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Some Biological Parameters of Round Herring, *Etrumeus teres* (De Kay, 1842) in the Gulf of Antalya (Mediterranean Sea)

Raziye Yılmaz, Belgin Hoşsucu

Ege University, Faculty of Fisheries, Department of Hydrobiology, 35100, Izmir, Turkey

Özet: ***Antalya Körfezi'ndeki Kalem Sardalyası'nın,* Etrumeus teres *(De Kay, 1842), bazı biyolojik özellikleri.*** Antalya Körfezi'nde populasyonu gittikçe artmakta olan *Etrumeus teres* Doğu Akdeniz'e Kızıl Deniz'den göç eden (Lesepsiyen) bir balık türüdür. *E. teres* türünün Akdeniz'e yerleşmesi ekosistemdeki diğer türlerle gireceği rekabet ihtimali açısından populasyonun izlenmesini gerektirmektedir. Konuyla ilgili yeterli araştırma olmaması nedeniyle bu çalışma gerçekleştirilmiştir. Antalya Körfezi'nden 438 adet *E.teres* bireyinin boy, büyüme, yaş kompozisyonu, kondüsyon faktörü, eşey oranı incelendi. Dişiler bireylerin %55.7'sini, erkekler %44.3'ünü oluşturdu. Min ve max. standart boy dişiler için 9.5-22.5 cm, erkekler için 9.5-21.5 cm'dir. Populasyonda en yoğun çıkan boy grubu dişiler için 15.5-17.5 cm ve erkekler için 16.5-17.5 cm'dir. Populasyonda yaşa göre ortalama standart boy değerleri dişi, erkek ve hepsi için sırasıyla I yaş için 14.50, 13.96, 14.23 cm; II yaş için 17.91, 17.90, 17.90 cm; III yaş için 20.89, 20.87, 20.88 cm'dir. Boy-ağırlık ilişkileri erkek, dişi ve tüm bireyler için sırasıyla $W= 0.00834\ L^{3.1683}$, $W= 0.00787\ L^{3.19108}$ ve $W= 0.00942\ L^{3.12159}$ .Aynı zamanda korelasyon katsayısı 0.99'dur. Büyüme parametre hesapları tüm bireyler için von Bertalanffy'ye göre $L\infty= 33.77$ cm, $K= 0.20$, $t_0= -1.6313$ olarak hesaplandı. Bireyler I ve III yaş arasında olup bunların %44.47'si I yaş ve %47.91'i II yaşında bulundu. Kondüsyon faktörleri I, II ve III yaş için sırasıyla 1.31, 1.35, 1.43 olarak saptandı.Yaş, eşey ve aylara göre bu verilerin istatistik analizleri yapıldı ve bütün gruplar için istatistiksel önemi saptandı. İstatistiki açıdan kondüsyon faktörü yaşa ve aylara göre önemli, eşeye göre önemsiz bulundu.

Anahtar Kelimeler: *Etrumeus teres*, büyüme, yaş, kondüsyon faktörü, Antalya Körfezi.

Abstract: *Etrumeus teres*, whose population in the Gulf of Antalya is gradually increasing, is a fish species which migrates from the Red Sea to the Eastern Mediterranean. The settling of the *E. teres* species in the Mediterranean makes a close observation of its population necessary from the point of view of the possible competition into which it may enter with other species of the eco-system. This study was carried out due to the lack of sufficient research on this subject. The length, growth, age composition, condition factors, and sex ratio of *E. teres* were studied on the basis of 438 specimens from the Gulf of Antalya. Females made up 55.7% and males 44.3% of the species. Min. and max. standard length was 9.5-22.5 cm in females, 9.5-21.5 cm in males. In the population the average standard length values according to age for females, males and all specimens combined at age I were 14.50, 13.96, 14.23 cm respectively; at age II these were 17.91, 17.90, 17.90 cm; at age III they were 20.89, 20.87, 20.88 cm The length-weight relationships estimated for males, females and all fish were $W= 0.00834\ L^{3.1683}$, $W= 0.00787L^{3.19108}$ and $W= 0.00942L^{3.12159}$ respectively. Growth parameter estimates $L\infty= 33.77$ cm, $K= 0.20$, $t_0 = -1.6313$ were calculated according to von Bertalanffy for all fish. Individuals were between I and III years old and 44.47% of them were I year old and 47.91% of them were II years old. The condition factor was found to be significant in relation to age and months, but nonsignificant in relation to sex.

Key Words: *Etrumeus teres*, growth, age, condition factor, Gulf of Antalya.

Introduction

The Gulf of Antalya is located in the Mediterranean Sea, which among all Turkish seas has the greatest variety of the Lessepsian species. Whereas *E. teres* (Clupeidae), whose population is steadily increasing, is generally cosmopolitan, here it is a species, which migrates (Lessepsian) from the Red Sea to the Eastern Mediterranean Sea (Whitehead, 1985; Golani, 1996). While this species is just beginning to attract attention from an economic point of view as regards the Gulf of Antalya's fishing industry, because it is exploited together with sardines there is no definite record of its production amount. However, according to unofficial fish market records (1997) this figure is known as 360 tons. Particularly in Japanese and South African as well as Red Sea fishing the amount of this fish caught in 1983 was 110.084 tons (Shaw and Drullinger, 1990).

E. teres, like sardine, is a commercially important pelagic fish and may form shoals with other pelagic species such as *Sardinella aurita* and *Trachurus lathami*. These undertake daily vertical migrations and are found on the surface at night and at depths of 9-37 m in the daytime. This planktonic feeder species is distributed far away from the coast (56-183 m) in summer and autumn, and near to the coast in winter and spring, the juveniles being found in medium depth waters and the larvae near the surface (Shaw and Drullinger 1990).

In studies by Bigelow and Schroeder (1953), Fore (1971), Houde (1977), Hildebrand (1963), Jones *et al* (1978), O'Toole and King (1974), Sylva and Davis (1963), Uchida (1958), Watson and Leis (1974), Cisneros *et al* (1990), some information has been given about the morphology, reproduction, ichthyoplankton and population parameters of the *E. teres*.

This species was first detected on the coast of Turkey in İskenderun Bay by Başusta and Mater (1997) and there is also an identification key by Akşıray (1987), which reports this species being found on the south coasts of Turkish Seas.

There is no research available on the biology of the *E. teres* species on Turkey's coasts. The aim of this study is to present some biological characteristics of the *E. teres* species obtained from the Gulf of Antalya.

Materials and Methods

438 round herring were obtained from among fish caught using purse-seines in Gulf of Antalya over a 7 month period from November 1997-May 1998 (Figure1). The satandard length (cm), weight (g.) and age of samples were determined. Because the fishes'sacales fell away easily and reliable results could not be obtained from age determination, otoliths were used to estimate age.

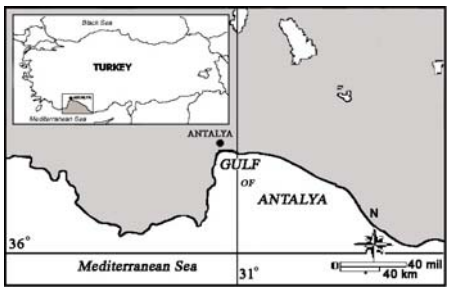

Figure 1. Study area, Gulf of Antalya.

Length-weight relationship was calculated according to the $W= a L^b$ equation (Gulland 1969), growth according to the $L_t= L_\infty[1-exp^{-k(t-t_0)}]$ formula (Von Bertalanffy 1957), condition factor (CF) according to the $CF= W.10^5/L^3$ equation (Lagler 1966). With respect to growth, the following formula was used for calculations of relative length increase (RLI) and relative weight increase (RWI) (Chugunova 1963):

RLI= $(Lt-Lt_{-1})/(Lt_{-1})$ and RWI= $(Wt-Wt_{-1})/Wt_{-1}$

For statistical interpretation of the differences between males and females with regard to length, weight and condition factors the Statgragh programme (version 6.0) was used and variance analyses (Tukey one-way Anova) were carried out.

Results

Standart length ranged between 9.5-22.5 cm for females and 9.5-21.5 cm for males. With respect to length frequency distribution males, females and all specimens combined were found to be more abundant in the length range 16-17 cm (Figure 2). The difference between the standard length classes of the 194 male and 244 females examined was found to be statistically significant [$F_{0.05}(1,436)= 2.53$, $F_{cal}= 22.08$].

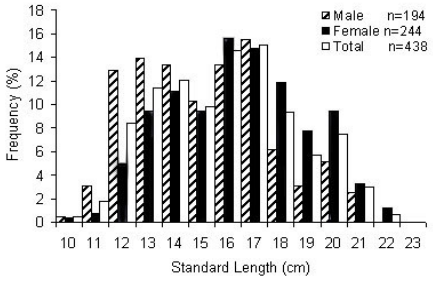

Figure 2. Frequency analysis of standard length in *E. teres* female, male and total individuals.

The weight of the females ranged between 15-155 g and that of the males between 15-135 g. With regard to weight frequency distribution, males were more abundant in the 20 g weight range, females and all specimens combined (total) were found to be more abundant in the 30 g weight range (Figure 3).

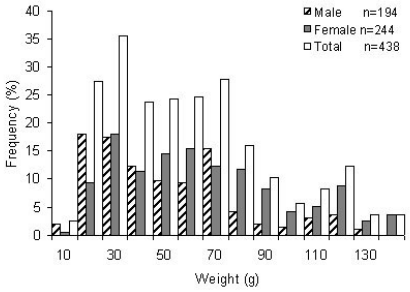

Figure 3. Frequency analysis of weight in *E. teres* female, male and total individuals.

The difference between male and female weights was found to be statistically significant [$F_{0.05}$ (1, 436)= 2.53, $F_{cal}= 12.49$].

The sex ratio of *E. teres* was studied on the basis of 438 specimens from the Gulf of Antalya. Females made up 55.7% and males 44.3% of the species.

In this study the specimens whose ages were determined were designated as belonging to age groups I, II and III. In the population age groups I and II were dominant and in general (females, males and all specimens) values were close to each other, varying between 40-50%.

However, the low number of specimens in age group III is notable, these values being for females, males and all specimens 10.5%, 3.9% and 7.6% respectively (Figure 4).

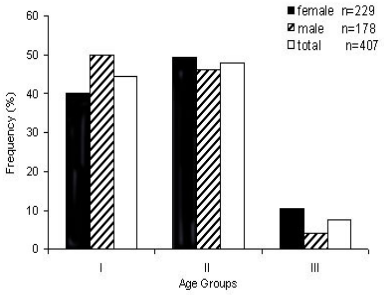

Figure 4. Frequencies of age groups.

Average standard length values among the population for females, males and all specimens respectively at age I were 14.50, 13.96, 14.23 cm; at age II 17.91, 17.90, 17.90 cm; at age III 20.89, 20.87, 20.88 cm Regarding relative length increase, it can be seen that the relative length increase between ages I-II is greater than that between ages II-III. When compared with females it is of note that in the transition from age group I to age group II the relative length increase of the males is greater than that of the females (Table 1, Figure 5, 6, 7).

Table 1. The length values of *E. teres* according to age groups (N= number of specimens, SD= standard deviation, SE= standard error, SL= standard length, RLI= relative length increase).

	Age	N	Min. S.L (cm)	Max. S.L (cm)	Mean S.L (cm)	S.D	S.E	RLI
	I	92	10.30	17.50	14.50	1.447	0.150	
Female	II	113	12.30	20.90	17.91	1.504	0.141	0.24
	III	24	18.90	22.70	20.89	0.892	0.182	0.17
	I	89	11.70	17.80	13.96	1.347	0.145	
Male	II	82	16.20	21.00	17.90	1.179	0.149	0.28
	III	7	20.00	21.30	20.87	0.475	0.179	0.17
	I	181	10.30	17.80	14.23	1.397	0.148	
Total	II	195	12.30	21.00	17.90	1.342	0.145	0.21
	III	31	18.90	22.70	20.88	0.683	0.180	0.17

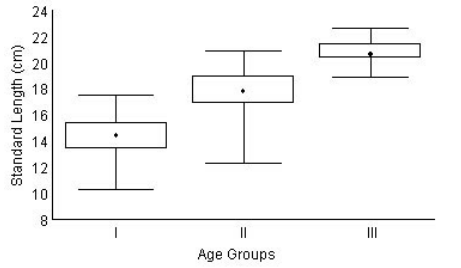

Figure 5. Age-length composition of the *E. teres* specimens for female (Min- Max. 25%- 75% Mean).

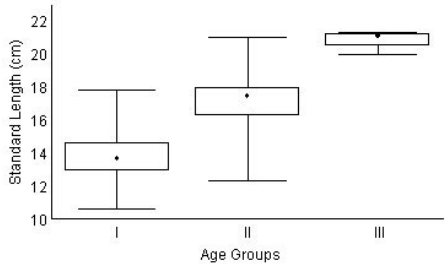

Figure 6. Age-length composition of the *E. teres* specimens for male (Min Max. 25%- 75% Mean).

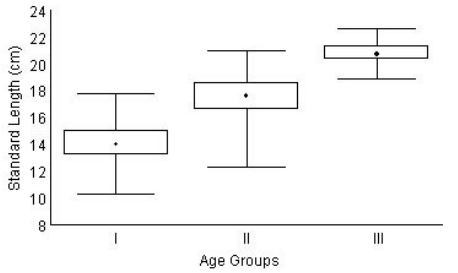

Figure 7. Age-length composition of the *E. teres* specimens for total (Min- Max. 25%- 75% Mean).

Average weight values of the population for females, males, and all specimens respectively at age I were 41.25, 35.73, 38.49 g; at age II 80.02, 70.40, 75.21 g; at age III 132.46, 124.54, 128.50 g. Regarding relative weight increase, it can be seen that the relative weight increase between ages I-II is greater than that between ages II-III. It is notable that, when compared with the females, the relative weight increase of the males is greater than that of the females in the transition from age group I to age group II (Table 2).

Table 2. The weight values of *E. teres* according to age groups (N= number of specimens, SD= standard deviation, SE= standard error, W= weight, RWI= relative weight increase).

	Age	N	Min. W (g)	Max. W (g)	Mean W (g)	S.D	S.E	RWI
Female	I	92	14.60	74.20	41.25	12.932	1.348	
	II	113	25.20	129.90	80.02	21.327	2.006	0.94
	III	24	94.60	168.60	132.46	18.162	3.707	0.66
Male	I	89	15.50	79.00	35.73	12.361	1.310	
	II	82	16.90	129.70	70.40	21.666	2.392	0.97
	III	7	111.10	137.90	124.54	9.061	3.424	0.77
Total	I	181	14.60	79.00	38.49	12.646	1.329	
	II	195	16.90	129.90	75.21	21.467	2.199	0.95
	III	31	94.60	168.60	128.50	13.612	3.566	0.71

The growth equation (von Bertalanffy) was calculated separately for females, males and the general population. The values were determined as seen below:

$L\infty$= 29.94 cm, K= 0.28, t_0= -1.2168 for males

$L\infty$= 41.54 cm, K= 0.13, t_0= -2.1847 for females

$L\infty$= 33.77 cm, K= 0.20, t_0= -1.6313 for all specimens.

The theoretically determined length values were compared with the length values of species caught in nature (Table 3).

The length-weight relationship values determined for females, males and all specimens are given below (Figure 8, 9, 10).

$W= 0.00787.SL^{3.1911}$ for females

$W= 0.00942.SL^{3.1216}$ for males

$W= 0.00834.SL^{3.1683}$ for all specimens.

Table 3. Comparison of average standard lengths according to age groups with theoretically calculated lengths (cm).

Age Groups	Caught in nature			Calculated theoretically		
	Female	Male	Total	Female	Male	Total
I	14.50	13.96	14.23	14.08	13.84	13.81
II	17.91	17.90	17.90	17.42	17.77	17.43
III	20.89	20.87	20.88	20.36	20.74	20.39

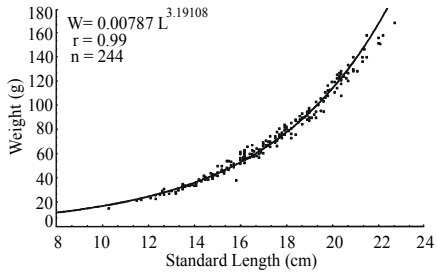

Figure 8. The length-weight relationship of specimens in the *E. teres* population for female.

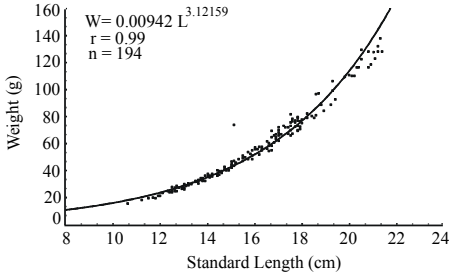

Figure 9. The length-weight relationship of specimens in the *E. teres* population for male.

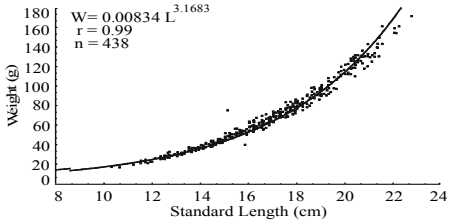

Figure 10. The length-weight relationship of specimens in the *E. teres* population for all specimens.

Condition factor values were calculated in *E. teres* specimens according to age, months and sex and their variance analyses were carried out and statistically evaluated.

The highest average CF value was found in the 3age group as 1.43, the lowest CF value occurring as 1.31 in the I age group (Table 4). The difference in CF values according to age was found to be statistically significant $F_{0.05}$ (2, 376)= 19.49, F_{cal}= 34.84.

Table 4. Average condition factor values according to age (N= number of specimens, SE= standard error, HSD= highest significant difference).

Age	N	Mean	S.E (Within groups) (general)	%95 Tukey HSDintervals for mean
I	177	1.306	.007 .006	1.296 1.317
II	172	1.352	.006 .006	1.341 1.362
III	30	1.434	.012 .015	1.409 1.459

Average CF values were determined as 1.33 for females and 1.35 for males (Table 5). The difference in CF values between the male and female groups was statistically non-significant $F_{0.05}$ (1, 436)= 253, F_{cal}= 9.087.

The CF values according to months are statistically significant $F_{0.05}$ (6, 408)= 3.71, F_{cal}= 4.90. In particular, the greatest difference was determined between February 1.37 and January 1.31, February 1.37 and March 1.31, and February 1.37 and May 1.32 (Table 6).

Table 5. Average condition factor values according to sex (N= number of specimens, SE= standard error, HSD= highest significant difference).

Sex	N	Mean	S.E (Within groups) (general)	%95 Tukey HSDintervals for mean
Female	244	1.33	.006 .006	1.32 1.33
Male	194	1.35	.006 .006	1.34 1.36

Table 6. Average condition factor values according to months (N= number of specimens, SE= standard error, HSD= highest significant difference).

Months	N	Mean	S.E (Within groups) (general)	%95 Tukey HSD intervals for mean
January	86	1.31	.007 .010	.007 .010
February	86	1.37	.010 .010	1.35 1.39
March	55	1.31	.008 .013	1.28 1.34
April	39	1.36	.008 .015	1.33 1.39
May	46	1.32	.010 .014	1.29 1.35
June	59	1.36	.017 .012	1.34 1.39
July	44	1.36	.023 .014	1.33 1.39

Discussion

As the aim of Başusta *et al*'s investigation on *E. teres* in Turkey (1997) was systematic, in order to give an idea, in 6 specimens a minimum total length value of 16.6 cm and a maximum value of 19.3 cm were given. In our investigation using 438 specimens a minimum standard length of 10.30 cm and a maximum standard length of 22.70 cm were found.

In a study conducted in Mexico's Gulf of California by Cisneros *et al* (1990), age-length relationship was investigated and a minimum standard length of 9.4 cm was found in age group I and a maximum standard length of 21.4 cm in age group III. When the results of both studies are compared the composition of the age-length distribution is seen to be similar.

In our research, regarding the age-length growth relationship, SL_{∞}= 33.77 cm, K= 0.20 and t_0= -1.6313. Cisneros *et al*. (1990) determined the growth equations for length as SL_{∞}= 23.1 cm, K= 0.86 and t_0= -0.10. When the infinite the standard length values of both studies are compared, the differences are thought to be due to the number of samples used and to the different length averages of the age groups.

In this study the length-weight relationships for females, males and all specimens were $W= 0.00787 . L^{3.1911}$, $W= 0.00942 . L^{3.1216}$ ve $W= 0.00834 . L^{3.1683}$ respectively and also the correlation coefficients presenting the relationship between length and weight were established as r= 0.99. The fact that the correlation is close to 1 shows us that there is a very good relationship between the length-weight of the population specimens.

In *E. teres* specimens the CF value increases with age in particular the specimens from age group III are able to feed better than the other age groups. The fluctuations in the CF values according to months may be connected with the maturation of the gonads and with the fact that eggs are released in batches.

In this study the sex ratio among the 438 specimens examined was found to be (female: male) 1:0.80**.** The ratio is given as 1:1.2 by Geldenhuys (1978) in South Africa. In a study conducted by Houde (1977) on 71 specimens in the eastern part of the Gulf of Mexico, the ratio is given as 1:1.22 and a great difference between values is not seen.

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