SEASONAL PATTERNS OF PHYTOPLANKTON COMMUNITIES IN THE ALBORAN SEA

M.C. García-Martínez *, J.M. Mercado , M. Vargas-Yáñez , F. Moya , T. Ramírez
Instituto Español de Oceanografía. Centro Oceanográfico de Málaga.Puerto Pesquero s/n. 29640. Fuengirola. Málaga - mcarmen.garcia@ma.ieo.es

Abstract
The changes of the phytoplankton communities in an upwelling area of the Alborán Sea (Western Mediterranean Sea) during an annual cycle and its relation to physical and meteorological forcing have been explored. The spring peak of chlorophyll a was associated to the increased abundance of diatoms and small flagellated cells while pico-phytoplankton cells accounted for a sharp increase of chlorophyll a in fall. The Shannon index for the micro-plankton increased from spring to summer and declined afterwards. The seasonal changes in the community taxonomic structure were linked to the annual hydrological cycle.
Keywords : Alboran Sea, Phytoplankton.

Introduction
The northwestern area of Alboran sea is characterized by a high seasonal variability in its hydrological structure due to deep mixing of the water column in winter and a strong stratification in summer. Nevertheless, the presence of superficial cores of colder and saltier water than the surface Atlantic is common, which toprovides evidence of the almost permanent influence of a geostrophic front where deep Mediterranean water is upwelled [1]. This upwelling is fuelled by the Atlantic jet coming in throughout the Strait of Gibraltar, although several other mechanisms also contribute to it, mainly the westerlies which intensify the upwelling.
Many previous studies indicate that the chlorophyll a concentration in the northwestern Alboran Sea is higher than in other Mediterranean regions, which has been assumed to be correlated to high microplanktonic abundances. Concordantly, an annual spring peak of chlorophyll and micro-phytoplankton cell abundance associated to more favourable upwelling conditions during this period has been described [2, 3]. However, a seasonal pattern in micro- and nano-phytoplankton taxonomic composition has been not described. Moreover, during the period 2000-2002, a reduction in the microplankton abundance was noticed, although a decline in chlorophyll a was not detected. This suggests that the pico- and nanoplankton contribution to the phytoplanktonic biomass may be important, at least during some periods.

Materials and methods
Three shelf bread stations were sampled during four surveys (July 2005, October 2005, January 2006, May 2006). Samples were collected from surface to 100 m water depth (0, 10, 20, 50, 100 m) and preserved in glutaraldehyde (for cytometric studies) and lugol (microscopy). In addition, different amounts of sample were filtered through 0.7-, 2- and 20-μm filters for spectrophotometric determination of chlorophyll a. Moreover, CTD profiles were taken at each station.
The taxonomic composition of the largest fraction of the phytoplankton (2-200 μm) was determined with an inverted microscope using Utermöhl technique. The smaller fraction (<2 μm) was estimated by flow cytometry. Wind data and satellite images were also analysed.

Results
The hydrological structure of the Alboran sea during the four surveys was strongly influenced by the meteorological conditions, from a strong stratification in summer to a complete destratification in winter induced by winds. In spring and fall, the upwelling was intensified, as deduced from satellite images and wind data. Two peaks of chlorophyll a concentration were obtained (in spring and fall) although the phytoplankton composition was quite different. During the spring bloom, the abundance of diatoms of the genera *Leptocylindrus, Rhizosolenia and Pseudonitzchia* was elevated (Figure 2). In contrast, the fall bloom was mainly caused by an increase of the pico- and nanoplankton size-fractions, particularly due to *Synechococcus* (Fig. 1). The microplankton spring peak coincided with the lowest abundance of pico- and nanoplankton while the fall peak was characterized by a very low microplankton abundance.
The Shannon index was calculated for the four surveys on the basis of the relative abundance of the identified microplanktonic groups. The results indicate an decrease in diversity from summer (when the highest value was reached) to spring, indicating that the spring bloom is due to the growth of a few genera (H=2.756) .

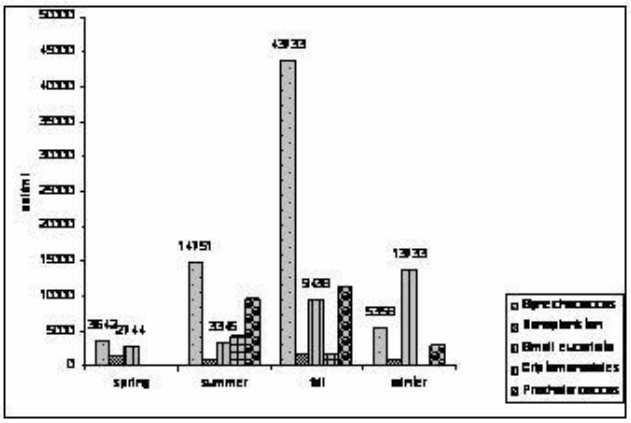

Fig. 1. Seasonal concentration of pico- and nanoplankton (cells/ml).

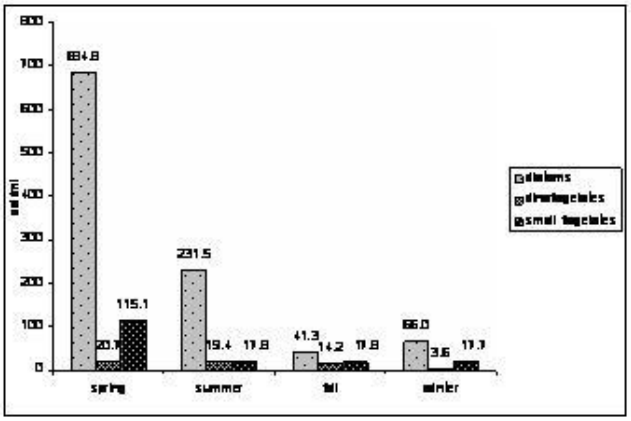

Fig. 2. Seasonal concentration of microplankton (cells/ml).

References
1 - Sarhan,T.; Lafuente,J.G.; Vargas,M.; Vargas,J.M.; Plaza, F.;2000.Upwelling mechnisms in the northwestern Alboran Sea. *Journal of Marine Systems* 23, 317-331
2 - Mercado,J.M., Ramirez, T.; Cortés, D; Sebastián, M.;Vargas-Yáñez, M.(2005). Seasonal and Inter-annual variability of the phytoplankton communities in an upwelling area of the Alborán Sea. (SW Mediterranean Sea). *Scientia Marina*, 69(4), 451-465
3 - A.Reul,V.Rodriguez, F.Jimenez, J.M.Blanco,B.Bautista,T.Sarhan, .Guerrero, J.Ruiz, and J.Garcia Lafuente.Variability in the spatio-temporal distribution and size-structure of phytoplnkton across an upwelling area in the NW-Alboran Sea, *Continental Shelf Research*, 25,2005.