Trace Element Concentrations in the Mediterranean Mussel *Mytilus galloprovincialis* Lamarck, 1819 Caught from Sinop Coast of the Black Sea, Turkey

Levent Bat*, Funda Üstün* and Oylum Gökkurt Baki*

Sinop University Fisheries Faculty 57000 Sinop, Turkey

Abstract: The concentrations of copper, zinc, lead and cadmium in the soft parts of Mediterranean mussel *Mytilus galloprovincialis* caught from the Sinop coasts of the Black Sea have been measured by an atomic absorption spectrophotometer for monitoring metal pollution level in the coastal water seasonally in 2010. In the present study, a statistically significant difference in the concentrations of all metals investigated was observed. The results were compared with previous studies and discussed. It is concluded that the mussels *M. galloprovincialis* are suitable biomonitors to assess changes in metal pollution in this coastal area of the Black Sea.

Keywords: *Mytilus galloprovincialis,* trace element, Sinop coast, Black Sea.

INTRODUCTION

Bivalves and especially mussels are very good indicators of marine pollution and so they have been widely used in biomonitoring programs all around the world. Contamination of the coastal environment by chemical contaminants such as trace elements in dredged sediments and wastewaters are major environmental concerns. Therefore, during the last four decades, the detection of trace elements and their effects in living organisms has become very important. Mussels, especially *Mytilus* spp., have been widely used as indicators of marine and estuarine pollution due to their capacity to bioaccumulate and concentrate metallic pollutants, thus providing temporally and spatially integrated levels of contamination [1-8]. The mussel *Mytilus galloprovincialis* Lamarck is a major component of the littoral fauna in the Black Sea. Marine mussels are sedentary organisms and easy to collect a large number of organisms from the location at a certain period of the year. In the present study, therefore, the Mediterranean mussel *Mytilus galloprovincialis* was chosen as a *biomonitor* of coastal metal pollution.

MATERIAL AND METHODS

Sampling stations are located in Sinop coast. Mussels were collected from rocky shores in inter-tidal zones by a diver Gazibey Rock (depth 15-22 m) and İçliman (depth 2-5 m) seasonally in 2010 (Fig. **1**). Living specimens were transported immediately from the sampling sites to the Fisheries Faculty Laboratory of Sinop University and subsequently they were kept in clean seawater in tanks (20x20x25 cm) for 24 h to defecate the contents in alimentary canals. Then, the specimens were sorted with respect to their sizes and were separated into soft part, shell valves and byssal tuft, and each was weighed. Only large size of mussels (60-80 mm) was measured.

Five analytical groups were prepared in which soft tissues of 25 individuals were pooled for each group to obtain means of the samples. They were then preserved in plastic bags in a deep freezer at -21°C.

Three replicate sub samples of each were then prepared.

After weighing, dried materials were digested in concentrated HNO_3 and double distilled water. Copper, zinc, lead and cadmium concentrations were determined by Atomic Absorption Spectrophotometer (AAS) modified from Bernhard [9].

RESULTS AND DISCUSSION

Results of the present study show the mean concentration of trace elements in the Mediterranean mussel *Mytilus galloprovincialis* caught from Sinop coast. As can be seen from Figs. (**2a,b,c,d**), the trace element concentrations show variations depending on the locality. The overall mean values for each of the four metals in the Mediterranean mussel *M. galloprovincialis* at each station were compared by analysis of variance to determine if there is a significant difference in the concentrations of the seven metals existed between the three stations [10]. As a result, there were statistically significant differences in the concentration of the metals in the mussels for the two stations examined ($P<0.05$).

While the variation between stations was statistically significant, in the authors' opinion further research is required before one may conclude that the difference between stations actually reflects a difference due to geographic location. In terms of geographical locations the highest values appeared to be associated with Içliman areas and this may be due to the discharge of untreated domestic wastes, harbour activities, the dumping of ship wastes and other coastal activities [11,12].

*Address correspondence to these authors at the Sinop University Fisheries Faculty 57000 Sinop, Turkey; Tel: +90 (368) 2715535; Fax: +90 (368) 2715530; E-mails: leventbat@gmail.com, fundaustun@hotmail.com, oylumgokkurt@hotmail.com

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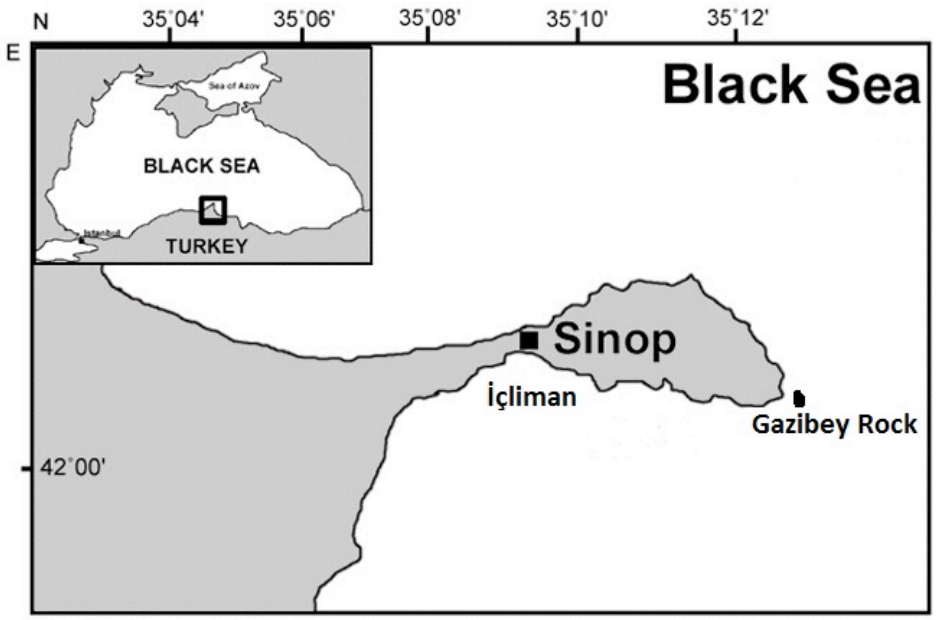

Fig. (1). Sampling sites from Sinop coasts of the Black Sea, Turkey.

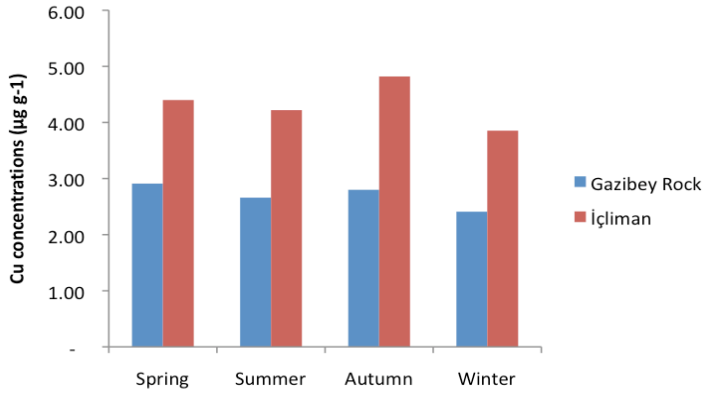

Fig. (2a). Cu concentrations (µg g^{-1}) in the Mediterranean mussel *Mytilus galloprovincialis* from Sinop coasts of the Black Sea in 2010.

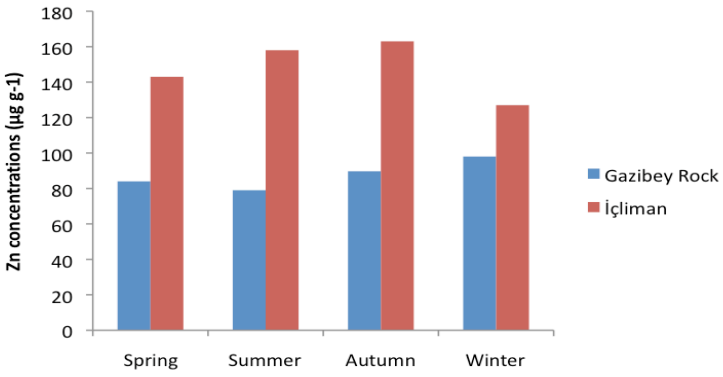

Fig. (2b). Zn concentrations (µg g^{-1}) in the Mediterranean mussel *Mytilus galloprovincialis* from Sinop coasts of the Black Sea in 2010.

Zn was found in higher concentrations in *M. galloprovincialis*. In general, the concentrations of the trace elements are as follow: Zn>Cu>Pb>Cd (Figs. **2a,b,c,d**).

Many metals are essential to organisms such that in their absence an organism can neither grow nor reproduce [13,14]. The essential metals (Zn and Cu) content being consistently higher in the mussels while the reverse condition existing for non-essential (Pb and Cd) metals (see Figs. **2a,b,c,d**). All metals are taken up by aquatic organisms from solution and from food or particles and can be accumulated at high concentrations [15-22] when, whether essential or not, they may be potentially toxic to living organisms [3,4,17,18].

In the present study, the concentrations of metals found in *M. galloprovincialis*, would appear to be lower, in general, than those found from different study areas. In Table **1**, the present results are compared with some of reported

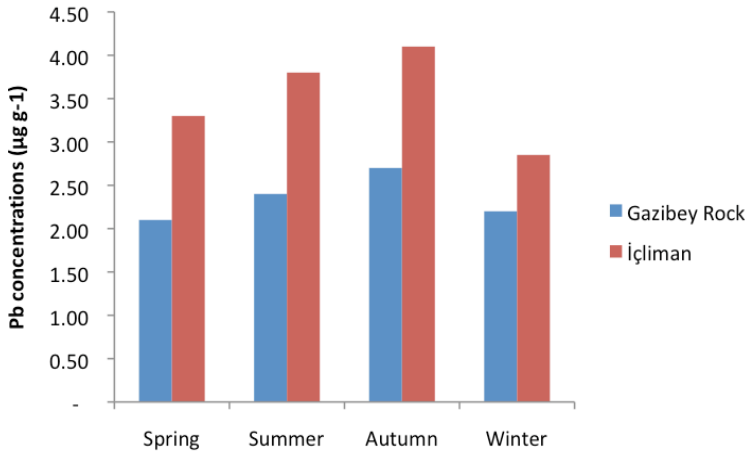

Fig. (2c). Pb concentrations (µg g^{-1}) in the Mediterranean mussel *Mytilus galloprovincialis* from Sinop coasts of the Black Sea in 2010.

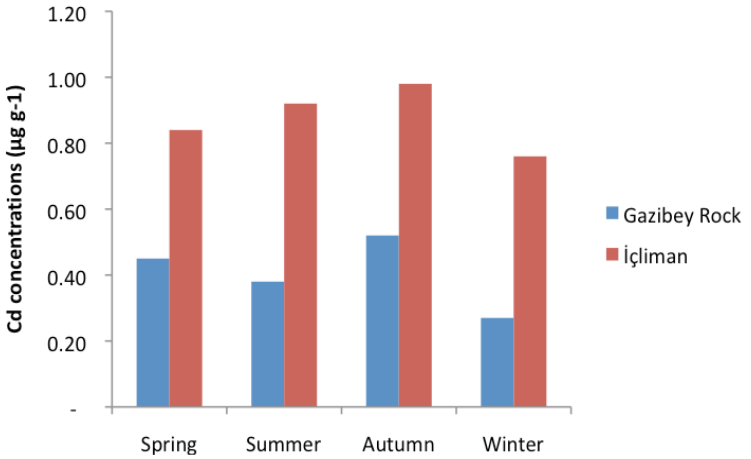

Fig. (2d). Cd concentrations (µg g^{-1}) in the Mediterranean mussel *Mytilus galloprovincialis* from Sinop coasts of the Black Sea in 2010.

studies. Regional comparison for results must be made with caution because of variations in both quality of analytical data and in sampling procedure. Moreover, the data obtained to date permits only limited conclusions to be made concerning the trace element variations in the mussel. More samples must be examined to assess geographical differences. The results of the present study, however, show that the values obtained are acceptable limits when compared with those of similar investigations carried out in the parts of the Black Sea (Table **1**). Many of the results in Table **1** show that the highest concentrations have been observed near known sources of anthropogenic inputs and metal contamination is increasing in the Black Sea coast of Turkey compare to previous studies. In the present study, results show that metal levels in mussels especially from Gazibey Rock are general low. This appears quite reasonable in the light of the available data that a small population of Sinop has not affected the metal concentrations in the mussel of the coastal region. Moreover, Sinop coasts are unpolluted areas in terms of industry. *M. galloprovincialis* from Gazibey Rock of Sinop coast can be consumed in terms of low metal levels.

Aquatic organisms, especially molluscs, have the ability to accumulate metals from the environment in which they live [32]. The value of these organisms has long been recognised global Mussel Watch program, which was the first put forward by Goldberg [33] in the USA during the mid-1960s and mussels regarded as a suitable biomonitor of marine health in marine biomonitoring programmes in regard to its ability of heavy metal bioaccumulation. Several European countries (e.g. France, Italy, and Spain) have also implemented similar national Mussel Watch programs in the 1970s [34]. In France, Mussel Watch programs have been used to assess the levels of trace elements along the French coastlines since IFREMER developed the Le Réseau National de la Contamination CHimique (ROCCH, ex Réseau Nationald'Observation, RNO) in 1974 [34]. *M. galloprovincialis* is collected twice a year in about one hundred sampling sites (passive biomonitoring). In a second phase, the "Réseau Intégrateur Biologique (RINBIO)" has been implemented in 1996 to monitor the concentrations of chemicals in organisms caged for several weeks prior to collection (biomonitoring) [35]. Rodriguez y Baena & Thébault [34] reported that in spite of the presence of several on-going national programs, no large-scale Mussel Watch network was coordinated at the Mediterranean level until 2002. Besides, there were no data available on pollutant content of mussels in some parts of the world; the research of the contaminant concentrations in organisms through the accumulation of contaminants in their tissues remains a necessary basic work [32]. Finally, CIESM developed a regional "Mediterranean Mussel Watch (MMW)", using the mussel *M. galloprovincialis* as a biomonitor species [34]. Rome´o *et al.,* [32] mentioned that recent papers have dealt with metal and radionuclide concentrations in the *M.*

Table 1. Trace Element Concentrations in *M. galloprovincialis* from the Turkish Black Sea Coast. *Modified from Bat et al.* [23]

	Area	Zinc	Copper	Lead	Cadmium	References
*	Sinop	1.023-8.946	0.039-1.438	1.36-0.32	0.075-0.863	[24]
*	Igneada	-	0.21-2.76	0.05-0.12	-	[25]
*	Inebolu	-	1.96-13.7	0.12-1.3	-	[25]
*	Sakarya	-	0.17-0.56	0.0-0.02	-	[25]
*	Zonguldak	-	0.33-3.63	0.1-0.84	-	[25]
*	Sinop	1.58-7.28	0.10-1.89	0.11-1.18	0.03-0.27	[12]
**	Amasra	512.5±2.6	7.26±0.02	2.60±1.1	6.44±0.01	[26]
**	Sinop	256.4±1.3	8.01±0.02	0.31±0.19	1.79±0.01	[26]
**	Rize	78.12±0.15	11.52±0.02	<0.05	<0.02	[26]
**	Sinop	24.862-519.701	4.301-10.96	-	0.305-4.878	[27]
**	Samsun	317.25	23.35	0.95	<0.02	[28]
**	Samsun	328.05	13.1	<0.05	<0.02	[28]
**	Samsun	396.5	12.85	108.6	<0.02	[28]
**	Samsun	312.15	11.75	14.7	<0.02	[28]
**	Çamburnu	630±32	190±6	21.0±1.0	4.0±0.2	[29]
**	Rize	600±30	260±8	5.0±0.3	3.0±0.2	[29]
**	Rize	340±10	90±3	9.0±0.5	3.0±0.2	[29]
**	Çayeli	230±7	130±4	5.0±0.2	2.0±0.1	[29]
**	Hopa	180±5	130±4	3.0±0.1	3.0±0.2	[29]
**	Sinop	182.21-296.97	6.30-7.92	-	2.08-2.95	[30]
**	Samsun	-	-	1.085±0.065	0.41	[31]
**	Sinop	-	-	0.26±0.03	0.47±0.01	[31]
**	Sinop	79-163	2.41-4.82	2.10-4.10	0.27-0.98	Present study

- : not measured.
*: expressed in µg metal g^{-1} wet wt.
**: expressed in µg metal g^{-1} dry wt.

galloprovincialis around the ocean but very few papers concern the same species of mussels collected from the Black Sea.

Rainbow *et al.,* [36] reported that an organism which is able to show spatial and temporal changes in metal concentrations is a suitable candidate to be used in biomonitoring surveys. Mussels are monitored for possible chemical, physiological or behavioural changes within the ecosystem as a reflection of environmental problems [37]. Namiesnik *et al.,* [37] showed that *M. galloprovincialis* to be used as biomarkers to establish physiological endpoints for chemical contaminant exposure and these species used by environmental researchers to monitor the health of an environmental ecosystem. The mobile organisms like fish may avoid pollution problems by escaping from the ecosystem of environmental concern. Whereas, sessile mussels basically stay in their environment and may concentrate important ecosystem pollutants [37].

In conclusion, the Mediterranean mussel *M. galloprovincialis* appears to be a useful biomonitor due to their accumulation of the metals, and continued sampling and individual tissue analysis are required for further investigations.

CONFLICT OF INTEREST

None declared.

ACKNOWLEDGEMENTS

This study was presented in 3rd Bi-annual BS Scientific Conference (Black Sea Outlook) and UP-GRADE BS-SCENE Project Joint Conference, 2011, Odessa, Ukraine. Suggestions from two anonymous reviewers are greatly appreciated.

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Received: January 02, 2012 Revised: January 06, 2012 Accepted: January 09, 2012