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Research Article

Age, Growth and Mortality Rates of *Symphodus tinca* (Osteichthyes: Labridae) in Izmir Bay (NE Aegean Sea)

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ABSTRACT

A total of 373 *Symphodus tinca* specimens were obtained from small-scale fisheries in January 2017 - December 2018 off Urla coasts (Izmir Bay), north-eastern Aegean Sea. The length and weight distribution of all *S. tinca* specimens ranged from 7.8 to 24.5 cm TL (mean: 14.4 ± 0.12) and from 6.6 to 209.3 g (mean: 43.2 ± 1.30), respectively. The female – male ratio was 1:0.41. The weight-length relationship parameters (a, b, r^2) were calculated to be 0.0175, 2.9023 and 0.9629, respectively. The age of *S. tinca* was determined to be between 0 and V years. The von Bertalanffy growth parameters were $L\infty$ = 39.06 ± 23.57 cm, K = 0.14 ± 0.14, and t_0 = -1.77 ± 0.77. In addition, the Von Bertalanffy Growth Formula for length is given by the following equation: $Lt = 39.06 [1 – e^{-0.14 (t + 1.77)}]$. Thus, the growth performance (Φ`) was estimated as 2.32. The values of mortality and exploitation rates of *S. tinca* are 1.015 (Z), 0.380 (M), 0.635 (F) and 0.626 (E), respectively. These results indicate that stocks of *S. tinca* in the Bay of Izmir are overexploited.

Keywords: East Atlantic peacock wrasse, fishing, length-weight, exploitation, Mediterranean

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INTRODUCTION

The East Atlantic peacock wrasse, *Symphodus tinca* (Linnaeus, 1758) is a marine reef-associated fish that inhabits depths ranging from 1 to 50 m (Froese & Pauly, 2024). It has been observed to occasionally enter salty lagoons (Quignard & Pras, 1986). The male constructs and maintains a nest of seaweed following the spawning of one or more females. It reproduces from April to July along the Mediterranean coasts of France, and from March to June along the Mediterranean African coast. The growth rate is relatively slow (Quignard & Pras, 1986). The species is known to feed on benthic invertebrates, with crustaceans, molluscs and echinoderms representing the majority of its diet (Golani et al., 2006). It has very distinct sexual dimorphism, and has partially protogynic hermaphroditic. *S. tinca* reaches sexual maturity after two years (Golani et al., 2006). Its geographic distribution spans from Spain to Morocco, encompassing both the Mediterranean and the Black Sea (Quignard & Pras, 1986).

There are 20 labrid species in eastern Mediterranean (Golani et al., 2006) of which 19 occurring in Turkish seas (Mater et al., 2002). Nevertheless, Lök & Gül (2005) and Çoker & Mater (2006) have documented the presence of 14 species in the Bay of Izmir. However, labrid species are frequently caught by gillnets, and occasionally by bottom trawl nets (Pallaoro & Jardas, 2003; Özaydın et al., 2007) and beach seine nets (Akyol, 2003; Skeljo & Ferri, 2012) in Turkish seas like the Mediterranean basin, and they are usually discarded due to a lack of commercial value (Gordoa et al., 2000; Akyol, 2003; Aydın et al., 2007).

The bio-ecological studies of labrid species has not been a prominent area of interest within the academic community to date. It is evident that there is a need for further research to determine population parameters in *S. tinca* and other labrids. While some studies have been made on reproduction, diet composition, otolithometry, morphometry, growth and length-weight relationships of *S. tinca* (Boughamou et al., 2014, 2015; Ouannes-Ghorbel & Bouain, 2006; Skeljo & Ferri, 2012; Shili et al., 2018; Kasapoglu et al., 2016; Gordoa et al., 2000; Pallaoro & Jardas, 2003; Petrakis & Stergiou, 1995; and references herein), there is still a paucity of information on the age, growth and mortality of *S. tinca* in the Mediterranean basin. The available literature on the age, growth and mortality rate of *S. tinca* in the Mediterranean Sea is limited. Accordingly, the study presents the first data on the age, growth, and mortality rates of *S. tinca* in Izmir Bay, North-eastern Aegean Sea.

MATERIALS AND METHODS

A total of 373 specimens of *S. tinca* were intermittently collected from Small-scale fisheries (SSF) off Urla coasts of Izmir Bay, Aegean Sea (Fig. 1) between January 2017 and December 2018.

The sex of the fish was macroscopically identified by means of gonads. The sagittal otoliths were used for the purpose of determining the ages. For age reading, a total of 217 sagittal otoliths was utilized under a binocular microscope (SOIF XSZ-7GX) at 10× magnification.

The specimens were measured both total length (TL, ±0.1 cm) and the wet weight (W, ±0.1 g). The length–weight relationship (LWR) was estimated with the formula: $W = a \times L^b$; where, W is weight (g), TL is total length (cm), *a* is the intercept and *b* is the slope.

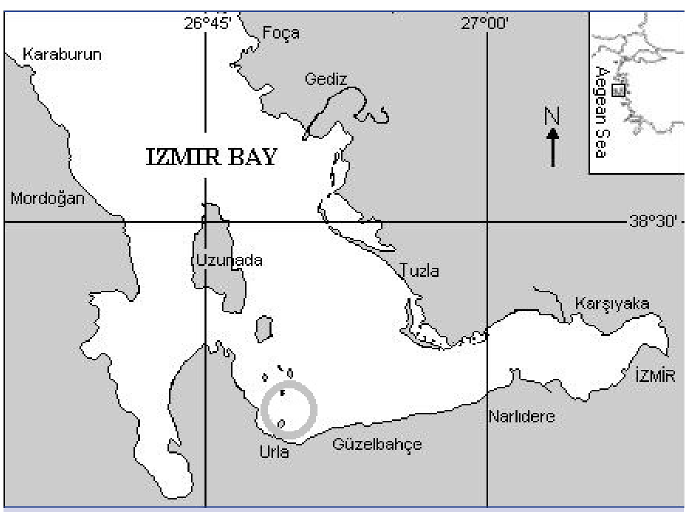

Figure 1. Sampling area (grey circle).

The von Bertalanffy growth parameters (VBGP, L_∞, K, and t_0) were computed with the von Bertalanffy growth formula (VBGF) by using the FISAT II (FAO–ICLARM Stock Assessment Tools, Gayanilo et al., 1994). The VBG equation (VBGE) is represented by the following formula: $L_t = L_\infty [1 - e^{-K(t - t_0)}]$; where, L_∞ is the asymptotic length, K the growth curve parameter, and t_0 the theoretical age when fish length would have been zero. The growth performance was calculated using the phi-prime index (Φ'), which is defined as $\Phi' = \log K + 2\log L_\infty$ (Pauly & Munro, 1984).

The natural mortality (M) of *S. tinca* was calculated using the multiple regression formula proposed by Pauly (1980), which is given by $\ln M = -0.0152 - 0.2779 \ln(L_\infty) + 0.6543 \ln(K) + 0.463 \ln(T)$. The mean annual temperature for the Aegean Sea, as estimated by the General Directorate of Meteorology (Anon., 2018) is assumed to be 18.7°C.

The total mortality (Z) was estimated using the average size of the catch (Beverton & Holt, 1957). The mean total mortality rate (Z) can be estimated from the mean length of individuals in a population by the following formula: $Z = K (L_\infty - L_{mean}) / (L_{mean} - L_c)$, where L_∞ and K are parameters of the VBGE. In the absence of L_c, Erkoyuncu (1995) proposed that L' can be used in the formula instead, that is to say, $L_c = L'$. The mean length (L_{mean}) is calculated from L' upwards, with L' representing a length not smaller than the smallest length of fish fully represented in catch samples (Pauly & Soriano, 1986).

The mortality rate of fishing (F) can be estimated from F = Z - M. Once values of F and M are available, an exploitation ratio (E) can be calculated using the equation E = F / Z (Sparre & Venema, 1992). This allows for an evaluation of whether a stock has been overfished, on the assumption that the optimal value of E is approximately equal to 0.5 (Pauly, 1980). The means were presented with their standard error (± s.e.).

RESULTS AND DISCUSSION

The length / weight distribution of all samples exhibited a range of 7.8 to 24.5 cm (average: 14.4 ± 0.12 cm) and from 6.6 to 209.3 g (average: 43.2 ± 1.30 g), respectively (Table 1). The length frequency in overall is illustrated in Figure 2. The length range of 11 - 15 cm exhibited the highest rate, approximating 85%. The female : male ratio (F : M) was 1 : 0.41. The F : M ratio according to the age groups was tested by χ2 of independence, which revealed a statistically significant difference between F : M ratios in all age groups ($p < 0.05$).

The LWR parameters (*a, b, r*²) were calculated as 0.0175, 2.9023 and 0.9629, respectively. And also, the LWR is indicated in Figure 3.

Of the individuals whose age was estimated, 128 were female, 75 were male, and 14 were of unknown gender. The age of *S. tinca* was estimated to be between 0 and V. The estimated VBGP were

Table 1. Length and weight range and means with standard error (s.e.) for *Symphodus tinca* in Izmir Bay, NE Aegean Sea.

Sex	n	L_{min} - L_{maks} (cm)	W_{min} - W_{maks} (g)	L_{ort} ± s.e.	W_{ort} ± s.e.
♀	250	8.7 – 20.6	11.3 – 113.0	13.9 ± 0.12	39.8 ± 1.20
♂	103	11.3 – 24.5	17.4 – 209.3	15.4 ± 0.28	52.4 ± 3.46
?	20	7.8 – 17.5	6.6 – 71.9	14.0 ± 0.61	40.1 ± 4.46
∑	373	7.8 – 24.5	6.6 – 209.3	14.4 ± 0.12	43.2 ± 1.30

L_∞ = 39.06 ± 23.57 cm, K = 0.14 ± 0.14, and t_0 = -1.77 ± 0.77. The VBGF for length was found to be $L_t = 39.06\,[1 - e^{-0.14\,(t + 1.77)}]$. The observed lengths of *S. tinca* assigned to each age group were employed in the fitting of the VBGF (Fig. 4). Moreover, the index of Φ` was estimated to be 2.32.

Table 2 presents the total (Z), natural (M), and fishing (F) mortalities of *S. tinca*. Furthermore, the exploitation rate was calculated to be 0.63.

The length frequency distribution of the sampled fish was found to encompass a range of 7.8 to 24.5 cm total length (TL). This length range encompasses the normal distribution of 12 - 25 cm, which is the common length observed throughout the Mediterranean (Golani et al., 2006; Froese & Pauly, 2024). Previously, various studies on *S. tinca* have provided length records (with VBGP, phi-prime index, and parameters of LWR), which are presented in Table 3. In a recent study, Aydın & Karadurmuş (2023) reported the largest specimen of *S. tinca* (male, 316 mm TL, 430.4 g) from the Turkish Black Sea coast. Furthermore, maximum length and maturity length have been documented as 44.0 cm SL for male specimen and 11.7 cm in FishBase, respectively (Froese & Pauly, 2024). Consequently, only 5.4% of fish is under first maturity length in this study. Due to the slow growth rate (Froese and Pauly, 2024), the sustainability of these fish can be achieved with low fishing pressure. The Izmir Bay population of *S. tinca* exhibits the lowest growth performance (Φ`= 2.32), while the Spanish coast population demonstrates the highest growth rate (2.88) (Gordoa et al., 2000) (Table 3).

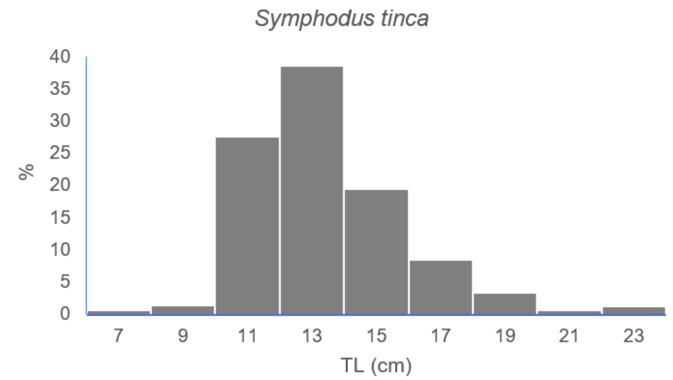

Figure 2. Length frequency distribution of *Symphodus tinca* in Izmir Bay, NE Aegean Sea.

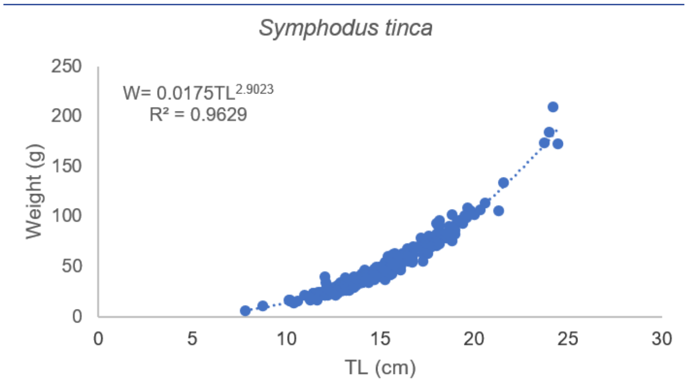

Figure 3. Length-weight relationship of *Sympodus tinca* in Izmir Bay, NE Aegean Sea.

The data indicated a negative allometric growth pattern for *Symphodus tinca* (*b* = 2.902). The preceding data on LWRs in the Mediterranean Sea are presented in Table 3. The *b* values observed in the study were found to be generally in agreement with the results of previous studies.

A limited number of studies (Table 3) have calculated the VBGP for *S. tinca* to be between 26.46 and 42.24, 0.21 and 0.81, -0.12 and -0.78 for L_∞, K and t_0, respectively (Pallaoro & Jardas, 2003; Gordoa et al., 2000; Boughamou et al., 2014). The VBGP and mortality rates presented in this study are the first to be reported for the Turkish seas.

The determination of mortality rates is a crucial aspect in the assessment of population abundance. The given values of mortality and E rates of *S. tinca* are 1.015 (Z), 0.380 (M), 0.635 (F) and 0.626 (E), respectively. The results demonstrate that the *S. tinca* stocks in the Bay of Izmir have been subjected to over exploitation. Although *S. tinca* is not a target species, its high exploitation rate may be attributed to the high rate of catch of this spe-

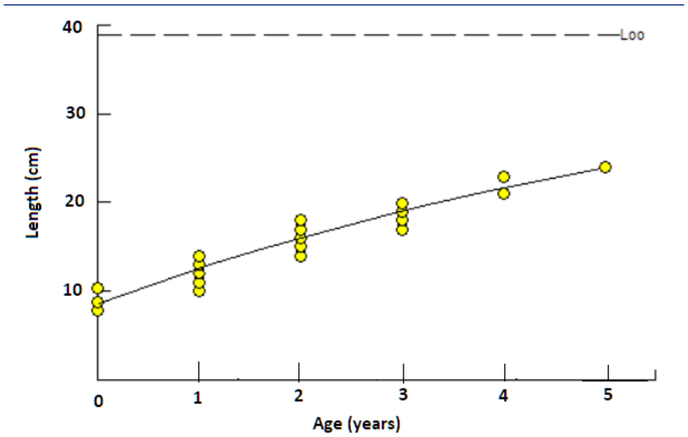

Figure 4. Von Bertalanffy growth curve fitted by length-at-age for *Symphodus tinca* in Izmir Bay, NE Aegean Sea.

Table 2. Mortalities (M, F, Z) and exploitation rate (E) of *Symphodus tinca* in Izmir Bay, NE Aegean Sea.

Total mortality Z $year^{-1}$	Natural mortality M $year^{-1}$	Fishing mortality F $year^{-1}$	Exploitation rate E $year^{-1}$
1.015	0.380	0.635	0.626

Table 3. Previous records on the age, length, weight, VBGP, phi-prime index, and parameters of LWR of *Symphodus tinca* in the Mediterranean Sea.

Authors	n	L_{min} - L_{max}	W_{min} - W_{max}	L_∞	K	t_0	Φ`	Age	*a*	*b*	r^2
Petrakis and Stergiou (1995)	31	12.7 – 20.8	-	-	-	-	-	-	0.00001	3.068	0.970
Dulčić & Kraljević (1996)	100	12.7 – 30.2	15.0 - 305	-	-	-	-	-	0.0003	2.726	0.905
Can et al. (2002)	10	12.1 – 17.2	-	-	-	-	-	-	0.002	3.675	0.997
Morey et al. (2003)	375	4.7 – 30.1	1.2 – 356	-	-	-	-	-	0.018	2.876	0.991
Pallaoro and Jardas (2003)	595♀ 848♂	8.6 - 42.5	7.9 - 764.2	28.18 42.24	0.290.21	-0.78 -0.63	2.26* 2.57*	I-XII I-XIII	0.022	2.815	0.983
Valle et al. (2003)	56	11.4 - 30.4	-	-	-	-	-	-	0.026	2.788	0.976
Karakulak et al. (2006)	248	10.0 - 26.8	-	-	-	-	-	-	0.011	3.046	0.974
Özaydın et al. (2007)	89	6.7 - 23.0	-	-	-	-	-	-	0.018	2.905	0.984
Uçkun İlhan et al. (2008)	277	6.7 - 24.3	4.3 - 185.2	-	-	-	-	-	0.018	2.907	0.984
Keskin & Gaygusuz (2010)	41	2.1 - 15.5	-	-	-	-	-	-	0.011	3.098	0.992
Gordoa et al. (2000)	291	-	-	30.65	0.81	-0.32	2.88*	0-VIII	0.290	2.795	0.960
Gurkan et al. (2010)	10	4.7 - 10.5	1.0 - 12.1	-	-	-	-	-	0.013	2.893	0.965
Boughamou et al. (2014)	277♀ 209♂ 232♀ 173♂	4.9 – 31.3	1.4 – 400.6	26.46° 32.32° 26.61ˢ 32.50ˢ	0.79 0.54 0.61 0.48	-0.12 -0.22 -0.45 -0.31	2.74 2.75 2.63 2.70	I-V	-	-	-
Boughamou et al. (2014)	303♀ 227♂	4.9 -31.3	1.4 – 400.6	-	-	-	-	-	0.010 0.020	3.010 2.860	0.920 0.910
Bilge et al. (2014)	110	6.6 - 22.0	-	-	-	-	-	-	0.018	2.924	0.969
Altın et al. (2015)	27	3.0 - 18.5	0.2 - 77.2	-	-	-	-	-	0.007	3.269	0.995
Dimitriadis & Fournari-Konstantinidou (2018)	83	12.4 - 25.3	-	-	-	-	-	-	0.026	2.760	0.976
Miled-Fathalli et al. (2019)	60	11.6 - 25.0	22.0 - 186	-	-	-	-	-	0.019	2.848	0.990
Cengiz (2021)	22	10.5 - 17.1	20.3 - 80.6	-	-	-	-	-	0.026	2.810	0.950
Onay (2021)	17	6.5 - 12.8	3.9 - 36.1	-	-	-	-	-	0.016	2.990	0.910
This study	373	7.8 - 24.5	6.6 - 209.3	39.06	0.14	-1.77	2.32	0 - V	0.018	2.902	0.963

*calculated by us; o: otolith, s: scale

cies due to intensive coastal fishing. A comparison between the mortalities of the species studied in this work and those presented in the literature is not possible due to the unavailability of the requisite data. The only other source to report a survival rate (S) is Pallaoro & Jardas (2003), who found it to be 0.80 for males and 0.76 for females.

CONCLUSION

The *S. tinca* is subjected to considerable fishing pressure, and the implementation of effective management measures is imperative. Rather than being discarded at sea, these species could be relocated to marine aquariums (Türkmen et al., 2011). It is a species that is sought after for marine aquariums, as are other Labrids. This is due to a combination of factors, including its attractive appearance and its status as a natural cleaner that consumes ectoparasites found on other fish species (Cato & Brown, 2003; Wabnitz et al., 2003; Rhyne et al., 2012). This approach could allow fishers to increase their income while ensuring the survival of these fish in marine aquariums. However, in order to prevent this situation from leading to overfishing of this species, protective measures such as appropriate size, closed and open seasons in a specific area, catch quotas, etc. should be planned by the fisheries authority.

Conflict of Interest: The authors declare that they have no conflict of interests.

Ethics Committee Approval: There is no necessary for ethical approvement for this research.

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