Zooplankton biomass and larval fish abundance during normal year and El Niño periods (1995-1998) in the central Pacific coast of Mexico

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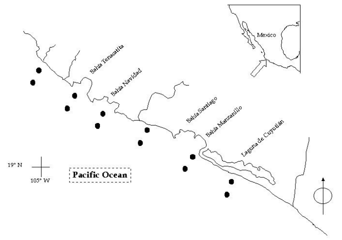
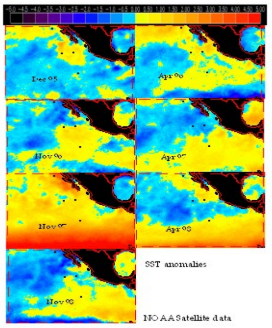


Introduction. The ENSO phenomenon is an irregular fluctuation that involves the entire tropical Pacific Ocean and global atmosphere. The 1997-1998 El Niño was by some measures the strongest of the 20th century and their consequences still are been surveyed. The knowledge about the El Niño and La Niña events has increased recently and the environmental variability in the Pacific Ocean is now well understood in global and regional scales, while the knowledge about ecological impacts in the marine habitats remain partial and spatially fragmented. For the time being the effects of ENSO events has been studied most intensively in Equatorial region and North American Pacific coast (40-60 N). During ENSO events a physical-biological coupling has been reported and some evidence of the prevalence of the seasonal environmental signal and of a coastal (nearshore) differential response of the ecosystem could be deduced from literature.

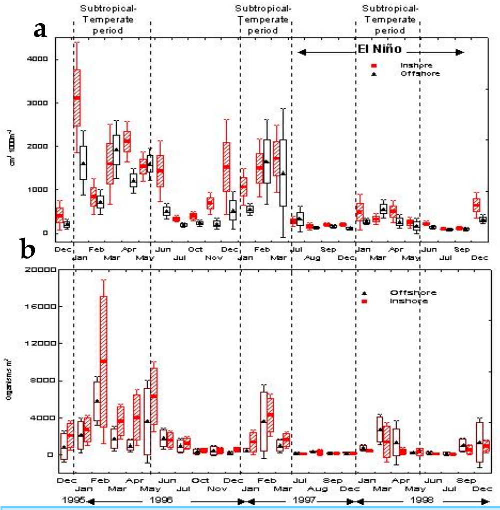
Methods

Zooplankton samples were collected monthly from December 1995 through December 1998. Samples were obtained using a bongo net (0.5 and 0.33 mm), and only the 0.5 mm net was analyzed. Plankton hauls were performed during night time (20:00-07:00 h) and were oblique, from a depth of 42-86 m to the surface at each station. Organisms measuring over 3 cm length were excluded from the samples; gelatinous zooplankters below this size were included in the biomass estimations. Temperature and salinity were measured at each station with a Seabird CB19 CTD profiler. Phytoplankton abundances were determined monthly at 25 m depth during 1998. Generalized linear models were used to determine the relation between environmental variability and zooplanktic biomass and larval fish abundances.

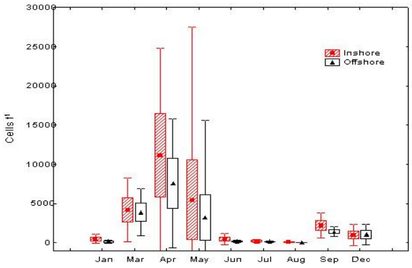


SST anomalies

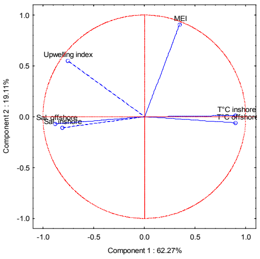
NOAA Satellite data



Similar variability can be observed in both a) zooplankton biomass and b) larval abundance. The time series shows three temporal patterns; a declining global trend, interannual changes defined by El Niño 1997-98 and seasonal variability related to hydroclimatic conditions.



Prevalence of normal hydroclimatic patterns during El Niño was observed in primary coastal production (phytoplankton abundance during 1998).



- -T°C at 10 m depth
- -MEI multivariate ENSO index (Wolter & Timlin 1993)
- -Upwelling Index (PFEL-NOAA)
- -Season (Franco-Gordo et al 2001a,b, 2002)
- -Distance (offshore-inshore)
- -Trend (sampling sequence)

The environmental variables employed in GLM´s were discriminated by Principal Component Analysis (PCA). Local temperature (10 m depth), MEI and Upwelling Index were selected and together with local hydroclimatic seasonality and the global trend constitute the spatiotemporal variables used.

Bregmaceros bathymaster

Most parsimonious models (GLM) builded by best subset Akaike information criterion procedure

	Var.	Var.	Var.	Var.	Var.	Var.	Var.	Degr. of freedom	p
Vinciguerria lucetia	MEI	Upwelling	T°C	trend	distance	season	1*2	9	< 0.01
Zooplanktic biomass	MEI	Upwelling	T°C	distance	season	1*2		8	< 0.01
Benthosema panamense	MEI	Upwelling	T°C	trend	distance	season		7	< 0.01
Gobionellus sp	MEI	Upwelling	T°C	trend	season	1*2		7	< 0.01
Lujanus spp.	MEI	Upwelling	T°C	trend	distance	season		7	< 0.01
Syacium ovale	MEI	Upwelling	T°C	trend	distance	1*2		7	< 0.01
Euthynus lineatus	MEI	Upwelling	T°C	trend	distance	season		6	< 0.01
Harengula thrissina	MEI	Upwelling	T°C	trend	distance	season		6	< 0.01
Auxis sp.	MEI	Upwelling	T°C	trend	1*2			5	< 0.01
Pomacentridae	MEI	Upwelling	T°C	distance	season			5	< 0.01
Engraulidae	MEI	Upwelling	T°C	distance				3	< 0.01
Sciaenidae	MEI	Upwelling	T°C					1	< 0.01
Gobidae	MEI	Upwelling	trend	season	1*2			7	< 0.01
Larval fish abundance	MEI	Upwelling	distance	season				5	< 0.01
Bregmaceros bathymaster	MEI	Upwelling	distance	season				5	< 0.01
Dormitator latifrons	T°C	1*2						3	< 0.01

1*2 = Distance*season interaction

MEI, Upwelling Index and local T°C (10 m) were the most influent variables. Trend, distance and season and the interaction of season and distance constituted a secondary group. Broad scale interannual processes appear to control environmental variability, however local, both temporal and spatial, signals are still perceived in coastal primary and secondary production and larval fish abundance

Parameters of Generalized Lineal Models fitted, a) Zooplankton biomass, larval fish abundance and most abundant larval fish species, b) important fisheries

a	Level of effect	Zooplanktic biomass	Larval fish abundance	*Auxis* sp.	*Benthosema panamense*	*Bregmaceros bathymaster*	*Dormitator latifrons*	Gobidae	*Gobionellus* sp	*Harengula thrissina*	*Syacium ovale*	*Vinciguerria lucetia*
Interc		7.73	6.39	-88.81	66.66	6.19	5.67	4.29	3513.30	158.15	6.43	-21.30
MEY		-0.46	-0.80	4.33	24.36	-0.95	0.10	0.41	88.20	23.44	0.49	1.25
Upwelling		0.00	0.01	-0.11	-0.02	0.01	0.00	-0.01	-5.23	0.10	-0.01	-0.01
Temperature		-0.06	0.00	3.40	-2.19	-0.01	-0.10	-0.30	-127.89	-6.41	-0.47	0.86
Trend		0.00	0.00	-0.94	-3.50	0.02	0.00	0.32	-12.36	-3.59	0.36	-0.16
Distance	Inshore	0.28	0.14	0.28	-0.85	0.11	-0.03	-0.17	-56.51	1.51	-1.01	-0.62
Season	Ttransition	0.06	-0.02	0.71	8.29	0.03	-0.04	-0.06	46.20	23.51	0.03	0.34
Season	Calif. Current	0.49	0.39	13.60	2.94	0.47	0.23	0.73	7.40	-53.71	0.62	3.45
Distance*season	1	0.18	-0.03	0.49	-0.14	-0.06	0.09	-0.48	57.63	2.37	-0.54	-0.26
Distance*season	2	-0.23	0.12	-0.85	0.07	0.15	-0.24	0.36	-41.43	1.48	0.64	0.32
Scale		580.38	1552.23	7.21	21.44	1513.52	29.66	10.72	9.62	38.80	5.12	17.35

b	Level of effect	*Caranx* spp.	Engraulidae	*Euthynus lineatus*	*Lujanus* spp.	Pomacentridae	Sciaenidae
Interc		4.95	-0.32	-68.62	-64.62	-88.40	51.76
MEY		24.61	-35.19	13.32	2.66	0.77	-67.34
Upwelling		-0.03	0.07	-0.05	0.02	-0.02	0.13
Temperature		0.19	-0.27	2.01	1.23	2.78	-3.35
Trend		-3.92	-2.41	-0.98	1.09	0.42	-0.50
Distance	Inshore	-0.43	-0.08	-0.23	1.12	-1.56	-0.47
Season	Ttransition	8.17	-11.40	3.91	-0.99	-4.35	4.11
Season	Calif. Current	7.88	-6.37	8.01	-4.11	8.58	-25.81
Distance*season	1	0.50	-2.88	0.12	-0.81	-2.29	-0.20
Distance*season	2	-0.61	1.93	-0.22	1.78	0.66	1.95
Scale		6.99	47.12	23.37	10.53	14.36	17.38

significant parameters $p < 0.05$

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