AQUATIC RESEARCH

E-ISSN 2618-6365

Aquatic Research 7(3), 121-130 (2024) • https://doi.org/10.3153/AR24011 *Research Article*

Length-weight relationships and growth parameters of axillary seabream *Pagellus acarne* (Risso, 1827) from the Didim coast in the Southern Aegean Sea

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Cite this article as:

Uyan, A. (2024). Length-weight relationships and growth parameters of axillary seabream *Pagellus acarne* (Risso, 1827) from the Didim coast in the Southern Aegean Sea *Aquatic Research*, 7(3), 121-130. https://doi.org/10.3153/AR24011

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Submitted: 02.02.2024

Revision requested: 20.02.2024

Last revision received: 24.02.2024

Accepted: 25.02.2024

Published online: 17.05.2024

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Available online at

http://aquatres.scientificwebjournals.com

ABSTRACT

The length-weight relationships and growth parameters of the axillary seabream *Pagellus acarne* caught from the Didim coast in the southern Aegean Sea were examined. A total of 667 axillary seabream individuals, of which 295 were female (44.23%) and 372 were male (55.77%), were collected by commercial trawlers and gillnets from November 2021 to December 2023. The length-weight relationships were calculated for females, males, and sexes as $W = 0.0052 \times L^{3.2378}$, $W = 0.0065 \times L^{3.1521}$, and $W = 0.0058 \times L^{3.1965}$, respectively. The growth of *P. acarne* on the Didim coast was determined as positive allometric. The maximum age was found to be 4 for both females and males. The von Bertalanffy growth parameters were $L_\infty = 28.55$ cm, $k = 0.213$ year^{-1}, $t_0 = -2.011$ years for females; $L_\infty = 22.13$ cm, $k = 0.489$ year^{-1}, $t_0 = -0.862$ years for males; $L_\infty = 23.75$ cm, $k = 0.373$ year^{-1}, $t_0 = -1.203$ years for both sexes. The growth performance index (φ') for females, males, and sexes were 2.239, 2.379, and 2.324, respectively. This study provides the first contribution to the basic growth parameters of *P. acarne* along the Didim coast, southern Aegean Sea.

Keywords: Axillary seabream, *Pagellus acarne*, Length-weight relationship, Growth, Southern Aegean Sea

Introduction

The axillary seabream *Pagellus acarne* (Risso, 1827), one of the commercially significant species belonging to the family Sparidae, is distributed along the coasts of Madeira, the Canary Islands, and Cape Verde, from the Bay of Biscay to Senegal in the eastern Atlantic but is rare in the British Isles. It has a wide distribution in the Mediterranean along all coasts except the Black Sea (Froese & Pauly, 2023). Juveniles are generally found closer to shore, while adults particularly inhabit seagrass beds and sandy bottoms in various layers to depths of 500 m. However, they are more commonly found between 40 and 100 m (Bauchot & Hureau, 1986). Despite feeding omnivorous, their dietary tendencies predominantly lean towards a carnivorous diet, preying on small teleosts, arthropods, molluscs, echinoderms, and worms (Fehri-Bedoui et al., 2009). The species is protandric hermaphrodite. Typically, individuals start as males and then transform into females over 2 to 7 years (Bauchot & Hureau, 1986). The maximum total length reported is 36 cm (Bauchot & Hureau, 1986; Froese & Pauly, 2023). *P. acarne* is categorised as Least Concern (LC) in the IUCN Red List (IUCN, 2023).

Considering the dynamic nature of variations in length and weight of fish over time, the length-weight relationship (LWR) and the von Bertalanffy growth function (VBGF) provide dynamical parameters that lead to important mathematical inferences about stock assessments of species in a certain geographical region (Sparre, 1998). This makes it possible to determine the dynamic structure of fish populations, mathematically explain the growth rates of fish according to their age, interpret the current stock situation, develop long-term sustainable fishery strategies, and determine catch limits. Length-weight relationships of *P. acarne* have been examined in various studies conducted in different areas of the world (Pajuelo & Lorenzo, 2000; Velasco et al., 2011; Akel, 2016; Bensahla Talet et al., 2017; Cetkovic et al., 2018; Bentata-Keddar et al., 2020; Falsone et al., 2022; Ali-Basha et al., 2023) and Turkish marine waters (Tosunoğlu et al., 1997; Özaydın et al., 2007; İlkyaz et al., 2008; Cengiz, 2013; Bilge et al., 2014; Akalın et al., 2015; Altın et al. 2015; Soykan et al., 2015; Öztekin et al., 2016; Tünay, 2017; İlhan, 2018; Yedier et al., 2019; Kara et al., 2020; Gül et al., 2021; Acarlı et al., 2022). However, the growth parameters of the species have been determined in a limited number of studies such as Phan & Kompowski (1972), Pajuelo & Lorenzo (1994), Dominguez (2000), Pajuelo & Lorenzo (2000), Coelho et al. (2005), Velasco et al. (2011), Bentata-Keddar et al. (2020), and Ali-Basha et al. (2023) for the world and Tosunoğlu et al. (1997), Soykan et al. (2015), İlhan (2018), and Gül et al. (2021) for Türkiye.

P. acarne, a commercial and exploited species captured with trawl and gill nets, was harvested in 2018 with 3654 tons, the highest catch data. There were gradual decreases in 2019 and 2020, with 2913 and 2713 tons harvested, respectively. Then, in 2021, a harvest of 2728 tons was achieved, increasing slightly compared to the previous year (FAO, 2023). However, there are no specific catch data of *P. acarne* in the fisheries statistics of the Turkish Statistical Institute (TURKSTAT, 2022). Although the literature provides various studies on the population parameters of axillary seabream in different regions of Turkish marine waters, there is a lack of research on the species' basic biological parameters in Didim, an important coastline of southern Aegean. Didim, extending from the Büyük Menderes Delta in the north to Akbük Bay in the south, is a coastal area that stands out in terms of both fishery and aquaculture activities. Therefore, this study provides the first information on the length-weight relationship and growth parameters, aiming to contribute to the optimal exploitation of *P. acarne* stocks along the Didim coast in the southern Aegean Sea.

Materials and Methods

Between November 2021 and December 2023, the specimens of *Pagellus acarne* were collected by commercial trawlers and gillnets with various mesh sizes along the coast of Didim (Figure 1). The total length of the samples was measured to the nearest 0.1 cm and the weight to the nearest 0.01 g.

The length-weight relationships (LWRs) were independently estimated for all individuals with the formula $W = a \times L^b$ (Ricker, 1975). This equation can be expressed logarithmically as $\log W = \log a + b \log L$, where W is total body weight (g), and L is total length (cm). A is a coefficient relative to body form, and exponent b is the allometry coefficient of the linear regression equation expressing isometric (= 3), positive allometric (> 3) and negative allometric (< 3) growth in length. The significance of the linear regression coefficients obtained from length-weight data was tested by analysis of variance ANOVA (Zar, 1999). Student's t-test with a ±95% confidence interval was applied to verify whether the b values obtained in the linear regressions were significantly different from the null hypothesis of isometric growth (H_0: $b = 3$), using the equation $t_s = (b - 3) / sb$, where t_s is the t-test value, b the slope and sb the standard error of the slope (b) (Sokal & Rohlf, 1987).

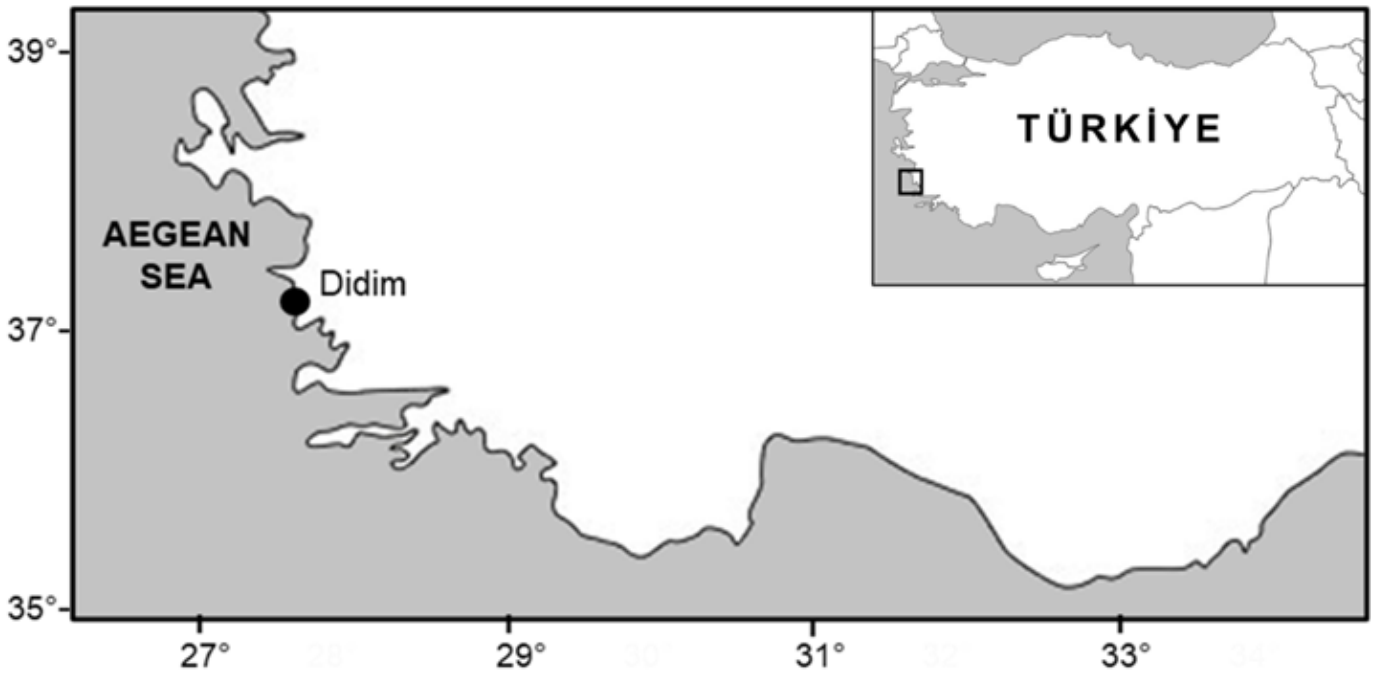

Figure 1. Sampling location of *Pagellus acarne*

Age readings were taken by counting growth annuli from all sagittal otoliths, as Holden and Raitt (1974) suggested. All otoliths were cleared in ethanol and then immersed in glycerine for examination. A reflected light binocular microscope was used to determine age.

Theoretical growth patterns for all individuals were calculated using the von Bertalanffy growth function (VBGF) (Beverton & Holt, 1957) $L_t = L_\infty [1 - e^{-k(t-to)}]$, where L_t is the fish length (cm) at the time t (year), L_∞ is the mean asymptotic length (cm), k is the growth coefficient (year^{-1}), and t_o (year) is the theoretical time at which the length equals to zero.

The growth performance index (φ') was estimated using the formula $\varphi' = \log k + 2 \log L_\infty$ (Munro & Pauly, 1983).

Results and Discussion

Descriptive Characteristics of the Sampling

During the research, 667 P. acarne samples, 295 female (44.23%) and 372 male (55.77%), were collected from the Didim coast. The overall sex ratio (F: M) was determined as 1:1.26. The chi-square test (χ^2) showed that the sex ratio was significantly different from the expected 1:1 ratio (χ^2, $P < 0.05$). Total length intervals were 12.0-21.8 cm for females, 11.6-21.0 cm for males, and weight intervals were 16.00-116.58 g for females, 14.66-99.86 g for males. The mean length and weights were 17.89 ±2.47 cm and 63.24 ±26.20 g for females and 16.43 ±2.44 cm and 47.91 ±21.53 g for males, respectively.

The maximum length and weight obtained from *P. acarne* individuals was 21.8 cm and 116.58 g. A statistically significant difference was found in overall length and weight values between male and female individuals (t_{test}, $P < 0.05$). Most individuals were between 16.0-16.9, 17.0-17.9, and 18.0-18.9 cm in total length, accounting for 53.07% of all samples (Figure 2).

Length-Weight Relationships

LWRs were independently calculated in logarithmic form as $log\ W = -2.2887 + 3.2378\ log\ L$ for females; $log\ W = -2.1838 + 3.1521\ log\ L$ for males; $log\ W = -2.2399 + 3.1965\ log\ L$ for both sexes.

Table 1 outlines the LWRs computed for males, females, and sexes of the axillary seabream sampled from the Didim coastline. The mean length and weight of females were higher than those of males, and all differences were statistically significant (t-test, $P < 0.05$). The exponent of the b parameter of females, males, and sexes demonstrated positive allometry and was statistically significant ($P < 0.05$). A strong correlation was obtained between the length and weight in the individuals of female, male, and both sexes ($P < 0.001$; $r^2 > 0.97$). A summary of the comparison between the length-weight relationships identified in this study and those from previous studies is presented in Table 2.

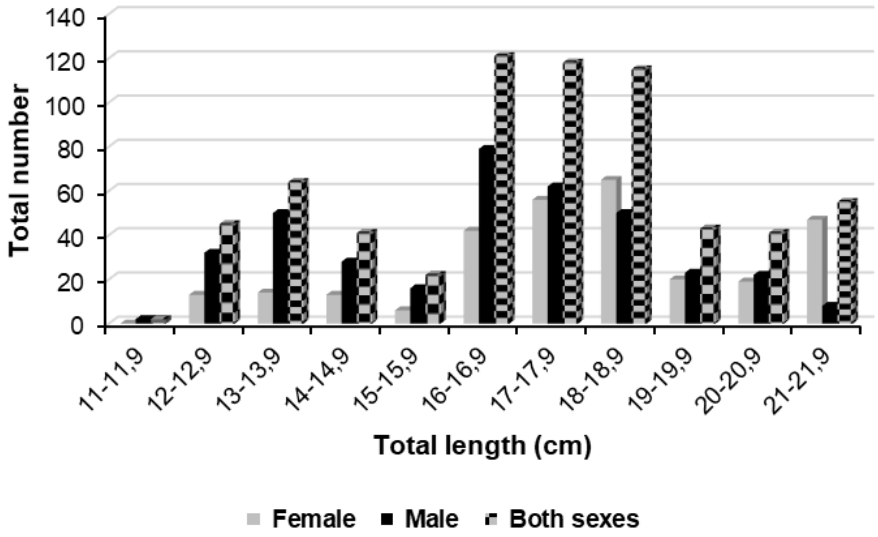

Figure 2. The length frequency distribution for females, males, and sexes of *Pagellus acarne* sampled from the Didim coast.

Table 1. General population statistics, LWR parameters and the isometric growth probability of *Pagellus acarne* were analysed with Student's *t*-test

Sex	N	Range of TL (cm) (L_{mean} ± SD)	Range of W (g) (W_{mean} ± SD)	LWR parameters		SE of *b*	95% CI of *b*	r^2	*t*-test
				a	*b*				
♀	295	12.0–21.8 (17.89 ±2.47)	16.00–116.58 (63.24 ±26.20)	0.0052	3.2378	0.0154	3.2102–3.2712	0.9922	15.55*
♂	372	11.6–21.0 (16.43 ±2.44)	14.66–99.86 (47.91 ±21.53)	0.0065	3.1521	0.0128	3.1263–3.1769	0.9925	11.77*
♀ + ♂	667	11.6–21.8 (17.08 ±2.56)	14.66–116.58 (54.69 ±24.89)	0.0058	3.1965	0.0096	3.1812–3.2191	0.9926	20.72*

♀, female; ♂, male; N, sample number; TL, length; W, weight; SD, standard deviation; *a*, intercept; *b*, slope; SE, standard error; CI, confidence interval; r^2, coefficient of determination; * $t > t_{0.05,N>250} = 1.65$

Determination of the von Bertalanffy Growth Function (VBGF) Parameters

Sagittal otolith examinations revealed age patterns ranging from I to IV age classes for both females and males. Table 3 displays the total length frequencies of *P. acarne* from the Didim coast based on age classes. In the female age class, III (43.04%) was dominant, followed by IV (24.42%), II (18.30%), and I (14.24%) classes, while in the male age class, II (49.19%) was dominant, followed by I (27.96%), IV (13.17%) and III (9.68%) classes.

The growth pattern in mean lengths from each age group was estimated for females, males, and both sexes of *P. acarne* from the Didim coast using the VBGF. The von Bertalanffy growth parameters were calculated as L_∞ = 28.55 cm, k = 0.213 year^{-1}, t_0 = -2.011 years for females; L_∞ = 22.13 cm, k = 0.489 year^{-1}, t_0 = -0.862 years for males; L_∞ = 23.75 cm, k = 0.373 year^{-1}, t_0 = -1.203 years for both sexes. The growth performance index (φ') was estimated for females, males, and both sexes as 2.239, 2.379, and 2.324, respectively. A summary of comparisons of von Bertalanffy growth parameters for *P. acarne* distributed in different geographical areas is presented in Table 4.

Overall, information on the age and growth parameters of *P. acarne* in southern Aegean Sea populations is limited. The present study is the first contribution to the biological parameters of *P. acarne* along the Didim coast (southern Aegean Sea). Thus, the LWR and VBGF parameters for the species have been compared using data from various locations within

its distribution area (Tables 2 and 4). The observed sex ratio of 1:1.26, favouring males, aligns with those obtained by Tünay (2017), İlhan (2018), Bentata-Keddar et al. (2020), and Ali-Basha et al. (2023). In contrast, it contrasts with the findings obtained by Pajuelo & Lorenzo (2000), Soykan et al. (2015), and Gül et al. (2021) in favour of females. These discrepancies in sex ratio could potentially be attributed to species-specific protandric hermaphroditism.

This study showed that the total length range of all *P. acarne* individuals from the Didim coast varied between 11.6-21.8 cm, which is similar to the ranges along the Aegean Sea determined by İlkyaz et al. (2008), Cengiz (2013), Bilge et al. (2014), Soykan et al. (2015), İlhan (2018), and Çolakoğlu (2021); however, it is inconsistent with the ranges estimated by Altın et al. (2015), Öztekin et al. (2016), Tünay (2017), Kara et al. (2020), and Acarlı et al. (2022). Kara & Bayhan (2015) emphasised that one of the important reasons for the fluctuations resulting from the similarities and differences in the total length range of the species in a region is the selectivity of the fishing gear used in sampling studies, while the other is the sampling performance carried out in different years.

Table 2. The LWR comparisons of *Pagellus acarne* from different geographical areas

Locations	N	Sex	*a*	*b*	GT	Author(s)
Gülbahçe Bay, Central Aegean Sea (Türkiye)	107	♀+♂	0.082	3.2887	A+	Tosunoğlu et al. (1997)
Canarian Archipelago, Northern Atlantic (Spain)	968	♀	0.0062	3.2416	A+	Pajuelo & Lorenzo (2000)
	556	♂	0.0065	3.2813	A+	
Izmir Bay, Central Aegean Sea (Türkiye)	303	♀+♂	0.0071	3.353	A+	Özaydın et al. (2007)
Izmir Bay, Central Aegean Sea (Türkiye)	334	♀+♂	0.0104	3.06	I	İlkyaz et al. (2008)
Gulf of Cadiz (Spain)	461	♀+♂	0.0048	3.3207	A+	Velasco et al. (2011)
Alboran Coast of Spain	406		0.0093	3.1132	A+	
Gallipoli Peninsula and Dardanelles (Türkiye)	228	♀+♂	0.0119	3.03	I	Cengiz (2013)
Southern Aegean Sea (Türkiye)	472	♀+♂	0.0121	3.2114	A+	Bilge et al. (2014)
Çandarli Bay, Aegean Sea (Türkiye)	83	♀+♂	0.0078	3.281	A+	Akalın et al. (2015)
Gökçeada Island, Northern Aegean Sea (Türkiye)	908	♀+♂	0.004	3.594	A+	Altın et al. (2015)
Izmir Bay, Central Aegean Sea (Türkiye)	281	♀	0.011	3.055	I	Soykan et al. (2015)
	80	♂	0.008	3.155	I	
Mediterranean Coast of Egypt	468	♀+♂	0.0348	2.6244	A-	Akel (2016)
Gallipoli Peninsula, Northern Aegean Sea (Türkiye)	53	♀+♂	0.0331	2.629	A-	Öztekin et al. (2016)
Oran Bay, Western Mediterranean (Algeria)	844	♀+♂	0.0089	3.10	A+	Bensahla Talet et al. (2017)
Gulf of Edremit, Northern Aegean Sea (Türkiye)	338	♀+♂	0.0145	2.911	A-	Tünay (2017)
Mediterranean Coast of Libya	100	♀+♂	0.00004	2.76	A-	Cetkovic et al. (2018)
Izmir Bay, Central Aegean Sea (Türkiye)	861	♀	0.0109	3.066	A+	İlhan (2018)
	905	♂	0.0153	2.943	A-	
Tekirdağ Coast of Marmara Sea (Türkiye)	294	♀+♂	0.02	2.8142	A-	Yedier et al. (2019)
Mediterranean Coast of Algeria	795	♀	0.0131	2.9716	A-	Bentata-Keddar et al. (2020)
		♂	0.0095	3.0756	I	
Izmir Bay, Central Aegean Sea (Türkiye)	525	♀+♂	0.0083	3.15	A+	Kara et al. (2020)
Saros Bay, North Aegean Sea (Türkiye)	246	♀	0.005	3.277	A+	Gül et al. (2021)
	115	♂	0.004	3.364	A+	
Gökçeada Island, Northern Aegean Sea (Türkiye)	1323	♀+♂	0.0170	2.8946	A-	Acarlı et al. (2022)
Southern Sicily, Central Mediterranean (Italy)	1250	♀+♂	0.0097	3.1093	A+	Falsone et al. (2022)
Lattakia Coast, Eastern Mediterranean (Syria)	465	♀	0.00564	3.290	A+	Ali-Basha et al. (2023)
	582	♂	0.00607	3.263	A+	
Didim Coast, Southern Aegean Sea (Türkiye)	295	♀	0.0052	3.2378	A+	Present Study
	372	♂	0.0065	3.1521	A+	

N, number of sample studied; *a*, intercept; *b*, slope; ♀, female; ♂, male; ♀+♂ = females + males (consist of unsexed individuals); GT, growth type; A+, allometric positive; A-, allometric negative; I, isometric

Table 3. Length key of female and male *Pagellus acarne* individuals depend on age classes from the Didim coast

	Age classes							
	♀				♂			
Range of TL (cm)	**I**	**II**	**III**	**IV**	**I**	**II**	**III**	**IV**
11-11.9					2			
12-12.9	13				32			
13-13.9	14				46	4		
14-14.9	12	1			24	4		
15-15.9	3	3				16		
16-16.9		40	2			79		
17-17.9		10	46			56	6	
18-18.9			47	18		24	20	6
19-19.9			16	4			10	13
20-20.9			13	6				22
21-21.9				47				8
Total	42	54	124	75	104	183	36	49
Coverage	14.24%	18.30%	43.04%	24.42%	27.96%	49.19%	9.68%	13.17%
Mean (TL)	13.44±1.05	16.52±0.47	18.35±0.95	20.61±1.24	13.28±0.91	16.81±1.00	18.56±0.60	20.15±0.78
Mean (W)	24.11±5.85	45.04±2.78	65.30±13.06	94.85±16.99	23.22±4.85	47.92±9.01	67.18±7.70	86.08±9.85

♀, female; ♂, male; TL, total length; W, weight

Table 4. The growth comparisons of *Pagellus acarne* from different geographical areas

Locations	**Sex**	L_∞	k	t_o	φ'	**Author(s)**
West Africa Coasts, Northern Atlantic	♀+♂	36.0	0.23	-0.97		Phan & Kompowski (1972)
Canarian Archipelago, Northern Atlantic (Spain)	♀+♂	32.09	0.232	-0.919		Pajuelo & Lorenzo (1994)
Gülbahçe Bay, Central Aegean Sea (Türkiye)	♀+♂	21.00	0.171	-3.222		Tosunoğlu et al. (1997)
Alboran Coast of Spain	♀+♂	29.62	0.27	-1.36		Dominguez (2000)
Canarian Archipelago, Northern Atlantic (Spain)	♀	33.90	0.21	-0.99		Pajuelo & Lorenzo (2000)
	♂	27.98	0.27	-0.67		
Algarve Coast, Northern Atlantic (Portugal)	♀	32.30	0.18	-2.56		Coelho et al. (2005)
	♂	28.82	0.29	-1.47		
Gulf of Cadiz (Spain)	♀+♂	31.65	0.21	-1.76	2.32	Velasco et al. (2011)
Alboran Coast of Spain		32.14	0.17	-2.69	2.24	
Izmir Bay, Central Aegean Sea (Türkiye)	♀+♂	22.66	0.315	-1.202	2.21	Soykan et al. (2015)
Izmir Bay, Central Aegean Sea (Türkiye)	♀	27.75	0.201	-2.347	2.190	İlhan (2018)
	♂	22.45	0.341	-1.554	2.235	
Mediterranean Coast of Algeria	♀+♂	29.97	0.41	-0.34	2.57	Bentata-Keddar et al. (2020)
Saros Bay, North Aegean Sea (Türkiye)	♀+♂	30.63	0.26	-0.95	2.39	Gül et al. (2021)
Lattakia Coast, Eastern Mediterranean (Syria)	♀	22.97	0.18	-0.239	1.97	Ali-Basha et al. (2023)
	♂	21.50	0.32	-0.238	2.17	
Didim Coast, Southern Aegean Sea (Türkiye)	♀	28.55	0.213	-2.011	2.239	Present Study
	♂	22.13	0.489	-0.862	2.379	

♀, female; ♂, male; L_∞, asymptotic length; k, growth coefficient; t_o, theoretical age at length equal to zero; φ', growth performance index

The *b* value of the LWR obtained from the present study indicated positive allometry for both females (3.2378) and males (3.1521), which generally agrees with the previous calculations outlined in Table 2. In contrast, Akel (2016), Öztekin et al. (2016), Tünay (2017), Yedier et al. (2019) and Acarlı et al. (2022) reported the negative allometric *b* value of *P. acarne* as 2.6244 (Mediterranean Coast of Egypt), 2.629 (Gallipoli peninsula), 2.911 (Edremit Bay), 2.8142 (Sea of Marmara), and 2.8946 (Gökçeada Island), respectively. The *b* value, indicating the natural growth of fish, varies between 2 and 4 (Tesch, 1971). Apart from protandric hermaphroditism contributing to different length distributions and variations in both sexes, a combination of factors such as sampling site, habitat, season, maturity, sex, age, diet, and differences in length ranges of fish samples may give rise to observed differences in length-weight relationships (Ricker, 1975).

Age estimations obtained from otolith readings of *P. acarne* individuals collected from the Didim coast revealed that samples from both sexes were between I to IV age classes. The dominant age class of females is III, where the most common total length ranges are 17.0-17.9 and 18.0-18.9 cm. As for males, the predominant age class is II, where the most frequent total length range is 16.0-16.9 cm. Tosunoğlu et al. (1997) determined that the dominant age classes of all individuals were I and II. The total length groups were 11 and 12 cm. Pajuelo & Lorenzo (1994, 2000) found the dominance of age class II for all individuals and determined the most prevalent size in this class as 15 and 16 cm. Coelho et al. (2005) detected the most dominant age class of females and males as VI and IV and found the size range with the highest number of individuals 25.0-27.7 and 22.4-25.5 cm, respectively. Velasco et al. (2011) estimated the dominance of age classes V and III for all Gulf of Cadiz and Alboran Sea individuals. They obtained the frequent length groups as 24 and 22 cm, respectively. İlhan (2018) found the dominant age classes of females to be I and II. The total length ranges with the highest number of individuals to be 11.9-15.5 and 14.9-17.1 cm, while for males, the dominant age classes were also I and II, with the most common length ranges being 11.1-15.3 and 13.5-18.5 cm. Using fishing equipment such as longlines, gill nets, and beach seines, capable of capturing larger specimens compared to trawling, might have led to the observed variations in age classes based on the size ranges suggested various studies in different regions.

The asymptotic length (L_∞) of *P. acarne* derived from this study was 28.55 cm for females, 22.13 for males, and 23.75 cm for both sexes, which is generally around the previous studies, except for Phan & Kompowski (1972), Pajuelo & Lorenzo (1994), Pajuelo & Lorenzo (2000), Coelho et al. (2005), Velasco et al. (2011), and Gül et al. (2021) (Table 4). Phan & Kompowski (1972) analysed the population structure of *P. acarne* from West African coasts and found L_∞ to be 36 cm for both sexes. Pajuelo and Lorenzo (1994, 2000) studied the biological parameters of *P. acarne* in the Canarian Archipelago**,** and their computation of L_∞ was 32.09 and 32.98 cm for all individuals, respectively. Coelho et al. (2005) studied some parameters of the *P. acarne* population from the Algarve coast and calculated L_∞ for all samples as 32.05 cm. Velasco et al. (2011) revealed the age and growth features of *P. acarne* in the Gulf of Cadiz and the Spanish coast of the Alboran Sea and found L_∞ to be 31.65 and 32.14 cm for all individuals, respectively. Gül et al. (2021) examined the population structure of *P. acarne* from Saros Bay and found L_∞ to be 30.63 cm for combined sexes. Wotton (1990) suggested that significant differences in growth characteristics can be observed in fish populations of the same species in different geographical regions. Additionally, differences in growth characteristics can be attributed to the potential changes in food quality and water temperature (Santic et al., 2002). In particular, variations in the estimated asymptotic length could be linked to phylogeographic diversity and factors such as fishing pressure, global climate change, and pollutants (Uyan et al., 2020).

The growth coefficient (*k*) was found to be 0.213 for females and 0.489 for males, around the several calculations provided in Table 4, pointing out higher growth performance in males than females. The present study attributes this observed phenomenon to protandric hermaphroditism, a suggestion supported by several studies (Pajuelo & Lorenzo, 2000; Coelho et al., 2005; İlhan, 2018; Ali-Basha et al., 2023). Furthermore, İlhan (2018) proposed that this can be substantiated by *P. acarne* females exhibiting a lower *k* and a higher L_∞.

The growth performance index (φ'), considering the correlation between L_∞ and *k*, of axillary seabream on the coast of Didim was 2.239 for females, 2.379 for males, and 2.324 for both sexes. These findings generally align with the growth performance index presented in Table 4 obtained from Gulf of Cadiz and Spanish coast of the Alboran Sea (Velasco et al., 2011), Izmir Bay (Soykan et al., 2015; İlhan, 2018), Mediterranean coast of Algeria (Bentata-Keddar et al., 2020), Saros Bay (Gül et al., 2021), Lattakia coast (Ali-Basha et al., 2023). This consistency provides evidence that the growth of seabream in these different regions is similarly affected by ecological conditions.

Conclusions

Ensuring effective fisheries management and enforcement is crucial for the protection and sustainable exploitation of natural resources. Rational and effective management of fisheries resources is possible through self-assessment of the investigated species and their regional stocks (Turan, 2021). The present study has provided the first contributions to the basic growth parameters of *P. acarne*, distributed along the Didim coast of the southern Aegean Sea. The information obtained is considerable for establishing collaborations between stakeholders, researchers, and policymakers and improving sustainability in the face of increasing predictable demand for seafood. This proactive approach will pave the way for the establishment of ecosystem-based sustainable fisheries for commercially important species in the future. Further studies investigating the populations of *P. acarne* in Turkish marine waters using genetic and morphological markers will contribute to a more detailed interpretation of the stock status and provide significant information from the perspective of sustainable fisheries management.

Compliance with Ethical Standards

Conflict of interest: The authors declare no actual, potential, or perceived conflict of interest for this article.

Ethics committee approval: Ethics committee approval is not required for this study.

Data availability: Data will be made available on request.

Funding disclosure: There is no funding supporting the research.

Acknowledgements: The author thanks the fishermen for their valuable help collecting samples.

Disclosure: -

References

Acarlı, D., Kale, S., Çakır, K. (2022). Length–Weight Relationships of Eighteen Fishes and a Cephalopod from Gökçeada Island, Northern Aegean Sea, Turkey. *Thalassa: An International Journal of Marine Sciences*, 38(1), 479-486. https://doi.org/10.1007/s41208-022-00408-6

Akalın, S., İlhan, D., Özaydın, O. (2015). Length-weight relationships for 30 demersal fish species from Çandarli Bay (North Aegean Sea, Turkey). *Croatian Journal of Fisheries: Ribarstvo*, 73(2), 73-76. https://doi.org/10.14798/73.2.822

Akel, E.H.K. (2016). Length-weight relationships and condition factors for fifteen species caught by experimental bottom trawl along the Egyptian Mediterranean coast. *Acta Velit*, 2(4), 15-19.

Ali-Basha, N., Hamwi, N., Saad, A. (2023). Age, growth, Mortality and Exploitation of the Axillary seabream, *Pagellus acarne* (Risso, 1826) (Sparidae) from the Syrian marine waters. *Damascus University Journal of Agricultural* Sciences, 39(4), 161-172.

Altın, A., Ayyıldız, H., Kale, S., Alver, C. (2015). Length-weight relationships of forty-nine fish species from shallow waters of Gökçeada Island, northern Aegean Sea Turkey. *Turkish Journal of Zoology*, 39(5), 971-975. https://doi.org/10.3906/zoo-1412-15

Bauchot M.L., Hureau J.C. (1986). Sparidae. In Fishes of the north-eastern Atlantic and the Mediterranean Vol. II; Whitehead P.J.P., Bauchot M.L., Hureau J.C., Nielsen J., Tortonese E., Eds.; UNESCO: Paris, France, pp 883-907. ISBN: 92-3-002308-6

Bensahla Talet, L., Gherram, M., Dalouche, F., Bensahla Talet, A., Boutiba, Z. (2017). Reproductive biology of *Pagellus acarne* (Risso, 1927) (Teleostei: Sparidae) off western Algerian waters (Western Mediterranean). *Journal of King Abdulaziz University: Marine Science*, 27(1), 1-9. https://doi.org/10.4197/Mar.27-1.1

Bentata-Keddar, I., Abid-Kachour, S., Bouderbala, M., Mouffok, S. (2020). Reproduction and growth of Axillary seabream *Pagellus acarne* (Risso, 1827) (Perciformes Sparidae) from the western Algerian coasts. *Biodiversity Journal*, 11(2), 351-358. https://doi.org/10.31396/Biodiv.Jour.2020.11.2.351.358

Beverton, R.J.H., Holt, S.J. (1957). On the dynamics of exploited fish populations. Springer Science+Business Media Dordrecht, Netherlands, 538 p. ISBN: 978-94-010-4934-4.

Bilge, G., Yapıcı, S., Filiz, H., Cerim, H. (2014). Weight–length relations for 103 fish species from the southern Aegean Sea, Turkey. *Acta Ichthyologica et Piscatoria*, 44(3), 263-269. https://doi.org/10.3750/AIP2014.44.3.11

Cengiz, Ö. (2013). Length-weight relationships of 22 fish species from the Gallipoli Peninsula and Dardanelles (northeastern Mediterranean, Turkey). *Turkish Journal of Zoology*, 37(4), 419-422.

https://doi.org/10.3906/zoo-1209-30

Cetkovic, K.J., Adabousi, M., Subotic, S. (2018). Lenght-weight relationship and condition factor of the axillary seabream (*Pagellus acarne*) in coastal waters of Lybia. *8th International Conference "WATER & FISH"*, June 13-15. Belgrade, SERBIA. Pp. 207-208.

Coelho, R., Bentes, L., Correia, C., Gonçalves, J.M.S., Lino, P.G., Monteiro, P., Ribeiro, J., Erzini, K. (2005). Age, growth and reproduction of the axilary seabream, *Pagellus acarne* (Risso, 1827), from the south coast of Portugal. *Thalassas: An International Journal of Marine Sciences*, 21(1), 79-84.

Dominguez J.B. (2000). Biología pesquera del besugo *Pagellus acarne* (Risso, 1826) del mar de Alborán (PhD thesis, Instituto Espanol de Oceanografia, Malaga, Espana). 228 p.

Falsone, F., Geraci, M.L., Scannella, D., Gancitano, V., Di Maio, F., Sardo, G., Quattrocchi, F., Vitale, S. (2022). Length-weight relationships of 52 species from the south of Sicily (Central Mediterranean Sea). *Fishes*, 7(2), 92. https://doi.org/10.3390/fishes7020092

FAO. (2023). Fishery and Aquaculture Statistics. Global capture production 1950-2021 (FishStatJ). In FAO Fisheries and Aquaculture Division [online], Updated 2023. Rome, Italy. www.fao.org/fishery/en/statistics/software/fishstatj

Fehri-Bedoui, R., Mokrani, E., Hassine, O.K.B. (2009). Feeding habits of *Pagellus acarne* (Sparidae) in the Gulf of Tunis, central Mediterranean. *Scientia Marina*, 73(4), 667-678. https://doi.org/10.3989/scimar.2009.73n4667

Froese, R., Pauly, D. (2023). FishBase. www.fishbase.org (accessed 20.12.2023).

Gül, G., İşmen, A., İhsanoğlu, M.A. (2021). Population structure of *Pagellus acarne* (Risso, 1927) in the North Aegean Sea. *International Journal of Environment and Geoinformatics*, 8(1), 19-27. https://doi.org/10.30897/ijegeo.800936

Holden, M.J., Raitt, D.F.S. (1974). Manual of Fisheries Science Part 2: Methods of Resource Investigation and Their Application. FAO Fisheries Technical Paper No 115, Rome, Italy. 255 p.

IUCN. (2023). The IUCN Red List of Threatened Species. Version 2023-1. www.iucnredlist.org (accessed 20.02.2024).

İlhan, D. (2018). Age, growth, and diet of axillary seabream, *Pagellus acarne* (Actinopterygii: Perciformes: Sparidae), in the central Aegean Sea. *Acta Ichthyologica et Piscatoria*, 48(4), 329-339. https://doi.org/10.3750/AIEP/02454

İlkyaz, A.T., Metin, G., Soykan, O., Kınacıgil, H.T. (2008). Length-weight relationship of 62 fish species from the Central Aegean Sea, Turkey. *Journal of Applied Ichthyology*, 24(6), 699-702. https://doi.org/10.1111/j.1439-0426.2008.01167.x

Kara, A., Acarlı, D., İlkyaz, A. T., & Babaoğlu, A.Ö. (2020). Length-weight and length-length relations for 21 fish species caught in Izmir Bay. *Acta Adriatica*, 61(2), 197-204. https://doi.org/10.32582/aa.61.2.8

Kara, A., Bayhan, B. (2015). Age and growth of *Boops boops* (Linnaeus, 1758) in Izmir Bay, Aegean Sea, Turkey. *Journal of Applied Ichthyology*, 31(4), 620-626. https://doi.org/10.1111/jai.12680

Munro, J.L., Pauly, D. (1983). A simple method for comparing the growth of fishes and invertebrates. *Fishbyte*, 1(1), 5-6.

Özaydın, O., Uçkun, D., Akalın, S., Leblebici, S., Tosunoğlu, Z. (2007). Length-weight relationships of fishes captured from Izmir Bay, Central Aegean Sea. *Journal of Applied Ichthyology*, 23(6), 695-696. https://doi.org/10.1111/j.1439-0426.2007.00853.x

Öztekin, A., Özekinci, U., Daban, İ.B. (2016). Length-weight relationships of 26 fish species caught by longline from the Gallipoli peninsula, Turkey (northern Aegean Sea). *Cahiers de Biologie Marine*, 57(4), 335-342.

Pajuelo, J.M.G., Lorenzo, J.M.N. (1994). Biological parameters of axillary sea bream *Pagellus acarne* (Pisces: Sparidae) in Gran Canaria, Canary Islands. *Boletín-Instituto Español de Oceanografía*, 10(2), 155-164.

Pajuelo, B.J., Lorenzo, J.M. (2000). Reproduction, age, growth and mortality of axillary seabream, *Pagellus acarne* (Sparidae), from the Canarian archipelago. *Journal of Applied Ichthyology*, 16(2), 41-47. https://doi.org/10.1046/j.1439-0426.2000.00154.x

Phan, L.T., Kompowski, A. (1972). The bronze bream, *Pagellus acarne* Risso from the north west African region. *Acta Ichthyologica et Piscatoria*, 2(1), 1-18.

Ricker, W.E. (1975). Computation and interpretation of biological statistics of fish populations. Bulletin - Fisheries Research Board of Canada, Ottawa, Canada, 382 p. ISBN: 0-662-01440-5.

Santic, M., Jardas, I., Pallaoro, A. (2002). Age, growth and mortality rate of horse mackerel *Trachurus trachurus* (L.) living in the eastern Adriatic. *Periodicum Biologorum*, 104(2), 165-173.

Sokal, R., Rohlf, F. (1987). Introduction to biostatistics, 2nd edn. Dover Publication, San Francisco, U.S.A., 384 p. ISBN: 9780486469614

Soykan, O., İlkyaz, A.T., Metin, G., Kınacıgil, H.T. (2015). Growth and reproduction of *Boops boops*, *Dentex macrophthalmus*, *Diplodus vulgaris*, and *Pagellus acarne* (Actinopterygii: Perciformes: Sparidae) from east-central Aegean Sea, Turkey. *Acta Ichthyologica et Piscatoria*, 45(1), 39-55. https://doi.org/10.3750/AIP2015.45.1.05

Sparre, P. (1998). Introduction to tropical fish stock assessment Part 1: Manual. FAO Fisheries Technical Paper No 306/1, Rome, Italy. 407 p.

Tesch, F.W. (1971). Age and growth. In Methods for assessment of fish production in freshwaters, 1st edn; Ricker, W.E., Ed.; Blackwell Scientific Publications: Oxford, U.K., pp 98-103. ISBN: 9780632046607.

Tosunoğlu, Z., Akyol, O., Metin, G., Tokaç, A., Ünsal, S. (1997). The study on the population characteristics of three sparid species in the Gülbahçe Bay. *Ege Journal of Fisheries and Aquatic Sciences*, 14, 127-143.

Tünay, Ö.K. (2017). Fish Fauna of Edremit Bay (Master's thesis, Balıkesir University Institute of Science Biology, Balıkesir, Türkiye). 256 p.

Turan, C. (2021). Data-limited stock assessment of two horse mackerel species (*Trachurus mediterraneus* and *T. trachurus*) from the Mediterranean coast of Turkey. *Regional Studies in Marine Science*, 44, 101732. https://doi.org/10.1016/j.rsma.2021.101732

TURKSTAT. (2023). Fishery Statistics. Ankara: Turkish Statistical Institute. https://data.tuik.gov.tr/Kategori/GetKategori?p=tarim-111&dil=1 (accessed 20.02.2024).

Uyan, A., Turan, C., Gürlek, M., Yağlıoğlu, D. (2020). Genetic and bio-ecologic characteristics of common pandora *Pagellus erythrinus* from the eastern Mediterranean coast of Turkey for the ecosystem-based fishery management. *Genetics of Aquatic Organisms*, 4(1), 29-37. https://doi.org/10.4194/2459-1831-v4_1_03

Velasco, E.M., Jiménez-Tenorio, N., Del Arbol, J., Bruzón, M.A., Baro, J., Sobrino, I. (2011). Age, growth and reproduction of the axillary seabream, *Pagellus acarne*, in the Atlantic and Mediterranean waters off southern Spain. *Journal of the Marine Biological Association of the United Kingdom*, 91(6), 1243-1253. https://doi.org/10.1017/S0025315410000305

Wotton R.J. (1990). Ecology of teleost fishes. Chapman & Hall, London, U.K., 404 p. ISBN: 0412317303. https://doi.org/10.1007/978-94-009-0829-1

Yedier, S., Kontaş, S. Bostancı, D. (2019). Condition Factor, Length-Length and Length-Weight Relationships for *Pagellus acarne* (Risso, 1827) Inhabiting the Sea of Marmara. *Journal of Anatolian Environmental and Animal Sciences*, 4(2), 82-88. https://doi.org/10.35229/jaes.542005

Zar, J.H. (1999). Biostatistical analysis, 4th edn. Pearson Prentice Hall, New Jersey, U.S.A., 663 p. ISBN: 9780130815422