

## Biogeographic inferences of shifting copepod distribution during 1997-1999 El Niño and La Niña in the California Current

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**ABSTRACT.**- Geographic distribution is provided for the 72 most common copepod species observed in waters off Baja California through the period 1997-1999. In that time the region was subject to extreme changes as the rest of the Pacific basin due to El Niño event, which was followed by a rapid shift to La Niña conditions. Multidimensional Scaling ordination analysis was used to define general spatial patterns. Species were clearly separated in climatic groups. The major cluster corresponded to species covering an extensive area during El Niño (October 1997 and January 1998) disappearing thereafter, or drastically retreating to oceanic locations (e.g. *Undinula darwini*), or southward (e.g. *Pareucalanus attenuatus*). A second assemblage, less copious in species, showed a relative continuous occupancy of the area, increasing the coverage even more during La Niña (January and April 1999). In this group were the endemic species of the Transition-Zone as *Calanus pacificus*, *Eucalanus californicus* and *Rhincalanus nasutus*, as well as subarctic species (e.g. *Neocalanus cristatus*) and other broadly distributed in the central Pacific (e.g. *Pleuromamma*). Other species were scantily represented in warm and cold extremes of the study period, with one cluster showing higher coverage during the warm relaxation phase after El Niño (July 1998), and others in the prelude to cool conditions (October 1998). Most of the species congregated in La Niña group are known for some type of adaptation to regulate their vertical position in the water column, either by seasonal or daily long-distance vertical migration. In contrast most of the "invasive" species are epipelagic, and would be transported with the tropical water and further swept by the renewed strength of the California Current. Most of the cyclopoid and poecilostomatoid copepod species showed an El Niño-type distributional pattern or some climatic relaxation-phase pattern. The biogeographic status of the different species is discussed.

Key words: Copepods, California Current, El Niño, La Niña, biogeography.

Palabras clave: copépodos, corriente de California, El Niño, La Niña, biogeografía.

### Introduction

Copepods are the most abundant and diverse invertebrates of the macrozooplankton. Planktonic communities of the California Current System (CCS) are particularly rich in copepod species due the confluence of temperate and tropical faunas. The CCS spans 27 degrees of latitude displaying a gradual physical and biological transition between subarctic and tropical waters. Coalescing with this gradient is an even stronger gradient from coast to ocean, driven by coastal upwelling (Lynn & Simpson 1987). The cooling of coastal waters extends the distribution of temperate species farther

south than in any other area in the North Pacific. Both north-south and east-west gradients have complex time and space interactions and variability at different scales (seasonal, interannual, decadal, etc.).

Winds, circulation, and stratification of the water column change seasonally in the CCS. The strongest winds and equatorward flow occurs in spring-summer and the highest stratification takes place in fall-winter (Hickey 1979, Lynn & Simpson 1987). The physical environment and biological processes of the CCS are sensitive to interannual changes (Chelton et al. 1982). During the warm phase of the El Niño Southern Oscillation (ENSO),