CIESM Mediterranean Mussel Watch Program Phase II: towards an increased awareness of marine environment and seafood quality

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The oceans are a prime source of food for mankind. Contamination of seafood by radionuclides and toxic contaminants represents a serious threat to human health and a major economic concern.

In order to protect the health of seafood consumers, many countries have set guidelines for the maximum permissible levels of toxic pollutants in seafood (e.g., European Communities, 2001). Although such guidelines are essential for public health protection, other problems arise when guidelines are not met, which may lead to dramatic economic impacts on people and companies making their living out of sea resources. It is therefore of prime importance to monitor the levels of key contaminants in the coastal zone, where most fishery and farming activities are carried out. This is especially true for bivalve molluscs, such as mussels, oysters and scallops. While fishing and farming of these organisms represents a multi-billion Euro worldwide industry (Ifremer, 2002), these organisms may easily become unsuitable for human consumption due to their well known ability to accumulate very large amounts of pollutants even in scarcely contaminated environments. Measuring and monitoring pollutant levels in organisms, i.e. *bio-monitoring* these levels, represents the only method that takes into account and integrates all those changes in the water quality which may influence the accumulation of pollutants in seafood and, ultimately, their possible transfer to mankind via seafood consumption.

Monitoring programs were historically conceived to control the quality of the marine environment without special emphasis on how contamination of the media could potentially impact the health of edible organisms and mankind. However, during the past few decades there has been increasing evidence of the existence of a deep, mutual relationship between the health of the environment and that of mankind. Strict environmental monitoring activities have thus adopted an ecosystem-based approach, and "Mussel Watch" programs have been developed following this innovative concept.

The first Mussel Watch program was implemented in the USA during the mid 1960s by the US-EPA (Goldberg, 1975) in order to monitor levels of heavy metals and organochlorines, and more recently those of several biochemical parameters in marine coastal waters. Nowadays, the US Mussel Watch is coordinated by NOAA and has been extended to Latin America in the early '90 (Tripp *et al*., 1992). The bivalve species used to biomonitor these regions are the blue mussel

Mytilus edulis and the Californian mussel *M. californianus* along the North Atlantic and the Pacific coasts, and the American oyster *Crassostrea virginica* in the Gulf of Mexico and Southern Atlantic (Cantillo, 1991).

Several European countries have implemented similar national Mussel Watch programs (e.g. France, Italy, Spain). For instance, in France IFREMER developed the "Réseau National d'Observation (RNO)" in 1974 to assess the levels of metals, organochlorines, and PAH along the French coastlines. Biota (the mussels *M. edulis* and *M. galloprovincialis* and the oyster *C. gigas*) are collected twice a year in about one hundred sampling sites (passive biomonitoring) (RNO, 2005). In a second phase, the "Réseau Intégrateur Biologique (RINBIO)" has been implemented in 1996 to monitor the concentrations of chemicals and radiochemicals in organisms caged for several weeks prior to collection (active biomonitoring) (Andral *et al*., 2004).

Despite the presence of several ongoing national programs, no large-scale Mussel Watch network was coordinated at the Mediterranean level until 2002, when CIESM developed and implemented a regional "Mediterranean Mussel Watch (MMW)", using the mussel *M. galloprovincialis* as a bioindicator species (CIESM, 2002a).

The CIESM MMW program was originally conceived with two main objectives: a) to develop an international trans-Mediterranean infrastructure of cooperating scientists and laboratories aiming to monitor levels of selected contaminants in coastal waters; b) to document reliable baseline levels of radionuclides in the Mediterranean and Black Sea coastal waters. Some 20 marine environmental laboratories from 15 different Mediterranean countries are now involved in this international, dynamic network, the first in the region specifically designed to monitor radionuclides before its extension to other selected pollutants. A major step was achieved by the end of 2004, when a specific reference material (AIEA-437) was used to carry out a large inter-comparison exercise across the entire Network. The production and testing of this external standard was financially supported and coordinated by IAEA-MEL and IRSN. Currently, samples from about 50 sites have been analyzed. On the basis of these results, the MMW network has been able to produce the first distribution map of Cesium-137 at the regional level.

After the successful outcome of the Phase I of the MMW program, it is now time to undertake Phase II. This second stage foresees the extension of the survey and monitoring activities to additional radionuclides and selected trace- and emerging-contaminants. In addition, the network will be extended to five additional Mediterranean countries in order to guarantee the monitoring coverage of the entire basin (Figure 1).

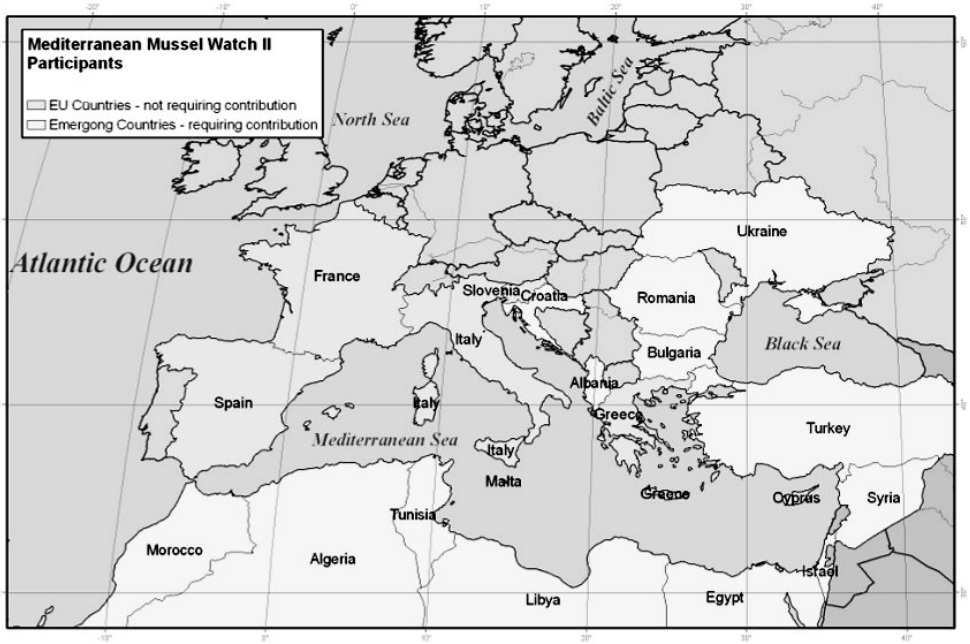

Fig.1. Countries participating to the Mediterranean Mussel Watch II project.

Trace contaminants such as arsenic (As), cadmium (Cd), copper (Cu), lead (Pb), zinc (Zn), silver (Ag) and mercury (Hg) are naturally occurring elements ubiquitously found in the marine environment; however, human activities, such as industry, agriculture and mining, can dramatically increase their levels in all the abiotic and biotic compartments of the marine environment. Polonium-210 (Po-210) is a radioactive element that occurs naturally in very low concentrations in the marine environment, but due to its use in static eliminators and its occurrence as by-product of phosphate fertilizers and phosphoric acid industries, Po-210 represents a potential health hazard in many marine coastal areas. In recent years, the presence in the marine environment of many chemical and microbial constituents that were not historically considered as contaminants has been increasingly reported (e.g. new generation pesticides, pharmaceutically active compounds, antibiotic, emerging pathogens). These *emerging contaminants* cause known or suspected adverse ecological and(or) human health effects (Alvarez-Cohen and Sedlak, 2003).

Therefore, the main goal of the Mediterranean Mussel Watch II (MMWII) is to exploit its well established scientific international network to assess the extent and severity of contamination of the coastal waters of the Mediterranean Basin with respect to the above mentioned chemicals, with special emphasis on emerging contaminants. Indeed, after its international workshop convened in 2004 to summarize the current state of the knowledge on the problems arising from new kinds of contaminants (CIESM, 2004), CIESM is now ready to pioneer this novel research activities along the Mediterranean coastal areas.

Measurements of chemicals in the marine environment are often subject to large errors both in terms of precision and accuracy. Therefore, one fundamental effort will be devoted to enable a constructive use of the data collected in the present program by reducing these errors to such a degree that the data from the different Institutions involved a) be comparable among each others and b) realistically reflect the status/changes of Mediterranean coastal waters. For this purpose, the MMWII will be subject to a strict Analytical Quality Control Service (AQCS), which will include: (1) an inter-comparison exercise involving all the laboratories of the Network; (2) the routine analysis of selected reference materials (NIST-SRM 2976 for the mussel and IAEA-433 for the sediment) by each participant laboratory.

Within the framework of the program, an active collaboration (expertise and/or funding) with IAEA-MEL, WHO (Geneva) and MED-POL will be developed.

Results obtained from Phase Two will reliably map the current distribution of Polonium-210 and that of the selected trace- and emerging-contaminants in wild and transplanted mussels across the entire Mediterranean Basin. The scientific outcomes of the project will be published in international scientific journals, and be made accessible to broader audience as well. All data produced by the participants will be synthesized in a CIESM database, where they will be fully available on-line to all concerned parties. This unique dataset will provide critical information on the particular issue of seafood safety for human health, fishing and aquaculture.