

## Carcharhinid shark species (Family Carcharhinidae), with special reference to the first records in the Egyptian Mediterranean Waters, Alexandria, Egypt.

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### ABSTRACT

The present study aimed to provide an update on carcharhinid sharks (Family: Carcharhinidae) in the Egyptian Mediterranean waters, based on the differences in morphological features of the body. A total of 36 specimens of carcharhinid sharks belong to 7 species of family Carcharhinidae were seasonally collected from the commercial catch at land fish market in Alexandria of Mediterranean Sea, during the period from May 2017 to June 2018. Morphometric characters were recorded for each specimen. Many photos had been captured for each shark specimen and processed by Image J software for calculating different ratios of morphological aspects for shark's body.

Results showed that seven species belonging to the family Carcharhinidae (*Carcharhinus altimus*, *C. brachyurus*, *C. brevipinna*, *C. falciformis*, *C. obscurus*, *C. plumbeus* and *Prionace glauca*) were found to inhabit the Egyptian Mediterranean waters at Alexandria. Four of them were firstly recorded in the Egyptian Mediterranean waters (i.e. *C. brachyurus*, *C. falciformis*, *C. obscurus* and *Prionace glauca*). Our study was attempted to add some morphometric characters for the identification of studied species. Statistical analysis of morphometric ratios showed significant differences between investigated species ( $P < 0.05$ ), revealing its capability as classifying tool.

### INTRODUCTION

Cartilaginous fishes (sharks, rays, skates, and chimaeras) were the phylogenetically oldest group of living jawed vertebrates. They are an important out-group for understanding the evolution of bony vertebrates such as teleost fish and human (Venkatesh *et al.*, 2007).

Several studies have been done on the composition of shark species in different regions of Mediterranean Sea (Renon *et al.*, 2001 and Iglesias *et al.*, 2005). FAO (2005) mentioned that, 49 species of sharks belongs to 17 families and 5 orders; Hexanchiformes, Squaliformes, Squatiniformes, Lamniformes and Carcharhiniformes were recorded in the Mediterranean and Black Seas.

In Egyptian Mediterranean water, Order Carcharhiniformes comprised 13 species belongs to 4 families; Scyliorhinidae, Triakidae, Carcharhinidae and

Sphyrnidae. Family Carcharhinidae represented by 4 species; *Carcharhinus brevipinna*, *Carcharhinus limbatus*, *Carcharhinus melanopterus* and *Carcharhinus plumbeus* (Akel & Karachle, 2017). However, shark species composition in the Egyptian Mediterranean waters is still scarcely known.

Twenty-four percent of shark, skate and ray species are considered threatened with extinction by the IUCN Red List's Shark Specialist Group (Dulvy *et al.*, 2014). The increasing consumption of shark products, along with the shark's fishing vulnerabilities, led to the decrease in certain shark populations (Chuang *et al.*, 2016).

Therefore, the present study aimed to provide an update on the carcharhinid species (Family: Carcharhinidae) in the Egyptian Mediterranean waters, based on differences in morphological features of the body.

## MATERIALS AND METHODS

### Sampling sites

Alexandria is located about 223 Km North of Cairo and lies between  $31^{\circ}12'56.3''N$  &  $29^{\circ}57'18.97''E$ . Four Fish land markets (El-Max, Anfushi, Abu Qir and Al-Maadia) were the main sites for shark specimen collection at the shoreline of Alexandria (Fig. 1).



Fig. 1: Map showing Alexandria coast of Egyptian Mediterranean Sea

### Samples collection

A total of 36 specimens of sharks belong to 7 species of family Carcharhinidae has been collected (14 of *Carcharhinus altimus*, one of *Carcharhinus brachyurus*, 7 of *Carcharhinus brevipinna*, 2 of *Carcharhinus falciformis*, 8 of *Carcharhinus obscurus*, 3 of *Carcharhinus plumbeus* and one of *Prionace glauca*). The samples were seasonally collected from the commercial catch at landed in the local fish markets of Alexandria during the period from May 2017 to June 2018.

Sharks freshly examined. Total length was measured to the nearest millimetre and recorded for each specimen. Meristic characters were recorded (number of gill slits, number of spines if present and number of fins). Many photos had been captured for each shark specimen and processed by Image J software to calculate different ratios of morphological aspects for shark's body. Some shark specimen were preserved in 10% formalin solution and transported to laboratory of Marine Biology, Zoology Department, Faculty of Science, Al-Azhar University, Cairo, Egypt for latter examinations. In the laboratory, sharks were identified according to FAO (2005) and the following studies were carried out.

### Morphometric characters

To study body morphometric characters of shark species, the following measurements (Figure 2) were recorded for each fish sample:

1. Total length (TL): Length from the tip of snout to the end of the caudal fin.
2. Fork length (FL): Length from the tip of snout to the fork of the caudal fin.
3. Pre-caudal fin length (PCL): Length from the tip of snout to the origin of the caudal fin.
4. Pre-1<sup>st</sup> dorsal fin length (PD<sub>1</sub>L): Length from the tip of snout to the anterior end of the first dorsal fin.
5. Pre-2<sup>nd</sup> dorsal fin length (PD<sub>2</sub>L): Length from the tip of snout to the anterior end of the second dorsal fin.
6. Pre-pectoral fin length (PPL): Length from the tip of snout to the anterior end of pectoral fin.
7. Pre-pelvic fin length (PPvL): Length from the tip of snout to the anterior end of pelvic fin.
8. Pre-anal fin length (PAL): Length from the tip of snout to the anterior end of the anal fin.
9. Head length (HL): Length from the tip of snout to the last gill slit.
10. Eye diameter (ED): Horizontal diameter of the eye.
11. Pre-orbital length (POL): Length from the tip of snout to the beginning of the eye.

Total length was taken as a reference for measurement of fork length (FL), pre-caudal length (PCL) and head length (HL). Fork length was taken as a reference for measurements of pre-1<sup>st</sup> dorsal fin length (PD<sub>1</sub>L), pre-2<sup>nd</sup> dorsal fin length (PD<sub>2</sub>L), pre-pectoral fin length (PPL), pre-pelvic fin length (PPvL) and pre-anal fin length (PAL). Head length was taken as a reference for measurements of eye diameter (ED) and pre-orbital length (POL).

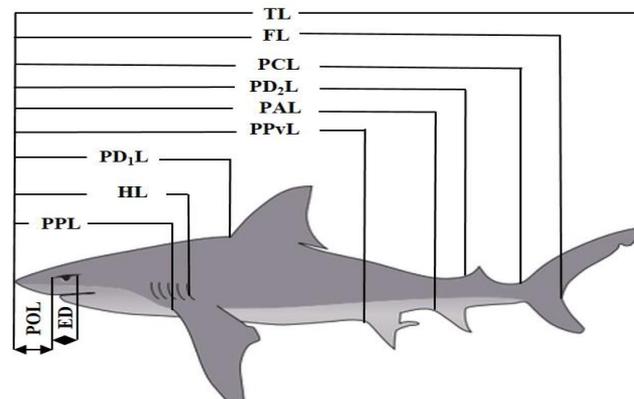


Fig. 2: Diagrammatic representation of body morphometric measurements of sharks.

### Data analysis

Statistical analysis and graphics of data was conducted by using Microsoft Excel and Minitab 18.0 and Pc-Ord 5.0 software, under windows programs.

## RESULTS

### Family: Carcharhinidae

Species of this family are characterized by round eye, 2<sup>nd</sup> dorsal fin much less than 2/3 height of 1<sup>st</sup> dorsal fin, except in *Negaprion* and *Triaenodon* and presence of precaudal pit. Only *Carcharhinus* species with an interdorsal ridge that has the dorsal fin origin behind the free rear tip of the pectoral fins. Seven species belongs to family

Carcharhinidae (*Carcharhinus altimus*, *C. brachyurus*, *C. brevipinna*, *C. falciformis*, *C. obscurus*, *C. plumbeus* and *Prionace glauca*) are found to inhabit the Egyptian Mediterranean waters at Alexandria. Four of them were first recorded in the Egyptian Mediterranean waters (*C. brachyurus*, *C. falciformis*, *C. obscurus* and *Prionace glauca*). Almost all family members show close correlation within the cluster as shown in Figure (3).

**Bignose shark, *Carcharhinus altimus*:**

Fourteen specimens of *C. altimus* were collected, and the total length of samples ranging from 54.62 to 160.82 cm with an average of  $108.47 \pm 34.08$  cm (Table 1). This species is rather heavily built; the bignose shark has a long, broad, and blunt snout with the nostrils preceded by well-developed, triangular flaps of skin. The moderately large, circular eyes are equipped with nictitating membranes (protective third eyelids). The mouth is broadly curved and lacks obvious furrows at the corners. The five pairs of gill slits are moderately long. The long and wide pectoral fins have pointed tips and nearly straight margins. The first dorsal fin originates roughly over the rear of the pectoral fin's bases; it is fairly tall and falcate (sickle-shaped), with a blunt apex and a long free rear tip. The second dorsal fin is relatively large with a short free rear tip, and is positioned slightly ahead of the anal fin. A high midline ridge is present between the dorsal fin. The caudal peduncle has a crescent-shaped notch at the origin of the upper caudal fin margin. The caudal fin has a large lower lobe and a strong ventral notch near the tip of the upper lobe. The coloration is gray to bronze above, with a faint pale stripe on the flank, and white below; sometimes there is a green sheen along the gills. The tips of the fins are darker, except for the pelvic fins; this is most obvious in young sharks (PLATE I).

The fork length, pre-caudal fin length and head length ranges were 78.7-85.08%, 70.07-78.42%, 17.51-23.46% of the total body length with averages of  $80.93 \pm 1.86\%$ ,  $74.52 \pm 2.12\%$  and  $21.1 \pm 1.57\%$ , respectively. While pre-first dorsal fin length, pre-second dorsal fin length, pre-pectoral fins length, pre-pelvic fins length and pre-anal fin length ranges were 36.53-41.06%, 82.88-88.68%, 25.94-34.52%, 65.45-72.66% and 81.48-88.44% of the pre-caudal fin length with averages of  $38.53 \pm 1.33\%$ ,  $85.17 \pm 1.57\%$ ,  $29.36 \pm 2.04\%$ ,  $68.77 \pm 2.03\%$  and  $84.97 \pm 1.86\%$ , respectively. On the other hand, the pre-orbital length and eye diameter are occupying 18.03-27.23% and 3.43-7.01% of the head length with an average of  $21.48 \pm 3.03\%$  in the former and  $4.97 \pm 1.23\%$  in the latter (Table 1). The body morphometric ratios showed significant differences with all investigated species ( $P < 0.05$ ) except *C. falciformis* ( $P > 0.05$ ) (Table 2).

**Copper shark, *Carcharhinus brachyurus*:**

Only one specimen of the *C. brachyurus* was obtained, this specimen measured 173.82 cm in total length (Table 1). This shark is recorded for the first time in the Egyptian Mediterranean waters. The body is a slender, streamlined with a slightly arched profile just behind the head. The snout is rather long and pointed, with the nostrils preceded by low flaps of skin. The round, moderately large eyes are equipped with nictitating membranes (protective third eyelids). The five pairs of gill slits are fairly long. The pectoral fins are large, pointed, and falcate (sickle-shaped). The first dorsal fin is tall, with a pointed apex and a concave trailing margin; its origin lies about even with the tips of the pectoral fins. The second dorsal fin is small and low, and positioned about opposite to the anal fin. There is usually no ridge between the dorsal fin. The caudal fin has a well-developed lower lobe and a deep ventral notch near the tip of the upper lobe. The underside is white, which extends onto the flanks as a prominent band (PLATE I).

The fork length, pre-caudal fin length and head length measured 91.33%, 86.74% and 29.39% of the total body length. Pre-first dorsal fin length, pre-pectoral fins length, pre-pelvic fins length and pre-anal fin length were 46.14%, 32.37%, 78.21% and 89.1% of the pre-caudal fin length respectively. The pre-second dorsal fin length is difficult to be measured due to the weight and the position of the shark specimen in the fish market and the difficult to flip it. On the other hand, the pre-orbital length and eye diameter occupying 28.58% and 3.12% of the head length, respectively (Table 1). The body morphometric ratios showed significant variance with all investigated species ( $P < 0.05$ ) (Table 2).

**Spinner shark, *Carcharhinus brevipinna*:**

Seven specimens of *C. brevipinna* were collected, and the total length of samples ranging from 63.65 to 176.77 cm with an average of  $110.99 \pm 42.91$  cm (Table 1). A slender shark with a long, narrow, pointed snout, long gill slits and small, narrow-cusped teeth; first dorsal fin small; no interdorsal ridge; labial furrows longer than in any other grey shark. The color is grey above and white below, with a conspicuous white band on sides; second dorsal, anal, undersides of pectorals and lower caudal-fin lobe black or dark grey-tipped in subadults and adults, but unmarked or nearly so in small individuals (PLATE I).

The fork length, pre-caudal fin length and head length forming 79.8-83.82%, 67.43-79.77% and 21.86-25.36% of the total body length with an average of  $82.44 \pm 1.48\%$ ,  $75.07 \pm 4.97\%$  and  $23.92 \pm 1.25\%$ , respectively. While pre-first dorsal fin length, pre-second dorsal fin length, pre-pectoral fins length, pre-pelvic fins length and pre-anal fin length ranging 44.8-47.78%, 82.31-88.67%, 25.66-34.36%, 70.08-73.37% and 84.44-88.67% of the pre-caudal fin length with averages of  $46.73 \pm 1.05\%$ ,  $86.52 \pm 2.03\%$ ,  $29.39 \pm 3.51\%$ ,  $71.58 \pm 1.11\%$  and  $86.82 \pm 1.34\%$ , respectively. On the other hand, the pre-orbital length and eye diameter occupying 26.7-33.13% and 4.53-5.98% of the head length with an average of  $29.82 \pm 2.16\%$  in the former and  $5.42 \pm 0.59\%$  in the latter (Table 1). The body morphometric ratios showed significant variance with all investigated species ( $P < 0.05$ ) except *P. glauca* ( $P > 0.05$ ) (Table 2).

**Silky shark, *Carcharhinus falciformis***

Two specimens of the *C. falciformis* were collected, and the total length of samples ranging from 75.77 to 114.5 cm with an average of  $95.14 \pm 27.39$  cm (Table 1). This shark is recorded for the first time in the Egyptian Mediterranean waters. The body is large, slim shark with a moderately long, flat and rounded snout, large eyes, small jaws, and oblique-cusped teeth with serrations. 2nd dorsal fin is low with greatly elongated rear tip. Grey or bluish-grey above, white below; no conspicuous fin markings. The dorsal fin origin is behind the free rear tip of the pectoral fins (PLATE I).

The fork length, pre-caudal fin length and head length ranging from 81.67-81.71%, 74.62-74.66% and 19.68-22.28% of the total body length with averages of  $81.69 \pm 0.02\%$ ,  $74.64 \pm 0.02\%$  and  $20.98 \pm 1.83\%$ , respectively. While pre-first dorsal fin length, pre-second dorsal fin length, pre-pectoral fins length, pre-pelvic fins length and pre-anal fin length ranging 42.09-42.87%, 85.59-87.27%, 24.69-27.27%, 67.77-68.63% and 83.76-85.75% of the pre-caudal fin length with averages of  $42.48 \pm 0.55\%$ ,  $86.43 \pm 1.18\%$ ,  $25.98 \pm 1.82\%$ ,  $68.2 \pm 0.61\%$  and  $84.76 \pm 1.4\%$ , respectively. On the other hand, the pre-orbital length and eye diameter occupying 19.96-22.34% and 5.58-5.59% of the head length with an average of  $21.15 \pm 1.68\%$  in the former and  $5.585 \pm 0.007\%$  in the latter (Table 1).

Table 1: Morphometric characters of shark species in family: Carcharhinidae, collected from Alexandria, during the period from May 2017 to June 2018.

Species	N	Desc. Stat.	TL (cm)	FL/TL	PCL/TL	PD <sub>1</sub> L/ PCL	PD <sub>2</sub> L/ PCL	PPL/ PCL	PPvL/ PCL	PAL/ PCL	HL/TL	POL/ HL	ED/ HL
<i>C. altimus</i>	14	Range	54.62- 160.82	78.7 -85.08	70.07- 78.42	36.53- 41.06	82.88- 88.68	25.94- 34.52	65.45- 72.66	81.48- 88.44	17.51- 23.46	18.03- 27.23	3.43 -7.01
		Mean± SD	108.47± 34.08	80.93± 1.86	74.52± 2.12	38.53± 1.33	85.17± 1.57	29.36± 2.04	68.77± 2.03	84.97± 1.86	21.1± 1.57	21.48± 3.03	4.97± 1.23
		Mean± SD	173.82 91.33	86.74 46.14	- -	- -	- -	32.37 78.21	78.21 89.1	29.39 28.58	28.58 3.12		
<i>C. brachyurus</i>	1	Range	-	-	-	-	-	-	-	-	-	-	-
<i>C. brevipinna</i>	7	Range	63.65- 176.77	79.8 -83.82	67.43- 79.77	44.8 -47.78	82.31- 88.67	25.66- 34.36	70.08- 73.37	84.44- 88.67	21.86- 25.36	26.7 -33.13	4.53 -5.98
		Mean± SD	110.99± 42.91	82.44± 1.48	75.07± 4.97	46.73± 1.05	86.52± 2.03	29.39± 3.51	71.58± 1.11	86.82± 1.34	23.92± 1.25	29.82± 2.16	5.42± 0.59
		Mean± SD	42.91 1.48	81.67- 81.71	74.62- 74.66	42.09- 42.87	85.59- 87.27	24.69- 27.27	67.77- 68.63	83.76- 85.75	19.68- 22.28	19.96- 22.34	5.58 -5.58
<i>C. falciformis</i>	2	Range	75.77- 114.5	81.67- 81.71	74.62- 74.66	42.09- 42.87	85.59- 87.27	24.69- 27.27	67.77- 68.63	83.76- 85.75	19.68- 22.28	19.96- 22.34	5.58 -5.58
		Mean± SD	95.14± 27.39	81.69± 0.02	74.64± 0.02	42.48± 0.55	86.43± 1.18	25.98± 1.82	68.2± 0.61	84.76± 1.4	20.98± 1.83	21.15± 1.68	5.58± 0.007
		Mean± SD	58.08- 192.86	78.65- 83.29	71.19- 80.92	27.89- 32.52	83.49- 87.31	39.71- 42.92	68.58 -70.4	83.49- 87.31	18.83- 24.47	24.67- 31.51	4.71 -7.39
<i>C. obscurus</i>	8	Range	58.08- 192.86	78.65- 83.29	71.19- 80.92	27.89- 32.52	83.49- 87.31	39.71- 42.92	68.58 -70.4	83.49- 87.31	18.83- 24.47	24.67- 31.51	4.71 -7.39
		Mean± SD	134.11± 44.77	81.01± 1.56	74.84± 2.92	29.73± 1.79	85.9± 1.25	41.4± 1.23	69.71± 0.68	85.9± 1.25	20.81± 1.84	28.32± 2.65	5.66± 0.81
		Mean± SD	88.03- 106.94	80.64 -83.2	69.62- 75.43	31.71- 34.51	85.23- 87.27	23.65- 25.42	66.77- 67.89	85.57- 87.27	16.47- 22.21	19.85 -21.5	2.96 -3.47
<i>C. plumbeus</i>	3	Range	88.03- 106.94	80.64 -83.2	69.62- 75.43	31.71- 34.51	85.23- 87.27	23.65- 25.42	66.77- 67.89	85.57- 87.27	16.47- 22.21	19.85 -21.5	2.96 -3.47
		Mean± SD	99.48 ±10.06	81.56± 1.42	72.58± 2.9	33.12± 1.4	86.2± 1.02	24.59± 0.88	67.2± 0.6	86.31± 0.87	19.24± 2.87	20.78± 0.84	3.26± 0.26
		Mean± SD	-	-	-	-	-	-	-	-	-	-	-
<i>P. glauca</i>	1	Range	-	-	-	-	-	-	-	-	-	-	-
		Mean± SD	256.95	87.54	80.16	52.03	87.02	27	68.17	84.91	22.97	17.39	5.32

The body morphometric ratios showed significant differences with all investigated species ( $P < 0.05$ ) except *C. altimus* and *C. obscurus* ( $P > 0.05$ ) (Table 2).

**Dusky shark, *Carcharhinus obscurus*: (first record):**

Eight specimens of the *C. obscurus* were collected, and the total length of samples ranging 58.08-192.86 cm with an average of  $134.11 \pm 44.77$  cm (Table 1). This shark is recorded for the first time in the Egyptian Mediterranean waters. The body of this shark is a slender, streamlined with a broadly rounded snout no longer than the width of the mouth. The nostrils are preceded by barely developed flaps of skin. The medium-sized, circular eyes are equipped with nictitating membranes (protective third eyelids). The large pectoral fins measure around one-fifth as long as the body, and have a falcate (sickle-like) shape tapering to a point. The first dorsal fin is of moderate size and somewhat falcate, with a pointed apex and a strongly concave rear margin; its origin lies over the pectoral fin's free rear tips. The second dorsal fin is much smaller and is positioned about opposite the anal fin. A low dorsal ridge is present between the dorsal fin. The caudal fin is large and high, with a well-developed lower lobe and a ventral notch near the tip of the upper lobe. This species is bronzy to bluish gray above and white below, which extends onto the flanks as a faint lighter stripe. The fins, particularly the underside of the pectoral fins and the lower caudal fin lobe darken towards the tips; this is more obvious in juveniles (PLATE II).

The fork length, pre-caudal fin length and head length ranges were 78.65-83.29%, 71.19-80.92% and 18.83-24.47% of the total body length with averages of  $81.01 \pm 1.56\%$ ,  $74.84 \pm 2.92\%$  and  $20.81 \pm 1.84\%$ , respectively. While pre-first dorsal fin length, pre-second dorsal fin length, pre-pectoral fins length, pre-pelvic fins length and pre-anal fin length ranging 27.89-32.52%, 83.49-87.31%, 39.71-42.92%, 68.58-70.4% and 83.49-87.31% of the pre-caudal fin length with averages of  $29.73 \pm 1.79\%$ ,  $85.9 \pm 1.25\%$ ,  $41.4 \pm 1.23\%$ ,  $69.71 \pm 0.68\%$  and  $85.9 \pm 1.25\%$ , respectively. On the other hand, the pre-orbital length and eye diameter occupying 24.67-31.51% and 4.71-7.39% of the head length with an average of  $28.32 \pm 2.65\%$  in the former and  $5.66 \pm 0.81\%$  in the latter (Table 1). The body morphometric ratios showed significant variance with all investigated species ( $P < 0.05$ ) except *P. glauca* and *C. falciformis* ( $P > 0.05$ ) (Table 2).

Table 2: Analysis of variance Using Fisher LSD Method and 95% Confidence Species

Species	Grouping			
<i>C. brachyurus</i>	A			
<i>C. brevipinna</i>		B		
<i>P. glauca</i>		B	C	
<i>C. obscurus</i>			C	D
<i>C. falciformis</i>				D E
<i>C. altimus</i>				E
<i>C. plumbeus</i>				F

*Means that do not share a letter are significantly different.*

**Sandbar shark, *Carcharhinus plumbeus*:**

Three specimens of *C. plumbeus* were collected, and the total length of samples ranging 88.03-106.94 cm with an average of  $99.48 \pm 10.06$  cm (Table 1). The dorsal fin is triangular and very high, and it has very long pectoral fins. *C. plumbeus* sharks usually have heavy-set bodies and rounded snouts that are shorter than the average shark's snout. Its second dorsal fin and anal fin are close to the same height. Its body

color can vary from a bluish to a brownish grey to a bronze, with a white or pale underside (PLATE II).

The fork length, pre-caudal fin length and head length ranging 80.64-83.2%, 69.62-75.43% and 16.47-22.21% of the total body length with averages of  $81.56 \pm 1.42\%$ ,  $72.58 \pm 2.91\%$  and  $19.24 \pm 2.87\%$ , respectively. While pre-first dorsal fin length, pre-second dorsal fin length, pre-pectoral fins length, pre-pelvic fins length and pre-anal fin length ranging 31.71-34.51%, 85.23-87.27%, 23.65-25.42%, 66.77-67.89% and 85.57-87.27% of the pre-caudal fin length with averages of  $33.12 \pm 1.4\%$ ,  $86.2 \pm 1.02\%$ ,  $24.59 \pm 0.88\%$ ,  $67.2 \pm 0.6\%$  and  $86.31 \pm 0.87\%$ , respectively. On the other hand, the pre-orbital length and eye diameter occupying 19.85-21.5% and 2.96-3.47% of the head length with an average of  $20.78 \pm 0.84\%$  in the former and  $3.26 \pm 0.26\%$  in the latter (Table 1). The body morphometric ratios showed significant variance with all investigated species ( $P < 0.05$ ) (Table 2).

#### **Blue shark, *Prionace glauca* (first record):**

Only one specimen of *P. glauca* was collected and the total length of this sample is 256.95 cm (Table 1). This shark is recorded for the first time in the Egyptian Mediterranean waters. The dorsum is a deep shade of indigo, while the flanks are a vibrant blue. The ventral surface fades to a light grey. The body is streamlined and thin, with an elongated heterocercal caudal (tail) fin. The second dorsal fin is approximately half the size of the first, and the pectoral fins are proportionately longer than in most other shark species. The eyes are large (PLATE II).

The fork length, pre-caudal fin length and head length have percentages of 87.54%, 80.16% and 22.97% of the total body length, respectively. While pre-first dorsal fin length, pre-pectoral fins length, pre-pelvic fins length and pre-anal fin length are 52.03%, 87.02%, 27%, 68.17% and 84.91% of the pre-caudal fin length, respectively. On the other hand, the pre-orbital length and eye diameter occupying 17.39% and 5.32% of the head length, respectively (Table 1). The body morphometric ratios showed significant variance with all investigated species ( $P < 0.05$ ) except *C. brevipinna* and *C. obscurus* ( $P > 0.05$ ) (Table 2).

#### **Statistical analysis:**

Due to the rarity and hard to find *Carcharhinus brachyurus* and *Prionace glauca*, they only represented by one specimen for each. However, the statistical analysis came along to what to be expected refusing null hypothesis, and proving the validation of dorsal fin morphometric measures to separate and classify studied shark species. Revealing that, in the future the finding of more replicates from this species could improve what already have been obtained.

Using Fisher LSD method and 95% confidence, ratios showed significant variance between different species revealing its capability as classifying tool (Table 3).

Multi-variant data analysis was conducted to evaluate the potential of species separation using body morphometric measurements; which has been proven as shown in Figures (3-5).

As shown in Figure (3), two-way cluster analysis (Heat map) shows color graded variables on which the species has been clustered, showing the similarities and the differentiations between contribute variables. Also, species belonging to the same order has been clustered in the same clade.

2-D ordination graph (Figure 4) showed that specimens of species represented as triangular points, while different variables represented as arrows with direction towards its positive correlated species within ordination and the variable length reveal its more or less correlation value. Revealing the ratios on which closely related species

share positive correlation with. 3-D ordination (Figure 5) explains that the species is actually localized in 3-D dimensional space with the effecting variables adding more clarification on the understanding of the simplified 2-D dimensional ordination.

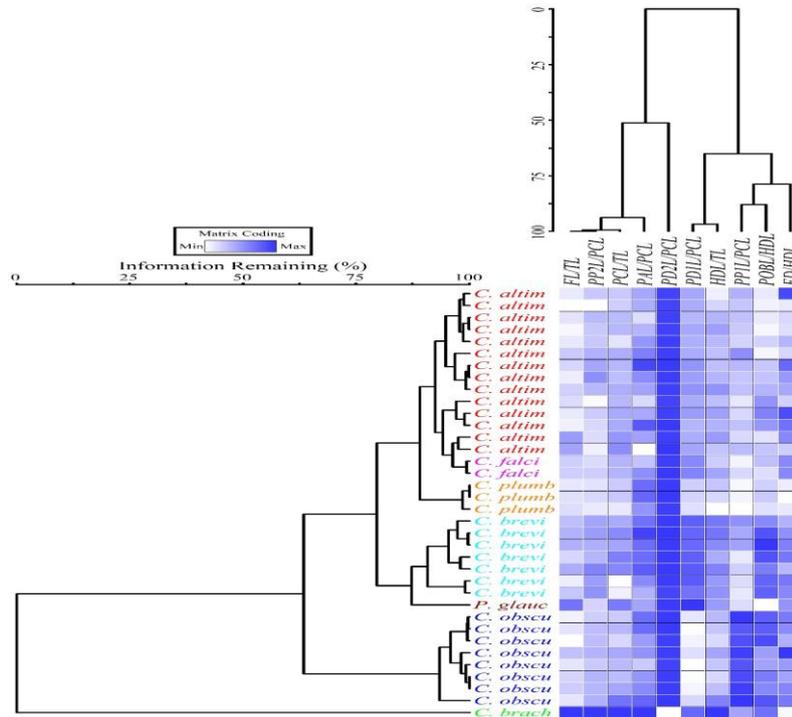


Fig. 3: Tow way cluster analysis (Heat map) for body morphometric ratios using Euclidean distance measure with Ward’s group linkage method of family Carcharhinidae, collected from Alexandria, during the period from May 2017 to June 2018.

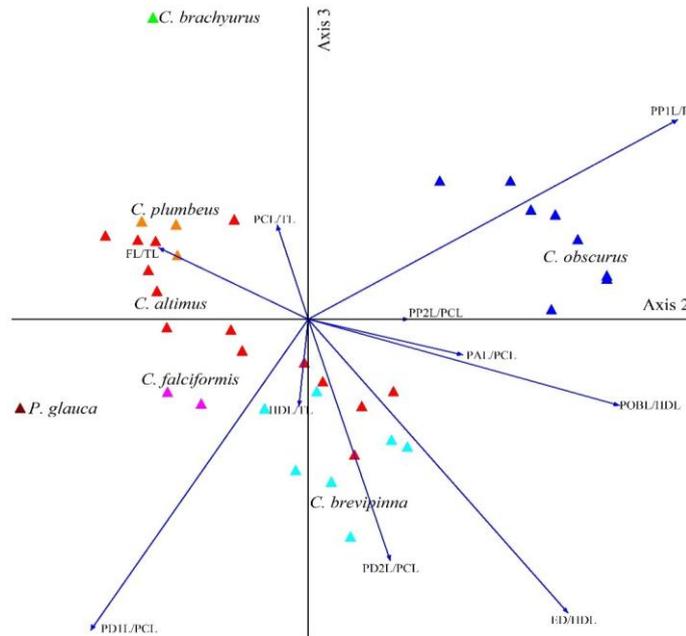


Fig. 4: 2D principal component analysis (PCA) for body morphometric ratios of shark species (color coded to their species), collected from Alexandria, during the period from May 2017 to June 2018.

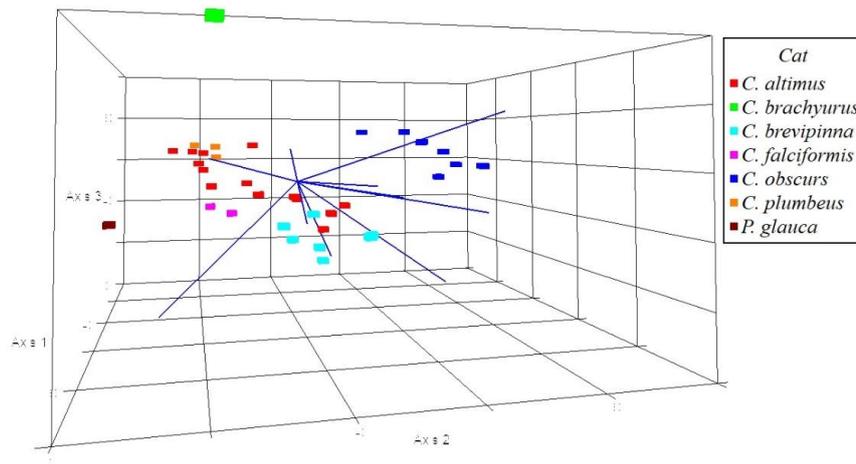


Fig. 5: 3D principal component analysis (PCA) for body morphometric ratios of shark species (color coded to their species), collected from Alexandria, during the period from May 2017 to June 2018.

## DISCUSSION

The present study aimed to provide an update on shark species of family Carcharhinidae in the Egyptian Mediterranean waters, based on differences in morphological features of the body.

In the present study, 7 species of sharks collected from Alexandria, Mediterranean Sea; belongs to family: Carcharhinidae represented as; *Carcharhinus altimus*, *C. brachyurus*, *C. brevipinna*, *C. falciformis*, *C. obscurus*, *C. plumbeus* and *Prionace glauca*. four of them considered as first record in the Egyptian Mediterranean waters (*C. brachyurus*, *C. falciformis*, *C. obscurus* and *Prionace glauca*) (Moftah *et al.*, 2011 and Akel & Karachle, 2017).

The present study revealed that; the morphometric characters of shark fish species under investigation were similar to that obtained by FAO (2005), Moftah *et al.* (2011) and Akel & Karachle (2017). Although such indices were frequently used by fish taxonomists, they were subjected to different criticism since they were found to vary according to individual factors such as size and sex (Osman, 2000).

In the present study, the total length of *Carcharhinus altimus* ranged from 54.62-160.82 cm with an average of  $108.47 \pm 34.08$  cm. Tyabji *et al.* (2018) said that, 3 male and 1 female of *C. altimus* in Andaman and Nicobar Archipelago, India was ranged from 90-237.5 taking in consideration. Two of the male specimens ranged in size from 103 to 128 cm.

In the present study, the total length of one small specimen of *Carcharhinus brachyurus* was 173.82 cm in total length. Psomadakis *et al.* (2009) recorded the first historical appearance of *C. brachyurus* in the Mediterranean Sea estimated as follows: first specimen estimated to be 5236 cm and second one was 5287 cm. Mas *et al.* (2014) reported that, total length of *C. brachyurus* found in southwestern Atlantic Ocean was ranged between 123-280cm with an average of 218 cm.

On the other hand, the pre-orbital length and eye diameter of *C. brachyurus* in our study were occupied 28.58% and 3.12% of the head length respectively. Morey and Massutí (2017) found that, *C. brachyurus* in the Balearic Islands (Western Mediterranean) to have pre orbital length of 13.5 cm and eye diameter of 2.4 cm.

In the present study, the total length of *Carcharhinus obscurus* ranged from 58.08-192.86 cm with an average of  $134.11 \pm 44.77$  cm. Hussey *et al.* (2009) said that, *C. obscurus* was the largest members of its genus, the dusky shark reaches 4.2 m in

length and 347 kg in weight. The size of new born was  $\leq 79$  cm of pre-caudal length to mature adults  $\geq 210$  cm.

In the present study, the total length of *Carcharhinus plumbeus* ranged from 88.03-106.94 cm with an average of  $99.48 \pm 10.06$  cm. The average of fork length, pre-caudal fin length and head length attain  $81.56 \pm 1.42\%$ ,  $72.58 \pm 2.91\%$  and  $19.24 \pm 2.87\%$  respectively. This result was nearly similar in some parameters and lower or higher in other parameters in the result recorded at the same species from Southern Tyrrhenian Sea (Consoli *et al.*, 2004) and Middle Adriatic Sea (Dragicevic *et al.*, 2010 and Sutaria *et al.*, 2015).

In the present study, the total length of one specimen of *Prionace glauca* was 256.95 cm. This result was matching with McKBwzln and Tibbo (1964). He described the morphometric characteristic of Blue Shark, *P. glauca* from Canadian Atlantic waters and mentioned that, the Specimens categorized into four size categories average lengths of: 156.21, 96.1, 252.2, 298 cm respectively. Megalofonou *et al.* (2009) reported that, the *P. glauca* of Mediterranean Sea ranging from 70 to 349 cm.

The fork length, pre-caudal fin length and head length of *Prionace glauca* were percentages of 87.54%, 80.16% and 22.97% of the total body length respectively. Mas *et al.* (2014) said that, the fork length of *P. glauca* found in southwestern Atlantic Ocean ranged between 64-259 cm, with an average of 151cm while, precaudal length ranged between 52-235 cm with 136 cm average length.

## CONCLUSION

Our study was attempted to add some morphometric characters for identification of species studied. Body morphometric ratios show significant variance between different species revealed its capability as classifying tool.

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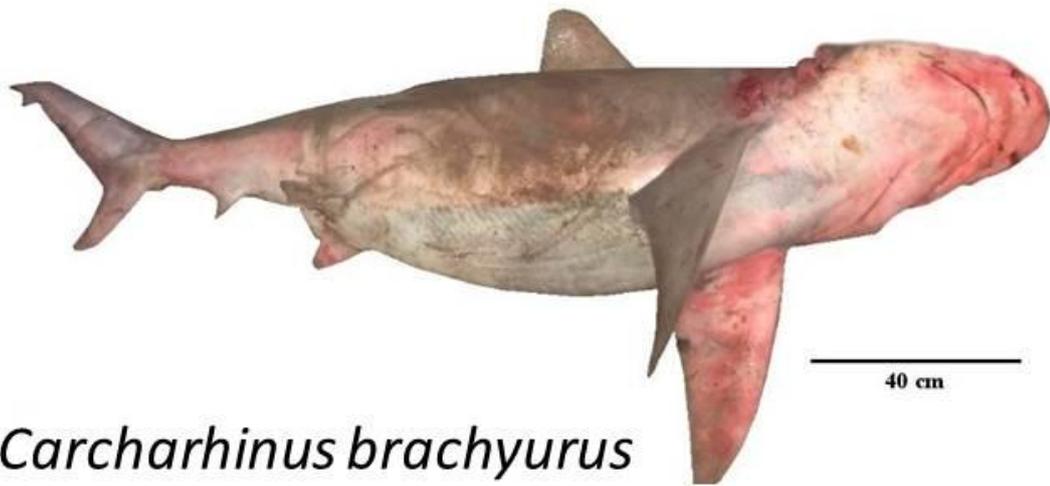
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Plate I



*Carcharhinus altimus*



*Carcharhinus brachyurus*



*Carcharhinus brevipinna*



*Carcharhinus falciformis*

**Plate II**

*Carcharhinus obscurus*



*Carcharhinus plumbeus*



*Prionace glauca*

## ARABIC SUMMARY

أسماك القرش الحريري (فصيلة: Carcharhinidae) مع الإشارة الى الأنواع التي تسجل للمرة الأولى في المياه المصرية للبحر المتوسط بالاسكندرية، مصر

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تهدف هذه الدراسة إلى تقديم معلومات محدثة عن أسماك القرش الحريري (فصيلة: Carcharhinidae) في المياه المصرية للبحر المتوسط بالاسكندرية، بناءً على الاختلافات في السمات المورفولوجية للجسم. تم تجميع ٣٦ عينة من أسماك القرش الحريري التي تنتمي إلى ٧ أنواع من هذه الفصيلة بصورة موسمية من المصايد التجارية بأسواق الأسماك في الإسكندرية على البحر المتوسط، خلال الفترة من مايو ٢٠١٧ إلى يونيو ٢٠١٨. تم تسجيل الصفات المورفومترية لكل عينة. تم التقاط العديد من الصور لكل عينة من أسماك القرش لتتم معالجتها بواسطة برنامج Image J لحساب النسب المختلفة للصفات المورفولوجية لجسم القرش.

أظهرت النتائج أن هناك سبعة أنواع تنتمي إلى فصيلة كاركارينيدي وهم: القرش كبير الأنف، القرش النحاس، القرش الدوار، القرش الحريري، القرش الداكن، القرش شريط الرمل والقرش الأزرق تقطن المياه المصرية للبحر المتوسط. تم تسجيل أربعة منهم لأول مرة في مياه البحر المتوسط المصرية وهم القرش النحاس، القرش الحريري، القرش الداكن والقرش الأزرق.

**الخلاصة:** حاولت الدراسة إضافة بعض الصفات المورفومترية لتحديد الأنواع المدروسة. أظهر التحليل الإحصائي للنسب المورفومترية تبايناً كبيراً بين الأنواع التي تم فحصها، والتي تكشف قدرتها على استخدامها كأداة تصنيف.