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Review of Heavy Metal Accumulation in Aquatic Environment of Northern East Mediterrenean Sea Part II: Some Non-Essential Metals

Yilmaz, A. B*., Yanar, A. and Alkan, E.N.

Faculty of Marine Sciences and Technology, Iskenderun Technical University, 31200 Iskenderun/ Hatay, TURKEY

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ABSTRACT: Heavy metals that enter marine environment and remain in the water as well as the sediments are accumulated by aquatic organisms, thus becoming highly good indicators to monitor metal accumulation in the long run. Metals are potentially harmful to humans and most organisms at varied levels of exposure and absorption. Northern East Mediterranean Sea is a crucial region as it is an area, shared by numerous aquatic species with pollutant factors such as heavy marine traffic, transportation ports, industry plants, iron and steel works, oil pipeline installation, and other small factories. While the previous part of this review (Review of heavy metal accumulation on aquatic environment in Northern East Mediterranean Sea part I: some essential metals) evaluated the data from previous studies concerning toxic effects of selected essential metals on seawater, sediment, and different tissues of aquatic animals, collected from different areas in Northern East Mediterrenean Sea since the 1990s, the present part intends to evaluate the data from previous studies on toxic effects of selected non-essential metals. For this purpose, 94 articles and 6 theses have been examined and a good deal of information has been gathered to open a forward-looking view of the studied area's pollution. Althought there has not been any harmonization, when comparing heavy metals investigations in the bay, all studies have shown that consumption of aquatic species from the region causes no problem to human health.

Key words: Iskenderun Bay; heavy metal; pollution; aquatic organisms; monitoring

INTRODUCTION

Marine systems are potyential to receive all types of eco-system pollutants from a variety of anthropogenic activities, one way or another. Being quite complex ecosystems, they include chemical and biological components, aquatic lives, physical, and physico-chemical activities.

Pollutants, especially heavy metals may be taken up into the tissues of marine organisms through their food chains. In recent years, monitoring metal pollution in marine environment has become increasingly important among competing industrial activities; therefore, marine environments are occasionally monitored for heavy metal contamination in water, sediment, and animals. A great number of previous studies have shown that the levels of metal accumulation of aquatic organisms are related to animal species, sex, seasonal effects, eating habits, habitats, metal characteristics, bioavailability of chemicals, and physio-chemical parameters of the aquatic

*Corresponding author, Email: aybahar@yahoo.com, abahar.yilmaz@iste.edu.tr

environment (Çoğun et al., 2005; Yılmaz & Yılmaz, 2007; Yılmaz et al., 2010).

This study has been carried out in İskenderun Bay (Eastern Mediterranean coast of Turkey, 36°10′00″N– 36°55′ 00″E, 35°46′00″; 36° 10′ 00″N), which is economically important for fishing. Additionally, there are many huge and small industry plants [such as Iron and Steel Works (Isdemir), Oil Pipeline Installation (Botaş), and rolling mills] around the bay. The city, İskenderun, also contains a big harbor as well as lots of transportation ports. In 2004, the sinking of M/V Ulla in the bay, made it necessary to monitor the area for heavy metal accumulation (Yılmaz et al., 2010). This study aims at evaluating the data from previous studies concerning the impact of some selected non-essential metal concentrations in seawater, sediment, algae mollusks (invertabres), and fish (demersal and bentic) on different organism's tissues, gonads, skin, and muscle, from aquatic species, collected at the bay from stations with different rates of pollution (Figure 1).

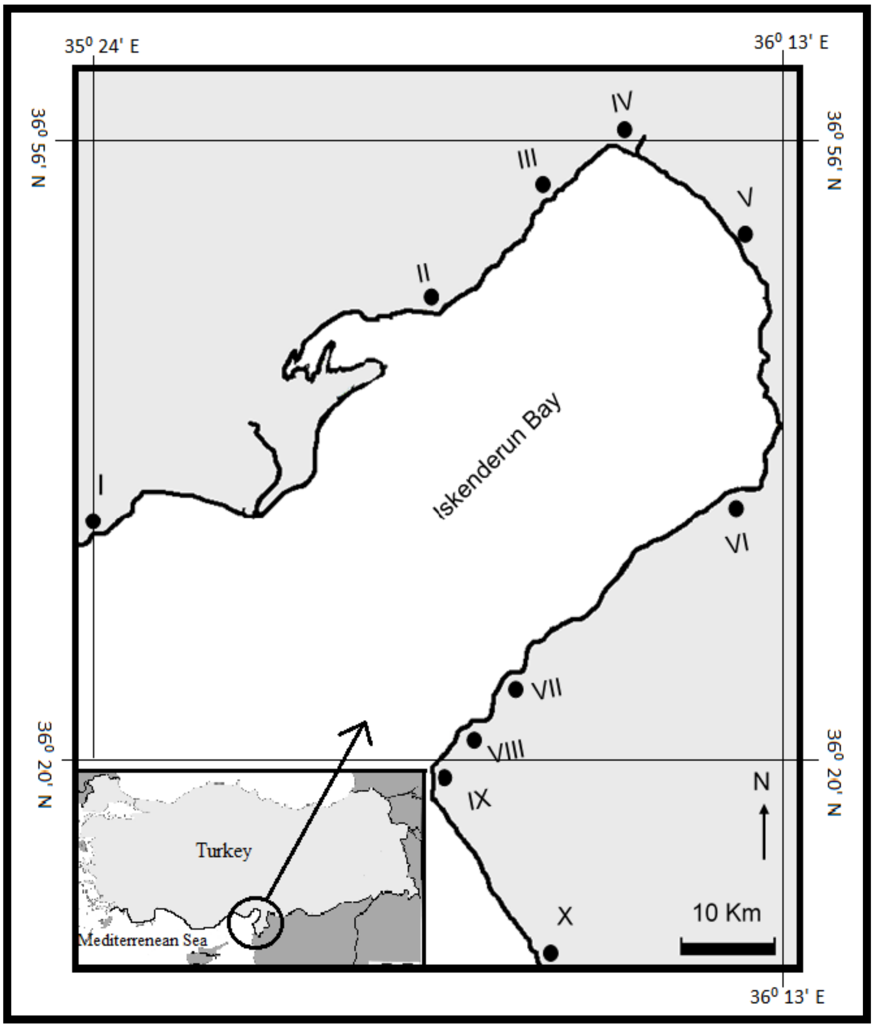

Fig. 1. Stations belongs to previous heavy metal monitoring studies in Iskenderun Bay. I; Karataş, II; Yumurtalık, III; Botaş, IV; Petrotrans, V; Dörtyol, VI; Iskenderun, VII; Arsuz, VIII; Konacık, IX; Akıncı Burnu, X; Samandağ

Some concern has arisen from previous studies, particularly in terms of human consumption safety; therefore, it is necessary to monitor the research on heavy metals.

HEAVY METALS

Aquatic organisms require trace nutrients, many of which include components of bioactive proteins or enzyme cofactors. Some metals (e.g. zinc, iron, chromium, manganese, cobalt, nickel, copper, and selenium) are essential elements in trace amounts for normal growth and development; however, others like mercury, cadmium, and lead have no biological importance (Kalay & Canlı, 2000).

All heavy metals are potentially harmful to most marine organisms at a certain level of exposure and absorption. Like essential metals, nonessential metals are also taken up by the fish to get accumulated in their tissues. Results from field and laboratory experiments show that heavy metal accumulation in the tissue depends mainly on metal concentrations in water as well as the exposure period, yet a number of other environmental factors, such as salinity, pH, hardness, and temperature, play a significant role in metal accumulation. There are four possible routes for heavy metals to enter a fish, namely through the gill, drinking water for saltwater fish, skin, and food. The levels of metals in upper members of the food web like fish can reach values much higher than the ones, found in aquatic environment or in sediments.

Data of Heavy Metals of Previous Studies on Seawater and Sediment

Even in very low values, natural or anthropogenic pollutants that enter sea water from surface waters may reach higher values through the food chain. As one of the pollutants, heavy metals are present at trace or ultra-trace concentrations in seawater.

Neff (2002) reported that typical concentrations [µg/l (ppb)] of Arsenic (As), Cadmium (Cd), and Nickel (Ni) in seawater and ocean water are 1-3, 0.001-0.1, 0.1-1.0, , 1-100, 0.1.10-3-0.55.10-3, 0.05-0.35, ---, 0.002-0.2, ---, 0.07.10-3-6.10-3, ---, ---, 0.006-0.523, respectively.

The investigation of the heavy metal parameters on the sea water and sediment in the Bay, Northern East Mediterranean Sea, is still very limited [Ergin et al. (1996), Türkmen & Türkmen (2004)]. Ergin et al. (1996) conducted a research on surface sediment samples from seventy-three stations of the Bay from 1988 to 1991, showing that Ni, Co, and Pb contents of all samples ranged between 305 and 1337, 8 and 333, and 13 and 97 ppm (on $CaCO_3$ - free data for all samples), respectively. Having compared the relative abundance of these metals in average crustal rocks, they claimed that the concentration of the selected metals (Ni, Co, and Pb) measured in surface sediments of the Bay were noticeably high. The high Pb contents were measured in the sediments from northeastern part of the Bay, close to discharge areas of industrial and domestic effluents. Türkmen & Türkmen (2004) investigated suspended particulate material from the Bay between August 2001 andd July 2002, reporting that the seasonal and spatial variations of Al, Pb, Co, Cd, and Ni concentrations in suspended particulate matter from the Bay stayed in the following ranges: Al: 15726-27747, Pb: 65.0-783, Co: 21.8-202, Cd: 5.88-66.7, and Ni: 261-915 mg /kg dry weight, respectively. Variations at five stations (Arsuz, İskenderun Harbour Area, İsdemir, Dörtyol Botaş and Petrotrans area) of the İskenderun Bay indicated that concentrations of Ni at Arsuz station, Pb in the area between stations V and VI (İsdemir), and Cd and Co at Petrotrans station were higher than other stations. They also showed that concentrations Cd and Pb were the lowest at Arsuz station. So was that of Co at İsdemir and that of Ni at Petrotrans station. Olgunoğlu (2008) claimed that heavy metal (Pb and Cd) concentrations varied significantly among the three stations in İskenderun Bay, Eastern Mediterranean coast of Turkey. Results showed that in general, Cd concentrations of the sediment did not showed seasonal variations, although the levels of Pb were higher in summer than other seasons.

Heavy Metal Data of Previous Studies on Algae

For normal metabolism of the algae, the essential metals must be extracted from water, thus heavy metal accumulation by marine algae is a continuous process throughout their lifespan. However, similar to essential metals, the non-essential ones are also taken up by the algae and accumulated in their organisms. All heavy metals are potentially harmful to aquatic organisms at some level of exposure and absorption.

Yılmaz et al. (2017) stated that heavy metal concentrations generally depend both on the external factors (temperature, light, oxygen, and nutrients) and on physico-chemical parameters (pH, salinity, inorganic, and organic complex molecules), which control the metabolic rate. Also, the level of accumulated heavy metals change, according to the species (Yılmaz et al., 2016).

The concentrations of some non-essential heavy metals (Pb, Cd, Co, and Ni) in several algae species *Jania rubens*, *Padina pavonia*, *Laurencia papillosa* and *Cystoseira corniculata* and *Cystoseira barbata, Padina pavonia* (brown algae); *Ulva lactuca, Enteromorpha compressa, Cladophora vagabunda, Chaetomorpha gracilis* (green algae); *Antithamnion cruciatum, Corallina mediterranea, Corallina officinalis, Jania rubens, Pterocladia capillacea* (red algae) from the Iskenderun Bay of the Mediterranean Sea were determined by Olgunoğlu & Polat (2007) and Topçuoğlu et al. (2010), respectively.

Olgunoğlu (2008) investigated the accumulation of Pb and Cd by four macro algae, namely *Jania rubens*, *Padina pavonia*, *Laurencia papillosa,* and *Cystoseira corniculata*, at three stations (Figure 1, stations II, V, and VI). The patterns of Pb and Cd metals on the algae can be written as follows in descending order: *Jania rubens* > *Padina pavonia* > *Laurencia papillosa* > *Cystoseira corniculata*. According to the study, macro algae metal pollution index values of the average annual rankings were *J. rubens > P . pavonia > L. papillosa > C. corniculata.*

Topcuoğlu et al. (2010) reported that non-essential metal concentrations of *Jania rubens* and *C. mediterranea* from the Bay (collected in 2004) were as follows: Cd < 0.02, Pb < 0.1, Co = 1.66± 0.09, Ni: 21.33±0.04 µg /g dry weight and Cd:0.95±0.01, <0.02, Pb: <0.1, Co: 12.96± 0.14, Ni: 157.39±2.57 µg /g dry weight , respectively.

Having analyzed the stations in all seasons, Yılmaz et al. (2016) suggested that *Jania rubens* accumulated more metals than *Padina pavonia*. In both types of algae, metal accumulatiom occurred in the following order: Cu> Fe> Ni> Mn> Zn> Cr> Co. In the samples taken from the Kaleköy Station (IX), they found that nickel levels were higher in summer than winter, reporting that while nickel accumulation of *Jania rubens* ranged between 63.80 and 402.31 ppm, for *Padina pavonia* it was from 18.63 to 330.24 ppm. In winter and summer, cobalt values of *J. rubens* and *P. pavonia,* caught from Kaleköy and Yumurtalık stations, were from 3.87 to 24.02 ppm and n.d.-17.07 ppm, respectively.

Selected Data of Heavy Metals from Previous Studies on Aquatic Animals

Accumulation of heavy metals in tissues of aquatic animals depends on environmental factors, different feeding habits (carnivorous, herbivorous, or omnivorous), differences in aquatic environmental lives (demersal, pelagic, or bento-pelagic), and differing growing rates of the species (Yılmaz et al., 2010). Apart from the fish, the invertebrates, like cuttlefish, shrimp, oyster, and mollusks, represent important economic seafood for human consumption.

The gill and intestine are the primary organs for uptaking soluble metals from aquatic environments. In soft-bodied invertebrate species, the body wall may also be so too. Since the skin is a consumable part of the fish, it has been suggested by many researchers to pay special attention to heavy metal accumulation (Yılmaz, 2003; Dural et al., 2010a; Yılmaz et al., 2010). These studies indicated that concentration of the heavy metals were higher in all skin samples than the muscles. Yılmaz (2003) reported that the reason for high metal concentrations in the skin could be due to complex mixture of metal with the mucus that was impossible to be thoroughly removed from the tissue prior to any analysis. It is generally accepted that the edible muscle is not an organ in which metal accumulation occurs.

Researchers used different units to explain the accumulation, such as wet weight, dry weight, µg /g, mg /kg, ppm, etc. The levels of accumulated metals were given as wet weight (wet wt) or dry weight (dry wt), with the latter (dry wt) being derived from the former (wet wt) by being multiplied by a dry wet/wet ratio of 5 (El-Nemr, 2010).

- Aluminum (Al)

Numerous aluminosilicate minerals such as feldspars, micas, clay, berly, and spinel, are the most abundant metal in the Earth. Although Al is very active, it does not corrode readily thanks to an adherent oxide layer that forms rapidly in the air, preventing further O^2 permeation (Silberberg, 2012). Aluminum is metallic in its physical properties and forms Al^{3+} ion in some compounds, but it bonds covalently in most others. It can be taken with drinking water as well as diet, and water soluble forms are more active for biological accumulation. Aluminum toxicity is reported to be among the factors, leading to Alzheimer's disease, dementia, and Parkinson's disease (Gensemer & Playle, 1999).

Table 1 shows Aluminum concentration data (in µg /g)from previous studies in this area . The Aluminum levels of muscle on *Mullus barbatus*, carnivore, and demersal, have been studied by Türkmen et al. (2005a) (1.608-2.925 d.w), Turan et al. (2009) (8.384 d.w), and Dural et al. (2010a) (6.67 d.w).

Although Al accumulation levels depend on such factors as fish species, organs, feeding habits, etc., mean values of Al levels, based on the fish organs, from all previous studies are in the following order: Liver > Skin > Muscle in *Mullus surmuletus* and *Upeneus pori*. In contrast, Dural et al. (2010a) reported that aluminum concentration in the skin of *Mullus barbatus* and *Upeneus molluccensis* were higher than livers. Generally the levels of metals, found in tissues of the *M. surmuletus,* were higher than those of *M. barbatus*. Dural et al. (2010a) concluded that metal accumulation was the highest in liver and skin, while it was low in the muscles of two species, which was probably due to their physiological roles in fish metabolism.

Yılmaz et. al. (2010), indicated that Aluminum values on muscles of their study's samples ranged between 2.23 and 4.93 µg metal /g w.w., while Al concentrations of liver and skin tissues in *T. lucerna*, *L. budegassa* and *S. lascaris* were 4.27, 5.19, and 8.34 µg metal /g w.w., and 16.6, 3.69, and 3.51 µg metal /g w.w., respectively.

Türkmen & Türkmen (2005) and Duysak & Ersoy (2014) studied aluminum concentrations in invertebrate samples, collected from different stations in the Bay (Table 2) . Duysak & Ersoy (2014) reported that the concentration of aluminum in the edible part of *Monodonta turbinata* was high during the spring, indicating that Al concentrations in muscles of *M. turbinata* changed from 3.49 (Yumurtalık station) to 409.30 (Kaleköy station) µg metal /g d.w. in the spring. Türkmen & Türkmen (2005) obtained Al concentrations in edible body parts of *Spondylus spinosis* samples, collected from different stations and seasons in the Bay, which turned out to be within 33.2-155 µg metal /g d.w.

Al toxicity and bioavailability to aquatic biota largely depends on its solubility, generally increasing as pH drops (Gensemer & Playle, 1999). Aluminium bioavailability and toxicity, at a pH greater than 7.0, is largely unknown; however, at pH < 5.5, Al can be toxic to many plant species. Concentrations of 400-500 microgrammes per litre (µg /l) of Al in water, within a pH range of 4.0-4.3, had negligible effects on mortality in amphipods, snails, or insect larvae. There is no evidence of aluminum bioaccumulation in aquatic invertebrates; however, it is probable for foodstuff, such as invertebrates, tadpoles, and a few plant species, to have sufficient concentrations of Al to be toxic for avian species (Gensemer & Playle, 1999; Sparling & Lowe, 1996).

Table 1. Mean concentration (µg metal /g) and associated standard deviations (means ± SD) of aluminium in the muscle, liver, and skin of fish samples in Iskenderun Bay (Turkey).

Species	FT	En	Se	St	Tissues			Wt	Ref.
					Muscle	Liver	Skin		
Chelidonichthys lucerna (As: Trigla lucerna)	c	d	su	VI	4.93 ± 2.11	4.27 ± 1.45	16.6 ± 4.11	w.w	Yılmaz et al., 2010
Engraulis encrasicholus	c	p	*1	VI	24.753 ± 4.799	-	-	d.w	Turan et al., 2009
Lophius budegassa	c	d	su	VI	2.51 ± 1.12	5.19 ± 2.22	3.69 ± 1.55	w.w	Yılmaz et al., 2010
Merlangius merlangus	c	bp	*1	VI	84.816 ± 7.841	-	-	d.w	Turan et al., 2009
Mugil cephalus	om	bp	su	VII	0.614	-	-	d.w	Türkmen et al., 2006
Mugil cephalus	om	bp	su	VI	1.492	-	-	d.w	Türkmen et al., 2006
Mugil cephalus	om	bp	su	IV	1.713	-	-	d.w	Türkmen et al., 2006
Mullus barbatus	c	d	su	VII	1.608	-	-	d.w	Türkmen et al., 2005a
Mullus barbatus	c	d	su	VI	2.925	-	-	d.w	Türkmen et al., 2005a
Mullus barbatus	c	d	su	IV	2.151	-	-	d.w	Türkmen et al., 2005a
Mullus barbatus	c	d	*1	VI	8.384 ± 1.020	-	-	d.w	Turan et al., 2009
Mullus barbatus	c	d	sp	VI	6.67 ± 0.17	13.35 ± 0.33	17.21 ± 1.09	d.w	Dural et al., 2010a
Mullus surmuletus	c	d	*1	VI	7.528 ± 0.157	13.949 ± 1.565	9.393 ± 0.393	w.w	Bıçkıcı, 2010
Mullus surmuletus	c	d	sp	VI	7.52 ± 0.15	13.94 ± 1.56	9.39 ± 0.39	d.w	Dural et al., 2010a
Pegusa lascaris (As: Solea lascaris)	c	d	su	VI	2.23 ± 1.28	8.34 ± 4.98	3.51 ± 2.94	w.w	Yılmaz et al., 2010
Saurida undosquamis	c	d	su	VII	0.512	-	-	d.w	Türkmen et al., 2005a
Saurida undosquamis	c	d	su	VI	0.757	-	-	d.w	Türkmen et al., 2005a
Saurida undosquamis	c	d	su	IV	1.234	-	-	d.w	Türkmen et al., 2005a
Sparus aurata	c	d	su	VII	0.839	-	-	d.w	Türkmen et al., 2005a
Sparus aurata	c	d	su	VI	0.691	-	-	d.w	Türkmen et al., 2005a
Sparus aurata	c	d	su	IV	1.229	-	-	d.w	Türkmen et al., 2005a
Upeneus moluccensis	c	d	*1	VI	5.902 ± 0.216	13.258 ± 0.701	20.737 ± 2.372	d.w	Dural & Bıçkıcı, 2010
Upeneus pori	c	d	*1	VI	6.728 ± 0.179	30.240 ± 3.554	14.767 ± 0.787	d.w	Dural & Bıçkıcı, 2010

Note: FT: feeding type, c: carnivore, om: omnivore, En: environment, d: demersal, p: pelagic, bp: bento-pelagic, Se: Season, *1: no season info, sp: spring, su: summer, St: stations, IV: Petrotrans, VI: İskenderun, VII- Arsuz, d.w.: dry weight, w.w.: wet weight.

Table 2. Mean concentration (µg metal /g) and associated standard deviations (means ± SD) of aluminium in the muscles of invertebrate samples in Iskenderun Bay (Turkey).

Species	Se	St	Tissues	Wt	Ref.
			Muscle		
Monodonta turbinata	sp	X	11.86 ± 2.44	d.w.	Duysak & Ersoy, 2014
Monodonta turbinata	sp	VIII	57.57 ± 10.76	d.w.	Duysak & Ersoy, 2014
Monodonta turbinata	sp	IX	409.30 ± 37.94	d.w.	Duysak & Ersoy, 2014
Monodonta turbinata	sp	VII	329.41 ± 46.69	d.w.	Duysak & Ersoy, 2014
Monodonta turbinata	sp	VI	21.58 ± 9.50	d.w.	Duysak & Ersoy, 2014
Monodonta turbinata	sp	V	70.33 ± 23.78	d.w.	Duysak & Ersoy, 2014
Monodonta turbinata	sp	II	3.49 ± 1.02	d.w.	Duysak & Ersoy, 2014
Monodonta turbinata	a	X	37.02 ± 12.78	d.w.	Duysak & Ersoy, 2014
Monodonta turbinata	a	VIII	34.64 ± 8.28	d.w.	Duysak & Ersoy, 2014
Monodonta turbinata	a	IX	41.82 ± 26.53	d.w.	Duysak & Ersoy, 2014
Monodonta turbinata	a	VII	38.25 ± 7.12	d.w.	Duysak & Ersoy, 2014
Monodonta turbinata	a	VI	3.059 ± 5.60	d.w.	Duysak & Ersoy, 2014
Monodonta turbinata	a	V	100.75 ± 27.60	d.w.	Duysak & Ersoy, 2014
Monodonta turbinata	a	II	26.29 ± 8.68	d.w.	Duysak & Ersoy, 2014
Spondylus spinosus	w	VII	123.64	d.w.	Türkmen, 2003
Spondylus spinosus	sp	VII	33.232	d.w.	Türkmen, 2003
Spondylus spinosus	su	VII	87.511	d.w.	Türkmen, 2003
Spondylus spinosus	a	VII	70.814	d.w.	Türkmen, 2003
Spondylus spinosus	w	VI	154.48	d.w.	Türkmen, 2003
Spondylus spinosus	sp	VI	54.167	d.w.	Türkmen, 2003
Spondylus spinosus	su	VI	133.54	d.w.	Türkmen, 2003
Spondylus spinosus	a	VI	109.28	d.w.	Türkmen, 2003
Spondylus spinosus	w	II	49.304	d.w.	Türkmen, 2003
Spondylus spinosus	sp	II	63.033	d.w.	Türkmen, 2003
Spondylus spinosus	su	II	67.134	d.w.	Türkmen, 2003
Spondylus spinosus	a	II	84.634	d.w.	Türkmen, 2003
Spondylus spinosus	a	VII	70.8	d.w.	Türkmen & Türkmen, 2005
Spondylus spinosus	w	VII	124	d.w.	Türkmen & Türkmen, 2005
Spondylus spinosus	sp	VII	33.2	d.w.	Türkmen & Türkmen, 2005
Spondylus spinosus	su	VII	87.5	d.w.	Türkmen & Türkmen, 2005
Spondylus spinosus	a	VI	109	d.w.	Türkmen & Türkmen, 2005
Spondylus spinosus	w	VI	155	d.w.	Türkmen & Türkmen, 2005
Spondylus spinosus	sp	VI	54.2	d.w.	Türkmen & Türkmen, 2005
Spondylus spinosus	su	VI	134	d.w.	Türkmen & Türkmen, 2005
Spondylus spinosus	a	IV	84.6	d.w.	Türkmen & Türkmen, 2005
Spondylus spinosus	w	IV	49.3	d.w.	Türkmen & Türkmen, 2005
Spondylus spinosus	sp	IV	63.0	d.w.	Türkmen & Türkmen, 2005
Spondylus spinosus	su	IV	67.1	d.w.	Türkmen & Türkmen, 2005

Note: Se: Season, a: autumn, w: winter, sp: spring, su: summer; St: stations, II: Yumurtalık, IV: Petrotrans, V: Dörtyol, VI: İskenderun, VII- Arsuz, VIII: Konacık, IX: Akıncı Burnu, X: Samandağ; Wt: weight, d.w.: dry weight.

- Arsenic

It is well known that arsenic, classified as non-metal or metalloid, is one of the most abundant and highly toxic elements on earth. It can occur in natural waters and sediments in different valency states such as elemental arsenic (^{0}), ($^{3-}$) states, arsenide ($^{3+}$), and arsenate ($^{5+}$). While the dominant forms of inorganic arsenic in marine ecosystems are arsenide ($^{3+}$) and arsenate ($^{5+}$), the other forms are not often detected. Additionally, two organic forms of methylarsonic acid (MMA) and dimethylarsinic acid (DMA) are also frequently found in seawater at lower concentrations (Andreae, 1986). In aerobic seawater, arsenide is oxidized rapidly to arsenate, both abiotically and by means of bacteria (Francesconi and Edmonds, 1993). Physico-chemical parameters of water such as pH, redox potential, complexing ions, sulfur, iron, and calcium determine the arsenic valence and speciation.

Arsenic probably is an essential micronutrient for all plants and animals (Uthus, 1992) since inorganic and organic arsenic is measured in nearly all marine organisms tissues. Researchers argue that there are in fact two arsenic cycles, one for inorganic arsenic species and the other organoarsenic compounds. Both cycles are converted by marine sediment microbes and marine algea. Dissolved arsenate is transferred to the bacteria and marine macroalgae by a cellular phosphate transport system; however, arsenate does not complete these mechanisms in many marine algae (Andrea & Klump, 1979). Although marine plants accumulate inorganic arsenic, it is not transferred efficiently through marine food webs (Lindsay & Sanders, 1990). On the other hand, mollusk and crustaceas, filter-feeders bioaccumulate organoarsenic compounds from phytoplankton. Mammals, like humans, accumulate inorganic and organic forms of arsenic from their food and drinking water (Butchet et al., 1994). Organoarsenic types are not toxic or carcinogenic to marine animals themselves or their consumers, including humans (Francesconi & Edmonds, 1993).

According to U.S. EPA, acute and chronic water quality criteria for arsenic (in the form of arsenide: As^{3+}) for protection of marine life are 69 µg/l and 36µg/l, respectively. According to Byrd (1990) and Neff (2002), natural and anthropogenic inputs result in higher arsenate concentrations in some estuaries [As 1-3 µg /l (ppb)] than open seawater or oceans [As 0.5- 3 µg /l (ppb)]. U.S. Environmental Protection Agency has set a human health criterion of 0.00175 µg /l for total dissolved arsenic in seawater, from which fishery products are harvested and are used for human consumption (USEPA, 2000).

Although the main purposes of this paper is to investigate Arsenic parameters on the sea water, sediment, and marine organisms in the Bay, there is still very limited knowledge about it (Yılmaz et al., 2010). In the study by Yilmaz et al., median arsenic concentrations varied from 0.98 to 1.74 µg metal/g w.w. in the muscle of three fish species (Table 3). They also found the highest arsenic level in the liver of S. lascaris (1.98 µg metal/g w.w), while mean value of arsenic levels in *L.budegassa* and *S. lascaris* were Liver > Muscle > Skin, and in *T. Lucerna,* Muscle > Liver > Skin. The highest level of arsenic belonged to the muscles of a demersal fish *Merluccius merluccius,* living in the Adriatic Sea, while lower levels were found in tissues of pelagic species like *Trachurus trachurus* and *Sardina pilchardus* (Juresa et al., 2003).

The risk-based concentrations (RBC) for total arsenic in tissues of marine organisms, destined to be consumed by human, were 0.81 µg/g wet weight (4.05 µg/g dry wet) for non-carcinogenic and 0.042 µg/g (0.21 µg/g dry wt) for carcinogenic effects. RBCs of total arsenic harmed human consumers, because, with just a few exceptions, nearly the entire arsenic in marine fishery products were presented in nontoxic organic forms (Neff, 2002).

Table 3. Mean concentration (µg metal /g) and associated standard deviations (means ± SD) of arsenic in the muscle, liver, and skin of fish samples in Iskenderun Bay (Turkey).

Species	FT	En	Se	St	Tissues			Wt	Ref.
					Muscle	Liver	Skin		
Lophius budegassa	c	D	su	VI	0.98 ± 0.07	1.32 ± 0.32	0.83 ± 0.42	w.w.	Yılmaz et al., 2010
Pegusa lascaris (As: Solea lascaris)	c	D	su	VI	1.74 ± 0.21	1.98 ± 1.01	0.87 ± 1.02	w.w.	Yılmaz et al., 2010
Chelidonichthys lucerna (as: Trigla lucerna)	om	D	su	VI	1.38 ± 0.72	1.01 ± 0.98	0.76 ± 0.37	w.w.	Yılmaz et al., 2010

Note: FT: feeding type, c: carnivore, om: omnivore, En: environment, d: demersal, Se: Season, su: summer, St: stations, VI: İskenderun, Wt: weight, w.w.: wet weight.

- Cadmium

Metallic cadmium is obtained as a by-product of zinc industry. Although its chemical behavior is very similar to zinc, it is not amphoteric. This metal can be easily converted into wire and sheet, being malleable and drawable. Since it can make important alloys with lead, tin, and bismuth, it has been widely used in industry in recent years, where it is used as the electrode in batteries, yellow color (CdS) in paint, corrosion-protecting covering for iron, and a substance for production of different alloys.

In open sea, concentrations of dissolved cadmium are usually very low at the surface (≤ 1 ng/l) and increase with the depth (1-100 ng/l), reaching their maximum rate at the level of the nutrient (Yeast et al., 1995). Its concentration increases more than fifty times in estuaries, receiving drainage from metal mining areas (Schuhmacher et al., 1995). Cadmium (Cd, free ionic state in water as a divalent cation) is insoluble in water, but its chloride and sulfate salts are freely soluble, all of them being poisonous. It can be found in seawater in a variety of dissolved, dominant cadmium species in seawater ($CdCl^+$, $CdCl_2$ and $CdCl_3^{1-}$) and solid forms. Nearly, the total cadmium in coastal seawater is complexed with dissolved or colloidal organic matter (Muller, 1998) and their amounts depend on seawater salinity (Sadiq, 1992). The affinity of cadmium for complexation with colloidal organic matter is much less than that of copper and lead. Cadmium does not readily sorb to or complex with humic and fulvic acids in seawater (Yuan-Hui, 1991). Ionic cadmium (Cd^{2+}), usually representing only a small fraction of the total cadmium dissolved in seawater, is relatively mobile in marine environment and is exchangeable; therefore it is the most bioavailable form among the species (Kudo et al., 1996). Fish is also capable of accumulating cadmium from food (Canlı & Furness, 1995).

Metallothioneins are a family of low-molecular-mass, metal-binding proteins, believed to function in the regulation of essential metals of Cu and Zn and in the detoxification of these and nonessential metals such as Cd and Hg. The capacity for metallothionein induction is greatest in tissues which are active in metal uptake, storage, and excretion. Cadmium displaces copper and zinc from the cells' enzyme pools, thus disrupting copper and zinc homeostasis (Hilmy et al., 1985; Bay et al., 1990; Brown et al., 1990). Not surprisingly, high concentrations of cadmium may result in enzyme inhibition, and enzymes from different tissues may also be affected very differently by cadmium. Cadmium has received considerable attention thanks to its high toxicity and the fact that there is little known concerning its function in the cells.

Nonessential, toxicologically-significant metals, such as Cd and Hg, are not considered to have any specific uptake mechanism and appear to behave adventitiously, following existing pathways for essential metals. In animals, metallothioneins have been observed in the small intestine, liver, and gills of fish and in the digestive gland and gills of mollusks and crustaceans, which results in relatively high concentrations of metallothionein-bound metals in these organs and, in case of metals like Cd, in a slower turnover of the metal (Malins & Ostrander, 1994). Cadmium can traverse model membranes in ionic form and has been shown to be taken up through Ca channels in the pituitary cells as well as hepatocytes of mammals and in the gills of fish and mollusks (Blazka & Ostrander, 1991; Roesijadi & Unger, 1993).

Table 4 shows concentration data for Cadmium from previous studies in this area (µg /g). Studies have shown that cadmium accumulation levels of aquatic animals might be related to many factors, including species, size and age of animals, feeding habits, physiochemical parameters of aquatic environment, and bioavability of chemicals in food and water. Mormede & Davies (2001) suggested that liver was the target organ. They showed the detoxification and accumulation role of liver. Levels of cadmium in other organs were very low, in contrast to the gills which might be an uptake route. Yılmaz et al. (2010) observed that Cd levels in skin, also another possible uptake route in all samples, were higher than the ones in the muscles.

Cadmium values of muscle on *Sparus aurata*, carnivore, and pelagic, have been put forward by various studies (Kargın, 1996; Çoğun et al., 2005; Dural et al., 2006 & 2011; Ersoy & Çelik, 2010; and Türkmen et al., 2005a). Mean value of the cadmium levels were reported in the following orders: Spleen > Kidney > Liver > Gill > Muscle according to Kargın (1996) and Liver > Gill> Muscle according to Çoğun et al. (2005) and Dural et al. (2006). However, mean values of cadmium levels were reported in these orders: Liver > Gill > Gonads > Muscle and Liver> Gill> Muscle (Table 4) according to Dural et al. (2006) and Çoğun et al. (2006), respectively, whereas for *Mugil cephalus* (omnivore, bento-pelagic) during four seasons, Kalay et al. (1999) found Liver > Gill > Muscle in the same season (in Autumn).

The Cd levels (µg g^{-1}) of muscle on *Mullus barbatus*, carnivore, and demersal, from different seasons were studied by Kargın (1996) (5.4±0.88 - 10.2±1.38 d.w), Çoğun et al. (2006) (1.9±0.76 – 3.1±0.85 d.w), Kalay et al. (1999) (1.43±0.97 d.w), Türkmen et al. (2005a) (0.338-1.642 d.w), Turan et al. (2009) (0.494±0.183 d.w.), and Dural et al. (2010a) (n.d.). Kalay et al. (1999) reported that cadmium concentration in the gill of *Mullus barbatus*, carnivore and demersal, were higher than livers and muscles. Yılmaz et al. (2010) studied the other carnivore and demersal fish species, *Solea lascaris* (*Pegusa lascaris*) and reported that the cadmium levels in muscle were 0.04±0.01 w.w.. Çoğun et al. (2005) and Ersoy & Çelik (2010) claimed that the cadmium levels in the muscles of *Solea solea* were between 2.1±0.62 and 3.5±1.65 d.w. and within 0.03-0.11 w.w., respectively. Ersoy & Çelik (2009) stated that the accumulation of cadmium in muscles of *Trachurus mediterraneus*, carnivore, and pelagic, were from 0.04 to 0.27 w.w. in Karataş area.

The cadmium levels in the muscles of *Penaeus semisulcatus* were studied by Kargın et al. (2001) (1.0±0.56- 1.9±0.66 d.w.), Çoğun et al. (2005) (2.7±0.87 - 5.0±0.86 d.w.), Fırat et al. (2008) (16.72±5.71 d.w), and Kaymacı (2011) (0.557 w.w). *Sepia officinalis* and *Spondylus spinosis* were investigated by Duysak et al. (2013) (2.39±0.37 w.w) and Türkmen & Türkmen (2005) (0.52-40.3 d.w), respectively. Also several researchers including Kaymacı (2011), Fırat et al. (2008), Kaymacı (2011), Duysak & Ersoy (2014), Yüzereroğlu et al. (2010), and Kaymacı (2011) studied *Aristeus antennatus*, *Charybdis longicollis*, *Metapenaeus monoceros*, *Monodonta turbinata*, *Patella caerulea*, *Parapenaus longirostris,* and *Penaus kerathurus*, respectively (Table 5).

Maximum admissible value for fish is 0.05 mg /kg w.w. (EU comission Regulation, 2001). The risk-based concentration (RBC) for cadmium in edible tissues of marine animals, consumed by man, is 2.70 µg /g wet wt or 13.5 µg /g dry wt (dry wt was converted from wet wt by being multiplied by a dry/wet ratio of 5) (Neff, 2002). Sometimes edible tissues of marine animals, particularly bivalve mollusks, and coastal marine areas of the world contain cadmium concentrations, above 6.75 µg /g dry wt RBC. It is uncertain whether these concentrations of cadmium in marine products pose any health risk to shellfish consumers. Most of the cadmium was present in marine animals in the form of solid concentrations in the kidneys, which were not bioavailable to consumers of fishery products (Nott and Nicolaidou, 1994). Permissible levels of cadmium has been given as 0.02 µg /g by FAO/WHO (2006). FAO of the United Nations and WHO (2006) has established a provisional tolerable weekly intake (PTWI) of cadmium as 7.0 µg /kg body weight for humans, equal to 420 µg cadmium/week for a person weighing 60 kg (Deshpande et al., 2009; Ploetz et al., 2007).

Table 4. Mean concentration (μg metal /g) and associated standard deviations (means ± SD) of cadmium in muscle, liver, gill, kidney, skin, gonad, intestine, and spleen of fish samples in Iskenderun Bay (Turkey).

Species	FT	En	Se	St	Tissues								Wt	Ref.
					Muscle	Liver	Gill	Kidney	Skin	Gonad	Intestine	Spleen		
Belone belone	c	p	sp-su	VI	0.07 ± 0.03	0.21 ± 0.05	-	-	-	-	-	-	w.w	Türkmen et al., 2009a
Caranx crysos	c	d	a	VI	1.23 ± 0.23	5.93 ± 1.14	2.64 ± 0.40	-	-	-	-	-	d.w	Kalay et al., 1999
Carcharhinus altimus	c	d	*1	IX	-	0.05 ± 0.02	-	-	-	-	-	-	w.w	Özyılmaz & Öksüz, 2015
Chelidonichthys cuculus (As: Aspitrigla cuculus)	c	d	sp	VI	0.07 ± 0.01	0.22 ± 0.12	-	-	-	-	-	-	w.w	Tepe, 2009
Chelidonichthys lucerna (As:Chelidonichthys lucernus)	c	d	su	I	0.07 ± 0.00	0.32 ± 0.02	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Chelidonichthys lucerna (As:Chelidonichthys lucernus)	c	d	a	I	0.05 ± 0.00	0.36 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Chelidonichthys lucerna (As:Chelidonichthys lucernus)	c	d	w	I	0.05 ± 0.00	0.06 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Chelidonichthys lucerna (As:Chelidonichthys lucernus)	c	d	sp	I	0.04 ± 0.00	0.19 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Chelidonichthys lucerna (As: Trigla Lucerna)	c	d	w-sp-su	*2	0.11 ± 0.03	0.46 ± 0.21	-	-	-	-	-	-	w.w	Ateş et al., 2015
Chelidonichthys lucerna (As: Trigla lucerna)	c	d	su	VI	0.01 ± 0.05	0.24 ± 0.22	-	-	0.12 ± 0.09	-	-	-	w.w	Yılmaz et al., 2010
Dasyatis pastinaca	c	d	2 years	VII	0.12 ± 0.01	0.20 ± 0.01	0.10 ± 0.01	-	-	-	-	-	w.w	Türkmen et al., 2013
Dasyatis pastinaca	c	d	*1	*2	-	0.03 ± 0.00	-	-	-	-	-	-	w.w	Özyılmaz & Öksüz, 2015
Dicentrarchus labrax	c	d	a	II	0.092 ± 0.0005	0.98 ± 0.01	0.50 ± 0.003	-	-	0.45 ± 0.01	-	-	d.w	Dural et al., 2006
Dicentrarchus labrax	c	d	w	II	0.107 ± 0.001	1.49 ± 0.03	0.44 ± 0.005	-	-	0.43 ± 0.003	-	-	d.w	Dural et al., 2006
Dicentrarchus labrax	c	d	sp	II	0.027 ± 0.01	1.16 ± 0.07	0.45 ± 0.02	-	-	0.40 ± 0.01	-	-	d.w	Dural et al., 2006
Dicentrarchus labrax	c	d	w-sp-su	II	0.03 ± 0.01	0.21 ± 0.03	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Engraulis encrasicholus	h	p	*1	VI	0.183 ± 0.026	-	-	-	-	-	-	-	d.w	Turan et al., 2009
Epinephelus fasciatus (As: Epinephelus alexandrinus)	c	d	sp	VI	0.03 ± 0.01	0.47 ± 0.33	-	-	-	-	-	-	w.w	Tepe, 2009
Etrumeus teres	c	p	su	I	0.05 ± 0.00	0.28 ± 0.02	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Etrumeus teres	c	p	a	I	0.09 ± 0.00	0.10 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Etrumeus teres	c	p	w	I	0.07 ± 0.00	0.35 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Etrumeus teres	c	p	sp	I	0.07 ± 0.00	0.28 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Gymnura altavela	om	d	2 years	II	0.07 ± 0.01	0.15 ± 0.02	0.08 ± 0.02	-	-	-	0.10 ± 0.02	-	w.w	Türkmen et al., 2013
Lithognathus mormyrus	c	d	sp	VI	0.04 ± 0.01	0.12 ± 0.03	-	-	-	-	-	-	w.w	Tepe, 2009
Liza aurata	om	p	su	I	0.05 ± 0.00	0.13 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Liza aurata	om	p	a	I	0.05 ± 0.00	0.11 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Liza aurata	om	p	w	I	0.07 ± 0.00	0.07 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Liza aurata	om	p	sp	I	0.04 ± 0.00	0.21 ± 0.01	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Liza ramada	om	p	w-sp-su	VI	0.17 ± 0.7	0.56 ± 0.28	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Lophius budegassa	c	d	su	VI	0.02 ± 0.03	0.26 ± 0.19	-	-	0.09 ± 0.001	-	-	-	w.w	Yılmaz et al., 2010
Merlangius merlangus	c	bp	*1	VI	1.685 ± 0.124	-	-	-	-	-	-	-	d.w	Turan et al., 2009
Merluccius merluccius	c	d	su	I	0.06 ± 0.00	0.13 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Merluccius merluccius	c	d	a	I	0.06 ± 0.00	0.10 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010

Note: FT: feeding type, c: carnivore, om: omnivore, h: herbivore, En: environment, d: demersal, p: pelagic, bp: bento-pelagic, Se: Season, *1: no. season info, a: autumn, w: winter, sp: spring; su: summer, St: stations, *2: no. station info, I: Karataş, II: Yumurtalık, IV: Petrotrans, V: Dörtyol, VI: İskenderun, VII- Arsuz, nd: not detected, Wt: weight, d.w.: dry weight, w.w.: wet weight.

Table 4. Mean concentration (µg metal /g) and associated standard deviations (means ± SD) of cadmium in muscle, liver, gill, kidney, skin, gonad, intestine, and spleen of fish samples in Iskenderun Bay (Turkey). (continued)

Species	FT	En	Se	St	Tissues								Wt	Ref.
					Muscle	Liver	Gill	Kidney	Skin	Gonad	Intestine	Spleen		
Merluccius merluccius	c	d	w	I	0.05 ± 0.00	0.32 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Merluccius merluccius	c	d	sp	I	0.07 ± 0.00	0.20 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Merluccius merluccius	c	d	w-sp-su	*2	0.22 ± 0.06	1.53 ± 0.31	-	-	-	-	-	-	w.w	Ateş et al., 2015
Mugil cephalus	om	bp	a	II	0.06 ± 0.02	0.94 ± 0.03	0.54 ± 0.003	-	-	0.40 ± 0.01	-	-	d.w	Dural et al., 2006
Mugil cephalus	om	bp	w	II	0.100 ± 0.032	1.64 ± 0.07	0.50 ± 0.003	-	-	0.41 ± 0.01	-	-	d.w	Dural et al., 2006
Mugil cephalus	om	bp	sp	II	0.06 ± 0.02	1.48 ± 0.52	0.77 ± 0.05	-	-	0.40 ± 0.008	-	-	d.w	Dural et al., 2006
Mugil cephalus	om	bp	w	I	1.2 ± 0.68	5.9 ± 1.02	3.2 ± 0.75	-	-	-	-	-	d.w	Çoğun et al., 2006
Mugil cephalus	om	bp	sp	I	1.1 ± 0.24	6.1 ± 0.86	3.4 ± 0.86	-	-	-	-	-	d.w	Çoğun et al., 2006
Mugil cephalus	om	bp	su	I	2.2 ± 0.85	8.1 ± 1.21	4.9 ± 0.93	-	-	-	-	-	d.w	Çoğun et al., 2006
Mugil cephalus	om	bp	a	I	1.3 ± 0.72	6.2 ± 1.21	3.1 ± 0.83	-	-	-	-	-	d.w	Çoğun et al., 2006
Mugil cephalus	om	bp	su	VI	0.195	-	-	-	-	-	-	-	d.w	Türkmen et al., 2006
Mugil cephalus	om	bp	su	VII	0.234	-	-	-	-	-	-	-	d.w	Türkmen et al., 2006
Mugil cephalus	om	bp	su	IV	0.551	-	-	-	-	-	-	-	d.w	Türkmen et al., 2006
Mugil cephalus	om	bp	sp	VI	0.12 ± 0.08	0.56 ± 0.16	-	-	-	-	-	-	w.w	Tepe, 2009
Mugil cephalus	om	bp	a	VI	1.07 ± 0.30	3.61 ± 1.65	2.36 ± 0.27	-	-	-	-	-	d.w	Kalay et al., 1999
Mullus barbatus	c	d	sp	VI	5.4 ± 0.88	15.9 ± 2.66	6.1 ± 0.66	19.4 ± 2.67	-	-	-	68.5 ± 4.78	d.w	Kargın, 1996
Mullus barbatus	c	d	su	VI	10.2 ± 1.38	28.0 ± 2.15	12.4 ± 1.05	33.8 ± 3.82	-	-	-	93.7 ± 4.41	d.w	Kargın, 1996
Mullus barbatus	c	d	a	VI	7.2 ± 1.01	18.2 ± 2.17	8.2 ± 0.66	24.1 ± 3.22	-	-	-	77.0 ± 6.49	d.w	Kargın, 1996
Mullus barbatus	c	d	w	VI	6.2 ± 0.61	16.3 ± 1.19	7.1 ± 0.68	20.7 ± 3.06	-	-	-	71.4 ± 6.26	d.w	Kargın, 1996
Mullus barbatus	c	d	su	VII	0.338	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Mullus barbatus	c	d	su	VI	0.513	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Mullus barbatus	c	d	su	IV	1.642	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Mullus barbatus	c	d	w	I	1.9 ± 0.76	10.9 ± 1.15	5.3 ± 1.12	-	-	-	-	-	d.w	Çoğun et al., 2006
Mullus barbatus	c	d	sp	I	2.0. ± 0.95	11.2 ± 1.45	5.6 ± 1.04	-	-	-	-	-	d.w	Çoğun et al., 2006
Mullus barbatus	c	d	su	I	3.1 ± 0.85	14.5 ± 1.76	7.9 ± 1.40	-	-	-	-	-	d.w	Çoğun et al., 2006
Mullus barbatus	c	d	su	I	2.1 ± 1.06	10.8 ± 1.36	6.0 ± 1.10	-	-	-	-	-	d.w	Çoğun et al., 2006
Mullus barbatus	c	d	a	VI	1.43 ± 0.97	1.98 ± 0.49	2.25 ± 0.50	-	-	-	-	-	d.w	Kalay et al., 1999
Mullus barbatus	c	d	*1	VI	0.494 ± 0.183	-	-	-	-	-	-	-	d.w	Turan et al., 2009
Mullus barbatus	c	d	sp	VI	nd	nd	-	-	nd	-	-	-	d.w	Dural et al., 2010a
Mullus barbatus	c	d	su	VI	0.04 ± 0.01	0.48 ± 0.16	-	-	-	-	-	-	w.w	Tepe et al., 2008
Mullus surmuletus	c	d	sp	VI	0.39 ± 0.01	0.86 ± 0.01	-	-	-	-	-	-	w.w	Tepe, 2009
Mullus surmuletus	c	d	sp	VI	0.14 ± 0.04	0.02 ± 0.01	-	-	0.03 ± 0.01	-	-	-	d.w	Dural et al., 2010a
Mullus surmuletus	c	d	sp	*2	0.25 ± 0.22	-	-	-	-	-	-	-	w.w	Öksüz et al., 2011
Mustelus mustelus	c	d	*1	IX	-	0.02 ± 0.02	-	-	-	-	-	-	w.w	Özyılmaz & Öksüz, 2015
Myliobatis aquila	c	d	*1	I	-	0.07 ± 0.04	-	-	-	-	-	-	w.w	Özyılmaz & Öksüz, 2015
Oblada melanura	c	d	w-sp-su	*2	0.07 ± 0.03	0.23 ± 0.04	-	-	-	-	-	-	w.w	Ateş et al., 2015
Pagellus acarne	c	bp	w-sp-su	VI	0.11 ± 0.06	0.26 ± 0.10	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Pagellus erythrinus	om	bp	sp	VI	0.14 ± 0.04	0.57 ± 0.12	-	-	-	-	-	-	w.w	Tepe, 2009
Pagellus erythrinus	om	bp	sp	VI	0.279 ± 0.04	0.365 ± 0.10	-	-	0.221 ± 0.06	-	0.268 ± 0.09	-	w.w	Dural et al., 2010b
Pagellus erythrinus	om	bp	su	VI	0.282 ± 0.12	0.612 ± 0.15	-	-	0.200 ± 0.08	-	0.275 ± 0.06	-	w.w	Dural et al., 2010b
Pagellus erythrinus	om	bp	a	VI	0.309 ± 0.02	0.260 ± 0.05	-	-	0.222 ± 0.01	-	0.221 ± 0.04	-	w.w	Dural et al., 2010b
Pagellus erythrinus	om	bp	w	VI	0.223 ± 0.07	0.422 ± 0.13	-	-	0.198 ± 0.02	-	0.309 ± 0.06		w.w	Dural et al., 2010b
Pagrus caeruleostictus	c	bp	w-sp-su	VI	0.21 ± 0.03	0.45 ± 0.04	-	-	-	-	-	-	w.w	Türkmen et al., 2009b

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					Muscle	Liver	Gill	Kidney	Skin	Gonad	Intestine	Spleen		
Pegusa lascaris (As: Solea lascaris)	c	d	su	VI	0.04 ± 0.01	0.39 ± 0.05	-	-	0.08 ± 0.07	-	-	-	w.w	Yılmaz et al., 2010
Pomadasys incisus	c	d	w-sp-su	VI	0.08 ± 0.02	0.28 ± 0.07	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Pomatomus saltatrix	c	p	w-sp-su	VI	0.38 ± 0.07	0.77 ± 0.12	-	-	-	-	-	-	w.w	Türkmen et al., 2009a
Pteromylaeus bovinus	c	bp	2 years	I	0.05 ± 0.01	0.13 ± 0.02	0.10 ± 0.02	-	-	-	3.17 ± 1.44	-	w.w	Türkmen et al., 2013
Raja clavata	c	d	2 years	V	0.07 ± 0.02	0.10 ± 0.02	0.16 ± 0.02	-	-	-	0.43 ± 0.11	-	w.w	Türkmen et al., 2013
Raja clavata	c	d	w	*2	-	0.10 ± 0.10	-	-	-	-	-	-	w.w	Özyılmaz, 2016
Raja miraletus	c	d	2 years	II	0.06 ± 0.01	0.14 ± 0.02	0.07 ± 0.01	-	-	-	0.20 ± 0.03	-	w.w	Türkmen et al., 2013
Raja radula	c	d	2 years	II	0.09 ± 0.02	0.25 ± 0.11	0.19 ± 0.05	-	-	-	0.45 ± 0.12	-	w.w	Türkmen et al., 2013
Rhinobatos rhinobatos	c	d	*1	III	-	0.03 ± 0.02	-	-	-	-	-	-	w.w	Özyılmaz & Öksüz, 2015
Rhinoptera marginata	c	d	*1	*2	-	0.07 ± 0.04	-	-	-	-	-	-	w.w	Özyılmaz & Öksüz, 2015
Sardinella aurita	om	p	sp	VI	0.11 ± 0.02	0.45 ± 0.19	-	-	-	-	-	-	w.w	Tepe, 2009
Saurida undosquamis	c	d	su	VII	0.515	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Saurida undosquamis	c	d	su	VI	0.927	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Saurida undosquamis	c	d	su	IV	2.488	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Saurida undosquamis	c	d	su	I	0.06 ± 0.00	0.06 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Saurida undosquamis	c	d	a	I	0.04 ± 0.00	0.16 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Saurida undosquamis	c	d	w	I	0.06 ± 0.00	0.09 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Saurida undosquamis	c	d	sp	I	0.04 ± 0.00	0.35 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Saurida undosquamis	c	d	w-sp-su	*2	0.02 ± 0.00	0.09 ± 0.02	-	-	-	-	-	-	w.w	Ateş et al., 2015
Scomber japonicus	c	p	su	I	0.05 ± 0.00	0.78 ± 0.03	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Scomber japonicus	c	p	a	I	0.04 ± 0.00	0.07 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Scomber japonicus	c	p	w	I	0.06 ± 0.00	0.57 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Scomber japonicus	c	p	sp	I	0.06 ± 0.00	0.48 ± 0.02	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Scomber japonicus	c	p	w-sp-su	VI	0.04 ± 0.01	0.12 ± 0.02	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Serranus scriba	c	d	w-sp-su	VI	0.31 ± 0.15	-	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Serranus cabrilla	c	d	w-sp-su	*2	0.17 ± 0.06	0.69 ± 0.22	-	-	-	-	-	-	w.w	Ateş et al., 2015
Siganus luridus	h	d	sp	*2	0.00 ± 0.00	-	-	-	-	-	-	-	w.w	Öksüz et al., 2010
Siganus rivulatus	h	d	w-sp-su	*2	0.24 ± 0.05	1.21 ± 0.20	-	-	-	-	-	-	w.w	Ateş et al., 2015
Siganus rivulatus	h	d	sp	*2	0.00 ± 0.00	-	-	-	-	-	-	-	w.w	Öksüz et al., 2010
Solea solea	c	d	w	II	2.1 ± 0.62	7.8 ± 1.24	4.8 ± 0.87	-	-	-	-	-	d.w	Çoğun et al., 2005
Solea solea	c	d	sp	II	2.5 ± 0.47	8.1 ± 1.15	5.2 ± 0.84	-	-	-	-	-	d.w	Çoğun et al., 2005
Solea solea	c	d	su	II	3.5 ± 1.65	13.7 ± 2.83	9.5 ± 1.89	-	-	-	-	-	d.w	Çoğun et al., 2005
Solea solea	c	d	a	II	2.7 ± 0.64	9.3 ± 1.24	6.1 ± 1.77	-	-	-	-	-	d.w	Çoğun et al., 2005
Solea solea	c	d	su	I	0.08 ± 0.00	0.31 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Solea solea	c	d	a	I	0.03 ± 0.00	0.05 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Solea solea	c	d	w	I	0.11 ± 0.00	0.63 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Solea solea	c	d	sp	I	0.11 ± 0.00	0.54 ± 0.01	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Sparus aurata	c	d	sp	VI	4.1 ± 0.41	9.2 ± 0.95	5.1 ± 0.53	15.2 ± 1.50	-	-	-	54.9 ± 5.05	w.w	Kargın, 1996
Sparus aurata	c	d	su	VI	7.6 ± 0.98	19.9 ± 1.87	9.4 ± 0.89	25.3 ± 3.29	-	-	-	71.8 ± 5.93	w.w	Kargın, 1996
Sparus aurata	c	d	a	VI	5.3 ± 0.40	12.3 ± 0.93	7.0 ± 0.75	18.1 ± 1.95	-	-	-	60.9 ± 4.32	w.w	Kargın, 1996
Sparus aurata	c	d	w	VI	5.2 ± 0.66	11.3 ± 1.06	6.6 ± 0.55	17.1 ± 1.72	-	-	-	57.5 ± 5.13	w.w	Kargın, 1996
Sparus aurata	c	d	w	II	2.4 ± 0.88	6.7 ± 1.24	4.2 ± 0.95	-	-	-	-	-	d.w	Çoğun et al., 2005

Note: FT: feeding type, c: carnivore, om: omnivore, h: herbivore, En: environment, d: demersal, p: pelagic, bp: bento-pelagic, Se: Season, *1: no. season info, a: autumn, w: winter, sp: spring; su: summer, St: stations, *2: no. station info, I: Karataş, II: Yumurtalık, IV: Petrotrans, V: Dörtyol, VI: İskenderun, VII- Arsuz, nd: not detected, Wt: weight, d.w.: dry weight, w.w.: wet weight.

Table 4. Mean concentration (μg metal /g) and associated standard deviations (means ± SD) of cadmium in muscle, liver, gill, kidney, skin, gonad, intestine, and spleen of fish samples in Iskenderun Bay (Turkey). (continued)

Species	FT	En	Se	St	Tissues								Wt	Ref.
					Muscle	Liver	Gill	Kidney	Skin	Gonad	Intestine	Spleen		
Sparus aurata	c	d	sp	II	2.2 ± 0.44	5.9 ± 1.25	3.8 ± 0.50	-	-	-	-	-	d.w	Çoğun et al., 2005
Sparus aurata	c	d	su	II	3.2 ± 1.35	9.7 ± 2.08	6.2 ± 1.07	-	-	-	-	-	d.w	Çoğun et al., 2005
Sparus aurata	c	d	a	II	2.1 ± 0.97	6.3 ± 2.06	4.7 ± 1.18	-	-	-	-	-	d.w	Çoğun et al., 2005
Sparus aurata	c	d	su	VII	1.441	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Sparus aurata	c	d	su	VI	1.783	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Sparus aurata	c	d	su	IV	1.404	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Sparus aurata	c	d	a	II	0.12 ± 0.01	0.58 ± 0.01	0.50 ± 0.003	-	-	0.39 ± 0.003	-	-	d.w	Dural et al., 2006
Sparus aurata	c	d	w	II	0.13 ± 0.002	0.93 ± 0.09	0.43 ± 0.006	-	-	0.38 ± 0.003	-	-	d.w	Dural et al., 2006
Sparus aurata	c	d	sp	II	0.13 ± 0.01	1.33 ± 0.05	0.38 ± 0.02	-	-	0.42 ± 0.01	-	-	d.w	Dural et al., 2006
Sparus aurata	c	d	su	I	0.11 ± 0.00	0.13 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Sparus aurata	c	d	a	I	0.05 ± 0.00	0.22 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Sparus aurata	c	d	w	I	0.20 ± 0.00	0.28 ± 0.02	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Sparus aurata	c	d	sp	I	0.19 ± 0.00	0.29 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Sparus aurata	c	d	sp	VI	1.255 ± 0.793	0.742 ± 0.129	0.188 ± 0.004	-	2.044 ± 0.957	-	0.433 ± 0.006	-	w.w	Dural et al., 2011
Sphyraena viridensis	c	p	w-sp-su	VI	<0.01 ± 0.00	0.05 ± 0.01	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Spicara maena	c	d	w-sp-su	*2	0.37 ± 0.06	1.01 ± 0.07	-	-	-	-	-	-	w.w	Ateş et al., 2015
Trachinotus ovatus	c	p	w-sp-su	VI	0.05 ± 0.01	-	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Trachinus draco	c	d	w-sp-su	*2	0.05 ± 0.01	0.12 ± 0.02	-	-	-	-	-	-	w.w	Ateş et al., 2015
Trachurus mediterraneus	c	p	su	I	0.04 ± 0.00	0.05 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Trachurus mediterraneus	c	p	a	I	0.04 ± 0.00	0.04 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Trachurus mediterraneus	c	p	w	I	0.06 ± 0.00	0.45 ± 0.04	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Trachurus mediterraneus	c	p	sp	I	0.27 ± 0.02	0.39 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Trigla lyra	c	d	w-sp-su	VI	0.13 ± 0.02	0.71 ± 0.02	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Upeneus molluccensis	c	d	su	I	0.04 ± 0.00	0.25 ± 0.03	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Upeneus molluccensis	c	d	a	I	0.05 ± 0.00	0.19 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Upeneus molluccensis	c	d	w	I	0.08 ± 0.00	0.59 ± 0.01	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Upeneus molluccensis	c	d	sp	I	0.05 ± 0.00	0.61 ± 0.03	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Upeneus moluccensis	c	d	*1	VI	0.297 ± 0.030	0.747 ± 0.139	-	-	1.063 ± 0.108	-	-	-	d.w	Dural & Bıçkıcı, 2010
Upeneus moluccensis	c	d	w-sp-su	*2	0.29 ± 0.04	1.11 ± 0.10	-	-	-	-	-	-	w.w	Ateş et al., 2015
Upeneus moluccensis	c	d	sp	*2	0.18 ± 0.23	-	-	-	-	-	-	-	w.w	Öksüz et al., 2011
Upeneus pori	c	d	*1	VI	nd	nd	-	-	nd	-	-	-	d.w	Dural & Bıçkıcı, 2010

Note: FT: feeding type, c: carnivore, om: omnivore, h: herbivore, En: environment, d: demersal, p: pelagic, bp: bento-pelagic, Se: Season, *1: no. season info, a: autumn, w: winter, sp: spring; su: summer, St: stations, *2: no. station info, I: Karataş, II: Yumurtalık, IV: Petrotrans, V: Dörtyol, VI: İskenderun, VII- Arsuz, nd: not detected, Wt: weight, d.w.: dry weight, w.w.: wet weight.

Table 5. Mean concentration (µg metal /g) and associated standard deviations (means ± SD) of cadmium in the muscle, liver, gill, and hepatopancreas of invertebrate samples in Iskenderun Bay (Turkey).

Species	Se	St	Tissues				Wt	Ref.
			Muscle	Liver	Gill	H.pancreas		
Aristeus antennatus	a	VI	nd	-	-	-	w.w	Kaymacı, 2011
Aristeus antennatus	w	VI	nd	-	-	-	w.w	Kaymacı, 2011
Aristeus antennatus	sp	VI	0.219 ± 0.051	-	-	-	w.w	Kaymacı, 2011
Callinectes sapidus	su	VI	1.055	-	-	-	d.w	Türkmen et al., 2006
Callinectes sapidus	su	VI	2.509	-	-	-	d.w	Türkmen et al., 2006
Callinectes sapidus	su	VI	1.741	-	-	-	d.w	Türkmen et al., 2006
Charybdis longicollis	1 year	VI	25.44 ± 7.84	111.2 ± 22.27	75.50 ± 8.77	-	d.w	Fırat et al., 2008
Illex coindetii	a	*2	1.35 ± 0.59	-	1.23 ± 0.11	-	w.w	Duysak & Dural, 2015
Metapenaeus monoceros	w	VI	0.6 ± 0.34	-	2.1 ± 0.85	3.4 ± 0.76	d.w	Kargın et al., 2001
Metapenaeus monoceros	sp	VI	0.5 ± 0.43	-	2.1 ± 0.95	3.3 ± 1.17	d.w	Kargın et al., 2001
Metapenaeus monoceros	su	VI	1.1 ± 0.78	-	3.1 ± 1.16	5.6 ± 1.32	d.w	Kargın et al., 2001
Metapenaeus monoceros	a	VI	0.7 ± 0.44	-	2.2 ± 1.24	3.5 ± 1.12	d.w	Kargın et al., 2001
Metapenaeus monoceros	a	VI	0.288 ± 0.094	-	-	-	w.w	Kaymacı, 2011
Metapenaeus monoceros	w	VI	0.354 ± 0.215	-	-	-	w.w	Kaymacı, 2011
Metapenaeus monoceros	sp	VI	0.236 ± 0.056	-	-	-	w.w	Kaymacı, 2011
Monodonta turbinata	sp	X	9.01 ± 3.02	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	VIII	3.24 ± 0.66	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	IX	2.51 ± 0.43	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	VII	5.42 ± 1.35	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	VI	3.50 ± 1.15	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	V	4.95 ± 1.01	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	II	2.15 ± 0.08	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	X	7.63 ± 0.29	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	VIII	6.50 ± 1.28	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	IX	8.58 ± 0.95	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	VII	6.48 ± 1.05	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	VI	7.69 ± 1.57	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	V	6.63 ± 2.70	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	II	8.15 ± 1.23	-	-	-	d.w	Duysak & Ersoy, 2014
Parapenaeus longirostris	a	II	0.827 ± 0.249	-	-	-	w.w	Kaymacı, 2011
Parapenaeus longirostris	w	II	0.821 ± 0.556	-	-	-	w.w	Kaymacı, 2011
Parapenaeus longirostris	sp	II	0.267 ± 0.478	-	-	-	w.w	Kaymacı, 2011
Parapenaeus longirostris	*1	*2	0.784 ± 0.081	-	-	-	w.w	Öksüz et al., 2009
Patella caerulea	w	VI	0.50 ± 0.06	-	0.59 ± 0.02	-	w.w	Yüzereroğlu et al., 2010
Patella caerulea	w	II	0.35 ± 0.01	-	0.46 ± 0.08	-	w.w	Yüzereroğlu et al., 2010
Patella caerulea	sp	VI	0.60 ± 0.01	-	0.46 ± 0.04	-	w.w	Yüzereroğlu et al., 2010
Patella caerulea	sp	II	0.44 ± 0.08	-	0.26 ± 0.01	-	w.w	Yüzereroğlu et al., 2010
Patella caerulea	su	VI	0.68 ± 0.03	-	0.49 ± 0.01	-	w.w	Yüzereroğlu et al., 2010
Patella caerulea	su	II	0.27 ± 0.01	-	0.32 ± 0.02	-	w.w	Yüzereroğlu et al., 2010
Patella caerulea	a	VI	0.41 ± 0.03	-	1.25 ± 0.02	-	w.w	Yüzereroğlu et al., 2010
Patella caerulea	a	II	0.24 ± 0.03	-	0.36 ± 0.01	-	w.w	Yüzereroğlu et al., 2010

Note: Se: Season, a: autumn, w: winter, sp: spring, su: summer, St: stations, *2: no station info, II: Yumurtalık, IV: Petrotrans, V: Dörtyol, VI: İskenderun, VII- Arsuz, VIII: Konacık, IX: Akıncı Burnu, X: Samandağ, H.pancreas: hepatopancreas, Wt: weight, d.w.: dry weight, w.w.: wet weight.

Table 5. Mean concentration (μg metal /g) and associated standard deviations (means ± SD) of cadmium in the muscle, liver, gill, and hepatopancreas of invertebrate samples in Iskenderun Bay (Turkey). (continued)

Species	Se	St	Tissues				Wt	Ref.
			Muscle	Liver	Gill	H.pancreas		
Patella caerulea	su	VII	3.19 ± 1.09	-	-	-	d.w	Türkmen et al., 2005b
Patella caerulea	su	VI	2.39 ± 0.92	-	-	-	d.w	Türkmen et al., 2005b
Patella caerulea	su	IV	4.97 ± 1.04	-	-	-	d.w	Türkmen et al., 2005b
Penaeus kerathurus	a	II	0.286 ± 0.144	-	-	-	w.w	Kaymacı, 2011
Penaeus kerathurus	w	II	0.454 ± 0.283	-	-	-	w.w	Kaymacı, 2011
Penaeus kerathurus	sp	II	0.256 ± 0.060	-	-	-	w.w	Kaymacı, 2011
Penaeus semisulcatus	w	VI	1.1 ± 0.42	-	2.5 ± 0.76	8.2 ± 1.15	d.w	Kargın et al., 2001
Penaeus semisulcatus	sp	VI	1.0 ± 0.56	-	2.4 ± 0.93	7.9 ± 1.26	d.w	Kargın et al., 2001
Penaeus semisulcatus	su	VI	1.9 ± 0.66	-	4.5 ± 1.14	12.7 ± 1.71	d.w	Kargın et al., 2001
Penaeus semisulcatus	a	VI	1.1 ± 0.53	-	2.6 ± 0.94	8.3 ± 1.10	d.w	Kargın et al., 2001
Penaeus semiculatus	w	VI	3.2 ± 1.14	20.2 ± 2.17	15.8 ± 2.45	-	d.w	Çoğun et al., 2005
Penaeus semiculatus	sp	VI	2.7 ± 0.87	21.6 ± 2.36	14.3 ± 2.74	-	d.w	Çoğun et al., 2005
Penaeus semiculatus	su	VI	5.0 ± 0.86	37.4 ± 2.32	24.8 ± 2.85	-	d.w	Çoğun et al., 2005
Penaeus semiculatus	a	VI	3.0 ± 0.74	23.3 ± 2.54	13.3 ± 2.15	-	d.w	Çoğun et al., 2005
Penaeus semisulcatus	w-sp-su-a	VI	16.72 ± 5.71	80.89 ± 7.65	70.93 ± 9.01	-	d.w	Fırat et al., 2008
Penaeus semisulcatus	a	VI	0.557 ± 0.362	-	-	-	w.w	Kaymacı, 2011
Penaeus semisulcatus	w	VI	0.096 ± 0.114	-	-	-	w.w	Kaymacı, 2011
Penaeus semisulcatus	sp	VI	nd	-	-	-	w.w	Kaymacı, 2011
Plesionika martia	*1	*2	1.56 ± 0.184	-	-	-	w.w	Öksüz et al., 2009
Sepia officinalis	sp	VI	2.39 ± 0.37	-	2.17 ± 1.09	34.7 ± 67	w.w	Duysak et al., 2013
Spondylus spinosus	w	VII	13.542	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	sp	VII	0.5206	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	su	VII	1.0630	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	a	VII	4.7083	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	w	VI	29.763	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	sp	VI	3.7413	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	su	VI	1.7751	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	a	VI	9.2076	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	w	II	40.279	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	sp	II	4.7083	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	su	II	4.0829	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	a	II	11.243	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	a	VII	4.71	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	w	VII	13.5	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	sp	VII	0.52	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	su	VII	1.63	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	a	VI	9.21	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	w	VI	29.8	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	sp	VI	3.74	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	su	VI	1.78	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	a	IV	11.2	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	w	IV	40.3	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	sp	IV	4.71	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	su	IV	4.08	-	-	-	d.w	Türkmen & Türkmen, 2005

Note: Se: Season, a: autumn, w: winter, sp: spring, su: summer, St: stations, *2: no station info, II: Yumurtalık, IV: Petrotrans, V: Dörtyol, VI: İskenderun, VII- Arsuz, VIII: Konacık, IX: Akıncı Burnu, X: Samandağ, H.pancreas: hepatopancreas, Wt: weight, d.w.: dry weight, w.w.: wet weight.

- Lead

Being a rare metal on Earth, Lead (Pb) has two common oxidation states, namely divalent lead (Pb^{2+}) and tetravalent lead (Pb^{4+}). It is found mostly in the structure of the ore called galena (PbS), which turns to PbO with exposure to O_2, then to reduce by means of C and electro refining. Pb is the heaviest metal with a density of 11.34 g m/l. Its melting and boilding points are 327 °C and 1751 °C, respectively. It does not corrode readily because of an adherent oxide layer that forms rapidly in the air, preventing further O_2 to penetrate (Silberberg, 2012).

Although the lead concentration in clean open-sea water ranges from 0.002 tp about 0.2 µg/l, its concentration may increase nearly to 10 µg/l in some industrialized estuaries. Lead compounds are generally water-insoluble. The most water-soluble compounds are lead nitrate [$Pb(NO_3)_2$] and lead acetate [$Pb(CH_3COO)_2$]. There is an inverse relation between salinity and dissolved lead concentration in estuaries (Neff, 2002). Inorganic lead is available in more than seven forms in seawater, the most significant of which includes carbonate ($PbCO_3$), chloride complexes ($PbCl_n$), and hydroxide complexes ($PbOH_n$), being most abundant in normal pH and salinity of seawater (Sadiq, 1992). Dissolved lead, bound to sulfides, oxides, and dissolved organic matters, is in a non-labile form for marine organisms.

Lead mostly can be used an automotive batteries, gasoline additive, solder, and ammunition. The major source of toxic air pollutants is lead and much of this atmospheric lead finds its way into the surface waters (Lankey et al., 1998). Tetraethly lead, $(C_2H_5)_4Pb$, was used as a gasoline additive to improve fuel efficiency, but now is banned because of its inactivation of auto catalytic converters. As a result, the concentration of lead in the atmosphere as well as surface waters of the ocean has decreased dramatically in recent years (Veron et al., 1998). Although inorganic lead is moderately toxic to marine organisms, alkyllead compounds are usually considered more toxic than inorganic lead. Lead apparently exerts its toxic effects by binding to cellular binding sites and biomolecules such as enzymes and hormones (Zelikoff & Cohen, 1996).

It is known that lead affects the brain, kidney, bone tissue, central nervous system, and biochemical activities adversely. If humans are exposed to lead for a long time, they may suffer from memory deterioration along with reduced ability to understand (WHO, 1995). Animals, affected by lead toxicity, have also shown reproductive disorders as well as structural anomalies (Papanikolaou, 2005). In fish, it can cause deficits or decreases in survival, growth rates, development and metabolism, in addition to increased mucus formation (Burger et al., 2002). Yanar (2016) indicated that, in contrast to muscles, there were many pathlogical findings in the gills, due to lead accumulation, including epithelial lifting, hyperplasia, aneurism, lamellar fusion, and oedema.

Table 6 (µg/g) shows the results of the studies, conducted in the Bay, which dealt with lead accumulation in tissues of different species. In wild marine fish, the mean value of lead concentrations are Gonads > Skin > Gill > Liver > Muscle, true for nearly all previous studies. Muscles contain much lower lead concentration than skin and gill.

In competition between Pb and Ca uptakes in fish species, gills suggested a Ca^- dependent mechanism for Pb, with Pb^{2+} traversing the gill in the same manner as Ca^{2+} (Masoud et al., 2007). According to Yılmaz et al. (2010), skin accumulated more lead than muscle tissue did. Previous researchers concluded that this could be attributed to the similarity between lead and calcium in their deposition and mobilization from gills. The reason for high metal concentration in the skin could be metal's complexing with mucus that is impossible to completely remove from the tissue, prior to the analysis (Yılmaz, 2003).

The level of lead concentration shows significant differences among the seasons, stations, fish species, and tissues in all samples (Table 6). Many researchers have put forward lead values in the muscles of *Mugil cephalus*, including Kalay et al. (1999), Yılmaz (2003), Yılmaz (2005), Türkmen et al. (2006), Çoğun et al. (2006), and Tepe (2009), who obtained such vlues as 7.33±2.21 d.w., 4.16±1.66 w.w.- 10.87±2.69 w.w., 3.59±1.79- 10.02±2.86 w.w, 1.690-2.088 d.w., 5.7±1.45- 7.8±1.65 d.w, and 1.15±0.20 w.w., respectively. Generally in case of lead, the significant differences in the muscle concentration levels of *Mugil cephalus* (omnivore, bento-pelagic), found by several studies at same seasons, turned out to be above the permitted level.

The lead levels in muscle of *Mullus barbatus*, carnivore and demersal, were studied by Kargın (1996) (19.4±1.67- 28.5±2.19 d.w), Kalay et al. (1999) (9.11±6.05 d.w), Türkmen et al. (2005a) (1.332 - 2.616 d.w), Çoğun et al. (2006) (6.0±1.75-9.4±1.84 d.w), Tepe et al. (2008)(0.50±0.15 w.w.) , Turan et al. (2009) (0.559±0.164 d.w.), and Dural et al. (2010a) (2.26±0.26 w.w.). The other carnivore and demersal fish, *Sparus aurata,* was studied by Kargın (1996) (14.0±1.79-24.6±4.33d.w.), Çoğun et al. (2005) (13.6±2.15- 22.1±1.85 d.w.), Yılmaz (2005) (4.84±1.67-7.33±1.85 w.w.)(~24.2-36.65 d.w.), Türkmen et al. (2005a) (1.985-2.667 d.w.), Ersoy & Çelik (2010)(0.15±0.04-0.58 ±0.02 w.w.) and Dural et al. (2011) (3.830±1.445 w.w.). With regards to the results, given in Table 6, the pattern of metal occurrence in the selected tissues can be written in descending order as follows Kargın (1996): Spleen > Kidney >Liver >Gill > Muscle; Çoğun et al. (2005): Liver >Gill > Muscle; and Ref 14: Gonads > Skin > Muscle.

The concentration of lead in edible parts of body in invertebrate samples, collected from different stations in the Bay, were studied by many researchers (Table 7). The lead levels of muscle in *Penaeus semisulcatus* were reported by Kargın et al. (2001) (5.7±0.58-8.5±0.96 d.w), Çoğun et al. (2005) (15.4±1.44-28.6±2.15 d.w), Yılmaz & Yılmaz (2007) (0.2±0.1- 0.6±0.2 w.w for female fish), and Kaymacı (2011) (n.d.-1.035±0.516 w.w). *Sepia officinalis*, *Monodonta turbinata*, and *Spondylus spinosis* were investigated by Duysak et al. (2013) (1.74±0.36 w.w for female fish), Duysak & Ersoy (2014) (1.44±0.32- 90.8±2.61 d.w), and Türkmen & Türkmen (2005) (4.63-352 d.w). Duysak & Ersoy (2014) reported that the high concentration of lead in the edible parts of *M. turbinata* occurred during spring on station X.

According to Neff (2002), there was no Risk-Based Concentration (RBC) for inorganic lead in the edible tissues of marine animals, consumed by man. The RBC for tetraethyllead in fish tissue was 0.00014 µg /g wet wt (0.0007 µg /g dry wt). Even small amounts of lead, consumed by humans, particularly children, are considered to be potentially hazardous. Food and Agriculture Organization (FAO)/World Health Organization (WHO) (2004; 2006) established a provisional tolerable weekly intake (PTWI) of lead, equal to 25 µg /kg of the body weight for humans, which would be 1500 µg lead/week for a 60-kg person (Ploetz et al., 2007; Deshpande et al., 2009). FAO limits for Pb were 0.5 mg kg^{-1}. According to Turkish Food Codex, the tolerance levels in fish muscle was 1 mg kg^{-1} for Pb (all expressed as wet mass) and FAO/WHO reported that the Provisional Permissible Tolerable Weekly Intake (PTWI) of Pb was 25 g kg^{-1} body weight $week^{-1}$ (FAO/WHO, 2004).

Table 6. Mean concentration (μg metal /g) and associated standard deviations (means ± SD) of lead in the muscle, liver, gill, kidney, skin, gonad, intestine, and spleen of fish samples in Iskenderun Bay (Turkey).

Species	FT	En	Se	St	Tissues								Wt	Ref.
					Muscle	Liver	Gill	Kidney	Skin	Gonad	Intestine	Spleen		
Belone belone	c	p	sp - su	VI	0.81 ± 0.28	2.43 ± 0.48	-	-	-	-	-	-	w.w	Türkmen et al., 2009a
Caranx crysos	c	d	a	VI	7.50 ± 1.69	15.72 ± 2.86	17.51 ± 1.59	-	-	-	-	-	d.w	Kalay et al., 1999
Carcharhinus altimus	c	d	*1	IX	-	0.52 ± 0.14	-	-	-	-	-	-	w.w	Özyılmaz & Öksüz, 2015
Chelidonichthys cuculus (As: Aspitrigla cuculus)	c	d	sp	VI	0.32 ± 0.13	6.05 ± 4.94	-	-	-	-	-	-	w.w	Tepe, 2009
Chelidonichthys lucerna (As: Trigla lucerna)	c	d	su	VI	0.14 ± 0.15	2.48 ± 1.21	-	-	1.81 ± 0.67	-	-	-	w.w	Yılmaz et al., 2010
Chelidonichthys lucerna (As: Trigla Lucerna)	c	d	w-sp-su	*2	0.45 ± 0.17	1.26 ± 0.29	-	-	-	-	-	-	w.w	Ateş et al., 2015
Chelidonichthys lucerna (As:Chelidonichthys lucernus)	c	d	su	I	0.42 ± 0.54	0.21 ± 0.05	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Chelidonichthys lucerna (As:Chelidonichthys lucernus)	c	d	a	I	0.15 ± 0.00	0.50 ± 0.05	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Chelidonichthys lucerna (As:Chelidonichthys lucernus)	c	d	w	I	0.12 ± 0.00	0.50 ± 0.44	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Chelidonichthys lucerna (As:Chelidonichthys lucernus)	c	d	sp	I	0.15 ± 0.02	0.18 ± 0.02	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Dasyatis pastinaca	c	d	2 years	VII	0.45 ± 0.08	0.78 ± 0.09	0.65 ± 0.12	-	-	-	-	-	w.w	Türkmen et al., 2013
Dasyatis pastinaca	c	d	*1	*2	-	0.79 ± 0.15	-	-	-	-	-	-	w.w	Özyılmaz & Öksüz, 2015
Dicentrarchus labrax	c	d	a	II	0.48 ± 0.10	1.26 ± 0.12	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Engraulis encrasicholus	h	p	*1	VI	0.055 ± 0.019	-	-	-	-	-	-	-	d.w	Turan et al., 2009
Epinephelus aeneus	c	d	sp	VI-VII	0.47 ± 0.38	-	3.86 ± 2.00	-	12.39 ± 10.38	5.96 ± 0.17	-	-	w.w	Sağıroğlu, 2009
Epinephelus aeneus	c	d	su	VI-VII	0.48 ± 0.33	-	1.02 ± 0.34	-	13.03 ± 11.65	0.47 ± 0.47	-	-	w.w	Sağıroğlu, 2009
Epinephelus aeneus	c	d	a	VI-VII	0.55 ± 0.41	-	0.75 ± 0.78	-	5.73 ± 4.32	5.28 ± 5.82	-	-	w.w	Sağıroğlu, 2009
Epinephelus aeneus	c	d	w	VI-VII	nd	-	4.04 ± 3.33	-	4.81 ± 2.60	13.55 ± 11.78	-	-	w.w	Sağıroğlu, 2009
Epinephelus fasciatus (As: Epinephelus alexandrinus)	c	d	sp	VI	0.53 ± 0.11	1.91 ± 0.34	-	-	-	-	-	-	w.w	Tepe, 2009
Etrumeus teres	c	p	su	I	0.14 ± 0.01	0.28 ± 0.06	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Etrumeus teres	c	p	a	I	0.36 ± 0.04	0.36 ± 0.05	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Etrumeus teres	c	p	w	I	0.17 ± 0.00	0.16 ± 0.06	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Etrumeus teres	c	p	sp	I	0.14 ± 0.02	0.17 ± 0.03	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Gymnura altavela	c	d	2 years	II	0.65 ± 0.17	1.20 ± 0.17	0.55 ± 0.03	-	-	-	0.78 ± 0.04	-	w.w	Türkmen et al., 2013
Lithognathus mormyrus	c	d	sp	VI	0.39 ± 0.09	1.59 ± 0.16	-	-	-	-	-	-	w.w	Tepe, 2009
Liza aurata	om	p	su	I	0.16 ± 0.02	0.26 ± 0.07	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Liza aurata	om	p	a	I	0.26 ± 0.05	0.45 ± 0.05	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Liza aurata	om	p	w	I	0.14 ± 0.05	0.16 ± 0.10	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Liza aurata	om	p	sp	I	0.14 ± 0.00	0.20 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009

Note: FT: feeding type, c: carnivore, om: omnivore, h: herbivore, En: environment, d: demersal, p: pelagic, bp: bento-pelagic, Se: Season, a: autumn, w: winter, sp: spring, su: summer, St: stations, I: Karataş, II: Yumurtalık, IV: Petrotrans, V: Dörtyol, VI: İskenderun, VII- Arsuz, IX: Akıncı Burnu, nd: not detected, Wt: weight, d.w.: dry weight, w.w.: wet weight.
* Probable misprinting

Table 6. Mean concentration (µg metal /g) and associated standard deviations (means ± SD) of lead in the muscle, liver, gill, kidney, skin, gonad, intestine, and spleen of fish samples in Iskenderun Bay (Turkey). (continued)

Species	FT	En	Se	St	Tissues								Wt	Ref.
					Muscle	Liver	Gill	Kidney	Skin	Gonad	Intestine	Spleen		
Liza ramada	om	p	w-sp-su	VI	0.64 ± 0.21	1.30 ± 0.26	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Lophius budegassa	c	d	su	VI	0.17 ± 0.02	1.77 ± 1.05	-	-	1.69 ± 0.29	-	-	-	w.w	Yılmaz et al., 2010
Merlangius merlangus	c	bp	*1	VI	0.426 ± 0.191	-	-	-	-	-	-	-	d.w	Turan et al., 2009
Merluccius merluccius	c	d	su	I	0.12 ± 0.00	0.29 ± 0.01	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Merluccius merluccius	c	d	a	I	0.31 ± 0.4	0.89 ± 0.02	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Merluccius merluccius	c	d	w	I	0.13 ± 0.03	0.20 ± 0.10	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Merluccius merluccius	c	d	sp	I	0.13 ± 0.04	0.17 ± 0.04	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Merluccius merluccius	c	d	w-sp-su	*2	0.15 ± 0.05	0.40 ± 0.26	-	-	-	-	-	-	w.w	Ateş et al., 2015
Mugil cephalus	om	bp	a	IX	4.16 ± 1.66	-	-	-	17.83 ± 3.91	30.85 ± 6.01	-	-	w.w	Yılmaz, 2003
Mugil cephalus	om	bp	a	VI	7.32 ± 1.78	-	-	-	36.43 ± 7.66	70.99 ± 14.47	-	-	w.w	Yılmaz, 2003
Mugil cephalus	om	bp	a	II	10.87 ± 2.69	-	-	-	57.91 ± 11.32	85.15 ± 14.10	-	-	w.w	Yılmaz, 2003
Mugil cephalus	om	bp	a	IX	3.59 ± 1.79	-	-	-	15.86 ± 5.75	30.93 ± 14.23	-	-	w.w	Yılmaz, 2005
Mugil cephalus	om	bp	a	VI	6.42 ± 2.82	-	-	-	39.04 ± 12.94	61.00 ± 14.85	-	-	w.w	Yılmaz, 2005
Mugil cephalus	om	bp	a	II	10.02 ± 2.86	-	-	-	50.74 ± 21.17	90.97 ± 16.72	-	-	w.w	Yılmaz, 2005
Mugil cephalus	om	bp	w	I	5.8 ± 1.18	11.2 ± 2.45	18.7 ± 2.17	-	-	-	-	-	d.w	Çoğun et al., 2006
Mugil cephalus	om	bp	sp	I	5.7 ± 1.45	12.0 ± 1.85	20.0 ± 1.94	-	-	-	-	-	d.w	Çoğun et al., 2006
Mugil cephalus	om	bp	su	I	7.8 ± 1.65	16.8 ± 2.33	26.7 ± 2.24	-	-	-	-	-	d.w	Çoğun et al., 2006
Mugil cephalus	om	bp	a	I	6.0 ± 0.97	12.1 ± 1.91	19.3 ± 1.85	-	-	-	-	-	d.w	Çoğun et al., 2006
Mugil cephalus	om	bp	su	VI	1.690	-	-	-	-	-	-	-	d.w	Türkmen et al., 2006
Mugil cephalus	om	bp	su	VII	1.263	-	-	-	-	-	-	-	d.w	Türkmen et al., 2006
Mugil cephalus	om	bp	su	IV	2.088	-	-	-	-	-	-	-	d.w	Türkmen et al., 2006
Mugil cephalus	om	bp	sp	VI	1.15 ± 0.20	1.87 ± 0.38	-	-	-	-	-	-	w.w	Tepe, 2009
Mugil cephalus	om	bp	a	VI	7.33 ± 2.11	11.21 ± 5.93	21.13 ± 3.30	-	-	-	-	-	d.w	Kalay et al., 1999
Mullus barbatus	c	d	sp	VI	19.4 ± 1.67	50.7 ± 9.18	32.60 ± 4.34	128.6 ± 3.38	-	-	-	279.5 ± 6.04	d.w	Kargın, 1996
Mullus barbatus	c	d	su	VI	28.5 ± 2.19	74.0 ± 4.30	47.7 ± 2.33	208.4 ± 6.02	-	-	-	318.5 ± 8.56	d.w	Kargın, 1996
Mullus barbatus	c	d	a	VI	21.5 ± 2.26	58.0 ± 4.04	36.6 ± 4.76	136.3 ± 2.44	-	-	-	288.3 ± 3.69	d.w	Kargın, 1996
Mullus barbatus	c	d	w	VI	22.2 ± 3.46	53.5 ± 4.68	35.4 ± 3.67	133.7 ± 3.86	-	-	-	282.4 ± 4.16	d.w	Kargın, 1996
Mullus barbatus	c	d	su	VII	1.477	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Mullus barbatus	c	d	su	VI	1.332	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Mullus barbatus	c	d	su	IV	2.616	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Mullus barbatus	c	d	w	I	6.1 ± 2.42	16.8 ± 2.84	21.8 ± 3.15	-	-	-	-	-	d.w	Çoğun et al., 2006
Mullus barbatus	c	d	sp	I	6.0. ± 1.75	17.1 ± 2.65	22.4 ± 2.74	-	-	-	-	-	d.w	Çoğun et al., 2006
Mullus barbatus	c	d	su	I	9.4 ± 1.84	23.6 ± 3.75	32.5 ± 3.62	-	-	-	-	-	d.w	Çoğun et al., 2006
Mullus barbatus	c	d	a	I	5.8 ± 1.92	18.3 ± 2.72	21.4 ± 2.86	-	-	-	-	-	d.w	Çoğun et al., 2006
Mullus barbatus	c	d	a	VI	9.11 ± 6.05	8.42 ± 1.90	15.61 ± 3.94	-	-	-	-	-	d.w	Kalay et al., 1999
Mullus barbatus	c	d	*1	VI	0.559 ± 0.164	-	-	-	-	-	-	-	d.w	Turan et al., 2009
Mullus barbatus	c	d	*1	VI	2.262 ± 0.261	4.990 ± 1.071	-	-	11.87 ± 0.84	-	-	-	w.w	Bıçkıcı, 2010
Mullus barbatus	c	d	sp	VI	2.26 ± 0.26	4.99 ± 1.07	-	-	5.85 ± 0.64	-	-	-	d.w	Dural et al., 2010a
Mullus barbatus	c	d	su	VI	0.50 ± 0.15	2.46 ± 0.27	-	-	-	-	-	-	w.w	Tepe et al., 2008
Mullus surmuletus	c	d	sp	VI	0.69 ± 0.14	1.66 ± 0.48	-	-	-	-	-	-	w.w	Tepe, 2009
Mullus surmuletus	c	d	sp	VI	8.10 ± 0.87	15.18 ± 1.71	-	-	5.851 ± 0.640	-	-	-	d.w	Dural et al., 2010a
Mustelus mustelus	c	d	*1	IX	-	0.17 ± 1.26	-	-	-	-	-	-	w.w	Özyılmaz & Öksüz, 2015
Myliobatis aquila	c	d	*1	I	-	0.90 ± 0.22	-	-	-	-	-	-	w.w	Özyılmaz & Öksüz, 2015

Note: FT: feeding type, c: carnivore, om: omnivore, h: herbivore, En: environment, d: demersal, p: pelagic, bp: bento-pelagic, Se: Season, a: autumn, w: winter, sp: spring, su: summer, St: stations, I: Karataş, II: Yumurtalık, IV: Petrotrans, V: Dörtyol, VI: İskenderun, VII- Arsuz, IX: Akıncı Burnu, nd: not detected, Wt: weight, d.w.: dry weight, w.w.: wet weight.
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Species	FT	En	Se	St	Tissues								Wt	Ref.
					Muscle	Liver	Gill	Kidney	Skin	Gonad	Intestine	Spleen		
Oblada melanura	c	d	w-sp-su	*2	0.64 ± 0.15	2.78 ± 0.50	-	-	-	-	-	-	w.w	Ateş et al., 2015
Pagellus acarne	c	bp	w-sp-su	VI	0.55 ± 0.30	2.88 ± 0.68	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Pagellus erythrinus	om	bp	sp	VI	0.68 ± 0.13	1.88 ± 0.40	-	-	-	-	-	-	w.w	Tepe, 2009
Pagellus erythrinus	om	bp	sp	VI	2.413 ± 0.26	2.162 ± 0.27	-	-	1.942 ± 0.51	-	4.823 ± 2.38	-	w.w	Dural et al., 2010b
Pagellus erythrinus	om	bp	su	VI	1.840 ± 0.37	3.367 ± 0.92	-	-	2.053 ± 0.15	-	2.379 ± 0.24	-	w.w	Dural et al., 2010b
Pagellus erythrinus	om	bp	a	VI	3.702 ± 1.57	1.877 ± 0.39	-	-	2.155 ± 0.62	-	9.125 ± 6.90	-	w.w	Dural et al., 2010b
Pagellus erythrinus	om	bp	w	VI	3.153 ± 1.08	4.147 ± 0.55	-	-	6.204 ± 1.70	-	6.655 ± 1.96	-	w.w	Dural et al., 2010b
Pegusa lascaris (As: Solea lascaris)	c	d	su	VI	0.39 ± 0.05	2.98 ± 0.75	-	-	2.09 ± 1.05	-	-	-	w.w	Yılmaz et al., 2010
Pagrus caeruleostictus	c	bp	w-sp-su	VI	0.84 ± 0.29	1.45 ± 0.18	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Pomadasys incisus	c	d	w-sp-su	VI	0.52 ± 0.15	2.05 ± 0.36	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Pomatomus saltatrix	c	p	w-sp-su	VI	0.62 ± 0.16	1.43 ± 0.14	-	-	-	-	-	-	w.w	Türkmen et al., 2009a
Pteromylaeus bovinus	c	bp	2 years	I	0.49 ± 0.07	0.73 ± 0.19	0.92 ± 0.13	-	-	-	0.85 ± 0.12	-	w.w	Türkmen et al., 2013
Raja clavata	c	d	2 years	V	0.58 ± 0.14	0.97 ± 0.18	1.38 ± 0.23	-	-	-	0.90 ± 0.18	-	w.w	Türkmen et al., 2013
Raja clavata	c	d	w	*2	-	0.50 ± 0.30	-	-	-	-	-	-	w.w	Özyılmaz, 2016
Raja miraletus	c	d	2 years	II	0.41 ± 0.09	0.64 ± 0.09	0.73 ± 0.21	-	-	-	0.67 ± 0.12	-	w.w	Türkmen et al., 2013
Raja radula	c	d	2 years	II	0.52 ± 0.08	0.88 ± 0.14	0.54 ± 0.11	-	-	-	0.72 ± 0.11	-	w.w	Türkmen et al., 2013
Rhinobatos rhinobatos	c	d	*1	III	-	0.31 ± 0.14	-	-	-	-	-	-	w.w	Özyılmaz & Öksüz, 2015
Rhinoptera marginata	c	d	*1	*2	-	0.89 ± 0.40	-	-	-	-	-	-	w.w	Özyılmaz & Öksüz, 2015
Sardinella aurita	om	p	sp	VI	0.50 ± 0.16	1.97 ± 0.64	-	-	-	-	-	-	w.w	Tepe, 2009
Saurida undosquamis	c	d	su	VII	2.992	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Saurida undosquamis	c	d	su	VI	3.280	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Saurida undosquamis	c	d	su	IV	4.149	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Saurida undosquamis	c	d	su	I	0.20 ± 0.06	0.33 ± 0.03	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Saurida undosquamis	c	d	a	I	0.53 ± 0.03	0.33 ± 0.01	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Saurida undosquamis	c	d	w	I	0.17 ± 0.00	0.11 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Saurida undosquamis	c	d	sp	I	0.18 ± 0.08	0.16 ± 0.05	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Saurida undosquamis	c	d	w-sp-su	*2	0.57 ± 0.15	2.67 ± 0.34	-	-	-	-	-	-	w.w	Ateş et al., 2015
Scomber japonicus	c	p	su	I	0.16 ± 0.00	0.17 ± 0.00	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Scomber japonicus	c	p	a	I	0.30 ± 0.02	0.80 ± 0.02	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Scomber japonicus	c	p	w	I	0.14 ± 0.02	0.17 ± 0.01	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Scomber japonicus	c	p	sp	I	0.14 ± 0.00	0.22 ± 0.03	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Scomber japonicus	c	p	w-sp-su	VI	0.22 ± 0.07	0.71 ± 0.09	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Serranus cabrilla	c	d	w-sp-su	*2	0.21 ± 0.07	0.56 ± 0.17	-	-	-	-	-	-	w.w	Ateş et al., 2015
Serranus scriba	c	d	w-sp-su	VI	1.28 ± 0.47	-	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Siganus rivulatus	h	d	w-sp-su	*2	0.39 ± 0.08	0.87 ± 0.09	-	-	-	-	-	-	w.w	Ateş et al., 2015
Solea solea	c	d	w	II	14.0 ± 2.72	38.2 ± 4.23	29.5 ± 3.64	-	-	-	-	-	d.w	Çoğun et al., 2005
Solea solea	c	d	sp	II	17.2 ± 1.63	42.5 ± 3.86	33.9 ± 3.74	-	-	-	-	-	d.w	Çoğun et al., 2005
Solea solea	c	d	su	II	26.6 ± 1.89	62.8 ± 4.87	44.9 ± 3.29	-	-	-	-	-	d.w	Çoğun et al., 2005
Solea solea	c	d	a	II	17.8 ± 1.14	51.3 ± 4.73	36.3 ± 2.85	-	-	-	-	-	d.w	Çoğun et al., 2005
Solea solea	c	d	su	I	0.13 ± 0.00	0.28 ± 0.04	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Solea solea	c	d	a	I	0.38 ± 0.02	0.42 ± 0.01	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Solea solea	c	d	w	I	0.15 ± 0.02	0.25 ± 0.10	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Solea solea	c	d	sp	I	0.25 ± 0.03	0.23 ± 0.10	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010

Note: FT: feeding type, c: carnivore, om: omnivore, h: herbivore, En: environment, d: demersal, p: pelagic, bp: bento-pelagic, Se: Season, a: autumn, w: winter, sp: spring, su: summer, St: stations, I: Karataş, II: Yumurtalık, IV: Petrotrans, V: Dörtyol, VI: İskenderun, VII- Arsuz, IX: Akıncı Burnu, nd: not detected, Wt: weight, d.w.: dry weight, w.w.: wet weight.
* Probable misprinting

Table 6. Mean concentration (µg metal /g) and associated standard deviations (means ± SD) of lead in the muscle, liver, gill, kidney, skin, gonad, intestine, and spleen of fish samples in Iskenderun Bay (Turkey). (continued)

Species	FT	En	Se	St	Tissues								Wt	Ref.
					Muscle			Kidney	Skin	Gonad	Intestine	Spleen		
Sparus aurata	c	d	sp	VI	14.0 ± 1.79	42.0 ± 8.21	28.2 ± 3.03	117.6 ± 4.08	-	-	-	164.3 ± 6.61	d.w	Kargın, 1996
Sparus aurata	c	d	su	VI	24.6 ± 4.33	56.3 ± 3.70	41.3 ± 3.10	185.4 ± 5.38	-	-	-	217.4 ± 8.11	d.w	Kargın, 1996
Sparus aurata	c	d	a	VI	17.3 ± 1.93	46.1 ± 6.96	31.0 ± 3.92	122.0 ± 5.73	-	-	-	171.2 ± 3.23	d.w	Kargın, 1996
Sparus aurata	c	d	w	VI	18.9 ± 2.62	44.1 ± 2.49	29.9 ± 2.73	120.9 ± 3.28	-	-	-	168.1 ± 5.02	d.w	Kargın, 1996
Sparus aurata	c	d	w	II	13.6 ± 2.15	29.9 ± 3.14	18.5 ± 1.34	-	-	-	-	-	d.w	Çoğun et al., 2005
Sparus aurata	c	d	sp	II	17.6 ± 1.63	33.0 ± 2.67	23.5 ± 2.84	-	-	-	-	-	d.w	Çoğun et al., 2005
Sparus aurata	c	d	su	II	22.1 ± 1.85	45.5 ± 4.66	34.1 ± 2.84	-	-	-	-	-	d.w	Çoğun et al., 2005
Sparus aurata	c	d	a	II	15.6 ± 1.78	36.8 ± 3.64	24.7 ± 1.35	-	-	-	-	-	d.w	Çoğun et al., 2005
Sparus aurata	c	d	a	IX	4.84 ± 1.67	-	-	-	11.11 ± 4.25	6.40 ± 2.76	-	-	w.w	Yılmaz, 2005
Sparus aurata	c	d	a	VI	7.33 ± 1.85	-	-	-	22.13 ± 8.54	45.28 ± 16.20	-	-	w.w	Yılmaz, 2005
Sparus aurata	c	d	a	II	6.39 ± 2.49	-	-	-	35.75 ± 11.51	75.31 ± 19.20	-	-	w.w	Yılmaz, 2005
Sparus aurata	c	d	su	VII	1.985	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Sparus aurata	c	d	su	VI	2.291	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Sparus aurata	c	d	su	IV	2.667	-	-	-	-	-	-	-	d.w	Türkmen et al., 2005a
Sparus aurata	c	d	su	I	0.16 ± 0.03	0.19 ± 0.09	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Sparus aurata	c	d	a	I	0.58 ± 0.02	0.76 ± 0.03	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Sparus aurata	c	d	w	I	0.15 ± 0.04	0.17 ± 0.04	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Sparus aurata	c	d	sp	I	0.19 ± 0.00	0.27 ± 0.09	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Sparus aurata	c	d	sp	VI	3.830 ± 1.445	2.658 ± 0.614	2.428 ± 0.494	-	3.052 ± 0.594	-	2.032 ± 0.477	-	w.w	Dural et al., 2011
Sphyraena viridensis	c	p	w-sp-su	VI	0.36 ± 0.06	1.34 ± 0.30	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Spicara maena	c	d	w-sp-su	*2	0.55 ± 0.12	1.32 ± 0.26	-	-	-	-	-	-	w.w	Ateş et al., 2015
Trachinotus ovatus	c	p	w-sp-su	VI	0.49 ± 0.11	-	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Trachinus draco	c	d	w-sp-su	*2	0.17 ± 0.07	0.52 ± 0.06	-	-	-	-	-	-	w.w	Ateş et al., 2015
Trachurus mediterraneus	c	p	a	IX	0.71 ± 0.28	-	-	-	2.65 ± 0.57	5.68 ± 1.48	-	-	w.w	Yılmaz, 2003
Trachurus mediterraneus	c	p	a	VI	1.38 ± 0.48	-	-	-	6.67 ± 1.00	10.35 ± 2.08	-	-	w.w	Yılmaz, 2003
Trachurus mediterraneus	c	p	a	II	1.01 ± 0.44	-	-	-	5.03 ± 1.47	9.21 ± 1.91	-	-	w.w	Yılmaz, 2003
Trachurus mediterraneus	c	p	su	I	0.15 ± 0.00	0.27 ± 0.03	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Trachurus mediterraneus	c	p	a	I	0.35 ± 0.00	0.66 ± 0.03	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Trachurus mediterraneus	c	p	w	I	0.14 ± 0.00	0.14 ± 0.04	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Trachurus mediterraneus	c	p	sp	I	0.18 ± 0.01	0.14 ± 0.04	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2009
Trigla lyra	c	d	w-sp-su	VI	0.42 ± 0.09	2.36 ± 0.39	-	-	-	-	-	-	w.w	Türkmen et al., 2009b
Upeneus molluccensis	c	d	su	I	0.13 ± 0.02	0.27 ± 0.05	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Upeneus molluccensis	c	d	a	I	0.26 ± 0.01	0.45 ± 0.02	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Upeneus molluccensis	c	d	w	I	0.12 ± 0.00	0.20 ± 0.06	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Upeneus molluccensis	c	d	sp	I	0.18 ± 0.07	0.26 ± 0.04	-	-	-	-	-	-	w.w	Ersoy & Çelik, 2010
Upeneus moluccensis	c	d	*1	VI	1.596 ± 0.183	4.536 ± 0.631	-	-	5.067 ± 0.723	-	-	-	d.w	Dural & Bıçkıcı, 2010
Upeneus moluccensis	c	d	w-sp-su	*2	0.35 ± 0.06	2.65 ± 0.31	-	-	-	-	-	-	w.w	Ateş et al., 2015
Upeneus pori	c	d	*1	VI	4.518 ± 0.877	11.159 ± 11.159	-	-	5.640 ± 1.191	-	-	-	d.w	Dural & Bıçkıcı, 2010

Note: FT: feeding type, c: carnivore, om: omnivore, h: herbivore, En: environment, d: demersal, p: pelagic, bp: bento-pelagic, Se: Season, a: autumn, w: winter, sp: spring, su: summer, St: stations, I: Karataş, II: Yumurtalık, IV: Petrotrans, V: Dörtyol, VI: İskenderun, VII- Arsuz, IX: Akıncı Burnu, nd: not detected, Wt: weight, d.w.: dry weight, w.w.: wet weight.
* Probable misprinting

Table 7. Mean concentration (µg metal /g) and associated standard deviations (means ± SD) of lead in the muscle, liver, gill, gonad, and hepatopancreas of invertebrate samples in Iskenderun Bay (Turkey).

Species	Se	St	Tissues					Wt	Ref.
			Muscle	Liver	Gill	Gonad	H.pancreas		
Aristeus antennatus	a	VI	nd	-	-	-	-	w.w	Kaymacı, 2011
Aristeus antennatus	w	VI	nd	-	-	-	-	w.w	Kaymacı, 2011
Aristeus antennatus	sp	VI	0.950 ± 0.490	-	-	-	-	w.w	Kaymacı, 2011
Callinectes sapidus	su	VII	3.529	-	-	-	-	d.w	Türkmen et al., 2006
Callinectes sapidus	su	VI	4.304	-	-	-	-	d.w	Türkmen et al., 2006
Callinectes sapidus	su	IV	2.667	-	-	-	-	d.w	Türkmen et al., 2006
Illex coindetii	a	*2	1.49 ± 0.07	-	2.27 ± 0.30	-	-	w.w	Duysak & Dural, 2015
Metapenaeus monoceros	w	VI	11.3 ± 0.86	-	72.9 ± 1.86	-	52.3 ± 1.34	d.w	Kargın et al., 2001
Metapenaeus monoceros	sp	VI	10.3 ± 0.94	-	69.9 ± 2.15	-	50.2 ± 1.62	d.w	Kargın et al., 2001
Metapenaeus monoceros	su	VI	21.6 ± 1.12	-	101.2 ± 2.15	-	76.2 ± 2.30	d.w	Kargın et al., 2001
Metapenaeus monoceros	a	VI	12.1 ± 0.92	-	73.2 ± 1.98	-	53.1 ± 1.86	d.w	Kargın et al., 2001
Metapenaeus monoceros	a	VI	0.757 ± 0.507	-	-	-	-	w.w	Kaymacı, 2011
Metapenaeus monoceros	w	VI	0.801 ± 0.521	-	-	-	-	w.w	Kaymacı, 2011
Metapenaeus monoceros	sp	VI	0.994 ± 0.499	-	-	-	-	w.w	Kaymacı, 2011
Monodonta turbinata	sp	X	90.8 ± 2.61	-	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	VIII	2.97 ± 0.61	-	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	IX	3.25 ± 0.19	-	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	VII	1.44 ± 0.32	-	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	VI	3.34 ± 1.82	-	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	V	5.36 ± 2.11	-	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	II	2.64 ± 0.89	-	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	X	13.34 ± 0.44	-	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	VIII	15.68 ± 1.55	-	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	IX	13.02 ± 1.40	-	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	VII	13.29 ± 3.17	-	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	VI	13.54 ± 0.91	-	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	V	12.47 ± 1.63	-	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	II	14.30 ± 1.19	-	-	-	-	d.w	Duysak & Ersoy, 2014
Parapenaeus longirostris	a	VI	1.269 ± 0.434	-	-	-	-	w.w	Kaymacı, 2011
Parapenaeus longirostris	w	VI	0.834 ± 0.403	-	-	-	-	w.w	Kaymacı, 2011
Parapenaeus longirostris	sp	VI	0.869 ± 0.497	-	-	-	-	w.w	Kaymacı, 2011
Patella caerulea	w	VI	0.70 ± 0.03	-	5.83 ± 0.11	-	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	w	II	0.31 ± 0.02	-	4.10 ± 0.04	-	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	sp	VI	0.66 ± 0.01	-	4.79 ± 0.26	-	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	sp	II	0.14 ± 0.05	-	1.80 ± 0.11	-	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	su	VI	0.13 ± 0.01	-	2.36 ± 0.16	-	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	su	II	0.05 ± 0.01	-	1.77 ± 0.04	-	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	a	VI	0.27 ± 0.01	-	4.12 ± 0.19	-	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	a	II	0.11 ± 0.08	-	1.63 ± 0.10	-	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	su	VII	4.28 ± 0.86	-	-	-	-	d.w	Türkmen et al., 2005b
Patella caerulea	su	VI	7.26 ± 1.27	-	-	-	-	d.w	Türkmen et al., 2005b
Patella caerulea	su	IV	14.53 ± 2.01	-	-	-	-	d.w	Türkmen et al., 2005b
Penaeus kerathurus	a	VI	1.002 ± 0.546	-	-	-	-	w.w	Kaymacı, 2011

Note: Se: Season, a: autumn, w: winter, sp: spring, su: summer, St: stations, II: Yumurtalık, IV: Petrotrans, V: Dörtyol, VI: İskenderun, VII- Arsuz, VIII: Konacık, IX: Akıncı Burnu, X: Kaleköy, H.pancreas: hepatopancreas , Wt: weight, d.w.: dry weight, w.w.: wet weight.

Table 7. Mean concentration (µg metal /g) and associated standard deviations (means ± SD) of lead in the muscle, liver, gill, gonad, and hepatopancreas of invertebrate samples in Iskenderun Bay (Turkey). (continued)

Species	Se	St	Tissues					Wt	Ref.
			Muscle	Liver	Gill	Gonad	H.pancreas		
Penaeus kerathurus	w	VI	0.784 ± 0.571	-	-	-	-	w.w	Kaymacı, 2011
Penaeus kerathurus	sp	VI	0.379 ± 0.278	-	-	-	-	w.w	Kaymacı, 2011
Penaeus semisulcatus	w	VI	6.3 ± 0.64	-	18.9 ± 1.72	-	13.7 ± 1.10	d.w	Kargın et al., 2001
Penaeus semisulcatus	sp	VI	5.7 ± 0.58	-	17.3 ± 1.75	-	12.2 ± 1.36	d.w	Kargın et al., 2001
Penaeus semisulcatus	su	VI	8.5 ± 0.96	-	26.2 ± 2.24	-	19.7 ± 2.13	d.w	Kargın et al., 2001
Penaeus semisulcatus	a	VI	6.8 ± 0.72	-	18.6 ± 1.84	-	13.9 ± 1.26	d.w	Kargın et al., 2001
Penaeus semiculatus	w	VI	15.4 ± 1.44	58.4 ± 3.75	159.0 ± 6.32	-	-	d.w	Çoğun et al., 2005
Penaeus semiculatus	sp	VI	16.2 ± 0.97	50.9 ± 2.25	168.6 ± 5.74	-	-	d.w	Çoğun et al., 2005
Penaeus semiculatus	su	VI	28.6 ± 2.15	127.1 ± 5.36	317.5 ± 7.46	-	-	d.w	Çoğun et al., 2005
Penaeus semiculatus	a	VI	16.5 ± 1.76	54.3 ± 3.86	179.6 ± 4.58	-	-	d.w	Çoğun et al., 2005
Penaeus semiculatus	sp	VI	0.2 ± 0.1	0.9 ± 0.5	1.7 ± 1.4	0.2 ± 0.1	-	w.w	Yılmaz & Yılmaz , 2007
Penaeus semiculatus	su	VI	0.6 ± 0.2	0.7 ± 0.2	1.6 ± 1.1	0.1 ± 0.0	-	w.w	Yılmaz & Yılmaz , 2007
Penaeus semiculatus	a	VI	0.4 ± 0.2	0.5 ± 0.3	0.7 ± 0.3	0.1 ± 0.0	-	w.w	Yılmaz & Yılmaz , 2007
Penaeus semiculatus	w	VI	0.2 ± 0.1	0.4 ± 0.2	1.1 ± 0.1	1.1 ± 0.6	-	w.w	Yılmaz & Yılmaz , 2007
Penaeus semiculatus	a	VI	0.803 ± 0.448	-	-	-	-	w.w	Kaymacı, 2011
Penaeus semiculatus	w	VI	1.035 ± 0.516	-	-	-	-	w.w	Kaymacı, 2011
Penaeus semiculatus	sp	VI	nd	-	-	-	-	w.w	Kaymacı, 2011
Sepia officinalis	sp	VI	1.74 ± 0.36	-	1.24 ± 0.37	1.64 ± 0.42	1.541 ± 0.43	w.w	Duysak et al., 2013
Spondylus spinosus	w	VII	151.04	-	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	sp	VII	54.792	-	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	su	VII	29.167	-	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	a	VII	4.6251	-	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	w	VI	265.47	-	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	sp	VI	79.263	-	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	su	VI	63.542	-	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	a	VI	12.958	-	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	w	II	352.18	-	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	sp	II	70.682	-	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	su	II	41.667	-	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	a	II	67.123	-	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	a	VII	4.63	-	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	w	VII	151	-	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	sp	VII	54.8	-	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	su	VII	29.2	-	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	a	VI	12.9	-	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	w	VI	266	-	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	sp	VI	79.3	-	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	su	VI	63.5	-	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	a	IV	67.1	-	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	w	IV	352	-	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	sp	IV	70.7	-	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	su	IV	41.7	-	-	-	-	d.w	Türkmen & Türkmen, 2005

Note: Se: Season, a: autumn, w: winter, sp: spring, su: summer, St: stations, II: Yumurtalık, IV: Petrotrans, V: Dörtyol, VI: İskenderun, VII- Arsuz, VIII: Konacık, IX: Akıncı Burnu, X: Kaleköy, H.pancreas: hepatopancreas , Wt: weight, d.w.: dry weight, w.w.: wet weight.

- Strontium

Strontium is in the same group as calcium and magnesium in the Periodic Table, though it is not quite common and abundant in nature. The sulfate (Celestite, $SrSO_4$) and carbonate (Strontianite, $SrCO_3$) compounds of strontium are the most common compounds found in nature, their oxides converted into hydroxides when interacting with water. Strontium compounds are used to make fireworks that give a dark red color and to refine sugar. This element is also used in construction of nuclear batteries and phosphorous paints. It is so well-known that 90Sr has been regarded as one of the most harmful components of fission products, released from nuclear test explosions, due to its long effective half-life and strong affinity to bone (Suzuki et al., 1972).

Having investigated Strontium parameters in the sea water, sediment, and marine organisms of the Bay, we did not find much information about it. Only, Yılmaz et al. (2010) reported the values of the Sr from three fish species.

Table 8 shows strontium concentration data from previous studies in this area ($\mu g.g^{1}$). In all studied fish species, Sr accumulation occurred in the following order: Liver > Skin > Muscle. Yılmaz et al. (2010) foun out that Sr values in the muscle of *L.budegassa*, *S. lascaris*, carnivore and demersal, and *T. lucerna*, omnivore demersal) in the İskenderun Bay were 0.78 w.w., 1.58 and 0.97 w.w., respectively.

Moiseenko & Kudryavtseva (2001) reported that the highest accumulation of Sr was in the skeleton and the gill of *Coregonus lavaretus*, *Salmo trutta,* and *Salvelinus alpinus,* while the lowest values belonged to muscle tissues of the species. This distribution is determined by the physiological role of Sr in the organism, in which Sr and Ca together are involved in the metabolic processes of bones and cartilage (Kovalsky, 1974). The limit of consumption for Sr metal is not known, and no comparable studies of tissue accumulation have been found.

Table 8. Mean concentration (µg metal /g) and associated standard deviations (means ± SD) of strontium in the muscle, liver, and skin of fish samples in Iskenderun Bay (Turkey).

Species	FT	En	Se	St	Tissues			Wt	Ref.
					Muscle	Liver	Skin		
Lophius budegassa	c	d	su	VI	0.78 ± 0.44	2.03 ± 1.08	1.07 ± 0.28	w.w.	Yılmaz et al., 2010
Pegusa lascaris (As: Solea lascaris)	c	d	su	VI	1.58 ± 0.73	2.46 ± 0.99	2.40 ± 1.65	w.w.	Yılmaz et al., 2010
Chelidonichthys lucerna (as: Trigla lucerna)	c	d	su	VI	0.97 ± 0.17	2.24 ± 0.67	1.20 ± 0.93	w.w.	Yılmaz et al., 2010

Note: FT: feeding type, c: carnivore, En: environment, d: demersal, Se: Season, su: summer, St: stations, I: Karataş, II: Yumurtalık, IV: Petrotrans, VI: İskenderun, VII- Arsuz, IX: Akıncı Burnu, na: not available, Wt: weight, w.w.: wet weight.

- Nickel

Quite abundant on earth but scarce in the air, Nickel originates mainly from volcanoes and is an element that forms a compound with oxygen and sulfur in natural environment, usually associated with particles containing iron and manganese in the soil and sediment. Nickel is used to make coins, stainless steel, and jewelery in form of alloys with iron, copper, chromium, and zinc.

In the absence of nickel, which is essential for human beings, it has been reported that people are likely to have chronic bronchitis and shortness of breath problems (ATSDR, 2003). It has also been reported that nickel is mostly contaminated by air, food, and smoking. Nickel and certain nickel compounds are seriously listed on the list of materials considered carcinogens. In case of excess amount of this metal, Lung and sinus cancers have been reported in workers with nickel compounds in the breathing air.

According to EPA, it should be less than 0.04 ppm in drinking water (Özdilek, 2002). Nickel is rarely found in fish, plants, and animals and its accumulation in aquatic life is very rare (Table 9).

Many researchers have dealt with Carnivore and demersal fish species, finding nickel values in muscle off Caranx crysos, Chelidonichthys lucernus, Dicentrarchus labrax, Epinephelus aeneus, Epinephelus alexandrines, Lophius budegassa, Merluccius merluccius, Saurida undosquamis, and Trigla lucerna; they include Kalay et al. (1999) (4.80±1.06 d.w.), Ersoy & Çelik (2010) (0.11±0.06- 0.17 ±0.03 w.w.), Türkmen et al. (2009b) (1.02±0.17 w.w.), Sağıroğlu (2009) (1.43±0.65 -2.05±2.74 w.w.), Tepe (2009) (0.42±0.15 w.w.), Yılmaz et al. (2010) (0.54±0.22 w.w.), Ersoy & Çelik (2010) (0.12±0.03- 0.23±0.06 w.w.), Ersoy & Çelik (2010) (0.10±0.02- 0.20±0.06 w.w.), and Yılmaz et al. (2010) (0.72±0.61 w.w.). What is more, the nickel levels in the muscles of Mullus barbatus, another carnivore and demersal fish, was studied by Türkmen et al. (2005a) (0.824 - 2.069 d.w), Kalay et al. (1999) (6.07±4.60 d.w), Turan et al. (2009) (0.663±0.354 d.w.), Dural et al. (2010a) (n.d.), and Tepe et al. (2008) (0.92±0.16 w.w.).

In case of omnivore, bento-pelagic species, nickel values in muscles of *Mugil cephalus* were obtained by many researchers, like Kalay et al. (1999), Yılmaz (2003), Yılmaz (2005), Türkmen et al. (2006), Tepe (2009) who reached 4.25±0.86 d.w., 0.83±0.25 w.w.- 1.72±1.13 w.w., 0.73±0.43- 1.34±0.58 w.w, 0.661-1.587 d.w., 1.05±0.24 w.w, respectively.

Many researchers have studied the concentration of nickel in edible parts of the invertebrate samples' body, collected from different stations in the Bay (Table 10). The nickel levels in the muscle of *Penaeus semisulcatus* from station VI were reported by Kaymacı (2011) (1.187-1.968 w.w) as well as Yılmaz & Yılmaz (2007) (for female fish, 0.6- 3.6 w.w). They indicated that the highest nickel levels of edible tissues of *P. semisulcatus* occurred in autumn. Yılmaz & Yılmaz (2007) showed that nickel accumulation in the tissues differed from the selected ones. Gills of male shrimp were shown to be the main tissue in which Ni accumulated, followed by gonads, hepatopancreas, and muscle, whereas in case of female samples accumulation in the gills was followed by hepatopancreas, gonads, and muscle. Duysak & Ersoy (2014) reported that the highest concentration of nickel in the edible parts of *M. turbinata* was observed in spring at station VII and in autumn at station IX. *Parapenaeus longirostris* and *Patella caerulea* were investigated by Kaymacı (2011) (station VI, for three seasons, 0.811- 1.816 w.w) and Yüzereroğlu et al. (2010) (for station II and VI, for four seasons, 0.39-1.60 d.w). Nickel accumulation of the edible parts of *Spondylus spinosis* was investigated by Türkmen & Türkmen (2005) for stations IV, VI, and VII, for four seasons. They reported that the level of nickel values varied between 4.79 and 101 d.w.

Table 9. Mean concentration (µg metal /g) and associated standard deviations (means ± SD) of nickel in the muscle, liver, skin, gill, gonad, and intestine of fish samples in Iskenderun Bay (Turkey).

Species	FT	En	Se	St	Tissues						Wt	Ref.
					Muscle	Liver	Skin	Gill	Gonad	İntestine		
Belone belone	c	p	sp-su	VI	0.12 ± 0.04	1.04 ± 0.22	-	-	-	-	w.w	Türkmen et al., 2009a
Caranx crysos	c	d	a	VI	4.80 ± 1.06	11.23 ± 1.73	11.20 ± 2.67	-	-	-	d.w	Kalay et al., 1999
Chelidonichthys cuculus (As: Aspitrigla cuculus)	c	d	sp	VI	1.89 ± 0.26	7.26 ± 0.62	-	-	-	-	w.w	Tepe, 2009
Chelidonichthys lucerna (As: Chelidonichthys lucernus)	c	d	su	I	0.11 ± 0.06	0.46 ± 0.01	-	-	-	-	w.w	Ersoy & Çelik, 2010
Chelidonichthys lucerna (As: Chelidonichthys lucernus)	c	d	a	I	0.14 ± 0.00	0.28 ± 0.00	-	-	-	-	w.w	Ersoy & Çelik, 2010
Chelidonichthys lucerna (As: Chelidonichthys lucernus)	c	d	w	I	0.12 ± 0.11	0.49 ± 0.03	-	-	-	-	w.w	Ersoy & Çelik, 2010
Chelidonichthys lucerna (As: Chelidonichthys lucernus)	c	d	sp	I	0.17 ± 0.03	0.36 ± 0.07	-	-	-	-	w.w	Ersoy & Çelik, 2010
Chelidonichthys lucerna (As:Trigla lucerna)	c	d	su	VI	0.72 ± 0.61	1.67 ± 1.23	-	0.78 ± 0.33	-	-	w.w	Yılmaz et al., 2010
Chelidonichthys lucerna (As: Trigla Lucerna)	c	d	w-sp-su	*2	0.22 ± 0.07	2.67 ± 1.72	-	-	-	-	-	Ateş et al., 2015
Dasyatis pastinaca	c	d	2 years	VII	1.56 ± 0.23	7.59 ± 0.97	3.20 ± 1.10	-	-	-	w.w	Türkmen et al., 2013
Dicentrarchus labrax	c	d	w-sp-su	II	1.02 ± 0.17	3.06 ± 0.49	-	-	-	-	w.w	Türkmen et al., 2009b
Engraulis encrasicholus	c	p	*1	VI	0.559 ± 0.19	-	-	-	-	-	d.w	Turan et al., 2009
Epinephelus aeneus	c	d	sp	VI-VII	1.43 ± 0.65	-	3.71 ± 2.89	7.62 ± 4.78	3.48 ± 0.67	-	w.w	Sağıroğlu, 2009
Epinephelus aeneus	c	d	su	VI-VII	2.05 ± 2.74	-	1.25 ± 0.05	nd	24.35 ± 39.65		w.w	Sağıroğlu, 2009
Epinephelus aeneus	c	d	a	VI-VII	1.86 ± 1.87	-	7.90 ± 11.91	25.30 ± 23.15	4.64 ± 2.99		w.w	Sağıroğlu, 2009
Epinephelus aeneus	c	d	w	VI-VII	1.61 ± 0.90	-	2.62 ± 0.79	3.19 ± 2.43	2.55 ± 0.85		w.w	Sağıroğlu, 2009
Epinephelus fasciatus (As: Epinephelus alexandrinus)	c	d	sp	VI	0.42 ± 0.15	1.31 ± 0.43	-	-	-	-	w.w	Tepe, 2009
Etrumeus teres	c	p	su	I	0.24 ± 0.04	0.35 ± 0.00	-	-	-	-	w.w	Ersoy & Çelik, 2009
Etrumeus teres	c	p	a	I	0.19 ± 0.00	0.23 ± 0.00	-	-	-	-	w.w	Ersoy & Çelik, 2009
Etrumeus teres	c	p	w	I	0.18 ± 0.03	0.35 ± 0.12	-	-	-	-	w.w	Ersoy & Çelik, 2009
Etrumeus teres	c	p	sp	I	0.11 ± 0.03	0.60 ± 0.02	-	-	-	-	w.w	Ersoy & Çelik, 2009
Gymnura altavela	om	d	2 years	II	0.35 ± 0.08	0.47 ± 0.04	0.32 ± 0.04	-	-	3.10 ± 0.57	w.w	Türkmen et al., 2013
Lithognathus mormyrus	c	d	sp	VI	0.22 ± 0.09	1.51 ± 0.39	-	-	-	-	w.w	Tepe, 2009
Liza aurata	om	p	su	I	0.14 ± 0.01	0.28 ± 0.08	-	-	-	-	w.w	Ersoy & Çelik, 2009
Liza aurata	om	p	a	I	0.12 ± 0.01	0.15 ± 0.00	-	-	-	-	w.w	Ersoy & Çelik, 2009
Liza aurata	om	p	w	I	0.18 ± 0.04	0.26 ± 0.07	-	-	-	-	w.w	Ersoy & Çelik, 2009
Liza aurata	om	p	sp	I	0.17 ± 0.02	0.17 ± 0.02	-	-	-	-	w.w	Ersoy & Çelik, 2009
Liza ramada	om	p	w-sp-su	VI	0.55 ± 0.05	1.76 ± 0.25	-	-	-	-	w.w	Türkmen et al., 2009b
Lophius budegassa	c	d	su	VI	0.54 ± 0.22	1.59 ± 1.09	-	1.09 ± 0.62	-	-	w.w	Yılmaz et al., 2010
Merlangius merlangus	c	bp	*1	VI	1.044 ± 0.337	-	-	-	-	-	d.w	Turan et al., 2009
Merluccius merluccius	c	d	su	I	0.16 ± 0.05	0.14 ± 0.00	-	-	-	-	w.w	Ersoy & Çelik, 2010
Merluccius merluccius	c	d	a	I	0.17 ± 0.00	0.25 ± 0.00	-	-	-	-	w.w	Ersoy & Çelik, 2010
Merluccius merluccius	c	d	w	I	0.12 ± 0.03	0.30 ± 0.04	-	-	-	-	w.w	Ersoy & Çelik, 2010
Merluccius merluccius	c	d	sp	I	0.23 ± 0.06	0.27 ± 0.00	-	-	-	-	w.w	Ersoy & Çelik, 2010
Merluccius merluccius	c	d	w-sp-su	*2	0.24 ± 0.13	1.38 ± 0.89	-	-	-	-	w.w	Ateş et al., 2015

Note: FT: feeding type, c: carnivore, om: omnivore, En: environment, d: demersal, p: pelagic, bp: bento-pelagic, Se: Season, *1: no. of season info, a: autumn, w: winter, sp: spring, su: summer, St: stations, I: Karataş, II: Yumurtalık, IV: Petrotrans, V: Dörtyol, VI: İskenderun, VII- Arsuz, IX: Akıncı Burnu, nd: not detected, Wt: weight, d.w.: dry weight, w.w.: wet weight.

Table 9. Mean concentration (µg metal /g) and associated standard deviations (means ± SD) of nickel in the muscle, liver, skin, gill, gonad, and intestine of fish samples in Iskenderun Bay (Turkey). (continued)

Species	FT	En	Se	St	Tissues						Wt	Ref.
					Muscle	Muscle	Muscle	Muscle	Muscle	Muscle		
Mugil cephalus	om	bp	a	IX	0.83 ± 0.25	-	-	1.07 ± 0.52	5.51 ± 1.68	-	w.w	Yılmaz, 2003
Mugil cephalus	om	bp	a	VI	1.72 ± 1.13	-	-	4.15 ± 1.58	10.47 ± 3.41	-	w.w	Yılmaz, 2003
Mugil cephalus	om	bp	a	II	1.10 ± 0.56	-	-	2.95 ± 0.68	6.09 ± 2.56	-	w.w	Yılmaz, 2003
Mugil cephalus	om	bp	a	IX	0.73 ± 0.43	-	1.21 ± 0.79	-	3.35 ± 2.32	-	w.w	Yılmaz, 2005
Mugil cephalus	om	bp	a	VI	1.34 ± 0.58	-	4.33 ± 1.27	-	9.17 ± 2.42	-	w.w	Yılmaz, 2005
Mugil cephalus	om	bp	a	II	0.94 ± 0.42	-	2.41 ± 1.02	-	5.56 ± 1.68	-	w.w	Yılmaz, 2005
Mugil cephalus	om	bp	su	VI	1.274	-	-	-	-	-	d.w	Türkmen et al., 2006
Mugil cephalus	om	bp	su	VII	0.661	-	-	-	-	-	d.w	Türkmen et al., 2006
Mugil cephalus	om	bp	su	IV	1.587	-	-	-	-	-	d.w	Türkmen et al., 2006
Mugil cephalus	om	bp	sp	VI	1.05 ± 0.24	2.66 ± 0.47	-	-	-	-	w.w	Tepe, 2009
Mugil cephalus	om	bp	a	VI	4.25 ± 0.86	8.55 ± 3.53	11.22 ± 2.49	-	-	-	d.w	Kalay et al., 1999
Mullus barbatus	c	d	su	VII	2.069	-	-	-	-	-	d.w	Türkmen et al., 2005a
Mullus barbatus	c	d	su	VI	1.183	-	-	-	-	-	d.w	Türkmen et al., 2005a
Mullus barbatus	c	d	su	IV	0.824	-	-	-	-	-	d.w	Türkmen et al., 2005a
Mullus barbatus	c	d	a	VI	6.07 ± 4.60	5.51 ± 0.96	15.83 ± 6.06	-	-	-	d.w	Kalay et al., 1999
Mullus barbatus	c	d	?	VI	0.663 ± 0.354	-	-	-	-	-	d.w	Turan et al., 2009
Mullus barbatus	c	d	sp	VI	nd	nd	-	0.12 ± 0.27	-	-	d.w	Dural et al., 2010a
Mullus barbatus	c	d	su	VI	0.92 ± 0.16	9.31 ± 0.30	-	-	-	-	w.w	Tepe et al., 2008
Mullus surmuletus	c	d	sp	VI	4.72 ± 0.13	9.99 ± 0.66	-	-	-	-	w.w	Tepe, 2009
Mullus surmuletus	c	d	sp	VI	1.51 ± 0.18	2.55 ± 0.73	-	1.99 ± 0.55	-	-	d.w	Dural et al., 2010a
Oblada melanura	c	d	w-sp-su	*2	0.40 ± 0.07	2.27 ± 0.67	-	-	-	-	w.w	Ateş et al., 2015
Pagellus acarne	c	bp	w-sp-su	VI	0.32 ± 0.13	1.41 ± 0.59	-	-	-	-	w.w	Türkmen et al., 2009b
Pagellus erythrinus	om	bp	sp	VI	0.56 ± 0.08	1.65 ± 0.33	-	-	-	-	w.w	Tepe, 2009
Pagrus caeruleostictus	c	bp	w-sp-su	VI	0.67 ± 0.12	1.22 ± 0.15	-	-	-	-	w.w	Türkmen et al., 2009b
Pegusa Lascaris (As:Solea lascaris)	c	d	su	VI	1.01 ± 0.92	1.55 ± 1.01	-	1.84 ± 1.23	-	-	w.w	Yılmaz et al., 2010
Pomadasys incisus	c	d	w-sp-su	VI	0.51 ± 0.15	1.07 ± 0.22	-	-	-	-	w.w	Türkmen et al., 2009b
Pomatomus saltatrix	c	p	w-sp-su	VI	4.70 ± 0.37	9.56 ± 1.07	-	-	-	-	w.w	Türkmen et al., 2009a
Pteromylaeus bovinus	c	bp	2 years	I	0.39 ± 0.06	0.86 ± 0.02	0.50 ± 0.08	-	-	3.69 ± 1.38	w.w	Türkmen et al., 2013
Raja clavata	c	d	2 years	V	0.37 ± 0.05	1.80 ± 0.72	0.48 ± 0.02	-	-	3.78 ± 0.85	w.w	Türkmen et al., 2013
Raja miraletus	c	d	2 years	II	0.22 ± 0.05	0.62 ± 0.08	0.71 ± 0.14	-	-	2.33 ± 0.58	w.w	Türkmen et al., 2013
Raja radula	c	d	2 years	II	0.57 ± 0.08	0.71 ± 0.16	0.82 ± 0.12	-	-	2.15 ± 0.50	w.w	Türkmen et al., 2013
Sardinella aurita	om	p	sp	VI	4.60 ± 0.24	8.60 ± 0.21	-	-	-	-	w.w	Tepe, 2009
Saurida undosquamis	c	d	su	VII	4.973	-	-	-	-	-	d.w	Türkmen et al., 2005a
Saurida undosquamis	c	d	su	VI	6.465	-	-	-	-	-	d.w	Türkmen et al., 2005a
Saurida undosquamis	c	d	su	IV	8.153	-	-	-	-	-	d.w	Türkmen et al., 2005a
Saurida undosquamis	c	d	su	I	0.10 ± 0.02	0.16 ± 0.03	-	-	-	-	w.w	Ersoy & Çelik, 2010
Saurida undosquamis	c	d	a	I	0.12 ± 0.00	0.19 ± 0.00	-	-	-	-	w.w	Ersoy & Çelik, 2010
Saurida undosquamis	c	d	w	I	0.19 ± 0.00	0.27 ± 0.01	-	-	-	-	w.w	Ersoy & Çelik, 2010
Saurida undosquamis	c	d	sp	I	0.20 ± 0.06	0.30 ± 0.12	-	-	-	-	w.w	Ersoy & Çelik, 2010

Note: FT: feeding type, c: carnivore, om: omnivore, En: environment, d: demersal, p: pelagic, bp: bento-pelagic, Se: Season, *1: no. of season info, a: autumn, w: winter, sp: spring, su: summer, St: stations, I: Karataş, II: Yumurtalık, IV: Petrotrans, V: Dörtyol, VI: İskenderun, VII- Arsuz, IX: Akıncı Burnu, nd: not detected, Wt: weight, d.w.: dry weight, w.w.: wet weight.

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Species	FT	En	Se	St	Tissues						Wt	Ref.
					Muscle	Muscle	Muscle	Muscle	Muscle	Muscle		
Saurida undosquamis	c	d	w-sp-su	*2	0.35 ± 0.13	1.39 ± 0.26	-	-	-	-	w.w	Ateş et al., 2015
Serranus scribae	c	d	w-sp-su	VI	0.58 ± 0.25	-	-	-	-	-	w.w	Türkmen et al., 2009b
Serranus cabrilla	c	d	w-sp-su	*2	0.33 ± 0.17	1.13 ± 0.46	-	-	-	-	w.w	Ateş et al., 2015
Siganus rivulatus	h	d	w-sp-su	*2	3.43 ± 0.49	7.12 ± 0.69	-	-	-	-	w.w	Ateş et al., 2015
Scomber japonicus	c	p	su	I	0.10 ± 0.02	0.13 ± 0.0	-	-	-	-	w.w	Ersoy & Çelik, 2009
Scomber japonicus	c	p	a	I	0.16 ± 0.00	0.22 ± 0.00	-	-	-	-	w.w	Ersoy & Çelik, 2009
Scomber japonicus	c	p	w	I	0.11 ± 0.02	0.11 ± 0.01	-	-	-	-	w.w	Ersoy & Çelik, 2009
Scomber japonicus	c	p	sp	I	0.18 ± 0.01	0.77 ± 0.16	-	-	-	-	w.w	Ersoy & Çelik, 2009
Scomber japonicus	c	p	w-sp-su	VI	0.39 ± 0.17	1.97 ± 1.02	-	-	-	-	w.w	Türkmen et al., 2009b
Solea solea	c	d	su	I	0.22 ± 0.02	0.36 ± 0.03	-	-	-	-	w.w	Ersoy & Çelik, 2010
Solea solea	c	d	a	I	0.12 ± 0.00	0.24 ± 0.00	-	-	-	-	w.w	Ersoy & Çelik, 2010
Solea solea	c	d	w	I	0.07 ± 0.00	0.35 ± 0.00	-	-	-	-	w.w	Ersoy & Çelik, 2010
Solea solea	c	d	sp	I	0.16 ± 0.02	0.35 ± 0.15	-	-	-	-	w.w	Ersoy & Çelik, 2010
Sparus aurata	c	d	a	IX	0.29 ± 0.23	-	0.85 ± 0.44	-	0.57 ± 0.51	-	w.w	Yılmaz, 2005
Sparus aurata	c	d	a	VI	0.86 ± 0.37	-	5.21 ± 2.42	-	1.24 ± 0.53	-	w.w	Yılmaz, 2005
Sparus aurata	c	d	a	II	0.87 ± 0.20	-	1.49 ± 0.58	-	0.47 ± 0.29	-	w.w	Yılmaz, 2005
Sparus aurata	c	d	su	VII	3.231	-	-	-	-	-	d.w	Türkmen et al., 2005a
Sparus aurata	c	d	su	VI	2.684	-	-	-	-	-	d.w	Türkmen et al., 2005a
Sparus aurata	c	d	su	IV	1.697	-	-	-	-	-	d.w	Türkmen et al., 2005a
Sparus aurata	c	d	su	I	0.06 ± 0.00	0.09 ± 0.02	-	-	-	-	w.w	Ersoy & Çelik, 2010
Sparus aurata	c	d	a	I	0.21 ± 0.00	0.22 ± 0.00	-	-	-	-	w.w	Ersoy & Çelik, 2010
Sparus aurata	c	d	w	I	0.31 ± 0.01	0.64 ± 0.42	-	-	-	-	w.w	Ersoy & Çelik, 2010
Sparus aurata	c	d	sp	I	0.37 ± 0.10	0.60 ± 0.42	-	-	-	-	w.w	Ersoy & Çelik, 2010
Spicara maena	c	d	w-sp-su	*2	2.69 ± 0.61	5.75 ± 0.89	-	-	-	-	w.w	Ateş et al., 2015
Sphyraena viridensis	c	p	w-sp-su	VI	0.47 ± 0.14	1.79 ± 0.24	-	-	-	-	w.w	Türkmen et al., 2009b
Trachinotus ovatus	c	p	w-sp-su	VI	0.03 ± 0.01	-	-	-	-	-	w.w	Türkmen et al., 2009b
Trachinus draco	c	d	w-sp-su	*2	0.30 ± 0.11	0.98 ± 0.09	-	-	-	-	w.w	Ateş et al., 2015
Trachurus mediterraneus	c	p	a	IX	0.32 ± 0.13	-	-	0.88 ± 0.28	0.43 ± 0.31	-	w.w	Yılmaz, 2003
Trachurus mediterraneus	c	p	a	VI	1.63 ± 0.90	-	-	3.18 ± 0.67	1.65 ± 0.52	-	w.w	Yılmaz, 2003
Trachurus mediterraneus	c	p	a	II	0.88 ± 0.25	-	-	2.00 ± 0.69	0.88 ± 0.31	-	w.w	Yılmaz, 2003
Trachurus mediterraneus	c	p	su	I	0.20 ± 0.01	0.11 ± 0.03	-	-	-	-	w.w	Ersoy & Çelik, 2009
Trachurus mediterraneus	c	p	a	I	0.13 ± 0.00	0.20 ± 0.01	-	-	-	-	w.w	Ersoy & Çelik, 2009
Trachurus mediterraneus	c	p	w	I	0.24 ± 0.02	0.26 ± 0.00	-	-	-	-	w.w	Ersoy & Çelik, 2009
Trachurus mediterraneus	c	p	sp	I	0.22 ± 0.07	0.26 ± 0.07	-	-	-	-	w.w	Ersoy & Çelik, 2009
Trigla lyra	c	d	w-sp-su	VI	0.45 ± 0.05	1.75 ± 0.23	-	-	-	-	w.w	Türkmen et al., 2009b
Upeneus molluccensis	c	d	su	I	0.15 ± 0.07	0.28 ± 0.01	-	-	-	-	w.w	Ersoy & Çelik, 2010
Upeneus molluccensis	c	d	a	I	0.14 ± 0.00	0.26 ± 0.01	-	-	-	-	w.w	Ersoy & Çelik, 2010
Upeneus molluccensis	c	d	w	I	0.19 ± 0.02	0.26 ± 0.06	-	-	-	-	w.w	Ersoy & Çelik, 2010
Upeneus molluccensis	c	d	sp	I	0.21 ± 0.08	0.41 ± 0.18	-	-	-	-	w.w	Ersoy & Çelik, 2010
Upeneus moluccensis	c	d	*1	VI	0.576 ± 0.103	1.853 ± 0.725	2.419 ± 0.408	-	-	-	d.w	Dural & Bıçkıcı, 2010
Upeneus moluccensis	c	d	w-sp-su	*2	2.11 ± 0.36	7.21 ± 1.01	-	-	-	-	w.w	Ateş et al., 2015
Upeneus pori	c	d	*1	VI	0.036 ± 0.036	nd	0.026 ± 0.020	-	-	-	d.w	Dural & Bıçkıcı, 2010

Note: FT: feeding type, c: carnivore, om: omnivore, En: environment, d: demersal, p: pelagic, bp: bento-pelagic, Se: Season, *1: no. of season info, a: autumn, w: winter, sp: spring, su: summer, St: stations, I: Karataş, II: Yumurtalık, IV: Petrotrans, V: Dörtyol, VI: İskenderun, VII- Arsuz, IX: Akıncı Burnu, nd: not detected, Wt: weight, d.w.: dry weight, w.w.: wet weight.

Table 10. Mean concentration (µg metal /g) and associated standard deviations (means ± SD) of nickel in the muscle, gill, gonad, and hepatopancreas of invertebrate samples in Iskenderun Bay (Turkey).

Species	Se	St	Tissues				Wt	Ref.
			Muscle	Gill	Gonad	H.pancreas		
Aristeus antennatus	a	VI	nd	-	-	-	w.w	Kaymacı, 2011
Aristeus antennatus	w	VI	nd	-	-	-	w.w	Kaymacı, 2011
Aristeus antennatus	sp	VI	0.924 ± 0.894	-	-	-	w.w	Kaymacı, 2011
Metapenaeus monoceros	a	VI	0.826 ± 0.503	-	-	-	w.w	Kaymacı, 2011
Metapenaeus monoceros	w	VI	0.640 ± 0.487	-	-	-	w.w	Kaymacı, 2011
Metapenaeus monoceros	sp	VI	0.493 ± 0.348	-	-	-	w.w	Kaymacı, 2011
Monodonta turbinata	sp	X	4.91 ± 1.97	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	VIII	5.81 ± 1.84	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	IX	3.22 ± 1.51	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	VII	16.89 ± 1.11	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	VI	2.93 ± 1.46	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	V	12.04 ± 4.20	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	II	5.33 ± 2.63	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	X	2.67 ± 0.82	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	VIII	4.86 ± 1.13	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	IX	26.93 ± 14.10	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	VII	17.16 ± 4.80	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	VI	2.55 ± 0.37	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	V	9.08 ± 4.57	-	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	II	2.38 ± 0.62	-	-	-	d.w	Duysak & Ersoy, 2014
Parapenaeus longirostris	a	VI	1.816 ± 0.497	-	-	-	w.w	Kaymacı, 2011
Parapenaeus longirostris	w	VI	1.239 ± 0.814	-	-	-	w.w	Kaymacı, 2011
Parapenaeus longirostris	sp	VI	0.811 ± 0.419	-	-	-	w.w	Kaymacı, 2011
Patella caerulea	w	VI	1.60 ± 0.05	5.97 ± 0.24	-	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	w	II	0.68 ± 0.01	4.95 ± 0.71	-	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	sp	VI	0.60 ± 0.09	3.47 ± 0.01	-	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	sp	II	0.53 ± 0.27	1.33 ± 0.01	-	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	su	VI	0.53 ± 0.01	0.94 ± 0.02	-	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	su	II	0.39 ± 0.03	0.73 ± 0.08	-	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	a	VI	1.35 ± 0.02	1.76 ± 0.08	-	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	a	II	1.05 ± 0.03	1.07 ± 0.02	-	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	su	VII	3.60 ± 1.02	-	-	-	d.w	Türkmen et al., 2005b
Patella caerulea	su	VI	9.35 ± 1.93	-	-	-	d.w	Türkmen et al., 2005b
Patella caerulea	su	IV	12.21 ± 1.83	-	-	-	d.w	Türkmen et al., 2005b
Penaeus kerathurus	a	VI	1.402 ± 1.246	-	-	-	w.w	Kaymacı, 2011
Penaeus kerathurus	w	VI	0.831 ± 0.669	-	-	-	w.w	Kaymacı, 2011
Penaeus kerathurus	sp	VI	0.699 ± 0.253	-	-	-	w.w	Kaymacı, 2011
Penaeus semiculatus	sp	VI	0.6 ± 0.2	28.5 ± 1.0	0.7 ± 0.3	3.7 ± 1.0	w.w	Yılmaz & Yılmaz , 2007
Penaeus semiculatus	su	VI	3.0 ± 1.2	30.2 ± 21.5	2.4 ± 1.0	4.7 ± 1.4	w.w	Yılmaz & Yılmaz , 2007
Penaeus semiculatus	a	VI	3.6 ± 3.0	33.2 ± 5.7	6.0 ± 2.0	7.7 ± 1.9	w.w	Yılmaz & Yılmaz , 2007
Penaeus semiculatus	w	VI	1.4 ± 0.2	27.3 ± 17.6	10.8 ± 2.7	7.3 ± 1.4	w.w	Yılmaz & Yılmaz , 2007
Penaeus semisulcatus	a	VI	1.968 ± 1.301	-	-	-	w.w	Kaymacı, 2011
Penaeus semisulcatus	w	VI	1.187 ± 0.660	-	-	-	w.w	Kaymacı, 2011
Penaeus semisulcatus	sp	VI	nd	-	-	-	w.w	Kaymacı, 2011
Spondylus spinosus	w	VII	38.479	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	sp	VII	33.792	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	su	VII	8.9127	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	a	VII	9.8467	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	w	VI	72.625	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	sp	VI	50.542	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	su	VI	4.7923	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	a	VI	29.417	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	w	II	101.39	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	sp	II	42.167	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	su	II	5.2084	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	a	II	36.542	-	-	-	d.w	Türkmen, 2003
Spondylus spinosus	a	VII	9.85	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	w	VII	38.5	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	sp	VII	33.8	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	su	VII	8.91	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	a	VI	29.4	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	w	VI	72.6	-	-	-	d.w	Türkmen & Türkmen, 2005

Species	Se	St	Tissues				Wt	Ref.
			Muscle	Gill	Gonad	H.pancreas		
Spondylus spinosus	sp	VI	50.5	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	su	VI	4.79	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	a	IV	36.5	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	w	IV	101	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	sp	IV	42.2	-	-	-	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	su	IV	5.21	-	-	-	d.w	Türkmen & Türkmen, 2005

Note: Se: Season, a: autumn, w: winter, sp: spring, su: summer, St: stations, II: Yumurtalık, IV: Petrotrans, V: Dörtyol, VI: İskenderun, VII- Arsuz, VIII: Konacık, IX: Akıncı Burnu, X: Samandağ , nd: not detected, H.pancreas: hepatopancreas, Wt: weight, d.w.: dry weight, w.w.: wet weight.

- Cobalt

Cobalt, which is a ferromagnetic metal, can only be found in the Earth's crust, in a chemically-combined form, being frequently associated with nickel as both are characteristic components of meteoric iron, even though cobalt is much less abundant in iron meteorites than nickel. There is a stable isotope cobalt-59 alongside cobalt-60. Common oxidation states of cobalt are $^{+2}$ and $^{+3}$, which are protected from further oxidation with a passivating oxide film. Cobalt-60 is a commercially important radioisotope, used as a radioactive tracer and for the production of high energy gamma rays. The cobalt compounds (cobalt silicate and cobalt (II) aluminate ($CoAl_2O_4$, cobalt blue) give a distinctive deep blue color to glass, ceramics, and paints. Cobalt is used in electroplating thanks to its attractive appearance, hardness, and resistance to oxidation.

Although cobalt is interpreted as a non-essential metal, it is essential in very small amounts for all animals. Like some heavy metals, molecular compounds and polyatomic ions of cobalt are classified as coordination complexes. Molecules or ions that contain cobalt link to several ligands. Cobalt is the active center of coenzymes called cobalamins, the most common example of which is vitamin B12. The average daily intake of cobalt, in all forms, ranges from 0.30 to 1.77 mg /day (Underwood, 1977). It has also been implicated in blood pressure regulation and has been found to be necessary for proper thyroid function (Blackhima & Mills, 1970). Its inorganic form is also a micronutrient for bacteria, algae, and fungi.

Table 11 shows the data on cobalt concentration in this area from previous studies (µg /g). The cobalt levels (µg g^{-1}) in the muscles of *Mullus barbatus*, carnivore and demersal, from different areas of the Bay were studied in the same season (summer) by Türkmen et al. (2005a) (0.528-1.421 d.w) and Tepe et al. (2008) (0.06±0.02 w.w.). Also, Yılmaz et al. (2010) investigated Carnivor and pelagic fishes, namely *Lophius budegassa*, *Solea lascaris,* and *Trigla lucerna,* finding such rates as 0.13±0.09, 0.39±0.17, and 0.06 ±0.03 w.w., respectively. Türkmen et al. (2006) and Tepe (2009) reported that cobalt concentration in the muscles of *Mugil cephalus* (omnivore-bento-pelagic) were 1.183 d.w. and 0.33±0.13 w.w., respectively.

Furthermore, some researchers have studied the concentration of Cobalt in edible parts of the body in invertebrate samples, collected from different stations of the Bay (Table 12). The cobalt levels in the muscles of *Monodonta turbinata*, *Patella caerulea*, and *Spondylus spinosis* were investigated by Duysak & Ersoy (2014) (1.56±0.56- 14.21±4.63 d.w), Yüzereroğlu et al. (2010) (0.05±0.03-0.66±0.080 d.w), Türkmen et al. (2005b), (2.31±0.67-5.15±1.24 d.w.), Türkmen (2003) (0.3749-14.722 d.w), and Türkmen & Türkmen (2005) (0.38-16.4 d.w), respectively.

Table 11. Mean concentration (µg metal /g) and associated standard deviations (means ± SD) of cobalt in the muscle, liver, skin, gill, gonad, and intestine of fish samples in Iskenderun Bay (Turkey).

Species	FT	En	Se	St	Tissues: Muscle	Liver	Skin	Gill	Gonad	İntestine	Wt	Ref.
Belone belone	c	p	sp-su	VI	0.05 ± 0.02	0.24 ± 0.10	-	-	-	-	w.w	Türkmen et al., 2009a
Chelidonichthys cuculus (As: Aspitrigla cuculus)	c	d	sp	VI	0.17 ± 0.05	0.62 ± 0.10	-	-	-	-	w.w	Tepe, 2009
Chelidonichthys lucerna (As: Trigla lucerna)	c	d	su	VI	0.06 ± 0.03	0.50 ± 0.23	0.32 ± 0.02	-	-	-	w.w	Yılmaz et al., 2010
Chelidonichthys lucerna (As: Trigla Lucerna)	c	d	w-sp-su	*2	0.06 ± 0.02	0.26 ± 0.09	-	-	-	-	w.w	Ateş et al., 2015
Dasyatis pastinaca	c	d	2 years	VII	0.05 ± 0.01	0.12 ± 0.01	-	0.07 ± 0.01	-	-	w.w	Türkmen et al., 2013
Dicentrarchus labrax	c	d	w-sp-su	II	0.10 ± 0.03	0.45 ± 0.14	-	-	-	-	w.w	Türkmen et al., 2009b
Epinephelus aeneus	c	d	sp	VI-VII	0.08 ± 0.11	-	0.59 ± 0.17	0.21 ± 0.25	0.19 ± 0.11	-	w.w	Sağıroğlu, 2009
Epinephelus aeneus	c	d	su	VI-VII	nd	-	nd	nd	0.28 ± 0.01	-	w.w	Sağıroğlu, 2009
Epinephelus aeneus	c	d	a	VI-VII	nd	-	nd	nd	nd	-	w.w	Sağıroğlu, 2009
Epinephelus aeneus	c	d	w	VI-VII	0.10 ± 0.07	-	nd	nd	nd	-	w.w	Sağıroğlu, 2009
Epinephelus fasciatus (As: Epinephelus alexandrinus)	c	d	sp	VI	0.02 ± 0.01	0.08 ± 0.02	-	-	-	-	w.w	Tepe, 2009
Gymnura altavela	om	d	2 years	II	0.11 ± 0.01	0.14 ± 0.01	-	0.14 ± 0.02	-	0.19 ± 0.04	w.w	Türkmen et al., 2013
Lithognathus mormyrus	c	d	sp	VI	0.02 ± 0.01	0.23 ± 0.05	-	-	-	-	w.w	Tepe, 2009
Liza ramada	om	p	w-sp-su	VI	0.08 ± 0.01	0.13 ± 0.04	-	-	-	-	w.w	Türkmen et al., 2009b
Lophius budegassa	c	d	su	VI	0.13 ± 0.09	0.75 ± 0.72	0.41 ± 0.07	-	-	-	w.w	Yılmaz et al., 2010
Merluccius merluccius	c	d	w-sp-su	*2	0.10 ± 0.04	1.06 ± 0.23	-	-	-	-	w.w	Ateş et al., 2015
Mugil cephalus	om	bp	su	VII	1.183	-	-	-	-	-	d.w	Türkmen et al., 2006
Mugil cephalus	om	bp	su	VI	0.726	-	-	-	-	-	d.w	Türkmen et al., 2006
Mugil cephalus	om	bp	su	IV	1.912	-	-	-	-	-	d.w	Türkmen et al., 2006
Mugil cephalus	om	bp	sp	VI	0.33 ± 0.13	0.95 ± 0.13	-	-	-	-	w.w	Tepe, 2009
Mullus barbatus	c	d	su	VII	0.528	-	-	-	-	-	d.w	Türkmen et al., 2005a
Mullus barbatus	c	d	su	VI	0.911	-	-	-	-	-	d.w	Türkmen et al., 2005a
Mullus barbatus	c	d	su	IV	1.421	-	-	-	-	-	d.w	Türkmen et al., 2005a
Mullus barbatus	c	d	su	VI	0.06 ± 0.02	0.48 ± 0.26	-	-	-	-	w.w	Tepe et al., 2008
Mullus surmuletus	c	d	sp	VI	0.44 ± 0.01	1.00 ± 0.06	-	-	-	-	w.w	Tepe, 2009
Oblada melanura	c	d	w-sp-su	*2	0.05 ± 0.01	0.42 ± 0.08	-	-	-	-	w.w	Ateş et al., 2015
Pagellus acarne	c	bp	w-sp-su	VI	0.02 ± 0.00	0.14 ± 0.05	-	-	-	-	w.w	Türkmen et al., 2009b
Pagellus erythrinus	om	bp	sp	VI	0.22 ± 0.06	0.58 ± 0.08	-	-	-	-	w.w	Tepe, 2009
Pagrus caeruleostictus	c	bp	w-sp-su	VI	0.26 ± 0.04	0.75 ± 0.09	-	-	-	-	w.w	Türkmen et al., 2009b
Pegusa lascaris (As: Solea lascaris)	c	d	su	VI	0.39 ± 0.17	0.55 ± 0.21	0.47 ± 0.16	-	-	-	w.w	Yılmaz et al., 2010
Pomadasys incisus	c	d	w-sp-su	VI	0.02 ± 0.00	0.13 ± 0.02	-	-	-	-	w.w	Türkmen et al., 2009b
Pomatomus saltatrix	c	p	w-sp-su	VI	0.42 ± 0.07	0.88 ± 0.06	-	-	-	-	w.w	Türkmen et al., 2009a
Pteromylaeus bovinus	c	bp	2 years	I	0.14 ± 0.02	0.21 ± 0.03	-	0.05 ± 0.01	-	0.23 ± 0.06	w.w	Türkmen et al., 2013
Raja clavata	c	d	2 years	V	0.12 ± 0.02	0.19 ± 0.03	-	0.13 ± 0.03	-	0.27 ± 0.04	w.w	Türkmen et al., 2013

Note: FT: feeding type, c: carnivore, om: omnivore, En: environment, d: demersal, p: pelagic, bp: bento-pelagic, Se: Season, *1: no. season info, a: autumn, w: winter, sp: spring, su: summer, St: stations, *2: no. station info, I: Karataş, II: Yumurtalık, IV: Petrotrans, VI: İskenderun, V: Dörtyol, VI: İskenderun, VII- Arsuz, nd: not detected, Wt: weight, d.w.: dry weight, w.w.: wet weight.

Table 11. Mean concentration (µg metal /g) and associated standard deviations (means ± SD) of cobalt in the muscle, liver, skin, gill, gonad, and intestine of fish samples in Iskenderun Bay (Turkey). (continued)

Species	FT	En	Se	St	Tissues						Wt	Ref.
					Muscle	Liver	Skin	Gill	Gonad	İntestine		
Raja miraletus	c	d	2 years	II	0.10 ± 0.02	0.48 ± 0.18	-	0.18 ± 0.02	-	0.17 ± 0.02	w.w	Türkmen et al., 2013
Raja radula	c	d	2 years	II	0.12 ± 0.02	0.18 ± 0.03	-	0.14 ± 0.03	-	0.24 ± 0.03	w.w	Türkmen et al., 2013
Sardinella aurita	om	p	sp	VI	0.43 ± 0.02	1.24 ± 0.08	-	-	-	-	w.w	Tepe, 2009
Saurida undosquamis	c	d	su	VII	1.493	-	-	-	-	-	d.w	Türkmen et al., 2005a
Saurida undosquamis	c	d	su	VI	2.131	-	-	-	-	-	d.w	Türkmen et al., 2005a
Saurida undosquamis	c	d	su	IV	2.853	-	-	-	-	-	d.w	Türkmen et al., 2005a
Saurida undosquamis	c	d	w-sp-su	*2	0.02 ± 0.00	0.07 ± 0.01	-	-	-	-	w.w	Ateş et al., 2015
Scomber japonicus	c	p	w-sp-su	VI	0.08 ± 0.03	0.23 ± 0.04	-	-	-	-	w.w	Türkmen et al., 2009b
Serranus cabrilla	c	d	w-sp-su	*2	0.13 ± 0.01	0.32 ± 0.04	-	-	-	-	w.w	Ateş et al., 2015
Serranus scriba	c	d	w-sp-su	VI	0.37 ± 0.19	-	-	-	-	-	w.w	Türkmen et al., 2009b
Siganus rivulatus	h	d	w-sp-su	*2	0.39 ± 0.10	1.24 ± 0.09	-	-	-	-	w.w	Ateş et al., 2015
Sparus aurata	c	d	su	VII	1.032	-	-	-	-	-	d.w	Türkmen et al., 2005a
Sparus aurata	c	d	su	VI	1.336	-	-	-	-	-	d.w	Türkmen et al., 2005a
Sparus aurata	c	d	su	IV	1.517	-	-	-	-	-	d.w	Türkmen et al., 2005a
Sphyraena viridensis	c	p	w-sp-su	VI	0.05 ± 0.02	0.13 ± 0.05	-	-	-	-	w.w	Türkmen et al., 2009b
Spicara maena	c	d	w-sp-su	*2	0.38 ± 0.04	0.85 ± 0.07	-	-	-	-	w.w	Ateş et al., 2015
Trachinotus ovatus	c	p	w-sp-su	VI	0.03 ± 0.01	-	-	-	-	-	w.w	Türkmen et al., 2009b
Trachinus draco	c	d	w-sp-su	*2	0.01 ± 0.00	0.35 ± 0.04	-	-	-	-	w.w	Ateş et al., 2015
Trigla lyra	c	d	w-sp-su	VI	0.05 ± 0.02	0.51 ± 0.09	-	-	-	-	w.w	Türkmen et al., 2009b
Upeneus moluccensis	c	d	w-sp-su	*2	0.34 ± 0.06	0.86 ± 0.13	-	-	-	-	w.w	Ateş et al., 2015

Note: FT: feeding type, c: carnivore, om: omnivore, En: environment, d: demersal, p: pelagic, bp: bento-pelagic, Se: Season, *1: no. season info, a: autumn, w: winter, sp: spring, su: summer, St: stations, *2: no. station info, I: Karataş, II: Yumurtalık, IV: Petrotrans, VI: İskenderun, V: Dörtyol, VI: İskenderun, VII- Arsuz, nd: not detected, Wt: weight, d.w.: dry weight, w.w.: wet weight.

Table 12. Mean concentration (µg metal /g) and associated standard deviations (means ± SD) of cobalt in the tissues of invertebrate samples in Iskenderun Bay (Turkey).

Species	Se	St	Tissues			Wt	Ref.
			Muscle	Gill	Muscle+internal organs		
Monodonta turbinata	sp	X	6.63 ± 1.14	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	VIII	1.73 ± 0.20	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	IX	14.21 ± 4.63	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	VII	1.97 ± 0.59	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	VI	1.56 ± 0.56	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	V	5.40 ± 1.56	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	sp	II	2.62 ± 0.34	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	X	12.76 ± 1.03	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	VIII	10.66 ± 1.32	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	IX	8.47 ± 1.42	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	VII	5.21 ± 0.80	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	VI	4.21 ± 0.16	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	V	4.92 ± 1.44	-	-	d.w	Duysak & Ersoy, 2014
Monodonta turbinata	a	II	2.74 ± 0.76	-	-	d.w	Duysak & Ersoy, 2014
Patella caerulea	w	VI	0.25 ± 0.01	0.66 ± 0.08	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	w	II	0.14 ± 0.06	0.25 ± 0.03	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	sp	VI	0.33 ± 0.02	0.55 ± 0.02	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	sp	II	0.12 ± 0.05	0.21 ± 0.05	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	su	VI	0.20 ± 0.01	0.35 ± 0.01	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	su	II	0.13 ± 0.03	0.23 ± 0.06	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	a	VI	0.15 ± 0.06	0.32 ± 0.05	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	a	II	0.05 ± 0.03	0.13 ± 0.01	-	d.w	Yüzereroğlu et al., 2010
Patella caerulea	su	VII	2.31 ± 0.67	-	-	d.w	Türkmen et al., 2005b
Patella caerulea	su	VI	3.85 ± 1.06	-	-	d.w	Türkmen et al., 2005b
Patella caerulea	su	IV	5.15 ± 1.24	-	-	d.w	Türkmen et al., 2005b
Spondylus spinosus	w	VII	10.447	-	-	d.w	Türkmen, 2003
Spondylus spinosus	Sp	VII	0.3749	-	-	d.w	Türkmen, 2003
Spondylus spinosus	su	VII	0.5206	-	-	d.w	Türkmen, 2003
Spondylus spinosus	a	VII	2.5413	-	-	d.w	Türkmen, 2003
Spondylus spinosus	w	VI	14.722	-	-	d.w	Türkmen, 2003
Spondylus spinosus	sp	VI	3.1666	-	-	d.w	Türkmen, 2003
Spondylus spinosus	su	VI	8.9580	-	-	d.w	Türkmen, 2003
Spondylus spinosus	a	VI	12.547	-	-	d.w	Türkmen, 2003
Spondylus spinosus	w	II	16.384	-	-	d.w	Türkmen, 2003
Spondylus spinosus	sp	II	2.0420	-	-	d.w	Türkmen, 2003
Spondylus spinosus	su	II	8.3323	-	-	d.w	Türkmen, 2003
Spondylus spinosus	a	II	11.674	-	-	d.w	Türkmen, 2003
Spondylus spinosus	a	VII	-	-	2.54	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	w	VII	-	-	10.5	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	sp	VII	-	-	0.38	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	su	VII	-	-	0.52	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	a	VI	-	-	12.6	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	w	VI	-	-	14.7	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	sp	VI	-	-	3.17	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	su	VI	-	-	8.96	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	a	II	-	-	11.7	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	w	II	-	-	16.4	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	sp	II	-	-	2.04	d.w	Türkmen & Türkmen, 2005
Spondylus spinosus	su	II	-	-	8.33	d.w	Türkmen & Türkmen, 2005

Note: Se: Season, a: autumn, w: winter, sp: spring, su: summer, St: stations, II: Yumurtalık, IV: Petrotrans, V: Dörtyol, VI: İskenderun, VII: Arsuz, VIII: Konacık, IX: Akıncı Burnu, X: Samandağ , nd: not detected, Wt: weight, d.w.: dry weight, w.w.: wet weight.

CONCLUSION

Throughout history, people have been nourished with aquatic products. Aquaculture has always been the leading food group thanks to of its diversity and rich protein source. The growing world population and the results from unconscious contempt for natural aquatic resource uses have been major advances in the field of aquaculture fishery products; however, people still prefer natural products.

Since Iskenderun Bay is an important site for fishing activities, many researchers have studies heavy metal accumulation levels of the products, caught from the Bay. The present study was carried out to provide information on heavy metal concentration in different fish species from Iskenderun Bay.

As expected, there were significant differences in various tissues in view of accumulation of the selected metals.

This current study found no harmony when comparing heavy metal investigations in the bay in terms of species and metals with all of them showing that the accumulation of metals were the most in organs (liver, kidney etc.) wherein the highest metabolic activity could be seen in the species, while the least belonged to the muscles. It may be concluded that consumption of these species from the region is not a problem for human health. However, while the concentrations were below the limit values for fish, it might lead to a potential danger in the future, depending on the domestic waste waters and industrial activities in the region. Even though the bioaccumulation levels are not yet critical, further monitoring programs should be undertaken.

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