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A study on Diet Composition and Feeding Habits of Barracuda fish (*Sphyraena chrysotaenia and S. flavicauda*) in the Gulf of Suez

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ABSTRACT

The most common and commercial species of Family Sphyraenidae in the Gulf of Suez are *Sphyraena chrysotaenia* and *S. flavicauda*. A total of 865 individuals of *S. chrysotaenia* and 71 individuals of *S. flavicauda* were collected for food and feeding studies. The feeding intensity estimated as full stomach percent were represented by 37% and 59.2%, while the empty stomach were represented by 63% and 40.8% for *S. chrysotaenia* and *S. flavicauda* respectively. The relative length of gut indicated that both species were carnivorous as RLG= 0.29 and 0.15 for *S. chrysotaenia* and *S. flavicauda* respectively. The fullness index for the two species showed seasonal variations, as the highest fullness percent were recorded during winter, where the lowest fullness percent was observed during spring for both species. The most important food items for *S. chrysotenia* were fish with IRI% of 16023.6 followed by crustaceans with IRI% of 1452.36. The most important food items for *S. flavicauda* were crustaceans followed by fishes then mollusks, where IRI% were 1482, 1429 and 910 respectively. The prey sizes have a positive relationship with length of fish for both species.

INTRODUCTION

Feeding habits and food items for each fish species is very important to know the relation between all species live in the same fishery ecosystem. Fish migration, growth, reproduction and all other biological aspects were influenced by the food items and feeding habits (Shehata, 1994). Feeding habits studies are important also to determine the biological interaction between species in the same fishery, or in the multi species fishery**.** In the case of the Gulf of Suez, It is not easy to determine whether observed fluctuations and cycles in stock abundance are due to predator-prey interactions or environmental fluctuations**,** while both variables may contribute and one factor may be dominant (El-Ganainy, 2003).

Barracuda is carnivorous species attacks its prey through camouflage or in an ambush and tears it into pieces by its sharp jaws (Ramachadran *et al*., 2006). The barracuda *S. jello* feeds on plankton in its post larva and juvenile stages of life cycle and then start to be carnivorous at maturity as, it feeds on shell fish, cephalopods, crustaceans, and other fishes (Hosseini *et al*, 2009). Many studies were conducted on the food and feeding habits of barracuda fish species all over the world and all of them were concluded that Barracudas are highly predatory fishes (Premalatha and

Manojkumar, 1990; Carpenter *et al*., 1997; Barreiros *et al*., 2002; Ragheb, 2003; Bachok *et al.*, 2004; Mohammadizadeh *et al.*, 2010; Aggrey –Fynn *et al*., 2013).

Although the high abundance of barracuda fish in the Red Sea and Gulf of Suez they are one of the least investigated species in this region, thus previous studies on their biology and fisheries are very scarce. This is the first attempt to investigate the food contents and feeding habits as well as the seasonal variation in feeding activity of two commercially important barracuda species *Shyraena chrysotaenia* and *S. flavicauda* in the Gulf of Suez.

MATERIALS AND METHODS

Samples collection and laboratory examination:

A total of 865 specimens of *S. chrysotaenia* and 71 specimens of *S. flavicauda* were collected from Attaka fishing harbor during 2013/2014, samples were weighted for the nearest gram and measured for the nearest centimeter. The nearly and completely filled stomachs were carefully removed, the type of food organisms found in the stomach were identified to the lowest possible taxon, the number and weight of each type of food items were recorded after drying to remove surface moisture. The full stomach were divided into three grades according to the quantity of food in the stomach, 1/3 filling when the stomach have 1/3 its size filled with food which usually was digested food, 2/3 filling when the stomach have 2/3 its size filled with food, and the third division when the stomach is completely filled with food. Then the following indices were estimated.

Calculation of Gastro Somatic Index (GSI):

Filling index or GSI is a useful and an efficient way for comparing the scale of feeding (food consumption) during various months and for determining the environmental and physiological effects on feeding habits. The GSI was obtained according to the following equation (Desai, 1970):

$$GSI = (\text{Weight of gut} / \text{Body weight}) \times 100$$

The length of gut was measured with the accuracy of 0.1cm in order to obtain the Relative Length of Gut (RLG). The RLG was calculated by the following equation (Al Husaainy, 1949):

$$RLG = \text{Length of gut} / \text{Total length}$$

Coefficient of Emptiness:

It is expressed as the percentage of empty stomachs compared to the total number of fish stomach examined.

Percentage of Occurrence (O%):

It is the percentage of the number of stomachs contain the same food item to the total number of full stomach.

Diet composition percentage, Numerical (N%):

It is represented by the number of individuals of each food items counted as a percentage in relation to the total individual number of all food items.

Gravimetric percentage (G%):

Each food item was weighted to deduce its percentage in relation to the total weight of all food items present.

Index of Relative Importance (IRI):

The combination of numerical (N %), Gravimetric (G %) and frequency of occurrence (O %) of a given food item was carried out by the model of relative importance. It is used to rank the importance of each food item in the diet. This index

was computed for each food item by the formula given by Rosecchi and Nouaze (1987).

IRI%= O% (N%+G %)

RESULTS

Sphyraena chrysotaenia

Feeding intensity:

A total of 865 specimens of *S. chrysotaenia* collected from the Gulf of Suez were examined, 545 specimens was empty stomachs representing 63 %, while 320 specimens was full stomachs constituted 37 %. The feeding intensity varied according to length as the small fish (from13.0 to 21.9 cm) have high percentage of empty stomachs and the large individuals from length 22.1 to 28 cm have the highest value of filled stomachs (Figure, 1). The results revealed that the highest percentage of fullness was recorded during winter and the highest emptiness values was recorded during spring (the spawning season) (Figure 2).

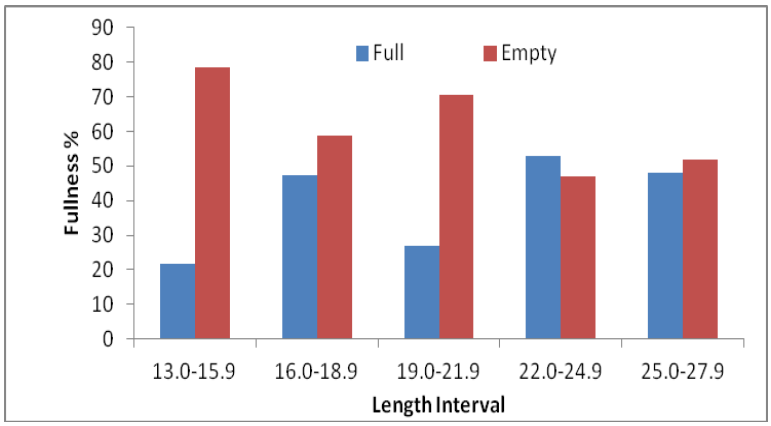
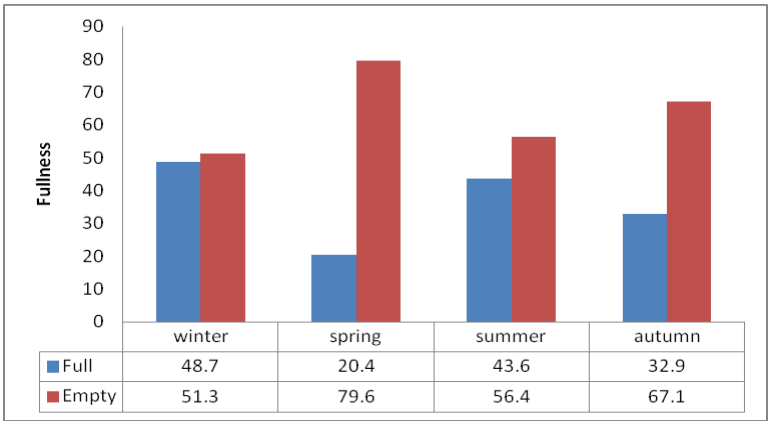


Fig. 1: Stomach fullness and emptiness of *S. chrysotaenia* according to fish length



	winter	spring	summer	autumn
Full	48.7	20.4	43.6	32.9
Empty	51.3	79.6	56.4	67.1

Fig. 2: Seasonal variation in the fullness index during the study period 2013/2014 for *S. chrysotaenia* from the Gulf of Suez.

The filling index

The filling index (Gastro somatic index) was ranked according to stomach fullness into three categories. For the 1/3 filled stomach the value of filling index was ranged from 0.6 to 2.0; and it was ranged from 2.1 to 2.9 for the 2/3 filled stomach**,** while it was ≥ 3 for the completely filled stomachs.

Species diversity:

Stomach contents of *S. chrysotaenia* from the Gulf of Suez have high species diversity.

Four fish species plus fish remains and two crustacean species were recorded, as well as two species of sea grass were also found. This diversity fluctuated through different seasons as some species were represented in season and other species was absent (Table 1).

Table 1: Species diversity in stomachs of *S. chrysotaenia* from the Gulf of Suez.

Food items	**Total**	**Seasonal**			
		Winter	Spring	Summer	Autumn
Fish	5	5	4	5	4
Crustacean	1	0	1	1	1
Cephalopod	2	2	0	0	0
Sea grass	2	2	2	2	0

Relative Length of Gut (RLG):

The relative length of gut was calculated by the equation of (Al-Hussainy, 1949) who stated that, when the value of RLG is less than 1, the fish will be carnivorous and if more than 1 it tends to be herbivorous and the medium size indicated to be omnivore. By calculating the RLG for *S. chrysotaenia* the average value was 0.29 (ranged from 0.13 to 0.49) with standard deviation (SD=0.076) indicating that the species is carnivorous one.

Relation between length of fish and prey length:

The size of the prey generally increases with the increasing of predator size (Figure, 3). *S. chrysotaenia* samples ranged from 13.0 to 15.9 cm were found to be feed on preys ranging in size between 0.4 and 0.6 cm and the mean range of prey length increased gradually to reach 4.6 cm in fish length ranged from 25.0 to 28.0 cm.

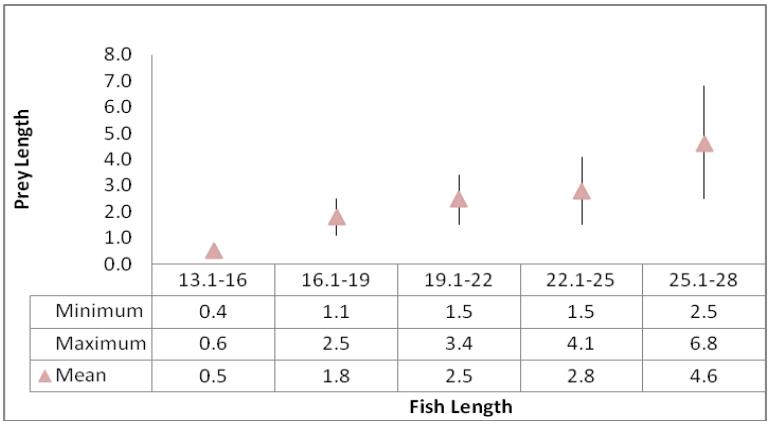


Fig. 3: Relation between the fish length and the prey length of *S. chrysotaenia*

Food items:

In most of the examined stomachs the most important food items were fishes of Anchovy species, Lizard fish, Horse mackerel, fish larvae and fish remains. The most important food item was fish with Index of Relative Importance IRI % of 14578.2, 14416.5, 13804, and 16023.6 during autumn, summer, spring and winter respectively. Then cephalopod represented by *Octopus vulgaris* and *Loligo duvaceli*. Fish eggs and sea grass were found in small quantities (Table 2).

Table 2: Seasonal variation in food items of *S. chrysotaenia* in relation to Numerical, Gravimetric, Percentage of Occurrence and IRI%.

Food item	Season															
	Winter				Spring				Summer				Autumn			
	O%	N%	G%	IRI%	O%	N%	G%	IRI%	O%	N%	G%	IRI%	O%	N%	G%	IRI%
Fish	92.3	88.9	84.7	16023.6	95.2	52.1	92.9	13804	95.6	56.3	94.5	14416.5	91	73.9	86.3	14578.2
Fish remains	15.4	11.1	13.9	385.0	28.6	10.7	31.8	1215.5	8.7	2.8	7.6	90.5	27.3	13	20.3	909.09
Fish larvae	5.1	11.1	2.3	68.3	23.8	16	20.2	861.56	30.4	21.2	23.9	1371.0	18.2	21.7	10.6	587.86
Anchovy	20.5	25.9	15.5	848.7	19	18.7	14.6	632.7	21.7	18.3	18.1	789.9	27.3	30.4	24.9	1509.69
Lizard fish	38.5	31.3	41.3	2795.1	23.8	6.7	26.3	785.4	21.7	8.4	28.2	794.2				
Mackerel	12.8	9.4	11.7	270.1					13	5.6	16.7	289.9	18.2	8.7	30.5	713.44
Cephalopod	7.7	9.3		71.6												
Octopus	5.1	7.4	8.3	80.1												
Squid	2.6	1.9	6.6	22.1												
Crustaceans																
Shrimps					14.3	5.3	5.3	151.58	13	5.6	4.1	126.1	36.4	26.2	13.7	1452.36
Fish egg					14.3	40	1.2	589.16	8.7	35.2	0.7	286.2				
Sea grass	5.1	1.9	0.4	11.7	9.5	2.6	0.6	30.4	8.7	2.8	0.7	30.5				

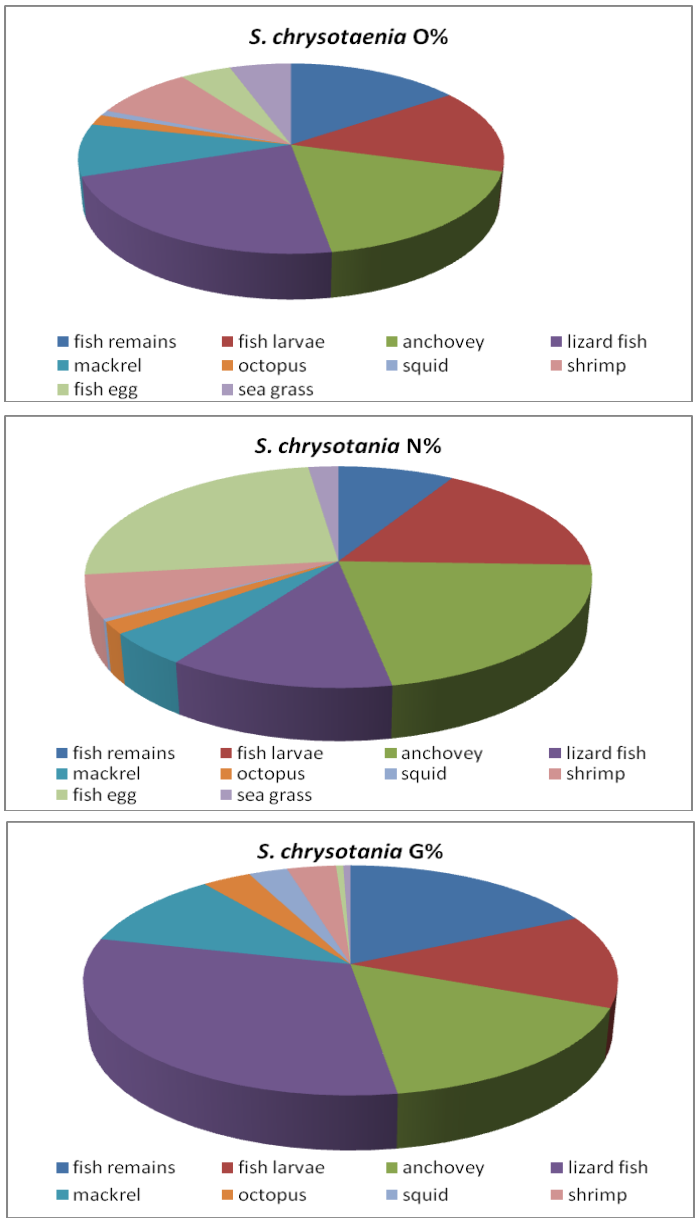


Fig 4: Fluctuation of food items in *S. chrysotenia* in relation to percentage of occurrence, numerical, and gravimetric percentage.

Sphyraenia flavicauda

A total of 71 stomachs of *Sphyraenia flavicauda* were examined. 29 individuals with empty stomachs and 42 were full stomachs, representing 40.8% and 59.2% of the total sample respectively.

The feeding intensity varied according to the length interval, where more than 70% of the small and larger fish sizes had full stomachs, in the median sizes the number of full and empty stomachs is nearly equaled Fig. (5).

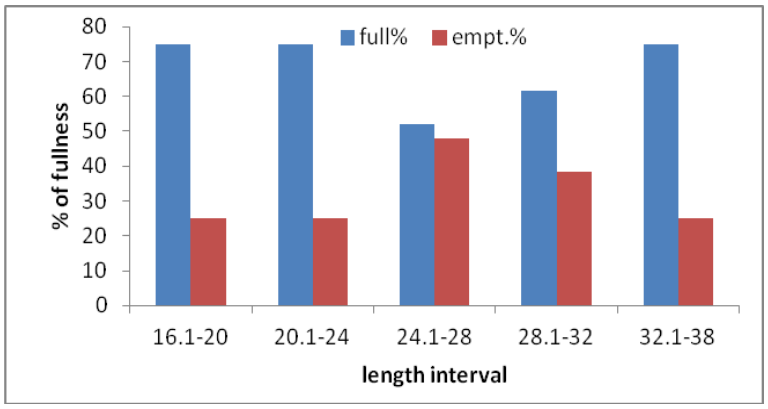


Fig. 5: Stomach fullness and emptiness of *S. flavicauda* from the Gulf of Suez according to fish length

The maximum feeding intensity was attained in winter where most of the examined fishes (61.2%) were found to be feeding. In summer the feeding activity of *S. flavicauda* was relatively low where more than 70% of the stomachs were empty. The minimum feeding intensity was observed in spring, particularly during May, where almost of the examined stomachs (80 %) were found empty (Fig 6).

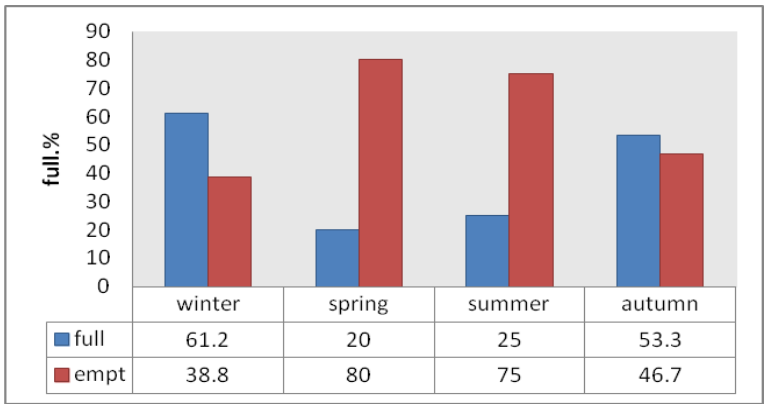


Fig. 6: Seasonal variation in the fullness index during the study period 2013/2014 for *S. flavicauda* from the Gulf of Suez.

The Filling Index

Calculation of Gastro Somatic Index (GSI) or filling index for *S. flavicauda* is divided according to stomach fullness into three divisions, 1.0 - 1.9 for the fish with 1/3 filled stomach, 2.0- 3.9 for the fish with 2/3 filled stomach and more than 4 for the completely filled stomach**.**

Relative Length of Gut (RLG):

The relative length of gut was estimated for *S. falvicauda*. The average RLG was found to be 0.15, where it ranged from 0.055 to 0.280, with standard deviation of 0.0678.

Relation between fish length and prey length:

Generally the size of the prey increases with the increasing of the predator size (Fig 8). The length group 16.1-20.0 cm were found to be feed on preys ranging in size between 1.0 and 1.8 cm, while the length group 24.1-28.0 cm ingested preys with a mean length of 3.9 cm and the fishes with large length group (32.1-38.0 cm) feed on larger preys of mean length of 8.7 cm (Fig. 7).

	16.1-20	20.1-24	24.1-28	24.1-28	28.1-32	32.1-38
minimum	1	1.5	1.8	3	3.4	5
maximum	1.8	3.6	4	4.9	8.5	12.4
▲avearge	1.4	2.5	2.9	3.9	5.9	8.7

Fig. 7: Relation between fish length and prey length of *S. flavicauda*

Food items:

The main food items intake by *S. flavicauda* were fishes, mollusks and crustaceans. According to percentage of Occurrence O% fishes (Anchovy and fish larvae) took the highest percent then crustaceans (*Trachypeneaus curvirostris*) and followed by mollusks (*Loligo duvauceli*) with values of 40%, 35% and 25% respectively. According to the Relative Importance Index (IRI %) Crustacean (*Trachypeneaus curviraster*) is the most important food item followed by fishes (fish larvae) and mollusk(*Loligo duvaceli*) where the IRI% were 1482, 1429 and 910 respectively. with IRI% of 1360, 1185 and 652.5 respectively (Fig 8).

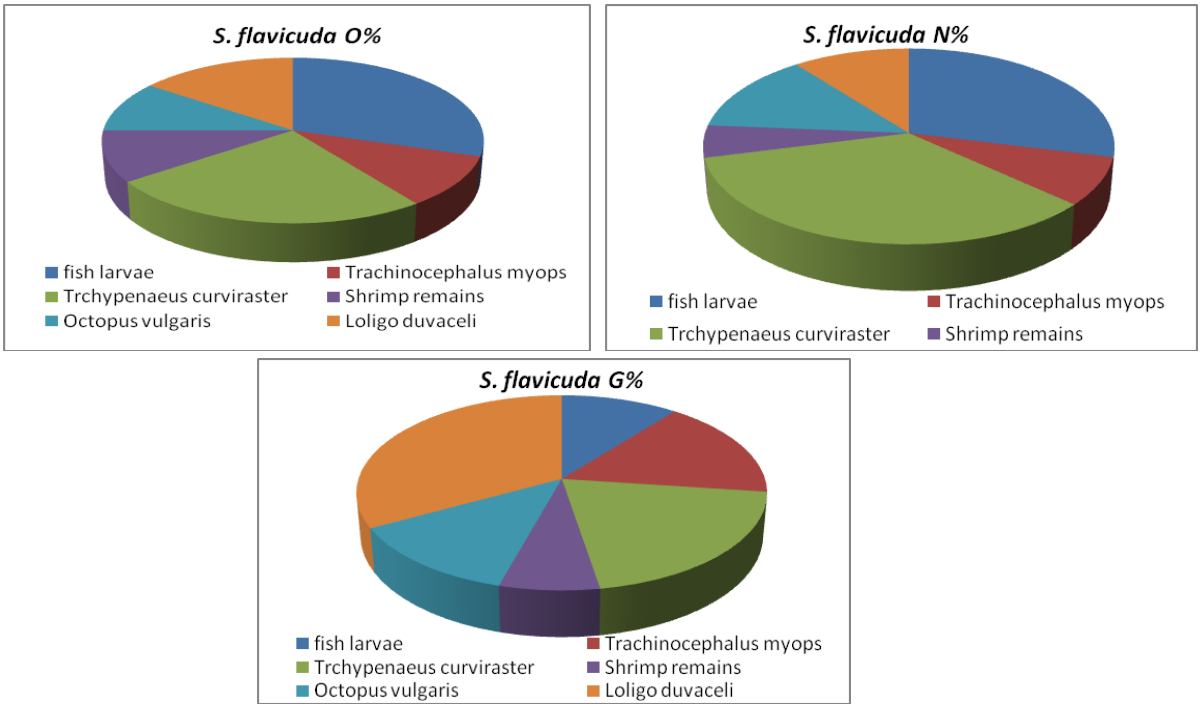


Fig 8: Food items in *S. flavicauda* in relation to percentage of occurrence, numerical, and gravimetric percentages.

DISCUSSION

Although the high abundance of barracuda fish in the Red Sea and Gulf of Suez they are one of the least investigated species in the region, thus previous studies on their biology and fisheries are very scarce (Osman, 2016). This is the first attempt to study the food and feeding of two of the most commercial barracuda species in the Gulf of Suez.

Food and Feeding for each fish species is very important to be studied as survival growth and reproductive activity depended on the income energy which represented by nutrients and feeding activity (Wootton, 1990). The results showed that *S. chrysotaenia* and *S. flavicauda* are mainly carnivorous, where the relative length of gut (RLG) for *S. chrysotaenia* and *S. flavicuda* are 0.49 and 0.15 respectively. According to Al-Husaainy (1949) when the RLG value ≤1 indicated that the fish is carnivorous. This is in agreement with Mohammadi zadeh *et al*., (2010) who indicated that *S. verridensis* RLG is 0.34 and more than 98% of stomach contents were eaten fishes. Barreiros *et al*., (2002) recorded that the stomach contents of *S. veridensis* were mainly fishes of family Carangidae, and Sparidae. The recorded food items for *S. chrysotaenia* and *S. flavicauda* in the Gulf of Suez were fishes, crustacean, and cephalopod indicating that the fish under investigation is mainly carnivorous, this agreed with Randall (1967); Sinha (1987) and Premaltha and Manjkumar (1990) Carpenter (1997); who emphasized that most barracuda species are carnivorous feed on other pelagic species. The mouth of barracuda is strong with sharp strong teeth which help them to be voracious predator (Fischer & Bianchi, 1984, Fischer *et al.,* 1987 and Ghisotti, 1995). *S. chrysotaenia* have high empty coefficient of 63.0% and *S. flavicauda* low empty coefficient of 40.8% which in agreement with (Ragheb, 2003) who found that empty coefficient for *S. chrysotaenia* and *S. flavicauda* was 61 and 40.6% respectively. This is also in agreement with (Schmidit, 1989) for *S. barracuda* and (Blaber, 1986) who recorded that *S. barracuda* empty coefficient was 56%. Mohammadi zedh *et al*., (2010) recorded the empty coefficient for *S. verridensis* as 47%. Barreiros *et al*., (2002) recorded the empty coefficient as 34% for *S. veridensis* from the northeastern Atlantic.

The present study indicated that *S. chrysotaenia* and *S. flavicauda* slow down their rate of feeding during spring which is the season of extensive spawning (Osman, 2016). These results revealed that the fish attains its lowest feeding activity before and during spawning season and its feeding activity increased after spawning , this agreed with (Ragheb, 2003) as she reported that the fullness intensity is higher in summer for both *S. chrysotaenia* and *S. flavicauda,*. Mohammadi zedh *et al*., (2010) indicated that fullness index increased before spawning and decreased during spawning for *S. veredensis* from North Persian Gulf. The most important food item was fish with Index of Relative Importance IRI % 14578.2, 14416.5, 13804, and 6249.6 during autumn, summer, spring and winter respectively. Then cephalopod represented by *Octopus vulgaris* and *Loligo duvaceli,* fish eggs and sea grass were found in small quantities. Whithead *et al.,* (1986) and Fischer *et al*., (1987) stated that *S. chrysotaenia* and *S. sphyraenia* from the Mediterranean Sea feed mainly on fishes. Ragheb (2003) recorded that *S. chrysotaenia* feeds mainly on fishes especially *S. aurita* and *E. encrasicolus* followed by crustacean. This in accordance with Carpenter *et al*., (1997) who confirmed that *S. putnamae* feed on fishes. Hosseini *et al*., (2009) stated that the main food item was *Liza subviridis* and *Tenualoza illisia* for *S. jello* in Bushier province water with percentage of occurrence (O% = 49.8% and 39.8%) of stomach content, then fish fragment and *Sepia pharanois* with

percentage occurrence of 5%. Randall (1967) stated that the stomach content of *S. picullidae* and *S. barracuda* from the western Indian Ocean contained fish by 97% and 82% respectively. Paterson (2000) as well as Grubich *et al.,* (2008) stated that *S. barracuda* is fish eater species. Also Bachok *et al*., (2004) studied the feeding habit of *S jello* and *S. chrysotaenia*, and found that they feed on yellow strip scads and big eye scads.

The predator-prey size relationship showed that as the predator grows in length the prey size increases in length. The guts of *S. chrysotaenia* and *S. flavicauda* are highly flexible where a fish of 16 cm length can ingest a prey of 2 cm and a fish of 28 cm can swallow a prey of 9 cm.

This study thrown light on the feeding habits of sphyraenids species in the Gulf of Suez and provided new information on the feeding habits of the most abundant high-order piscivores in the coastal study area.

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