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SOME BIOLOGICAL ASPECTS OF THE RED MULLET, *UPENEUS JAPONICUS* (HOUTTUYN, 1782) FROM THE GULF OF SUEZ, RED SEA, EGYPT

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Key words: Reproductive biology, feeding habits, goat fishes, U. japonicus, Gulf of Suez, Red Sea.

ABSTRACT

Mullidae sp. is considered as one of the most economic fishes in the Red Sea and Gulf of Suez. They are distributed throughout the tropical and sub-tropical waters around the world. Reproductive biology and the feeding habits of *U. japonicus* are studied in the present paper. Seasonal variations of the gonado-somatic index showed that spawning of this species takes place in spring. Monthly variations of the maturity stages indicated that the fish has a distinct spawning season that takes place in the spring months. The length at first sexual maturity for males and females were 9.6 cm and 9.8 cm respectively. The relationship between the absolute fecundity and the fish length, weight and age indicated that the fecundity increases as the fish gets longer, heavier and older. The study of the feeding habits of *U. japonicus* revealed that it feeds mainly on crustaceans (63.45%), fish flesh (26.11%) and nematodes (10.44%). It was also noticed that small fish< 12cm preferred nematodes while the fishes > 12 cm to 19 cm feed mainly on crustaceans.

1. INTRODUCTION

The Red Mullet (Upeneus spp.) or the goat fish, family Mullidae constitute one of the most economically important edible fishes in the Egyptian waters especially in the Gulf of Suez and the Red Sea. They are demersal fishes caught by bottom trawling and come in the fifth category of the trawl production in the Gulf. Upeneus spp. constitutes about 10% of the annual total trawl catch. *Upeneus japonicus* is the most abundant species of family Mullidae constituting about 70% of the Upeneus fish catch taken from such fishing area (Yousif & Sabrah, 2004 and Sabrah, 2006). Goat fishes are soft bottom species live around coral reefs, characterized by having a pair of long barbells extending under their chains which usually lay flat against the chains. The barbells with chemosensory receptors make them moving actively over or into the sediment to find food organisms (Masuda & Allen, 1993). Upeneus species are the only ones in family Mullidae which has teeth on both jaws and palatines (Randall & Kulbicki, 2006). The species is recently migrated to the eastern Mediterranean via Suez Canal (Ben-Tuvia, 1989).

The reproduction and feeding habits of the Red Mullet *U. japonicus* have been studied in different areas of the Indo-pacific; Wantiez, 1992 and Kulbicki, 2005 in New Caledonia. Sommer *et.al.* 1996 in Somalia. Ni and Kwok, 1999 in Hong kong waters. Ahmed, *et.al.*, 2003 in Malaysia. Chen, p., 2003 in the south western continental shelf of Nansha Islands. Hardy, 2003 in USA, and Travers,*et.al.*, 2006 in Australia.

The biology and the feeding habits of *U. japonicus* received less attention in the Red Sea particularly in the Gulf of Suez. The present investigation is considered to be the first study in details in the Gulf of Suez to obtain a clear picture of the reproductive biology as well as the food and feeding habits of *U. japonicus* to give the basic knowledge for the management of fisheries of this species.

2. MATERIAL AND METHODS

Upeneus japonicus samples were collected from the commercial trawl catch landed by Attaka harbored in the Gulf of Suez during the period from September 2001 to May 2002, where the fishing season in the Gulf of Suez is yearly starts in Sep. and closed at the end of May. For reproduction study a total of 366 fish were examined ranging from 8.0 to 19.8 cm in total length and from 7.0 to 77.8 g in total weight. Sex and sexual maturity stages for each sample were recorded and the gonads were weighed to the nearest 0.01 g. The condition and development of the gonads were studied by applying the monthly variations of the gonadosomatic index (G.S.I.), where G.S.I. = [Gonad weight (G Wt)/Total fish weight (Wt)]× 100. The first sexual maturity of males and females of *U. japonicus* was estimated by the determination of L50 according to (Pitt, 1970). For fecundity the full ripe gonads of 42 fish during the spawning season were preserved in 4% formaldehyde aqueous solution, and then each sample was weighed after drying. A sub-sample of about 0.1 to 0.2 g. from each ovary was taken and weighed to the nearest 0.001 g. The absolute fecundity (Fa) was estimated as**:** gonad weight X the eggs number in the sub-sample / sub-sample weight.

The relative fecundity (Fr) will be estimated for each of length and weight, where Fr = absolute fecundity / total length (cm) or total weight (g).

Concerning the food and feeding studies, the degree of the stomachs fullness were recorded for each sample and then preserved in 4% formalin solution. 240 guts of *U. japonicus* were examined and the food items were identified to the nearest taxonomical level. The percentage composition or the point method of different food items were estimated according to (Hynes, 1950). Besides, the selectivity index for different food items was calculated according to (Berhaut, 1973) equation:

Selectivity index S = n / NE

Where n is the number of stomachs containing a certain food item and NE is the total number of examined stomachs.

3. RESULTS

3.1. Reproductive biology study

3.1.1. Description of maturity stages

The condition of gonads of *U. japonicus* throughout the different months of the study period was followed according to the scale of (Moran *et. al.,* 1993) with some modifications and the sequence of the maturity stages as follows:

Immature (stage I): This stage is noted only in young fishes (less than 9 cm). The ovaries and testes are thread and transparent occupying the one third of the body cavity. It is easy to distinguish between males and females.

Maturing (stage II): This stage is slightly enlarged than in stage I. testes are translucent white and the ovaries are translucent pink. They were occupying about the half of the body cavity length.

Developing (stage III): testes become thicker and enlarged. No milt appears on pressure. Ovaries are reddish yellow and thicker. Testes and ovaries occupied two thirds of the body cavity.

Ripe (stage IV): Testes become very large milky white in color. Ovaries are opaque yellow, very large. Tests and ovaries are occupying all the entire body cavity.

Running (stage V): Milky white sperms from the testis and small yellow ova from the ovary were easily released by a slight pressure.

Spent (stage VI): testes became very loose wall and rich in blood vessels and white reddish in color. Ovaries with loose bloody folded walls, deep red in color with few residual ova. Testes and ovaries became shrunken with a thicker membrane.

3.1.2. Monthly variations in maturity stages

The monthly variation in the percentage of the gonad maturity stages of *U. japonicus* (Figs 1 and 2) show that, the ripe gonads in both males and females occurred in April and May with high percentage, while the percentages of the spent gonads appeared in a gradual decreasing during September, October and November. It was noticed also that, the immature stage show a high percentage during September and October that revealed the presence of new recruit entering the fishery ground. This indicated that *U. japonicus* in the Gulf of Suez spawns in the late spring and a new recruit is expected to enter the fishing area in the next year.

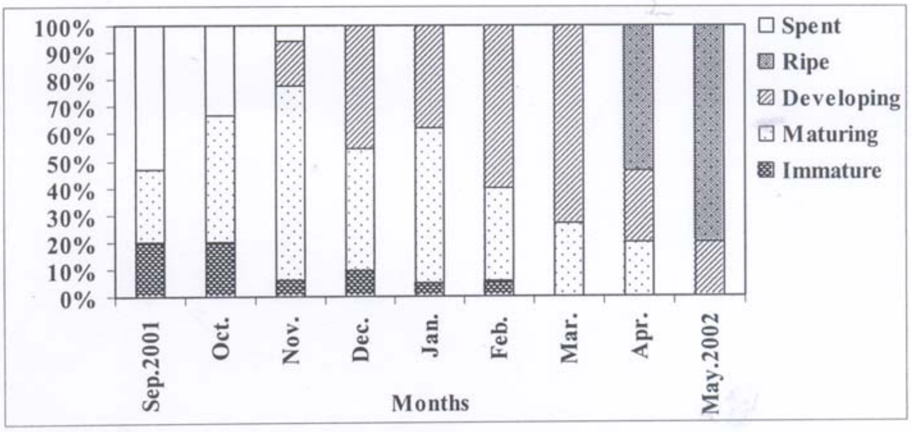

Fig. (1): Monthly distribution of maturity stages of *Up. japonicus* (females) from the Gulf of Suez.

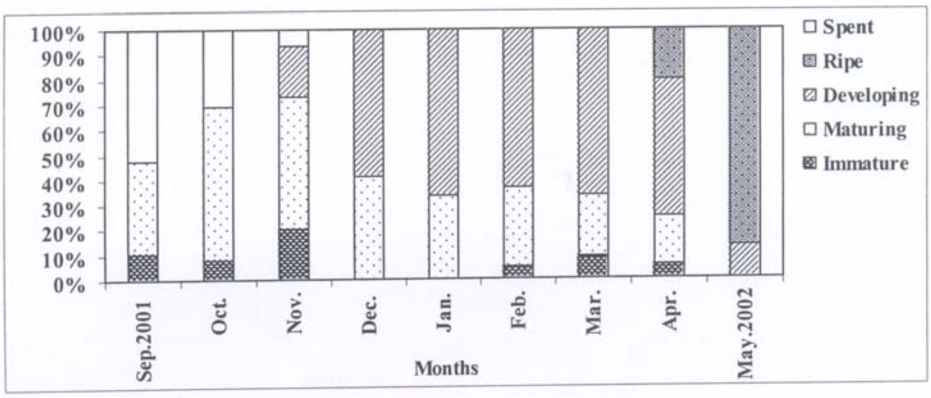

Fig. (2): Monthly distribution of maturity stages of *Up. japonicus* (males) from the Gulf of Suez.

3.1.3. Gonado- somatic index GSI

The seasonal variation in the G.S.I (Fig 3) for both males and females show that the average values of GSI increase gradually from the beginning of autumn until the end of spring then decrease and reach their minimum values in summer due to the emptiness of the ovary. The highest values were recorded in spring, this indicate that the spawning season of *U. japonicus* is restricted to spring.

3.1.4. Length and age at first sexual maturity

Analysis of the percentage of mature and immature fish in each length class during the spawning season showed that the size at which 50% of fishes are mature is about 9.6 cm and 9.8cm for males and females respectively (Figs 4&5). It was noticed during the study period that, all the *U. Japonicus* either males or females smaller than 9.0cm are immature individuals, while fishes larger than 12.0 cm were full mature. Converting the length at first sexual maturity to the corresponding ages (Sabrah, 2006) revealed that both sexes of *U. japonicus* reach their first sexual maturity by their first year of life.

3.1.5. Fecundity

The absolute and relative fecundity of *U. japonicus* were estimated according to length, weight and age. It is obvious that egg production increases as the fish increase in length, weight and age (Tables 1, 2 and 3).

3.1.5.1. Fecundity in relation to length

The relation between fecundity and total length (table 1) was found to be best fitted according to the following logarithmic equation:

$$\text{Log } F = a + b \log L$$

$$\log F = 1.11231 + 2.94669 \log L \quad \text{with} \quad r^2 = 0.099594$$

It was noticed from the table (1) that there was a good agreement between the observed and calculated absolute fecundity and it increases as the fish gets longer. It appears also that the equation achieved a high correlation coefficient. The absolute fecundity of *U. japonicus* ranges between 13640 and 81965 eggs for fishes ranging in mean size from 10.8 to 19.6 cm. in total length. On the other hand, the relative fecundity increases with the increase in length and ranges from 1263 to 4183 egg per each cm.

3.1.5.2. Fecundity in relation to weight

The weights of the fishes selected for fecundity studies were grouped in classes of 10 g interval (Table 2). The best fit that described the relationship between fecundity and weight of fish as measured by the coefficient of correlation, was realized according to the logarithmic formula: $\log F = 3.06308 + 0.95766 \log wt$ with $r^2 = 0.98659$

The values of absolute fecundity range from 19398 to 74933 eggs for mean weight range from 19.97 to 71.20 g. in total weight, while the values of relative fecundity range from 971 to 1052 egg per gm. It is obvious that the absolute and the relative fecundity increase as the fish gets heavier.

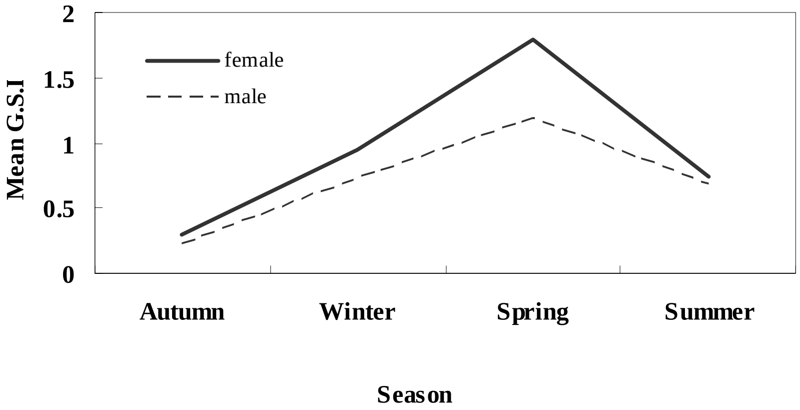

Fig. (3): Seasonal variation in gonadasomatic index of *U. japonicus* from the Gulf of Suez.

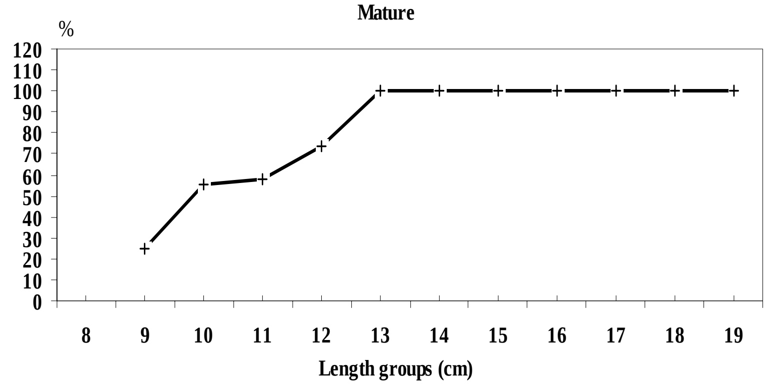

Fig (4): Length at first sexual maturity of *U. japonicus* (females) from the Gulf of Suez.

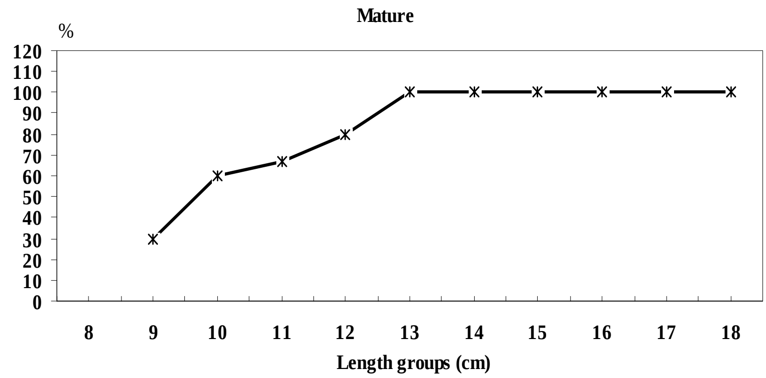

Fig (5): Length at first sexual maturity of *U. japonicus* (males) from the Gulf of Suez.

Table (1): Average observed and calculated absolute fecundity per total length group of *U.japonicus* from the Gulf of Suez.

Length group (cm)	Mean length	No. of fish	Observed absolute fecundity			Calculated fecundity	Average relative fecundity F/L
			Minimum	Maximum	Average ±SD		
10.0 – 10.9	10.80	1	-	-	13640	14371	1263
11.0 – 11.9	11.57	3	13440	20740	17891 ± 3188	17605	1546
12.0 – 12.9	12.63	4	16800	25700	21968 ± 3311	22793	1739
13.0 – 13.9	13.49	8	26800	30740	28812 ±1533	27676	2136
14.0 – 14.9	14.41	8	31250	42000	36494 ±4311	33615	2533
15.0 – 15.9	15.48	6	36181	51788	42736 ± 5646	41514	2761
16.0 – 16.9	16.52	4	42940	55000	50635 ± 4643	50281	3065
17.0 – 17.9	17.42	4	47200	59120	53100 ± 4222	58789	3048
18.0 – 18.9	18.10	2	64000	71800	67900 ±3900	65811	3751
19.0 – 19.9	19.60	2	76630	87300	81965 ± 5335	83212	4183

a = 1.11231 b = 2.94669 r = 0.99594

Table (2): Average observed and calculated absolute fecundity per total weight group of *U.japonicus* from the Gulf of Suez.

Weight range (gm)	Mean weight	No. of fish	Observed absolute fecundity			Calculated fecundity	Average relative fecundity F/Wt
			Minimum	Maximum	Average ±SD		
15.0 – 24.9	19.97.	8	13440	25700	19398 ± 4194	20342	971
25.0 – 34.9	28.50	12	26800	42000	31113 ± 4819	28597	1092
35.0 – 44.9	38.49	10	31250	47600	39306 ± 4598	38133	1021
45.0 – 54.9	52.55	5	42680	53400	47568 ± 4219	51381	905
55.0 – 64.9	60.90	3	51788	59120	54827 ± 2726	59175	900
65.0 – 74.9	71.20	4	64000	87300	74933 ± 8443	68727	1052

a = 3.06308 b = 0.95766 r = 0.98659

Table (3): Average observed and calculated absolute fecundity per age group of *U.japonicus* from the Gulf of Suez.

Age group (yr)	No. of fish	Observed absolute fecundity			Calculated fecundity
		Minimum	Maximum	Average ±SD	
I	10	13440	26800	22478 ± 4766	21525
II	21	27670	51788	37119 ± 7476	39689
III	8	42680	68300	54137 ± 8794	56771
IV	3	71800	87300	78577 ± 6476	73184

a = 4.33294 b = 0.88276 r = 0.99200

3.1.5.3. Fecundity in relation to age

Individuals of *U. japonicus* of different lengths and weights were grouped and assorted into age classes as estimated by Sabrah, 2006. The available data was based on fishes of age groups I, II. III, IV (Table 3). The average absolute fecundity for fishes of each age group was estimated according to the formula:

$$\log F = 4033294 + 0.88276 \log \text{age} \quad \text{with} \quad r^2 = 0.99200$$

It is clear that, the absolute fecundity increases as the fish gets older. It ranges from 22478 to 78577 eggs in age groups from I to IV.

3.2. Food and feeding habits

3.2.1. Food composition

The analysis of the stomach contents of *U. japonicus* showed three main food items namely, crustaceans (63.45%), fish flesh (26.11%) and nematodes (10.44%) (fig.6). Percentage of diet composition was compared for 240 stomachs. The stomachs analysis revealed that the most common crustaceans were shrimps which would be considered as the primary food item constituting about 31.9% of the food composition, followed by copepods (19.07%). Amphipods came in the third favorite crustaceans food (12.48%). fish flesh came in the second preferable food item and nematodes came in the third preferable food, although it was occurring frequently in the stomachs, and were of minor importance. There were no differences in quantity or quality between the diet of males and females.

3.2.2. Food in relation to length

To investigate the effect of size on type of food of the red mullet *U. japonicus*, fishes were grouped in 2 cm class intervals (Fig. 7). It is clear that nematodes are abundant in small fishes ranging from 10.0 to 15.9 cm in length, while fish flesh occurred in fishes that ranged in length from 14.0 to 17.9 cm. Crustaceans, the most abundant food item, occurred in all examined fish sizes except in the small individuals ranging from 10.0 to 11.9 cm. It is clear from the fig. that lengths from 12.0 to 19.9 cm feed mainly on crustaceans, while the smaller fish length less than 12 cm feed on nematodes only.

3.2.3. Selectivity index "S"

Selectivity index gives a good idea on the feeding preference or the food selection. Berhaut, 1973 suggested three states for this index, when, S is greater than 0.5 the food item became a preferential one, if it is between 0.1 and 0.5 the food item will be a secondary item and when it is less than 0.1 it called accidental item. Table (4) shows the selectivity indices for different food items taken by *U. japonicus*. It is clear that crustaceans constitute a preferential food item (0.600), while fish flesh and nematodes are secondary food items (0.275 and 0.125).

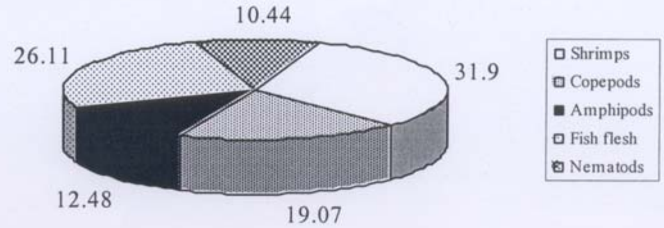

Fig. (6): Percentage composition of the different food items in the gut of *U. japonicus* from the Gulf of Suez.

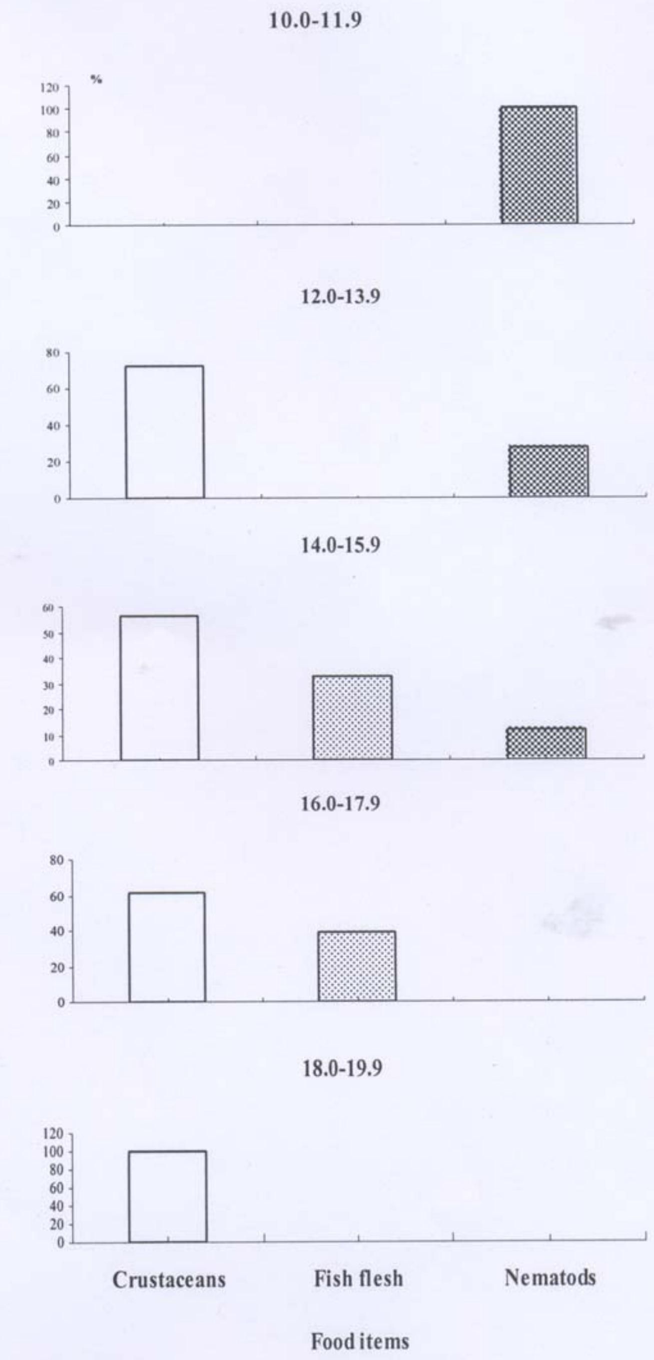

Fig. (7): Percentage composition of the different food items in the gut of U. japonicus in relation to length groups.

Table (4): Selectivity index of the different food items in the gut of *U. japonicus* from the Gulf of Suez.

Food item	No. of fish	Selectivity index	State
Crustaceans	144	0.600	preferential selectivity
Nematodes	66	0.275	secondary selectivity
Fish flesh	30	0.125	secondary selectivity
Total examined stomachs	240		

4. DISCUSSION

The Gulf of Suez is the most productive fishing ground area of the Red Sea, due to its suitable environmental conditions for fish living. Goat fishes are widely distributed in the indo- pacific region including the Red Sea and the Gulf of Suez. *Upeneus japonicus* constitutes the most economical species of the goat fish found in the Gulf (Sabrah, 2006). Monthly variations in maturity stages reveal that, the ripe stage occurs in April and May while, the spent stage appear in autumn months. According to the results of monthly variations in gonado-somatic index (males and females) show an increase from autumn to the end of spring with a sharp peak in spring. These results show that *U. japonicus* has a distinct spawning period by the end of spring. This is in accordance with (Boraey, 1969) in his study on *U. bensasi* in the Red Sea, hence this species has a spawning season starts in April and ends by July with a peak in June. Horikawa and Ishida (1986), Ishida (1986) and Wahben (1992) gave the same results on the present species. According to Harris (1986) who concluded that some factors in the environment regulating and affect the fish breeding such as temperature and light. This would mean that *U. japonicus* which spawns in spring is affected by the day light and temperature which increase in that season.

The length at first sexual maturity is an important parameter in the fisheries biology it has a practical application to determine the minimum legal fishable length to protect an adequate spawning stock.

Concerning the length at first sexual maturity of *U. japonicus*, it is found that males and females attain their maturation at about 10 cm in length and by the first year of age. All fishes under 9 cm are immature while those more than 12 cm are fully mature. These results show a good agreement with the study of (Horikawa and Ishida, 1986), where They concluded that, at 12 cm length all the females were capable to enter the spawning , and the recruits appear in shallower water in autumn and early winter.

The estimation of fecundity is an important aspect in the fishery biology, where it determines the stock size. The present study shows good agreement between the observed and calculated absolute fecundity in length, weight and age. This indicates the fitness of the used equations. It was also observed that fecundity increases as the length or weight or age are increase. Our observations are in accordance with that of Wahben (1992) on the same species in the Red Sea.

Goat fishes are benthic carnivores, feeding on a wide variety of small animals, where they are demesal neritic group. Barbells act as a tongue that disturbs the substratum during feeding (Mc-Cormick, 1995 and Sommer, *et.al.*, 1996). They are chemosensory receptors which seek out prey such as small crustaceans, worms and polychaetes in soft bottom (Randall and Kulbicki, 2006). Goat fishes form stationary aggregation over coral reefs during the day and move to soft bottoms for feeding at sun set (Masuda &Allen, 1993 and Yousif & Sabrah, 2004). The presence of the goat fish in the soft bottom has an importance on reef bordered where it exploits invertebrates and small fishes, there is a harmony between the soft bottoms and the fish living on it (Wantiez, 1992).

The analysis of the stomach contents of *U. japonicus* revealed that crustaceans are the main preferable food item (63.45%) followed by fish flesh (26.11) then nematodes came by (10.44%). These results coincide with those given by different authors (Hashimoto, *et.al* 1985; Daud &Taha, 1986; Heck&Weinstein, 1989; Wahben, 1992; Nakamura, *et.al*. 2003 and Kulbicki, 2005). They concluded that goat fish feed mainly on crustacean, fishes and worms. The study of food composition in relation to the length groups indicated that small fishes feed predominantly on nematodes while the large fishes on crustaceans. Golani, 1994 pointed that Mullidea feed primarily on crustaceans and the prey size is an important factor where young fishes less than 11.5 cm SL feed upon a prey of 20-160 mg and the older individual feed upon large prey of 600-2200 mg. Platell, *et.al.* 1998 state that "small Upeneus species feed on amphipods, while large fish feed on large hard bodies as decapods and crabs". This would mean that *U. japonicus* has prey selection or food selectivity.

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