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AGE AND GROWTH OF ANGUILLA ANGUILLA (L) IN LAKE MANZALAH, EGYPT.

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ABSTRACT

Age and growth of **Anguilla anguilla** was studied in Lake Manzalah, which is one of the largest northern Delta Lakes, east of Damietta branch. The present results show that, the growth rate of this fish is highest by the end of its second year of fresh water life. Eels in this lake reach about 63 cms by the end of six years of fresh water life. Maximum rate of putting on weight was noted by the end of fourth year (fresh water life). Condition factor of this fish was found to be about 1.8.

INTRODUCTION

Little is known concerning the general biology of the eels **Anguilla anguilla** L. in Egyptian littoral lakes. The ecological and economical importance of eels is apparent.

The objective of this paper is to study the age and growth of eels in one of the Egyptian littoral lakes.

Lake Manzalah (Fig. 1), has an area of 171,000 hectars, mean depth rarely exceeds ons meter. It is connected with the Mediterranean Sea through an opening at El-Gamil lying a little distance to the west of Port Said. Salinity, expressed in terms of chlorosity is highest in the northern eastern part (Cl_v = 2.99 to 10.1 g/l) and least in the south eastern part (0.68 - 2.009 g/l), (S. Wahby et al, 1972).

MATERIAL AND METHODS

Eels were fished by professional fishermen from Lake Manzalah. The following observations were recorded for each fish

1 - Date and place of capture.
2 - Total length to the nearest mm.
3 - Total weight to the nearest gram.

Fig. 1. Lake Manzalah.

Otoliths were preserved dry in envelops on which the above informations were written. Reading of the oteliths was done after immersing them in xylol (Deedler 1957) , using a stereoscopic microscope, under reflected light. Power of mangnification was X 30.

A complete description of the otolith of the eels was given by Frost 1945 and Bertin 1956. Otolith rings have often been used to determine the age of eels (Bertin 1956). They represent however certain difficulties, due to closeness of the concertric lamellae, the thing which renders them diffulct to read.

We denote the age of an eel, which has passed one year in freshwater by 3.1. This is because the elevers when they reach our waters have already completed 3 years of marine life (Wimpenny 1931).

Otoliths of 210 eels of Manzalah lake were analysed for age determination.

RESULTS

(a) Growth in length

Length otolith relationship (Fig. 2), in the eels is found to be represented by the formula

$$L = 7.35 + 25.2907\ S,$$

where L = total length of the fish in mm, S = Otolith radius in micrometer division X 30.

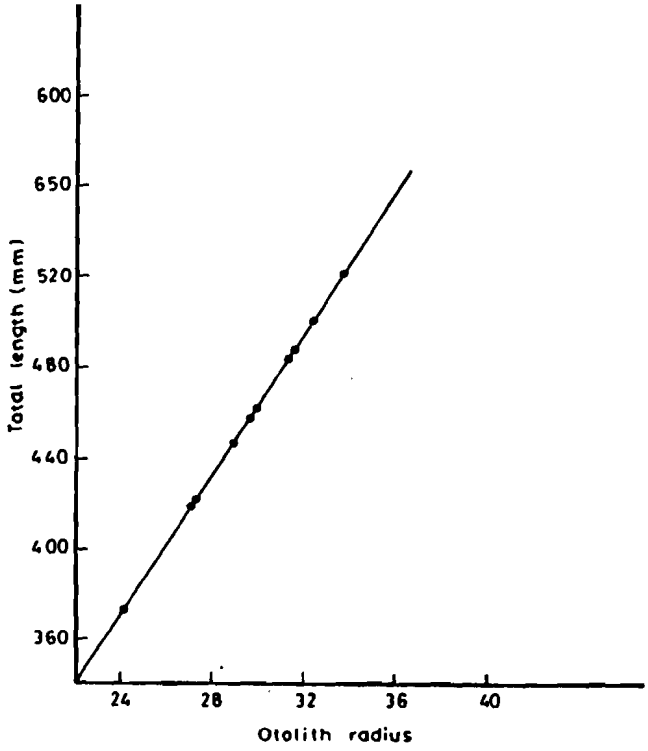

Fig. 2. Relation between otolith radius and total length of **Anguilla anguilla** in Manzalah lake (1972-1973).

This equation suggests that, where S is zero the fish had already reached a length of 7.35 mm total length (Rounsefel and Everhart 1969). As this fish reached very big sizes about 800 mm total length, we neglected this intercept and proceeded with the direct proportionality method (Lea 1920).

Table (1), shows the back-calculated lengths of the eels at the end of different years of life. From this table we note the following:

1 - The growth rate of **Anguilla anguilla** in Lake Manzalah is hgihest by the end of its second year of freshwater life.
2 - Mean length of the fish at the end of its third year of life is 7.2 cm. This corresponds to the length of elevers entering Egyptian coasts.
3 - Eels in Manzalah Lake reach 62.67 cm when they are 3.6 years old. It should be noted that the length of the fish at the end of each year of marine life was not calculated due to difficulty in separating the annuli representing marine life.

TABLE 1
CALCULATED LENGTH OF **A. ANGUILLA** AT THE END OF EACH YEAR OF FRESHWATER LIFE IN MANZALAH LAKE 1973 - 1974

Age in years	3.0	3.1	3.2	3.3	3.4	3.5	3.6
Mean length (cm)	7.2	14.3	28.79	39.23	49.71	56.54	62.67
Increment	7.2	7.1	14.49	10.44	10.48	6.83	6.13

N.B. 3.0 = elver of 3 years marine life.
3.1 = Anguilla of 3 years marine life and 1 year freshwater life.

Length Weight Relationship and Condition Factor

The mean weight per length group of **A. anguilla** in Lake Manzalah, is shown in Fig. 3. The formula representing their length weight relationship is the following

$$\text{Log } W = -6.4776 + 3.2762 \text{ log } L,$$

where W = total weight in gram, L = total length in mm.
Eels used for length weight analysis varied from 55 gm and 600 gm in weight. They measured between 300 and 760 mm total length.

This formula can be expressed as follows

$$W = 0.002994 \quad L^{3.2762}$$

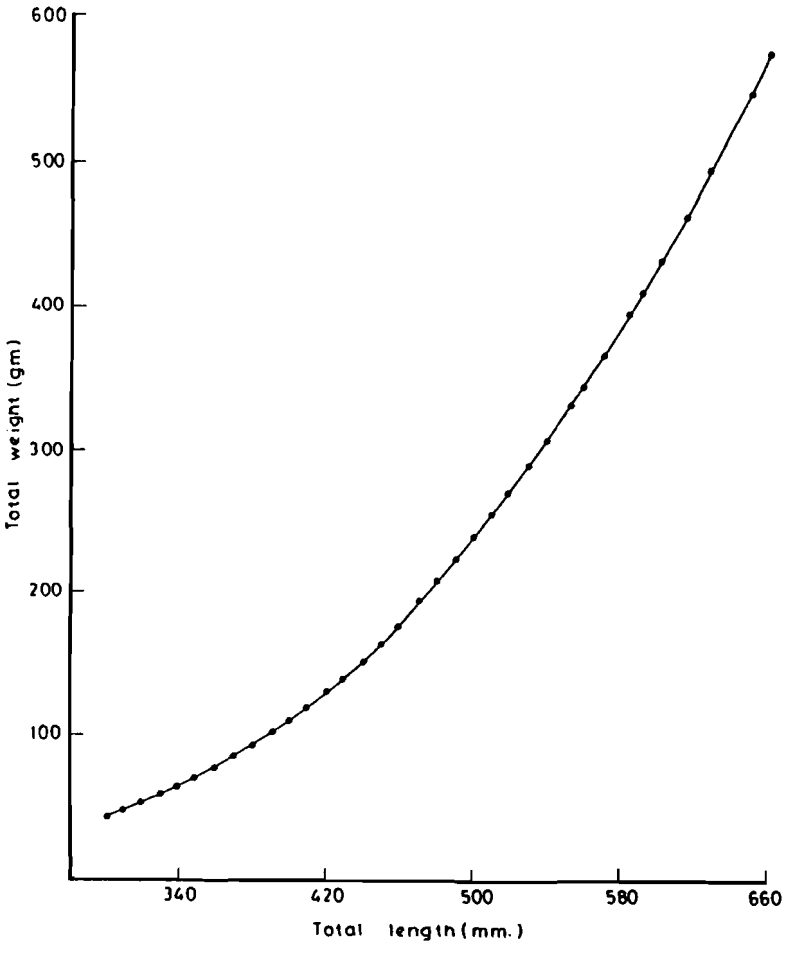

Fig. 3. Length-weight relationship for **Anguilla anguilla** in Lake Manzalah (calculated values), 1972-1973.

In the above equation the value of (n) is higher than 3. This means that the fish becomes heavier for its length as it grows longer.

(b) Growth in weight

Fig. 4 shows various values of weight corresponding to each year of freshwater life. From the curve, we can see that the fish gains weight at a good rate by the end of its first year of fresh water life.

The gain in weight increases from year to year till the end of its fourth year (freshwater life) where the fish reaches its maximum rate of gaining weight. After this the increment growth in weight decreases gradually.

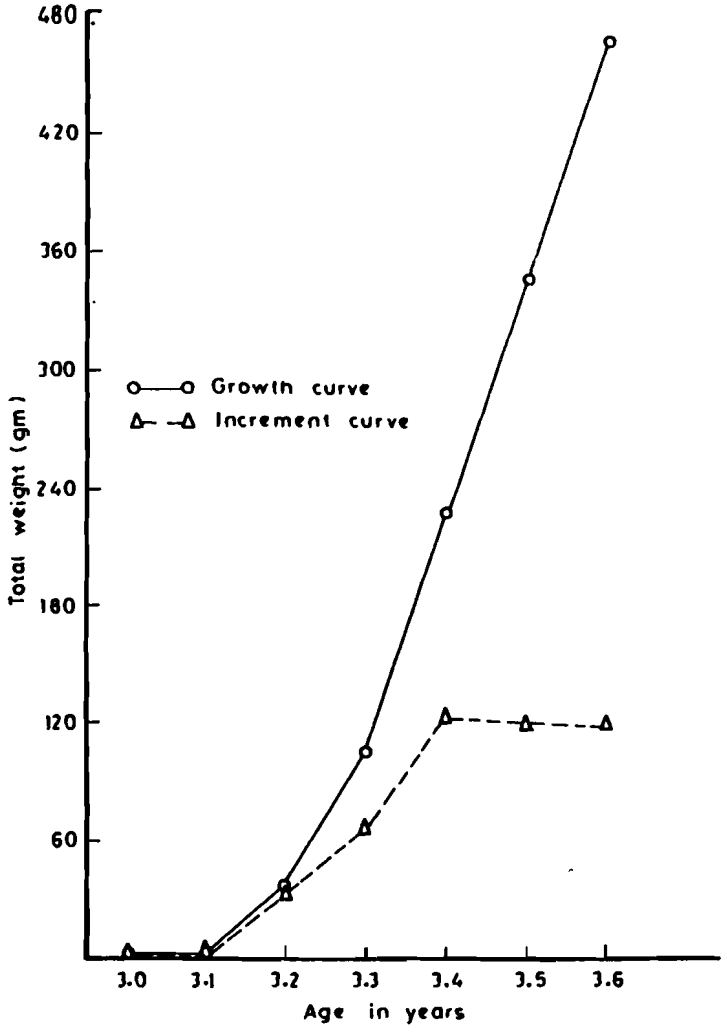

Fig. 4. Growth and increment curves of **Anguilla anguilla** in Lake Manzalah (1972-1973).

(c) Condition factor

Fulton's coefficient of condition K (calculated from a formula of the type, $K = W/L^3$) has often been used to investigate seasonal and habitat dependent differences in fatness and general well-being.

Table (2) shows the K values for eels in Manzalah Lake. It is clear that they increase with length, indicating that there is a change in shape as the fish increases in length.

TABLE 2
K - VALUES PER LENGTH GROUP FOR **A. ANGUILLA**
IN LAKE MANZALAH(1973-1974).

T.L.(cm)	K	T.L.(cm)	K
310	1.45	520	1.88
340	1.64	550	1.89
370	1.71	580	1.89
400	1.72	610	2.00
430	1.74	640	2.01
460	1.77	670	2.10
490	1.78	-	-

DISCUSSION

Study of the growth of the yellow eel, made the subject of various investigations. Otolith rings have often been used to determine the age of eels (Frost 1945, Bertin 1965). Scale rings may also be used, but are usually read in conjunction with otoliths since scales first appear on eels 15 to 20 cms long when the fish has attained an age of 4 to 6 years (Bertin, 1965, Smith and Saunders 1955). Inspite of difficulties met with when reading otoliths of eels, they are regarded as reasonable approximation for age determination for most eels.

Jespersen 1926, in his study on growth of eels from Norfolk and Cumberland, used otoliths and scales for age determination. He found differences in growth rates of males and females. He found also that, rate of growth of eels was higher in Norfolk than in the Cumberland, and explained this variation as being due to locality.

Tesch 1928 studied eels in Dutch waters, and found extreme irregularities in the growth of yellow eel. The length and weight of one fish may be five times as great as those of another fish of the same age and the same locality.

Hornyold 1930, made his study on 596 of Tunisian eels. He mentioned that an eel reaches 56 cm by the end of its eighth year of life.

Frost 1945 using otolith rings counts in **A. anguilla** reported that elevers enter water of Windermere when they are 7 to 8 cm in length and about three years old. According to this author a female **A. anguilla** may spend from 9 to 19 years in fresh water. These eels range in size from 47 to 95

cm. The most common length for female **A. anguilla** at the time of migrateion from freshwater is 54 to 60 cm. and most eels of this size range have spent 10 to 12 years in freshwater.

Deedler 1957 studied the age and growth **A. anguilla** in Ijsselmeer (Netherland), using otoliths. According to him, early stages of eels show individual variation in growth rate. As the fish gets older its growth rate decreases. He gave a length of 36 cm for a 9 years old fish. Bertin 1956 mentioned the irregularity in the growth of eels. He mentioned that an eel of 45 cm length could belong to any of the age groups VI to X. Cunning and Shoop 1962, have considered that otolith is more reliable as age indicators. They found that the locality has a major effect on the growth of eels, they said (one expects slower growth in Canada than in Lousisiana due to latitudinal differences).

Moriarty 1972 used otolith in his studies on **A. anguilla** in Ireland in the lakes of the Corrib system, his observations on growth rate of eels. He suggested that the eels of Corrib system belonged to a single population but higher proportions of small young eels were found in the lower reaches of the system than the upper. This author stated that there was a linear relationship between age and length of the fish for big sized eels.

Our results for eels of Manzalah lake show that they reach 62.67 cm by the end of their sixth year of freshwater life. The highest growth rate was recorded by the end of their second year of freshwater life. This is due to heavy feeding in freshwater. Frost 1945 mentioned the same phenomenon for eels in Lake Windermere.

The mean lengths for the different age groups, as calculated by various authors in various geographic localities (freshwater life) are shown in Table 3.

From this table the following are to be noted

1 - Eels of Manzalah Lake have higher rate of growth than eels from other localities. This can be explained to be due to high temperature recorded in this lake.
2 - Eels in Lake Windermere have the least growth rate.
3 - There is a controversy in the lengths at various ages as determined by various authors. The variation in growth patterns among eels was noted by various authors (Smith and Saunders 1955, Deelder 1957, and Cunning and Shope 1962).
4 - By the end of 6th year of freshwater life, i.e 9 years of age, eels in Manzalah Lake reach 62.67 cm total length. This is the biggest size recorded for eels in this age. It is corresponding to eels of 10 to 12 years of age recorded by Frost 1945 in Lake Windermere.

The form of an eel body differs radically from that of a typical fish. Thus a typical fish is triangular in cross section, while an eel is elliptical. We

TABLE 3
MEAN LENGTH OF **ANGUILLA ANGUILLA** FOR VARIOUS AGE GROUPS IN DIFFERENT LOCALITIES ACCORDING TO DIFFERENT AUTHORS

Area and author	Length in cm at the end of each year freshwater life								
	0 group	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8
Norfolk Jespersen 1922	-	-	-	31.5	34	36	36.5	44	48
Hornyold 1930	-	-	-	-	-	-	46	51	-
(Windermere Frost 1945	9	15.4	19.5	22.7	26.4	32.2	48.4	40.8	-
Manzalah lake (present study)	7.2	14.3	28.79	39.23	49.71	56.54	62.67	-	-

should therefore expect that the general cube law, used for length weight relationship does not apply to the eel.

In fact, Frost 1945, tried to prove that eels do not obey the cube law in their length weight relations. He stated that yellow eel changes in shape as it increases in length, the eels becoming more bulky and heavier in robustness as it gets longer.

Burnet 1952, proved that eels obey the cube law in their length weight relationship. Vladykov 1955 described the increase in fatness which occurs in the eels at the stage when they descend to the sea.

The present results, show clearly the application of cube law to the length weight relationship of eels. They did not show a shift in the rate of ponderal growth in the length range studied. However we should mention that silver eels were not examined.

The values of (n) in Lecren's equation of length weight relationship 'Log $W = \log a + n \log L$, is said to reflect the condition of the fish. Table 5 , shows the values (n) as obtained by various authors in different geographic localities.

From this table, it can be seen that the values of (n) of **A. anguilla** varies between 3.13 and 3.27. It is clear also that the ponderal growth rate of eel's of Lake Manzalah lies within the normal range of this species.

TABLE 4
DIFFERENT VALUES OF (n) AS OBTAINED BY VARIOUS AUTHORS
FOR **A. ANGUILLA** L.

Month	Water temperature
January	12.6
February	16.7
March	19.1
April	25.7
May	29.5
June	30.8
July	31.1
August	30.4
September	28.9
October	25.7
November	21.0
December	16.1

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