Bull. Environ. Contam. Toxicol. (1998) 60:822-828

Bulletin of Environmental Contamination and Toxicology

Metal Concentrations in Tissues of the Freshwater Fish *Capoeta barroisi* from the Seyhan River (Turkey)

F. Kargin

Biology Department, University of Çukurova, 01330 Adana, Turkey

Received: 7 October 1997/Accepted: 12 March 1998

The Seyhan River is situated in the Çukurova region which is at the southern part of Turkey and empties into the Mediterranean (Figure 1). This region comprises an area that is rapidly expanding in population, agriculture and industry. The Seyhan River recieves large quantites of untreated industrial, chemical pollutants and domestic sewage due to heavy agricultural and industrial activities. It is exposed to industrial and domestic sewage discharge from the city of Adana. This is the first study on concentrations of heavy metals in the Seyhan River fish tissues form.

Heavy metal pollution of river ecosystem has been reported by several authors (Vinikour et a1.,1980; Blevins and Pancorbo,l986; Legorburu et a1.,1988). Since fish are often the last link in aquatic food chains, the metal concentrations of many fish species have been analysed in relation to metal contents of aquatic environments (Norris and Lake, 1984; Dallinger and Kautzky, 1985;Capelli and Minganti,1987).

Zinc (Zn), Copper (Cu), Iron (Fe), Cadmium (Cd) and Lead (Pb) were selected because most studies on heavy metal concentrations in fish dealing these metals. Some heavy metals, such as Cu and Zn are necessary in trace amounts for the functioning of biological systems (Collvin, 1985; Hilmy et a1.,1987; Tort et al., 1987) while metals like Pb and Cd are known to interfere with the functioning of biological systems(Villareal-Trevino et al., 1986).

Temperature, one of the most significant environmental parameters was found to affect the metabolism of a number poikilotherms (Voutsinou-Taliodori, 1982; Hilmy et al., 1987). The freshwater fish *Capoeta barroisi* naturally lives in this area. Since the natural reproduction of these species is extraordinarily easy, it is economically important for human consumption.

In this study, the level of various metals were determined periodically in the liver,gill and muscle tissues of edible freshwater fish *C. barroisi.*

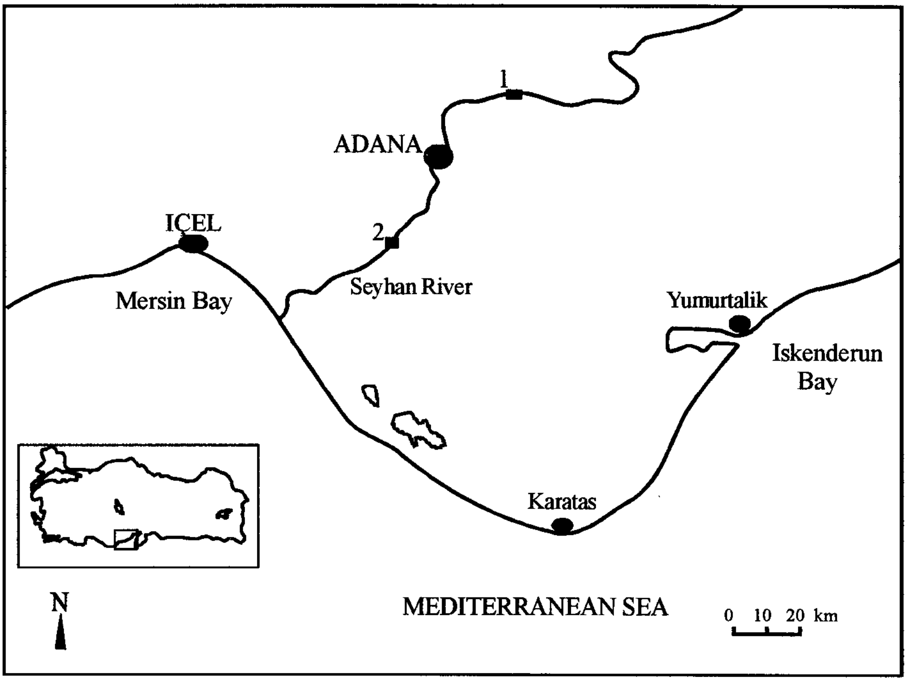

Figure 1. Study area and sampling sites (1: Upstream, 2: Downstream)

MATERIALS AND METHODS

Fish samples were captured by seining in October 1996 and January, April and July of 1997 in the Seyhan River (Figure 1). Ten samples were analysed in every season in order to determine metals in their tissues. Fish were transported daily to the laboratory and stored -20°C until dissection of the selected organs. The length of *C. barroisi* samples varies from 8.5cm up to 19cm with a mean value 14.3 ± 1.14 cm. Similarly, the weight of the same species are observed to be within the ranges of 61 to 108 g, with a mean value of 82.6±1.27 g.

Some of the physicochemical parameters of River Seyhan are given below;

Parameters	Downstream	Upstream
Water depth	2.8 m	2.1 m
Water flow	112 m/sec	54 m/sec
Temperature	17.2°C	18.4°C
PH	6.15	8.15
O_2	5.20	7.24

Prior to sample preparation fish were rinsed in distilled water to remove foreign particles , excess mucus coating , or other such materials that could have adsorbed metals.

Their liver,gill and muscle tissues were dissected seperately. Sample preparation and analysis were carried out according to the procedure described by Bernhard

(1976).Tissues were dried at 105°C for 48 hours and digested with concentrated nitric acid and concentrated perchloric acid (2:1 v/v) at 120°C for 3 hours (Muramoto, 1983). After dilution, copper,zinc,iron,lead and cadmium contents of tissues were measured on a Perkin Elmer AS 3100 atomic absorbtion flame spectrophotometer.

RESULTS AND DISCUSSION

Metal concentration in various tissues of *Capoeta barroisi* are given Tables1 and 2 for each region respectively. Data were analysed statistically by a series of Student Newman Keul's test to identifiy any differences among tissues (s,t and x) and among monthly (a and b) accumulation distributions of the metals which are shown in Table 1. Data were shown with different letters are significant at the 0.01 level.

Table 1. Concentrations of Heavy Metals (µg/g dry wt.) in *Capoeta barroisi* from Downstream Site of the Seyhan River.

Metal	Tissue	October $\bar{X} \pm S\bar{x}$ *	January $\bar{X} \pm S\bar{x}$ *	April $\bar{X} \pm S\bar{x}$ *	July $\bar{X} \pm S\bar{x}$ *	Range
	Muscle	71.3 ± 2.15 **as**	68.4 ± 3.10 **as**	73.2 ± 3.54 **as**	85.4 ± 2.90 **bs**	68-85
Iron	Gill	218.9 ± 3.21 **at**	212.5 ± 2.89 **at**	217.4 ± 5.56 **at**	259.9 ± 4.98 **bt**	212-260
	Liver	431.2 ± 5.36 **ax**	425.7 ± 5.15 **ax**	434.6 ± 6.72 **ax**	504.7 ± 6.24 **bx**	425-504
	Muscle	27.3 ± 2.11 **as**	25.4 ± 1.87 **as**	28.2 ± 2.05 **as**	38.2 ± 2.24 **bs**	25-38
Zinc	Gill	54.6 ± 3.18 **at**	51.9 ± 2.75 **at**	57.1 ± 3.24 **at**	74.2 ± 3.53 **bt**	52-74
	Liver	174.7 ± 4.25 **ax**	172.2 ± 5.10 **ax**	180.6 ± 5.15 **ax**	204.5 ± 5.84 **bx**	172-204
	Muscle	7.5 ± 0.90 **as**	6.4 ± 0.75 **as**	7.3 ± 1.05 **as**	11.2 ± 1.17 **bs**	6-11
Copper	Gill	13.0 ± 1.13 **at**	12.7 ± 1.24 **at**	13.7 ± 1.35 **at**	20.2 ± 1.72 **bt**	13-20
	Liver	91.1 ± 2.75 **ax**	96.2 ± 3.10 **ax**	97.3 ± 3.84 **ax**	119.4 ± 4.25 **bx**	91-119
	Muscle	7.1 ± 0.59 **as**	6.7 ± 0.67 **as**	7.7 ± 0.75 **as**	10.9 ± 0.97 **bs**	7-11
Lead	Gill	16.6 ± 1.02 **at**	15.9 ± 1.14 **at**	17.2 ± 1.24 **at**	25.2 ± 1.73 **bt**	16-25
	Liver	11.7 ± 0.98 **ax**	10.5 ± 0.86 **ax**	11.3 ± 1.05 **ax**	18.2 ± 0.96 **bx**	10-18
	Muscle	3.4 ± 0.24 **as**	2.9 ± 0.20 **as**	3.2 ± 0.35 **as**	5.9 ± 0.52 **bs**	3-6
Cadmium	Gill	4.4 ± 0.65 **as**	3.7 ± 0.53 **as**	4.1 ± 0.72 **as**	6.9 ± 0.85 **bs**	4-7
	Liver	7.4 ± 0.72 **at**	6.9 ± 0.84 **at**	7.3 ± 0.85 **at**	11.9 ± 0.96 **bt**	7-12

* = SNK : Letters s, t and x show differences among tissues; a and b among months. Data shown with different letters are statistically significant at the $P<0.01$ level.

$\bar{X} \pm S\bar{x}$: Mean ± Standard Error

Concentrations of all metals were elevated in fish tissues from the downstream station in every season. We conclude that this high levels metals is due to dumped agricultural and industrial wastes to downstream region of the Seyhan River.

A number of studies show that the concentrations of the non-essential metals (cadmium and lead) in the aquatic organisms depend mainly on their environmental levels (Amiard et al., 1987 ; Heath, 1987 ; Bryan and Langston, 1992). The presence of Cd and Pb in *C. barroisi* is not normally expected and therefore the observed accumulation of *C. barroisi* tissues is unusual and clearly shows that the downstream region of Seyhan River is contaminated at high level by these metals.

Table 2. Concentrations of Heavy Metals (µg/g dry wt.) in *Capoeta barroisi* from Upstream Site of the Seyhan River.

		October	January	April	July	
Metal	Tissue	$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$	Max.
	Muscle	2.1 ± 0.63	—	2.2 ± 0.38	3.2 ± 0.31	3
Iron	Gill	—	2.9 ± 0.65	3.2 ± 0.80	4.2 ± 0.72	4
	Liver	5.3 ± 1.05	4.3 ± 0.76	5.4 ± 0.95	6.1 ± 1.05	6
	Muscle	2.8 ± 0.76	2.1 ± 0.74	—	3.6 ± 1.00	4
Zinc	Gill	4.3 ± 0.95	3.6 ± 0.92	4.5 ± 1.12	4.3 ± 1.11	4
	Liver	4.9 ± 1.15	—	6.3 ± 1.25	7.4 ± 1.5	7
	Muscle	—	—	—	—	-
Copper	Gill	—	—	—	1.1 ± 0.21	1
	Liver	2.2 ± 0.54	—	3.9 ± 0.92	5.3 ± 1.14	5
	Muscle	—	—	—	—	-
Lead	Gill	0.4 ± 0.31	—	—	0.7 ± 0.50	0.7
	Liver	—	—	—	0.3 ± 028	0.3
	Muscle	—	—	—	—	-
Cadmium	Gill	—	—	—	—	-
	Liver	—	—	0.2 ± 0.09	0.5 ± 0.15	0.5

$\bar{X} \pm S\bar{x}$: Mean ± Standard Error
—: Not detectable

Mathis and Cummings (1973) studied the metal accumulation of 10 freshwater fish from the Illinois River and they found that omnivorous fish had higher metal accumulation than carnivorous fish. We have studied *C. barroisi* which is a omnivorous type fish. High metal accumulation is determined from tissues of fish which may be a role of the omnivorous feature of *C. barroisi.*

The level of a given metal showed significant differences between the tissues of *C. barroisi* in every season. The livers contained the highest levels of Cd, Zn, Cu, Fe followed by the gills. Howover the highest lead levels was observed in the gills of *C. barroisi.* Muscle generally accumulated the lowest levels of metals in every season.

Heavy metals mainly accumulate in metabolicaly active tissues (Haesloop and Schrimer, 1985 ; Thomas et al., 1985). The liver tissue is highly active in the uptake and storage of heavy metals Fish respond to heavy metal exposure by producing metallothionein, particularly in liver (Roth and McCarter, 1984 ; Heath, 1987). The gill is a tissue which were active and passive exchanges occur between the animal and aquatic environment. First high levels of metals accumulate in the gill tissues by absorbtion and adsorbtion (Heath, 1987). Generally, freshwater fish muscle is not considered as a metal accumulating tissue (Miklovics et al., 1985 ; Legorbru et al.,

1988) but some studies have demonstrated elevated concentration of heavy metal in muscle tissue fish from metal-contaminated habitats (Blevins and Pancorbo, 1985; Bradley and Morris, 1986).

Amounts of iron and zinc have been found to be highest tissues in every season. In general, cadmium and lead have been found at lower levels, while the amount of copper was between that of iron-zinc and cadmium-lead.

The levels of all metals in tissue *C. barroisi* were higher in July compared with the other months, while no statistical differences were found between October, January and April. A number of studies have shown that various factors such as season (Kargin, 1996) length and weight (Uysal and Tuncer, 1982) physical and chemical status of the water (Johnson, 1988) can play in the tissue accumulation of metals. Temperature is known to be a significant effecting metal uptake by water organisms through increasing metabolism (Voutsinou-Taliadouri, 1982). Larson et al. (1985) indicated that many of physiological parameters in fish are subjected to seasonal variations.

The results obtained from samples collected in summer show very high metal concentrations. This high level metal accumulation could be due to heavy rainfall during spring which increases the metal content of the water by washing down the metal contained soil.

Our results show that metal concentrations are the highest in liver and gills while it is low in muscle. These results are consistent with previous studies which are carried out on freshwater fish (Norris and Lake, 1984; Dallinger and Kautzky,1985; Legorburu et al., 1988).

REFERENCES

Amiard JC, Amiard-Triquet C, Berthet B, Metayer C (1987) Comparative study of the patterns of bioaccumulation of essential (Cu, Zn) and non-essential (Cd, Pb) trace metals in various estuarine and coastal organisms. J Exp Mar Biol Ecol 106: 73-89.

Bernhard M (1976) Manual of methods in aquatic environment research, part. 3: sampling and analyses of biological material. FAO Fish Tech Paper No 158, UNEP Rome.

Blevins RD, Pancorbo OC (1986) Metal concentrations in muscle of fish from aquatic systems in East Tennesse, U.S.A. Water Air Soil Pollut 29: 361-367.

Bradley RW, Morris IR (1986) Heavy metals in fish from a series of metal-contaminated lakes near Sudbury, Ontario. Water Air Soil Pollut 27: 341-354.

Bryan G, Langston WI (1992) Bioavailability, accumulation and effects of heavy metals in sediments with special reference to United Kingdom estuaries: a review. Environ Pollut 76: 89-131.

Capelli R, Minganti V (1987) Total mercury, organic mercury, copper, manganese, selenium and zinc in *Sarda sarda* from the Gulf of Genoa. Sci Tot Environ 63: 83-99.

Collvin L (1985) Effects of copper on growth and starvation in perch, *Perca fluviatilis* L. J Fish Biol 27: 757-764.

Dallinger R, Kautzky H (1985) The importance of contaminated food for the uptake of heavy metals by rainbow trout (*Salmo gairdneri*): a field study. Oecologia (Berlin) 67: 82-89.

Haesloop U, Schirmer M (1985) Accumulation of orally administered cadmium by the eel (*Anguilla anguilla*). Chemosphere 14: 1627-1634.

Heath AG (1987) Water pollution and fish physiology. CRC Press, Inc. Boca Rotan, Florida, 245 pp.

Hilmy AM, El-Domiaty NA, Daabees AY, Abdel Latife HA (1987) Toxicity in *Tilapia zilli* and *Clarias lazera* (Pisces) induced by zinc, seasonally. Comp Biochem Physio1 86: 263-265.

Johnson I (1988) The effects of combinations of heavy metals, hypoxia and salinity on ion regulation in *Crangon crangon* (L.) and *Carcinus means* (L.). Comp Biochem Physiol 91: 459-463.

Kargin F (1996) Seasonal changes in levels of heavy metals in tissues of *Mullus barbatus* and *Sparus aurata* collected from Iskenderun Gulf (Turkey). Water Air Soil Pollut 90: 557-562.

Larson A, Haux C, Sjöbeck M (1985) Fish physiology and metal pollution Results and experiences from laboratory and field studies. Ecotoxicol Environ Saf 9 : 250-281.

Legorburu I, Canton L, Millan A, Casado A, (1988) Trace metal levels in fish from Urola River (Spain) Anguillidae, Mugillidae and Salmonidae. Environ Technol Lett 9 : 1373-1378.

Mathis BJ, Cummings TF (1973) Selected metals in sediments, water and biota in the Illinois River. J Water Pollut Control Fed 48 :1913-1918.

Miklovics MH, Kovacs-Gayer E, Szakolczai J (1985) Accumulation and effect of heavy metals in the fishes of lake Balaton, Symposia Biologica Hungarica 29: 111-118.

Muramoto S (1983) Elimination of copper from Cu-contaminated fish by long-term exposure to EDTA and freshwater. J Environ Sci Health 18 : 455-461,

Norris RH, Lake PS (1984) Trace metal concentrations in fish from the south Esk River, Northeastern Tasmania, Australia. Bull Environ Contam Toxicol 33: 348-354.

Roch M, McCarter JA (1984) Hepatic metallothionein production and resistance to heavy metals by rainbow trout (*Salmo gairdneri*)-I. Exposed to an artifical mixture of zinc, copper and cadmium. Comp Biochem Physiol 77 :71-75.

Thomas DG, Brown MW, Shurben D, Solbe JF, Creyer A, Kay J (1985) A comparison of the sequestration of cadmium and zinc in the tissues of rainbow trout (*Salmo gairdneri*) following exposure to the metals singly or in combination. Comp Biochem Physiol 82. 55-62.

Tort L, Torres P, Flos R (1987) Effects on dogfish haematology and liver composition after acute copper exposure.Comp Biochem Physiol 87:349-353.

Uysal H, Tuncer S (1982) Levels of heavy metals in some commerical food species in the Bay of Izmir. VIes Journees Etud Pollutions,Cannes, C.I.E.S.M 323-327.

Villareal-Trevino CM, Obregon-Morales ME, Lozano-Morales JF , Villages-Navarro (1986) Bioaccumulation of lead, copper, iron and zinc by fish in a transect of the Santa Catarina River in Cadereyta Jimenez, Nuevo Mexico. Bull Environ Contam Toxicol 37 : 395-401.

Vinikour WS, Goldstein RM, Anderson RV (1980) Bioconcentration patterns of zinc, copper, cadmium and lead in selected fish species from the Fox River, Illinois. Bull Environ Contam Toxicol 24 : 727-734.

Voutsino-Taliadouri F (1982) Monitoring of some metals in some marine organisms from the Saronikos Gulf. VIes Journees Etud Pollutions, Cannes, C.I.E.S.M. 329-333.