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-RESEARCH ARTICLE-

The effects of age and individual size on metal levels of Serranus cabrilla (Linnaeus, 1758) from the Yeşilovacık Bay (Northeasthern Mediterranean, Turkey)

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Abstract

In this study, the relationships were determined between the macro (Na, Mg, P, K, Ca), potential toxic metal, As, and trace element, Zn, levels of the muscle tissue and fish size (length and weight) in *Serranus cabrilla* (Linnaeus, 1758) caught via bottom trawl boat from the Yeşilovacık Bay (Northeastern Mediterranean, Turkey). The potential toxic metal, macro and trace element levels of the muscle tissue of *S. cabrilla* were determined. Besides, the relationships between fish size and metal levels were investigated. For this study, *S. cabrilla* individuals of 0-1, 1-2 and 2-3 age groups were used. Min-Max total length of the age groups was determined as 10.5-11.8, 13.0-15.5 and 15.8-16.5 cm; Min-Max weights were 15.34-23.66, 30.41-43.82 and 41.89-58.18 g respectively. There was no statistical difference between the age groups according to the macro and trace element levels of muscle tissue. The Arsenic levels of the muscle tissue were high and in general displayed variation with age. The present study firstly reported the relationship between mineral-metal levels and individual size-age of *S. cabrilla*.

Keywords:

Serranus cabrilla, Comber, Potential Toxic Metals, Macro Elements, Trace Elements

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Introduction

Fish are considered to be an important source of food for human health in terms of macro nutrients (carbohydrates, animal proteins, fatty acids, vitamins and polyunsaturated fatty acids) and micronutrients (copper, zinc, iron and selenium). Marine chemical pollution can increase levels of toxic heavy metals in the food web, thus affecting fish in a negative way in terms of contamination. Some trace metals are required in small quantities in order for metabolic processes to continue by marine organisms. Although low levels of arsenic (As), chromium (Cr), lead (Pb) and other metals have toxic biological effects for aquatic organisms, the activities for metabolism of some metals such as manganese, zinc, copper and iron are important. (Burger & Gochfeld, 2001; Ikem & Egibo, 2005). Even trace metals may be toxic to biological activities of organisms at certain levels (Perez-Cid et al., 2001).

Comber belongs to *Serranidae* family (*Serranus cabrilla* L. 1758), and it is demersal species which lives in littoral zone, *Posidonia* areas, sand and muddy areas. It is largely inhabited in West Atlantic, South Africa, Mediterranean Sea and Black Sea. It is subtropical fish species whose maximum length reaches to 40 cm (Frose & Pauly, 2016). Comber is carnivore species and it feeds on macrofauna, zoobenthose, cephalopods, crustaceans and fish (Abdallah, 2008; Frose & Pauly, 2016).

Comber which is widely found both in Atlantic and Mediterranean Sea is discarded for trolling (Ilhan et al., 2010; Gordo et al., 2016). Comber has a wide distribution and is not a highly commercial fish, although it is often caught by fishermen. This has led to limited scientific research on the *S. cabrilla* (Ilhan et al., 2010; Gordo et al., 2016). There are studies on feeding habitats (Turker-Cakir & Torcu-Koc, 2002; Abdallah, 2008) growth characteristics (Torcu-Koc, 2002; Ozaydın et al., 2007; Ilhan et al., 2010) and heavy metal levels (Celik & Oehlenschläger, 2005; Ates et al., 2015) of *S. cabrilla*.

Although *S. cabrilla* is discarded species for trolling, it has become marketable in recent years (Ilhan et al., 2010). The most important reason for that it is cheaper than the other target species. Comber is also important for ecosystem because it is largely distributed. As a result, some studies have been conducted on the metal levels of that species. The fact it has become consumable is another reason to determine the metal contamination levels of the muscle tissues. Determining the metal contamination levels is important for both human health and marine ecosystem (Bouguegneau et al., 1982). Marine organisms make it possible to observe environmental pollution. Yeşilovacık Bay is exposed to different pollutants such as ship transportation, agricultural facilities and domestic waste.

Seafood is one of the most preferred foods in the world and it is important to examine the accumulation of metals in commercially important fish and fish products. The search of metal contamination in marine species in relation to age and size not only determines the contamination levels for a short period of time but also it shows the metal contamination for a longer period. In this study, the relationships were determined between the macro (Na, Mg, P, K, Ca), potential toxic metal, As, and trace element, Zn, levels of the muscle tissue and fish size (length and weight) and ages in *Serranus cabrilla* (Linnaeus, 1758) from the Yeşilovacık Bay (Northeastern

Mediterranean, Turkey). This is the first study that indicates the relationship between metal levels of the muscle and fish size and ages of comber.

S. cabrilla (Linneus, 1758) caught via bottom trawl boat from the Yeşilovacık Bay (Northeastern Mediterranean, Turkey). Age of comber specimens were calculated by otolith reading. Before otolith reading, all otoliths were cleaned with 4% NAOH and stayed in 70% ethyl alcohol. Annuli were determined with using a binocular microscope.

Table 1. Total length and weight variation of *S. cabrilla* with age.

Age (Years)	N	Total Length (cm) Min-Max	$\overline{X} \pm S_{\overline{X}}$	Weight (g) Min-Max	$\overline{X} \pm S_{\overline{X}}$
0-1	16	10.5-11.8	11.11±0.18	15.34-23.66	18.92 ±1.09
1-2	44	13.0-15.5	14.49±0.25	30.41-43.82	39.03±1.75
2-3	12	15.8-16.5	16.06±0.08	41.89-58.18	50.72±2.19

$\overline{X} \pm S_{\overline{X}}$: mean±standard error

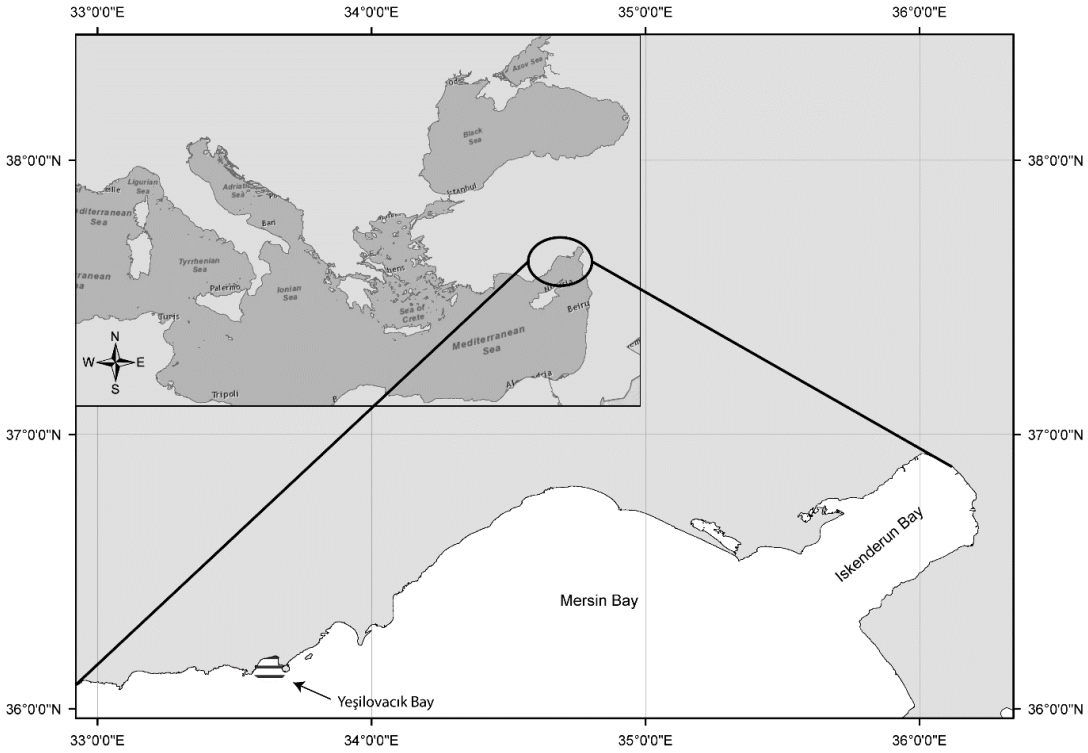

Figure 1. Sampling location map. (The shaded region (Yeşilovacık Bay) is the sampling area)

Metal analysis

The samples (0.1 g dry weight) used for metal analysis were dried at 105°C to reach constant weights, and then concentrated nitric acid (2 mL, Merck, Darmstadt, Germany) and percholoric acid (1 mL, Merck, Darmstadt, Germany) were added to the samples, and they were put on a hot plate set to 150°C until all tissues were dissolved (Canli & Atli, 2003).

Inductively coupled plasma mass spectrometer (ICP-MS, Agilent, 7500ce Model, Japan) was used to determine metals. ICP-MS operating conditions were the following: radio frequency (RF) (W),1500; plasma gas flow rate (L min-1),15; auxiliary gas flow rate (L min-1), 1; carrier gas flow rate (L min-1),1.1; spray chamber T (°C),2; sample depth (mm),8,6; sample introduction flow rate (mL min-1),1; nebuliser pump (rps),0.1; extract lens (V),1.5. All digested samples were analyzed three times for each metals. All chemicals and standard solutions used in the study were obtained from Merck and were of analytical grade. The levels of the macro (Na, Mg, P, K, Ca), potential toxic metal, As, and trace element, Zn in samples were detected as μg metal g^{-1} dry weight. High Purity Multi Standard (Charleston, SC 29423) was used for determination of the metal analyses. Standard solutions for calibration curves were prepared by dilutions of the elements. Solution has prepared for the toxic metal had a content of arsenic in the range of 1-50 ppb (0.001 to 0.050 mg/L).

Statistical analysis

Prior to the analyses, all data were checked for outliers and homogeneity of variance was also tested. Statistical analysis of data was carried out with the IBM SPSS STATISTICS 22 statistical program. ANOVA (Analysis of Variance) was used to evaluate the effect of age on the metal levels.

Results

In this study, the relationship between fish size (age) and potential toxic metal (As), macro (Na, Mg, P, K, Ca) and trace element (Zn) levels in muscle tissues of comber (*S. cabrilla*) was determined. Fish were examined in three groups according to their age and size: 0+, 1+ and 2+. The mean lengths were 11.11 cm, 14.49 cm and 16.06 cm, respectively; the average weights were determined as 18.92 g, 39.03 g and 50.72 g, respectively (Table 1).

Table 2. The effects of age on metal levels of muscle tissues of *S. cabrilla* (μg g^{-1} dry weight)

Macro Element	**0-1** $\overline{X} \pm S_{\overline{x}}$	**1-2** $\overline{X} \pm S_{\overline{x}}$	**2-3** $\overline{X} \pm S_{\overline{x}}$
Na	4847.11±184.96^{b}	3723.57±149.99^{a}	3558.61±374.64^{a}
Mg	1401.29±65.79^{a}	1339.76±37.38^{a}	1379.98±185.97^{a}
P	9217.27±397.16^{a}	10096.57±503.25^{a}	10488.79±1048.75^{a}
K	17852.92±813.54^{a}	17865.78±684.55^{a}	19042.19±1972.32^{a}
Ca	1673.76±350.67^{a}	2762.79±511.41^{a}	3011.21±707.21^{a}
Zn	21.05±1.70^{a}	19.93±1.78^{a}	18.79±0.63^{a}
As	25.65±1.39^{a}	28.08±0.65^{ab}	31.36±1.87^{b}

Different letters (a, b, c) in the same rows for each group of age significant differences ($p<0.05$).
$\overline{X} \pm S_{\overline{x}}$: mean±standard error

Discussion

According to our findings, Na, Mg, Zn levels decreased with age and P, As, K and Ca levels increased with age. The levels of the elements in muscle tissue was changed from big to small as K>P>Na>Ca>Mg>As>Zn, respectively. Ca, K, Mg, Na levels (mg / kg) in the muscle tissue of *S. cabrilla* collected in the Canarias islands were reported as 562.17, 2475.96, 282.18, 909.33,

respectively by Trujillo (2017). These findings are lower than the levels of metal obtained in our study. This is thought to be due to the differences in the collecting areas and collecting times of this species. In our study, Na and Mg levels decreased as individuals aged, especially Mg levels decreased significantly. However, P, K and Ca levels increased as individuals aged. This condition is thought to be associated with increased muscle and skeletal development with age of fish. It is also contemplated that increased Ca concentration may be associated with increased metal accumulation (Regoli, 1991).

Celik & Oehlenschläger (2005) determined the highest Zn level (9.73 mg/kg, w/w) in Mediterranean shad (*Alosa fallax nilotica*) from 49 fish species caught from Izmir Bay and Mersin Bay. In *S. cabrilla* species, Zn was found to be 3.39 (mg/kg, w/w). Ates et al. (2015) reported Zn levels in muscle tissue of *S. cabrilla* as 7.76 (μg / g) in Central Aegean and 7.26 (μg / g) in Iskenderun Bay. The declared Zn levels by the researchers are lower than the levels of Zn obtained in our study. Abdallah (2008) reported the maximum Zn level in *S. cabrilla* species caught on the Egyptian coast as 17.1 (mg / kg). Catsiki & Strogyloudi (1999) determined the zinc levels of red mullet and bogue in muscle tissues from the Aegean Sea as 18 and 24 mg / kg (dw). The levels of Zn in our study was found to be 18.79-21.02 μg/g (dw). Findings reported by researchers support our study.

Fe and Zn levels in fish muscle tissue are also influenced by various chemical and physiological processes (Merciai et al., 2014). Zn levels decreased as individuals age increased. This may be due to the metabolic detoxification metabolism or the higher metabolic rate of younger individuals. FAO (1983) and Turkish Food Codex (TFC, 2011) reported the Zn limit values as 30, 50 μg/g respectively. The Zn values determined in our study are below both limit values.

Toxic metal level monitoring is important for the detection of environmental pollution. Kalantzi et al. (2017) found as values for sardine and anchovy in the Greek coastline as 8.6 to 58.8 mg/kg dw. Similar to these findings, the amount of as in our study was found to be 25.65-31.36 μg /g dw. As levels were associated with individual age. As individual size and age increase, heavy metal accumulation in fish body is increasing. This is thought to be due to the slowing of metabolism and hence the inadequacy of the detoxification mechanism. Turkey has set national standards for total arsenic in aquatic fish and other aquatic products of animal origin at 1 mg/kg ww (TFC, 2011). *S. cabrilla* is contaminated with As.

Conclusion

Since *S. cabrilla* is a predator species, identification of fish size and mineral-metal association is important to ensure that food safety policies can be accurately performed. In general, there was a positive correlation between fish size-age and metal levels. This is thought to be caused by slowing down and malfunctioning of metal detoxification metabolism. Regular monitoring of metal levels in *S. cabrilla* species can be considered as an important criterion for ecosystem pollution level. It has been found that *S. cabrilla*, which is determined to have a high macro element level as a result of our work, is very useful for human consumption. In subsequent studies, the investigation of metal levels in muscle as well as liver, gill, and kidneys will contribute to a better understanding of the economic and ecological importance of the *S. cabrilla*.

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