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Biological aspects of some Goatfish (Mullidae) from the southern Egyptian Red Sea; Hurghada to Shalateen

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ABSTRACT

Goatfish or Red Mullets are considered to be the most important economical family associated the Egyptian Red Sea coral reefs. It is the first time to appraise the difference between the biological parameters for different goatfish species in the Egyptian Red Sea. The current study was designed to evaluate the biological characteristics of some Goatfish collected seasonally from the commercial artisanal fishery operating in the Egyptian Red Sea during the period from autumn 2016 to summer 2018. The study based on five Mullidae species belonged to three different genera: *Mulloidichthys flavolineatus* (Lacepède, 1801), *Mulloidichthys vanicolensis* (Valenciennes, 1831), *Upeneus moluccensis* (Bleeker, 1855), *Parupeneus cyclostomus* (Lacepède, 1801), and *Parupeneus frosskali* (Fourmanoir & Gue´ze´, 1976). *P. frosskali* and *M. vanicolensis* were the most dominant species; constituted 28.13% and 20.31% of the total goatfish catch, respectively. The seasonal occurrence of different Mullidae species revealed that all species were recorded by rational percentages in spring and summer. The growth parameters (L∞ and K) were determined for all species by applying the von Bertalanffy growth function. By following the seasonal Gonado-somatic index (GSI) for different species uncover spawning period occurred between spring and summer. The lengths at first sexual maturity were determined as 18.0, 18.6, 24.50, 17.2 and 13.68 cm for *M. flavolineatus*; *M. vanicolensis*; *P. cyclostomus*; *P. forsskali* and *U. moluccensis*, respectively.

INTRODUCTION

Goatfish species are occurring by monophyletic group in Perciformes order under family Mullidae. This family contains 70 species belonged to 6 genera that are widely distributed in tropical and subtropical seas (Aydin, 2016). Goatfishes have a pairs of barbels that play a very important role in food seeking and work as a chemoreceptor (Uiblein, 2007; Rajan *et al.*, 2012).

Despite goatfishes are considered to be the most economical catch from the Red Sea and the Mediterranean Sea, there were very little known about their fisheries biology. The only relevant studies addressing the biological characteristics of some goatfish species endemic the Gulf of Suez and the Egyptian Red Sea were conducted by Sabrah (2007 and 2015) in *U. japonicas* and *P. frosskali* as well as Sabrah & El-Ganainy (2009) in *U. vittatus* and *U. tragula*. Ramadan & El-Halfawy (2014) pointed on the fishery and the reproductive biology of *U. pori* in the Egyptian Mediterranean Coast. In Turkey, Ismen (2006) and Cicek & Avser

(2011) studied the age, growth, mortality and reproduction of *U. pori*. Moreover, age, growth and reproduction of *U. moluccensis* from Üskenderun Bay, Eastern Mediterranean were studied by Ismen (2005) and Ozvrol *et al*. (2010). Motomura *et al.* (2012) recorded *U. guttatus* for the first time in Japan and El-Drawany (2012& 2013) noticed some Upeneus species in the Libyan coast.

This study aims to understand the similarities between the different biological parameters of five goatfish species where there were no studies interested this topic in the Egyptian Red Sea before.

MATERIALS AND METHODS

Samples were collected seasonally from the commercial artisanal fishery operating along the southern Egyptian Red Sea fishing ports (Hurghada to Shalateen), during the period from autumn 2016 to summer 2018. This sampling area (Fig. 1) is a small scale fishery area that characterized by many fishing gears as the artisanal long line, gillnets and trammels net.

Fig. 1: Map showing the southern Egyptian Red Sea sampling areas (Hurghada to Shalateen).

In the laboratory, the collected specimens were identified and separated into different species, as the Mullidae catch constitutes many species belonged to different genera. The recorded species were *Mulloidichthys Flavolineatus* (Lacepède, 1801), *Mulloidichthys Vanicolensis* (Valenciennes, 1831), *Upeneus Moluccensis* (Bleeker, 1855), *Parupeneus Cyclostomus* (Lacepède, 1801), *Parupeneus Frosskali* (Fourmanoir & Gue´ze´, 1976), *Parupeneus Macronema* (Lacepède, 1801), *Parupeneus Rubescen* (Lacepède, 1801) and *Parupeneus bifasciatus* (Lacepède, 1801). Our study based on five Mullidae species (Fig 2).

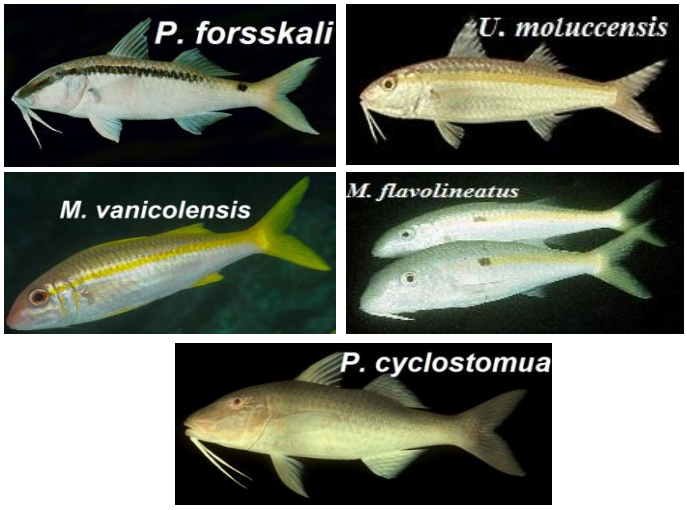

Fig. 2: Five of goatfish species collected from the southern Egyptian Red Sea (Hurghada to Shalateen)

Total length of different collected samples were measured to the nearest 0.1 cm and weighted to the nearest 0.1 g. The length- weight relationship was estimated according to Snedecor (1956) using the formula $W = a L^b$; for the combined sexes, where W is the total fish weight, L is the total fish length, "a" and "b" are constants. Otoliths reading were used for age determination of the different Mullidae species. Growth parameters were estimated using ELEFAN I to obtain preliminary estimates of asymptotic length ($L\infty$) and the growth rate (K) of the von Bertalanffy Growth Function (VBGF) following Gayanilo *et al.* (2002) incorporated in the FiSAT II software program. Pauly and Munro (1984) clarify the growth performance index (Φ) that calculated by using the equation: $\Phi = \log K + 2 \cdot \log 10 L_\infty$. Gonado-somatic index (GSI): Sex was identified in all samples. Ovary and testis weights were recorded to the nearest 0.01g for each sample. The seasonal gonado-somatic index was estimated according to De Viaming *et al.*, 1982 formula: (GSI= gonad weight/total body weight × 100). Length at sexual maturity (L_m) was estimated by fitting the percentage maturity against mid-lengths (king, 1995). L_m is represented at the point on X-axis corresponding to 50% point on Y-axis.

RESULTS

Fisheries Studies:

Species composition:

Eight species of goatfishes were landed at the different Egyptian Red Sea fishing ports. It is noticed that, *Parupeneus frosskali* was the dominant species forming (28.13%) followed by *Mulloidichtys vanicolensis* (20.30%), *Parupeneus cyclostomus* (17.97%), *M. flavolineatus* (17.19%) and *U. moluccensis* (11.72%). The other species (*Parupeneus Macronema*, *Parupeneus Rubescen* and *Parupeneus bifaciatus*) were recorded by small quantities (4.69%), Fig. (3).

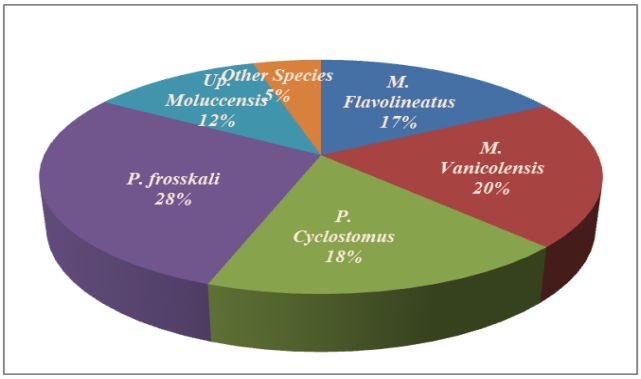

Fig. 3: Species composition of family Mullidae collected from the southern Egyptian Red Sea (Hurghada to Shalateen).

Seasonal occurrence of goatfishes

Figure (4), it is clear that, all goatfish species were recorded in spring and summer by a reasonable percentage. *P cyclostomus* and *U. moluccensis* are the most abundant species (64% and 71%) in spring, while *P. forsskali* and *M. vanicolensis* were recorded by high percentage in summer (67% and 53%). On the other hand, all the goatfish species were reported by very low percentage during winter and autumn seasons except *M. flavolineatus* and *M. vanicolensis* were appeared with a reasonable value in winter (23.3%) and autumn (15.2%) respectively.

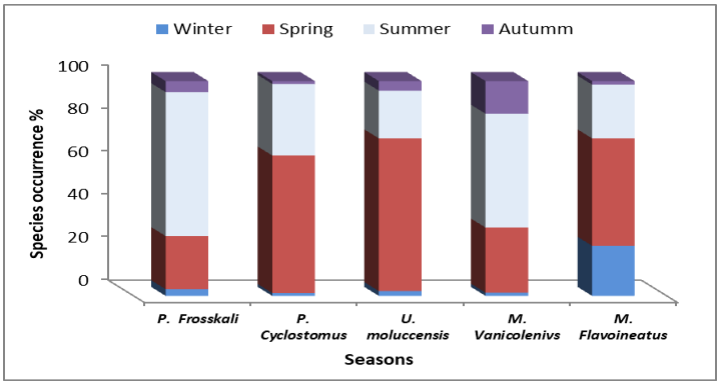

Fig. 4: Seasonal occurrence percentage of different goatfish species collected from the southern Egyptian Red Sea (Hurghada to Shalateen) .

Biological studies:

Length-weight relationships:

The regression of total body weight as a function of length of all species as well as the mean and the standard deviation was illustrated in Table (1). *P. Cyclostomus* found to be the largest maximum length values with length ranged from 21.0 to 41.6 cm, followed by *M. Flavoineatus* from 15.0 to 32.8 cm, and *U. moluccensis* from 17.0 to 31.6 cm, while *P. frosskali* and *M. Vanicolenivs* represented the smallest maximum length values of 25.3 and 26.2 cm, respectively.

Figure (5) represented the length weight – relationship for all studied species, it is distinct that the exponent (b) demonstrated a positive allometric growth for all studied species except for *P. forsskali*, it exhibited a negative allometric growth pattern.

Table 1: Length-weight relationships of some goatfish species collected from the southern Egyptian Red Sea (Hurghada to Shalateen)

Species	No	Total Length (cm)			Total Weight (g)			a	b	r	GT
		Min	Max	Mean± SD	Min	Max	Mean± SD				
P. forsskali	97	15	25.3	21.51± 1.68	40.3	183	118.13± 28.02	0.027	2.730	0.772	NA
P. cyclostomus	75	21	41.6	28.07± 4.82	108	997	289.01± 186.42	0.007	3.142	0.991	PA
U. moluccensis	45	12	31.6	21.51± 4.26	42.1	316	112.28± 78.35	0.006	3.187	0.975	PA
M. vanicolensis	66	16	26.2	19.1± 2.13	37.8	195	64.65± 35.23	0.003	3.408	0.853	PA
M. flavolineatus	60	15	32.8	22.16± 2.91	37.4	493	124.70± 71.18	0.005	3.245	0.972	PA

C: Combined sexes; No.: sample number; S.D.: deviation; a& b: constant; r: coefficient of determination; GT: growth type; NA: negative allometric; PA: Positive allometric.

Age Determination

Otoliths reading revealed the maximum ages were five years for *M. flavolineatus*, *U. moluccensis* and *P. cyclostomus*, where it was four years for *M. vanicolensis* and three years for *P. forsskali*, (Table 2). It is clear that the age group II is the most abundant one in all the studied species, except *P. forsskali*, the age group one is the most dominant. The results showed that, growth increment was rapid towards the first years of life and then declined gradually over subsequent years as the fish gets older.

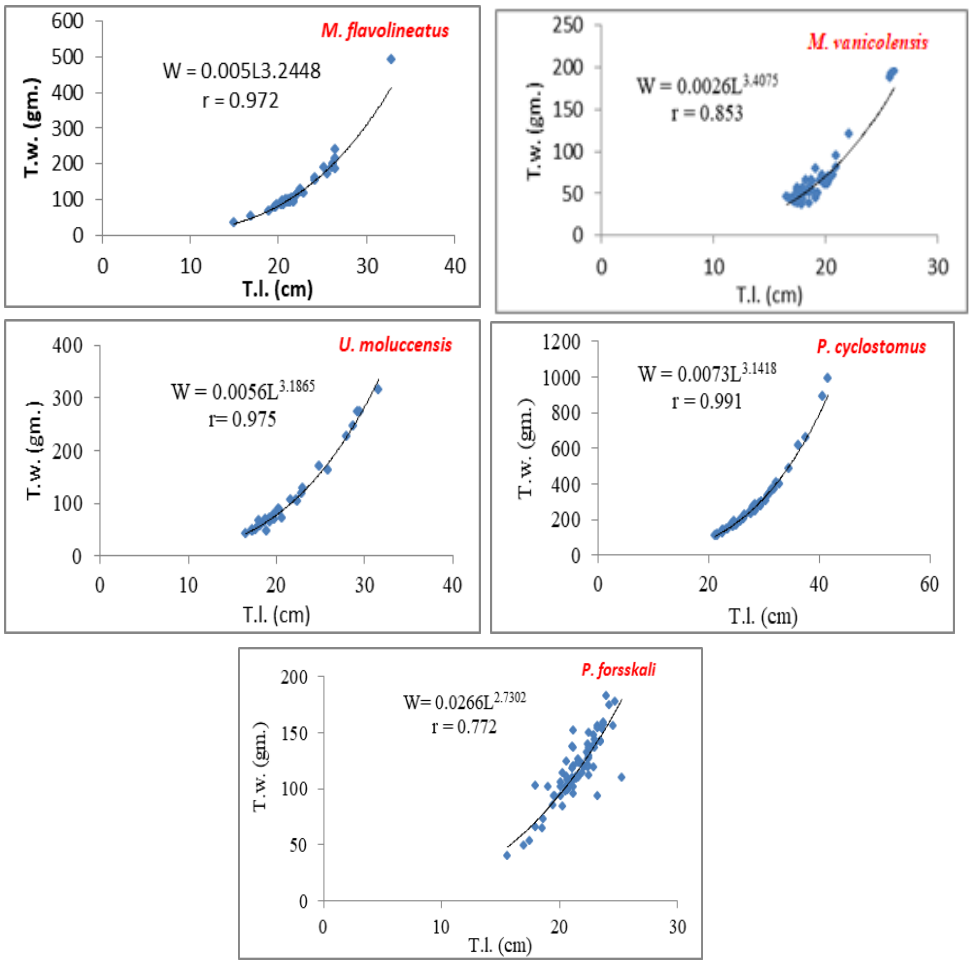

Fig. 5: Length-weight relationships of some goatfish species collected from the southern Egyptian Red Sea (Hurghada to Shalateen)

Table 2: Mean lengths at different age groups of some goatfish species collected from the southern Egyptian Red Sea (Hurghada to Shalateen)

Species	Age group (Y)	No. of Fish	Mean L.(cm)	growth Increment
M. flavolineatus	**II**	25	18.30	18.30
	III	17	25.00	6.70
	IV	11	29.43	4.43
	V	8	32.8	3.37
M. vanicolensis	**II**	34	18.21	18.21
	III	17	23.50	5.29
	IV	15	25.97	2.47
U. moluccensis	**II**	18	18.29	18.29
	III	14	23.79	5.50
	IV	8	27.5	3.71
	V	5	30.10	2.60
P. cyclostomus	**II**	30	21.55	21.55
	III	20	28.95	7.40
	IV	15	34.42	5.47
	V	10	38.10	3.68
P. forsskali	**I**	42	15.60	15.60
	II	35	19.85	4.01
	III	20	22.50	2.75

Growth parameters:

The von Bertalanffy growth parameters (L∞ and K) were estimated by using ELEFAN I for each species represented in Table (3). The results showed that the

different species were characterized by a relatively high growth rate, where K ranged from 0.44/y in *M. flavolineatus* to 0.76/y in *M. vanicolensis*. *P. Cyclostomus* is characterized by relatively lower growth rate (K=0.23/y).

The growth performance index (Ǿ) computed to compare the von Bertalanffy growth model of different species. It is clear that in Table (3) the growth performance (Ǿ) have the same trend in all species except *U. moluccensis* (Ǿ) has relatively lower value than the other ones (2.546).

Table 3: The von- Bertalanffy growth parameters (K and L∞) and the growth performance (Ǿ) for some goatfish species collected from the southern Egyptian Red Sea (Hurghada to Shalateen) .

Species	K/y	L∞ (cm)	Ǿ
M. flavolineatus	0.442	34.14	2.712
M. vanicolensis	0.762	27.65	2.765
P. Cyclostomus	0.239	44.00	2.665
P. forsskali	0.731	26.65	2.715
U. moluccensis	0.320	33.15	2.546

Gonado-somatic index (GSI):

Gonado-Somatic index in (Fig. 6) was estimated to determine the spawning period for males and females of each species. The minimum values of GSI were observed in winter and autumn, while it increased gradually in spring until reached its maximum ratio in summer. GSI of all studied species exhibit an identical trend with each other, except *U. moluccensis*. Therefore, it can be concluded that the spawning period of *P. forsskali*, *P. Cyclostomus*, *M. vanicolensis* and *M. flavolineatus* takes place in summer, while in case of *U. moluccensis* it occurs in spring.

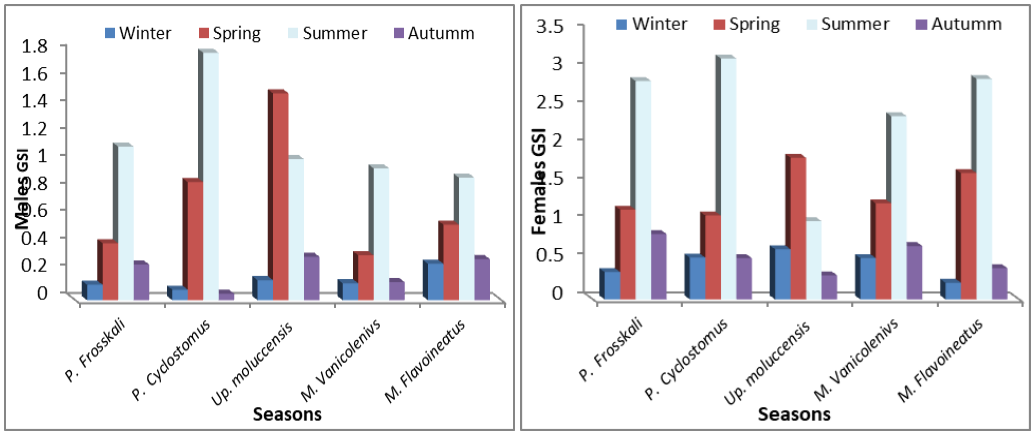

Fig. 6: Seasonal variations in Gonado-somatic index (GSI) (males and females) of some goatfish species collected from the southern Egyptian Red Sea (Hurghada to Shalateen)

Length at sexual maturity (L_m)

The lengths at first sexual maturity (L_m) were found to be 18.0, 18.6, 24.50, 17.2 and 13.68 cm for *M. flavolineatus*; *M. vanicolensis*; *P. cyclostomus*; *P. forsskali* and *U. moluccensis*, respectively.

DISCUSSION

It is the first time to demonstrate the difference between growth parameters and reproductive biology for five different goatfish species collected from the Egyptian Red Sea. The species composition reveal that eight species of goatfishes were landed at the different Red Sea fishing ports, however *Mulloidichtys vanicolensis* and

Parupeneus frosskali are the most dominant species constituting more than 20% of the total species composition. The seasonal occurrence of the species studied were represented high catch rate during spring and summer, which can be considered as favorable seasons for their spawning. The relationship between fish length and weight is an important aspect, as it reflects the environmental condition where the fish live and the food availability. The (b) value of the length-weight relationships in the present study were 3.24, 3.41, 3.19, 3.14 and 2.73 for *M. flavolineatus*, *M. vanicolensis, U. moluccensis, P. cyclostomus* and *P. forsskali* respectively. It is clear that (b) values clarify the growth pattern of each species and revealed that all species possess the positive allometric growth pattern, except for *P. forsskali* which exhibit a negative allometric pattern.

From table (4) there is small variation in the "b" values of the present study with the same species in other regions worldwide; this may be related to the difference in the growth rate of each species that affected by the nutrition, spawning conditions and the response to the changes in the environmental factors, as well as the size range and size selectivity of the sampling gear (Cherif *et al.,* 2007; Erguden *et al.,* 2009 and Pavlov *et al,* 2013). It is clear that there was no significant difference between the growth parameters of the species studied ($P > 0.05$). This is in agreement with Goncalves *et al* (2003) who revealed that the estimated von Bertalanffy growth parameters may vary according to regions and years. In addition Cicek and Avsar (2011) decided that, the major driving force in the population fluctuation is the recruitment variability year by year. The absence of zero and one age groups in the samples was probably due to the net mesh size selectivity. However, the low levels of the older age groups after the age group two cannot be related to selectivity, and are more likely to be the result of the extremely intensive fishing activities (Ismen, 2005). The growth rate for the five species is found to be rapid at the first years of life and declined gradually over subsequent years. The differences in growth rates might be attributed to the different in the bio-ecological conditions (Kaya *et al.*, 1999).

The GSI results revealed that the spawning activity occurred at spring and summer when the GSI reached its highest level as the other tropical fishes (Sadovy, 1996). (Golani, 1990) reported that the Eastern Mediterranean Sea goatfish species spawn between June and September. These results were in agreement with the previous studies that recorded by (El-Drawany, 2012) for *U. moluccensis* in Elkhoms coast of Libya; (Ismen, 2005) in Üskenderun Bay, the Eastern Mediterranean; (Torcu and mater, 2000) in the Fethiye and Mersin Gulfs; Ozvarol *et al*., (2010) in the Gulf of Antalya and Kaya *et al,* (1999) in south Aegean. Emel'yanovaa *et al.,* (2015) concluded that goatfishes are pelagic spawning and the maturity stages progression with the time of spawning in summer. Cole *et al.,* (2009) concluded that the spawning period of the yellow stripe goatfish (*M. flavolineatus*) and the yellow fin (*M. vanicolensis*) was from April through July, as they have an extended spawning season. The estimated length at maturity of different species studied revealed that this family caught before the second year of life. Nowadays goatfish considered as a target species for fishermen due to their highly economic value and their high market price, this leads to a gradually decrease in the total production of these species as a result of overfishing (Tserpes *et al.*, 2002 and Cicek & Avsar, 2014). Gundogdu & Baylan (2016) declared that the assessment of family Mullidae fishery is required for suitable management and regulation.

In conclusion, the enforcement system should be applied to manage the fishing activity by covers restrictions on economical species, fish sizes, mesh sizes,

locations and breeding seasons, etc. The available data suggest that the minimum fishing size for the Red Sea goatfish should be increased to suitable length more than the length at maturity and the fishing season should be closed from May to September. This extended period covers spawning time of multispecies to conserve the species stock biomass, where single species assessments do not give suitable solutions.

Table 4: Represent the "b" values for the species in the present study with the same one in different regions worldwide

Country	Area	Sex	Species	b	Growth pattern	Source
Turkey.	Aegean Sea	Combined Sexes	*P. forsskali*	3.30	Positive allometeric	Anonymous (1993)
Turkey	Iskenderun Bay	Combined Sexes		3.11	Positive allometeric	Froese *et al.*, 2014
Egypt	Red Sea	Combined Sexes		2.80	Negative allometeric	Sabrah, 2015
Turkey	north-eastern Mediterranean	Combined Sexes	*U. Moliccensis*	3.21	Positive allometeric	Torcu (1995)
Turkey	Aegean coasts	Males		3.15	Positive allometeric	Kaya *et al.*, (1999)
		Females		3.35		
Eastern Mediterranean Sea	Iskenderun Bay	Males		2.99	Positive allometeric	Ismen, (2005)
		Females		3.00		
Turkey	of Antalya	Combined Sexes		3.231	Positive allometeric	Ozvarol *et al*., (2010)
Elkhoms coast	Libya	Combined Sexes		3.01	Positive allometeric	El-drawany *et al.*, (2012)
				3.09		
Indian Ocean	Rodrigues Island	Combined Sexes	*M. flavolineatus*	3.1758	Positive allometeric	Edwards *et al.*, (2011)
			M. vanicolensis	3.1590		
			M. flavolineatus	2.77	Negative allometeric	Kamikawa *et al.*, (2015)
USA	Guam fishery	Combined Sexes	*M. vanicolensis*	2.96	Negative allometeric	
			P. cyclostomus	3.11	Positive allometeric	
USA	Guam fishery	Combined Sexes	*M. flavolineatus*	3.21	Positive allometeric	Peyton *et al.*, (2016)
Philippines	Davao Gulf	Combined Sexes	*P. cyclostomus*	2.960	Positive allometeric	Bos *et al.*, 2017
Egypt	Red Sea	Combined Sexes	*M. flavolineatus*	3.2448	Positive allometeric	Present study
			M. vanicolensis	3.4075	Positive allometeric	
			P. cyclostomus	3.1418	Negative allometeric	
			P. forsskali	2.7302	Negative allometeric	
			U. moluccensis	3.1865	Positive allometeric	

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ARABIC SUMMARY

بعض الخصائص البيولوجيه لأسماك البربونى (Mullidae) من البحر الأحمر فى مصر، من الغردقه حتى شلاتين

رشا على حنيش ، منال مصطفى صبره ، وعزة عبد الحميد الجنايني
المعهد القومى لعلوم البحار والمصايد، مصر

تعتبر أسماك البربونى من أهم الأسماك الاقتصاديه المرتبطه بالشعاب المرجانيه فى البحر الأحمر بمصر. هذه هى المره الأولى التى يتم فيها تقيم الفرق بين مختلف المعاملات البيولوجيه لعدد من أنواع أسماك البربونى التى تم تجميعها من البحر الأحمر.

صُممت الدراسة الحالية لتقييم الخصائص البيولوجية لبعض أنواع أسماك البربونى التي تم جمعها بشكل موسمي من مصايد حرف الصيد الصغير في الساحل المصرى للبحر الأحمر (من الغردقة الى الشلاتين) خلال الفترة من خريف ٢٠١٦ إلى صيف عام ٢٠١٨. اعتمدت الدراسة التي أجريت على خمسة أنواع من عائله المولیدى والتى تنتمى إلى ثلاثة أجناس مختلفة وهى :

{*Mulloidichthys Flavolineatus* (Lacepède, 1801), *Mulloidichthys Vanicolensis* (Valenciennes, 1831), *Upeneus Moluccensis* (Bleeker, 1855), *Parupeneus Cyclostomus* (Lacepède, 180), and *Parupeneus Frosskali* (Fourmanoir & Gue´ze´, 1976)}.

وجد ان (*P. frosskali* and *M. vanicolensis*) هما أكثر الأنواع السائدة بنسبة ٢٨.١٣ ٪ و ٢٠.٣١ ٪ ، على التوالي. كما ان الأنواع المختلغه من عائله المولیدى كانت متواجده بكثرة في فصلي الربيع والصيف. ويلاحظ أن نسبه ظهور *M. vanicolensis* في فصل الصيف كانت (٧١.١٥ ٪) ، في حين *M. flavolineatus* ظهر فى فصل الشتاء بنسبه (٥٩.٠٩ ٪).

تم تحديد الطول اللا نهائى (L_∞) و معدل النمو (K) لكل الأنوع عن طريق تطبيق Von Bertalanffy growth function).

اتباع مراحل نضج المناسل الموسمية ، و بحساب مؤشر النضوج الجسدي (GSI) للأنواع المختلفة وجد ان فترة تفريخ البيض تظهر بين الربيع والصيف. تم تحديد أطوال النضج للأنواع المختلفه كانت ١٦.٠ و ١٧.٥١ و ٢٤.٥٠ و ١٥.١٤ و ١٣.٦٨ سم لـ *M. flavolineatus*؛ *M. vanicolensis* ؛ *P. cyclostomus*؛ *P. forsskali* & *U. moluccensis* على التوالي.