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Population Parameters of Whiting (*Merlangius merlangus euxinus* L., 1758) in the South-Eastern Black Sea

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Abstract

Whiting (*Merlangius merlangus euxinus* L., 1758) is one of the most commonly distributed species in the entire Black Sea coastal waters of Turkey. Population parameters of whiting were studied using 1884 specimens obtained off the coasts of Sinop, Samsun, Giresun and Ordu provinces (Turkey) in 2009-2010. Average annual length and weight increment was 2.41 cm (17.45%) and 14.99 g (75.47%), respectively. Maximum ages were determined as 5 yrs for females and 4 yrs for males. Mean lengths and weights for male and females were calculated as 14.5±0.06 cm; 22.60±0.274 g and 15.1±0.05 cm; 25.74±0.278 g, respectively. Average length and weight for both sexes were calculated as 14.9±0.04 cm and 24.42±0.201 g. Although females were observed as bigger in size in comparison to males, there was no gender dependent statistical difference in length-weight relationship in which $W=0.0064\ L^{3.0441}$ represents the whole population. Von Bertalanffy growth equation was derived as $L_t=38.16\ (1\text{-}e^{-0,124(t+2,583)})$ for females, $L_t=26.26\ (1\text{-}e^{-0.203(t+2,505)})$ for males and $L_t=33.56\ (1\text{-}e^{-0,141(t+2,654)})$ for both sexes. Instantaneous total mortality, natural mortality and fishing mortality rates were calculated as $Z=1.68\ yr^{-1}$, $M=0.27\ yr^{-1}$, and $F=1.41\ yr^{-1}$. Exploitation rate was $E=0.84\ yr^{-1}$.

Keywords: Whiting, *Merlangius merlangus euxinus*, Eastern Black Sea, population parameters.

Güneydoğu Karadeniz Mezgit Balığının (*Merlangius merlangus euxinus* L., 1758) Popülasyon Parametreleri

Özet

Karadeniz'in Türkiye kıyılarında yayılış gösteren mezgit stoklarının bazı popülasyon parametrelerini tespit etmek amacıyla yürütülen bu araştırmada, toplam 1884 adet balığın yaş, boy, ağırlık, cinsiyet kompozisyonları, boy-ağırlık ilişkisi, kondisyon faktörü, Von Bertalanffy büyüme denklemi ve ölüm oranları incelenmiştir. Boyca ortalama yıllık büyüme oranı 2,4 cm olarak bulunmuştur. Dişiler için maksimum yaş 5, erkekler için 4 olarak bulunmuştur. Ortalama boy ve ağırlık dişi bireyler için 15,10±0,05 cm, 25,74±0,278 g, erkek bireyler için 14,50±0,06 cm, 22,60±0,274 g ve tüm bireyler için 14,85±0,04 cm, 24.42±0.201 g olarak belirlenmiştir. Genel olarak dişiler erkeklerden daha büyük boy ve ağırlık değerine sahiptir. Boy-ağırlık ilişkisi dişi ve erkelerde benzerlik göstermektedir. Genel olarak populasyonda boy ağırlık ilişkisi $W = 0.0064\ L^{3.0441}$ olarak hesaplanmıştır. Von Bertalanffy büyüme denklemi dişi bireyler için $L_t=38,16\ (1\text{-}e^{-0,124(t+2,583)})$, erkek bireyler için $L_t=26,26\ (1\text{-}e^{-0,203(t+2,505)})$ ve tüm bireyler için $L_t=33,56\ (1\text{-}e^{-0,141(t+2,654)})$ olarak hesaplanmıştır. Anlık toplam ölüm katsayısı $Z=1,68\ yıl^{-1}$, doğal ölüm katsayısı $M=0,27\ yıl^{-1}$, avlanma ölüm katsayısı $F=1,41\ yıl^{-1}$ ve işletme oranı $E=0,84\ yıl^{-1}$ olarak bulunmuştur.

Anahtar Kelimeler: Mezgit, *Merlangius merlangus euxinus*, Doğu Karadeniz, populasyon parametreleri.

Introduction

The whiting, *Merlangius merlangus euxinus*, is bento-pelagic or demersal fish belonging to the gadidae family. It is distributed in the western Mediterranean Sea, Black Sea, Aegean Sea and Adriatic Sea (Aksiray, 1987). Whiting has a relatively high fecundity and this species is commonly found near the bottom in waters from 10 to 200 m, but may move into midwater in the pursuit of its prey. Whiting fisheries in Black Sea was mostly occurred by deep trawl and gill nets. Due to the deep trawling fisheries is prohibited in the south-eastern Black Sea whiting fisheries have been mostly done using by gill nets.

Whiting is one of the most abundant and economically important fish. The whiting total catch exceeded 31,000 t in 1988 in the Black Sea. The total catches of whiting was decreased from 31,000 t to

18,000 t in 2000 and 800 t in 2003. The total catch in Black sea was reported as 11,894 t in 2010 (TUIK, 2012). But in recent years there is an increasing trend, except in the Western Black Sea area, as shown in Figure 1.

There were several studies in Turkey on whiting in the Black Sea. These studies investigated the determination of population parameters, meat yield and abundances by Aksiray (1954) and Slastenenko (1956) (distribution and taxonomy); Kutaygil and Bilecik (1979) (catch composition in Kefken-Eregli and Sinop-Çatlı locations); Kara (1980) (abundance off Sinop-Ordu coasts); Duzgunes and Karacam (1990) (population parameters, meat yield and proximate composition); Uysal (1994), Ismen (2002), Sahin and Akbulut (1997) (population parameters in Sinop-Hopa, Trabzon, Surmene, Besikduzu areas); Samsun (2005) (reproduction and feeding), and Ak *et al*. (2009) (length frequency, length weight relationship and sex ratio). There are also several studies in the Black Sea performed by scientists in the riparian countries. Probatov and Ural'skaja (1957), Kaneva and Marinov (1960), Burdak (1964), Dehnik (1973) and Owen (1979) studied on the biology, ripeness, fecundity, spawning, ageing, growth and feeding of whiting in their territorial waters. Prodanov (1980, 1982) worked on age, growth and optimum exploitation level in Bulgarian coasts and Ivanov and Beverton (1985) evaluated stock size and derived population parameters of whiting in the Black Sea.

The majority of these studies were carried out before 2000. Therefore, most of the previous studies did not consider recent changes in population parameters due to the ongoing impact of climate change, pollution and the introduction of invasive species to the Black Sea from the Mediterranean. This research aimed to determine the recent changes in population parameters of whiting in the Eastern Black Sea in order to observe any changes by comparing with the previous findings although assessment and evaluation of the environmental parameters were not targeted and included into the objectives of the survey.

Materials and Methods

Specimens of whiting were monthly collected with gillnets along the South-Eastern Black Sea coast of Turkey between November 2010 and January 2012 within the areas among Sinop, Samsun, Ordu and Giresun (Figure 2). The mesh size, depth, and length of the gill net are 32 mm, 2.73 m and 127.2 m. Sampling depth was varied between 25 and 70 m. In each area the same gill net characteristic was used.

All samples were carried to the laboratory and then total weight and total length of each fish were measured with 0.01 g and 0.1 cm accuracy, respectively. Sex was determined by gonad shape and color.

Otoliths were removed and dried in the laboratory and stored in labeled envelopes. Age was determined by stereo microscope (Nikon 8MZ800) and recorded. In order to prepare otoliths for examination they were removed from the area between two lobes and burned slightly under a spirit flame. In the second stage, they were washed and polished with EDTA 5% solution, then replaced into game paste to observe age rings under stereomicroscope with X3 magnification with lightening from above.

Length and weight relationship was calculated following Le Cren's equation: $W = a L^b$ (Le Cren, 1951) after log transformation. Parameters (a) and (b) were calculated by the least squares method (Ricker, 1975). Bertalanffy growth equations were used to determine the age-length and age-weight relationships of the population (Bertalanffy, 1957; Ricker, 1975). The significance of the differences for the female and male groups and values for length within the same age

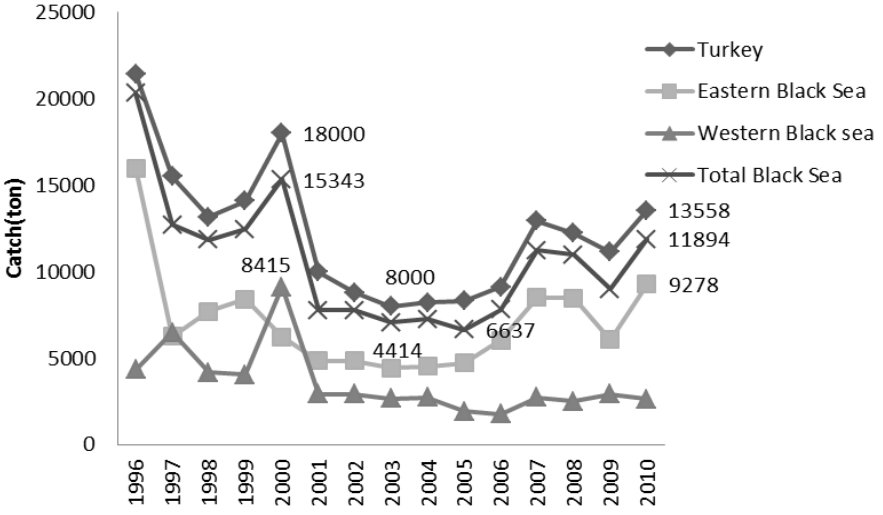

Figure 1. Whiting production in Turkey and in the Black Sea in 1996-2010.

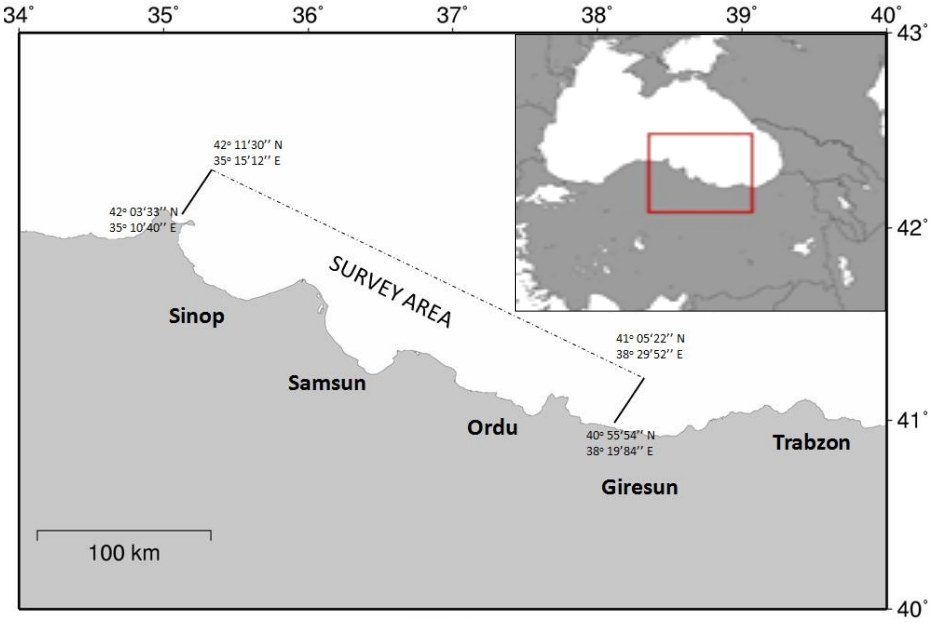

Figure 2. Survey area.

group were tested by student t-test with the probability of P= 0.05.

Fulton Condition Factor (K) and hepatosomatic index (HSI) were derived using the K= (TW/L^3) x 100 equation (Ricker, 1975) and HIS = (LW/TW) x 100. Although they are not very sensitive, they may serve as an initial screening biomarker to indicate exposure and the effects of environmental impacts (i.e. pollution) (EPD, 2007) where TW: total weight (g); L: total length (cm); LW: liver weight (g).

In order to analyze the spawning period based on gonad weight variation, gonadosomatic index (GSI) was calculated as GSI = [GW/(TW-GW)] x 100 where TW is total weight (g) and GW is gonad weight (g).

Total mortality rate (Z) was estimated using the linearized length-converted catch curve method using the growth parameters from the Von Bertalanffy plot as input data (Pauly, 1984). Annual Mortality Rate was determined by A= 1-S (Gulland, 1971; Ricker, 1975) and Mortality Rate (M) was derived by Pauly's (1983) empirical formulae as log M=-0.0066 – 0.279 log L_∞ + 0.6543 log K + 0.4634 log T where L_∞ and K are the VBG parameters, and T is the mean water temperature (8°C) in the habitat of whiting. Fishing Mortality Rate (F) was estimated by F=Z-M (Gulland, 1971). Exploitation Rate of whiting was calculated as E=F/Z (Ricker, 1975).

Phi prime (Ø') was used to evaluate the reliability of L_∞ and K and calculated as Ø'= ln K + 2 ln L_∞ where K and L_∞ are VBG parameters (Munro and Pauly, 1983).

Microsoft Excel®, Fisat II®, and SPSS 18® were used for the calculations, graphics and statistical tests where necessary.

Results

A total of 1884 fish were sampled within the survey period and females (57.9%) were more abundant than males (42.1%). The sex ratio (M:F) was found as 1:1.38 but this difference is not statistically significant according to the Chi-square test so it can be said that sex ratio is 1:1 in the whiting population in the Black Sea.

The majority of the samples were found in the size range of 13-16 cm (Figure 3). Females were abundant in majority of length groups. Mean lengths and weights for male and females were calculated as 14.5±0.06 cm (10.3-21.0); 22.60±0.274 g (6.42-67.16) and 15.1±0.05 (10.1-23.1); 25.74±0.278 g (6.33-96.73), respectively. Corresponding values for both sexes were derived as 14.9±0.04 cm and 24.42±0.201 g (n=1091) (Table 1). The mean size of whiting (14.9±0.04 cm) found in this research was above the legal allowable catch size. There is recruitment overfishing in this region characterized by decreasing proportion of older fish in the catch.

Differences between the lengths of whiting for different ages of each sex were found to be statistically significant (P<0.05) except for the age group "0". Annual absolute increments in length and weight were calculated as 2.41 cm and 14.99 g while relative growth rate was 17.45% in length and 75.47% in weight. Differences between the lengths of whiting for males and females in different ages were found statistically significant (P<0.05) except for the age 0. Females have significantly higher growth rates than males in case of absolute and relative increase rates in 1, 2 and 3 yrs but the differences between males and females were not statistically significant in general (Table 1).

Age-frequencies with mean, range and standard errors and average absolute and relative increments

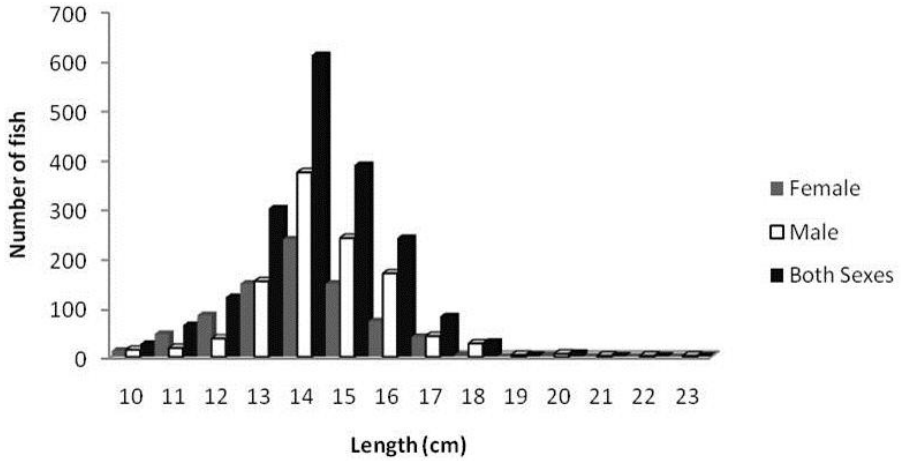

Figure 3. Length-frequency distribution of whiting by sexes in the Eastern Black Sea in 2009-2010.

Table 1. Age, length and weight of whiting in the Eastern Black Sea in 2009-2010

Age (Year)	Sex	N	Length			Weight		
			Mean±SE	AI	RI	Mean±SE	AI	RI
0	M	5	10.4±0.07			7.01±0.247		
	F	5	10.3±0.09			6.72±0.171		
1	M	447	13.5±0.05	3.07	29.49	18.03±0.207	11.01	157.08
	F	591	14.1±0.04	3.79	36.84	20.69±0.181	13.97	208.06
2	M	296	15.6±0.04	2.11	15.64	27.37±0.274	9.34	51.81
	F	452	16.1±0.03	1.95	13.86	29.94±0.257	9.25	44.71
3	M	38	17.5±0.04	1.87	11.98	36.11±0.930	8.75	31.97
	F	31	18.6±0.09	2.55	15.88	46.57±1.109	16.63	55.56
4	M	7	19.2±0.48	1.77	10.12	50.47±4.879	14.35	39.74
	F	10	21.2±0.32	2.61	14.04	65.31±3.991	18.74	40.24
5	M	0	-.	-	-	-.	-	-
	F	2	23.10±0.00	1.89	8.92	96.73±0.000	31.42	48.10
Total	M	793	14.5±0.06	2.21	16.81	22.60±0.274	10.86	70.15
	F	1091	15.1±0.05	2.56	17.91	25.74±0.278	18.00	79.33
	M+F	1884	14.9±0.04	2.41	17.45	24.42±0.201	14.99	75.47

M: males; F: females; AI: Absolute increment, RI: Relative increment

for length and weight by sexes were all derived and summarized in Table 1. According to the age-length and age-weight data mean absolute growth increment by length and weight were calculated as 2.41 cm (17.45%) and 14.99 g (75.47%), respectively.

Figure 4 shows the results of monthly variations of mean length and weight. The best growing season was observed between August and December. Females showed higher mean lengths in November, January, July, August, September and October in comparison to males ($P<0.05$). No significant differences in monthly weight variation were observed for December, February, April, May and June. On the other hand, females have higher mean weights than males in the rest of the year ($P<0.05$).

Length-weight relationship equations were derived as $W = 0.0071L^{3.0017}$ ($n = 793$, $R^2 = 0.8807$) for males, $W = 0.006L^{3.0651}$ ($n = 1,091$, $R^2 = 0.8671$) for females and $W = 0.0064\ L^{3.0441}$ ($n = 1,884$, $R^2 = 0.8772$) for both sexes. Values of "b" show that there is isometric growth in whiting population (Table 2).

Age of whiting samples varied between 0 and 5 in 1884 specimens. The maximum age group determined as 5 yrs for females and 4 yrs for males. Females were dominant in age groups 1 (31.4%) and followed by the age groups 2 (24.0%), 4 (0.5%), and 5 (0.1%). Males were abundant only in age 3 (1.6 %) and have same share in age 0 (0.3%) (Figure 5). Von Bertalanffy growth equations and phi- prime values (Ø') were derived as $L_t=38.16\ (1\text{-}e^{-\ 0,124(t+2.583)})$ for females, $L_t=26.26\ (1\text{-}e^{-0,203(t+2.505)})$ for males and $L_t=33.56\ (1\text{-}e^{-0,141(t+2.654)})$ for both sexes (Figure 4), and growth performances were calculated as Ø'=2.26, Ø'=2.15 and Ø'=2.20, with the same order.

Fulton's conditions factor (K) was estimated monthly to compare the condition of whiting in different sampling periods (Figure 5). The lowest K value was 0.665 in September 2011 and the highest in January 2001 (0.781) while males have the highest value (0.644) in September 2011 and the lowest (0.759) in November 2010. The lower condition factors for both sexes coincide with the intensive

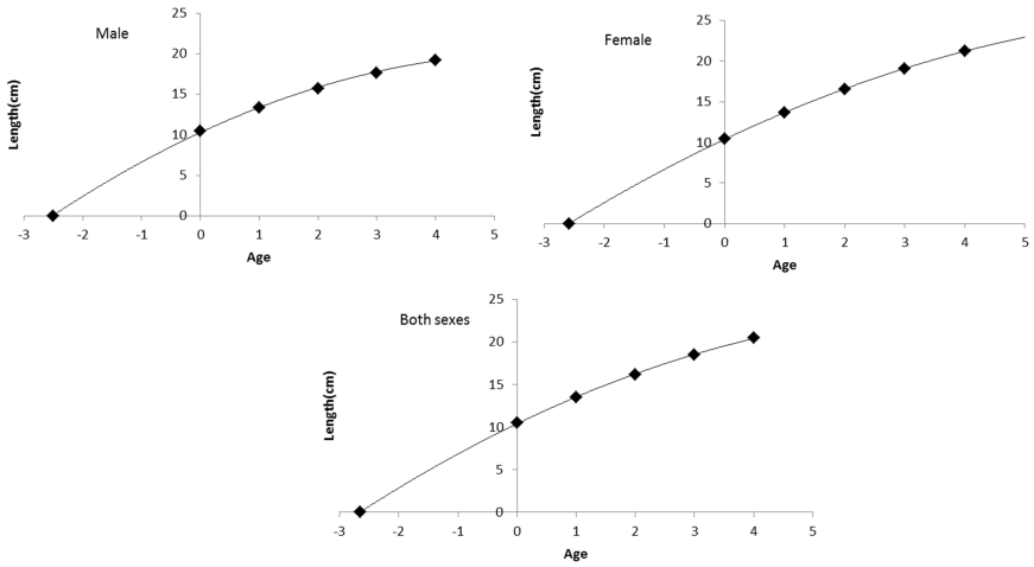

Figure 4. Von Bertalanffy age-length growth curves for whiting.

Table 2. Length-weight equation parameters of whiting

Sex	N	a	b	Growth	R^2
Male	793	0.0071	3.0017	Isometric	0.8807
Female	1091	0.0060	3.0651	Isometric	0.8671
Both sexes	1884	0.0064	3.0441	Isometric	0.8772

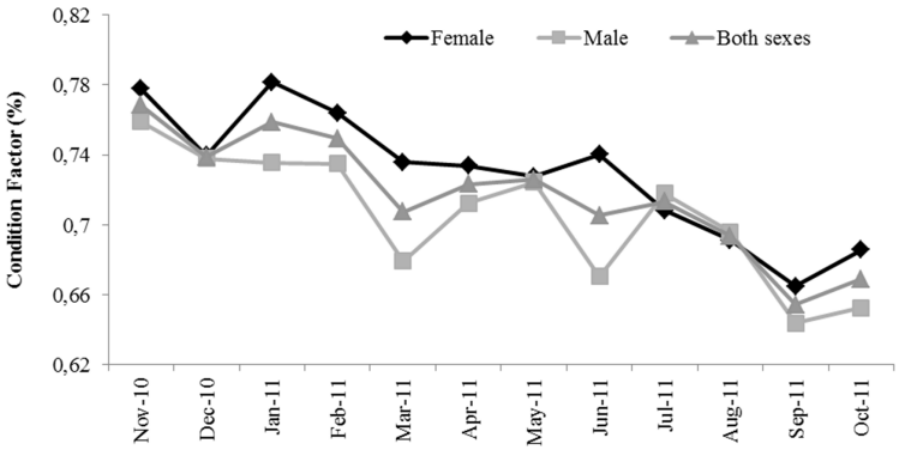

Figure 5. Variation of condition factor for whiting in the survey area.

spawning season from March to July. Lower GSI values in these months also coincide with the lower CF values in the same period. The differences between CF value for males and females in March and June were found to be statistically significant ($p<0.05$). In the rest of the year values of CF were close to each other.

HSI was higher from November to April and lower from May to October with an increasing trend (Figure 6).

Monthly variations in GSI are one of the basic indicators for the determination of reproduction time of fish populations. Spawning mainly took place from March to July in the South-Eastern Black Sea (Figure 7). There are also some indications of autumn spawning to a lesser extent.

Instantaneous total mortality rate (Z) was calculated as 1.68 yr^{-1} from the age frequency data of samples (Figure 8). Survival rate, annual mortality rate, instantaneous natural mortality rate and fishing mortality rate were calculated as follows: S= 0.19 yr^{-1}. A = 0.81 yr^{-1}. M = 0.27 yr^{-1} and F = 1.41 yr^{-1}.

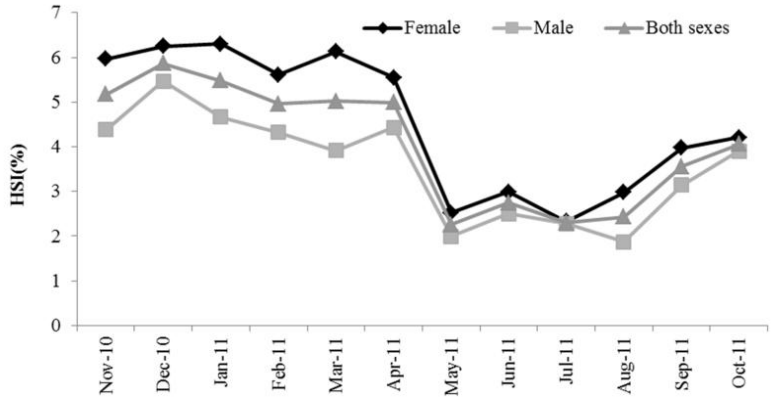

Figure 6. Changes in the Hepatosomatic Index (HSI) of whiting in the survey area.

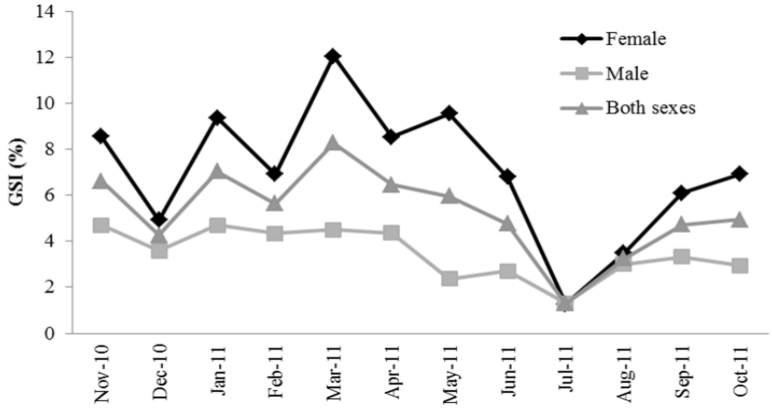

Figure 7. Gonadosomatic index (GSI) for *M. merlangus* in the South-eastern Black Sea Coast.

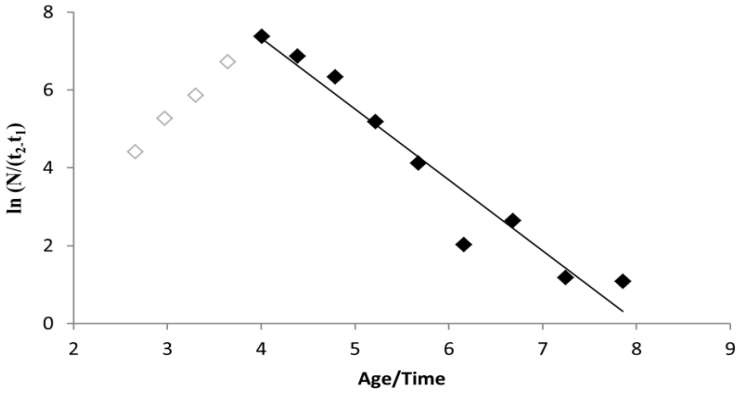

Figure 8. Catch curve for the calculation of Z in whiting population.

Exploitation rate was estimated as E = 0.84 yr^{-1}.

Discussion

The results about sex ratio in present study is also similar with the ratios found by Ismen (2002) and Samsun (2009) in the Black Sea but rather different from the M:F ratio found by Ak *et al*. (2009) as 1.00:1.95.

According to fishery regulations in Turkey, minimum allowable catch size of whiting is 13 cm total length (MFAL, 2011). It is obvious that the mean size of whiting (14.9±0.04 cm) found in this research was above the legal allowable catch size. The reason can be attributed to effective control mechanism of fishery experts in landing port offices and high value of big sized fish in the markets rather than smaller sizes.

Conclusions drawn in this study about growth of whiting as mean length (14.9 cm) for 2010-2011 are close to those of Ozdamar and Samsun (1995) (14.6 cm) for 1994-95, Samsun and Erkoyuncu (1998)

(14.53 cm) for 1995-96, Genc *et al*. (1999) (14.70 cm), Samsun (2005) (15.07 cm); lower than the values given by (Anonymous, 1986) (16.6 cm) for 1985-86, Duzgunes and Karacam (1990) (19.5 cm) for 1989-1990, Samsun *et al*. (1994) (16 cm) for 1988-1989, Aydin (1997) (18.77 cm) and higher than the other studies carried out by Samsun (1995) (13.41 cm) for 1991-1994, Ak *et al*. (2009) (14.21 cm) for 2007-2008, by Ozdemir and Erdem (2011) (13 cm) for 2005-2006. The decrease in mean lengths can be explained with the collapse of fisheries due to the predation of the alien ctenophere, *Mnemiopsis leidyi*, on fish eggs and larvae and overfishing in late 1980's in Turkish fisheries (Kideys, 1994). Another reason may be related to the use of different sampling methodology carried out by different fishing gears (trawl nets and gill nets) and different sampling periods in some of the above mentioned studies.

The functional regression "b" value is closely related with body shape and fish weight which is affected by ecological factors such as temperature, food supply, spawning conditions and the characteristics of habitat within a year (Ismen, 2002). Regression coefficient (b) values were found to be slightly greater than 3 for each sex. But there is no significant difference from b value 3, therefore, it was concluded that whiting shows an isometric growth in the survey period in the Eastern Black Sea.

It was observed that most of the fish over 4 years were females and has greater lengths and weights in line with the results of the previous studies carried out in the same area (Duzgunes and Karacam, 1990; Samsun *et al.*, 1994; Samsun, 1995; Genc *et al*., 1998; Samsun and Erkoyuncu, 1998; Gerritsen *et al.*, 2003). Although total length was used in all previous surveys conducted in the same region, 'b' coefficient was found significantly lower (2.573) in the study carried out by Duzgunes and Karacam (1990). The reason for the difference might be attributed to overfishing and the ecological impacts of *Mnemiopsis leidyii* causing the collapse in fisheries in the 1988-89 fishing season by consuming food of mainly small pelagics and even their eggs and larvae. The growth of fish populations can be directly affected due to changes in food abundance in such habitat. There are insignificant differences in "b" with the studies carried out in the South Eastern Black Sea coasts in different years. Growth of whiting showed positive allometry in all other studies unlikely isometric growth found in the present study. The difference may be the reason of ecological changes causing less food abundance, reduced biodiversity and increasing effect of fishing pressure which have great impact on the existing trophic levels in the Eastern Black Sea as indicated by Cochrane and Garcia (2009).

The lower condition factors for both sexes coincide with the intensive spawning season from March to July. Lower GSI values in these months also coincide with the lower CF values in the same period. The differences between CF value for males and females in March and June were found to be statistically significant ($p<0.05$). In the rest of the year values of CF were close to each other. Mean CF of 0.717 in the present study is higher than the previous research data given by Duzgunes and Karacam (1990) (0.704) but lower than the findings of Samsun *et al*. (1994) (0.740), Samsun (1995) (0.810), and Samsun and Erkoyuncu (1998) (0.740). These differences may also be the evidence of changes in the Black Sea ecosystem.

The Hepatosomatic Index (HSI) provides an indication on status of energy reserve in an animal. In a poor environment, fish usually have a smaller liver with less energy reserve (EPD, 2007). The decreasing section from March to July can also be attributed to energy loss due to reproduction activities of whiting in that period.

The estimated growth parameters of the present and previous surveys conducted in South Eastern Black Sea since the late 1970's are given in Table 3. In this study L_∞ of female is greater than the male showing the similarity with the results given by Uysal (1994), Sahin and Akbulut (1997), Genc *et al.* (1999), Ciloglu and Sahin (2001), Ismen (2002), Samsun (2005). The maximum asymptotic lengths were given by Uysal (1994), Sahin and Akbulut (1997), Genc *et al.* (1999) from about 45 cm to 33 cm showing a decreasing trend. Ø' values found in this research ($Ø'_F$=2,26, $Ø'_M$=2,15, $Ø'_{F+M}$=2,20) are similar to those given by Ozdamar and Samsun (1995), Bingel *et al*. (1996), Genc (2002) and Samsun (2005) which represents similar growth patterns. However Uysal (1994) and Ciloglu and Sahin (2001) reported higher Phi prime values showing faster growth rate and highest maximum lengths (L_∞) for whiting in their surveys in the same location (Table 3).

Total mortality (Z) values according to the reports of Ismen (2002) for the years of 1990, 1991 and 1992 as 2.18 yr^{-1},1.43 yr^{-1} and 1.29 yr^{-1} , respectively; Uysal (1994) as 1.28 yr^{-1} (Sinop-Giresun) and 1.17 yr^{-1} (Giresun-Hopa); and Genc (2002) as 0.86 yr^{-1}. Maximum Z estimate given by Bingel *et al*. (1996) as 4.25 yr^{-1} showing the main irregular value which can be attributed to the different methodology applied for the estimation of this parameter.

In terms of natural mortalities, Prodanov (1980) stated that M was between 0.4 yr^{-1} and 0.5 yr^{-1} in Bulgarian territorial waters. According to the research carried out by Ismen (2002) in the Black Sea, M was reported as 0.43 yr^{-1}, 0.38 yr^{-1} and 0.36 yr^{-1} for the years of 1990, 1991 and 1992, respectively. M was given as 0.29 yr^{-1} by Samsun *et al*.(1994) in the Eastern Black Sea. Uysal (1994) stated M was 0.31 yr^{-1} and 0.32 yr^{-1} for the locations from Sinop-Giresun and Giresun-Hopa respectively. M was found as 0.29 yr^{-1} for the same area obtained by Samsun (1995). Ozdamar and Samsun (1995) found the M value to be 0.38 yr^{-1} for Samsun Bay, Samsun and Erkoyuncu (1998) derived the M value as 0.26 yr^{-1} in the Sinop

Table 3. Population parameters of anchovy in the Eastern Black Sea

	Area	b	L_∞	t_o	Ø'	Z	M	A	S	F	E	K	Seasons
Prodanov (1980)	Bulgaria	♀+♂-	31.8	-2.488	2.12		0.4-0.5						1979-1980
Samsun *et al*. (1994)	Cent.Black Sea	♀+♂3.196	40.04	-1.5275	2.36	1.20	0.29	0.70	0.30	-	0.76	0.740	1988-1989
Düzgüneş and Karaçam (1990)	Eastern Black Sea	♀+♂2.573	31.90	-1.9705	2.32	1.41	-	0.76	0.24	-	-	0.704	1989-1990
Uysal (1994)	Central	♀+♂-	49.1	-1.24	2.42	1.17	0.31	-	-	0.86	0.73	-	1991-1992
	Black Sea	♀+♂-	41.8	-2.16	2.39	1.28	0.32			0.96	0.75		1992-1993
Bingel *et al*. (1996)	Black Sea	♀+♂-	33.6	-0.54	2.25	4.25	-	-	-	3.67	0.86	-	1991-1992
						3.59				3.00	0.84		1992-1993
İşmen (2002)	Black Sea	♀3.250	37.3♀	-0.97	2.37	2.18	0.43	-	0.114	1.74	0.74		1990-1991
		♂3.220	29.1♂	-1.05	2.13	1.43	0.38		0.240	1.05	0.73		1991-1992
		♀+♂3.240	37.9♀+♂	-1.05	2.36	1.29	0.36		0.275	0.93	0.72		1992-1993
						1.63	0.39		0.210	1.24		0.0094	1990-1993
Samsun (1995)	Cent.Black Sea	♀+♂3.187	39.73	-1.3076	2.37	2.01	0.29	0.86	0.14	1.72	0.86	0.810	1991-1994
Özdamar and Samsun (1995)	Central Black Sea	♀+♂3.158	29.89	-1.4393	2.26	1.36	0.38	0.74	0.26	0.98	0.72	-	1994-1995
Samsun and Erkoyuncu (1998)	Central Black Sea	♀+♂3.238	35.45	-2.0428		1.15	0.26		0.20	0.89	0.77	0.740	1995-1996
Genç *et al*. (1999)	Eastern	♀3.181	43.26	-1.912	2.31	1.05	0.23	-	-	0.82	0.78	-	1988-1996
	Black Sea	♂3.111	34.24	-2.02	2.20								
		♀+♂3.142	43.74	-1.962	2.29								
Şahin and Akbulut	Eastern	♀3.151	45.356	-1.8063	2.32	-	-	-	-	-	-	0.731	1996-1997
(1997)	Black Sea	♂3.110	35.925	-1.8067	2.21							0.732	
Çiloğlu *et al*. (2001)	Eastern	♀3.259	52.50	-1.759	2.40	-	-	-	-	-	-	-	1996-1997
	Black Sea	♂3.206	37.19	-2.39	2.20								
Genç (2002)	Eastern Black Sea	♀+♂3.08	39.50	-2.21	2.25	0.86	0.25	-	-	0.61	0.71	-	1998-2000
Samsun (2005)	Central	♀3.196	39.00	-2.219	2.24	1.34	0.23	0.26	0.74	1.11	0.83	-	2001-2003
	Black Sea	♂3.193	32.29	-2.338	2.17								
		♀+♂3.201	39.00	-2.193	2.24								
Kalaycı *et al*. (2007)	Cent.Black Sea	♀+♂3.024	-	-	-	-	-	-	-	-	-	-	2004-2005
Ak *et al*. (2009)	Eastern Black Sea	♀+♂3.266	-	-	-	-	-	-	-	-	-	-	2007-2008
This research	Central Black Sea	♀+♂3.044	38.16♀	-2.583	2.26	1.68	0.27	0.81	0.19	1.41	0.84	0.717	2010-2011
			26.26♂	-2.505	2.15								
			33.56♀+♂	-2.654	2.20								

region, and finally Genc *et al*. (1999) reported M value as 0.25 yr^{-1} for the Black Sea. M estimation in the present research is 0.27 yr^{-1}, which is a similar value to those recent studies given above, indicating that the F rate is increasing in the total mortality rate Z.

Conclusion

Autors believe that present study provide updated data regarding whiting population living in the South-eastern Black Sea. The results could be used as a baseline for further studies. On the other hand, regular monitoring studies are essential to understand the dynamics of exploited whiting stocks under the pressure of environmental changes in the Black Sea ecosystem. Moreover, the exploitation rate of whiting population in the Black Sea was found high as 0.84 in this study. This figure indicates that there was recruitment overfishing in this region. Therefore, whiting fishery needs new regulation measures and management plans for the sustainable fisheries.

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