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RESEARCH ARTICLE **ARAŞTIRMA MAKALESİ**

Some biological aspects of Spotted Flounder *Citharus linguatula* (Linnaeus, 1758) in Izmir Bay (Aegean Sea)

İzmir Körfezi'nde Kancaağız Pisi balığının *Citharus linguatula* (L., 1758) bazı biyolojik özellikleri

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Abstract: In this study, some biological features of spotted flounder *Citharus linguatula* (L.,1758) were investigated from İzmir Bay. 2555 specimens were captured with bottom trawl net by R/V Egesuf between January 2005-May 2006. It is determined that the samples of population distributed between I-VI age groups. Minimal, maximal and mean total length were established as 9.1cm, 23.9 cm and 15.90±0.096 cm, respectively. Minimal, maximal and mean weights were found as 5.02g, 105.34g and 32.06±0.61g, respectively. The weight-length relationships and von Bertalanffy growth equations were calculated as $W=0.005*L^{3.14}$, r= 0.98, $L_t = 27.38 * [1-e^{-0.2142 (t+1.6353)}]$.

Keywords: *Aegean Sea, Izmir Bay, spotted flounder, Citharus linguatula*

Öz: Bu çalışmada, İzmir Körfezi'nde kancaağız pisi balığının *Citharus linguatula* ,(L., 1758) bazı biyolojik özellikleri tespit edilmiştir. Ocak 2005–Mayıs 2006 tarihleri arasında, İzmir Körfezi'nden Egesüf Araştırma Gemisi'nden trol ağı ile aylık olarak toplam 2555 adet elde edilmiştir. Bireylerin I-VI yaş grupları arasında dağılım gösterdiği saptanmıştır. Minimum, maksimum ve ortalama total boy sırasıyla, 9,1cm, 23,9cm ve 15,90±0,096 cm'dir. Minimum, maksimum ve ortalama ağırlık sırasıyla, 5,02g, 105,34g ve 32,06±0,61 g'dır. Total boy-ağırlık ilişkisi esas alınarak hesaplanan boy ağırlık ilişkileri, $W=0,005*L^{314}$, r= 0,98 olarak tespit edilmiştir. von Bertalanffy büyüme parametreleri tüm bireyler için $L_t = 27,38 * [1-e^{-0,2142 (t+1,6353)}]$ olarak hesaplanmıştır.

Anahtar kelimeler: *Ege Denizi, İzmir Körfezi, Kancaağız pisi balığı, Citharus linguatula*

INTRODUCTION

Citharus linguatula is a small and demersal flatfish species which inhabits soft sandy-muddy bottoms, about 200-300m depths and it is distributed across the Mediterranean and Atlantic (Nielsen, 1986). Spotted flounder most likely to be inhabited at depths between 10 and 100m (Sartor et al., 2002).

Citharus linguatula is commercially important species in Atlantic and Mediterranean waters. In Portugal, they were landed 39 937 kg/per year between 1992 and 2005 and also Portugal sea food industry made profit by spotted flounder sells (98 415 €/per year) (Teixeira et al., 2011). Spotted flounders are also economically important flatfish species as bycatch, especially bigger than 18 cm, in Greece (Vassilopoulou, 1994). Spotted flounder is found in Marmara sea, Aegean and Mediterranean seas, coasts of Turkey (Bilecenoglu, 2002) and also important species in Edremit bay (Çakır et al., 2005), in Izmir bay (Bayhan et al., 2009)

There are many studies on *Citharus linguatula* in Mediterranean and Atlantic Ocean. Studies are focused on distribution in Adriatic sea (Jardas, 1983) , in Mediterranean (Sartor et al., 2002), egg and larvae distribution and features from Spanish coast (Sabates, 1988), population biology in Adriatic (Jardas,1984), in Greek waters (Vassilopoulou and Papaconstantinou, 1992; 1994), in Turkish seas (Özaydın et al., 2003; Cakır et al., 2005 and Bayhan et al., 2009) and in Portugal waters (Texeira et al., 2010), its feeding habits in Adriatic sea (Jardas, 1984), in Spanish waters (Redon,1994), in Italian waters (Carpentieri et al., 2010) and in Portugal waters (Texeira et al., 2010). After all there were many data on weight and length relationships of the spotted flounders in several studies (Dulcic and Kraljevic, 1997; Moutopoulos and Stergiou,

2002; Mendes et al., 2004; Karakulak et al., 2006).

The main aim of the our study is to determine growth parameters of the spotted flounder in Izmir Bay (Aegean Sea)

MATERIAL AND METHODS

Total of 2555 *Citharus linguatula* specimens were collected montly from Izmir Bay (Aegean Sea) (Figure 1) between January 2005 and May 2006. The samplings were carried out by research vessel EGESUF with a conventional trawl net (cod-end mesh size of 44 mm) and surveys were performed on sandy-muddy bottoms with a depth of 30 to 50 m. After sampling total length (TL) was measured to the nearest 0.1 cm and weight to the nearest 0.01 g.

The sagittal otoliths were used for age reading. After removing the otoliths, they were cleaned in %4 NaOH solitions and stored in u-plate. Before reading the ages, they were exposed to alcohol series (%70, %50, %30, %10). Otoliths were placed in a black petri dish containing glycerin. They were read under reflected light of a stereo zoom microscope at a magnification of 4.5X zoom range.

The relationship between length and weight was estimated as $W = a L^b$, where W is body weight (g), L is total length (cm), and a and b are coefficient of the equation (Ricker, 1975). The parameter "b" shows the growth type (Froese, 2006).

The growth model was formulated by $Lt = L\infty [1-exp-K(t-t0)]$ where Lt is the length at age t, $L\infty$ is the maximum asymptotical TL, K is the growth coefficient, and t0 is the theoretical age of the fish prior to hatching from the egg (Sparre et al., 1989). The growth performance index (Φ') was calculated by using von-Bertalanffy growth equations (VBGE) parameters thus this formula was $\Phi' = \log(k) + 2\log(L\infty)$ where k and $L\infty$ are the VBGE parameters (Pauly and Munro, 1984).

The sex was determined and gonads were staged macroscopically by using gonad stage scale which was stated by Teixeira et al. (2010). This scale has four stages: 1 = immature, 2 = maturing, 3 = ovipositing, and 4 = postoviposition (Teixeira et al., 2010). The gonadosomatic index was formulated as follows: GSI = [gonad weight × (body weight–gonad weight)] × 100 by King (1995). The average GSI values were calculated monthly from January 2005 to May 2006 for males and females to determined spawning season.

Student's t-test was used to test the significance of the difference between males and females length.

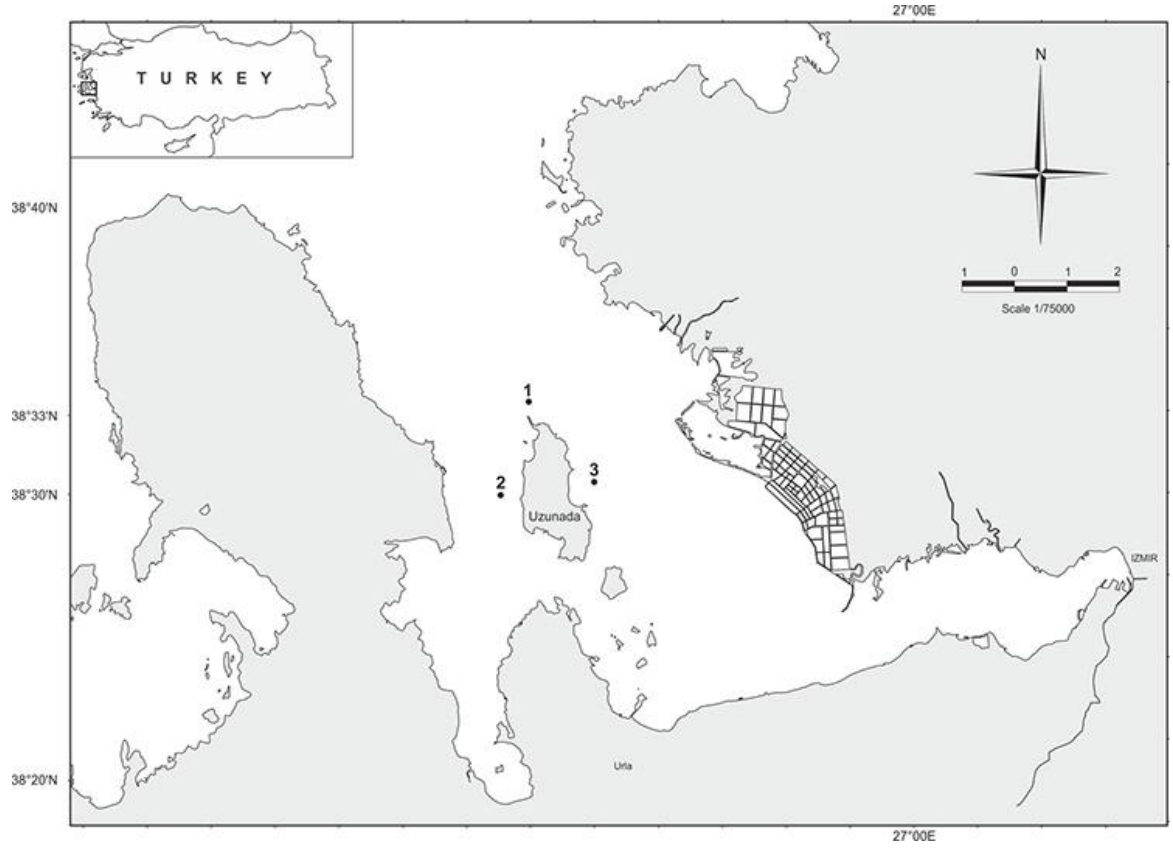

Figure 1. Sampling locality of *Citharus linguatula* in Aegean Sea

RESULTS

Length, Weight, Age and Sex Distribution

A total of 2555 specimens were examined with 59.4% (n=1518) was female, 38.1% (n=973) was male and %2.5 (n=64) was indetermined individual. The ratio of female to male was 1:0.64. Significant differences were observed between sexes (χ^2=59,62 p≤0.05).Measured Total length values of overall, female and male specimens ranged from 9.1-23.9 cm, 9.1-23.9 cm and 9.1-19.6 cm respectively. Weight values for overall, female and male specimens were in order of 5.02-105.34 g, 5.32-105.34 g and 5.6-60.84 g (Table 1). It was found that there was significant difference between length of male and female individuals. Females were larger than males (df: 972 p<0.05).

Table 1. Range and mean of total length (cm) and weight (g) values of Spotted flounder from Izmir bay (Agean Sea)

		N	Range	Mean±CI.
Females	**Total Length**	1518	9.2-23.9	17.1±0.1
	Weight	1518	5.3-105.3	40.0±0.7
Males	**Total Length**	973	9.1-19.6	14.1±0.1
	Weight	973	5.6-60.84	21.8±0.5

A total of 2491 specimens were aged. The results of age distribution and sex ratio between ages are given in Table 2. Ages of overall, female (n=1518) and male (n=973) ranged between 1 to 6, 1 to 6, 1 to 4 respectively. Most individuals were obtained from group of II years old fish for all specimens, III years old for females, II years old for males. *Citharus linguatula* specimens showed that sexual age differentiations because females reached older ages than males (Table 2). Minimum, maximum and mean values of total length by ages of males, females and overall is given in Table 3.

Table 2. Age distribution of *C. linguatula* specimens in Izmir Bay

	Males		Females		All Fish		
Ages	**N(♂)**	**%N**	**N(♀)**	**%N**	**N**	**%N**	**♀:♂**
I	247	9,92	53	2,13	300	12,04	1:4,66
II	614	24,65	416	16,70	1030	41,35	1:1,47
III	103	4,13	522	20,96	625	25,09	1:0,19
IV	9	0,36	425	17,06	434	17,42	1:0,02
V			86	3,45	86	3,45	-
VI			16	0,64	16	0,64	-
Σ	**973**	**39,06**	**1518**	**60,94**	**2491**	**100,00**	**1-0,64**

Table 3. Mean, minimum, maximum and standard deviation of length value per age groups of *C. linguatula* specimens

Ages	**N**	**Mean TL±C.I**	**Min.**	**Max.**	**S.D.**
Males					
I	247	11,81±0,10	9,10	13,00	0,83
II	614	15±0,06	13,10	16,00	0,77
III	103	16,73±0,09	16,10	18,00	0,47
IV	9	18,74±0,36	18,20	19,60	0,47
Females					
I	53	12±0,22	9,20	13,00	0,82
II	416	15±0,08	13,10	16,00	0,81
III	522	17,1±0,05	16,10	18,00	0,56
IV	425	19±0,05	18,10	20,00	0,54
V	86	21±0,12	20,10	22,00	0,55
VI	16	22±1,05	22,10	23,90	0,51
All Fish					
I	300	11,87±0,09	9,10	13,00	0,84
II	1030	15±0,05	13,10	16,00	0,80
III	625	17±0,1	16,10	18,00	0,56
IV	434	19±0,05	18,10	20,00	0,54
V	86	21±0,12	20,10	22,00	0,55
VI	16	22±0,12	22,10	23,90	0,51

Growth and Length-Weight Relationships

Parameters of von-Bertalanffy growth equation were calculated for all the individuals, females and males (Table 4). As mentioned before the equations L_∞ parameter for females and males; were, 27.60 cm, 23.26 cm respectivelly. Other parameter values are given in Table 1. Length-Weight relationships were calculated as $W = 0{,}005\ L^{3.144}$ for overall;

W= 0,005 $L^{3.146}$ for females and as W= 0,0053 $L^{3.126}$ for males. According to student's t-test, we observed positive allometric growth for overall (b= 3.144; p≤0.05), females (b= 3.146; p≤0.05) and males (b= 3.126; p≤0.05) (Table 5).

Table 4. Growth parameters of *Citharus linguatula*

	N	k	t_0	L_∞
Males	973	0,286	-1,429	23,7
Females	1518	0,2073	-1,733	27,6

Reproduction

Means of GSI values of female and male is given per month (only January 2005 to December 2005) in Figure 2. Highest mean of GSI value of female was in Agust 2005 and GSI mean value of female was increased between July 2005 and September 2005. Therefore, values of GSI started to decrease in October 2005 and the lowest value was in March 2005 (Figure 2).

Highest mean of GSI value of male specimens was in November 2005 and also GSI values of male spotted flounder had an up and down curve at sampling period (Figure 2) but especially at spawing period their GSI values was increased.

Table 5. Length and Weight Relationship parameters of *C. linguatula* specimens

	N	a	b	r	Growth Type
Males	973	0.005	3.126	0.9813	A(+)
Females	1518	0.005	3.146	0.9809	A(+)
All Fish	2555	0.005	3.144	0.9876	A(+)

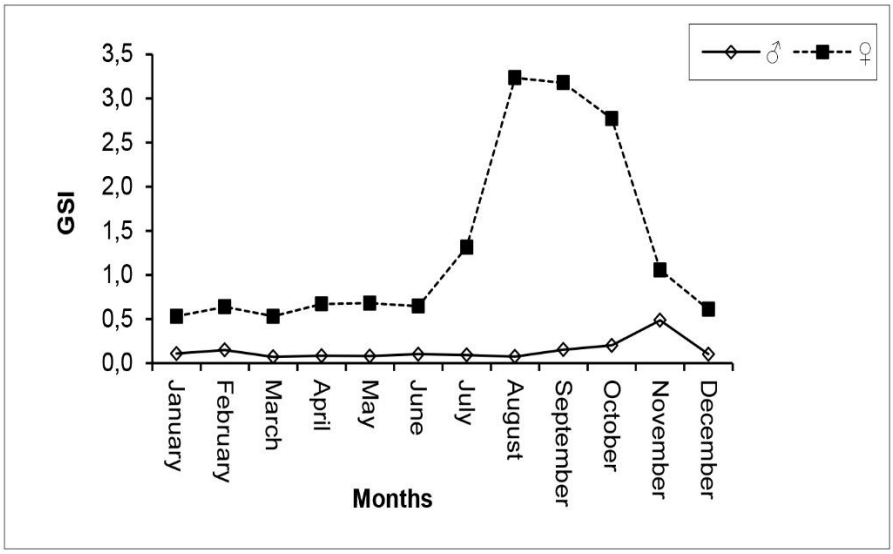

Figure 2. Mean GSI values of *C. linguatula* specimens for males and females

DISCUSSION

In this study, we observed that growth rates were different for males and females. Males growth rate (von bertalanffy k= 0.286) was greater than females (k=0.207), on the other hand asymptotic length of females specimens ($L\infty$= 27.6) was higher than males ($L\infty$=23.7). Same result was stated by Vassilopoulou and Papconstantinou, 1994. They estimated that k value of male specimens (k= 0.296) was higher than females k= 0.257), and they found asymptotic length of females ($L\infty$= 25.8) was higher than males ($L\infty$= 22.9). However, Teixeira et al., 2010, found asymptotic length of female ($L\infty$= 30.8) was lower than male ($L\infty$=30.2) and also k value of females (k= 0.19) was higher than male (k= 0.15). They also mentioned that asymptotic lengths for some flatfish species, which are Lepidorhombus boscii, Platichthys flesus and Microchirus azevia, were higher for females than males except for C. linguatula (Teixeira et al., 2010).

This differentiation was conditioned by several reasons which effected the growth of spotted flounders (Latitudinal variations, temperature, food ingestion, etc.) (Teixeira et al.,2010).

Teixeira et al. (2010), also mentioned that asymptotic length of *C. Linguatula*'s is higher than other research, which were in the eastern Mediterranean. The estimate von Bertalanffy parameters stated in this work were similar to other studies of spotted flounder, except for Teixiera et al. (2010) (Table 6).

In this study, age determination showed that six different age groups (I-II-III-IV-V-VI) for spotted flounder. Furthermore, males and females have shown different age groups which

females were older than males. The oldest female was estimated as 6 years old and the oldest male was 4 years old. Most of the individuals were from II years old age group, females were III and males were II years old. The comparison of age for spotted flounder specimens from different locations given in Table 7.

To determine spawning season of *C. linguatula* examined GSI index values by the monthly. We estimated the spawning season between August to November. There are few studies on reproduction of *C. linguatula*. Similar results have been stated the spawning season to be between August to November in Spain coast and in western part of Mediterranean sea (Sabastes, 1988). Other studies and similar results from Portuguese coast mentioned the spawning season between late Summer to Autumn (Teixeira et al., 2010).

In this study, the growth type of spotted flounder was observed as positive allometric. Other studies on spotted flounders weight and total length relationship form Turkish seas and different locations were found positively allometric growth (Vassilopoulou and Papaconstantinou, 1994; Dulcic and Kraljevic, 1997; Cakir et al. 2005, Karakulak et al. 2006; Bayhan et al., 2009),on the other hand some studies found negatively allometric growth (Mendes et al., 2004). This difference was stated by several authors such as Moutopoulos and Stergiou (2002), indicate that the specimen amount, location's differences (Latitudinal variations) and seasonal differences effect b values. Also Froese (2006) mentioned that "a" and "b" parameters of WLR equation were affected by several reasons such as environmental conditions, gonad development, habitat differences, sex, diet, catching methods and number of specimens.

Table 6. von-Bertalanfy growth parameters comparasion between this study and other research on *C. Linguatula*

Area	Locality	Reference	Sex	L_∞ (cm)	k (year $^{-1}$)	to (year)
Mediterranean	Aegean Sea	Vassilopoulou and Papaconstantinou(1994)	♀	25.8	0.257	-0.417
			♂	22.9	0.296	-0.457
			All fishes	25.7	0.257	-0.430
	Aegean Sea (Edremit Bay)	Çakır et al. (2005)	All fishes	25.3	0.25	-1.680
	Aegean Sea (Izmir Bay)	Bayhan et al. (2009)	All fishes	26.2	0.301	-0.621
	Aegean Sea (Izmir Bay)	This Study	♀	27.6	0.207	-1.730
			♂	23.7	0.286	-1.429
			All fishes	27.4	0.214	-1.635
Atlantic	Portuguese coasts	Teixeira et al. (2010)	♀	30.2	0.19	-3.40
			♂	30.8	0.15	-4.40

Table 7. Age distribution comparasions between this study and other

Area	Locality	reference	Sex	Age
Mediterranean	Aegean Sea	Vassilopoulou and Papaconstantinou (1994)	♀+♂	0-VII
			♂	0-V
	Aegean Sea (Edremit Bay)	Çakır et al. (2005)	All fishes	I-IV
	Aegean Sea (Izmir Bay)	Bayhan et al. (2009)	All fishes	I-IV
	Aegean Sea (Izmir Bay)	This Study	♀+♂	I-IV
			♂	I-VI
Atlantic	Portuguese coasts	Teixeira et al. (2010)	All fishes	I-VI
			All fishes	I-VII

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REFERENCES

Bayhan, B., Sever, T. M. & Taşkavak, E. (2009). Age and feeding habits of Atlantic spotted flounder *Citharus linguatula* (Linnaeus, 1758) (Pisces: Pleuronectiformes) from central Aegean Sea of Turkey. *North-Western Journal of Zoology*, 5(2): 330-337.

Bilecenoğlu, M., Taşkavak, E., Mater, S. & Kaya, M. (2002). Checklist of the marine fishes of Turkey, 1. *Zootaxa,* 13: 1-194.

Carpentieri, P., Cantarelli, T., Colloca, F., Criscoli, A. & Ardizzone, G. (2010). Feeding behaviour and daily ration of the spotted flounder *Citharus*

linguatula (Osteichthyes: Pleuronectiformes) in the central Tyrrhenian Sea. *Scientia Maria* 74(4): 659-667.doi: 10.3989/scimar.2010.74n4659

Çakır, D.T., Bayhan, B., Hossucu, B., Unluoglu, A. & Akalin, S. (2005). Some parameters of the population biology of spotted flounder (*Citharus linguatula* Linnaeus, 1758) in Edremit Bay (North Aegean Sea). Turkish *Journal of Veterinary and Animal Sciences,* 29: 1013-1018.

Dulcic, J. & Kraljevic, M. (1997). Corrigendum to "Weight-length relationships for 40 fish species in the eastern Adriatic (Croatian waters). *Fisheries Research*, 30: 169-171. doi: 10.1016/S0165-7836(97)00555-9

Froese, R. (2006). Cubelaw, condition factor and weight-length relationships: history, meta-analysis and recommendations. *Journal Applied Ichthyology,* 22: 241-253. doi: 10.1111/j.1439-0426.2006.00805.x

Jardas, I. (1983). Citharus macrolepidotus (Bloch, 1787) (Pisces, Pleuronectiformes) Horizontal and vertical distribution in the Adriatic Sea. *Acta Biologica Jugosl* (e Ichthyol.), 15(2): 23-28.

Jardas, I. (1984). Citharus macrolepidotus (Bloch, 1787) (Pisces, Pleuronectiformes) Nourisment and length-weight relationships in the Adriatic Sea. *Acta Biologica Jugosl* (e Ichthyol.), 16 (1,2): 1-4.

Karakulak, S., Erk, H. & Bilgin, B. (2006). Length-weight relationships for 47 coastal fish species from the northern Agean Sea, Turkey. *Journal of Applied Ichthyology*, 22: 274-278. doi: 10.1111/j.1439-0426.2006.00736.x

Mendes, B., Fonseca, P. & Campos, A. (2004). Weight-length relationships for 46 fish species of the Portuquese west coast. . *Journal of Applied Ichthyology*,20: 355-361. doi: 10.1111/j.1439-0426.2004.00559.x

Moutopoulos, D. K. & Stergiou, K. I. (2002). Length-weight and length-length relationships of fish species from the Agean Sea (Greece). *Journal of Applied Ichthyology* ,18: 200-203. doi: 10.1046/j.1439-0426.2002.00281.x

Nielsen, J. G. (1986). Citharidae p. 1286 In Whitehead P.J.P., Bauchot, M.-L., Hureau,J.-C., Nielsen, J. and Tontonese, E. (Eds), Fishes of the North-Eastern Atlantic and the Mediterranean Volume III (pp. 517-1007), Paris, UNESCO.

Özaydın, O., Taşkavak, E. & Akalın, S. (2003). Preliminary study on the growth of the spotted flounder *Citharus linguatula* (Linnaeus, 1758) in the Aegean Sea. (*in Turkish with English abstract*). *Türk Sucul Yaşam Dergisi*, 1: 50-55.

Pauly, D. & Munro, J.L. (1984). Once more on the comparison of growth in fish and invertabrates. *Fishbyte*, 2(1): 21.

Redon, M. J., Morte, M. S. & Sanz-Brau, A. (1994). Feeding habits of the spotted flounder *Citharus linguatula* of the eastern coast of Spain. *Marine Biology*, 120: 197-201. doi: 10.1007/BF00349679

Ricker, W. E. (1975). Computation and interpretation of biological statistics of fish populations. Department of Enviroment, Fisheries and Marine Service, Ottawa, ON. 382 pp.

Sabates, A. (1988). Larval development and spawning of *Citharus linguatula* (Linnaeus, 1758) in the western Mediterranean. *Journal of Plankton Research*, 10(6): 1131-1140. doi: 10.1093/plankt/10.6.1131

Sartor, P., Sbrana, M., Ungaro, N., Marano, C. A., Piccinetti, C., Manfrin & Piccinetti, G. (2002). Distribution and abundance of *Citharus linguatula*, *Lepidorhombus boscii* and *Solea vulgaris* (Osteichthyes: Pleuronectiformes) in the Mediterranean Sea. *Scientia Marina,* 66(2): 83-102.

Sparre, P., Ursin, E. & Venema, S.C. (1989). Introduction to Tropical Fish stock Assessment. Part 1, Manual, *FAO Fish. Tech. Paper*, No. 306-1, FAO: Rome, 337 pp.

Teixeira, C. M., Batista, M. I. & Cabral, H. N. (2010). Diet, growth and reproduction of four flatfishes on the Portuguese coast. *Scientia Marin*a, 74(2): 223-233. doi: 10.3989/scimar.2010.74n2223

Teixeira, C. M., Batista, M. I. & Cabral, H. N. (2011). Landing profiles and typologies of flatfish fisheries on the Portuguese coast. *Aquatic Living Resources,* 24: 169-182. doi: 10.1051/alr/2011134

Vassılopoulou, V. & Papaconstantinou, C. (1992). A priliminary study of the biology of the spotted flounder, in the North Aegean Sea. Rapp. Comm. int. Mer *Medit*., 33.

Vassilopoulou, V. & Papaconstantinou, C. (1994). Age, growth and mortality of the spotted flounder (*Citharus linguatula* Linnaeus, 1758) in the Agean Sea. *Scientia Marina*, 58(3): 261-267.

King, M. (1995). Fisheries Biology, Assesment and Management, Fishing News Books, 352p.

Uluturk, E., Kaya M. & Irmak E. (2010). The importance of flatfishes (Pisces / Pleurronectiformes) of the World and Turkish seas (*in Turkish with English abstract*). *Ege Journal of Fisheries and Aquatic Sciences*, 29(2): 101-108.