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

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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

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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.

Month Set i Imin im im im Main im im Main im im im im im im im im im im im im im im im im im im Main im im im im im im im im im im im im Main im im im im im im im im im im Main im im im im im im im im im Main imMain im im im im im im im im im im im imMain im im im im im im im im im im im im imMain im i			n	Sex ratio (F:M)	Length (cm)		Weight (g)			Regression parameters			
(2007) M 24 P-0.05 9.90 15.70 6.88 31.68 0.007 3.038 2585.3418 0.924 b-3 Fehruary F 29 0.561 8.70 0.50 3.92 8.71 0.0023 3.362 3.161.3519 0.984 b-3 March F 20 0.561 1.270 16.90 7.00 3.43 3.0015 3.123 3.44 0.984 b-33 April F 3.63 4.901 1.120 18.70 9.74 52.13 0.0067 3.43 2.689.3131 0.997 b-33 May F 48 1.891 10.70 2.240 8.18 9.958 0.0037 3.12 2.647.300 0.930 b-33 3.169.358 0.956 b-33 June F 43 1.817 1.070 1.840 1.084 4.70 0.900 2.424 2.984.347 0.969 b-33 June F 43 1.1270	Month	Sex			Min	Max	Min	Max	а	b	95%Cl of b	r^2	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	January	F	25	1:1	8.80	24.20	4.35	106.72	0.0071	3.035	2.838-3.351	0.977	b=3
February M 50 P<0.05 8.10 1.5.90 3.7.0 33.63 0.033 3.333 3.213.3.44 0.987 b.3 March F 20 0.56.1 12.70 16.30 16.40 0.011 2.188 2.591.3.232 0.931 b-3 April F 36 4.50.1 11.20 18.70 9.7.4 52.13 0.0007 3.043 2.580.3.478 0.924 b-3 May F 48 1.80.11 10.70 22.40 8.18 9.58 0.0028 3.35 3.160.3.558 0.956 b-3 June F 48 1.80.1 1.840 10.08 47.30 0.0018 3.33 2.247.370 0.960 b-3 June F 43 5.1 1.270 19.20 14.70 49.40 0.009 2.948.3.127 0.948 3.33 June F 43 5.1 1.270 19.50 12.80 7.00 3.30 2.948.	(2007)	М	24	P>0.05	9.90	15.70	6.88	31.68	0.007	3.038	2.585-3.418	0.924	b=3
M Silo F-20.0 Silo J.0 J.0 J.0 J.0.0 J.3.33 J.215-J.432 O.931 b-3 March F 20 O.66:11 I.70 I6.30 I.06 J.3.10 J.215 J.0065 J.170 J.250 J.3.33 J.215-J.3.43 O.937 b-3 April F 36 4.501 I.120 I8.70 O.46 2.13 O.0055 J.127 J.3.33 O.937 D.93 May F 48 I.891 I.120 I8.80 O.66 2.280 O.0053 J.127 J.3.73 O.936 b-33 June F 40 5.1 I.7.0 I8.40 I0.68 47.30 O.0039 J.216 Z447.320 O.936 b-33 June F 43 P.0.05 I0.10 I2.70 V.4940 O.031 J.309 Z473.20 O.963 J.330 Z473.30 O.963 J.330 Z473.30 O.963 J.30 Z47	February	F	29	0.56:1	8.70	20.50	3.92	86.71	0.0029	3.362	3.161-3.519	0.984	b>3
March M 27 P<0.05 11.70 16.30 10.61 29.15 0.0065 3.017 2.530.373 0.924 b=3 April R S 4.501.5 11.20 18.70 9.74 52.13 0.0067 3.043 2.689.3.31 0.937 b=5 May F 4.8 1.891.1 10.70 2.40 8.18 9.958 0.0028 3.55 3.160.3.558 0.953 b=3 June F 40 5.1 11.30 18.40 10.08 4.70 0.0039 3.216 2.948.3.471 0.948 b=3 Jule F 43 5.1 12.70 19.20 14.00 0.0031 3.09 2.985.3510 0.969 b=3 August M 11.2 10.20 17.00 14.04 11.2 0.967 3.31 3.948.3707 0.967 b=3 August M 18 P<-10.05		Μ	50	P<0.05	8.10	15.90	3.70	33.63	0.0033	3.333	3.213-3.464	0.987	b>3
M 27 P-0.00 11.70 16.30 10.61 29.15 0.0067 3.017 2.33.48 0.6924 b=3 April F 36 4.50.1 11.00 18.70 9.74 52.13 0.0067 3.013 2.689-3.313 0.937 b=3 May F 48 P-0.005 10.10 16.80 81.13 31.09 0.0067 3.013 2.585 2.647-3.203 0.953 b=-3 June F 40 5:1 12.70 19.20 14.70 49.40 0.009 2.942 2.688-3.126 0.952 b=-3 July F 43 5:1 12.70 19.20 14.70 49.40 0.009 2.942 2.688-3.126 0.952 b=-3 August F 43 5:1 12.70 19.20 14.70 49.40 0.009 2.942 2.688-3.10 0.958 b=-3 July F 43 5:10 12.70 19.20 12.00<	March	F	20	0.56:1	12.70	16.90	13.09	34.84	0.0111	2.818	2.591-3.232	0.931	b<3
April M 8 P<0.05 11.00 14.50 9.66 22.80 0.0055 3.127 2.377.3970 0.960 b>3 May F 48 1.89:1 10.70 2.240 8.18 99.58 0.0013 2.855 3.161-3288 0.956 b>3 June F 40 5:11 11.30 18.40 10.08 47.30 0.0039 3.216 2.948-3.471 0.938 b>3 June F 43 5:11 12.70 19.20 17.40 49.40 0.009 2.942 2.688-3.126 0.952 b>-3 August M 2.6 P-0.05 13.80 17.10 8.08 17.10 8.0077 3.371 1.70* 0.969 9.53 August M 11 12.10 2.00 12.00 12.00 12.00 12.00 2.007 3.353 3.26*3.356 0.075 b>3 August M 50 P-0.05 12.00 17.00 </td <td>Μ</td> <td>27</td> <td>P<0.05</td> <td>11.70</td> <td>16.30</td> <td>10.61</td> <td>29.15</td> <td>0.0065</td> <td>3.017</td> <td></td> <td>0.924</td> <td>b=3</td>		Μ	27	P<0.05	11.70	16.30	10.61	29.15	0.0065	3.017		0.924	b=3
M 8 P<0.05 11.00 14.30 9.66 2.280 0.0028 3.12 2.377.30 0.960 b>3 May F 48 1.89:1 10.70 2.40 8.81 9.58 0.0028 3.321 2.377.30 0.960 b>3 June F 40 5:1 11.30 18.40 10.08 47.30 0.0003 3.781 2.998-5.05 0.960 b>-3 July F 43 5:11 12.70 19.20 14.70 49.40 0.000 3.778 2.998-5.05 0.960 b>-3 August F 43 5:1 12.70 19.20 14.70 9.40 0.0001 3.433 3.284-3.707 0.967 b>-3 August M 11 P-0.05 10.00 12.80 72.69 0.001 3.433 3.284-3.707 0.967 b>-3 September F 55 2:11 12.70 12.80 0.0028 3.584 3.4438.3	April	F	36		11.20	18.70	9.74	52.13	0.0067	3.043		0.937	b=3
		М	8	P<0.05	11.00	14.50	9.66	22.80	0.0055			0.960	b>3
	May	F			10.70	22.40	8.18	99.58	0.0028	3.355		0.956	b>3
	May	М	27	P<0.05	10.10	16.80	8.11	31.09	0.0103	2.853		0.953	b<3
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Juna	F	40		11.30	18.40	10.08	47.30	0.0039	3.216		0.948	b>3
	Julie			P<0.05	12.30	15.90	12.26	29.02	0.0009	3.778	2.998-5.055	0.960	b>3
	July	F	43		12.70	19.20	14.70	49.40	0.009	2.942	2.688-3.126	0.952	b<3
				P<0.05	10.00	16.70	5.90	36.80	0.0031	3.309		0.969	
M 11 F 35 2:1 13.80 17.10 18.00 41.12 0.0027 3.77 1.769-4.001 0.834 bes/s September H 18 P<0.05	August	F	45		12.70	20.50	12.80	72.69	0.0019	3.493		0.967	b>3
	. ingust			P<0.05	13.80	17.10				3.377		0.834	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	September	F	35		12.70	18.60	13.72	46.04	0.0028	3.354	3.048-3.645	0.947	b>3
		М	18	P<0.05	12.60	17.00	12.57	42.86	0.0012	3.669	3.209-4.101	0.958	b>3
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	October	F	50		12.10	29.00	12.03	26.42	0.0026	3.388	3.236-3.556	0.975	b>3
November M 2.5 P-0.05 9.70 17.60 5.40 56.60 0.019 3.522 3.101-3.901 0.949 b>3 December R 1.4 3.64:1 10.00 22.60 5.84 96.32 0.0045 3.212 2.982-3.706 0.969 b>3 January F 36 1.41:1 0.100 7.32 181.80 0.0027 3.214 3.3070-3.337 0.981 b>3 Gu0081 M 2.5 P-0.05 10.40 16.00 7.32 29.75 0.0068 3.082 3.174-3.394 0.989 b>3 Gu0081 M 2.1 P-0.05 10.30 15.40 7.38 23.73 0.0053 3.082 2.809-3.370 0.979 b>3 March R 8.6 2.081 11.00 17.30 8.18 36.94 0.0014 3.228 3.090-3.353 0.966 b>3 March R 8.6 2.081 1.50 16.30 10.2		М	50	P>0.05	12.00	17.60	10.94	45.63	0.0008	3.855	3.607-4.153	0.948	b>3
	November	F	55		9.70	24.60	5.30	122.80	0.0022	3.436	3.321-3.541	0.987	b>3
December M 52 P<.005 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 10.20 28.30 7.34 181.68 0.0037 3.274 3.070-3.397 0.981 b>3 General M 25 P>0.05 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 9.30 23.40 7.13 8.01 0.0054 3.283 3.174.399 0.989 b>3 March F 73 2.08:1 11.30 24.70 8.87 125.86 0.0021 3.458 3.263-3.475 0.964 b>3 March F 86 2.08:1 11.60 18.00 0.75 47.56 0.0021 3.354 2.991-3.878 0.909 b>3 Mag F 65 3.75:1 12.20 2.05	November	Μ	25	P>0.05	9.70	17.60	5.40	56.60	0.0019	3.522	3.101-3.901	0.949	b>3
M 52 F<0.03 11.00 16.20 9.46 31.65 0.0025 3.417 3.296-3.52 0.984 b>3 January (2008) M 25 P-0.05 10.40 16.00 7.52 29.75 0.0037 3.274 3.070-3.397 0.981 b>3 February F 47 1.44:1 9.30 23.40 5.13 98.01 0.0034 3.283 3.174-3.394 0.989 b>3 M 21 P>0.05 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 11.30 24.70 8.87 125.86 0.0036 3.268 3.232-3.441 0.979 b>3 March M 35 P<0.05 11.00 15.00 16.70 8.40 38.63 0.0011 3.268 3.239-3.370 0.975 b>3 March M 29 P<0.05 11.00 15.00 15.00<	Description	F	14	3.64:1	10.00	22.60	5.84	96.32	0.0045	3.212	2.982-3.706	0.969	b>3
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	December	Μ	52	P<0.05	11.00	16.20	9.46	31.65	0.0025	3.417	3.296-3.552	0.984	b>3
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	January	F	36	1.44:1	10.20	28.30	7.34	181.68	0.0037	3.274		0.981	b>3
February M 21 P>0.05 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 11.30 24.70 8.87 125.86 0.0036 3.268 3.232-3.441 0.979 b-3 March M 35 P<0.05 11.00 17.30 8.18 36.94 0.0021 3.458 3.232-3.441 0.979 b-3 April F 86 2.08:1 10.50 16.70 8.40 38.63 0.0041 3.228 3.090-3.353 0.966 b-3 May M 29 P<0.05 11.50 16.30 10.75 47.56 0.0025 3.304 3.156-3.470 0.943 b>-3 June F 65 3.75:1 12.20 20.50 10.88 70.89 0.0027 3.304 3.199-3.731 0.943 b>-3 July F 47 3.61:1 12.20 19.80	(2008)	Μ	25	P>0.05	10.40	16.00	7.52	29.75	0.0068	3.018	2.711-3.371	0.949	b=3
M 21 P>0.05 10.30 15.40 7.38 23.73 0.0055 3.082 2.890-3.570 0.979 b>3 March K 73 2.08:1 11.30 24.70 8.87 125.86 0.0036 3.268 3.232-3.441 0.979 b>3 April F 86 2.08:1 10.50 16.70 8.40 38.63 0.0021 3.458 3.263-3.755 0.964 b>3 May I P<0.05 11.90 15.90 11.20 30.72 0.0021 3.458 3.263-3.755 0.966 b>3 May F 109 3.75:1 11.60 18.00 10.75 47.56 0.0035 3.304 3.156-3.470 0.943 b>3 June F 65 3.75:1 12.20 20.50 10.88 70.89 0.0027 3.304 3.199-3.576 0.954 b>3 June F 47 3.61:1 12.00 19.80 13.66 58.60	Fohmory	F	47	1.44:1	9.30	23.40	5.13	98.01	0.0034	3.283	3.174-3.394	0.989	b>3
March M 35 P<0.05 11.00 17.30 8.18 36.94 0.0021 3.488 3.263-3.755 0.964 b>3 April F 86 2.08:1 10.50 16.70 8.40 38.63 0.0021 3.488 3.263-3.755 0.964 b>3 May 21 P<0.05 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 11.60 18.00 10.75 47.56 0.0021 3.343 2.991-3.878 0.909 b>3 June F 65 3.75:1 12.20 20.50 10.88 70.89 0.0027 3.304 3.199-3.576 0.954 b>3 July F 65 3.75:1 12.00 17.00 18.42.15 0.019 3.526 3.323-3.738 0.995 b>3 July F 47 3.61:1 13.00 17.00 18.42.15 0.019	rebluary	Μ	21	P>0.05	10.30	15.40	7.38	23.73	0.0055	3.082	2.890-3.370	0.979	b>3
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Marah	F	73	2.08:1	11.30	24.70	8.87	125.86	0.0036	3.268	3.232-3.441	0.979	b>3
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Waten	М	35	P<0.05	11.00	17.30	8.18	36.94	0.0021	3.458	3.263-3.755	0.964	b>3
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	April	F	86		10.50	16.70	8.40	38.63	0.0041	3.228		0.966	b>3
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Арт	М	21	P<0.05	11.90	15.90	11.20	30.72	0.0029	3.362		0.917	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	May	F	109		11.60	18.00	10.75	47.56	0.0035	3.304	3.156-3.470	0.943	b>3
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		М	29	P<0.05	11.50	16.30	10.32	33.53	0.0031	3.343	2.991-3.878	0.909	b>3
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	June	F	65	3.75:1	12.20	20.50	10.88	70.89	0.0027	3.304	3.199-3.576	0.954	b>3
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		М	36	P<0.05	11.20	17.70	9.18	42.15	0.0019	3.526		0.975	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	July	F	47		12.50	19.80	13.66	58.60	0.0028	3.368	3.199-3.731	0.943	b>3
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		М	13	P<0.05	13.00	17.00	15.47	45.55	0.0022	3.462	2.359-4.010	0.896	b>3
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	August	F	45	3.61:1	13.10	18.90	14.28	53.92	0.0056	3.103	2.799-3.348	0.931	b>3
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	August	М	21	P<0.05	12.60	17.08	12.70	39.10	0.0012	3.693	3.251-4.454	0.9.09	b>3
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	October	F	21		13.60	30.00	17.97	30.00	0.0098	2.909		0.986	b<3
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $				P<0.05	13.00	19.00	14.56	45.58	0.0085	2.979	2.949-3.334	0.827	b<3
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		F	31		12.70	18.00	12.24	49.30	0.0019	3.508		0.959	b>3
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		М	12	P<0.05	12.60	16.20	13.28	33.19	0.002	3.506		0.896	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		F	96		8.60	19.30	4.42	62.16	0.0017	3.599		0.969	b>3
$ \begin{array}{c cccc} \hline December & M & 27 & P < 0.05 & 10.6 & 15.80 & 8.38 & 30.58 & 0.0047 & 3.179 & 2.874 + 3.463 & 0.960 & b > 3 \\ \hline M & 596 & \frac{1.951}{P < 0.05} & \frac{14.78 \pm 0.08}{13.65 \pm 0.08} & 27.54 \pm 0.54 & 0.0036 & 3.268 & 3.237 + 3.303 & 0.971 & b > 3 \\ \hline December & M & 596 & \frac{1.951}{P < 0.05} & \frac{13.65 \pm 0.08}{13.65 \pm 0.08} & 19.95 \pm 0.36 & 0.0036 & 3.273 & 3.215 + 3.334 & 0.954 & b > 3 \\ \hline \end{array} $		Μ	56	P<0.05	8.70	17.50	4.52	42.48	0.0022	3.493		0.943	
M 27 P<0.05 10.6 15.80 8.38 30.58 0.0047 3.179 2.874-3.463 0.960 b>3 Overall F 1167 14.78±0.08 27.54±0.54 0.0036 3.268 3.237-3.303 0.971 b>3 Overall M 596 1.95:1 13.65±0.08 19.95±0.36 0.0036 3.273 3.215-3.334 0.954 b>3	December	F	38		11.1	22.80	10.74	109.7	0.0037	3.282	3.116-3.424	0.983	b>3
Overall M 596 $\frac{1.95:1}{P<0.05}$ 13.65±0.08 19.95±0.36 0.0036 3.273 3.215-3.334 0.954 b>3		Μ	27	P<0.05	10.6	15.80	8.38	30.58	0.0047	3.179	2.874-3.463	0.960	b>3
Overall M 596 $P < 0.05$ 13.65 ± 0.08 19.95 ± 0.36 0.0036 3.273 3.213-3.334 0.954 0.95	Overall	F	1167	1.05.1	14.78±0.08		27.54±0.54		0.0036	3.268	3.237-3.303	0.971	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		Μ	596		13.65±0.08		19.95±0.36		0.0036	3.273		0.954	b>3
		F+M	1763	1 \0.05	14.21±0.08		23.75±0.46		0.0037	3.266	3.239-3.295	0.969	b>3

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).

References	Location	Sex	Sex ratio (F:M)	Length Min-Max	a	b
	Eastern	Ŷ		-	0.0182	2.717
Düzgüneş and Karaçam [19]	Black Sea	ð	2.44:1	-	0.07972	2.220
		Both		13.2-24.9	0.2721	2.573
	Middle	Ŷ	0.87:1	13.57	0.0038	3.248
Samsun [16]	Black Sea	3		13.25	0.0049	3.182
		Both		-	0.0045	3.187
	Eastern	Ŷ		6.6-43.2	0.0046	3.181
Genç et al ., [8]	Black Sea	ð	1.63:1	6.8–30.5	0.0056	3.111
		Both		5.6-43.2	0.0052	3.142
	Black Sea	Ŷ		5.5-32.5	0.004	3.251
İşmen [7]		3	1.32:1	6.5-18.8	0.0044	3.220
		Both		5.5-32.5	0.0042	3.240
	Middle	Ŷ		8.4–31.5	0.0043	3.196
Samsun [6]	Black Sea	ð	1.15:1	8.7-22.9	0.0043	3.193
		Both		8.4–31.5	0.0042	3.201
	Middle	Ŷ		8.8-22.7	0.0070	3.011
Kalaycı et al [20]	Black Sea	8	1.20:1	8.1-22.4	0.0840	2.930
		Both		8.1-22.7	0.0067	3.024

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





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 reproduce is 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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References

- [1] Svetnovidov, A.N. 1986. Gadidae. In: Whitehead, P.J.P., Bauchot, M.L., Hureau, J.C., Nielsen, J., and Tortonese, E. (eds.). Fishes of the North-eastern Atlantic and the Mediterranean. UNESCO, United Kingdom. 1473 pp.
- [2] Başar, E., 1997. Sürmene (Doğu Karadeniz) Koyu'nda Bazı Teleost Balıkların Pelajik Yumurta ve larvalarının Mevsimsel Dağılımı, Yüksek Lisans Tezi, Trabzon, 79s
- [3] Ak, Y., 2000. İzmir Körfezi'nde yasayan bazı teleost balıkların pelajik yumurta ve larvalarının dagılımı ve bollugu üzerine arastırmalar. E.Ü. Fen Bil. Enst. Su Ürünleri Temel Bil. Anabilim Dalı, **Yüksek Lisans Tezi**, 142 s.
- [4] Satılmış, H.H., 2001. Balık Yumurta ve Larvalarının Sinop Yarımadasında Mevsimsel Dağılımı, OMÜ, Su Ürünleri Yetiştiriciliği Anabilim Dalı, **Yüksek** Lisan Tezi, 90 s.
- [5] Çoker, T., 2003. İzmir Körfezi'ndeki Teleost Balıkların Pelajik Yumurta ve Larvalarının Morfolojisi ve Ekolojisi, E.Ü. Fen Bil. Enst., **Doktora Tezi**, 539 s.
- [6] Samsun, S., 2005. Mezgit balığının (*Gadus merlangus euxinus* Nordmann, 1840)
 bazı üreme ve beslenme özellikleri üzerine bir araştırma, Yüksek Lisans Tezi,
 OMU, Fen Bilimleri Enstitüsü, Samsun, Türkiye, 119 s.
- [7] İşmen, A., 1995. The Biology and Population Parameters of the Whiting in the Turkish Coast of the Black sea, **Ph.D. Thesis**, The Middle East Technical University Marine Biology and Fisheries, İçel, Turkey, 182 p.
- [8] Genç, Y., Zengin, M., Başar, S., Tabak, İ., Ceylan, B., Çiftçi, Y., Üstündağ, C., Akbulut, B. ve Şahin, T., 1999. Ekonomik deniz ürünleri araştırma projesi, TKB, Araştırmalar Genel Müdürlüğü, Ekonomik Deniz Ürünleri Araştırma Projesi, SUMEA, 158 s
- [9] Ak, O., Özdemir, G.P., Genç, Y., Kutlu S., Alkan, A., 2008. Trabzon kıyılarında balık yumurta ve larvalarının dağılımı ile ekonomik demersal balıklardan mezgit (Merlangius merlangus euxinus Nordmann, 1840) ve barbunya (Mullus barbatus ponticus, Ess. 1927)'nın yumurta üretiminin incelenmesi. TUBİTAK 106 O 635, Trabzon 169p.
- [10] Özer. A. Erdem. O ve Sezgin. T., 2000. Mezgit balığında (Merlangius merlangus euxinus) görülen Hysterothylacium aduncum (Nematoda: Anisakidae) enfeksiyonu üzerine bir araştırma. Su Ürünleri Sempozyumu. Sinop
- [11] Erkoyuncu. İ. 1995. Balıkçılık Biyolojisi ve Populasyon Dinamiği. Ondokuz Mayıs. Üniv. Yayınları. Samsun. 265 s.
- [12] Ricker. WE.. 1973. Linear regression in fisheries research. J. Fish. Res. Board Can. 30: 409-434.

- [13] Spiegel. M.R., 1991. Theorite et aPPlications de la statistique. McGraw-Hill. Paris. 358 P.
- [14] Anonymus 2008. 36–1 Nolu Su Ürünleri Avlanma Sirkülerleri. 2/1 Nolu Tebliğ İle Getirilen Başlıca Düzenlemeler. Tarım ve Köy İşleri Bakanlığı. Koruma Kontrol Genel Müdürlüğü, Ankara.
- [15] Uysal, A. 1990. Biology and Population Dynamics of Whiting (*Merlangius merlangus euxinus* Nordmann, 1840) in the Area of East Black Sea (Sinop-Hopa), (in Turkish). Doktora Tezi, T.C. İstanbul Üniv. Deniz Bilimleri ve Coğrafya Enstitüsü Deniz Biyolojisi Anabilim Dalı, İstanbul, Türkiye, 65 s.
- [16] Samsun, O., 1995. Investigation of the Whiting (*Gadus merlangus euxinus* Nordmann, 1840) Caught by the Bottom Trawlers in the Fisheries Catching Term of 1991–1994 from the Viewpoint of Fishery Biology, (in Turkish), Süleyman Demirel Üniv. Eğirdir Su Ürünleri Fakültesi Dergisi, Sayı: 4, Isparta, Türkiye, 273–282.
- [17] Samsun, N. 1996. The Research on the Estimation of Some Parameters of Whiting (*Gadus merlangus euxinus* Nordmann, 1840) Caught by the Bottom Trawlers in the Area of Sinop (Black Sea) from the Viewpoint of Fishery Biology, (in Turkish). Yüksek Lisans Tezi, Ondokuz Mayıs Üniv. Fen Bilimleri Enstitüsü, Samsun, Türkiye, 43 s.
- [18] Çiloğlu E., 1997. Vertically Distribution and Population Parameters of *Merlangius merlangus euxinus* Nordmann, 1840 on the East coasts of Trabzon, (in Turkish), Yüksek Lisans Tezi, İstanbul Üniv. FBE, İstanbul, Türkiye, 58 s.
- [19] Düzgüneş, E. ve Karaçam, H., 1990. Doğu Karadeniz'deki Mezgit (*Gadus euxinus* Nord.,1840) Balıklarında Bazı Populasyon Parametreleri, Et Verimi ve Biyokimyasal Kompozisyon, **Doğa-Tr. J. of Zooloji**, 14: 345–352.
- [20] Kalaycı, F., Samsun, N., Bilgin, S. and Samsun, O., 2007. Length-Weight Relationship of 10 Fish Species Caught by Bottom Trawl and Midwater Trawl from the Middle Black Sea, Turkey. Turkish Journal of Fisheries and Aquatic Sciences 7: 33-36.