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THE FOOD OF *Raja miraletus* LINNAEUS, 1758 IN MEDITERRANEAN WATERS OFF ALEXANDRIA

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ABSTRACT

The analysis of the stomach contents of Raja miraletus revealed the following facts; Raja miraletus is voracious and the stomachs of over 70% of fish examined contained food. The intake of adult females is reduced in summer, period of egg laying. The stomach contents consisted of a wide range of crustacea and teleosts. Mollusca and Annelida formed a relatively small portion. The juveniles feed upon small crustacea. Adults eat more teleosts and less crustacea than the youngs. The analysis of preys with respect to size at capture showed that as the rays grew, they attained deeper depths. No important seasonal variations in type of food is noticed.

INTRODUCTION

In Alexandria waters, **Raja miraletus** is considered to be one of the most abundant rays. Different studies were done on the feeding of Rajidae, but studies on the juvenile stage were relatively less numerous. Clark (1922) studied the juvenile stages of **Raja clavata**, **R. montagui**, **R. naevus** and **R. brachyura** in Plymonth Bay. Stevens (1930) continues his study but he was more interested in adult individuals. Holden and Tucker (1974) resumed the study by expanding their zones of sampling in all British waters, his results show that for very small size classes, stomach contents are composed of two groups, Amphipods and Crangonids. The preys of big sizes are represented essentially by fishes and Potunids. Du Buit (1974) indicated that up to size 40 cm, the young rays (**R. clavata**) cosume essentially crustacea and polychaetes more than fishes. Finally, Aloncle (1970) on Atlantic coast of Marocco and Capape (1975 a,b) and Capape and Azouz (1975) on rays of Tunisiennes coasts found that young stages feed on small crustacea, teleosts and mollusca and that older fish consume mostly teleosts. Quiniou and Andriamirado (1979) analysed the stomach contents of **Raja brachyura**, **R. clavata** and **R. montagui** and found that the youngest individuals feed upon small benthic or nektobenthic crustacea.

by relating type of preys with size at capture of fish they showed that as the fish grows, it changes its diet. From the type of diet they suggested that these rays attaine deeper and deeper depths as they grow. Ajavi (1982) studied the food preferences of three rays, **Raja clavata, R. microocellata** and **R. montagui** and found that between species, diets of the size groups to a large extent preyed on different items.

MATERIAL AND METHODS

Fish were collected from professional fishermen. For each fish, total length, disc length (to nearest cm), total and gutted weights (to nearest gm), sex and sexual maturity were recorded. The stomachs were preserved in 10 % formalin. For each stomach, the preys were determined to generic name. For certain zoological groups the enumeration was rather difficult due to presence of fragments of individual of the same species, hence for small crustacea we have put in our consideration, the characteristic organs (urosome for head of Amphipeds, cephalothorox for Natantia; the pairs of eyes for Mysidacea). All individuals exceeding the length of first sexual maturity were considered as adults, i.e. more than 40 cm total length for females and more than 34 cm for males (El-Aziz et at 1986, in press).

Analysis of Results:

About 381 stomaches of **Raja miraletus** were studied 256 females (79 juveniles and 177 adults), and 125 males (53 juveniles and 72 adults). Total length range varied between 18 and 50 cm.

The following indices, were calculated seasonally for each sex separately:

- The fullness coefficient (F.C.), is the percentage of stomachs containing food to the total number of stomachs examined.

- The frequency index (F.I.); the ratio of the number of stomachs containing a certain food item to the total number of stomachs examined.

- Abundance of the main food items, which is the percentage frequency of each food item in the stomach examined.

- Filling index; the ratio of the weight of stomach contents to the gutted weight of the body.

RESULTS

Fulleness Coefficient: (Table 1, Fig. 1):

The fullness coefficient (F.C.) of **R. miraletus** is high all the year round, i.e. there are no important seasonal variation about the nutrition of this species. The fullness coefficient of adult fish is higher than that

TABLE (1)

Seasonal variation of fullness coefficient in function of sex and sexual maturity for **Raja miraletus**.

Sex	Males								Females								
Sexual maturity	Juveniles				Adults				Juveniles				Adults				
Seasons	W	Sp	S	F	W	Sp	S	F	W	Sp	S	F	W	Sp	S	F	Total
Number of individuals	9	12	12	20	8	20	16	28	27	11	21	20	46	43	43	45	381
Number of full stomachs	6	8	7	11	6	16	12	18	17	7	12	12	37	35	29	35	268
Fullness Fullness % coefficient	66.6	66.6	58.3	55.0	75	80	75	64.3	63	63	57	60	80.4	81.1	64.7	77.8	70.3

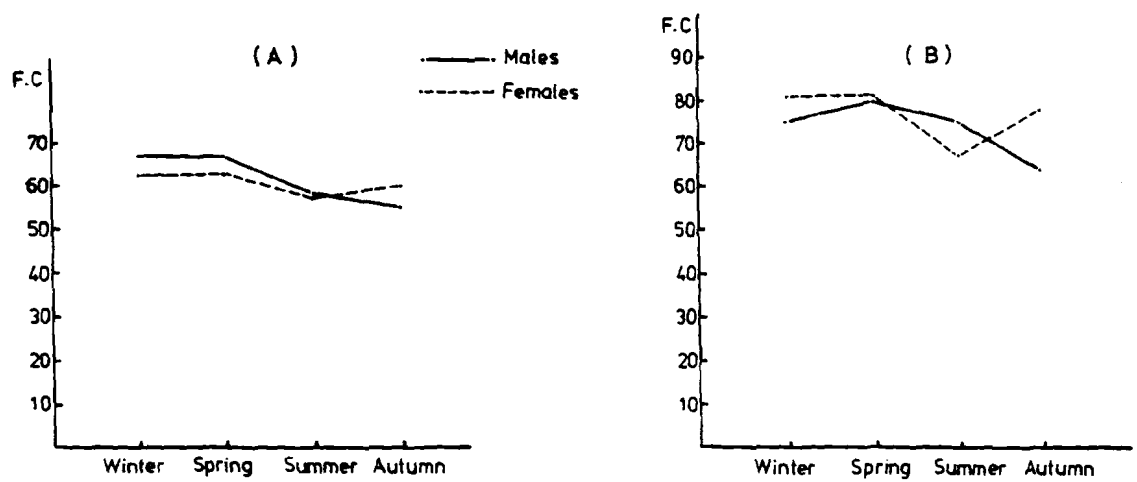

Fig. (1)
Seasonal variation of fullness coefficient (F.C.) in function of sex and sexual maturity of R. miraletus.
A. Juveniles individual.
B. Adult individual.

of the juvenile. The adult female feeds more heavily than the adult male.

For the adult females, feeding is heavy during winter and spring, reaching a minimum in summer. While for adult males heavy feeding occurs in spring, it decreases considerably in fall. From the above, it is clear that **Raja miraletus** is voracious and the stomachs of over 70 % of fish examined contained food.

Frequency Index (F.I.) And Its Seasonal Variations :

The values of frequency index for the whole fish examined show that crustacea constitute the main prey for **Raja miraletus** (F.I. = 0.63) followed by teleosts (F.I. = 0.58). Mollusca are secondary prey (F.I. = 0.11) while annelida are accidental (F.I. = 0.05), (Table 2).

TABLE (2)

Variation in frequency index (F.I.) of food items in stomach of **Raja miraletus** with sex and sexual maturity.

Sex		Males		Females		
Sexual maturity / Food items		Juveniles	Adults	Juveniles	Adults	Total
Crustacea	No	29	25	44	72	170
		29	25	44	72	170
	F.I	0.91	0.48	0.92	0.53	0.63
Teleosts	No	6	38	9	101	154
	F.I	0.19	0.73	0.19	0.74	0.57
Mollusca	No	2	8	4	16	30
	F.I	0.06	0.15	0.08	0.12	0.11
Annelida	No	0	4	4	8	13
	F.I		0.08	0.08	0.06	0.05
Other groups	No	4	3	4	12	23
	F.I	0.13	0.06	0.08	0.09	0.09

Crustacea were found in 170 stomachs out of 268, these were mainly small crabs, shrimps and euphausiacea. Teleosts, consisting mainly of **Boopps boops**, sardines and flat fishes (Pleuronectidae), were represented in 154 stomachs. Molluscs consisted of cephalopods (Octopi and Squids) were found in 30 stomachs. Annelida consisted entirely of Nereidae were found only in 13 stomachs.

If we consider juveniles rays, it is clear that crustaceans form the most common prey in the stomach contents of juvenile males and females. The adults of both sexes eat more teleosts and less crustacea than the juveniles, (Table 2, Fig. 2).

Shrimps, Euphausiacea, and Mysidacea are the more important crustaceans in the food of juvenile fish. Adult fish feed more on crabs and prawns than shrimps and Euphausiacea, (Fig. 3, Table 3).

Crustacea have the highest frequency index (i.e. selectively F.I. > 0.5) for juveniles (males and females), in all seasons, (Table 4, Fig. 4).

For adults (males and females), teleosts have the highest frequency index in all seasons. Crustacea are also prefrential, F.I. > 0.5 although not in all seasons. Cephalopods are secondary prey for adult males and females (F.I. 0.1-0.5) but are accidental (F.I. < 0.1) in juveniles (males and females). Annelida are accidental in all fish examined.

We notice that frequency index of each food item does not show significant seasonal variations.

Filling Index And its Seasonal Variation: (Table 5 and Fig. 5):

We notice that males and females have almost the same seasonal variation in their filling indices. Here, it is also evident that **Raja miraletus** feeds at a higher rate in winter and spring. Rate of feeding is low in both summer and autumn for both sexes where the fish is exhausted due to spawning. It is evident that female feeds more heavily than males in the four seasons of the year.

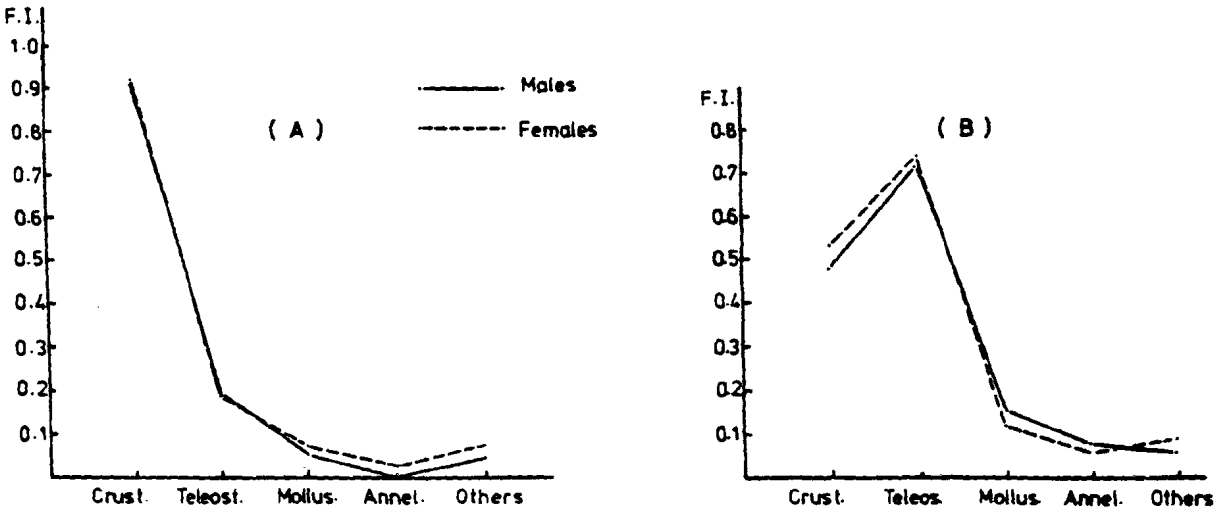

Fig. (2)
Variation in frequency index of food items in function of sex and sexual maturity.
A. Juvenile individual.
B. Adult individual.

TABLE (3)

Variation in frequency index (F.I.) of ingested crustacea with sex and sexual maturity.

Sex		Males		Females		
Sexual maturity / Ingested crustacea		Juveniles	Adults	Juveniles	Adults	Total
Crabs	No	3	22	6	49	80
	F.I	0.09	0.42	0.13	0.36	0.30
Shrimp	No	16	5	22	14	57
	F.I	0.50	0.10	0.46	0.10	0.21
Prawns	No	0	7	1	17	25
	F.I		0.15	0.02	0.15	0.09
Euphausiacea	No	16	7	25	8	56
	F.I	0.50	0.13	0.52	0.06	0.21
Mysidacea	No	4	0	9	2	15
	F.I	0.13		0.19	0.01	0.06
Unidentfiable crustacean remains	No	6	12	11	13	42
	F.I	0.19	0.23	0.25	0.10	0.16
No. of full stomachs		32	52	48	136	268
No. of stomachs ingested crustacea		29	25	44	72	170

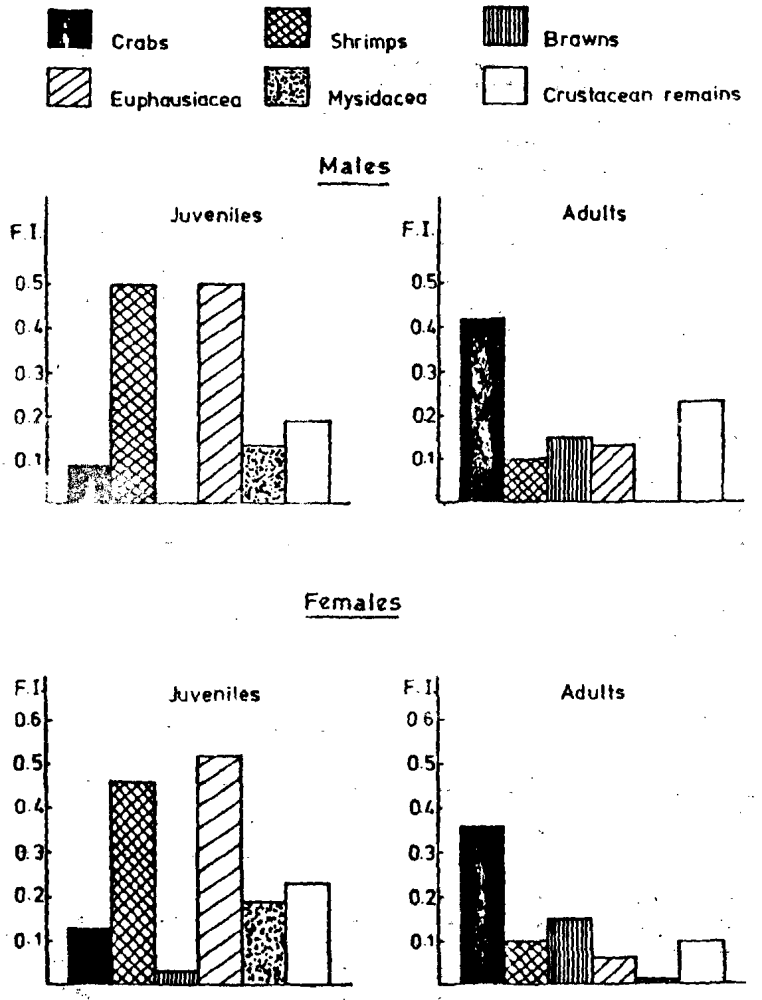

Fig. (3)
Histogram of variation in frequency index (F.I.) of ingested crustacea with sex and sexual maturity of R. miraletus.

TABLE (4)

Seasonal variation of frequency index of the different food items ingested by *R. mirabetus* in function of sex and sexual maturity.

A: MALES

Sexual maturity		Juveniles				Adults				
Seasons / Food items		W	Sp	S	F	W	Sp	S	F	Total
Crustacea	No	10	7	6	7	7	6	7	5	54
	F.I	0.91	0.70	1.00	1.00	0.58	0.40	0.50	0.45	0.64
Teleosts	No	2	2	1	1	8	11	11	8	44
	F.I	0.18	0.12	0.20	0.14	0.67	0.73	0.78	0.73	0.52
Mollusca	No	1	1	0	0	2	4	2	0	10
	F.I	0.09	0.11			0.17	0.27	0.14		0.05
Annelida	No	0	0	0	0	1	0	1	2	4
	F.I					0.08		0.08	0.08	0.05
Other groups	No	2	0	1	1	2	1	0	0	7
	F.I	0.18		0.20	0.14	0.17	0.07			0.08

B: FEMALES

Sexual maturity		Juveniles				Adults				
Seasons / Food items		W	Sp	S	F	W	Sp	S	F	Total
Crustacea	No	16	4	10	14	21	21	17	13	116
	F.I	1.00	1.00	0.83	0.88	0.58	0.48	0.55	0.52	0.63
Teleosts	No	3	1	2	3	28	30	24	19	110
	F.I	0.19	0.25	0.17	0.19	0.78	0.83	0.77	0.76	0.60
Mollusca	No	1	0	1	2	4	5	4	3	20
	F.I	0.06		0.08	0.13	0.11	0.11	0.13	0.12	0.11
Annelida	No	0	0	0	1	2	3	2	1	9
	F.I				0.06	0.06	0.07	0.06	0.04	0.05
Other groups	No	2	0	1	1	5	1	2	4	16
	F.I	0.13		0.06	0.06	0.14	0.02	0.06	0.16	0.09

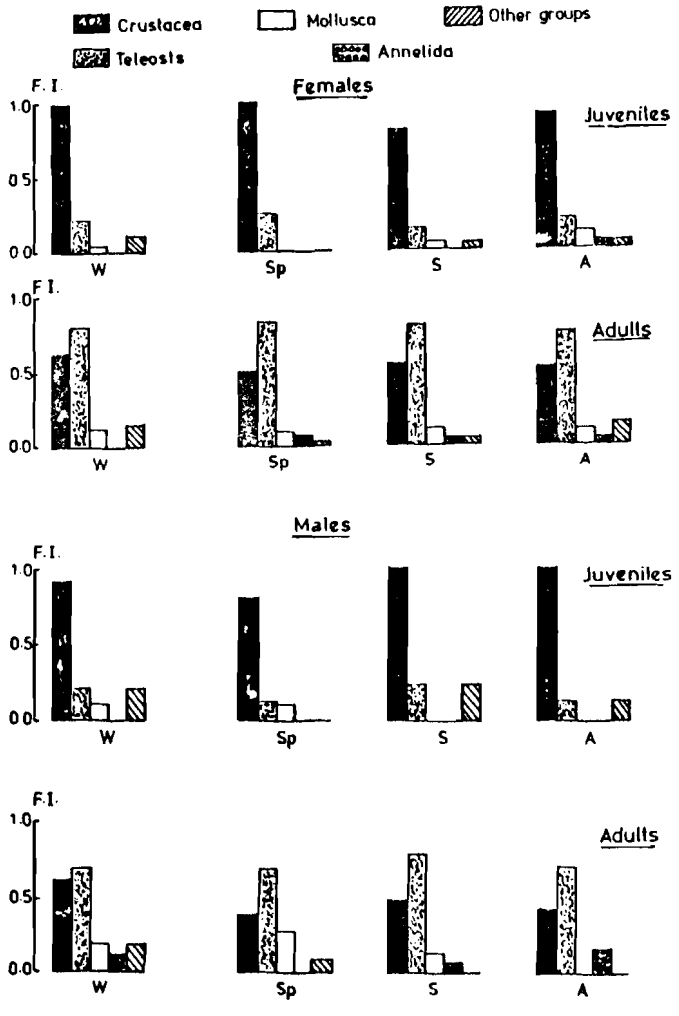

Fig. (4)
Histogram of seasonal variation in frequency index of different food items ingested by **R. miraletus.**

TABLE (5)

Seasonal variation in filling index in function of sex of **R. miratus**

Season	Mean filling index	
	Females	Males
Winter	3.816	3.166
Spring	4.178	3.761
Summer	3.334	2.742
Autumn	3.614	2.462
Mean	3.736	3.033

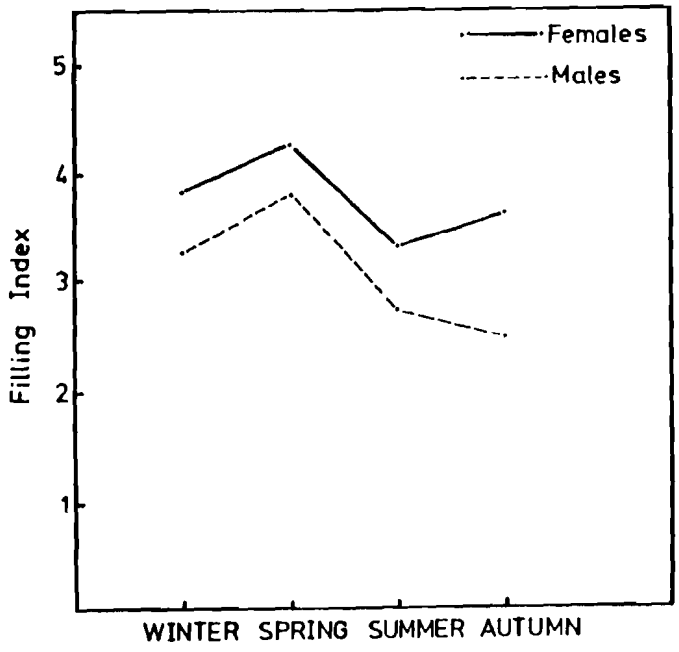

Fig. (5)
Seasonal variation of filling index in function of sex of **R. miraletus.**

DISCUSSION

The present study shows that fullness coefficient of **R. miraletus** is highest in winter and spring for both juveniles and adults in both sexes. Adult males having lower fullness coefficient than females were mentioned by Capape (1975 a,b) who explained this to be due to the reproductive activity which affects males more than females. Seasons corresponding to the lowest rate of feeding in this fish are summer for adult females and autumn for adult males. We notice that the F.C. in adult fish is affected by reproduction which extends from May to October. Jardas (1972) showed that females **R. clavata** stop feeding in Summer. The present results show that juveniles have the same trend in their seasonal variations of F.C.

Stomach contents of **R. miraletus** consisted of a wide range of crustacean species, teleosts, molluscs and annelida. The present results indicate that crustacea and teleosts are the major food items present in this fish and that while youngs feed mostly on crustacea, adults depend mostly on teleosts as food. This result seems to be in accordance with the previous results given by Capape and Azouz (1975) in **Raja miraletus** and **R. radula**, and by Capape (1975 a) in **R. melitensis** and (1975 b) in **R. clavata** and by Clark (1922), Steven (1932), Holden and Tucker (1974) and Quiniou and Andriamirado (1979) in **R. clavata, R. montagui, R. naevus** and **R. brachyura.**

Analysis of ingested crustacea in the stomach of **R. miraletus** indicate that juvenile fish feeds on small crustacea like shrimp, Euphausiaeca and Mysidacea. Adult fish feeds mainly on crabs and prawns.

Holden and Tucker (1974) reported that the stomach contents of **R. clavata, R. montagui** and **R. naevus** reflect the increasing ability of the larger fish to catch more active prey, not only fish but also the larger more active crustacea, such as portunus that occurred more frequently with increasing size.

From the above results, although **R. miraletus** is adapted for a bottom-living existence and feeds primarily on benthoic species, the fish can feed on pelagic animals as it becomes larger. Quiniou and Andriamirado (1979) and Ajayi (1982) reported that the analysis of preys with respect to the size at capture of the fish showed that as the rays grew, they attained deeper and deeper depths.

Sanford (1972) have described the way of feeding of two cartilagenous fishes, **Torpedo marmorata** and **Ginglymostoma cirratum.** According to him the fish curves its pectoral fin to the anterior so as to create a water current leading the prey to its mouth. This observation was given by Capape and Azouz (1975) on the **R. miraletus** and **R. radula.** Holden and Tucker (1974), made the same observation on **R. clavata,**

R. **montagui, R. naevus** and **R. brachyura.** This shows that as the discal width of this fish increases, the fish can feed on bigger prey (Capape, 1975 a). DuBiut (1974) admitted also that qualitative changes in composition of food items in function of length is classic in fishes.

Holden and Tucker (1974) concluded that **R. clavata, R. brachyura, R. montagui** and **R. naevus** are non selective feeders, whose range of food species is limited by three factors;

1. The availability of potential prey species, whether caused by regional variations in abundance or depth stratification within the substrata;
2. The relative speeds of predator and prey;
3. The structure of their mouth parts.

The change in abundance of crustacea in the stomach content of R. **miraletus** may be due to movement of adult fish to deeper waters, where crustacea become lower in abundance in the ambient medium (Ramadan, 1976).

Clark (1962) recorded differences in tooth structure of **R. clavata, R. montagui, R. naevus** and **R. brachyura** although these are not apparently reflected by differences in the food species eaten, but rather in the general type of food upon which they can feed. Quiniou and Andriamirado (1979) reported that the adaptation to hunt more rapid and vigerous prey takes place by presence of grooves between the crown and root of teeth (**R. brachyura**). These grooves retain more easily the prey which are swallowed complete. The surface of root is weak with respect to the whole tooth. On the contrary, in **R. montagui** the root occupies a more important place (La forme tabulaire cone en faced pourrait etre une adaptation an regime conchyliophage).

Du Buit (1968) have observed the presence of sexual dimorphism in the form of teeth in **R. montagui** where the male have pointed teeth and hence feed more on fish than the female. This phenomenon seems not to be present in **R. miraletus.**

From the present data, frequency index of crustacea is highest in juveniles and decreases in adults in both sexes. Cephalopods can be considered to be accidental as well as Annelids. Azouz and Capape (1971) have calculated the frequency index for crustacea in the stomach of **Raja clavata** to be about 0.91, for teleost it was 0.12. These authors studied only young individuals and that is why they gave high frequency index for crustacea (Capape, 1975 b).

Crustacea and Teleosts which seem to form the basic food items for this fish are present in their stomach contents throughout the year. This shows that seasonal variation in food spectrum is not present, which might lead us to suggest that the ambient medium as mentioned by Capape (1975 a & b) is practically stable throughout the year.

Stevens (1930) was able to show seasonal differences in the stomach contents related to the availability of prey. Ampelisca (Amphipoda) eaten in winter was almost entirely replaced by megalopa larvae of Corystes in summer in the stomachs of both **R. clavata**, and **R. montagui** and for **R. clavata** only, Pandalidae, occuring in winter, was largely replaced by Galathea in summer.

Study of filling index shows that feeding activity is higher in winter and spring than summer and autumn. It is higher in spring than winter. This is in accordance with previous results discussed before in the fullness coefficient.

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