Comparison of heavy metal levels in native and cultured mussel *Mytilus galloprovincialis* (L, 1758) from the Bay of Izmir (Aegean Sea/Turkey)

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Introduction

In the marine ecosystem, heavy metals occur in the water mass, suspended particles, sediment and biota. The use of biological indicators to monitor environmental contamination by trace metals has many advantages over the measurement of metals in water samples, since their content of pollutants harmful to marine life represents a time integrated image of the bioavailability of a pollutant which is not affected by short term fluctuations in sea water. Trace elements, when discharged to the marine environment, will be transported by prevailing currents and removed by either physical, chemical or biological processes. Through absorption, ion exchange and complexing of chelation, trace elements are filtered by marine bivalves and picked up by particulate organic matter and settle on the bottom. So marine bivalves and their environment, i.e. bottom sediments are known to accumulate high levels of metals, and are commonly used in monitoring studies.

More than 3 million people live around Izmir, which is located at the western end of Anotolia. Parallel to the population inflation, there is a rapid increase, in fisheries, industrial and commercial activities.

The domestic and industrial wastes of this densely populated settlement enter to the Bay water. Since 1999 50-60% of these wastes are treated in the sewage plant called "Big Channel". The untreated waste waters of Izmir city consist of factory discharges (leather, textiles, food, detergents, beverages, chemicals, etc.). All these wastes dumped into the sea have an adverse effect both on the sea organisms and the water quality. Izmir Bay has become an important marine pollution focus point in Turkey.

The aim of this study is to compare the present status of heavy metals in the economically important native and cultured mussel *Mytilus galloprovincialis* (L, 1758) and in their living environment, i.e. bottom sediments.

Study Area and Methodology

Izmir Bay, situated in the western coast of the Aegean Sea, lies between the latitudes 28°20' 38°42' N and longitudes 29°25' 27°10' E. From the topographic and hydrographic point of view it is divided into the inner, middle and outer, bay regions (Fig. 1). During October 1998-September 2000, samples of mussel (*M. galloprovincialis)* of about 6 cm length were collected

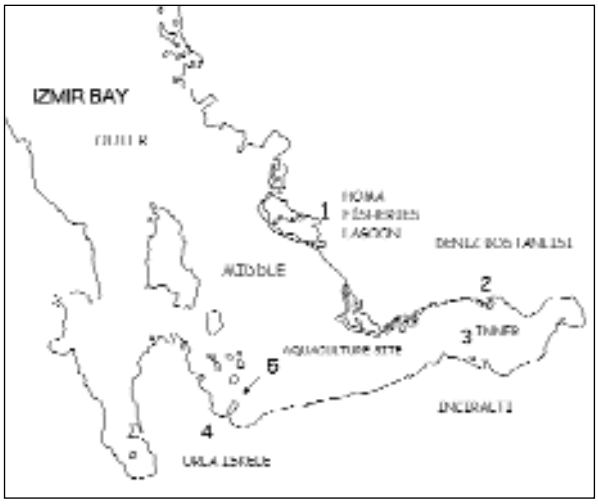

Fig. I. Map of sampling locations.

monthly by hand from the ropes at aquaculture site and four different sampling stations in the Bay of Izmir and on rocks in the shoreline of Izmir bay. Immediately after collection, the shell was cleaned and the soft part samples were made from 20 individuals, which had been carefully rinsed with abundant distilled water in order to eliminate sediment and other impurities. Then these samples were kept in a deep freeze (-21°C) until analysis and were prepared according to international standard methods (Bernhard, 1976). The composite samples of mussels were weighed and digested with conc. HNO_3: $HClO_4$ (5:1) (extra pure Merck) under reflux and filtered.

Sediments were collected monthly with an "Orange peel" grab of capacity 4,5 l from these sites at the same time and then stored plastic bags at -21°C. Each sediment sample was oven dried at -60°C for 24h and then sieved using a mesh. From the dried sediment samples an aliquot of 1g. (< 160 μ) was oxidized with 10ml., conc. HCl:HNO_3 (3:1) (extra pure Merck) under reflux at 120°C for two hours and then filtered through Whatman 40 filter paper. All samples were diluted with bi-distilled water and analyzed (Arnoux *et al*., 1981). Metal samples were analyzed by Atomic Absorption Spectrophotometer using a 2380 Perkin-Elmer (AAS). Metals were determined by direct aspiration using an air acetylene flame. Intercalibration homogenate samples (IAEA-142/TM for mussel, IAEA-314 for sediment samples from the IAEA, Monaco Laboratory) were used as a quality control for the analytical methodology.

RESULTS IN MUSSEL TISSUES

The concentrations of some heavy metals (Pb, Cd, Cu, Zn, Ni) in the tissues of the Mussel *M. galloprovincialis* were determined separately from different regions of Izmir Bay. Minimum, maximum and mean levels of heavy metal in native and cultured mussel tissues are given in Table 1.

Table I. Minimum, maximum and average levels of heavy metal in M. galloprovincialis (L, 1758) from different regions of Izmir Bay (mg/g.wet weight).

Stations	Pb	Cd	Cu	Zn	Ni
Homa Fisheries Lagoon (1)	0.61-1.40	0.15-0.56	0.32-2.30	9.55-26,05	0.38-1.19
	1.08	0.40	1.40	18.72	0.68
Deniz Bostanlisi (2)	0.58-1.82	0.41-1.12	0.82-3.25	13.20-30.60	0.30-1.32
	1.20	0.68	1.54	21.75	0.82
Inciralti (3)	0.62-1.70	0.04-0.48	0.71-2.10	10.05-58.50	0.50-0.92
	1.18	0.26	1.42	29.36	0.71
Urla Iskele (4)	0.60-0.86	0.16-0.34	0.90-2.09	11.10-26.60	0.35-0.90
	0.73	0.22	1.29	18.20	0.54
Aquaculture Site (5)	0.60-0.85	0.09-0.30	0.81-2.04	9.90-24.41	0.20-0.70
	0.70	0.19	1.20	16.85	0.48

It can be seen from the tables that there are differences in the metal concentrations according to the localities. The heavy metal concentrations of native *M. galloprovincialis* is slightly higher than cultured ones.

RESULTS IN SEDIMENT SAMPLES

Table II presents minimum, maximum and mean values obtained from the superficial sediments of Izmir Bay.

According to the results obtained, sediments show a contaminations of the metals such as Pb, Cd, Cu, Zn, Ni. The level of trace metals decreases from Ni to Cd.

Levels of contaminations by heavy metals in the Inner Bay are more important due to the factories, harbor activity and domestical discharges, but we note a clear decrease at the exit of the area.

Table II. Minimum, maximum and average levels of heavy metals in sediment samples from different regions of Izmir Bay (mg/g.dry weight).

Stations	Pb	Cd	Cu	Zn	Ni
Homa Fisheries Lagoon(1)	28.20-38.20 32.20	1.60-2.70 1.90	14.20-18.50 15.35	23.80-41.60 31.64	34.50-53.00 42.96
Deniz Bostanlisi (2)	30.10-45.50 36.80	2.10-2.90 2.55	17.50-28.20 23.85	42.00-56.50 50.50	62.00-110.00 90.50
Inciralti (3)	34.00-54.50 42.50	2.10-2.60 2.34	17.00-21.20 19.01	54.60-68.20 62.80	38.00-65.00 46.26
Urla Iskele (4)	24.50-30.00 27.80	1.40-2.20 1.65	12.00-17.50 13.75	15.00-38.00 25.25	29.00-41.00 35.10
Aquaculture Site (5)	18.79-28.40 20.60	0.90-1.98 1.24	10.75-14.90 11.93	11.94-25.04 17.24	20.89-35.25 26.85

CONCLUSIONS

Some mollusk species (especially *M. galloprovincialis, Ostrea edulis*) are known to accumulate high levels of trace metals in their soft tissues and these species are commonly used in biomonitoring studies. Bioaccumulation in mollusk species adequately reflects the changing levels in the marine environment for trace metals. The degree of their accumulation depends on their metabolic activity, growth, biochemical composition, reproductive and feeding condition.

According to our results, a dominant source of metal contamination is from urban and industrial activities and less important inputs are from continental and agricultural origins. Metal concentrations distribution in native mussels indicate higher levels in inner parts of Izmir Bay and the Homa fisheries lagoon is affected by the heavy polluted river of Gediz. *M. galloprovincialis* seems to be much more adapted to the environmental conditions of the polluted bay waters than the other mollusk species (Egemen *et al*., 1998; Sunlu *et al*., 1998). Aquaculture site relatively far from anthropogenic sources is affected very little by chemical contamination. In our present studies, heavy metal levels in *M. galloprovincialis* and sediment samples show the similarity with the previous studies in the Mediterranean Sea. (UNEP, 1996).

In Izmir Bay, here are still no toxic levels in the tissues of M. galloprovincialis and values lie just within the safety level for human consumption. On the other hand the average consumption of these mollusk in our region is generally low.

Consequently, Inner part of Izmir Bay needs to be monitored quite closely in the future until the Big Channel wastewater treatment project will be completed.