Length-weight and length-length relationships of the bogue *Boops boops* (Linneaus, 1758) in Izmir Bay (Aegean Sea of Turkey)

Ali Kara* & Bahar Bayhan

*** Ege University, Faculty of Fisheries, Department of Fishing and Processing Technology, 35100 Bornova-Izmir, Turkey**
Ege University, Faculty of Fisheries, Department of Hydrobiology, 35100 Bornova, Izmir-Turkey.

Corresponding author : * Ali Kara, Ege University, Faculty of Fisheries, Department of Fishing and Processing Technology, 35100 Bornova-Izmir, Turkey; Tel: 00 90 232 3884000/1302; Fax: 00 90 232 3883685; e-mail (1): ali.kara@ege.edu.tr; e-mail (2): bahar.bayhan@ege.edu.tr

ABSTRACT. A total of 1190 specimens of bogue, *Boops boops*, were collected by gillnet and trammel net fishing between January 2005 and December 2005 in Izmir Bay (Aegean Sea of Turkey). Fish size in total length ranged from 9.2cm (minimum) in September to 27.6cm (maximum) in January. The length-weight relationships were determined for males, females, hermaphrodites and combined sexes as $W=0.0021L^{3.522}$, $W=0.0044L^{3.272}$, $W=0.0037L^{3.350}$ and $W=0.0035L^{3.419}$ respectively. The results indicated further that the length-length relationships were highly correlated ($r^2>0.990$, $P<0.001$).

KEY WORDS : *Boops boops,* length-weight relationship, length-length relationship, Izmir Bay, Aegean Sea.

INTRODUCTION

The length-weight (LWR) and length-length (LLR) relationships have been applied for basic uses for assessment of fish stocks and populations (RICKER, 1968). The length-weight relationships also helps to figure out the condition, reproduction history, life history and the general health of fishing species (NIKOLSKY, 1963; WOOTTON, 1992; PAULY, 1993; ERKOYUNCU, 1995; AVSAR, 1998) and is also useful in local and interregional morphological and life historical comparisons in species and populations.

It is necessary to use standard measures for all populations to render the results more reliable when making comparisons between populations. Therefore, the length-length relations of species under various environmental conditions should be known. The length-length relationship is also of great importance for comparative growth studies (MOUTOPOULOS & STERGIOU, 2002). In fisheries studies, fish length can often be measured more rapidly and easily than mass. The knowledge of the length-weight relationship makes it easier to determine the mass where only the length is known. In the field, the tail flukes are often cut, which makes it difficult to measure the total length accurately. Knowing the standard length will enable us figure out the total length.

The aim of the present study is to determine the length-weight and length-length relationships of females, males and hermaphrodites of *Boops boops,* the species caught in Izmir Bay in 2005.

MATERIALS AND METHODS

The samples were obtained monthly during commercial fishing trials conducted with gillnets and trammel nets during 2005 in Izmir Bay (Fig. 1).

The specimens were taken from commercial boats, kept in wooden boxes and brought to the laboratory as soon as possible (within two hours). Fish were measured in the laboratory for total length (TL), fork length (FL) and standard length (SL) to the nearest cm and weighed (W, wet weight) to the nearest g.

The length-weight relationships for weight were calculated using the equation, $W=aL^b$ (RICKER, 1979) where a is a coefficient related to body form and b is an exponent indicating isometric growth when equal to 3. The statistical significance level of r^2 was estimated by linear regressions on the transformed equation, LogBW=loga +b.logSL. Moreover, (1) TL vs FL; (2) FL vs SL; and (3) SL vs TL relationships were calculated by linear regressions. In order to test for likely significant differences in both slope and intercept, covariance analysis was performed. All statistical analyses were evaluated at $P<0.05$ significance level.

RESULTS AND DISCUSSION

A total of 1190 individuals were sampled during the study period. The shortest individual, 9.2cm, was obtained in September and the longest, 27.6cm TL, in January. It was determined that 54% of the samples were females (n=640), 43% males (n=516) and 3% hermaphrodites (n=34).

Seasonal length-weight relationships for males, females, hermaphrodites and the total sample population were determined as $W=0.0021L^{3.522}$, $W=0.0044L^{3.272}$, $W=0.0037L^{3.350}$ and $W=0.0035L^{3.419}$ respectively (Table 1).

Analysis of covariance revealed significant differences between sexes for the slopes (b) of the regression lines ($P<0.001$).

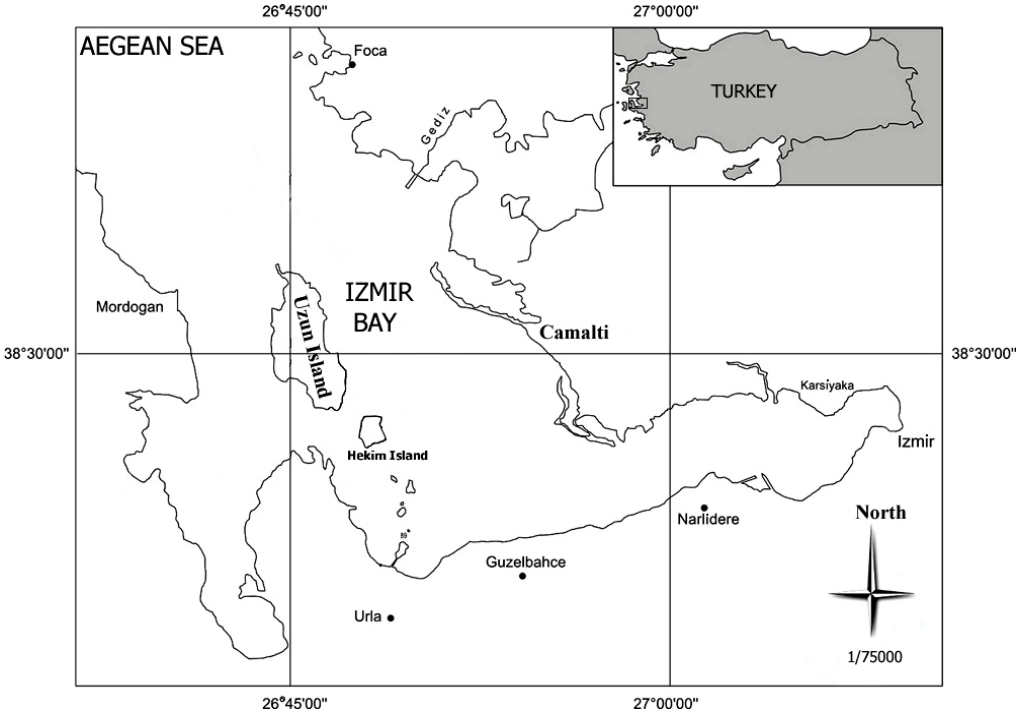

Fig. 1. – Study area (Izmir Bay)

TABLE 1

Monthly descriptive statistics and estimated parameters of length-weight relationships for both sexes of *Boops boops* in Izmir Bay (Aegean Sea) from January 2005 to December 2005 (M: male, F: female, H: hermaphrodite, A: all sexes, n: number of individuals, a: intercept, b: slope, CI: confidence limits, r^2: coefficient of determination).

Months	Sex	n	Length characteristics		Weight characteristics		Relationship parameters			
			TL Range (cm)	Mean TL (±SD)	W Range (g)	Mean W (±SD)	a	b	SE of b	r^2
January	M	20	22.0-27.0	24.42±1.63	150.35-243.96	191.68±33.38	0.0699	2.475	0.264	0.917
	F	40	21.8-27.6	24.20±1.42	149.99-250.21	184.44±27.91	0.1188	2.304	0.204	0.876
February	F	78	16.0-21.1	19.25±1.50	36.47-98.67	69.87±17.14	0.0062	3.145	0.136	0.935
March	M	180	13.6-22.9	19.14±2.20	22.44-117.68	69.87±22.26	0.0106	2.965	0.121	0.873
	F	96	15.0-21.6	19.21±1.80	32.11-123.92	72.72±23.90	0.0078	3.076	0.259	0.854
April	M	32	15.4-19.5	17.55±1.08	34.57-66.28	49.20±9.23	0.0118	2.901	0.010	0.889
	F	28	14.7-20.0	18.04±1.46	30.20-74.87	53.68±12.19	0.0124	2.887	0.159	0.965
May	M	40	22.2-26.6	24.65±1.07	151.96-281.67	260.64±26.96	0.0485	2.606	0.320	0.887
June	M	76	18.0-22.0	19.74±1.13	51.84-106.36	69.04±13.20	0.0088	3.002	0.182	0.884
	F	80	18.2-22.9	20.54±1.30	54.28-117.35	80.46±15.87	0.0142	2.854	0.179	0.870
July	M	14	18.4-23.5	21.26±1.80	69.88-128.65	97.31±23.75	0.0201	2.770	0.365	0.920
	F	126	11.3-23.3	17.79±2.72	12.10-132.86	60.70±27.92	0.0065	3.148	0.050	0.989
August	M	68	15.4-23.4	20.57±1.60	38.32-143.31	91.39±22.81	0.0059	3.184	0.149	0.935
	F	88	14.8-25.8	17.34±1.78	29.21-98.90	53.00±19.01	0.0046	3.263	0.070	0.979
	H	6	10.9-16.0	12.80±2.79	11.41-41.01	22.17±16.37	0.0044	3.298	0.080	0.999
September	F	48	15.6-23.3	19.56±2.39	38.48-124.17	77.06±27.28	0.0106	2.976	0.114	0.967
	H	8	9.2-18.2	14.35±3.76	7.18-57.30	33.24±20.52	0.0078	3.083	0.080	0.997
October	M	12	10.2-19.2	16.25±2.33	17.70-68.24	42.23±17.00	0.0101	2.973	0.157	0.989
	F	30	15.2-20.2	17.01±1.40	29.73-82.60	48.25±15.39	0.0024	3.487	0.198	0.960
	H	20	15.3-19.7	16.59±1.21	32.10-69.65	43.68±10.24	0.0122	2.909	0.113	0.938
November	M	38	18.3-25.6	22.03±2.35	54.78-169.26	118.08±35.62	0.0055	3.194	0.137	0.970
	F	18	17.1-26.7	22.07±3.79	46.69-191.75	117.10±62.47	0.0037	3.316	0.178	0.980
December	M	36	16.0-24.5	20.97±2.57	35.99-148.33	93.82±32.65	0.0057	3.177	0.080	0.991
	F	8	15.5-24.2	21.43±3.99	32.83-145.87	106.92±50.52	0.0033	3.363	0.020	0.999
Overall	M	516	13.6-27.0	20.28±2.69	17.70-281.67	91.41±48.80	0.0021	3.522	0.062	0.926
	F	640	11.3-27.6	19.14±2.73	12.10-261.76	75.62±40.83	0.0044	3.272	0.044	0.947
	H	34	9.2-24.9	16.84±4.30	7.18-222.75	62.82±40.28	0.0037	3.350	0.089	0.988
	A	1190	9.2-27.6	19.55±2.86	7.18-281.67	81.74±45.63	0.0035	3.419	0.016	0.948

Monthly LWRs of *Boops boops* presented in Table 1 show that the calculated allometric coefficients vary between 2.475 (January) and 3.194 (November) in males, between 2.304 (January) and 3.487 (October) in females and between 2.909 (October) and 3.298 (August) in hermaphrodites. All LLRs presented in Table 2 were highly significant (P<0.001), with all coefficient of determination values being greater than 0.990.

The LWR can be obtained from the length and weight measurements of the same fishes throughout their lives or from a sample of fish taken at a given time (WOOTTON, 1990). The parameters of the fish, LWRs are affected by a series of factors including season, habitat, gonad maturity, sex, diet, stomach fullness, health and preservation techniques (TESCH, 1971; BAGENAL & TESCH, 1978; HOSSAIN et al., 2006).

All allometric coefficients (b) estimated in this study were within the expected range 2.3-3.5, and according BAGENAL & TESCH (1978); KOUTRAKIS & TSIKLIRAS (2003), allometric coefficients (b) may range from 2 to 4.

There have been some other studies on the length-weight and length-length relationships of *B.boops* L., in Turkish Seas and other localites (MENNES, 1985; ALGERIA-HERNANDEZ, 1989; MERELLA et al., 1997; GONÇALVES et al., 1997; ABDALLAH, 2002; VALLE et al., 2003; OZAYDIN & TASKAVAK, 2006; KARAKULAK et al., 2006) and the b values reported in these studies are presented in Table 3.

The values of b found in studies conducted on *B. boops* in Turkish Seas indicate positive allometry of growth. Table 3 shows that in other parts of the Mediterranean Sea fish of this species exhibit isometric growth values as well as those positively approaching isometry (more positively).

TABLE 2

Length-length relationships between total length (TL), fork length (FL) and standard length (SL) of *Boops boops* in Izmir Bay (Aegean Sea) from January 2005 to December 2005 (n: number of individuals, a: intercept, b: slope, r^2: coefficient of determination).

Sex	Equation	n	a	b	r^2
	TL=a+bFL		-0.2165	1.1362	0.991
Male	FL=a+bSL	516	0.9006	1.0152	0.994
	SL=a+bTL		-05657	0.8616	0.990
	TL=a+bFL		-0.0405	1.1277	0.995
Female	FL=a+bSL	640	0.5915	1.0332	0.997
	SL=a+bTL		-0.7071	0.8683	0.992
	TL=a+bFL		-0.1872	1.1339	0.997
Hermaphrodite	FL=a+bSL	34	0.6199	1.0255	0.999
	SL=a+bTL		-0.4361	0.8595	0.999
	TL=a+bFL		-0.0877	1.1299	0.995
All	FL=a+bSL	1190	0.6866	1.0270	0.997
	SL=a+bTL		-0.6295	0.8644	0.994

TABLE 3

Length-weight relationships of *Boops boops* L. from different localities.

Author(s)	Area	Sex	Length range (cm)	Length type	a	b
MENNES, 1985	Western Sahara, Morocco	unsexed	-	-	0.0145	3.000
ALGERIA-HERNANDEZ, 1989	Central Adriatic Sea	female	13.50-23.00	TL	0.0056	3.088
		male	12.80-22.30	TL	0.0087	3.000
DJABALI et al.,1993	Bou-Ismail, Algeria	unsexed	-	-	0.0097	3.000
PETRAKIS & STERGIOU, 1995	G.S. Evvoikos, Greece	mixed	9.60-24.30	FL	0.0149	3.093
MERELLA et al., 1997	Balearic Islands, Spain	unsexed	12.40-26.60	TL	0.0082	3.000
GONÇALVES et al., 1997	South coast, Portugal	unsexed	15.80-35.50	TL	0.0083	3.037
ABDALLAH, 2002	Alexandria, Egypt	unsexed	3.70-14.60	TL	0.0070	3.130
VALLE et al., 2003	East coast, Spain	unsexed	9.70-16.70	SL	0.0161	2.812
KARAKULAK et al., 2006	Gökceada, Turkey	mixed	10.20-32.10	TL	0.0048	3.258
		female	15.40-32.10	TL	0.0032	3.390
		male	15.30-27.60	TL	0.0074	3.116
OZAYDIN & TASKAVAK, 2006	Izmir Bay, Turkey	mixed	10.70-23.50	FL	0.0003	3.033
This study	Izmir Bay, Turkey	mixed	9.20-27.60	TL	0.0035	3.419
		female	11.30-27.60	TL	0.0044	3.272
		male	13.60-27.00	TL	0.0021	3.522
		hermaphrodite	9.20-24.90	TL	0.0037	3.350

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