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Population dynamics of the small tooth emperor, *Lethrinus microdon* (Valenciennes, 1830) from the Egyptian Red Sea

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Abstract
The present study is the first to study the population dynamics and management of the small tooth emperor, *Lethrinus microdon* in the Egyptian sector of Red Sea. A total of 927 fish specimens were monthly collected from the commercial catch of artisanal boats at different sites in the Egyptian Red Sea during the fishing seasons 2014 and 2015. Results showed that, the longevity of *L. microdon* is 7 years in the Egyptian Red Sea and age group one was the most frequent one forming up to 32% of the total catch. The highest growth in length was observed at the end of the first year of life (24.95 cm) after which the annual increment decreases gradually with increase in age. The "b" value (2.90) reflected the tendency to be negative allometric growth. The length at first capture was 23.71 cm with corresponding age 0.93 year. The total, natural and fishing mortality were estimated as 1.04, 0.30 and 0.74 yr^{-1}, respectively. The exploitation ratio E was estimated at 0.71 indicating a high level of exploitation. The relative yield per recruit analysis showed that the present level of exploitation is greatly higher than both E_{max} and $E_{0.5}$ (0.55 & 0.32 respectively) and for management purposes, the exploitation rate should be reduced from 0.71 to 0.32 (55%) to maintain the spawning stock biomass.

Keywords: Population dynamics; *Lethrinus microdon*; Egyptian Red Sea

1. Introduction
Family Lethrinidae, which known as emperors, contains some of the most common and economically important fish species. Emperor fishes are demersal and carnivorous feeders that consume a wide range of prey including polychaetes, molluscs, echinoderms, crustaceans and small fishes [1]. Emperors are of great economic importance in the Egyptian Red Sea where they constitute up to 22% of the total artisanal catch achieving more than 150 million LE annually. Due to the high prices and strong demand of emperors in the local and national markets, the fishing pressure is rapidly increasing in recent years leading to their over exploitation [2 - 10].

Although Lethrinid fishes are one of the most important components of the artisanal fishery and wide spread in the Red Sea, the studies on their biology and dynamics are very rare. Of about eight lethrinid species found in Egyptian Red Sea [8], *Lethrinus microdon* is very common and important one. It is wide-spread in the Indo-west Pacific, inhabiting sandy areas near coral reefs to depths around 80m. It caught mostly with hand-lines, traps, gill nets and trawls. *Lethrinus microdon* was excellent food fish and marketed mostly fresh with good prices.

In spite of the economic importance of *Lethrinus microdon,* there is no studies dealing with its biology and dynamics in the Egyptian waters and the only previous works on it were those of [2] in Djibouti and [11] in Great Barrier Reef. Therefore, the present study is aimed to provide information on the population dynamics and management of *Lethrinus microdon* in the Egyptian coast of Red Sea.

2. Material and methods
2.1. Collection of Samples
A total of 927 of *Lethrinus microdon* were monthly collected from the commercial catch of artisanal boats at different sites in the Red Sea (Al Tour, Suez, Hurghada, Shalateen and

Abo-Ramad) (Fig. 1) during 2014 and 2015. In the laboratory, the following data were recorded for each specimen: date of capture, total length to the nearest cm, total weight to the nearest 0.1g. Scales were removed, cleaned and kept in special envelopes with full information for subsequent examination relevant to age determination.

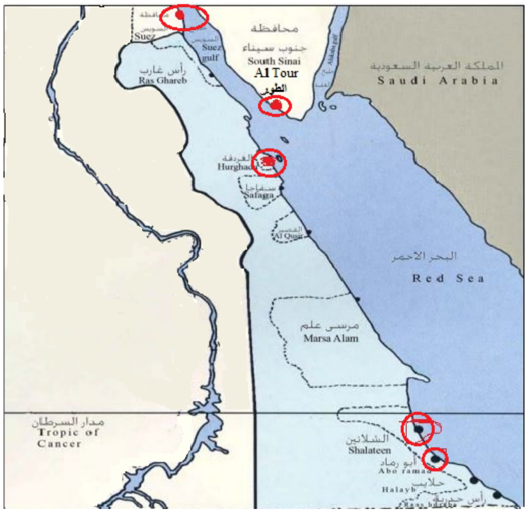

Fig. 1: Chosen landing sites on the Egyptian coast of the Red Sea.

2.2. Age determination

Scales of *Lethrinus microdon* were removed from the left side of each fish behind the pectoral fin. The scales were put in 10% solution of Ammonium hydroxide. Then, it washed in distilled water, dried with filter paper and mounted between two glass slides. The annual growth rings were counted and scale radius (R) and the radius of each annual growth rings (R_n) were measured (to the nearest mm) using scale projector (Ernst Leitz Wetzlar GMBH, Germany). The relationship between scale radius and total fish length (TL) was determined according to [12] by the equation TL = a + b (R). The back-calculated lengths at the end of each year of life are estimated using Lee's [13]. equation as follows:

$L_n = (L_t – a) R_n/R + a$

Where: L_n is the length (mm) at the end of n year, L_t is the total length (mm) at capture and "a" is the intercept with Y-axis.

2.3. Length-weight relationship

Length (L) –weight (W) relationship was determined according to [14] as the following equation:

$W = aL^b$

Where a & b are constants, whose values are estimated by the least square method.

2.4. Theoretical growth

The von Bertalanffy growth model was applied to describe the theoretical growth of *Lethrinus microdon*. The constants of the von Bertalanffy model ($L\infty$ and K) were estimated by using the method [15 - 16].

2.5. Length (L_c) and age (T_c) at first capture

The length at first capture (L_c), the length at which 50% of the fish at that size are vulnerable to capture was estimated by the analysis of catch curve using the method of [17] and the corresponding age at the first capture (T_c) was obtained by converting L_c to age using the von Bertalanffy growth equation as follows:

$T_c = -1/K \ln (1 – L_c / L_\infty) + t_o$

2.6. Mortalities and exploitation ratio

2.6.1. Total mortality coefficient (Z)

The total mortality coefficient (Z) was estimated by using two different methods; analysis of the cumulative catch curve [18] and analysis of the length converted catch curve [19].

2.6.2. Natural mortality coefficient (M)

The natural mortality coefficient (M) was estimated as the geometric mean of three different methods [20 - 22].

2.6.3. Fishing mortality coefficient (F)

The fishing mortality coefficient (F) was estimated by subtracting the value of natural mortality coefficient (M) from the value of total mortality coefficient (Z) as follows:

$F = Z – M$

2.6.4. Exploitation ratio (E)

The exploitation ratio (E) was calculated according to the following relation:

$E = F / Z$ [23 - 24].

2.7. Relative yield per Recruit (Y/R)

The model of [25] was applied to analyze the relative yield per recruit (Y/R)' of *Lethrinus microdon* as follows:

(Y/R)' = E*U (M/K) *

[1- 3U/(1+m) + 3U2 / (1+2m)- U3/ (1+3m)]

Where: (Y/R)' = relative yield per recruit.

M= 1-E /(M/K) = K/Z.

$U=1– (Lc/L\infty)$.

3. Results

3.1. Age determination

The longevity of *Lethrinus microdon* is found to be 7 years in the Egyptian Red Sea and age group one was the most frequent one forming up to 32% of the total catch (Fig. 2).

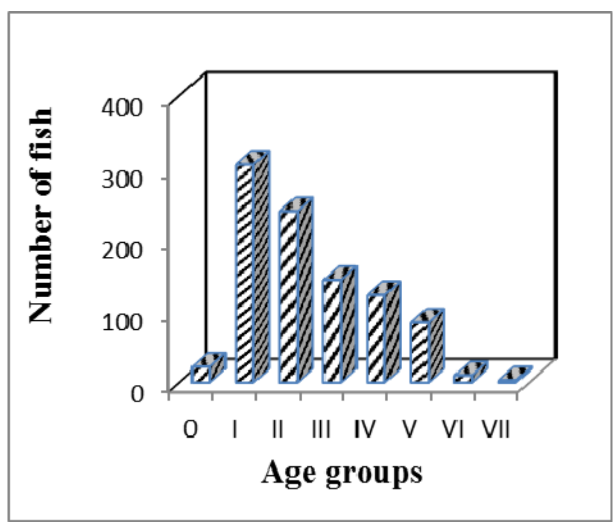

Fig. 2: Age composition of *Lethrinus microdon* from the Egyptian Red Sea

3.2. Back-calculation and growth in length
Since the relationship between total fish length and scale radius is linear and do not pass through the origin **(**Fig. 3**),** the length of former ages was back calculated using Lee's equation as follows:

$L_n = (L - 1.2153)\ R_n / R + 1.2153$

It is obvious that, *Lethrinus microdon* attains its highest growth in length at the end of the first year of life (24.95 cm) after which the annual increment decreases gradually with increase in age until reaches its minimum value at the end of the last year of the life (2.14 cm) (Fig. 4).

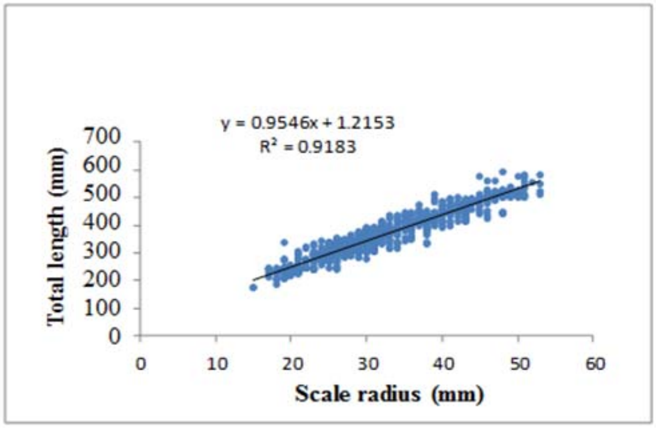

Fig. 3: Body length- scale radius relationship of *Lethrinus microdon* from the Egyptian Red Sea

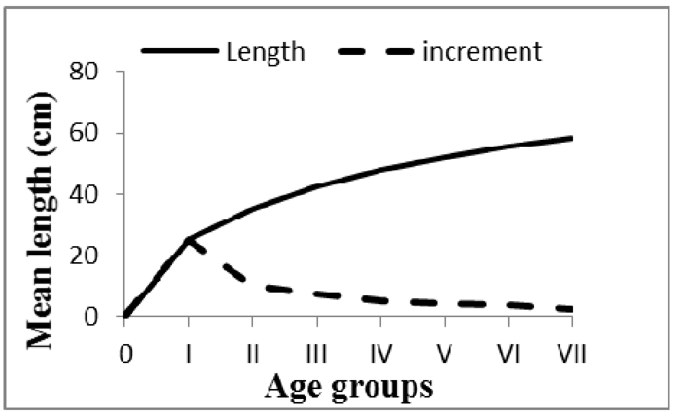

Fig. 4: Back calculated length and annual increment of *Lethrinus microdon*, from the Egyptian Red Sea

3.3. Length- weight relationship
The total length of fishes ranged between 17.5 to 59.5 cm, while their total weight was varied between 85 and 2430 g. The obtained length-weight equation was $W = 0.0173\ L^{2.9054}$. The b-value (2.90) reflected the negative allometric growth (Fig. 5).

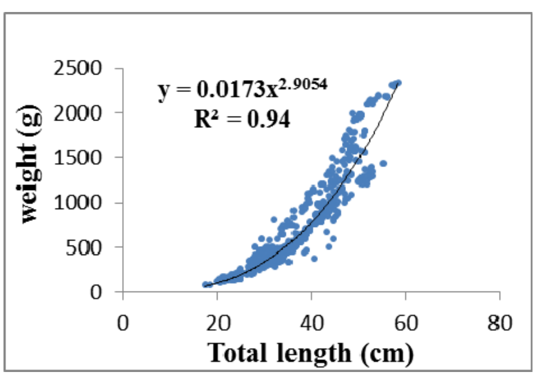

Fig. 5: Length-weight relationship of *Lethrinus microdon* from the Egyptian Red Sea

3.4. Growth in weight
The weights at the end of each year of life of *Lethrinus microdon* were calculated by applying the corresponding length- weight equation to the back-calculated length. It is clear that, the growth in weight is much slower at the first year of life and annual increment in weight increases with further increase in age until reaches its maximum value at age group (III), after which a gradual decrease in annual increment was observed (Fig. 6).

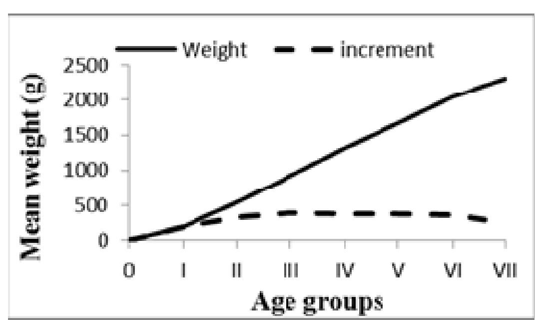

Fig. 6: Calculated weight (g) and annual increment at the end of each year of life of *Lethrinus microdon* from the Egyptian Red Sea

3.5. Growth parameters
The obtained von Bertalanffy growth model for both growth in length and weight was as follows:
For growth in length
$L_t = 67.46\ (1-e^{-0.25(t+0.80)})$.
For growth in weight
$W_t = 3565.80\ (1-e^{-0.25(t+0.80)})^{2.905}$

3.6. Mortality and exploitation rates
The mean values of total and natural mortality coefficients were 1.04 and 0.3 yr^{-1} respectively. Consequently the estimated F-value was 0.74 yr^{-1} and the E-value was 0.71.

3.7. Length and age at first capture Lc &Tc
The length at first capture of *Lethrinus microdon* collected from the Egyptian Red Sea was estimated as 23.71 cm (Fig. 7), and the corresponding age was calculated as T_c = 0.93 year.

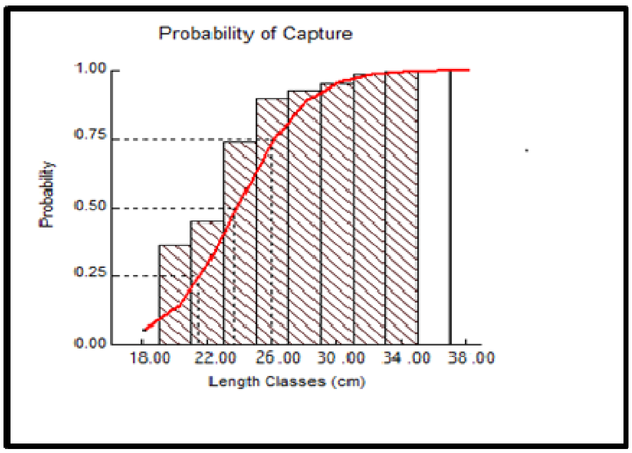

Fig. 7: Length at first capture of *Lethrinus microdon* from the Egyptian Red Sea

3.8. Relative Yield per Recruit (Y/R)
The maximum (Y/R)' was obtained at E_{max} = 0.55. The exploitation level which conserves 50% of the spawning stock biomass $E_{0.5}$ was estimated at 0.32. It is clear that, the present level of exploitation (0.71) is higher than both E_{max} and $E_{0.5}$. For management purposes, the exploitation rate should be reduced from 0.71 to 0.32 (55%) to maintain the spawning stock biomass (Fig. 8).

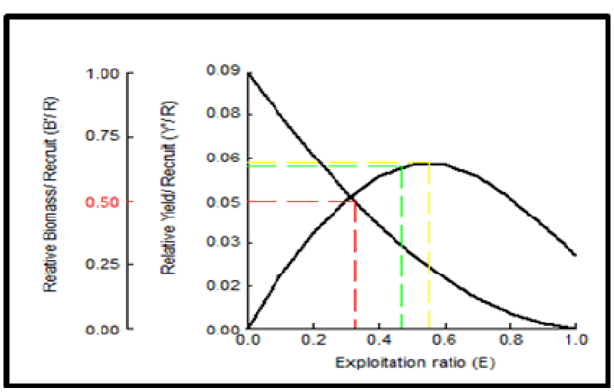

Fig. (8): Relative yield per recruit for *Lethrinus microdon* from the Egyptian Red Sea

4. Discussion
Egyptian fisheries are under pressure as well as all economic fish stocks are overexploited, the management and regulation of the fisheries become more complicated every year. In fisheries management, the reliability of scientific advice is highly dependent on the quantity and quality of data that are available for stock assessment [8].

Age determination is one of the most important parameters in the field of fisheries management. It forms the basic knowledge required for the evaluation of longevity, growth rate, mortality rate and yield. These parameters are constituted the basic information needed for the construction of a management strategy for a rational exploitation of any exploited fish stocks [4].

In the present study, the scales of *Lethrinus microdon* were used in age determination. Scales as reliable method for lethrinid species were proven in the previous studies [3 - 6, 26-27].

The longevity of *Lethrinus microdon* is estimated to be 7 years and age group one was the most frequent one forming up to 32% of the total catch**.** This means that, *Lethrinus microdon* in the Egyptian Red Sea become fully recruited to the artisanal fishery at an age of one year indicating the high fishing pressure on this species. The only previous study dealing with the age determination of the same species is that of [11], who recorded 7 years in Southern Arabian Gulf.

Lethrinus microdon attains its highest growth rate in length during the first year of life, after which a gradual decrease in growth increment was noticed with further increase in age. This result is in agreement with the findings of previous studies on this aspect [6, 28-37]. They stated that, the young stages of fish are characterized by a higher growth rate than the old ones and the first year of life had the maximum growth rate in length.

In the present study, the exponent "b" in length-weight equation of *Lethrinus microdon* is different from 3 reflecting the tendency to be negative allometric growth. The fish in which the value of "b" ranges between 2.5 to 4 live in good conditions [14, 38]. These results indicated that, the environmental conditions in Egyptian Red Sea are suitable for *Lethrinus microdon* growth.

In the present study, the growth in weight of *Lethrinus microdon* was much slower in the first year of life and annual increment in weight increases with further increase in age until reaches its maximum value at age group (III), after which a gradual decrease in annual increment was observed. This means that the *Lethrinus microdon* should be protected until reach the third year of life.

The mathematical description of growth is of a great importance in the field of fisheries management and fish stock assessment. The obtained growth parameters (L_∞, K and t_o) are the basic input data into various models used for managing and accessing the status of the exploited fish stocks. Besides, the mathematical descriptions of the growth facilitate the comparison between growth of fishes belonging to different species or to the same species at different times and different localities. Several models have been developed for the mathematical description of growth, from which the von Bertalanffy growth model is the most widely used [4].

In the present study, the growth model of von Bertalanffy was applied to describe the theoretical growth of *Lethrinus microdon* in the Egyptian Red Sea. The L_∞ of *Lethrinus microdon* (67.46 cm) was higher than those estimated for the same species (34 cm) from Southern Arabian Gulf [11]. This higher value may be due to the difference in the locality and difference in recorded maximum length. The growth coefficient value (K= 0.25/ year) of *Lethrinus microdon* indicated that the growth was lower than that recorded in Southern Arabian Gulf (0.64/ year) [11].

The total mortality is defined as the total number of fishes missed by death from a given population during a certain time interval. The total mortality can be distinguished into two components; the first is called the natural mortality coefficient (M) and the second is the fishing mortality coefficient (F). In the present study, total mortality (Z), Natural mortality (M) and Fishing mortality (F) were estimated for *Lethrinus microdon* in the Egyptian Red Sea. It is obvious that, the fishing mortality of *Lethrinus microdon* (0.74) is very high in another indication for over exploitation. The optimum level of exploitation is 0.5 when fishing mortality is equal to natural one [23] and [17] gave a less value for optimum exploitation level (0.4). So, the obtained value of E in the present study (0.71) is greatly higher than those given by [23] and [17]. reflecting the high level of fishing pressure on this species.

Based on relative yield per recruit analysis of *Lethrinus microdon* in the Egyptian Red Sea, the present level of exploitation (E= 0.71) is found to be greatly higher than both E_{max} and $E_{0.5}$ (0.55 and 0.32 respectively). For management purposes, the exploitation rate of *Lethrinus microdon* should be reduced from 0.71 to 0.32 (55%) to maintain the spawning stock biomass.

For evaluation the effect of L_c which is related to hook or mesh size, a higher value of L_c was applied (L_c = 33 cm ≈ L_m) (L_m is the length at first sexual maturity). It was obvious that the relative yield per recruit increases by the increase of L_c and at the same time both E_{max}= 0.68 and $E_{0.5}$ = 0.37 still lower than the current E (Fig. 9).

It could be concluded that the stock of *Lethrinus microdon* in the Egyptian Red Sea is over exploited and to maintain this valuable species, the fishing effort should be reduced by at least 40% and the hook sizes should be increased to catch fish not less than 30 cm TL.

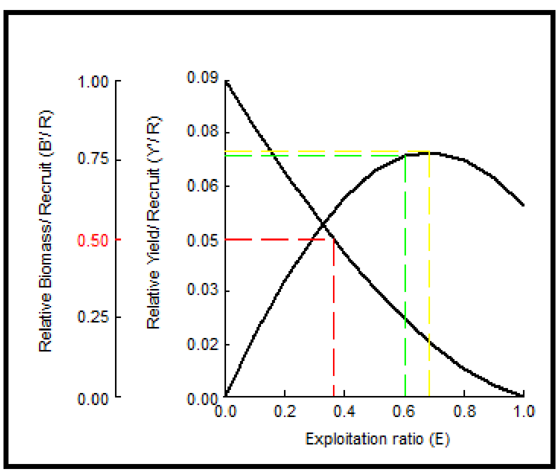

Fig. 9: Relative yield per recruit for *lethrinus microdon* from the Egyptian Red Sea with LC = 33 cm

5. References

1. Vasantharajan M, Jawahar P, Venkatasamy M. Recruitment pattern, virtual population analysis (Vpa) and exploitation status of *Lethrinus lentjan* (Lacepede, 1802) exploited in Thoothukudi Coast,Tamil Nadu, India. International Journal of Marine Science, 2015; 5(36):1- 4.
2. Carpenter KE, Allen GR. Emperor fishes and large-eye breams of the world (Family Lethrinidae). An annotated and illustrated catalogue of Lethrinid species known to date. FAO Fisheries Synopsis, 1989; 125(9):118.
3. Wassef EA. Comparative growth studies on *Lethrinus lentjan*, Lacepede 1802 and *Lethrinus mahsena*, Forssk°al 1775 (Pisces, Lethrinidae) in the Red Sea. Fisheries Research, 1991; 11:75-92.
4. Mehanna SF. A study of the biology and population dynamics of *Lethrinus mahsena* (Forsskal, 1775) in the Gulf of Suez. Ph. D. Thesis. Fac. Sci., Zagazig Univ, 1996, 230.
5. Grandcourt EM. Demographic characteristic of a selection of exploited reef fish from the Seychelles; preliminary study. Mar. freshwater Res. 2002; 53:1-8.
6. Mohammed MKAM. Studies on the fish *Lethrinus Lentjan* (Lethrinidae) from artisanal fisheries on the Red Sea coast of Yemen. Ph.D. Thesis, Fac. Sci., Suez Canal Univ. 2007, 300.
7. Grandcourt EM, Al Abdessalaam TZ, Franci SF, Al Shamsi AT. Reproductive biology and implications for management of the painted sweetlips, *Diagramma pictum* in the southern Arabian Gulf. Journal of Fish Biology. 2011; 79:615-632.
8. Mehanna SF. Population dynamic and mangment of snubnose emperor *Lethrinius bungus* (*L. borbonicus*) from the Foul Bay, Red Sea. International symposium, 2011, 121-129.
9. Currey LM, Williams AJ, Mapstone BD, Davies CR, Carlos G, Welch DJ *et al*. Comparative biology of tropical *Lethrinus* species (Lethrinidae): challenges for multi-species management. Journal of Fish Biology. 2013; 82:764-788.
10. Mehanna SF, Al-Mamry D, Al-Bulushi N. Biological study, distribution and biomass of the Arabian scad, *Trachurus indicus* (Nekarsov, 1966) in the Arabian Sea coast of Oman. INOC-XIII International Symposium, Malaysia, 2013.
11. Grandcourt E, Al Abessalaam TZ, Francis F. Age-based life history parameters and status assessments of by-catch species (*Lethrinus borbonicus*, *Lethrinus microdon*, *Pomacanthus maculosus* and *Scolopsis taeniatus*) in the southern Arabian Gulf. J. App. Ichth. 2010; 26(3):381-389.
12. Whitney RR, Carlender KD. In temperature of body Scale regression for competing body length of fish. J. wild. management, 1956; 20:21-27.
13. Lee RM. A review of the methods of age and growth determination in fishes by means of scales, Fish. Invest. Min. Agr. Fish., Ser., 1920; 2:4(2):1-32.
14. Le Cren ED. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviattilis*). J. Anim. Ecol. 1995; 20:201-219.
15. Ford E. An account of the herring investigations conducted at Plymouth during the years from 1924 to1933. J. Mar. Biol. Ass. U.K., 1933; 19:305-384.
16. Walford LA. A new graphic method of describing the growth of animals. Biol. Bull. Mar. Biol. 1946; 90(2):141-147.
17. Pauly D. Length-converted catch curves. A powerful tool

for fisheries research in the tropics (part II). ICLARM Fishbyte, 1984; 2(1):17-19.
18. Jones R, Van Zalinge NP. Estimates of mortality rate and population size for shrimp in Kuwait waters. Kuwait Bull. Mar. Sci. 1981; 2:273-288.
19. Pauly D. Length-converted catch curves. A powerful tool for fisheries research in the tropics. Part1. ICLARM Fish byte. 1983; 1(2):9-13.
20. Taylor CC. Temperature, growth and mortality-the Pacific cockle. J. Cons. CIEM. 1960; 26:117-124.
21. Ursin E. A mathematical model of some aspects of fish growth, respiration and mortality. J. Fish. Res. Bd. Can, 1967; 24:2355-2453.
22. Pauly D. On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. J. Cons. CIEM. 1980; 39(3):175-192.
23. Gulland JA. The fish resources of the Ocean. West Byfleet, Surrey, Fishing News (Books), Ltd., for FAO, 1971, 255.
24. Gulland JA. Fish stock assessment: a manual of basic methods. FAO/Wiley Series on Food and Agriculture, 1983; 1:223.
25. Beverton RJH, Holt SJ. Manual of Methods for Fish Stock Assessment. Part II. Tables of Yield Function. FAO Fisheries Biology Technical Paper. 1966; 38:10-67.
26. Toor HS. Biology and fishery of the pig-face bream, *Lethrinus lentjan* Lacepede from Indian waters. 2-age and growth. Indian J. fisheries. 1968; 11(2):597-620.
27. Kedidi SM. Stock assessment of the redspot emperor *Lethrinus lentjan* from areas adjacent to Suakin and Muhamad Qol (Sudan). Survey conducted during 1982-1984. FAO Project for the Development of Fisheries in Areas of the Red Sea and Gulf of Aden. RAB/83/023/07, 1984, 27.
28. Motlagh SAT, Seyfabadi J, Vahabnezhad A, Shojaei MG, Hakimelahi M. Some reproduction characteristics and weight-length relationships of the spangled emperor, *Lethrinus nebulosus* (Lethrinidae) of the south coastal of Iran (Persian Gulf and Oman Sea). Turkish Journal of Fisheries and Aquatic Sciences. 2010; 10:221-227.
29. Ahmed SM. Population dynamic and fisheries management of Eeuropen sea bass, *Dicentrarchus labrax* (f. Moronidae) from Bardawil lagoon, North Sinai, Egypt. Egypt J. Aquat. Biol. & Fish. 2011a; 15(1):43- 56.
30. Ahmed SM. Population dynamics and fisheries management of Gilthead sea bream, *Sparus aurata* (f. Sparidae) from Bardawil lagoon, North Sinai, Egypt. Egypt J. Aquat. Biol. & Fish. 2011b; 15(1):57-69.
31. Mehanna SF, Salem M. Fisheries regulations based on yield per recruit analysis for the common sole, *Solea solea* (Soleidae) at Bardawil lagoon, Mediterranean coast of Sinai, Egypt. Egyptian J. Anim. prod. 2012; 49(1):113-121.
32. Salman MA. The Nile Basin Cooperative Framework Agreement: a peacefully unfolding African spring. Water International, 2013; 38(1):17-29.
33. Mehanna SF, Ameran M, El-Aiatt A, alem M. Population dynamics of the Egyptian sole *Solea aegyptiaca* (Soleidae) at Bardawil lagoon, Mediterranean coast of Sinai, Egypt. 3rd International conference on Fisheries and Aquaculture, 29 November-1 December, Cairo, Egypt, 2010.
34. Mehanna SF, Zaki S, Al-kiuymi F, Al-Kharusi L, Al-Bimani S. Biology and fisheries management of spangled emperor, *Lethrinus nebulosus* from the Arabian Sea coast of Oman. INOC - CNRS, International Conference on Land-Sea Interactions in the Coastal Zone" Jounieh - LEBANON, 06-08 November, 2012, 161-171.
35. Mohammad AS, Mehanna SF, Mahmoud UM. Age and growth based on the scale readings of the two carangid species *Carangoides bajad* and *Caranx melampygus* from Shalateen fishing area, Red Sea, Egypt. International conference on research for food security, Natural resource management and rural development. Vienna, Austria, 2016.
36. Ahmed YA. Population dynamics and stock assessment of the most important species of family Scaridae (parrot) in Hurghada, Red Sea. M.Sc. Thesis, Fac. Sci, Port Said University, Egypt, 2016.
37. Desouky MG. Population dynamics of the Egyptian Sole *Solea aegyptiaca* Chabanaud, 1927 (Osteichthyes: Soleidae), in Qarun Lake, Egypt. Int. J. Fish. Aquat. Stud. 2016; 4(5):421-425.
38. Hile R. Age and growth of the Cisco, leucichthys artedi (Le Sueur) in the lakes of the North Eastern highlands, Wisconsim. Bull. U. S. Bur. Fish. 1936; 19:211-317.