Variations of Some Growth Characteristics and Length-Length Relationships of Sakarya Bleak (*Alburnus esherichii* Steindachner, 1897) in Different Habitats

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A B S T R A C T

In this study, some growth characteristics and relationships of Sakarya bleak inhabiting different water habitats (dam, pond and creek) in the Bilecik Province of Türkiye were examined. Sample weights ranged from 0.17 to 111.25 g. Total lengths were measured between 2.70 and 19.80 cm. According to the localities, the *b* values varied between 2.9469±0.07 and 3.2548±0.03. R^2 values were computed between 0.850 and 0.996. The relative condition factor values were similar to each other, while the Fulton's condition factor values ranged from 0.79±0.01 to 1.29±0.03. The length-weight (*LWR*) and length-length relationships (*LLRs*) of samples were examined. According to localities, growth type of the length - weight relationships were either isometric or positive allometric.

Keywords: Fulton's condition factor, isometric, growth, positive allometric, Sakarya bleak

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İnci Balığı (*Alburnus escherichii* Steindachner, 1897)'nın Farklı Habitatlarda Bazı Büyüme Özellikleri ve Boy-Boy İlişkilerinin Değişimi

Öz: Bu çalışmada Bilecik ilindeki farklı su kaynaklarında (baraj, gölet ve dere) dağılım gösteren inci balığı (*Alburnus escherichii* Steindachner, 1897)'nın büyüme özellikleri ve ilişkileri çalışılmıştır. Örneklerin ağırlıkları 0,17 ile 111,25 g, arasında değişmiştir. Toplam boyları 2,70 - 19,80 cm arasında ölçülmüştür. Lokalitelere göre *b* değerleri 2.9469±0.07 - 3,2548±0,03. arasında değişmiştir. R^2 değerleri 0,850 - 0,996 arasında hesaplanmıştır. Oransal kondisyon faktörü değerleri birbirine benzer bulunurken Fulton kondisyon faktörü değerleri 0,79±0,01 - 1,29±0,03 arasındadır. Örneklerin boy-ağırlık (*W=aL^b*) ve boy-boy (*TL=a+SLb*) ilişkileri çalışılmıştır. Lokalitelere göre balıklar izometrik ve pozitif allometrik büyüme özelliği göstermiştir.

Anahtar kelimeler: Fulton kondisyon faktörü, izometrik, büyüme, pozitif allometrik, İnci balığı

Introduction

The most inhabited area for *Alburnus* species is Türkiye with 20 species among total of 41 species (Özuluğ and Freyhof 2007). Sakarya bleak (*Alburnus escherichii* Steindachner, 1897) inhabits in the Büyükmenderes river (Yılmaz et al. 2003), Sakarya and Kızılırmak rivers, Filyos, Bayındır-Yalımkaya, Karafasıl creeks (İlhan and Balık 2008), Çamlıdere, Kirmir creeks and Mogan lake (Innal et al. 2007), Gelingüllü dam (Kırankaya and Ekmekçi 2007), and Kunduzlar dam (Özbek and Öztürk 2010). Sakarya bleak is a small bodied Cyprinid with silver color (Bogutskaya 1997; Geldiay and Balık 2007) (Figure 1).

The fish growth can show variations depending to the waters in which they live. Those can be found by various methods. For this purpose, length-weight (*LWR*) and length-length relationships (*LLRs*), and condition factor of fish are utilized to elucidate the differences in growth (Yılmaz et al. 2010).

The length weight relationship is very important to determine the sustainable utilization and management of fish populations (Pervin and Mortuz 2008). The length-weight relationship is used to determine fish condition and somatic growth form (i.e. isometric or allometric) (Le Cren 1951; Ricker 1975). The fish weight and biomass can be determined using the length-weight relationship in the presence of length data only (Le Cren 1951; Koutrakis and Tsikliras 2003). The length-length relationship is especially important

when compared the studies made with using different lengths values (Moutopoulos and Stergiou 2002).

The *LWR* and *LLRs* and condition factors of freshwater fish associated with a number of studies have been carried out previously (Alp and Kara 2004; Bostancı et al. 2007; Yılmaz et al. 2007; Kırankaya and Ekmekçi 2007; Bostancı et al. 2009; Tarkan et al. 2009). Nevertheless, there are no adequate studies on growth features of Sakarya bleak. Innal (2010) studied on population structure and some growth characteristics of the species. So, in this study, the determination of length-weight, length-length and condition factors values of Sakarya bleak were aimed. Also, it was aimed comparing the growth and length relationships with obtained data from different water sources.

Materials and Methods

The Bilecik Province selected as the study area is located in the Marmara region of Türkiye. The samples of Sakarya Bleak which reported its presence in Türkiye (Kuru 2004; Fricke et al. 2007; Geldiay and Balık 2007) were found in Dodurga and Kızıldamlar dams, Borçak, Ertuğrulgazi, Kurtköy, Küçükelmalı, Pelitözü and Zemzemiye ponds, Göksu, Karasu and Dipsiz creeks in the Bilecik province (Figure 2).

The study was carried out as single sampling in all sampling sites in May-August 2010. The samples obtained with various mesh sizes of gill nets (16x16, 20x20, 25x25, 30x30, 40x40 and 50x50 mm) and beach seine were transported in formalin solution (4% *v/v*) to Eğirdir Fisheries Research Station laboratory, then the weights and lengths of them were measured. Total, standard and fork lengths (*TL*, *SL*, *FL*) (cm) were measured by using measuring board (nearest to 1 mm) and body weight (g) was taken on a digital balance with 0.01 g accuracy. The *LWRs*, *LLRs*, Fulton's condition factor (*K*) and relative condition factor (*Kn*) were determined for obtained samples in Dodurga and Kızıldamlar dams, Ertuğrulgazi, Kurtköy, Küçükelmalı, Pelitözü ponds and Karasu creek.

The *LWRs* were examined;

$$W=aL^b$$

formula (*W*= weight (g); *L*: total length (cm); *a*= constant; *b*= constant) (Bagenal and Tesch 1978).

LLRs were examined;

$$TL=a+FLb, \quad FL=a+SLb, \quad SL=a+TLb$$

formulas, where *a*, *b* are constants values obtained by linear regression (Yılmaz et al. 2010).

To compare the obtained samples from different localities condition factors (Fulton's condition factor);

$$K=100 \; W/L^3 \; \text{(Simon and Mazlan 2008)}$$

and relative condition factor;

$$Kn=W/W' \; \text{(Le Cren 1951)}.$$

W=weight (g); *L*=total length (cm), *W'*=calculated weight from *LWRs* were used. The *t* test (*tt*) was used for determination of growth type. Differences between condition factor, and relative condition factor in the all localities were tested by analysis of variance (ANOVA).

Figure 1. Sakarya bleak (*Alburnus escherichii* Steindachner, 1897) Küçükelmalı Pond-Bilecik (the original photo taken by Dr. Vedat Yegen).
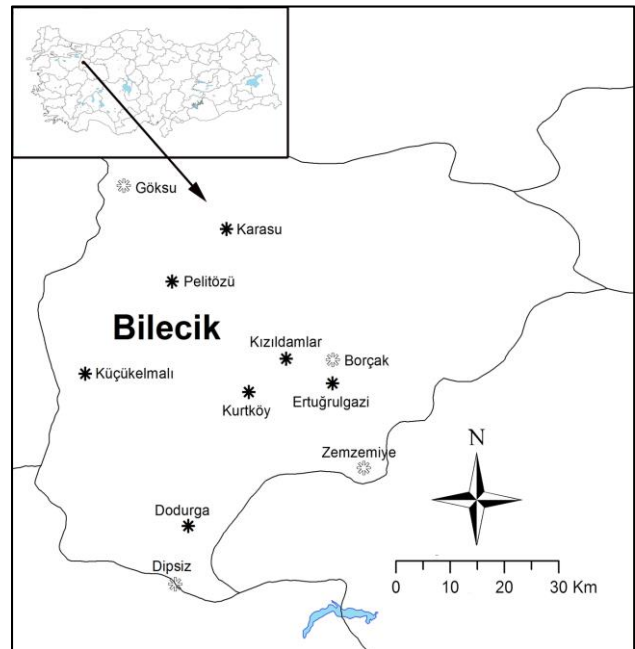

Figure 2. Study areas (Dodurga and Kızıldamlar dams, Borçak, Ertuğrulgazi, Kurtköy, Küçükelmalı, Pelitözü and Zemzemiye ponds, Göksu, Karasu and Dipsiz creeks).

Results

Weight and length values obtained in the study are presented in Table 1. The weight values in the all localities changed between 0.17 g to 111.25 g. The length values (total, fork, and standard) were measured as from 2.70 to 19.80 cm, from 2.50 to 18.30 cm and from 2.30 to 17.00 cm, respectively.

The parameters of *LWRs* and their graphics are given in Table 2 and Figure 3, respectively. The determined equations for length-length relationships are given in Table 3. The equations provide a comparison with other studies performed by different lengths. The Fulton's and relative condition factors are given in Table 4.

Table 1. The minimum, maximum and mean weight and length values of Sakarya bleak.

Locality	n	*W* (g) Mean±*SE* (*Min-Max*)	*TL* (cm) Mean±*SE* (*Min-Max*)	*FL* (cm) Mean±*SE* (*Min-Max*)	*SL* (cm) Mean±*SE* (*Min-Max*)
Dodurga	18	73.52±4.26 (44.51 – 111.25)	17.74±0.30 (15.20 – 19.80)	16.34±0.28 (14.00 – 18.30)	15.06±0.28 (12.70 – 17.00)
Ertuğrulgazi	50	4.56±0.36 (0.20 – 9.89)	7.63±0.30 (3.00 – 10.40)	6.91±0.27 (2.80 – 9.60)	6.27±0.25 (2.50 – 8.70)
Karasu	18	16.18±2.06 (7.43 – 41.85)	11.52±0.41 (9.40 – 16.00)	10.43±0.39 (8.70 – 14.70)	9.37±0.35 (7.50 – 13.30)
Kızıldamlar	50	10.89±1.63 (0.17 – 44.25)	9.15±0.55 (2.80 – 15.90)	8.29±0.50 (2.50 – 14.60)	7.56±0.46 (2.30 – 13.20)
Kurtköy	52	23.52±2.42 (0.18 -55.59)	11.57±0.72 (3.00 – 16.60)	10.42±0.65 (2.70 – 14.90)	9.40±0.59 (2.50 – 13.80)
Küçükelmalı	25	14.62±3.73 (0.35 – 50.90)	9.05±0.91 (3.50 – 16.40)	8.29±0.85 (3.20 – 15.20)	7.58±0.78 (3.00 – 13.90)
Pelitözü	50	2.59±0.20 (0.17 – 6.61)	6.64±0.19 (2.70 – 9.30)	5.94±0.17 (2.50 – 8.30)	5.31±0.15 (2.39 – 7.50)

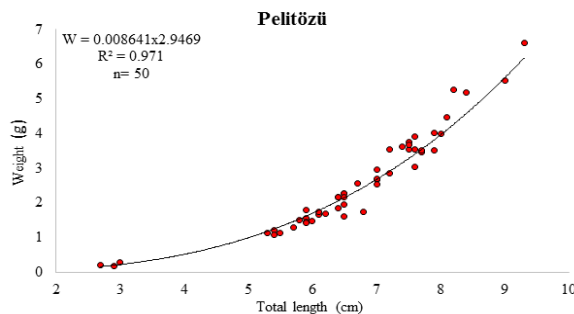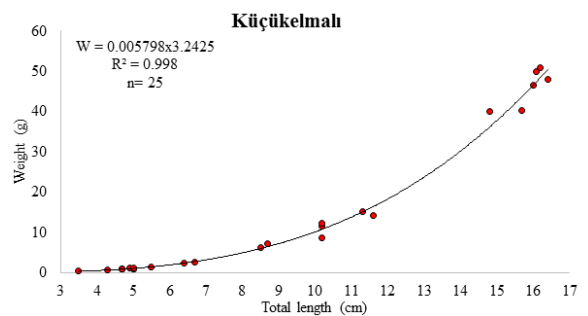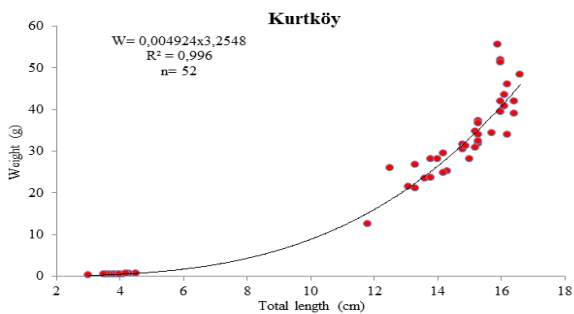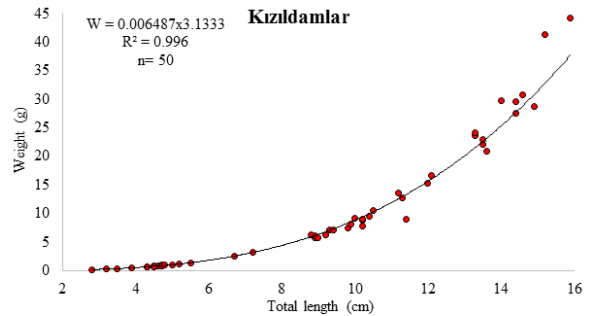**Table 2.** The length-weight relationships parameters of Sakarya bleak.

Locality	n	a	b±SE	R^2	t_{t*}	Growth type[**]
Dodurga	18	0.0075	3.1879±0.33	0.850	0.56[a]	*i*
Ertuğrulgazi	50	0.0069	3.1011±0.03	0.995	3,26[b]	*a+*
Karasu	18	0.0080	3.0893±0.17	0.956	0.52[c]	*i*
Kızıldamlar	50	0.0065	3.1333±0.03	0.996	4.53[d]	*a+*
Kurtköy	52	0.0049	3.2548±0.03	0.996	8.77[e]	*a+*
Küçükelmalı	25	0.0058	3.2425±0.03	0.998	7.26[f]	*a+*
Pelitözü	50	0.0086	2.9469±0.07	0.971	-0.73[g]	*i*

[*]*tt*= t test value, *tT*0.05= table value, a, (*tt<tT*0.05, 17=1.73); b, (*tt>tT*0.05, 49=1.68); c, (*tt<tT*0.05, 17=1.73); d, (*tt>tT*0.05, 49=1.68); e, (*tt>tT*0.05, 51=1.68); f, (*tt>tT*0.05, 24=1.71); g, (*tt>tT*0.05, 49=1.68).
[**] *i*= isometric growth; *a+* =positive allometric.

Table 3. The length-length relationships of Sakarya bleak.

Locality	n	TL-FL	R^2	FL-SL	R^2	SL-TL	R^2
Dodurga	18	0.402+1.061*FL*	0.976	1.169+1.007*SL*	0.987	-0.636+0.884*TL*	0.962
Ertuğrulgazi	50	0.048+1.096*FL*	0.998	1.102+1.087*SL*	0.997	-0.103+0.835*TL*	0.996
Karasu	18	0.424+1.064*FL*	0.992	0.295+1.082*SL*	0.987	-0.495+0.856*TL*	0.992
Kızıldamlar	50	0.098+1.091*FL*	0.998	0.055+1.090*SL*	0.999	-0.105+0.838*TL*	0.997
Kurtköy	52	-0.009+1.111*FL*	0.999	0.028+1.105*SL*	0.998	-0.009+0.813*TL*	0.998
Küçükelmalı	25	0.120+1.077*FL*	0.999	0.035+1.090*SL*	0.999	-0.125+0.851*TL*	0.999
Pelitözü	50	0.065+1.107*FL*	0.983	0.126+1.096*SL*	0.991	-0.030+0.803*TL*	0.976
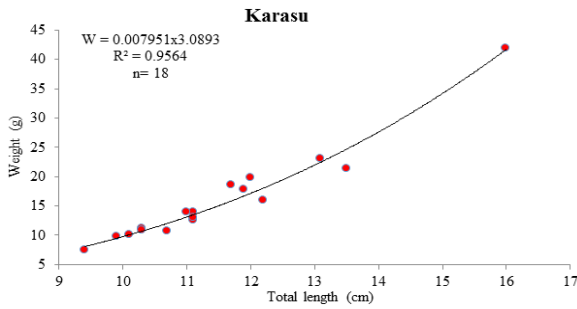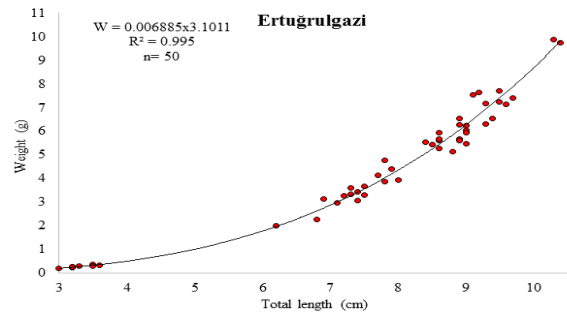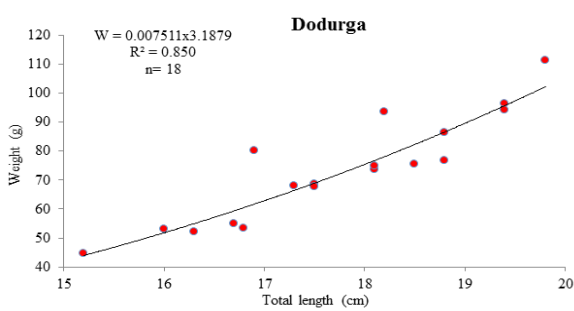
Figure 3. The length-weight relationships of Sakarya bleak.

The Fulton's condition factors were determined as minimum in the Pelitözü pond as 0.79±0.01, in the Ertuğrulgazi pond as 0.87±0.01, and in the Kızıldamlar dam as 0.87±0.01, and as maximum in the Dodurga dam as 1.29±0.03 (Table 4). The relative condition factors were determined same as to each other. According to the localities, the *b* values were similar except for Pelitözü pond (Figure 4). It was not found any statistical difference among *Kn* values in all sampling sites ($p<0.05$) (Table 4, Figure 5).

Table 4. The Fulton's and relative condition factors of Sakarya bleak.

Localities	*n*	*K±SE*	(*Min-Max*)	*Kn±SE*	(*Min-Max*)
Dodurga	18	1.29±0.03[d]	(1.12-1.66)	1.00±0.02[a]	(0.88-1.30)
Ertuğrulgazi	50	0.84±0.01[ab]	(0.68-1.00)	1.01±0.01[a]	(0.86-1.18)
Karasu	18	0.99±0.02[c]	(0.87-1.16)	1.01±0.02[a]	(0.87-1.17)
Kızıldamlar	50	0.87±0.01[ab]	(0.60-1.17)	1.00±0.01[a]	0.67-1.26)
Kurtköy	52	0.90±0.03[bc]	(0.56-1.38)	1.01±0.02[a]	(0.80-1.42)
Küçükelmalı	25	0.97±0.03[c]	(0.79-1.23)	1.00±0.02[a]	(0.79-1.13)
Pelitözü	50	0.79±0.01[a]	(0.55-1.07)	1.01±0.02[a]	(0.71-1.32)

* Values in the same column with same lowercase are statistically equal ($p>0.05$).
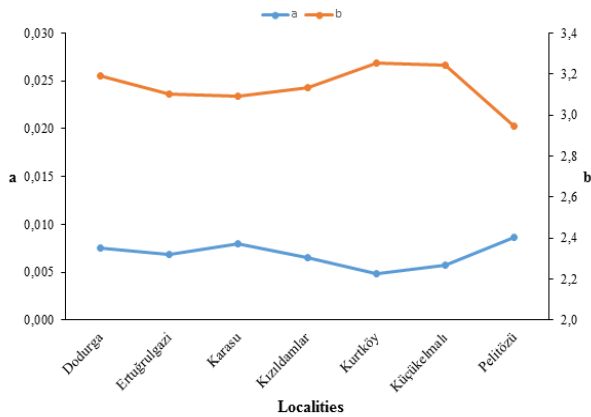

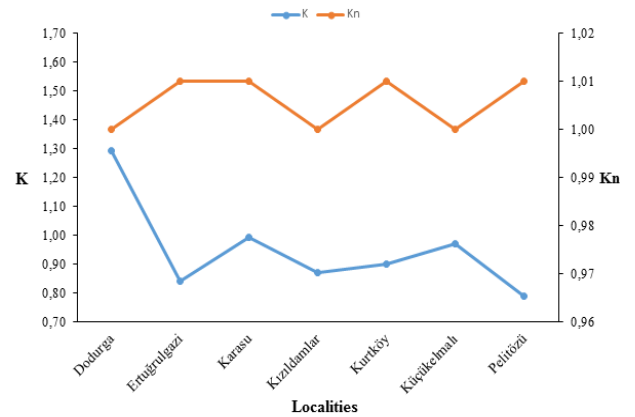**Figure 4.** Changing the *a*, and *b* values according to the localities.

Figure 5. Changing the *K*, and *Kn* values according to the localities.

Discussion

The analysis of length-weight values lead to two different objects, first of which is the relationship between length and weight values may be converted to each one to other, and second one is to determine expected weight for length and indications of general specialization of growth of fish like as fatness or general well-being, etc. (Le Cren 1951). As anticipated, *b* constants were changed from 2.5 to 3.5 (Soomro et al. 2007). According to the *t* test results, the samples of Dodurga dam, Pelitözü pond and Karasu creek showed isometric growth characteristics. Also, obtained samples in Kızıldamlar dam, Ertuğrulgazi, Kurtköy, and Küçükelmalı ponds indicated positive allometric growth characteristics. Bagenal and Tesch (1978) reported those changes may be due to season, habitat, gonadal maturity, sex, stomach fullness, health and preservation techniques. We thought that, the Fulton's condition factors were low because of the

effect of over sport fishing in the Kızıldamlar dam, Ertuğrulgazi, and Pelitözü ponds. In contrast, when evaluating the relative condition factors of fish according to the localities it were not determined any differences. The changes in *a,* and *b* values for the localities were given in Figure 4. It was determined negative meaningful correlation between *a,* and *b* values according to the localities (r=-0.855; p<0.05). There were not differences in the values of Dodurga dam samples because maybe there is not overfishing pressure, exploitation or predation. In a study carried out in the Camkoru pond (in Ankara-Türkiye) the weight values were changing between 7.1 to 56.8 g, and the length values were between 7.5-16.4 cm, also the length-weight equation determined as *W= 0.0066LF³·²⁵⁰¹* (Innal 2010). In that study, the gill nets with various mesh sizes were used for obtaining samples, while we used gill nets and beach seine. The differences were seen in the obtained values, it is maybe because of differences in the samples catching tools.

Acknowledgements

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