J. Black Sea/Mediterranean Environment
Vol. 18, No. 3: 380-387 (2012)

RESEARCH ARTICLE

Length-weight relationship and relative condition factor of white bream, *Blicca bjoerkna* (L., 1758), from Lake Ladik, Turkey

Savaş Yılmaz*, Okan Yazıcıoğlu, Mesut Erbaşaran, Sinan Esen, Melek Zengin, Nazmi Polat

Department of Biology, Faculty of Arts and Sciences, Ondokuz Mayıs University, Kurupelit, Samsun, TURKEY

***Corresponding author:** savasyilmaz033@yahoo.com

Abstract

Length-weight relationship (LWR) and relative condition factor (K_n) of totally 434 white bream, *Blicca bjoerkna* (L., 1758) specimens, monthly collected in Lake Ladik between November 2009 and October 2010, were examined. Length-length relationships (LLRs) were also determined. The slopes of LWRs of females and males did not differ statistically in the same season, while they differed among the seasons. The positive allometric growth was observed in both sexes. The mean K_n values of females and males were not statistically different within season except in spring. The mean K_n showed an increase according to length classes. All LLRs were highly significant.

Keywords: *Blicca bjoerkna*, relative condition, length-weight relationship, Lake Ladik, Turkey.

Introduction

The white bream, *Blicca bjoerkna* (L., 1758), is a member of family Cyprinidae. This species which is very widespread in Europe has a large distribution from eastern side of England up to the Caspian Sea (Slastenenko 1956; Kottelat and Freyhoff 2007). Its distribution areas in Turkey are the rivers and lakes of Marmara, Middle and Eastern Black Sea regions (Geldiay and Balık 2007).

Studies on the biology and ecology of *B. bjoerkna* are scarce, and several papers about its feeding strategy and growth (Specziár *et al.* 1997), growth and reproduction aspects (Balık *et al*. 1999; Hamalosmanoğlu 2003), maturity and fecundity (Gürsoy 2001) and length-weight relationship (Tarkan *et al.* 2006)

have been published. No study has previously been conducted, however, on this species in Lake Ladik. The aim of present study was to investigate variations in relative condition factor (K_n) and length-weight relationship (LWR) of *Blicca bjoerkna* inhabiting Lake Ladik, Turkey.

Materials and Methods

Lake Ladik (35°40'-36°05'E and 40°50'-41°00'N) is located in the borders of Ladik district of Samsun Province in the central Black Sea region of Turkey (Figure 1). It is 10 km far from the Ladik district and situated on the northern side of Akdağ Mountain. The lake is fed by Çakırgümüş and Küpecik Streams coming from the Akdağ Mountain. Tersakan Stream, which is an outlet stream helping to control water levels of the lake, run into the Yeşilırmak River. Its length, width, depth, drainage area and altitude are 5 km, 2 km, 2.5 - 6 m, 141.40 km^2 and 867 m, respectively (Anonymous 2007). The water temperature ranges from 7 to 28 °C throughout the year. The lake has been classified as an eutrophic and shallow lake (Maraşlıoğlu 2001). The fish species including *Abramis brama*, *Capoeta tinca*, *Chondrostoma regium*, *Squalius cephalus*, *Scardinius erythrophthalmus*, *Esox lucius*, *Perca fluviatilis*, *Barbatula kosswigi* are also present in Lake Ladik (Uğurlu *et al.* 2009). The invasive fish *Carassius gibelio* was intentionally introduced by fishermen in 2007 (Recep Düzenli, pers.comm.).

Specimens of *B. bjoerkna* were collected from different regions of the lake on a monthly basis from November 2009 to October 2010. The fish were caught using fishnets with meshes of 17, 20, 25, 30, 35 and 40 mm nets, 30, 35, 40, 50, 55, 60, 70 and 80 mm trammel nets and fyke nets.

The total length (TL), fork length (FL) and standard length (SL) of each fish specimens were measured to the nearest 0.1 cm. Individual weights (W) were taken using a digital balance with a precision of 0.01 g. Sex determination is made by examination of gonads macroscopically. The chi-squared test was carried out on the observed female and male specimens to show whether the proportions deviated significantly from the expected 1: 1 ratio (Zar 1999). The length-weight relationships (LWR) were estimated using the equation $W=a\times L^b$, where W is the total weight of specimen (g), L is the total length (cm), a is the intercept and b is the slope of relationship (Bagenal and Tesch 1978). The parameters a and b of LWR were estimated by linear regression on the transformed equation: log W = log a + b log TL. The student's t-test employed to test whether the slopes (b) were significantly different from 3, indicating the growth type: isometric (b = 3), positive allometric (b > 3) or negative allometric (b < 3). The parameter (b) of LWR was compared for significant difference between sexes in same seasons and among seasons by analysis of covariance (ANCOVA) (Zar 1999). The relative condition factor (K_n) was calculated from equation $K_n = 100 \times W/\hat{W}$, where W is observed weight of fish, $\hat{W}$ is the calculated weight derived from length-weight relationship (Le Cren 1951). K_n

values of fish were also defined according to total length class of female and male individuals separately. Difference between K_n values of females and males was tested using the student's *t*-test in same season and it was tested by analysis of variance (ANOVA) among seasons. All length-length relationships (LLRs) of female, male and entire samples were computed using linear regression analysis (Zar 1999).

Results and Discussion

Of the total of 434 specimens collected for the study, 219 (50.46%) were females and 215 (49.54%) were males. The sex ratio (female:male) was 1 : 0.98 in favour of females, but did not deviate significantly from 1:1 ($x^2 = 0.037$; $P > 0.05$). This ratio was estimated as 1: 0.35 in Lake Kuş (Balık *et al.* 1999), 1: 1.07 and 1:0.53 in Sapanca Lake (Gürsoy 2001; Hamalosmanoğlu 2003).

The total lengths and weights of examined samples varied as 13.2 - 27.8 cm and 22.8 - 259 g, respectively. The standard lengths of fish ranged from 3.8 to 32.9 cm in Lake Balaton (Specziár *et al.* 1997). Balık *et al.* (1999) reported that distributions of the fork lengths and weights of Kuş Lake population were 3.5 - 17.2 cm and 0.5 - 134.6 g, respectively. These ranges were determined as 9.6 - 49.2 cm and 11 to 2690 g for Lake Sapanca (Hamalosmanoğlu 2003). Tarkan *et al.* (2006) studied with specimens varied as 12 - 21.2 cm of total lengths. Differences of weight and length distributions can be attributed to sampling time and method, type of length measured, population density, ecological features of studied lakes.

The LWRs were highly significant ($P < 0.001$, $r^2 > 0.910$, Table 1). The values of parameter *b* in present study were within the expected range of 2.5 - 3.5, but they can vary between 2 and 4 (Bagenal and Tesch 1978). The parameter *b* of seasonal LWRs for females and males ranged from 3.273 (winter) to 3.531 (summer) and from 3.206 (summer) to 3.336 (spring), respectively. Totally, exponent *b* of LWR was calculated as 3.395 for females, 3.329 for males, and 3.361 for both sexes. No significant difference was found in *b* values of LWRs of females and males within seasons (ANCOVA, $P > 0.05$). This means that the female and male individuals are the same body shapes in the same seasons. However, coefficient *b* of female and male samples differed between seasons (ANCOVA, $P < 0.05$). In this case, body shapes of both sexes varied seasonally. Seasonal variations in the *b* values of LWR may be ascribed to the feeding ratios and gonadal developments.

The growth of this species in Lake Ladik was positively allometric throughout the year ($b > 3$, t-test, $P < 0.05$, Table 1), except summer for males (isometric growth; $b = 3$, t-test, $P > 0.05$). Specziár *et al.* (1997) reported that growth of population in Balaton Lake, Hungary, was positive allometric with *b* value of 3.267. In Turkey, *b* values of LWR for females, males and total individuals of *B. bjoerkna* inhabiting Lake Kuş were estimated as 3.24, 3.27 and 3.31,

respectively (Balık *et al.* 1999). These parameters were determined as 3.09 for females, 2.96 for males and 3.04 for entire population in Lake Sapanca by Hamalosmanoğlu (2003), and 3.18 for all specimens in the same lake by Tarkan *et al.* (2006). Our results are in accordance with the previous ones.

The mean values of seasonal K_n for females and males ranged from 0.988 (summer) to 1.028 (spring) and from 0.971 (autumn) to 1.015 (winter), respectively (Table 1). Totally, the mean K_n of females, males and all samples were computed as 1.007 ± 0.005, 1.018 ± 0.006 and 0.997 ± 0.004, respectively (Table 1). There was no significant difference in mean K_n between sexes (t-test, $P > 0.05$). The mean K_n values of both females and males did not reflect statistical difference in the same season except in spring (*t*-test, $P > 0.05$). On the other hand, seasonal variation in K_n was observed for females (ANOVA, $P < 0.001$), but it was not determined for males (ANOVA, $P > 0.001$). Mean K_n values of both sexes were increased with length groups (Figure 2).

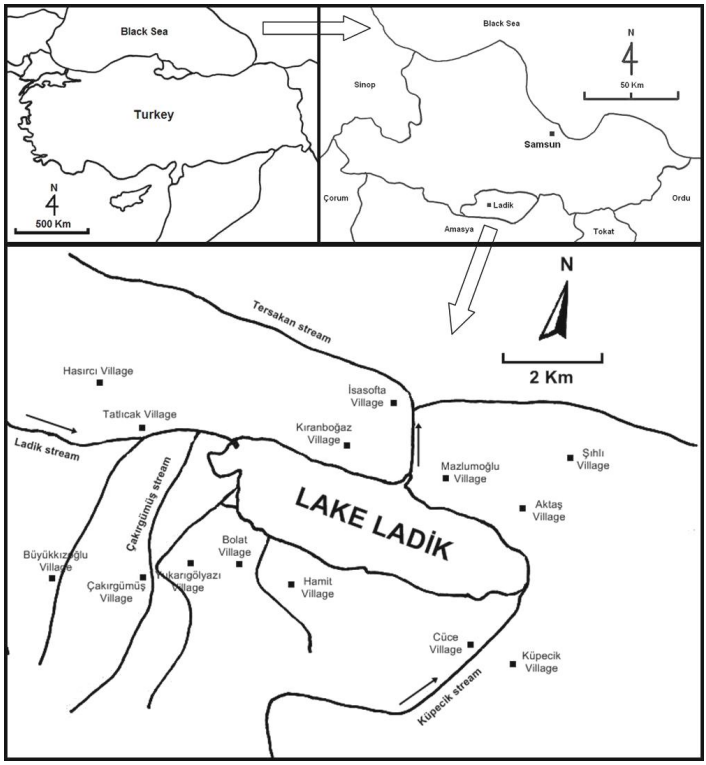

Figure 1. The study area

Table 1. Measurements and calculated parameters of length-weight relationships (LWRs) and relative condition factor (K_n) for *Blicca bjoerkna* from Lake Ladik, Turkey

			Total Length		Weight		Parameters of LWR				Relative Condition Factor		
Season	**Sex**	**n**	**Min**	**Max**	**Min**	**Max**	**a**	**b**	**95% CI of b**	**r^2**	**K_n**	**SE**	**Min-Max**
Win	F	75	14.9	23.1	36.00	150.00	0.0050	3.273	3.121-3.426	0.962	1.023	0.009	0.843-1.196
	M	66	14.7	23.7	38.00	176.00	0.0059	3.216	3.062-3.371	0.964	1.015	0.010	0.832-1.241
	T	141	14.7	23.7	36.00	176.00	0.0055	3.240	3.134-3.347	0.963	1.019	0.006	0.834-1.236
Spr	F	70	13.8	27.8	26.75	259.00	0.0026	3.489	3.371-3.608	0.981	1.028	0.009	0.861-1.213
	M	81	13.8	24.5	28.48	176.76	0.0039	3.366	3.230-3.503	0.968	0.994	0.009	0.825-1.244
	T	151	13.8	27.8	26.75	259.00	0.0032	3.431	3.342-3.521	0.975	0.996	0.007	0.830-1.242
Sum	F	29	15.5	20.5	38.40	96.60	0.0024	3.531	3.114-3.949	0.918	0.988	0.014	0.841-1.170
	M	33	15.3	22.8	37.60	125.53	0.0061	3.206	2.840-3.571	0.911	1.007	0.018	0.775-1.230
	T	62	15.3	22.8	37.60	125.53	0.0046	3.298	3.034-3.563	0.912	1.014	0.012	0.789-1.246
Aut	F	45	13.6	23.6	26.00	147.74	0.0045	3.300	3.136-3.463	0.975	0.997	0.011	0.851-1.162
	M	35	13.2	21.1	22.80	106.00	0.0045	3.306	3.158-3.453	0.984	0.971	0.011	0.857-1.100
	T	80	13.2	23.6	22.80	147.74	0.0044	3.307	3.201-3.413	0.980	0.995	0.007	0.852-1.165
Total	F	219	13.6	27.8	26.00	259.00	0.0035	3.395	3.315-3.475	0.970	1.007	0.005	0.836-1.202
	M	215	13.2	24.5	22.80	176.76	0.0042	3.329	3.244-3.413	0.966	1.018	0.006	0.792-1.294
	T	434	13.2	27.8	22.80	259.00	0.0039	3.361	3.302-3.419	0.968	0.997	0.004	0.780-1.263

n: sample size, F: female, M: male, T: total specimens, a and b: parameters of length-weight relationship, K_n: relative condition factor

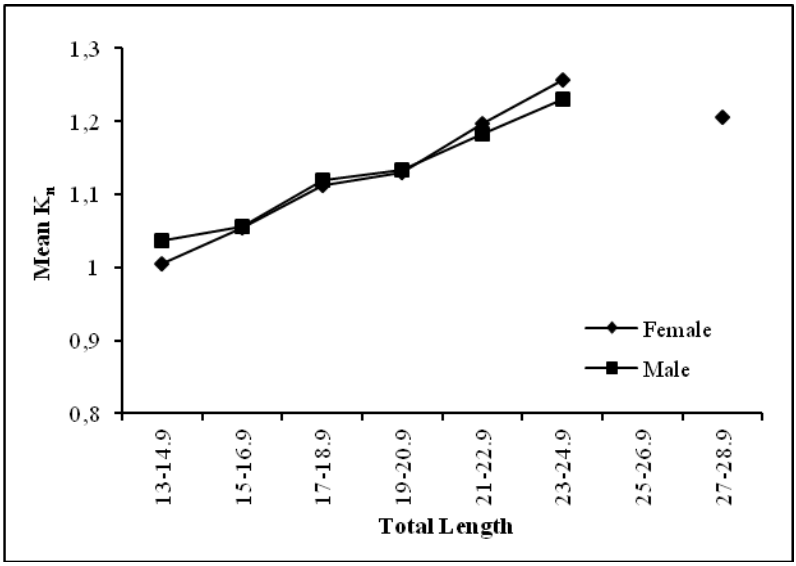

Figure 2. Mean relative condition factor (K_n) per total length class for female and male of *Blicca bjoerkna* in Lake Ladik

Table 2. Length-length relation parameters between total, fork and standard length of *Blicca bjoerkna* inhabiting Lake Ladik, Turkey

Sex	n	Equation	a	B	r^2
Female	219	TL= a + bFL	0.339	1.11	0.979
		FL= a + bSL	0.786	1.05	0.981
		SL= a + bTL	-0.598	0.84	0.984
Male	215	TL= a + bFL	0.634	1.09	0.982
		FL= a + bSL	0.341	1.08	0.989
		SL= a + bTL	-0.494	0.83	0.982
Combined	434	TL= a + bFL	0.419	1.10	0.980
		FL= a + bSL	0.636	1.06	0.985
		SL= a + bTL	-0.558	0.83	0.983

n: sample size, a and b: parameters of length-length relationship

All LLRs of *B. bjoerkna* were shown in Table 2. The determined r^2 values for all LLRs of females, males and entire specimens were greater than 0.978 and highly significant ($P < 0.001$). Length-length conversions in fish provide to compare studies performed using different lengths (Yılmaz *et al.* 2010).

In conclusion, this study is the first reference for the K_n, LLR and LWR of *B. bjoerkna* population in Lake Ladik. According to the results of present research, it is suggested that the growth of species is satisfactory in this lake.

Acknowledgement

Financial support was given by the Ondokuz Mayıs University (Project No: PYO. 1901.09.005). We thank to Sadettin Düzenli and Aydın Düzenli for their help during the sampling.

Ladik Gölü (Samsun, Türkiye)'ndeki tahta balığı, *Blicca bjoerkna* (L., 1758)'nın boy-ağırlık ilişkisi ve nispi kondisyon faktörü

Özet

Ladik Gölü (Samsun, Türkiye)'nden Kasım 2009-Ekim 2010 tarihleri arasında aylık olarak yakalanan toplam 434 tahta balığı, *Blicca bjoerkna* (L., 1758) bireyinin boy-ağırlık ilişkisi ve nispi kondisyon faktörü incelenmiştir. Ayrıca boy-boy ilişkileri de tespit edilmiştir. Dişi ve erkeklerin boy-ağırlık ilişkileri aynı mevsimde istatistiksel farklılık göstermezken ($P > 0,05$), mevsimler arasında farklılık belirlenmiştir ($P < 0,05$). Her iki eşeyde pozitif allometrik büyüme gözlenmiştir. Dişi ve erkek bireylerin ortalama nispi kondisyon faktörleri ilkbahar hariç aynı mevsimlerde farklı çıkmamıştır ($P > 0,05$). Nispi kondisyon faktörü boy gruplarına göre artış göstermiştir. Boy tipleri arasında kuvvetli ilişkiler elde edilmiştir ($P < 0,001$, $r^2 > 0,978$).

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Received: 27.02.2012
Accepted: 16.05.2012