ESTIMATION OF THE GREEK COASTAL ZONE CONTAMINATION BY THE MEANS OF BIOINDICATORS

Vassiliki - Angelique Catsiki [1]*, Caterina Tsangaris [1], Evangelia Strogyloudi [1] and Francois Galgani [2]
[1] HELLENIC CENTRE FOR MARINE RESEARCH - cats@ath.hcmr.gr
[2] IFREMER

Abstract
The contamination of the Greek coastal zone was investigated in the framework of the Programme MYTIMED (INTERREG IIIb - MEDOCC). Caged mussels were transplanted in 38 sites along the Greek coastline. Measured contaminant levels in caged mussels were similar to those from previous studies and achieved to differenciate contaminated and unpolluted areas. Mussels from Saronikos and other gulfs were the more contaminated, followed by Ionian sea, North. Central and Eastern Aegean areas had intermediate concentrations and South Aegean and Libyan areas had the lowest. Biomarker's and metal's statistical analysis showed similar results with small exceptions. However biomarker's and bioaccumulation's results are complementary and offer different information for the environmental status of a site.
Keywords: Bio-Accumulation, Metals, Bio-Indicators, Monitoring

Introduction
The contamination of the Greek coastal zone was investigated in the framework of the Programme MYTIMED (INTERREG IIIb - MEDOCC). The Programme aimed evaluating the chemical quality of Eastern Mediterranean exploiting the active biomonitoring qualities of mussels [1].

Materials and methods
Caged mussels originated from an aquaculture in Saronikos gulf, were transplanted in 38 sites along the Greek coastline in depths ranging from 20 to 30 m and occasionaly deeper for a period of 3 months. Metals (Cu, Ni, Mn, Zn and Fe) and biomarkers (Metallotheioneins, Acetylholynesterase, Catalase and Glutathione-S-Transferase) were determined in 4-5 pooled replicates from each station. The standardisation of metallic results was based on the condition index, while biomarker results were not standardised.

Results and discussion
The recovery of cages reached 92%: only 3 cages couldn't be collected. Mortality was less than 20% that is similar to previous studies [2]. Concentration of metals expressed in µg/g dry weight ranged from 2.33 to 5,81 for Cu, 1.61 to 7,56 for Ni, 38 to 233 for Zn, 1,76 to 11,0 fro Mn and 38 to 182 for Fe. Metallothioneins ranged between 94 and 225 µg/g tissue, Acetylholynesterase activities between 165 and 326 U/mg protein, Catalase activities between 0,7 and 3,59 U/mg protein and Glutathione-S-Transferase activities between 35.9 and 70.4 nmoles CDNB/mg protein.

Generally the measured contaminant levels in caged mussels were similar to those from previous studies in native populations [3], [4], [5] and achieved to describe differences between contaminated and unpolluted areas Fig 1.
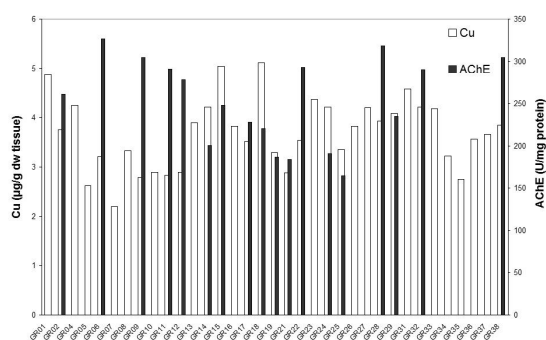

Fig. 1. Average values of Cu and AChE in transplanted mussel samples along Greece

In order to simplify the data we grouped the sampling stations in 8 groups as follows: Ionian sea, North Aegean, Central Aegean, South Aegean, east Aegean, Liberian Sea, Saronikos gulf, and Gulfs (Korinthiakos, Thermaikos, Evoikos and others gulfs). Analysis of variance between the 8 metal datasets showed similar results for all metals and revealed statistically significant differences among the 8 areas ($P<0.05$) Saronikos and the other gulfs being the more contaminated, followed by Ionian sea stations. North, Central and Eastern Aegean areas had intermediate concentrations while South Aegean and Libyan areas had the lowest. Biomarker's statistical analysis showed also similar results for all of them. Although the observed differences among the areas were not statistically significant, the obtained pattern was similar with that of metals, with the exception of Libyan stations witch showed stress. The above phenomenon could possibly be attributed to other kind of stress than contaminants, since the used species reached there its geographical limits.
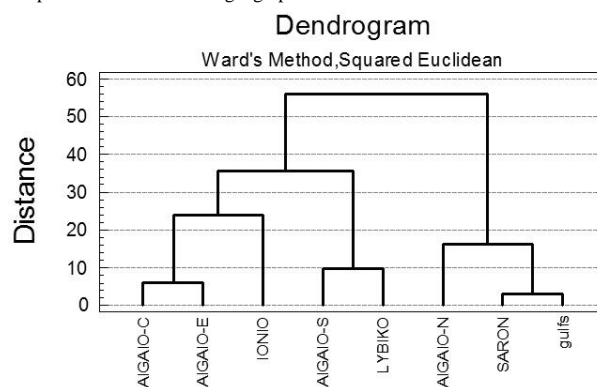

Fig. 2. Cluster of mean values of measured parameters per main geographical Greek area

The clustering of data (Fig 2) -containing mean values of each parameter per geographic area was in accordance with ANOVA analysis foundlings. However we have to note that biomarker's and bioaccumulation's results are complementary and offer different information for the environmental status of a site.

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