Organochlorine residue content in Red Mullet (*Mullus barbatus*) from the Greek Seas

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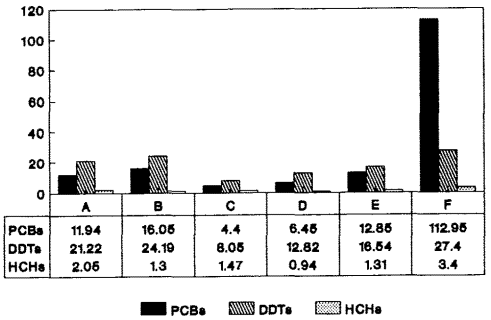
Organochlorine compounds, such as PCBs, DDTs, HCHs, along with technical impurities and metabolites belong to the most persistent and toxic pollutants in the environment, and accumulate in adipose tissues of marine organisms. In order to study the extent of the damage caused to fish in various locations of the Greek Seas and detect differences between them, their concentrations were determined in the flesh of red mullet, a quite abundant and commercially important fish species of the Greek Seas.

Fig. 1 : Map showing location of sampling stations (A : Alexandroupolis, B : Chios, C : Rhodos D : Canea, E : Preveza F : Aegina).

Samples were collected at six locations (Fig. 1) from 1988 to 1991. Organochlorine concentrations were determined according to the procedure proposed by SATSMADJIS *et al.*, (1988). GC analysis was performed by a GC equiped with a 63 Ni electron capture detector and a fused Silica DB-1 Megabore Column 30 m long (i.d. 0.53 mm) operating isothermally at 217°C.

The higher mean concentration of total PCBs (112.95 ppb) was found off Aegina Island (area F) and the lowest (4.4 ppb) off Rhodes Island (area C) (Fig. 2). The latter area, located in the southwestern Aegean Sea, exhibited also the lowest PCBs value during the 1986-1988 survey (GEORGAKOPOULOS-GREGORIADES and VASSILOPOULOU, 1990). The observed difference between the present PCBs value in area F and that in 1986-1988 could be possibly attributed to different sampling location; in 1986-1988 sampling took place in the SW part of Aegina Isle, whereas in 1989-1991 in the NE part of the island which is in the proximity of the Athens central sewage outfall. Areas F and C presented respectively the highest (8.05 ppb) and the lowest (3.3 ppb) DDTs values.



	A	B	C	D	E	F
PCBs	11.94	16.05	4.4	6.45	12.85	112.95
DDTs	21.22	24.19	8.05	12.82	16.54	27.4
HCHs	2.05	1.3	1.47	0.94	1.31	3.4

Fig. 2 : Mean concentrations of PCBs, DDTs, HCHs (ppb on a wet weight basis) in the flesh of red mullet in the six locations of the Greek seas

In all cases, the main component of DDTs was p,p'-DDE (Fig. 3), due to its higher persistence in relation to the other DDT metabolites (OLSSON, 1977). HCHs ranged from 3.4 ppb (area F) to 0.94 ppb (area D).

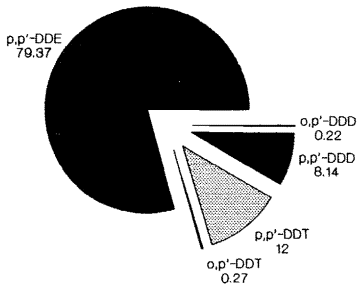


Fig.3 : Proportion % of the DDT metabolites in the flesh of red mullet.

The fact that the ratio PCBs/DDTs is less than 1 at the areas A, B, C, D, E possibly indicates that atmospheric transport is the main source of pollution, while at area F being 4.12, reveals the industrial origin of pollution, which was expected since the latter site is geographically close to the city of Athens and to the industrial zone of Elefsis.

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Biological responses of mussels transplanted in a heavy metal polluted environment of North Tyrrhenyan Sea

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Many studies have indicated that trace metal concentrations in mussels reflect the condition of the environment (review by PHILLIPS, 1980), and this is the reason why they are often chosen as "bioindicators" for monitoring programs.

It has also been outlined the importance of investigations on the biological effects of pollutants which could possibly relate the level of pollution in the environment with the health conditions of the organisms.

However, biological responses to heavy metals (such as accumulation and excretion, cellular and physiological effects..) have been usually studied in laboratory conditions and seldom in field experiments.

In this work, control mussels *Mytilus galloprovincialis*, obtained from a marine farm, were transplanted in plastic cages to a heavy metal polluted site of the North Thyrrhenian Sea (Scarlino), and removed by SCUBA diving at each sampling time.

Analysis of heavy metals revealed a strong accumulation in the digestive gland of transplanted mussels. After 1 week concentrations increased from less than 2 µg/g to 60 µg/g for Pb, from 19 to 100 µg/g for Mn, from 600 to 4000 µg/g for Fe. These high levels of metals in Scarlino are related to the presence of factories which produce sulphuric acid and titanium dioxide from pyrites and titanium minerals.

A "digestive gland index" was calculated as the ratio between digestive gland and shell weight. Variations of this d.g. index reflect changing digestive gland weight, shell being considered a much less variable parameter.

Figure 1 shows "d.g. index" in mussels from the farm and in those transplanted to Scarlino.

During the gametogenesis, the digestive gland is progressively penetrated by gonadal tissues, this determining the increase of digestive gland weight and, consequently, of the "d.g. index" observed in control mussels (Fig. 1A). This is confirmed by the fact that the highest values of the d.g. index were observed just before spawning period, when gonadal development is maximum.

The initial decrease of the "d.g. index" in transplanted mussels (Fig. 1B) indicates a loss of weight by this organ. This fact probably reflects the presence of defence mechanisms, such as a decrease of filtration rate, which reduce the exposure to metals (with obvious consequences on the nutritional state of the organisms), as well as the presence of a general stress induced by the environmental conditions.

The "d.g. index" resulted always lower in transplanted than in control mussel, this indicating the persistance of stress by heavy metals.

Furthermore, low values of the d.g. index in transplanted organisms also indicate a reduced gonadal development as a consequence of a low availability for gametogenesis of energy reserves which are rapidly utilized during stress period (THOMPSON *et al.*, 1974).

Responses to heavy metals were investigated also at the subcellular level where a severe disfunction of the lysosomal compartment was observed (REGOLI, 1992).

Transplanted mussels showed a reduced lysosomal membrane stability, the presence of enlarged secondary lysosomes and an enhanced production of lipofuscin in tertiary lysosomes.

These subcellular alterations as "early warning systems" can reveal a toxicity of pollutants before damages shift to higher levels of biological organization, and they could be used in monitoring programs as early biomarkers of stress.

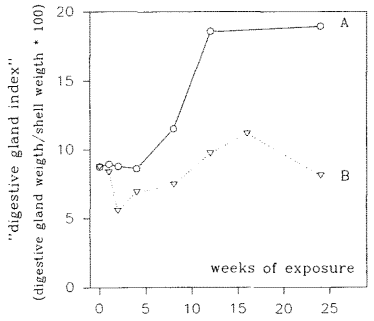

FIGURE 1

A) Control mussels
B) Transplanted mussels

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