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RESEARCH PAPER

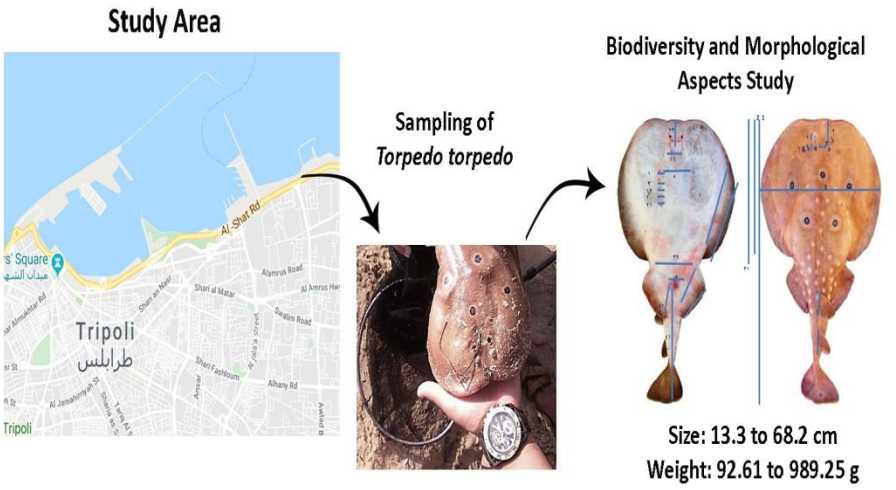
Biodiversity aspects of Common Torpedo (*Torpedo torpedo)* in by-catch in Sidi Sha'ab Harbour, Tripoli, Libya

Esam Buzaid *, Sayed Mohamed Ali, Ramadan Atea Ali
Department of Zoology, Faculty of Science, Omar Al-Mukhtar University, Al-Bayda, Libya

Highlights

- The Mediterranean Sea is known to encompass a high diversity of important habitats threatened nowadays.
- In Libya, fish are essential component of coast, which constitutes 36% of the Arabic Mediterranean coasts.
- The present study is of the first studies in the biology of elasmobranches in Libya.
- More studies are required to create good database for elasmobranches in this region.

Graphical Abstract



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Abstract

Forty-four specimen of common Torpedo (*Torpedo torpedo*) were collected from discarded catch of long-line boat's haul from Sidi Sha'ab harbor, Tripoli, in May 2016 and used for establishing morphometric traits of the fish. The specimens ranged in size from 13.3 to 68.2 cm and in total weight from 92.61 to 989.25 gm. The results revealed that the value of the constant b of the length-weight relationship was 1.9064 indicating negative allometric growth (b< 3). The condition factors K_f and K_c decreased progressively from 2.54 and 1.82 in the smallest fish size group (17.2cm) to the largest one (67.5cm.) which recorded a rare values of (K_f= 0.32 and $K_{c=}$ 0.25), respectively. The length frequency distribution indicated that the youngest size-group (17.2cm) peaked to a quarter of the studied samples. Morphometric traits of the torpedo were related to total length as percentage ratios. Disk length and diameter were larger in female (48.6 and 43.0%) than in male (47.4 and 41.2%).

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* Corresponding author: esam.buzaid2019@yahoo.com (E. Buzaid)

1. Introduction

The Mediterranean Sea encompasses a high diversity of elasmobranches and many critical habitats that are threatened nowadays. Forty-nine sharks and 36 rays are recorded in the Mediterranean (La Mesa et al., 2016; Betts et al., 2019). In Libya, fish are an essential component of the coast, which constitutes 36% of the Arabic Mediterranean coasts. However, the contribution of individual fish, including Elasmobranches, to eastern Libya's fisheries has not yet been established, and a satisfactory database is still lacking (Buzaid and El-Mor, 2015; Dyldin and Orlov, 2018). Most elasmobranches caught in Libya are undersized. Juveniles of Lesser Electric Ray comprised 95% of hauls of Shrimp fisheries in the Mediterranean. In Libya, elasmobranches are not observed in bycatch of Benghazi trawlers, which comprises 10% of the catch.

The Common Torpedo *Torpedo torpedo* grows to about 60cm in length (Tiralongo et al., 2019). These species are stated by IUCN as data deficient (DD) globally due to lack of biological data on catches and population trends despite being guilty of inflicting bites on humans in the waters off the Libyan coasts and despite being one of the most known fish in bycatch of trammels and trawling nets in Libya. The first study on the growth of *T.torpedo in* the Mediterranean used modal analysis of length-frequency data on juveniles and tagged capture-recapture data for older fish in the Gulf of Tunis (Bradai et al., 2004). The annual growth rate of 43.1 cm TL samples was 2.58 cm/year. However, other techniques, such as Length-weight relationship, Length-frequency distribution, and condition factors, can approximate the growth. These techniques will be used in the present work.

In Algarve, southern Portugal, values of the Length-Weight relationship's constant b were between 2.689 and 3.050, and 2.79 to 3.020, respectively for T.torpedo and T *marmorata* in the Central Aegean Sea (Veiga et al., 2009; Başusta et al., 2017). The condition factor for *nobiliana* inhabiting Iskenderun Bay, northeastern Mediterranean Sea, ranged from 2.11 in juveniles (14.1 cm TL) to 1.89 in the semi-adults (35.5 cm TL). The zenith of the length-frequency distribution of *T. nobiliana* reached 22.0 % for the average sizes of 26.6 cm. Slopes of total length-weight regressions of whole and eviscerated fish did not differ significantly (Eronat and Özaydın, 2014; Ali et al., 2013). In general, elasmobranches studies are essential to appreciate the species biology and ecology and to establish better approaches to their fisheries management (Marramà et al., 2018). This work is the first case study of Torpedos in the By-catch of the western Libyan Coast.

2. Materials and Methods

2.1. Study area (Sidi Sha'ab Harbour - 32°53′53″ N, 13°11′47″ E)

This study started at Sidi Sha'ab harbor's pavements, in the western region of Libya. Forty-four of Ocellate Torpedo (*Torpedo torpedo)* individuals were collected from long-line boats (Fig. 1). Their measurements were taken in May 2016. Tripoli coastline is a stretch with relatively high rainfall and developed agriculture (Pike et al., 2016; Groeneveld et al., 2018). Shore appears in different shapes of cliffs, low rocky areas, and sandy beaches. The location of Sidi Sha'ab is a permanent landing site and trawlers' harbor of deep waters (Reed et al., 2017).

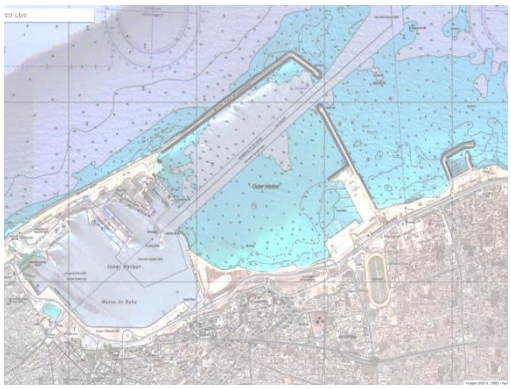

Fig. 1. Sidi Sha'ab Harbour, Tripoli (32° 53′ 53″ N, 13° 11′ 47″ E). and the sampling of Torpedo torpedo individual sin bycatch from Sidi Sha'ab, Harbour, Tripoli in May 2016.

2.2. Measurements

The 44 Torpedos samples collected were identified, and their biometric was measured (Fig. 2), the nearest 0.1 cm, and 0.01 g, according to (Tiralongo et al., 2019).

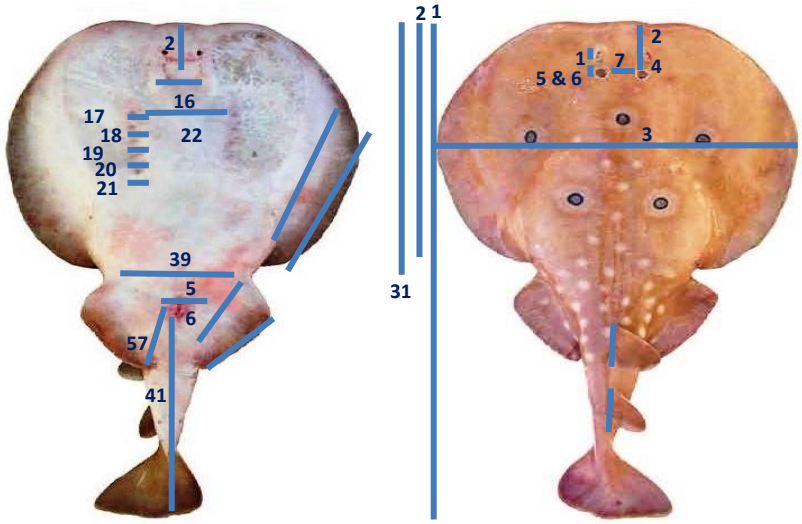

Fig. 2. Some Measurements are taken in the largest male and female specimens of Torpedo torpedo from Sidi Sha'ab, Harbour, Tripoli, in May 2016.

A. The length-weight relationship (LWR)was estimated according to the following equation:

W = aLb: Where: W = Total weight, L = Total Length, a and b are constants

B. Condition factors were calculated as:

1. Fulton's method: KF = 100 WtL-3 Where: Wt =Totalweight(gm), L = Total Length (cm).
2. Clark's method: Kc = 100 WtL-3 Where: Wg = Gutted weight (gm), L = Total Length (cm).

Statically studies: All statistical analysis was done by MS Excel 2010.

3. Results and Discussion

The total weight of all specimens was 15.560 g. The size range was 13.3 to 68.2 cm corresponding to a total weight of 92.61 to 989.25 g. Averages and standard deviations of the collected Torpedo torpedo are presented in Table 1.

Table 1. Averages total lengths and ranges, observed and calculated weight and condition factors (K_F) and (K_C) of the 44 *Torpedo torpedo* from Sidi Sha'ab, Harbour, Tripoli in May 2016.

No.	Total Length Range (cm)	Total Length Average(cm)	No. of fish	T. W. Observed (gm)(Mean±S.D.)	Cal. wt. (gm)	K (F) (Mean±S.D.)	Gutted Weightgm.) (Mean±S.D.)	K (C) (Mean±S.D.)
1	13.3 - 21.1	17.2	11	116.01 ± 19.39	156.07	2.54 ± 1.11	85.61 ± 17.11	1.82 ± 0.65
2	21.2 - 29.0	23.4	9	285.39 ± 75.59	245.15	2.20 ± 0.35	233.25 ± 55.73	1.81 ± 0.31
3	29.1 - 36.9	32.1	8	471.56 ± 54.97	389.79	1.43 ± 0.08	362.64 ± 70.40	1.09 ± 0.07
4	37.0 - 44.8	40.7	8	677.76 ± 35.21	552.16	1.04 ± 0.28	589.50 ± 64.52	0.89 ± 0.14
5	44.9 - 52.7	48.8	4	753.38 ± 36.50	720.61	0.66 ± 0.11	662.60 ± 43.98	0.58 ± 0.11
6	52.8 - 60.6	59.5	2	857.94 ± 46.34	963.84	0.48 ± 0.06	766.90 ± 58.13	0.43 ± 0.05
7	60.7 - 68.4	67.5	2	970.69 ± 26.25	1159.79	0.32 ± 0.01	776.68 ± 22.98	0.25 ± 0.02
			44					

The length-weight relationship obtained in the present study was $W= 2.4032 * L^{1.9064}$, $R^2= 0.9831$ (Fig. 3). The obtained b value of (1.9064) reflects negative allometric growth (<3). Values of Fulton and Clark's condition factors (K_f and K_c) of *Torpedo torpedo* decreased progressively with increasing length (increasing size groups). They started from 2.54 and 1.82 for the size group of 17.2 cm and decreased to less than a half of the value in the mid-sized class (40.7) with $K_f= 1.04$ and $K_c= 0.89$. The values decreased further with increasing length to the nadir values of $K_f= 0.32$ and $K_c= 0.25$ in the largest size group (67.5 cm.) (Fig. 4).

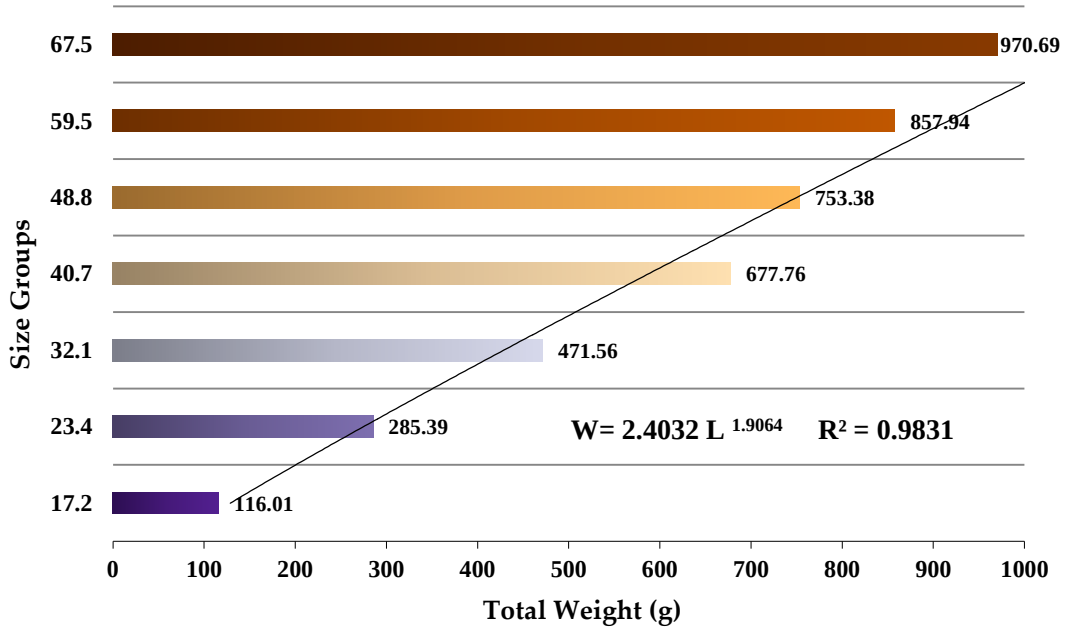

Fig. 3. The relationship between average total length (cm) and average total weight (g) for 44 *Torpedo torpedo* individuals from Sidi Sha'ab, Harbour, Tripoli in May 2016.

The total length-frequency distribution by sex of this species is given in Fig. 5. The youngest group (17.2 cm) recorded the highest frequency (23.4 cm) recorded (25.0%). Mid-size groups (32.1-40.70 cm) dropped to approximately 18.0 %. The highest 67.5 cm group dropped to less than 4.5% (Giménez et al., 2016).

Morphometric measurements of the largest male and female encountered in the 44 collected *Torpedo torpedo* is related to the total length in Table 2. The disk length of male and female Torpedo represented 47.4 and 48.6% of their total length. Disk length (DL) represented 41.2% and 43.0%. The female had a slightly shorter tail (51.4%) than in males (53.2%). The female snout (2.8%) was taller than the male snout (2.5%). However, females had smaller mouth width and distance between eyes than the male. The horizontal eye diameters in both the male and the female (6 and 8 mm) were twice the vertical diameters (3 and 4 mm).

The distance between the eyes in females was wider than in males, as well. The gill silts were ranged between 12 and 25 mm in specimens. The claspers in the male sample were scaled at 62 mm (9.1%) of the whole length.

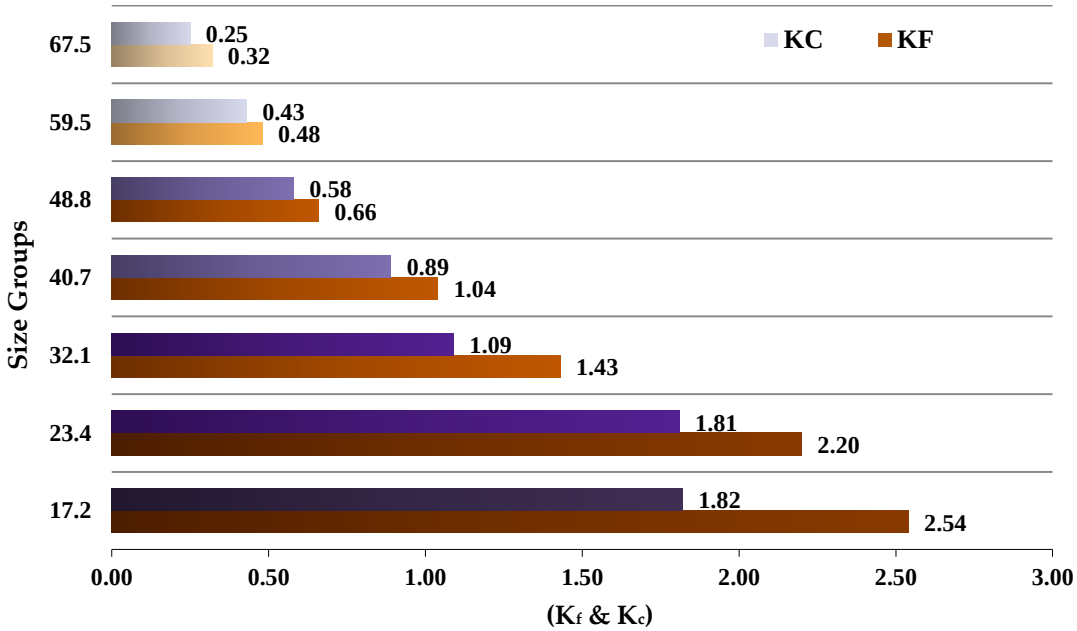

Fig. 4. The relationship between the condition factors and the total length of 44 *Torpedo torpedo* individuals from Sidi Sha'ab, Harbour, Tripoli, in May 2016.

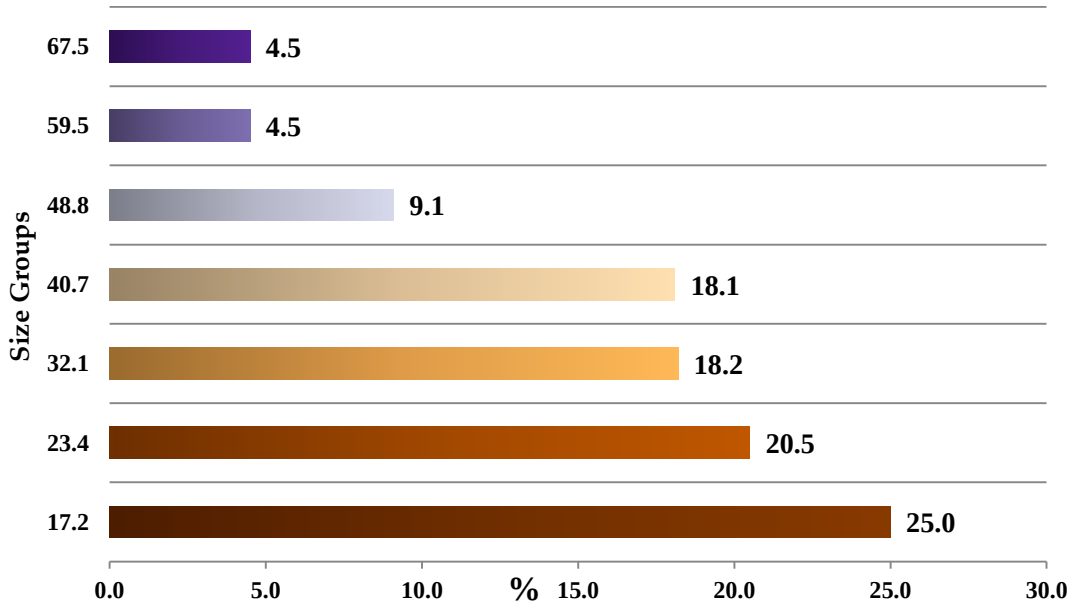

Fig. 5. Length frequency distribution per size groups of 44*Torpedo Torpedo* individuals from Sidi Sha'ab, Harbour, Tripoli, in May 2016.

The common Torpedo is known in the eastern Atlantic coasts from Biscay to South Africa and recorded in the west-southern Mediterranean coasts, including the Libyan area as well (Isbert et al., 2018; Tiralongo et al., 2019). The length-weight relationship of the present study (1.9064) showed negative allometric growth (b< 3). The coefficient of determination (R^2= 0.9831) was high. The obtained (b) value was lower than reported by (Khan et al., 2012). In Table 1, the observed and calculated weights were close to each other in every size group. In general, Weight-length relationships are useful parameters for comparative studies between populations of

species (Beckman, 1948). Some factors influence the length-weight relationship in fishes, including growth phase, sex, size range, temperature, and preservation techniques (Borges et al., 2003).
The coefficients of the length-weight relationship differ between species and between stocks of the same species due to the sex season and maturity stage. For those reasons, parameters in this work are not acceptable (Froese, 2006).

Table 2. Morphometrics of the largest male and female specimens encountered in the 44 collected *Torpedo torpedo*. The total length was taken as reference 100%. The other measurements were presented as % of the total length. (Sample 1: Total Weight: 989.25gm., Sex: Male; Sample 2: Total Weight: 952.12gm., Sex: Female) from Sidi Sha'ab, Harbour, Tripoli, in May 2016.

Measurement	Male		Female		Measurement	Male		Female	
	Cm.	% TL	Cm.	% TL		Cm.	% TL	Cm.	% TL
Total length	68.2	100.0	66.7	100.0	Snout tip to second dorsal	49.9	73.1	50.2	75.2
Disc length	32.3	47.4	32.4	48.6	Snout tip to birth of dorsal caudal	56.9	83.5	59.4	89
Disc width	28.1	41.2	28.7	43.0	Snout tip to birth of ventral caudal	55.7	81.6	57.6	86.3
Disc depth	5.9	8.6	5.9	8.9	Pectoral fin anterior margin	25.6	37.6	22.8	34.2
Horizontal eye diameters	0.6	0.9	0.8	1.2	Pectoral fin posterior margin	17.7	26.0	16.9	25.3
Vertical eye diameters	0.3	0.4	0.4	0.6	Pectoral fin inner margin	1.8	2.7	1.5	2.3
Distance between eyes	1.7	2.5	1.6	2.4	Pelvic fin anterior margin	9.1	13.3	8.5	12.8
Pre-orbital length	4.6	6.8	5.0	7.5	Pelvic fin posterior margin	9.7	14.2	10.7	16.0
Inter-orbital width	4.9	7.2	3.3	4.9	Pelvic fin inner margin	3.7	5.4	3.3	4.9
Space between eye and spiracle	2.5	3.6	2.1	3.2	Span of pelvic fins	19.0	27.9	20.4	30.6
Inter-spiracular width	6.8	10.0	3.4	5.1	Tail base width	7.6	11.1	6.8	10.2
Spiracle diameter	2.0	3.0	1.6	2.4	Tail base depth	3.5	5.1	3.7	5.6
Inter-nasal width	3.4	5.0	3.3	4.9	Tail length	36.3	53.2	34.3	51.4
Nasal curtain	3.6	5.3	3.4	5.1	Caudal superior	11.2	16.4	11.0	16.5
Pre-oral length	7.6	11.1	5.9	8.9	Caudal inferior edge	11.9	17.4	11.7	17.6
Mouth width	1.8	2.6	1.4	2.1	Caudal posterior edge	7.9	11.6	8.2	12.3
First gill slit	1.5	2.2	1.5	2.3	Caudal careen	13.0	19.1	12.4	18.6
Second gill slit	2.0	2.9	1.7	2.5	First dorsal anterior edge	6.3	9.2	7.3	10.9
Third gill slit	2.5	3.6	2.0	3	First dorsal posterior edge	4.1	6.0	5.3	8.0
Fourth gill slit	2.0	2.9	1.7	2.6	First dorsal inner edge	4.2	6.1	3.6	5.4
Fifth gill slit	1.4	2.0	1.2	1.8	First dorsal base	3.8	5.6	4.9	7.3
Width between first gill slit	10.9	16.0	10.1	15.1	Second dorsal anterior edge	4.3	6.3	6.0	9.0
Snout length	1.7	2.5	1.9	2.8	Second dorsal posterior edge	4.5	6.6	4.1	6.1
Snout tip to eye	6.9	10.1	6.4	9.6	Second dorsal inner edge	2.9	4.2	2.6	3.9
Snout tip to mouth	7.2	10.5	6.6	9.9	Second base	3.5	5.1	3.3	5.0
Snout tip to first gill slit	11.8	17.3	13.3	20	Second dorsal to caudal birth	3.7	5.4	3.5	5.2
Snout tip to fifth gill slit	19.6	28.7	20.2	30.3	Inter-dorsal distance	3.3	4.8	3.5	5.2
Snout tip pelvic fin	35.9	52.6	36.0	54	Cornea	2.4	3.5	2.1	3.1
Snout tip to vent	37.5	55.0	38.7	58	Clasper length	6.2	9.1		
Snout tip to first dorsal	42.4	62.2	40.6	60.9					

The decrease in condition factors with an increase in fish size observed in the present study was similar to that reported by for *T. nobiliana*in Iskenderun Bay, northeastern Mediterranean Sea, although the decrease in this study was sharper. The largest torpedo size encountered in the present study was more significant than that stated in *T. nobiliana* (Zogaris et al., 2018; Tiralongo et al., 2019). These torpedoes may be considered

juveniles and adults. Related to total length as a percentage, disc length, width, and depth in the female specimen were larger than in males. Also, the female tail is shorter than in male specimens; the significance of larger disk in females might be necessary. It may provide more space for embryos in their wombs, as is the case in many other ovoviviparous species. Eye diameters in both specimens were the double of the vertical diameters, and the distance between eyes in females (0.8 cm) was wider than in males (0.6 cm), and all eyes dimensions were compared at the total length in this work. Instead of the disk length, like has been in *Dasyatis chrysonota* samples of *T. grabata*. Either five-gill silts varied between 1.2 and 2.5 cm in both individuals; their measurements are folded than in results of at normal female sample common torpedo, which is observed in the northern Tunisian coast. In general, these differences in all studied morphometric aspects might be related to the sample sizes in both studies.

3. Conclusions

Common *Torpedo* is a known species in the Libya coast. However, only very few studies were done on it. (b). the present study is one of the first studies in the biology of elasmobranches in Libya. More studies are required to create a good database for elasmobranches in this region.

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