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Study of the Age and Growth by Scalimetry of *Pagellus erythrinus* (Sparidae, Linnaeus, 1758) along the El-Kala Coast (North East Algeria)

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ABSTRACT

The age and growth of the common pandora (*Pagellus erythrinus*) were investigated along the El-Kala coastline (northeastern Algeria), marking the first study of its kind in this area. From March 2023 to February 2024, a total of 492 specimens were sampled, with total lengths (TL) ranging from 10.5 to 23.5 cm, total weights (TW) from 7.03 to 164.3g, and eviscerated weights (EW) from 6.1 to 157.3g. The ages of the specimens ranged from 0 to 6 years, determined using the direct method of scalimetry. The growth parameters based on the von Bertalanffy growth model, derived from the average age-length pairs, were as follows: $L\infty = 23.72$cm, $K = 0.2$ year^{-1}, $t_0 = -0.901$, and $W\infty = 166.25$g, with a performance index (φ') of 2.05 for both sexes combined. The relative growth equations for males, females, and all specimens were $TW = 0.043TL^{2.59}$, $TW = 0.067TL^{2.43}$, and $TW = 0.052TL^{2.52}$, respectively, indicating negative allometry for all three categories.

INTRODUCTION

Widely distributed in tropical and temperate coastal waters around the world, the Sparidae family, belonging to the order Perciformes, includes approximately 33 genera and 115 species. In the Mediterranean Sea, 24 species are known, of which four belong to the genus *Pagellus*: the blackspot seabream, *P. bogaraveo* (Brünnich, 1756), the common pandora, *P. erythrinus* (Linnaeus, 1758) **(Louisy, 2002)**, the axillary seabream, *P. acarne* (Risso, 1810), and the red pandora, *P. bellottii* (Steindachner, 1882). The common pandora *P. erythrinus* has a relatively broad distribution, also found in the Black Sea and the Northeast Atlantic Ocean **(Bauchot & Hureau, 1986; Fisher *et al.*, 1987; Froese & Pauly, 2014)**. *P. erythrinus* is a semi-pelagic and gregarious demersal species, inhabiting various substrates (rocks, gravel, sand, or mud) at depths ranging from 20 to 100 meters, reaching even 320 meters in some regions **(Bauchot *et al.*, 1987)**. It is a commercial target for trawls, gillnets, and trammel nets, and is subject to fisheries conservation legislation, which sets the minimum size limit at 15cm (EU Regulation 1967/2006), also

applicable in the Algerian waters according to Executive Decree N°. 04-86 of March 18, 2004 **(J.O.R.A.D.P, 2004)**.

In Algeria, demersal resources account for approximately 7% of the total fisheries production, estimated at around 112.000 tons **(M.P.P.H, 2023)**. Among these, the species *Pagellus erythrinus* stands out as one of the primary targets of artisanal fishing, with a production of about 453 tons **(M.P.P.H, 2023)**, highlighting its significant commercial value and considerable economic potential due to its high market price.

Valdés *et al.* (2004) emphasized that *P. erythrinus* is well-suited not only for fisheries but also for aquaculture, and that proper management of this species is crucial for the local economy. According to **Mahé *et al.* (2009)**, to ensure sustainable management of fish populations, whether they are exploited or part of conservation programs, it is essential to thoroughly understand their structure and dynamics. Indeed, parameters such as age, growth rate, mortality, and renewal rate are key life history traits that directly influence stock management decisions **(Campana & Thorrold, 2001)**.

The economic interest in the common pandora, *P. erythrinus*, has prompted several biological studies across different regions of the Atlantic Ocean **(Pajuelo & Lorenzo, 1998; Coelho *et al*., 2010; Erzini *et al*., 2001)**, the Algeria-central region **(Harchouche, 2009)**, the Mediterranean **(Abella *et al*., 2010; Busalacchi *et al.*, 2014; Lteif *et al*., 2020; Mehanna, 2022)**, as well asthe western region **(Mahdi *et al*., 2018)**. In our study area, investigations have revealed a lack of information on this species. This article addressed the age and growth of the common pandora, *P. erythrinus*, caught in the waters of the eastern Algerian coast (El-Kala coastline). These fundamental parameters are crucial for stock assessment techniques and would shed lights on the biological cycle of these fish.

MATERIALS AND METHODS

Sampling area

Our study area is located in the extreme northeastern Algeria (Marine Area of the El-Kala National Park) extending for approximately 50km from Cape Rosa to Cape Roux (8°15' E and 36° 58' N) (Fig. 1). The UNESCO has classified the coastal marine area of El-Kala as a natural biosphere reserve, bordering the Mediterranean Sea and protecting a mosaic of habitats: wetlands, pine and oak forests, mountainous areas and marine ecosystems.

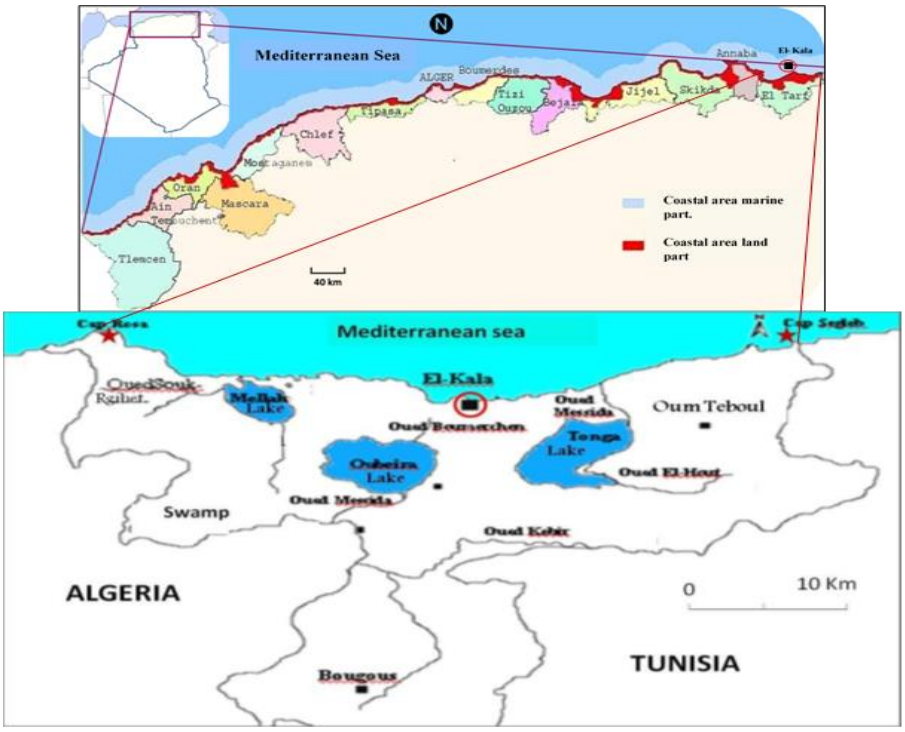

Fig. 1. Sampling area (Northeast Algeria, modified)

Data collection and sampling procedure

The fish samples were monthly collected during an annual cycle from commercial landings in the city of El-Kala (extreme northeastern Algeria) (Fig. 1). A total of 492 individuals of *P. erythrinus* were collected from March 2023 to February 2024 as follows: ($10.5 \leq TL \leq 23.5$cm, $7.03 \leq TW \leq 164.3$g, $6.1 \leq EW \leq 157.3$g), 213 males ($11 \leq TL \leq 22$cm, $7.03 \leq TW \leq 151.4$g, $14.8 \leq EW \leq 130.2$g), 192 females ($10.5 \leq TL \leq 23.5$cm, $22 \leq TW \leq 164.3$g, $20.9 \leq EW \leq 157.3$g) and 87 undetermined individuals. The samples obtained were measured to the nearest total length (TL) of 10^{-1}cm and to the nearest weight (W) of 10^{-2}g with Kern EMB 600-2 model of electronic balance. Age was determined by scalimetry; several scales were taken, cleaned and placed between two glass slides, and observed under an optical microscope.

Age and growth

Using the FiSAT II program, version 1.2.2 **(Gayanilo *et al.*, 2005)**, the von Bertalanffy growth parameters (1938) were deduced and expressed as: $\boldsymbol{Lt = L\infty \times (1 - e^{-K(t-t_0)})}$, where Lt is the TL at time t; L∞ is the asymptotic length; k is the growth constant which determines how fast the fish approaches L∞, and to is the theoretical age at Lt = 0, which was obtained from the study of **Pauly (1980)**, where $\boldsymbol{\mathrm{Log}(-t_0) = -0.3922 - 0.2752 \log L\infty - 1.038\, logK}$. In order to compare our results with others published elsewhere for *P. erythrinus* fish, the growth performance index **(Pauly & Munro, 1984)** was calculated as follows: $\boldsymbol{\varphi' = \log K + 2 \log L\infty}$.

Length-weight relationship

The relative growth expressed by the formula of **Froese** (**2006**) was applied: $W = a \times TL^b$, where W is the weight (g); TL is the total length (cm); a: constant, and b: slope. The ANCOVA test was applied to detect differences between the slopes of the length-weight relationship of the two sexes, and t-test was performed to verify hypothesis of isometric growth.

RESULTS

Length-frequency distribution

The majority of samples have a length ranged between 13 and 19.9cm (about 89%), with low numbers for small and large size classes (Fig. 2). It was noted that common sizes are the best represented.

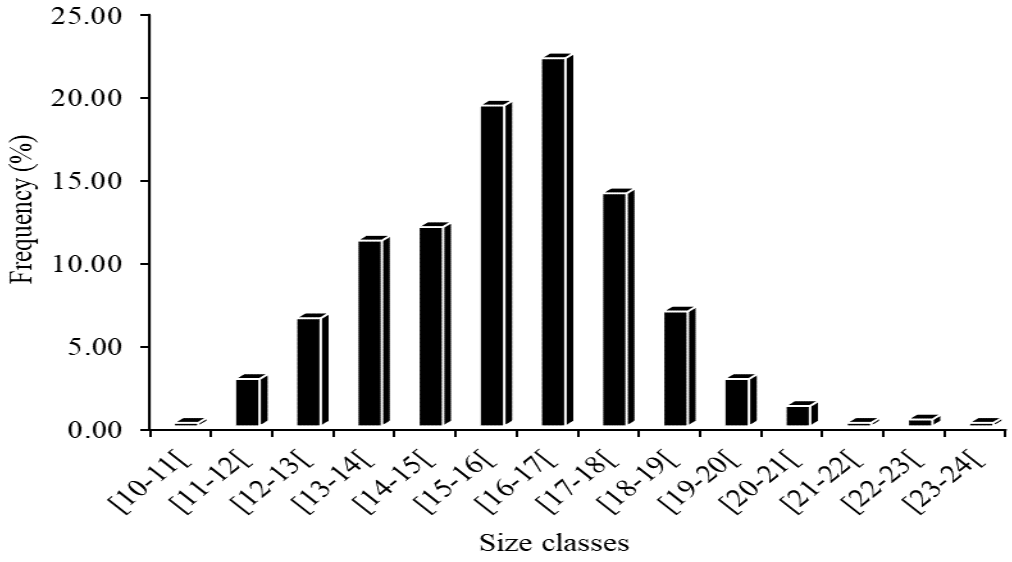

Fig. 2. The length frequency distribution of *Pagellus erythrinus* along the El-Kala coast

Age determination

As shown in Fig. (3), the scalimetry method enabled us to decompose all the individuals of *P. Erythrinus* into six age classes (1 - 6 years). The three and four years cohorts were dominant (23.76% for the both), followed by age group two (20.52%). The lowest frequencies were recorded for individuals of one and six years old (9.29 and 7.78%, respectively).

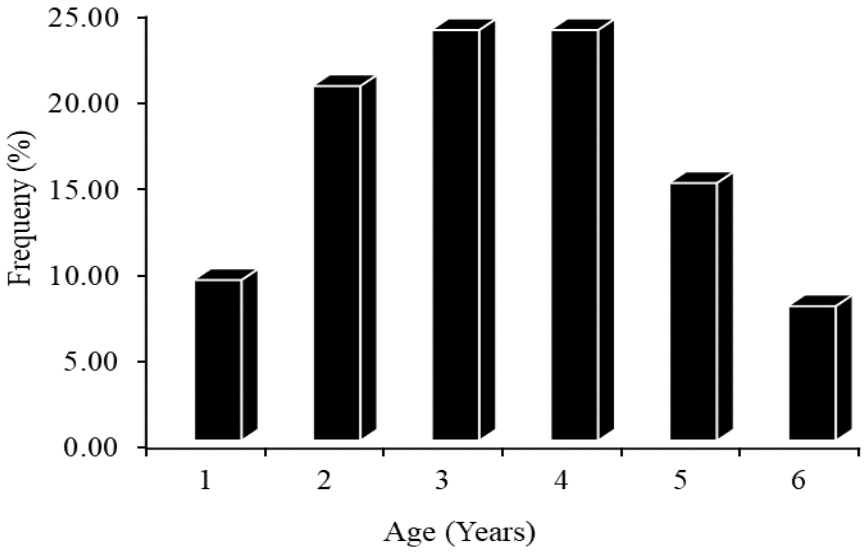

Fig. 3. Age composition of *Pagellus erythrinus* along the El-Kala coast

Linear growth

The growth model of the von Bertalanffy yielded the following results: $L\infty$ = 23.72cm TL, K = 0.2y^{-1}, and t_0 = -0.901y for sex combined. The performance index value (φ') for common pandora was 2.05 for all individuals. The equation of the linear curve, according to the von Bertalanffy model was TL = 23.72 $(1-e^{-0.2\ (t+0.901)})$. The observed and the theoretical total length were very close (Fig. 4). The theoretical annual increase was at its maximum during the first year (7.5cm), then gradually decreased to reach its minimum during the sixth year (1.32cm).

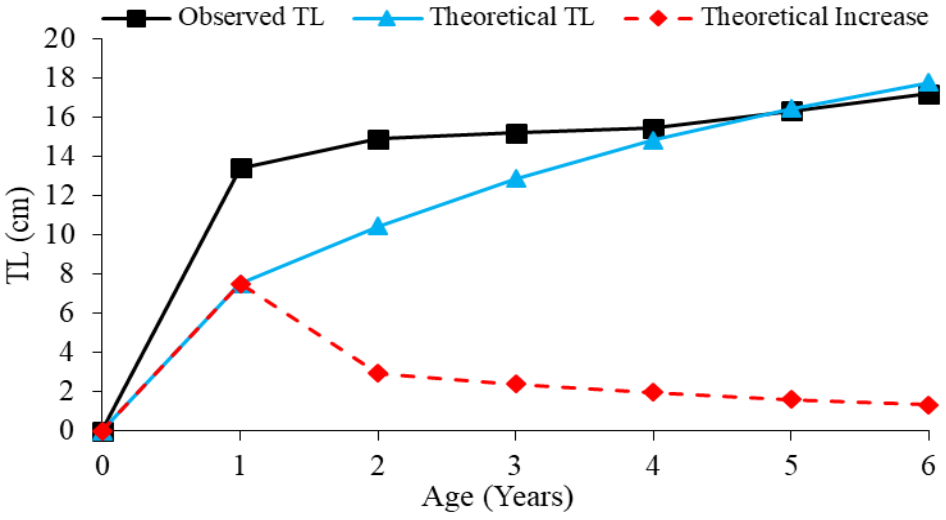

Fig. 4. Linear growth of *Pagellus erythrinus* along the El-Kala coast

The relative growth

The length-weight relationships were calculated as: TW = 0.043 $TL^{2.59}$ and EW = 0.074 $TL^{2.37}$ for males, TW = 0.067 $TL^{2.43}$ and EW = 0.062 $TL^{2.43}$ for females, and TW = 0.052 $TL^{2.52}$ and EW = 0.052 $TL^{2.50}$ for all individuals (Fig. 5). In the study area, a negative allometry was observed according to Student's *t*-test for the three groups, where the length of the fish grows faster than its weight. No significant differences between sexe's slopes for the TL-W relation were detected (ANCOVA-*tes*t: $F = 0.57$, $P > 0.05$).

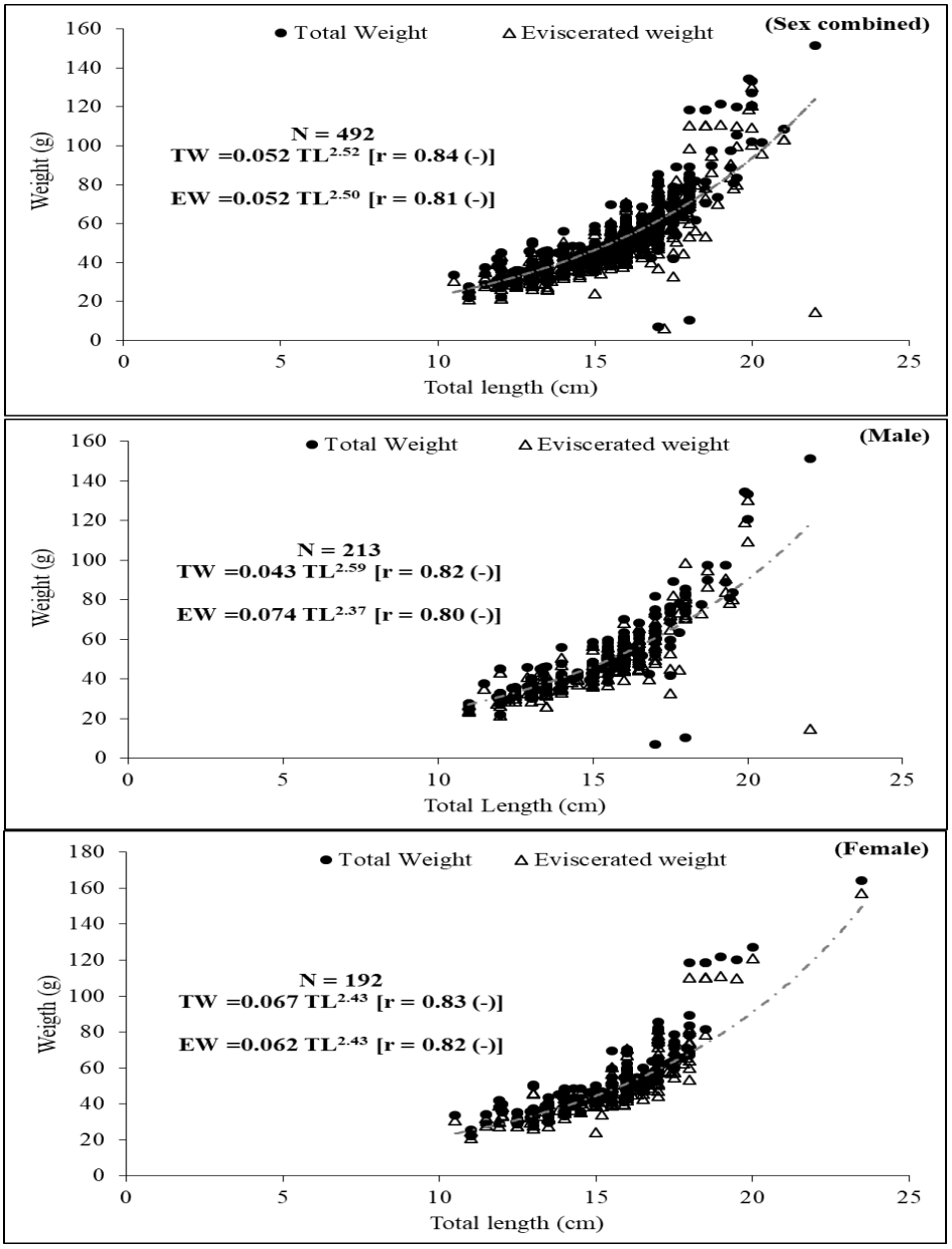

Fig. 5. Linear regressions between total length and weight for *Pagellus erythrinus* along the El-Kala coast

Absolute weight growth

The application of the size-weight relationship calculated for this species allowed us to deduce an asymptotic weight equal to 166.25g, which is slightly greater than the observed maximum weight (TW = 164.3g). The maximum weight gain was recorded in the first year (52.59g/ year), and a minimum of 9.26g/ year was observed during the sixth year (Fig. 6).

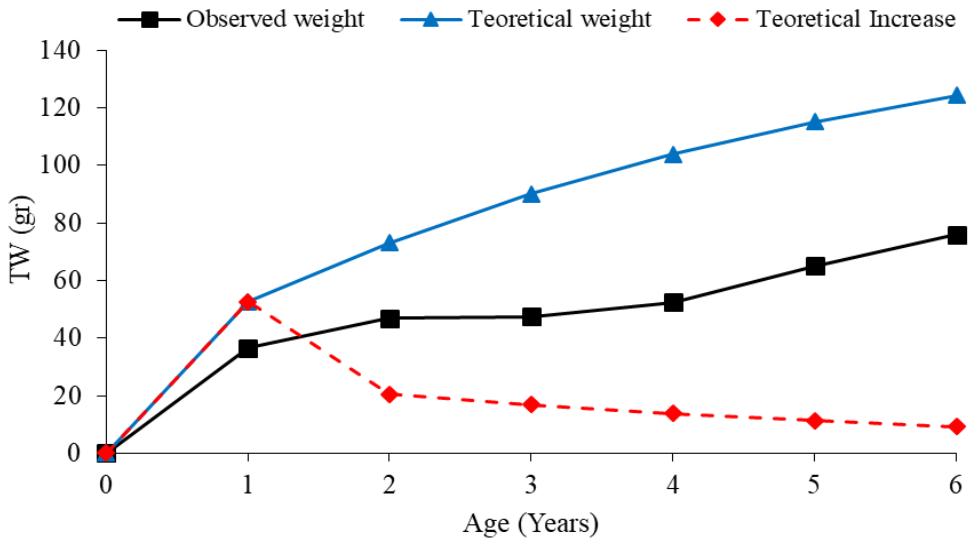

Fig. 6. Weight growth of *Pagellus erythrinus* along the El-Kala coast

DISCUSSION

The aim of this study was the presentation of the detailed age structure and growth of the *P. erythrinus* stock along the El-Kala coast (North-East Algeria). In the present work, the maximum total length observed (23.5cm) is smaller than that reported on the western coast of Algeria, in Oran Bay and the Golf of Tunis (28.5cm) **(Zarrad *et al.*, 2010; Mahdi *et al.*, 2018)**, in Lybia (28.2cm) **(Saleh, 2018)**, along the Lebanese coast (40cm) **(Lteif *et al.*, 2020)**, in the Central Aegean Sea (27.8cm) **(Metin *et al.*, 2011)**, the Southern Tyrrhenian Sea (48cm) **(Busalacchi *et al.*, 2014)** and southern Portugal (44.8cm) in the Atlantic Ocean **(Coelho *et al.*, 2010)**. On the other hand, it is superior to the maximum length recorded by **Mehanna (2022)** on the Egyptian coasts (22.9cm) (Table 1). These differences between several regions can be attributed to the sampling methods, depth at which fishing operations took place, the fishing pressure, biotic and abiotic conditions and also food vailability.

Six age classes are estimated in this study (from 1 to 6 years). The reported maximum ages were recorded to be 4 years **(Mehanna, 2022)**. While, a 10 years maximum age was reported **(Metin *et al.*, 2011)** in the Mediterranean Sea. On the other hand, ages between 5 and 8 years **(Hossuçu & çakir, 2003; Mehanna & Fattouh, 2009)** were recorded as well as the age class of the 21 years **(Coelho, 2010)** in the Atlantic. The

differences in age and length structure may be due to the ecological factors (food availability, competition, etc.), different environmental conditions, fishing pressure exerted on certain regions and method of reading the sclerochronological structures. Table (1) presents the von Bertalanffy growth parameters obtained in different areas. The asymptotic length in this work ($L\infty$ = 23.72cm) is close to that observed in the eastern Mediteranean by **Mehanna (2022)** ($L\infty$ = 26.39cm) in Egypt. Similarly, coincided values were determined by **Somarakis and Machias (2002)** ($L\infty$ = 27.8 cm) in the Cretan shelf of the Mediteranean and **Hossuçu and çakir (2003)** ($L\infty$ = 24cm) in Edremit Bay (Turkey) and. On the other hand, it is much less than those reported in Western Mediterranean and which varies from 40 to 54.3cm **(Abella *et al*., 2010; Fiorentino *et al.*, 2012)** (Table 1). The growth coefficient (K) of the common pandora obtained in the present study and those reported in other localities are displayed in Table (1). In the Mediterranean, it oscillates between 0.08 & 0.37 ans^{-1}. According to **Panfili *et al.* (2002)**, differences in growth parameters between areas can be attributed to environmental conditions, competition, biological characteristics of the species and feeding habits. 2.05 is the value of growth performance index (φ') calculated in the present work; this index varies from 2.217 to 2.54 in the western Mediteranean, from 1.96 to 2.62 in the eastern Mediteranean and between 2.25 and 2.59 in the Atlantic. Table (1) summarizes the different results obtained in previous works, and highlights a difference in the growth of *P. erythrinus* among the western Mediterranean, eastern Mediterranean and eastern Atlantic regions.

Table 1. Comparisons of common pandora *P. erythrinus* growth parameters ($L\infty$, k, t_0) and growth performance index in different areas (φ')

Reference	$L\infty$ (cm)	K ($year^{-1}$)	t_0 (year)	φ'	Area	
(Girardin & Quingard, 1985)	34.5	0.33	/	2.59	Lion Golf, France	Atlantic
(Pajuelo & Lorenzo, 1998)	41.8	0.21	-0.55	2.56	Canary Islands, Spain	
(Erzini *et al*., 2001)	47.1	0.08	-4.42	2.25	Off South Portugal	
(Coelho *et al*., 2010)	47.14	0.08	-4.42	2.271*	South of Portugal	
(Joksimovich, 2001)	32.8	0.20	-0.57	2.34	Montenegrin Shelf	Eastern Mediterranean
(Somarakis & Machias, 2002)	27.8	0.32	-0.74	2.40	Cretan shelf	
(Hoşsucu & Çakir, 2003)	24.00	0.16	-2.6	1.96	Edremit Bay, Turkey	
(Mehanna & Fattouh, 2009)	33.4	0.37	-0.23	2.62	Egypt	
(Metin *et al*., 2011)	30.673	0.165	-0.857	2.19*	Central Aegean Sea,Turkey	
(El-Haweet *et al.*, 2011)	40.1	0.17	0.75	2.44	South Levant Sea	
(Mehanna, 2011)	33.4	0.37	-0.23	2.62	South Levant Sea	
(Mehanna, 2022)	26.39	0.34	-0.79	2.40	Egypt	
(Abella *et al*., 2010)	54.3	0.12	1.12	2.54	Northern Tyrrhenian Sea	Western Mediterranean
(Fiorentino *et al.*, 2012)	40.0	0.18	-1	2.45	Sicilian Channel	
(Bussalacchi *et al.*, 2014)	45.4	0.08	-2.57	2.217*	South of Tyrrhenian Sea	
This study	**23.72**	**0.2**	**-0.901**	**2.05**	**Northeast Algeria**	

*Calculated from available data.

The observed negative allometric growth of *P. erythrinus* in the study area is similar to other works in the Mediterranean **(Hoşsucu & Çakır, 2003; Ciçek, 2006; Metin *et al.*, 2011; Busalacchi *et al.*, 2014; Mehanna, 2022)** and the Atlantic **(Coelho *et al.*, 2010)**. The length-weight relationship in both sexes showed also minor allometry, with b equal to 2.59 and 2.43 for male and female, respectively. Similar observations were reported in previous works (Table 2). On the other hand, a positive allometry was reported in Egypt in the study of **Mehanna and Fattouh (2009)** for sex combined, and in the central Aegean Sea (Turkey) by **Metin *et al.* (2011)** for female. According to **Zorica *et al.* (2006)**, this variation is probably attributed to interannual changes in the nutritional condition of the organisms.

Table 2. Comparison of the length-weight relationship parameters of *P. eryhtrinus* with other regions : (=) isometry, (-) minor allometry, (+) positive allometry, (b) allometry coefficient, (a) constant, (r^2) determination coefficient

Reference	sex	a	b	r^2	Allometry	Area
(Hossucu & çakir, 2003)	*SC*	0.00007	2.738	-	-	Edermit Bay, Turkey
	M	0.0001	2.580	-	-	
	F	0.00005	2.7918	-	-	
(Mendes *et al.*, 2004)	*SC*	0.0171	2.906	0.94	=	Western coastline, Portugal
(Ciçek, 2006)	*SC*	0.0152	2.840	0.97	-	North East Mediterranean
(Gokçe *et al.*, 2007)	*SC*	0.0076	3.20	0.99	=	North Aegean Sea, Turkey
(Sangun *et al.*, 2007)	*SC*	0.0145	2.905	0.94	=	Northeast Turkey
(Mehanna & Fattouh, 2009)	*SC*	0.0096	3.1181	-	+	Egypt
(Coelho *et al.*, 2010)	*M*	-4.108	2.929	0.982	-	South of Portugal, Atlantic
	F	-4.071	2.91	0.982	-	
(Giacalone *et al.*, 2010)	*SC*	0.0163	2.92	0.99	=	Northern Sicily, Central Mediterranean
(Metin *et al.*, 2011)	*SC*	0.0143	2.950	0.99	-	Central Aegean Sea, Turkey
	M	0.0125	2.99	0.99	=	
	F	0.0107	3.06	0.98	+	
(Busalacchi *et al.*, 2014)	*SC*	0.016	2.905	0.676	-	South of Tyrrhenian Sea
	M	0.013	2.965	0.684	=	
	F	0.016	2.901	0.674	-	
(Mehanna, 2022)	*SC*	0.0183	2.875	-	-	Egypt
	M	0.0178	2.885	-	-	
	F	0.0196	2.847	-	-	
This study	*SC*	**0.052**	**2.52**	**0.70**	-	**Northeast Algeria**
	M	**0.043**	**2.59**	**0.68**	-	
	F	**0.067**	**2.43**	**0.69**	-	

SC: Sex Combined, M: Male, F: Female.

CONCLUSION

Sparid fishes are among the most important species in the Algerian Mediterranean waters and are primary targets for artisanal fishing. Among these, the common pandora (*Pagellus erythrinus*) is highly valued as seafood, possessing a significant commercial value and considerable economic potential. Despite the growing interest in this species, which is well-suited for both fisheries and aquaculture, there is a lack of research along the Algerian coast regarding its biology, particularly its growth. This gap has prompted us to address this crucial aspect, which is essential for the effective management of natural stocks of *Pagellus* in the study area.

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