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Back-Calculation of Fork Lengths of *Capoeta capoeta umbla* (Pisces: Cyprinidae) from Otolith Lengths

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Abstract: In this study, the ages of *Capoeta capoeta umbla* inhabiting in Hazar Lake (Turkey) were determined from otolith. The lengths of fish at previous ages were estimated from otolith length by using back-calculation method. The calculated fork length values for male, female and all fish samples ranged 67.26-329.27, 71.05-341.03 and 69.36-336.33 respectively. In all age groups, calculated lengths were always found smaller than measured lengths. The relationship in calculated lengths was significantly different between some age groups, but did not differ between females and males. It was found that the gap between calculated length and measured length was gradually close to each other with increasing fish age.

Key words: *Capoeta capoeta umbla*, back-calculation, otolith, length, Hazar lake, Turkey

Introduction

Although the general information and methods about age determination and growth estimation in fish have been given by some researchers (Lagler, 1956; Chugunova, 1963; Tesch, 1968; Summerfelt and Hall, 1987; Çelikkale, 1991; Erkoyuncu, 1995; Geldiay and Balık, 1996; Avsar, 1998), it is not always possible to catch smaller age groups of fish at growth estimation studies. So, back-calculation of fish lengths at previous ages from scales or otoliths is a widely used approach to estimate individual and population growth history (Starostka and Nelson, 1974; Miller and Nelson, 1974; Nelson, 1974; Tanyolac, 1979; Duncan, 1980; Bartlett *et al.*, 1984). 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). Recently Francis (1990) reviewed the literature concerning back-calculation of fish lengths based on annual marks on scales, otoliths etc.

Capoeta capoeta umbla inhabiting in Hazar Lake (Turkey) has an economic importance in eastern region of Turkey, so this species has been studied with many different aspects such as the meat yield (Özdemir, 1982a), some biological characteristics (Özdemir, 1982b; Ekingen and Polat, 1987), digestive system contents (Şen and Özdemir, 1986), seasonal distribution of fatty acid in muscles (Yılmaz *et al.*, 1996a), the seasonal changes of total lipid and fatty acid levels (Yılmaz *et al.*, 1996b), growth characteristics (Girgin *et al.*, 1997) and heavy metal levels in tissues and organs (Şeker *et al.*, 1998; Canpolat and Çalta, 2001; Canpolat, 2001). However, there is no any study on back-calculation of lengths at previous ages to estimate growth history of this species. Therefore, this study was carried out to determine fork lengths at the previous ages of *C. c. umbla*.

Materials and Methods

Fish samples were collected from Hazar Lake, located 25km south-east of Elazığ City (Turkey) is a tectonic lake with 84 km-squares surface area and its altitude from sea level is 1248 meters (Tiktik, 1995), between November 1996 and October 1998 by using trimmer nets with 18, 24, 32, 36 and 54 mm in mesh size. After fork lengths of fish were measured, their otoliths were removed and cleaned (Lagler, 1956) and then otoliths were examined under binocular microscope for determination of ages and otolith lengths of fish. By means of otolith and fish lengths measured, the estimated fork lengths at previous ages of fish were determined by using back-calculation equation (Chugunova, 1963) given below;

$$L_n = (S_n/S) * L$$

where, L_n : Fish length when annulus "n" was formed

L: Fish length at capture

S_n : Radius length of annulus "n"

S: Otolith length at capture

The results were statistically examined by Chi-square, ANOVA and ANCOVA tests (Fowler and Cohen, 1992) by means of Minitab programme (Microsoft Cooperation Ltd.).

Results

The mean estimated fork lengths for male, female and all fish samples (Table 1) were calculated according to age groups by using back-calculation method. The mean calculated fork length values for male, female and all fish samples ranged 67.26-329.27, 71.05-341.03 and 69.36-336.33 respectively.

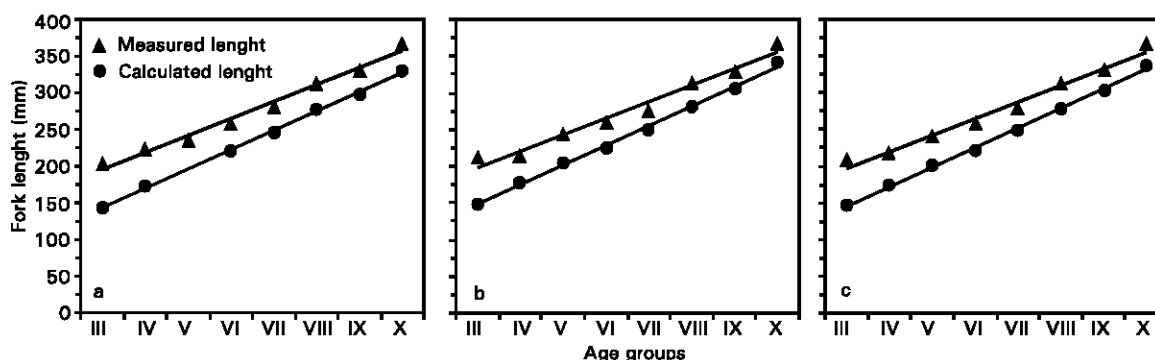


Fig. 1: The relationship between measured and calculated fork lengths of *C.c. umbla*. (a): males, (b) Females, (c) all fish samples

Sen *et al.*: Back calculation of fork length of *C. capoeta umbra*

Table 1: The mean calculated fork lengths determined by back-calculation method according to age groups for males (a), females (b) and all fish samples © of *C. c. umbra*.

Age groups	Fish number	Calculated lengths (mm) for males according to age groups									
		L ₁	L ₂	L ₃	L ₄	L ₅	L ₆	L ₇	L ₈	L ₉	L ₁₀
a											
III	8	77.53	121.35	166.71							
IV	25	77.30	119.51	154.95	190.17						
V	25	65.51	107.43	141.44	171.75	202.84					
VI	21	65.88	105.96	137.31	162.61	198.82	222.89				
VII	16	64.31	100.77	134.31	162.59	191.00	216.33	247.67			
VIII	8	52.28	94.17	131.75	161.07	187.11	218.89	246.59	278.69		
IX	3	45.79	82.67	115.36	153.72	181.31	208.91	233.26	268.84	297.35	
X	2	51.83	103.66	150.36	173.72	199.63	225.60	248.90	277.49	300.78	329.27
Mean values		67.26	108.25	143.30	171.62	196.56	219.42	245.97	276.23	298.72	329.27
ANOVA*		***	***	***	**	**	**	NS	NS	NS	
b											
III	17	90.05	131.42	170.21							
IV	34	77.81	116.37	149.83	182.46						
V	46	65.36	107.75	144.61	179.05	208.98					
VI	17	64.88	104.39	141.46	171.47	203.39	233.94				
VII	7	61.63	103.16	134.91	162.56	188.93	217.71	249.78			
VIII	7	60.71	101.34	138.45	165.91	193.34	217.87	254.22	283.04		
IX	3	51.85	103.45	135.05	161.70	186.62	216.84	246.41	273.83	303.43	
X	3	73.94	120.08	148.31	172.67	195.32	219.69	247.39	279.84	309.63	341.03
Mean values		71.05	112.12	147.83	176.56	203.53	225.29	250.47	280.18	306.54	341.03
ANOVA*		***	***	***	*	NS	NS	NS	NS	NS	
c											
III	25	86.05	128.20	169.09							
IV	59	77.62	117.69	152.00	185.73						
V	71	65.42	107.64	143.49	176.48	206.82					
VI	38	65.43	105.26	139.18	166.58	200.86	227.83				
VII	23	63.49	101.51	134.49	162.59	190.37	216.75	248.31			
VIII	15	56.22	97.52	134.88	163.33	190.02	218.41	250.15	280.72		
IX	6	48.82	93.06	125.21	157.71	183.97	212.87	239.83	271.33	300.39	
X	5	65.09	113.51	149.13	173.09	197.04	222.05	248.00	278.09	306.09	336.32
Mean values		69.36	110.62	145.81	174.28	200.22	221.92	247.81	278.21	303.00	336.32
ANOVA*		**	**	**	**	NS	NS	NS	NS	NS	

*Significance levels amongst lengths calculated from different age groups.

Analyses of Variance (ANOVA): NS (not significant) P> 0.05; *P< 0.05; **P< 0.01; ***P< 0.001

Significance levels amongst lengths calculated from different age groups were statistically found significant for L₁-L₅ in males, for L₁-L₄ in females and in all fish samples but non significant for L₇-L₉ in males, L₅-L₉ in females and in all fish samples (Table 1).

In all age groups, the calculated fork lengths were statistically found non significant (Chi-Square Test: P> 0.05) between females and males. The changes of radius lengths depending on age and sex were statistically tested and found significant (ANCOVA; P< 0.05).

In all age groups, the calculated fork lengths were always found smaller than measured fork lengths (Fig. 1). However calculated length was gradually closed to measured length with increasing fish age (Fig. 1).

Discussion

In this study, fish ages obtained from otolith ranged between 3 and 10. The mean fork lengths of *C. c. umbra* found by back-calculation method in this study were smaller than the mean fork lengths measured by some other researchers (Özdemir, 1982a) for same species and ages. This shows that calculated lengths are always smaller than measured lengths.

It was found that lengths back calculated from earlier annuli of older fish were quite different from observed lengths for each age and lengths back-calculated from recent annuli (Escot and Granado-Lorencio, 1999).

The differences between calculated length and measured length increased when earlier annuli of otoliths of older fish were used for back-calculation. Erkoyuncu (1995) found similar relationship between calculated and measured lengths. As similar to our findings, it was determined that the relationship was significantly different between populations, but did not differ between females and males (Escot and Granado-Lorencio, 1999).

In conclusion, back-calculation method is very useful to estimate individual and population growth history and the length of age groups which were not captured normally. Although only a small

quantity of fish could be captured for an age group, it is possible to have many length values for this age group.

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