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FULL LENGTH ARTICLE

Catch and effort of night purse seine with emphasize to Age and Growth of lessepsian *Etrumeus teres* (Dekay, 1842), Mediterranean Sea, Egypt

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Abstract Catch and effort (CPUE) of the purse-seine using light, age and growth of lessepsian fish "*Etrumeus teres*" from the Egyptian Mediterranean waters were studied in the period 2008. It was found that, the average annual catch (CPUE) was 1.7 (ton/boat/night). The catch diversity was composed of seventeen different species. Clupeids were the dominant 74.1% of the total catch. Seven lessepsian species were involved and constituted 41.18% and 19.01% of the total number and weight of the catch, respectively. Round herring *E. teres* was the highest one of these immigrants, accounting for 10.93% of the total catch; it exhibited the highest average values of the catch during winter and autumn (19.7% and 19.2%, respectively). The exponent "b" of length-weight was 3.052 revealing positive allometric mode of growth. The length range was 9–25 cm for combined sexes with an average of 17.22 ± 3.29 cm while the smallest lengths were recorded during the summer season. The highest condition factor (k) was recorded in July, while the lowest one was in February, this factor increased with the increase in fish length. Round herring, *E. teres* reached to five years that was determined by otolith. Growth parameters; L_∞ were 31.71, 29.058 and 30.26 cm for males, females and combined sexes, respectively. Growth coefficients (K) were 0.214, 0.246 and 0.225 year^{-1} for males, females and combined sexes, respectively; values of t_o were −0.776, −0.686 and −0.744 year^{-1} for males, females and combined sexes. Growth performance indexes ($Ø$) were 2.33, 2.31 and 2.31 for males, females and combined sexes, respectively. This study reflected the importance of such fishing gear in the Egyptian marine fisheries. Round herring "*E. teres*" as lessepsian species is predicted to be of economic value in the marine fisheries and give the positive impact of the lessepsian migration. The age of *E. teres* was five age groups that were higher than those from the Red Sea reflecting the good establishment of such immigrants in the new habitat. This may be ascribed to the environmental

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variations between different localities and due to the low exploitation rate of such new immigrant species in the Egyptian Mediterranean waters.

Introduction

Purse-seine (Shansholla) is one of the most important fishing gears in the Egyptian fisheries. In the Red Sea particularly the Gulf of Suez, it represents about 76% of the total annual fish production from the Gulf (Mehanna, 2004). This net was developed to take advantage of the surface schooling behavior of small pelagic fishes. Purse seine using light has been enhanced in the Red Sea since 1960 and in the Egyptian Mediterranean since 1969 (Rafail, 1972). Purse-seine using light was adapted to capture off shore pelagic fishes at more than 40 m depths to attract fishes at night. This method participated in increasing the total landing catch of the pelagic species (Akel, 2009 and Farrag, 2010).

Round herring "*Etrumeus teres*" is one of the important fish species in the catch of purse seine which is attracted by light (Mehanna, 2004 and Farrag, 2010). It accounted for 38% in the pelagic fishery of the Gulf of Suez (El-Sayed, 1996) and about 25.27% in the total landing catch of purse-seine in Red Sea (Mehanna, 2004). This fish is a lessepsian immigrant belonging to clupeid species (Sardine & herring) that migrated from the Red Sea to the Mediterranean Waters via the Suez Canal and is distributed rapidly in many Mediterranean countries (Farrag, 2010 and Osman et al., 2013).

A little attention has been given to the study of the structural composition of purse seine using light and to the biological characteristics of the lessepsian migrants in the Egyptian water. Aging of fish is a very important issue in biology, and the accurate knowledge about age and growth is required to manage fisheries of fish populations (Panfili et al., 2002). The present work is a part of a detailed investigation on the biology of lessepsian fish, *E. teres* from the Mediterranean water. The aim of this study is to give knowledge about catch composition and catch per unit effort of purse-seine using light focusing on age and growth of the round herring *E. teres* from the Egyptian Mediterranean water.

Materials and methods

The study area located between El-Hammam to Rosetta at (31° 00 & 31° 50 N) and (27° 00 & 31° 40 E) along the Egyptian Mediterranean coast and the fishing ground fluctuated from 40 m to 80 m depth (Fig. 1). The used fishing vessel was the night seiner which used artificial light to attract fish at night; it was supported by the echo-sounder and radar to detect the sailing course and depth.

Catch of 100 night seiners was observed and recorded from the landing centers of Alexandria during the period from January to December 2008 to describe species diversity, catch and catch per unit effort. For each fishing trip; date of landing, trip duration, name of the boat and fishing grounds were recorded. Species identification was done to the lowest species level by using keys identification of Whitehead et al. (1986) and Golani et al. (2002). Catch composition and percentage of each species were recorded, then the annual and seasonal catch per unit effort (CPUE) was analyzed per boat/night. Random specimens of round herring *E. teres* were collected every month during the study period. In the laboratory, the total length (TL) was measured to the nearest mm; the gutted weight was measured to the nearest gram to avoid any bias from weights of gonads and stomachs. The length–weight relationship was studied for 748 specimens and described by the power function equation: $W = a\ L^b$ where W is the gutted weight in gm, L is the total length in cm, a and b are constants. The exponent "b" was tested according to Snedecor (1956) to determine whether it is allometric or isometric growth. The condition factor $K = 100 \times W/L^3$ is estimated according to Bagenal and Tesch (1978).

For age determination, otoliths of 583 specimens were carefully removed, cleaned, dried, immersed in glycerol and examined on a dark background with reflected light using binocular microscope at (25×) magnification. The time of annulus formation (MI) was performed for the dominant age group. The relationship between otolith radius (R) and total fish length (L) was considered to determine the length of fish at previous ages. This relationship was applied by the following formula:

$$L = a + bR$$

where a and b are constants. They were estimated by the least square method. The back-calculated lengths, at the end of each year of life from otolith measurements by Lee's equation which were estimated by the following equation (Lee, 1920):

$$L_n = (L_t - a)R_n/R + a$$

where L_n = the fish length at the end of n years (cm). L_t = the total length at capture (cm). R_n = the otolith radius to the n annulus. R = the total otolith radius (micrometer divisions). a = is the intercept with Y-axis from the relationship of length and otolith radius.

The calculated growth in weight was determined by applying the length–weight equation on the back-calculated length at different age groups.

The von Bertalanffy growth parameters (L_∞ and K) were estimated according to Ford (1933) and Walford (1946), where L_∞ = asymptotic length and K = growth coefficient. While t_o was estimated according to Pauly (1979). Growth performance index (Ø) was computed according to the formula of Pauly and Munro (1984) as follows: Ø = Log k + 2Log L_∞. The potential longevity of age (t_{max}) is the age at which fish species can reach, it was estimated by using $t_{max} = 3/k + t_o$ (Pauly, 1983). The results were treated statistically by using Microsoft Excel Program and Covariance analysis program.

Results

Species composition and catch per unit effort

Catch per unit effort and species composition of purse-seine using light in the Egyptian Mediterranean Water off

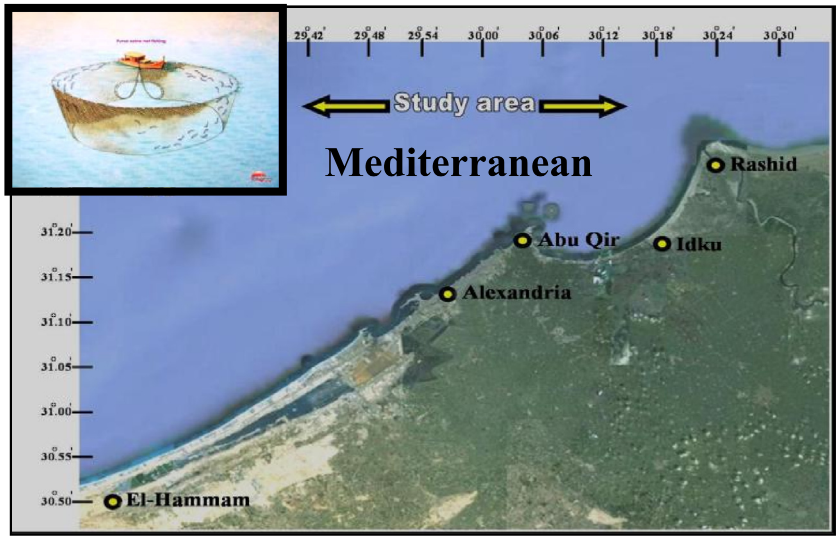

Figure 1 Map showing the study area for purse-seine using light in the Egyptian Mediterranean waters.

Alexandria were analyzed and shown in Table 1 and Fig. 2. The average of the total annual catch per unit effort (CPUE) was 1703.855 kg (1.7 ton/boat/night). The maximum average value was attained in summer (2909.38 kg), followed by spring (2737.8 kg), and winter (621.72 kg). The lowest average value of catch was reported in autumn (546.52 kg). Species diversity involved seventeen species namely: *Sardinella aurita*, *Sardina pilchardus, Sardinella maderensis*, *E. teres*, *Dussumieria elopsoides, Engraulis encrasicolus*, *Scomber japonicus*, *Boops boops*, *Trachurus trachurus*, *Trachurus mediterraneus*, *Atherinomorus lacunosus*, *Euthynnus alletteratus*, *Fistularia commersonii*, *Trachinotus ovatus*, *Scomberomorus commerson*, *Sphyraena sphyraena* and *Hirundichthys rondeletii*.

Sardine and herring (Family: Clupeidae) were the dominant group accounting for about 74.1% of the total catch. Seasonal variations illustrated that clupeids showed high catch during spring (83.7%), followed by autumn (82.9%) and winter (71.7%) while the lowest one was recorded during summer (63.9%). This family was represented by *S. pilchardus* (36.5%), *S. aurita* (24.9%), *E. teres* (10.93%) *S. maderensis* (1.5%) and *D. elopsoides* (0.24%) of the total catch.

E. encrasicolus reported to be the second category and accounted about 14.19% of the total catch. *S. japonicus* occupied the third rank and represented 5.99% of the total catch while *B. boops* came as fourth category representing 3.71% of the total catch. *Atherina lacunosus* represented 0.85% followed by *T. mediterraneus* which accounted 0.44% of the total catch. The other species (*E. alletteratus*, *F. commersonii*, *H. rondeletii*, *S. commerson*, *T. trachurus*, *S. sphyraena* and *T. ovatus*) were recorded in lower percentages (less than 1%) of the total catch of the purse-seine using light (Fig. 3).

Concerning Red Sea immigrants, catch of purse-seine using light involved many lessepsian immigrants (*E. teres*, *D. elopsoides, S. japonicus, A. lacunosus, F. commersonii*, *H. rondeletii* and *S. commerson*). They constituted 41.18% of the total number of fish catch. Their catch percentage by weight was 19.01% of the total catch of purse-seine using light. Round herring "*E. teres*" represented the highest one of the migratory fishes caught by this net and accounting for 10.93% of the total catch. This species exhibited seasonal variation recording the highest values during winter and autumn (19.7% and 19.2%, respectively), while the lowest values were recorded during spring and summer (9.6% and 8.8%, respectively).

Growth of E. teres

This species was fluctuated in length from 9 to 25 cm with an average length of 17.22 ± 3.29 cm, the majority of fishes (69.39%) ranged from 13 to 19 cm for combined sexes. The distribution of the length groups of this species exhibited seasonal variation. All lengths (from 9 and 25 cm) were recorded during the summer season, while lengths from 13 to 21 cm dominated the catch during winter and autumn seasons.

The length–weight relationship of 219 males and 437 females of *E. teres* (9–25 cm Total length) using the gutted weight were analyzed and represented by the following equations:

For males	$W = 0.0047\ L^{3.1618}$	$r = 0.9987$
For females	$W = 0.0063\ L^{3.0637}$	$r = 0.9995$
For combined sexes	$W = 0.0066\ L^{3.0512}$	$r = 0.9989$

The values of the exponent "b" for male, female and combined sexes of *E. teres* revealed a positive allometric mode of growth. This species exhibited insignificant differences between males and females in length weight relationship at 0.05 level of significance ($F \geqslant 0.02062$ d. F. 1, 26).

Condition factor (k) showed fluctuations according to months and length during the period of investigation (Tables 2 and 3 and Fig. 4 and 5). The higher conditions were observed during July (0.802 ± 0.02, 0.773 ± 0.03 and 0.775 ± 0.03) for males, females and combined sexes, respectively. While the lower values were recorded during February (0.691 ± 0.03, 0.705 ± 0.04 and 0.701 ± 0.04) for males, females and combined sexes, respectively. Generally, the high conditions were recorded from April to September, then the conditions started to decrease. The general annual average values of condition factors for males, females and combined sexes were 0.746 ± 0.04, 0.752 ± 0.04 and 0.745 ± 0.04, respectively.

Table 1 Total and seasonal catch composition of purse-seine using light in the Egyptian Mediterranean waters, off Alexandria (The boat is the unit effort).

Species	Season														
	Winter			Springer			Summer			Autumn			Annual catch		
	Total	CPUE		Total	CPUE		Total	CPUE		Total	CPUE		Total	CPUE	
		(kg)	%		(kg)	%		(kg)	%		(kg)	%		(kg)	%
E. teres	**3060**	**122.4**	**19.7**	**6552**	**262.1**	**9.6**	**6392**	**255.7**	**8.8**	**2620**	**104.8**	**19.2**	**18,624**	**186.2**	**10.93**
D. elopsoides	0	0	0.0	0	0.0	0.0	408	16.3	0.6	0	0	0.0	408	4.1	0.24
S. aurita	1140	45.6	7.3	26,460	1058.4	38.7	13,090	523.6	18.0	1740	69.6	12.7	42,430	424.3	24.90
S. pilchardus	6820	272.8	43.9	24,264	970.6	35.5	24,276	971.0	33.4	6840	273.6	50.1	62,200	622.0	36.50
S. maderensis	120	4.8	0.8	36	1.4	0.1	2278	91.1	3.1	120	4.8	0.9	2554	25.5	1.50
Total sardine catch	**11,140**	**445.6**	**71.7**	**57,312**	**2292.5**	**83.7**	**46,444**	**1857.8**	**63.9**	**11,320**	**452.8**	**82.9**	**12,6216**	**1262.2**	**74.1**
T. mediterraneus	120	4.8	0.8	288	11.5	0.4	102	4.1	0.1	240	9.6	1.8	750	7.5	0.44
S. japonicus	500	20	3.2	2484	99.4	3.6	5984	239.4	8.2	1240	49.6	9.1	10,208	102.1	5.99
E. encrasicolus	3340	133.6	21.5	2700	108.0	3.9	17,918	716.7	24.6	220	8.8	1.6	24,178	241.8	14.19
A. lacunosus	160	6.4	1.0	576	23.0	0.8	544	21.8	0.7	160	6.4	1.2	1440	14.4	0.85
B. boops	240	9.6	1.5	4500	180.0	6.6	1224	49.0	1.7	360	14.4	2.6	6324	63.2	3.71
*Others	43	1.72	0.3	585	26.3	0.9	518.5	27.5	0.9	123	4.92	0.9	1269.5	12.7	0.75
Total catch	**15,543**			**68,445**			**72,734.5**			**13,663**			**17,0385.5**		
Av. catch (kg)	**621.72**			**2737.8**			**2909.38**			**546.52**			**1703.855**		
No. of boats	**25**			**25**			**25**			**25**			**100**		

* The others are composed of (*E. alletteratus, F. commersonii, H. rondeletii, S. commerson, T. trachurus, S. sphyraena and T. ovatus*) (Each < 1% of the total catch).

According to the length, the condition factor of *E. teres* increased with the increase of fish length. For length group 9–15 cm, the values were 0.725 ± 0.05, 0.732 ± 0.05 and 0.728 ± 0.05 for male, female and combined sexes, respectively. These values increased to 0.758 ± 0.03, 0.745 ± 0.04 and 0.754 ± 0.04 for male, female and combined sexes, respectively at the length group 16–20 cm. For length group larger than 20 cm, the values increased to be 0.776 ± 0.04, 0.779 ± 0.03 and 0.781 ± 0.03 for male, female and combined sexes, respectively (Table 3).

Age of round herring *E. teres* was determined by reading otolith (Fig. 6). It was found that, the maximum life span of *E. teres* was five years. The mean back-calculated length at the end of each year of life for males were 10.10, 14.10, 17.70, 20.50 and 22.50 cm for 1st, 2nd, 3rd, 4th and 5th years of life, respectively. For females the back-calculated lengths were 10.20, 14.20, 17.60, 20.20 and 22 cm for 1st, 2nd, 3rd, 4th and 5th years of life respectively. Combined sexes of *E. teres* attained their back-calculated lengths at the end of each year of life as 10.30, 14.31, 17.50, 20.20 and 22.15 cm for 1st, 2nd, 3rd, 4th and 5th years of life, respectively (Table 5). *E. teres* attained the highest increment at the end of the first year of life, after which the annual increment in length decreased gradually with the increase in age until it reached its minimum value at the end of the 5th year of life.

The time of annulus formation started during August (0.26 mm) and September (0.27 mm) where the lowest values of marginal increment were observed. It is evident that age group II was the most dominant contributing about 35.2%. Age group III represented the second age group accounting about 31.2%. Age group IV contributed about 13.4%. Age groups I and V represented the least percentages of the catch.

The weight at the end of each year of life for males, females and combined sexes of *E. teres* was calculated by applying the corresponding length-weight equation to the back-calculated lengths (Table 6). The growth in weight acquired lowest values in the first year of life 7.26, 7.87 and 8.14 g for males, females and combined sexes, respectively. The annual increment of weight increased with the increase in age until it reached its maximum value at the end of age group IV for males (24.74 g), females (21.58 g) and combined sexes (22.44 g), after which a gradual decrease in the annual increment was observed. The weights of males at each age group were estimated to be 7.26, 20.28, 41.49, 66.23 and 88.60 g for the 1st, 2nd, 3rd, 4th and 5th years of life, respectively. For females the calculated weights at the end of each year of life was 7.87, 21.39, 41.29, 62.86 and 79.19 g during the 1st, 2nd, 3rd, 4th and 5th. The calculated weights at the end of each year of life were 8.14, 22.17, 40.97, 63.41 and 84.05 g during the 1st, 2nd, 3rd, 4th and 5th years of life, respectively for combined sexes.

The growth parameters of *E. teres* are shown in Table 7. The asymptotic lengths of fish (L_∞) were estimated as 31.71; 29.06 and 30.26 cm for males, females and combined sexes, respectively. The growth coefficients (K) were 0.214; 0.246 and 0.225 $year^{-1}$ for male, female and combined sexes, respectively. The prenatal ages at which the length is theoretically zero (to) was estimated as −0.776, −0.686 and −0.744 $year^{-1}$ for male, female and combined sexes. The growth performance index (Ø) was found to be 2.33, 2.31 and 2.31 for male, female and combined sexes, respectively. The maximum age (t_{max}) was found to be 13.26, 11.48 and 12.56 years for male, female and combined, respectively.

Discussion

Purse-seine using light had been introduced to the Mediterranean Sea to catch pelagic fishes that were found off shore especially after construction of the High Dam and to compensate the reduction of the Nile flood nutrients (Akel, 2009). Fishery biologists and management agencies have recognized

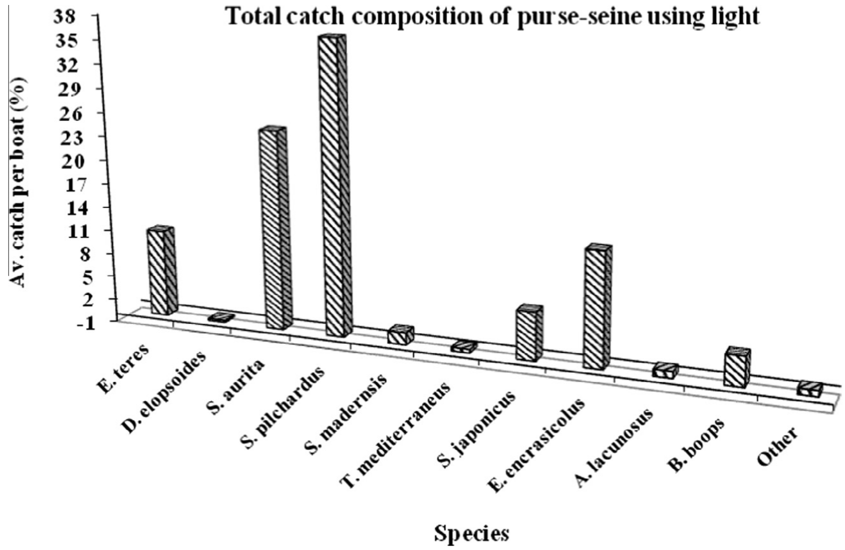

Figure 2 Annual catch composition of purse-seine using light in the Egyptian Mediterranean waters.

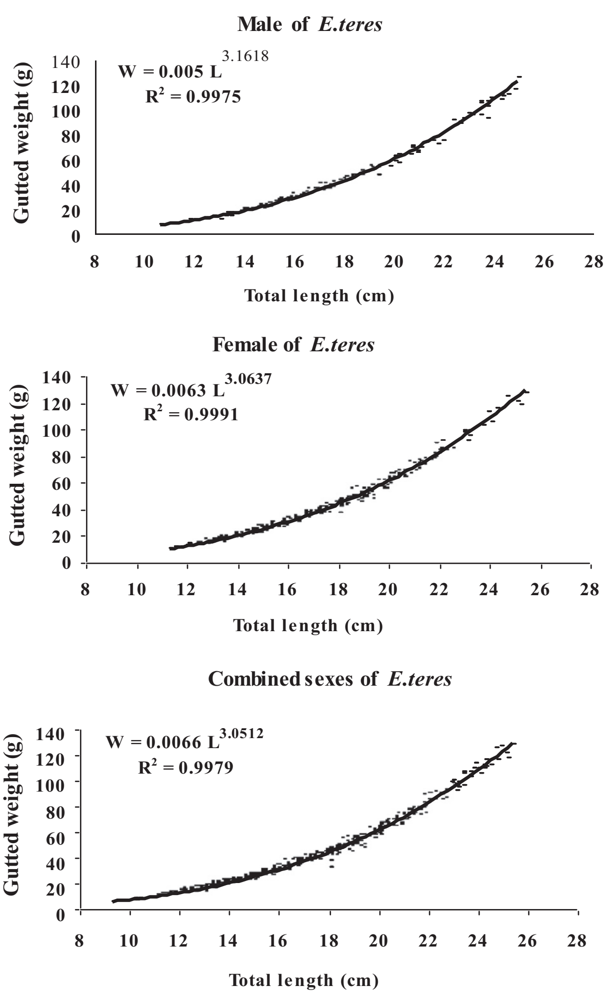

Figure 3 Length–weight relationship of male, female and combined sexes of *E. teres*. (W: gutted weight, L: total length and R2: square of correlation).

the importance of reliable quantitative information on the discrepancies between landings and actual catches of a species (Alverson et al., 1994 and Stratoudakis et al., 1999a,b). According to the present results, the average annual catch per unit effort (CPUE) was 1703.855 kg (1.7 ton/boat/night). The maximum average was attained in summer (2909.38 kg), followed by spring (2737.8 kg), winter (621.72 kg) while the lowest average value of catch was reported in autumn (546.52 kg). These findings reflect the important rank of this fishing method in the Egyptian fisheries. The seasonal variations may be attributed to the change in climatic conditions which are common during winter and autumn and to the flourishing of fish larvae during spring and summer seasons which attract large quantities of pelagic fishes caught by the purse seine using light as supported by Farrag (2010) and Osman et al. (2013).

In the present work, the catch of purse-seine using light was dominated by clupeids (74.1%). The majority of clupeids in the catch of this fishing method were previously observed by Hashem et al. (1982), Faltas (1983), Wassef et al. (1985), Bariche et al. (2006) and Akel (2009) in the Mediterranean waters. Most of the these studies confirmed that, the catch of clupeids (sardine and herring) was always representing the major target of purse-seine and its catch ranked as the most important pelagic fish species along the Egyptian Mediterranean water.

E. encrasicolus occupied the second rank in abundance of the catch (14.19%). This was in agreement with Hashem et al. (1982), Faltas (1983), Wassef et al. (1985) and Bariche et al. (2006). Regarding fish species, the catch of purse seine using light involved seventeen economically important fish species, reflecting the importance of such fishing gear in the marine fisheries in Egypt. Many species of the present catch are Red Sea immigrants (*E. teres*, *D. elopsoides, S. japonicus, A. lacunosus, F. commersonii*, *H. rondeletii*, *S. commerson*), which constituted 41.18% and 19.01% by the number of total species and weight of purse seine catch, respectively. This finding shows both the role of this fishing method to catch immigrant

Table 2 Monthly variations in average condition factor (K) for male, female and combined sexes of *E. teres*.

Month	Male			Female			Combined sexes		
	No.	Av.K	±SD	No.	Av.K	±SD	No.	Av.K	±SD
January	26	0.714	0.06	54	0.730	0.04	80	0.724	0.05
February	21	0.691	0.03	53	0.705	0.04	74	0.701	0.04
March	2	0.702	0.04	34	0.727	0.03	36	0.726	0.03
April	70	0.748	0.02	31	0.770	0.02	101	0.753	0.02
May					*Closed month*				
June	18	0.781	0.03	35	0.770	0.04	53	0.774	0.04
July	10	0.802	0.02	63	0.773	0.03	87	0.775	0.03
August	5	0.789	0.04	58	0.766	0.05	73	0.751	0.10
September	4	0.724	0.04	21	0.767	0.04	50	0.747	0.05
October	8	0.774	0.04	21	0.768	0.04	60	0.756	0.05
November	27	0.749	0.04	46	0.755	0.04	85	0.756	0.04
December	28	0.730	0.04	21	0.743	0.04	49	0.736	0.04
Av. Annual of K	0.746 ± 0.04			0.752 ± 0.04			0.745 ± 0.04		
Total No.	219			437			748		

Table 3 Variations of average condition factor (K) with length for male, female and combined sexes of *E. teres*.

Length (cm)	Male			Female			Combined sexes		
	No.	Av. k	±SD	No.	Av. k	±SD	No.	Av. k	±SD
9–15 cm	52	0.752	0.05	132	0.735	0.05	247	7.052	0.05
16–20 cm	113	0.722	0.03	234	0.752	0.04	371	7.025	0.04
21–25 cm	54	7.007	0.04	71	0.707	0.03	130	7.021	0.03
Total No.	219			437			748		

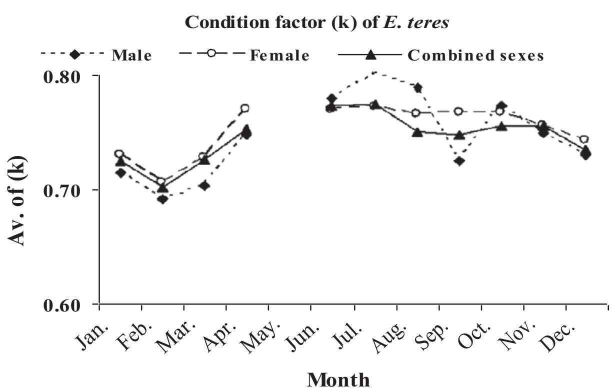

Figure 4 Monthly variations of average condition factor (*K*) for male, female and combined sexes of *E. teres*.

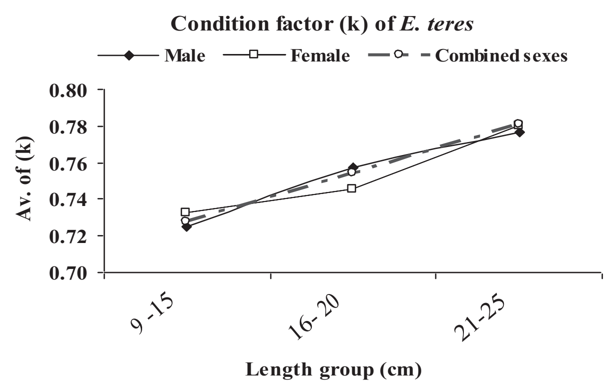

Figure 5 Variations of average condition factor (*K*) with length for male, female and combined sexes of *E. teres*.

species and the positive effect of the lessepsian migration phenomenon.

Round herring *E. teres* represented the highest percentage of the migratory fishes caught by this net, and occupied the third rank (10.93%) in the total catch of clupeids after *S. aurita* (36.5%) and *S. pilchardus* (24.9%). This finding reflects the importance of this species in the commercial fisheries especially in its new habitat after its migration from Red Sea via Suez Canal. The result was in agreement with Akel (2009), who reported that, *E. teres* occupied the second rank in the total purse-seine catch (16.04%) from the Mediterranean Sea, Egypt.

The seasonality in catch per unit effort of *E. teres* showed remarkable variations in the present study. The highest catch was during winter (19.7%) while the lowest one was in summer (8.8%). These findings gave attention towards the importance of this fishing method to catch the round herring *E. teres*. The lower values which were recorded during spring (9.9%) and summer (8.8%) seasons may be attributed to the increased number of other fish species caught during these seasons. Hence, the percentage of round herring *E. teres* during these seasons compared to the total number of fish species was lower than its percentage during winter. These assumptions were supported by that the flourishing zooplankton especially fish larvae during spring and summer seasons which attract a large number of pelagic fishes caught by the purse seine using light (Farrag, 2010 and Osman et al., 2013). The latter authors reported that the round herring *E. teres* preferred fish larvae

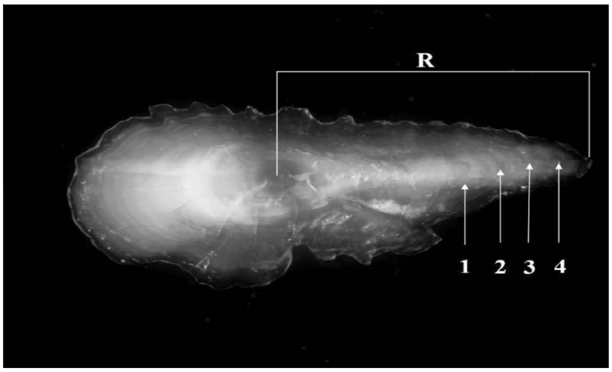

Figure 6 Otolith of round herring, *Etrumeus teres* from the Egyptian Mediterranean water. Age: 4^{+}, Sex: Male, Length: 24 cm.

during summer when there was a diversity of fish larvae flourishing in the Egyptian Mediterranean Sea.

In the Red Sea, the catch of purse seine was mainly composed of *E. teres* (Sanders et al., 1984). This species contributed 57% of the purse-seine catch (El-Sayed, 1996) and accounted for 25.27% of the total catch of purse seine with light (Mehanna, 2004). These findings reflected the important role of *E. teres* in the fisheries of purse seine in the Red Sea. The difference between Red Sea catch and the present one (10.93%) in the Mediterranean Sea may be attributed to the recent migration of the round herring from the Red Sea to the Mediterranean Sea via the Suez Canal which also explain why the effort of this net in Mediterranean waters is still less than that in the Red Sea.

The length range of *E. teres* in the present study was from 9 to 25 cm TL, this range is in slight agreement with Yilmaz and Hossucu (2003), Bariche et al. (2006) and Akel (2009) from the Mediterranean water. Moreover, this range was nearly in agreement with those of El-Sayed (1996) and Mehanna and El-Gammal (2005) from the Red Sea. This finding indicates that this species has well-established itself in its new habitats of the Mediterranean Sea. The differences between present length range and that of Erguden et al. (2009) may be due to the differences in the time of collection and/or time of fishing seasons. Concerning seasonal variations, all lengths were recorded during summer in accordance with the end of breeding season and start of a new generation of individuals (Farrag, 2010).

Length–weight relationship enables seasonal variations in fish growth to be followed and condition indices to be calculated (Richter et al., 2000). Le Cren (1951) stated that (b) value is usually used to show the robustness of the fish, the value of (b) equals 3 for fishes of isometric growth, the values of (b) are higher or lower than 3 usually for fishes of allometric growth. The present results were compared with other results of *E. teres* collected from different localities (Table 4). The exponent b was 3.051 revealing positive allometry mode of growth. This mode of growth was nearly the same as those of Sanders et al. (1984), Xu et al. (1994), El-Sayed (1996), Yilmaz and Hossucu (2003), Mehanna and El-Gammal (2005), Bariche et al. (2006), Akel (2009) and Erguden et al. (2009). This similarity reflects the continuous positive allometric mode of growth. The difference between present results and that of Erguden et al. (2009), may be ascribed to the differences in the length range used and number of specimens.

Condition factor (k) is used to express the degree of well being and relative robustness of the fish population, it varies with length, weight, season and habitat for the same species (Lagler, 1956). In the present work, the absolute condition factor (k) showed the highest value during July, while the lowest values were recorded from December to May for female and to early July for male. These lower values may correlate with the spawning requirements during the spawning period (Farrag, 2010 and Osman et al., 2011). Moreover, fish condition could be influenced by certain extrinsic factors such as changes in temperature and photoperiod (Samat et al., 2008).

From another point of view, the present results disagreed with those of El-Sayed (1996) for *E. teres* from the Suez Gulf. The latter author reported that, the peak of condition was recorded in January, this may be due to the using of another index (Observed weight/calculated weight) which is known as relative condition (k_n). Also, the present results showed disagreement with those of Yilmaz and Hossucu (2003) from the Mediterranean Sea; they reported that the higher condition was during winter and spring. Unlike Yilmaz and Hossucu (2003), in the present work we used gutted weight to avoid the weight of food or gonads particularly during maturation. These findings reflect that there are many factors affecting the well-being of fishes. According to length, the condition factor increased with increasing length reflecting the healthy status of fish in accordance with their requirement of fast movement and spawning activity.

Few studies had used otolith for aging of *E. teres* (Table 5). The present work revealed that the age of *E. teres* was five years old in contrast with Yilmaz and Hossucu (2003) and Mehanna and El-Gammal (2005). They reported that the age of *E. teres* was three years old. It was noticed that the present species has lower growth rate than those from the Gulf of Suez. According to El-Sayed (1996), round herring *E. teres* is a pelagic, strong shoaling short lived clupeid and suffers from high natural and fishing mortalities in the Gulf of Suez. This statement shows contradictious with the present results and agreed with other results of El-Sayed (1996); Yilmaz and Hossucu (2003) and Mehanna and El-Gammal (2005), although the last two authors and the present one used the same hard structure (Otolith) to determine age classes. The present result illustrated that the maximum age groups were higher than those obtained in the other works. These differences may be due to many factors as the variations in habitats, length range, fishing season, collecting period and exploitation rate especially this species is lessepsian immigrant and has not been exploited yet as in the Red Sea giving it the chance to reach maximum old.

The time of annulus formation in the present work was during August and September in accordance with the end of breeding season and the start of new generation. This finding is supported by Farrag (2010) and Osman et al. (2011).

Growth pattern of *E. teres* indicated that, both males and females attained high growth rate during the first year of life, after which a gradual decrease in growth increment was noticed with the increase in age. The poor growth rate after the first year of life may be associated with the onset of maturity, which often causes a discontinuity in the growth curve (Beverton and Holt, 1957). The annual increments in weight increased with the increase in age reaching the maximum value

Table 4 The length weight relationship parameters of *E. teres* from different locations.

Authors	Sex	Location	Length (cm)	*a*	*b*	*r*
Sanders et al. (1984)	C. sexes	Gulf of Suez, Red Sea, Egypt	–	0.0059	3.158	–
Xu et al. (1994)	C. sexes	Daya Bay, China	–	0.0043	3.790	0.945
El-Sayed (1996)	C. sexes	Gulf of Suez, Red Sea, Egypt	12–27 cm (T.L)	0.0011	3.443	0.985
Yilmaz and Hossucu (2003)	C. sexes	Gulf of Antalya, Medit. Sea	9.5–22.5 cm (S.L.)	0.00,834	3.1683	0.99
Mehanna and El-Gammal (2005)	C. sexes	Gulf of Suez, Red Sea, Egypt	11–24.8 cm (T.L)	0.0091	3.037	0.988
Bariche et al. (2006)	C. sexes	Lebanese coast, Medi. Sea	Up to 25 cm (TL)	0.0039	3.375	0.996
Akel (2009)	C. sexes	Eastern of Alex. Medi. Sea, Egypt	11–25 cm (TL)	0.0071	3.055	–
Erguden et al. (2009)	C. sexes	Iskenderun Bay, Turkey	10–16.7 cm (T.L)	0.0078	2.989	0.983
Present work	C. sexes	Alex. coast, Medi. Sea, Egypt	9–25 cm (TL)	0.0066	3.051	0.998

Table 5 Back-calculated lengths of the different age groups of *E. teres* at different localities.

Authors	Sex	Method	Age groups (Mean length)				
			I	II	III	IV	V
Yilmaz and Hossucu (2003) Gulf of Antalya	Combined	Otolith	14.23	17.90	20.88	–	–
Mehanna and El-Gammal (2005) Gulf of Suez	Combined	Otolith	15.33	20.77	23.61	–	–
Present work Medi. Sea, Egypt	Combined	Otolith	10.30	14.31	17.50	20.20	22.15

Table 6 Back-calculated weights at the different age groups of *E. teres* at different localities.

Authors	Sex	Weight used	Age groups (Mean weight g)				
			I	II	III	IV	V
Yilmaz and Hossucu (2003) Gulf of Antalya	Combined	T.W	38.49	75.21	128.50	–	–
Mehanna and El-Gammal (2005) Gulf of Suez	Combined	T.W	36.13	90.83	134	–	–
Present work Medi. Sea, Egypt	Combined	Gutted weight	8.14	22.17	40.97	63.41	84.05

at age group IV after which a gradual decrease in the annual growth increment was observed. This finding was in accordance with those of El-Okda (1998), Ezzat et al. (1982) and Harabawy (2002).

It is obvious that, there was high difference in the back-calculated weights between the present result and those of Yilmaz and Hossucu (2003) and Mehanna and El-Gammal (2005) as illustrated in Table 6. This difference may be attributed to the difference in the estimated age groups where the difference in lengths at different age groups lead to variations in calculated weights. However for the same groups of the same population, the weights can be varied according to feeding conditions as supported by Nikolsky (1963) who mentioned that the variations in weight values from one place to another seem to be correlated more or less with feeding condition.

The growth parameters (L_∞, K and t_o) are the basic input data into various models used for managing and assessing the status of the exploited fish stocks. It facilitates the comparison between growth of fishes belonging to different species or to the same species at different times and different localities (Farrag, 2008). These parameters were compared with the other studies (Table 7). Asymptotic lengths (L_∞) in the present study showed slightly an agreement with El-Sayed (1996) and Mehanna and El-Gammal (2005). But it showed disagreement with those given by Sanders et al. (1984), Cisneros et al. (1990) and Yilmaz and Hossucu (2003). The differences may be attributed to the different length ranges used and also due to the difference of the obtained age classes by different authors. The growth coefficient (K) in the present work was lower than those given by Sanders et al. (1984), Cisneros et al. (1990), El-Sayed (1996), Yilmaz and Hossucu (2003) and Mehanna and El-Gammal (2005). The present value of female was higher than those recorded by Yilmaz and Hossucu (2003). The prenatal ages (t_o) of the present work were different from those given by the other authors.

Growth performance index ($Ø$) was used to compare the growth rate of fish species with other species or the same population from different habitats (Pauly and Munro, 1984). In the present study, it was nearly close to Yilmaz and Hossucu (2003) from the Antalya Gulf, Turkish waters. While it was lower than that obtained from the Suez Gulf, Red sea (Mehanna and El-Gammal, 2005) reflecting the variations between different habitats. Maximum age (t_{max}) of fish species might be affected by the environmental conditions under which a fish lives (Wootton, 1990), the present longevity was estimated as 13.26, 11.48 and 12.56 years for males, females and combined sexes, respectively. This means that *E. teres* has the ability to live more than 11 years. These findings were significantly higher than those reported by many studies (Sanders et al., 1984; Cisneros et al., 1990; El-Sayed, 1996; Yilmaz and Hossucu, 2003 and Mehanna and El-Gammal, 2005). This difference may be attributed to the difference in calculated age classes and environmental conditions.

Table 7 Growth parameters (K; L_∞ and t_o); growth performance index (Ø) and maximum age (t_{max}) estimated for *E. teres* by various authors in different localities.

Authors	Location	Sex	Length	L_∞ (cm)	K (year^{-1})	t_o (year)	Ø	t_{max} (year)
Sanders et al. (1984)	Gulf of Suez, Red Sea, Egypt	Combined	TL	26.8	0.805	0.549	2.76	4.26
Cisneros et al. (1990)	Gulf of California, Mexico	Combined	SL	23.1	0.86	–	2.66	3.48
El-Sayed (1996)	Gulf of Suez, Red Sea, Egypt	Combined	TL	29.7	1	−0.159	2.95	2.84
Yilmaz and Hossucu (2003)	Gulf of Antalya Medit. Sea, Izmir, Turkey	Male	SL	29.9	0.28	−1.22	2.40	9.49
		Female	SL	41.5	0.13	−2.19	2.35	20.88
		C. sexes	SL	33.77	0.20	−1.63	–	–
Mehanna and El-Gammal (2005)	Gulf of Suez, Red	Combined	TL	26.97	0.59	−0.4	2.63	4.68
Present work	Alex. Coast, Medi. Sea, Egypt	Male	TL	31.71	0.214	−0.776	2.33	13.26
		Female	TL	29.07	0.246	−0.686	2.31	11.48
		Combined	TL	30.26	0.225	−0.744	2.31	12.56

In conclusion, the catch of purse-seine using light showed the importance of such fishing gear in the Egyptian Mediterranean water. Clupeid species (Sardine and herring) were the main target of this gear. Round herring "*E. teres*" as economically important immigrant species was recorded in the catch and predicted to be of economic value in the marine fisheries. The maximum life span of *E. teres* was five age groups for males, females and combined sexes with no significant differences. This species had lower growth in length and weight than those collected from the Gulf of Suez. Growth parameters (K, t_o and L_∞); growth performance index (Ø) and maximum age (t_{max}) were not compatible with those values given by other authors for the same species from different geographic localities. This may be ascribed to the environmental variations between different localities and due to the low exploitation rate of such new immigrant species in the Egyptian Mediterranean waters.

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