Age determination and morphological study using otoliths in *Cyprinus carpio* Linnaeus, 1758 in the Southern Caspian Sea

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Abstract

The relationships between sagitta otolith morphology and fish size were examined for common carp in the Southern Caspian Sea; and also the aging of different length groups were determined. Statistical tests to examine correlation between left and right otoliths dimensions were carried out and no statistically significant difference between them was found. The biggest otolith had 0.032g weight belongs to an individual with BW= 428g and FL=36cm; and the smallest otolith had 0.014g for a fish with BW=220g and FL= 26cm. Regression model relations to each otolith morphometric parameter to fish length are provided. Also, the aging of this species was done by sectioning of sagitta otolith and a high significant correlations was found between fish age and morphometric parameters of both body weight and fork length and also otolith weight and length. The maximum age was determined 6^{+} years. The length-weight relationship was BW= 0.006 $TL^{3.232}$ (r = 0.963). According to the morphometric relationships obtained, it was concluded that otolith length and weight are good indicators of fish body weight and fork length.

Keywords: Sagitta otolith, *Cyprinus carpio*, age, Caspian Sea

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Introduction

The common carp (*Cyprinus carpio* Linnaeus, 1758; Cyprinidae) is one of the most important and commercial species in the Southern Caspian Sea with a total catch of 1761 tones in year 2010 (Iran Fishery Organization, Statistical Dept., 2011). The total biomass (in number was estimated about 27.2 million individuals (Daryanabard et al., 2009). The main habitats of *C. carpio* in the Caspian Sea basin are mouth of river, lagoons and coastal waters (Karperich, 1975; Kasyanove and Izyumov, 1995); and also is one of the main aquaculture species in Iran that are cultured in the earthen ponds.

Otoliths are composed of calcium carbonate, generally in the form of aragonite arranged in a laminar form in a protein matrix. Otoliths commonly are used to determine the taxon, age and size of fishes. This information is used for fisheries management, prey-predator studies and archeological research (Harvey et al., 2000). The determination of fish age around the world for fishery stock assessment purposes constitutes the most significant application of direct ageing and age structured analysis in any biological application (Campana and Thorrold, 2001).

Regarding to the importance of morphological studies of otoliths, it should be noted that paleontologists, archeologists and oceanographers have recorded otoliths in sediments and have determined species of fishes from otolith (Fitch, 1968, 1969; Casteel, 1976).

Trouth (1954), Templemana and Squires (1956) were among the first to demonstrate a significant positive relationship between otolith size and fish size of Barents Sea cod and haddock. Relationship between fish size and otolith morphometric in some clupeids from the Persian Gulf and Oman Sea were investigated (Valinassab et al., 2012). Since these early studies, relationship between otolith length and fish length have been generalized for fish species including for example North Pacific gadids, rockfishes, fishes off Baja California, and 10 species of clupeids in the Persian Gulf and Oman Sea (Valinassab et al., 2012).

The present study focuses on morphology of saccular otolith (sagitta) of *C. carpio* species, which is the largest and/or most massive of three types of otoliths in most groups of teleosts including Cyprinids. On the other hand, age structure was described according to the prepared cross sections of otolith.

Materials and methods

A total of 160 specimens were collected seasonally from artisanal fishermen at several landing sites. The study area restricted to the Southern Caspian Sea, from longitude 49º 00´E to 54º 00´E (Fig. 1) during the period of 2011-2012.

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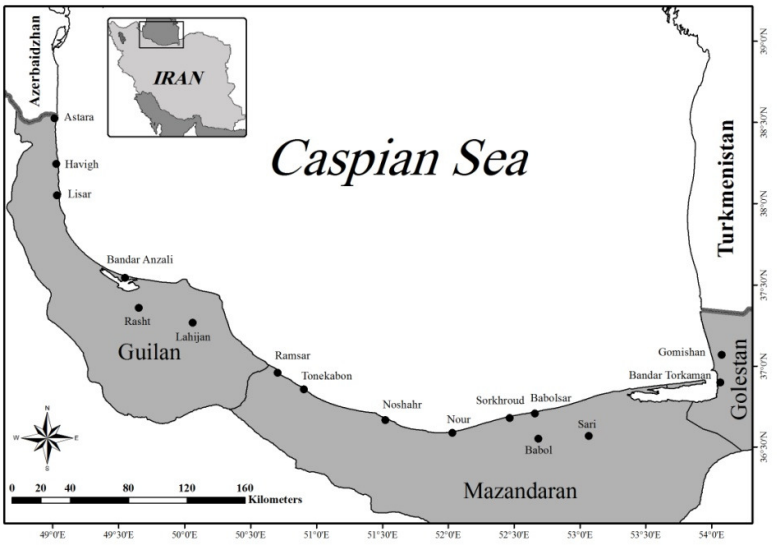


Figure 1: Map of study area in the southern Caspian Sea

Fish samples were caught mostly by beach seine method. Collected common carps were preserved in ice boxes and were transferred to the laboratory for further biological measurements and otolith extraction.

The fork (FL) and total length (TL) of fish were measured by biometry board (to the nearest 0.1 mm) and body weight to the nearest of 0.01 g for all specimens. Length-weight relationship was described using the potential function (Sparre et al., 1992; King, 1995) as:

$$BW = a \times FL^b$$

Where: BW is the body weight (g), FL is the fork length (mm), a is intercept of regression and b is regression coefficient.

An abdominal incision was made to determine sex of specimens. Sagitta otoliths were taken for each specimen, cleaned and stored dry in glass vials for later age determination. Total sagitta otolith weight (OW) was measured using an electronic balance to the nearest 0.00001g. Otolith length (OL) is defined as the longest dimension between the posterior edges of otolith; and otolith width (OH) as the dimension from the dorsal to ventral edge (Fig. 2).

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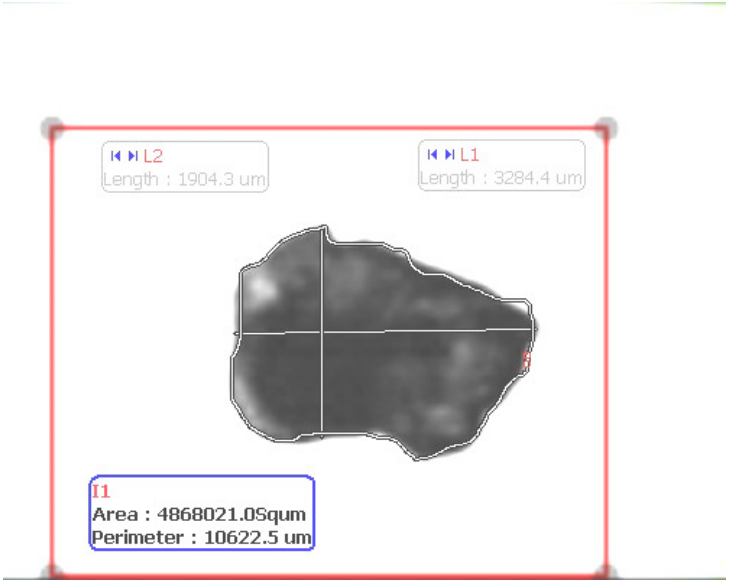


Figure 2: Morphometric measurement of sagitta otolith in *Cyprinus carpio* using MATIC proramme

Then 30 otoliths were selected in different fish sizes and were embedded in clear epoxy resin and sectioned using a Buehler low-speed saw containing a diamond blade which cut a thin section (300 µm) through the nucleus. A grinding wheel fitted with silicon carbide paper with different grit sizes flushed with water was used to remove excess resin to provide a polished face for viewing. The section is then mounted on a glass slide and read under a Nikon compound microscope. The sectioned otoliths were read independently twice with no reference to the previous readings and without any knowledge of the fish specifications.

Morphometric and age relationships were built using regression models which best fit the data distribution such as: BW vs. TL, OW vs. BW, OL vs. TL, age vs. OL.

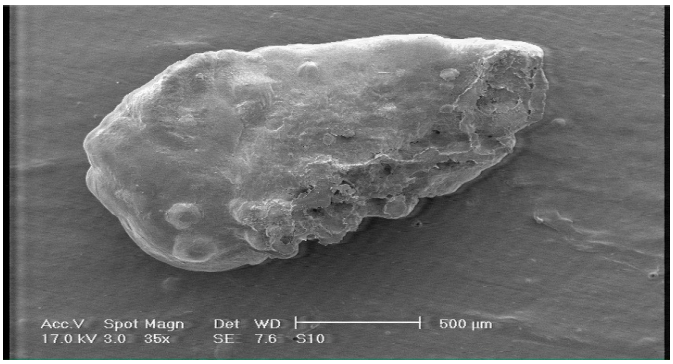


Figure 3: The SEM image of *Cyprinus carpio* sagitta otolith

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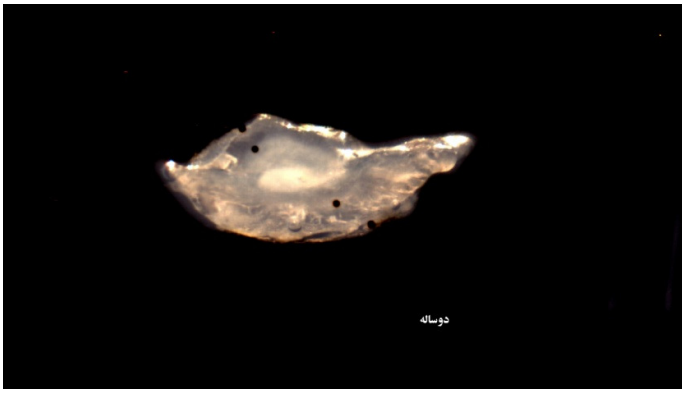


Figure 4: A sample of sectioned *Cyprinus carpio* sagitta otolith

Results

The maximum and minimum otolith length and weight are 6426, 3224 µm; and 0.0073, 0.0021 g, respectively. All parameters measured did not show significant morphometric differences between left and right otoliths (P>0.05). The statistical analysis of otolith morphometric parameters showed that otolith length and otolith weight are good indicators of fish size. The exponential equation from scatter diagram (Fig. 5) can be given as follow:$BW = 0.006\ TL^{3.232}$.

The exponential regression model, were described for some morphometric parameters such as FL vs. OW and BW vs. OW (Figs. 6 and 7). High correlation coefficients (r=0.96) was calculated for the fork length (FL) and body Wight (BW).

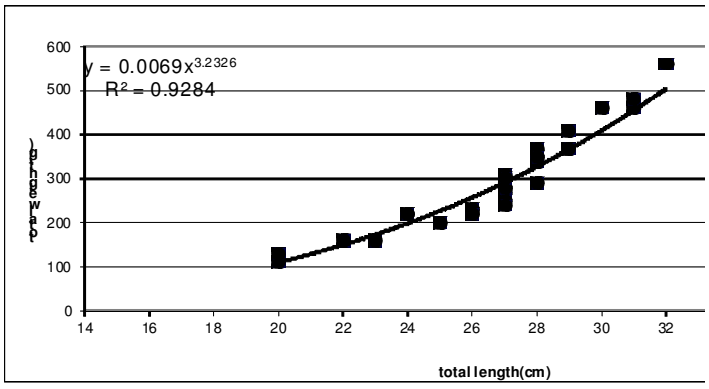


Figure 5: The length-weight relationship in *Cyprinus carpio* in the southern Caspian Sea

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The results revealed that the minimum and maximum age were determined as 1^+ to 6^+ years with the otolith length and weight 3224-6426 µm and 0.0021-0.0073g, respectively. The following linear relationships between them were analyzed:

$$Age = 0.001\ OW + 0.001\ (r = 0.938)$$

$$Age = 613.5\ OL + 2782\ (r = 0.964)$$

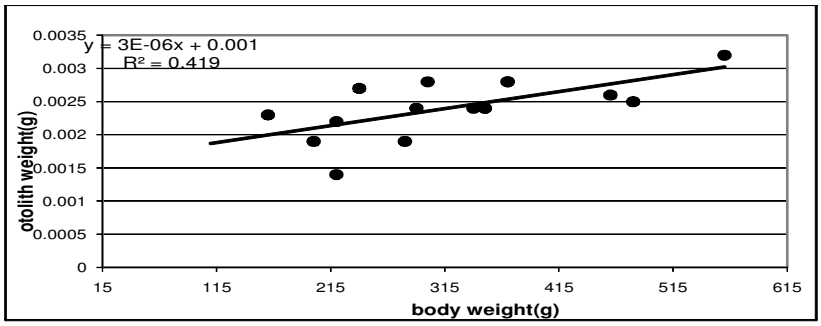


Figure 6: The body weight-otolith weight relationship in *Cyprinus carpio*

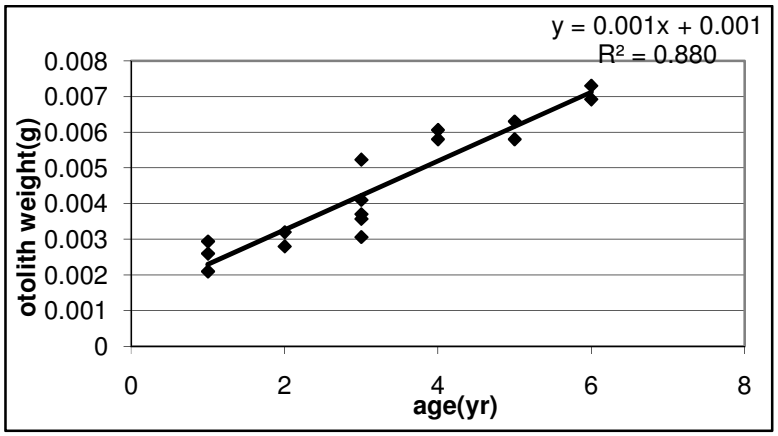


Figure 7: The relationship between age and otolith weight in *Cyprinus carpio*

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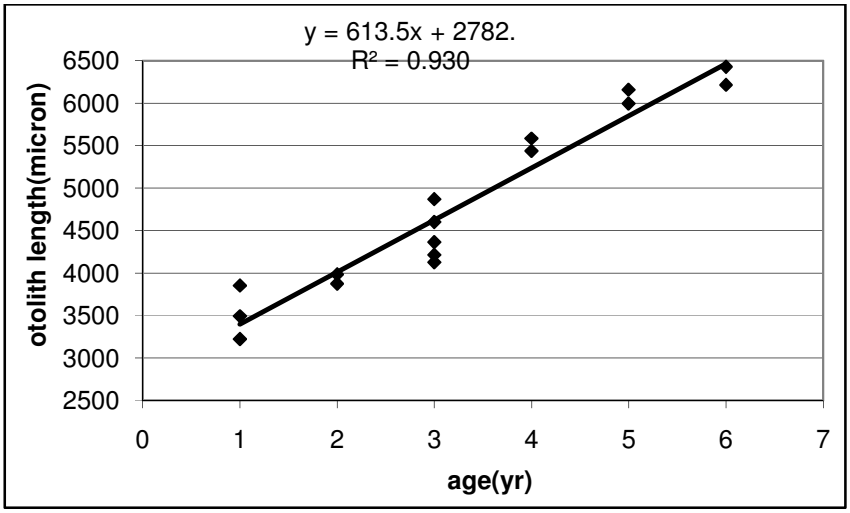


Figure 8: The relationship between age and otolith length in *Cyprinus carpio*

Discussion

This study on exponential of TL vs. BW relationship in *Cyprinus carpio* provides isometric growth as BW=0.006 $TL^{3.232}$ since the regression coefficient b did not differ significantly from the theoretical value 3. This finding is in agreement with the result of Daryanabard et al. (2009) in which the stock assessment of commercial bony fishes including *C. carpio* in the Iranian waters of the Caspian Sea was carried out during 2005 to 2007. The length-weight relationship is an important factor in fish biological and stock assessment studies (Abdurahimian et al., 2004) and having high application in different biological studies such as: growth, gonadal development, feeding rate, maturity and condition factor (Kasyanov and Izyumov, 1995; Kamali and Valinassab, 2003).

No significant morphometric differences between left and right otoliths were described. This finding is in agreement with Homauni et al., 2011; Valinassab et al., 2012 with study of clupeids of the Persian Gulf. Also investigation of sagitta morphometric parameters in eight species of the NW Atlantic Ocean carried out by Hunt (1992) showed no statistically significant difference between left and right otoliths. Similarly, Harvey et al. (2000) revealed that 63 species of the Eastern North Pacific Ocean, the relationship between otolith length and body weight was

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not significantly different between left and right otolith for all with except for one species.

The linear regression between otolith length and weight with fish length and weight were described and it was found that the otolith morphometric parameters were good indicators especially otolith weight. The same results have been reported by Homauni et al., 2011 for clupeids, Mansour-Kiaiee et al. (2011) for carangids and Valinassab et al. (2012) for clupeids of the Persian Gulf and Oman Sea. There is a significant linear relationship between above mentioned parameters and they are in agreement with studies on salmonids, cod and perch fish.

There was significant correlation between otolith length and weight with fish size. The somatic growth rate is governed by the aquatic environment, food quality and quantity, internal patterns and etc. (Wright et al., 1990).

The shape of *C. carpio* otolith is shown in Figures 2 and 3. One of the main important application of the shape and morphology of the otolith of each species is to describe the prey-predator relationship in food chain and therefore the identification of number and size of fish eaten (with emphasize on common carp in this study) can be applied.

In this research, in previous studies the age up to 8 years old has been reported (Daryanabard et al., 2009), meanwhile the based on finding of this research the maximum age was determined as 6 years old. The absence of some older ages can be due to overexploitation within last decade (Daryanabard et al., 2009). Also a significant linear regression was found between age and otolith length and weight (Figs. 7, 8) and it was attested a high correlated relationship between otolith length and weight with fish size.

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تعیین سن و بررسی ریخت سنجی اتولیت کپور معمولی (*Cyprinus carpio*) در حوزه جنوبی دریای خزر

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دریافت: دی ۱۳۹۱ پذیرش:آبان ۱۳۹۲

چکیده

روابط بین ویژگی های ریخت سنجی اتولیت ساجیتا و اندازه ماهی کپور معمولی (*Cyprinus carpio*) در جنوب شرقی دریای خزر مورد بررسی قرار گرفت ، وسن گروه های مختلف تعیین شد. بررسی آماری برای تعیین ضریب هبستگی بین اتولیت های راست وچپ انجام شد واز لحاظ آماری اختلاف قابل توجهی بین آنها یافت نشد . بزرگترین اتولیت دارای وزن۰/۰۳۲گرم با وزن بدن ۴۲۸ گرم و طول فورک ۳۶ سانتیمتر، و کوچکترین اتولیت ۰/۰۱۴گرم با وزن بدن ۲۲۰ گرم وطول چنگالی ۲۶ سانیمتر می باشد .روابط مدل رگرسیون پارامتر های ریخت سنجی اتولیت ها با اندازه ماهی تعیین شد . طبق نتایج بدست آمده ، وزن وطول اتولیت ، شاخص مناسبی برای تعیین وزن بدن وطول چنگالی ماهی است .تعیین سن این گونه توسط برش اتولیت ساجیتا انجام گرفت ، و حداکثر سن ماهی کپور معمولی ۶+سال تعیین گردید .ضریب همبستگی بالائی بین سن ماهی با طول و وزن اتولیت ، و همچنین بین سن با طول و وزن بدن ماهی بدست آمد . رابطه بین طول ووزن بدن کپور معمولی $BW=0.006TL^{3.232}$ ($r=0.963$) محاسبه شد.

لغات کلیدی : اتولیت ساجیتا، سن، *Cyprinus carpio*، دریای خزر

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