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Community structure of near-surface zooplankton in the northern California Current in relation to oceanographic conditions

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Abstract

We analyzed how near-surface zooplankton are distributed in the northern California Current, not only in space and time but also with reference to species assemblages, habitat characteristics, and environmental factors. The community structure, spatial distribution patterns, and environmental associations of near-surface zooplankton from June and August 2000 GLOBEC cruises were examined. Crab megalopae, hyperiid amphipods, euphausiids, and chaetognaths dominated the near-surface zooplankton community during both cruises. A geostatistical approach was used to determine that near-surface zooplankton concentrations differed spatially and quantitatively between June and August. Near-surface zooplankton concentration was spatially patchy during June, with the highest levels occurring nearshore in various locations throughout the study region. In August, zooplankton concentration was more uniformly distributed; however, higher concentrations were observed north of Cape Blanco. During June, zooplankton species richness was spatially patchy, whereas in August, species richness was more uniformly distributed throughout the study area. Highest values were observed during June in localized areas along the coast, with lowest values observed further offshore near the shelf break at 200 m. During August, species richness was highest nearshore south of Cape Blanco; yet in the north, higher values extended across the shelf and further offshore. To explore patterns in community structure, we applied cluster analysis, indicator species analysis, and nonmetric multidimensional scaling (NMS) ordination to both data sets. Cluster analyses differentiated taxa by inshore and offshore location in the first division and by latitude in the second division. Results from NMS confirmed the cross-shelf zonation of near-surface zooplankton, with sea-surface temperature the most consistent environmental parameter explaining the distributions. An offshore assemblage of zooplankton was entrained in an eddy and transported onto the shelf in August.

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1. Introduction

The California Current is a dynamic and highly productive ecosystem, characterized by substantial spatial and temporal variability. The macrozooplanton and ichthyoplankton of this system have been intensely studied for several decades off Central and Southern California as part of the CalCOFI sampling (Moser et al., 1987; Roemmich and McGowan, 1995) and also off central and northern Oregon by researchers at Oregon State University (Peterson and Miller, 1975, 1977; Richardson and Pearcy, 1977; Morgan et al., 2003). The biota from the area between these regions, namely the southern Oregon and northern California coast, have received considerably less attention until the recent US GLOBEC Northeast Pacific Program (NEP) cruises (Peterson and Keister, 2002). The main goal of the NEP is to understand biophysical mechanisms through which zooplankton and salmon populations respond to physical forcing and biological interactions in the coastal regions of the northern California Current (Batchelder et al., 2002).

The near-surface zooplankton, represent a group of organisms adapted to a unique environment. This habitat often contains concentrated food resources that are utilized by early life stages of many species of fish (Kingsford and Choat, 1986; Brodeur, 1989). A substantial number of near-surface collections have been made in the northern California Current, and the geographic distributions of many taxa have been described. However, with the exception of Brodeur et al. (1987) most studies within this geographic region have concentrated on only one or two taxonomic groups in their analyses (Shenker, 1988; Doyle, 1992). What is known is that the main environmental factors affecting zooplankton assemblages include water temperature, nutrient concentrations, and salinity. Increased nutrient concentrations typically correspond with increased phytoplankton abundance, which can have an effect on zooplankton. Secondary production is dependent upon primary production, and therefore changes in primary production leads to changes in the distributions and abundances of zooplankton species (Francis et al., 1998).

During summer 2000, we collected near-surface zooplankton at multiple stations at which we also trawled for juvenile fish (Brodeur et al., 2004). We examined the composition of these near-surface samples and the distribution of dominant key taxa (those greater than 5 mm) relative to the environment. We compared our results to the study done in the mid-1980s (Brodeur et al., 1987; Brodeur, 1989) to examine changes in species abundance and distribution patterns. Finally, we compared the community structure of these taxa, particularly with respect to cross-shelf and north-south differences. Cross-shelf zonation of zooplankton between northern California and British Columbia has been observed in Euphausiacea and Copepoda (Peterson and Keister, 2002; Morgan et al., 2003; Gómez-Gutiérrez et al., 2005). The typical pattern observed is one of a nearshore and offshore zone, with a gradual transition between. Similarly, substantial latitudinal differences in species associations were observed in this study region, particularly with respect to Cape Blanco, a prominent geographic feature of the region (Peterson and Keister, 2002). These distributions, however, were established using either a full water-column sampling effort (vertical net tows) or oblique tows with a large vertical component. Distributions of zooplankton in the very upper water column, the neuston, have not been investigated in this regard. Thus, the objectives of this study were to (1) describe the near-surface community composition and structure off the Oregon and Northern California shelf, (2) identify species patterns associated with cross-shelf and north–south gradients, and (3) describe environmental parameters that may best correlate with patterns in species distribution.

2. Methods

2.1. Field sampling

Near-surface zooplankton tows were conducted at each trawling station as part of a mesoscale and fine-scale sampling study within the US GLOBEC NEP program. Eighty-five collections were made from May 29 to June 11 (hereafter called the June