

# THE SPATIAL ZOOPLANKTON DISTRIBUTION IN THE NORTH BALEARIC FRONT (WESTERN MEDITERRANEAN): EARLY SPRING, 2005

Maria Luz Fernandez De Puellas \*, Ana Morillas , Eva Alou Font and Laura Vicente

Centro Oceanografico de Baleares. Muelle de poniente s/n .07015 Palma de Mallorca Spain - mluz.fernandez@ba.ieo.es

## Abstract

During the early spring, 2005, the micro and mesozooplankton have been analyzed in northern waters off the Balearic islands and related to the main physico-chemical properties of the sea surface water (EFLUBIO cruise). A frontal structure separating the Atlantic from the Mediterranean waters was clearly observed all along the northern part of the Mallorca and Menorca islands (North Balearic Front) which strongly affected the distribution of the main zooplankton groups. Acting those surface water masses as a boundary for the zooplankton structure. Into the mesozooplankton, the copepods were the most abundant group (86%) followed by the appendicularians (9%) and the nauplii into the microzooplankton (77%). A higher abundance of micro and mesozooplankton was observed in the northern area in relation to the higher salinity and enrichment of nutrients, meanwhile the larger organisms exhibited their higher abundance in the southern area. The most pronounced differences were observed for the group of the copepods. To understand the Balearic Sea productivity the impact of the frontal system on the distribution on zooplankton communities is analyzed.

**Keywords :** *Balear Sea, Copepoda, Fronts, Western Mediterranean, Zooplankton.*

## Introduction

The Balearic islands are a geographical barrier into the Western Mediterranean that keeps two sub-basins apart, the Gulf of Lions and the Algerian basin, where different waters masses of northern and southern origin meet. Therefore, the Balearic sea form a hydrographic boundary influenced by all these different waters in the surface [4,5]. The channels between the islands are strategic areas where the different waters masses all flow through. The physical-biological interactions have been studied in other forward areas but little information exists on this relationship in the western Mediterranean [2]. The maximum zooplankton abundance occurs in spring in the Balearic sea [3]. The main goal of this study was to examine the relationship of the frontal system on zooplankton community, spatial distribution and composition.

## Material and Methods

From March 16th to 30th, 2005 a large survey of 77 stations (EFLUBIO project\*) was carried out in the surface waters of the Balearic Sea. We present here the main results of the zooplankton community (micro and mesozooplankton) in relation to the hydrographic conditions around the frontal system found in the area. Satellite images were taken every day for temperature and chlorophyll a, only when the weather allowed it. CTD (SBE 911 plus profiles were taken previously each zooplankton haul. Mesozooplankton was sampled by a triple WP2 net, 200  $\mu\text{m}$  mesh and the microzooplankton by a double Calvet net 53  $\mu\text{m}$ , by means of vertical hauls from 100 m depth to the surface. and the data shown as abundance (ind m<sup>-3</sup> and %). Hydrographic samples for oxygen, nutrients and chlorophyll data were collected by a Rosetta with 10 L Niskin bottles at depths of 0, 25, 50, 75, 100 and 200 m depth.

## Results and Discussion

**Physical environment-** Compared with the last 20 years surface temperature data showed an extremely cool late winter with no spatial gradient and values below 13.5°C in the 100 m upper layer. Salinity, however, exhibited a clear gradient between the Atlantic waters (AW <38.0 PSU), just flowing up close to the north Balearic islands (limited by 40°15N; and 4°30'E) and the further northern Mediterranean surface waters (MSW >38.2 PSU). Moreover, the dynamic topography confirmed the frontal boundary and the current direction. According to the salinity data, an obvious frontal system was observed in the area (NW-SE) and further northeast of Menorca island a filament southward of cool northern waters. The front produces a convergence between the two water masses with a sinking of the denser northern waters where the convective movement was intense. In the southern part of the front the overlapping of more oxygenated and less dense Atlantic Waters produced a vertical density gradient which made the mixing difficult. In the eastern part, the northern filament performed a divergence zone. The highest nutrient concentrations and less oxygen Mediterranean waters were related to the upwelling generated by the previous polar event (March, 2006) in the area and the later relaxed wind forcing which favored the inflow of Atlantic waters in the area. In relation to that nutrients and oxygen concentrations also depicted the frontal system in the upper 100 m layer.

The chlorophyll a also showed an intense gradient between both water masses regardless of whether small (<20  $\mu\text{m}$ ) or large phytoplankton cells

were analyzed [1]. According to such late winter situation in the Mediterranean Sea, very unusual high values (>2  $\mu\text{g l}^{-1}$ ) for the studied area were found in the northern part of the front. In contrast, very poor but more oxygenated waters were found in the southern part which were influenced by the recent Atlantic waters (<1  $\mu\text{g l}^{-1}$ ).

**Zooplankton** - The zooplankton distribution was related to the hydrographic features and both, micro and mesozooplankton, depicted the frontal system. The microzooplankton was 3 times more abundant than the mesozooplankton but accounted for only 10% total biomass. Copepod nauplii and small copepods were the most abundant (75%) into the microzooplankton and both of them were separated by the highest salinity gradient with higher amount of nauplii in the northern part of the front. Copepodites and others, however, were more abundant in the south. In the mesozooplankton the copepods (86%) were the most important group in all the area. The larger size groups but less abundant such as, appendicularians (8%), siphonophores (2%), chaetognaths and doliolids (2%) were more abundant closer to the islands, in those waters less saline and where the convective movements were less important .

More than 50 copepod species were identified in the upper layer of the North Balearic front (0-100 m) and the 25 most abundant species indicated their preference for different properties of the water masses. *Oithona* and *Clausocalanus* were the most abundant copepods (50%). The smaller *Clausocalanus spp.* were the most important species (22%), followed by *Ctenocalanus vanus*, *Calocalanus styliremis*, *C. arcuicornis*, *Paracalanus parvus* and *Centropages typicus* (>1%). Besides the previously mentioned groups, the copepods such as *Nannocalanus minor*, *Ctenocalanus vanus*, *Mecynocera clausi*, *Farranula rostrata* were more abundant in the warmer AW. Meanwhile on the other hand, the smaller copepod nauplii and the bulk of larger Copepods, such as *Calanus helgolandicus*, *C. entropages typicus*, *Euchirella rostrata* and *Paracalanus parvus*, showed their higher preference for the most saline waters.

## References

- 1 - Fernandez de Puellas, M.L., Alou E-A., Jansa, J., Morillas, A., Vicente, L., Aparicio, A., Amengual, B. & J.L. Lopez-Jurado, 2006. Zooplankton distribution in the Balearic Sea Front during an early cool spring 2005. *ASLO summer meeting Victoria (Canada)* June 2006.
- 2 - Fernández de Puellas M.L., Pinot J.M. & Valencia J. 2003. Seasonal and interannual variability of zooplankton community in waters off Mallorca island: 1994-1999. *Oceanolog. Acta*, 26: 673-686.
- 3 - Fernández de Puellas M.L., Valencia J., Jansá J & A. Morillas, 2004. Hydrographic characteristics and zooplankton distribution in the Mallorca channel (W.M). *ICES J. Mar. Sci.*, 61: 654-666.
- 4 - Garcia E., Tintoré J., Pinot J.M., Font J. & M. Manriquez, 1994. Surface circulation and dynamic of the Balearic Sea. Seasonal and interannual variability of the WM Sea. *Coast. Estuar. Stud.*, 46: 73-91.
- 5 - Pinot J.M., López-Jurado J.L. & R. Riera, 2002. The CANALES experiment (1996-1998). Interannual, seasonal and mesoscale variability of the circulation in the Balearic Channels. *Progr. Oceanogr.* 55 (3-4): 335-370.