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Length Frequency, Length-Weight Relationship and Sex ratio of the whiting, *Merlangius merlangus euxinus* in the Black Sea, Turkey

Orhan AK[1,*], Sebahattin KUTLU[1], Yaşar GENÇ[1] and Halil İbrahim HALİLOĞLU[2]

[1] *Central Fisheries Research Institute (CFRI) P.K. 129, 61250 Trabzon, TURKEY*
[2] *Atatürk University, Agriculture Faculty, Aquaculture Department, 25240 Erzurum, TURKEY*

Abstract

In this study, the length frequency, monthly length weight relationships (LWR) and sex ratio of whiting are described. A total of 1.763 whiting (596 Males; 1167 Females) were determined sex monthly, in the Eastern Black Sea. The overall allometric coefficient b of LWR was close to the positive allometrik values (b=3.266). Overall sex ratio was (F: M) 1.95:1 (P<0.05). The mean length for female and male were calculated as 14.78±0.08 cm and 13.65±0.08 cm, respectively.

Key words: *Whiting, Merlangius merlangus euxinus, length frequency, length-weight relationships, sex ratio*

Karadeniz'de bulunan mezgit balığının *Merlangius merlangus euxinus*, boy frekans dağılımı, boy ağırlık ilişkisi ve cinsiyet oranı

Özet

Bu çalışmada, mezgidin boy frekans dağılımı, aylık boy ağırlık ilişkisi ve aylık cinsiyet oranları incelenmiştir. Toplam 1763 mezgit balığının (596 erkek, 1167 dişi) cinsiyeti Karadeniz de aylık olarak belirlenmiştir. b değeri pozitif allometrik (b=3.266) olarak bulunmuştur. Genel cinsiyet oranı (F:M) 1.95:1 olarak hesaplanmıştır (P<0.05). Dişi ve erkek bireyler için ortalama boy uzunluğu sırasıyla 14.78±0.08 cm ve 13.65±0.08 cm olarak hesaplanmıştır.

Anahtar Kelimeler: *Mezgit, Merlangius merlangus euxinus, boy frekans dağılımı, boy ağırlık ilişkisi, cinsiyet oranı*

[*] Orhan AK, orhanak57@gmail.com, Tel: (+90 462) 341 10 53 / 213.

1. Introduction

Merlangius merlangus euxinus belongs to the family Gadidae, and is known as the whiting. The species distributed from Norway and Iceland to the Mediterranean and into the Adriatic, the Aegean, the Azov and the Black Seas [1]. Whiting is one of the most abundant and economically important fish species for the local fishery in the Black Sea. Studies have been conducted on its early life history [2, 3, 4, 5], age and growth [6, 7, 8], reproductive biology and fecundity [7, 9], disease [10] and feeding habits [6]. In this study, sex ratio, size frequency and length-weight relationship on monthly of the whiting population in the Eastern Black Sea were examined. It is estimated the length-weight relationship (LWR) of this species according to sex and sampling time. The findings of this study will be a basis for the future population dynamics studies about the distribution, growing up, amount and stock composition of this type in the Black Sea.

2. Materials and methods

A total of 1.763 whiting (596 males; 1167 females) were monthly sampled from January 2007 to December 2008, in the Eastern Black Sea. Fish samples were caught by bottom trawl owned by research vessel (SEARC–1, Central Fisheries Research Institute, Trabzon). The samplings were caught by bottom trawl of mesh size 14 mm and three different deeps (20m, 40m and 60m).The monthly collections were sexed and size grouped (0.5 cm). From the fresh samples, total length (TL) and body weight (W) were measured to the nearest 0.1 cm and 0.01 g, respectively. The parameters a and b estimated by linear regressions on the transformed log W= log a + b log L [11]. To test for possible significant differences in both slope and intercept, we followed the analysis of covariance. Length-weight relationships are also originally used to provide information on the condition of fish and may help determine whether somatic growth is isometric (b=3) or allometric (negative allometric: b<3 or positive allometrik: b>3) [12, 13]. All statistical analysis were considered significant at P<0.0.5.

3. Results and discussion

Sex of the 1.763 determined specimens, 66% was female and 34% was male. Overall sex ratio was (F: M) 1.95:1 (P<0.05) (Table 1). There have been some studies on sex ratio of whiting in the Black Sea (Table 2).

Length frequency data for all determined sex individuals are presented in Figure 1. The males were found to be ranged from 8 to 19 cm in length and the total weights were found to be ranged from 3.70 to 56.8 g. In case of female, the length and weight were ranged between from 8.7 to 30 cm and 3.92 to 181.68 g, respectively (Table 1). The mean length for male was calculated as 13.65±0.08 cm and the mean weight calculated as 19.95±0.36 g (n=596). For female, the mean length and weight were calculated as 14.78±0.08 cm and 27.54±0.54 g (n=1167), respectively. According to Turkish Ministry of Agriculture and Rural Affairs (MARA), minimum catch length of whiting is 13 cm [14]. The previous studies of whiting in Black Sea found that maximum length by Uysal [15] 28 cm, Samsun [16] 40 cm, Samsun [17] 24 cm, Çiloğlu [18] 30 cm and Genç [8] 43,2 cm.

Table 1. Descriptive estimated parameters of length-weight relationship and sex ratio for whiting *M. merlangus euxinus* caught bottom trawl in the Eastern Black Sea (Turkey).

Month	Sex	n	Sex ratio (F:M)	Length (cm)		Weight (g)		Regression parameters				
				Min	Max	Min	Max	a	b	95%Cl of b	r^2	Length type
January (2007)	F	25	1:1 P>0.05	8.80	24.20	4.35	106.72	0.0071	3.035	2.838-3.351	0.977	b=3
	M	24		9.90	15.70	6.88	31.68	0.007	3.038	2.585-3.418	0.924	b=3
February	F	29	0.56:1 P<0.05	8.70	20.50	3.92	86.71	0.0029	3.362	3.161-3.519	0.984	b>3
	M	50		8.10	15.90	3.70	33.63	0.0033	3.333	3.213-3.464	0.987	b>3
March	F	20	0.56:1 P<0.05	12.70	16.90	13.09	34.84	0.0111	2.818	2.591-3.232	0.931	b<3
	M	27		11.70	16.30	10.61	29.15	0.0065	3.017	2.530-3.478	0.924	b=3
April	F	36	4.50:1 P<0.05	11.20	18.70	9.74	52.13	0.0067	3.043	2.689-3.313	0.937	b=3
	M	8		11.00	14.50	9.66	22.80	0.0055	3.127	2.377-3.970	0.960	b>3
May	F	48	1.89:1 P<0.05	10.70	22.40	8.18	99.58	0.0028	3.355	3.160-3.558	0.956	b>3
	M	27		10.10	16.80	8.11	31.09	0.0103	2.853	2.647-3.203	0.953	b<3
June	F	40	5:1 P<0.05	11.30	18.40	10.08	47.30	0.0039	3.216	2.948-3.471	0.948	b>3
	M	8		12.30	15.90	12.26	29.02	0.0009	3.778	2.998-5.055	0.960	b>3
July	F	43	5:1 P<0.05	12.70	19.20	14.70	49.40	0.009	2.942	2.688-3.126	0.952	b<3
	M	26		10.00	16.70	5.90	36.80	0.0031	3.309	2.952-3.510	0.969	b>3
August	F	45	4:1 P<0.05	12.70	20.50	12.80	72.69	0.0019	3.493	3.284-3.707	0.967	b>3
	M	11		13.80	17.10	18.00	41.12	0.0027	3.377	1.769-4.601	0.834	b>3
September	F	35	2:1 P<0.05	12.70	18.60	13.72	46.04	0.0028	3.354	3.048-3.645	0.947	b>3
	M	18		12.60	17.00	12.57	42.86	0.0012	3.669	3.209-4.101	0.958	b>3
October	F	50	1:1 P>0.05	12.10	29.00	12.03	26.42	0.0026	3.388	3.236-3.556	0.975	b>3
	M	50		12.00	17.60	10.94	45.63	0.0008	3.855	3.607-4.153	0.948	b>3
November	F	55	2:1 P>0.05	9.70	24.60	5.30	122.80	0.0022	3.436	3.321-3.541	0.987	b>3
	M	25		9.70	17.60	5.40	56.60	0.0019	3.522	3.101-3.901	0.949	b>3
December	F	14	3.64:1 P<0.05	10.00	22.60	5.84	96.32	0.0045	3.212	2.982-3.706	0.969	b>3
	M	52		11.00	16.20	9.46	31.65	0.0025	3.417	3.296-3.552	0.984	b>3
January (2008)	F	36	1.44:1 P>0.05	10.20	28.30	7.34	181.68	0.0037	3.274	3.070-3.397	0.981	b>3
	M	25		10.40	16.00	7.52	29.75	0.0068	3.018	2.711-3.371	0.949	b=3
February	F	47	1.44:1 P>0.05	9.30	23.40	5.13	98.01	0.0034	3.283	3.174-3.394	0.989	b>3
	M	21		10.30	15.40	7.38	23.73	0.0055	3.082	2.890-3.370	0.979	b>3
March	F	73	2.08:1 P<0.05	11.30	24.70	8.87	125.86	0.0036	3.268	3.232-3.441	0.979	b>3
	M	35		11.00	17.30	8.18	36.94	0.0021	3.458	3.263-3.755	0.964	b>3
April	F	86	2.08:1 P<0.05	10.50	16.70	8.40	38.63	0.0041	3.228	3.090-3.353	0.966	b>3
	M	21		11.90	15.90	11.20	30.72	0.0029	3.362	2.828-3.792	0.917	b>3
May	F	109	3.75:1 P<0.05	11.60	18.00	10.75	47.56	0.0035	3.304	3.156-3.470	0.943	b>3
	M	29		11.50	16.30	10.32	33.53	0.0031	3.343	2.991-3.878	0.909	b>3
June	F	65	3.75:1 P<0.05	12.20	20.50	10.88	70.89	0.0027	3.304	3.199-3.576	0.954	b>3
	M	36		11.20	17.70	9.18	42.15	0.0019	3.526	3.332-3.738	0.975	b>3
July	F	47	3.61:1 P<0.05	12.50	19.80	13.66	58.60	0.0028	3.368	3.199-3.731	0.943	b>3
	M	13		13.00	17.00	15.47	45.55	0.0022	3.462	2.359-4.010	0.896	b>3
August	F	45	3.61:1 P<0.05	13.10	18.90	14.28	53.92	0.0056	3.103	2.799-3.348	0.931	b>3
	M	21		12.60	17.08	12.70	39.10	0.0012	3.693	3.251-4.454	0.9.09	b>3
September	F	21	1.75:1 P<0.05	13.60	30.00	17.97	30.00	0.0098	2.909	2.787-3.148	0.986	b<3
	M	12		13.00	19.00	14.56	45.58	0.0085	2.979	2.949-3.334	0.827	b<3
October	F	31	1.75:1 P<0.05	12.70	18.00	12.24	49.30	0.0019	3.508	3.229-3805	0.959	b>3
	M	12		12.60	16.20	13.28	33.19	0.002	3.506	3.254-3.802	0.896	b>3
November	F	96	1.71:1 P<0.05	8.60	19.30	4.42	62.16	0.0017	3.599	3.440-4.094	0.969	b>3
	M	56		8.70	17.50	4.52	42.48	0.0022	3.493	3.072-3.962	0.943	b>3
December	F	38	1.71:1 P<0.05	11.1	22.80	10.74	109.7	0.0037	3.282	3.116-3.424	0.983	b>3
	M	27		10.6	15.80	8.38	30.58	0.0047	3.179	2.874-3.463	0.960	b>3
Overall	F	1167	1.95:1 P<0.05	14.78±0.08		27.54±0.54		0.0036	3.268	3.237-3.303	0.971	b>3
	M	596		13.65±0.08		19.95±0.36		0.0036	3.273	3.215-3.334	0.954	b>3
	F+M	1763		14.21±0.08		23.75±0.46		0.0037	3.266	3.239-3.295	0.969	b>3

Table 2. Some study result of length-weight relationship and sex ratio for whiting. *M. merlangus euxinus* in different area of Black Sea

References	Location	Sex	Sex ratio (F:M)	Length Min-Max	a	b
Düzgüneş and Karaçam [19]	Eastern Black Sea	♀	2.44:1	-	0.0182	2.717
		♂		-	0.07972	2.220
		Both		13.2–24.9	0.2721	2.573
Samsun [16]	Middle Black Sea	♀	0.87:1	13.57	0.0038	3.248
		♂		13.25	0.0049	3.182
		Both		-	0.0045	3.187
Genç *et al* ., [8]	Eastern Black Sea	♀	1.63:1	6.6–43.2	0.0046	3.181
		♂		6.8–30.5	0.0056	3.111
		Both		5.6–43.2	0.0052	3.142
İşmen [7]	Black Sea	♀	1.32:1	5.5-32.5	0.004	3.251
		♂		6.5-18.8	0.0044	3.220
		Both		5.5–32.5	0.0042	3.240
Samsun [6]	Middle Black Sea	♀	1.15:1	8.4–31.5	0.0043	3.196
		♂		8.7–22.9	0.0043	3.193
		Both		8.4–31.5	0.0042	3.201
Kalaycı *et al* [20]	Middle Black Sea	♀	1.20:1	8.8–22.7	0.0070	3.011
		♂		8.1–22.4	0.0840	2.930
		Both		8.1–22.7	0.0067	3.024

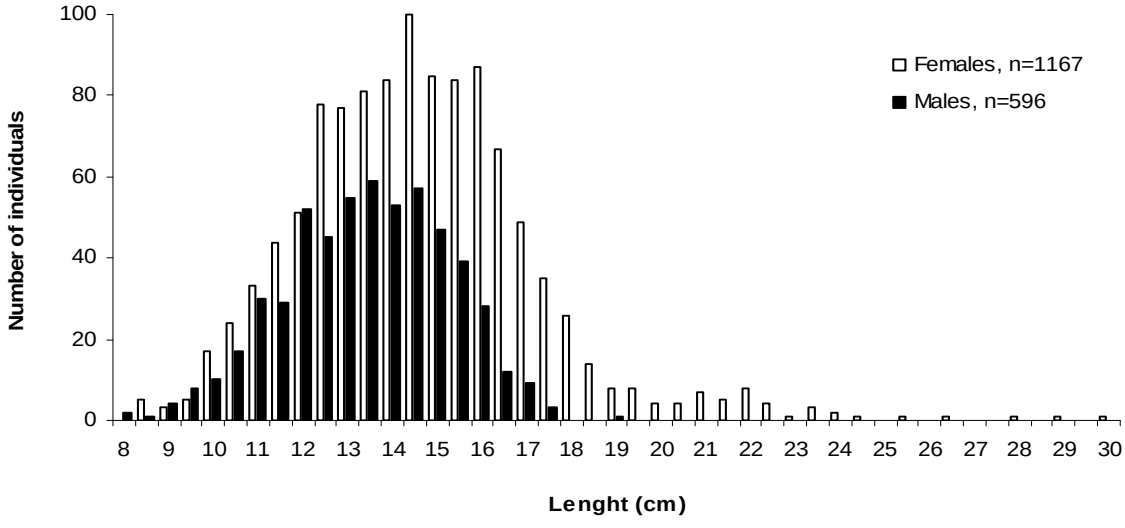

Figure 1. Length frequency distribution of whiting, *Merlangius merlangus euxinus*.

Length-weight relationships were estimated as $W= 0.0036L^{3.2682}$, $r^2= 0.954$ for males, as $W= 0.0036L^{3.2737}$, $r^2= 0.971$ for females, and as $W= 0.0037L^{3.2663}$, $r^2= 0.969$ for all fishes (Figure 2). Analysis of covariance revealed significant differences between sexes for slopes (b) of regression lines ($P<0.05$). Monthly length-weight relationships of whiting are given in Table 1 and show that b values varied around 3.0 in both sexes, but overall were significantly higher for females.

Ricker [12], observed that the value of the regression coefficient "n" usually lies between 2.5 and 4.0 and for ideal fish maintain the shape n=3. The values of regression coefficient for male (3.2682), female (3.2737) and combined sexes (3.2663) in the present analysis are very much closed to 3.0 and therefore, whiting does follow the cube law. For whiting in this study, the b values were generally in agreement with previous results. Also, it is well known that the functional regression "b" value represents the body form, and it is directly related to the weight affected by ecological factors such as temperature, food supply, spawning conditions and other factors, such as sex, age, fishing time and area and fishing vessels [12, 20].

From the year long study of size-frequency distribution of whiting it was found that the numbers of females were more than that of males which is supported by the findings of other authors working such as [6, 7, 8]. The higher values of "n" in females revealed that, the length-weight relationships might be affected by the general condition of appetite and gonadal contents of the fish. In particular, in the demersal fish, while the female and male ratio is 1:1 at the beginning, the female ratio decrease in age progresses of population. In addition to growth rate of females are faster than male. Because of these properties all the bigger individuals are female. Although whiting reproduce is more intensive in the winter months, especially 0^+ age group individuals of whiting recruitment to population in the April and May months. Before and during reproductive period, it consists of larger individuals of whiting in the population. Therefore, average length is higher than spawning time. Similar results are parallel with other studies [6,7,8].

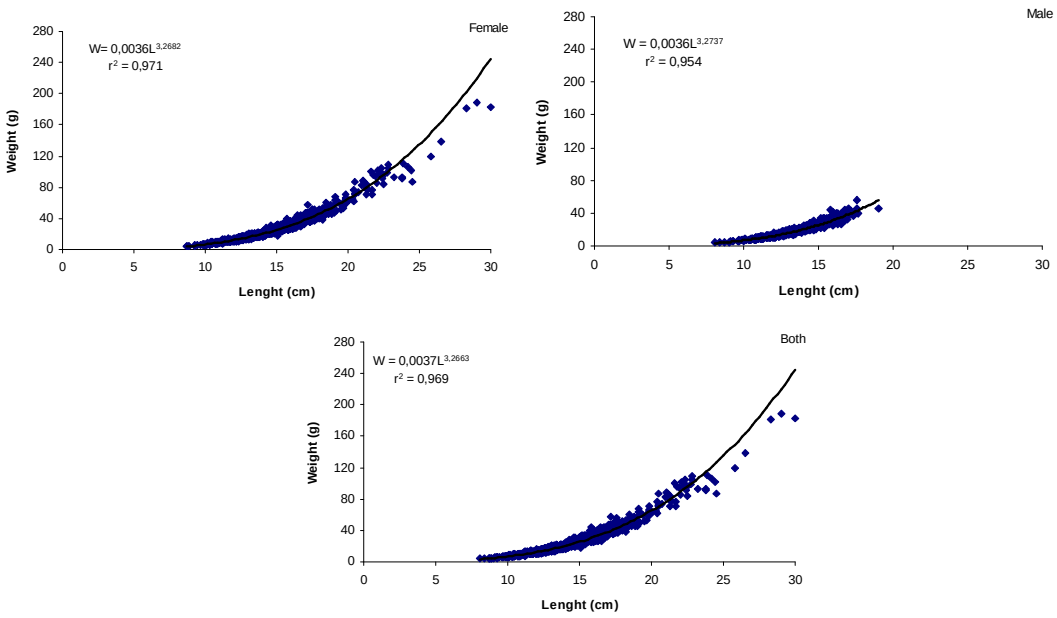

Figure 2. Length weight relationships of female, male and all sex whiting, *M. merlangus euxinus*

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