

Bottom trawls specifications and their relation with the stock of *Rhabdosargus haffara* in the Gulf of Suez, Red Sea Egypt.

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ABSTRACT

This study was conducted at Attaka harbor in the Gulf of Suez (Red Sea) during the 2018-2020 fishing seasons to assess the technical specifications of trawl nets, morphometric characteristics of haffara sea bream (*Rhabdosargus haffara*), and their selectivity parameters. Results indicated that these trawl nets have different design characteristics; it depends on the technical characters of the trawler (i.e. horsepower, length of trawler). The hanging ratio of the bottom trawl ranged from 0.44 to 0.76 while the horizontal opening of the net ranged from 17.91 to 30.94 m. The length-weight relationship (LWR) of *Rhabdosargus haffara* had a significant correlation and the exponent b was observed to be 3.03. On the other hand, length-girth and length depth were analyzed and the correlation coefficients were determined to be 0.85 and 0.80, respectively. Lengths at first capture (L_{50}) for male, female, and combined sexes were 12.67, 14.45 and 13.17 cm, respectively; which were higher than the minimum landing size. This information may be used by fishery managers to get an approximate estimate of the bottom trawl effect and to design appropriate marine spatial planning.

INTRODUCTION

The Egyptian marine fisheries are suffering from many problems such as decline in marine fish production as a result of many reasons; over-fishing, some illegal fishing methods, small mesh sizes of nets which used to catch small species, establishment of new factories on the coasts, increasing in the rate of tourism from year to year and increase the percent of pollution from land-depend on sources of this pollution. As a result, it is critical to identify and establish a long-term plan to manage fishing operations, as well as to preserve and improve the development advantages that these fisheries provide (El Ganainy *et al.*, 2005).

The harvesting potential (fishing power) of a vessel in the Gulf of Suez is also highly dependent on many other factors including availability of catch in the Gulf, the individual skipper's ability, as well as technical characteristics of all fishing methods such as gears deployed and onboard electronic equipment (El Ganainy *et al.*, 2005; Osman *et al.*, 2019; Saber & Gewida, 2020 and Saber *et al.*, 2020).

Rhabdosargus haffara is a commercially valuable species belong to Family Sparidae (Ibrahim, 1999; Ahmed & El-Ganainy, 2000; EL-Halfawy, 2001; El-Boray, 2003; Osman *et al.*, 2020 and Saber *et al.*, 2020). Its annual production has a considerable commercial importance in the Gulf of Suez. This species is caught by trawling, while it is caught in the shallow water of the Gulf of Suez in the northern of Suez by trammel nets (El Ganainy, 2017 and Saber *et al.*, 2020).

The relation between length-girth and their parameters are important tools in the fisher's management of all fisheries especially artisanal fisheries (Jasper & Evenson, 2006 and Saber *et al.*, 2020). Body length and body girth are related to some of the other biological parameters such as swimming speed and condition factor of fishes. The length and girth parameters determine if the fishnet is selective to catch a specific length and a special fish. Thus, they explain the relation between the fish and fishing methods and fish's ecological position within the food webs in which they are embedded (Hambricht, 1991; Pauly, 2000 and Stergiou & Karpouzi, 2003).

This study was conducted to observe the technical specifications of the trawl nets in the Gulf of Suez. It also focused on the morphometric characteristics of *Rhabdosargus haffara* and assesses the length at first capture (L_{C50}) for *R. haffara* landed from trawl at the Attaka fishing Harbor, Gulf of Suez, Red Sea.

MATERIALS AND METHODS

Study area:

From Suez in the north (Lat.29°56' N) to the Island of Shadwan in the south (Lat.27°36' N), the Gulf of Suez extends for roughly 250 kilometers. The Suez Gulf is characterized by a width ranged between 20 to 40 km, and its depth ranged between 5 to 200 meters with an average of 45 m (Fig. 1). The Suez Gulf is regarded one of the most productive areas along the Egyptian red sea coast since it produces more than 64 percent of all red sea fish. In the Gulf there are three main fishing methods; trawl, purse seine, and artisanal fishing (long line, trammel, and gill nets).

Bottom trawls specification:

The technical specifications of trawling gear were collected in the Attaka harbor and analyzed in this article. Some measurements are taken during the interviews with fishermen on board. The data collected includes some details on the characteristic of trawling gear (headline length, ground rope length, wing length, wing mesh, codend length, and target species, etc.), otter boards (weight, length, and height) and general fishing vessel features such as engine power.

The hanging ratio (**E**) is calculated by the equation:

$$E = \frac{l_b}{n MS} \quad \text{Notti et al. (2013)}$$

Where:

l_b = the bosom length.

n = the total number of meshes in the panel along the bosom.

MS = the panel's mesh size (totally stretched) related to the bosom.

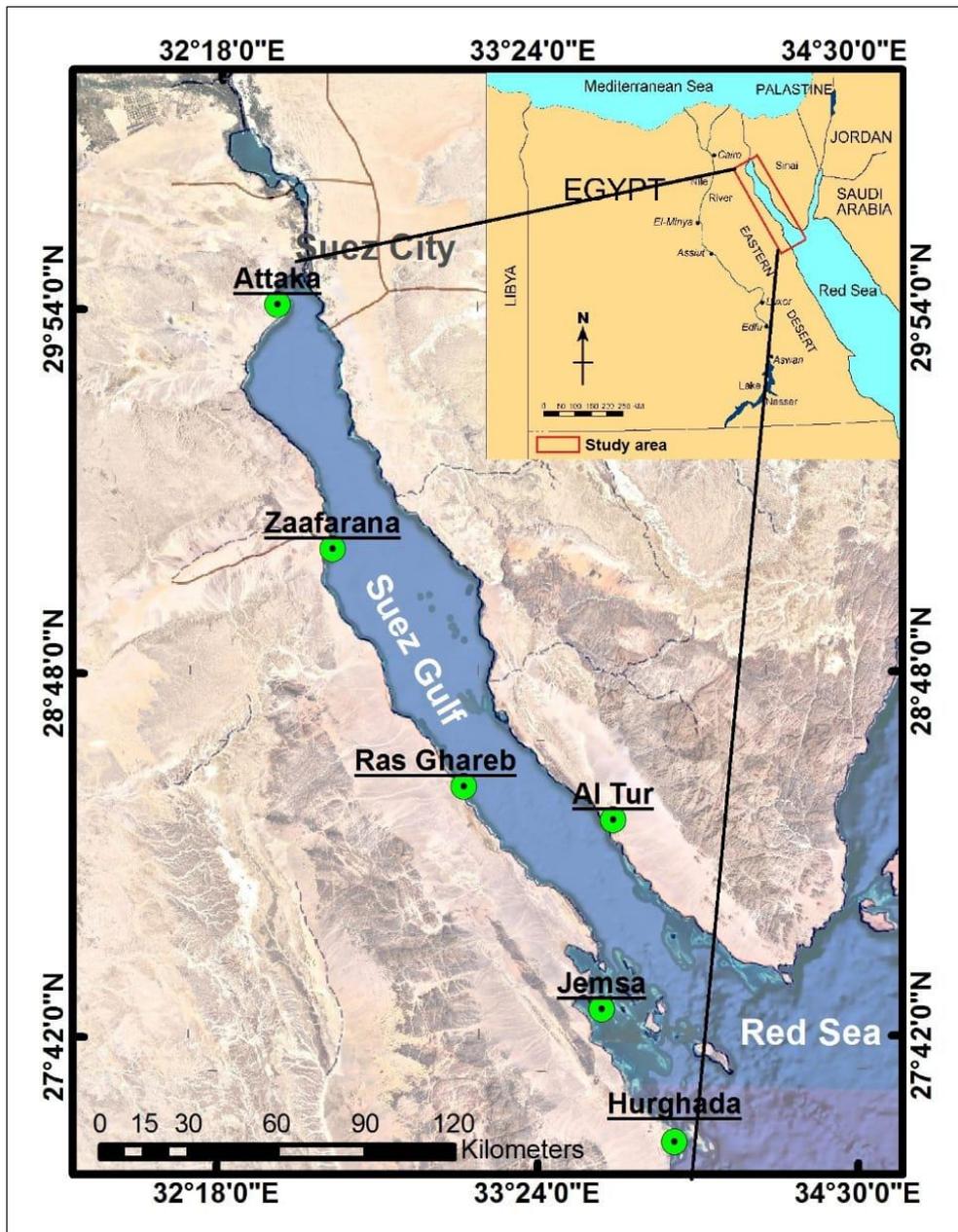


Fig. 1. A map of the Gulf of Suez, Red Sea, Egypt.

The horizontal and vertical net are affected by many factors; hanging ratio, the number of meshes corresponding to the length of bosom and the length of head rope. Overall, these parameters can change the distribution of resulting forces along the head rope: with the lower the hanging ratio its lead to longer the mesh panel length for the same bosom length, and the smaller the net openings.

The length of horizontal trawl opening (HNO) is calculated by the equation:

$$\text{HNO} = \text{HL} * \text{E}_1 \quad \text{Notti et al. (2013)}$$

Where:

HL= head rope length (m).

E_1 = the hanging ratio between rope and net.

HNO= the length of horizontal trawl opening (m).

Morphometric relationships:

The length-weight relationship and the relationship between total length (L) and total girth (G) and total depth (D) were estimated using the following equations:

(1) The relation between body weight and body length (L-W) of all samples was calculated by the following equation:

$$W = a L^b$$

(2) Relationship between (L-G) was calculated using the following equation:

$$G = a+b \times L$$

(3) Relationship between (L-D) was assessed using the following equation:

$$D = a+b \times L$$

Where: W is the total weight (g), G is the total girth (cm), D is the total depth (cm), L is the total length (cm) and a&b are the intercept and slope respectively (Santos *et al.*, 2006).

Selectivity parameters:

The length-cumulative curve was used to calculate the probability of capture P for each length class of Haffara sea bream. The total length at initial capture L_{50} was calculated by plotting the cumulative probability of capture against the mid-length of the class interval. The L_{50} is defined as the cumulative probability at 50% of the time. This is the number of recruits at which 50% of the captures are kept by the gear or 50% of the recruits are fully exploited. The total length at 25% and 75% exploitation (L_{25} and L_{75}) were also calculated for *Rhabdosargus haffara* under investigation. Using a running average method and logs, the probabilities were smoothed.

RESULTS

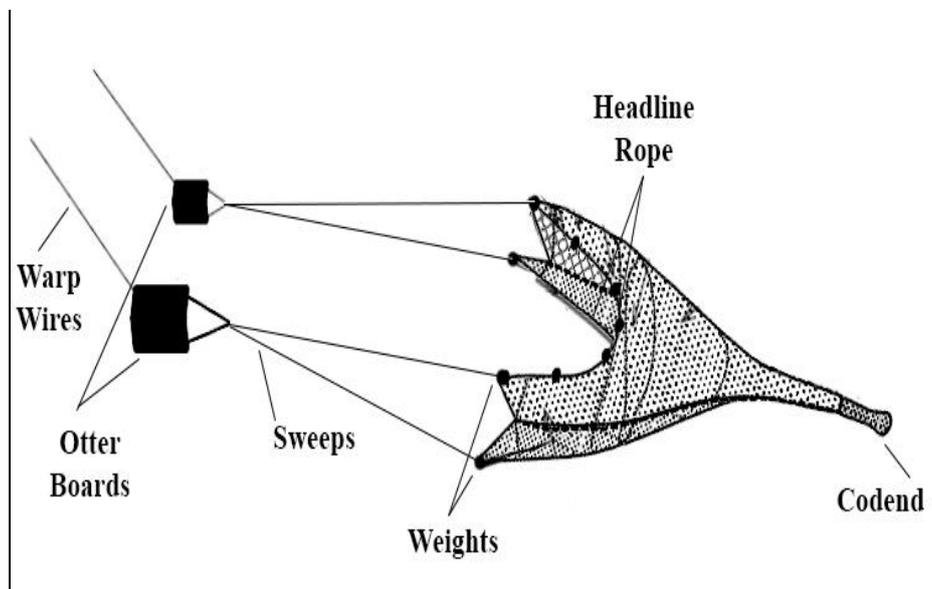
Bottom trawls specifications:

The data of bottom trawl specifications: vessel characteristics (length, horsepower, fisheries depth, and target species), and gear specifications (headline, foot line, wings, and codend) were collected through interviews with the fishermen in the Gulf of Suez (**Table 1**).

The results of these data indicated that the bottom trawl which used in the Gulf of Suez is a modified trawl from Italian trawl (**Fig. 2**). The bottom trawl consists of asymmetric two-face trawl with long foot rope, different horizontal openings. Also, the bottom trawl is usually made of polyamide material (nylon) or polyethylene material (PE). The length of the ground rope ranged between 36.5 to 58.5 m (on average of 45.5 m); head rope was ranged between 31.09 to 54.86 m with average of 41.53 m. There were some accessories which base in establishing of fishing gear such as chains were set in ground rope with weight about 100 kg per trawl along the foot rope (**Table 1**).

Table 1. Technical specifications of bottom trawl (vessel characteristics and gear specifications) through interviews with the fishermen in the Gulf of Suez.

ID	Vessel length	Horse power	Mean depth	Head rope	Foot rope	Wings		Cod end		Target species
						Mesh	Length	Mesh	Length	
1	25	500	50	47.549	54.86	75	18.63	10	12	Shrimp, Lizardfish
2	26	425	30	32.91	36.57	65	13.71	15	20	Shrimp, Lizard fish
3	24	425	20	54.864	58.533	75	17.801	15	12	Lizard Fish
4	25	425	40	38.40	40.40	75	18.288	20	10.3	Shrimp
5	24	500	35	43.85	45.72	65	17.973	20	10.3	Shrimp
6	27	500	40	42.06	45.80	75	12.98	20	10.3	Shrimp, Lizard fish
7	27	425	55	31.096	36.654	65	13.87	15	13.72	Shrimp
8	25	425	40	44.5	47	75	17	15	14	Shrimp, Lizard fish
9	19	350	25	35.5	39	65	12.5	20	10	Shrimp, Lizard fish Other species
10	18	230	40	37	40	65	13.5	25	7	Shrimp, Lizard fish
11	21	385	40	36	40	65	12.5	25	8	Shrimp, Lizard fish
12	28	565	70	45	48	75	18.6	20	12	Shrimp, Lizardfish

**Fig. 2.** Bottom trawls and their parts that work in the fisheries of the Gulf of Suez.

The Designer should be considered the relation between the size of the otter, and tire reaction to the water-flow forces which push it outward in opposition to the in-pulling forces from the warps and the body of the gear (**Fig. 3**).The data relating to

the length of bosom, hanging ratio (E), and bottom trawls horizontal opening HNO, were represented in **Table (2)**.

Table 2. Otter trawl investigation; bosom (B), hanging ratio (E), and horizontal opening (HNO) for commercial trawl in Gulf of Suez.

B(m)	E(%)	HNO (m)
7	0.76	30.94
7	0.65	26.46
6	0.51	20.76
6	0.44	17.91

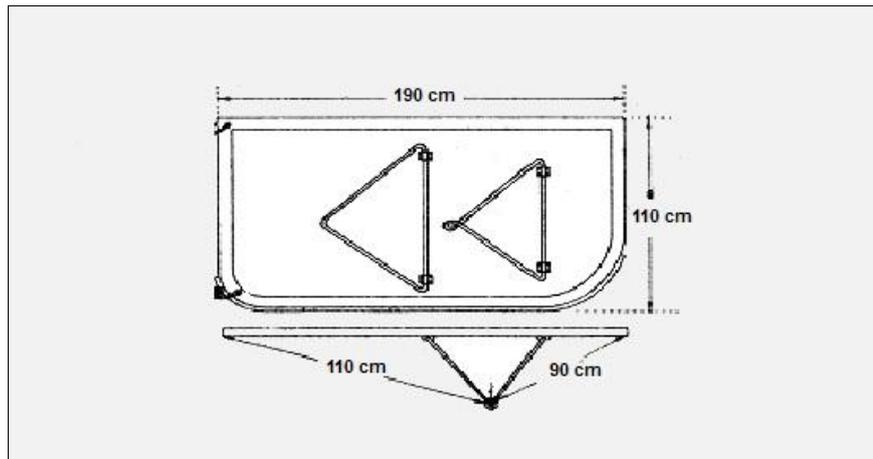


Fig. 3. General structure of otter board.

Morphometric relationships:

Length-weight (L-W) relationship is an important biological parameter needed to appreciate the suitability of the environment for any fish species. As a result of that, many fishery biological studies are focusing on this relationship. The relationships between total length (L) and total body depth (D) and total girth (G) are essential in estimating the allowable catch and appropriate mesh size to be used in a fishery.

The total lengths and weights of *Rhabdosargus haffara* in the Gulf of Suez ranged between (9.9 cm/12.49 g) to (23.1 cm/193 g) for both sex. Length-weight relationship (L-W) with power regression equation: $W=0.0134L^{3.0343}$, $R^2 = 0.9424$ (**Fig. 4**).

Length-girth relationships (L-G) are presented in **Fig. (5)**, the exponent b value was estimated to be 0.14 for *R. haffara*. The coefficients of determination (R^2) of the L-G regressions were found to be 0.85. The relationship between total length and body depth (L-D) is shown in **Fig. (6)**, the regression coefficient (R^2) was estimated to be 0.80.

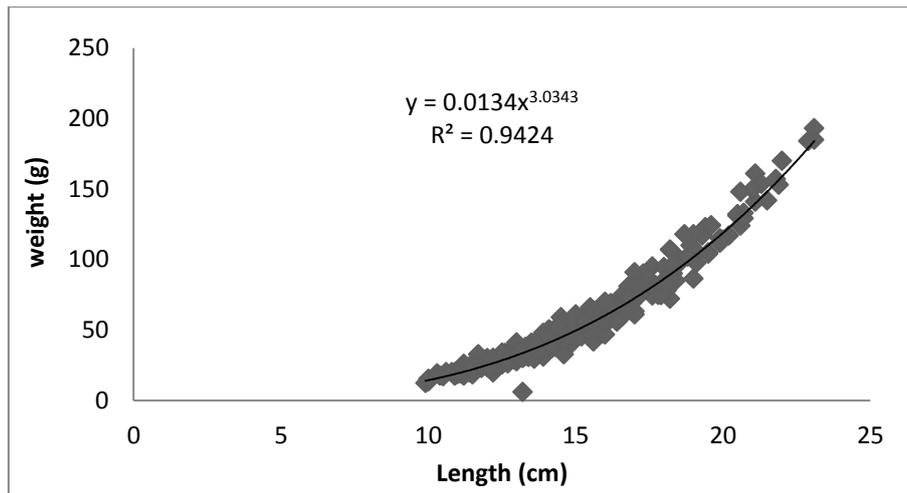


Fig. 4. Length-weight relationship of *R. haffara* captured by trawl net in Gulf of Suez.

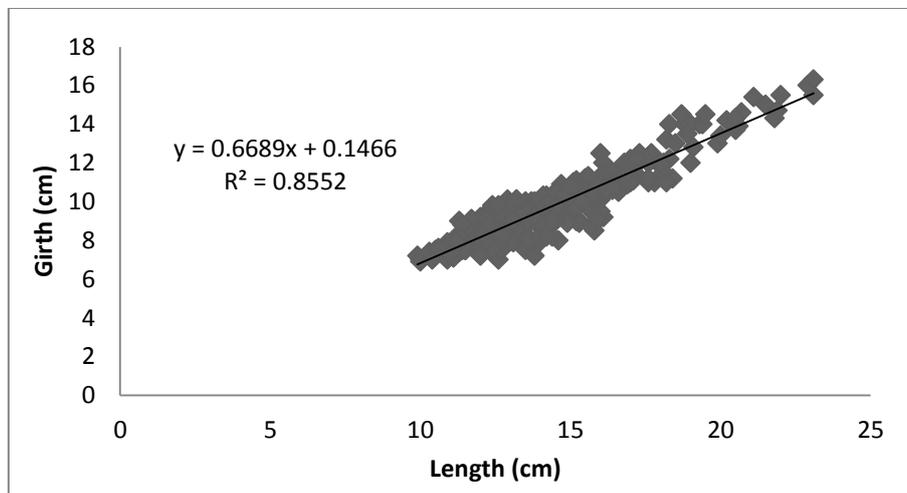


Fig. 5. Length-girth relationship of *R. haffara* captured by trawl net in Gulf of Suez.

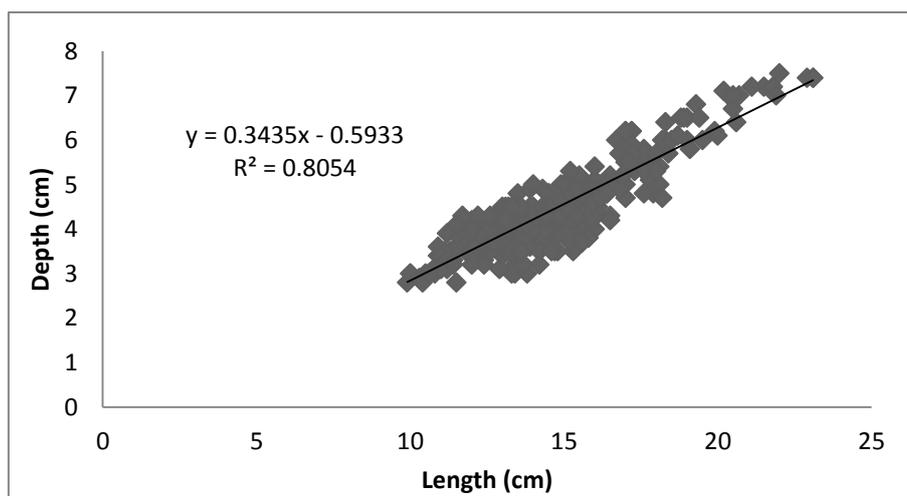


Fig. 6. Length-depth relationship of *R. haffara* captured by trawl net in Gulf of Suez.

Selectivity parameters:

The computed length-at-first capture, L_{50} or L_c (length at which 50% of *R. haffara* entering the gear are retained) was 13.17 cm for combined sexes, 12.67 for males, and 14.45 cm for females (Fig. 7), by cumulated catch curve and running average routines.

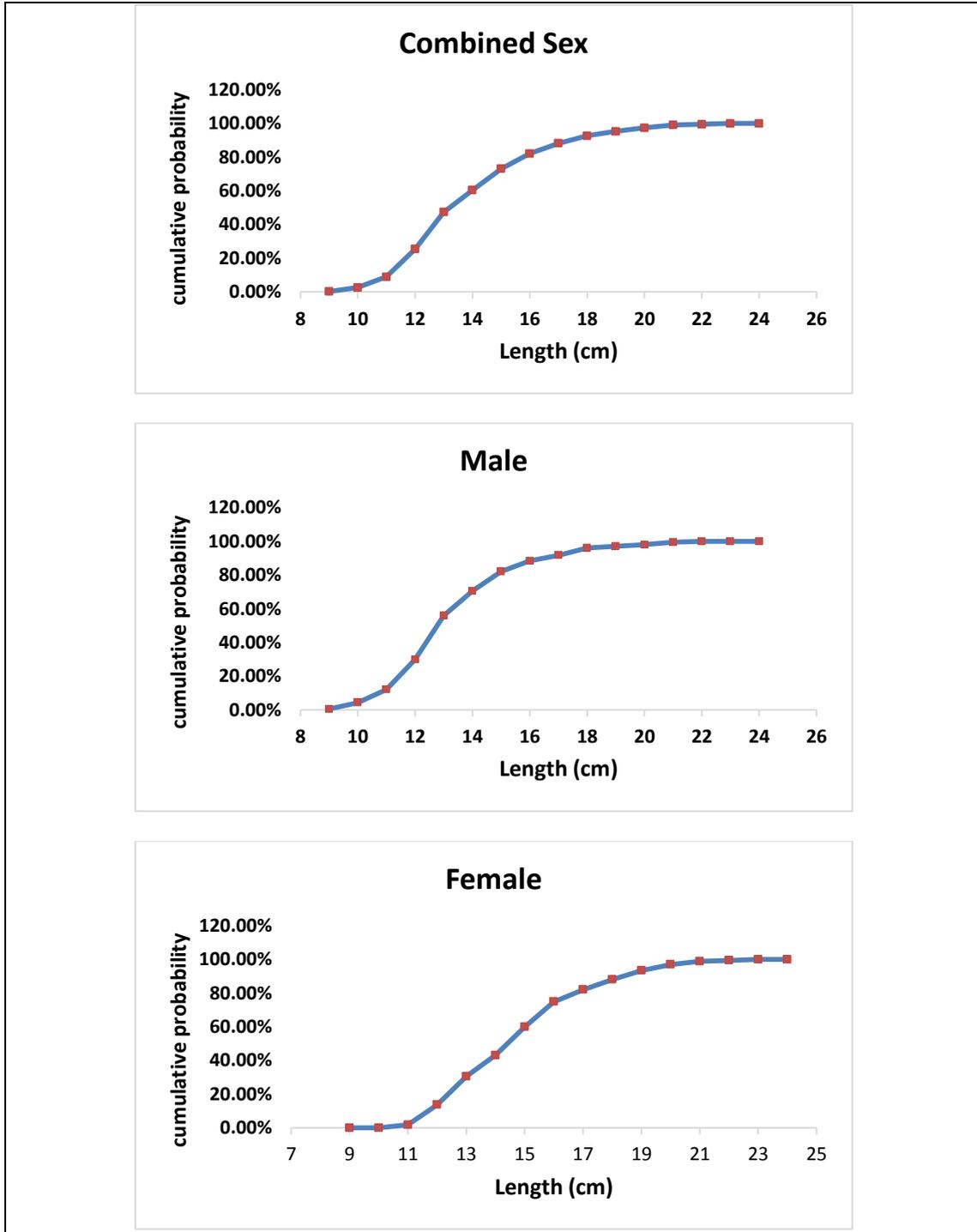


Fig. 7. Length at first capture (L_{c50}) of combined sex, male, and female of *R. haffara* landed by trawl net at the Attaka fishing harbor, Gulf of Suez.

DISCUSSION

Bottom trawls are often used to capture shrimp and bottom fish at depths ranging from shallow coastal waters to depths (Morgan & Chuenpagdee, 2003). Between 2000 and today, the number of trawl vessels operating in the Gulf of Suez has fluctuated between 72 and 78. The vessel lengths ranged from 20 to 30 m, with horse power ranging from 200 to 600 horsepower, with the majority (68 boats) being 400-600 horsepower (Mehanna & El-Gammal, 2007).

Nine hundred meshes and bigger sizes trawl nets are used generally in Gulf of Suez to catch commercially important species mainly shrimp (*Penaeus semisulcatus*, *Marsupenaeus japonicus*, and *Metapenaeopsis stridulans*), hake (*Saurida undosquamis*), and Mullidae as well as Sparidae members (*Rhabdosargus haffara*) are often targeted with 900 mesh and smaller sizes trawl nets (El Ganainy *et al.*, 2005; Mehanna & El-Gammal, 2007 and Osman *et al.*, 2019).

The major technical element determining bottom trawl selectivity in the Gulf of Suez is codend mesh opening (Saber *et al.*, 2020). In Egypt, most fishing gear has tiny mesh sizes, resulting in a high proportion of small fish and juveniles in the catch. The horizontal net opening ranged between 17.9 to 30.94 m. These results are higher in comparison of horizontal net opening in the Mediterranean Sea, Egypt (Lucchetti *et al.*, 2016).

The current results can be used as support to the management of trawl fisheries in the Gulf of Suez, specifically for the stock of *Rhabdosargus haffara*. Technical specifications in this study are limiting in the Red Sea and Gulf of Suez. Some dimensions of all parts of trawl like headline, footrope, codend, and otter board are basically for trawl fishery management.

Sparidae is one of the most commercial families in the Gulf of Suez fisheries (Osman *et al.*, 2019 and Saber *et al.*, 2020). *Rhabdosargus haffara* is the most common Sparid species in trawl and artisanal catches. Family Sparidae is one of the considerable commercial families in the large industrial and small scale fishery in the Gulf of Suez with most dominant species *Rhabdosargus haffara* (Osman *et al.*, 2019, and El-Boraay, 2004).

The relation between length-girth with other biological parameters (behavior of fish) and technical aspects (gear construction, dimensions, and fishing techniques) determining the size selectivity of fishing gear were discussed by Santos *et al.* (1998) and Stergiou & Karpouzi (2003). In the present study the length at 50% capture was 13.17 cm for combined sexes, 12.67 cm for male, and 14.45 cm for female. In comparison of the length at first capture of male, female, and combined sexes which assessed for species are slightly higher than what was reported by El-Boraay (2004) who estimated the L_{m50} for male *Rhabdosargus haffara* as 10.3cm in the Suez bay.

The length at first maturity ($L_{m50} = 12.3$ and 12.7 for male and female, respectively) which assessed by Osman *et al.* (2020) were relatively lower than the length at first capture for male, female, and combined sexes which observed in the present study. This indicated that the stocks of this species are harvested after they reach the matured stage. These differences may be attributed to the different recorded maximum length of the species in the different localities.

CONCLUSION

In the present study we observed the trawl fishing net that used in the Gulf of Suez have two faces. Some technical parameters of bottom trawl were assessed to be available to fisheries manager. The lengths of mesh size have ranged between 65 for wings to 10 mm for codend. The fisheries manager should be consider the use of square mesh cod ends, modification of otter trawl, modification of trawl vessel is mandatory in Red Sea and Gulf of Suez. Furthermore, because to the high fishing pressure, bottom trawling in critical regions such as reproductive and nursery areas should be prohibited. The current results can be used as support to the management of trawl fisheries overall and for *Rhabdosargus haffara* fisheries in the Gulf of Suez.

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