Check List 2007: 3(3)
ISSN: 1809-127X

LISTS OF SPECIES

Fish larvae in Bahía Sebastián Vizcaíno and the adjacent oceanic region, Baja California, México.

S. Patricia A. Jiménez–Rosenberg[1]
Ricardo J. Saldierna–Martínez[1]
Gerardo Aceves–Medina[1]
Víctor M. Cota–Gómez[2]

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

[2]*Departamento de Pesquerías y Biología Marina, Centro Interdisciplinario de Ciencias Marinas. Av. IPN s/n, Col. Playa Palo de Santa Rita, C. P. 23096. La Paz, Baja California Sur, Mexico.*

Abstract: The taxonomic composition of the fish larvae assemblage of Bahía Sebastián Vizcaíno and the adjacent oceanic region is presented based on oblique zooplankton hauls made during 12 oceanographic surveys between fall 1997 and fall 2000. In total, 186 taxa representing 71 families were collected. Myctophidae, Phosichthyidae, and Engraulidae were the most abundant during winter and Myctophidae, Merlucciidae, and Bathylagidae during spring. In summer and fall Phosichthyidae and Myctophidae were the most abundant. During 1999 and 2000, seasonal variability was identified in the area by the fish larvae composition, defining winter and fall as a low diversity period and spring and summer as a high diversity period. Interannual variability was detected with an El Niño event, with higher larval abundances of tropical and subtropical taxa, and a La Niña event, with high abundances of larvae of *Engraulis mordax*.

Introduction

Bahía Sebastián Vizcaíno (BSV) is on the Pacific coast of México in the middle of the Baja California Peninsula (Figure 1). It has been selected by the Mexican Government as a Priority Marine Area because of its high richness in plant and animal species. The study area is in a transitional zone under the influence of the California Current (Tsuchiya 1982), where the biota of three major water masses converge (Central Pacific Water Mass, Eastern Tropical Pacific Water Mass, and Subarctic Water Mass).

Although the physical and biological dynamics of BSV and its oceanic vicinity have been described by several authors (Wyllie 1961; Bakun and Nelson 1977; Husby and Nelson 1982; Amador–Buenrostro et al. 1995), BSV-specific ichthyo-faunal studies are scarce and only one work listed a total of 59 species, 50 genera, and 36 families (De la Cruz–Agüero et al. 1996). Several studies of fish larvae include BSV as a small area in the vast California Current region where most of the work is focused on commercially important species (Ahlstrom 1965; Loeb et al. 1983; Moser et al. 1987; 1993; 1994). Some studies have been made to characterize the composition and species abundance of ichthyoplankton of California and the Baja California Peninsula (Moser and Smith 1993; Funes–Rodríguez et al. 1995; 1998a; 1998b; 2000; 2002; 2006).

Fish larvae assemblages reflect the oceanographic complexity of the California Current Region with subarctic–transitional, eastern tropical, and central water mass components, which are affected by the seasonal and interanual variability modifying their composition and boundaries (Moser et al. 1987; Moser and Smith 1993). Off the west coast of Baja California seasonal variations in species distribution and abundance have been related to changes in flow within the California Current System (Funes–Rodríguez et al. 2002).

Even though there are a considerable number of ichthyoplankton studies along the Pacific coast of California and Baja California, fish larval dynamics in BSV and its oceanic vicinity have been scarcely studied. Our goal is to analyze the changes in the structure of the larval assemblages associated with the seasonal and interannual variability that occurred in the area during the sampling period.

Materials and methods

The study area is between 26°43’ and 29°04’ N, and 114°29’ and 115°58’ W (Figure 1). It is an extensive shelf area of approximately 36,000 km^2 over the Pacific Plate and consists of a wide platform and an ocean floor of igneous rock. Mudflats, coastal dunes, and three lagoons (Manuela, Guerrero Negro, and Ojo de Liebre) are

LISTS OF SPECIES

there. Two channels, Kellet Channel (14.8 km wide and 40 to 45 m deep) and Dewey Channel (7.4 km wide and 25 to 30 m deep) are open to the ocean in the southeast of the bay. Three islands are present, forming the Isla Cedros complex: Cedros, Natividad, and San Benito (Arriaga–Cabrera et al. 1998). The mean annual temperature is 18 to 20 ˚C, rainfall is minimal during winter, and no sources of freshwater empty into the bay (Wyllie 1961).

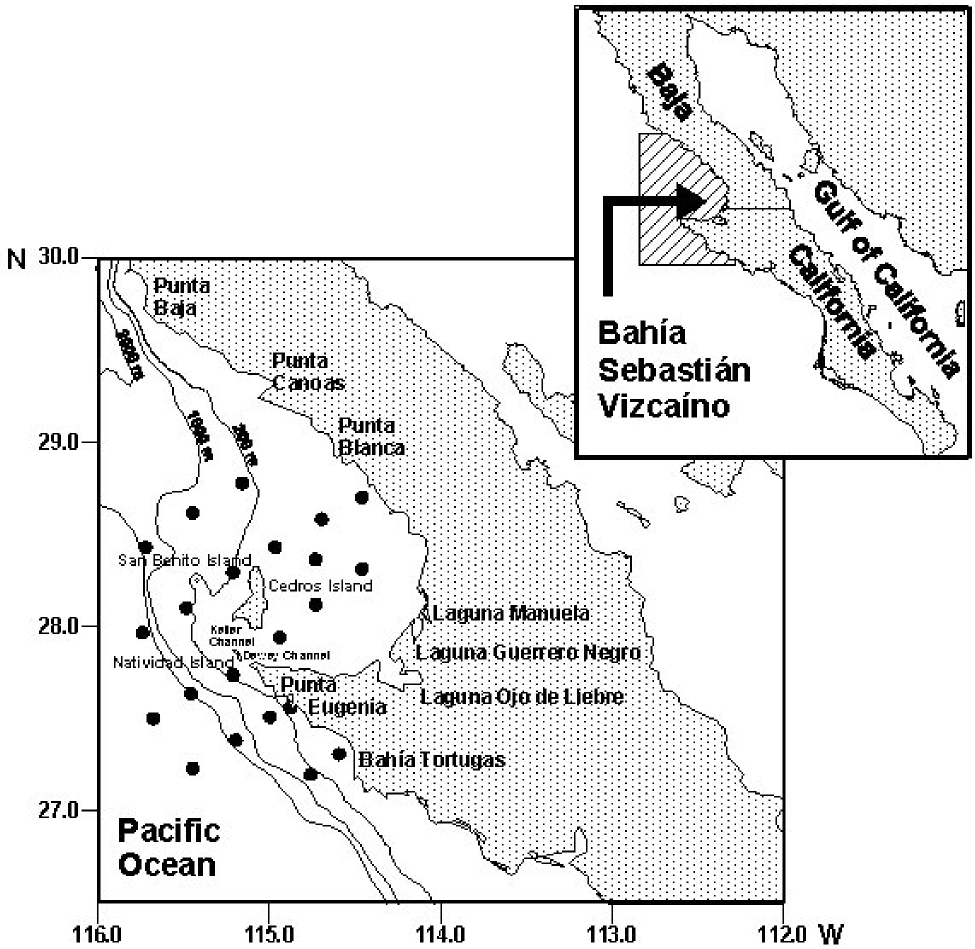

Figure 1. Study area and sampling stations in Bahía Sebastián Vizcaíno and the adjacent oceanic region.

Between September 1997 and October 2000, 12 oceanographic surveys were made in BSV and the adjacent oceanic region; September-October 1997 (fall), January-February 1998 (winter), July 1998 (summer), November 1998 (fall), January 1999 (winter), April 1999 (spring), August 1999 (summer), October 1999 (fall), January 2000 (winter), April 2000 (spring), July 2000 (summer), and October 2000 (fall). A basic plan of 22 stations (an average of 20), both coastal and oceanic, were sampled in the area during this study. Zooplankton collections were made according to Smith and Richardson (1977) using standard CalCOFI procedures (Kramer et al. 1972). Bongo nets with 0.61-m mouth diameter, 3-m length, and 505-µm mesh 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. At each station the sea surface temperature (SST) and sea surface salinity (SSS) were recorded with a Seabird CTD.

The zooplankton biomass was measured with the displaced wet–volume method (Beers 1976). The total ichthyoplankton was sorted out and counted. Fish larvae were preserved in 4 % Formalin buffered with sodium borate and identified to the lowest taxonomic level possible using mainly

Moser (1996). The number of larvae was standardized to 10 m^2 of sea surface (Smith and Richardson 1977). Adult habitat and zoogeographic affinity information of the identified taxa were obtained from Eschmeyer et al. (1983) and Froese and Pauly (2000). Voucher specimens of all species were cataloged and deposited in the Ichthyoplankton Collection at CICIMAR–IPN. Community diversity (*H'*) and equitability (J) were estimated with Shannon's Index (Shannon and Weaver 1949).

Results

Mean SST values were lowest in winter and spring and highest in summer and fall (Figure 2a). Fall 1997 had the highest SST values (mean 24.9 ºC) and was remarkably higher than fall 1998, 1999, and 2000 (mean SST 19.6, 19.8, and 20.3 ºC, respectively). During winter 1998, the mean SST (19.2 ºC) was remarkably higher than in winter 1999 and 2000 (15.7 and 16.5 ºC, respectively). Summer 1998 had the highest mean SST value for this season (21.1 ºC compared to 18.7 and 18.6 ºC in summer 1999 and 2000). Spring 1999 had the lowest SST (mean 14.7 ºC), whereas spring 2000 had a mean SST of 16.0 ºC.

The highest SSS values were measured during fall 1997 and winter 1998 (Figure 2a), whereas the mean SSS values were more uniform in the other seasons (between 33.6 and 33.8) (Figure 2a).

The annual mean zooplankton volume was lower during fall, except for fall 1997 where values were high for this season, followed by higher than normal values for winter in 1998. Spring 1999 and 2000 had the highest values for each year (Figure 2b). Higher larval abundances coupled with higher numbers of taxa were found during fall 1997 and winter and summer 1998 (Figure 2c). Lower larval abundances were measured during 1999, but the number of taxa was similar between seasons during 1999 and 2000. The highest larval abundance was found during summer 1998 (17,840 larvae/10 m^2 sea surface) and the largest number of taxa was measured during fall 1997 (Figure 2c). The lowest larval abundance and a comparatively low number of taxa were collected during fall 2000 (Figure 2c).

Fish larvae belonging to 186 taxa of 71 families were identified (Table 1). Of these, two were identified to the family level, 26 to the genus level, and 158 to the species level. Larvae identified to the family and–or genus level were distinguished with the notation "type" followed by a number to denote types. These larvae could not be identified to the species level because of the lack of larval descriptions or damage to the larvae.

Diversity (*H'*) values were particularly high during spring and summer 1999 and 2000, contrasting with the low *H'* values obtained during summer 1998, which resemble the low *H'* values of winter 1998 and 2000 (Figure 2d). Fall *H'* values were similar during 1998-2000, but higher in 1997 (Figure 2d). The lowest equitability (J) values were obtained during fall 1997 and 1998 and winter 1998, whereas during the rest of the sampling period J values were similar (Figure 2d).

During winter five taxa comprised at least 80 % of the total larval abundance in 1998 with *Vinciguerria lucetia* being the most abundant species, 11 taxa comprised ≥ 80 % of the abundance during 1999 with *Diogenichthys laternatus* as the most abundant, and four taxa in 2000 represented ≥ 80% of the abundance with larvae of the coastal pelagic species *Engraulis mordax* being the most abundant (Table 1). Eleven and nine taxa contributed with ≥ 80 % of the abundance in spring 1999 and 2000 respectively, with *Merluccius productus* (1999) and *Sardinops sagax* (2000) as the most abundant species (Table 1). Two species accounted for ≥ 80 % of the larval abundance during summer 1998 with *V. lucetia* being the most abundant species as it was in summer 1999, when 12 species accounted for ≥ 80 % of the abundance (Table 1). In summer 2000 five species accounted for ≥ 80% of the abundance and *Triphoturus mexicanus* was the most abundant species (Table 1). In fall *V. lucetia* was the most abundant species, except for fall 2000 when *T. mexicanus* was the most abundant one (Table 1). Eighty percent of the total larval abundance during fall was composed of seven, five, eight, and six species during 1997, 1998, 1999, and 2000, respectively (Table 1).

LISTS OF SPECIES

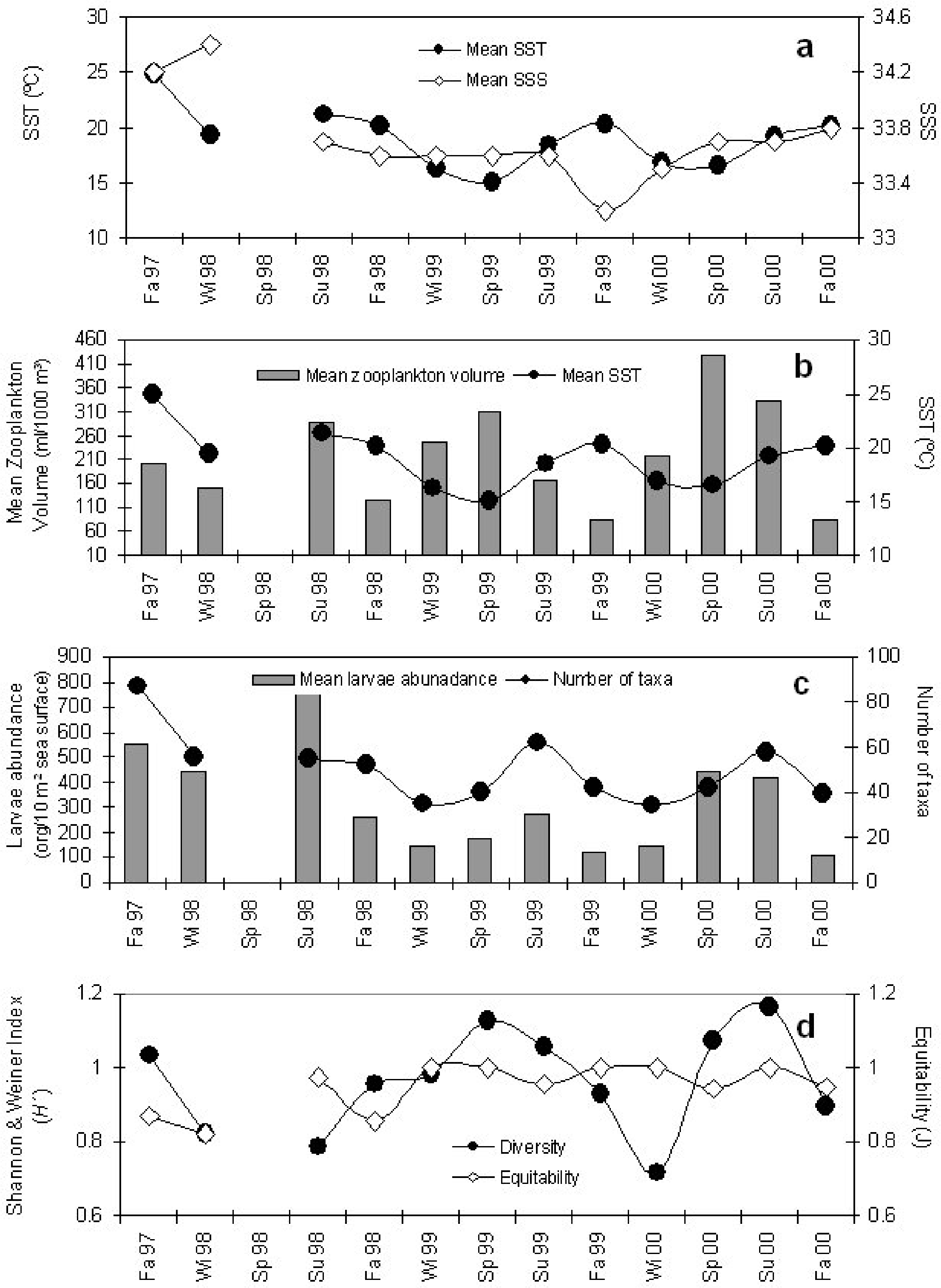

Figure 2. Bahía Sebastián Vizcaíno and the adjacent oceanic region from September 1997 to October 2000. (a) Mean SST and SSS. (b) Mean Zooplankton volume and SST. (c) Mean larvae abundance and number of taxa. (d) Diversity and Equitability. Fall (Fa); winter (Wi); spring (Sp); summer (Su).

Check List 2007: 3(3)
ISSN: 1809-127X

LISTS OF SPECIES

Table 1. Taxonomic composition of fish larvae collected between September 1997 and October 2000 in Bahía Sebastián Vizcaíno and the adjacent oceanic region. Abundance is given in larvae/10 m^2 of sea surface. Abundance of taxa that cumulatively contributed with 80 % or more of total abundance by cruise are underlined. Adult habitat: M = Mesopelagic; D = Demersal; CP = Coastal Pelagic; E = Epipelagic. Adult zoogeographic affinity: Sa-Tran = Subarctic-Transitional; Tr = Tropical; Sbtr = Subtropical.

Taxa	Adult Habitat	Zoogeographic Affinity	Winter cruises			Spring cruises		Summer cruises			Fall cruises			
			1998	1999	2000	1999	2000	1998	1999	2000	1997	1998	1999	2000
Ophichthidae type 1	D	Sa-Tran									2			
Ophichthus cruentifer	D	Sa-Tran									7			
Ophichthus zophochir	D	Sa-Tran	5								11			
Myrophis vafer	D	Sa-Tran	5											
Bathycongrus macrurus	D	Sbtr									7			
Gnathophis cinctus	D	Sbtr										3		
Derichthys serpentinus	M	Sbtr									6			
Facciolella gilbertii	D	Sbtr	22											
Etrumeus teres	CP	Tr	100					43	98	110	45		2	23
Opisthonema type 1	CP	Sbtr						5			41			
Sardinops sagax	CP	Sa-Tran	242	109	258	107	1718	29	397	983		80	47	172
Engraulidae type 1	CP	Sa-Tran								7				
Engraulis mordax	CP	Sa-Tran	1781	343	1888	408	239	5	101	6		63		
Argentina sialis	D	Sa-Tran			15	30	27		13	28				
Bathylagus ochotensis	M	Sa-Tran				29	20							
Bathylagus wesethi	M	Sa-Tran	48	60		63	74	378	115	151	49	45	32	5
Leuroglossus stilbius	M	Sa-Tran		196		467	940		6	54				
Microstoma type 1	M	Sa-Tran		20							7			
Nansenia candida	M	Sa-Tran			7		5							
Nansenia crassa	M	Sbtr		20		16								
Nansenia pelagica	M	Sa-Tran	6											
Cyclothone acclinidens	M	Sbtr	36		15		26	127	48	31	160	43	33	32
Cyclothone signata	M	Sbtr	56	25		46	24	42	14		188	149	7	19
Diplophos taenia	M	Sa-Tran									12			

ISSN: 1809-127X

LISTS OF SPECIES

Table 1. Continuation.

Taxa	Adult Habitat	Zoogeographic Affinity	Winter cruises			Spring cruises		Summer cruises			Fall cruises			
			1998	1999	2000	1999	2000	1998	1999	2000	1997	1998	1999	2000
Argyropelecus lychnus	M	Sa-Tran							18					
Argyropelecus sladeni	M	Sbtr							15		7			
Ichthyococcus irregularis	M	Sa-Tran		7		7		20	24	19	34	15		5
Vinciguerria lucetia	M	Tr	3438	547	64	126	586	9810	1574	1686	5872	1936	1132	235
Stomias atriventer	M	Sa-Tran	265	70	8		39	10		5	41	5		10
Astronesthes type 1	M	Sbtr									6			
Idiacanthus antrostomus	M	Sbtr			7								7	
Rosenblattichthys volucris	M	Sbtr						5		4				
Scopelarchoides nicholsi	M	Sbtr						6						
Scopelarchus guentheri	M	Sbtr	5	5				11	13	4	11	8	7	5
Scopelosaurus harryi	D	Sa-Tran									6			
Synodus type 1	D	Sa-Tran						5						
Synodus lucioceps	D	Sa-Tran	1107	72	89	7		15	22	32	416	1010	27	400
Arctozenus risso	M	Sbtr											7	
Lestidiops ringens	M	Sa-Tran		5	14	36	28	12	56	14			37	
Stemonosudis macrura	M	Sbtr												5
Evermanella ahlstromi	M	Sa-Tran						11						
Ceratoscopelus townsendi	M	Sa-Tran		17	7		34	862	43		175	48	13	
Diaphus pacificus	M	Tr									6			
Diaphus theta	M	Sa-Tran											7	
Lampadena urophaos	M	Sbtr						5	21		19			5
Lampanyctus parvicauda	M	Sbtr	9	7				11			5		7	
Nannobrachium type 1	M	Sbtr				7								
Nannobrachium idostigma	M	Sbtr	26	8	6		15	22			25	22		5
Nannobrachium bristori	M	Sbtr	11											
Nannobrachium regalis	M	Sa-Tran				6			6					
Nannobrachium ritteri	M	Sa-Tran	6	43	49	114	161	6	33	16		5	16	5

ISSN: 1809-127X

LISTS OF SPECIES

Table 1. Continuation.

Taxa	Adult Habitat	Zoogeographic Affinity	Winter cruises			Spring cruises		Summer cruises			Fall cruises			
			1998	1999	2000	1999	2000	1998	1999	2000	1997	1998	1999	2000
Notolychnus valdiviae	M	Sbtr				6			7		6	8		
Notoscopelus resplendens	M	Sbtr						40	13	102		11	9	4
Parvilux ingens	M	Sa-Tran	12											
Stenobrachius leucopsarus	M	Sa-Tran				7								
Triphoturus mexicanus	M	Sa-Tran	119	56	15	267	838	4165	1316	3112	1345	542	507	466
Diogenichthys atlanticus	M	Sbtr		70	16	57	29	11	25		16	40	97	23
Diogenichthys laternatus	M	Tr	767	597	17	41	389	822	166	412	828	992	79	53
Electrona risso	M	Sa-Tran										21		
Gonichthys tenuiculus	M	Tr	82	7		7		54		4	25	3		9
Hygophum atratum	M	Tr	70	74			7	112			60	3		5
Hygophum reinhardtii	M	Sbtr	49	44				84						10
Loweina rara	M	Sbtr	6	8	6			17						5
Myctophum nitidulum	M	Sbtr	5	20	7		21			20	6	15		
Protomyctophum crockeri	M	Sa-Tran		135	24	128	39	10	62	45	38		43	18
Symbolophorus californiensis	M	Sa-Tran			7	24	195		31	13	6		14	5
Symbolophorus evermaneli	M	Tr											7	
Tarletonbeania crenularis	M	Sa-Tran	6			7	12			5				
Bregmaceros type 1	E	Tr	5											
Caelorinchus scaphopsis	D	Sbtr	5											
Physiculus nematopus	M	Sbtr	6									4		
Physiculus restreliger	D	Sbtr						6		5				
Merluccius productus	M	Sa-Tran			40	525	1169		6					
Chilara taylori	D	Sa-Tran	15				5		24		4		22	37
Lepophidium negropinna	D	Sbtr									255	53		9
Ophiodon scrippsae	D	Sa-Tran	10		9		9	44	68	17	57	130	7	27
Echiodon exsilium	D	Sbtr	6											
Bythitidae type 1	D	Sa-Tran							7					

ISSN: 1809-127X

LISTS OF SPECIES

Table 1. Continuation.

Taxa	Adult Habitat	Zoogeographic Affinity	Winter cruises 1998	1999	2000	Spring cruises 1999	2000	Summer cruises 1998	1999	2000	Fall cruises 1997	1998	1999	2000
Brosmophycis marginata	D	Sa-Tran									7			
Cataetyx rubrirostris	M	Sa-Tran					4							
Antennarius avalonis	D	Sbtr									7			
Melanocetus johnsoni	M	Sbtr									6	3		
Gigantactis sp 1	M	Sbtr									11			
Cololabis saira	E	Sa-Tran							6					
Cheilopogon heterurus hubbsi	E	Sa-Tran						17						
Fodiator acutus rostratus	E	Sbtr						5						
Desmodema lorum	E	Sa-Tran											9	5
Zu cristatus	E	Sbtr								4	11			5
Melamphaes type 1	M	Sa-Tran											7	
Melamphaes lugubris	M	Sa-Tran		20	14	15	40	23	59	23	23	9	33	5
Poromitra crassiceps	M	Sbtr							7					
Scopelogadus bispinosus	M	Sbtr						5						
Macroramphosus gracilis	M	Sbtr			163	9								
Syngnathus californiensis	D	Sbtr								4				
Sebastes type 1	D	Sa-Tran	63	220	16	124	270							
Sebastes type 2	D	Sa-Tran		16		54	479			5		3		
Sebastes type 3	D	Sa-Tran				34								
Sebastes type 4	D	Sa-Tran				21			7					
Sebastes type 5	D	Sa-Tran			5									
Sebastes aurora	D	Sa-Tran					7							
Sebastes macdonaldi	D	Sa-Tran					12							
Pontinus type 1	D	Sbtr				7								
Scorpaena type 1	D	Sa-Tran			21							9		
Scorpaena guttata	D	Sa-Tran				36		82	44	36		5	7	
Prionotus ruscarius	D	Sbtr						562	44	13	730	46		14

LISTS OF SPECIES

Table 1. Continuation.

Taxa	Adult Habitat	Zoogeographic Affinity	Winter cruises 1998	1999	2000	Spring cruises 1999	2000	Summer cruises 1998	1999	2000	Fall cruises 1997	1998	1999	2000
Prionotus stephanophrys	D	Sbtr	6							24		60	51	
Stereolepis gigas	D	Sa-Tran									2			
Epinephelus type 1	D	Sbtr									7			
Diplectrum type 1	D	Sbtr	11											
Paralabrax clathratus	D	Sa-Tran								32	7			
Paralabrax maculatofasciatus	D	Sa-Tran						10			25			
Serranus type 1	D	Sbtr							33	4	29	3	7	
Pronotogrammus multifasciatus	D	Sbtr	25		4			17	6		204	14	7	
Pristigenys serrula	D	Sbtr									7			
Apogon atricaudus	D	Sbtr									6			
Caranx caballus	E	Sbtr									5			
Chloroscombrus orqueta	E	Sbtr									50			
Naucrates ductor	E	Sa-Tran									6			
Oligoplites type 1	D	Sbtr										4		
Seriola lalandi	D	Sbtr	11			205	23	16	77	70	22			
Trachurus symmetricus	E	Sa-Tran	13			31	340							
Coryphaena hippurus	E	Sbtr							18		36			
Taractichthys steindachneri	M	Sa-Tran										5		
Brama dussumieri	M	Sa-Tran								7				
Lutjanus type 1	D	Sbtr									12	5		
Caulolatilus princeps	D	Sbtr	5					5		4		11		
Eucinostomus currani	D	Sa-Tran									43			
Eucinostomus dowii	D	Sa-Tran							6		7			
Eucinostomus gracilis	D	Sa-Tran									15			
Xenistius californiensis	D	Sbtr								14				
Calamus brachysomus	D	Sbtr								5				
Sciaenidae type 1	D	Sbtr							23					

LISTS OF SPECIES

Table 1. Continuation.

Taxa	Adult Habitat	Zoogeographic Affinity	Winter cruises 1998	1999	2000	Spring cruises 1999	2000	Summer cruises 1998	1999	2000	Fall cruises 1997	1998	1999	2000
Sciaenidae type 2	D	Sbtr								5				
Atractoscion nobilis	D	Sa-Tran								6				
Menticirrhus undulatus	D	Sa-Tran									7			
Roncador stearnsii	D	Sa-Tran							268					
Umbrina roncador	D	Sa-Tran	6											
Mulloidichthys dentatus	D	Sbtr									4	6		
Hermosilla azurea	D	Sa-Tran	10											
Chromis punctipinnis	D	Sa-Tran						68	293	27	110	50	15	5
Halichoeres semicinctus	D	Sa-Tran						15	35	13	409	13		
Oxyjulis californica	D	Sa-Tran							19					
Semicossyphus pulcher	D	Sa-Tran	6					10	6					
Xyrichthys mundiceps	D	Sbtr	6											
Chiasmodon niger	M	Sbtr	33	36			27	43	19		12	27	15	9
Kathetostoma averruncus	D	Sbtr	22				39	5			6			
Labrisomus multiporosus	D	Sbtr							6		6			
Labrisomus xanti	D	Sa-Tran								8				
Hypsoblennius gentilis	D	Sa-Tran						19			6	3		
Hypsoblennius gilberti	D	Sa-Tran											20	
Hypsoblennius jenkinsi	D	Sa-Tran								14				
Plagiotremus azalea	D	Sbtr									14			
Eleotris picta	D	Sa-Tran	17								27			
Erotelis armiger	D	Sbtr									6			
Bollmannia type 1	D	Sa-Tran									24	36		
Microgobius type 1	D	Sa-Tran		16								16		
Acanthogobius flavimanus	D	Sa-Tran	5											
Coryphopterus nicholsii	D	Sa-Tran								5				
Lepidogobius lepidus	D	Sa-Tran			5				6					

ISSN: 1809-127X

LISTS OF SPECIES

Table 1. Continuation.

Taxa	Adult Habitat	Zoogeographic Affinity	Winter cruises 1998	Winter cruises 1999	Winter cruises 2000	Spring cruises 1999	Spring cruises 2000	Summer cruises 1998	Summer cruises 1999	Summer cruises 2000	Fall cruises 1997	Fall cruises 1998	Fall cruises 1999	Fall cruises 2000
Lythrypnus type 1	D	Sa-Tran			5									
Lythrypnus dalli	D	Sa-Tran	5	6		6		5	22		31	11	17	5
Lythrypnus zebra	D	Sa-Tran							6				8	
Quietula y-cauda	D	Sbtr									6			
Sphyraena lucasana	CP	Sbtr										3		
Sphyraena argentea	CP	Sa-Tran							12	19				
Sphyraena ensis	CP	Sbtr									2			
Gempylus serpens	E	Sbtr	5								17			
Euthynnus lineatus	E	Sbtr									2			
Sarda chiliensis	E	Sa-Tran			8		12			33				
Scomber japonicus	CP	Sa-Tran	1076		15	264	253	5	260	340	7			
Lepidopus fitchi	D	Sbtr						10	6	17	64		8	9
Cubiceps pauciradiatus	E	Sbtr									38			
Peprilus snyderi	E	Sbtr									5			
Citharichthys fragilis	D	Sa-Tran	6				182	49						
Citharichthys gordae	D	Sbtr								6				
Citharichthys sordidus	D	Sa-Tran	21	34	84	27	73		80					
Citharichthys stigmaeus	D	Sa-Tran							11	8			13	5
Citharichthys xanthostigma	D	Sa-Tran	22	39	13	14	22	5	17	130	37	36	173	9
Etropus crossotus	D	Sbtr							48	137		4	20	
Hippoglossina stomata	D	Sa-Tran		17			5	61	12	37	10	9	7	5
Paralichthys californicus	D	Sa-Tran							17	8				
Bothus leopardinus	D	Sbtr									13			
Lyopsetta exilis	D	Sa-Tran				7								
Pleuronichthys verticalis	D	Sa-Tran	6											
Symphurus atricaudus	D	Sa-Tran	6						62	4	223	121	104	9
Diodon holocanthus	D	Sbtr									11			

LISTS OF SPECIES

During winter 1998 the most abundant families were Phosichthyidae and Engraulidae (Table 2). Myctophidae and Phosichthyidae were the most abundant during winter 1999 and Engraulidae and Clupeidae during winter 2000 (Table 2). In spring, Myctophidae was the most abundant, whereas during summer and fall Myctophidae and Phosichthyidae were always first or second in abundance, except fall 2000 when Synodontidae replaced Phosichthyidae as second (Table 2).

Table 2. Most abundant fish larvae families recorded during the sampling period in Bahía Sebastián Vizcaíno and adjacent oceanic region. Values are given in percentage of abundance for each sampling season.

Family	Winter			Spring		Summer			Fall			
	1998	1999	2000	1999	2000	1998	1999	2000	1997	1998	1999	2000
Clupeidae	3.5	3.7	8.8	3.2	20.4	0.4	8.4	13.8	0.7	1.4	1.9	11.6
Engraulidae	18.3	11.5	64.6	12.0	2.8		1.7	0.2		1.1		
Bathylagidae	0.5	8.6		16.5	12.3	2.1	2.1	2.6	0.4	0.8	1.2	0.3
Phosichthyidae	35.4	18.6	2.2	3.9	6.9	55.1	27.2	21.5	48.5	33.8	42.1	14.3
Synodontidae	11.4	2.4	3.0			0.1	0.4	0.4	3.4	17.5	1.0	23.8
Myctophidae	12.0	36.6	5.3	19.8	20.6	34.9	29.3	46.9	21.0	29.6	29.7	36.5
Merlucciidae			1.4	15.5	13.9		0.1					
Scombridae	11.1		0.8	7.8	3.1		4.4	4.7	0.1			

Larvae of commercially important species were among the most abundant during all seasons along with the mesopelagic species, *V. lucetia*, several myctophids, and demersal taxa such as *Sebastes* (Table 1). Except for summer 1998, larvae of *S. sagax* were among the most abundant species year round (Table 1). Larvae of *E. mordax*, present in all seasons, were most abundant during winter and spring (Table 1). *Scomber japonicus* larvae were among the 10 most abundant taxa during winter 1998, spring 1999 and 2000, and during summer 1999 and 2000 (Table 1).

Larvae of mesopelagic (> 20 % of all taxa) and demersal (usually > 10 % of all taxa) dwelling adults were well represented during all seasons (Figures 3a and b), whereas coastal pelagic and epipelagic taxa each accounted for less than 10% of the total taxa (Figures 3c and d), and had larger intra– and interannual variability compared with the mesopelagic and demersal taxa.

In general, mesopelagic taxa were the most abundant, with cumulative larval abundances between 50% and 90% of the total in all seasons, except for winter 2000 when most of the abundance was represented by larvae of a few coastal pelagic taxa (Figure 3b). The highest larval abundances of mesopelagic taxa were in the oceanic region off BSV year round (Figure 4). Demersal taxa larvae usually were more abundant during fall (Figure 3a), with the highest abundances related to the slope zone in BSV and south of Punta Eugenia (Figure 4). The larvae of coastal pelagic taxa were concentrated around Punta Eugenia during winter and summer, whereas in spring they were more widely distributed including in the oceanic region (Figure 4). The lowest abundances of these larvae were found during fall, also related to Punta Eugenia (Figures 3c and 4). Epipelagic taxa had low abundances in all sampling periods and were widely distributed in the sampling area (Figures 3d and 4).

The larval abundances of tropical and subarctic–transitional water taxa were higher than those of subtropical taxa, usually ≥ 20 % and ≥ 40 %, vs. < 20 % of the total abundance (Figure 5). Among these groups, tropical taxa were the least well represented with no more than 15 % of the total taxa (Fig 5a), whereas subarctic–transitional and subtropical taxa accounted for about 40-80 % and about 20-55 % of the total taxa (Figure 5b and c).

ISSN: 1809-127X

LISTS OF SPECIES

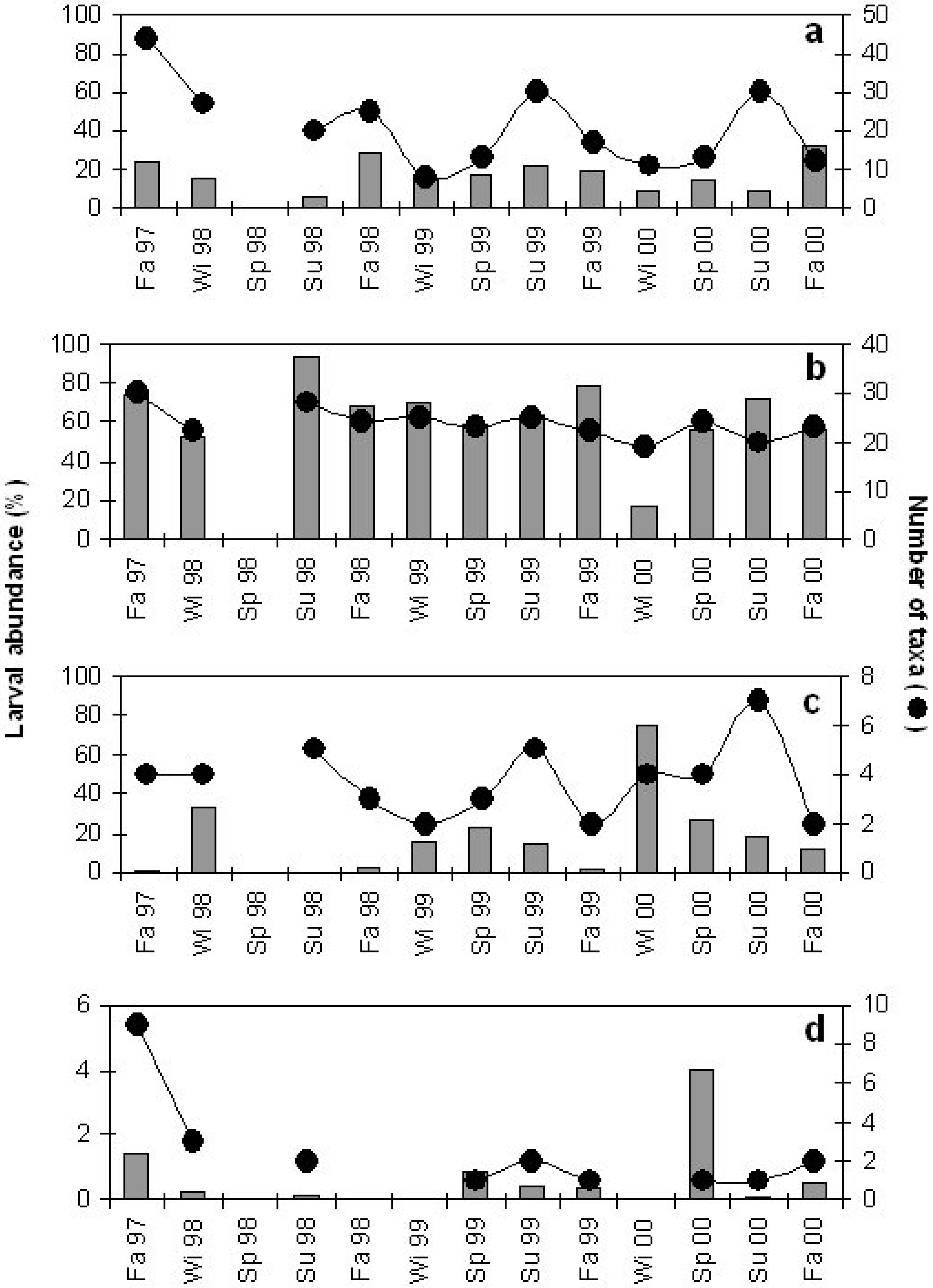

Figure 3. Habitat composition of fish larvae taxa collected in Bahía Sebastián Vizcaíno and the adjacent oceanic region from September 1997 to October 2000. (a) Demesal taxa. (b) Mesopelagic taxa. (c) Coastal pelagic taxa. (d) Epipelagic taxa. Fall (Fa); winter (Wi); spring (Sp); summer (Su).

ISSN: 1809-127X

LISTS OF SPECIES

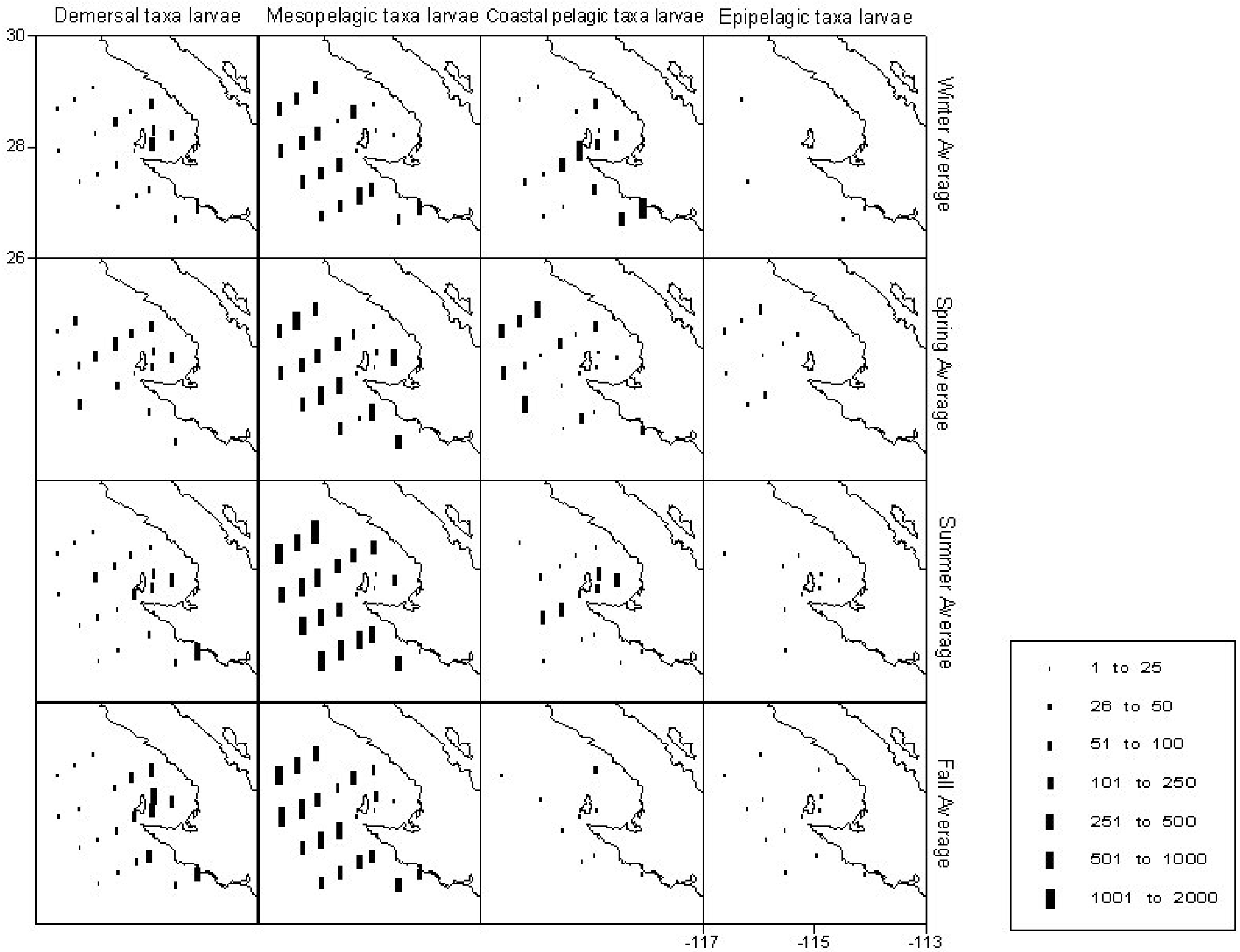

Figure 4. Fish larvae distributions by taxa habitat affinity in Bahía Sebastián Vizcaíno and the adjacent oceanic region, averaged by season from September 1997 to October 2000.

LISTS OF SPECIES

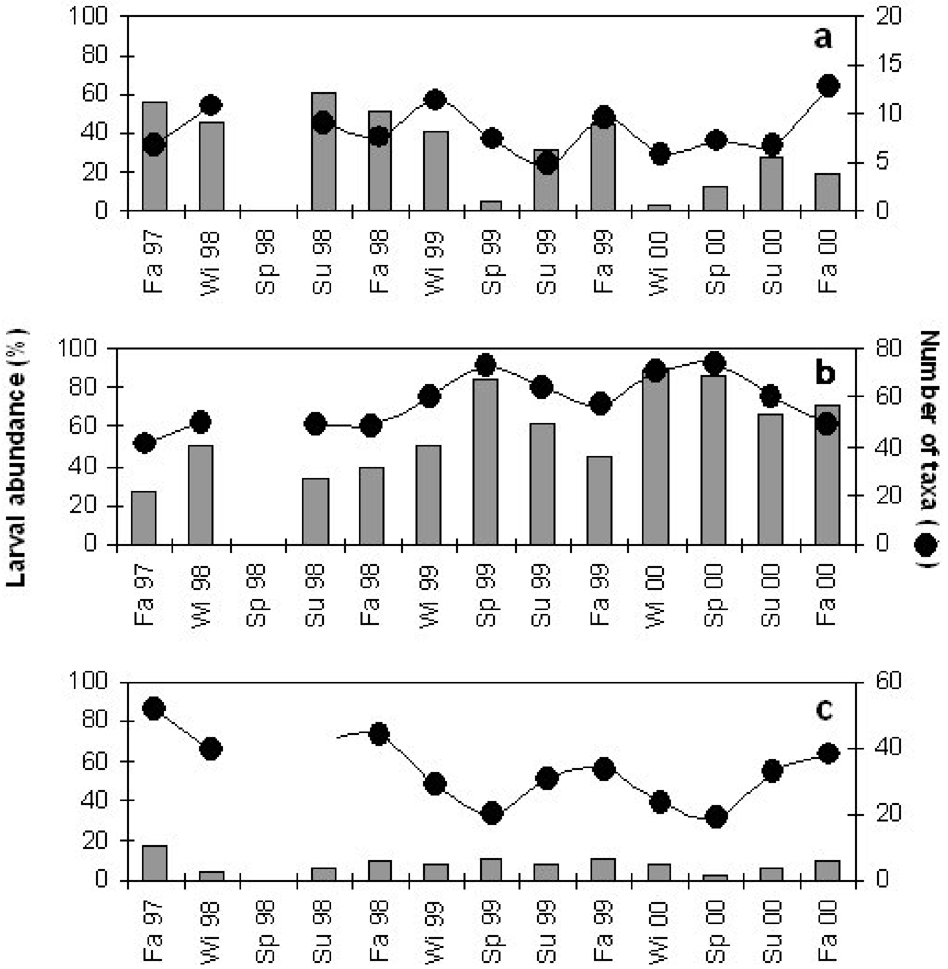

Figure 5. Affinity composition of fish larvae taxa collected in Bahía Sebastián Vizcaíno and the adjacent oceanic region from September 1997 to October 2000. (a) Tropical taxa. (b) Subarctic-Transitional taxa. (c) Subtropical taxa.

Discussion

Bahía Sebastian Vizcaíno is an area of high faunistic diversity in the California Current System. This is reflected in the elevated number of fish larvae taxa found during the study period. BSV and the adjacent oceanic region represent 32% of the IMECOCAL sampling area – from Ensenada, BC (~31º N) to the Gulf of Ulloa (~25º N), and from 20 nm to 60-80 nm offshore. Approximately 70 % of the total larvae taxa collected in all the sampling area of IMECOCAL (Spanish acronym for Mexican Investigations of the California Current) are present in BSV.

The large number of fish taxa found in the BSV area is consistent with that found by other authors, who agree that the Pacific Coast of the Baja California Peninsula has characteristics that allow mixing of Eastern Tropical, Central North Pacific, Subarctic, and Transitional taxa, all associated with the California Current (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).

LISTS OF SPECIES

Myctophidae and Phosichthyidae have high larval abundance as previously seen in diverse oceanic regions (Ahlstrom 1969; 1972; Loeb 1979; Moser et al. 1993; 1994; Aguilar–Ibarra and Vicencio–Aguilar 1994; Rodríguez 2000; Funes–Rodríguez et al. 2006). The presence of larvae of mesopelagic species in the area together with larvae of coastal pelagic and demersal species can be explained by both the inclusion of sampling stations outside the bay and the large interaction with oceanic waters. The only geographic characteristic that limits both regions is the Isla Cedros complex.

El Niño conditions were identified in the southern portion of the California Current during summer 1997 through summer 1998 (Lynn et al. 1998; Durazo and Baumgartner 2002). A transition to cooler conditions began in fall 1998 and persisted through 2000 as La Niña conditions weakened (Hayward et al. 1999; Durazo et al. 2001; Durazo and Baumgartner 2002). Fall 1997 had the highest number of taxa, but only one species accounted for 50 % of the total larval abundance, which resulted in low equitability. During winter and summer 1998, a warm period with low fish-larvae *H'* can be identified. Equitability during winter 1998 was low and only the larvae of two species contributed with more than 50 % of the total abundance. Summer 1998 had the highest larval abundances in all the sampling periods, but the lowest *H'* for the summers. Most of the larvae taxa had similar low abundances, whereas only the larvae of *V. lucetia* represented more than 50% of the abundance. This period was affected by an El Niño and no seasonal pattern can be identified. The only constant is the preponderance of *V. lucetia* larvae, which had been recorded previously by Moser et al. (1987).

The years 1999 and 2000 were similar. Many of the fish larvae were resident taxa of subarctic–transitional affinities. Tropical and subtropical taxa were more represented in the larval composition during summer and fall, but still tended to be less abundant than subarctic–transitional taxa. The assemblage as a whole during these two years showed a consistent seasonal pattern: high *H'* in spring and summer, when most of the fish taxa had their highest reproductive activity, and lower *H'* during fall and winter. This contrasts somewhat with that reported by Avendaño–Ibarra et al. (2004) in Bahía Magdalena, a coastal lagoon located south of the study area, who identified summer and fall as a warm period with high *H'* and winter and spring as a cool period with low *H'* values. Differences in the hydrodynamics of these two areas that promote smaller variations in sea surface temperatures between seasons compared with those recorded in Bahía Magdalena may explain the differences in timing of periods of the two bay systems. The high diversity of the demersal taxa in Bahía Magdalena, correlated with the great variety of habitats, causes strong changes in species composition between warm and cool periods (Avendaño–Ibarra el al. 2004). The taxa of larvae of warm temperate water are the most represented in Bahía Magdalena during the year, with an increase in diversity and abundance of tropical–subtropical taxa from late spring to summer (Funes–Rodrígues et al. 1998b; Avendaño–Ibarra el al. 2004).

During El Niño 1958–59 and 1982–1983, a large abundance of fish larvae of tropical taxa was measured along the Pacific coast of the Baja California Peninsula (Funes–Rodríguez et al. 1995; 1998a) and this was related to the influence of warm waters during these two events. In the present study the influence of El Niño was evident during fall 1997 with larval abundances more than twice higher when compared with fall 1998, more than four times higher when compared with fall 1999, and eleven times higher when compared with fall 2000. During fall 1997 taxa recorded were from 1.7 to 2.2 times greater than that in fall 1998–2000. Winter and summer 1998 also contrasted with other winter and summer seasons in larval abundances. Winter 1998 had triple the abundance of 1999 and 2000 and summer 1998 was two to three times higher than the abundance of summer 1999 and 2000. Larvae of tropical and subtropical taxa were the most abundant during El Niño and subarctic–transitional species were the most abundant in 1999 and 2000.

During winter 1998 larvae of tropical taxa accounted for more than 40 % of the total larvae and during winter 1999, after the El Niño, larval abundances of tropical taxa were slightly below 40 % of the total. These two winters contrast

LISTS OF SPECIES

strongly with winter 2000, when La Niña conditions weakened and tropical larvae were < 10 % of total larval abundance.

Lavaniegos and Jiménez–Pérez (2006) found a similar pattern in the copepod community structure of the southern portion of the California Current. They found that the species richness of copepods was higher during El Niño than during La Niña, observing an incursion of tropical epipelagic species, but during La Niña endemic transitional-zone species had a higher occurrence in the study area. Funes–Rodríguez et al. (2006) also found that during El Niño 1982–84 a larval group of tropical species was useful in distinguishing the event, whereas assemblages of larvae of temperate taxa characterized ‘normal years’ along the Pacific coast of Baja California Sur.

Because the larvae of mesopelagic taxa were among the most abundant and represented 20-40 % of the total taxa during all seasons, *H’* variations between seasons were low. In all seasons mesopelagic larvae were the most represented and also among the 10 most abundant taxa, and *V. lucetia* was consistent in all seasons. Winter 2000 was an exception to the predominance of mesopelagic taxa, when the coastal-pelagic species *E. mordax* accounted for nearly 2/3 of the total larvae.

Several commercial species spawn around the BSV area. The coastal-pelagic *S. sagax* is one of the most important and its populations are known to be affected by long-term climatic changes like El Niño and La Niña (Chavez et al. 2003; Lluch–Belda et al. 2003). During this study, larval *S. sagax*, a transitional species that spawns in the area year round with its highest abundance during summer (Moser et al. 1993; 1994) were collected in all seasons except for fall 1997, coinciding with the highest SST recorded. Only during 1998, again coinciding with a high SST annual average, larvae of this species were not among the most abundant taxa. Larval *E. mordax* were among the most abundant during winter, in agreement with Smith and Eppley (1982), who observed the highest abundances of *E. mordax* larvae in the California Current in winter and spring correlated with an increase of primary production and with minimal abundances recorded during El Niño. Larvae of *M. productus*, a subarctic–transitional species that spawns during winter and spring (Moser et al. 1993), were absent during winter 1998 and 1999 but abundant during spring 1999 and 2000. Results for these three commercial species are partially in agreement with those of Moser et al. (1987) and Funes–Rodríguez et al. (2002), who showed that once the warming events ended larval *S. sagax* and *M. productus* remained less abundant, but larval *E. mordax* increased. The exception in this study was that *S. sagax* larvae were the most abundant species during 1999 and 2000.

There are no records of *Opisthonema* spp. larvae being collected in the study area (Moser et al. 1993; 1994). The *Opisthonema* spawning season off the southern Baja California Peninsula is July–December, with highest larval abundance during summer (Moser 1996). Several postflexion larvae were collected in BSV in fall 1997 and preflexion larvae were collected in summer 1998. During an El Niño the northward–flowing countercurrent along the Baja California coast probably plays an important role in the limiting of the spawning habitat of the adults and in transporting larvae of warm water taxa to the north (e.g. Moser et al. 1987; Moser et al. 2001). Thus, the unusual presence of early larvae of *Opisthonema* spp. in BSV may imply local spawning, which would indicate northward movement of the adults during the warm conditions, whereas the presence of more developed larvae could indicate advection of them by the currents.

In conclusion, the large number of larval fish taxa found during this study is consistent with an interpretation of the high productivity of BSV and its adjacent oceanic region. In terms of hydrographic anomalies, larval diversity, equitability, and taxa composition, the 1997-98 El Niño seems to have been more notable than the 1998-2000 La Niña and was represented by a high proportion of tropical and subtropical taxa that contributed the highest larval abundances. Effects of the La Niña could have been partially dampened by the dominance of subarctic–transitional species year round in the area, but these effects were apparent in the greater than usual larval abundances of opportunistic species like *E. mordax*.

LISTS OF SPECIES

During 1999 and 2000, the seasonal variability was evident in the high larval fish diversity during spring and summer and low diversity during fall and winter, despite the interannual variability recorded during La Niña 1999. During El Niño 1997–1998 no clear seasonal pattern could be found in the larval fish assemblage.

Acknowledgements
This study was made within the framework of projects CONABIO SO97 and SIP20060927. The authors wish to thank CICIMAR–IPN/COFAA/EDI, CONACyT, and SNI authorities for their grants. The assistance provided by the scientific and technical staff from the B. O. Francisco de Ulloa and the Southwest Fisheries Science Center La Jolla, California, was of great value.

Literature cited

Aguilar–Ibarra, A. and M. E. Vicencio–Aguilar. 1994. Ictioplancton en la región del Domo de Costa Rica. Revista de Investigación Científica, Serie Ciencias Marinas 5: 47–54.
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.
Amador–Buenrostro, A., M. L., Argote–Espinoza, M. Mancilla–Peraza, and M. Figueroa–Rodríguez. 1995. Variaciones de periodo corto de la circulación anticiclónica en Bahía Sebastián Vizcaíno, B. C. Ciencias Marinas 21(2): 201–223.
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. CONABIO. 198 p.
Avendaño–Ibarra, R., R. Funes–Rodrígues, A. Hinojosa–Medina, R. González–Armas, and G. Aceves–Medina. 2004. Seasonal abundance of fish larvae in a subtropical lagoon in the west coast of the Baja California Peninsula. Estuarine, Coastal and Shelf Science 61: 125–135.
Bakun, A. and C. S. Nelson. 1977. Climatology of upwelling related processes off Baja California. California Cooperative Oceanic Fisheries Investigations Report 19: 107–127.
Beers, J. R. 1976. Volumetric methods: Zooplankton fixation and preservation, p. 56-60 in H. F. Steedmann (ed.), Monographs of Oceanic Methods. Paris: UNESCO Press.
Chavez, F. P., J. Ryan, S. E. Lluch–Cota, and M. Ñiquen. 2003. From anchovies to sardines and back: Multidecadal change in the Pacific Ocean. Science 299: 217–221.
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.
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., E. S. Herald, and H. Hammann. 1983. A field guide to Pacific coast fishes of North America. Houghton Mifflin Co. 336 p.
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(a). Larvas de peces recolectadas durante dos eventos El Niño en la costa occidental de Baja California Sur, México. Oceánides 13(1): 67–75.

LISTS OF SPECIES

Funes–Rodríguez, R., R. González–Armas, and R. Avendaño–Ibarra.1998(b) Distribución y abundancia de las larvas de peces en el sistema lagunar de Bahía Magdalena–Almejas, Baja California Sur, México. Hidrobiológica 8(1): 55–66.

Funes–Rodríguez, R., M. E. Hernández-Rivas, R. Saldierna–Martínez, R. González–Armas, A. Hinojosa-Medina, and R. Avendaño-Ibarra. 2000. Biodiversidad del Ictioplancton de Bahía Magdalena, Baja California, p. 35–37 in E. Ríos–Lara, E. Juárez–Carrillo, M. Pérez-Peña, E. López–Uriarte, E. G. Robles–Jarero, D. U. Hernádez–Becerril, and, M. Silva–Briano (ed.), Estudios sobre el plancton en México y El Caribe. México: SOMPAC–UG.

Funes–Rodríguez, R., C. Flores–Coto, A. Esquivel–Herrera, M. A. Fernández–Alamo, and A. Garcia–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.

Funes–Rodríguez, R., A. Hinojosa–Medina, G. Aceves–Medina, S. P. A. Jiménez–Rosenberg, and J. Bautista–Romero. 2006. Influences of El Niño on assemblages of mesopelagic fish larvae along the Pacific coast of Baja California Sur. Fisheries Oceanography 15: 244–255.

Froese, R., and Pauly D. (ed.). 2000. Fish base 2000: Concepts, design and data sources. Filipinas: ICLARM. 344 p.

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.

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.

Husby, D. M. and C. S. Nelson. 1982. Turbulence and vertical stability in the California Current. California Cooperative Oceanic Fisheries Investigations Report 23: 113–129.

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. USA Department of Commerce NOAA Technical Report NMFS, Circular 378: 38 p.

Lavaniegos, B. E. and L. C. Jiménez–Pérez. 2006. Biogeographic inferences of shifting copepod distribution during 1997–1999 El Niño and La Niña in the California Current, p. 113–158 in M. E. Hendrickx (ed.), Contributions to the study of East Pacific Crustaceans. México: Instituto de Ciencias del Mar y Limnología.

Loeb, V. J. 1979. Larval fishes in the zooplankton community of the North Pacific Central Gyre. Marine Biology 53: 173–191.

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., D. B. Lluch–Cota and S. E. Lluch–Cota. 2003. Scales of interanual variability in the California Current System: associated physical mechanisms and likely ecological impacts. California Cooperative Oceanic Fisheries Investigations Reports 44: 76–84.

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.

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

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

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. USA 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. USA California Cooperative Oceanic Fisheries Investigations Atlas No. 32. 181 p.

Moser, H. G. et al 2001. The CalCOFI ichthyoplankton time series: potential contributions to the management

LISTS OF SPECIES

of rocky-shore fishes. California Cooperative Oceanic Fisheries Investigations Reports 42: 112-128.

Rodríguez, J. M. 2000. Fish larvae from the Canary region in autumn. Scientia Marina 64(1): 79–85.

Shannon, C. E. and W. Weaver. 1949. The Mathematical Theory of Communication. USA: University Illinois Press. 144 p.

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

Smith, P. E. and R. W. Eppley. 1982. Primary production and the anchovy population in the southern California bight: comparison of time series. Limnology and Oceanography 27(1): 1–17.

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.

Wyllie, J. G. 1961. The water masses of Sebastian Vizcaino Bay. California Cooperative Oceanic Fisheries Investigations Reports 8: 83-93.

Received March 2007
Accepted August 2007
Published online August 2007