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Environmental assessment of the Shatt al-Arab water resource by measuring concentrations of some pollutants from heavy metals in *Scomberoides commersonnianus* fish tissues

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Abstract:

The concentrations of heavy metals (cadmium, copper, chrome, Iron, manganese, nickel, lead and Zink) in several parts of body (muscles, liver, ovaries, intestine, and gills) of *Scomberoides commersonnianus* hunted from Shatt Al-Arab estuary were studied. Metal concentrations were measured by Flame Atomic Absorption Spectrophotometer. The results showed that the highest values were recorded for Iron (3422.931) µg/g (dry weight); the least concentration was for lead (2.179) µg/g (dry weight). nickel, cadmium, manganese, zink, copper and chrome recorded (6.7, 20.81, 27.51, 325.5,327.799, 1078.37) µg/g respectively. The results showed that fish body parts that accumulated the metals were as follows; liver, gills, intestine, muscles and ovaries whereas the sequence of metals in fish body was as follows; Iron, chrome, copper, Zink, manganese, cadmium, nickel and lead. It was the order of the seasons in the concentration of elements as follows autumn, spring, winter, summer.

Keywords: *Scomberoides commersonnianus*; biological accumulation; heavy metals.

Introduction

Many sediments in the seas and oceans are exposed to pollution, some of these pollutants are discharged directly from factories and alternative wastewater treatment plants , others come from polluted water runoff in urban and agricultural areas , Some as a result of loading and unloading ships from ports, and the deposition of these pollutants can threaten the living organisms in the aquatic environment and bottom, some types of these toxic deposits may kill benthic organisms, reducing the food available to larger animals such as fish [1] . Some of these pollutants in sediments are taken by living organisms in the bottom in a process called accumulation. When other animals feed on these contaminated organisms, the toxins are transferred to them. Thus, the concentration of contaminants in the food chain increases in a process known as bioinflation [2]. Contaminated sediments do not always remain in the lower part of the water body due to the movement of water by the tidal processes, which means that all objects in the water are directly exposed to toxic pollutants, not just living organisms at the bottom. Response of aquatic organisms to external influences such as pollution and in different ways varies , The degree of accumulation of heavy metals in fish varies depending on the type of fish and the area of absorption and the amount and form of the element in water, sediments or nutrients, Leading to the possibility of being used as an important biological monitor in assessing the accumulation and biomagnification of pollutants within the ecosystem [3]. Many chemical elements are hazardous if they are released into the environment and accumulate in the sediments of water bodies and aquatic organisms that are transmitted through the food chain to higher levels including fish [4] . When the pH is reduced by the presence of binary metals and metal ions, it can bind to the gels and then move through the blood stream to the body parts , Chemical elements accumulated in silt and sediments at the bottom of water bodies can migrate back to water at varying degrees of acidity, silt can become a secondary source of heavy metal contamination [5] .

The present study aims to study the seasonal changes in the concentration of some heavy metals in fish collected from Shatt al-Arab estuary in the Iraqi marine waters and compared with other studies .

Material and Methods

Sample collection and identification

Seventy-five seasonal samples of fish were used near the Shatt al-Arab estuary in Iraqi sea water. The lengths and weights were taken of the fish where the average length was(295)mm and the average weight was (358)g .

Experimental Design

The method mentioned in [6] was adopted to digest four members (liver, gills, ovaries, muscles) from *Scomberoides commersonianus* and the evaluation of the content of heavy metals after the collection and configuration of samples, the weight of 0.5 g of freezing dryed and grinding samples were used in a glass tube, add 3 ml of a mixture of concentrated perchloric and nitric acid as 1: 1 ratio. The tubes are placed in a water bath and then transferred to the heating plate to complete the digestion process (until the mixture becomes clear). After the filtration process by filter paper and separated by the centrifuge to dispose of the remaining undigested parts (fibers), the leachate is taken and the volume is supplemented by the deionised distilled water to 25 ml . The samples are then kept in sealed plastic bottles until the test is carried out by

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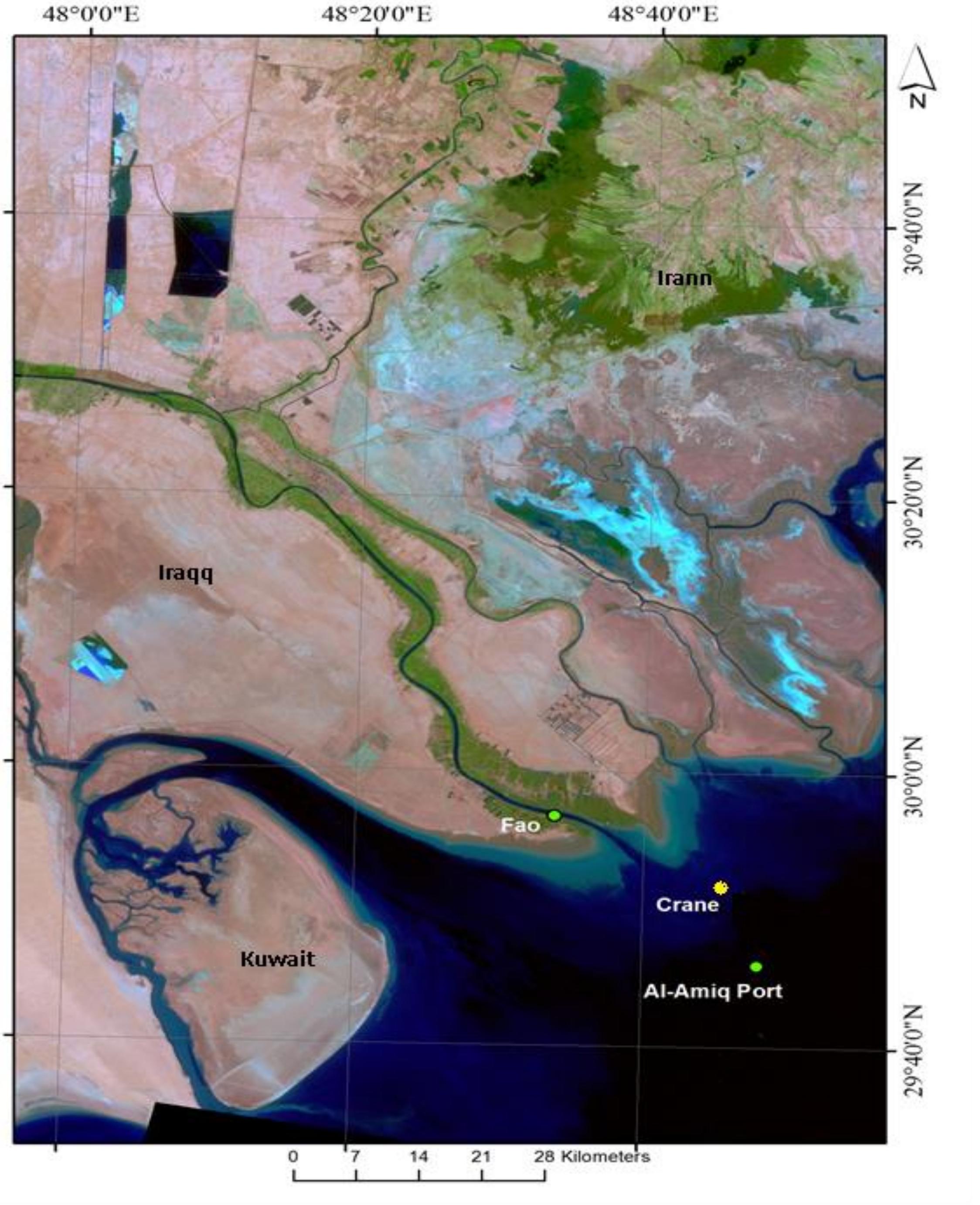
the atomic absorption spectrometer with the wavelengths (240.7 , 324.8 , 232 ,279.5 , 228.8) nm of the elements (copper, nickel, lead, iron, cobalt) respectively . The output is expressed in µg / g dry weight , the crane area shown on the map.

Statistical Analysis

The statistical program was tested to analyze the results statistically, and the significance of the differences between the averages was tested using the Revised Least Significant Difference (RLSD) at the probability level (0.05) .



Map showing sample collection area

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Results and Discussion

The fish *Scomberoides commersonianus* desired , mission commercially in Iraq and Arabian Gulf , Knowing the concentration of heavy metals in these fish is important both in terms of management and the nature of human consumption of fish and their content of heavy metals (Cadmium, copper, chromium, iron, manganese, nickel, lead and zinc) [7]. The results of the study showed that in winter (table 1) the highest accumulation of iron was in the ovaries about (318.2) µg/g (dry weight) , followed by chromium component in the intestines about (104.9) µg/g (dry weight) , This may be due to the presence of the two elements naturally in the water systems or through the manufacture and use of fertilizer in agricultural operations as well as the process of continuous mixing downstream water , When salt water is mixed with fresh water, iron particles may deposited in the downstream and accumulate in aquatic organisms [8]. Followed by the zinc and cadmium in the gills abot (34.5 , 1) µg/g (dry weight) ,this is due to the location of the gills in the body of the fish and its composition and direct contact with water, the concentration of elements varies by the concentration of the element in water, and most fish able to accumulate the heavy elements in their bodies through the diet or through gills [9]. In the spring (Table 2), the highest concentration of iron was also in the intestine about (298) µg/g (dry weight) followed by chromium in the liver (86.7) µg/g (dry weight) and then zinc had the highest concentration in the liver (33.2) µg/g (dry weight) , this is due to the location of the liver is important in circulation, it saves the blood from the heavy elements and focuses and then get rid of them in several ways [10] .

(Table 3) shows the concentration of elements in the members of the fish body during the summer season. Iron was more concentrated in the muscles about (273.1) µg/g (dry weight) followed by zinc in the liver (20.9) µg/g (dry weight) and then chromium in the ovaries (16.3) µg/g (dry weight) and copper in the muscles (10.34) µg/g (dry weight) , This may be due to several factors, including the rate of metabolism in fish, the degree of water pollution and sediment, available food and the nature of fat in its tissues, in addition to other factors, including salinity of water and temperature [9] .

The concentration of elements in the members of the fish in the autumn (table 4) The iron and chromium were the most accumulation in the liver (303.4 , 166.2) µg/g (dry weight) , then copper in the intestines (90) µg/g (dry weight) and zinc in gills (38.7) µg/g (dry weight). This may be due to differences in the ability of fish to regulate the level of elements in their bodies through the nature of nutrition and waste disposal in addition to the difference in osmotic behavior and regulation [11].

The lower concentration of elements such as manganese, nickel and lead during the study period, some of which were below the level of sensitivity of the atomic absorption spectrometer may return to high and low salinity values or may be due to differences in pH values and environmental conditions and seasonal fluctuations may affect the accumulation of lead In fat [12].

Table (1) Concentrations of the elements in the body organs during the Winter

element	organ	con.	rate	SD
Cd	muscles	0.2	0.4212	0.07
	liver	0.5		
	ovaries	0.4		
	intestines	0.006		
	gills	1.0		
Cu	muscles	0.481	0.4778	1.47
	liver	0.485		
	ovaries	0.292		
	intestines	0.599		
	gills	0.532		
Cr	muscles	77.3	66.26	4.29
	liver	58.9		
	ovaries	35.9		
	intestines	104.9		
	gills	54.3		
Fe	muscles	96.5	192.34	4.74
	liver	146.4		
	ovaries	18.2		
	intestines	99.5		
	gills	301.1		
Mn	muscles	0.1	0.02	5.26
	liver	ND		
	ovaries	ND		
	intestines	ND		
	gills	ND		
Ni	muscles	0.5	0.28	4.31
	liver	0.3		
	ovaries	0.2		
	intestines	ND		
	gills	0.4		
Pb	muscles	0.02	0.021	0.96
	liver	0.031		
	ovaries	ND		
	intestines	ND		
	gills	0.053		
Zn	muscles	6	19.32	1.97
	liver	16.2		
	ovaries	11.8		
	intestines	28.1		
	gills	34.5		
LSD	1.06			

ND = Not Detected

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Table (2) Concentrations of the elements in the body organs during the Spring

element	organ	con.	rate	S.D.
Cd	muscles	0.5	0.68	4.16
	liver	1.4		
	ovaries	ND		
	intestines	0.4		
	gills	1.1		
Cu	muscles	5.71	4.486	6.64
	liver	2.83		
	ovaries	4.61		
	intestines	2.29		
	gills	8.79		
Cr	muscles	74.8	60.44	5.32
	liver	86.7		
	ovaries	71.9		
	intestines	41.4		
	gills	27.4		
Fe	muscles	101.4	243.94	1.42
	liver	359		
	ovaries	231.3		
	intestines	298		
	gills	230		
Mn	muscles	ND	3.38	1.63
	liver	1.5		
	ovaries	4.8		
	intestines	1.5		
	gills	9.1		
Ni	muscles	0.4	0.72	4.77
	liver	ND		
	ovaries	0.3		
	intestines	0.3		
	gills	2.6		
Pb	muscles	ND	0.842	2.1
	liver	3.91		
	ovaries	ND		
	intestines	ND		
	gills	0.3		
Zn	muscles	11.4	14.34	3.57
	liver	33.2		
	ovaries	10.3		
	intestines	10.8		
	gills	6		
LSD	1.47			

ND = Not Detected

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Table (3) Concentrations of the elements in the body organs during the Summer

element	Organ	con.	rate	S.D.
Cd	Muscles	2.4	1.74	2.11
	Liver	3.2		
	Ovaries	0.7		
	Intestines	1.2		
	Gills	1.2		
Cu	Muscles	10.34	6.938	5.30
	Liver	6.56		
	Ovaries	6.66		
	Intestines	4.47		
	Gills	6.66		
Cr	Muscles	7.47	6.604	1.40
	Liver	1.058		
	Ovaries	16.3		
	Intestines	5.9		
	Gills	2.29		
Fe	Muscles	273.1	168.5	13.22
	Liver	214.6		
	Ovaries	117.4		
	Intestines	105.8		
	Gills	131.6		
Mn	Muscles	0.01	0.738	0.77
	Liver	0.07		
	Ovaries	2.1		
	Intestines	0.5		
	Gills	1.01		
Ni	Muscles	0.1	0.24	5.76
	Liver	0.1		
	Ovaries	0.7		
	Intestines	0.3		
	Gills	ND		
Pb	Muscles	0.11	0.385	1.10
	Liver	0.744		
	Ovaries	0.6		
	Intestines	0.301		
	Gills	0.17		
Zn	Muscles	15.6	13.54	0.97
	Liver	20.9		
	Ovaries	10.5		
	Intestines	4.9		
	Gills	15.8		
LSD	2.07			

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Table (4) Concentrations of the elements in the body organs during the Autumn

element	Organ	con.	rate	S.D.
Cd	Muscles	1.5	1.32	2.81
	Liver	1.6		
	Ovaries	1.3		
	Intestines	1.2		
	Gills	1		
Cu	Muscles	53.1	55.64	1.13
	Liver	53.3		
	Ovaries	22.8		
	Intestines	90		
	Gills	59		
Cr	Muscles	16.6	88.96	0.49
	Liver	166.2		
	Ovaries	41.2		
	Intestines	91.4		
	Gills	129.4		
Fe	Muscles	22	145.32	19.91
	Liver	303.4		
	Ovaries	71.6		
	Intestines	218.1		
	Gills	111.5		
Mn	Muscles	ND	1.38	0.58
	Liver	3.5		
	Ovaries	2.6		
	Intestines	ND		
	Gills	0.8		
Ni	Muscles	0.7	0.44	6.58
	Liver	ND		
	Ovaries	0.5		
	Intestines	ND		
	Gills	1		
Pb	Muscles	0.06	0.024	0.05
	Liver	0.04		
	Ovaries	0.01		
	Intestines	0.01		
	Gills	ND		
Zn	Muscles	12.3	18.88	0.33
	Liver	23.6		
	Ovaries	14.9		
	Intestines	4.9		
	Gills	38.7		
LSD	1.81			

ND = Not Detected

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Table (5) shows the total concentrations of the elements in the members during the study period where the iron component was the most concentrated in fish members, which amounted to (3422.93) µg/g followed by the chromium (1078.368) µg/g , while the lead was the lowest concentration (2.179) µg/g followed by nickel (6.7) µg/g fig (1) , This may be due to the presence of these elements in the environment, which may be high and since the fish have the ability to accumulate these elements higher than in water and sediments because of feeding on algae and small neighborhoods in addition to the organic materials found in the aquatic environment [13]. Heavy elements enter the fish either indirectly through food or directly through gills and skin [14] . While in the [15] study on some fish caught from Malaysian coasts, zinc and lead concentrations were higher than the current study .

Table (5) The concentration of elements in the organs during the study period (ppm

	Cd	Cu	Cr	Fe	Mn	Ni	Pb	Zn
muscles	4.6	63.921	159.52	493	0.1	1.7	0.19	45.3
liver	6.7	63.175	312.858	1023.4	5	0.4	0.815	93.9
ovaries	2.4	31.362	149	510.43	9.5	1.7	0.61	47.5
intestines	2.806	97.359	243.6	621.9	2	0.6	0.311	43.8
gills	4.3	71.982	213.39	774.2	10.91	2.3	0.253	95
total	20.806	327.799	1078.368	3422.93	27.51	6.7	2.179	325.5

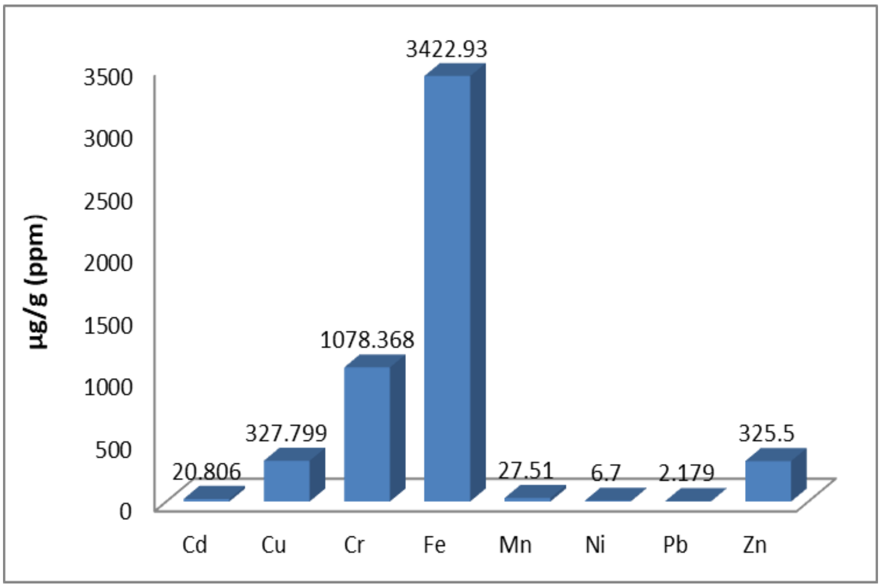

Fig (1) The total concentrations of the elements during the study period

The total concentration of the elements during the four seasons (Table 6) and Figure (2) showed that the highest concentration of elements was in the Autumn of (1538.32) µg/g . This may be due to the decrease in pH values and salinity increase (Appendix 1) and the distribution of heavy elements in the aquatic environment between the dissolved phase , the colloids and Sediments as less than 0.1% of the minerals actually melt in water and more than 99.9 % are stored in sediments and soils [16,17] . While [18] recorded the highest concentration of elements in the summer, unlike the current study

Table (6) The concentrations of elements during the study seasons

	Cd	Cu	Cr	Fe	Mn	Ni	Pb	Zn
Winter	2.106	2.389	331.3	862.2	0.1	1.4	0.104	96.6
Spring	3.4	18.52	302.2	991.631	16.9	1.9	0.03	71.7
Summer	8.7	28.69	16.668	842.5	3.61	1.2	1.925	67.7
Autumn	6.6	278.2	428.2	726.6	6.9	2.2	0.12	89.5

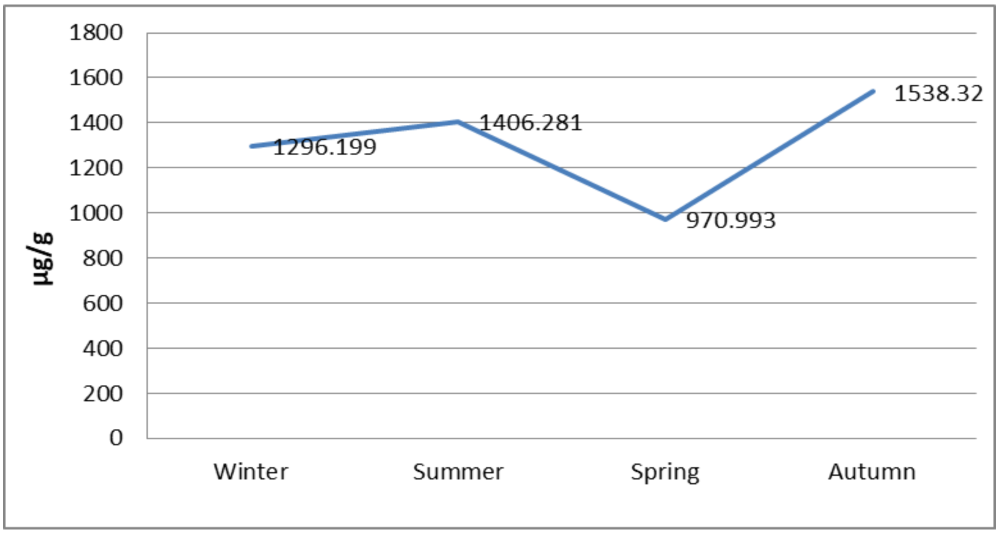

Fig (2) The total concentrations of the elements during the study seasons

Figure (3) shows the total concentrations of the elements in the fish members during the study, where the liver was the most concentrated members of the elements (1506.248) µg/g followed by gills (1172.335) µg/g , Most studies have agreed with the current study that the accumulation of heavy elements in the liver is higher than in the other organs and may be due to its location within the circulatory system, where it captures most heavy metals transmitted by blood , In addition, the liver synthesizes the melatothionine proteins, which are important in the association with the elements in order to transfer and put them out of the body [19,20]. The difference in the accumulation of elements in different organs is due to the nature of the tissue and physiological structure of the organ and the amounts of fat within the tissue and the presence of enzymes that have the ability to combine with heavy elements and remove them outside the tissue and thus out of the body [21].

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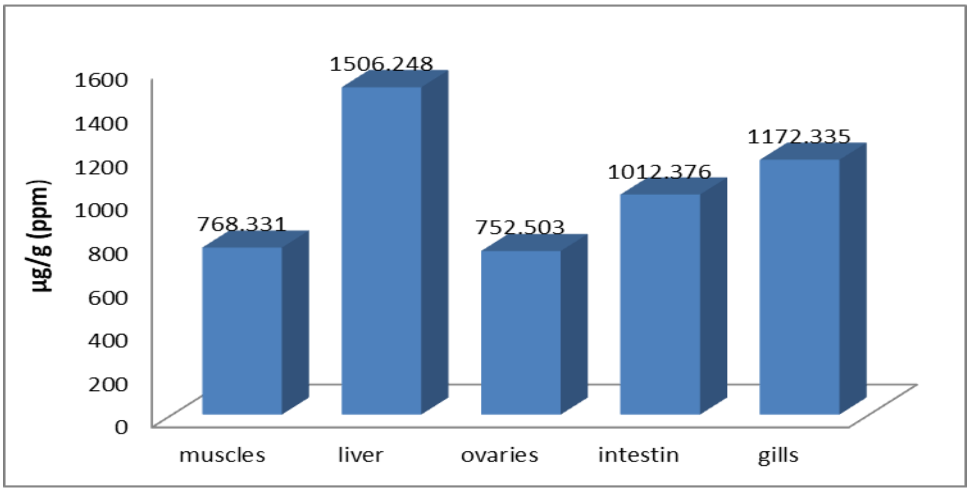

Fig (3) Total concentrations of the elements in fish members during the study period

Appindex (1) Environmental factors during the study

Month	temperature	salinity	PH	Dissolved Oxygen mg / L
January	11	12.1	7.8	12.3
February	16	19.6	7.8	11.70
March	17.7	12.9	7.9	11.60
April	20	9.6	8.1	10.90
May	28.3	8.2	8.0	10.50
Jun	27	17.6	8.1	10.50
July	30	26.2	7.6	10.27
August	29.1	21.7	7.5	9.67
September	18.8	23.5	7.3	9.90
October	20	18.2	7.7	10.63
December	10	15.3	7.9	11.90

Appendix(2) Values of heavy metals in some types of Iraqi marine fish.

References	Ni	Pb	Cd	Co	Cu	Fe	Mn	species
11	44,85	_	ND	4,9	2,87	62	13,1	*Acanthopagrus latus*
20	11,9	–	11,9	–	51,1	1,7	26	*Otolithes ruber*
21	4,16	_	ND	3	—	43,9	1,4	*Tenualosa ilisha*
22	109	-	5,9	3,3	9,5	57	6,72	*Liza subviridis*

23	1.46		24.53	11.1	19.5	215.3	5.73	*Acanthopagrus latus*
1	12.59	5.3	-	98.6	29.4	948.5		*chirocentrus dorab*
This study	6.7	2.17	20.8	-	327.7	3422.9	27.51	*Scomberoides commersonnianus*

Appendix(3) Limits for heavy metals in fish (µg /g dry weight).

References	Pb	Cd	Fe	Mn	Ni	Cu
24	3.1	3.9	50	7.9	17.8	–
25 in26	4.0	1	55	4.5	20.0	–
27 in 26	1.7	4	40	—	80	–
28	5	6.7-8.3	–	–	–	5

Conclusions

(1) The ability of *Scomberoides commersonnianus* to accumulate heavy metals in large quantities, especially some metals appeared in high concentrations in the fish, indicating the possibility of using fish to determine the state of water pollution trace metals .

(2) The accumulation of these metals in the members of the fish is varying .

(3) Concentrations of the metals in the muscles of the fish are few compared to other organs such as liver and gills, which

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