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Observation on Biological Traits of Striped Goatfish (*Upeneus vittatus*) and Freckled Goatfish (*Upeneus tragula)* from the Gulf of Suez, Egypt

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Abstract: Age, growth, reproduction, nutrition and mortality parameters of goat fish *U. vittatus* and *U. tragula* from the Gulf of Suez were evaluated. The estimated life span of the investigated species was three years using the fish scales reading. The Von Bertalanffy growth parameters were L4 = 19.8 and 18.7 cm TL and K = 0.598 and 0.648 year G^{1} for the two studied species respectively. The total, natural and fishing mortality rates were recorded. The exploitation ratio was estimated as E = 0.56 and 0.60 for the two species respectively. Following the variations in monthly gonado-somatic index and the maturity stages indicated that the two species spawn once a year in spring. The length at 50% sexual maturity was estimated and the results indicated that L_{50} were laid between 11.0-12.0 cm TL for males and females of the two species, respectively. The analysis of the gut contents revealed that *U. vittatus* and *U. tragula* were feed mainly on crustaceans (shrimps and crabs made the bulk of the diet), followed by fishes and mollusks. The study deposited some recommendations that may be profitable for the goat fish's fishery management purpose in the Gulf of Suez.

Key words: Goat fishes % *U. vittatus* % *U. tragula* % Fisheries biology % Fishery management % Gulf of Suez % Red Sea

INTRODUCTION

The goatfish family (Mullidea) is commercially important demersal fish group throughout their distribution around the world. It constitutes of 15 genera, of which Upeneus or the Red Mullet is the most important one inhibiting the Gulf of Suez and the Egyptian Red Sea. Recently some fishes of this genus were recorded in the Mediterranean Sea, migrating throughout the Suez Canal [1- 3].The genus Upeneus is represented in the Gulf of Suez by five species [4, 5]. *Upeneus tragula* and *Upeneus vittatus* occupies an important position in the goatfish catch at the Gulf, they were estimated by about 20% of the total goatfish catch from the Gulf. *U. vittatus* and *U. tragula* are benthic species, found mainly in sandy and muddy bottoms especially near coral reef colony [6]. The taxonomy of the Upeneus in the Red Sea had received considerable attention where they have a high ability to change their coloration which often leads to high confusion with their identification. Some authors concluded that *U. pori* was misclassified as *U. vittatus* and *U. tragula* and some information about these species were given under this name [7]. Golani and Ritte [8] reported that *U. pori* is not found in the Red Sea, after a study on the genetic relationship in goatfishes (Mullidae) of the Red Sea and the Mediterranean. There are only few attempts to describe the distribution, the biological features and the identification characteristics for these species in different regions [9-14].

The main aim of the present study was to shed light on some biological and dynamic features of the Red Mullets *U.vittatus* and *U. tragula*. Using such information is essential for the management and the good precision of the trawl fishery in the Gulf of Suez.

MATERIALS AND METHODS

Materials: Samples of *Upeneus* species (Family Mullida e) were monthly collected from the trawl fishery landings in the Gulf of Suez (Attaka site) during the fishing season 2002/2003. Samples were separated into the different Upeneus species (5 species according to Sabrah, [5]). A total of 268 fish of *U. vittatus* (9-18.4 cm TL) and 238 fish of *U. tragula* (8-17.8 cm TL) were obtained. Age determination was carried out by inspection of scales. Gonads and stomachs were taken from each fish and preserved in 4% formalin solution for the biological studies.

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Methods: Age was determined by counting the annual rings on the scales of *U. vittatus* and *U. tragula*, using the scale projector (Measuring scale projector "Leitz PT 300", connected to an electronic reversible counter "Leitz vrz U"). The body length – scale radius relationship were determined using the least square method. The back calculated lengths at the end of each year of life were obtained by using Lee's equation [15]:

$$L_n = (L - a)\, s_n / S + a$$

Whereas L_n is the calculated lengths at the end of n^{th} year, L is the fish length, s_n is the distance from the scale focus to the successive annuli, S is the total scale radius and a is the intercept of the regression line with the Y axis.

- Length-weight relationship was determined for the two species, using the equation $W=a\,L^b$ [16]. W is the total weight in grams, L is the total length of the fish in cm and the parameters (a) and (b) are constants. The degree of association between the variables was r^2 correlation coefficient.
- Von Bertalanffy [17] growth equation was applied to estimate the growth parameters (K, L4 and t_0) of *U. vittatus* and *U. tragula*.
- The total mortality rate Z was calculated from the annual cumulative length frequency data according to Jones and Van Zalinge [18]. The natural mortality rate M was estimated by applying Pualy [19] equation. The fishing mortality was obtained by the subtracted M from Z. The growth performance index was estimated by Moreau, *et.al.* [20] equation. The exploitation rate E = F/ Z.
- For the description of the sexual cycle of the two Red Mullets the sequence of gonad maturation was observed and the spawning period was determined monthly during the fishing season. The seasonal evolution of the gonado-somatic index was analyzed according to the formula: GSI = Wg / W_f X 100 whereas Wg is the gonad weight to the nearest 0.01 gram and W_f is the fish weight in gram. Length at first sexual maturity (L_{m50}) was estimated by King [21] method.
- A brief study on the feeding habits of *U. vittatus* and *U tragula* was carried out to evaluate the more dominant food items. The food items were defined and the food composition percentage was estimated for each food item.

RESULTS

Growth in Length: The relationship between the scale radii and the total fish lengths showed direct proportional as well as high correlation for *U. vittatus* and *U. tragula* (Figs 1&2). The following equations achieved this relationship:

$L = 1.9304\ S + 4.8573$ n = 268 $r^2 = 0.944$ for *U. vittatus*
$L = 1.9232\ S + 4.9889$ n = 238 $r^2 = 0.863$ for *U. tragula*

The results indicated that the life span of the two studied species is three years old. The observed and the calculated total lengths at age were nearly similar at the ages from 1 to 3 (Table 1 & 2). Upeneus species attained approximately 69% of its maximum size during the first year of life, (i.e. rapid growth occurs at the first year of life), so the fishery became full recruited in age group one then after completion of the first year the annual growth rate decreases as the fish got older (Table 1& 2).

Length-Weight Relationship: The total length of *U. vittatus* ranged from 9.0 to 18.4 cm while the total weights ranged from 8.5 to 63.4 g. The total length of *U. tragula* ranged from 8.4 to 17.8 cm and the total weight from 7.8 to 54.6 g. The results of the length-weight regression were described by the following equations:

$W = 0.00911\ L^{3.0749}$ $r^2 = 0.967$ *U. vittatus*
$W = 0.00651\ L^{3.1921}$ $r^2 = 0.961$ *U. tragula*

Table 1: Back calculated lengths at the end of each year of life of *U. tragula* from the Gulf of Suez

Age group	Number	Mean observed Length	Back calculated lengths 1	2	3
0	18	10.31			
I	120	12.3	11.48		
II	69	14.5	11.52	14.92	
III	31	16.2	11.10	13.4	16.72
Increment			11.48	3.44	1.80

Table 2: Back calculated lengths at the end of each year of life of *U.vittatus* from the Gulf of Suez

Age group	Number	Mean observed Length	Back calculated lengths 1	2	3
0	26	10.52			
I	109	13.5	12.25		
II	88	16.2	12.31	15.65	
III	45	18.0	11.93	14.58	17.52
Increment			12.25	3.45	1.87

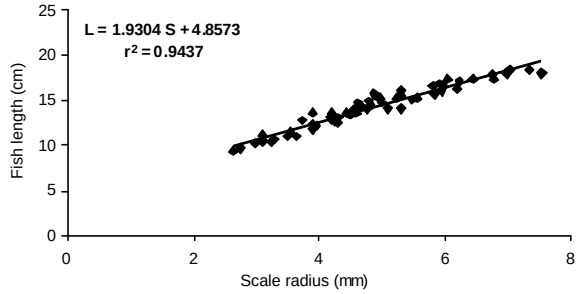

Fig. 1: Lenght-scale radius relationship of *U. Vittatus* from the Gulf of Suez

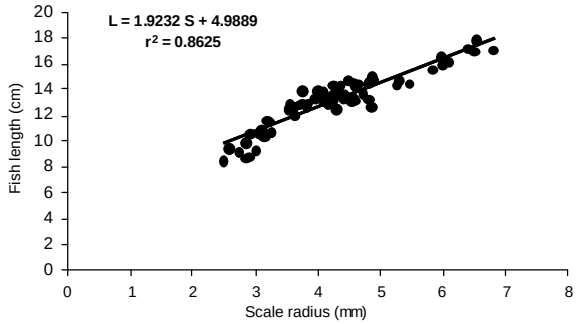

Fig. 2: Lenght-scale radius relationship of *U. tragula* from the Gulf of Suez

Table 3: Estimated parameters of *U. vittatus* and *U. tragula* from the Gulf of Suez

Parameters	*U.vittatus*	*U. tragula*
L_{min}	9.00	8.4
L_{max}	18.4	17.8
L_4	19.8	18.7
K	0.598	0.648
t_0	0.6132	0.4649
Z	3.11	3.26
M	1.38	1.29
F	1.73	1.97
E	0.56	0.600
M	0.60	0.56
L_{50}		
%	11.7	11.0
&	12.0	11.4

Theoretical Growth in Length: The estimated von Betalanffy growth parameters for *U. vittatus* was L8 = 19.8 cm, K= 0.598 yearG¹ and t_0 = -0.6132 and for *U. tragula* was L8 = 18.7cm, K = 0.648 yearG¹ and t_0 = -0.4649. The obtained results indicate that *U. tragula* has a higher K value than that of *U. vittatus*, so it attains its asymptotic length faster. The growth performance index (Ö) was found to be 2.37 and 2.33 for *U.vittatus* and *U. tragula* respectively (Table 3).

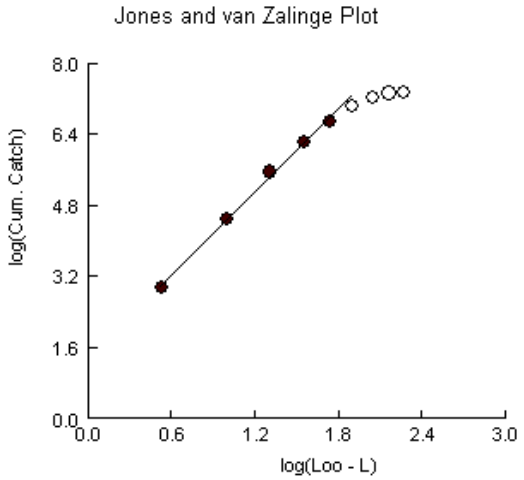

Fig. 3: Output of Jones and vanzaling method for estimating total mortality of *U. tragula* from the Gulf of Suez.

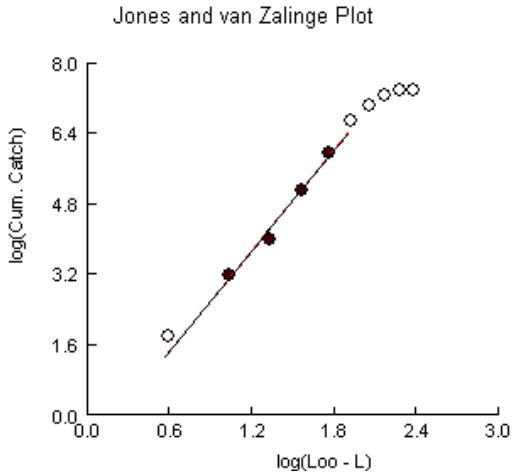

Fig. 4: Output of Jones and vanzaling method for estimating total mortality of *U. vittatus* from the Gulf of Suez

Mortality and Exploitation: The annual total mortality coefficient was estimated as 3.26 and 3.11 yearG¹ with CI = 2.243-4.275 and 2.783-3.439 for *U. vittatus* and *U. tragula* (Figs 3&4). Natural mortality coefficient was calculated as 1.29 and 1.38 yearG¹ for the two studied species respectively and the fishing mortality rates were obtained as 1.97 and 1.73 yearG¹ respectively (Table 3).

The exploitation rate (E) was calculated as 0.60 and 0.56 for *U. vittatus* and *U. tragula* respectively.

Sexual Cycle and Spawning Period: The maximum GSI value was recorded in April and May for males and females of both species (Figs 5&6). The minimum value of GSI was observed in September for the two species.

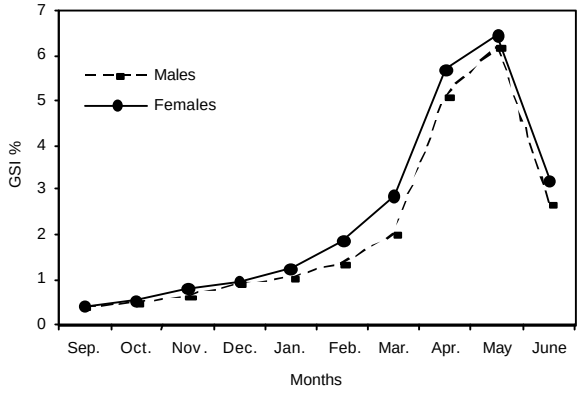

Fig. 5: Monthly variation in gonado-somatic index of *U. Vittatus* from the gulf of Suez

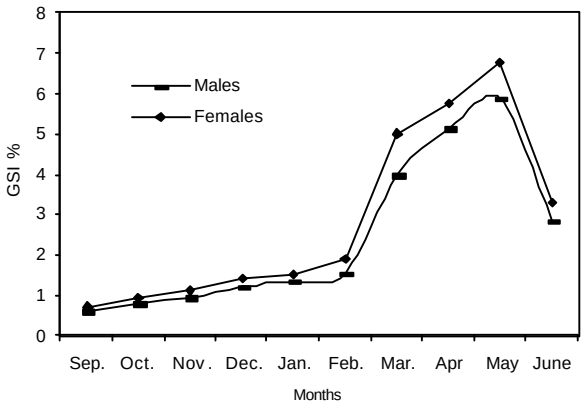

Fig. 6: Monthly variation in gonado-somatic index of *U. Tragula* from the gulf of Suez

On the other hand, by chasing the variations in the different maturity stage of the two species, it was observed that for both sexes the ripe stage was firstly appeared by low percentage in February and then it increased gradually till reached its highest values in April and May. The spent stage percentage in the two species appeared for the first time in May reached its highest value in June. It is clear that the collateral peaked of the gonado-somatic index with the increase of the full ripe stage percentages throughout March, April and May suggested that *U. vittatus* and *U. tragula* are spring spawners.

Size at First Sexual Maturity: The smallest mature males and females of *U. vittatus* was 10.0 cm, whereas the smallest mature males and females of *U. tragula* was 9.0 cm. From the maturation curves (Figs. 7&8) the estimated mean size at which 50% of males and females were mature occurred between 11.0 and 12.0 cm for both males and females of the two studied species, which corresponds to the first year of their life.

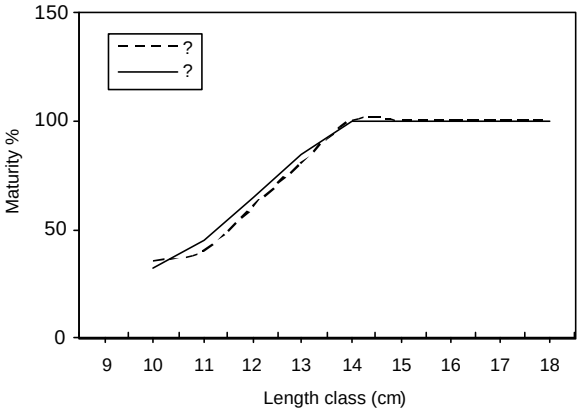

Fig. 7: Length at first maturity of *U. Vattatus* from the Gulf of Suez

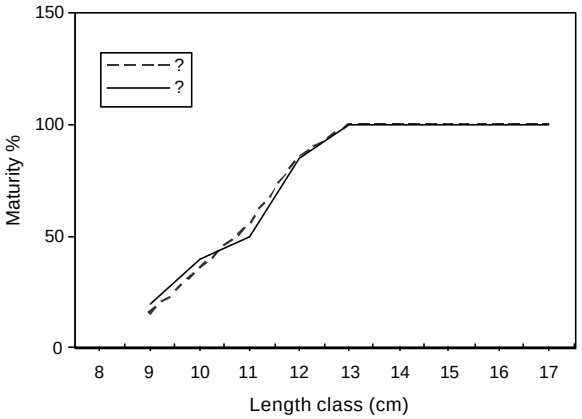

Fig. 8: Length at first maturity of *U. Tragula* from the Gulf of Suez

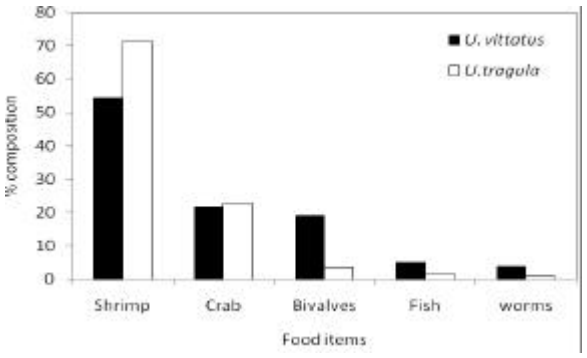

Fig. 9: Percentage composition of diffrent food items of *U. Vittatus and U. Tragula* from the Gulf of Suez

Diet Composition: The preliminary analysis of 102 and 88 stomachs content of the striped (*U. vittatus*) and freckled (*U. tragula*) goat fishes respectively revealed that the food items mainly include crustaceans (shrimps and crabs), fish, mollusks (bivalves) and worms (polychaets). The percentage composition of diets (Fig. 9) showed

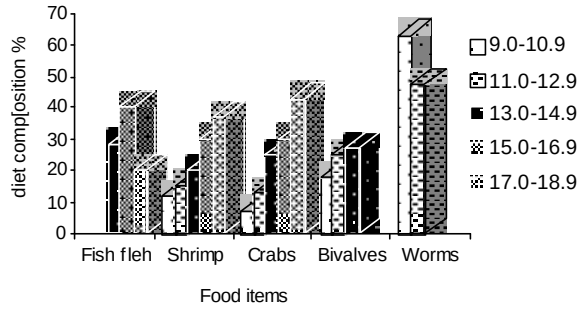

Fig. 10: Percentage of diet composition for *U. Vittatus* in relation to length class

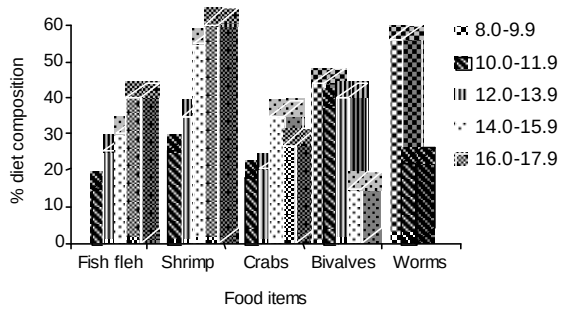

Fig. 11: Percentage of diet composition for *U. Tragula* in relation to length class

that crabs were ingested by about an equal value in *U. vittatus* (21.9%) and *U. tragula* (22.7%), while shrimps were represented by 54.4% and 71.3% in the two fish respectively. This indicating that *U. tragula* diet depends on shrimps more than *U. vittatus* and vice verse in case of bivalves (19.2% for striped goat and 3.6% for the freckled goat). It was noticed in all samples that, crustaceans could not be identified since they were in the larval stage, also the fish flesh was found in the digestion stage and the bivalves were broken.

Variations in the Feeding Habits in Relation to Length Class: The study of the diet composition in relation to size for the two goat fishes showed that shrimps and crabs formed the main important food items throughout various size of fishes (Figs 10 & 11), they represented by a small percentage in fishes smaller than 14.0 cm whereas in fishes above 15.0 cm they were abundant by a high percentage. On the other hand the fish flesh was found in the fish sizes above 13.0 cm, while worms were abundant in the small sizes only; below 12.0 cm. Bivalves and worms were found by a considerable value in the small fishes of the two species.

DISCUSSION

Goat fishes or the Red Mullets, Family Mullidae, are considered to be one of the most important fishery resources in the Gulf of Suez and Red Sea, due to their high prices and marketable power, that recently reached about 40 L.E./Kg in the local market. Upeneus are represented in the Gulf of Suez by five species [4].

Scale was found to be valid for age determination, whereas it has a distinct hyaline and opaque zones, it was also observed that the annuli is formed once a year coincides the maturation period (spring) and the recruits appeared by a marked numbers in September and October (autumn). This result was in agreement with those of El-Drawany [22] and El-Serafy [23] who reported that the scales of Upeneus species in the Red Sea exhibited a pattern of concentric annuli, they were valid for age determination and the checks are appear in the spring during the maturation cycle. Four age groups from 0 to 3 could be detected on the scales of *U. vittatus* and *U. tragula* from the Gulf of Suez. The two species grow rapidly attaining about 12.0 cm at the end of the first year of life, then the growth rate slow thereafter. Thomas [24] reported the back calculated lengths of *U. tragula* in the Gulf of Manner in India as 11.7, 15.9, 17.4 and 17.9 cm for the age groups from 1 to 4. El-Drawany [22] demonstrated the following lengths 12.4, 14.2, 17.4, 19.2 and 20.6 cm for the age groups from 1 to 5 for *U. vittatus* in the Egyptian Red Sea using scales. Table (4) shows the results obtained by different authors studied the growth of *U. vittatus* and *U. tragula* in different regions. These results could be coincident with the present study, but there was a slightly differences which may be attributed to the difference in the maximum lengths that recorded in the different regions and the variations in the environmental condition.

Table 4: Growth and mortality parameters recorded in different regions

Authors	Regions	L4	K	Z	M	F	M
U.vittatus							
43	Phlippine	23.1	0.59				2.46
22	Red sea,	26.5	0.21				
9	India	21.4	0.63				2.46
44	Nansha Isl.	20.2	0.53				2.33
Present	Gulf of Suez	19.8	0.598	3.26	1.29	1.97	2.37
Study	Gulf of Suez	19.8	0.598	3.26	1.29	1.97	2.37
U. tragula							
24	India	18.2	1.04	3.48	1.58	1.9	2.54
14	Brunei	20.5	1.00		2.17		2.58
Present study	Gulf of Suez	18.7	0.648	3.11	1.38	1.73	2.33

Table 5: Length weight relationships of *U. vittatus* and *U. tragula* recorded by some authors in different tropical regions

Authors	Regions	Sex	a	b
U. vittatus				
45	Mozambique	&	0.0129	3.041
		%	0.0066	3.300
9	India	&	0.0041	3.428
		%	0.0082	3.207
46	New-Caledonia	Unsexed	0.0081	3.309
39	New-Caledonia	Unsexed	0.0072	3.354
Present study	Gulf of Suez Egypt	Unsexed	0.0085	3.075
U. tragula				
24	India	Unsexed	0.0042	3.302
47	Thailand	Unsexed	0.0144	2.845
46	New-Caledonia	Unsexed	0.0166	2.989
39	New-Caledonia	Unsexed	0.0137	3.068
Present Study	Gulf of Suez Egypt	Unsexed	0.0065	3.192

The estimated fishing mortality (relating to the fishing effort) is high versus the natural mortality and the exploitation rate is higher (0.60 and 0.56) than the expected value (0.50), these confirm the over exploitation on the goat fishes fisheries resource. Table (4) clarified the recorded mortality rates and the growth performance given by several authors in different tropical areas. The results reflected a good approval except some differences which may be due to some factors such as temperature, salinity or the food availability [25, 26].

The results obtained from the L/Wt relationship for the two studied goat fishes from the Gulf of Suez showed that the value of "b" is very close to 3 indicating the isometric growth; this result is in good agreement with those given by several authors, in different tropical regions (Table 5).

The spawning season of goat fishes in the Gulf of Suez takes place in the spring between April and June with a clear peak in May. This result agreed with that reported by Boraey & Soliman [27] and El-Drawany [22] in the Red Sea. In the Mediterranean Sea Osman [28] discussed the same results on *Up. species* in the coastal waters of Alexandria but with short spawning period, due to the difference in water temperature between the Red and Mediterranean Seas. The genus Upeneus responded to its new environment by shorting its spawning season due to low temperature, as a migratory species [29, 30]. Thomas [24] in India and N'DA & Deniel [31] in the south coast of Britain reported the same results. The length at the first maturity of *U. vittatus* and *U. tragula* was occurred between the length of 11 and 12 cm for males and females, which corresponds to the first year of their life. El-Drawany [22] reported the length at maturity of *U. vittatus* in the Red Sea to be 11.7 cm for males and 12.1 cm for females, while Thomas [24] found that *U. tragula* from the Gulf of Manner attain its first maturity at 12.0 cm.

The account on the feeding ecology of *U. vittatus* and *U. tragula* revealed that they are often live in groups inhibiting sandy, muddy and sheltered coastal waters. They are benthic carnivorous feeders, feed mainly on small crustaceans [6, 32-34]. Tropical goat fishes posse a pair of chemosensory barbell to rifle through the sediment in search of a meal like goats, they seek any thing edible, as worms, crustaceans, mollusks and other mobile benthic invertebrates, where barbells contained gustatory system or taste buds [12, 35, 36,].

The analysis of the stomach contents of the two Red Mullets, *U. vittatus* and *U. tragula* revealed the main food items included Crustaceans (shrimp and crabs), bivalves, fish flesh and worms. It was noticed that, *U. vittatus* ingested more bivalves than the *U. tragla*, while *U. tragula* ingested more shrimp than *U. vittatus*. The study also revealed that, crustaceans (shrimp & crabs) were ingested by all the fish sizes, but fishes > 13.0 cm ingest more crustaceans than the smaller fishes. Small fish lengths < 12.0 cm preferred bivalves and worms than the larger ones. These species are carnivore, feeding voraciously on benthic and sub-benthic organisms detected by chemoreceptor rich barbells [13, 37-42]. Osman [28] illustrated that crustaceans represented more than three quarter of the food of Upeneus in the Egyptian waters. Thomas [24] concluded that the adults of *U. tragula* are vertically migratory in their feeding habits and there were no differences between the food of males and females and the food of mature and immature fishes.

In conclusion, the available results and the results obtained by Sabrah [4, 5] suggested that, Upeneus species in the Gulf of Suez is overexploited and need some management regulations such as the establishment of fisheries reserves in the nursery and spawning grounds and shallow waters to protect the fish during spawning and to protect juveniles and recruits. Detailed studies involving the gear selectivity for the trawl to find the suitable mesh size should be undertaken.

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