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# Exploitation Rate of Whiting, *Merlangius merlangus* (Linnaeus, 1758) in the Central Black Sea, Turkey

# Orta Karadeniz'de (Türkiye) Mezgit Balığının *Merlangius merlangus* (Linnaeus, 1758) Sömürülme Oranı

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## ABSTRACT

This study provides some actual information such as length, weight, age and mortality rates of whiting population in the Central Black Sea in order to detect whether fishing pressure or not. A total of 1495 whitings from the Central Black Sea were monthly collected from commercial coastal gillnet and bottom trawl fisheries, which have landed at Sinop fishing ports between September 2016 and January 2017. Total length and weight of whiting specimens were ranged from 8.8 cm to 22.8 cm (average: 14.97 ±0.04 cm), and 5.3 g to 83.2 g (average: 27.4 ±0.25 g). The samples grouped densely between 13 and 16 cm length. In this study, 89% of all samples are over legal size. The LWR equation was $W = 0.0113 \times TL^{2.8656}$ ($R^2 = 0.9243$). Age groups of whiting in the Central Black Sea were between I and IV. Mean lengths according to age groups (I, II, III and IV) were 13.7 ±0.23, 15.9 ±0.08, 18.2 ±0.16 and 21.6 ±0.34, respectively. Also, von Bertalanffy Growth Parameters were $L_\infty$ = 28.69 cm, K = 0.21 year$^{-1}$, $t_0$ = -1.91 year$^{-1}$. Mortalities (M, F and Z) and exploitation rate (E) of whiting from the Central Black Sea were 0.502 year$^{-1}$, 0.468 year$^{-1}$, 0.970 year$^{-1}$ and 0.48 year$^{-1}$, respectively. The rates of exploitation and minimum landing size indicate that there is no overfishing on whiting population in the area for the time being.

**Keywords:** Whiting, *Merlangius merlangus*, length, weight, mortality rate, exploitation, the Black Sea.

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## ÖZET

Bu çalışma, Orta Karadeniz'de mezgit populasyonunun balıkçılık baskısına maruz kalıp kalmadığının belirlenmesi için boy, ağırlık, yaş ve ölüm oranları gibi güncel bilgileri sağlamaktadır. Toplam 1495 mezgit bireyi Eylül 2016-Ocak 2017 tarihleri arasında Sinop limanına getirilen ticari kıyı uzatma ağları ve troller tarafından yakalanmış balıklardan aylık olarak örneklenmiştir. Mezgit bireylerinin toplam boy ve ağırlıkları 8,8 - 22,8 cm (ortalama: 14,97 ±0,04 cm), ve 5,3 g - 83,2 g (ortalama: 27,4 ±0,25 g) arasında değişmiştir. En fazla örneğin bulunduğu boy sınıfı 13-16 cm'dir. Çalışmada, incelenen örneklerin %89'u yasal boyun üzerindedir. Boy-ağırlık ilişkisi eşitliği $W = 0.0113 \times TL^{2.8656}$ ($R^2 = 0.9243$) olarak hesaplanmıştır. Orta Karadeniz'de mezgitin yaş grupları I ve IV arasında olup, yaş gruplarına göre ortalama boylar sırasıyla 13,7 ±0,23, 15,9 ±0,08, 18,2 ±0,16 ve 21,6 ±0,34 cm olarak belirlenmiştir. von Bertalanffy büyüme parametreleri $L_\infty$ = 28,69 cm, K = 0,21 yıl$^{-1}$, $t_0$ = -1,91 yıl$^{-1}$ olarak hesaplanmıştır. Mezgitin ölüm (M, F ve Z) ve sömürme oranı (E) sırasıyla 0,502 yıl$^{-1}$, 0,468 yıl$^{-1}$, 0,970 yıl$^{-1}$ ve 0,48 yıl$^{-1}$ olarak hesaplanmıştır. Sömürme oranı ve minimum karaya çıkarma boyu mezgit populasyonları üzerine şimdilik bir aşırı avcılık baskısı olmadığını göstermektedir.


**Anahtar sözcükler**: Mezgit, *Merlangius merlangus*, boy, ağırlık, ölüm oranı, sömürme, Karadeniz.

## 1. INTRODUCTION

Whiting, *Merlangius merlangus* (Linnaeus, 1758) is a benthopelagic fish species and inhabits mainly muddy or hard substrate but found also among rocks and sandy bottom at depth of 10-200 m (usually 30-100 m). They feed on crustaceans, molluscs and small fish. Spawning season is in winter and spring. Larvae and juveniles are associated with jellyfish. Young live closer to shore (5-30 m). Size to 70 cm SL, usually 30-40 cm; smaller in the Black Sea (to 58 cm), usually 15-20 cm. *M. merlangus* is Atlanto-Mediterranean from south-eastern Barents Sea and Iceland to Portugal, also in the Black Sea, adjacent parts of Azov Sea, Sea of Marmara, Aegean Sea, Adriatic Sea and adjacent areas. Rare in the north-western Mediterranean (Svetovidov, 1986; Golani et al., 2006; Froese and Pauly, 2017).

Whiting is a commercial fish species along the coasts of Black Sea and it is mainly caught by trawl and gillnets along the Turkish coasts of the Black Sea. Erdoğan-Sağlam and Sağlam (2012) stated that whiting fisheries in Black Sea was mostly carried out by bottom trawl and gill nets and since the bottom trawling fisheries has been prohibited in the south-eastern Black Sea; whiting fisheries have been mostly done using by gill nets in the area.

The annual catch of whiting exceeded 31.000 tons in 1988 in the Black Sea. The total catches of whiting were decreased to 18.000 tons in 2.000 and then, 800 tons in 2003. In the last decade, whiting catches in Turkey fluctuated between 7.367 tons in 2012 and 13.558 tons in 2010. The sequential annual catch records indicated that whiting production tends to increasing in the last years. The total catch of whiting in the Black sea was reported as 8.240 tons in 2013. A recent fishery statistic shown that a total of 13.158 tons of whiting was

fished from Turkish seas, mostly the Black Sea (12.611 tons) in 2015 (TUIK, 2015).
Catch amount of whiting in the Black Sea is about 96% in all whiting production of Turkey (TUIK, 2015). As seen, there is an intensive fishing on whiting stocks in the Black Sea. Thus, this study provides some actual information such as length, weight, age and mortality rates of whiting population in the Central Black Sea in order to detect whether fishing pressure or not.

## 2. MATERIAL AND METHOD

A total of 1495 whiting from the Central Black Sea were monthly collected from commercial coastal gillnet and bottom trawl fisheries, which have landed at Sinop fishing ports between September 2016 to January 2017.
Total length (TL) and weight of fish has been measured to nearest ± 0.1 cm and ± 0.1 g. Length-weight relationship (LWR) was computed from the following formula: $W = a \times TL^b$. Where TL is total length, W is weight, *a* and *b* are constants.
A total of 105 otoliths were used for ageing. Sagittal otoliths were removed, wiped clean, and stored dry, and then otoliths were placed in glycerol and were examined (10X magnification) under reflected light using a binocular microscope (SOIF XSZ-7GX).
Natural mortality of whiting was computed from Pauly (1980)'s following multiple regression formula: $\ln M = -0.0152 - 0.279 * \ln L_\infty + 0.6543 * \ln K + 0.463 * \ln T$. Where M is natural mortality in a given stock, $L_\infty$ is asymptotic length, K is growth coefficient and the value of T is the annual mean temperature (in ºC) of the sea water. Non-seasonal growth parameters, $L_\infty$ and K, were estimated with von Bertalanffy growth formula in the FISAT (FAO-ICLARM Stock Assessment Tools) computer programme (Gayanilo et al., 1994). Mean annual temperature (T) for the Black Sea was obtained from Turkey's Statistical Yearbook (TUIK, 2010).
Total mortality (Z) was estimated from the mean size in the catch, developed by Beverton and Holt (1957). Z can be estimated from mean length in the catch from a given population by means of $Z = K (L_\infty - L_{mean}) / (L_{mean} - L_c)$. Where $L_\infty$ and K are parameters of the von Bertalanffy growth equations; Erkoyuncu (1995) stated that if $L_c$ is not available, L' can use in the formula instead of the $L_c$, i.e. $L_c = L'$. $L_{mean}$ is the mean length computed from L' upward, the latter being a length not smaller than the smallest length of fish fully represented in catch samples (Pauly and Soriano, 1986). Note that L' is the lower limit of the corresponding length interval (Sparre and Venema, 1998).
Fishing mortality (F) can be estimated from F=Z-M. Once values of F and M are available, an exploitation ratio (E) can be computed from E = F / Z. Which allows one to assess if a stock is overfished or not, on the assumption that the optimal value of E ($E_{opt}$) is about equal to 0.5 (Pauly, 1980). All of the means were given with standard error (± SE).

## 3. RESULTS

Length and weight of whiting specimens were ranged from 8.8 cm to 22.8 cm (average: 14.97 ±0.04 cm), and 5.3 g to 83.2 g (average: 27.4 ±0.25 g). The samples grouped densely between 13 and 16 cm (Figure 1).
Minimum landing size (MLS) is 13 cm for whiting according to Turkish Fisheries Regulation Circular (TFRC). Thus, 11% of all samples in this study are under legal size (Figure 2).
The LWR equation calculated was $W = 0.0113 \times TL^{2.8656}$ ($R^2 = 0.9243$) (Figure 3). As seen, there is a negative allometry in terms of *b* value.
Age groups of whiting in the Central Black Sea were ranged from I to IV. Mean lengths according to age groups were 13.7 ±0.23, 15.9 ±0.08, 18.2 ±0.16 and 21.6 ±0.34, respectively. von Bertalanffy Growth Parameters were $L_\infty = 28.69$ cm, K

= 0.21 year$^{-1}$, $t_0$ = -1.91 year$^{-1}$ (Figure 4). Mortalities (M, F and Z) and exploitation rate (E) of whiting from the Central Black Sea were 0.502 year$^{-1}$, 0.468 year$^{-1}$, 0.970 year$^{-1}$ and 0.48 year$^{-1}$, respectively. The mean annual habitat temperature (T), $L_{mean}$ and L' were assumed as 16ºC, 14.97 cm and 12 cm, respectively.

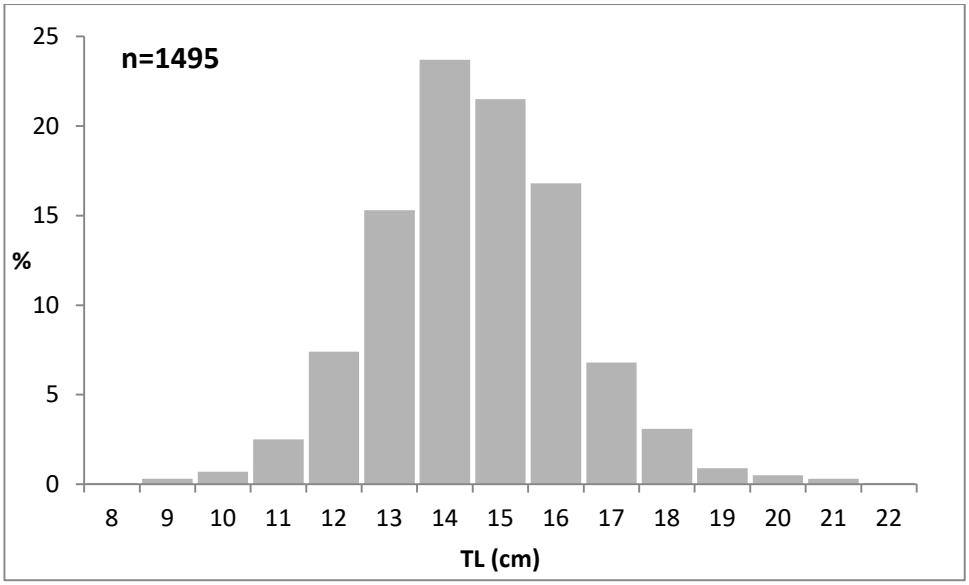


**Figure 1.** Length frequency of *Merlangius merlangus* in the Central Black Sea.

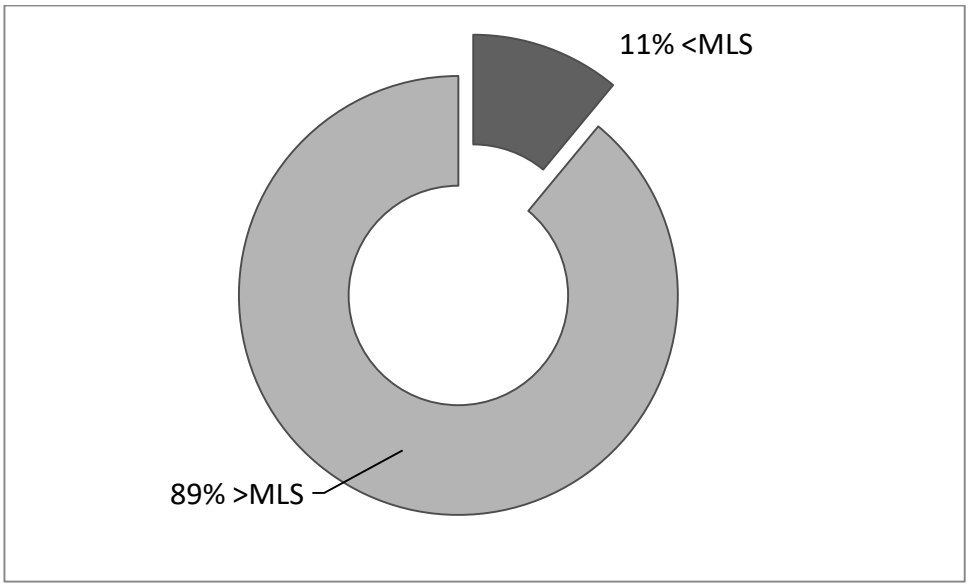


**Figure 2.** MLS percentages for *Merlangius merlangus* in the Central Black Sea.

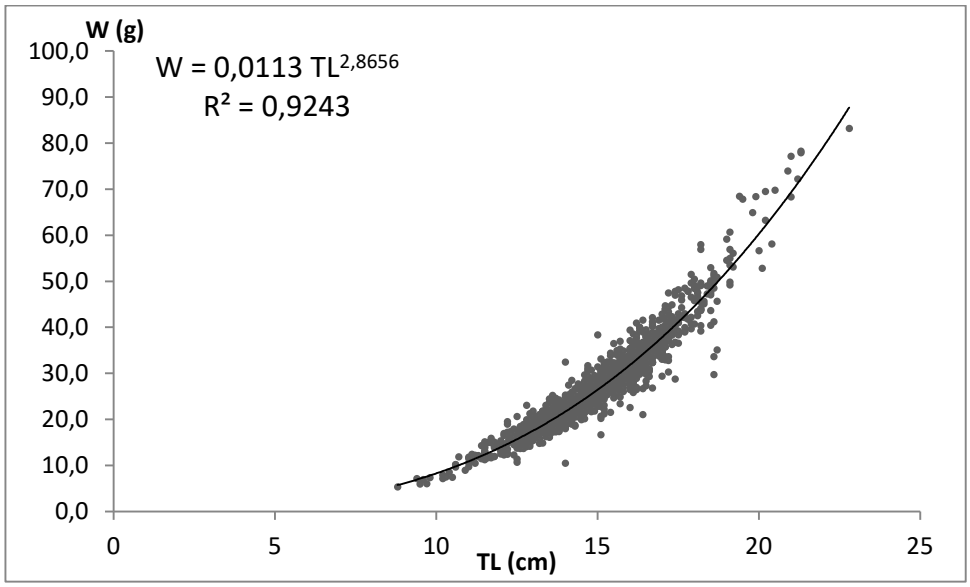


**Figure 3.** Length-weight relationship of *Merlangius merlangus* in the Central Black Sea.

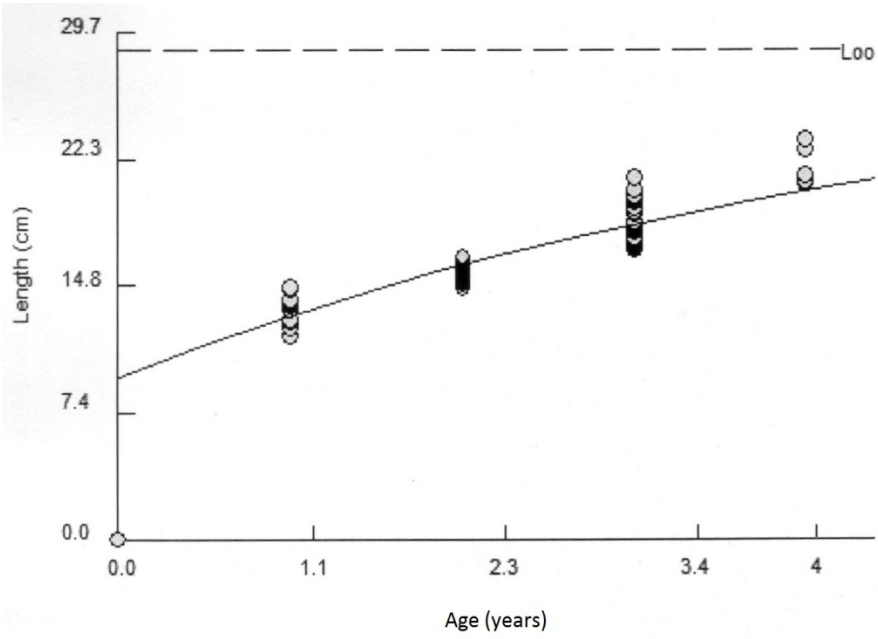


**Figure 4.** Age-length curve of *Merlangius merlangus* in the Central Black Sea.

## 4. DISCUSSIONS AND CONCLUSIONS

LWR of whiting seems that there is a negative allometric growth (*b* = 2.87). Other LWR parameters and minimum and maximum lengths and weights of whiting in the Black Sea were shown in Table 1. In previous LWR studies, *b* values of whiting shown positive allometry, while there were negative allometry in the last two studies. As you know, *b* value is concerning with body thickness or plumpness in most of fishes (*see*, Froese, 2006) and thus, the fish may not be fed enough in recent years. However, it should be taken into accounted the reproduction status during the sampling period. The fishes in this study (sampling period: from September to January) might be caught in before or after spawning. Golani et al. (2006) reported that the spawning season of whiting is winter and spring.

**Table 1.** Substantial LWR records of whiting in the Black Sea.

| Authors | Area | n | $L_{min}$-$L_{max}$ | $W_{min}$-$W_{max}$ | *a* | *b* | $R^2$ |
|---|---|---|---|---|---|---|---|
| Samsun and Erkoyuncu (1998) | C. Black Sea | 1302 | 9-24 | 5.7-118.7 | 0.0039 | 3.238 | 0.94 |
| Çiloğlu et al. (2001) | SE Black Sea | 1122 | 11-30.4 | 8.23-283.8 | 0.0037 | 3.259 | 0.96 |
| İşmen (2002) | Black Sea | 7357 | 10.8-30.6 | - | 0.0042 | 3.240 | 0.98 |
| Göksungur and Erdem (2005) | Marmara | 920 | 9.6-22.2 | 14.9-125.4 | 0.0050 | 3.140 | - |
| Kalaycı et al. (2007) | C Black Sea | 904 | 7.7-22.7 | 3-79.8 | 0.0067 | 3.025 | 0.96 |
| Ak et al. (2009) | E Black Sea | 943 | 6.7-29.5 | 2.2-241.2 | 0.0040 | 3.169 | 0.96 |
| Samsun (2010) | C Black Sea | 2006 | 8.4-31.5 | 3.4-259 | 0.0043 | 3.202 | 0.94 |
| Yankova et al. (2011) | Bulgaria | 3715 | 5.5-22.5 | 1.1-80.9 | 0.0040 | 3.151 | 0.99 |
| Erdoğan-Sağlam and Sağlam (2012) | SE Black Sea | 1884 | 10.3-21 | 6.4-67.2 | 0.0064 | 3.044 | 0.88 |
| Özdemir and Duyar (2013) | SE Black Sea | 426 | 9.4-17 | 6-34.5 | 0.0104 | 2.856 | 0.93 |
| This study | C Black Sea | 1495 | 8.8-22.8 | 5.3-83.2 | 0.0113 | 2.866 | 0.92 |

Age groups of whiting in the present study were ranged from I to IV; the largest group was III. Erdoğan-Sağlam and Sağlam (2012) reported that age groups of I and II accounted for the majority of the whiting population in the Eastern Black Sea. However, whiting can be reached the age IX in the Black Sea (Çiloğlu et al., 2001; İşmen, 2002). $L_\infty$ value (28.69 cm) is closer to that obtained by Erdoğan-Sağlam and Sağlam (2012) study (33.6 cm), whereas, lower than that calculated (38.4 cm) by Çiloğlu et al. (2001) and İşmen (2002) (39.1 cm). In both studies, length ranges of the fish, sampled had the larger size. Thus, this variation may be due to the maximal sizes.

The estimate of fishing mortality (F = 0.468) is some lower than natural mortality (M = 0.502), and according to exploitation rate (E = 0.48), whiting fishery seems stable. Namely, there is no overfishing on whiting population in the area for the time being. Whereas, previous studies (Samsun and Erkoyuncu, 1998; İşmen, 2002; Erdoğan-Sağlam and Sağlam, 2012) reported that there was heavy fishing pressure on whiting stocks in the Black Sea (E value was between 0.76 and 0.84). In fact, the last TFRC (no. 2016/35) banned the trawl fishery along the Sinop and the most area of eastern Black Sea. When the trawl pressure on whiting stocks is declined due to the banning, E value may have also decreased.

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