the gulf, and the area off Bahía de La Paz (Ávalos-García *et al.* 2003; Sánchez-Velasco *et al.* 2004; 2007; González-Armas *et al.* 2008; Peguero-Icaza *et al.* 2008; Avendaño-Ibarra *et al.* 2009; Contreras-Catala *et al.* 2012). Extensive sampling directed to a few commercial species carried out in the rocky reefs along the entire Gulf of California added only two new taxa in which adult fishes in spawning aggregations with eggs observed by diving were reported (Sala *et al.* 2003). Sampling from Franco-Gordo *et al.* (1999; 2003), Silva-Segundo *et al.* (2008), and León-Chávez *et al.* (2010) from the mouth of the gulf to the oceanic and coastal area in front of Jalisco-Colima contributed with 96 additional taxa. Finally, in our study, with an important sampling effort (315 samples) and area coverage (from the north of the Gulf of California to Bahía de Banderas), 76 new taxa not previously reported by the former authors were added. In terms of relative abundance, our study increased the number of taxa from the list of Aceves-Medina *et al.* (2003) by 25.7%, followed by Franco-Gordo *et al.* 1999 (15.5%), and Ávalos-García *et al.* (2003) (10.5%), which altogether contributed with 51.7% of the total new taxa added. The compiled list added more than 100% to the number of original taxa reported by Aceves-Medina *et al.* (2003).

Some discrepancies between the species names and also important changes in family names were found when compiling the list. These were due to the continuous change in the systematics of fishes to date. Fourteen species found in the analyzed lists changed: *Antennarius avalonis* to *Fowlerichthys avalonis* (Jordan & Starks, 1907), *Antennarius sanguineus* to *Antennatus sanguineus* (Gill, 1863), *Bathylagus nigrigenys* to *Bathylagoides nigrigenys* (Parr, 1931), *Encheliophis dubius* to *Carapus dubius* (Putnam, 1874), *Chaenopsis alepidota alepidota* to *Chaenopsis alepidota* (Gilbert, 1890), *Paraconger nitens* to *Rhynchoconger nitens* (Jordan & Bollman, 1890), *Cheilopogon heterurus hubbsi* to *Cheilopogon hubbsi* (Parin, 1961), *Fodiator acutus rostratus* to *Fodiator rostratus* (Günther, 1866), *Diplophos proximus* to *Diplophos taenia* Günther, 1873, *Tetrapturus audax* to *Kajikia audax* (Philippi, 1887), *Trichiurus nitens* to *Trichiurus lepturus* Linnaeus, 1758, *Enneanectes sexmaculatus* to *Enneanectes carminalis* (Jordan & Gilbert, 1882), *Auxis rochei* to *Auxis rochei rochei* (Risso, 1810), and *Sarda chiliensis* to *Sarda chiliensis chiliensis* (Cuvier, 1832). The Mirapinnidae family also changed to Cetomimidae, Atherinidae to Atherinopsidae, and *Etrumeus teres* (DeKay, 1842), in the Clupeidae family changed to the Dussumieriidae family. All these changes were according to the Catalog of Fishes (Eschmeyer 2013) and Fish Base (Froese and Pauly 2012) web pages.

Moser (1996) presented the most extensive work (50 years of ichthyoplanktonic research) to date in fish larvae taxonomy. Their sampling area covered from Oregon, USA to the southern tip of the Baja California peninsula,

Mexico and offshore to ca. 400 nm (early CalCOFI sampling program). In addition to this area, they had an important source of fish larvae for early life history studies from different expeditions, programs, and cruises such as NORPAC (Northeast Pacific, 20°–48° N, 111°–154° W), the CalCOFI cruises in the Gulf of California (23°–32° N, 107°–115° W), and EASTROPAC I and II (Eastern Tropical Pacific, 20° N–20° S, 76°–126° W), among others. They reported 141 families and 467 species in this large region. From the 306 taxa they reported to be distributed only in the Gulf of California or in the Mexican Tropical Pacific, 72 species have never been collected again. Our compiled taxonomic list included 423 species that represented approximately 48.3% of the 875 species recorded as adults in the Gulf of California (Thomson *et al.* 2000). All this indicates that our species records are still low. The high number of “forms” registered in some taxa: eight in the Gobiidae family (Table 4, Ávalos-García *et al.* 2003), or in the Anguilliformes order with ten forms (Table 4, this study), indicate that these forms may be an important source of species increment if they do represent species. The presence of several forms in our compiled list occurred in 14 families and one order: Bothidae, Chiasmodontidae, Clinidae, Congridae, Cyematidae, Eleotridae, Gobiiesocidae, Gobiidae, Haemulidae, Labrisomidae, Macrouridae, Paralichthyidae, Pomacentridae, Sciaenidae families, and the Anguilliformes order (Table 4). Taking into account only the maximum number of forms reported in each one of them, around 65 more could be representing species. These results show that a strong taxonomic effort to describe fish larvae still needs to be done, particularly in the mentioned taxa that represent an opportunity to eliminate the gap in our knowledge of the fish larvae diversity in the Gulf of California.

There are more fish larvae studies inside the Gulf of California, but they did not include any different taxa to the date they were published and we did not use them. Taxonomic lists from the coastal lagoon and bays were

also not included in our compiled list. Although coastal ecosystems in the Gulf of California are reservoirs of great biological diversity (Martínez-López *et al.* 2007), the exportation and contribution of shallow fish larvae to neritic or oceanic adjacent waters depends on several environmental variables and still needs to be investigated. A coastal sampling program covering the first 20 nm from the coast could be a first step to understand, not only the close to the coast fish larvae diversity, but several other oceanographic processes linking coastal to oceanic waters.

In terms of sampling, the most common sampling technique for fish larvae collection used by the authors in the compiled list was the oblique Bongo net tow; only two used opening-closing conical zooplankton nets (Sánchez-Velasco *et al.* 2007; Contreras-Catala *et al.* 2012), one did surface trawls with a conical net (González-Armas *et al.* 2008), and only Silva-Segundo *et al.* (2008) used oblique shallow trawls at very coastal sampling stations. Trawl selectivity of these sampling techniques, depth of tow, distance to the coast, mesoscale oceanographic processes such as eddies and fronts, intra- and interannual variability, locality, bathymetric differences along the study area, sampling frequency, and reproductive strategies of adult fishes, among other variables, could determine different species composition in the samples collected (Aceves-Medina *et al.* 2003; Franco-Gordo *et al.* 2008; Inda-Díaz 2010; Jiménez-Rosenberg *et al.* 2010).

The taxonomic list of fish larvae species from the Gulf of California to Colima compiled here represents the most extensive and comprehensive list presented to date. This list added more than twice the number of taxa previously reported by Aceves-Medina *et al.* (2003) but it still remains conservative in relation to the total number of adult fishes reported. The numerous “forms” pertaining to the family level reported in 14 families and one order showed the need to emphasize the taxonomic work as a primary tool to identify and understand the alpha diversity of the Gulf of California.

**TABLE 3.** Systematic list of fish larvae species registered in the Gulf of California to Colima, Mexico. A = Aceves-Medina *et al.* (2003), B = Moser *et al.* (1974), C = Ávalos-García *et al.* (2003), Sala *et al.* (2003), Sánchez-Velasco *et al.* (2004), Sánchez-Velazco *et al.* (2007), González-Armas *et al.* (2008), Peguero-Icaza *et al.* (2008), Avendaño-Ibarra *et al.* (2009), and Contreras-Catala *et al.* (2012). D = Franco-Gordo *et al.* (1999; 2003), Silva-Segundo *et al.* (2008), and León-Chávez *et al.* (2010). This study =Gulf of California to Jalisco, 2003-2007.

FAMILY	TAXA	A	B	C	D	This study
ELOPIDAE	<i>Elops affinis</i> Regan, 1909	X		X	X	
ALBULIDAE	<i>Albula vulpes</i> (Linnaeus, 1758)	X		X		X
	<i>Albula</i> sp. 1			X	X	X
	<i>Albula</i> spp.			X		
NOTACANTHIDAE	<i>Notacanthus chemnitzii</i> Bloch, 1788					X
	Notacanthidae	X				X
O. ANGUILLIFORMES	Anguilliforme		X	X	X	X
MURAEINIDAE	<i>Anarchias</i> sp. 1	X				
	<i>Gymnothorax</i> sp. 1	X			X	X
	<i>Uropterygius</i> sp. 1	X				
	Muraenidae	X		X	X	
OPHICHTHIDAE	<i>Myrophis vafer</i> Jordan & Gilbert 1882	X		X	X	X
	Myrophinae					X
	<i>Ophichthus triserialis</i> Kaup 1856	X		X	X	X
	<i>Ophichthus zophochir</i> Jordan & Gilbert, 1883	X		X	X	X
	<i>Ophichthus</i> sp. 1	X		X	X	X
	Ophichthidae	X		X	X	X
COLOCONGRIDAE	<i>Coloconger giganteus</i> (Castle, 1959)					X

**TABLE 3. CONTINUED.**

FAMILY	TAXA	A	B	C	D	This study	
CONGRIDAE	<i>Ariosoma gilberti</i> (Ogilby, 1898)	X		X	X	X	
	<i>Bathycongrus macrurus</i> (Gilbert, 1891)	X		X	X	X	
	<i>Chiloconger dentatus</i> (Garman, 1899)			X		X	
	<i>Chiloconger</i> sp. 1	X					
	<i>Gnathophis cinctus</i> (Garman, 1899)	X					
	<i>Heteroconger canabus</i> (Cowan & Rosenblatt, 1974)				X		
	<i>Heteroconger digueti</i> (Pellegrin, 1923)			X	X	X	
	<i>Heteroconger</i> sp. 1			X	X	X	
	<i>Paraconger californiensis</i> Kanazawa, 1961			X	X	X	
	<i>Paraconger</i> sp. 1	X					
	<i>Rhynchoconger nitens</i> (Jordan & Bollman, 1890)			X	X	X	
	<i>Rhynchoconger</i> sp. 1					X	
	Congridae		X		X	X	X
	DERICHTHYDAE	<i>Derichthys serpentinus</i> Gill, 1884			X		
Derichthyidae		X		X	X		
NEMICHTHYDAE	Nemichthyidae	X		X			
SERRIVOMERIDAE	Serrivomeridae	X		X			
NETTASTOMATIDAE	<i>Hoplunnis sicarius</i> (Garman, 1899)	X		X	X		
	<i>Hoplunnis</i> sp. 1	X				X	
CYEMATIDAE	Cyematidae	X		X			
CLUPEIDAE	<i>Harengula thrissina</i> (Jordan & Gilbert, 1882)	X		X	X		
	<i>Opisthonema libertate</i> (Günther, 1867)	X		X	X	X	
	<i>Opisthonema</i> sp. 1			X	X	X	
	<i>Opisthonema</i> spp.		X	X			
	<i>Sardinops sagax</i> (Jenyns, 1842)	X	X	X		X	
	Clupeidae		X	X			
DUSSUMIERIIDAE	<i>Etrumeus teres</i> (DeKay, 1842)	X	X	X	X	X	
ENGRAULIDAE	<i>Anchoa</i> sp. 1			X	X	X	
	<i>Anchoa</i> spp.			X			
	<i>Cetengraulis mysticetus</i> (Günther, 1867)			X	X	X	
	<i>Engraulis mordax</i> Girard, 1854	X		X	X	X	
	Engraulidae		X	X	X	X	
CHANIDAE	<i>Chanos chanos</i> (Forsskål, 1775)					X	
ARGENTINIDAE	<i>Argentina sialis</i> Gilbert, 1890	X	X	X	X	X	
MICROSTOMATIDAE	Microstomatidae	X		X			
BATHYLAGIDAE	<i>Bathylagoides nigrigenys</i> (Parr, 1931)		X		X	X	
	<i>Bathylagus pacificus</i> Gilbert, 1890	X				X	
	<i>Bathylagoides wesethi</i> (Bolin, 1938)	X		X	X	X	
	<i>Bathylagoides</i> sp. 1				X		
	<i>Leuroglossus stilbius</i> Gilbert, 1890	X	X	X		X	
	Bathylagidae			X		X	
GONOSTOMATIDAE	<i>Cyclothone acclinidens</i> Garman, 1899					X	
	<i>Cyclothone signata</i> Garman, 1899					X	
	<i>Cyclothone</i> spp.			X		X	
	<i>Diplophos taenia</i> Günther, 1873	X	X	X	X	X	
	<i>Diplophos</i> sp. 1					X	
	Gonostomatidae			X		X	
STERNOPTYCHIDAE	<i>Argyropelecus lychnus</i> Garman, 1899					X	
	<i>Argyropelecus</i> sp. 1		X				
PHOSICHTHYIDAE	<i>Ichthyococcus irregularis</i> Rehnitz & Böhlke, 1958	X					
	<i>Vinciguerria lucetia</i> (Garman, 1899)	X	X	X	X	X	
	<i>Vinciguerria nimbaria</i> Jordan & Williams, 1895)					X	
	<i>Vinciguerria poweriae</i> (Cocco, 1838)					X	
	<i>Woodsia nonsuchae</i> (Beebe, 1932)					X	
	Phosichthyidae					X	
STOMIIDAE	<i>Bathophilus filifer</i> (Garman, 1899)		X		X		
	<i>Bathophilus flemingi</i> Aron & McCrery, 1958				X		
	<i>Idiacanthus antrostomus</i> Gilbert, 1890				X		
	<i>Stomias atriventer</i> Garman, 1899	X	X	X		X	
	<i>Tactostoma macropus</i> Bolin, 1939				X		



**TABLE 3. CONTINUED.**

FAMILY	TAXA	A	B	C	D	This study
	Chauliodontinae				X	
	Melanostomiinae					X
	Stomiidae	X		X	X	
AULOPIDAE	<i>Aulopus bajacali</i> Parin & Kotlyar, 1984	X		X		X
	Aulopidae		X			
SCOPELARCHIDAE	<i>Scopelarchoides nicholsi</i> Parr, 1929	X	X	X	X	X
	<i>Scopelarchus guentheri</i> Alcock, 1896	X				
	Scopelarchidae	X				
SYNODONTIDAE	<i>Synodus lucioceps</i> (Ayres, 1855)	X		X	X	X
	<i>Synodus evermanni</i> Jordan & Bollman, 1890				X	
	<i>Synodus sechurae</i> Hildebrand, 1946			X	X	
	<i>Synodus</i> sp. 1			X	X	X
	<i>Synodus</i> sp. 2			X		X
	<i>Synodus</i> spp.	X	X			X
PARALEPIDIDAE	<i>Lestidiops neles</i> (Harry, 1953)	X		X	X	X
	<i>Lestidiops pacificus</i> (Parr, 1931)			X		
	<i>Lestidiops</i> sp. 1	X				
	<i>Magnisudis atlantica</i> (Krøyer, 1868)				X	
	<i>Stemonosudis macrura</i> (Ege, 1933)				X	
	Paralepididae		X			
EVERMANNELLIDAE	Evermannellidae				X	
NEOSCOPELIDAE	Neoscopelidae	X				
MYCTOPHIDAE	<i>Benthoosema panamense</i> (Tåning, 1932)	X	X	X	X	X
	<i>Bolinichthys longipes</i> (Brauer, 1906)					X
	<i>Ceratoscopelus townsendi</i> (Eigenmann & Eigenmann, 1889)	X				X
	<i>Diaphus pacificus</i> Parr, 1931	X	X	X	X	X
	<i>Diaphus</i> sp. 1				X	
	<i>Diogenichthys atlanticus</i> (Tåning, 1928)				X	
	<i>Diogenichthys laternatus</i> (Garman, 1899)	X	X	X	X	X
	<i>Gonichthys tenuiculus</i> (Garman, 1899)	X			X	X
	<i>Hygophum atratum</i> (Garman, 1899)	X	X	X	X	X
	<i>Hygophum proximum</i> Becker, 1965				X	
	<i>Hygophum reinhardtii</i> (Lütken, 1892)			X	X	
	<i>Lampanyctus macdonaldi</i> (Goode & Bean, 1896)				X	
	<i>Lampanyctus parvicauda</i> Parr, 1931	X		X	X	X
	<i>Lampanyctus</i> spp.		X			
	<i>Myctophum aurolaternatum</i> Garman, 1899		X		X	X
	<i>Nannobranchium idostigma</i> (Parr, 1931)	X		X		X
	<i>Nannobranchium</i> sp. 1	X				
	<i>Nannobranchium</i> spp.					X
	<i>Triphoturus mexicanus</i> (Gilbert, 1890)	X	X	X	X	X
	Myctophidae	X	X	X	X	X
LOPHOTIDAE	<i>Lophotus lacepede</i> Giorna, 1809			X		
TRACHIPTERIDAE	<i>Zu cristatus</i> (Bonelli, 1819)	X				
	Trachipteridae	X				
BREGMACEROTIDAE	<i>Bregmaceros bathymaster</i> Jordan & Bollman, 1890	X	X	X	X	X
	<i>Bregmaceros</i> sp. 1	X		X	X	X
	Bregmacerotidae	X		X		
MACROURIDAE	<i>Caelorinchus scaphopsis</i> (Gilbert, 1890)	X		X		X
	<i>Coryphaenoides</i> sp. 1			X		X
	<i>Nezumia</i> sp. 1	X				
	<i>Nezumia</i> spp.			X	X	X
	Macrouridae		X			X
MORIDAE	<i>Laemonema verecundum</i> (Jordan & Cramer, 1897)				X	X
	<i>Physiculus nematopus</i> Gilbert, 1890	X		X		X
	<i>Physiculus rastrelliger</i> Gilbert, 1890			X		
	<i>Physiculus</i> sp. 1		X	X		X
MERLUCCIIDAE	<i>Merluccius productus</i> (Ayres, 1855)	X		X		X
	<i>Merluccius</i> sp. 1		X			
OPHIDIIDAE	<i>Brotula</i> sp. 1			X		



**TABLE 3. CONTINUED.**

FAMILY	TAXA	A	B	C	D	This study
	<i>Cherublemma emmelas</i> (Gilbert, 1890)	X		X	X	X
	<i>Chilara taylori</i> (Girard, 1858)	X		X		X
	<i>Lepophidium negropinna</i> Hildebrand & Barton, 1949	X		X	X	X
	<i>Lepophidium stigmatistium</i> (Gilbert, 1890)	X		X	X	X
	<i>Lepophidium</i> sp. 1	X		X		X
	<i>Ophidion scrippsae</i> (Hubbs, 1916)	X		X	X	X
	<i>Ophidion</i> sp. 1	X		X	X	X
	Ophidiidae	X	X	X	X	X
CARAPIDAE	<i>Carapus dubius</i> (Putnam, 1874)	X		X	X	
	<i>Encheliophis</i> sp. 1	X				
	<i>Echiodon exsilium</i> Rosenblatt, 1961	X		X		X
	Carapidae	X	X			
BYTHITIDAE	Bythitidae	X			X	
BATRACHOIDIDAE	<i>Porichthys margaritatus</i> (Richardson, 1844)				X	
O. LOPHIIFORMES	Lophiforme					X
LOPHIIDAE	<i>Lophiodes caularis</i> (Garman, 1899)			X	X	X
	<i>Lophiodes spilurus</i> (Garman, 1899)	X		X	X	X
	<i>Lophiodes</i> sp. 1	X		X		
	Lophiidae	X	X			
ANTENNARIDAE	<i>Fowlerichthys avalonis</i> (Jordan & Starks, 1907)	X		X	X	
	<i>Antennatus sanguineus</i> (Gill, 1863)				X	
	<i>Antennarius</i> sp. 1	X				X
	Antennaridae			X		
OGCOEPHALIDAE	<i>Zalieutes elater</i> (Jordan & Gilbert, 1882)	X		X	X	
	Ogcoephalidae					X
MELANOCETIDAE	<i>Melanocetus johnsoni</i> Günther, 1864				X	X
	Melanocetidae	X				
ONEIRODIDAE	<i>Dolopichthys</i> spp.					X
	<i>Oneirodes acanthias</i> (Gilbert, 1915)					X
	<i>Oneirodes</i> sp. 1	X				
	<i>Oneirodes</i> spp.			X	X	X
	Oneirodidae	X				
CERATIIDAE	Ceratiidae					X
GIGANTACTINIDAE	<i>Gigantactis</i> sp. 1	X				X
	Gigantactinidae		X			
LINOPHRYNIDAE	<i>Borophryne apogon</i> Regan, 1925	X				X
GOBIESOCIDAE	<i>Gobiesox eugrammus</i> Briggs, 1955				X	
	<i>Gobiesox papillifer</i> Gilbert, 1890				X	
	<i>Gobiesox</i> sp. 1				X	X
	Gobiesocidae				X	X
ATHERINOPSIDAE	<i>Atherinella nepenthe</i> (Myers & Wade, 1942)				X	
	<i>Atherinella</i> sp. 1				X	
	<i>Atherinops affinis</i> (Ayres, 1860)					X
	Atherinopsidae	X	X			
BELONIDAE	<i>Strongylura exilis</i> (Girard, 1854)			X		
HEMIRAMPHIDAE	<i>Hemiramphus saltator</i> Gilbert & Starks, 1904			X	X	X
	<i>Hemiramphus</i> spp.					X
	<i>Hyporhamphus rosae</i> (Jordan & Gilbert, 1880)	X		X	X	X
	<i>Hyporhamphus</i> spp.					X
	<i>Oxyporhamphus micropterus micropterus</i> (Valenciennes, 1847)	X		X	X	X
	Hemiramphidae	X	X	X	X	
EXOCOETIDAE	<i>Cheilopogon hubbsi</i> (Parin, 1961)			X	X	X
	<i>Cheilopogon pinnatibarbatus californicus</i> (Cooper, 1863)	X				X
	<i>Cheilopogon xenopterus</i> (Gilbert, 1890)					X
	<i>Cheilopogon</i> sp. 1			X		
	<i>Cheilopogon</i> spp.					X
	<i>Exocoetus volitans</i> Linnaeus, 1758			X		
	<i>Fodiator rostratus</i> (Günther, 1866)	X				X
	<i>Hirundichthys rondeletii</i> (Valenciennes, 1847)	X		X		
	<i>Hirundichthys</i> spp.	X				X



**TABLE 3. CONTINUED.**

FAMILY	TAXA	A	B	C	D	This study
	<i>Prognichthys tringa</i> Breder, 1928	X		X		X
	<i>Prognichthys</i> spp.					X
MELAMPHAIDAE	Exocoetidae	X			X	X
	<i>Melamphaes lugubris</i> Gilbert, 1890				X	
	<i>Melamphaes</i> sp. 1			X	X	X
	<i>Melamphaes</i> spp.	X				
	<i>Scopelogadus mizolepis bispinosus</i> (Gilbert, 1915)	X		X	X	X
HOLOCENTRIDAE	Melamphaidae		X	X		X
	<i>Myripristis leiognathos</i> Valenciennes, 1846	X		X	X	X
	<i>Myripristis</i> spp.	X				
	<i>Sargocentron suborbitalis</i> (Gill, 1863)					X
	Holocentridae					X
CETOMIMIDAE	<i>Eutaeniophorus festivus</i> (Bertelsen & Marshall, 1956)					X
	Cetomimidae	X				
FISTULARIIDAE	<i>Fistularia commersonii</i> Rüppell, 1838	X		X		X
	<i>Fistularia corneta</i> Gilbert & Starks, 1904	X		X	X	X
	Fistulariidae		X			
SYNGNATHIDAE	<i>Doryrhamphus excisus excisus</i> Kaup, 1856			X	X	
	<i>Hippocampus ingens</i> Girard, 1858			X		
	<i>Syngnathus californiensis</i> Storer, 1845			X		
	<i>Syngnathus</i> sp. 1	X				X
	Syngnathidae		X			
SCORPAENIDAE	<i>Pontinus furcirhinus</i> Garman, 1899				X	
	<i>Pontinus sierra</i> (Gilbert, 1890)	X		X		
	<i>Pontinus</i> sp. 1			X	X	X
	<i>Pontinus</i> sp. 2					X
	<i>Pontinus</i> spp.	X				X
	<i>Scorpaena guttata</i> Girard, 1854	X		X	X	X
	<i>Scorpaena</i> sp. 1				X	X
	<i>Scorpaena</i> spp.	X				
	<i>Scorpaenodes xyris</i> (Jordan & Gilbert, 1882)	X		X	X	X
	<i>Scorpaenodes</i> spp.					X
	<i>Sebastes constellatus</i> (Jordan & Gilbert, 1880)			X		
	<i>Sebastes macdonaldi</i> (Eigenmann & Beeson, 1893)	X				
	<i>Sebastes</i> sp. 1			X		
	<i>Sebastes</i> sp. 2			X		
	<i>Sebastes</i> sp. 3			X		X
	<i>Sebastes</i> sp. 6					X
	<i>Sebastes</i> spp.	X	X	X		X
	<i>Sebastolobus altivelis</i> Gilbert, 1896	X		X		X
	Scorpaenidae	X		X	X	X
	TRIGLIDAE	<i>Bellator loxias</i> (Jordan, 1897)	X		X	
<i>Prionotus ruscarius</i> Gilbert & Starks, 1904		X		X	X	X
<i>Prionotus stephanophrys</i> Lockington, 1881		X		X		X
<i>Prionotus</i> sp. 1						X
Triglidae		X	X	X		X
CYCLOPTERIDAE	Cyclopteridae				X	
HOWELLIDAE	<i>Howella</i> sp. 1			X		
	<i>Howella</i> spp.	X				
POLYPRIONIDAE	<i>Stereolepis gigas</i> Ayres, 1859					X
SERRANIDAE	Anthiinae			X		
	<i>Diplectrum pacificum</i> Meek & Hildebrand, 1925			X		
	<i>Diplectrum</i> sp. 1			X	X	X
	<i>Diplectrum</i> sp. 2			X		X
	<i>Diplectrum</i> spp.	X		X		X
	<i>Epinephelus</i> sp. 1			X		X
	<i>Epinephelus</i> spp.	X				X
	<i>Hemanthias peruanus</i> (Steindachner, 1875)					X
	<i>Hemanthias signifer</i> (Garman, 1899)	X		X		X
	<i>Hemanthias</i> sp. 1			X		X



**TABLE 3. CONTINUED.**

FAMILY	TAXA	A	B	C	D	This study
	<i>Hemanthias</i> spp.	X				
	<i>Mycteroperca prionura</i> Rosenblatt & Zahuranec, 1967			X		
	<i>Mycteroperca rosacea</i> (Streets, 1877)			X		
	<i>Mycteroperca</i> spp.	X				
	<i>Paralabrax auroguttatus</i> Walford, 1936			X		X
	<i>Paralabrax maculatofasciatus</i> (Steindachner, 1868)	X		X		X
	<i>Paralabrax nebulifer</i> (Girard, 1854)				X	X
	<i>Paralabrax</i> sp. 1			X		X
	<i>Paralabrax</i> sp. 2			X		X
	<i>Paranthias colonus</i> (Valenciennes, 1846)	X		X	X	
	<i>Paranthias</i> sp. 1				X	
	<i>Pronotogrammus eos</i> Gilbert, 1890			X		X
	<i>Pronotogrammus multifasciatus</i> Gill, 1863	X		X		X
	<i>Pronotogrammus</i> spp.					X
	<i>Pseudogramma thaumasia</i> (Gilbert, 1900)	X			X	
	<i>Serranus</i> sp. 1			X	X	X
	<i>Serranus</i> sp. 2			X	X	X
	<i>Serranus</i> sp. 3				X	
	<i>Serranus</i> sp. 4					X
	<i>Serranus</i> spp.	X				X
	Serranidae	X	X	X		X
OPISTOGNATHIDAE	<i>Opistognathus</i> sp. 1			X	X	
	<i>Opistognathus</i> spp.	X				
PRIACANTHIDAE	<i>Heteropriacanthus cruentatus</i> (Lacepède, 1801)					X
	<i>Pristigenys serrula</i> (Gilbert, 1891)	X		X		X
	Priacanthidae	X			X	X
APOGONIDAE	<i>Apogon atricaudus</i> Jordan & McGregor, 1898			X	X	
	<i>Apogon guadalupensis</i> (Osburn & Nichols, 1916)			X		
	<i>Apogon retrosella</i> (Gill, 1862)	X		X	X	X
	<i>Apogon</i> sp. 1					X
	<i>Apogon</i> spp.	X				
	Apogonidae	X	X	X	X	X
MALACANTHIDAE	<i>Caulolatilus affinis</i> Gill, 1865					X
	<i>Caulolatilus princeps</i> (Jenyns, 1840)	X		X		X
	<i>Caulolatilus</i> sp. 1					X
	Malacanthidae		X			
CARANGIDAE	<i>Alectis ciliaris</i> (Bloch, 1787)	X				X
	<i>Caranx caballus</i> Günther, 1868	X		X	X	X
	<i>Caranx sexfasciatus</i> Quoy & Gaimard, 1825	X		X	X	X
	<i>Caranx</i> sp. 1			X	X	X
	<i>Caranx</i> sp. 2			X		
	<i>Caranx</i> spp.	X				
	<i>Chloroscombrus orqueta</i> Jordan & Gilbert, 1883	X		X	X	X
	<i>Decapterus</i> sp. 1			X	X	X
	<i>Decapterus</i> spp.	X		X		
	<i>Elagatis bipinnulata</i> (Quoy & Gaimard, 1825)	X				
	<i>Gnathanodon speciosus</i> (Forsskål, 1775)	X				X
	<i>Hemicaranx</i> spp.					X
	<i>Naucrates ductor</i> (Linnaeus, 1758)			X	X	X
	<i>Oligoplites saurus</i> (Bloch & Schneider, 1801)	X		X		X
	<i>Oligoplites</i> sp. 1	X		X		X
	<i>Oligoplites</i> sp. 2					X
	<i>Selar crumenophthalmus</i> (Bloch, 1793)	X		X		X
	<i>Selene brevoortii</i> (Gill, 1863)	X			X	
	<i>Selene orstedii</i> Lütken, 1880					X
	<i>Selene peruviana</i> (Guichenot, 1866)	X		X	X	X
	<i>Selene</i> spp.	X				X
	<i>Seriola lalandi</i> Valenciennes, 1833	X		X	X	X
	<i>Seriola</i> sp. 1			X	X	X
	<i>Seriola</i> sp. 2					X



**TABLE 3. CONTINUED.**

FAMILY	TAXA	A	B	C	D	This study
	<i>Seriola</i> sp. 3					X
	<i>Seriola</i> spp.	X				
	<i>Trachinotus kennedyi</i> Steindachner, 1876				X	X
	<i>Trachinotus rhodopus</i> Gill, 1863	X				X
	<i>Trachurus symmetricus</i> (Ayres, 1855)	X		X	X	X
	Carangidae	X	X	X	X	X
NEMATISTIIDAE	<i>Nematistius pectoralis</i> Gill, 1862	X				
CORYPHAENIDAE	<i>Coryphaena equiselis</i> Linnaeus, 1758					X
	<i>Coryphaena hippurus</i> Linnaeus, 1758	X		X	X	X
	Coryphaenidae		X			
BRAMIDAE	Bramidae	X	X		X	
LUTJANIDAE	<i>Hoplopagrus guentherii</i> Gill, 1862					X
	<i>Lutjanus argentiventris</i> (Peters, 1869)	X		X	X	X
	<i>Lutjanus guttatus</i> (Steindachner, 1869)	X			X	
	<i>Lutjanus novemfasciatus</i> Gill, 1862	X		X	X	X
	<i>Lutjanus peru</i> (Nichols & Murphy, 1922)	X		X	X	X
	<i>Lutjanus</i> spp.	X				X
	Lutjanidae	X	X			
LOBOTIDAE	<i>Lobotes surinamensis</i> (Bloch, 1790)				X	
GERREIDAE	<i>Diapterus peruvianus</i> (Cuvier, 1830)	X		X		
	<i>Eucinostomus argenteus</i> Baird & Girard, 1855			X		
	<i>Eucinostomus currani</i> Zahuranec, 1980	X				X
	<i>Eucinostomus dowii</i> (Gill, 1863)	X		X		X
	<i>Eucinostomus entomelas</i> Zahuranec, 1980				X	
	<i>Eucinostomus gracilis</i> (Gill, 1862)	X		X	X	
	<i>Eucinostomus</i> spp.				X	
	Gerreidae	X	X			X
HAEMULIDAE	<i>Anisotremus davidsoni</i> (Steindachner, 1876)	X		X		X
	<i>Anisotremus</i> spp.	X				
	<i>Conodon serrifer</i> Jordan & Gilbert, 1882			X		
	<i>Orthopristis reddingi</i> Jordan & Richardson, 1895			X		
	<i>Orthopristis</i> spp.	X				
	<i>Pomadasys</i> sp. 1					X
	<i>Xenistius californiensis</i> (Steindachner, 1876)	X		X	X	
	Haemulidae	X	X	X	X	X
SPARIDAE	<i>Calamus brachysomus</i> (Lockington, 1880)	X		X		X
SCIAENIDAE	<i>Bairdiella</i> sp. 1			X	X	
	<i>Cynoscion</i> sp. 1				X	X
	<i>Cheilotrema saturnum</i> (Girard, 1858)				X	
	<i>Larimus</i> sp. 1				X	
	<i>Larimus</i> sp. 2				X	
	<i>Menticirrhus undulatus</i> (Girard, 1854)	X				
	<i>Menticirrhus</i> sp. 1				X	X
	<i>Menticirrhus</i> spp.			X		
	<i>Micropogonias</i> sp. 1				X	
	<i>Micropogonias</i> sp. 2				X	
	<i>Micropogonias</i> spp.					X
	<i>Roncador stearnsii</i> (Steindachner, 1876)	X		X		
	<i>Seriphus politus</i> Ayres, 1860	X				
	<i>Umbrina roncador</i> Jordan & Gilbert, 1882	X		X		
	<i>Umbrina xanti</i> Gill, 1862					X
	<i>Umbrina</i> sp. 1				X	X
	Sciaenidae	X	X	X	X	X
POLYNEMIDAE	<i>Polydactylus approximans</i> (Lay & Bennett, 1839)	X		X	X	X
	<i>Polydactylus opercularis</i> (Gill, 1863)	X		X		
	Polynemidae		X			
MULLIDAE	<i>Mulloidichthys dentatus</i> (Gill, 1862)			X		X
	Mullidae	X		X		X
KYPHOSIDAE	<i>Hermosilla azurea</i> Jenkins & Evermann, 1889			X		
	<i>Kyphosus analogus</i> (Gill, 1862)					X



TABLE 3. CONTINUED.

FAMILY	TAXA	A	B	C	D	This study
	<i>Kyphosus</i> sp. 1			X		
	<i>Medialuna californiensis</i> (Steindachner, 1876)			X		X
CHAETODONTIDAE	Kyphosidae	X	X	X	X	X
	<i>Chaetodon humeralis</i> Günther, 1860			X		X
	<i>Chaetodon</i> sp. 1					X
	Chaetodontidae	X				X
CIRRHITIDAE	<i>Cirrhitichthys oxycephalus</i> (Bleeker, 1855)			X		
	Cirrhitidae			X	X	X
MUGILIDAE	<i>Mugil cephalus</i> Linnaeus, 1758	X		X	X	X
	<i>Mugil curema</i> Valenciennes, 1836			X		X
	<i>Mugil</i> sp. 1			X	X	
	<i>Mugil</i> spp.					X
POMACENTRIDAE	Mugilidae	X	X		X	X
	<i>Abudefduf troschelii</i> (Gill, 1862)	X		X	X	X
	<i>Chromis punctipinnis</i> (Cooper, 1863)			X		
	<i>Chromis</i> sp. 1	X		X	X	X
	<i>Chromis</i> sp. 2	X				
	<i>Hypsypops rubicundus</i> (Girard, 1854)	X		X		X
	<i>Stegastes rectifraenum</i> (Gill, 1862)	X		X	X	X
	Pomacentridae	X	X	X	X	X
LABRIDAE	<i>Decodon melasma</i> Gomon, 1974					X
	<i>Halichoeres dispilus</i> (Günther, 1864)	X		X	X	
	<i>Halichoeres semicinctus</i> (Ayres, 1859)	X		X	X	X
	<i>Halichoeres</i> sp. 1			X	X	X
	<i>Halichoeres</i> spp.	X				X
	<i>Iniistius pavo</i> (Valenciennes, 1840)			X		
	<i>Oxyjulis californica</i> (Günther, 1861)	X				
	<i>Semicossyphus pulcher</i> (Ayres, 1854)	X		X	X	
	<i>Thalassoma</i> sp. 1			X	X	X
	<i>Thalassoma</i> spp.	X		X		
	<i>Xyrichthys mundiceps</i> Gill, 1862	X		X	X	X
	<i>Xyrichthys pavo</i> (Valenciennes, 1840)	X				
	<i>Xyrichthys</i> sp. 1			X	X	X
	Labridae	X	X	X	X	X
SCARIDAE	<i>Nicholsina denticulata</i> (Evermann & Radcliffe,			X		
	<i>Scarus</i> sp. 1				X	X
	<i>Scarus</i> spp.	X				
	Scaridae					X
CHIASMODONTIDAE	<i>Chiasmodon niger</i> Johnson, 1864	X				X
	Chiasmodontidae	X			X	
AMMODYTIDAE	<i>Ammodytoides gilli</i> (Bean, 1895)			X	X	X
	<i>Ammodytoides</i> sp. 1				X	
SO. BLENNIOIDEI	Blennioidei			X		
TRIPTERYGIIDAE	<i>Enneanectes carminalis</i> (Jordan & Gilbert, 1882)				X	
	Tripterygiidae	X				
LABRISOMIDAE	<i>Labrisomus multiporosus</i> Hubbs, 1953				X	
	<i>Labrisomus xanti</i> Gill, 1860	X		X	X	X
	<i>Paraclinus</i> sp. 1				X	
	Labrisomidae			X	X	X
CLINIDAE	Clinidae		X			X
CHAENOPSIDAE	<i>Chaenopsis alepidota</i> (Gilbert, 1890)				X	
	<i>Neoclinus blanchardi</i> Girard, 1858			X		
	Chaenopsidae			X		X
DACTYLOSCOPIIDAE	<i>Dactylagnus mundus</i> Gill, 1863				X	
	<i>Dactyloscopus</i> sp. 1				X	
	<i>Gillellus semicinctus</i> Gilbert, 1890			X	X	
	<i>Myxodagnus opercularis</i> Gill, 1861				X	
	Dactyloscopidae				X	
BLENNIIDAE	<i>Entomacrodus chiostictus</i> (Jordan & Gilbert, 1882)				X	
	<i>Hypsoblennius brevipinnis</i> (Günther, 1861)			X	X	



TABLE 3. CONTINUED.

FAMILY	TAXA	A	B	C	D	This study
	<i>Hypsoblennius gentilis</i> (Girard, 1854)	X		X		X
	<i>Hypsoblennius gilberti</i> (Jordan, 1882)					X
	<i>Hypsoblennius jenkinsi</i> (Jordan & Evermann, 1896)	X				X
	<i>Hypsoblennius proteus</i> (Krejsa, 1960)			X		
	<i>Hypsoblennius</i> sp. 1			X	X	X
	<i>Hypsoblennius</i> spp.	X				
	<i>Ophioblennius steindachneri</i> Jordan & Evermann, 1898	X		X	X	X
	<i>Plagiotremus azaleus</i> (Jordan & Bollman, 1890)			X		
	Blenniidae	X		X		
CALLIONYMIDAE	<i>Synchiropus atrilabiatus</i> (Garman, 1899)			X	X	X
ELEOTRIDAE	<i>Dormitator latifrons</i> (Richardson, 1844)				X	
	<i>Eleotris picta</i> Kner, 1863			X		
	<i>Erotelis armiger</i> (Jordan & Richardson, 1895)	X		X		X
	Eleotridae	X		X	X	X
GOBIIDAE	<i>Bollmania</i> sp. 1				X	
	<i>Coryphopterus nicholsi</i> (Bean, 1882)				X	
	<i>Coryphopterus</i> sp. 1	X		X		
	<i>Ctenogobius manglicola</i> (Jordan & Starks, 1895)			X		
	<i>Ctenogobius sagittula</i> (Günther, 1862)			X		
	<i>Gillichthys mirabilis</i> Cooper, 1864	X				
	<i>Gobulus crescentalis</i> (Gilbert, 1892)	X		X		
	<i>Gobionellus</i> sp. 1				X	
	<i>Ilypnus gilberti</i> (Eigenmann & Eigenmann, 1889)	X				X
	<i>Lythrypnus dalli</i> (Gilbert, 1890)	X		X		X
	<i>Lythrypnus zebra</i> (Gilbert, 1890)			X		X
	<i>Lythrypnus</i> spp.	X			X	
	<i>Microgobius</i> sp. 1					X
	<i>Quietula y-cauda</i> (Jenkins & Evermann, 1889)	X				
	<i>Rhinogobiops nicholsii</i> (Bean, 1882)			X		X
	Gobiidae	X	X	X	X	X
MICRODESMIDAE	<i>Clarkichthys bilineatus</i> (Clark, 1936)	X		X	X	X
	<i>Microdesmus</i> sp. 1					X
	Microdesmidae	X	X		X	X
EPHIPPIDAE	<i>Chaetodipterus zonatus</i> (Girard, 1858)	X			X	X
	<i>Parapsettus panamensis</i> (Steindachner, 1876)	X				
	Ephippidae			X	X	
ACANTHURIDAE	Acanthuridae				X	X
SPHYRAENIDAE	<i>Sphyraena argentea</i> Girard, 1854	X				
	<i>Sphyraena ensis</i> Jordan & Gilbert, 1882	X		X	X	X
	<i>Sphyraena lucasana</i> Gill, 1863	X				
	<i>Sphyraena</i> sp. 1				X	
	Sphyraenidae		X			
GEMPYLIDAE	<i>Gempylus serpens</i> Cuvier, 1829	X				X
	Gempylidae	X	X	X		
TRICHIURIDAE	<i>Lepidopus fitchi</i> Rosenblatt & Wilson, 1987	X		X		X
	<i>Trichiurus lepturus</i> Linnaeus, 1758	X		X		X
	Trichiuridae	X	X			
SCOMBRIDAE	<i>Acanthocybium solandri</i> (Cuvier, 1832)					X
	<i>Auxis rochei rochei</i> (Risso, 1810)					X
	<i>Auxis thazard thazard</i> (Lacepède, 1800)					X
	<i>Auxis</i> sp. 1		X		X	X
	<i>Auxis</i> sp. 2				X	
	<i>Auxis</i> spp.	X		X		
	<i>Euthynnus lineatus</i> Kishinouye, 1920	X		X	X	X
	<i>Euthynnus</i> spp.		X			
	<i>Katsuwonus pelamis</i> (Linnaeus, 1758)					X
	<i>Sarda chiliensis chiliensis</i> (Cuvier, 1832)	X	X			
	<i>Sarda</i> sp. 1	X			X	
	<i>Scomber japonicus</i> Houttuyn, 1782	X	X	X		X
	<i>Scomberomorus sierra</i> Jordan & Starks, 1895			X		X

**TABLE 3. CONTINUED.**

FAMILY	TAXA	A	B	C	D	This study
	<i>Scomberomorus</i> sp. 1		X			X
	<i>Thunnus albacares</i> (Bonnaterre, 1788)			X		
	<i>Thunnus</i> sp. 1					X
	<i>Thunnus</i> spp.	X				
	Scombridae					X
ISTIOPHORIDAE	<i>Istiophorus platypterus</i> (Shaw, 1792)					X
	<i>Kajikia audax</i> (Philippi, 1887)			X		X
NOMEIDAE	<i>Cubiceps pauciradiatus</i> Günther, 1872	X		X	X	X
	<i>Cubiceps</i> spp.	X				X
	<i>Nomeus gronovii</i> (Gmelin, 1789)					X
	<i>Psenes pellucidus</i> Lütken, 1880			X	X	X
	<i>Psenes sio</i> Haedrich, 1970	X		X	X	X
	<i>Psenes</i> sp. 1	X				X
	Nomeidae	X	X	X		X
TETRAGONURIDAE	Tetragonuridae		X		X	
STROMATEIDAE	<i>Peprilus similimus</i> (Ayres, 1860)			X		
	<i>Peprilus</i> sp. 1	X				
	Stromateidae	X	X			
PARALICHTHYIDAE	<i>Citharichthys fragilis</i> Gilbert, 1890	X		X	X	X
	<i>Citharichthys gordae</i> Beebe & Tee-Van, 1938	X		X	X	X
	<i>Citharichthys platophrys</i> Gilbert, 1891	X		X	X	X
	<i>Citharichthys sordidus</i> (Girard, 1854)			X	X	X
	<i>Citharichthys xanthostigma</i> Gilbert, 1890					X
	<i>Citharichthys</i> sp. 1			X	X	X
	<i>Citharichthys</i> sp. 2			X		
	<i>Citharichthys</i> spp.	X		X	X	X
	<i>Cyclopsetta panamensis</i> (Steindachner, 1876)	X			X	X
	<i>Cyclopsetta querna</i> (Jordan & Bollman, 1890)					X
	<i>Cyclopsetta</i> sp. 1			X		X
	<i>Etropus crossotus</i> Jordan & Gilbert, 1882	X		X	X	X
	<i>Etropus peruvianus</i> Hildebrand, 1946				X	
	<i>Etropus</i> sp. 1			X		
	<i>Etropus</i> spp.					X
	<i>Hippoglossina stomata</i> Eigenmann & Eigenmann, 1890	X		X		X
	<i>Paralichthys californicus</i> (Ayres, 1859)	X				X
	<i>Paralichthys woolmani</i> Jordan & Williams, 1897	X			X	
	<i>Paralichthys</i> sp. 1			X		
	<i>Syacium latifrons</i> (Jordan & Gilbert, 1882)				X	X
	<i>Syacium ovale</i> (Günther, 1864)	X		X	X	X
	<i>Syacium</i> sp. 1					X
	<i>Xystreureys liolepis</i> Jordan & Gilbert, 1880	X				X
	Paralichthyidae	X		X		X
BOTHIDAE	<i>Bothus leopardinus</i> (Günther, 1862)	X		X	X	X
	<i>Bothus</i> sp. 1					X
	<i>Engyophrys sanctilaurentii</i> Jordan & Bollman, 1890	X		X	X	
	<i>Monolene asaedai</i> Clark, 1936	X		X	X	X
	<i>Perissias taeniopterus</i> (Gilbert, 1890)	X			X	X
	Bothidae		X			X
PLEURONECTIDAE	<i>Hypsopsetta guttulata</i> (Girard, 1856)	X		X		
	<i>Pleuronichthys verticalis</i> Jordan & Gilbert, 1880	X		X		X
	Pleuronectidae			X		
ACHIRIDAE	<i>Achirus mazatlanus</i> (Steindachner, 1869)	X		X	X	X
CYNOGLOSSIDAE	<i>Symphurus atramentatus</i> Jordan & Bollman, 1890			X	X	X
	<i>Symphurus atricaudus</i> (Jordan & Gilbert, 1880)	X		X	X	X
	<i>Symphurus callopterus</i> Munroe & Mahadeva, 1989			X	X	X
	<i>Symphurus chabanaudi</i> Mahadeva & Munroe, 1990				X	X
	<i>Symphurus elongatus</i> (Günther, 1868)				X	X
	<i>Symphurus oligomerus</i> Mahadeva & Munroe, 1990			X	X	X
	<i>Symphurus prolatinaris</i> Munroe, Nizinski & Mahadeva, 1991				X	
	<i>Symphurus williamsi</i> Jordan & Culver, 1895	X		X	X	X

TABLE 3. CONTINUED.

FAMILY	TAXA	A	B	C	D	This study
	<i>Symphurus</i> sp. 1			X	X	X
	<i>Symphurus</i> sp. 2			X	X	X
	<i>Symphurus</i> sp. 4				X	X
	<i>Symphurus</i> sp. 8			X	X	
	<i>Symphurus</i> spp.	X	X	X		X
	Cynoglossidae					X
BALISTIDAE	<i>Balistes polylepis</i> Steindachner, 1876	X		X	X	X
	<i>Canthidermis maculata</i> (Bloch, 1786)					X
	<i>Sufflamen verres</i> (Gilbert & Starks, 1904)				X	X
	Balistidae		X		X	X
MONACANTHIDAE	<i>Aluterus scriptus</i> (Osbeck, 1765)			X	X	X
	Monacanthidae				X	
TETRAODONTIDAE	<i>Sphoeroides annulatus</i> (Jenyns, 1842)	X		X	X	X
	<i>Sphoeroides lobatus</i> (Steindachner, 1870)	X		X		X
	<i>Sphoeroides</i> sp. 1	X		X		
	<i>Sphoeroides</i> sp. 2			X		
	<i>Sphoeroides</i> spp.					X
	Tetraodontidae	X	X		X	X
DIODONTIDAE	<i>Diodon holocanthus</i> Linnaeus, 1758			X		X
	<i>Diodon</i> sp. 1				X	X
	Diodontidae					X

TABLE 4. Total number and relative abundance of taxa registered from the Gulf of California to Colima per author included in the compiled list. This study = (Gulf of California to Jalisco, 2003-2007). Nb = number of taxa used as baseline for comparison (Aceves-Medina et al. 2003); N = number of taxa registered; AT = number of additional taxa (not registered by previous authors to that date); AT % = relative abundance of additional taxa; TF = total number of forms, FF = number of morphological forms by family: Bot = Bothidae, Chi = Chiasmodontidae, Cli = Clinidae, Con = Congridae, Cye = Cyematidae, Eleo = Eleotridae, Gobie = Gobiesocidae, Gob = Gobiidae, Hae = Haemulidae, Lab = Labrisomidae, Mac = Macrouridae, Par = Paralichthyidae, Ple = Pleuronectidae, Pom = Pomacentridae, Sci = Sciaenidae, Ang = order Anguilliformes.

	Nb	N	AT	AT (%)	TF	FF
Aceves-Medina et al. 2003	283				2	2 Gob
Moser et al. 1974		46	27	9.1	0	0
Franco-Gordo et al. 1999		56	46	15.5	0	0
Ávalos-García et al. 2003		97	31	10.5	18	8 Gob, 4 Hae, 3 Pom, 3 Sia
Franco-Gordo et al. 2003		105	2	0.7	3	3 Gob
Sala et al. 2003		5	2	0.7	0	0
Sánchez-Velasco et al. 2004		81	6	2.0	8	4 Gob, 2 Hae, 2 Sci
Sánchez-Velasco et al. 2007		107	15	5.1	4	2 Pom, 2 Cye
González-Armas et al. 2008		71	18	6.1	0	0
Peguero-Icaza et al. 2008		68	5	1.7	7	5 Gob, 2 Ple
Silva-Segundo et al. 2008		52	25	8.4	20	5 Gobie, 7 Hae, 6 Lab, 2 Sci
Avendaño-Ibarra et al. 2009		93	18	6.1	3	3 Con
León-Chávez et al. 2010		124	23	7.8	11	2 Bot, 2 Chi, 2 Con, 3 Gob, 2 Ang
Contreras-Catala et al. 2012		49	2	0.7	14	3 Ele, 3 Gob, 6 Ang, 2 Par
This study		264	76	25.7	38	2 Cli, 3 Con, 7 Ele, 7 Gob, 2 Mac, 10 Ang, 2 Pom, 5 Sci
Total	283		296			

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