بيولوجيا النمو للسلطاني المهاجر (أبو نقطة) *Parupeneus forsskali* في الساحل السوري (شرقي البحر المتوسط)

Growth Biology of Red Sea Goatfish *Parupeneus forsskali* from the Syrian Coast (Eastern Mediterranean Sea)

نادر اسكندر حموي(1) نور عدنان علي باشا(2)

Nader Hamwi(1) **Nour Ali-Basha**(2)

nader836@gmail.com dr.nour.alibasha@gmail.com

(1) مخبر الأسماك، كلية الطب البيطري، جامعة حماه، سورية.

(1) Icthyology Laboratory, Faculty of Veterinary Medicine, Hama University, Hama, Syria.

(2) مخبر علوم البحار، كلية الزراعة، جامعة تشرين، اللاذقية، سورية.

(2) Marine Sciences Laboratory, Faculty of Agriculture, Tishreen University, Lattakia, Syria.

الملخص

يعد السلطاني المهاجر (أبو نقطة) *Parupeneus forsskali* من الأنواع السمكية المهاجرة من البحر الأحمر والمستوطنة حديثاً في الساحل السوري، ولا توجد أية دراسة بعد حول بيولوجيا نموه في البحر الأبيض المتوسط، إذ أن بيولوجيا النمو ذات أهمية كبيرة في الإدارة الجيدة لصيد هذا النوع وزيادة فرص استغلال مخزونه بالشكل الأمثل. تم جمع 778 فردًا من النوع *Parupeneus forsskali* من الساحل السوري خلال الفترة الممتدة بين شهر تموز/ يوليو 2019 و شهر حزيران/ يونيو 2020. وقد أظهر تحليل التركيب العمري تشكل خمس فئات عمرية، إذ أظهر النمو الطولي نمواً غير متجانساً سالباً لجميع الأفراد (b= 2.79). تم تقدير مؤشرات النمو (L_∞= 22.41, K= 0.27, t_0 = - 0.84) من خلال تطبيق دالة النمو اللوجستي. بلغ العمر الأعظمي (T_{max})، ومؤشر أداء النمو (φ'_L) 10.27 سنة و 2.13 على التوالي. وقد أبدى السلطاني المهاجر (أبو نقطة) مرونة / إنتاجية متوسطة ($0.16 \le K < 0.30$)، واعتماداً على العمر الأقصى (T_{max}) أبدى هذا النوع مرونة/ إنتاجية متوسطة (T_{max}: 4 - 10). كان العمر والطول عند أول صيد (T_c، L_c) 1.03 سنة و8.90 سم على التوالي. أما العمر والطول عند الإمداد (T_r، L_r) وبلغ 0.25 سنة و5.71 سم على التوالي. أشارت معاملات النفوق الكلي (Z) 0.69 سنة$^{-1}$، والنفوق الطبيعي (M) 0.69 سنة$^{-1}$ إلى أن هذا النوع المستوطن حديثاً على الساحل السوري لا يزال في مرحلة غير مستغلة، وبلغ معدل البقاء على قيد الحياة (S) والوفيات السنوية (A) 0.50 سنة$^{-1}$ و0.50 سنة$^{-1}$ على التوالي.

الكلمات المفتاحيّة : *Parupeneus forsskali*، النمو، النفوق، الاستغلال، الساحل السوري.

ISSN:2305 - 5243 ; AIF-023 (p:131 -139)

Abstract

The *Parupeneus forsskali* is considered as an immigrant from the Red Sea and a new settler to the Syrian coast, and there is no study yet on its growth biology in the Mediterranean Sea. As the growth biology is of great importance in the good management of fishing of this species and increases opportunities to optimally exploit its stock. A total of 778 individuals of *Parupeneus forsskali* were collected from the Syrian coast between July 2019 and June 2020. The age composition consisted of five age groups. The length growth revealed a negative Allometric growth for all population (b= 2.79). Growth parameters (L_∞= 22.41 cm, K= 0.27, t0 = - 0.84 year) were estimated by applying the logistic growth function. The maximum age (Tmax) and growth performance index (φL`) were 10.27 years and 2.13 respectively. The resilience /productivity of P. forsskali was medium (0.30 > K ≥ 0.16) and, depending on the concept of maximum age (Tmax), it had medium value (Tmax: 4 – 10 years). Age and length at first capture (Tc, Lc) were 1.03 years and 8.90 cm respectively. The age and length at recruitment (Tr, Lr) were 0.25 year and 5.71 cm respectively. The equalities of the total mortality coefficient (Z= 0.69 $year^{-1}$) and the natural mortality (M= 0.69 $year^{-1}$) indicated that the new settler population on the Syrian coast was still in the phase of unexploited. The survival rate (S) and annual mortality (A) were 0.50 $year^{-1}$ and 0.50 $year^{-1}$ respectively.
Keywords: *Parupeneus forsskali,* Growth, Mortality, Exploitation, Syrian coast.

Introduction

Goatfishes (Family: Mullidae) are marine carnivorous species that are important components of the demersal communities across the Atlantic, Indian and Pacific Oceans, and are globally considered among the most important commercial fish (Whitehead et al.,1986; Nelson *et al*., 2016). Six goatfishes belong to this family in the Mediterranean; five of these have been confirmed to be present in the Syrian waters, two are native and three are Lessepsian (Ali, 2018).

Parupeneus forsskali (Fourmanoir and Guézé, 1976) is one of the most exploited goatfishes in the Red Sea (Farrag *et al*., 2018), and inhabits sandy bottoms and coral reefs (Golani,1999; Al-Rousan *et al*., 2005). It is the least studied alien mullid in the eastern Mediterranean, and specific information on its biology is generally lacking in the literature, so the present study aims to shed light on the basic information required for fisheries management of such fish species especially its age, growth, mortality and exploitation rates in its non-native range. This is of great importance for the good management of fishing of this species, and for increasing the opportunities to optimally exploit the fish stock.

Materials and Methods

This research has been carried out on /778/ individuals of P. forsskali, collected from the Syrian coast (Ras albasit, Lattakia, Jableh, Baniyas, Tartus) (Fig 1, a), by various local fishing methods (Gill nets, Trammel nets) during the period from July 2019 to the end of June 2020. For each fish, total length TL (cm), standard length SL (cm), total and gutted body weight (g) were recorded (Fig 1, b).

-Age determination and back- calculations:

Scales were removed from between the first ray of the dorsal fin and the lateral line, cleaned and viewed with low-power microscope (16X). Scale radius and distance from focus to each ring were measured with an ocular micrometer. Mean values of scale radius were calculated for each 1 cm length group. The scale radius and standard length relationship was determined by the least square method. Correction for back calculated fish length-at-each year of life was calculated by Lee formula:

$$Ln = Sn\,(SL - a) / S + a$$

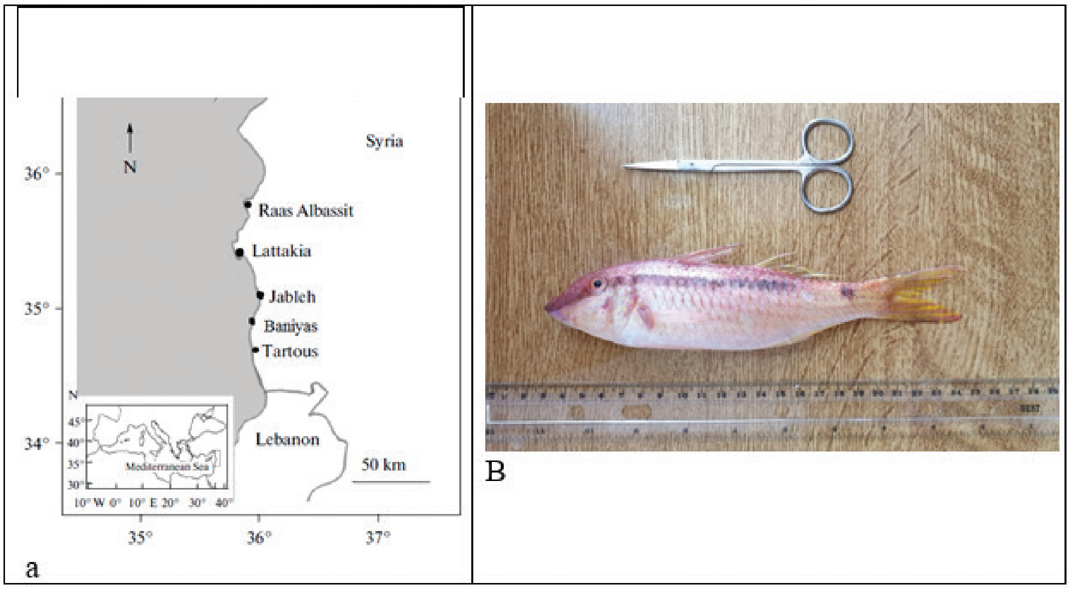

Fig. 1. a. Locations of sampling area. b. *P. forsskali* with 21 cm (TL) and 100 g (TW).

Where: Ln is the length (cm) at age 'n', SL is the standard length (cm), Sn is the radius of annulus 'n', S is the scale radius and a is the intercept of the regression line.

Mean observed length-at-age and back-calculated lengths were computed.

-Length-weight relationship:

Length-weight relationships were determined using the formula:

$$W= aL^{b}$$

Where: W is the total weight (g), L is the Standard length (cm), b is the length-weight factor and a is a constant.

-Logistic growth model:

The logistic growth model was chosen to back-calculated length–at-age and describe the growth of P. forsskali, depending on the Akaike Information Criterion **(AIC) [AIC= N ln (WSS) + 2M** (Akaike, 1974)] in the comparison between the available growth models that describe the growth of the fish species (Hamwi, 2018). Where: N is the number of data points, WSS is the weighted sum of squares of residuals and M is the number of model parameters.

The model was of the form:

$$L_t= L_\infty / [1+e^{-k\,(t - I)}]$$

Where: Lt is the length at time t (years), L_∞ is the asymptotic length (cm), K is the growth coefficient and I is the point of inflection.

-Growth performance index:

In order to compare different estimations of growth parameters, the empirical equation of growth performance **($\varphi L' = \log k + 2\log L_\infty$)** of Pauly and Munro (1984) was used. In addition, maximum Age (Tmax) and maximum length (Lmax) were estimated as:

$$T_{max} = 3 / k + t_0 \qquad \text{(Pauly, 1983)}$$

$$\log(-t_0) = -0.3922 - 0.2752 \log L_\infty - 1.038 \log K \qquad \text{(Pauly, 1980)}$$

$$\log L_\infty = 0.044 + 0.9841 \log L_{max} \qquad \text{(Froese and Pauly, 2000)}$$

-Mortality and exploitation rates:

The total instantaneous mortality rate (Z) was calculated from the catch curve as described in Ricker (1975).

Natural mortality coefficient (M) was estimated from the equation of Pauly (1980) as:

$$\log M = -0.0066 - 0.279 \log L_\infty + 0.6543 \log K + 0.4634 \log T$$

where: L_∞ and K are the parameters of the Logistic Growth Model and T is the annual mean sea surface temperature of the fishing area, here set at T = 18.96˚C.

The difference between total mortality coefficient (Z) and the natural mortality coefficient (M) gives an estimate of fishing mortality (F):

$$F = Z - M$$

Survival rate (S) was estimated from the equation (Ricker, 1975):

$$S = e^{-z}$$

According to Cushing (1968), the rate of exploitation, E, is:

$$E = F*A / Z$$

Where: F and Z are fishing and total mortalities and A is the annual mortality coefficient (A = 1 – S).

-Length at first capture and recruitment:

Length at first capture (Lc) and length at recruitment (Lr) were determined using Beverton and Holt (1957) equations:

$$Lc = L' - [K (L_\infty - L') / Z] \qquad Lr = L' - [K (L_\infty - L0) / Z]$$

where L' is the mean length of fish in the catch sample, K and L_∞ are parameters of the logistic growth equation and Z is the instantaneous mortality rate.

The corresponding age at first capture (Tc) and age at recruitment (Tr) were calculated as:

$$Tc = - (1 / K) * \ln (1 - Lc / L_\infty) + t0$$

$$Tr = - (1/K) * \ln (1 - Lr / L_\infty) + t0$$

Results and discussion

After this Lessepsian fish species was registered in Syria for the first time (Ali *et al*., 2016), it was noticed that this species had spread over the entire Syrian coast, and artisanal fishermen began targeting it in their commercial catches to offer it to consumers, as other known consumable species.

P. forsskali was represented by five age groups, as the most abundant was the age group III (35.86 %), while the age group I was the least abundant (7.07 %) (Fig 2). The relative frequency of the standard length categories (SL) varied between 9.4 and 17cm; individuals with lengths (11.1-11.5 cm) were the most abundant (by 20.31%) (Fig 3).

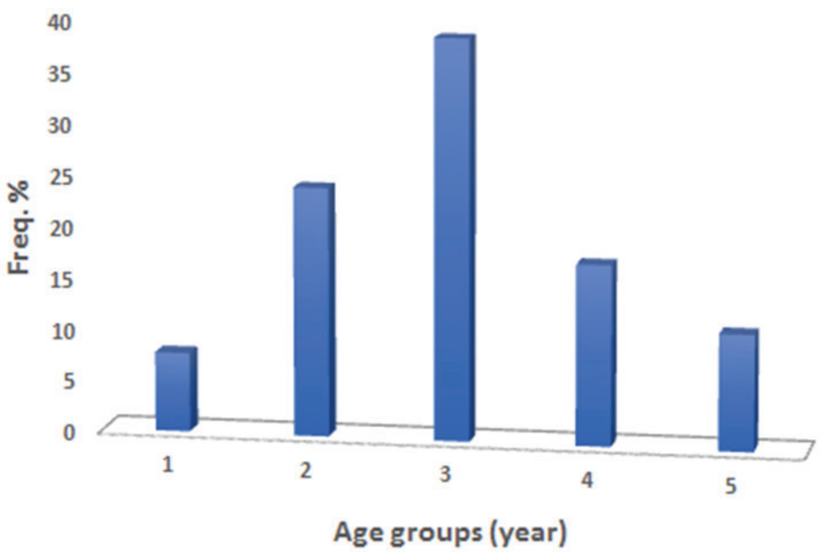

Fig. 2. Age composition of *P. forsskali* in the Syrian coast.lower surfaces.

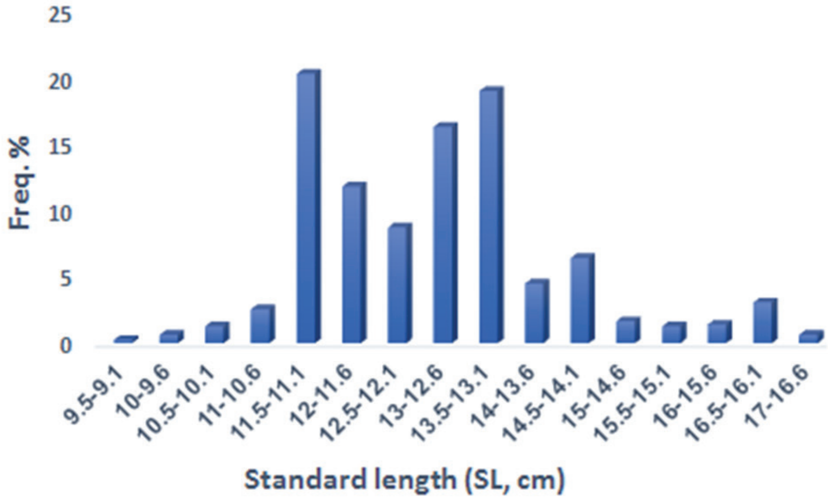

Fig. 3. Standard length frequency distribution of *P. forsskali* in the Syrian coast.

The total length (TL) of P. forsskali caught from the Syrian coast was 21 cm and the standard length was 17 cm at the age of 5+; the smallest total length of the individuals was 11.2 cm and that of the standard length was 9.1 cm at the age of 1+. The total length ranged between 26.5 cm and 10.9 cm in other areas of the Mediterranean basin and 27.9 - 28.5 cm in Red Sea at the age of 5+ (Table 1).

Table 1. Age and size of *P. forsskali* from different water bodies of its area.

Locality and Author	Age	Total length (TL, cm)
Syrian coast (**present study**)	**5**	**21**
Eastern Mediterranean, Bay (Sonin *et al*., 2013)	-	17.4
Lebanon (Bariche *et al*., 2013)	-	20.9
Syrian coast (Ali *et al*., 2016)	-	20.5
coastal waters of Egyptian Mediterranean Sea (Mehanna *et al*., 2016)	-	26.5
Greece (Kondylatos and Corsini-Foka, 2017)	-	10.9
Western Mediterranean Coast of Turkey (Ergüden *et al*., 2018)	-	15.2
Cyprus (Evagelopoulos *et al*., 2020)	-	20.4
Northern Red Sea, Hurghada, Egypt (Sabrah, 2015)	5	28.5
Hurghada fishing area, Egypt (Mehanna *et al*. 2017)	5	27.9

When the backward calculation method was used, the average standard lengths of age groups of *P. forsskali* population increased to 9.4 cm (SL) in the first year of growth, reaching a maximum length of 15.7 cm in the fifth year (Table 2), and the annual length growth rate for the age groups ranged between 1 cm and 9.4 cm, and the highest annual length growth rate was recorded between the first age group (59.87%) and the second (14.01%) (Table 2).

Table 2. Average of standard length by the back-calculation. t - absolute annual linear increment.

	Length at each age-group					Num.
	SL_1	SL_2	SL_3	SL_4	SL_5	
Average of standard length (SL, cm)	9.4±0.16	11.6±0.28	12.7±0.25	13.7±0.14	15.7	778
$t= SL_{(n)} - SL_{(n-1)}$	9.4	2.2	1.1	1	2	
% of increment	59.87	14.01	7.01	6.37	12.74	

The length growth in the present study showed a negative Allometric growth (b= 2.79, R^2 = 0.97). Since the information available on this newly settled species in the Mediterranean sea is limited to data recorded and observed for the first time, we have compared its biological data available from this present study with those data from its native habitat (Red Sea), as the present length growth is similar to that from Red Sea (a negative Allometric growth, b=2.80) (Sabrah, 2015) and is different from the positive Allometric growth (b=3.17) that obtained by Mehanna et al.,(2017).

The logistic growth model showed the following parameters "L∞, K, and I" for *P. forsskali*, $L_t= 22.41 / [1+e^{-0.27 (t-2.03)}]$, (AIC= 2.39; 95% confidence; WSS= 0.486) (Fig 4 ,Table 3). Accordingly, growth coefficient (k) and the asymptotic length (L∞) were 0.27 and 22.41 cm respectively; these are less than those indicated in the Red Sea as they were 0.38 and 30 cm respectively (Sabrah, 2015) and 0.32 and 31.60 cm respectively (Mehanna *et al*., 2017) (Table 3). The difference is due to the eco-biological factors in the native range comparing to the new non-native one.

The computed growth performance index (φ`) is used to compare the growth rate of *P. forsskali* in different localities as it was 2.13 which is less than that indicated in the Red Sea (2.53) (Sabrah, 2015) and 2.50 (Mehanna *et al*., 2017) (Table 3).

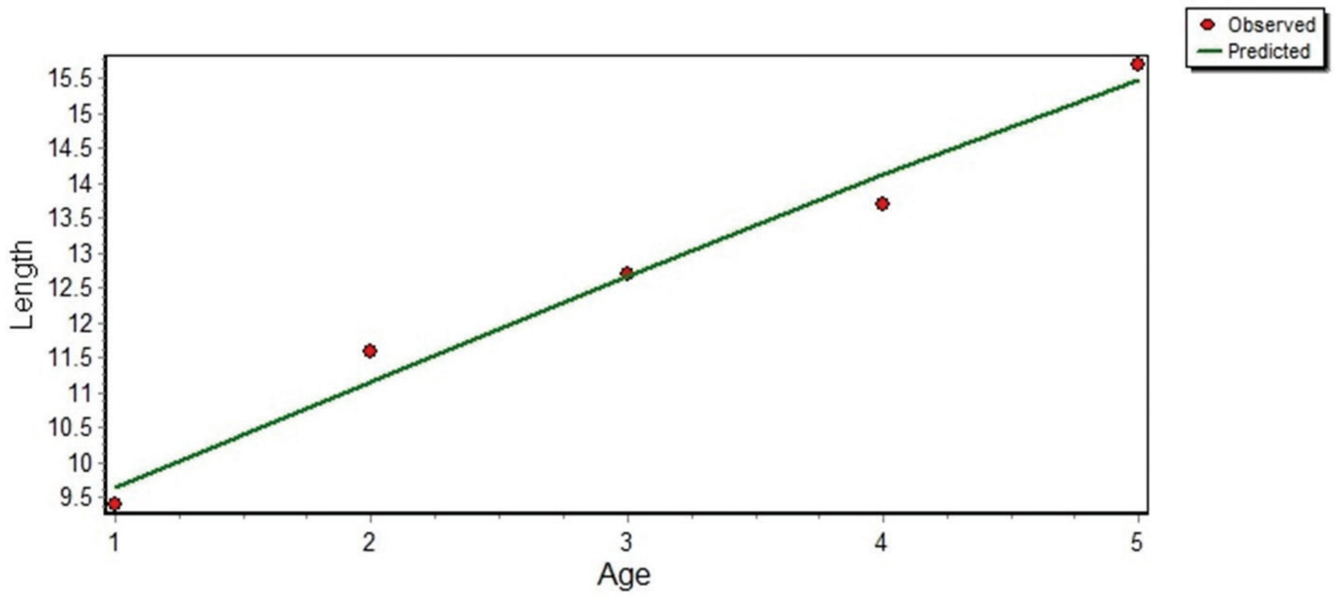

Fig. 4. The logistic growth model of *P. forsskali* from the Syrian coast, $L_t= 22.41 / [1+e^{-0.27 (t-2.03)}]$

Table 3. Parameters of growth function that describes the linear growth of *P. forsskali* population from different water bodies.

Locality and author	Length	Aging method	Growth function	L_∞, cm	K	φ_L`	Num.
Syrian coast (**present study**)	SL	Scales	Logistic growth	22.41	0.27	2.13	778
Hurghada, Egyptian Red Sea (Sabrah, 2015)	TL	Otolith	von Bertalanffy growth	30.00	0.38	2.53	456
Hurghada, Egyptian Red Sea (Mehanna *et al.*, 2017)	TL	Otolith	von Bertalanffy growth	31.60	0.32	2.50	375

According to Musick's classification (1999), the resilience / productivity growth of *P. forsskali* in this study was medium (0.16 ≤ k <0.30) while it is considered high (k> 0.30) in the Red Sea (Sabrah, 2015; Mehanna *et al*., 2017). The maximum age (Tmax) was 10.27 years and the maximum length (Lmax) was 21.26 cm in the present study, while it was 8.12 years in the Red Sea (Mehanna *et al.*, 2017), so resilience / productivity is therefore taken into account - depending on the concept of maximum age (Tmax), which can be accessed for *P. forsskali* during its lifetime in the present study as medium value (Tmax: 4 - 10 years). This is considered as medium value (Tmax: 4 – 10 years) (Musick, 1999) comparing to that recorded from the Red Sea (Mehanna *et al*., 2017).

It is found in the present study that the mean length of the commercial capture was estimated as 13.39 cm (SL) for fishes ranging from 9.4 to 17 cm (SL). Consequently, the average age and length of the *P. forsskali* at the first catch (Tc, Lc) were 1.03 years and 8.90 cm, respectively and the average age and length of individuals at recruitment (Tr , Lr) were 0.25 years and 5.71 cm, respectively. It is clear that the length at the first catch (Lc) in the Syrian coast is smaller than that indicated in the Red Sea (Lc= 12 cm) (Sabrah, 2015).

Considering Beverton and Holt (1956), the age at first capture (Tc) is a true indicator of the mesh size used in practice or actually in fishing. Accordingly, the nets used for fishing of *P. forsskali* from the Syrian coast were somewhat small (20 - 26 mm). This corresponds to what was previously indicated that the third age group and the individuals with the lengths (11.1 - 11.5 cm) were the predominant and higher than the age at first capture (Tc) and the length at first capture (Lc) previously defined. Thus, the P. forsskali individuals in the Syrian coast were captured with relatively small sizes and ages, which requires to use larger mesh sizes than previously used to give greater chance for fish growth.

The instantaneous total mortality, corresponding to the slope of the descending limb of the catch curve, was Z=0.69 year^{-1}. The natural mortality (M) was 0.69 year^{-1} (Table 4). Calculation of fishing mortality gave F= 0 year^{-1}. With the values of M and F available, then exploitation ratio was computed as E=0 (Table 4).

Table 4. Mortality, exploitation and survival coefficients of *P. forsskali* from Mediterranean Sea and Red Sea.

Locality and author	S (year^{-1})	M (year^{-1})	Z (year^{-1})	A (year^{-1})	F (year^{-1})	E (year^{-1})
Syrian coast (**Present study**)	0.50	0.69	0.69	0.50	0.00	0.00
Hurghada, Egyptian Red Sea (Sabrah, 2015)	-	0.90	2.76	-	1.86	0.67

It is quite clear that the coefficients Z, M and F are significantly lower than those from the Red Sea (2.76, 0.90 and 1.86 respectively) (Sabrah, 2015).

Fish are subject to a variety of environmental pressures (biotic and abiotic), in addition to the pressures from fishing and exhaustion of their numbers. Thus, there are two different phases in the life of these fish: the unexploited phase from hatching to age at first capture (Tc) and exploited phase (started from Tc) (Beverton and Holt, 1956).

It is noticed from this study that the P. forsskali underwent the unexploited phase (birth to Tc) due to lack of exposure to fishing stress (F) and exploitation (E), but the largest effect was due to the natural mortality (M), which was almost equal to the total mortality (Z) which indicates the area between age at recruitment (Tr) and age at first catch (Tc) (i.e. when Z = M). This can be explained by the recent spread of this species along the Syrian coast and formation of young groups that not yet subjected to the stress of fishing by local artisanal fishermen. This is shown in this study through the age composition (5 age groups), and through the conditions prevailing in the region such as food deficiency, competition, predation, and disease infections that affect individuals as a result of pathogens and pollution.

Fishing during population recruitment may lead to fishing mortality. This death often reaps the adult stages but the natural mortality reaps the early stages (Sparre *et al*., 1998). Small fish are also less likely to undergo fishing mortality than large fish because they are able to pass through the nets and/or are far from fishing sites known to fishermen (Gayanilo *et al*., 1994).

Conclusions and recommendations:

1. The age groups of *P. forsskali* in the Syrian coast range between (1+ - 5+) which indicates the existence of a fixed young population that succeeded in settlement in the area as a species coming from Red Sea to the Mediterranean Sea. It has well spread in the Syrian coast along with many species of this genus.
2. The total length of the *P. forsskali* individuals caught from the Syrian coast is 21 cm and a standard length of 17 cm at the age of 5+, while the smallest total length of the individual is 11.2 cm and a standard length of 9.1 cm at the age of 1+.
3. The length growth shows a variable negative allometric growth (b = 2.79).
4. The resilience / productivity growth of *P. forsskali* is medium (0.16 ≤ k <0.30), and depending on the concept of maximum age (Tmax), it has medium value (Tmax: 4 - 10 years).
5. The age and length at first capture (Tc, Lc) are 1.03 years and 8.90 cm, respectively and the age and length at recruitment (Tr, Lr) are 0.25 years and 5.71 cm, respectively.
6. *P. forsskali* underwent the unexploited phase due to the lack of exposure to fishing mortality (F) and exploitation (E), but the largest effect is due to the natural mortality (M), which is almost equal to the total mortality (Z).
7. P. forsskali in the Syrian coast are caught in relatively small sizes and ages, which necessitates the use of nets with mesh sizes larger than those used (20 – 26 mm) to allow these fish to grow.

References

- Akaike, H. 1974. A new look at the statistical model identification. *IEEE Trans. Automat. Control*, 19: 716-723.
- Ali, M., Y. Diatta, H. Alkusairy, A. Saad and C. Capapé. 2016. First record of Red Sea goatfish *Parupeneus forsskali* (Osteichthyes: Mullidae) from the Syrian coast (Eastern Mediterranean). *Journal of Ichthyology*, 56: 616–619.
- Ali, M. 2018. An updated Checklist of the Marine fishes from Syria with emphasis on alien species. *Mediterranean Marine Science*, 19: 388–393.
- Al-Rousan, S.A., M.Y. Rasheed, M.A. Khalaf and M.I. Bardan. 2005. Ecological and geochemical characteristics of bottom habitats at the northern Jordanian coast of the Gulf of Aqaba. *Chemistry and Ecology*, 21: 227–239.
- Bariche, M., M. Bilecenoglu and E. Azzurro. 2013. Confirmed presence of the Red Sea goatfish *Parupeneus forsskali* (Fourmanoir and Guézé, 1976) in the Mediterranean Sea. Bio. Invasions Records, 2: 173–175.
- Beverton, R.J.H. and S. J. Holt. 1956. A review of methods for estimating mortality rates in fish populations, with special references to sources of bias in catch sampling. *Rapp Proces-verb Reun Cons Int Explor Mer*, 140: 67-83.

- Beverton, R. J. H. and S. J. Holt. 1957. On the dynamics of exploited fish population. *Fishery Investigations, Series II (London)*, 19: 1- 533.
- Cushing D.H. 1968. Fisheries biology. A study of population dynamic. *Univ. Wisconsin press, Madison*., 200p.
- Ergüden, D., Y.K. Bayhan, S. Alagöz Ergüden and A. Altun. 2018. Occurrence of the Red Sea Goatfish *Parupeneus forsskali* (Fourmanoir & Guézé, 1976) from the Western Mediterranean Coast of Turkey. *Turkish Journal of Maritime and Marine Sciences*, 4(1): 68–72.
- Evagelopoulos, A., A. Nikolaou, N. Michailidis, T.E. Kampouris and I.E. Batjakas. 2020. Progress of the dispersal of the alien goatfish *Parupeneus forsskali* (Fourmanoir and Guézé, 1976) in the Mediterranean, with preliminary information on its diet composition in Cyprus. *Bio.Invasions Records*, 9(2): 209–222.
- Farrag, M., A. Osman, S. Mehanna and Y. Ahmed. 2018. Fisheries status of the common species of family Mullidae in the Southern Red Sea, Hurghada, Egypt. Egyptian Journal of Aquatic Biology and Fisheries, 22: 249–265.
- Froese, R. and D. Pauly. Editors. 2000. FishBase 2000: concepts, design and data sources. *ICLARM, Los Banos, Laguna, Philippines*. 344p.
- Gayanilo, F.C., P. Sparre and D. Pauly. 1994. The FAO-ICLARM Stock Assessment Tools (FiSAT) User's Guide. FAO Computerized Information Series (Fisheries), *FAO Rome*, 6, 186 pp.
- Golani, D. 1999. Fish colonization of an artificial reef in the Gulf of Elat, northern Red Sea. *Environmental Biology of Fishes*, 54: 275–282.
- Hamwi, N. 2018. Use Akaike (AIC) and Schwartz (SC) information criterions in the differentiation between nonlinear growth models of different fish species. *Journal of Al-Baath University*, 40(3): 45-66.
- Kondylatos, G. and M. Corsini-Foka. 2017. Two aliens new to the Hellenic Aegean waters: *Parupeneus forsskali* (Perciformes, Mullidae) and *Herdmania momus* (Tunicata). *Mediterranean Marine Science*, 18, 544.
- Mehanna, S.F., U.M. Mahmoud and E.M. Hassanien. 2016. First occurrence of the Red Sea goatfish, *Parupeneus forsskali* (Fourmanoir & Guézé, 1976) in the coastal waters of Egyptian Mediterranean Sea. *International Journal of Fisheries and Aquacultur*e, 8: 94–97.
- Mehanna, S.F., A.G.M. Osman, M.M.S. Farrag and Y.A.A. Osman. 2017. Age and growth of three common species of goatfish exploited by artisanal fishery in Hurghada fishing area, Egypt. *Journal of Applied Ichthyolog*y, 34: 917–921.
- Musick, J.A. 1999. Criteria to define extinction risk in marine fishes. *Fisheries*, 24(12):6-14.
- Nelson, J.S., T.C. Grande and M.V.H. Wilson. 2016. Fishes of the World, 5th Edition. *John Wiley & Sons Inc., Hoboken, USA*, 707 pp.
- Pauly, D. 1980. A new methology for rapidly acquiring basic information on tropical fish stocks: growth, mortality and stock recruitment relationships. *P.*154-172. In stock assessment for tropical small-scale fisheries. Edited by Saila S.B. & Roedel P.M. ICMRD, *Univ. Rhode Island, Kinston*.
- Pauly, D. 1983. Some simple methods for the assessment of tropical fish stocks. *FAO Fisheries and Aquaculture-Technical Papers*., (234):52p.
- Pauly, D. and J.L. Munro. 1984. Once more on the comparison of growth in fish and invertebrates. *FishByte*, 2(1),21.
- Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. *Bulletin of the Fisheries Research Board of Canada*, 191, 382p.
- Sabrah, M.M. 2015. Fisheries biology of the Red Sea goatfish *Parupeneus forsskali* (Fourmanoir and Guézé, 1976) from the northern Red Sea, Hurghada, Egypt. *The Egyptian Journal of Aquatic Research*, 41: 111–117.
- Sonin, O., P. Salameh, D. Edelist and D. Golani. 2013. First record of the Red Sea goatfish, *Parupeneus forsskali* (Perciformes: Mullidae) from the Mediterranean. *Marine Biodiversity Records*, 6, 105.
- Sparre, P., E. Ursin and S.C. Venema. 1998. Introduction to tropical fish stock assessment-Part 1: *Manual. FAO Fisheries Technical Paper* 306/1, Rev. 2, 407.
- Whitehead, P. J. P., M. L. Bauchot, J.C. Hureau, J. Nielsen and E. Tortonese. 1986. *Fishes of the North- Eastern Atlantic and the Mediterranean*. Volumes I-III. UNESCO, Paris, France, 1473 pp.

N° ref: 1019