

**Food and Feeding Habits of the Por's goatfish *Upeneus pori* (Ben-Tuvia and Golani, 1989), Mullidae, in Ain El-Ghazala Lagoon, Eastern Libya Mediterranean Sea****Salem S. S. Sergiwa<sup>1</sup>, Ramadan A. S. Ali<sup>1</sup>, Zainab Mukhtar Abd\_Elsameea<sup>1</sup>, Sayed Mohamed Ali<sup>1,2</sup>, Mohammad A. A. Elmor<sup>1</sup>**

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**ABSTRACT:** *Monthly random samples of the Por's goatfish *Upeneus pori* (Ben Tuvia and Golani, 1989) totaling 274 fish were collected from the artisanal catch of Ain El-Ghazala lagoon, eastern Libya Mediterranean coast, during September 2015 to August 2016 for use in the present study. No collection was made during May, June and July because the study fish disappeared from the catch during these months. Total length of studied fish ranged from 8.5 to 20.4 cm. Degree of fullness of stomach classified as empty, trace, quarter, half full, three quarters and completely full was assessed visually for each fish. Diet composition of individual fish was established by points of assessment of gut content. Crustacea, represented by small prawns and amphipods, made up 50.3% by volume of annual composition of the bulk of *U. pori* diet followed by polychaetes (15.7%), mollusks represented by bivalves and gastropods (10.2%) and sea grasses (4.5%). Sediments made up 19.3%. These items were consumed all-round the year. Monthly changes in their ratios do not follow regular trends. In autumn crustaceans composed 50.7% *U. pori* food, sediments (19.4%) and polychaetes (15.3%), whereas in winter crustaceans composed (49.4%), sediments (22.0%) and polychaetes (14.9%). In spring crustaceans were ingested by (54.6%), sediments by (19.9%) and polychaetes by (14.9%). In summer the fish consumed crustaceans by (43.1%), mollusks by (23.5%) and polychaetes by (21.1%). Crustaceans, polychaetes, mollusks, sea grasses and sediments were consumed by all length groups of *U. pori*. However importance of crustaceans, mollusks and sea grasses increased as the fish length increased while that of polychaetes and sediments decreased. Crustaceans increased from 22.1% in the length group (8.5 - 10.4 cm) to 45.9% in the length group (18.5 - 20.4cm). Polychaetes decreased from 38.3% in the length group (8.5 - 10.4 cm) to 2.8% in the length group (18.5 - 20.4cm), mollusks increased from 11.3% in the length group (8.5 - 10.4 cm) to 31.5% in the length group (18.5 - 20.4cm). Sea grass ingested in the length group (8.5 - 10.4 cm) by 11.2% was increased in the following length groups and recorded the highest value (19.1%) in the length group (18.5 - 20.4cm). Sediments were taken up by 17.1% in small fish (8.5 - 10.4cm), then decreased with further increase in fish length. Fish with stomach half full, almost full and full of food together constituted 59.6% of all samples investigated during the study, whereas those with stomach that were empty, with traces of food and quarter full represented 40.4% of the total. The feeding activity was quite high during autumn (66.2%), spring (62.1%) and summer (70.1%) and low in winter (48.3%).*

**KEYWORDS:** Por's goatfish, *Upeneus pori*, Mullidea, food and feeding habits, Lessepsian.

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## INTRODUCTION

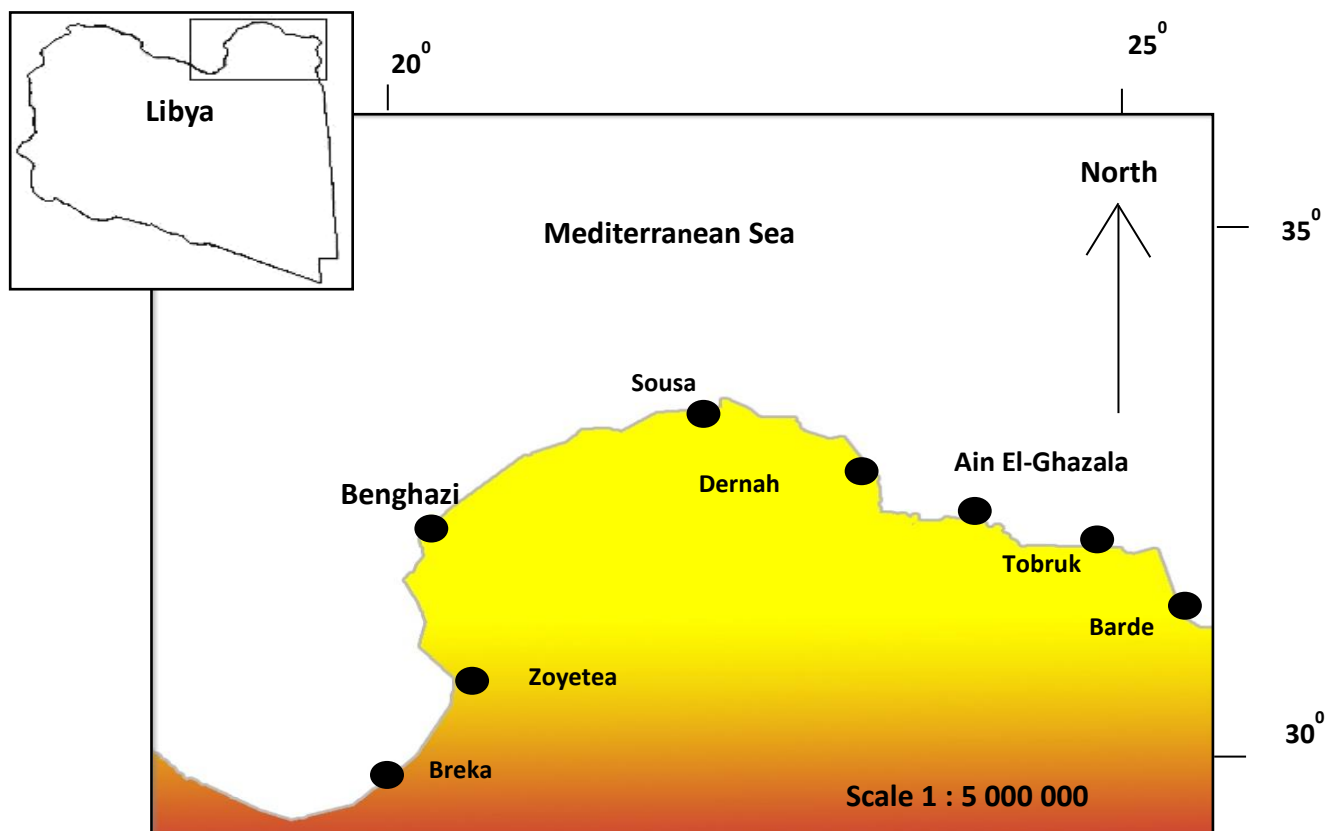
Goatfishes, or the red mullets, are medium length (25 to 60cm) tropical and subtropical benthic coastal marine perciform fish of the family Mullidae. Depending on the authority Mullidae include 67 to 86 species in six genera: *Mulloidichthys*, *Mullus*, *Parupeneus*, *Pseudupeneus*, *Upeneichthys* and *Upeneus*. Five mullid species are reported in the Mediterranean Sea (Quignard and Tomasini, 2000 and Golani *et al.*, 2006): the red mullet, *Mullus barbatus* (Linnaeus, 1758), the striped red mullet, *M. surmuletus* (Linnaeus, 1758), the west African goatfish, *Pseudupeneus prayensis* (Cuvier, 1829), the gold band goatfish, *Upeneus moluccensis* (Bleeker, 1855) and the Por's goatfish *U. pori* (Ben-Tuvia and Golani, 1989).

*Upeneus pori* is a demersal lessepsian migrant that have established itself in coastal water of the Mediterranean Sea where it became commercially important. It is caught in large quantities by trawl in shallow waters of 10 - 40 m (Cicek and Avsar, 2011; Bingel *et al.*, 1993; Golani and Ben-Tuvia, 1995). Recently, El-Drawany, 2012, showed that *U. pori* and *U. moluccensis* represent an important item in the catch along the Southern Mediterranean coast of Libya. El-Drawany, 2013, established aspects of age, growth and reproduction of this species in Tripoli coast, Southern Mediterranean Sea, Libya. The present work attempts to compliment El-Drawany studies by giving an account on the food and feeding habits of the Por's goatfish *U. pori* in Ain El-Ghazala lagoon, eastern coast of Libya.

### Procedures and Methods

Monthly random samples of Por's goatfishes were obtained from the artisanal catch of Ain El-Ghazala lagoon (Figs. 1 and 2), eastern Libyan Mediterranean coast, during September 2015 to August 2016. All together 274 fish were collected for the study. At the Marine Biology Laboratory of the Zoology Department, Omar Al-Mukhtar University, Albaida, the fish was identified according to (Golani *et al.*, 2006) as the Por's goatfish *Upeneus pori* (Ben Tuvia and Golani, 1989).

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**Figure (1):** Map showing the location of Ain El-Ghazala on eastern Libya

Total length of individual fish was obtained to the nearest mm and total and gutted weights to the nearest 0.1 gm. Individual stomachs of the 274 fish were examined to establish the feeding habit including, annual diet composition, variation in diet composition within different fish length groups, monthly and seasonal variation of diet composition and feeding intensity based on degree of fullness of stomach which was estimated visually as empty stomach, stomach with trace of food, quarter full, half full, three quarters full and completely full according to Pillay, 1952



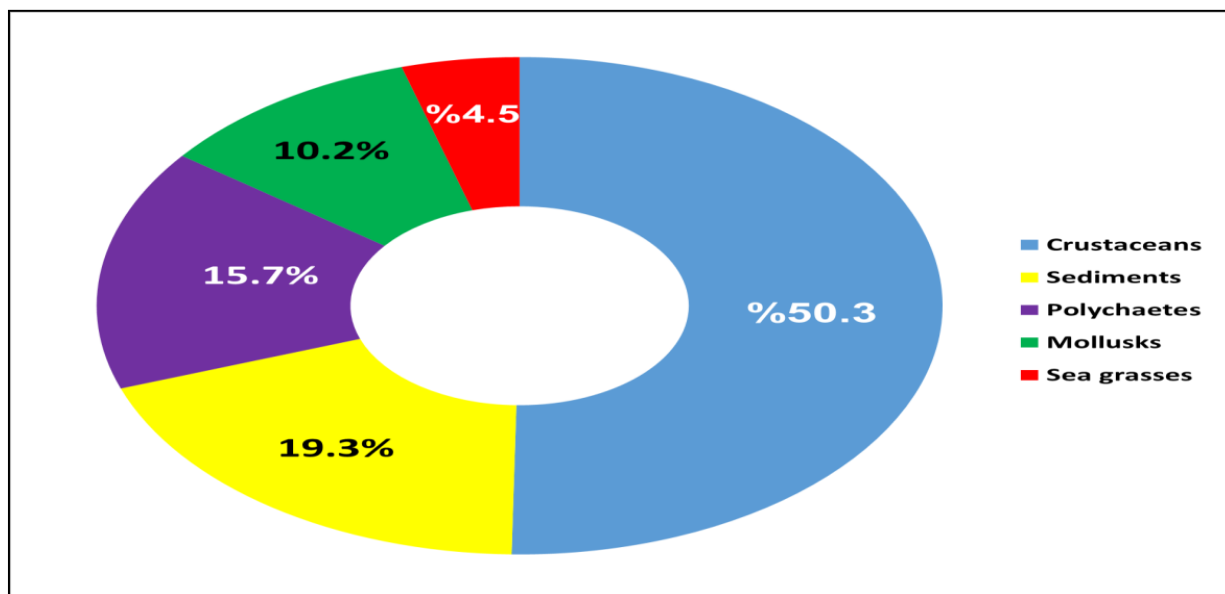
**Figure (2):** Aerial view of Ain El-Ghazala lagoon on the eastern coast of Libya. (Google Earth)

Each stomach was then cut opened longitudinally and its contents scraped off and transferred into a small Petri dish containing a small amount of water. Food items were sorted out and identified under a binocular microscope down to their groups. A list of general diet composition was made by points of assessment (Hynes, 1950, and Hyslop, 1980).

## RESULTS AND DISCUSSION

### Annual diet composition

The variety of food items of *Upeneus pori* in Ain El-Ghazala lagoon during the study period (September 2015 to August 2016) was large. Crustaceans supplemented with polychaetes and mollusks formed the major groups (Fig. 3), other items were sea grass and sediments.



**Figure (3):** Diet composition of 274 *Upeneus pori* from Ain El-Ghazala lagoon, eastern Libya, during September 2015 to August 2016.

Crustacea, which was represented by small prawns and amphipods, made up 50.3% by volume composition of the bulk of the diet, whereas polychaetes (15.7%) came in the second position of importance. The other food items were mollusks (10.2%) represented by bivalves and gastropods, sea grass (4.5%) and large quantities of sediments (19.3%). Similar findings were reported by Golani, 1994, and Golani and Bogorodsky, 2010. *U. pori* was found to feed on crustaceans, echinoderms, fish, polychaetes and mollusks. In Visakhapatna, India, crustaceans mainly shrimps and crabs and teleost fishes made the bulk of the diet of *U. vittatus* with bivalve mollusks being at times important (Prabha and Manjulatha, 2008). Similar observations were reported for *U. vittatus* in Mangalore coast, India, by Jayaramaiah *et al.*, 1996. Golani and Galil, 1991, found that the most important taxonomic group in the diet of the mullids: *Upeneus asymmetricus*, *U. moluccensis*, *Mullus barbatus* and *M. surmuletus* in the eastern Mediterranean was four species of decapods crustaceans. Crustaceans constituted most of the food of *Upeneus parvus* in the continental shelf of the Gulf of Mexico (Campos-Davila *et al.*, 2002). Johnson and Gill, 1998, mentioned that goatfish are tireless benthic feeders, using a pair of long chemosensory barbells ("whiskers") protruding from their chins to rifle through the sediments in search of a meal. Like goats, they seek anything edible; worms, crustaceans, mollusks and other small invertebrates are staples. Arslan and İşmen, 2014, stated that most mullids feed primarily on polychaetes and crustaceans, however considerable differences have been found in the diets of different species. The stable food item for *Upeneus sulphureus* from Nizampatnam coast, India, was crustaceans and their larvae, small fishes, polychaetes worms, miscellaneous matter and digested food (Krishna *et al.*, 2015). Crustaceans, Mollusks, Polychaetes and Echinoderms were taken as food by *Mullus barbatus* in Edremit Bay, Turkey (Çelik and Koç, 2000). Ebziuo, 2009, indicated that crustaceans were a major ingredient in the menu of *M. surmuletus* in Darna shores, Libya, whereas sediments has little place. Randall, 1967, reported that the mullids feed primarily

over muddy or sandy bottom upon surface or sub surface invertebrates. In the present study *U. pori* stomach was found to contain considerable amount of sand (19.3%). Sand particles help in degradation of cell wall of plants and animals and thus making the food more susceptible to digestive enzymes (El-Mor, 2002). The possibility that the organic component of the soil was also utilized cannot be ruled out.

### Monthly and seasonal variation in diet composition

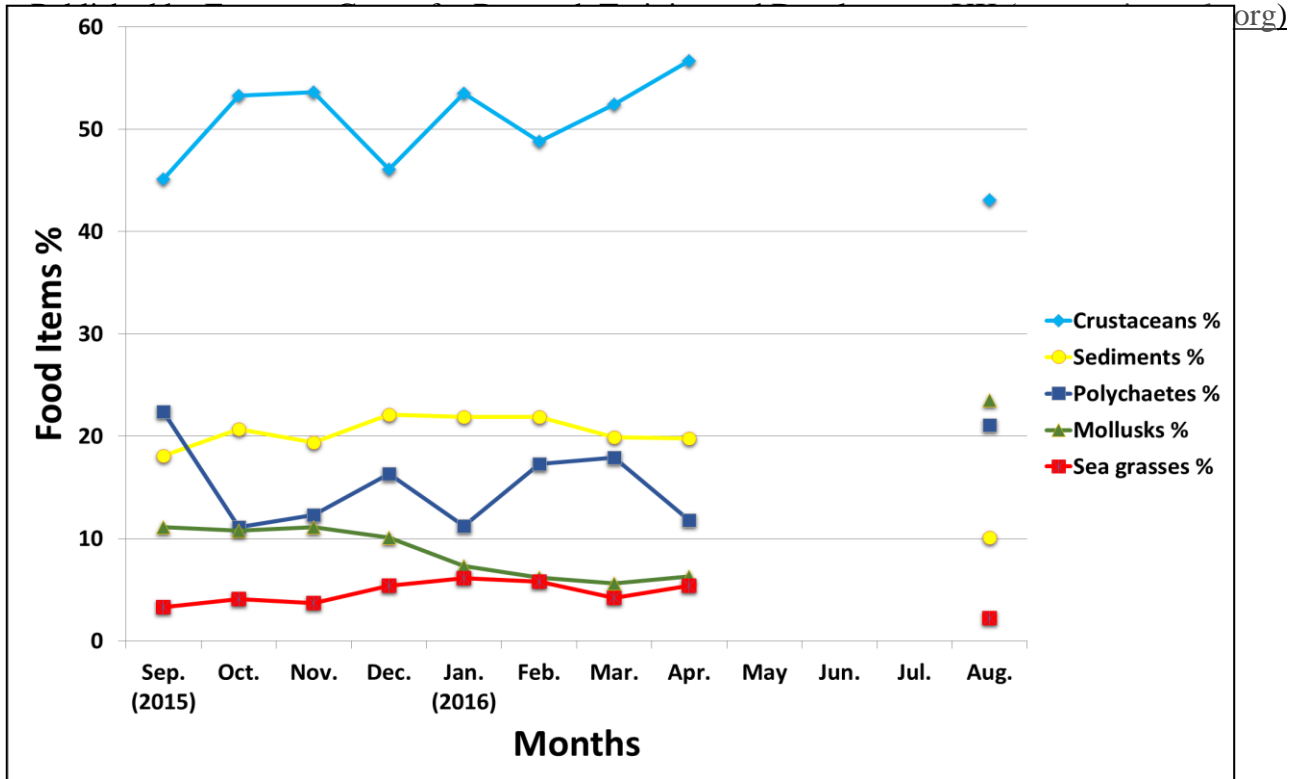
In the present study crustaceans, polychaetes, mollusks, sea grass and sediments constituted the major food items of *U. pori*. They were consumed all-round the year (Table 1 and Fig. 4). However, no data was available for May, June and July because the study fish disappeared from the catch during these months and so food composition was not established.

**Table (1):** Monthly variations in diet composition (expressed as percentage) of the studied *U. pori*.

Months	No.	Food items					
		Crustaceans	Polychaetes	Mollusks	Sea grasses	Sediments	
Sep. (2015)	11	45.1	22.4	11.1	3.3	18.1	
Oct.	39	53.3	11.1	10.8	4.1	20.7	
Nov.	41	53.6	12.3	11.1	3.7	19.4	
Dec.	43	46.1	16.3	10.1	5.4	22.1	
Jan. (2016)	45	53.5	11.2	7.3	6.1	21.9	
Feb.	43	48.8	17.3	6.2	5.8	21.9	
Mar.	42	52.4	17.9	5.6	4.2	19.9	
Apr.	3	56.7	11.8	6.3	5.4	19.8	
May	*-	-	-	-	-	-	
Jun.	-	-	-	-	-	-	
Jul.	-	-	-	-	-	-	
Aug.	7	43.1	21.1	23.5	2.2	10.1	
<i>x</i>	-	274	50.3	15.7	10.2	4.5	19.3

\*: (-) *U. pori* were not collected in this month.

Remarks:   Maximum value,   Minimum value within the column.



**Figure (4):** Monthly variations in diet composition of the studied *U. pori*.

In autumn (Table 2 and Fig. 5) *U. pori* consumed crustaceans (50.7%), sediments (19.4%) and polychaetes (15.3%), whereas in winter it ingested crustaceans (49.4%), sediments (22.0%) and polychaetes (14.9%). In spring crustaceans were taken up by 54.6%, sediments by (19.9%) and polychaetes by (14.9%). In summer the food was mainly crustaceans (43.1%), mollusks (23.5%) and polychaetes (21.1%).

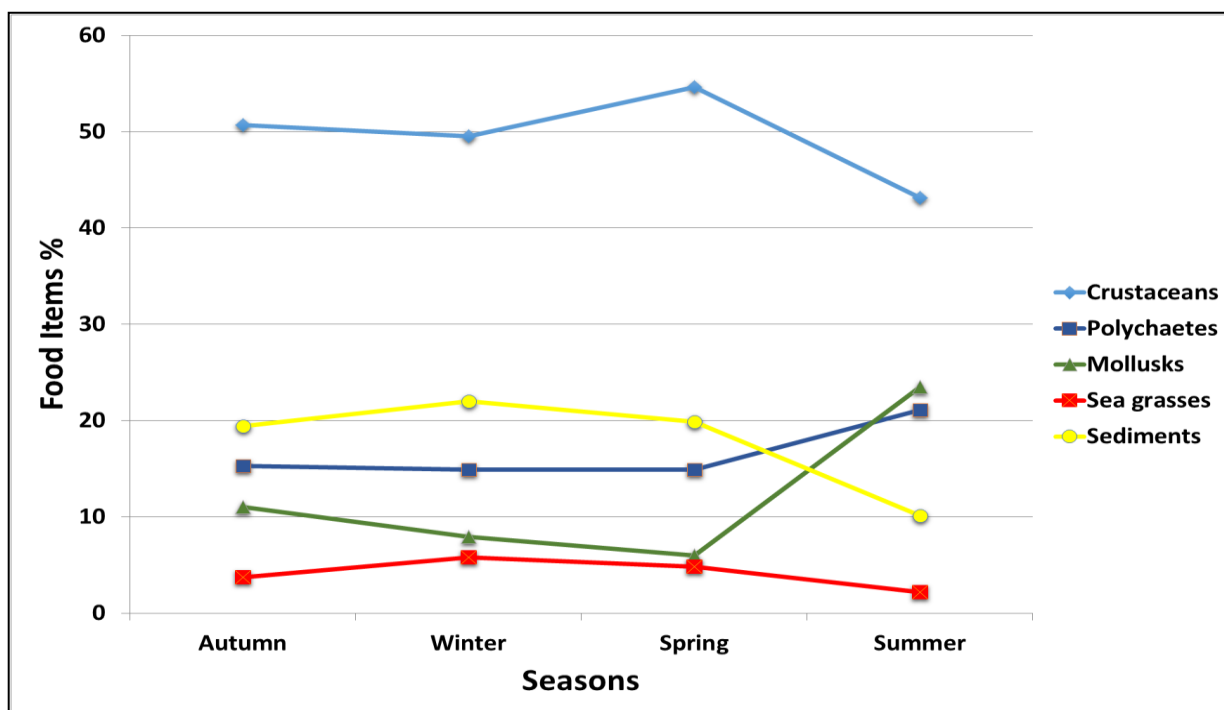
Kariman *et al.*, 2009, and Krishna *et al.*, 2015, said it is important to emphasize that the effect of seasonality should always be considered in the studies on feeding fish because temporal changes in biotic and abiotic factors alters the structure of the food web along the year and as a consequence, the fish often shows seasonal diet shift. Prabha and Manjulatha, 2008, reported that for *U. vittatus* from Visakhapatnam, India, shrimps formed the most important food throughout the year, crabs were found to be the dominant food item in October while bivalve mollusks dominated in January, February and December. The dwarf goatfish *Upeneus parvus*, on the continental shelf of the Gulf of Mexico exhibited seasonal and length group changes in prey consumption (Campos-Davila *et al.*, 2002). Dulcic, 2002, found that diets of *Mullus Surmuletus* in the eastern central Adriatic varied seasonally. Amphipods were the most important prey group in winter and spring. Decapod crustaceans predominated during the summer, Mysidacea during the autumn. Similar observations were stated by Labropoulou *et al.*, 1997, for *M. surmuletus* in Cretan shelf (north-eastern Mediterranean). Crustacean in the diet of *M. surmuletus* in Darna coast, Libya, showed significant fluctuation from 43.9% in March to 75.5% in April. Diet composition of *M. barbatus* from Tyrrhenian Sea along the Sicilian coast was significantly different between winter and summer. The seasonal differences were mainly determined by mysids and the bivalve *Angulus fatula* (Esposito *et al.*, 2013). Similar seasonal changes were

reported for *M. barbatus* in The Gulfs of Saronikos And Thermaikos in the Aegean Sea (Caragitsou and Tsimenidis, 1982 a) and in the Thracian Sea, Aegean Sea, (Caragitsou and Tsimenidis, 1982 b). The same species in the northern Tunisian coast feeds mainly on crustaceans and polychaetes throughout the year but with no clear seasonal changes of IRI% within groups.

**Table (2):** Seasonal variations in diet composition (expressed as percentage) of the studied *U. pori*.

Seasons	No. of fish	Crustaceans	Polychaetes	Mollusks	Sea grasses	Sediments
Autumn	91	50.7	15.3	11.0	3.7	19.4
Winter	131	49.5	14.9	7.9	5.8	22.0
Spring	45	54.6	14.9	6.0	4.8	19.9
Summer	7	43.1	21.1	23.5	2.2	10.1

Remarks:  Maximum value,  Minimum value within the column.



**Figure (5):** Seasonal variations in diet composition (expressed as percentage) of *U. pori*.

### Feeding habits in relation to fish length

The total length range (8.5 to 20.4 cm) of the examined *U. pori* population was ranked into 6 classes having 1.9 cm intervals (Table 3 and Fig. 6). Crustaceans, polychaetes, mollusks, sea



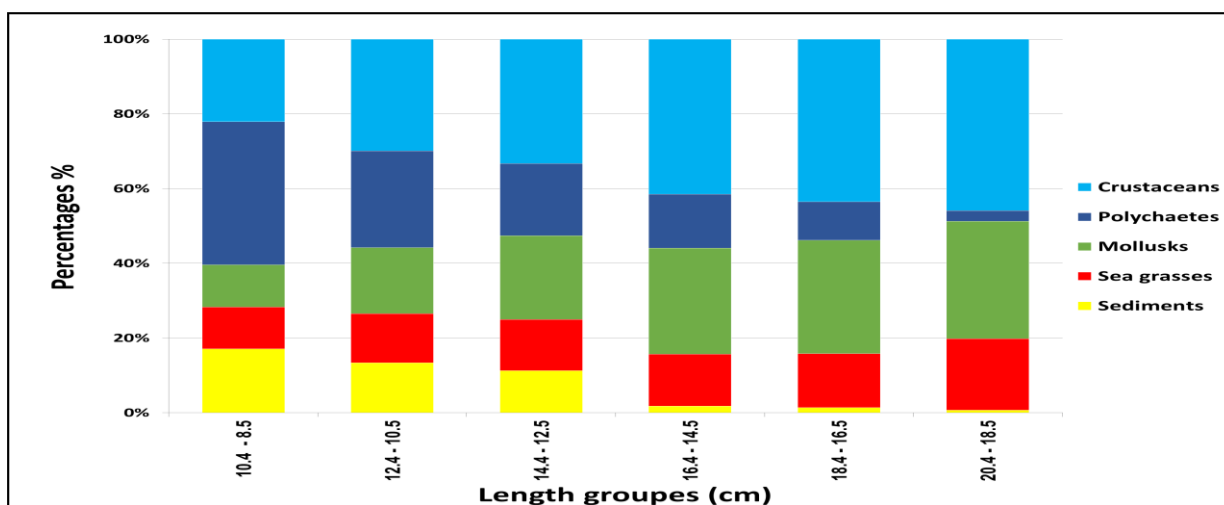
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grass and sediments were found in all length classes. Crustaceans, mollusks and sea grasses increased as the fish length increased, while polychaetes and sediments decreased.

**Table (3):** Diet composition (expressed as percentage) of different length classes of studied *Upeneus pori*.

length classes (cm)	No.	Food items				
		Crustaceans	Polychaetes	Mollusks	Sea grass	Sediments
8.5 - 10.4	35	22.1	38.3	11.3	11.2	17.1
10.5 - 12.4	39	29.9	25.9	17.7	13.1	13.4
12.5 - 14.4	43	33.3	19.3	22.4	13.7	11.3
14.5 - 16.4	45	41.5	14.4	28.4	13.9	1.8
16.5 - 18.4	55	43.5	10.3	30.4	14.4	1.4
18.5 - 20.4	57	45.9	2.8	31.5	19.1	0.7

Remarks: ■ Maximum value, ■ Minimum value within the column.



**Figure (6):** Diet composition (expressed as percentage) of different length groups of the studied *U. pori*.

Crustaceans were found in all length classes of *U. pori* but increased from 22.1% in the length class (8.5 - 10.4 cm) to 45.9% in the length class (18.5 - 20.4cm). Polychaetes decreased from 38.3% in the length class (8.5 - 10.4 cm) to 2.8% in the length class (18.5 - 20.4cm), mollusks increased from 11.3% in the length class (8.5 - 10.4 cm) to 31.5% in the length class (18.5 -

20.4cm). Sea grass ingested in the length class (8.5 - 10.4 cm) by 11.2% increased in the following higher length classes and reached the highest value (19.1%) in the length class (18.5 - 20.4cm). Sediments, which constituted 17.1% of diet of small fish (8.5 - 10.4cm), decreased with increasing fish length.

Generally, the food extent demand and ability for food acquisition increase with fish development (Honda, 1984). Cherif *et al.*, 2011, studied the feeding habits of *Mullus barbatus* off the northern Tunisian coast (central Mediterranean). Numbers and size prey taxa increased with increase in fish length due to the ability of larger fishes to consume a wide range of prey sizes than smaller fishes. This phenomenon was observed in the present work; consumption of crustaceans, mollusks and sea grass increased as the fish length increased, while that of polychaetes and sediments decreased. Sabrah and El-Ganainy, 2009, found that for *U. vittatus* and *U. tragula* from the Gulf of Suez, Egypt, shrimps and crabs were represented by a smaller 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 fish flesh was found in the fish lengths above 13.0 cm, while worms were abundant in the small lengths only; below 12.0 cm. bivalves and worms were found by a considerable value. *U. vittatus*, Visakhapatnam coast of India, of bigger length groups often ingested crabs and teleosts in larger quantities than *U. vittatus* of smaller length groups (Prabha and Manjulatha, 2008). Fish and cephalopods occurred exclusively in the diet of *Mullus surmuletus* (eastern central Adriatic Sea) larger than 185 mm TL (Dulcic, 2002).

Golani and Galil, 1991, however, pointed out that although larger fish are able to capture relatively larger prey, morphological constraints such as toothless upper jaw, small mouth size and gape and the foraging behavior can impose certain limitations on the diet of a fish and restrict their food to small benthic animals. Ebziuo, 2009, found that crustacean had the dominance in the small-lengths of *Mullus surmuletus* in Darna, Libya, while the majority of the other food items decreased as the fish length increased. Similar findings were reported by Cherif *et al.*, 2011, for *M. barbatus* off the northern Tunisian coast (central Mediterranean). Teleosts were found only in fish of the smallest length group and algae only in those of larger length groups. The importance of crustaceans and polychaetes increased with length, concomitantly the importance of mollusks and echinoderms decreased. Machias and Labropoulou, 2002, stated that small specimens of red mullet, which have a small mouth, premaxillary dentition and a poorly developed sensory capability, mainly rely on small crustaceans (peracarids) for their diet. However the study of Eposito *et al.*, 2014, on *M. barbatus* from the southern Tyrrhenian Sea highlighted no differences in diet between length groups.

### **Monthly and seasonal variation in Feeding intensity**

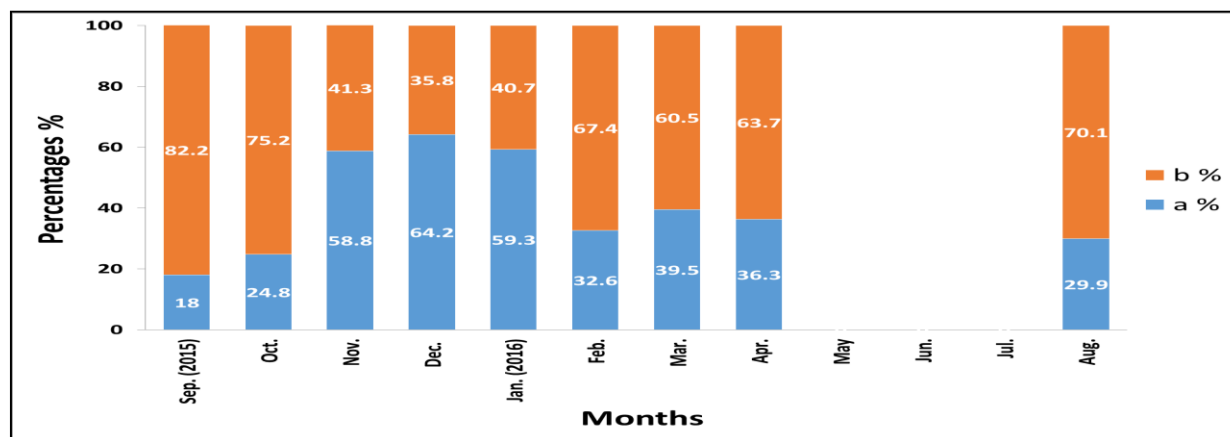
In the present study fish with stomachs that were empty, with traces of food and quarter full were ranked a%, whereas those with stomachs that were half full, almost full and full of food were ranked b% in Table 4 and Fig. 7. The “a” and “b” groups consecutively constituted 40.4% and 59.6% of all examined fish. The feeding intensity (Table 5 and Fig. 8) was high in autumn (66.2%), spring (62.1%) and summer (70.1%). The minimal rate was in winter (48.3%).

**Table (4):** Monthly variations in feeding intensity (expressed as percentage) of *U. pori* from.

Months	No. of fish	The degree of distension of the stomach							
		Empty	Trace	1/4	a %	1/2	3/4	Full	b %
Sep. (2015)	11	12.4	3.3	2.3	18.0	10.1	43.3	28.8	82.2
Oct.	39	14.2	4.4	6.2	24.8	15.3	11.8	48.1	75.2
Nov.	41	16.8	22.1	19.9	58.8	13.1	10.1	18.1	41.3
Dec.	43	17.2	22.7	24.3	64.2	8.9	12.1	14.8	35.8
Jan. (2016)	45	21.1	23.4	14.8	59.3	16.0	1.4	23.3	40.7
Feb.	43	11.8	5.7	15.1	32.6	11.7	38.6	17.1	67.4
Mar.	42	12.5	10.3	16.7	39.5	23.1	14.1	23.3	60.5
Apr.	3	23.2	11.8	1.3	36.3	15.4	15.2	33.1	63.7
May	-	-	-	-	-	-	-	-	-
Jun.	-	-	-	-	-	-	-	-	-
Jul.	-	-	-	-	-	-	-	-	-
Aug.	7	16.5	11.5	1.9	29.9	23.3	24.8	22.0	70.1
<b>Average</b>					<b>40.4 ± 22.1</b>				<b>59.6 ± 29.3</b>

\*(-) No fish in month occurred.

Remarks: ■ Maximum value, ■ Minimum value within the column.

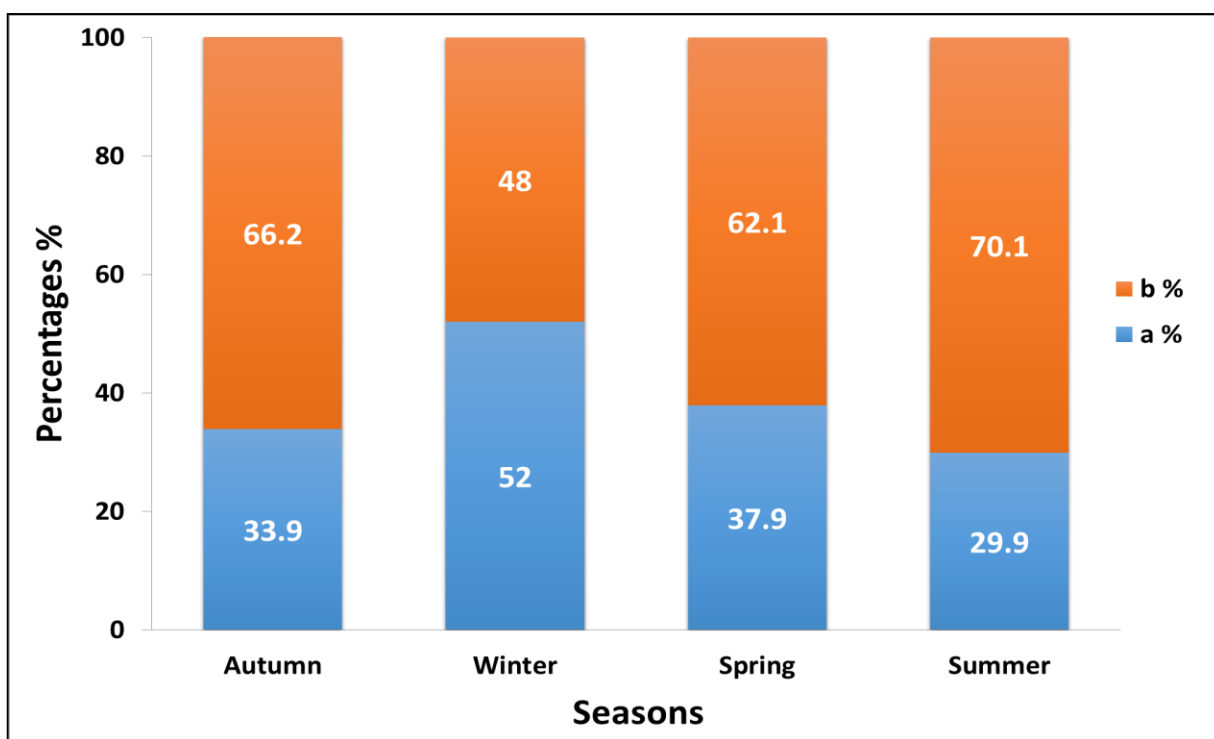


**Figure (7).** Monthly variations in feeding intensity of 274 *U. pori*.

**Table (5):** Seasonal variations in feeding intensity of 274 *U. pori*.

Seasons	No. of fish	The degree of distension of the stomach							
		Empty	Trace	¼	a %	½	¾	Full	b %
Autumn	91	14.5	9.9	9.5	33.9	12.8	21.7	31.7	66.2
Winter	131	16.7	17.3	18.1	52.0	12.2	17.4	18.4	48.0
Spring	45	17.9	11.1	9.0	37.9	19.3	14.7	28.2	62.1
Summer	7	16.5	11.5	1.9	29.9	23.3	24.8	22.0	70.1

**Remarks:** Data expressed as percentage, ■ Maximum value, ■ Minimum value in the column.

**Figure (8).** Seasonal variations in feeding intensity of studied *U. pori* from.

It is important to emphasize that the effect of seasonality should always be considered in studies on feeding of fish, because temporal changes of biotic and abiotic factors alters the structure of the food web along the year and as a consequence the fish often show seasonal diet shift (Kariman *et al.*, 2009). Krishna *et al.*, 2015, mentioned that maximum intensity of feeding of *U. sulphureus* in Andhra Pradesh coast of India was in June and July. In Visakhapatnam (India) *U. vittatus* with

high percentage of full guts were found mainly during January, those with average feeding intensity during December and those with poor feeding intensity during most months of the year (Prabha and Manjulata, 2008). Caragitsou and Tsimenidis, 1982 a, reported that intensity of feeding of *Mullus barbatus* in the Gulfs of Saronikos and Thermaikos fluctuated according to season but appeared to be greater in spring than in other seasons, however, the low frequency of empty stomachs encountered in their study indicated that food was readily available in all seasons. Vassilopoulou and Papaconstantinou, 1993, reported that fullness indices obtained for the same species in a gulf in western Greece fluctuated in relation to month and area of capture. Significantly greater quantities of food were found in the stomachs of specimens in the western part of the Gulf in September. Ebziuo, 2009, found that 75.3 % of *M. surmuletus* in Darna coast, Libya, had full stomach between August and September, reached 96.3 % in October, 93.4% in March and was between 70 to 80 % at the rest of year. Seasonal variations were observed in intensity of feeding and food consumption of the goatfish *Parupeneus barberinus* from Aqaba, Jordan (Wahbeh and Ajiad, 2006).

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