ISSN 1809-127X (online edition)

Check List
Journal of species lists and distribution

Lists of Species

Fish larvae off the northwestern coast of the Baja California Peninsula, Mexico

S. Patricia A. Jiménez-Rosenberg*, Ricardo J. Saldierna-Martínez, Gerardo Aceves-Medina, Alejandro Hinojosa-Medina, René Funes-Rodríguez, Martín Hernández-Rivas, Raymundo Avendaño-Ibarra

Departamento de Plancton y Ecología Marina, Centro Interdisciplinario de Ciencias Marinas Av. IPN s/n, Col. Playa Palo de Sta. Rita, C.P. 23096, La Paz, Baja California Sur, México
* Corresponding author E-mail: *srosenbe@ipn.mx*

Abstract: The structure of the larval fish assemblage of the northwestern Pacific coast of Mexico is analyzed from zooplankton samples taken between 1998 and 2000 off northern and southern Baja California Peninsula. The 198 fish taxa identified reflected the faunal complexity reported previously for the area. Adult distribution patterns and reproductive behavior, added to the environmental seasonality and bathymetric characteristics of the coast, explained differences in the larval fish assemblage. Larvae of meso- and bathypelagics *Vinciguerria lucetia, Diogenichthys laternatus,* and *Triphoturus mexicanus* were the most abundant year round. Larvae of commercially important species, such as *Engraulis mordax*, *Sardinops sagax*, *Merluccius productus,* and *Trachurus symmetricus,* were also abundant during winter and spring, depending on the year and surveyed region. Adult distribution patterns and reproductive behavior, intra- and interannual environmental variability, and bathymetric characteristics of the coast all likely contributed to the differences in the larval fish community through space and time. For example, the abundance of temperate species in northern Baja California was relatively low when warm-water El Niño conditions prevailed in 1998 but increased during the cool-water La Niña period in 1999 and 2000. The results enhance knowledge of the community dynamics of fishes in an ecologically complex and commercially important region.

Introduction

The coastal and adjacent oceanic region of the Baja California Peninsula (BCP) is cataloged as a priority area by the Mexican Government (Arriaga-Cabrera *et al*. 1998) and is known for its important commercial resources. Despite its significance, it has been considered a poorly sampled region compared with others in the Eastern North Pacific (Durazo and Baumgartner 2002). The monitoring program IMECOCAL (Spanish acronym for Mexican Investigations of the California current) began a quarterly oceanographic sampling plan in September 1997. This sampling plan includes both coastal and oceanic stations off the BCP, in the southern area of influence of the California current. The IMECOCAL program, along with other programs, has provided oceanographic data that provides improved understanding of the biotic and abiotic variability that occurs in this portion of the Pacific Ocean (Reid *et al*. 1958; Hubbs 1960; Gómez and Velez 1982; Tsuchiya 1982; Parés-Sierra *et al*. 1997). To augment this knowledge, the goal of our study is to provide information about the community structure of fish larvae of the northwestern coast of the BCP.

Ichthyoplankton studies in this region have primarily concentrated on important commercial species: round herring (*Etrumeus teres*), deep-body thread herring (*Opisthonema libertate*), northern anchovy (*Engraulis mordax*), and Pacific sardine (*Sardinops sagax*). These studies largely were conducted under the CalCOFI (California Cooperative Oceanic Fisheries Investigations) Program that began in the late 1940's to help explain changes in abundance of *S. sagax* in the California current but rapidly expanded to evaluate the status of multiple species (Reid *et al*. 1958; Loeb *et al*. 1983). Most of the taxonomic work on ichthyoplankton collected by this program is summarized in Moser *et al*. (1984) and Moser (1996). Another multidisciplinary oceanographic program involved in the study of ichthyoplankton this area is that of the Centro Interdisciplinario de Ciencias Marinas (CICIMAR), which sampled stations along the western coast of Baja California Sur periodically from 1982 to 1994.

Data obtained from these and other sampling programs demonstrated the major influence of the California current and Tropical Pacific waters in the region, with latitudinal and coastal-oceanic gradients in the physical, chemical, and biological characteristics imposed by seasonal changes (Hickey 1979; Loeb *et al*. 1983; McGowan *et al*. 1996). For fish larvae and overall fauna, Bahía Sebastián Vizcaíno (BSV), about in the middle of the peninsula (Figure 1A), has been described as bay of high diversity where fauna of the Eastern Tropical Pacific, Central Pacific, Subarctic, and Transitional waters coincide (Hubbs 1960; Ahlstrom 1972; Loeb 1980; Moser *et al*. 1987; Torres and Castro 1992; Danemann and De La Cruz-Agüero 1993; De La Cruz-Agüero *et al*. 1996; De La Cruz-Agüero and Cota-Gómez 1998; Jiménez-Rosenberg *et al*. 2007).

Materials and Methods

The study area is along the northwestern coast of the BCP, México, with a northern (BC: between Ensenada, 31°40'37" N, 116°50'23" W, and Punta Baja, 29°46'07" N, 115°55'51" W; Figure 1A) and a southern (BCS: south of Punta Eugenia, 26°17'11" N, 113°47'46" W, to north of Cabo San Lazaro, 25°01'51" N, 112°11'60" W; Figure 1B) sampling grid. The whole area is within the San Diegan

Zoogeographic Province (Briggs 1974) with the California current and the California countercurrent as the major oceanographic influences (Christensen and Rodríguez 1979; Hickey 1979; Lynn and Simpson 1987). The ocean floor along the coast varies from mostly hard bottom north of BSV, a mix of hard and soft bottom in BSV and mostly soft bottom south of BSV (De la Lanza-Espino 1991; Parés-Sierra *et al*. 1997). Continental shelf of the BCP varies in width from 13 km off Ensenada to 140 km in Bahía Sebastián Vizcaíno, and 115 km south of Punta Eugenia (Parés-Sierra *et al*. 1997) (Figure 1A). Perennial fresh water sources are scarce, and the study area is considered under the influence of Equatorial waters, with marked seasonal shifts in cooling and heating (Hickey 1979; Lynn and Simpson 1987; De la Lanza-Espino 1991).

Large variability of the environment in the area is caused principally by seasonal upwellings and strong ENSO (El Niño Southern Oscillation) events (De la Lanza-Espino 1991).

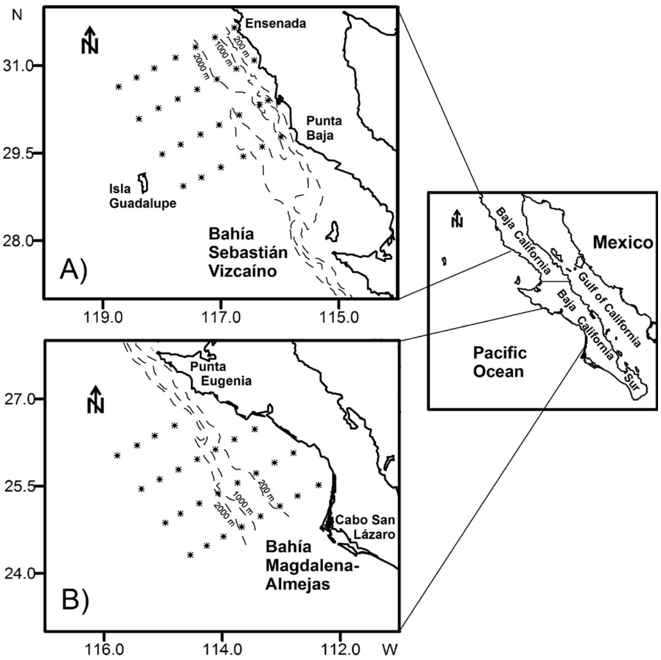

Figure 1. Study area: A) sampling grid off Baja California; B) sampling grid off Baja California Sur. Dashed lines indicate the 200, 1000 and 2000 m isolines.

Between January 1998 and October 2000, the IMECOCAL Program made 11 oceanographic cruises in the study area. Three cruises took place during winter, January-February 1998, January 1999 and 2000; two during spring, April 1999 and 2000; three during summer, July 1998, August 1999, and July 2000; and three during fall, November 1998, October 1999 and 2000. A spring 1998 oceanographic cruise was not made because of adverse weather conditions and in winter 1999 the area off BCS was not sampled because of poor logistics. Twenty-five stations, on average, were sampled in each cruise off BC and 13 off BCS. Zooplankton collections were made according to Smith and Richardson (1977) using standard CalCOFI procedures (Kramer *et al*. 1972). Bongo nets, with a 0.61 m mouth diameter, 3 m length, and 505 µm mesh, and with a flow-meter installed in each mouth, were used to collect pairs of samples. Only one sample of each pair was used in this study. Samples were fixed in 4 % Formalin buffered with sodium borate. At each station the sea surface temperature (SST) and the sea surface salinity (SSS) were taken with a Seabird CTD.

In the laboratory, ichthyoplankton were sorted from zooplankton samples. Fish larvae were identified to the lowest possible taxonomic level, mainly using Moser (1996), counted, and preserved in 2 % Formalin buffered with sodium borate. The number of larvae was standardized to 10 m^2 of sea surface (Smith and Richardson 1977). The taxa lists follow the Eschmeyer, W. N. Catalog of Fishes electronic version (updated 09/09) (Eschmeyer 2009). Zoogeographic affinity and habitat characteristics for the adults of each taxon was obtained using the FishBase electronic version 2009 (updated 09/09) (Froese and Pauly 2009).

Voucher specimens of all species were cataloged and deposited in the Ichthyoplankton Collection of the Mexican North Pacific (acronym ICTIOPLANCTON) at CICIMAR in La Paz, BCS, México.

Results and Discussion

Fish larvae belonging to 198 taxa were identified (Tables 1 and 2). Of these, seven were identified to the family level, 24 to the genus level, and 167 to the species level. Larvae identified to the family or genus level were distinguished with the notation "type" followed by a number to denote types in each. These larvae could not be identified to species because of the lack of larval descriptions of species inhabiting the area or damage to the larvae. Of the 198 taxa identified, 151 were found off BC and 128 off BCS (Tables 1 and 2).

The mean SST off BC in winter and spring was 15.3-17.7 °C and 18.5-19.6 °C in summer and fall (Figure 2A). The highest winter-spring SST values were in winter 1998 (mean 17.7 °C). The highest SSS mean value was during winter 1998 (33.9) and the lowest during fall 2000 (32.9) (Figure 2A), whereas the mean SSS values were more uniform in the other seasons (between 33.2 and 33.6) (Figure 2A).

Off BCS, the mean SST was also lower in winter and spring (16.7-18.6 °C), except for winter 1998 when it was higher (20.6 °C) and similar to summer and fall (20.6- 22.5 °C) (Figure 3A). Winter 1998 also had the highest mean SSS value (34.5) in the BCS area (Figure 3A).

The highest mean larval abundance for the BC area was during spring 2000 (Figure 2B) (mean of 654 larvae/10 m^2 of sea surface). Winter 1998 had an unusually high mean larval abundance for winter, coupled with one of the largest number of taxa found during the sampling period, along with spring and fall 2000 (Figure 2B). Off BCS, the highest mean larval abundance was in winter-summer 2000 (Figure 3B). These mean values were similar to those of summer 1998 and spring 1999, whereas winter 1998 and the fall in all three years were had low mean larval abundance (Figure 3B).

Fish that reside throughout the whole water column were represented by their larvae in this study. Habitat categories are summed into three groups: interior waters, including mesopelagic and bathypelagic species; bottom-related, with benthodemersal, benthopelagic, demersal, and reef-associated fish species; and surface waters, which include epipelagic and coastal pelagic species. Most of the larval abundance and taxa off BC and BCS were in the mesopelagic and bathypelagic group (Figures 4A and 5A). Fifteen to 33 taxa contributed over 50 % of the total larval abundance year round, except for winter 2000 off BCS, with the lowest larval abundance recorded for these taxa (33 %) (Figures 4A and 5A).

Bottom-related fish larvae off BC were comprised of less than 20 taxa and represented less than 20 % of the total abundance (Figure 4B), except for winter 2000 when 42 % of the abundance consisted of these larvae. Off BCS, larvae of these fish were most abundant during summer and fall 1999 and winter and fall 2000, achieving15-30 % of the total larval abundance and representing up to 25 species in these seasons (Figure 5B).

Less than five taxa of coastal pelagic fish were represented by their larvae each season in both areas (Figures 4C and 5C). Off BC, coastal pelagic larval abundances were highest during spring 2000 (33 %) , whereas off BCS abundances peaked in winter (33%) and spring 2000 (51 %) (Figures 4C and 5C). The rest of the year in both areas, coastal pelagic fish accounted for less than 10 % of the total abundance, and they were absent from the samples collected off BC in winter 1999 (Figure 4C) and off BCS in fall 1998 and 2000 (Figure 5C).

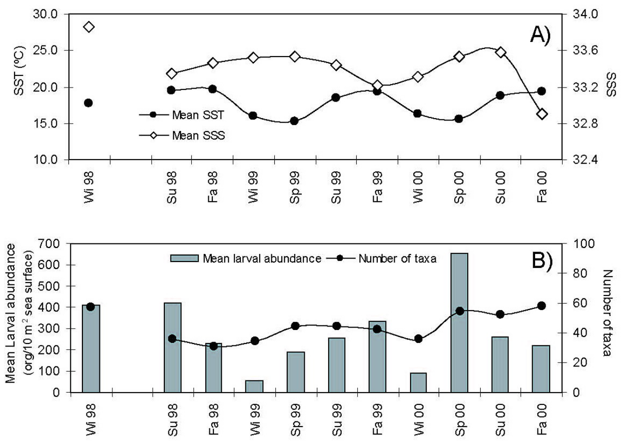

Figure 2. A) Mean sea surface temperature and salinity and B) mean larval abundance and number of taxa identified for winter 1998 to fall 2000 off Baja California.

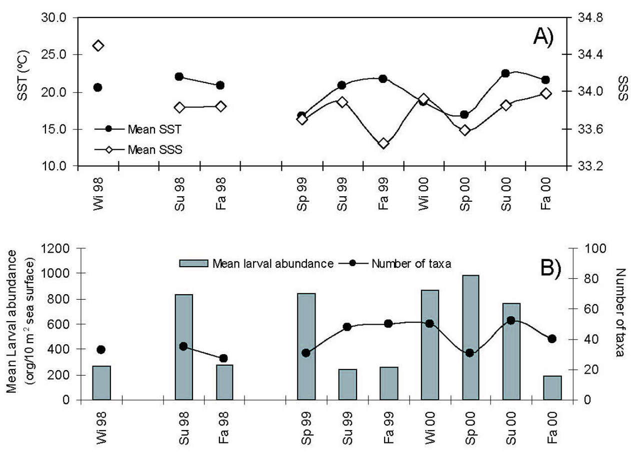

Figure 3. A) Mean sea surface temperature and salinity and B) mean larval abundance and number of taxa identified for winter 1998 to fall 2000 off Baja California Sur.

Larvae of epipelagic species were either absent or lowest in abundance and representative taxa year round off BC (Figure 4D), with their highest abundance in spring of 1999 and 2000 (Figure 4D). Similar to BC, the number of epipelagic fish taxa was low in each sampling period (Figure 5D), and their abundances were even lower off BCS than BC (Figures 4D and 5D).

The species-specific zoogeographic affinities listed in Tables 1 and 2 were summarized for statistical purposes into three generalized zoogeographic provinces: temperate (including species from the subarctic zone), subtropical, and tropical. Species with a primary affinity to one zone also may range into adjacent zones, hence their notation here as tropical-subtropical or temperate-subtropical. Some species that are widely distributed between the subarctic and the tropical zones are notated here as widely distributed in the northeastern Pacific.

In 1998, in both areas, fish with subtropical and tropical-subtropical zoogeographic affinity were the best represented: 26 to 48 taxa off BC and 22 to 30 off BCS (Figures 6A, 6B, 7A and 7B). Combined larval abundance of these taxa in both areas was more than 95 % of the total in each season (Figures 6A, 6B, 7A and 7B). Temperate-subtropical fish and those widely distributed in northeastern Pacific were represented by 5 or less taxa in each case and their larval abundances represented less than 5 % in the three seasons sampled (Figures 6C, 6D, 7C and 7D).

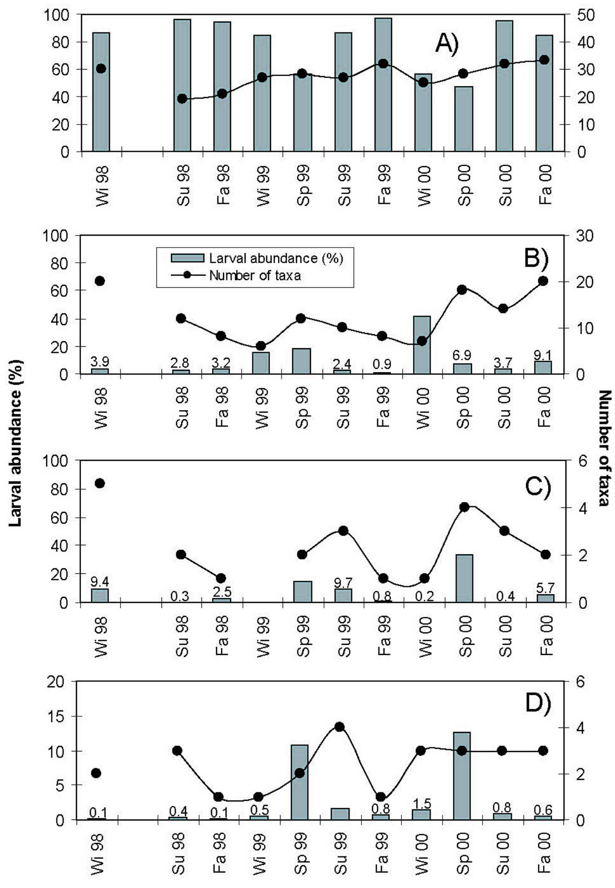

Figure 4. Adult habitat composition of fish larvae taxa collected off Baja California from winter 1998 to fall 2000: A) meso and bathypelagic; B) bottom-related; C) coastal pelagic; D) epipelagic. Seasons: winter (Wi); spring (Sp); summer (Su); fall (Fa). Years: 1998 (98), 1999 (99), 2000 (00). For less than 10 % of larval abundance, value is shown above the bar.

In 1999 off BC, the larvae of the tropical-subtropical taxa were the most abundant category in winter (49 %), but subtropical species were most abundant during both spring (46 %) and summer (53 %), and tropical-subtropical again during fall (77 %) (Figure 6A and 6B). The numbers of subtropical taxa were highest during spring and summer, whereas the tropical-subtropical taxa were most represented during winter and fall (Figure 6A and 6B). The temperate-subtropical fish ranked second in larval abundance in winter and spring and third in summer and fall. As for taxa represented, they ranked first in spring 1999 and third the rest of the year (Figure 6C). The widely distributed taxa were always the lowest in number of taxa and larval abundance (Figure 6D).

Off BCS the larvae of tropical-subtropical taxa were the most abundant category during spring (61 %) and summer (52 %) in 1999, and the subtropical taxa larvae, which were second in abundance during spring and summer (34 % and 45 %), were the most abundant during fall (53 %) (Figure 7A and 7B). The temperate-subtropical and widely distributed species were the most poorly represented larvae during all 1999, with less than 10 taxa each season and less than 5% of the total larval abundance (Figure 7C and 7D).

In 2000 off BC, the temperate-subtropical taxa were the most abundant category in winter (46 %) (Figure 6C), although the number of taxa represented (14) was not much higher than the subtropical (9) and tropical-subtropical categories (11) (Figure 6C and 6B). During spring the temperate-subtropical taxa ranked second in larval abundance (35 %) and number of taxa (15), preceded by the larvae of subtropical fish (55 % in larval abundance and 20 taxa) (Figure 6C and 6A). The summer and fall were dominated by the larvae of subtropical and tropical-subtropical taxa, with a cumulative abundance greater than 90 % of the total and more taxa than the temperate-subtropical and widely distributed categories (Figure 6).

Subtropical and tropical-subtropical taxa dominated throughout 2000 off BCS with more than 95 % of cumulative larval abundance and the highest number of taxa (up to 47) (Figure 7). During winter and spring subtropical taxa were the most abundant (Figure 7A) and during summer and fall the tropical-subtropical taxa were highest (Figure 7B). The highest abundance (3 %) and number of taxa (9) of temperate-subtropical taxa were during winter (Figure 7C), whereas during the rest of the year their abundances were less than 5 %, with no more than 7 taxa (Figure 7C), as occurred with the larvae of widely distributed species (Figure 7D).

For the fish-larvae composition, during winter off BC, the larvae of at least one of four mesopelagic and bathypelagic taxa were among those that comprised 80 % of the total larval abundance in each year (Panama lightfish

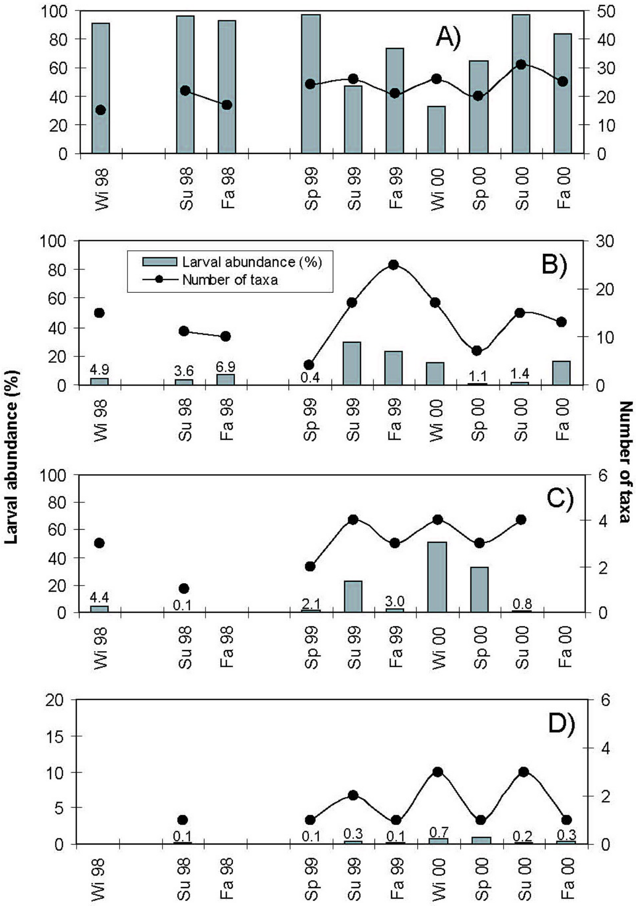

FIGURE 5. Adult habitat composition of fish larvae taxa collected off Baja California Sur from winter 1998 to fall 2000: A) meso and bathypelagic; B) bottom-related; C) coastal pelagic; D) epipelagic. Seasons: Winter (Wi); spring (Sp); summer (Su); fall (Fa). Years: 1998 (98), 1999 (99), 2000 (00). For less than 10 % of larval abundance, value is shown above the bar.

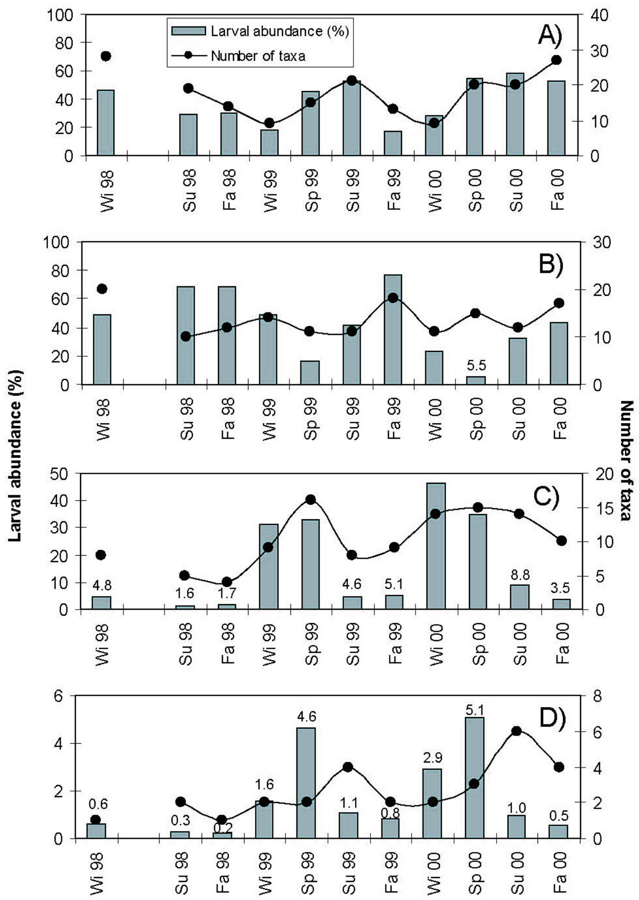

FIGURE 6. Adult affinity composition of fish larvae taxa collected off Baja California for winter 1998 to fall 2000: A) subtropical; B) tropical-subtropical ; C) temperate-subtropical; D) wide distribution in northeastern Pacific. Seasons: winter (Wi); spring (Sp); summer (Su); fall (Fa). Years: 1998 (98), 1999 (99), 2000 (00). For less than 10 % of larval abundance, value is shown above the bar.

Vinciguerria lucetia, longfin lanternfish *Diogenichthys atlanticus*, Mexican lampfish *Triphoturus mexicanus,* and California lanternfish *Symbolophorus californiensis*; Table 1). Winter 1998 also had high larval abundances of northern anchovy *Engraulis mordax* and Pacific sardine *Sardinops sagax*, whereas in winter 1999 and 2000 rockfish species (genus *Sebastes*) were abundant (Table 1). In spring 1999 and 2000 there were more species that comprised 80 % or more of the total larval abundance than in other seasons during the study period. Most of them were larvae of commercially important species such as *S. sagax*, *E. mordax*, Jack mackerel (*Trachurus symmetricus*), Pacific hake (*Merluccius productus*)*,* and *Sebastes* spp. During summer and fall, larvae of two species were the most abundant in the area: *V. lucetia* and *T. mexicanus* (Table 1).

Off BCS, *V. lucetia* was among the most abundant in all seasons, along with larvae of the Diogenes lanternfish *Diogenichthys laternatus*, and *T. mexicanus* (Table 2). Commercially important species larvae were among the most abundant during summer and fall 1999 (round herring *Etrumeus teres* and *S. sagax*) and winter and spring 2000 (*E. mordax*, *S. sagax,* and chub mackerel *Scomber japonicus*) (Table 2).

The northwestern coast of the Baja California Peninsula (BCP) reflects, in the taxonomic composition of fish larvae identified in this study, the faunal complexity expected

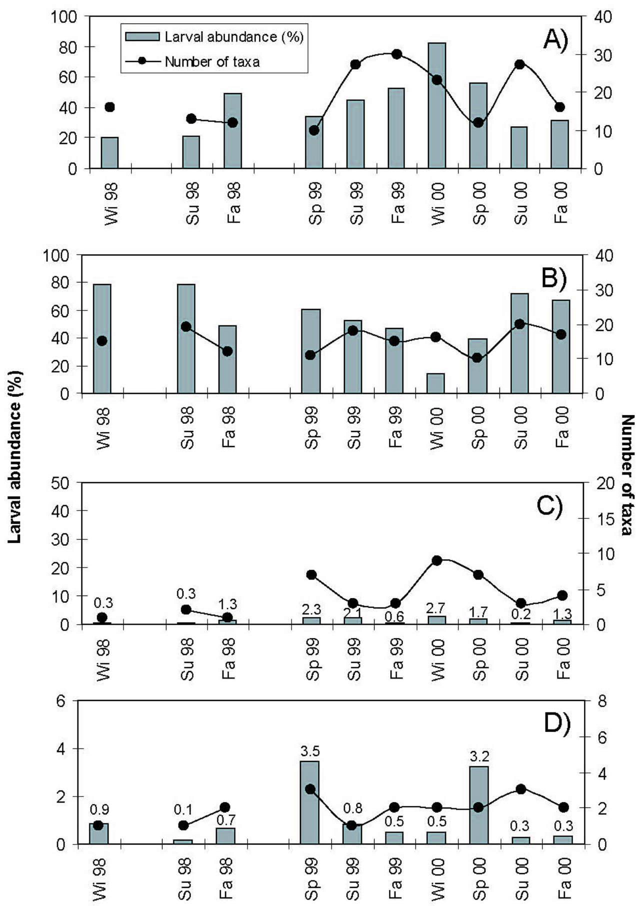

FIGURE 7. Adult affinity composition of fish larvae taxa collected off Baja California Sur from winter 1998 to fall 2000: A) subtropical; B) tropical-subtropical ; C) temperate-subtropical; D) wide distribution in north-eastern Pacific. Seasons: winter (Wi); spring (Sp); summer (Su); fall (Fa). Years: 1998 (98), 1999 (99), 2000 (00). For less than 10 % of larval abundance, value is shown above the bar.

for the area (Hickey 1979; Loeb *et al*. 1983; McGowan *et al*. 1996). The differences mainly can be attributed to the transitional character of the southern California Current and the so-called provincial boundary at the latitude of Punta Eugenia (27°5'43" N, 115°08'15" W) for a wide variety of taxa (Hubbs 1960; Tsuchiya 1982). The number of representative taxa in each area studied off the BCP: BC, BCS and BSV (Jiménez-Rosenberg *et al*. 2007) is not the same. The area off BC is about 32 % of the total IMECOCAL sampling area (31°40'37" N, 116°50'23" W to 25°01'51" N, 112°11'60" W, and from 20 to 80 nautical miles off the coast). Of the total taxa identified in the IMECOCAL area between January 1998 and October 2000, 57 % were present off BC. This percentage of the taxa is low compared to the ~70 % found in almost the same sampling period in BSV (29°04'01" N, 115°09'26" W to 26°43'15" N, 114°29'00" W), which also represents 32 % of the IMECOCAL sampling area (Jiménez-Rosenberg *et al*. 2007). The area off BCS is 30 % of the IMECOCAL sampling area and is the least sampled of the three, but has 48 % of the total taxa identified off the BCP in the same period, compared with BC and BSV (Jiménez-Rosenberg *et al*. 2007).

Reproductive period, spawning grounds, and environmental seasonality also explain differences among the number of taxa identified and larval abundances in the three areas (Moser *et al*. 1993; Moser *et al*. 1994; Lluch-Belda 2000). To this, we need to add the possible effect of the interannual variability recorded during the sampling period. During the study period two large oceanographic events occurred, El Niño 1997-1998 and La Niña 1999-2000 (Lynn *et al*. 1998; Durazo and Baumgartner 2002). The effects of these events were identified in the composition of the larval fish assemblage, but with different intensities among the three areas. During 1998, the mean larval abundances (MLAs) were more similar between BSV and BCS than between BC and BSV, although in all three areas tropical and tropical-subtropical taxa contributed most of the larval abundance all the year. During 1999, the highest larval abundances of temperate-subtropical taxa off BC were during winter and spring, whereas off BSV the highest abundances of subarctic-transitional taxa were during spring and summer (Jiménez-Rosenberg *et al*. 2007). This was likely caused by enhanced reproductive activity of subarctic and temperate taxa in the northern study area during the cooler La Niña conditions (Moser *et al*. 1993; Moser *et al*. 1994). Off BCS, the larvae of tropical and tropical-subtropical taxa were abundant all year round, showing, even during a cold year, a greater influence of equatorial waters than in the more northern areas. MLAs were similar in 2000 off BC and BSV (Jiménez-Rosenberg *et al*. 2007). The highest values were in spring and summer and the lowest in winter and fall. Off BC, the spring MLA was one-third greater than in BSV, with this attributed to the spawning activity of the coastal pelagic species. In 2000 off BCS, MLAs were highest in winter and spring and lowest in fall. Seasonality can also be observed in the MLA community contribution as the subtropical taxa were most abundant in winter and spring whereas the tropical-subtropical taxa were most abundant during summer and fall.

In addition to the aforementioned differences in total larval fish abundance during the study period, changes in the distribution patterns of particular fish species were detected. This dynamic was probably associated with changes in the oceanic dynamics caused by major El Niño and La Niña events, as has occurred before in this region (Loeb 1980; Moser *et al*. 1987; Funes-Rodríguez *et al*. 1995; 1998; 2002). In our study, temperate-subtropical fish had, in general, lower larval abundances and number of taxa during the 1998 El Niño, whereas larvae of tropical and tropical-subtropical taxa were the most abundant and mostly meso and bathypelagic species. Minor contributors were reef-associated species such as Yellow snapper (*Lutjanus argentiventris*), and benthopelagic Driftfish (*Psenes sio*), whose larvae, though normally distributed south of the area (Moser *et al*. 1994; Moser 1996), were found off BCS in this study. Once the typical California Current flow in the area was restored, during the transition to cool conditions between 1999 and 2000 (Hayward *et al*. 1999; Durazo *et al*. 2001; Durazo and Baumgartner 2002), the larvae of subarctic and temperate species, which are absent or occur only in small numbers south of BSV under normal conditions were found, like those of Blue lanternfish (*Tarlentonbeania crenularis*), all of them in the earliest stage of the larval development reflecting ENSO-related shifts in adult spawning ranges (Moser *et al*. 1987; Funes-Rodríguez *et al*. 1995; 1998; 2002).

In the northern area, off BC, 10 types of *Sebastes* larvae were collected, although their identification to the species level was not always possible because of the lack of information about larval-development characteristics in this family. Most *Sebastes* species are distributed in subarctic and temperate waters, north of Baja California (Moser *et al*. 1993; Moser *et al*. 1994; Moser 1996). Eight of these larvae types were recorded during winter and spring of the La Niña years (1999 and 2000). The summer and fall of these years, by contrast, showed only four types of *Sebastes* larvae off BC, and only three during all of the 1998 El Niño year.

Oceanographic and bathymetric characteristics off the BCP also explained the similarities and dissimilarities between the three areas. In the IMECOCAL area and the California Current region, mesopelagic species constitude most of the larval abundance and the largest number of taxa (Ahlstrom 1969; Loeb 1980; Moser *et al*. 1993; Moser *et al*. 1994; Jiménez-Rosenberg *et al*. 2007). This is related to the major oceanographic influence in the region of the California current, its proximity to the coast and the narrow continental shelf on most of the BCP (Christensen and Rodríguez 1979; Hickey 1979; Lynn and Simpson 1987; Parés-Sierra *et al*. 1997). A higher number of taxa and larval abundances were recorded for mesopelagic and bathypelagic species than for the other habitat categories in the three areas. Most of the abundant species off BC and BCS are similar to those found at BSV, where *V. lucetia*, *D. laternatus*, and *T. mexicanus* larval abundances during the year were approached only by those of *E. mordax* during spring. The larvae of bottom-related taxa are less represented off the BC and BCS sampling areas than in the BSV. The changes generated by intrusion of warm water into the California Current region during summer and fall (Hickey 1979; Lynn and Simpson 1987), and the wider continental shelf found in the BSV compared to the BC and BCS areas, may allow the increased number of taxa and higher abundance of fish larvae of bottom-related species, most with tropical and subtropical affinities (Jiménez-Rosenberg *et al*. 2007).

Larvae of several coastal pelagic and epipelagic taxa have been recorded along the western coast of Baja California (Ahlstrom 1969; Loeb *et al*. 1983; Moser *et al*. 1987). Although many of the same species are present among the BC, BCS, and BSV regions, they often differ dramatically in abundance, likely as a result of the productivity of the area and the reproductive habits of the species (Ahlstrom 1969; Moser *et al*. 1987; Jiménez-Rosenberg *et al*. 2007). For example, *E. mordax* and *S. sagax*, larvae were abundant only during winter and spring off BC and BCS, but were highly abundant in BSV year round. By contrast, *Trachurus symmetricus*, often one of the most abundant species in the area, had higher larval abundances off BC than in BCS and BSV during the same period (Jiménez-Rosenberg *et al*. 2007). In the latter two areas, *T. symmetricus* were scarcer from north to south, were found only in winter and spring in BSV and in spring in BCS, and comprised less than 1 % of total larval abundance in both areas (Jiménez-Rosenberg *et al*. 2007).

In conclusion, the taxonomic composition of fish larvae found off BC and BCS reflects the faunal complexity reported previously for the area and in accordance with what has been recognized for adult distributions and reproductive areas and periods (Ahlstrom 1965; Loeb *et al*. 1983; Moser *et al*. 1987; Moser and Smith 1993; Funes-Rodríguez *et al*. 2002). Changes in the fish larvae distributions and abundance patterns were associated with environmental changes observed during El Niño 1997-1998 and La Niña1999-2000, similar to that previously reported for these major oceanographic events (Moser *et al*. 1987; Funes-Rodríguez *et al*. 1995; 1998; 2002), although more analysis is needed to strengthen this conclusion. In addition, bathymetric differences between the areas off BC, BCS, and BSV also likely contribute to the variations found among larvae abundances of mesopelagic, pelagic, and bottom-related fish.

Table 1. Taxonomic composition of fish larvae collected between winter 1998 and fall 2000 off Baja California. Total abundance is given in larvae/10 m2 of sea surface. Abundances of taxa that cumulatively contributed 80% or more of total abundance by season are underlined. Adult habitat: B = bathypelagic; M = mesopelagic; BP = benthopelagic D = demersal; RA = reef associate; CP = coastal pelagic; EP = epipelagic. Adult zoogeographic affinity: Sa = subarctic; Sbtr = subtropical; Tm = temperate; Tr = tropical.

Taxa	Adult	Zoo-geographic	Winter			Spring		Summer			Fall		
	habitat	affinity	1998	1999	2000	1999	2000	1998	1999	2000	1998	1999	2000
Nettastomatidae													
Facciolella gilbertii (Garman, 1899)	BP	Sbtr	23										
Clupeidae													
Etrumeus teres (DeKay, 1842)	CP	Sbtr	5					6					
Sardinops sagax (Jenyns, 1842)	CP	Sbtr	283			128	1197						
Engraulidae													
Engraulis mordax Girard, 1854	CP	Sbtr	723		6	404	3500	24	662		130	73	312
Argentinidae													
Argentina sialis Gilbert, 1890	D	Sbtr	15			7							
Bathylagidae													
Bathylagoides wesethi Bolin, 1938	B	Sbtr	235	20		460	154	199	231	476	33	71	129
Bathylagus pacificus Gilbert, 1890	B	Sa-Tm		5	39								
Leuroglossus stilbius Gilbert, 1890	B	Sa-Tr		14	67	153	711		37	28			
Lipolagus ochotensis (Schmidt 1938)	B	Sa-Tm	70	5	55	12	236			33			
Melanolagus bericoides (Borodin, 1929)	B	Sa-Tr						5					
Microstomatidae													
Microstoma type 1	B	Tr-Sbtr		7	7							5	
Nansenia candida Cohen, 1958	B	Sa-Tm				6							
Nansenia crassa Lavenberg, 1965	BP	Sbtr						6					
Nansenia pelagica Kawaguchi & Butler, 1984	M	Tr-Sbtr					6						
Gonostomatidae													
Cyclothone acclinidens Garman, 1899	B	Tr-Sbtr	162		39		6	21	74			86	109
Cyclothone signata Garman, 1899	B	Tr-Sbtr	136	78	8	74	80	137	16	103	97	152	234
Sternoptychidae													
Argyropelecus affinis Garman, 1899	B	Sbtr	5										
Argyropelecus lychnus Garman, 1899	B	Tr-Sbtr	5	7		14						9	
Argyropelecus sladeni Regan, 1908	B	Tr-Sbtr					8						
Danaphos oculatus (Garman, 1899)	M	Sbtr										10	
Sternoptyx type 1	B	Tr-Sbtr							13	6			
Sternoptychidae type 1	B	Tr-Sbtr				7							
Phosichthyidae													
Ichthyococcus irregularis Rechnitzer & Böhlke, 1958	B	Sbtr	37			6	20		6	4		7	4
Vinciguerria lucetia (Garman, 1899)	B	Tr-Sbtr	3984	320	313	273	98	6535	2433	1956	3371	5769	1698
Stomiidae													
Astronesthes type 1	B	Sa-Tr											4
Bathophilus filifer (Garman, 1899)	B	Sa-Tr											4
Idiacanthus antrostomus Gilbert, 1890	B	Sa-Tr			6		6		19	5		63	9
Stomias atriventer Garman, 1899	B	Tr-Sbtr	353	9		69	69	31	30	14	9	14	49
Scopelarchidae													
Rosenblattichthys volucris (Rofen, 1966)	B	Tr-Sbtr	6	8	7							18	5
Scopelarchoides nicholsi Parr, 1929	B	Tr-Sbtr											8
Scopelarchus analis (Brauer, 1902)	B	Tr-Sbtr										6	
Scopelarchus guentheri Alcock, 1896	B	Tr-Sbtr	25	7		6					4	22	
Notosudidae													
Scopelosaurus harryi (Mead, 1953)	B	Sa-Tm				7				19			

Table 1. (Continued).

Taxa	Adult	Zoo-geographic	Winter			Spring		Summer			Fall		
	habitat	affinity	1998	1999	2000	1999	2000	1998	1999	2000	1998	1999	2000
Synodontidae													
Synodus lucioceps (Ayres, 1855)	D	Sbtr	75									6	
Paralepididae													
Alepisaurus ferox Lowe, 1833	B	Sa-Sbtr											4
Arctozenus risso (Bonaparte, 1840)	B	Sa-Sbtr								20			
Lestidiops neles (Harry, 1953)	M	Sbtr							6				
Lestidiops ringens (Jordan & Gilbert, 1880)	B	Sa		26	22	71	77	46	29	72	20	62	40
Myctophidae													
Ceratoscopelus townsendi (Eigenmann & Eigenmann, 1889)	B	Tr-Sbtr	19	20	44	20	332	127	157	46	6	426	96
Diaphus theta Eigenmann & Eigenmann, 1890	B	Sa-Tm		7					62	94			4
Diogenichthys atlanticus (Tåning, 1928)	M	Tr-Sbtr		172	76	80	123	6	107	71	59	313	105
Diogenichthys laternatus (Garman, 1899)	M	Sbtr	3401	24	8	29	67	228	123	25	114	64	68
Gonichthys tenuiculus (Garman, 1899)	B	Tr-Sbtr	179	6		14	7	12				21	5
Hygophum atratum (Garman, 1899)	B	Tr-Sbtr	220						7	9	5		
Hygophum reinhardtii (Lütken, 1892)	B	Tr-Sbtr	80	16	32		6				3	5	5
Lampadena urophaos urophaos Paxton, 1963	M	Tr-Sbtr	5						11	41		11	17
Lampanyctus parvicauda Parr, 1931	B	Tr-Sbtr		6			25						
Lampanyctus steinbecki Bolin, 1939	B	Tr-Sbtr								6			
Loweina rara (Lütken, 1892)	B	Tr-Sbtr	5		35								4
Myctophum nitidulum Garman, 1899	B	Tr-Sbtr	89	24	8	7	6			5	8	24	62
Nannobrachium idostigma (Parr, 1931)	B	Tr-Sbtr	5	6	8			11	5				
Nannobrachium bristori Zahuranec, 2000	B	Sbtr	10					7	7		4		5
Nannobrachium hawaiiensis Zahuranec, 2000	B	Sbtr											4
Nannobrachium regale (Gilbert, 1892)	B	Sa-Tm	15							7		6	
Nannobrachium ritteri (Gilbert, 1915)	B	Sa-Tm	140	64	67	60	331	31	96	110	24	105	51
Nannobrachium type 1	MB	Sa-Tr					13						
Nannobrachium type 2	MB	Sa-Tr								5			
Notolychnus valdiviae (Brauer, 1904)	B	Tr-Sbtr									9	6	
Notoscopelus resplendens (Richardson, 1845)	B	Tr-Sbtr	30			28			13	8	13	6	15
Parvilux ingens Hubbs & Wisner, 1964	B	Sbtr	36										
Protomyctophum crockeri (Bolin, 1939)	M	Tm	59	149	162	85	250	52	85	33	37	131	10
Stenobrachius leucopsarus (Eigenmann & Eigenmann, 1890)	B	Sa-Tm			83	60	15						
Symbolophorus californiensis (Eigenmann & Eigenmann, 1889)	M	Sbtr	4	54	96	93	548	61	194	375	18	176	79
Tarletonbeania crenularis (Jordan & Gilbert, 1880)	B	Sa-Tm			22	7	117			42			
Triphoturus mexicanus (Gilbert, 1890)	M	Sbtr	118	115	85	49	320	2239	2162	2925	1098	1088	1896
Myctophidae type 1	MB	Sa-Tr							12				
Moridae													
Physiculus nematopus Gilbert, 1890	D	Tr-Sbtr	4										
Physiculus rastrelliger Gilbert, 1890	D	Tr-Sbtr											9
Merlucciidae													
Merluccius productus (Ayres, 1855)	MB	Tm			98	284	3064						
Ophidiidae													
Chilara taylori (Girard, 1858)	D	Sbtr											31
Ophidion scrippsae (Hubbs, 1916)	D	Sbtr				21					7		
Ophidiidae type 1	D	Sbtr					11						

Table 1. (Continued).

Taxa	Adult habitat	Zoo-geographic affinity	Winter			Spring		Summer			Fall		
			1998	1999	2000	1999	2000	1998	1999	2000	1998	1999	2000
Bythitidae													
Brosmophycis marginata (Ayres, 1854)	D	Sa-Sbtr											5
Antennariidae													
Antennarius avalonis Jordan & Starks, 1907	D	Sbtr											4
Onerodidae													
Oneirodes type 1	B	Sbtr											8
Ceratiidae													
Ceratiidae type 1	B	Sbtr											9
Gobiesocidae													
Gobiesox eugrammus Briggs, 1955	D	Sbtr	8										
Scomberesocidae													
Cololabis saira (Brevoort, 1856)	EP-CP	Sa-Sbtr					7		6	11			
Exocoetidae													
Cheilopogon heterurus (Rafinesque, 1810)	EP	Sbtr						17					
Fodiator rostratus (Günther, 1866)	CP	Sbtr							7				
Trachipteridae													
Desmodema lorum Rosenblatt & Butler, 1977	EP	Sbtr							6		6		
Trachipterus altivelis Kner, 1859	EP	Sbtr		7	6			13		11			
Melamphaidae													
Melamphaes lugubris Gilbert, 1891	B	Sa-Tm	29	12	20	39	49	12	31	112	9	69	23
Melamphaes parvus Ebeling, 1962	B	Tm										7	
Melamphaes type 1	B	Sa-Tm										35	
Poromitra crassiceps (Günther, 1878)	B	Sa-Tr				13			6	16			
Scopeloberyx robustus (Günther, 1887)	B	Sa-Tr								5			
Scopelogadus mizolepis bispinosus (Gilbert, 1915)	B	Sa-Tr										12	
Centriscidae													
Macroramphosus gracilis (Lowe, 1839)	EP	Sbtr			14	14	12		5				
Syngnathidae													
Syngnathus californiensis Storer, 1845	D	Sbtr								37			
Sebastidae													
Sebastes aurora (Gilbert, 1890)	D	Sa-Tm					7						
Sebastes dallii (Eigenmann & Beeson, 1894)	D	Sbtr					61						
Sebastes paucispinis Ayres, 1854	D	Sa-Tm					19						
Sebastes type 1	D	Sa-Tm	187	160	261	391	198						
Sebastes type 2	D	Sa-Tm	17	12	104	119	555	17	6	35		6	10
Sebastes type 3	D	Sa-Tm			165	13							28
Sebastes type 4	D	Sa-Tm			36	14							
Sebastes type 7	D	Sa-Tm							7				
Sebastes type 8	D	Sa-Tm			8								
Sebastes type 10	D	Sa-Tm								24			
Scorpaenidae													
Scorpaena guttata Girard, 1854	D	Sbtr						19	6				17
Triglidae													
Prionotus ruscarius Gilbert & Starks, 1904	D	Tr-Sbtr						35		6			
Hexagrammidae													
Zaniolepis latipinnis Girard, 1858	D	Sbtr		8					20	13			

Table 1. (Continued).

Taxa	Adult habitat	Zoo-geographic affinity	Winter 1998	Winter 1999	Winter 2000	Spring 1999	Spring 2000	Summer 1998	Summer 1999	Summer 2000	Fall 1998	Fall 1999	Fall 2000
Cottidae													
Artedius lateralis (Girard, 1854)	D	Tm								8			
Liparidae													
Liparis mucosus Ayres, 1855	D	Sbtr							7				
Serranidae													
Pronotogrammus multifasciatus Gill, 1863	D	Sbtr								4			
Carangidae													
Caranx caballus Günther, 1868	CP	Sbtr	5										
Seriola lalandi Valenciennes, 1833	BP	Tr-Sbtr	15				6	49					4
Trachurus symmetricus (Ayres, 1855)	EP	Sbtr	5			369	1767			43			6
Bramidae													
Brama japonica Hilgendorf, 1878	EP	Sbtr	5						7				4
Taractichthys steindachneri (Döderlein, 1883)	BP	Tr-Sbtr									4		
Malacanthidae													
Caulolatilus princeps (Jenyns, 1840)	RA	Sbtr											8
Gerreidae													
Eucinostomus currani Zahuranec, 1980	D	Tr-Sbtr					7						
Sciaenidae													
Atractoscion nobilis (Ayres, 1860)	D	Sbtr	8							5			
Medialuna californiensis (Sieindachner, 1876)	D	Sbtr									10		
Pomacentridae													
Chromis punctipinnis (Cooper, 1863)	RA	Sbtr				15	5	95	57	27	11		8
Hypsypops rubicundus (Girard. 1854)	RA	Sbtr						7					
Howellidae													
Howella type 1	D	Tr-Sbtr										6	
Labridae													
Oxyjulis californica (Günther, 1861)	RA	Sbtr							18				165
Semicossyphus pulcher (Ayres, 1854)	RA	Sbtr	4										
Labridae type 1	D	Sbtr		14			6						
Bathymasteridae													
Rathbunella alleni Gilbert, 1904	D	Sbtr				13	5						
Chiasmodontidae													
Chiasmodon niger Johnson, 1864	B	Sa-Tr	63	8				22		8	11		14
Labrisomidae													
Alloclinus holderi (Lauderbach 1907)	D	Sbtr					6						
Blenniidae													
Hypsoblennius gentilis (Girard, 1854)	D	Sbtr						6			8		
Hypsoblennius gilberti (Jordan, 1882)	D	Sbtr						6					
Hypsoblennius jenkinsi (Jordan & Evermann, 1896)	D	Sbtr								8			
Hypsoblennius type 1	D	Sbtr	5										
Eleotridae													
Eleotris picta Kner, 1863	D	Tr-Sbtr	4										
Gobiidae													
Acanthogobius flavimanus Temminck & Schlegel, 1845	D	Tm	9										
Bollmannia type 1	D	Tr-Sbtr					6						
Ilypnus gilberti (Eigenmann & Eigenmann, 1889)	D	Sbtr										6	

Table 1. (Continued).

Taxa	Adult	Zoo-geographic	Winter			Spring		Summer			Fall		
	habitat	affinity	1998	1999	2000	1999	2000	1998	1999	2000	1998	1999	2000
Lepidogobius lepidus (Girard, 1858)	D	Sbtr	5										
Lythrypnus dalli (Gilbert, 1890)	D	Sbtr							13	4		7	58
Lythrypnus zebra (Gilbert, 1890)	D	Sbtr		8							19		9
Rhinogobiops nicholsii (Bean, 1882)	D	Sbtr	5				12	17		5	4	6	
Typhlogobius californiensis Steindachner, 1879	D	Sbtr	8					11	13				
Scombridae													
Sarda chiliensis chiliensis (Cuvier, 1832)	CP	Sbtr								10			
Scomber japonicus Houttuyn, 1782	CP	Sbtr	19				80			6			8
Trichiuridae													
Lepidopus fitchi Rosenblatt & Wilson, 1987	BP	Sbtr								11			5
Nomeidae													
Cubiceps pauciradiatus Günther, 1872	BP	Tr-Sbtr											18
Tetragonuridae													
Tetragonurus cuvieri Risso, 1810	EP	Sbtr			16		36	14	100	5		68	23
Paralichthyidae													
Citharichthys fragilis Gilbert, 1890	D	Sbtr	10	11	<u>201</u>	14	12						5
Citharichthys platophrys Gilbert, 1891	D	Tr	4										
Citharichthys sordidus (Girard, 1854)	D	Tm				7	48					36	25
Citharichthys stigmaeus Jordan & Gilbert 1882	D	Sbtr			<u>258</u>	8	25	16		74			93
Citharichthys xanthostigma Gilbert 1890	D	Sbtr	16						20		107	9	
Hippoglossina stomata Eigenmann & Eigenmann, 1890	D	Sbtr	6										5
Pleuronectidae													
Glyptocephalus zachirus Lockington, 1879	D	Tm				7							
Lyopsetta exilis (Jordan & Gilbert, 1880)	D	Tm					6						
Cynoglossidae													
Symphurus atricaudus (Jordan & Gilbert, 1880)	D	Sbtr											6
Unidentified Fish larvae			4	<u>30</u>	8	15	28		16	7	9	49	39

Table 2. Taxonomic composition of fish larvae collected between winter 1998 and fall 2000 off Baja California Sur. Total abundance is given in larvae/10 m2 of sea surface. Abundance of taxa that cumulatively contributed 80% or more of total abundance by season are underlined. Adult habitat: B = bathypelagic; M = mesopelagic; BP = benthopelagic D = demersal; RA = reef associate; CP = coastal pelagic; EP = epipelagic. Adult zoogeographic affinity: Sa = subarctic; Sbtr = subtropical; Tm = temperate; Tr = tropical.

Taxa	Adult	Zoo-geographic	Winter		Spring		Summer			Fall		
	habitat	affinity	1998	2000	1999	2000	1998	1999	2000	1998	1999	2000
Albulidae												
Albula type 1	RA	Sbtr									9	
Ophichthidae												
Ophichthus triserialis (Kaup, 1856)	D	Sbtr	6									
Congridae												
Rhynchoconger nitens (Jordan & Bollman, 1890)	D	Tr-Sbtr	4									
Nettastomatidae												
Facciolella gilbertii (Garman, 1899)	BP	Sbtr									5	
Clupeidae												
Etrumeus teres (DeKay, 1842)	CP	Sbtr		27				<u>470</u>	17		7	
Sardinops sagax (Jenyns, 1842)	CP	Sbtr		<u>2475</u>	74	<u>1482</u>		<u>259</u>	76		<u>131</u>	
Engraulidae												
Engraulis mordax Girard, 1854	CP	Sbtr	71	<u>8836</u>		43	7	56				

Table 2. (Continued).

Taxa	Adult habitat	Zoo-geographic affinity	Winter		Spring		Summer			Fall		
			1998	2000	1999	2000	1998	1999	2000	1998	1999	2000
Engraulidae type 1	CP	Sbtr							21			
Argentinidae												
Argentina sialis Gilbert, 1890	D	Sbtr	13	43	6	5						
Bathylagidae												
Bathylagoides wesethi Bolin, 1938	B	Sbtr		96	104	12	39	18	146	7	20	39
Leuroglossus stilbius Gilbert, 1890	B	Sa-Tr		61	195	160		28	16			
Lipolagus ochotensis Schmidt 1938	B	Sa-Tm		6								
Microstomatidae												
Nansenia candida Cohen, 1958	B	Sa-Tm		7							8	5
Nansenia crassa Lavenberg, 1965	BP	Sbtr	7		6					3		
Nansenia pelagica Kawaguchi & Butler, 1984	M	Tr-Sbtr		56								
Gonostomatidae												
Cyclothone acclinidens Garman, 1899	B	Tr-Sbtr	6	73	24		9	39	78	8	71	42
Cyclothone signata Garman, 1899	B	Tr-Sbtr	77	93	117	15	132	75	104	29	66	54
Diplophos taenia Günther, 1873	B	Tr-Sbtr							4	9		
Sternoptychidae												
Argyropelecus sladeni Regan, 1908	B	Tr-Sbtr			27					4		
Phosichthyidae												
Ichthyococcus irregularis Rechnitzer & Böhlke, 1958	B	Sbtr		14	35	5		7	34		5	5
Vinciguerria lucetia (Garman, 1899)	B	Tr-Sbtr	1517	2213	3206	2138	3732	845	11448	564	1892	1327
Stomiidae												
Astronesthes type 1	B	Sa-Tr								5		
Idiacanthus antrostomus Gilbert, 1890	B	Sa-Tr									7	
Stomias atriventer Garman, 1899	B	Tr-Sbtr	55	92	20		24	18	5	3	18	33
Scopelarchidae												
Rosenblattichthys volucris (Rofen, 1966)	B	Tr-Sbtr					9					
Scopelarchus analis (Brauer, 1902)	B	Tr-Sbtr							13			
Scopelarchus guentheri Alcock, 1896	B	Tr-Sbtr	8			5		14	11		7	
Synodontidae												
Synodus lucioceps (Ayres, 1855)	D	Sbtr	9	480						3	361	161
Paralepididae												
Lestidiops ringens (Jordan & Gilbert, 1880)	B	Sa			6	11						5
Stemonosudis macrura (Ege, 1933)	B	Tr-Sbtr									6	4
Evermannelidae												
Evermannella ahlstromi Johnson & Glodek, 1975	B	Tr-Sbtr					7	11	4			5
Myctophidae												
Bolinichthys longipes (Brauer, 1906)	B	Tr-Sbtr						6				
Ceratoscopelus townsendi (Eigenmann & Eigenmann, 1889)	B	Tr-Sbtr			27	5	999	49	128	14	8	15
Diogenichthys atlanticus (Tåning, 1928)	M	Tr-Sbtr		7	108			7	9		17	
Diogenichthys laternatus (Garman, 1899)	M	Sbtr	180	3219	713	379	541	78	894	501	883	304
Gonichthys tenuiculus (Garman, 1899)	B	Tr-Sbtr	27	99	74	33	10	6	11	18	6	57
Hygophum atratum (Garman, 1899)	B	Tr-Sbtr	84	177	220		52	25	87	9	29	80
Hygophum reinhardtii (Lütken, 1892)	B	Tr-Sbtr	23			34			5			5
Lampadena urophaos urophaos Paxton, 1963	M	Tr-Sbtr	7				44	18	61			15
Lampanyctus parvicauda Parr, 1931	B	Tr-Sbtr		46		5	29	6	9			
Loweina rara (Lütken, 1892)	B	Tr-Sbtr		29			9	6	4	8		14
Myctophum nitidulum Garman, 1899	B	Tr-Sbtr		6			17		12			4
Nannobrachium idostigma (Parr, 1931)	B	Tr-Sbtr	72	258	142	56	46	27	23		120	67
Nannobrachium regale (Gilbert, 1892)	B	Sa-Tm						6				
Nannobrachium ritteri (Gilbert, 1915)	B	Sa-Tm		35	12	20	11					
Notoscopelus resplendens (Richardson, 1845)	B	Tr-Sbtr		7	75	5	14	14	127			9
Parvilux ingens Hubbs & Wisner, 1964	B	Sbtr	7									

Table 2. (Continued).

Taxa	Adult habitat	Zoo-geographic affinity	Winter		Spring		Summer			Fall		
			1998	2000	1999	2000	1998	1999	2000	1998	1999	2000
Protomyctophum crockeri (Bolin, 1939)	M	Tm		139	94	20	6	57	27	18	6	
Symbolophorus californiensis (Eigenmann & Eigenmann, 1889)	M	Sbtr		7				7			6	
Tarletonbeania crenularis (Jordan & Gilbert, 1880)	B	Sa-Tm			15							
Tarletonbeania type 1	B	Sa-Tm			6							
Triphoturus mexicanus (Gilbert, 1890)	M	Sbtr	112	187	1219	875	650	294	3142	79	404	273
Triphoturus nigrescens (Brauer, 1904)	B	Tr-Sbtr					9					
Bregmacerotidae												
Bregmaceros type 1	CP	Sbtr	7					23				
Moridae												
Physiculus rastrelliger Gilbert, 1890	D	Tr-Sbtr	7	14		5						
Merlucciidae												
Merluccius productus (Ayres, 1855)	MB	Tm	7	341		14						
Ophidiidae												
Chilara taylori (Girard, 1958)	D	Sbtr		9		5	16	13			9	
Lepophidium negropinna Hildebrand & Barton, 1949	D	Tr-Sbtr					16				24	
Ophidion scrippsae (Hubbs, 1916)	D	Sbtr		7			5	105		4	136	
Carapidae												
Echiodon exsilium Rosenblatt, 1961	D	Tr-Sbtr									5	
Ceratiidae												
Ceratias holboelli Krøyer, 1845	B	Sa-Tr							4			
Hemirhamphidae												
Hyporhamphus rosae (Jordan & Gilbert, 1880)	D	Sbtr							7			
Lophotidae												
Lophotus lacepede Giorna, 1809	B	Sbtr						6	4			
Trachipteridae												
Desmodema lorum Rosenblatt & Butler, 1977	EP	Sbtr		7					4			
Zu cristatus (Bonelli, 1819)	B	Sbtr							7	4		5
Melamphaidae												
Melamphaes lugubris Gilbert, 1891	B	Sa-Tm		40	14	11		12	9		14	15
Poromitra crassiceps (Günther, 1878)	B	Sa-Tr			7							
Scopelogadus mizolepis bispinosus (Gilbert, 1915)	B	Sa-Tr										5
Centriscidae												
Macroramphosus gracilis (Lowe, 1839)	EP	Sbtr		153	6						5	
Sebastidae												
Sebastes type 1	D	Sa-Tm		6	7	17						
Sebastes type 2	D	Sa-Tm				5			4			
Scorpaenidae												
Scorpaena guttata Girard, 1854	D	Sbtr					67	58	31		11	
Scorpaena type 1	D	Sbtr		2499								
Scorpaenodes xyris (Jordan & Gilbert, 1882)	RA	Sbtr				7						
Triglidae												
Prionotus ruscarius Gilbert & Starks, 1904	D	Tr-Sbtr	11	40				676				187
Prionotus stephanophrys Lockington, 1881	D	Sbtr									113	
Serranidae												
Diplectrum type 1	D	Sbtr										13
Diplectrum type 2	D	Sbtr					31					
Paralabrax clathratus (Girard, 1854)	BP	Sbtr						7				
Paranthias colonus (Valenciennes, 1846)	RA	Tr-Sbtr									5	
Pronotogrammus multifasciatus Gill, 1863	D	Sbtr		76						45	18	
Carangidae												
Seriola lalandi Valenciennes, 1833	BP	Tr-Sbtr					38					

Table 2. (Continued).

Taxa	Adult habitat	Zoo-geographic affinity	Winter 1998	Winter 2000	Spring 1999	Spring 2000	Summer 1998	Summer 1999	Summer 2000	Fall 1998	Fall 1999	Fall 2000
Trachurus symmetricus (Ayres, 1855)	EP	Sbtr				57						
Coryphaenidae												
Coryphaena hippurus Linnaeus, 1758	EP	Tr-Sbtr					9	6				
Bramidae												
Brama japonica Hilgendorf, 1878	EP	Sbtr							6			9
Caristiidae												
Paracaristius maderensis (Maul, 1949)	B	Sbtr							4			
Lutjanidae												
Lutjanus argentiventris (Peters, 1869)	RA	Sbtr	5									
Lutjanus type 1	RA	Sbtr							11			
Malacanthidae												
Caulolatilus princeps (Jenyns, 1840)	RA	Sbtr	12	68			5	7	5		5	
Sciaenidae												
Roncador stearnsii (Steindachner, 1876)	D	Sbtr						11				
Seriphus politus Ayres, 1860	D	Sbtr									34	
Umbrina roncador Jordan & Gilbert, 1882	D	Sbtr							5			
Haemulidae												
Xenistius californiensis (Steindachner, 1876)	D	Sbtr							3			
Pomacentridae												
Chromis punctipinnis (Cooper, 1863)	RA	Sbtr					16	20			8	5
Pomacentridae type 1	D	Sbtr										9
Mugilidae												
Mugil cephalus Linnaeus, 1758	BP	Sbtr						6				
Labridae												
Halichoeres semicinctus (Ayres, 1859)	RA	Sbtr		7				7	15	4	41	5
Semicossyphus pulcher (Ayres, 1854)	RA	Sbtr						7		6		
Chiasmodontidae												
Chiasmodon niger Johnson, 1864	B	Sa-Tr	21	43	28	32	9		26	4	16	4
Uranoscopidae												
Kathetostoma averruncus Jordan & Bollman, 1890	D	Sbtr	8									
Labrisomidae												
Labrisomus multiporosus Hubbs, 1953	RA	Tr-Sbtr									5	
Blenniidae												
Hypsoblennius gentilis (Girard, 1854)	D	Sbtr		7				5				
Hypsoblennius gilberti (Jordan, 1882)	D	Sbtr										4
Hypsoblennius jenkinsi (Jordan & Evermann, 1896)	D	Sbtr							7		4	
Eleotridae												
Eleotris picta Kner, 1863	D	Tr-Sbtr	11							4		
Erotelis armiger (Jordan & Richardson, 1895)	D	Tr-Sbtr										4
Gobiidae												
Lythrypnus dalli (Gilbert, 1890)	D	Sbtr					7	8			8	
Lythrypnus zebra (Gilbert, 1890)	D	Sbtr	4								27	
Rhinogobiops nicholsii (Bean, 1882)	D	Sbtr							5			
Typhlogobius californiensis Steindachner, 1879	D	Sbtr						20				
Sphyraenidae												
Sphyraena argentea Girard, 1854	EP	Tm		6								
Scombridae												
Sarda chiliensis chiliensis (Cuvier, 1832)	CP	Sbtr									8	
Scomber japonicus Houttuyn, 1782	CP	Sbtr	29	144	66	451			13			
Trichiuridae												
Lepidopus fitchi Rosenblatt & Wilson, 1987	BP	Sbtr	4						22		6	
Nomeidae												
Cubiceps baxteri McCulloch, 1923	BP	Sbtr										5

Table 2. (Continued).

Taxa	Adult habitat	Zoo-geographic affinity	Winter 1998	Winter 2000	Spring 1999	Spring 2000	Summer 1998	Summer 1999	Summer 2000	Fall 1998	Fall 1999	Fall 2000
Psenes sio Haedrick, 1970	BP	Tr	6									
Tetragonuridae												
Tetragonurus atlanticus Lowe, 1839	EP	Sbtr						6				
Tetragonurus cuvieri Risso, 1810	EP	Sbtr							31			
Stromateidae												
Peprilus simillimus (Ayres, 1860)	BP	Sbtr		13							2	
Paralichthyidae												
Citharichthys fragilis Gilbert, 1890	D	Sbtr				20						
Citharichthys gordae Beebe & Tee-Van, 1938	D	Tr		7								
Citharichthys sordidus (Girard, 1854)	D	Tm		22								13
Citharichthys xanthostigma Gilbert 1890	D	Sbtr		82	8		34	54	89	11	161	44
Etropus crossotus Jordan & Gilbert, 1882	D	Sbtr							20		66	
Hippoglossina stomata Eigenmann & Eigenmann, 1890	D	Sbtr		41			5	42			5	5
Syacium ovale (Günther, 1864)	D	Tr								4		
Cynoglossidae												
Symphurus atramentatus Jordan & Bollman, 1890	RA	Tr							5			
Symphurus atricaudus (Jordan & Gilbert, 1880)	D	Sbtr	12					6	15	11	95	6
Unidentified Fish larvae				36	46	5					9	5

Acknowledgments: Data were collected in the IMECOCAL Program which has been founded by CONACyT through scientific initiatives G0041T, G35326T, 017PÑ-1297, CO2-42569, 47044, 48367, 23947 and 99252. The authors wish to thank CICIMAR-IPN/COFAA/EDI, CONACyT, and SNI authorities for their grants and founding of projects SIP20060927, SIP20090421 and CONABIO HA-012. The assistance provided by the scientific and technical staff from the R.V. Francisco de Ulloa and the Southwest Fisheries Science Center La Jolla, California was of great value. Authors also thank the reviewers for their valuable comments.

Literature Cited

Ahlstrom, E.H. 1965. Kinds and abundance of fishes in the California current region based on eggs and larvae surveys. *California Cooperative Oceanic Fisheries Investigations Reports* 10: 31-52.

Ahlstrom, E.H. 1969. Mesopelagic and bathypelagic fishes in the California Current Region. *California Cooperative Oceanic Fisheries Investigations Reports* 13: 39-44.

Ahlstrom, E.H. 1972. Kinds and abundance of fish larvae in the Eastern Tropical Pacific on the second multivessel EASTROPAC survey and observations on the annual cycle of larval abundance. *Fishery Bulletin* 70: 1153-1242.

Arriaga-Cabrera, L., E. Vázquez-Domínguez, J. González-Cano, R. Jiménez-Rosenberg, E. Muñoz-López and V. Aguilar-Sierra. 1998. *Regiones Prioritarias Marinas de México*. México, D.F.: Comisión Nacional para el Conocimiento de la Biodiversidad. 198 p.

Briggs, J.C. 1974. *Marine zoogeography*. New York: McGraw Hill. 475 p.

Christensen, N. and N. Rodríguez. 1979. A study of the sea level variations and currents of Baja California. *Journal of Physical Oceanography* 9(3): 177-184.

Danemann, G.D. and J. De la Cruz-Agüero. 1993. Ichthyofauna of San Ignacio Lagoon, Baja California Sur, México. *Ciencias Marinas* 19(3): 333-341.

De la Cruz-Agüero, J. and V.M. Cota-Gómez. 1998. Ichthyofauna of San Ignacio Lagoon, Baja California Sur, México: New records and range extensions. *Ciencias Marinas* 24(3): 353-358.

De la Cruz-Agüero, J., M. Arellano-Martínez and V.M. Cota-Gómez. 1996. Systematic list of the marine fishes from Ojo de Liebre and Guerrero Negro Lagoons, BCS and BC, México. *Ciencias Marinas* 22(1): 111-128.

De la Lanza-Espino, G. 1991. *Oceanografía de los mares mexicanos*. México, D.F.: AGT Editor. 569 p.

Durazo, R. and T.R. Baumgartner. 2002. Evolution of oceanographic conditions off Baja California: 1997–1999. *Progress in Oceanography* 54: 7-31.

Durazo, R., T. Baumgartner, S.J. Bograd, C.A. Collins, S. de la Campa, J. García, G. Graxiola-Castro, A. Huyer, K.D. Hyrenbach, D. Loya, R.J. Lynn, F.B. Schwing, R.L. Smith, W.J. Sydeman and P. Wheeler. 2001. The state of the California Current, 2000-2001: A third straight La Niña year. *California Cooperative Oceanic Fisheries Investigations Reports* 42: 29-60.

Eschmeyer, W.N. (ed.) 2009. *Catalog of Fishes*. Electronic database accessible at http://www.calacademy.org/research/ichthyology/catalog/fishcatsearch.html. Captured on 9 September 2009.

Froese, R. and D. Pauly (eds.) 2009. *FishBase*. Electronic publication accessible at http://www.fishbase.org. Electronic version August 2009. Captured on 1 September 2009.

Funes-Rodríguez, R., R. González-Armas and A. Esquivel-Herrera. 1995. Distribución y composición específica de larvas de peces durante y después de El Niño en la costa del Pacífico de Baja California Sur. *Hidrobiológica* 5(1-2): 113-125.

Funes-Rodríguez, R., A. Fernández-Alamo and R. González-Armas. 1998. Larvas de peces recolectadas durante dos eventos El Niño en la costa occidental de Baja California Sur, México. *Oceánides* 13(1): 67-75.

Funes-Rodríguez, R., C. Flores-Coto, A. Esquivel-Herrera, M.A. Fernández-Alamo and A. García-Gásca. 2002. Larval fish community structure along the west coast of Baja California during and after the El Niño event (1983). *Bulletin of Marine Science* 70(1): 41-54.

Gómez, J. and H. Velez. 1982. Variaciones estacionales de temperatura y salinidad en la región costera de la corriente de California. *Ciencias Marinas* 8(2): 167-176.

Hayward, L.T., T.R. Baumgartner, D.M. Checkley, R. Durazo, G. Gaxiola-Castro, K.D. Hyrenbach, A.W. Mantyla, M.M. Mullin, T. Murphree, F.B. Schwing, P.E. Smithand and M. J. Tegner. 1999. The state of the California Current in 1998-1999: Transition to cool-water conditions. *California Cooperative Oceanic Fisheries Investigations Reports* 40: 29-62.

Hickey, B.M. 1979. The California Current system – Hypotheses and facts. *Progress in Oceanography* 8: 191-279.

Hubbs, C.L. 1960. The marine vertebrates of the outer coast; p. 134-137. *In* L. H. Hyman (ed.). *Systematic Zoology*. New York: The Society of Systematic Zoology.

Jiménez-Rosenberg, S.P.A., R.J. Saldierna-Martínez, G. Aceves-Medina and V.M. Cota-Gómez. 2007. Fish larvae in Bahía Sebastián Vizcaíno and the adjacent oceanic region, Baja California, México. *Check List* 3(3): 204-223.

Kramer, D., M.J. Kalin, E.G. Stevens, J.R. Thrailkill and J.R. Zweifel. 1972. Collecting and processing data on the fish eggs and larvae in the California Current region. La Jolla: *NOAA Technical Report NMFS*, Circular 378: 38 p.

Loeb, V.J. 1980. Patterns of spatial and species abundance within the larval fish assemblages of North Pacific Central Gyre during late summer. *Marine Biology* 60: 189-200.

Loeb, V.J., P.E. Smith and H.G. Moser. 1983. Geographical and seasonal patterns of larval fish species structure in the California Current Area, 1975. *California Cooperative Oceanic Fisheries Investigations Reports* 24: 132-151.

Lluch-Belda, D. 2000. Centros de actividad biológica en la costa occidental de Baja California; p. 49-64. *In* D. Lluch-Belda, J. Elorduy-Garay, S.E. Lluch-Belda and G. Ponce-Días (eds.). *Centros de Actividad Biológica del Pacífico Mexicano*. La Paz: Centro de Investigaciones Biológicas del Noroeste.

Lynn, R.J. and J.J. Simpson. 1987. The California Current system: the seasonal variability of its physical characteristics. *Journal of Geophysical Research* 92: 12947-12966.

Lynn, R.J., T. Baumgartner, C.A. Collins, J. García, T.L. Hayward, K.D. Hyrebrach, A.W. Mantyla and T. Murphree. 1998. The state of the California Current, 1997-98: transit to El Niño conditions. *California Cooperative Oceanic Fisheries Investigations Reports* 39: 29-49.

McGowan, J.A., D.B. Chelton and A. Conversi. 1996. Plankton patterns, climate, and change in the California Current. *California Cooperative Oceanic Fisheries Investigations Reports* 37: 45-68.

Moser, H.G. (ed.).1996. The early stages of fishes in the California Current region. *California Cooperative Oceanic Fisheries Investigations Atlas*, No. 33. Kansas: Allen Press Incorporation. 1505 p.

Moser, H.G. and P.E. Smith. 1993. Larval Fish assemblages in the California Current region, and their horizontal and vertical distributions across a front. *Bulletin of Marine Science* 53(2): 645-691.

Moser, H.G., W.J. Richards, D.M. Cohen, M.P. Fahay, A.W. Kendall, Jr. and S.L. Richardson (eds.). 1984. *Ontogeny and Systematics of fishes*. La Jolla: American Society of Ichthyologists and Herpetologists Special Publication 1. 760 p.

Moser, H.G., P.E. Smith and L.E. Eber. 1987. Larval Fish assemblages in the California Current Region, 1954-1960, a period of dynamic environmental change. *California Cooperative Oceanic Fisheries Investigations Reports* 28: 97-127.

Moser, H.G., L.R. Charter, P.E. Smith, D.A. Ambrose, S.R. Charter, C.A. Meyer, E.M. Sandknop and W. Watson. 1993. Distributional atlas of fish larvae and eggs in the California Current region: taxa with 1000 or more total larvae, 1951 through 1984. *California Cooperative Oceanic Fisheries Investigations Atlas*, No. 31. 233 p.

Moser, H.G., L.R. Charter, P.E. Smith, D.A. Ambrose, S.R. Charter, C.A. Meyer, E.M. Sandknop and W. Watson. 1994. Distributional atlas of fish larvae and eggs in the California Current region: taxa with less than 1000 total larvae, 1951 through 1984. *California Cooperative Oceanic Fisheries Investigations Atlas*, No. 32. 181 p.

Parés-Sierra, A., M. López and E.G. Pavia. 1997. Oceanografía física del océano Pacífico Nororiental; p. 1-24. *In* M.F. Lavín (ed.). *Contribuciones a la oceanografía física en México*. México, D.F.: Unión Geofísica Mexicana, Monografía No. 3.

Reid, J.L., G.L. Roden and J.C. Wyllie. 1958. Studies in the California Current system. *California Cooperative Oceanic Fisheries Investigations Reports* 6: 27-57.

Smith, P.E. and S.L. Richardson. 1977. Standard techniques for pelagic fish egg and larva surveys. *FAO Fisheries Technical Papers*, 175: 100 p.

Torres, O.R.E. and J.L. Castro. 1992. Registros de nuevos peces tropicales en el complejo lagunar de Bahía Magdalena-Bahía Almejas, Baja California Sur, México. *Anales del Instituto de Biología UNAM Serie Zoología* 63(2): 281-286.

Tsuchiya, M. 1982. On the Pacific upper-water circulation. *Journal of Marine Research* 40: 777-799.

Received: December 2009
Revised: February 2010
Accepted: March 2010
Published online: June 2010
Editorial responsibility: Michael Maia Mincarone