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Back-calculate length-at-age estimates of *Capoeta capoeta gracilis* in dough stream, South Eastern Caspian Sea, Iran

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ABSTRACT:

This study was carried out between April and May 2010 and 2011 in Dough Stream, southern basin Caspian Sea. A total 130 individuals of *C. c. gracilis* were sampled to study back-calculation estimations. Fish ages were determined from operculum. The lengths of fish at previous ages (Back-calculated lengths) were estimated from operculum using back-calculation method. Back-calculations were based upon a linear regression model developed by Fraser and Lee. The calculated total length values for male and female ranged from 6.372-16.208 and 6.935-16.518 cm respectively. Calculated lengths were found smaller than the observed lengths.

Keywords:
Capoeta, operculum, back-calculation, Caspian Sea.

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INTRODUCTION

Growth is an important aspect of the ecology and life history of fish, and quantification of growth is frequently a crucial part of fisheries research and management (Summerfelt and Hall 1987; Weatherley and Gill 1987).

Back-calculation models are valuable because they provide growth data for fish populations from a single sampling event and have been used for over 80 years in fisheries management and research. In the field, fish length is measured and calcified structures (scales, otoliths, etc.) are collected for growth analyses. The relationship between size of calcified structures and the body of fish has been used widely in fisheries science to estimate body size at a younger age by back-calculation (Casselman, 1990). Further more back-calculations can be used to trace the effects of winter oxygen levels (Casselman and Harvey, 1975), fishing pressures (Nicholls, 1958), and food consumption (Weatherly 1959) on growth rate.

Capoeta capoeta gracilis, one of the subspecies of the genus *Capoeta* is a very common and ubiquitous species that occur in the rivers and streams of the South Caspian Sea basin (north of Iran) (Kiabi *et al*, 1999 and Abdoli, 2000) and inhabiting both lotic and lentic habitats (Samaee *et al*, 2006). This species is important for inland water fishing, aquaculture (Abdoli, 2000), sport fishing (Kiabi *et al*, 1999) and zoogeographical studies (Armantrout, 1980).

Even though, there are some reports on growth models of *C. c. gracilis* (Abdoli *et al*. 2008, Patimar *et al*. 2009), little is known on Back-Calculate Length-at-Age of this species. So, the aim of this study was to determine variation of total length at the previous age's of *C. c. gracilis.*

MATERIALS AND METHOD

The materials were collected by electro-shocking during the spawning April-May 2010 and 2011 in Dough Stream, south-eastern basin Caspian Sea. A total of 130 specimen's *C. c. gracilis* were measured. Operculums for age and growth analysis were collected from each fish and were examined by three readers who were uniformed of specimen age or length. Total length-operculum length relationships were estimated from the Fraser-Lee formula because of its popularity

$$Li = c + (L_c (. - c)* (S_i/Sc),$$

L_i = back-calculated fish body length at age i, L_c = fish body length at capture, S_i = mean scale length at annulus i, Sc = mean scale total length, c = intercept from the regression of body length on mean scale length.

RESULT

In this study, fish ages obtained from operculum ranged between 1 and 6 years. The result shown that total length-operculum length relationships were positive linear. Calculated length was gradually closed to measured length with increasing fish age (**Fig. 1**).

The mean estimated total length for males and females were given in **Table1.** The calculated total length values for male and female ranged 6.776-16.208 and 6.654-16.518 cm respectively.
In all age groups, calculated lengths were found smaller than measured lengths.

There were significant different in L_1 and L_2 in male and female ($p<0.05$) but there weren't significant different in L_3-L_6 in male and female ($P<0.05$).

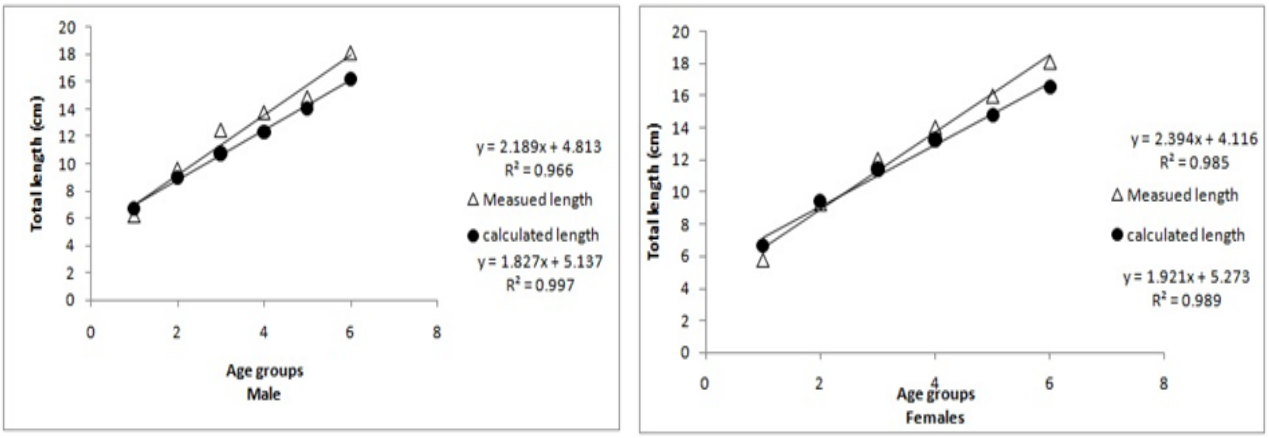

Fig. 1: The relationship between measured and calculated total lengths of *C.c. gracilis.* (a): males and (b) Females in Dough stream, south-eastern Caspian sea, Iran

Table 1. Back calculation of total length *of Capoeta capoeta gracilis*

Males

Age groups							
1	6.175±0.964	4.373±0.962					
2	9.590±0.504	5.771±1.096	7.414±1.198				
3	12.436±0.866	6.847±1.186		10.888±1.083			
4	13.733±0.399	6.825±1.065	8.507±1.119	10.394±0.998	12.145±1.004		
5	14.825±0.457	6.812±1.133	8.567±0.744	10.517±0.284	12.253±0.284	13.319±0.288	
6	18.1± 2.687	7.605±2.525	9.369±1.817	11.387±2.535	13.215±2.451	14.790±2.010	16.208±2.147
Average	12.4765	6.372	8.544	10.796	12.538	14.054	16.208
Anova		*	*	NS	NS	NS	

Females

Age groups							
1	5.729±0.345	4.197±0.458					
2	9.238±1.795	6.279±1.517	8.033±1.497				
3	12 ± 1.729	7.227±1.546	9.102±1.964	10.651±1.898			
4	14 ± 2.257	7.911±1.526	10.280±1.420	11.769±1.568	13.310±1.885		
5	15.943±1.628	7.654±0.988	9.477±1.112	11.463±1.399	13.052±1.441	14.511±1.514	
6	18.064±2.517	8.449±1.468	10.071±1.481	11.776±1.900	13.416±1.834	15.005±1.752	16.518±1.813
average	12.496	6.953	9.393	11.415	13.26	14.758	16.518
Anova		*	*	NS	NS	NS	

Significance levels among lengths calculated from different age groups (*p<0.05, NS: not significant)

DISCUSSION

Back-calculations were based upon a linear regression model developed by Fraser (1916) and Lee (1920), which assumes that fish length is directly proportional to scale radius (Dahl, 1909). It is importance and widespread use of back-calculation in studies of fish growth our comparisons of back-calculated body lengths with observed body lengths shown back-calculation estimate growth history accurately. Back - calculation of fish lengths at previous ages from scales or otoliths is a widely used approach to estimate individual and population growth history (Duncan, 1980 and Bartlett *et al.*, 1984).

In this study fish ages were ranged between 1 and 6. The result shown that calculated lengths are always smaller than measured lengths. A similar interpretation was given by Aydin and Calta (2002). Calculated length was gradually closed to measured length with increasing fish age. With increase in the size of the fish, the difference between the actual and back-calculated lengths decreases. The differences between calculated length and measured length increased when earlier annuli of operculum of older fish were used for back-calculation.

In conclusion, back-calculation method is important to estimate individual and population growth history and the length of age groups which were not captured normally and fisheries management.

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