INTERANNUAL AND BATHYMETRIC VARIATIONS IN BODY SIZE OF *CALANUS HELGOLANDICUS* (COPEPODA: CALANOIDA) DIAPAUSING POPULATIONS IN THE NORTH AEGEAN SEA

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Abstract
Significant interannual differences in abundance and size distributions of diapausing *Calanus helgolandicus* populations were observed between four years in the North Aegean Sea (NA) implying a strong variability in the physical regime during the reproduction period. Moreover, a clear increase of mean size with depth was evident in all diapausing populations, possibly related to the overwintering depth selection of the individuals.
Keywords : Aegean Sea, Copepoda, Deep Waters.

Introduction
Calanus helgolandicus comprises an important part of the zooplankton biomass in the offshore as well as coastal European waters and presents an interesting vertical distribution pattern during its life cycle [1]. The North Aegean Sea, in Eastern Mediterranean, forms a suitable area for the study of this species due to its topography (a deep basin close to the continental shelf) and hydrology (Black Sea Water influence).

Materials and Methods
Stratified mesozooplankton sampling was carried out in September 1989, 1997, 2003 and in July 2004 over the Lemnos deep basin (max. depth 1640m) in the North Aegean Sea with a vertically towed WP2 net (200 μm). More details for the sampling layers are shown in Fig.2. Total and relative abundance of *C.helgolandicus* copepodite stage V (CV) were estimated. Prosome length (PL) of up to 400 individuals (CV only) was determined in each sample under a stereomicroscope (accuracy $\pm$40 μm).

Results and Discussion
C. helgolandicus was the dominant species in mesozooplankton below 500 m during all cruises, whereas it was absent in the upper 200 m. Mean abundance values of the population below 500 m (18 ind.m^{-3}, 19 ind.m^{-3}, 104 ind.m^{-3} and 20 ind.m^{-3} in 1989, 1997, 2003 and 2004 respectively) were the highest reported in the Mediterranean for diapausing populations of the species [1], thus indicating the existence of favorable conditions during the reproduction period (December-May) at the surface layer [1].
Mean values and range of *C.helgolandicus* PL varied significantly among years (Fig.1). Highest values were observed in 2003 (PL=2.10$\pm$0.12) whereas lowest in 1989 (PL=1.91$\pm$0.14). Temperature and food are considered as the two main factors controlling body size in copepods [2], hence we may assume that their interannual variability in the surface layer during winter/spring, influenced the body size, as well as the abundance of the species. Temperature variability is expected in the study area due to the seasonal and annual variability of the BSW (colder and less saline than Aegean Sea water) outflow intensity and circulation [3]. Variability in food concentration is also expected as the presence of BSW creates a permanent thermohaline front, strongly affecting phytoplankton and zooplankton biomass [4].
A significant increase (ANOVA & SNK tests) in mean prosome length with depth was evident in the overwintering populations (Fig.2). This gradual increase might be indirectly related (mainly through stored lipids) with the maintenance of neutral buoyancy during diapause. The maximum amount of stored lipids has been correlated with PL in *C.finmarchicus* [5] and the depth of neutral buoyancy is strongly affected by the amount of lipids in diapausing organisms [6]. Thus, in our case, a possible scenario is that bigger animals, assuming they have stored more lipids, attain neutral buoyancy at greater depth. Supporting evidence comes from *C. finmarchicus* in the Gulf of Maine [5] where a strong separation in oil-sac fullness between depths was evident in the 0-100 m layer and the authors conclude that "*Strong sorting* (i.e. in oil-sac fullness or size with depth) *apparently requires availability of depths greater than 100 m.*". However, further investigation is needed for any safe conclusions on this topic.
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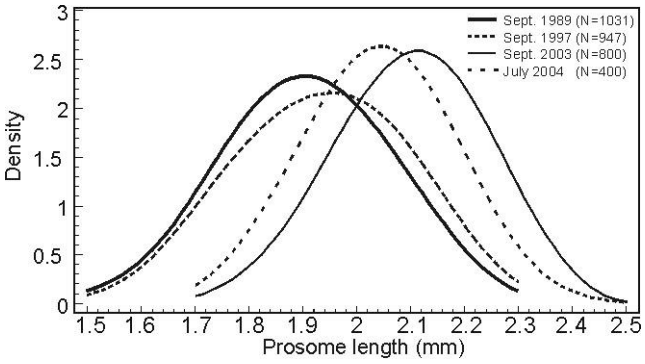

Fig. 1. Prosome length distributions of *C. helgolandicus* CV.

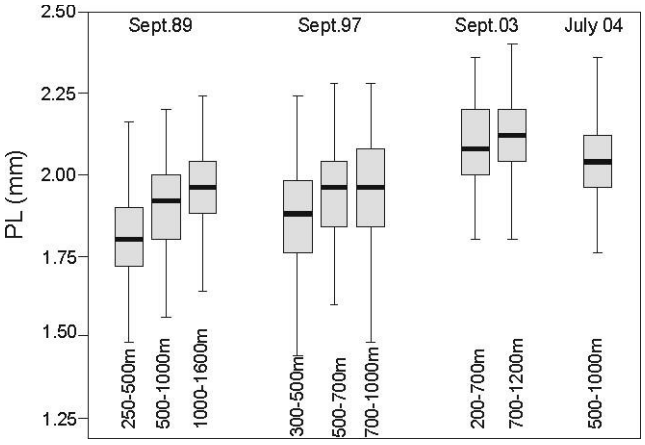

Fig. 2. Box plot graphs of *C. helgolandicus* PL in different years and layers.

References
1 - Bonnet D. et al., 2005. An overview of *Calanus helgolandicus* ecology in European waters. *Prog. Oceanog.*, 65: 1-53.
2 - Escribano R. and McLaren I.A., 1992. Influence of food and temperature on lengths and weights of two marine copepods. *J. Exp. Mar. Biol. Ecol.*, 159: 77-88.
3 - Poulos S.E., Drakopoulos P.G. and Collins M.B., 1997. Seasonal variability in sea surface oceanographic conditions in the Aegean Sea (Eastern Mediterranean): an overview. *J. Mar. Sys.*, 225-244.
4 - Zervoudaki S., Nielsen T.G., Christou E.D. and Siokou-Frangou I., 2006. Zooplankton distribution and diversity in a frontal area of the Aegean Sea. *Mar.Biol.Res.*, 2: 149-168.
5 - Miller C.B., Grain J.A. and Morgan C.A., 2000. Oil storage variability in *Calanus finmarchicus*. *ICES J. Mar. Sci.*, 57: 1786-1799.
6 - Visser A.W. and Jonasdottir S.H., 1999. Lipids, buoyancy and the seasonal vertical migration of *Calanus finmarchicus*. *Fish. Oceanogr.*, 8 (Suppl. 1): 100-106.