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

Raymundo Avendaño-Ibarra 1,2*, Gerardo Aceves-Medina 2, Enrique Godínez-Domínguez 1, Roxana De Silva-Dávila 1,2, S. Patricia A. Jiménez-Rosenberg 2, Homero Urias-Leyva 1,3 and Carlos J. Robinson 3

1 Universidad de Guadalajara, Centro Universitario de la Costa Sur (CUICSUR), Depto. de Estudios para el Desarrollo Sustentable de la Zona Costera, Av. V. Gómez Farias 82, CP 48980, San Patricio Melaque, Jalisco, México.
2 Instituto Politécnico Nacional. CICIMAR. Departamento de Plancton y Ecología Marina, Av. IPN s/n, Fracc. Playa Palo de Sta. Rita, CP 23096, La Paz, BCS, México.
3 Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México, Ciudad Universitaria, Coyoacán, DF, México.
* Corresponding author. E-mail: ravendan@ipn.mx

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%), Benthosema panamense (13.9%), and Opisthonomia 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 within 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; Lavin 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...
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. Seaman of the Sea Education Association, Woods Hole Laboratory, Massachusetts, U.S.A. For the six cruises (CGC0503, CGC0505, GOLCA0511, GOLCA0603, 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 separated, concentrated, and preserved in 96% alcohol. The number of larvae was standardized to 10 m² 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 Ichthyo plankton Collection of the Mexican North Pacific (acronym ICTIOPLANCNT) 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     |
|-----------------------------------------------|--------|-----|---------|
| Ctenogadus mysticus (Günther, 1867)           | 18.2   | st  | cp      |
| Benthosema panamense (Tåning 1932)            | 13.9   | tr  | sd      |
| Opisthonema libertae (Günther, 1867)          | 12.7   | tr  | cp      |
| Vinciguerra lucetia (Garman, 1899)            | 10.4   | tr-st| mp      |
| Diogenichthys laternatus (Garman, 1899)       | 7.7    | st  | mp      |
| Engraulis mordax Girard, 1854                 | 6.8    | st  | cp      |
| Triphoturus mexicanus (Gilbert, 1990)         | 5.8    | st  | mp      |
| Leuroglossus stibius Gilbert, 1990            | 4.3    | tm-st| mp      |
| Sardinops sagax (Jenyns, 1842)                | 1.8    | st  | cp      |
| Gobiidae                                      | 1.2    |     |         |
| Scomber japonicus Houttuyn, 1782              | 1.0    | st  | cp      |
| Citharichthys fragilis Gilbert, 1890          | 0.8    | st  | sd      |
| Scaeniidae                                    | 0.8    |     |         |
| Hygophum atratum (Garman, 1899)               | 0.8    | tr-st| bp      |
| Oligopilus saurus inornatus (Bloch & Schneider, 1801) | 0.7 | st | cp      |
| Auxis thazard thazard (Lacepède, 1800)        | 0.7    | tr  | op      |
| Scomberomorus sierra Jordan & Starks, 1895    | 0.7    | tr  | cp      |
| Thanuss sp. 1                                 | 0.6    |     |         |
| Etrumeus teres (DeKay, 1842)                  | 0.6    | st  | cp      |
| Eucinostomus dowi (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.

| FAMILY             | A   | B   | C   | D   | E   | This study |
|--------------------|-----|-----|-----|-----|-----|------------|
| 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       |
| HABITAT            |      |     |     |     |     |            |
| 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 mysticus* (40,149 Larvae/10 m³) not recorded by Moser et al. (1974) or Moser-Medina et al. (2003), and of *Opisthonema libertate* (24,252 Larvae/10 m³) 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 (Salas 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), *Bathyergus nigrigryns* to *Bathylagoides nigrigryns* (Parr; 1931), *Encheliophis dubius* to *Carapus dubius* (Putnam, 1874), *Chaenopsis alepidota alepidota* to *Chaenopsis alepidota* (Gilbert, 1890), *Paraconger nitens* to *Rhyynchocentra nitens* (Jordan & Bollman, 1890), *Cheilopogon heterurus hubbis* to *Cheilopogon hubbis* (Parin, 1961), *Folidator acutus rostratus* to *Folidator 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 carmallis* (Jordan & Gilbert, 1882), *Auxis rochei* to *Auxis rochei rochei* (Risso, 1810), and *Sarda chilensis* to *Sarda chilensis chilensis* (Cuvier, 1832). The Mirapinnidae family also changed to Cetomimidae, Atherinidae to Atherinopsidae, and *Etrumeus teres* (DeKay, 1842), in the Clupeidae family changed to Dussumieridae 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, Gobiesocidae, 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 of them, around 65 more could be representing species. 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.

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).

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**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), Sánchez-Velasco et al. (2004), Sánchez-Velasco 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; 2005), 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 | Elops affinis Regan, 1909 | X | X | X | | |
| ALBULIDAE | Albula vulpes (Linnaeus, 1758) | X | X | X | | |
| | Albula sp. 1 | X | X | X | | |
| | Albula spp. | X | | | | |
| NOTACANTHIDAE | Notacanthus chemnitzii Bloch, 1788 | X | | | | |
| | Notacanthidae | X | | | | |
| 0. ANGUILLIFORMES | Anguilliformes | X | X | X | X | |
| MURAEINIDAE | Anarchias sp. 1 | X | | | | |
| | Gymnotorhax sp. 1 | X | X | X | | |
| | Uropterygius sp. 1 | X | | | | |
| | Muraenidae | X | X | X | | |
| OPHICHTHIDAE | Myrophis vafer Jordan & Gilbert 1882 | X | X | X | X | |
| | Myrophinae | X | | | | |
| | Ophichthus triseriatus Kaup 1856 | X | X | X | X | |
| | Ophichthus zophochir Jordan & Gilbert, 1883 | X | X | X | X | |
| | Ophichthus sp. 1 | X | X | X | X | |
| | Ophichthidae | X | X | X | X | |
| COLOCONGRIDAE | Coloconger giganteus (Castle, 1959) | X | | | | |
| FAMILY           | TAXA                                                                 | A | B | C | D | This study |
|------------------|----------------------------------------------------------------------|---|---|---|---|------------|
| CONGRIDAE        | Arionsoma gilberti (Ogilby, 1898)                                     | X | X | X | X |            |
|                  | Bathycongrus macnurus (Gilbert, 1891)                                 | X | X | X | X |            |
|                  | Chiloconger dentatus (Garman, 1899)                                   | X |   |   |   |            |
|                  | Chiloconger sp. 1                                                      |   |   | X |   |            |
|                  | Gnathophis cinctus (Garman, 1899)                                     | X |   |   |   |            |
|                  | Heteroconger canabas (Cowan & Rosenblatt, 1974)                       |   |   |   | X |            |
|                  | Heteroconger digueti (Pellegrin, 1923)                                | X | X | X | X |            |
|                  | Heteroconger sp. 1                                                    | X | X | X | X |            |
|                  | Paraconger californiensis Kanazawa, 1961                             | X | X | X | X |            |
|                  | Paraconger sp. 1                                                      |   |   | X |   |            |
|                  | Rhyynchoconger nitens (Jordan & Bollman, 1890)                        | X | X | X | X |            |
|                  | Rhyynchoconger sp. 1                                                 |   |   | X |   |            |
|                  | Congridae                                                            | X | X | X | X |            |
| DERICHTHYDAE      | Derichthys serpentinus Gill, 1884                                     | X |   |   |   |            |
|                  | Derichthyidaea                                                       | X | X | X | X |            |
| NEMICHTHYDAE      | Nemichthyidae                                                        | X |   |   |   |            |
| SERRIVOMERIDAE    | Serrivomeridae                                                       | X |   |   |   |            |
| NETTASTOMATIDAE   | Hoplumis sicarius (Garman, 1899)                                      | X | X | X | X |            |
|                  | Hoplumis sp. 1                                                        | X |   |   |   |            |
| CYEMATIDAE        | Cyematidae                                                           | X | X |   |   |            |
| CLUPEIDAE         | Harengula thrissina (Jordan & Gilbert, 1882)                          | X | X | X | X |            |
|                  | Opisthonomia libertata (Günther, 1867)                                | X | X | X | X |            |
|                  | Opisthonomia spp.                                                     | X | X |   |   |            |
|                  | Sardinops sagax (Jenyns, 1842)                                       | X | X | X | X |            |
|                  | Clupeidae                                                            | X | X |   |   |            |
| DUSSUMIERIIDAE    | Etrumeus teres (DeKay, 1842)                                          | X | X | X | X |            |
| ENGRAULIDAE       | Anchoa sp. 1                                                          | X | X | X | X |            |
|                  | Anchoa spp.                                                           | X |   |   |   |            |
|                  | Cetengraulis mysticetus (Günther, 1867)                               | X | X | X | X |            |
|                  | Engraulis mordax Girard, 1854                                         | X | X | X | X |            |
|                  | Engraulidae                                                          | X | X | X | X |            |
| CHANIDAE          | Chanos chanos (Forsskål, 1775)                                        | X |   |   |   |            |
| ARGENTINIDAE      | Argentina sialis Gilbert, 1890                                       | X | X | X | X |            |
| MICROSTOMATIDAE   | Microstomatidae                                                      | X | X |   |   |            |
| BATHYLAGIDAE      | Bathylagoides nigrogenys (Parr, 1931)                                 | X | X | X | X |            |
|                  | Bathylagus pacificus Gilbert, 1890                                    | X | X | X | X |            |
|                  | Bathylagoides wesethi (Bolin, 1938)                                   | X | X | X | X |            |
|                  | Bathylagoides sp. 1                                                  | X |   |   |   |            |
|                  | Leuroglossus stribius Gilbert, 1890                                   | X | X | X | X |            |
|                  | Bathylagidae                                                         | X | X | X | X |            |
| GONOSTOMATIDAE    | Cyclothone acclinidens Garman, 1899                                   | X |   |   |   |            |
|                  | Cyclothone signata Garman, 1899                                       | X |   |   |   |            |
|                  | Cyclothone spp.                                                       | X | X |   |   |            |
|                  | Diplophos taenia Günther, 1873                                        | X | X | X | X |            |
|                  | Diplophos sp. 1                                                       |   |   | X |   |            |
|                  | Gonostomatidae                                                       | X |   |   |   |            |
| STERNOPTYCHIDAE   | Argyropelecus lychnus Garman, 1899                                    | X |   |   |   |            |
|                  | Argyropelecus sp. 1                                                  |   |   | X |   |            |
| PHOSICHTHYIDAE    | Ichthyococcus irregularis Rechmitter & Böhle, 1958                    | X |   |   |   |            |
|                  | Vinciguerria lucetta (Garman, 1899)                                   | X | X | X | X |            |
|                  | Vinciguerria nimbaria Jordan & Williams, 1895                         | X |   |   |   |            |
|                  | Vinciguerria poweriae (Cocco, 1838)                                   | X |   |   |   |            |
|                  | Woodia nonsuchae (Beebe, 1932)                                        | X |   |   |   |            |
|                  | Phosichthyidae                                                       | X |   |   |   |            |
| STOMIDAE          | Bathophilus filifer (Garman, 1899)                                    | X |   |   |   |            |
|                  | Bathophilus Flemingi Aron & McCrery, 1958                            | X |   |   |   |            |
|                  | Idiacanthus antrostomus Gilbert, 1890                                 | X |   |   |   |            |
|                  | Stomias atriventer Garman, 1899                                       | X | X | X | X |            |
|                  | Tactostoma macropus Bolin, 1939                                       | X |   |   |   |            |
| FAMILY          | TAXA                              | A | B | C | D | This study |
|----------------|-----------------------------------|---|---|---|---|------------|
| **AULOPIDAE**  | *Aulopus bajacali* Parin & Kothyar, 1984 | X | X | X |   |            |
|                | *Aulopus*                          |   |   |   | X |            |
| **SCOPELARCHIDAE** | *Scopelarchoides nicholsi* Parr, 1929 | X | X | X | X |            |
|                | *Scopelarchus guentheri* Alcock, 1896 |   | X |   |   |            |
|                | *Scopelarchidae*                   |   |   |   | X |            |
| **SYNODONTIDAE** | *Synodus lucioceps* Ayres, 1855     | X | X | X | X |            |
|                | *Synodus evermanni* Jordan & Bollman, 1890 | X |   |   |   |            |
|                | *Synodus sechurae* Hildebrand, 1946 | X | X | X |   |            |
|                | *Synodus sp. 1*                    | X | X | X |   |            |
|                | *Synodus sp. 2*                    | X | X | X |   |            |
| **PARALEPIDIDAE** | *Lestidiops neles* Harry, 1953      | X | X | X | X |            |
|                | *Lestidiops pacificus* Parr, 1931   | X |   |   |   |            |
|                | *Lestidiops sp. 1*                 | X |   |   |   |            |
|                | *Magnisudis atlantica* Krøyer, 1868 | X |   |   |   |            |
|                | *Stemonosudis macrura* Ege, 1933   | X |   |   |   |            |
| **EVERMANNELLIDAE** | *Evermannella*                    |   |   |   | X |            |
| **NEOSCOPELIDAE** | *Neoscoepidae*                    | X |   |   |   |            |
| **MYCTOPHIDAE** | *Beniosema panamense* Tåning, 1932 | X | X | X | X |            |
|                | *Boliniichthys longipes* Brauer, 1906 | X |   |   |   |            |
|                | *Ceratoscopelus townsendi* Eigenmann & Eigenmann, 1889 | X | X | X |   |            |
|                | *Diaphus pacificus* Parr, 1931     | X | X | X | X |            |
|                | *Diaphus* sp. 1                    | X |   |   |   |            |
|                | *Dioecichthys atlanticus* Tåning, 1928 | X |   |   |   |            |
|                | *Dioecichthys laternotus* Garman, 1899 | X | X | X | X |            |
|                | *Gonichthys tuniculus* Garman, 1899 | X | X | X |   |            |
|                | *Hygophum atratum* Garman, 1899    | X | X | X | X |            |
|                | *Hygophum proximum* Becker, 1965   | X |   |   |   |            |
|                | *Hygophum reinhardtii* Lütken, 1892 | X | X |   |   |            |
|                | *Lampamyctes macdonaldii* Goode & Bean, 1896 | X | X | X |   |            |
| **LAMITERIDAE** | *Lampamyctes parvicauda* Parr, 1931 | X | X | X | X |            |
|                | *Lampamyctes* sp.                  | X |   |   |   |            |
|                | *Mycophum aurolaternatum* Garman, 1899 | X | X | X | X |            |
|                | *Nannobrachium idostigma* Parr, 1931 | X | X | X | X |            |
|                | *Nannobrachium* sp. 1              | X |   |   |   |            |
| **LOPHOTIDAE** | *Lophophis lacertus* Giorni, 1809  | X |   |   |   |            |
| **TRACHIPTERIDAE** | *Zu cristatus* Bonelli, 1819       | X |   |   |   |            |
| **BREGMACEROTIDAE** | *Bregmaceros* bathymaster* Jordan & Bollman, 1890 | X | X | X | X |            |
|                | *Bregmaceros* sp. 1                | X | X | X |   |            |
|                | *Bregmacerotidae*                  | X |   |   |   |            |
| **MACROURIDAE** | *Caelorinchus scaphopsis* Gilbert, 1890 | X | X | X |   |            |
|                | *Coryphaenoides* sp. 1              | X | X | X |   |            |
|                | *Nezumia* sp. 1                    | X |   |   |   |            |
|                | *Nezumia* sp. 2                    | X | X | X | X |            |
| **MORIDAE**    | *Laemonema verecundum* Jordan & Cramer, 1897 | X | X | X |   |            |
|                | *Physiculus nematopus* Gilbert, 1890 | X | X | X |   |            |
|                | *Physiculus rastrelliger* Gilbert, 1890 | X |   |   |   |            |
| **MERLUCCIIDAE** | *Merlucci productus* Ayres, 1855 | X | X | X | X |            |
|                | *Merlucci* sp. 1                    | X |   |   |   |            |
| **OPHIDIIDAE** | *Brotula* sp. 1                    | X |   |   |   |            |

*Note: Table 3. Continued.*
| FAMILY | TAXA | A | B | C | D | This study |
|--------|------|---|---|---|---|------------|
|        | Cherublemma emmelas (Gilbert, 1890) | X | X | X | X |            |
|        | Chilara taylori (Girard, 1858) | X | X |   |   |            |
|        | Lepophidium negropinna Hildebrand & Barton, 1949 | X | X | X | X |            |
|        | Lepophidium stigmatistium (Gilbert, 1890) | X | X | X | X |            |
|        | Lepophidium sp. 1 | X |   |   |   |            |
|        | Ophidion scrippsei (Hubbs, 1916) | X | X | X | X |            |
|        | Ophidion sp. 1 | X | X | X |   |            |
|        | Ophididae | X | X | X | X |            |
| CARAPIDAE | Carapus dubius (Putnam, 1874) | X | X | X |   |            |
|         | Encheliophis sp. 1 | X |   |   |   |            |
|         | Echiodon exsilium Rosenblatt, 1961 | X | X |   |   |            |
|         | Carapidae | X | X |   |   |            |
| BYTHITIDAE | Bythitidae | X |   |   |   |            |
| BATRACHOIDIDAE | Porichthys margaritatus (Richardson, 1844) | X |   |   |   |            |
| O. LOPHIIFORMES | Lophiformes | X |   |   |   |            |
| LOPHIDAE | Lophiodus caulinaris (Garman, 1899) | X | X | X |   |            |
|         | Lophiodus spilurus (Garman, 1899) | X | X | X | X |            |
|         | Lophiodus sp. 1 | X | X |   |   |            |
|         | Lophiidae | X | X |   |   |            |
| ANTENNARIDAE | Fowlerichthys avalonis (Jordan & Starks, 1907) | X | X | X |   |            |
|         | Antennarius sanguineus (Gill, 1863) | X |   |   |   |            |
|         | Antennariidae | X |   |   |   |            |
| OGOCEPHALIDAE | Zalieutes elater (Jordan & Gilbert, 1882) | X | X | X |   |            |
|         | Ogocephalidae | X |   |   |   |            |
| MELANOCETIDAE | Melanocetus johnsoni Günther, 1864 | X | X |   |   |            |
|         | Melanocetidae | X |   |   |   |            |
| ONEIRODIDAE | Dolopichthys spp. | X |   |   |   |            |
|         | Oneirodes acantalias (Gilbert, 1915) | X |   |   |   |            |
|         | Oneirodes sp. 1 | X |   |   |   |            |
|         | Oneirodes spp. | X | X | X | X |            |
|         | Oneidiidae | X |   |   |   |            |
| CERATIIDAE | Ceratiidae | X |   |   |   |            |
| GIGANTACTINIDAE | Gigantactis sp. 1 | X | X |   |   |            |
|         | Gigantactinidae | X |   |   |   |            |
| LINOPHRYNIDAE | Borophryne apogon Regan, 1925 | X | X |   |   |            |
| GOBIOSOCIDAE | Gobiesox eugrammus Briggs, 1955 | X |   |   |   |            |
|         | Gobiesox papillifer Gilbert, 1990 | X |   |   |   |            |
|         | Gobiesox sp. 1 | X | X |   |   |            |
|         | Gobiesocidae | X | X |   |   |            |
| ATERINOPSIDAE | Atherinella nepenthe (Myers & Wade, 1942) | X |   |   |   |            |
|         | Atherinella sp. 1 | X |   |   |   |            |
|         | Atherinops affinis (Ayers, 1860) | X |   |   |   |            |
|         | Atherinopsidae | X | X |   |   |            |
| BELONI | Strongylura exilis (Girard, 1854) | X |   |   |   |            |
| HEMIRAMPHIDAE | Hemiramphus saltator Gilbert & Starks, 1904 | X | X | X | X |            |
|         | Hemiramphus spp. | X | X | X | X |            |
|         | Hyporhamphus rosae (Jordan & Gilbert, 1880) | X | X | X |   |            |
|         | Hyporhamphus spp. | X | X | X | X |            |
|         | Oxyporhamphus micropterus micropterus (Valenciennes, 1847) | X | X | X | X |            |
|         | Hemiramphidae | X | X | X | X |            |
| EXOCETIDAE | Cheilopogon hubbs (Parin, 1961) | X | X | X | X |            |
|         | Cheilopogon pinnatifibratus californicus (Cooper, 1863) | X | X |   |   |            |
|         | Cheilopogon xenopterus (Gilbert, 1890) | X |   |   |   |            |
|         | Cheilopogon sp. 1 | X |   |   |   |            |
|         | Cheilopogon spp. | X |   |   |   |            |
|         | Exocoetus volitans Linnaeus, 1758 | X |   |   |   |            |
|         | Fodiator rostratus (Günther, 1866) | X | X |   |   |            |
|         | Hirundichthys rondeletii (Valenciennes, 1847) | X | X |   |   |            |
|         | Hirundichthys spp. | X | X |   |   |            |
| FAMILY          | TAXA                                                      | A | B | C | D | This study |
|----------------|-----------------------------------------------------------|---|---|---|---|------------|
| MELAMPHAIDAE   | Prognichthys tringa Breder, 1928                         | X | X |   |   |            |
|                | Prognichthys spp.                                        |   |   | X |   |            |
|                | Exocoetidae                                              | X |   | X |   |            |
|                | Melampha suggubris Gilbert, 1890                         |   |   | X |   |            |
|                | Melamphae sp. 1                                          |   | X | X | X |            |
|                | Melamphae spp.                                           |   |   |   | X |            |
|                | Scopelogadus mizolepis bispinosus (Gilbert, 1915)         | X |   | X | X |            |
|                | Melamphaidae                                             | X |   | X |   |            |
| HOLOCENTRIDAES | Myrjprisitex leognathos Valenciennes, 1846               | X |   | X | X |            |
|                | Myrjprisitex spp.                                        |   |   | X |   |            |
|                | Sargocentron suborbitalis (Gill, 1863)                   |   |   |   | X |            |
|                | Holocentridae                                            |   |   |   | X |            |
| CETOMIMIDAE    | Eutaeniophorus festivus (Bertelsen & Marshall, 1956)     |   |   |   | X |            |
| FISTULARIIDAE  | Fistularia commersonii Rüppel, 1838                      | X | X |   |   |            |
|                | Fistularia corneta Gilbert & Starks, 1904                | X | X | X |   |            |
|                | Fistulariidae                                            |   | X |   |   |            |
| SYNGNATHIDAES  | Doryrhampus excisus excisus Kaup, 1856                   | X |   | X |   |            |
|                | Hippocampus ingens Girard, 1858                         |   |   | X |   |            |
|                | Syngnathus californiensis Storser, 1845                 | X | X |   |   |            |
|                | Syngnathus sp. 1                                         | X |   |   | X |            |
|                | Syngnathidae                                             | X |   |   |   |            |
| SCORPAENIDAE   | Pontinus furciferinus Garman, 1899                       |   |   |   | X |            |
|                | Pontinus sierra (Gilbert, 1890)                          | X | X |   |   |            |
|                | Pontinus sp. 1                                            | X | X | X |   |            |
|                | Pontinus sp. 2                                            | X |   |   |   |            |
|                | Pontinus spp.                                             | X |   |   |   |            |
|                | Scorpaena guttata Girard, 1854                          | X | X | X |   |            |
|                | Scorpaena sp. 1                                           | X | X |   |   |            |
|                | Scorpaena spp.                                            | X |   |   |   |            |
|                | Scorpaenodes xyris (Jordan & Gilbert, 1882)              | X | X | X |   |            |
|                | Scorpaenodes spp.                                         | X |   |   |   |            |
|                | Sebastes constellatus (Jordan & Gilbert, 1880)           |   |   | X |   |            |
|                | Sebastes macdonaldi (Eigenmann & Beeson, 1893)           | X |   |   |   |            |
|                | Sebastes sp. 1                                            | X |   |   |   |            |
|                | Sebastes sp. 2                                            | X |   |   |   |            |
|                | Sebastes sp. 3                                            | X |   |   |   |            |
|                | Sebastes sp. 6                                            | X | X |   |   |            |
|                | Sebastes spp.                                             | X | X | X |   |            |
|                | Sebastolobus altivelis Gilbert, 1896                     | X | X | X |   |            |
|                | Scorpaenidae                                              | X | X | X |   |            |
| TRIGLIDAE      | Bellator loxias (Jordan, 1897)                           | X | X |   |   |            |
|                | Prionotus ruscatus Gilbert & Starks, 1904                | X | X | X |   |            |
|                | Prionotus stephanophrys Lockington, 1881                 | X | X |   |   |            |
|                | Prionotus sp. 1                                           | X | X |   |   |            |
|                | Triglidae                                                 | X | X | X |   |            |
| CYCLOPTERIDAE  | Cyclopteridae                                             |   |   | X |   |            |
| HOWELLIDAE     | Howella sp. 1                                             | X |   |   |   |            |
|                | Howella spp.                                              | X |   |   |   |            |
| POLYPRIONIDAE  | Stereolepis gigas Ayres, 1859                            |   |   |   | X |            |
| SERRANIDAE     | Anthinæ                                                 | X |   |   |   |            |
|                | Diplectrum pacificum Meek & Hildebrand, 1925             | X |   |   |   |            |
|                | Diplectrum sp. 1                                          | X | X | X |   |            |
|                | Diplectrum sp. 2                                          | X | X |   |   |            |
|                | Diplectrum spp.                                           | X | X |   |   |            |
|                | Epinephelus sp. 1                                         | X | X |   |   |            |
|                | Epinephelus spp.                                          | X | X |   |   |            |
|                | Hemanthias peruanus (Steindachner, 1875)                 | X |   |   |   |            |
|                | Hemanthias signifer (Garman, 1899)                       | X | X | X |   |            |
|                | Hemanthias sp. 1                                          | X | X | X |   |            |
| FAMILY | TAXA | A | B | C | D | This study |
|--------|------|---|---|---|---|------------|
| Hemanthias spp. | X | | | | | |
| Mycteroperca prionura | Rosenblatt & Zahuranec, 1967 | | | | | |
| Mycteroperca rosacea (Streets, 1877) | | | | | | |
| Mycteroperca spp. | X | | | | | |
| Paralabrax aurorattatus | Walford, 1936 | X | X | | | |
| Paralabrax maculatofasciatus (Steindachner, 1868) | X | X | | | | |
| Paralabrax nebulifer (Girard, 1854) | X | X | | | | |
| Paralabrax sp. 1 | X | X | | | | |
| Paralabrax sp. 2 | X | | | X | | |
| Paranthias colonus (Valenciennes, 1846) | X | X | X | | | |
| Paranthias sp. 1 | X | | | | | |
| Pronotogrammus eos | Gilbert, 1890 | X | X | | | |
| Pronotogrammus multifasciatus | Gill, 1863 | X | X | X | | |
| Pronotogrammus spp. | | | | | | |
| Pseudogramma thaumasia (Gilbert, 1900) | X | X | | | | |
| Serranidae | | | | | | |
| Serranidae | X | X | X | X | | |
| Apogon spp. | X | | | | | |
| Apogonidae | X | X | X | X | | |
| Opistognathidae | | | | | | |
| Opistognathus sp. 1 | X | X | | | | |
| Opistognathus spp. | X | | | | | |
| Priacanthidae | | | | | | |
| Heteropriacanthus cruentatus | (Lacepède, 1801) | | | | X | |
| Pristigenys serrula | (Gilbert, 1891) | X | X | | X | |
| Priacanthidae | | | | | X | X |
| Aporogonidae | | | | | | |
| Apogon atricaudus | Jordan & McGregor, 1898 | X | X | | X | |
| Apogon guadalupensis | (Osborn & Nichols, 1916) | X | | | | |
| Apogon retrosella | (Gill, 1862) | X | X | X | X | |
| Apogon sp. 1 | X | | | | | |
| Apogonidae | | | | | | |
| Apogon spp. | | | | | | |
| Malacanthidae | | | | | | |
| Caulolatilus affinis | Gill, 1865 | X | | | | |
| Caulolatilus princeps | (Jenyns, 1840) | X | | X | | |
| Caulolatilus sp. 1 | X | | | | | |
| Malacanthidae | | | | | | |
| Carangidae | | | | | | |
| Alectis ciliaris | (Bloch, 1787) | X | X | | | |
| Caranx caballi | Günther, 1868 | X | X | X | X | |
| Caranx sexfasciatus | Quoy & Gaimard, 1825 | X | X | X | X | |
| Caranx sp. 1 | X | X | X | X | X | |
| Caranx sp. 2 | X | | | | | |
| Caranx sp. | X | | | | | |
| Chloroscombrus orqeta | Jordan & Gilbert, 1883 | X | X | X | X | |
| Decapterus sp. 1 | X | X | X | | | |
| Decapterus spp. | | | | | | |
| Elagatis bipinnulata | (Quoy & Gaimard, 1825) | X | | | | |
| Gnathanodon speciosus | (Forsskål, 1775) | X | | X | | |
| Hemicaranx spp. | | | | | | |
| Naucrates doctor | (Linnaeus, 1758) | X | X | X | | |
| Oligopiltes saurus | (Bloch & Schneider, 1801) | X | X | X | | |
| Oligopiltes sp. 1 | X | X | X | | | |
| Oligopiltes sp. 2 | X | | | | | |
| Salar crumenophthalmus | (Bloch, 1793) | X | X | X | | |
| Selene brevoortii | (Gill, 1863) | X | | | | |
| Selene orstedii | Lütken, 1880 | X | | X | | |
| Selene peruviana | (Guichenot, 1866) | X | X | | | |
| Selene spp. | X | | | | | |
| Seriola lalandi | Valenciennes, 1833 | X | X | X | X | |
| Seriola sp. 1 | X | | | | | |
| Seriola sp. 2 | X | | | | | |
| Seriola sp. 3 | X | | | | | |
| Seriola sp. 4 | X | | | | | |
| Seriola sp. 5 | X | | | | | |
| Seriola sp. 6 | X | | | | | |
| Seriola sp. 7 | X | | | | | |
| FAMILY          | TAXA                        | A | B | C | D | This study |
|----------------|-----------------------------|---|---|---|---|------------|
|                | Seriola sp. 3               | X |   |   |   |            |
|                | Seriola spp.                |   |   |   |   |            |
|                | Trachinotus kennedyi        |   |   | X |   |            |
|                | Trachinotus rhodopus        |   | X |   |   |            |
|                | Trachinus symmetricus       |   | X | X | X |            |
|                | Carangidae                 | X | X | X |   |            |
| NEMATISTIIDAE  | Nematistius pectoralis      | X |   |   |   |            |
| CORYPHAEIDAE   | Coryphaena equilis          | X | X | X |   |            |
|                | Coryphaena hippurus         |   | X |   |   |            |
|                | Coryphaenidae               | X |   |   |   |            |
| BRAMIDAE       | Bramidae                   | X |   | X |   |            |
| LUTJANIDAE     | Hoplophorus guentheri       | X |   |   |   |            |
|                | Latjanus argentiventris    | X | X | X | X |            |
|                | Latjanus guttatus          | X |   |   |   |            |
|                | Latjanus novemfasciatus    | X | X | X | X |            |
|                | Latjanus peru              | X | X | X | X |            |
|                | Latjanus spp.              | X |   | X |   |            |
|                | Lutjanidae                 | X | X |   |   |            |
| LOBOTIDAE      | Lobotes surinamensis       | X |   |   |   |            |
| GERRIDAE       | Diapterus peruvianus        | X |   |   |   |            |
|                | Eucinostomus argenteus      | X |   |   |   |            |
|                | Eucinostomus curranii      | X |   |   |   |            |
|                | Eucinostomus dawii         | X | X |   |   |            |
|                | Eucinostomus entomelas     | X |   |   |   |            |
|                | Eucinostomus gracilis      | X | X | X |   |            |
|                | Eucinostomus spp.          | X |   |   |   |            |
| HAEMULIDAE     | Anisotremus davidsoni      | X | X | X |   |            |
|                | Anisotremus spp.           |   |   |   |   |            |
|                | Conodon serrifer           | X |   |   |   |            |
|                | Orthopristis redingi       | X |   |   |   |            |
|                | Orthopristis spp.          | X |   |   |   |            |
|                | Pomadasys sp. 1            | X | X | X |   |            |
|                | Xenistius californiensis   | X | X | X |   |            |
| HAEMULIDAE     | Calamus brachysomus        | X | X | X |   |            |
| SCIAENIDAE     | Bairdiella sp. 1           | X |   |   |   |            |
|                | Cynoscion sp. 1            | X |   |   |   |            |
|                | Cheilotrema saturnum       | X |   |   |   |            |
|                | Larimus sp. 1              | X |   |   |   |            |
|                | Larimus sp. 2              | X |   |   |   |            |
|                | Menticirrhus undulatus     | X |   |   |   |            |
|                | Menticirrhus sp.           | X |   |   |   |            |
|                | Menticirrhus spp.          | X |   |   |   |            |
|                | Micropogonias sp. 1        | X |   |   |   |            |
|                | Micropogonias sp. 2        | X |   |   |   |            |
|                | Micropogonias spp.         | X |   |   |   |            |
|                | Roncador stearnsii         | X | X |   |   |            |
|                | Seriphus politus           | X |   |   |   |            |
|                | Umbrina roncador           | X | X |   |   |            |
|                | Umbrina xanti              | X |   |   |   |            |
|              | Sciaenidae                 | X | X | X | X |            |
| POLYNEMIDAE    | Polydactylus approximans   | X | X | X | X |            |
|                | Polydactylus opercularis   | X | X |   |   |            |
|                | Polynemidae                | X |   |   |   |            |
| MULLIDAE       | Mullodichthys dentatus     | X |   |   |   |            |
|                 | Mullidae                   | X | X | X |   |            |
| KYPHOSIDAE     | Hermosa azurea             | X |   |   |   |            |
|                | Kyphosus analogus          | X |   |   |   |            |
| FAMILY                  | TAXA                                               | A | B | C | D | This study |
|------------------------|----------------------------------------------------|---|---|---|---|------------|
|                       | Kyphosus sp. 1                                     | X |    |   |   |            |
|                       | Medaluna californiensis (Steindachner, 1876)      | X |    |   |   |            |
|                       | Kyphosida                                          |   | X | X |   |            |
| CHAETODONTIDAE         | Chaetodon humeralis Günther, 1860                  |   | X | X |   |            |
|                       | Chaetodon sp. 1                                    |   |   |   |   |            |
|                       | Chaetodontidae                                     |   | X |   |   |            |
| CIRRHITIDAE            | Cirrhichthys oxycephalus (Bleeker, 1855)          |   | X |   |   |            |
|                       | Cirrhitida                                         |   | X | X |   |            |
| MUGILIDAE              | Mugil cephalus Linnaeus, 1758                      | X | X | X |   |            |
|                       | Mugil curema Valenciennes, 1836                    | X |   |   |   |            |
|                       | Mugil sp. 1                                        | X | X |   |   |            |
|                       | Mugil spp.                                         | X |   |   |   |            |
|                       | Mugilida                                           |   | X | X |   |            |
| POMACENTRIDAE          | Abudefduf troschelli (Gill, 1862)                  | X | X | X | X |            |
|                       | Chromis punctipinnis (Cooper, 1863)                |   | X |   |   |            |
|                       | Chromis sp. 1                                      |   | X | X |   |            |
|                       | Chromis sp. 2                                      |   |   |   |   |            |
|                       | Hypsypops rubicundus (Girard, 1854)               | X | X | X |   |            |
|                       | Stegastes rectifraenum (Gill, 1862)               | X |   | X |   |            |
|                       | Pomacentridae                                      | X | X | X |   |            |
| LABRIDA                | Decodon melasna Gomon, 1974                       |   | X |   |   |            |
|                       | Halichoeres dispilus (Günther, 1864)              | X | X | X |   |            |
|                       | Halichoeres semicinctus (Ayres, 1859)             | X | X | X | X |            |
|                       | Halichoeres sp. 1                                  | X | X | X | X |            |
|                       | Halichoeres spp.                                   |   | X |   |   |            |
|                       | Inisitius pavo (Valenciennes, 1840)               | X |   |   |   |            |
|                       | Oxyjulis californica (Günther, 1861)              |   | X |   |   |            |
|                       | Semicossyphus pulcher (Ayres, 1854)               | X |   | X |   |            |
|                       | Thalassoma sp. 1                                   | X |   | X |   |            |
|                       | Thalassoma spp.                                    |   | X |   |   |            |
|                       | Xyrichthys mundiceps Gill, 1862                    | X | X | X |   |            |
|                       | Xyrichthys pavo (Valenciennes, 1840)              | X |   |   |   |            |
|                       | Xyrichthys sp. 1                                   | X | X | X | X |            |
|                       | Labridae                                           | X | X | X | X |            |
| SCARIDAE               | Nicholsina denticulata (Evermann & Radcliffe,     |   |   |   |   |            |
|                       | Scarus sp. 1                                       |   | X | X | X |            |
|                       | Scarus spp.                                        |   | X |   |   |            |
|                       | Scaridae                                           |   |   |   |   |            |
| CHIASMONTIDAE          | Chiasmodon niger Johnson, 1864                     | X |   |   |   |            |
|                       | Chiasmodontidae                                    |   | X |   |   |            |
| AMMODYTIDAE            | Ammodytoides gilli (Bean, 1895)                    | X | X | X |   |            |
|                       | Ammodytoides sp. 1                                 |   | X |   |   |            |
| SO. BLENNIOIDEI        | Blennioidei                                        |   |   |   |   |            |
| TRIPTERGYIDAE          | Enneanectes carinalis (Jordan & Gilbert, 1882)    |   |   |   |   |            |
|                       | Tripterygida                                        | X |   |   |   |            |
| LABRISOMIDAE           | Labrisomus multiporosus Hubbs, 1953                | X |   |   |   |            |
|                       | Labrisomus xanti Gill, 1860                       | X |   | X |   |            |
|                       | Paracrinus sp. 1                                   | X |   |   |   |            |
|                       | Labrisomida                                        | X |   | X |   |            |
| CLINIDAE               | Clinidae                                           |   | X |   |   |            |
| CHAENOPSISIDAE         | Chaenopsis alepidota (Gilbert, 1890)               |   | X |   |   |            |
|                       | Neoclinus blanchardi Girard, 1858                  | X |   |   |   |            |
|                       | Chaenopsis                                        |   | X |   |   |            |
| DACTYLOSCOPIAE         | Dactyagnus mundus Gill, 1863                       | X |   |   |   |            |
|                       | Dactyloscopus sp. 1                                |   | X |   |   |            |
|                       | Gilbellus semicinctus Gilbert, 1890                | X | X |   |   |            |
|                       | Myxodagnus opercularis Gill, 1861                  | X |   |   |   |            |
|                       | Dactyloscopida                                     |   | X |   |   |            |
| BLENNIIDAE             | Entomacrodus chiostictus (Jordan & Gilbert, 1882) | X |   |   |   |            |
|                       | Hypsooblennius brevipinnis (Günther, 1861)        |   | X | X |   |            |
| FAMILY          | TAXA                             | A | B | C | D | This study |
|----------------|----------------------------------|---|---|---|---|------------|
|                | Hypsoblennius gentilis (Girard, 1854) | X | X | X |   | X          |
|                | Hypsoblennius gilberti (Jordan, 1882) |   |   |   | X |            |
|                | Hypsoblennius jenkinsi (Jordan & Evermann, 1896) |   |   |   | X |            |
|                | Hypsoblennius proteus (Kreja, 1960) |   |   |   | X |            |
|                | Hypsoblennius sp. 1               |   | X | X |   | X          |
|                | Hypsoblennius spp.                |   |   |   | X |            |
|                | Ophioblennius steindachneri (Jordan & Evermann, 1898) | X | X | X | X |            |
|                | Plagiotrema azaleus (Jordan & Bolman, 1990) | X |   |   |   |            |
|                | Blenniidae                        | X |   |   |   |            |
| CALLIONYMIDAE  | Synchirous atrilabiatus (Garman, 1899) | X | X | X |   |            |
| ELEOTRIDAE     | Dormitor latifrons (Richardson, 1844) |   |   |   | X |            |
|                | Electris picta Kner, 1863         | X |   |   |   |            |
|                | Eretis armiger (Jordan & Richardson, 1895) | X | X | X |   |            |
|                | Eleotridae                        | X | X | X |   |            |
| Gobiidae       | Ballania sp. 1                    | X |   |   |   |            |
|                | Coryphopterus nicholi (Bean, 1882) |   |   |   |   |            |
|                | Coryphopterus sp. 1               |   | X |   |   |            |
|                | Ctenogobius mangilica (Jordan & Starks, 1895) | X |   |   |   |            |
|                | Ctenogobius sagittula (Günther, 1862) | X |   |   |   |            |
|                | Gillicthiss mirabilis Cooper, 1864 | X |   |   |   |            |
|                | Gobulus crescentalis (Gill, 1892) | X | X |   |   |            |
|                | Gobionellus sp. 1                 |   |   |   | X |            |
|                | Hypnus gilberti (Eigenmann & Eigenmann, 1889) | X | X |   |   |            |
|                | Lythrypnus dalli (Gilbert, 1890) | X | X |   |   |            |
|                | Lythrypnus zebra (Gilbert, 1890) | X | X |   |   |            |
|                | Lythrypnus spp.                   | X |   |   |   |            |
|                | Microgobius sp. 1                 | X |   |   |   |            |
|                | Quietula y-cauda (Jenkins & Evermann, 1889) |   |   |   | X |            |
|                | Rhinogobios nichioli (Bean, 1882) | X | X | X |   |            |
| MICRODESMIADA  | Clarkichthys bilineatus (Clark, 1936) | X | X | X |   |            |
|                | Microdesmus sp. 1                 | X | X | X | X |            |
|                | Microdesmidae                     | X | X | X |   |            |
| EPHIPPIDAE     | Chaetodipterus zonatus (Girard, 1858) | X | X | X |   |            |
|                | Parapsettus panamensis (Steindachner, 1876) | X |   |   |   |            |
|                | Ephiippidae                       | X | X |   |   |            |
| ACANTHURIDAE   | Acanthuridae                      | X | X |   |   |            |
| PHYRAENIDAE    | Sphyraena argentea Girard, 1854 | X |   |   |   |            |
|                | Sphyraena ensis Jordan & Gilbert, 1882 | X | X | X | X |            |
|                | Sphyraena lucasana Gill, 1863 | X |   |   |   |            |
|                | Sphyraena sp. 1                   | X |   |   |   |            |
|                | Sphyraenaefi                     | X |   |   |   |            |
| GEMPYLAED      | Gempylus serpen Cuvier, 1829 | X |   |   |   |            |
|                | Gempylidae                       | X | X |   |   |            |
| TRICHIURIDAE   | Lepidopus fitchi Rosenblatt & Wilson, 1987 | X | X | X |   |            |
|                | Trichiurus lepturus Linnaeus, 1758 | X | X | X |   |            |
|                | Trichiuridae                      | X | X |   |   |            |
| SCOMBRIDAE     | Acanthocybium solandri (Cuvier, 1832) | X |   |   |   |            |
|                | Auxis rochei rochei (Risso, 110) | X |   |   |   |            |
|                | Auxis thazard thazard (Lacepède, 1800) | X |   |   |   |            |
|                | Auxis sp. 1                       | X | X | X |   |            |
|                | Auxis sp. 2                       | X | X | X | X |            |
|                | Auxis spp.                       | X | X | X |   |            |
|                | Euthynnas lineatus Kishinouye, 1920 | X | X | X |   |            |
|                | Euthynnas spp.                    | X | X | X |   |            |
|                | Katsuwonous pelamis (Linnaeus, 1758) | X | X |   |   |            |
|                | Sarda chilensis chilensis (Cuvier, 1832) | X | X | X |   |            |
|                | Sarda sp. 1                       | X | X | X |   |            |
|                | Scomber japonicus Houttuyn, 1782 | X | X | X | X |            |
|                | Scomberomorus sierra Jordan & Starks, 1895 | X | X |   |   |            |
## Table 3. Continued.

| FAMILY            | TAXA                                | A | B | C | D | This study |
|-------------------|-------------------------------------|---|---|---|---|------------|
|                   | Scomberomorus sp. 1                 | X | X |   |   |            |
|                   | Thunnus albacares (Bonnaterre, 1788)| X |   |   |   |            |
|                   | Thunnus sp. 1                       |   | X |   |   |            |
|                   | Thunnus spp.                        |   |   | X |   |            |
|                   | Scombridae                          |   |   |   | X |            |
| ISTIOPHORIDAE     | Istiophorus platypterus (Shaw, 1792)| X |   |   |   |            |
|                   | Kajikia audax (Philippi, 1887)      |   | X |   |   |            |
| NOMEIDAE          | Cubiceps pauciradiatus Günther, 1872| X | X | X | X |            |
|                   | Cubiceps spp.                       | X |   |   |   |            |
|                   | Nomeus gronovii (Gmelin, 1789)      |   | X |   |   |            |
|                   | Psenes pellucidus Lütken, 1880      | X | X | X | X |            |
|                   | Psenes sio Haedrich, 1970           | X | X | X | X |            |
|                   | Psenes sp. 1                        | X |   |   |   |            |
|                   | Nomeidae                            | X | X | X | X |            |
| TETRAGONURIDAE    | Tetragonuridae                      | X | X |   |   |            |
| STROMATEIDAE      | Pepilus similimus (Ayres, 1860)     | X |   |   |   |            |
|                   | Pepilus sp. 1                       | X |   |   |   |            |
|                   | Stromateidae                        | X | X |   |   |            |
| PARALICHTHYIDAE   | Citharichthys fragilis Gilbert, 1890| X | X | X | X |            |
|                   | Citharichthys gordae Beebe & Tee-Van, 1938 | X | X | X | X |            |
|                   | Citharichthys platophrys Gilbert, 1891 | X | X | X | X |            |
|                   | Citharichthys sordidus (Girard, 1854) | X | X | X | X |            |
|                   | Citharichthys xanthostigma Gilbert, 1890 | X |   |   |   |            |
|                   | Citharichthys sp. 1                 | X | X | X | X |            |
|                   | Citharichthys sp. 2                 | X |   |   |   |            |
|                   | Citharichthys spp.                  | X | X | X | X |            |
|                   | Cyclosetta panamensis (Steindachner, 1876) | X | X | X | X |            |
|                   | Cyclosetta quarna (Jordan & Bollman, 1890) | X |   |   |   |            |
|                   | Cyclosetta sp. 1                    | X | X | X | X |            |
|                   | Etopus crososaicus Jordan & Gilbert, 1882 | X | X | X | X |            |
|                   | Etopus peruvianus Hildebrand, 1946   | X |   |   |   |            |
|                   | Etopus sp. 1                        | X | X | X | X |            |
|                   | Etopus spp.                         | X |   |   |   |            |
|                   | Hippoglossina stomata Eigenmann & Eigenmann, 1890 | X | X | X | X |            |
|                   | Paralichthys californicus (Ayres, 1859) | X | X | X | X |            |
|                   | Paralichthys woolmani Jordan & Williams, 1897 | X | X | X | X |            |
|                   | Paralichthyssp. 1                   | X | X | X | X |            |
|                   | Syacium latifrons (Jordan & Gilbert, 1882) | X | X | X | X |            |
|                   | Syacium ovale (Günther, 1864)       | X | X | X | X |            |
|                   | Syacium sp. 1                       | X | X | X | X |            |
|                   | Xystreursis liolepis Jordan & Gilbert, 1880 | X | X | X | X |            |
|                 | Bothidae                           | X | X | X | X |            |
| PLEURONECTIDAE    | Hypsosetta guttulata (Girard, 1856) | X | X |   |   |            |
| ACHIRIDAE         | Achirus mazatlanus (Steindachner, 1869) | X | X | X | X |            |
| CYNOGLOSSIDAE     | Symphurus atramentatus Jordan & Bollman, 1890 | X | X | X | X |            |
|                   | Symphurus atraeauus (Jordan & Gilbert, 1880) | X | X | X | X |            |
|                   | Symphurus callopterus Munroe & Mahadeva, 1989 | X | X | X | X |            |
|                   | Symphurus chabanaudi Mahadeva & Munroe, 1990 | X | X | X | X |            |
|                   | Symphurus elongatus (Günther, 1868)  | X | X | X | X |            |
|                   | Symphurus oligomerus Mahadeva & Munroe, 1990 | X | X | X | X |            |
|                   | Symphurus prolatinaris Munroe, Nizinski & Mahadeva, 1991 | X | X | X | X |            |
|                   | Symphurus williamsi Jordan & Culver, 1895 | X | X | X | X |            |
Table 3. Continued.

| FAMILY | TAXA | A | B | C | D | This study |
|--------|------|---|---|---|---|------------|
|        |      | X | X | X |   |            |
|        |      | X | X | X |   |            |
|        |      | X | X | X |   |            |
|        |      | X | X | X |   |            |
|        |      | X | X | X |   |            |
|        |      | X | X | X |   |            |
|        |      | X | X | X |   |            |
|        |      | X | X | 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 |
|--------|----|---|-----|--------|----|----|
|        | 283| 46| 27  | 9.1    | 0  | 0  |
|        | 201| 56| 46  | 15.5   | 0  | 0  |
|        | 181| 97| 31  | 10.5   | 18 | 3  |
|        | 180| 105| 2  | 0.7   | 3  | 3  |
|        | 181| 5  | 5   | 0.7    | 0  | 0  |
|        | 181| 81| 6   | 2.0    | 8  | 4  |
|        | 181| 107| 15 | 5.1   | 4  | 2  |
|        | 181| 71| 18  | 6.1    | 0  | 0  |
|        | 181| 68| 5   | 1.7    | 7  | 5  |
|        | 181| 52| 25  | 8.4    | 20 | 5  |
|        | 181| 93| 18  | 6.1    | 3  | 3  |
|        | 181| 124| 23 | 7.8   | 11 | 2  |
|        | 181| 49| 2   | 0.7   | 14 | 3  |
|        | 181| 264| 76 | 25.7  | 38 | 2  |
|        | 181| 264| 76 | 25.7  | 38 | 2  |
|        | 181| 264| 76 | 25.7  | 38 | 2  |
|        | 181| 264| 76 | 25.7  | 38 | 2  |

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