CICIMAR Oceánides
ISSN 2448-9123
www.oceanides.ipn.mx
Centro Interdisciplinario de Ciencias Marinas
https://doi.org/10.37543/oceanides.v35i(1-2).268

Vol . 35(1,2): 63-78
2020
Número especial
XXI Reunión Nacional de la Sociedad Mexicana de Planctología A.C.

UPDATED TAXONOMIC LIST OF FISH LARVAE FROM BAHÍA SEBASTIÁN VIZCAÍNO, BAJA CALIFORNIA, MÉXICO

Sylvia P. A. Jiménez-Rosenberg, Ricardo Saldierna-Martínez & Gerardo Aceves-Medina

Departamento de Plancton y Ecología Marina, Instituto Politécnico Nacional-CICIMAR, Av. IPN s/n, Col. Playa Palo de Santa Rita, C. P. 23096. La Paz, Baja California Sur, México. e-mail: srosenbe@ipn.mx

ABSTRACT. Larvae of 152 fish families were identified in the California Current between 1949-1984 through the CalCOFI Program. Sampling efforts in the southern California Current restarted in 1997 with the ongoing IMECOCAL Program, which includes the transitional area of Bahía Sebastián Vizcaíno (BSV). This work updates the fish larvae taxonomic list of BSV, summarizing the 20-year sampling efforts. Results showed 341 identified *taxa* (227 to species level, 60 to genus and 54 to family), representing 98 families. The most abundant were Phosichthyidae (37%), Myctophidae (14%) and Synodontidae (9%). Pelagic neritic species *Engraulis mordax* (Engraulidae) and *Sardinops sagax* (Clupeidae) showed their maximum larval abundance during spring and winter, respectively. Myctophidae contributed with the highest species richness (39 *taxa* in 20 genera), followed by the reef-associated Sebastidae (21 *taxa* in the *Sebastes* genus). Identified *taxa* were mostly from southern (tropical) zoogeographic affinity (80%), and a minor component had northern (boreal) affinity (8%) or wide distribution in the northeastern Pacific Ocean (12%). The highest larval abundance and species richness were registered during summer (207 *taxa*) and fall (219 *taxa*). In winter and spring, larval abundance and richness decreased almost 50%, however the number of dominant species was higher. The previous ichthyoplankton list for BSV included only samples taken during 1997-2001 and reported larvae of 186 *taxa* in 71 families, where mesopelagic larvae contributed with most of the abundance and taxonomic richness (>20%). Seasonal abundance of pelagic neritic species showed a spawning preference for spring and summer conditions. For demersal species, diversity and abundance increased during fall. With this work we increase from 186 to 341 registered *taxa*, most of them associated to demersal reef habitats with southern distribution. One third of the *taxa* found (114) could not be identified to species level, highlighting the urgency for more taxonomic studies of ichthyoplankton in the area.

Keywords: Southern California Current; IMECOCAL; CalCOFI; Fish Larvae

Lista taxonómica actualizada de larvas de peces de Bahía Sebastián Vizcaíno, Baja California, México

RESUMEN. Las larvas de 152 familias de peces fueron identificadas en la Corriente de California durante 1949-1984 a través del programa CALCOFI. El esfuerzo de muestreo en la parte sur de la Corriente de California se reinició en 1997 con el programa aun en operación, IMECOCAL, el cual incluye el área transicional de Bahía Sebastián Vizcaíno (BSV). Este trabajo actualiza la lista taxonómica de larvas de peces de BSV, resumiendo 20 años de esfuerzos de muestreo. Los resultados muestran 341 *taxa* identificados (227 a nivel especie, 60 a género y 54 a familia), representando 98 familias. Los más abundantes fueron Phosichthyidae (37%), Myctophidae (14%) y Synodontidae (9%). Las especies pelágico neríticas *Engrulis mordax* (Engraulidae) y *Sardinops sagax* (Clupeidae) mostraron su máxima abundancia larval durante primavera e invierno, respectivamente. Myctophidae contribuyó con la mayor riqueza de especies (39 *taxa* en 20 géneros), seguido de los asociados con arrecifes Sebastidae (21 *taxa* en el género *Sebastes*). Los *taxa* identificados fueron en su mayoría (80%) de afinidad zoogeográfica sureña (tropical), y un menor componente (8%) tuvo una afinidad norteña (boreal) o de distribución amplia en el noroeste del Oceáno Pacífico (12%). La mayor abundancia larval y riqueza de especies fue registrada durante el verano (207 *taxa*) y otoño (219 *taxa*). En invierno y primavera, la abundancia larval y la riqueza de especies decreció casi un 50%, aunque el número de especies dominantes fue alto. La lista ictioplanctónica para BSV incluía solo muestras tomadas durante 1997-2001 y larvas reportadas de 158 *taxa* en 71 familias, donde las larvas meopelágicas contibuyeron con la mayoría de la abundancia y riqueza taxonómica (>20%). La abundancia estacional de especies pelágico neríticas mostró una prefencia de desove en condiciones de primavera y verano. Para especies demersales, la ddiversidad y abundancia se incrementó en otoño. Con este trabajo incrementamos de 186 a 341 *taxa* registrados, la mayoría asociado a hábitas arrecifales demersales con distribución sureña. Un tercio de los taxa encontrados (114) no pudieron ser identificados a nivel especies, remarcando la urgencia de más estudios taxonómicos de ictioplancton en el área.

Palabras clave: Sur de la Corriente de California, IMECOCAL, CalCOFI, larvas de peces.

Jiménez-Rosenberg, S.P.A., R. Saldierna-Martínez & G. Aceves-Medina. 2020. Updated taxonomic list of fish larvae from Bahía Sebastián Vizcaíno, Baja California, México. CICIMAR Oceánides, 35(1-2):63-78.

INTRODUCTION

The California Current (CC) is one of the most extensively surveyed regions of the world (Durazo & Baumgartner, 2002). In the area it covers, there is a convergence of three coastal zoogeographic provinces (Oregonian, Californian, and Mexican), a coastal upwelling zone and three oceanic water masses (Central Pacific, Eastern Tropical Pacific and Subarctic) (Hubbs, 1960; Moser *et al*. 1993). Larvae of 152 fish families have been recorded since 1949, in an ambitious sampling program, the California Cooperative Oceanic Fisheries Investigations Program (CalCOFI). Until 1984, the pelagic ecosystem off Baja California, Mexico, was included in the CalCOFI sampling grid (Hewitt, 1988; Durazo & Baumgartner, 2002). Afterwards, in 1997, the ongoing Investigaciones Mexicanas de la Corriente de California Program (IMECOCAL) restarted the sampling efforts, covering the southern CC in

Fecha de recepción: 22 de agosto de 2019

Fecha de aceptación: 26 de septiembre de 2019

Mexican waters, including Bahía Sebastián Vizcaíno (BSV; Figure 1) and the adjacent oceanic region, which is a Priority Marine Area (PMA) selected by the Mexican government due to its high biotic richness (Arriaga-Cabrera *et al*., 1998). It is known that the fish larvae diversity in BSV is high, compared with the adjacent marine ecosystems. Jiménez-Rosenberg *et al*. (2007) reported for BSV, larvae of 186 taxa of 71 fish families collected during a four-year study period, which in turn represented 50% of the fish larvae *taxa* reported the along the entire area throughout the 50 years of the CalCOFI program.

Our aim was to characterize the fish larvae community of BSV during the 20-year sampling period, where intense inter-annual environmental variability was observed, in order to highlight the possible effects on the pelagic ecosystem. This work presents an extended taxonomical list of the fish larvae collected in BSV and adjacent areas during 20 years of continuous sampling.

MATERIAL AND METHODS

BSV is located between 26°43'–29°04'N and 114°29'–115°58'W (Figure 1), and consists of an extensive shelf area of approximately 36,000 km^2 over the Pacific Plate (Arriaga-Cabrera *et al*. 1998) where to the west, the Cedros islands complex (Cedros, Natividad, and San Benito islands) limit the oceanic waters from those of the platform. The geographic limits of BSV are between Punta Baja (29° LN) and Punta Eugenia (26° LN), which encompasses the transition zone between the northern temperate-subarctic and the southern tropical-subtropical zooplanktonic fauna (Spalding et al., 2007; Aceves-Medina *et al*., 2019).

Sixty oceanographic surveys were carried out between September 1997 and April 2016 in BSV and the adjacent oceanic region. From these, 16 surveys were on winter, 16 on spring, 14 during summer and 14 on fall, with an average of 24 sampled stations each. Zooplankton collections followed the standard CalCOFI procedures described by Smith & Richardson (1977) and Kramer *et al*. (1972). As stated by Jiménez-Rosenberg *et al*. (2007), Bongo nets with 0.61 m mouth diameter, 3 m length and 505 µm net mesh, with a flow-meter installed on each mouth were used to collect pairs of samples. Only one sample of each pair was used in this study to analyze the fish larvae community. All fish larvae were sorted out from each sample and preserved in 4%-formalin buffered with sodium borate. Larvae were identified to species level when possible, using the morphologic and meristic characters and the pigmentation patterns described by Moser (1996). Those larvae that could not be identified to the species level were assigned to a morphotype number for family (type) or genus (sp.) levels. Those genera comprising a wide number of morphotypes were expressed as "spp." and their larval abundances were summed.

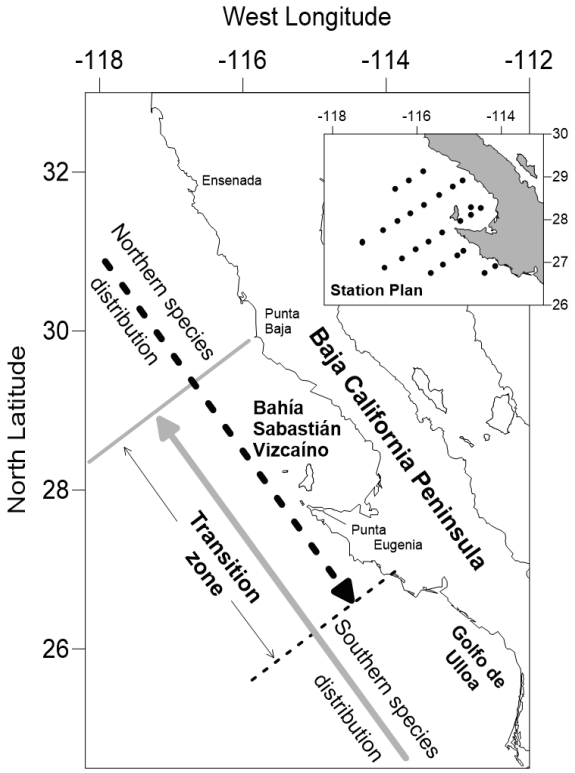

Figure 1. Study area and sampling station plan in Bahía Sebastián Vizcaíno. General scheme of northern (black dotted arrow and line) and southern (grey arrow and line) species distribution limits and the transition zone where they overlap (source: Aceves-Medina *et al*. 2019).

The number of larvae was standardized to 10 m^2 of sea surface (Smith & Richardson 1977). Adult habitat and zoogeographic affinity information for each identified *taxa* were obtained from Froese & Pauly (2019). The dominant fish *taxa* were obtained following the Olmstead–Tukey test (Sokal & Rohlf, 1994), which considers the abundance and relative frequency of each taxon.

The arrangement of the taxonomic list for orders and families follows the classification criteria of Nelson *et al.* (2016) and Fricke *et al.* (2019) for genera and species nomenclature. Distribution of species was consulted in http://www.idigbio.org, and voucher specimens of all species were cataloged and deposited in the "Colección Científica de Huevos y Larvas de Peces del Pacífico Mexicano (Acronym: Ictioplancton)", at IPN-CICIMAR in La Paz, Baja California Sur, Mexico.

RESULTS

A total of 341 fish *taxa* were identified in their larval stages in BSV during the study period (Table 1). From these, 227 *taxa* were identified to species level, 60 to genus and 54 only to family level. Most of the larvae identified to the species level had already been registered in BSV (104 species), other 16

species were previously registered on the southern oceanic and coastal region off BSV, and 71 species in the adjacent oceanic region (Table 1).

Fourteen fish families contributed with 95% of the total larval abundance during the study period. During winter and summer, the most abundant species were from the bathypelagic habitat, such as the Panama lightfish *Vinciguerria lucetia* (Garman, 1899) (Phosichthyidae), and Myctophidae, was represented by up to 30 *taxa*. During fall, the Synodontide family, represented mainly by *Synodus lucioceps* (Ayres, 1855), was the most abundant *taxa* (Table 2).

Pelagic neritic fishes belonging to families such as Engraulidae and Clupeidae were also abundant in BSV, with abundance peaks during spring and winter, respectively (Table 2). The Northern anchovy *Engraulis mordax* Girard, 1854 was the dominant species from winter to summer, and the South American pilchard *Sardinops sagax* (Jenyns, 1842) was dominant year-round (Table 1). Myctophidae contributed with the highest number of *taxa*, followed by reef-associated species of Scorpaenidae, represented by 13 morphotypes of the *Sebastes* genus (Tables 1 and 2).

Most of the fish *taxa* identified had mainly a southern zoogeographic affinity (tropical, subtropical), and a minor component were from northern affinity (subarctic, temperate) as well as of wide geographic distribution in the northeastern Pacific (Table 1).

The highest larval abundance and number of *taxa* were registered during summer (269,099 organisms; 207 *taxa*) and fall (170,556 organisms; 219 *taxa*), while in winter and spring larval abundance and richness decreased (86,409 organisms; 154 *taxa* and 130,374 organisms; 147 *taxa* respectively) (Table 2), whereas the number of dominant species was higher (Tables 1 and 2).

From the first 20 most abundant *taxa* ranked in BSV, 14 were between the most abundant species in the CalCOFI surveys, and most of them corresponded to species where adults distribute in the bathypelagic realm with subarctic and temperate zoogeographic affinity (Table 3).

DISCUSSION

The increase in the sampling effort for ichthyoplankton studies, from four to 20 years, showed an increment of approximately 50% of the previously registered *taxa* (186 to 341 *taxa*) in BSV and adjacent areas. The high diversity of fish larvae in BSV is a result of the environmental heterogeneity generated by the interaction of different water masses (Central Pacific, Eastern Tropical Pacific and Subarctic) and the intra and inter-annual environmental variability in the southern region of the CC (Aceves-Medina *et al*., 2018; 2019; Bautista-Romero *et al*., 2018).

In this work, larval fish species composition was dominated by the meso and bathypelagic species (71 %), similar to that found in the entire southern region of the CC by Jiménez-Rosenberg et al. (2007; 2010) who registered a relative abundance of deep-water species between 40-80%. In addition, Jiménez-Rosenberg *et al*. (2007, 2010) and Funes-Rodríguez *et al*. (2010) found that in short periods of time, deep-water fish fauna changed from a higher number and abundance of temperate affinity species during cold years, towards a community characterized by a higher number and dominance of tropical affinity species during warm years. However, in a more extended period (as in this work), no change was observed in the number of warm and cold species, rather, changes in the abundance of those species during warm and cold years, respectively, were observed. These changes seem to be related with longer scale processes, such as the PDO and NPGO, in which the abundance of temperate species remain similar between warm and cold periods, and the main changes are observed in the abundance of warm mesopelagic species (Aceves-Medina et al., 2019).

In the case of pelagic neritic species such as *S. sagax* and *E. mordax*, their seasonal abundance variations in BSV showed their spawning preferences for spring and summer conditions, while both diversity and abundance of demersal species, showed an increase during fall (Aceves-Medina *et al*., 2019). This is consistent, regardless the inter-annual variability, with the hydrographic characteristics off BSV, were in winter and spring subarctic water is predominant in the area, while wind speed and direction favors upwelling events and a higher primary productivity, whereas tropical-subtropical waters are predominant from the end of summer through fall (Durazo, 2009).

One important consideration for this taxonomic list is the presence of several species that constitute new records for BSV, such as the reef-associated Sabertooth blenny *Plagiotremus azalea* (Jordan & Bollman, 1890), registered in the Eastern Pacific from the Gulf of California to Perú, the Grunt sculpin *Rhamphocottus richardsonii Günther*, 1874, the demersal species distributed in the coasts from Alaska to Southern California, and the Black fathead *Cubiceps baxteri* McCulloch, 1923, a widely distributed oceanic species (Froese & Pauly, 2019). Presence of larvae of these species in many cases could be a product of the expansion from their distribution areas by advection of water masses into BSV and its surroundings (Central Pacific, Eastern Tropical Pacific and Subarctic). Fish larvae expatriation is a frequent process reported in mesopelagic fishes such as the Firefly lanternfish *Hygophum proximum* Becker, 1965 and several species belonging to the *Benthosema*, *Diaphus* and *Lobianchia* genus (Haedrich & Judkins, 1979; Zurbrigg & Scott, 1972). Most of

Table 1. *Taxa* list of fish larvae from Bahía Sebastián Vizcaíno (BSV) and their seasonal relative abundance: winter (WI), spring (SP), summer (SU), fall (FA). Adults of the species registered: in BSV (*); in the adjacent coastal region off BSV([C]); in the adjacent oceanic region ([O]).

ORDER	FAMILY	TAXA	WI	SP	SU	FA
Albuliformes	Albulidae	*Albula gilberti* Pfeiler & van der Heiden, 2011	0.2			1
Notacanthiformes	Notacanthidae	Notacanthidae type 1				0.3
Anguilliformes	Muraenidae	Muraenidae type 1				0.3
		Gymnothorax mordax (Ayres, 1859)*				1
	Derichthyidae	*Derichthys serpentinus* Gill, 1884*				0.5
	Ophichthidae	Ophichthidae type 1		1		
		Myrophis vafer Jordan & Gilbert, 1882*	0.3			
		Ophichthus sp 1				0.3
		Ophichthus triserialis (Kaup 1856)				3
		Ophichthus zophochir Jordan & Gilbert, 1882*	2	1		4
	Nettastomatidae	*Facciolella gilbertii* (Garman, 1899)*	5	0.4	0.3	2
	Congridae	Congridae type 1			0.4	1
		Congridae type 19				1
		Congridae type 20				1
		Ariosoma gilberti (Ogilby, 1898)	0.3			
		Gnathophis cinctus (Garman, 1899)*	1	1	1	2
	Saccopharyngidae	Saccopharyngidae type 1				1
		Saccopharynx lavenbergi Nielsen & Bertelsen, 1985		0.3		
	Nemichthyidae	Nemichthyidae type 1				0.3
Clupeiformes	Engraulidae	Engraulidae type 1			1	
		Engraulis mordax Girard, 1854*	357	1352	277	14
	Clupeidae	*Etrumeus acuminatus* Gilbert, 1890*	31	7	24	12
		Opisthonema sp 1*			0.3	3
		Sardinops sagax (Jenyns, 1842)*	519	611	241	74
Osmeriformes	Argentinidae	*Argentina sialis* Gilbert, 1890*	6	8	16	3
	Microstomatidae	*Microstoma* sp 1	3	3	1	2
		Nansenia sp 1	3	1		1
		Nansenia candida Cohen, 1958[C]	11	3	4	
		Nansenia crassa Lavenberg, 1965*	9	10	4	1
		Nansenia pelagica Kawaguchi & Butler, 1984	1	2	1	
	Bathylagidae	*Lipolagus ochotensis* (Schmidt, 1938)*	3	19	1	
		Bathylagoides wesethi (Bolin, 1938)*	104	390	537	186
		Leuroglossus stilbius Gilbert, 1890*	227	294	35	7
Stomiiformes	Gonostonatidae	*Cyclothone acclinidens* Garman, 1899[O]	14	15	79	63
		Cyclothone pseudopallida Mukhacheva, 1964[O]			0.5	1
		Cyclothone signata Garman, 1899[O]	116	101	150	204
		Cyclothone sp 1		2		1
		Diplophos taenia Günther, 1873[O]			0.2	4

Table 1. Continued.

ORDER	FAMILY	TAXA	WI	SP	SU	FA
	Sternoptychidae	Sternoptychidae type 1				0.2
		Argyropelecus affinis Garman, 1899[O]	0.3	1	1	0.5
		Argyropelecus lychnus Garman, 1899[O]	1	1	3	
		Argyropelecus sladeni Regan, 1908[O]	2	2	3	0.5
		Sternoptyx sp 1	1		1	1
		Sternoptyx sp 2				0.4
	Phosichthyidae	*Ichthyococcus irregularis* Rechnitzer & Böhlke, 1958[O]	11	15	16	14
		Vinciguerria lucetia (Garman, 1899)[O]	1415	1459	10297	3610
	Stomiidae	*Stomias atriventer* Garman, 1899[O]	*135*	32	22	31
		Astronesthes sp 1	1			0.4
		Chauliodus macouni Bean, 1890[C]			1	
		Bathophilus filifer (Garman, 1899)	0.3	0.2	0.3	
		Bathophilus flemingi Aron & McCrery, 1958[O]		0.5	2	
		Idiacanthus antrostomus Gilbert, 1890[O]	1		1	3
		Aristostomias scintillans (Gilbert, 1915)[C]	2	1	1	1
Aulopiformes	Synodontidae	*Synodus* sp 1			0.4	
		Synodus sp 3				0.3
		Synodus lucioceps (Ayres, 1855)*	*185*	2	40	*3873*
	Aulopidae	*Aulopus bajacali* Parin & Kotlyar, 1984[C]				1
	Notosudidae	*Scopelosaurus harryi* (Mead, 1953)[C]	0.2	1		1
	Scopelarchidae	*Rosenblattichthys volucris* (Rofen, 1966)[O]	1	2	2	9
		Scopelarchoides nicholsi Parr, 1929[O]	1	0.2	1	0.3
		Scopelarchus analis (Brauer, 1902)[O]	1	0.3	1	3
		Scopelarchus guentheri Alcock, 1896[O]	10	4	12	24
		Scopelarchus sp 1			0.4	
	Evermannellidae	*Evermannella ahlstromi* Johnson & Glodek, 1975			1	0.3
	Paralepididae	*Arctozenus risso* (Bonaparte, 1840)			1	1
		Lestidiops neles (Harry, 1953)[C]	0.3	0.2	0.2	
		Lestidiops ringens (Jordan & Gilbert, 1880)[O]	12	24	20	18
		Stemonosudis sp1			0.4	
		Stemonosudis macrura (Ege, 1933)[C]	0.2		0.3	1
Myctophiformes	Myctophidae	Myctophidae type 1		1		
		Benthosema panamense (Tåning, 1932)[O]			2	
		Diogenichthys atlanticus (Tåning, 1928)[O]	*37*	22	29	*93*
		Diogenichthys laternatus (Garman, 1899)[O]	1099	906	721	762
		Electrona risso (Cocco, 1829)[O]	0.2			3
		Gonichthys tenuiculus (Garman, 1899)[O]	*54*	27	14	18
		Hygophum atratum (Garman, 1899)[O]	*37*	10	22	12
		Hygophum reinhardtii (Lütken, 1892)[O]	14	6	10	6

Table 1. Continued.

ORDER	FAMILY	TAXA	WI	SP	SU	FA
		Loweina sp 1	0.2	0.4		
		Loweina rara (Lütken, 1892)^{O}	4	1	3	3
		Myctophum nitidulum Garman, 1899^{O}	20	8	25	25
		Parvilux ingens Hubbs & Wisner, 1964^{O}	1			
		Protomyctophum crockeri (Bolin, 1939)^{O}	70	64	70	39
		Protomyctophum thompsoni (Chapman, 1944)^{O}				3
		Symbolophorus californiensis (Eigenmann & Eigenmann, 1889)^{O}	36	84	59	19
		Symbolophorus evermanni (Gilbert, 1905)^{O}	1	2		1
		Tarletonbeania sp 1		0.2		
		Tarletonbeania crenularis (Jordan & Gilbert, 1880)^{O}	0.4	2	3	1
		Ceratoscopelus townsendi (Eigenmann & Eigenmann, 1889)^{O}	20	33	249	52
		Diaphus pacificus Parr, 1931^{O}		0.3	1	2
		Diaphus theta Eigenmann & Eigenmann, 1890^{O}	0.4	0.2	6	1
		Lampadena urophaos Paxton, 1963^{O}	2	2	56	27
		Lampanyctus sp 1		0.5		
		Lampanyctus acanthurus Wisner, 1974			5	
		Lampanyctus parvicauda Parr, 1931^{O}	3	1	2	1
		Lampanyctus steinbecki Bolin, 1939		1	1	
		Lampanyctus tenuiformis (Brauer 1906)			0.3	
		Nannobrachium sp 1	4	3		
		Nannobrachium sp 2	1			
		Nannobrachium idostigma (Parr, 1931)^{O}	30	15	17	18
		Nannobrachium bristori Zahuranec, 2000	1	1	1	1
		Nannobrachium hawaiiensis Zahuranec, 2000^{O}	2		2	2
		Nannobrachium regale (Gilbert, 1892)^{O}	2	1	0.5	1
		Nannobrachium ritteri (Gilbert, 1915)^{O}	54	112	35	26
		Notolychnus valdiviae (Brauer, 1904)^{O}		1	6	1
		Notoscopelus resplendens (Richardson, 1845)^{O}	6	7	122	20
		Stenobrachius leucopsarus (Eigenmann & Eigenmann, 1890)^{O}	1	4		
		Triphoturus mexicanus (Gilbert, 1890)^{O}	196	1175	3692	1401
		Triphoturus nigrescens (Brauer, 1904)^{O}			0.4	
Lampriformes	Regalicidae	*Regalecus glesne* Ascanius, 1772				2
	Lophotidae	*Desmodema lorum* Rosenblatt & Butler, 1977^{O}	0.3	1	1	2
	Trachiteridae	*Trachipterus altivelis* Kner, 1859^{O}	0.2	2	1	
		Zu cristatus (Bonelli, 1819)^{O}			1	3

Table 1. Continued.

ORDER	FAMILY	TAXA	WI	SP	SU	FA
Gadiformes	Macrouridae	Macrouridae type 1	0.3			
		Caelorinchus scaphopsis (Gilbert, 1890)	0.3			
		Nezumia sp 1	0.3			
	Moridae	Moridae type 1				0.3
		Physiculus nematopus Gilbert, 1890[O]	3	0.2		2
		Physiculus rastrelliger Gilbert, 1890[O]	3		3	1
	Merlucciidae	*Merluccius productus* (Ayres, 1855)[O]	21	*121*	2	5
	Bregmacerotidae	*Bregmaceros bathymaster* Jordan & Bollman, 1890[O]	0.2		0.2	
		Bregmaceros sp 1	1			
Beryciformes	Melamphaidae	Melamphaidae type 1		0.3		
		Melamphaidae type 2			0.3	
		Melamphaidae type 3			1	
		Melamphaidae type 4			0.3	
		Melamphaidae type 5			1	
		Melamphaidae type 6				0.2
		Melamphaes lugubris Gilbert, 1890	15	25	41	37
		Melamphaes sp 1	2	2	5	2
		Poromitra crassiceps (Günther, 1878)[O]	1	2	1	0.4
		Scopelogadus mizolepis (Günther, 1878) [O]	1	2	7	3
Ophidiiformes	Carapidae	*Echiodon exsilium* Rosenblatt, 1961	1			1
	Ophidiidae	Ophidiidae type 3				0.5
		Ophidiidae type 4			1	
		Ophidiidae type 6			1	
		Chilara taylori (Girard, 1858)[O]	7	1	9	35
		Lepophidium negropinna Hildebrand & Barton, 1949[O]			11	*148*
		Lepophidium sp 1			1	
		Lepophidium sp 2				1
		Lepophidium sp 4				0.2
		Lepophidium stigmatistium (Gilbert, 1890)*			1	1
		Ophidion sp 1		0.5		6
		Ophidion scrippsae (Hubbs, 1916)[O]	2	2	31	*78*
	Bythitidae	Bythitidae type 1			0.5	
		Cataetyx rubrirostris Gilbert, 1890[O]		1		
Kurtiformes	Apogonidae	*Apogon atricaudus* Jordan & McGregor, 1898[C]	0.2			1
		Apogon retrosella (Gill, 1862)*				1
Gobiiformes	Eleotridae	Eleotridae type 2				1
		Dormitator latifrons (Richardson, 1844)[C]	0.3	0.4		
		Eleotris picta Kner, 1863[O]	1			0.3
		Erotelis armiger (Jordan & Richardson, 1895)				2

Table 1. Continued.

ORDER	FAMILY	TAXA	WI	SP	SU	FA
	Gobiidae	Gobiidae type 1	0.4			1
		Gobiidae type 4			0.2	
		Gobiidae type 11			1	
		Gobiidae type 16				0.3
		Gobiidae type 18				1
		Gobiidae type 19				3
		Bollmannia sp 1				3
		Ctenogobius manglicola (Jordan & Starks, 1895)	3		0.3	12
		Ctenogobius sagittula (Günther, 1862)*	1			19
		Gobulus crescentalis (Gilbert, 1892)	0.4	0.2		1
		Lepidogobius lepidus (Girard, 1858)*	0.3		0.4	
		Lythrypnus sp 1	0.3			
		Lythrypnus dalli (Gilbert, 1890)*	1	0.4	5	19
		Lythrypnus zebra (Gilbert, 1890)*	0.4		1	6
		Microgobius sp 1	1			1
		Microgobius sp 2			0.3	3
		Quietula y-cauda (Jenkins & Evermann, 1889)*				0.5
		Rhinogobiops nicholsii (Bean, 1882)*	1	4	15	27
		Typhlogobius californiensis Steindachner, 1879[C]		1	2	1
	Microdesmidae	Microdesmidae type 1				0.4
		Clarkichthys bilineatus (Clark, 1936)		0.4		1
Ovalentaria	Pomacentridae	*Chromis* sp 2				0.3
(Subseries)		*Chromis* sp 3				8
		Chromis punctipinnis (Cooper, 1863)*		0.4	77	40
		Chromis alta Greenfield & Woods, 1980*				2
		Hypsypops rubicundus (Girard, 1854)*			1	1
		Stegastes sp 4				3
		Stegastes sp 5				0.2
		Stegastes rectifraenum (Gill, 1862)*			1	
Mugiliformes	Mugilidae	*Mugil cephalus* Linnaeus, 1758*		0.3		5
Blenniiformes	Blenniidae	Hypsoblennius brevipinnis (Günther, 1861)*			1	
		Hypsoblennius gentilis (Girard, 1854)*	2	0.2	5	5
		Hypsoblennius gilberti (Jordan, 1882)*			1	4
		Hypsoblennius jenkinsi (Jordan & Evermann, 1896)*			1	
		Plagiotremus azalea (Jordan & Bollman, 1890)				1
	Clinidae	Clinidae type 1				0.5
	Labrisomidae	Labrisomidae type 1			0.3	
		Labrisomidae type 2				0.3

Table 1. Continued.

ORDER	FAMILY	TAXA	WI	SP	SU	FA
		Cryptotrema corallinum Gilbert, 1890*	0.2			
		Labrisomus multiporosus Hubbs, 1953*			1	5
		Labrisomus xanti Gill, 1860*			1	0.4
Gobiesociformes	Gobiesocidae	Gobiesocidae type 1				1
		Gobiesox sp 1				0.3
Atheriniformes	Atherinopsidae	*Atherinopsis californiensis* Girard, 1854*	0.2			
Beloniformes	Exocoetidae	*Cheilopogon hubbsi* (Parin, 1961)*			3	
		Cheilopogon xenopterus (Gilbert, 1890)			0.3	0.2
		Exocoetidae type 1			2	
		Fodiator rostratus (Günther, 1866)*			0.4	
	Hemiramphidae	Hemirramphidae type 1			0.4	0.2
		Hyporhamphus rosae (Jordan & Gilbert, 1880)			1	
	Scomberesocidae	*Cololabis saira* (Brevoort, 1856)*	1	5	1	
Carangiformes	Coryphaenidae	*Coryphaena hippurus* Linnaeus, 1758*		0.3	2	3
	Carangidae	*Oligoplites* sp 1				1
		Oligoplites sp 2			0.3	
		Oligoplites saurus (Bloch & Schneider, 1801)		0.2	2	
		Seriola sp 1	2			
		Seriola lalandi Valenciennes, 1833*	2	18	60	1
		Seriola rivoliana Valenciennes, 1833*				1
		Naucrates ductor (Linnaeus, 1758)[O]				1
		Caranx *caballus* Günther, 1868*		0.2	1	1
		Chloroscombrus orqueta Jordan & Gilbert, 1883*			1	3
		Selar crumenophthalmus (Bloch, 1793)*				4
		Trachurus symmetricus (Ayres, 1855)*	23	177	38	1
Istiophoriformes	Sphyraenidae	*Sphyraena argentea* Girard, 1854*		0.4	12	
		Sphyraena ensis Jordan & Gilbert, 1882			1	1
		Sphyraena lucasana Gill, 1863*				0.2
Pleuronectiformes	Paralichthyidae	*Ancylopsetta dendritica* Gilbert, 1890				1
		Citharichthys sp 1		19	1	
		Citharichthys fragilis Gilbert, 1890*	41	144	61	35
		Citharichthys gordae Beebe & Tee-Van, 1938	0.3	0.3	1	1
		Citharichthys platophrys Gilbert, 1891[C]			0.2	
		Citharichthys sordidus (Girard, 1854)[O]	24	84	83	110
		Citharichthys stigmaeus Jordan & Gilbert, 1882*	18	60	60	62
		Citharichthys xanthostigma Gilbert, 1890*	13	16	22	50

Table 1. continuation

ORDER	FAMILY	TAXA	WI	SP	SU	FA
		Etropus crossotus Jordan & Gilbert, 1882*	3	0.1	22	7
		Hippoglossina stomata Eigenmann & Eigenmann, 1890*	7	11	12	11
		Paralichthys californicus (Ayres, 1859)*	1	8	3	
		Syacium ovale (Günther, 1864)				5
		Xystreurys liolepis Jordan & Gilbert, 1880*			0.2	
	Pleuronectidae	Pleuronectidae type 2		0.3		
		Pleuronectidae type 4	1			
		Hypsopsetta guttulata (Girard, 1856)		1		0.2
		Lyopsetta exilis (Jordan & Gilbert, 1880)[O]		1		
		Microstomus pacificus (Lockington, 1879)*			2	
		Parophrys sp 1		0.3		
		Parophrys vetulus Girard, 1854*		1	0.5	
		Pleuronichthys coenosus Girard, 1854*			0.2	1
		Pleuronichthys verticalis Jordan & Gilbert, 1880*	0.4	0.4	1	
	Bothidae	Bothidae type 1				0.3
		Bothus leopardinus (Günther, 1862)[C]	0.3		0.2	3
	Cynoglossidae	*Symphurus* sp 1			0.3	
		Symphurus atricaudus (Jordan & Gilbert, 1880)*	1	0.3	13	144
		Symphurus williamsi Jordan & Culver, 1895			1	5
Syngnathiformes	Syngnathidae	Syngnathidae type 1	1		0.2	
		Syngnathus californiensis Storer, 1845*		1	12	19
	Centriscidae	Centriscidae type 1	0.2			
		Macroramphosus gracilis (Lowe, 1839)*	14	2	1	11
Scombriformes	Gempylidae	*Gempylus serpens* Cuvier, 1829[O]	0.3			1
	Trichiuridae	*Lepidopus fitchi* Rosenblatt & Wilson, 1987[O]	5		14	27
		Trichiurus nitens Garman, 1899				54
	Scombridae	*Scomber japonicus* Houttuyn, 1782*	73	161	1256	9
		Sarda chiliensis (Cuvier, 1832)*	0.5	4	10	
		Auxis spp			2	
		Euthynnus sp 1			0.3	
		Euthynnus lineatus Kishinouye, 1920[C]				0.2
	Nomeidae	Nomeidae type 1	0.2			
		Nomeidae type 2	0.5			
		Cubiceps baxteri McCulloch, 1923			1	
		Cubiceps pauciradiatus Günther, 1872[O]			0.5	1
		Psenes pellucidus Lütken, 1880			1	4
	Tetragonuridae	*Tetragonurus cuvieri* Risso, 1810[O]	1	3	3	6

Table 1. continued

ORDER	FAMILY	TAXA	WI	SP	SU	FA
	Stromateidae	Stromateidae type 1			0.3	
		Peprilus sp 1				0.3
		Peprilus simillimus (Ayres, 1860)*	1	23	1	0.2
		Peprilus snyderi Gilbert & Starks, 1904				0.3
Trachiniformes	Chiasmodatidae	*Chiasmodon niger* Johnson, 1864^{O}	*49*	32	38	28
	Uranoscopidae	*Kathetostoma averruncus* Jordan & Bollman, 1890*	2	2	0.3	
Labriformes	Labridae	Labridae type 4			0.3	
		Labridae type 5				2
		Halichoeres dispilus (Günther, 1864)*	0.2			
		Halichoeres semicinctus (Ayres, 1859)*	1		8	*67*
		Oxyjulis californica (Günther, 1861)*	1	5	16	2
		Semicossyphus pulcher (Ayres, 1854)*	0.3		7	6
		Xyrichthys mundiceps Gill, 1962*	0.4			
	Scaridae	Scaridae type 1				0.3
Perciformes	Gerreidae	*Eucinostomus currani* Zahuranec, 1980*				3
		Eucinostomus dowii (Gill, 1863)*			1	0.5
		Eucinostomus gracilis (Gill, 1862)*				2
	Mullidae					
		Pseudupeneus grandisquamis (Gill, 1863)*				1
	Kyphosidae	*Kyphosus azureus* (Jenkins & Evermann, 1889)*	1		2	1
		Kyphosus sp 2	0.2			
	Serranidae	*Serranidae* type 1				1
		Epinephelus sp 2				0.3
		Diplectrum sp 1	1		0.4	
		Paralabrax clathratus (Girard, 1854)*			8	2
		Paralabrax maculatofasciatus (Steindachner, 1868)*			5	2
		Paralabrax nebulifer (Girard, 1854)*			1	
		Serranus sp 1			1	5
		Serranus sp 2				0.5
		Serranus sp 4			0.3	
		Pronotogrammus multifasciatus Gill, 1863*	5	0.5	15	42
		Mycteroperca rosacea (Streets, 1877)				0.5
		Paranthias colonus (Valenciennes, 1846)*				1
	Bramidae	*Brama dussumieri* Cuvier, 1831		0.3	0.4	3
		Brama japonica Hilgendorf, 1878*	1	2	3	2
		Taractichthys steindachneri (Döderlein, 1883)^{O}				0.4
	Caristiidae	*Paracaristius nudarcus* (Stevenson & Kenaley, 2011)			2	2
	Priacanthidae	*Pristigenys serrula* (Gilbert, 1891)*			0.3	0.5
	Malacanthidae	*Caulolatilus princeps* (Jenyns, 1840)*	1	24	4	7

Table 1. Continued

ORDER	FAMILY		WI	SP	SU	FA
	Haemulidae	*Haemulon californiensis* (Steindachner, 1876)*			2	0.5
	Lutjanidae	*Lutjanus* sp 1			0.3	1
	Cirrhitidae	Cirrhitidae type 2				1
	Polynemidae	*Polydactylus approximans* (Lay & Bennett, 1839)*				0.5
Scorpaeniformes	Scorpaenidae	*Sebastes aurora* (Gilbert, 1890)[O]	1	4		
		Sebastes sp 1	96	77	1	1
		Sebastes sp 2	20	*144*	5	1
		Sebastes spp	12	*57*	2	0
		Sebastolobus sp 1			0.2	
		Scorpaena sp 1	2			1
		Pontinus sp 1		0.4		
		Pontinus sp 2				1
		Scorpaena guttata Girard, 1854*	13	31	83	14
		Scorpaenodes xyris (Jordan & Gilbert, 1882)*			1	3
	Triglidae	*Prionotus stephanophrys* Lockington, 1881*	2		93	148
	Stichaeidae	*Plectobranchus evides* Gilbert, 1890*		1		
	Hexagrammidae	*Oxylebius pictus* Gill, 1862[C]	0.3			
		Zaniolepis frenata Eigenmann & Eigenmann, 1889*	0.2	0.4		
		Zaniolepis latipinnis Girard, 1858*		0.3		0.2
	Rhamphocottidae	*Rhamphocottus richardsonii* Günther, 1874		0.2		
	Agonidae	*Odontopyxis trispinosa* Lockington, 1880*		0.2		
	Cottidae	*Cottus asper* Richardson, 1836			0.1	
Acanthuriformes	Sciaenidae	Sciaenidae type 1			2	
		Sciaenidae type 2			0.4	
		Sciaenidae type 8			0.3	
		Atractoscion nobilis (Ayres, 1860)*		0.2	1	
		Menticirrhus undulatus (Girard, 1854)*			0.2	
		Roncador stearnsii (Steindachner, 1876)*		0.4	19	
		Umbrina sp 1			0.3	
		Umbrina roncador Jordan & Gilbert, 1882*	0.4		2	
Spariformes	Sparidae	*Calamus brachysomus* (Lockington, 1880)*			0.4	1
Lophiiformes	Lophiidae	Lophidae type 1			0.3	
		Lophiodes spilurus (Garman, 1899)*				2
	Antennariidae	*Antennarius avalonis* Jordan & Starks, 1907*				1
		Antennarius sp 2				0.4

Table 1. Continued

ORDER	FAMILY	TAXA	WI	SP	SU	FA
	Melanocetidae	*Melanocetus johnsonii* Günther, 1864*			0.5	1
	Oneirodidae	*Oneirodes* sp 1			1	5
	Ceratiidae	*Cryptopsaras couesii* Gill, 1883				0.2
	Gigantactinidae	*Gigantactis* sp 1			0.3	3
	Linophrynidae	*Borophryne apogon* Regan, 1925*				0.2
Tetraodontiformes	Tetraodontidae	*Sphoeroides annulatus* (Jenyns, 1842)*			1	

Table 2. Percentage of larval abundance per season for each fish family as well as by adult habitat and zoogeographic affinity. Only families that contributed with 95% of total fish larval abundance are listed in decreasing order of total larvae abundance.

	Winter		Spring		Summer		Fall	
	Larval Abundance (%)	Taxa	Larval Abundance (%)	Taxa	Larval Abundance (%)	Taxa	Larval Abundance (%)	Taxa
FAMILY								
Phosichthyidae	26.40	2	18.09	2	53.64	2	29.75	2
Myctophidae	31.41	28	30.57	30	26.80	28	20.84	26
Synodontidae	3.43	1	0.02	1	0.21	2	31.79	2
Engraulidae	6.60	1	16.59	1	1.44	2	0.11	1
Bathylagidae	6.17	3	8.64	3	2.98	3	1.58	2
Clupeidae	10.17	2	7.58	2	1.38	3	0.73	3
Scombridae	1.35	2	2.02	2	6.60	3	0.08	2
Paralichthyidae	1.99	8	4.21	9	1.39	11	2.32	9
Gonostonatidae	2.41	2	1.46	3	1.20	4	2.23	5
Scorpaenidae	2.65	14	3.85	19	0.48	10	0.18	8
Carangidae	0.49	3	2.40	4	0.53	6	0.11	8
Ophidiidae	0.17	2	0.05	3	0.29	7	2.22	8
Stomiidae	2.52	2	0.39	1	0.11	1	0.26	2
Triglidae	0.04	1			0.48	1	1.21	1
HABITAT								
Bathypelagic	70.84	59	60.41	59	85.22	71	55.75	73
Demersal-Reef associated	9.82	80	9.54	73	4.61	105	42.70	135
Pelagic Neritic	18.14	8	26.19	6	9.45	13	0.93	8
Pelagic Oceanic	1.20	12	3.86	13	0.72	22	0.62	13
ZOOGEOGRAPHIC AFFINITY								
Southern distr.	56.38	82	68.65	92	89.87	112	85.65	130
Wide distr.	26.14	26	17.72	20	6.80	35	9.26	34
Northern distr.	17.49	51	13.62	39	3.33	64	5.09	65
Total larval abundance per season (larvae/10 m^2)		86,409		130,374		269,099		170,556
Total taxa per season		154		147		207		219
Dominant taxa per season		20		19		11		16

Table 3. Ranked abundance of larval fish *taxa* identified from BSV (1997-2016) and CalCOFI (1951-1984) survey cruises. Information depicts the 20 best-ranked *taxa* by their larval abundance in each program.

	Adult Habitat	Adult Zoogeographic Affinity	BSV Rank	CalCOFI Rank
TAXA				
Vinciguerria lucetia	Bathypelagic	Tropical-Subtropical	1	3
Triphoturus mexicanus	Bathypelagic	Subtropical	2	6
Synodus lucioceps	Reef associated	Temperate-Subtropical	3	28*
Diogenichthys laternatus	Bathypelagic	Subtropical	4	11
Engraulis mordax	Pelagic neritic	Subtropical	5	1
Sardinops sagax	Pelagic neritic	Subtropical	6	8
Scomber japonicus	Pelagic neritic	Subtropical	7	24
Bathylagoides wesethi	Bathypelagic	Subarctic-Temperate	8	12
Leuroglossus stilbius	Bathypelagic	Subarctic-Temperate	9	5
Cyclothone signata	Bathypelagic	Subarctic-Subtropical	10	15*
Sebastes spp	Reef associated	Subarctic-Subtropical	11	4
Ceratoscopelus townsendi	Bathypelagic	Subarctic-Temperate	12	18
Citharichthys spp	Demersal	Temperate-Subtropical	13	10
Citharichthys sordidus	Demersal	Temperate	14	80
Citharichthys fragilis	Demersal	Subtropical	15	25
Trachurus symmetricus	Pelagic oceanic	Subarctic-Subtropical	16	9
Protomyctophum crockeri	Bathypelagic	Subarctic-Temperate	17	16
Nannobrachium ritteri	Bathypelagic	Subarctic-Temperate	18	20
Stomias atriventer	Bathypelagic	Temperate	19	38
Prionotus stephanophrys	Demersal	Subtropical	20	35*
Merluccius productus	Pelagic oceanic	Subarctic-Temperate	23	2
Nannobrachium spp	Bathypelagic	Subarctic-Subtropical	33	19
Sciaenidae	Demersal	Temperate-Subtropical	62	14
Lipolagus ochotensis	Bathypelagic	Subarctic-Temperate	63	13
Tarlentonbeania crenularis	Bathypelagic	Subarctic-Temperate	95	17
Stenobrachius leucopsarus	Bathypelagic	Subarctic-Temperate	106	7

* Closest reference only at the genus level

these expatriation cases do not imply the presence of adults in the area and represent lost populations because larvae lack of adequate conditions for their survival. Because of this, generally they are not included as extensions of species distribution in taxonomic lists.

Almost a third of the fish larvae *taxa* registered in this work could not be identified to the species level, thus highlighting the urgency of more taxonomic studies for a more accurate diagnosis of the early stages of fishes that inhabit the area. Since most of the families that lack larvae diagnostics are presumably from coastal origin, coastal sampling in the study area would improve the chance of collecting a higher and more representative number of those larvae, to complete the larval development series that connect to the juvenile and adult stages of fishes inhabiting the area. Complementary taxonomic methods using molecular techniques would improve fish larvae species recognition and clarify doubtful morphologic identification.

ACKNOWLEDGEMENTS

The authors would like to thank the crews of the R/V Francisco de Ulloa and Alpha Helix from CICESE and R/V El Puma from UNAM, for their support during cruises, and Dr. B. E. Lavaniegos-Espejo for the access to IMECOCAL samples and the zooplankton laboratory facilities in CICESE, Baja California. This work was supported by CONACyT via the IMECOCAL Program and Instituto Politécnico Nacional (projects SIP20200711, SIP20200686, SIP20210862, SIP20211237). The authors also thank SNI, COFAA and EDI for the re-

ceived grants. The present contribution in its final version was translated by the authors.

REFERENCES

Aceves-Medina, G., S. P. A. Jiménez-Rosenberg & R. Durazo. 2019. Fish larvae as indicator species of interannual environmental variability in a subtropical transition area off the Baja California peninsula. *Deep-Sea Research Part II*, https://doi.org/10.1016/j.dsr2.2019.07.019.

Arriaga-Cabrera, L., E. Vázquez-Domínguez, J. González-Cano, R. Jiménez-Rosenberg, E. Muñoz-López & V. Aguilar-Sierra. 1998. *Regiones Prioritarias Marinas de México*. CONABIO. 198 pp.

Durazo, R. 2009. Climate and upper ocean variability off Baja California, Mexico: 19972008. *Progress in Oceanography*, 83, 361–368. https://doi.org/10.1016/j.pocean.2009.07.043

Durazo, R. & T. Baumgartner. 2002. Evolution of oceanographic conditions off Baja California: 1997-1999. *Progress in Oceanography*, 54: 7-31. https://doi.org/10.1016/S0079-6611(02)00041-1

Durazo, R., T. Baumgartner, S. J. Bograd, C. A. Collins, S. de la Campa, J. García, G. GraxiolaCastro, A. Huyer, K. D. Hyrenbach, D. Loya, R. J. Lynn, F. B. Schwing, R. L. Smith, W. J. Sydeman & 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.

Durazo, R., R. Castro, L. E. Miranda, F. Delgadillo-Hinojosa & A. Mejía-Trejo. 2017. Anomalous hydrographic conditions off the northwestern coast of the Baja California Peninsula during 2013-2016. *Cienc Mar*, 43(2): 81-92. https://doi.org/10.7773/cm.v43i2.2754

Fricke, R., W. N. Eschmeyer & R. van der Laan (eds.) 2019. *Eschmeyer's catalog of fishes: genera, species, references.* (http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp). Electronic version accessed 30 August 2019.

Froese, R. & D. Pauly. Editors. 2019. *FishBase*. World Wide Web electronic publication. www.fishbase.org, version (08/2019).

Funes-Rodríguez, R., A. Zárate-Villafranco, A. Hinojosa-Medina, S. P. A. Jiménez-Rosenberg. 2010. Abundancia y diversidad de larva de peces durante el Niño y La Niña 1997-2000. In: Gaxiola-Castro, G., Durazo, R. (Eds.), *Dinámica del ecosistema pelágico frente a Baja California 1997-2007*. SEMARNAT, INE, CICESE y UABC. D.F., México, pp. 433-451.

Haedrich, R. L. & D. C. Judkins. 1979. Macrozooplankton and its environments. In: Spoel, V.D. & A.C. Pierrot-Bults (Eds). *Zoogeography and diversity of plankton*. Halsted Press. New York, USA. p. 2-28.

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. Smith & 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.

Hewitt, R. P. 1988. Historical review of the oceanographic approach to fisheries research. *California Cooperative Oceanic Fisheries Investigations Reports*, 29: 27-41.

Hubbs, C. L. 1960. The marine vertebrates of the outer coast. Symposium: The Biogeography of Baja California and Adjacent Seas. *Systematic Zoology*, 9 (3-4): 134-147. https://doi.org/10.2307/2411962

Jiménez-Rosenberg, S. P. A., R. J. Saldierna-Martínez, G. Aceves-Medina & V.M. Cota-Gómez, 2007. Fish larvae in Bahía Sebastián Vizcaíno and the adjacent oceanic region, Baja California. México. *Checklist*, 3 (3): 204-223. https://doi.org/10.15560/3.3.204

Kramer, D., M. J. Kalin, E. G. Stevens, J. R. Thrailkill & J. R. Zweifel. 1972. Collecting and processing data on the fish eggs and larvae in the California Current region. *National Oceanic and Admosferic Administration Technical Report, National Marine Fisheries Service*, Circular 378: 38 p.

McClatchie, S., J. Gao, E. J. Drenkard, A. R. Thompson, W. Watson, L. Ciannelli, S. J. Bograd, J. T. Thorson. 2018. Inter-annual and secular variability of larvae of mesopelagic and forage fishes in the southern California Current System. *Journal of Geophysical Research: Oceans*, 123 (9): 6277-6295. https://doi.org/10.1029/2018JC014011

Moser, H., 1996. The early stages of fishes in the California Current region. *California Cooperative Oceanic Fisheries Investigations Atlas No. 33*. Allen Press Inc., Kansas, 1505 pp

Moser, H. G., R. L. Charter, P. E. Smith, D. A. Ambrose, S. R. Charter, C. A. Meyer, E. M. Sandknop & 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 31*, 233 pp.

Nelson J. S., T. C. Grande & M. V. H. Wilson. 2016. *Fishes of the world*. Wiley. 752 pp. https://doi.org/10.1002/9781119174844

Smith, P. E & S. L. Richardson. 1977. Standard techniques for pelagic fish egg and larva surveys. *Food and Agriculture Organization of the United Nations, Fisheries and Aquaculture Technical Paper 175.* 100 pp.

Sokal, R. R. & F. J. Rohlf. 1994. *Biometry: The principles and Practices of Statistics in Biological Research.* Freeman. 880 pp.

Spalding, M.D., Fox, H.E., Allen, G.R., Davidson, N., Ferdaña, Z.A., Finlayson, M., Halpern, B.S., Jorge, M.A., Lombana, A., Lourie, S.A., Martin, K.D., McManus, E., Molnar, J., Recchia, C.A. & Robertson, J. 2007. Marine Ecoregions of the World: A Bioregionalization of Coastal and Shelf Areas. BioScience, 57 (7): 573-583.Zurbrigg, R. E. & W. B. Scott. 1972. Evidence of expatriate populations of the lanternfish *Myctophum punctatum* in the northwest Atlantic. *Journal of the Fisheries Research Board of Canada*, 29 (12): 1679-1683. https://doi.org/10.1139/f72-267