Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 23(3): 575 – 588 (2019)
www.ejabf.journals.ekb.eg

Morphological aspects of dorsal fin for eight shark species with special reference to the first records in Egyptian Mediterranean waters, Alexandria, Egypt

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ARTICLE INFO

Article History:
Received: Sept. 4, 2019
Accepted: Sept. 16, 2019
Online: Sept. 18, 2019

Keywords:
Mediterranean Sea
Egypt
Shark
Heptranchias perlo
Hexanchus griseus
Squalus megalops
Centrophorus uyato
Oxynotus centrina
Squatina squatina
Isurus oxyrinchus
Isurus paucus

ABSTRACT

The present study aimed to describe the dorsal fin measurements used to differentiate between some shark species in Egyptian Mediterranean waters. A total of 43 specimens of sharks were seasonally collected from the commercial catch of the Mediterranean Sea land fish markets in Alexandria, during the period from May 2017 to June 2018. Morphometric characters of dorsal fin were recorded for each specimen. Many photos had been captured for each shark specimen to be processed by Image J software to calculate different ratios of morphological aspects for dorsal fin.

Results showed that the collected specimens belong to 8 species (Heptranchias perlo, Hexanchus griseus, Squalus megalops, Centrophorus uyato, Oxynotus centrina, Squatina squatina, Isurus oxyrinchus and Isurus paucus) and three species of them (Heptranchias perlo, Squalus megalops and Isurus paucus) are a new record in the Egyptian Mediterranean waters. The morphological aspects of dorsal fin in these eight shark species were greatly varied in shape.

The morphological aspects of studied shark species proved the potential capability of this method for shark species identification. The statistical analysis of morphometric ratios showed significant variances between investigated species. Our study attempted to add more update information on shark dorsal fin morphological and dimensional scaling.

INTRODUCTION

The Mediterranean Sea was a semi-enclosed marine area with generally narrow continental shelf, lies between Europe, Asia and Africa (about 6°W and 36°E Long. and Lat. 30° to 46°N) and covers an were of approximately 2.5 million square kilometers, with an average depth of about 1.5 kilometers and a volume of 3.7 million cubic kilometers (UNEP, 1989). The Egyptian Mediterranean Sea coast attained about 1100 km. It extends from El-Salloum in the West to El-Arish in the East (Mehanna *et al*., 2005).

Sharks and their relatives (the batoids and chimaeras) comprise the Chondrichthyes fish, are a group of more than 1100 species, of which more than 400 were sharks (Compagno, 2005). Shark fins were the most valuable of shark products and used to make traditional shark fin soup, a delicacy in the Chinese culture. Shark fins removed from the body neatly to avoid including the fleshy lower part of the fin.

They were then dried and packed for marketing (Clarke *et al*., 2006). The first dorsal considered the most valuable fins on most sharks and shark-like batoids and usually sold as a set (Musick, 2005).

The shark's dorsal fin considered a key feature in taxonomy and identification of sharks in their natural habitat or after capturing by fishermen. Many wild life rangers classify sharks using photos of shark's dorsal fin when they swim near the surface. In Addition to the economic value of shark fins, many fishermen tend to cut off shark's fins and sold it in market; so the remaining of shark without its fins leaving us with question of the type of the shark and if it considered endangered species or not??. So, the need for more data and information about shark dorsal fin become essential.

Therefore, the present study aimed to describe the dorsal fin measurements used as taxonomic characters between some shark species in Egyptian Mediterranean waters.

MATERIALS AND METHODS

Collection sites

Alexandria is located about 223 Km North of Cairo and lies at 31°12'56.3"N & 29°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 43 specimens of sharks belong to 8 species (7 of *Heptranchias perlo*, 5 of *Hexanchus griseus*, 10 of *Squalus megalops*, 8 of *Centrophorus uyato*, one of *Oxynotus centrina*, 8 of *Squatina squatina*, 2 of *Isurus oxyrinchus* and 2 of *Isurus paucus*) were seasonally collected from the commercial catch of Mediterranean Sea at fish market in Alexandria (Fig. 1); during the period from May 2017 to June 2018. Shark specimens were freshly examined. Total length was measured to the nearest millimetres and recorded for each specimen. Many photos had been captured for each shark specimen to process by Image J software for calculating different ratios of morphological aspects of dorsal fin. Sharks 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.

Dorsal fin measurements

To study morphometric features of the dorsal fin (D.) in sharks, the following measurements (Figure 2) were recorded for it according to Marshall and Barone (2016):

Free rear tip (D. A): The distance between fin insertions to the end of the free rear tip.

Fin base (D. B): The distance between fin origin to the fin insertion; i.e. the length of the dorsal fin base.

Anterior margin (D. E): The distance between the dorsal fin origin and the fin tip.

Total fin width (D. F): The distance between anterior ends of fin base to the end of the free rear tip.

Upper posterior margin (D. H_1): The distance between the tip of the fin and the deepest point of the concave curve of the posterior margin.

Lower posterior margin (D. H_2): The distance between the deepest points of the concave curve of the posterior margin to the end of the free rear tip.

Posterior margin (D. I): The distance between the fin tip to the posterior tip of the free rear tip.

Fin angle (D. J°): The angle between the direct fin height (K) and the he mid-fin base (1⁄2 B).

Fin height (direct) (D. K): Distance from the mid-fin base (B) to the tip of the fin.

Fin height (absolute) (D. L): Perpendicular distance from the fin baseline (B) to the tip of the fin.

Anterior margin height (D. Ah): The greatest distance (perpendicular) between line E and the anterior margin of the fin, anterior to line E.

Posterior margin depth (D. Bh): The greatest distance (perpendicular) between line I and the posterior margin of the fin, anterior to line I.

Upper posterior margin convex depth (D. Dh): The greatest distance (perpendicular) between the line H and the posterior margin of the fin, posterior to line H.

Upper posterior margin concave depth (D. Eh): The greatest distance (perpendicular) between the line H and the posterior margin of the fin, anterior to line H.

Data analysis

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

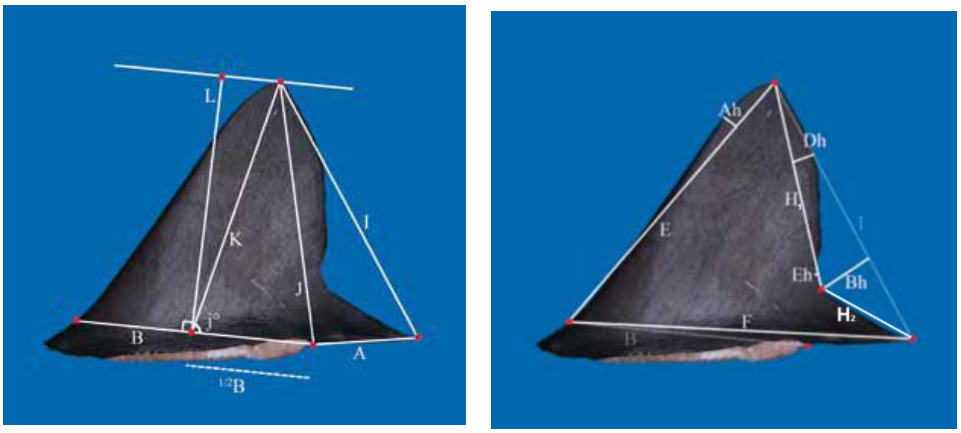

Fig. 2: Diagrammatic representation of morphometric measurements of dorsal fin of sharks

RESULTS

In the present study, 8 species of sharks (*Heptranchias perlo*, *Hexanchus griseus*, *Squalus megalops*, *Centrophorus uyato*, *Oxynotus centrina*, *Squatina squatina*, *Isurus oxyrinchus* and *Isurus paucus*) were collected from the Egyptian Mediterranean waters, at Alexandria. These shark species belong to 6 families and 4 orders. Three species of them (*Heptranchias perlo, Squalus megalops* and *Isurus paucus*) are new records in the Egyptian Mediterranean waters (Table 1).

Table 1: Classification of the studied shark species collected from Egyptian Mediterranean waters, during the period from May 2017 to June 2018.

Order	Family	Species	No.	Local name	New record
Hexanchiformes	Hexanchidae	*Heptranchias perlo*	7	قرش حاد الأنف	+
		Hexanchus griseus	5	قرش عريض الأنف	-
Squaliformes	Squalidae	*Squalus megalops*	10	قرش قصير الأنف	+
	Centrophoridae	*Centrophorus uyato*	8	قرش الماعز الصغير	-
	Oxynotidae	*Oxynotus centrina*	1	قرش الخشنة الزاوي	-
Squatiniformes	Squatinidae	*Squatina squatina*	8	قرش الملاك	-
Lamniformes	Lamnidae	*Isurus oxyrinchus*	2	قرش ماكو ذو الزعنفة القصيرة	-
		Isurus paucus	2	قرش ماكو ذو الزعنفة الطويلة	+

Dorsal fin of studied shark species is one or two parts with small, moderate and large in size. Triangular, rectangular, sail-like, leaf-like and sickle in shape. Anterior margin is concave or convex in shape and the posterior margin is concave in shape with round, blunt and pointed tips. The back margin is concave. One spine located on the anterior dorsal fin or absent. Color is dark tone, dark, light, glimmering, reddish, reddish dark tone, central white with dark edges, dark above and light below, black dots and light tone. Free rear tip is small, moderate and large in size.

Order: Hexanchiformes:

Family: Hexanchidae:

Heptranchias perlo

The dorsal fin of *H. perlo* is small in size, anterior and posterior margins are concave in shape with round tip and dark tone of color with pinkish concave back margin. Free rear tip is moderate in size (Figure 3A). Dorsal fin base (D.B) ranges between 4.37 and 6.77 cm with an average of 5.53±0.84 cm, while fin height (D.K) varies from 3.43 to 4.64 cm with an average of 3.94±0.44 cm (Table 2).

Dorsal fin height (absolute) (D.L) is attaining 48.99-54.22%, 60.64-63.66% and 86.1-90.83% of the total fin width (D.F), anterior margin (D.E) and fin height (direct) (D.K) respectively with an average of 51.23±1.92%, 62.03±1.07% and 88.7±1.54% respectively. Fin posterior height (D.J) and posterior margin depth (D.Bh) varies from 86.26 to 89.06% and 8.02-10.21% of the posterior margin (D.I) with averages of 87.32±0.96 % and 8.91±0.86%, respectively. Free rear tip (D.A) fluctuates between 29.13 and 31.97% of the fin base (D.B) with an average of 30.22±1.18%. Anterior margin height (D. Ah) attains 3.22-5.02% of the anterior margin (D.E) with an average of 4.18±0.84% (Table 2). Upper posterior margin convex (D. Dh), upper posterior margin concave depth (D.Eh) and upper posterior margin ($D.h_2$) attaining 15.77-16.97%, 3.76-6.11% and 26.98-32.08% of the lower posterior margin ($D.H_1$) with averages of 16.32±0.42%, 4.61±0.91% and 28.85±1.73%, respectively (Table 2).

Table 2: Morphometric measurements and ratios of dorsal fin in shark species collected from Egyptian Mediterranean waters at Alexandria, during the period from May 2017 to June 2018.

Species	No	Desc. Stat.	D.B (cm)	D.K (cm)	D.L/ D.F (%)	D.L/ D.E (%)	D.L/ D.K (%)	D.J/ D.I (%)	D.A/ D.B (%)	D.Bh/ D.I (%)	D.Dh/ $D.H_1$ (%)	D.Eh/ $D.H_1$ (%)	D.Ah/ D.E (%)	$D.H_2$/ $D.H_1$ (%)
H. perlo	7	**Range**	4.37-6.77	3.43-4.64	48.99-54.22	60.64-63.66	86.1-90.83	86.26-89.06	29.13-31.97	8.02-10.21	15.77-16.97	3.76-6.11	3.22-5.02	26.98-32.08
		Mean± SD	5.53± 0.84	3.94± 0.44	51.23± 1.92	62.03± 1.07	88.7± 1.54	87.32± 0.96	30.22± 1.18	8.91± 0.86	16.32± 0.42	4.61± 0.91	4.18± 0.84	28.85± 1.73
H. griseus	5	**Range**	12.85-19.97	7.59-12.37	53.28-57.36	59.6-76.78	94.09-98.39	86.1-97.29	25.15-29.41	6.48-8.06	5.2-6.83	1.53-3.03	2.93-6.14	16.89-43.2
		Mean± SD	17.12± 2.97	10.57± 1.81	54.98± 1.68	67.55± 6.53	96.07± 1.87	93.17± 4.46	27.06± 1.58	7.3± 0.74	6.13± 0.59	2.39± 0.64	4.5± 1.46	27.93± 10.71
S. megalops	10	**Range**	3.13-3.96	3.23-4.1	46.52-52.4	56.82-69.11	77.53-90.43	82.49-89.22	82.05-89.16	7.48-10.95	7.95-12.39	3.64-9.67	4.26-7.45	47.03-57.68
		Mean± SD	3.54± 0.31	3.72± 0.29	49.34± 1.92	63.38± 3.66	84.65± 3.9	85.68± 2.42	85.49± 2.77	9.14± 0.97	10.2± 1.39	6.1± 2.09	5.78± 1.05	52.84± 3.27
C. uyato	8	**Range**	3.65-8.91	2.5-6.68	31.84-37.31	48.28-59.33	80.42-88.12	60.42-71.03	66.61-76.15	7.83-10.4	7.57-11.28	1.14-2.49	4.55-5.83	43.26-48.89
		Mean± SD	5.17± 1.67	3.7± 1.46	34.25± 1.98	53.51± 4.09	83.31± 2.54	65.57± 3.19	70.11± 3.2	8.66± 0.82	9.22± 1.15	1.87± 0.56	5.17± 0.44	46.19± 2
O. centrina	1	**Range**	--	--	--	--	--	--	--	--	--	--	--	--
		Mean± SD	6.35	6.68	78.9	93.28	98.62	98.5	35.74	15.46	--	9.6	3.93	265.61
S. squatina	7	**Range**	2.28-7.8	3.78-11.3	80.72-86.9	67.22-74.45	81.04-85.48	125.65-134.3	45.42-53.11	14.03-16.32	14.51-17.36	--	8.75-10.16	48.81-53.37
		Mean± SD	4.42± 1.9	6.41± 2.59	82.96± 2.09	70.43± 2.15	83.9± 1.58	129.1± 2.95	50.12± 3.25	15.26± 0.81	15.92± 1.22	--	9.47± 0.5	51.2± 1.81
I. oxyrinchus	2	**Range**	8.15-8.8	6.83-7.59	72.68-75.24	81.53-83.11	95.52-97.1	94.76-95.46	21.39-25.84	6.15-7.81	7.31-8.37	1.79-2.62	10.7-11.93	22.22-23.32
		Mean± SD	8.47± 0.46	7.21± 0.53	73.96± 1.81	82.32± 1.11	96.31± 1.11	95.11± 0.49	23.61± 3.14	6.98± 1.17	7.84± 0.74	2.2± 0.58	11.32± 0.86	22.77± 0.77
I. paucus	2	**Range**	23.15-27.1	20.85-24.84	67.98-69.18	80.48-80.65	96.54-97.98	89.11-94.02	28.19-29.83	19.61-20.83	10.76-10.89	3.98-4.33	10.68-11.47	43.82-44.76
		Mean± SD	25.13± 2.79	22.84± 2.81	68.58± 0.85	80.56± 0.12	97.26± 1.01	91.57± 3.46	29.01± 1.16	20.22± 0.86	10.83± 0.09	4.16± 0.25	11.07± 0.56	44.29± 0.66

Hexanchus griseus

The dorsal fin of *H. griseus* is small in size and triangular in shape with dark in color. Free rear tip is moderate in size (Figure 3B). Dorsal fin base (D.B) ranges between 12.85 and 19.97 cm with an average of 17.12±2.97 cm, while fin height (D.K) varies from 7.59 to 12.37 cm with an average of 10.57±1.81 cm (Table 2).

Dorsal fin height (absolute) (D.L) attain 53.28-57.36%, 59.6-76.78% and 94.09-98.39% of the total fin width (D.F), anterior margin (D.E) and fin height (direct) (D.K) with averages of 54.98± 1.68%, 67.55± 6.53% and 96.07± 1.87%, respectively. On the other hand, fin posterior height (D.J) and posterior margin depth (D.Bh) ranging 86.1-97.29% and 6.48-8.06% of the posterior margin (D.I) with averages of 93.17±4.46% and 7.3±0.74%, respectively. Free rear tip (D.A) fluctuates between 25.15 and 29.41% of the fin base (D.B) with an average of 27.06±1.58%. Anterior margin height (D.Ah) attains 2.93-6.14% of the anterior margin (D.E) with an average of 4.5±1.46%. Upper posterior margin convex (D.Dh), upper posterior margin concave depth (D.Eh) and upper posterior margin ($D.H_2$) varies 5.2-6.83%, 1.53-3.03% and 16.89-43.2% of the lower posterior margin ($D.H_1$) with averages of 6.13±0.59%, 2.39±0.64% and 27.93±10.71%, respectively (Table 2).

Order: Squaliformes:

Family: Squalidae:

Squalus megalops

Dorsal fin of *S. megalops* is moderate in size, anterior margin is convex and posterior margin is concave in shape with light in color and round tip. One spine located on the anterior dorsal fin and relatively equal to the half fin height. Free rear tip is large in size (Figure 3C). Dorsal fin base (D.B) ranges between 3.13 and 3.96 cm with an average of 3.54±0.31 cm, while fin height (D.K) varies between 3.23 and 4.1 cm with an average of 3.72±0.29 cm (Table 2).

Dorsal fin height (absolute) (D.L) fluctuates 46.52-52.4%, 56.82-69.11% and 77.53-90.43% of the total fin width (D.F), anterior margin (D.E) and fin height (direct) (D.K) with averages of 49.34±1.92%, 63.38±3.66% and 84.65±3.9%, respectively. On the other hand, fin posterior height (D.J) and posterior margin depth (D.Bh) attain 82.49-89.22% and 7.48-10.95% of the posterior margin (D.I), with averages of 85.68±2.42% and 9.14±0.97%, respectively. Free rear tip (D.A) attains 82.05-89.16% of the fin base (D.B) with an average of 85.49±2.77%. Anterior margin height (D.Ah) attains 4.26-7.45% of the anterior margin (D.E) with an average of 5.78±1.05%. Upper posterior margin convex (D.Dh), upper posterior margin concave depth (D.Eh) and upper posterior margin (D.H2) attain 7.95-12.39%, 3.64-9.67% and 47.03-57.68% of the lower posterior margin (D.H1) with an average of 10.2±1.39%, 6.1±2.09% and 52.84±3.27%) respectively (Table 2).

Family: Centrophoridae:

Centrophorus uyato

The dorsal fin of *C. uyato* is small in size, triangular in shape with round tip and glimmering color. One spine located on the anterior dorsal fin and relatively equal to the third fin height. Free rear tip is large in size (Figure 3D). Dorsal fin base (D.B) ranges between 3.65 and 8.91 cm with an average of 5.17±1.67 cm, while fin height (D.K) ranges between 2.5 and 6.68 cm with an average of 3.7±1.46 cm (Table 2).

Dorsal fin height (absolute) (D.L) attain 31.84-37.31%, 48.28-59.33% and 80.42-88.12% of the total fin width (D.F), anterior margin (D.E) and fin height (direct) (D.K) with averages of 34.25±1.98%, 53.51±4.09% and 83.31±2.54%, respectively. Fin posterior height (D.J) and posterior margin depth (D.Bh) ranging 60.42-71.03% and 7.83-10.4% of the posterior margin (D.I) with averages of 65.57±3.19% and

8.66±0.82%, respectively. Free rear tip (D.A) attains 66.61-76.15% of the fin base (D.B) with an average of 70.11±3.2%. Anterior margin height (D.Ah) fluctuates between 4.55 and 5.83% of the anterior margin (D.E) with an average of 5.17±0.44%. Upper posterior margin convex (D.Dh), upper posterior margin concave depth (D.Eh) and upper posterior margin (D.H2) attain 7.57-11.28%, 1.14-2.49% and 43.26-48.89% of the lower posterior margin (D.H1) with averages of 9.22±1.15%, 1.87±0.56% and 46.19±2%, respectively (Table 2).

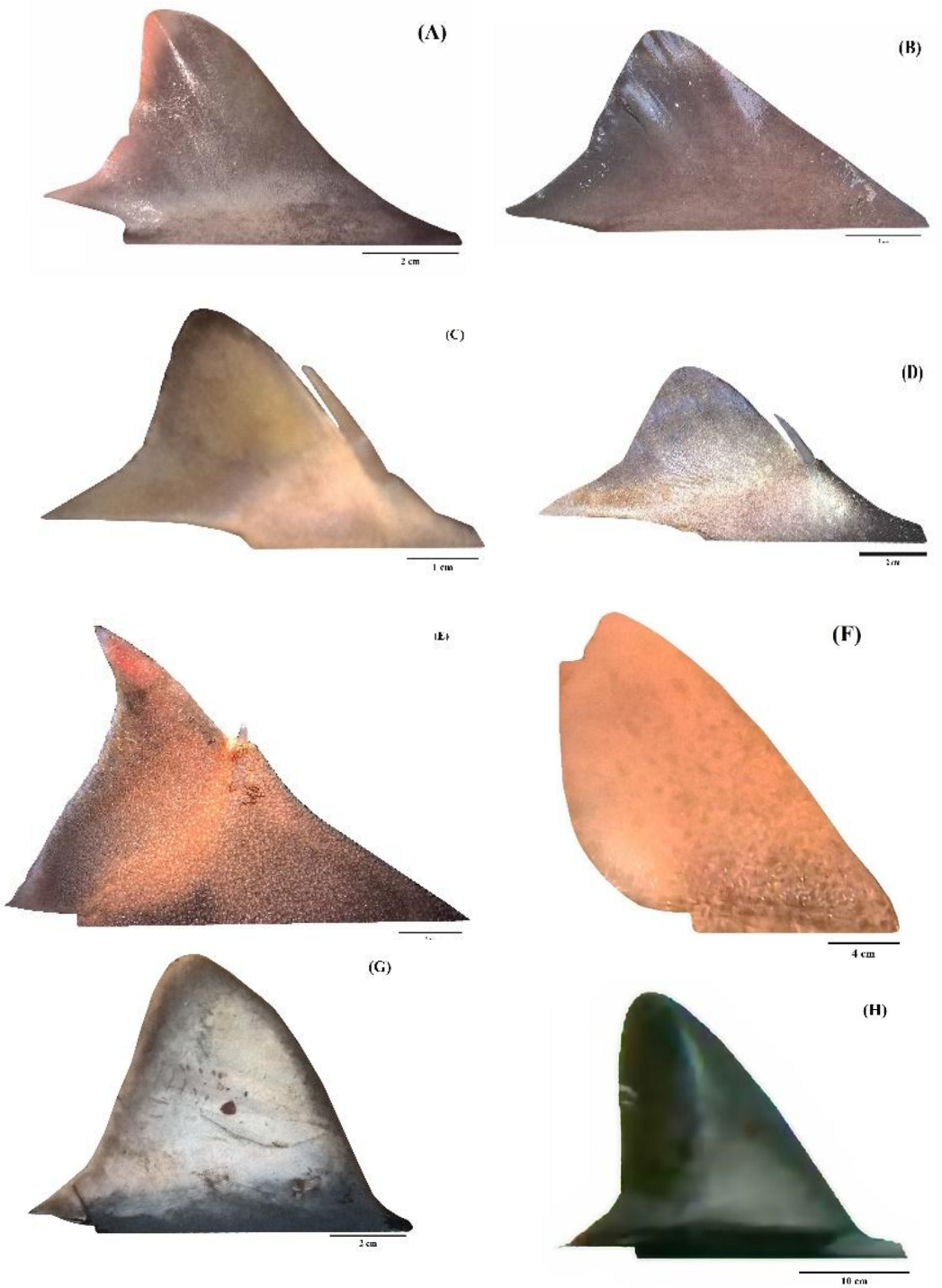

Fig. 3: Dorsal fin of (A) *Heptranchias perlo*, (B) *Hexanchus griseus*, (C) *Squalus megalops*, (D) *Centrophorus uyato*, (E) *Oxynotus centrina*, (F) *Squatina squatina*, (G) *Isurus oxyrinchus*, (H) *Isurus paucus.*

Family: Oxynotidae:

Oxynotus centrina

The dorsal fin of *O. centrina* is relatively large in size and sail-like in shape with reddish dark tone in color. One small spine located on the anterior dorsal fin. Free rear tip is small in size (Figure 3E). Dorsal fin base (D.B) is 6.35 cm, while fin height (D.K) is 6.68 cm (Table 2).

Dorsal fin height (absolute) (D.L) attain 78.9%, 93.28% and 98.62% of the total fin width (D.F), anterior margin (D.E) and fin height (direct) (D.K), respectively. Fin posterior height (D.J) and posterior margin depth (D.Bh) attain 98.5% and 15.46% of the posterior margin (D.I) respectively. Free rear tip (D.A) attains 35.74% of the fin base (D.B). Anterior margin height (D.Ah) attains 3.93% of the anterior margin (D.E). Upper posterior margin concave depth (D.Eh) and upper posterior margin (D.H2) attain 9.6% and 265.61% of the lower posterior margin (D.H1), respectively (Table 2).

Order: Squatiniformes:

Family: Squatinidae:

Squatina squatina

Dorsal fin of *S. squatina* is relatively small in size and leaf-like in shape with reddish color (Figure 3F). Dorsal fin base (D.B) ranges between 2.28 and 7.8 cm with an average of 4.42±1.9 cm, while fin height (D.K) varies from 3.78 to 11.3 cm with an average of 6.41±2.59 cm) (Table 2).

Dorsal fin height (absolute) (D.L) attain 80.72-86.9%, 67.22-74.45% and 81.04-85.48% of the total fin width (D.F), anterior margin (D.E) and fin height (direct) (D.K), respectively with averages of 82.96±2.09%, 70.43±2.15% and 83.9±1.58%. Fin posterior height (D.J) and posterior margin depth (D.Bh) ranging 125.65-134.3% and 14.03-16.32% of the posterior margin (D.I) with averages of 129.1±2.95% and 15.26±0.81%. Free rear tip (D.A) attains 45.42-53.11% of the fin base (D.B) with an average of 50.12±3.25%, respectively. Anterior margin height (D.Ah) varies from 8.75 to 10.16% of the anterior margin (D.E) with an average of 9.47±0.5%. Upper posterior margin convex (D.Dh) and upper posterior margin ($D.H_2$) fluctuate 14.51-17.36% and 48.81-53.37% of the lower posterior margin ($D.H_1$) with averages of 15.92±1.22% and 51.2±1.81%, respectively (Table 2).

Order: Lamniformes:

Family: Lamnidae:

Isurus oxyrinchus

The dorsal fin of *I. oxyrinchus* (Figure 3G) is relatively small in size and more like triangular in shape with rounded tip and centrally white color with dark edges. Free rear tip is small in size. Dorsal fin base (D.B) ranges between 8.15 and 8.8 cm with an average of 8.47±0.46 cm, while fin height (D.K) varies from 6.83 to 7.59 cm with an average of 7.21±0.53 cm (Table 2).

Dorsal fin height (absolute) (D.L) attaining 72.68-75.24%, 81.53-83.11% and 95.52-97.1% of the total fin width (D.F), anterior margin (D.E) and fin height (direct) (D.K) with averages of 73.96±1.81%, 82.32±1.11% and 96.31±1.11%, respectively. Fin posterior height (D.J) and posterior margin depth (D.Bh) attaining 94.76-95.46% and 6.15-7.81% of the posterior margin (D.I) with averages of 95.11±0.49% and 6.98±1.17%, respectively. Free rear tip (D.A) varies from 21.39 to 25.84% of the fin base (D.B) with an average of 23.61±3.14%. Anterior margin height (D.Ah) fluctuates between 10.7 and 11.93% of the anterior margin (D.E) (average: 11.32±0.86%). Upper posterior margin convex (D.Dh), upper posterior margin concave depth (D.Eh) and upper posterior margin ($D.H_2$) attain 7.31-8.37%, 1.79-2.62% and 22.22-23.32% of the

lower posterior margin ($D.H_1$) with averages of 7.84±0.74%, 2.2±0.58% and 22.77±0.77% respectively (Table 2).

Isurus paucus

The dorsal fin of *I. paucus* (Figure 3H) is large in size, more like triangular in shape with rounded tip, dark above and light below in color. Free rear tip is small in size. Dorsal fin base (D.B) ranges between 23.15 and 27.1 cm with an average of 25.13±2.79 cm, while fin height (D.K), varies from 20.85 to 24.84 cm with an average of 22.84±2.81 cm (Table 2).

Dorsal fin height (absolute) (D.L) attaining 67.98-69.18%, 80.48-80.65% and 96.54-97.98% of the total fin width (D.F), anterior margin (D.E) and fin height (direct) (D.K) with averages of 68.58±0.85%, 80.56±0.12% and 97.26±1.01%, respectively. Fin posterior height (D.J) and posterior margin depth (D.Bh) ranging 89.11-94.02% and 19.61-20.83% of the posterior margin (D.I) with averages of 91.57±3.46% and 20.22±0.86%, respectively. Free rear tip (D.A) fluctuates between 28.19 and 29.83% of the fin base (D.B) with an average of 29.01±1.16%. Anterior margin height (D.Ah) attains 10.68-11.47% of the anterior margin (D.E) with an average of 11.07±0.56%. Upper posterior margin convex (D.Dh), upper posterior margin concave depth (D.Eh) and upper posterior margin ($D.H_2$) attain 10.76-10.89%, 3.98-4.33% and 43.82-44.76% of the lower posterior margin ($D.H_1$) with averages of 10.83±0.09%, 4.16±0.25% and 44.29±0.66%, respectively (Table 2).

Statistical analysis:

Due to the rarity and hard to find *Oxynotus centrina*, only represented by one specimen. 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.

The difference in the mean values among the different levels of species is greater than would be expected by chance after allowing for effects of differences in factor. There is a statistically significant difference (P = <0.001). To isolate which group (s) differ from the others use a multiple comparison procedure. Power of performed test with alpha = 0.0500: for Species: 1.000, ratios show significant variance between different species revealed its capability as classifying tool (Table 3). Multi-variant data analysis was conducted to evaluate the potential of species separation using dorsal fin morphometric measurements.

Table 3: Fisher pairwise comparisons: species grouping information using Fisher LSD method and 95% Confidence for dorsal fin morphometric ratios of shark species, collected from Egyptian Mediterranean waters at Alexandria, during the period from May 2017 to June 2018.

Species	**Grouping**			
O. centrina	A			
S. squatina		B		
I. paucus		B	C	D
S. megalops			C	
I. oxyrinchus			C	D
H. griseus			C	D
H. perlo				D
C. uyato				D

Means that do not share a letter are significantly different.

As shown in (Figure 4), 2-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. dorsal fin morphometric ratios

result in perfect claustration of Hexanchiformes, Lamniformes, Squatiniformes and Squaliformes species into separate clades, revealing the great potentiality of using dorsal fin morphometric ratios for classification.

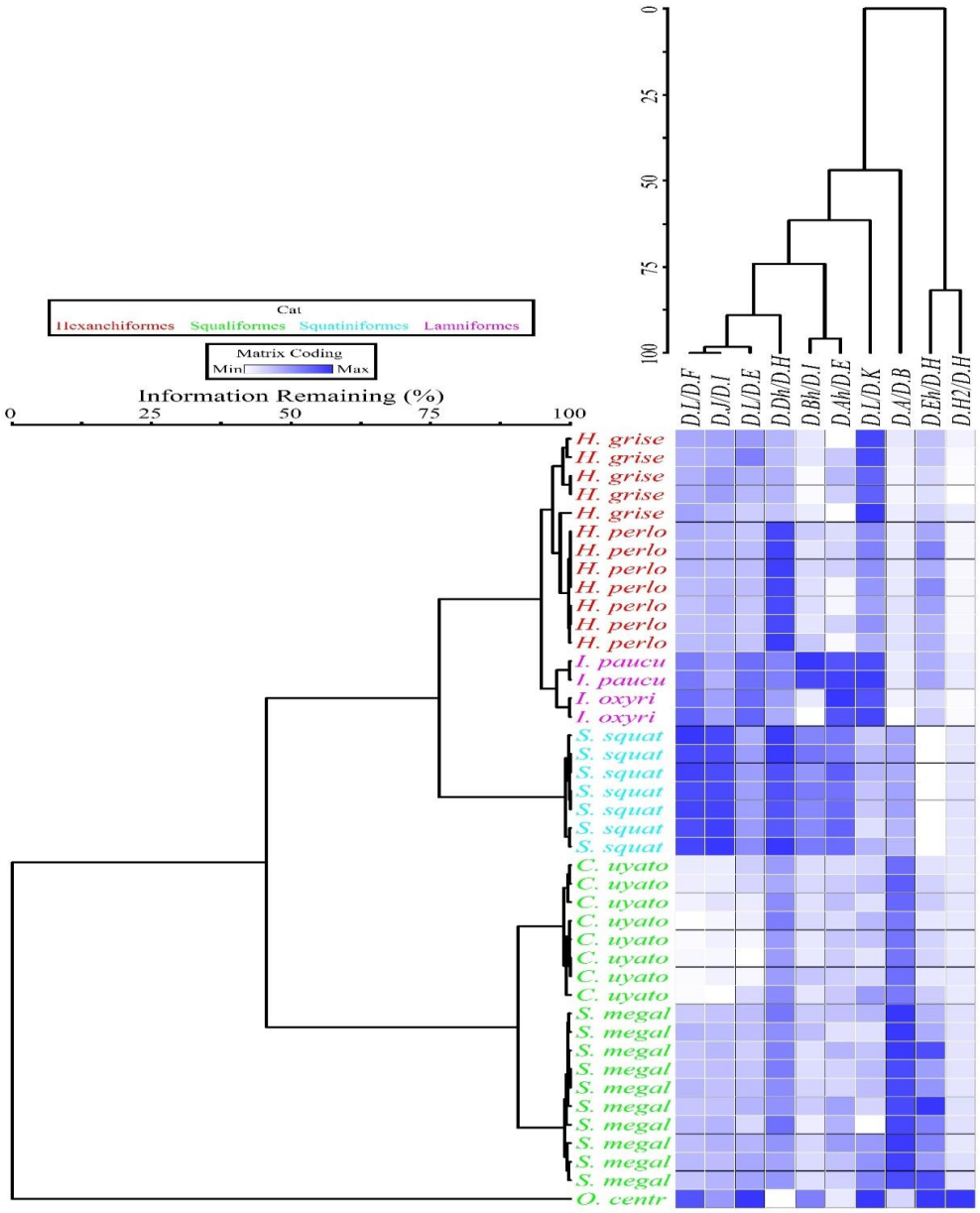

Fig. 4: Tow way cluster analysis (Heat map) for dorsal fin morphometric ratios using Euclidean distance measure with Ward's group linkage method of shark species (color coded to their orders), collected from Alexandria, during the period from May 2017 to June 2018.

2-D ordination graph (Figure 5) shows species specimens represented as triangular points, while different variables represented as arrows with direction towards its positive correlated species within ordination and the variable length reveal more or less correlation value. Reveal the ratios on which closely related species share positive correlation with. 3-D ordination (Figure 6) explains that, the species is actually localized in 3D dimensional space with the effecting variables adding more clarification on the understanding of the simplified 2D dimensional ordination. The ratios: D.L/D.E, D.L/D.F and D.Dh/D.H has the highest correlation value among other contributed ratios, while the lowest correlation value was ($D.H_2/D.H$).

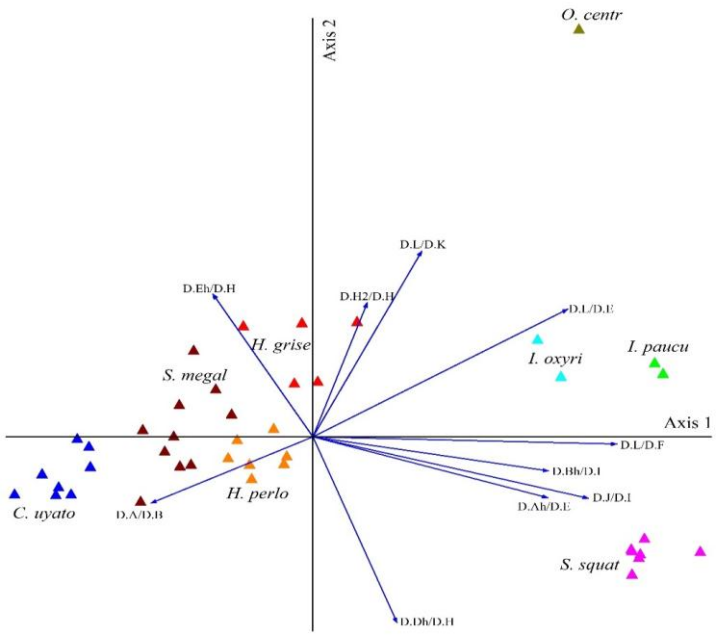

Fig. 5: 2D principal component analysis (PCA) for dorsal fin morphometric ratios of shark species (color coded to their species), collected from Alexandria, during the period from May 2017 to June 2018.

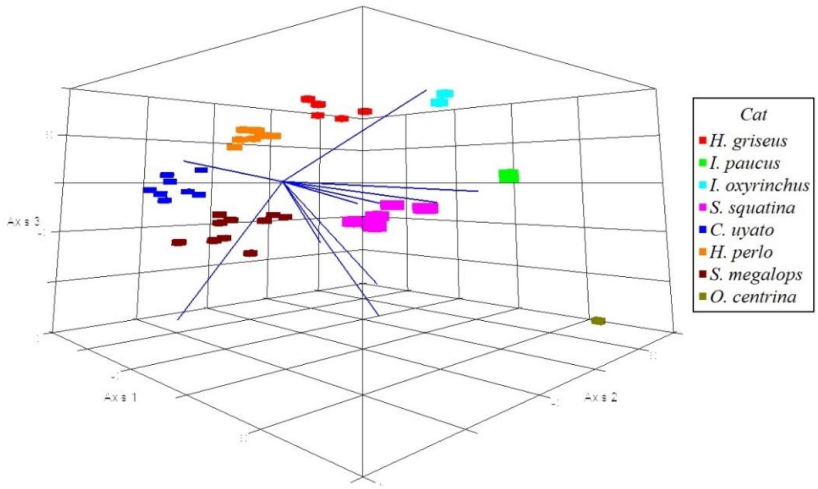

Fig. 6: 3D principal component analysis (PCA) for dorsal fin morphometric ratios of shark species (color coded to their species), collected from Alexandria, during the period from May 2017 to June 2018.

DISCUSSION

The shark's dorsal fin considered a key feature in taxonomical and identification of sharks in their natural habitat or after capturing by fishermen (FAO, 2005). In the present study, the morphological aspects of dorsal fin of *Heptranchias perlo*, *Hexanchus griseus*, *Squalus megalops*, *Centrophorus uyato*, *Oxynotus centrina*, *Squatina squatina*, *Isurus oxyrinchus* and *Isurus paucus* proved the potential capability for shark species identification. Three species of them (*Heptranchias perlo*, *Squalus megalops* and *Isurus paucus*) are new records in the Egyptian Mediterranean waters.

In the present study, the dorsal fin of *H. perlo* is small in size, anterior and posterior margins are concave in shape with rounded tip and dark tone of color with pinkish concave back margin. The average of dorsal fin base (D.B) and fin height (D.K) was 5.53±0.84 cm and 3.94±0.44 cm. This result was nearly similar to the result recorded at the female of the same species and higher than male from Northern Tunisian coast, Central Mediterranean Sea (Reynaud and capapé, 2014).

In the present study, the dorsal fin of *H. griseus* is small in size and triangular in shape with dark in color. The shape and average of dorsal fin measurements was matching with the result recorded at the same species from Baja California Sur, Mexico (Becerril-García *et al*. 2017).

In the present study, the dorsal fin of *S. megalops* is moderate in size, anterior margin is convex and posterior margin is concave in shape and light in color with round tip. One spine located on the anterior dorsal fin and relatively equal to the half fin height. This description was similar to that obtained at the same species by Marouani *et al.* (2012).

In the present study, the dorsal fin of *C. uyato* is small in size, triangular in shape with round tips and glimmering color. One spine located on the anterior dorsal fin and relatively equal to the third fin height. This result was similar to that obtained at the same species by White *et al*. (2008).

In the present study, the dorsal fin of *O. centrina* is relatively large in size and sail-like in shape with reddish dark tone in color. One small spine located on the anterior dorsal fin. The description of dorsal fin was similar to that obtained at the same species by Megalofonou & Damalas (2014) and Kousteni and Megalofonou (2016). In the present study, the average of dorsal fin base (D.B), fin height (D.K) and posterior margin depth (D.Bh) of *O. centrina* were nearly similar with the results recorded at the same species from Eastern Mediterranean Sea (Megalofonou *et al.* 2009) and lower than that recorded from Eastern Adriatic Sea (Dragicevic *et al*., 2009) and in Saros Bay, North Aegean Sea, Turkey (Yığın *et al.*, 2016).

In the present study, the dorsal fin of *S. squatina* is relatively small in size and leaf-like in shape with reddish in color. The description of dorsal fin was similar to that obtained at the same species by Cavallaro *et al*. (2015). In the present study, the dorsal fin measurements of *S. squatina* were lower than that recorded at the same species from Tyrrhenian coast of the Strait of Messina (Cavallaro *et al*., 2015). The differences in measurements may be due to differences in sex or length of data in different localities. The statistical analysis of morphometric ratios showed significant variance between investigated species.

CONCLUSION

The morphological aspects of studied shark species proved the potential capability for shark species identification. The statistical analysis of morphometric ratios showed significant differences between investigated species. Our study attempted to add more information and update on the sharks dorsal fin morphological and dimension scaling.

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ARABIC SUMMARY

الجوانب المورفولوجية للزعنفة الظهرية لثمانية أنواع من أسماك القرش مع إشارة خاصه إلى أول ظهور لبعض القروش في مياه البحر المتوسط المصرية، الإسكندرية، مصر

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هدفت الدراسة الحالية إلى وصف قياسات الزعانف الظهرية المستخدمة للتمييز بين بعض أنواع أسماك القرش في مياه البحر المتوسط المصرية. تم تجميع 43 عينة من أسماك القرش التي تنتمي إلى 8 أنواع بشكل موسمي من الصيد التجاري للبحر المتوسط في حلقات بيع الأسماك بالإسكندرية، خلال الفترة من مايو ٢٠١٧ إلى يونيو ٢٠١٨. تم تسجيل الصفات المورفومترية للزعنفة الظهرية لكل عينة. تم التقاط العديد من الصور لكل عينة من أسماك القرش لتتم معالجتها بواسطة برنامج Image J لحساب النسب المختلفة للصفات المورفولوجية للزعنفة الظهرية.

أظهرت النتائج أن القياسات المورفولوجية للزعنفة الظهرية كانت مختلفة في الشكل لأنواع قرش حاد الأنف و قرش عريض الأنف وقرش قصير الأنف وقرش الماعز الصغير وقرش الخشنة الزاوي وقرش الملاك وقرش ماكو ذو الزعنفة القصيرة وقرش ماكو ذو الزعنفة الطويلة. تبين أن ثلاثة من الأنواع السابقة تم تسجيلها لأول مرة في المياه المصرية للبحر المتوسط وهى القرش حاد الأنف والقرش قصير الأنف والقرش ماكو ذو الزعنفة الطويلة.

أظهرت النتائج أن القياسات المورفولوجية للزعنفة الظهرية لها القدرة على تحديد أنواع أسماك القرش المختلفة. أظهر التحليل الإحصائي للنسب المورفومترية تبايناً كبيراً بين الأنواع محل الدراسة. حاولت الدراسة إضافة المزيد من المعلومات والتحديثات على استخدام مواصفات الزعنفة الظهرية للتمييز بين الانواع المختلفة من اسماك القرش.