Journal of Life Sciences 9 (2015) 347-355
doi: 10.17265/1934-7391/2015.08.001

Feeding Habits of the Copper Shark, *Carcharhinus brachyurus* (Günther, 1870) from Ain El-Ghazala Lagoon, Eastern Libya during the Period from February till June 2013

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Abstract: The feeding habits of 140 specimens of *Carcharhinus brachyurus* (Fam. Carcharhinidae) inhabiting Ain-El-Ghazala lagoon on the Mediterranean Sea, eastern Libya were studied monthly from February to June 2013. The annual diet composition, monthly variations in the diet composition, the variations of diet with length and the intensity of feeding were studied. *Carcharhinus brachyurus* feed on a wide variety of prey types: Pelagic bony fishes (54.5%), benthic bony fishes (36.4%), Cephalopods (6.8%), Cartilaginous fishes (1.7%) and Fish parts (0.6%). The Pelagic bony fishes and benthic bony fishes were the major food items during the study period in question, and they were found in all length groups. According to the results that were gleamed from this study, when the size of the sharks increased, the proportion of pelagic bony fishes within the sharks' stomachs grew in size, while the benthic bony fishes and Cephalopods decreased in size. The feeding intensity was quite high during the winter, spring and summer, this study is the first to study the Elasmobranchs in Libya, and it will be good base to study another species, specifically.

Key words: Feeding habits, *Carcharhinus brachyurus*, Ain-El-Ghazala lagoon, eastern coast, Mediterranean Sea, Libya.

1. Introduction

The Mediterranean is known to encompass a high diversity of elasmobranches and many very important habitats that are threatened nowadays. The Mediterranean region, elasmobranches are characterized by their diversity (49 sharks and 36 rays). The region is known to be an important habitat for cartilaginous fish and it thought to encompass unique breeding grounds for species such as the white shark (*Carchardon carcharias*), the copper shark (*Carcharhinus brachyurus*) and thornback ray (*Raja clavata*) [1].

Among the 85 species known in the Mediterranean, only 71 were assessed within the framework of the International Union for Conservation of Nature IUCN red list. More than 40 percent are vulnerable and endangered to critically endangered [2].

Going back in the history, it has been demonstrated that sharks in the Mediterranean Sea have declined by more than 97 percent in number and catch weight over the last 200 years they risk extinction of current fishing pressure continues [3].

The copper shark grows to around 11 feet in length. It tends to hunt in numbers rather than solitary. It is not considered dangerous despite being guilty of inflicting bites on humans in the waters off the Australian coasts.

Studies of feeding habits are essential to understand the functional role of fish within the ecosystem. Knowing what a species eats can provide information about its possible distribution and its position in food webs. Sharks are considered as top predators and may have an important role in the regulation of marine

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ecosystems at lower trophic levels. Information about the food habits is essential to appreciate the species biology and ecology, since the quality and quantity of food directly affect species growth and their maturation and mortality. In addition, quantitatively describing the diet and foraging habitat and predator–prey interactions of top predators in a community is a key step in ecosystem approaches to fisheries management.

From the available literature, it was found that few works have been published on the biology of sharks in the Mediterranean Sea [4, 5]. The giant devilray *Mobula mobular* and the basking shark *Cetorhinus maximus* are mainly planktivorous. It appears that increased basking sharks occurrence is not directly influenced by changes in temperature and salinity. However, some data obtained suggest the relative importance of copepods, especially of *Calanus helgolandicus*, in relation to the occurrence of basking sharks [6].

The white shark *Carcharodon carcharias* ingests principally cartilaginous fishes (*Isurus sp*., *Myliobatis Aquila* and *Dasyatis sp*.) and bony fishes (*Scomber scombrus*, *Thynnus thunnis*, *Sarda sarda*) and other preys such as marine turtles (*Chelonia mydas*) and cetaceans (*Delphinus sp*.) [7-9].

This is the first study so far on the feeding habits of *Carcharhinus brachyurus* in Libyan eastern coast. *Carcharhinus brachyurus* position in the trophic structure of the Libyan eastern coast is poorly understood. So the aim of the present study is defining the trophic relationships between *Carcharhinus brachyurus* with other invertebrates and fishes in this area, in order to understand the dynamic of this regional ecosystem.

2. Materials and Methods

Monthly samples of *Carcharhinus brachyurus* were collected during the period from February to June 2013 by using special nets from artisanal fishing in Ain El-Ghazala lagoon on the Mediterranean (Fig. 1 and 2). A total of 140 specimens of *Carcharhinus*

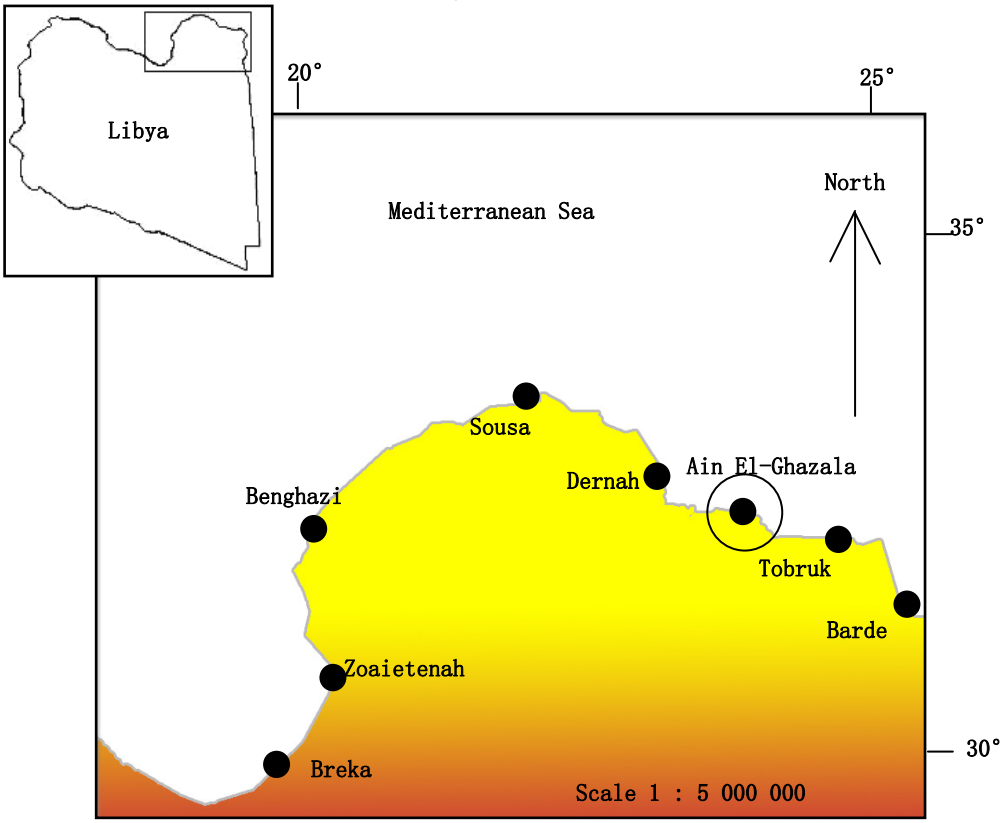

Fig. 1 Ain El-Ghazala lagoon, on the Mediterranean, Libya.

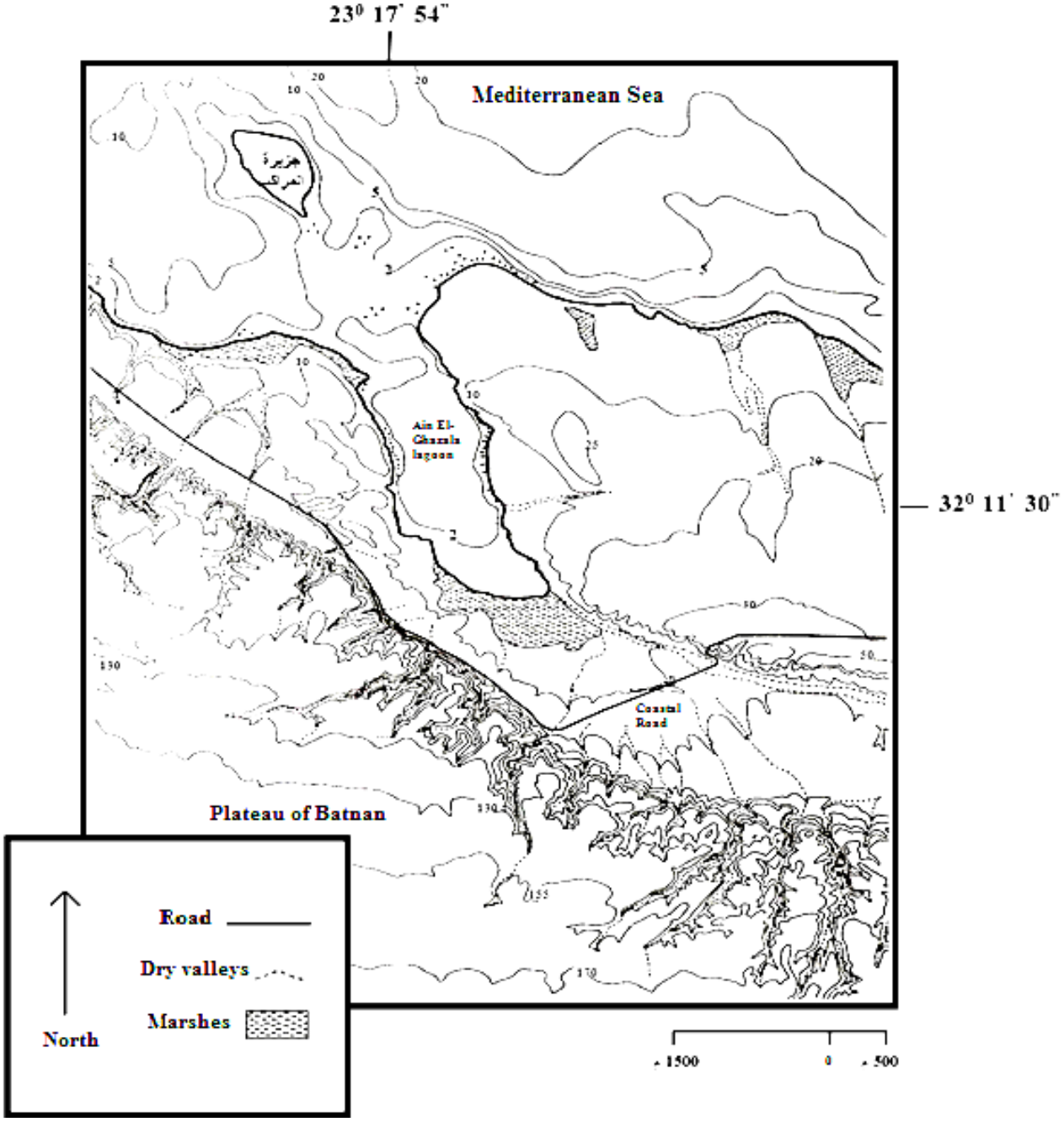

Fig. 2 Ain El-Ghazala lagoon, on the Mediterranean, Libya.

brachyurus were sampled for studying the feeding habits, Feeding Habits of the copper shark *Carcharhinus brachyurus* (Günther, 1870) from Ain El-Ghazala lagoon—Libya. Annual, diet composition, seasonal variations of diet, variations of diet with lengths and feeding intensity were estimated.

In this study, for each fish specimen total length measured to the nearest 0.1 cm. Each fish was dissected and the alimentary tract removed and preserved in formalin. The degree of fullness of the stomach was assessed by visual estimation and classified as empty, trace, quarter full, half full, three quarters full and completely full respectively [10]. Food items were identified to their groups. A list of general diet composition was made food analysis was made by numerical method [11]. The results were statistically

analysis subjected to the further statistical treatment [12] in order to give more precise information about food and feeding habits of *Carcharhinus brachyurus* (Fig. 3).

3. Results

3.1 Annual Diet Composition

The variety of food items was large (Fig. 4). However, Pelagic bony fishes supplemented by Benthic bony fishes and Cephalopods formed the major food groups for *Carcharhinus brachyurus*. Pelagic bony fishes made up of 54.5% by volume composition of the bulk of the diet which represented by *Oblada melanura, Diplodus vulgaris, D. sargus, D. annularis, Lithoganthus mormyrus and Pagrus pagrus*, whereas Benthic bony fishes (36.4%) coming in the second position of importance included *Mullus surmuletus* and *Solea solea*. Cephalopods (6.8%) were composed of *Sepia officinalis*, *S. elegans* and *Octobus vulgaris*. The other food items were Cartilaginous fishes constituting 1.7% which represented by small sharks and Rays, this followed by fish parts (0.6%) including fish scales and bones (Fig. 5).

3.2 Monthly Variations in Diet Composition

Food items were occurred in the study period from February to June (2013). The Pelagic bony fishes and benthic bony fishes were the major food items all study period (Table 1).

Table 2 showed seasonally variations in diet composition for 140 specimens *Carcharhinus brachyurus* in Ain El-Ghazala lagoon during the study period, in winter the fish preferred the pelagic bony fishes (48.5%) and Benthic bony fishes (37.3%). In spring the fish ingested on the pelagic bony fishes (48.5%), benthic bony fishes (37.3%) and Cephalopods (12.2%). While the Pelagic bony fishes (52.1%) and benthic bony fishes (43.3%) in summer. On the other hand, the target species was completely absent in autumn months.

3.3 Feeding Habit in Relation to Fish Size

The total length of *Carcharhinus brachyurus* population classified into 11 classes ranged from 80.5 cm to 212.4 cm with 11.9 cm interval (Table 3). Prey size differed between large size individuals, which had ingested the large size prey, whereas the small sized fish

Fig. 3 Some of Copper Sharks *Carcharhinus brachyurus* that where collected from Ain El-Ghazala lagoon during the period from February till June 2013.

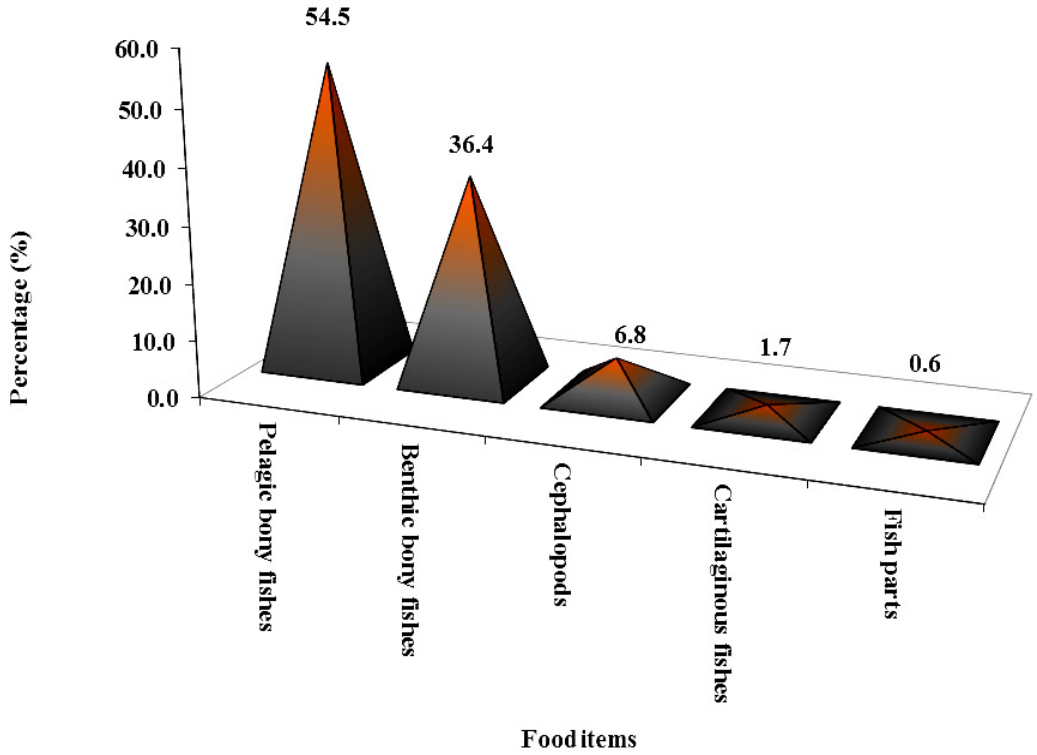

Fig. 4 The diet composition of *Carcharhinus brachyurus* from Ain El-Ghazala lagoon during the period from February till June 2013.

Fig. 5 Some of Bony fishes that where represented in the diet composition of *Carcharhinus brachyurus* from Ain El-Ghazala lagoon during the period from February till June 2013.

ingested the small size prey. The Pelagic bony fishes and benthic bony fishes were found in all length groups of *Carcharhinus brachyurus*.

In the present the pelagic bony fishes increased as the size increased while benthic bony fishes and Cephalopods decreased as the fish size increased. The Pelagic bony fishes were found in all length groups *Carcharhinus brachyurus*, they increased from 28.5% in size class (80.5-92.4 cm) to 74.4% in size class (200.5-212.4 cm). The Benthic bony fishes decreased

Table 1 Monthly variations in diet composition of *Carcharhinus brachyurus* from Ain El-Ghazala lagoon during the period from February till June 2013.

Months	No.	Food items				
		Pelagic bony fishes	Benthic bony fishes	Cephalopods	Cartilaginous fishes	Fish parts
Feb.(2013)	21	48.5	37.3	12.2	1.7	0.2
Mar.	23	54.8	38.9	4.1	1.6	0.6
Apr.	33	60.9	30.9	5.5	1.9	0.8
May	31	56.1	31.7	9.9	1.6	0.8
Jun.	32	52.1	43.3	2.3	1.7	0.6
Jul.	A	A	A	A	A	A
Aug.	A	A	A	A	A	A
Sep.	A	A	A	A	A	A
Oct.	A	A	A	A	A	A
Nov.	A	A	A	A	A	A
Dec.	A	A	A	A	A	A
Jan.(2014)	A	A	A	A	A	A
Total	140	272	182	34	9	3
%		54.5	36.4	6.8	1.7	0.6

Data expressed as percentage, (A) No fish in month occurred.

Table 2 Seasonally variations in diet composition of *Carcharhinus brachyurus* from Ain El-Ghazala lagoon during the period from February till June 2013.

Seasons	No. of fish	Pelagic bony fishes	Benthic bony fishes	Cephalopods	Cartilaginous fishes	Fish parts
Winter	21	48.5	37.3	12.2	1.7	0.2
Spring	87	48.5	37.3	12.2	1.7	0.2
Summer	32	52.1	43.3	2.3	1.7	0.6
Autumn	B	B	B	B	B	B

Data expressed as percentage, (B) No fish in season occurred.

Table 3 The diet composition of different size classes *Carcharhinus brachyurus* from Ain El-Ghazala lagoon during the period from February till June 2013.

Size groups (cm)	No.	Food items				
		Pelagic bony fishes	Benthic bony fishes	Cephalopods	Cartilaginous fishes	Fish parts
80.5 - 92.4	16	28.5	51.9	19.6	C	C
92.5 - 104.4	14	37.2	44.6	18.2	C	C
104.5 - 116.4	13	41.3	43.1	15.6	C	C
116.5 - 128.4	12	43.5	41.4	15.1	C	C
128.5 - 140.4	12	54.9	40.4	4.7	C	C
140.5 - 152.4	14	61.9	36.9	1.3	C	C
152.5 - 164.4	15	67.3	32.6	C	C	C
164.5 - 176.4	11	68.7	31.3	C	C	C
176.5 - 188.4	10	71.1	28.9	C	C	C
188.5 - 200.4	11	74.2	25.7	C	C	C
200.5 - 212.4	12	74.4	3.9	C	15.3	6.4

Data expressed as percentage, (C) No food in class occurred.

from 51.9% in size class (80.5-92.4 cm) to 3.9% in size class (200.5-212.4 cm), Cephalopods decreased from 19.6% in size class (80.5-92.4 cm) to 1.3% in size class (140.5-152.4 cm), then completely absent in the following length groups, Cartilaginous fishes and fish parts were ingested in size class (200.5-212.4 cm) by 15.3% and 6.4% respectively.

3.4 Feeding Intensity

Fishes with stomach half full, almost full and full of food ranked b% constituted 75.0% of all analyzed individual, whereas those with stomach that were empty or with traces of food and quarter full ranked a% represented 24.9% of the total specimens (Table 4).

The feeding activities were quite high during winter 80.7%, 75.0% in spring and summer 69.2%. In autumn no fish in season occurred (Table 5).

4. Discussion

The food and feeding habits of shark fishes have been studied by many authors [4, 5], Sharks are considered as top predators and may have an important role in the regulation of marine ecosystems at lower trophic levels. The information about the food habits is essential to appreciate the species biology and ecology, since the quality and quantity of food directly affect species growth and their maturation and mortality. In addition, quantitatively describing the diet and foraging habitat and predator–prey interactions of top predators in a community is a key step in ecosystem approaches to fisheries management. In the Mediterranean and Black Sea, 94 identified published works report information on the diet of 35 shark species. More than 55 percent of them appeared last decade [12-17].

In the current study *Carcharhinus brachyurus* feed on a wide variety of prey types: Pelagic bony fishes, Benthic bony fishes, Cephalopods, Cartilaginous fishes and Fish parts, formed the major food group for the target species this is full agreement with [13, 14].

In the present work, the pelagic bony fishes and benthic bony fishes were the major food items all study period and they were found in all length groups. Only, in spring the fish ingested on the pelagic bony fishes, benthic bony fishes and Cephalopods. On the other hand, the target species was completely absent in autumn months, this is full agreement.

Table 4 Monthly variations in the intensity of feeding of *Carcharhinus brachyurus* from Ain El-Ghazala lagoon during the period from February till June 2013.

Months	No.of fish	The degree of distension of the stomach							
		Empty	Trace	1/4	A %	1/2	3/4	Full	B %
Feb.(2013)	21	17.4	D	1.9	19.3	12.5	48.3	19.9	80.7
Mar.	23	13.9	D	D	13.9	6.0	30.1	49.9	86.0
Apr.	33	16.0	2.0	18.0	36.0	26.0	21.1	16.8	63.9
May	31	8.9	D	15.9	24.8	26.2	22.7	26.3	75.2
Jun.	32	23.2	7.5	D	30.7	13.3	15.3	40.6	69.2
Jul.	A	A	A	A	A	A	A	A	A
Aug.	A	A	A	A	A	A	A	A	A
Sep.	A	A	A	A	A	A	A	A	A
Oct.	A	A	A	A	A	A	A	A	A
Nov.	A	A	A	A	A	A	A	A	A
Dec.	A	A	A	A	A	A	A	A	A
Jan.	A	A	A	A	A	A	A	A	A
Average					24.9				75.0

Data expressed as percentage, (D) No food in month occurred, (A) No fish in month occurred.

Table 5 Seasonally variations in the intensity of feeding of *Carcharhinus brachyurus* from Ain El-Ghazala lagoon during the period from February till June 2013.

Seasons	No.of fish	The degree of distension of the stomach							
		Empty	Trace	1/4	A %	1/2	3/4	Full	B %
Winter	21	17.4	E	1.9	19.3	12.5	48.3	19.9	80.7
Spring	87	12.9	0.7	11.3	24.9	19.4	24.6	31.0	75.0
Summer	32	23.2	7.5	E	30.7	13.3	15.3	40.6	69.2
Autumn	B	B	B	B	B	B	B	B	B

Data expressed as percentage, (E) No food in season occurred, (B) No fish in season occurred.

Generally, the food extent demands and ability for food acquisition increase with fish development [18], and the feeding habits of different species of sharks in Italian waters on the western Adriatic Sea [22], and they concluded that the numbers and size prey taxa increased with size of the fish due to the ability of larger fishes to consume a wide range of prey sizes than smaller fishes [19], this phenomenon appeared to be done for the target species in present work, In the present the Pelagic bony fishes increased as the size increased while Benthic bony fishes and Cephalopods decreased as the fish size increased [12], It is a similar to the monthly variation in the condition factors fish is affected by the feeding activity which may show there reflection on the body condition [14], this phenomenon appears to be correct for species in the present work. The highest condition factor values (K_f and K_c) were recorded in winter and summer, these results coincide with the degree of stomach fullness in winter, spring and summer due to food availability, this supports observations describe in the Turkish coast of south eastern Black Sea [20].

5. Conclusions

To sum up, this study is carried out to be the first time to study the biology of sharks and rays in Libya, and Copper shark is one of the known species in this area, However, more extended studies could be required to create good data base for these species in this region.

Acknowledgments

The authors express their sincere gratitude to the stuff of the branch of Marine biology, the Zoology Department, Omar Al-Mukhtar University, El-Bieda, Libya, for the equipment and laboratory supports.

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