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FOOD AND FEEDING HABITS OF BARRACUDAS IN THE EGYPTIAN MEDITERRANEAN WATERS, OFF ALEXANDRIA.

By

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Key words: ***S. chrysotaenia, S. flavicauda, S. sphyraena, S. viridensis,*** **feeding habits.**

ABSTRACT

Food preferences of four species of barracudas; ***Sphyraena chrysotaenia, Sphyraena flavicauda, Sphyraena sphyraena*** *and* ***Sphyraena viridensis*** *from the Egyptian Mediterranean waters, off Alexandria were investigated during the period from March 1998 to February 1999. Fish prey (mainly anchovy) were mainly the most important food eaten by different* ***Sphyraena*** *species. Crustaceans and molluscs were accidental except for* ***S. flavicauda*** *where crustaceans were secondary in importance. All* ***Sphyraena*** *species studied are primary piscivores since they mostly feed on small fish. In order to deal with detailed information for each species, the diet variation with season and different length classes have been taken into consideration. Feeding intensity had maximum values in summer for all species.*

INTRODUCTION

Barracudas are voracious predator fishes, mostly pelagic but small species often found near the bottom (Fischer and Bianchi, 1984; Whitehead ***et al.***,1986; Fischer ***et al.***, 1987). They are mainly captured by purse-seine and trawling nets in the Egyptian Mediterranean waters (Rizkalla, 1985).

Barracudas of the Mediterranean include three species; these are ***S. sphyraena***, ***S. viridensis*** and the Red Sea immigrant ***S. chrysotaenia*** (Whitehead *et al.*,1986;Fischer *et al.* ,1987; Fredj and Maurin,1987).In addition, the present study recorded a new Red Sea immigrant species, ***Sphyraena flavicauda***, in the Egyptian Mediterranean waters, off Alexandria.

Some studies have been carried out on the feeding habits of ***Sphyraena*** species such as that for ***S. barracuda*** in the tropical Atlantic (De Sylva, 1963); mangrove areas of Australia (Blaber, 1986) and Florida Bay (Schmidt, 1989).

The present work provides detailed information on the feeding habits of ***Sphyraena*** species as well as its variations according to season and fish size in the Egyptian Mediterranean waters, off Alexandria.

MATERIAL AND METHODS

Samples of barracudas were monthly collected from the commercial catch at the landing centers of Alexandria during the period from March 1998 to February 1999. A total of 1279 ***S. chrysotaenia*** (13 – 27 cm T.L), 428 ***S. flavicauda*** (17 – 43 cm T.L), 630 ***S. sphyraena*** (15 – 44 cm T.L) and 72 ***S. viridensis*** (18 – 69 cm T.L) were taken. For each fish, the total length (cm) and gutted weight (gm) were recorded. Then, stomachs were preserved in 10% formalin solution. The stomach contents were identified to the lowest possible taxon according to Whitehead *et al.* (1986) and Aboussouan (1994). The weight and number of each food item were recorded.

The results were expressed by the following indices; Empty coefficient, E.C (Percentage of the empty stomachs to the total number of stomachs examined; Fullness index, F.I (Percentage of the weight of stomach contents to the gutted body weight of the fish);Percentage frequency of occurrence, O% (Percentage of stomachs with certain food item to total number of non-empty stomachs); Numerical percentage, N% (Percentage number of each food item to the total number of all food items) and Gravimetric percentage, G%(Percentage weight of each food item to the total weight of all food items).

The importance of each food item in the diet was judged by using the index of relative importance (IRI%) given by Rosecchi and Nouaze (1987), IRI% = 100 IRI/ Σ^{*}_{1} IRI; where IRI = O% (N% + G%).

RESULTS

I-Feeding intensity:

The overall percentage of empty stomachs was high (61%) for *S. chrysotaenia*, and low (33%) for *S. viridensis*, while it was about 41% and 46% for *S. flavicauda* and *S. sphyraena* respectively. The lowest value of empty coefficient was being in summer for all *Sphyraena* species (Table 1). Concerning the feeding intensity, which is represented by the fullness index, *S. chrysotaenia* had smaller value (0.87) comparing to the other species. *Sphyraena* species seem to exhibit a small seasonal variation in the feeding intensity being relatively high in summer for all species (Table 1).

Table 1- Seasonal variations of Empty coefficient (E.C) and Fullness index (F.I) of *Sphyraena* spp. in the Egyptian Mediterranean waters, off Alexandria.

Season	*S. chrysotaenia*			*S. flavicauda*			*S. sphyraena*			*S. viridensis*		
	N	E.C	F.I	N	E.C	F.I	N	E.C	F.I	N	E.C	F.I
Spring	233	57.08	0.77	183	49.73	1.20	80	67.50	1.33	**Not captured**		
Summer	390	56.15	1.20	44	22.73	2.62	260	28.08	2.63	38	13.16	3.71
Autumn	343	68.22	0.68	105	35.24	1.30	170	48.82	1.12	31	58.06	1.14
Winter	313	62.30	0.74	96	37.50	1.45	120	66.67	0.72	3	33.33	1.08
Total number of stomachs	1279			428			630			72		
Mean E.C		61.06			40.65			46.03			33.33	
Mean F. I			0.87			1.43			1.69			2.49

II-Food patterns:

The preferred prey eaten by ***Sphyraena*** species was exclusively fish while Mollusca was accidental. Crustacean prey was relatively important food contributor only for ***S. flavicauda*** whereas for other species it was occasional.

For *S.chrysotaenia*:

Teleosts constituted the most important food item (IRI = 99.4%), found in 88.5% of the stomachs examined and comprised about 96.96% of the total food weight (Table 2). The fish prey found in the stomachs of this fish ranged from 3 to 9 cm in total length. ***Engraulis encrasicolus*** was the most important fish prey in the stomachs of this fish species (IRI= 28.26%, G= 52.30%, O=32.88%). Other prey fishes such as ***Sardinella aurita, Sardina pilchardus, Lithognathus mormyrus, Atherina*** sp. and ***Engraulis*** larvae were rarely encountered and represented an unimportant part in the diet of ***S. chrysotaenia***. Unidentified fish remains were found in 59.46% of the stomachs examined and represented 70.26% by IRI. Crustaceans; mainly shrimp larvae had a minor importance (IRI = 0.58%).

For *S. flavicauda*:

Teleosts were preferential food item (IRI =87%) occurring in 90.83% of stomachs examined and constituted 95.54% of the food bulk weight (Table 2). The length of these fish prey found to be ranged from 3 to 13 cm in total length. ***E. encrasicolus*** represented the most important identified fish species in the stomachs of this fish species (IRI=7.27%, O=17.90%, G=19.35%). Others as ***S. aurita, S. pilchardus, Mullus surmuletus, Lithognathus mormyrus, Spicara smaris, Siganus*** spp., **Ophidiidae**, ***Atherina*** spp. and ***Apodes*** larvae were rarely found in the diet. Crustacea came next in importance (IRI=12.98%) where they were found in 20.09% of stomachs examined. Shrimp larvae (IRI=12.94%) were the most important item of crustaceans, were found in 17.90% of stomachs examined. Molluscs (Octopus) were of a negligible importance (IRI = 0.02%).

Table 2- Diet composition of different *Sphyraena* species in the Egyptian Mediterranean waters, off Alexandria. (O%= Percentage frequency of occurrence; N%=Numerical percentage; G%= Gravimetric percentage and IRI%= Relative importance index).

Food items	*S. chrysotaenia*				*S. flavicauda*				*S. sphyraena*				*S. viridensis*			
	0 %	N %	G %	IRI%	0 %	N %	G %	IRI%	0 %	N %	G %	IRI%	0 %	N %	G %	IRI%
A- Teleosts	**88.51**	**92.96**	**96.96**	**99.42**	**90.83**	**51.68**	**95.54**	**87.00**	**97.89**	**99.89**	**99.26**	**100**	**97.62**	**100**	**98.97**	**100**
Sardinella aurita	0.45	0.18	1.34	0.01	2.18	0.56	3.29	0.12	4.52	1.81	5.75	0.32	7.14	2.68	20.02	1.62
Sardina pilchardus	0.23	0.09	0.70	<0.01	1.31	0.34	2.50	0.05	1.20	0.42	2.77	0.04				
Engraulis encrasicolus	32.88	19.52	52.30	28.26	17.90	8.28	19.35	7.27	12.47	27.73	38.66	26.55	50.00	43.75	41.31	42.53
Mullus surmuletus					1.31	0.45	2.34	0.05								
Lithognathus mormyrus	0.23	0.09	0.13	<0.01	10.92	3.69	9.99	2.20								
Boops boops									1.81	0.64	7.45	0.14				
Spicara smaris					1.31	0.34	6.66	0.14	0.30	0.11	0.51	<0.01				
Siganus spp.					0.44	0.11	0.27	<0.01								
Ophidiidae					0.44	0.11	1.15	0.01								
Mugil spp.													2.38	0.89	6.83	0.18
Atherina spp.	0.23	0.18	0.10	<0.01	4.80	2.12	5.74	0.55								
Engraulis larvae	4.50	14.61	1.93	0.89												
Apodes larvae					0.87	0.34	0.03	0.01								
Unidentified fish remains	59.46	58.29	40.46	70.26	65.50	35.34	44.22	76.60	68.37	69.18	44.12	72.95	66.67	52.68	30.81	55.67
B- Crustacea	**6.98**	**7.04**	**0.68**	**0.58**	**20.09**	**47.98**	**2.45**	**12.98**	**0.30**	**0.11**	**0.07**	**<0.01**				
Parapenaeus longirostris	0.45	0.18	0.18	<0.01	2.18	0.67	0.57	0.04	0.30	0.11	0.07	<0.01				
Shrimp larvae	6.53	6.86	0.50	0.58	17.90	47.31	1.88	12.94								
C- Mollusca					**1.31**	**0.34**	**0.43**	**0.02**								
Octopus					1.31	0.34	0.43	0.02								
D- Digested food (Detritus)	9.68		2.36		6.11		1.58		**3.31**		**0.67**		**2.38**		**1.03**	

For *S. sphyraena*:

Fishes were the main important food item eaten by this fish species (IRI= 100%) whereas crustaceans were an accidental prey (Table 2). ***E. encrasicolus*** was the most important prey (IRI= 26.55%, O= 42.47%, G= 38.66%). ***S. smaris*** (IRI= <0.01%), ***S. pilchardus*** (IRI= 0.04%), ***S. aurita*** (IRI= 0.32%) and ***Boops boops*** (IRI=0.14%) occurred as occasional prey. The size prey varied between 3 and 11 cm in total length. Crustacea was of a negligible importance (IRI= <0.01%).

For *S. viridensis*:

The preferred prey item eaten by this fish was exclusively fishes (IRI= 100%, O= 97.62%, G= 98.97%). The most common fish species found in stomach contents of ***S. viridensis*** were ***E. encrasicolus*** (IRI= 42.53%), ***S. aurita*** (IRI= 1.62%) and ***Mugil*** sp. (IRI= 0.18%). The size of prey ranged from 4.5 to 12.5 cm in total length (Table 2).

III- Seasonal variation of food patterns:

For *S. chrysotaenia*:

Seasonal variation in the diet of ***S. chrysotaenia*** (Fig.1) reveals that fish prey was exclusively eaten all the year (IRI= >90%). ***E. encrasicolus*** was the most important fish prey represented in the diet of ***S. chrysotaenia*** in all seasons. The relative importance index of this fish prey increased from spring (5.71%) onward till reaching a highest value in autumn (51.04%) where 46.8% of stomachs examined contained this fish prey. On the other hand ***Engraulis*** larvae were recorded only in spring (O= 23.53% & IRI= 25.21%).

S. aurita and ***S. pilchardus*** prey were observed only in winter (IRI= 0.28 & 0.07%) and they were regarded as accidental prey. Also, ***L. mormyrus*** and ***Atherina*** sp. were rarely recorded in autumn and summer respectively and considered as an accidental fish prey eaten by this fish species. Crustacean prey had a relatively important food contribution only in winter (IRI= 8.92%) but in other seasons, they were rarely recorded and regarded to be accidental.

For *S. flavicauda*:

This fish species was found to feed mainly on fish prey during most of seasons (Fig. 1). In spring, ***S. flavicauda*** fed on both fishes (IRI= 48.84%) and Crustacea (IRI= 51.11%). ***S. flavicauda*** consumed large quantities of

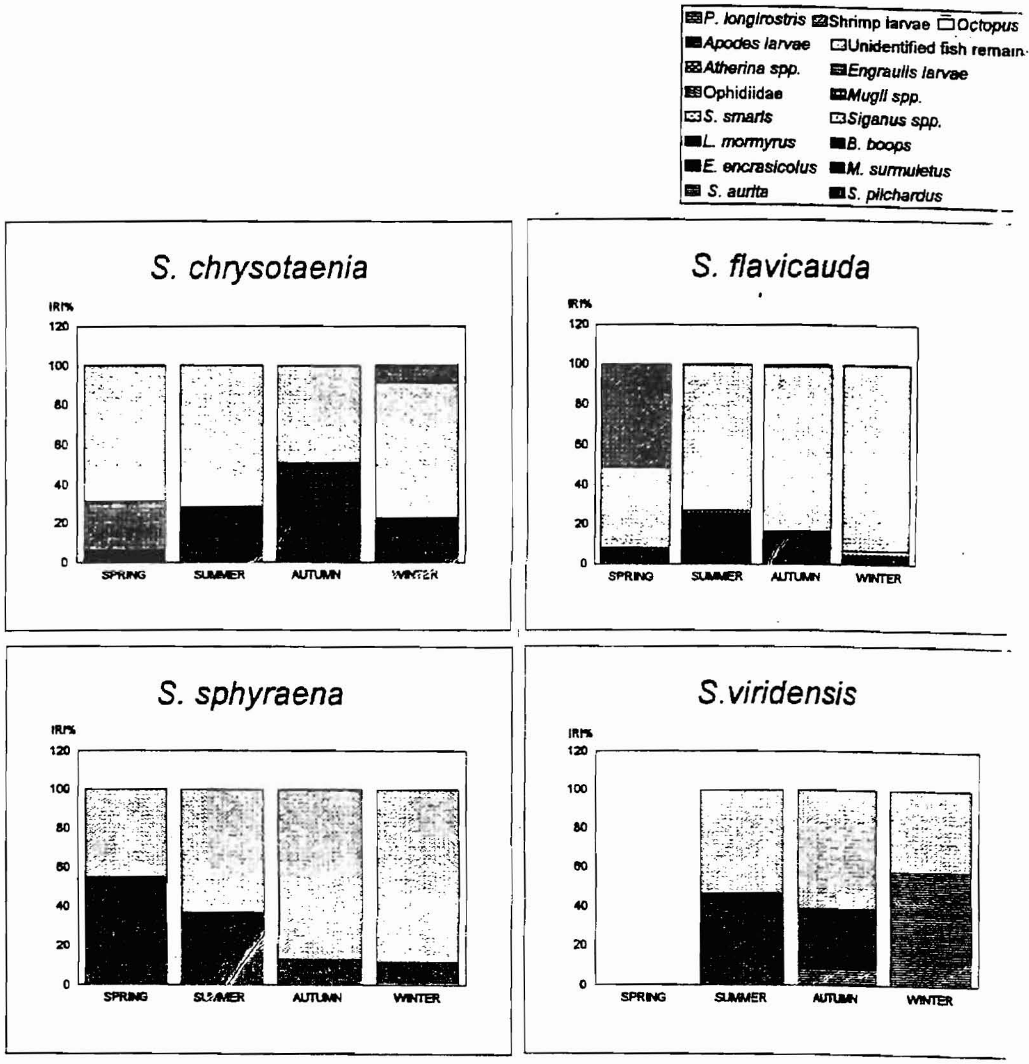

Fig. 1- Seasonal variations of different food items (IRI%) Of *Sphyraena* spp.

E. encrasicolus during summer (G= 41.75%) with a high IRI(25.64%). Although *E. encrasicolus* occurred only in 15.71% of the stomachs examined in spring, it constituted 32.08% by weight with a relatively lower IRI (7.11%). In autumn and winter, *E. encrasicolus* was accidental where the IRI was 1.73 and 1.74% respectively. *L. mormyrus* constituted 26.76% of food weight in autumn representing 13.68% of IRI. *S. smaris* was only recorded in winter but it was regarded to be accidental (IRI=1.93%). Crustacean shrimp larvae preferred to be eaten in huge numbers (N= 78.85%) in spring (IRI= 51.11%) while in other seasons they were seemed to be accidental. Mollusca rarely found in stomachs examined in winter (O=1.70% & IRI= 0.04%) and spring (O= 2.86% & IRI= 0.05%).

For *S. sphyraena*:

Fishes were mainly the dominant prey eaten by this fish species representing nearly the whole food (100%) in all seasons. *E.encrasicolus* was the most important prey eaten by *S. sphyraena* in all seasons where the IRI was 31.62, 36.72, 12.60 and 10.33% in spring, summer, autumn and winter respectively. *B. boops* was of higher importance only in spring (IRI= 23.09%). *S. aurita, S. pilchardus* and *S. smaris* were seemed to be accidental in all seasons (Fig. 1). *Parapenaeus longirostris* was appeared to be the only accidental crustacean prey found in the diet of *S. sphyraena* in winter (IRI= 0.05%).

For *S. viridensis*:

It was rarely caught and few numbers of specimens could be collected only in summer, autumn and winter seasons.

As shown from Fig. (1), fishes were the only food item observed in the stomachs of *S. viridensis* in all seasons (IRI= 100%). *E. encrasicolus* was the most important prey constituting 46.46% and 30.95% of IRI in summer and autumn respectively and disappeared from the diet in winter. *S. aurita* was the most preferable prey in winter (IRI= 57.85%). *Mugil* spp. were only eaten accidentally in summer.

IV-Feeding variations with fish length:

The specimens were grouped into length classes, they are three classes for *S. chrysotaenia* and five ones for other species.

For *S. chrysotaenia*:

Fish prey was the main food item occurred in the stomachs examined of all length classes, while crustaceans were of less importance. For specimens below 20 cm T.L, the crustacean shrimp larvae occurred in about 10.5% of stomachs but still of less importance (IRI= 1.87%). Also, ***P. longirostris*** was observed in the stomachs of fishes of more than 20 cm T.L, but it was regarded to be accidental. Fish larvae of ***Engraulis*** appeared only in the diet of fish of less than 20 cm T.L (IRI= 3.92%) while its adults represented 16.52% of IRI for the first length class (<20 cm T.L) increased to 44.68% for the second length class (20-24 cm) and then decreased to 8.16% for the third length class (≥25 cm T.L). Both ***L. mormyrus*** and ***Atherina*** sp. were of unimportant as food for fishes less than 25 cm T.L(Fig. 2).

For *S. flavicauda*:

Fish and crustaceans were the main food items for the smaller length classes (<20, 20–24 cm T.L), while those of larger classes (25–29, 30–34, ≥ 35 cm T.L), only fishes were the main diet (Fig. 2). The common identified fish prey was ***Atherina*** sp. for smaller fishes (<20 cm) but still of minor importance, ***L. mormyrus*** was important prey only for fishes of 20–24 cm (IRI= 18.86%). ***E. encrasicolus*** was eaten by all length classes but its importance increased for fishes of length classes 25–29 cm (IRI= 9.79%, O= 20.54%, G= 20.71%) & 30–34 cm (IRI= 25.35%, O= 40.74%, G= 43.25%) and being of minor importance (IRI= 0.17%) for larger fishes (≥ 35 cm). ***S. smaris*** was mostly taken in the largest length class (≥ 35 cm T.L) making about 5.66% of IRI. The largest percentage occurrence of crustacean larvae (O= 57.14%) was found in small fish (<20 cm T.L) and decreased continuously with increasing fish length till it occurred only in 4% of stomachs examined for length class more than 35 cm T.L. Therefore crustaceans were appeared to be very important food item for fishes less than 25 cm T.L. Mollusca appeared accidentally in the 25–29 cm (IRI= 0.03%) and 30–34 cm length classes (IRI= 0.08%).

For *S. sphyraena*:

Fishes were only the main food item for all length classes (IRI=100%), and crustaceans were rarely appeared in the 30–34 cm length class (Fig. 2).

The only identified fish prey in the small fish size (<20 cm T.L) was ***E. encrasicolus*** (IRI = 18.46 %, O= 30.77%, G= 47.27%) and also was

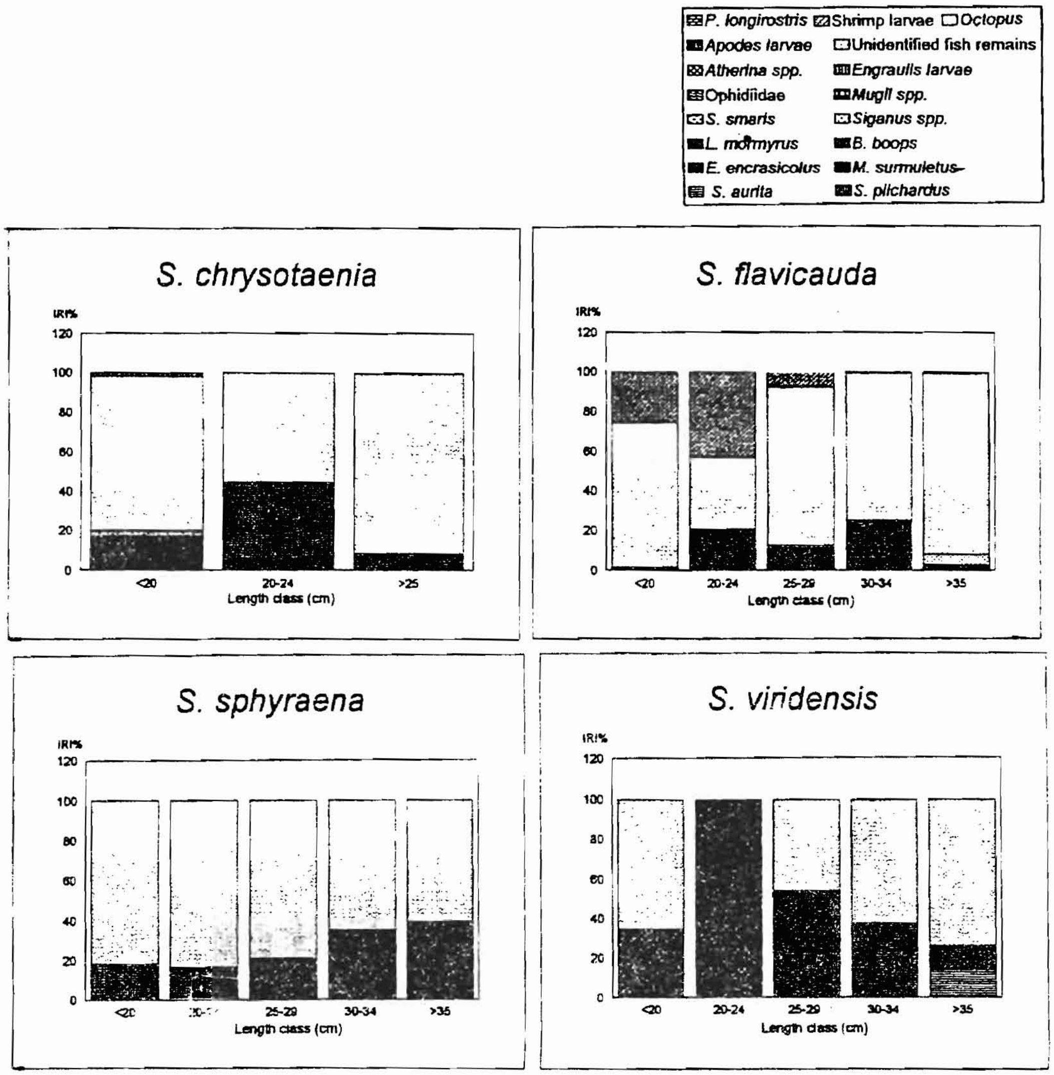

Fig. 2- Variation of food items with length class of *Sphyraena* spp..

represented in all length classes, with a slightly different importance. ***S. aurita*** began to appear in length class 20–24 cm representing 1.13% of IRI and progressively decreased in other length classes but they were seemed to be accidental. ***B. boops*** constituted 10.34% of IRI for the largest fish group (≥ 35 cm).

For *S. viridensis*:

It fed on fishes only (Fig. 2). ***E. encrasicolus*** was very important prey in the diets of fish of the length class 20 – 24 cm with maximum percentage (IRI= 100%), then its importance decreased in fishes ≥ 35cm(IRI= 14.24%): ***S. aurita*** (IRI= 10.95%) and ***Mugil*** sp. (IRI= 1.24%) appeared only in larger fishes (≥ 35 cm).

DISCUSSION

All members of family Sphyraenidae are voracious having long pointed snout with terrible teeth (Fischer and Bianchi, 1984; Whitehead ***et al.***, 1986; Fischer ***et al.***, 1987; Ghisotti, 1995).

All Sphyraena species studied feed mainly upon small fishes in addition to crustaceans and molluscs, so they are considered as primary piscivores. This result is in agreement with De Sylva (1963); Kuronuma and Abe (1972); Nelson (1976); Lagler ***et al.*** (1977); Beaubrun (1978); Sivasubramaniam and Ibrahim (1982); Fischer and Bianchi (1984); Blaber (1986); Whitehead ***et al.*** (1986); Fischer ***et al.*** (1987) and Schmidt (1989).

Piscivorous fishes were generally found to possess relatively high empty coefficient values (Faltas, 1993; Juanes and Conover, 1994). This is in parallel with the present result for ***Sphyraena*** species, which have large empty coefficient values particularly for ***S. chrysotaenia*** (61%). This may be attributed to low feeding frequency (Carrasson and Matallanas, 1998); methods of capture which reflects a great difference between the time of maximum activity and time of capture (Casadevall ***et al.***, 1994; Tuset ***et al.***, 1996) and/or rapid digestion of fish prey (Juanes and Conover, 1994).

In the present study, the stomachs of all ***Sphyraena*** species were found to contain mainly ***E. encrasicolus***. This can be attributed to the high abundance of ***E. encrasicolus*** in the Egyptian Mediterranean waters, off

Alexandria (Al-Kholy and El-Wakeel, 1975; Faltas, 1983; Faltas, 1997). De Sylva (1963) found that Gobiidae and Atherinidae ranked first and second as food of young *S. barracuda* (<30 cm F.L) in both the Bimini and Florida regions while Gerridae, Cyprinodontidae and invertebrates showed various fluctuations within the two regions. Also, Blaber (1986) showed that the most commonly prey taken were Atherinidae and Gobiidae for *S. barracuda* in mangrove areas of Australia. Schmidt (1989) found that Cyprinodontidae and Gerridae were dominant prey for *S. barracuda* in Florida Bay. The differences in the type of food taken by barracudas in various localities would seem to reflect a difference in habitats, rather than food preferences (De Sylva, 1963; Nikolsky, 1963; Wootton, 1990). On the other hand, Schmidt (1989) stated that *S. barracuda* was opportunistic epibenthic and pelagic feeder with differences in feeding attributed to depth of capture.

There is no doubt that the seasonal variation has a great influence on the diet composition of fishes. However, all *Sphyraena* species were found to eat small fish all the year round but they showed some change in the prey preferability. Generally, all *Sphyraena* species increased their preferability to *E. encrasicolus* in summer when this species dominated (Faltas, 1983). Crustacean shrimp larvae preferred to be eaten by *S. flavicauda* in spring. This agrees with Dowidar and El-Maghraby (1970) who stated that the flourishing of crustaceans in the Egyptian Mediterranean occurred in spring.

In the present study, fishes were the most important food items eaten by barracudas of all size groups. However, there were apparent differences in the type of fish prey eaten among different size groups. This result coincides with that given by Nikolsky (1963) who declared that changes in food selection were observed among fishes having different size range. Also the change in the diet between young (<30 cm F.L) and adult *S. barracuda* was reported by De Sylva (1963) in tropical western Atlantic. He deduced these variations in diet to the change in habitat with growth of the barracuda where adult barracuda shows a definite preference to comparatively fast-swimming fishes of the surface or mid-depths.

The present results indicated that the barracudas feed on small fish prey having total lengths ranged from 3 to 13 cm. The size of prey didn't show any significant variation relative to increasing size of the fish examined.

This finding coincided with De Sylva (1963), Blaber (1986) and Schmidt (1989) who showed that ***S. barracuda*** feed on small prey size. This can be attributed to the fact that predator digestive organs are not adapted to swallow a big fish (Zadual'skaya, 1960), as well as, piscivores do not select food prey on the basis of species but on their small size (Blaber, 1986) especially, in warm waters (Wootton, 1990).

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