Main effects of the 1997-1998 ENSO event in the tropical coastal ecosystem in the Mexican central Pacific

Godínez-Domínguez[1,2], E., Franco-Gordo C[1,2]., Lucano-Ramírez G [1]., Ruíz-Ramírez S [1]., Rojo-Vázquez J.A.[1], & Freire J.[2]

[1,] Centro de Ecología Costera, Universidad de Guadalajara. México. egodinez@costera.udg.mx

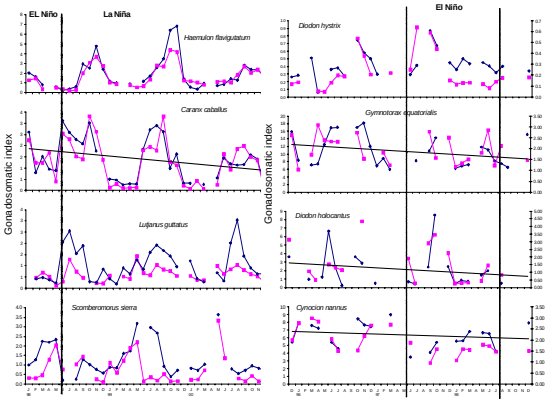
[2,] Departamento de Bioloxía Animal, Bioloxía Vexetal e Ecoloxía, Universidade da Coruña. Spain

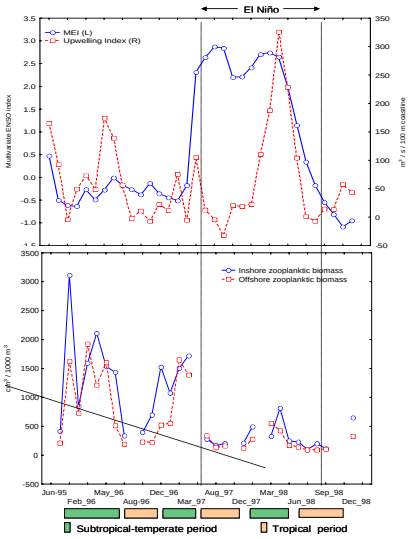
Introduction

The 1997-1998 El Niño was by some measures; the strongest of the 20th century and their consequences still are being surveyed. The ENSO phenomenon is an irregular fluctuation that involves the entire tropical Pacific Ocean and global atmosphere. ENSO itself consist of an unstable interaction between sea surface temperature (SST) and atmospheric pressure. It results in variations in winds, rainfall, thermocline depth, circulation, and ultimately in biological productivity, and in the feeding and reproduction of fish, birds and mammals. The declination of the primary and secondary production during the El Niño produce an empoverishment of the ocean and changes in the coastal ecosystem. Changes in the species composition and spatial distribution are expected, however the effects in the fish reproductive activity and the midle-term consequences for populations still keep unknown.

The first effect of the 1997-98 El Niño event

The physical-biological coupling has been reported as the main initial effect of El Niño, represented by a reduction of nutrient availability, and a subsequent decline of secondary production.The strongest and the most rapid effects appeared at lower trophic levels. A clear cascade effect with no lag can be observed with the start of the El Niño event and the drastic decrease of the zooplanktic biomass and larval fish abundance.





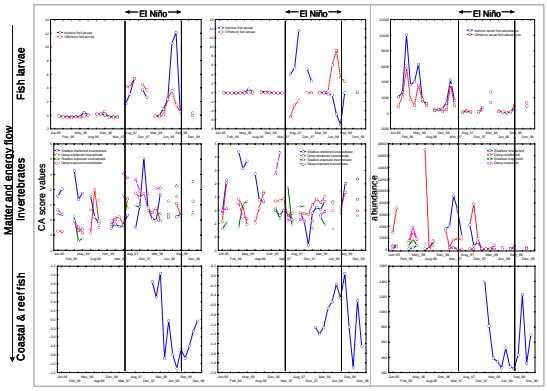
The decline of the zooplanktic biomass during the El Niño event evidence the physical-biological coupling, which affect with no lag to larval fish abundance. The seasonal signal in biomass and larval abundance remain during the El Niño event.

Source of ecosystem data

Variables	Sampling design		Methods	Biodiversity
	Inshore	Offshore		
Zooplankton biomass	X	X	Oblique tows in a 12 station net	
Ictioplankton assemblages	X	X	500 microns mesh size bongo net	137 taxa
Macroinvertebrate	Shallow (20-40 m)	Deep (60-80 m)	Tows on soft bottoms with	
	sheltered | exposed	sheltered | exposed	shrimp trawl gear. 1 ha sampled per tow	
Biomass	X X	X X		
Assemblages	X X	X X		230 species
Coastal and reef fishes	Sand, and hard bottoms (rocky and reef)		Gillneting with several mesh size nets	
Biomass	X		(7.62, 8.89, 10.16 and 11.43 cm mesh size)	
Assemblages	X			188 species
Fish reproductive activity	Continental shelf soft bottom & Hard bottom and reef		Gonadosomatic index	8 species

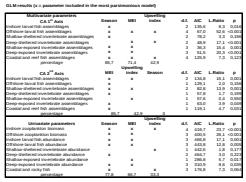
Analysis

Dimensionality of species matrices was reduced using the scores values of the first two axis of a correspondence analysis CA. A generalized linear model was employed to determine the most influent environmental variables during the previous El Niño 1997-1998 and during El Niño event. The reproductive activity of the fish community was surveyed using the gonadosomatic index GI.

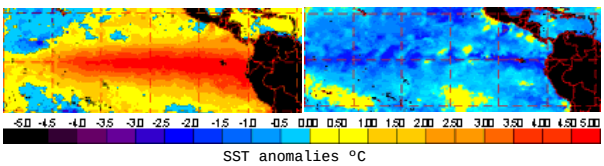


Effects in the fish reproductive activity

During the El Niño, a reduction in reproductive activity (expressed as the gonadosomatic index GI) was observed for most of the fish species; the rest of species showed no effects and inclusive some few species increased their reproductive activity. Most of the species showed an increase of the reproductive activity during La Niña 1998-1999. Abundance was correlated with the GI and a strong recomposition of species was observed during El Niño and La Niña event. The affinity of adults by some environmental conditions together with the differentiated reproductive activity and the diferent capacity of the larvae to survive in extreme environments (empoverished or enriched), constitute the main forces to model the fish communities in the coastal ecosystems and resilience.



El Niño 1997-1998 La Niña 1998-2000



SST anomalies ºC

The variability of the species composition (CA Axis 1 and 2) of larval fish assemblages evidence the effects of the El Niño event, while that of the invertebrate and fish could reflect the consequences of changes in spatial distribution that affect their catchability. The main changes in the invertebrate and fish abundance support the environmental-behavioural coupling. In the exposed site (both shallow and deep areas) abundance decreace strongly during El Niño, while in the sheltered, shallow area the abundance increase previous to the start of El Niño, and decrease sharply in the first phase of El Niño. In the deep, sheltered area invertebrate abundance decrease aproximately at the half of the El Niño period.

The GLM analysis in both uni- and multivariate (first axis of CAs) ecosystem parameters shows that the main source of temporal variability is related to normal seasonality, which is maintained in our data as a attenuated signal during El Niño event. The second CA axes are related clearly to the ENSO event. Besides CA axes 2 could explain the assemblage variability associated to El Niño, no significant cross-correlations were found between fish and invertebrates at any lag indicating that there were no cascading effects. The species recomposition caused by the ENSO can be related with the specific response of the different ecosystem components to environmental changes. In fishes, changes in their movements patterns associated to food searching, are the most frequently observed. Reports abouth the response of the soft-bottom invertebrates are scarce, however the observed shift to more coastal and sheltered areas could indicate a response similar to fishes.

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