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AGE DETERMINATION AND GROWTH STUDIES OF *GERRES OYENA* (FORSK) IN THE ARABIAN GULF WATERS

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ABSTRACT

Age determination and annual increases in both length and weight was made for *Gerres oyena* (Forsk) by the examination and measurements of scales. A linear relationship between the body length and the anterior radius of scale has been established with an intercept of 1.942 cm on the length axis. The annuli first appeared on the scales in April and the mean monthly growth increased progressively from April till October when maximum growth was recorded. It was also noticed that, there was a good relation between the annuli formation and water temperature. The annuli were formed on the scales at a water temperature range of 21 to 26°C.

The length-weight relationship was estimated and given by the equation: $W = 0.00812\ L^{3.13}$. The condition factor, K for the different size groups ranged between 0.72 and 0.88 and increased with length. Characteristics of scales, beside the time of annulus formation and its validity as a year mark have been discussed.

Key-words: Age and growth, *Gerres oyena*, Arabian Gulf.

INTRODUCTION

There is a large variety of bony fishes living in the Arabian Gulf waters. So far little is known about the biology of these fishes. Most of the work done deals with the systematics and the relative abundance (Kuronuma and Abe, 1972; Hussain and Abdullah, 1977; Al-Kholy and Soloviov, 1978; Randall, Allen and Smith-Vaniz, 1978 and El-Agamy, 1986).

Fishes belonging to family Gerridae are small to moderate in size with bright colours, living in shore waters and sandy bottom. Three Gerres species are recorded in the Arabian Gulf waters (Kuronuma and Abe, 1972). The most common is *Gerres oyena* (Forsk) while *G. filamentosus* (Cuvier) and *G. punctatus* (Cuvier and Valenciennes) are less common. *Gerres oyena* grows to a length of 30 cm although most of the catch on the market are about 20 cm. In spite of such small marketable sizes, the species is considered such a favourite food fish in many parts of the world (Kuronuma and Abe, 1972 and El-Agamy, 1987).

Age and growth determinations are important in studying longevity, age at first maturity, catchable size and other life history problems in fishes (Lagler, 1966; Ricker, 1971, and Lagler, Bardach, Miller and Passino, 1977).

The aim of the present work is to study the growth of *Gerres oyena* in the Arabian Gulf waters in order to manage and improve its fishery on a legitimate base.

MATERIAL AND METHODS

Random samples comprising a total of 634 specimens of *G. oyena* in the size range of 11-30 cm and weighing 13-332 g were obtained from the commercial catches from Doha Central fish market during the period from September 1985 to September 1986. The samples were taken to laboratory as soon as possible and the total length and weight of each fish in the sample were noted to the nearest cm and g. Fatness or quality of a fish is described by calculating the coefficient of condition or ponderal index "K" from the formula $K = 100\ W/L^n$, where W and L are respectively the weight and length of the fish and n the length-weight exponent (Le-Cren, 1951; Allen, 1951, and Nair, Iyer, Devi and Kutty, 1982).

A number of scales (6-10) were then taken from just behind the pectoral fin below the lateral line, cleaned in 10% solution of ammonium hydroxide and then mounted dry between two glass slides. Scale examination and measurement were carried out under a binocular microscope at a magnification (x 14). Distances from the focus of the scale to the successive annuli as well as the total radius of the scale were determined.

RESULTS AND DISCUSSION

Length-weight relationship: The length-weight relationship of *G. oyena* was computed for specimens ranging between 11 and 30 cm in total length, taken all the year round. The data have been grouped separately for each sex using the formula $W = cl^n$ (Hill, 1936, Martin, 1949), where W = fish weight in gram, L = fish length in cm and c and n are constants whose values were estimated by the usual method of least squares.

The relationship among males and females are given by the following equations:

Males : $\text{Log } W = -2.00978 + 3.0680 \log L$ or $W = 0.0098\ L^{3.068}$

Females : $\text{Log } W = -2.1103 + 3.1521 \log L$ or $W = 0.00776\ L^{3.1521}$

Since there was no difference between these two equations when tested statistically, a common equation (based on combined data without considering the time of capture, sex or stage of maturity) was worked out, hence the average value of "n" of 3.13 can be taken to represent the "n" value for both sexes. The length-weight relationship can be expressed as: $\text{Log } W = -2.09044 + 3.13 \text{ Log } L$ or $W = 0.00812\ L^{3.13}$

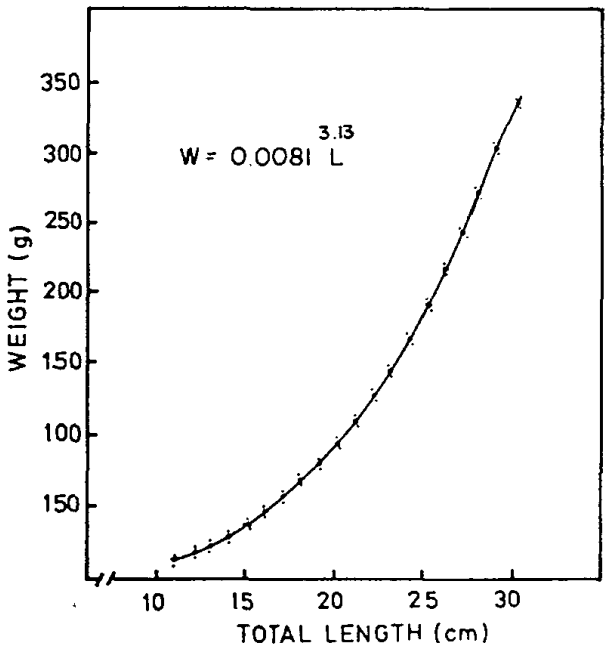

Fig.1. Length-weight relationship of *G. oyena*

The parabolic curve drawn between total length and total weight is depicted in (Fig.1) which indicated high degree of correlation among both measures. The agreement between the calculated and observed weights is satisfactory (Table I).

To know the degree of associationship, the coefficient of relation r, was estimated, the r values were 0.9765 ($P = <0.001$) and 0.9829 ($P = <0.001$) for males and females respectively and 0.98 ($P = <0.001$) for the pooled data.

According to Hile (1936), and Martin (1949), the values of the exponent "n" usually ranges between 2.5 and 4.0, but according to Allen (1951) the value of n remains constant at 3 for the ideal fish. A perusal of length-weight relationship, worked for *G. oyena* from Arabian Gulf, shows the value of n as 3.13, thus not satisfying the cube law. It may be said that the weight of the fish in the Arabian Gulf increases in proportion slightly more than the cube of its length.

Condition factor (K): It is useful to measure the 'condition', i.e., the variation from expected weight for length of fish as indication of fatness, general well being, and gonad development. Changes in condition have usually been analysed by means of a "condition factor" (Hile, 1936) which is given by the formula $K = \frac{100\,W}{L^3}$, where K represents the condition factor, W the weight and L the length of the fish.

Table I — The observed and calculated weights, as well as condition factor of *Gerres oyena** according to length.

Length (cm)	Observed weight (g)	Calculated weight (g)	Condition factor "K"
11 (2)	13	14.78	0.72
12 (4)	19	19.40	0.80
13 (3)	26	24.93	0.85
14 (11)	34	31.43	0.88
15 (27)	42	39.01	0.87
16 (40)	50	47.74	0.85
17 (37)	60	57.72	0.84
18 (58)	69	69.02	0.81
19 (64)	80	81.75	0.79
20 (87)	100	95.99	0.85
21 (65)	112	111.83	0.81
22 (50)	124	129.35	0.78
23 (39)	144	148.66	0.79
24 (61)	165	169.85	0.79
25 (29)	190	193.00	0.80
26 (21)	219	218.21	0.82
27 (17)	255	245.57	0.84
28 (7)	275	275.17	0.81
29 (9)	306	307.12	0.81
30 (3)	332	341.50	0.79

Total number of fish = 634, Average K = 0.82., * Number of fish are given in parentheses.

Hart (1946) has pointed out that the value of K may change with length, often attaining a maximum at the size of maturity. Allen (1951) used the condition factor to examine the changes in trout in two consecutive year class with respect to size, season, habitat, peak growing season and gonad condition. He found that K showed a decreasing trend with age.

Le-Cren (1951) has shown that the K values will be affected if the fish does not obey the cube law in its length-weight relationship. Since the exponent value (n) in male as well as in female *G. oyena* differed from 3, use of equation $K = 100\ W/L^n$ (Allen, 1951 and Nair, Iyer, Devi and Kutty, 1982) was felt to have certain advantages in estimating the condition factor as it reduces the variation in K arising from changes in form associated with growth and therefore would be more appropriate. In *G. oyena* the K values for the different size groups ranged between 0.72 and 0.88 with a mean value of about 0.82 (Table I). The larger this ratio, the better is the condition of the fish (Le Cren, 1951).

The average K values for different size groups are plotted in Fig.2A. It can be seen, that the K values for the combined data dropped at 11 cm. followed by an increase up to 14 cm. The values again declined at 19 cm., then increase, but declined gradually thereafter reaching the minimum at 22 cm. From 24 cm onwards the K values gradually increased.

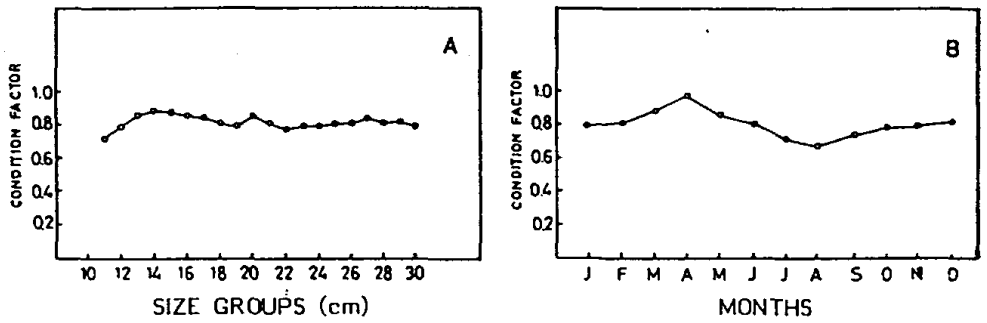

Fig.2. Condition factor in various size groups (A), and seasonal variations in condition factor of *G. oyena* (B).

The annual cycle in K values during different months are presented in Fig.2B which shows a peak in April (0.89) on account of mature gonads, followed by a fall in May-July corresponding to spawning period and attaining its minimum values in August (0.7), being the post-spawning and resting period of the fish. Thereafter, a gradual increase till December was recorded (0.75-0.82). Here, the normal growth and fat deposition in the body tissues of the fish is expected. In addition, during this period, the vitellogenesis in the female gonads also continues, when they increase rapidly in size, since in winter months, the ovaries enter "diapause" phase, exhibiting almost an arrest in the gonadal activities (El-Agamy, 1987).

This was accompanied with low K values. On the other hand with the approach of favourable weather conditions, the gonads mature further with an increase in K values. In the present study, April month was indicative of the approach of suitable conditions, when the gonads were fully mature and ready to spawn.

Age and growth: The scales of *Gerres oyena* are ctenoid moderate, more or less rectangular in shape and deeply embedded in the skin. The assumption used for identifying annuli on the scales is that a true annulus can be traced completely around the scale and generally exhibits crossing over in the posterior portion of the lateral fields (Blackburn, 1950, 1951). The true annulus ring was easily identified on the scales of *Gerres oyena* by "cutting over" of sclerities but vary according to location with respect to the focus of the scales (Fig.3). Accessory marks were frequently detected in the scales of these species and sometimes resemble the true annuli. However, they tend to be indistinct or absent in one or both of lateral field. A knowledge about the time of spawning and annulus formation may help in differentiating between the accessory and actual rings.

Time of annulus formation: To know the time of annulus formation on the scales of *Gerres oyena*, monthly samples of scales were compared. The distance on the scale (in micrometer division) from the last annulus to the scale margin was measured in the scales of each sampled fish. This represents the increment of scale growth from the time of last annulus formation. It is generally accepted that, the time at which this distance is very small for a certain age group, corresponds to the time of its annulus formation.

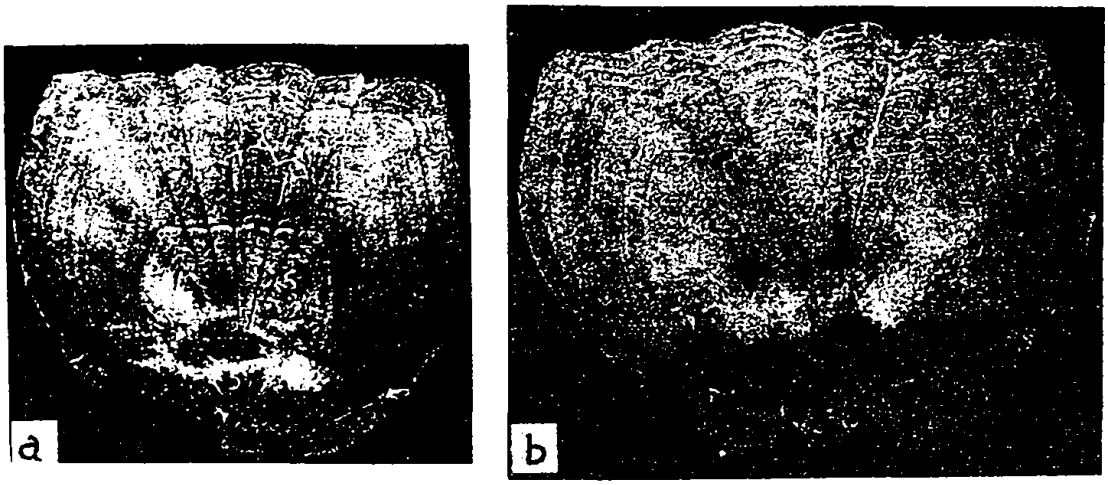

Fig.3. Annual rings deposited on the scales of *G. oyena* at 25 and 30 cm total body length. A - appearance of first well defined ring (3^+) and B - with 7^+ rings.

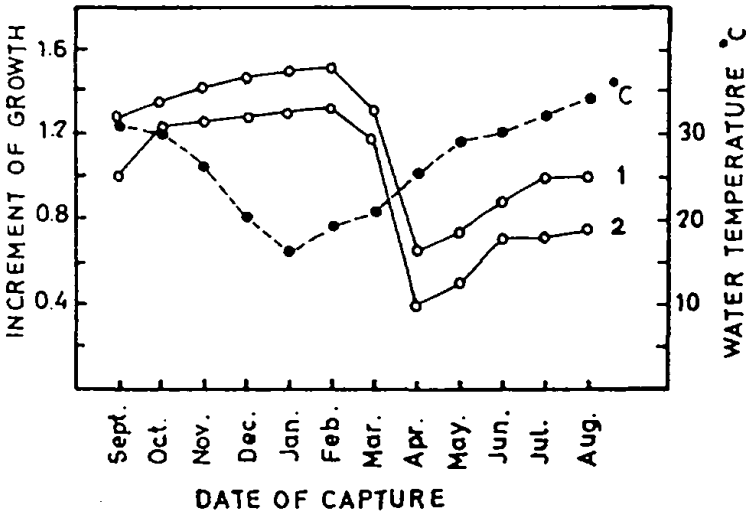

Fig.4. Average increments of growth of first and second year during the growing season (in micrometer division x 14) with relation to the mean monthly water temperature.

Figure 4 shows the average values of the monthly measurements of temperature and increments on the scales for fishes of age group 1 (first year) and 2 (second year). It is clear that the time of annulus formation and the progressive increase of growth beyond the last annulus was affected by the seasonal increase of water temperature. The percentage increase of growth was only 4.6 and 5.2% in April and May when the water temperature was 26°C and 29.7°C respectively. In June, as the water temperature

rose to 30°C the fish added 6.3% of its annual growth. The rise of water temperature after that did not affect the average annual growth increment. The cessation of growth with increase of water temperature was also observed. In October, as the water temperature decreased to 31.4°C the fish added 9.8% of its annual growth completing the full seasons growth. The season's growth was completed in October; after which there was practically no change in the amount of growth until the next season. From this study it was found that the annuli were completely formed on all the scales of fish of age group 1 and 2 in late April. This period coincides with an abundance of food and the beginning of the rise of water temperature. In some fish of age group 2, the annulus appear in May. El-Agamy (1986) found that the annulus is formed during the spring season for *Parupeneus pleurotaenia* in the Arabian Gulf waters.

Body scale relationship: The body scale relationship constructed from data from 559 fish was obviously linear. The mean fish length and the average scale radii were calculated. The body scale ratio (L/S) given in Table II was nearly constant and does not show any trend with change of body length. A straight line fitted by least squares to the means of magnified scale radii and length of fish is described by the equation:

$$L = 1.942 + 2.919\ S$$

where L = total length of fish in cm, and S = magnified scale radius. Fig.5 shows the graphical representation of the equation with the observed values. This linear relationship indicates that, the scale radius grows in direct proportions to the increases in total body length.

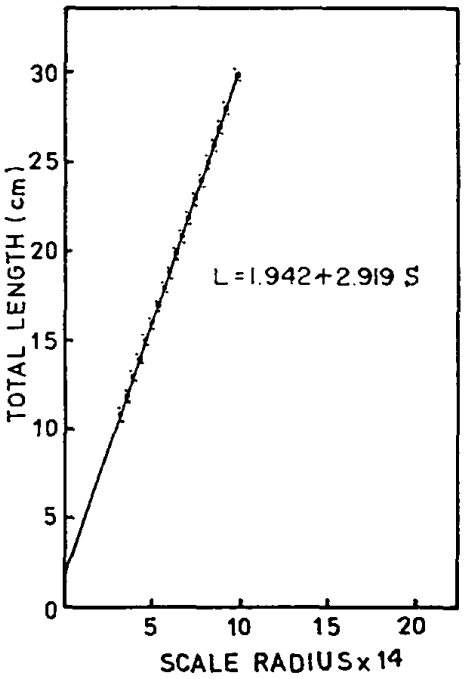

Fig.5. Relationship between average length (L) and scale radius (S).

Table II — Relationship between mean scale radius (x 14) and total length of *Gerres oyena**

Total length (cm)	Mean scale radius (x 14)	Calculated scale radius (x 14)	L/S ratio
11 (2)	3.0	3.10	3.67
12 (3)	3.3	3.44	3.64
13 (3)	4.0	3.79	3.25
14 (10)	4.1	4.13	3.41
15 (25)	4.5	4.47	3.33
16 (38)	4.8	4.81	3.33
17 (31)	5.0	5.16	3.40
18 (52)	5.3	5.50	3.40
19 (50)	6.0	5.84	3.17
20 (79)	6.3	6.18	3.17
21 (55)	6.5	6.53	3.23
22 (43)	6.8	6.87	3.24
23 (29)	7.2	7.21	3.19
24 (56)	7.6	7.55	3.16
25 (29)	7.9	7.90	3.16
26 (20)	8.2	8.24	3.17
27 (17)	8.6	8.58	3.14
28 (5)	9.0	8.92	3.11
29 (9)	9.2	9.27	3.15
30 (3)	9.5	9.61	3.16

Total number of fish = 559, Average L/S ratio = 3.27, * Number of fish are given in parentheses.

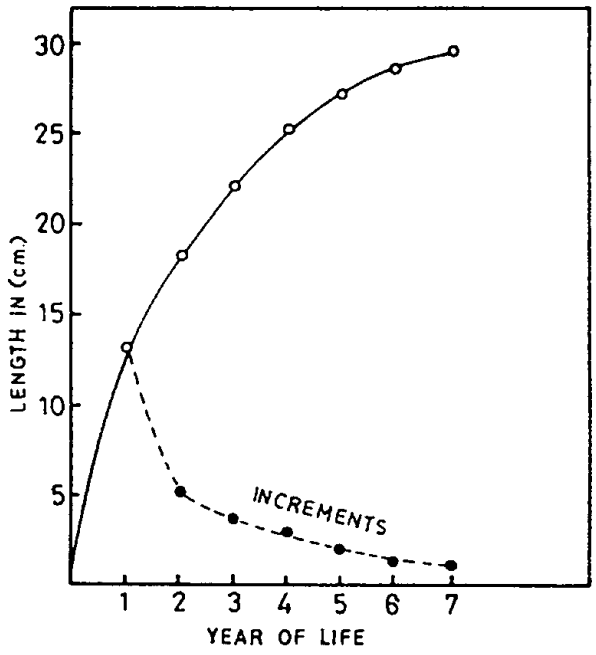

Fig.6. Growth in length and annual increments in length of *G. oyena*

Growth in length: The calculated lengths of *Gerres oyena* were computed by the Lee (1920) formula for back calculation:

$$L_n = S_n(L-1.942)/S + 1.942$$

(where L_n = calculated length at the end of n years, L = total fish length (cm) at capture, S_n = scale radius at annulus n, and S = total scale radius).

The average length at time of capture and average calculated lengths at the end of each year of life are given for combined sexes in Table III and Fig.6 respectively. The calculated and the corresponding actual length show good agreement, (r was 0.9978, P = < 0.001). There is a distinct overlapping in the lengths of the successive age groups, i.e. a fish of a particular length might belong to two or three age-groups. Discrepancies in the calculated lengths attained at the end of different years of life are obvious from one age-group to the next (Table III).

The highest growth takes place in the first year of life, after which the annual increment gradually and progressively decreases with further increases in age. There are differences in the calculated lengths of the various age groups especially in the first year of life. This may be due to the long spawning period of *G. oyena* (El-Agamy, 1987) i.e. more than one generation of the year which greatly affects the length frequency for the first year.

Growth in weight: The calculated growth in weight at the end of each year of life was estimated by applying the corresponding length-weight equation to the calculated lengths at each year of life. The annual increments and percentage increase in weight during successive years in relation to the weight reached at the end of life span are presented in Table III.

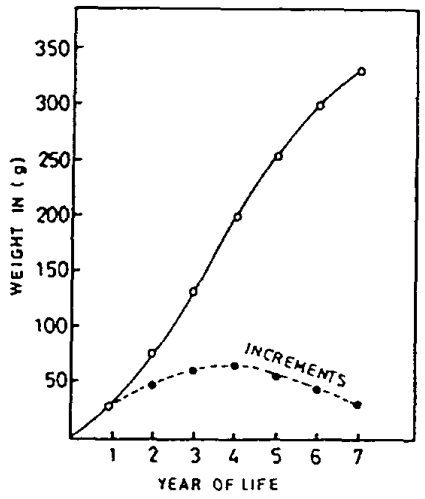

Fig.7. Growth in weight and annual increments in weights of *G. oyena*

Table III — The average calculated lengths§ and weights* at different years of life.

Age group	Number of fishes	Length (cm) at capture	Average calculated lengths at the end of each year (cm)						
			L_1	L_2	L_3	L_4	L_5	L_6	L_7
I	29	16.8	15.9						
II	146	22.1	14.8	21.7 (6.9)					
III	118	25.2	14.1	19.8 (5.7)	24.9 (5.1)				
IV	87	27.9	13.0	18.4 (5.4)	23.3 (4.9)	27.4 (4.1)			
V	52	28.7	12.4	17.7 (5.3)	21.9 (4.2)	25.8 (3.9)	28.4 (2.6)		
VI	21	29.3	11.8	16.7 (4.9)	20.6 (3.9)	24.2 (3.6)	27.3 (3.1)	29.1 (1.8)	
VII	7	29.9	11.3	15.9 (4.6)	20.4 (4.5)	23.8 (3.4)	26.5 (2.7)	28.4 (2.1)	29.8 (1.4)
Grand average calculated length (cm)			13.3	18.4	22.2	25.3	27.4	28.8	29.8
Annual increment of length (cm)			13.3	5.1	3.8	3.1	2.1	1.4	1.0
Percentage increase			44.64	17.11	12.75	10.40	7.05	4.70	3.36
Grand average calculated weight (g)			26.77	73.94	133.07	200.34	257.13	300.54	334.42
Annual increment of weight (g)			26.77	47.17	59.13	67.27	56.79	43.41	33.88
Percentage increase			8.0	14.11	17.68	20.12	16.98	12.98	10.13

§ Increments are given in parentheses, * weights calculated by length-weight equation.

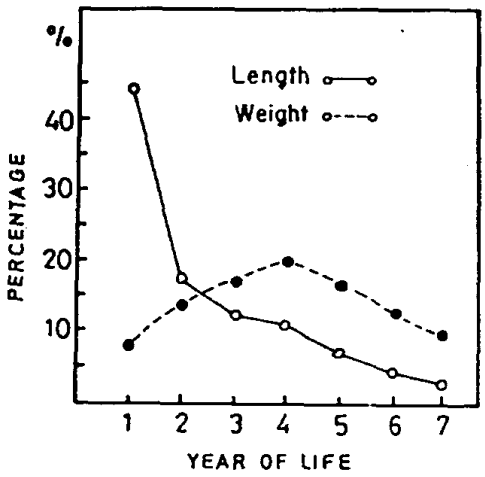

Fig.8. Percentage annual increase in length (solid line) and in weight (broken line) of *G. oyena*

Calculated weights at the end of each year of life and annual growth increments (Figs.7 & 8) indicate that the growth is very slow in the first year of life, then increases in successive years of life with little irregularity. The greatest weight increments were attained in the fourth year. Therefore, on the basis of the increase in weight it could be economically important to protect the fish in the Arabian Gulf waters till their fourth year of life, when they have reached a total body length of about 25 cm, and a total body weight of about 200 g. which is a good marketable size, and perform the first spawning activity.

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