Iranian Journal of Fisheries Sciences
http:doi.org/ 10.22092/ijfs.2025.134259 2025, 24(5) 1159-1174

Research Article

Study of some biological aspects and population dynamics of striped piggy fish, *Pomadasys stridens* (Forsskal, 1775), from Lake Timsah, Egypt

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Keywords

Striped piggy,
Growth,
Length-weight relationship,
Mortality,
Lake Timsah

Article info

Received: September 2024
Accepted: February 2025
Published: September 2025

Abstract

The present investigation was carried out to study the age, growth, length-weight relationship, spawning season, length at first sexual maturity, length and age at first capture, mortality, and growth performance of the commercial striped piggy fish, *Pomadasys stridens* (Forskål, 1775), inhabiting Lake Timsah in Egypt. Fish specimens collected during the period from January 2022 to December 2022 were selected to represent all fish size categories in the catch. The age distribution covered age groups I to V. Total length ranged from 8 to 17.8 cm, while total weight varied from 10.57 to 87.65 g. There was no significant difference between the length–weight relation (LWR) parameters of sexes and pooled data. The overall LWR was found to be $W=0.0112\times L^{3.0496}$. It was found that both males and females matured at a total length of about 12.3cm for males and 12.7 cm for females. The natural spawning period for *P. stridens* in Lake Timsah is at the end of spring and early summer, from May to July. The von Bertalanffy growth parameters were not significantly different between males and females. The model parameters for both sexes were: L_∞=21.01 cm, K= 0. 245, and t_0= -1.5475. The annual rates of total, natural and fishing mortality for male and female *P. stridens* were calculated as 2.0405 $^{Yr-1}$, 0.6367 $^{Yr-1}$, 1.4038 $^{Yr-1}$ and 2.0151^{Yr-1}, 0.7035 $^{Yr-1}$, 1.3116 $^{Yr-1}$, respectively. The current exploitation rate 'E' was estimated at 0.69 and 0.65 for males and females.

Introduction

Pomadasys is a genus of grunts native to the waters of the eastern Atlantic Ocean and through the Indian Ocean to the Pacific coast of the Americas (Froese and Pauly, 2019). This genus is represented by 37 species distributed around the world (Pajuelo *et al*., 2003). The striped piggy *Pomadasys stridens* (Forsskål, 1775) belongs to the family Haemulidae, this family contains 20 genera and 133 species inhabiting the world oceans (Froese and Pauly, 2023; Mehanna *et al.,* 2023). The variety of the family Haemulidae allows their large distribution throughout the world and the striped piggy, *P. stridens* has a wide distribution in the Pacific, Atlantic and Indian Ocean, inhabiting reefs, shelf area, muddy, sandy bottoms and in variety of inshore habitats (Fehri-Bedoui and Gharbi, 2008). The striped piggy is found in shallow tropical seas around the coastlines of the Indian Ocean throughout the Red Sea, South Africa coast, and western Indian Ocean (Froese and Pauly 2018; Avsar *et al*., 2021), the Gulf of Suez, and the Suez Canal (El-Azim *et al.* 2017). They are first observed in the Mediterranean in 1968 in the Gulf of Genoa (Ben-Tuvia, 1977; Erguden *et al.,* 2010).

According to Iwatsuki *et al*. (1995), the presence of *P. stridens* in the Mediterranean is due to immigration from the Red Sea via the Suez Canal. The migration of Red Sea fish species from the Suez Channel is a continuing process that is continuously changing the fish communities of the eastern Mediterranean Sea (Por, 1990; Golani, 1998). The striped piggy can be found within the depth range 55-68 m (Ben-Tuvia and McKay, 1986; Sommer *et al.,* 1996; Froese and Pauly, 2010; Erguden *et al*., 2010). The striped piggy feeds mainly on crustaceans and fishes (Froese and Pauly, 2010) and is caught mainly with bottom trawls and on hook and line (Carpenter *et al*., 1997).

Haemulidae is one of the most commercial families all over the world (Osman *et al*., 2019) also, it has a prime economic value in the Suez Gulf where *Pomadasys stridens* is the most common, abundant and distributed Haemulidae species; it is mainly exploited by the trawl fishing gears and constitutes 20% of its total catch (Mehanna *et al*., 2023). Within this family, the striped piggy is one among the fish species of economic importance in the Egyptian coastal waters and is considered one of the fish that the cities of the Suez Canal depend on in their food because it is cheap, high-quality meat, and its taste is delicious.

Different aspects of the biology and population dynamics of the fish under investigation has been (Fakhri *et al*., 2011; Hashemi and Taghavimotlagh, 2012; Safi *et al*., 2014; Karimi *et al*., 2015; El-Azim *et al.,* 2017; Uyan *et al.,* 2018; Osman *et al*., 2019; Avsar *et al.,* 2021; Mehanna *et al*., 2023); Sex-ratio, reproduction and feeding habits (Fehri-Bedoui and Gharbi, 2008; Safi *et al.,* 2013;) Reproductive Biology (AL-Ghais, 1995; Karimi *et al*., 2013; Vahabnezhad *et al*., 2018); Geographical distribution and spreading of stripped piggy (Erguden *et al*., 2010); food and feeding habits (Karimi *et al.,* 2019).

In general, the maintenance of ecosystem balance and the design of programs for ecological management depend on the availability of sufficient

information about the biology and life history of species. In this situation, the aim of the present investigation was twofold: one to estimate its population parameters via length frequency methods and the second to determine the length-weight relationship and population dynamics of this species in Lake Timsah, Egypt. Results will greatly contribute to elaborating management programs for this economically important fish species of Lake Timsah (Fig. 1).

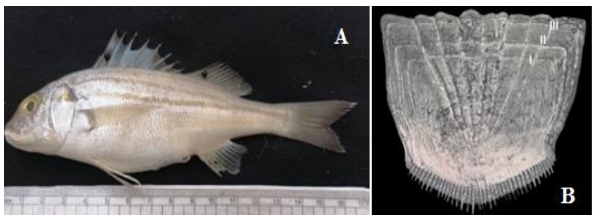

Figure 1: shows (A) Pomadasys stridens fish having 16.7 cm total length and (B) Shows the scales of *P. stridens* 3-year-old fish.

aterials and methods

As regards to 650 specimens of striped piggy fish, *Pomadasys stridens* were collected monthly from January 2022 to December 2022, from the landing site at Lake Timsah. Date of capture, total fish length (mm) and total fish weight (0.1 g) were recorded for each fresh specimen. Fishes were dissected to define their sex and gonad maturity stages. Gutted fish were weighed to the nearest 0.1 g and gonads were weighed to the nearest 0.0l g. Age was determined by counting the annual rings on the scales using a micrometer eyepiece and it was confirmed by otolith. Length Frequency Distribution Analysis (LFDA program) was used to evaluate growth, back-calculation (lengths-at-ages) for age as recommended by Kirkwood *et al*. (2001) which was fitted to the von Bertalanffy growth model (Ricker, 1975). Gulland and Holt (1959) plot were applied to estimate the von Bertalanffy growth parameters ($L\infty$ and K).

The length weight relationships were estimated from the allometric equation $W=aL^b$ Ricker (1975) where (W) is total body weight (g), (L) the total length cm; a and b are the coefficients of the functional regression between (W) and (L) and they were obtained using the Newton algorithm from the Microsoft® Excel Solver routine.

The back-calculated lengths were fitted to Von Bertalanffy growth Model (VBGM), $Lt = L\infty\ [1\text{-}^{e\text{-}k\ (t\text{-}to)}]$, Where, Lt = Total length (cm) of the fish at time t. $L\infty$ =Expected theoretical maximum total length. K = Coefficient of growth. t = Fish age. t_o = Theoretical age at length zero. The length–weight relationship was used to estimate the back-calculated total weights at various years of life.

The length at first sexual maturity (Lm) was estimated as the point on X-axis corresponding to 50% point on Y-axis on the maturation curve.

The spawning season was determined by the curvilinear average values of monthly Gonadosomatic index (GSI) for both males and females, where as below:

GSI= 100 [gonads weight (g) / gutted weight (g)]

Total mortality coefficient (Z) was estimated based on the length at first capture methods evaluated by Beverton and Holt (1957).

Instantaneous natural mortality rate (*M*) is related directly to the amount of production from the stock, so it is very important to estimate the yield per recruitment and exploitation rate, but it is very difficult to estimate the natural mortality (Brodziak *et al.,* 2009; Osman, *et al*., 2019). In the present work, the natural mortality was estimated by using two methods (Ursin, 1967; Pauly, 1980).

Fishing mortality rates (*F*) were calculated as the difference between *Z* and *M* (*Z = F + M*). The value of the average annual exploitation rate (*E*) was obtained by *E = F/Z*. According to Gulland (1971) which suggested that the optimum exploitation rate in an exploited stock should equal approximately 0.50.

Length and Age at first capture (L_c) was computed from the equation of Beverton and Holt (1956), which applies the growth constants of Von Bertalanffy: $L_c = L^- - K (L\infty - L^-) / Z$, Where: L^- = the mean length of the catch. The corresponding age at first capture tc was calculated using the equation, $t_c = (-1 / K) (Ln (1 - L_c / L_\infty) + t_0)$ (Beverton and Holt, 1957). The growth performance index (ϕ) was estimated according to the formula by Pauly and Munro (1984): $\phi = Log\ K + 2\ log\ L\infty$ where, *K* and $L\infty$ are the von Bertalanffy growth parameters as follows:

Φ_W = Log K+ 2/3 (Log W_∞) Where: W_∞= the asymptotic weight

Results

Total length frequency distribution

The total length of all individuals (n=650) collected in the present study ranged from 8 to 17.6 cm for male and 8.3 to 17.8 for female, the most frequent lengths for both males and females were length groups (12 - 12.9 cm) and (13 - 13.9 cm). While the least frequent lengths for both male and female were length groups (8 - 8.9 cm) and (17 - 17.9 cm) as illustrated in Figure 2.

The age composition and growth

The age distribution of samples ranged from I to V years for *P. stridens*, based on the results of scale reading (Fig. 1). The age group III was dominant (13.54%) for female followed by age groups II (12.0%), I (10.31%), IV (8.77%) and V (7.23%) While the age group III was dominant (12.61%) for male followed by age groups II (11.23%), I (9.54%), IV (8.31%) and V (6.46 %) (Fig. 3).

Growth in length

In the present study samples of *P. stridens* lengths ranged from 8 to 17.8 cm with average of (12.21±0.36 cm) corresponding to weights of 10.57 to 87.65 g with average of (46.25 g SD=±2.97) for male while lengths ranged from 8.3 to 17.6 cm with average of (12.34±0.25 cm) corresponding to weights of 11.2 to 88.76 g with average of (48.46 g SD= ±2.94) for female .

Also, the mean observed lengths at different ages of *P. stridens* showed that the males reached 16.96 cm TL by the fifth age and the average length by the end of each year was 8.73, 11.58, 13.79, 15.32 and16.96 cm for the five age groups of this fish**.** While the mean observed lengths at different ages showed that the females

reached 17.04 cm TL by the fifth age and the average length by the end of each year was 8.81, 11.13, 13.42, 15.63 and 17.04 cm for the five age groups of this fish as shown in Table 2.

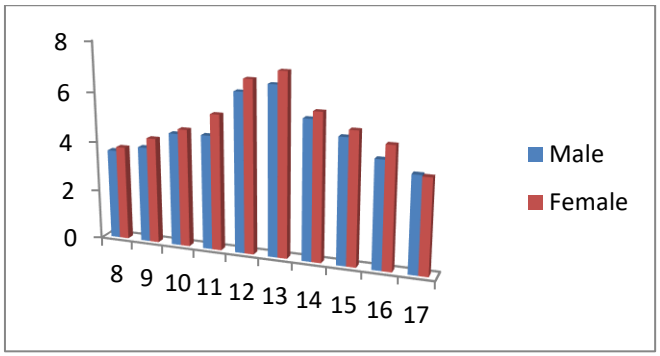

Figure 2: Length frequency distribution for males and females of *Pomadasys stridens* in LakeTimsah, Egypt.

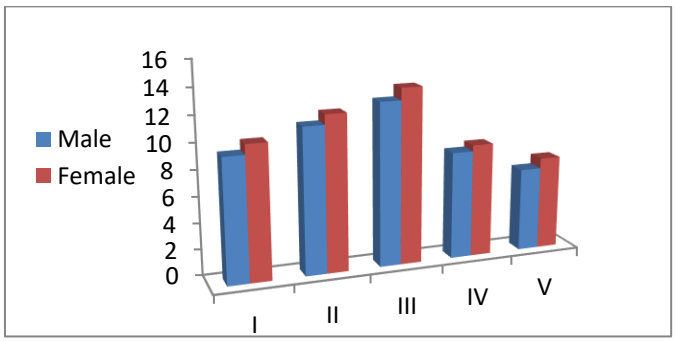

Figure 3: Relative age frequency for males and females of *Pomadasys stridens* in Lake Timsah.

Back-calculations

The scale radius-total length relationship of *P. stridens* is described by the following equations: $L=2.0442+1.5719\ S$ for males (r^2=0.996) and $L=2.0538+1.6073\ S$ for females (r^2 =0.984) where: L is the total length in centimeters, S is the scale radius in millimeters and r^2 is the correlation coefficient. The following formula was derived to obtain the back-calculated total length at the end of each year of life for males and females respectively. $L_n= (L - 2.0442)\ Sn / S + 2.0442$ and $L_n= (L - 2.0538)\ Sn / S + 2.0538$ where: L_n is the length at the end of n^{th} year, S_n is the radius of the scale to n^{th} annulus, S is the total radius of the scale and $\boldsymbol{L}$ is the total length at capture.

The calculated and observed total lengths at age are presented in Table 2. The observed lengths and growth increments are so close at different year of life. From the data given in Table 1 it is obvious that, *P. stridens* attains its highest growth rate in terms of length during the first year of life where the fish gain 48.12 % and 48.51% for males and females respectively, after which a gradual decrease in growth increments was noticed with further increase in age where the males fish gain17.09%, 13.76%, 11.15 %, 9.88% and females gain 17.03%, 12.01%, 12.18%, 10.27% of its final growth by the second, third, fourth, fifth year of life (Figs. 4 and 5).

Table 1: Back-calculated lengths at the end of each year of life of both male and female *Pomadasys stridens* from lake Timsah.

	Age				
Male	**I**	**II**	**III**	**IV**	**V**
Average Total	7.94	10.76	13.03	14.87	16.50
Increment of length	7.94	2.82	2.27	1.84	1.63
% of annual increment	48.12	17.09	13.76	11.15	9.88
Female					
Average Total	8.12	10.97	12.98	15.02	16.74
Increment of length	8.12	2.85	2.01	2.04	1.72
% of annual increment	48.51	17.03	12.01	12.18	10.27

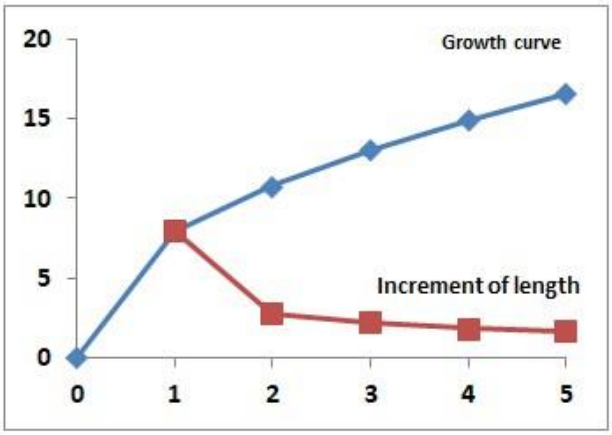

Figure 4: Growth in length and increment at end of each year of *Pomadasys stridens* from Lake Timsah.

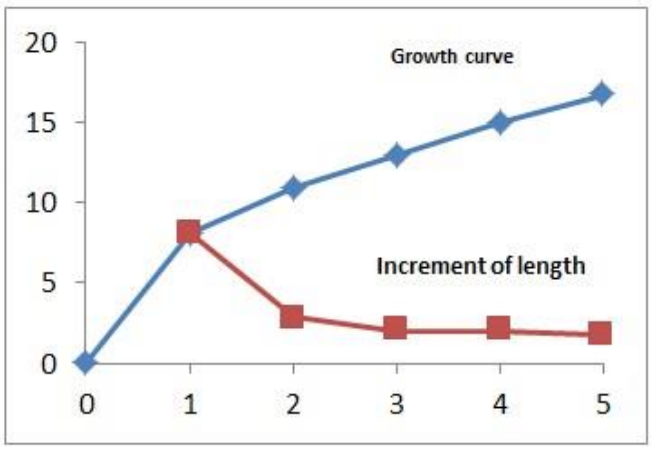

Figure 5: Growth in length and increment at the end of each year of female *Pomadasys stridens* from Lake Timsah.

Von Bertalanffy's growth formula

The estimation of Von Bertalanffy growth parameters was obtained by fitting the VBGE to back-calculated lengths. The value of $L\infty$ was determined by the method of Ford and Walford, while the value of t_o was calculated by the method of Ricker. The estimated values of VBGE were $L\infty$ was 20.76 cm, 21.25 cm, and 21.01 cm for male, female, and combined sexes respectively, while K was 0.253 1/y, 0.242 1/y, and 0.245 1/y, and also to was –1.4429, -1.6156 and -1. 5475 for male, female and combined sexes, respectively.

Thus, the Von Bertalanffy growth equation is stated as: Lt = L∞ [1-e-K (t + to)]. The maximum age (tmax) of this fish species was 10.41 years for males and 10.78 years for females. By applying the length-weight relationship, it was found that W∞ was equal to 114.426 g for males and 123.7538 g for females, while the value of growth performance (Φ) in length and weight was 2.038, 2.039s and 0.7755, 0.7789 for male and female, respectively.

The Von Bertalanffy growth equation adequately describes the growth of P. stridens in Lake Timsah, Egypt, since the calculated lengths for each age group derived from this equation were nearly identical to the mean lengths obtained by back-calculations based on scale reading, and also the mean lengths derived by length frequency method (Table 2).

Table 2: Total length (cm) at age values of both males and females of *Pomadasys stridens* from lake Timsah.

Age	Mean observed Length		Calculated Lengths (VBGE)		Back Calculated	
	Male	Female	Male	Female	Male	Female
I	8.73	8.81	9.57	9.97	7.94	8.12
II	11.58	11.13	11.39	12.39	10.76	10.97
III	13.79	13.42	14.01	14.29	13.03	12.98
IV	15.32	15.63	15.52	15.79	14.87	15.02
V	16.96	17.04	16.69	16.96	16.50	16.74

Length-weight relationship

One of the most important biological aspects of fish that describes the environment in which the fish lives is the relationship between length and weight, because this relationship can easily reflect information about the amount of food present in the fish's environment. On the other hand, it is important in fisheries management as it is useful in determining the weight of fish at any given length or vice versa, and it is also useful in determining the size of fish most suitable for catching. It is easier to precisely measure the length of a fish in the field than to measure the weight of the fish. Also, the length of the fish is an increasing function of age. This is in contrast to the weight of fish, which shows great variation at any given age, consequently, the length-weight relationship is used to convert calculated growth in length to the corresponding growth in weight. Using the grouped lengths and corresponding weights of 650 fish (337 females and 313 males) sampled at various times of the year, ranging in total length from 8 cm to 17.8 cm. This is represented by the following equations: $W=0.012\ L^{3.021}\ (r^2) = 0.9846$ for male; $W=0.0116\ L^{3.0406}\ (r^2)=0.9839$ for female and $W=0.0112\ L^{3.0496}$ (r^2) = 0.9846 for combined sexes Where: W is the total weight (gm) L is total length (cm) R is the correlation coefficient. The high values of (r^2) indicate a good measure for the strength of these equations and closeness of observed and calculated values of fish weight. The length and weight measurements of the analyzed specimens used to describe the length-weight relationship are given in Figures 6 to 8.

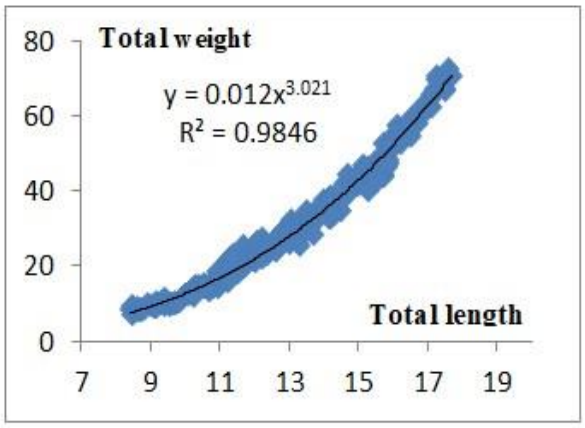

Figure 6: Length- weight relationship of male *Pomadasys stridens* in Lake Timsah, Egypt.

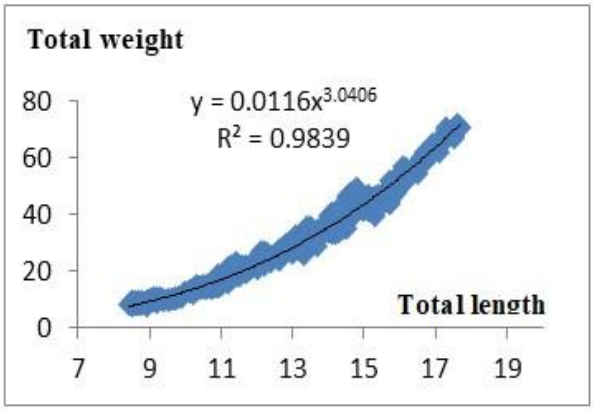

Figure 7: Length- weight relationship of female *Pomadasys stridens* in Lake Timsah, Egypt.

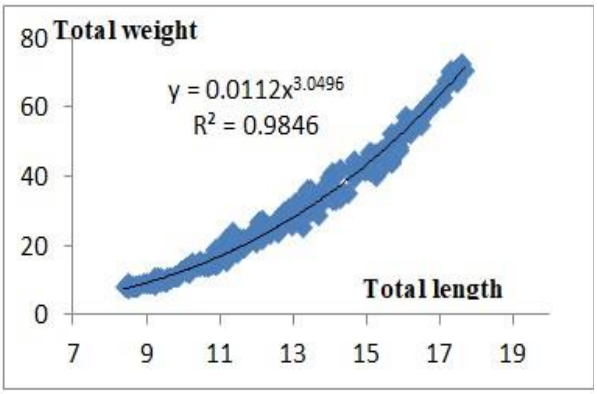

Figure 8: Length- weight relationship of combined sexes *Pomadasys stridens* in Lake Timsah, Egypt.

Length at first maturity

To determine the length at first maturity, males and females were grouped into 10 mm size groups and the percentage occurrence of fish at the different maturity stages in each size group was calculated. Examination of the male and female maturity stages indicated that males and females of *P. stridens* matured at about 12.3 cm and12.7 cm total length respectively (Fig. 9). Derivative of the von Bertalanffy equation was applied to calculate the age at first sexual maturity (t_m) from its corresponding length (L_m) was (t_m) = 1.42 year for male and 1.37 year for female.

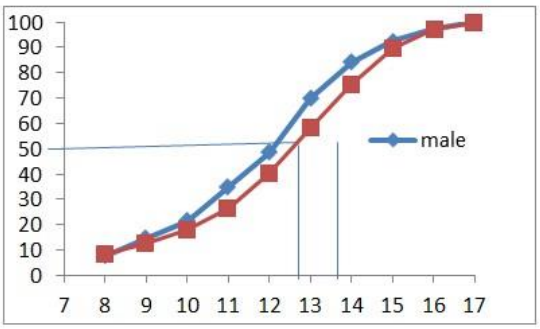

Figure 9: Length at first sexual maturity of both sexes of *Pomadasys stridens* in Lake Timsah of Egypt.

Gonadosomatic index (GSI)

The monthly changes in GSI values of individuals of both sexes are given in Figure 10. It was observed that the GSI values of males and females were low during November, December, January and February 2022 while the lowest GSI value in September. Index values began to increase after March to reached maximum values in June, and then began to decrease, indicating that June is the month of highest activity, but the spawning season starts in April until July.

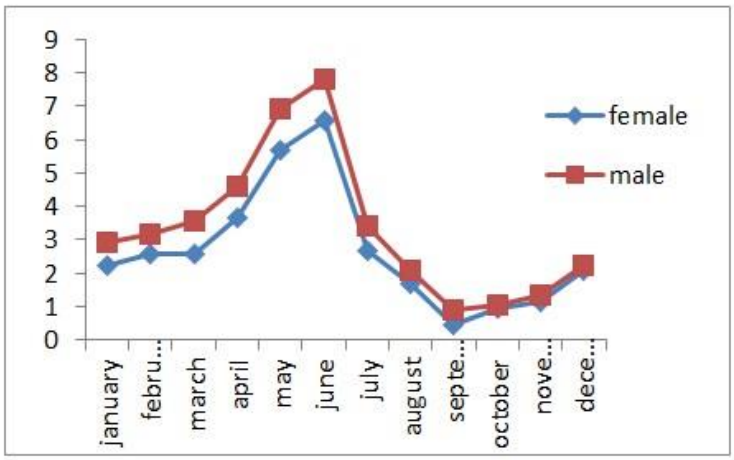

Figure 10: Monthly changes in the Gonad somatic Index of both sexes of *Pomadasys stridens*.

Mortality rates

The total mortality coefficient (Z) of P. stridens was estimated using its length at first capture. It was found to be 2.0405 years^{-1} for males and 2.0151 years^{-1} for females. The natural mortality coefficient "M" was also obtained as 0.6367 years^{-1} for males and 0.7035 years^{-1} for females. Using the estimated M and Z, the fishing mortality rate (F) was obtained where Z=M+F (1.4038 years-1 for males and 1.3116 years-1 for females).

Length and age at recruitment

Length at recruitment (L_r) is defined as the smallest length at which the fish enters the fishing ground and may become susceptible to fishing. The obtained value of (L_r) of *P. stridens* in the present study was 10.63 cm for males and 10.78 cm for females, while the corresponding value of age at recruitment (t_r) was 1.39 years for males and 1.31 years for females.

Length and age at first capture

The length at the first capture (Lc) is the length at which the fish may be become susceptible to fishing gears. In the present study of *P. stridens* the (Lc) value was 11.14 cm, for male and 11.26 cm, for female corresponding age at first capture (tc) which marks the beginning of the exploited phase was 1.6 years for male and 1.5 for female. Based on these results, the P. stridens starts to suffer from fishing mortality at sizes bigger than 11.14 cm T.L for males and 11.26 for females and we can suggest that the exploited phase starts at ages more than 1.6 and 1.5 years for males and females, respectively.

Exploitation rate (E)

According to Gulland, which suggested that the optimum exploitation rate in an exploited stock should equal approximately 0.50. The current exploitation rate "E" was estimated at 0.69 for males and 0.65 for females. Accordingly, the high value of the current exploitation rate indicates that the stock of *P. stridens* in Lake Timsah is subjected to overfishing.

Discussion

Pomadasys stridens are widely distributed in Egyptian coastal waters. It is considered one of the important coastal and economic fish that live in Egyptian waters. According to Ozyurt *et al.* (2018) in Iskenderun Bay

(Northeast Mediterranean) *P. stridens* constitutes one of the most dominant fish in the shallow coastal waters, invading the soft bottoms on the Turkish coast. Consequently, the fish is one of the most popular fish for citizens in the Suez Canal cities, due to its delicious taste and affordable price. Therefore, this investigation attempted to present detailed information about some biological aspects of this fish in Lake Timsah, in Egypt.

In the setting of the study, the mean length of investigated individuals was12.21±0.36cm for male and 12.34±0.25 cm for female ranged from 8 cm. to 17.8cm; the results are closer with that reported by Avsar *et al*. (2021) which clarified that the mean length of investigated individuals was 12.32±0.11 cm ranging from 7.3 to 18.9 cm. and Ergüden *et al.* (2015) explained the maximum length as 17.7 cm from the Gulf of Iskenderun in the Mediterranean. Based on the studies performed in the Gulf of Suez and the Suez Canal reported maximum length values close to our study which were 19 cm (Osman *et al.,* 2019); 15.6 cm (El-Ganainy and Sabra, 2008). On the other hand, the maximum length was reported as 23.5 cm by Hashemi and Taghavimotlagh (2012), 21.9 cm in Pakistan coasts (Safi *et al.,* 2013, 2014) and 22cm, 23cm for male and female respectively in northern part of the Persian Gulf (Karimi *et al.* 2019).

The life history of most marine fish species can be used to assess their intrinsic vulnerability to fishing as well as their rate of productivity within the same group (Roberts and Hawkins, 1999; Cheung *et al.,* 2005). One of the most important fisheries management strategies is to know the size at first sexual maturity. On this basis, the results of the present study indicated that the striped pigfish *P. stridens* has a medium productivity rate and ability to tolerate exploitation.

The most abundant size class (13cm) for both sexes of stripped piggy is composed of individuals that have already matured at 12.3 cm and 12.7 cm for males and females, respectively. This observation is close to that reported by Mehanna *et al*. (2023) concluded that the length at first sexual maturity was 12.51 and 12.85 cm for males and females, respectively. Likewise, Karimi *et al*. (2013) explained that female *P. stridens* in the Persian Gulf began to mature at a length of 12.6 cm and males 11.7 cm. As for Vahabnezhad *et al*. (2018) using the logistical curve and the length of the sexual maturity of *P. Stridens* (L_m50 %) in the coastal waters of Bushehr Province in the Persian Gulf was calculated to be 19.84 cm. While Osman *et al*. (2019) for the same species in the Gulf of Suez was calculated to be 11 and 9.7 cm for females and males respectively, which corresponds to an age group of 1 year. And also, El-Ganainy and Sabra (2008) reported that the size at which 50% of the fish are mature is 8.5 cm. These differences are caused by various factors such as sampling and even chemical, physical and geographical differences for habitats and food availability, as well as fish condition.

Fish scales represent the most suitable option for determining the age of fish species caught from the temperate regions. The maximum ages of males and females were detected in the scales of P. stridens and were validated by otoliths observed as five years old in the present study. However, Osman *et al*. (2019) stated that

the maximal age of both males and females of *Pomadasys stridens* was seven age groups detected in the otoliths of *P. stridens* in the Gulf of Suez. Like that Avsar *et al*. (2021) reported that the oldest specimens collected off Yumurtalık, Gulf of Iskenderun were seven years old. As well, El-Sayed (1990), which used the otolith to determine the life span of *P. stridens* in the Gulf of Suez and obtained the age of the fish was 8 years old. On the other hand, as for the results recorded by El-Ganainy and Sabra (2008), they are inconsistent with our results, as it was found that the same species have been discussed in the Bitter Lake and it was found that the lifespan is 3 years with a maximum size of 15 cm. The great variations in the estimates may be attributed to the difference in the recorded maximum length and to the different environmental conditions.

The Von Bertalanffy growth model (Von Bertalanffy, 1938) is one of the most common methods which are used to assess the theoretical growth in fisheries. For the estimated growth parameters of *P. stridens,* the growth coefficient value in the present study were (K=0.253 year^{-1} for male and 0.242 year^{-1} for female) closer to the results with that mentioned by Osman *et al*. (2019) in the Gulf of Suez (K = 0.29 year^{-1}), and the results mentioned by El-Sayed (1990) in the Gulf of Suez (K=0.28 year^{-1}), and less than from the results that recorded by El-Ganainy and Sabra (2008) in the Bitter Lakes (K=0.5 year^{-1}), as well as by Hashemi and Taghavimotlagh (2012) in the Persian Gulf (K=0.7 year^{-1}). However, Mehanna *et al.* (2023) stated that the growth parameters of males and females of *P. stridens* in the Gulf of Suez showed that there is a difference in the age and growth rate between males and females (K=0.539 and 0.395 for males and females, respectively).

The study of the relationship between length and weight in fish is affected by many factors, the most important of which are the growth rate, fishing season, the shape of the different species, as well as the fish condition factor and the characteristics of the fishing gear (Ecoutin *et al*., 2005). In the present study, isometric growth was observed in striped piggy from Lake Timsah in Egypt. These results agree with Pauly *et al.* (1998), who reported that Isometric growth was observed in striped piggy in Philippine waters and the same results were obtained by Hashemi and Taghavimotlagh (2012) in the Persian Gulf. On the other hand, Osman *et al*. (2019) stated that the slopes (b) of the regressions were significantly more than 3 indicating positive allometric growth. The same results obtained by Erguden *et al.* (2015), who showed that the slope of striped piggy was a positive allometric growth. These results are in contrast with El-Sayed (1990); El-Ganainy and Sabra (2008), who estimated the b value as 2.8 and 2.92, respectively. Moreover, Safi *et al.* (2014) in Pakistan found that the b value was 2.7 and 2.82.

The monthly changes in GSI values of individuals of both sexes were studied, accordingly, the patterns in the monthly Gonadosomatic indices showed that the spawning season is during April and May, while a peak in June. These findings are closer to the results given by El-Sayed (1990) in the Suez Gulf and El-Ganainy and

Sabra (2008) in Bitter Lakes as well as Osman *et al*. (2019) in the Suez Gulf.

On the other hand, Amtyaz *et al*. (2013) reported that the spawning period has been to be between September and February in Karachi Coast, Pakistan. While Vahabnezhad *et al*. (2016) found that striped piggy spawns between December and June along the northern coasts of the Persian Gulf. As Karimi *et al*. (2013) found that *P. stridens* fishes to spawn from December to March in the Persian Gulf waters. There is diversity in the breeding season and its periodicity due to the diversity of ecological niches (Agarwal, 2008).

The length at first capture of striped piggy was recorded to be (Lc)=11.14 cm for males and 11.26 cm for females, showing that the fish have been caught before achieving sexual maturity (Lm=12.21±0.36 cm for male and 12.34±0.25 cm for females). This is the same result obtained by Othman *et al.* 2019 for the same specie (*P. stridens*) in the Suez Gulf. The results obtained require the need for developing trawl fishing gear selectivity, which is used to collect demersal fish species in Lake Timsah and the Suez Gulf.

The obtained value of the length at recruitment (L_r) of *P. stridens* in the present study was 10.63 cm for males and 10.78 cm for females. On the other hand, Mehanna *et al*. (2023) explained that the length at recruitment of males and females striped piggy in the Gulf of Suez were 9.8 and 9.4 cm, respectively. These small values of Lr indicate the use of nets with small meshes to prevent the escape of fish.

In this study, the calculated growth performance values (Φ) 2.04 of *P. stridens* were somewhat consistent with both Uyan *et al*. (2018) (Φ=2.03) and Avsar *et al*., (2021) (Φ=2.01) for the same species. Moreover, the calculated growth performance (Φ) values from the Gulf of Suez were also close to the values reported in our study. The growth performance values (Φ) given by El-Sayed (1990) were 2.07 and Osman *et al.* (2019), the value was calculated as 1.91 for the same fish. This conformity may be explained by the similar ecological conditions, particularly the temperature of the Gulf of Iskenderun and the Gulf of Suez (Ben-Tuvia, 1977; Avşar *et. al*., 2021).

On the other hand, the striped piggy populations that inhabit the Suez Canal seem to have better growth performance with 2.15 (El-Ganainy and Sabra, 2008) and 2.44 (El-Azim *et al*., 2017) Ø′ values than in the Mediterranean and the Gulf of Suez. Therefore, the higher growth rates can be attributed to the younger population structure along with specific environmental conditions in the canal (Avsar *et al*., 2021).

As for exploitation rates reported in the previous studies, striped piggy populations are subject to overfishing in the Bitter Lakes, Suez Canal (E=0.64; El-Ganainy and Sabra, 2008 and E=0.69; El-Azim *et al.,* 2017) and in the Gulf of Suez (E=0.72; Osman *et al.,* 2019 and E=0.69 and 0.64; Mehanna *et al*., 2023). These results are completely consistent with our results, which are that Lake Timsah, Suez Canal, is subject to overfishing (E=0.69 for males and E=0.65 for females). On the other hand, Avsar *et al*. (2021) determined that the population inhabiting the Gulf of Iskenderun was clearly under fished with an exploitation rate of 0.42.

Conclusion

This research aims to study the biological aspects and evaluate the fisheries status of the *Pomadasys stridens* in Lake Timsah, Egypt and the obtained results will lead to an assessment of the impact of fishing operations on the stock of this species and the management and development of its resources, especially in Lake Timsah.

It can be concluded from this research that high fishing effort clearly affects the growth and quantity of fish production of *Pomadasys strides* in the lake, as it leads to the disappearance of many large-sized specimens from the fishery and their significant decrease. Therefore, we recommend reducing fishing effort in the lake by a significant percentage from its current level, as well as banning all illegal fishing methods, reviewing fisheries and environmental laws, and checking and preventing all pollutants to maintain water quality.

Conflicts of interest

The authors in this research have no conflicts of interest to disclose.

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