STUDIES ON MUGIL SEHELI AND MUGIL CAPITO IN LAKE TIMSAH.
I. AGE AND GROWTH.

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ABSTRACT

Analysis of total length-weight relation of **Mugil seheli** and **M. capito** from Lake Timsah revealed that the exponent n is about 2.8. Condition factor is the lowest in the post-spawning period and the highest in spring. Scales are reliable for age determination. For the combined sexes **M. seheli** calculated lengths were 10.73, 14.05 and 15.41 cm. and the calculated weights were 17, 36 and 57 gm. for age groups I, II, and III respectively. In **M. capito**, the calculated lengths of the combined sexes were 17.47, 21.95 and 26.54 cm. and the calculated weights were 39, 90 and 184 gm. for age groups I - III respectively. Females longivity is greater than males.

INTRODUCTION

The biological studies of Family Mugilidae have received attention in different regions of the world (Heldt 1948, Thompson 1966, Grant and Spain 1975, Chan and Chua 1979 and Albetini 1978... etc). In Egypt, the mugilids are common fish and have been an interesting subject by various authors (e.g. Wimpenny and Fauzi 1935, Rafail 1968, El-Maghraby et al. 1973, Fayek 1973 etc...). In the Suez Canal, the studies stated since a long time and concerned only with the distribution and migration of mullets through the Canal (Tillien 1902, Norman 1926, Tortonese 1948).

In the Suez Canal, **Mugil seheli** and **M. capito** are the common species while **M. cephalus**, **M. saliens** and **M. auratus** are of much less frequent and generally appear at different periods of the year. In Lake Timsah, mullets and especially **M. capito** and **M. seheli** share a considerable part in the commercial landings at the lake. The present work is a part of a research program directed to these species and deals with age and growth of **Mugil capito** and **M. seheli**.

MATERIAL AND METHODS

Random samples of fishes were collected monthly during 1980 from the commercial catch from Lake Timsah. Total lengths (mm) and total and gutted weights (gm) were recorded. Scale samples were also collected from

fish's left side just behind the pectoral fin, then soaked for 10-12 hours in 10% ammonia solution, washed by distilled water, dried and mounted between two slides. The scales were then examined by means of a binocular microscope (x25) to measure the radius and the distance from the focus to each annulus.

RESULTS AND OBSERVATIONS

### 1. Length–Weight Relationship and Condition Factor

Based on 811 specimens of **Mugil seheli** and 469 specimens of **M. capito**, the relation between the two variables of length and weight according to the formula $W = c\,L^n$ was computed as

$$\text{Log } W = -1.6704 + 2.8017 \text{ log } L \quad \textbf{M. seheli}$$
$$\text{Log } W = -1.8123 + 2.8060 \text{ log } L \quad \textbf{M. capito},$$

where W = weight in g. and L = total length in cm.

On this account, the value of "n" is nearly comparable in both species and is somewhat less than 3. The pattern of the relation betwen length and weight is shown in Fig. 1. In **M. seheli,** the difference between the empirical and calculated weights is limited within the total length range 9.5-19.5 cm. However, the picture is different in **M. capito** as this difference is also narrow for small fish but becomes wider in fish larger than 27 cm.


Fig.1 : Length _ weight relation of M. seheli (A) and M. capito (B)
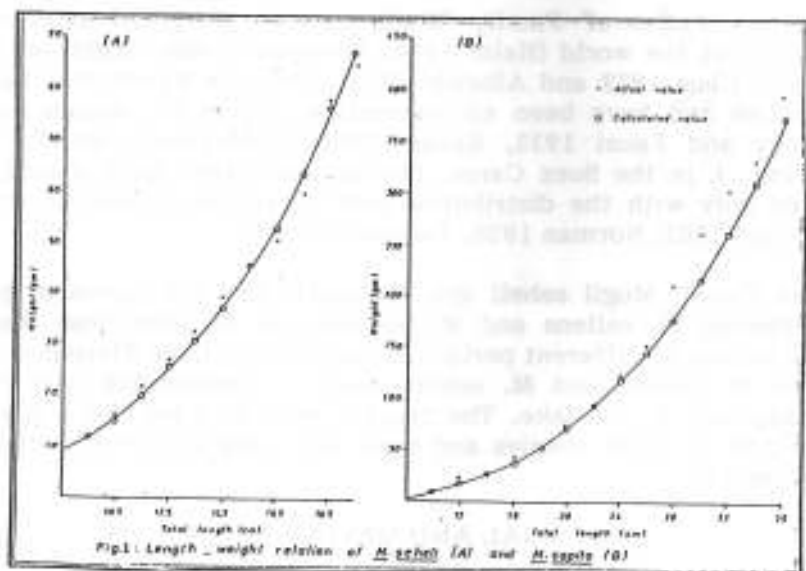
Besides, the condition factor (K) was calculated from the formula

$$K = 100 \ W \ / \ L^3 \ ,$$

where W = weight in g. and L = total length of fish in cm. The number 100 was introduced to eliminate decimals. In **M. seheli**, K is generally higher for the larger fish than in smaller ones. The data available reflect an increase from 1.64 to 1.77 for fish from 9.5 to 12.5 cm. but for larger fish from 12.5 to 19.5 cm. length, K varies between 1.89, Fig. 2a. With reference to monthly values K increses from January to May and from 1.72 to 1.93, decreasing to 1.78 in June and further to 1.60 in July but increasing afterwards to reach 1.89 in October but decreasing slightly in December, Fg. 2b.

Fig. 2: Condition factor of Mugil. seheli according to
(A) Fish length   (B) Different months
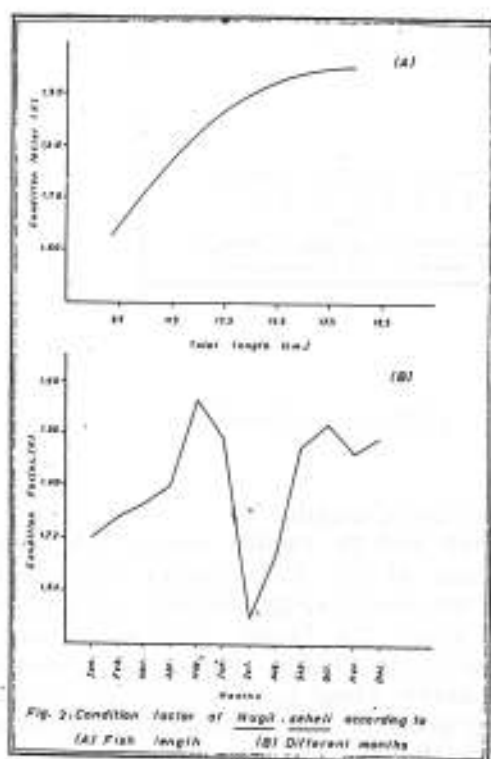
In **M. capito**, K increased progressively from 1.59 to 1.86 with growth in length from 10 to 22 cm. Inlarger fish, K values generally tended to decrease and flactuated between 1.66 to 1.87 (Fig. 3 A). Concerning monthly variation, K increased from 1.39 to 1.92 from January through June, then decreased to 1.72 in July and further to 1.62 in August. Afterwards followed a gradual increase from September to November which is followed by a decline from 1.90 to 1.70 in December (Fig. 3 B).

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Fig.: Condition Factor of *M. capito* according to (A) Fish length (B) Different months
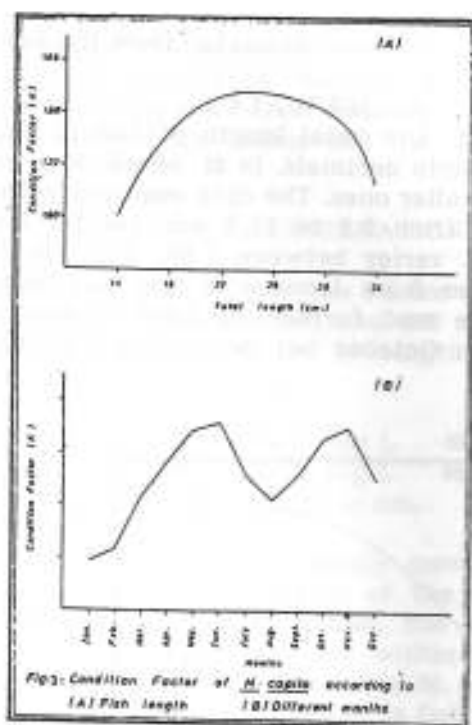
AGE AND GROWTH

A. Scale Characteristis

a. Shape of scales and definition of annulus

The scales of **Mugil seheli** and **M. capito** are of the ctenoid type, (e.g. Kesteven, 1942; El-Maghraby et al., 1973......etc) and are lined by small mucus canals. The scales are oval to egg shaped, thin and have concentric ridges or circuli arranged about the focus. The focus may be central on slightly anterior or posterior to the center. The annuli appear on the anterior field of the scales as a narrow clear band of circuli outside the closely-spaced circuli of the winter growth. At the beginning of spring, new growth is narrow and distinguished with difficulty.

b. Validity of annulus as year mark

Examination of the scales of **Mugil seheli** and **M. capito** from Lake Timsah revealed that :(i) As the fish grows, the number of scales remains constant but their size increases parallel with the increase in length; (ii) The increase in size of fish is accompanied by an increase in number of annuli; (iii) The true annuli are valid as year marks and consequently for age and growth studies. These annuli are considered as spring rings on considering the period of their appearance.

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In M. seheli, the scales collected from January and February showed no marginal annulus. From March to May, the annulus increases from one month to that follows whereby the new growth appeared in 60, 65 and 79 % of the scales examined in March, April and May respectively.

In M. capito, Scales collected in March have no marginal annulus. In April and May, new growth becomes prominent in 61 % and 74 % of cases respectively. Till the end of the year, the last annulus lies at varying position from the scale's margin, being the farthest during the fall-winter period.

c. Body-Scale Relation:

Figure 4 shows that the anterior scale radius grows in direct proportion to the body length. The relation can be described by the following equations:

$$L = 1.445 + 2.940 \, S \quad \text{M. seheli}$$
$$L = 1.767 + 3,731 \, S \quad \text{M. capito}$$

where L = total length in cm., S = magnified (x25) anterior scale radius).

Fig. 4:Relation between total length and anterior scale radius (x25) in Mugil seheli (A) and M. capito (B)
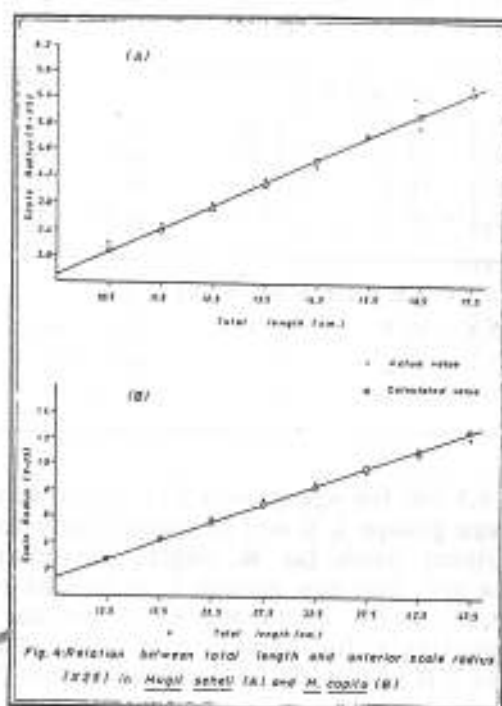
B. GROWTH IN Length

a. Length at Capture :

The actual length of **M. seheli, and M. capito** show overlaps between the successive age groups to varying degrees (Tables 1 & 2). The mean of the actual lengths for the various age groups indicates a progressive increase. Thus, in **M. seheli,** the mean total lengths for the age groups I, II, and III are 11.25, 13.59 and 15.54 cm. respectively in the male, and

Table 1
Range and Means of actual lengths and weights
of **Mugil seheli** by age groups.

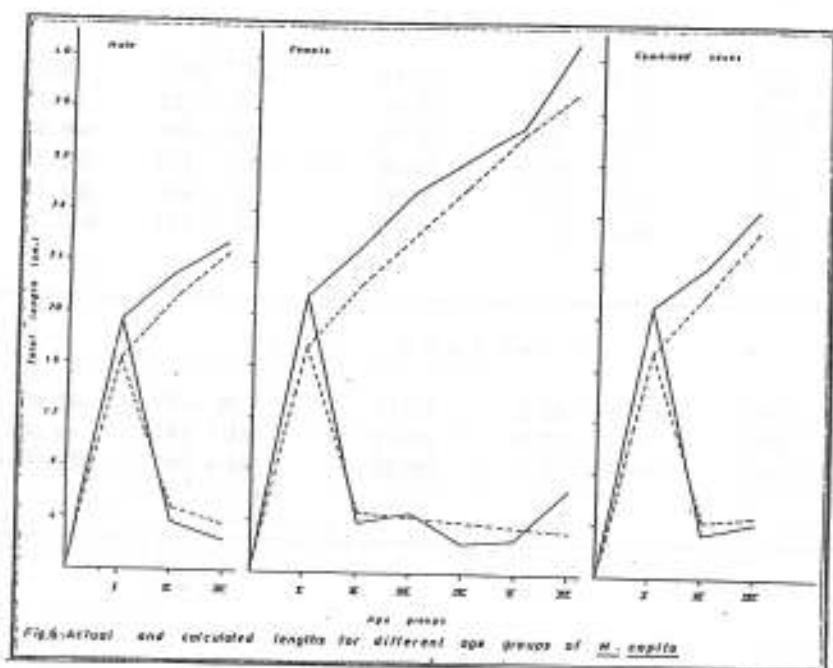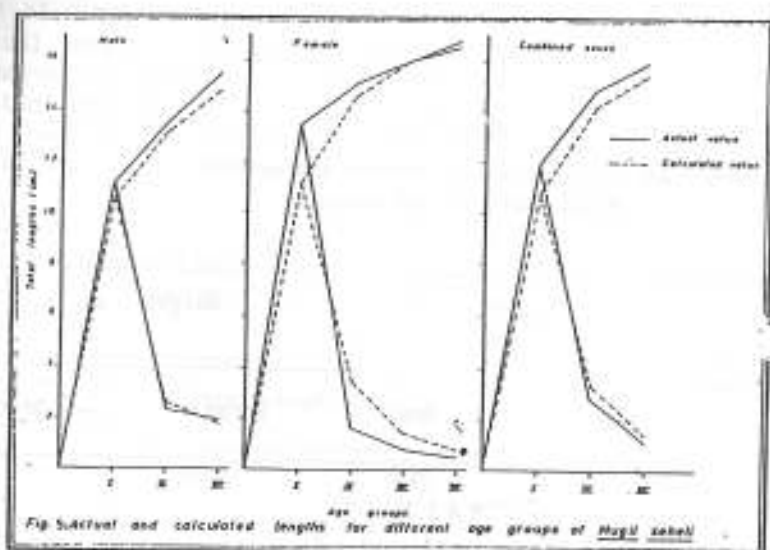| Age groups	No. of specemens	Total Length (cm.)		Weight (gm.)	
		Range	Mean	Range	Mean
M A L E					
I	109	10.4 - 14.6	11.25	22.2 - 33.9	25.28
II	75	13.5 - 16.1	13.59	28.6 - 45.3	38.99
III	15	15.1 - 17.7	15.54	55.1 - 70.2	65.41
F E M A L E					
I	39	12.5 - 15.6	13.46	25.8 - 40.2	28.02
II	356	14.8 - 17.2	15.02	39.5 - 57.2	50.66
III	196	15.3 - 18.1	15.94	56.3 - 76.4	69.44
IV	62	16.1 - 19.3	16.5	68.6 - 95.0	84.89
C O M B I N E D S E X E S					
I	158	10.4 - 15.6	11.93	22.2 - 40.2	26.04
II	435	13.5 - 17.2	14.79	28.6 - 57.4	48.54
III	208	15.1 - 18.1	15.91	55.3 - 76.4	69.17

13.46, 15.02, 15.94 and 16.5 cm for age groups I–IV in the female; and 11.93, 14.79 and 15.91 cm. for age groups I, II and III respectively for the combined sexes (Fig. 5). On the otherr hand, for **M. capito** the mean actual length is 19.39, 23.03 and 25.04 cm. for age groups I, II and III respectively for the male 21.64, 25.4, 29.88, 32.09, 34.88 and 41.75 cm for the successive age groups 1 to VI respectively for female and 21.15, 24.41 and 28.75. respectively for age groups I, II and III of the combined Sexes (Fig. 6).

b. Calculated length

The historical length of fish under study was calculated by applying the following formula

Table 2

Ranges and Means of actual lengths and weights
of **Mugil capito** by age groups.

Age groups	No. of specimens	Total Length (cm.)		Weight (gm.)	
		Range	Mean	Range	Mean
M A L E					
I	35	17.5 - 21.5	19.39	35 - 92	42.35
II	90	21.5 - 28.4	23.03	65 - 140	97.67
III	42	23 - 34	25.04	129 - 234	179.54
F E M A L E					
I	210	17.5 - 29.2	21.64	41 - 89.5	49.25
II	123	19.5 - 32.5	25.40	71 - 152	99.28
III	117	20.5 - 38.5	29.88	119 - 246	168.54
IV	66	26 - 40.1	32.09	231 - 410	280.41
V	45	32.2 - 41.7	34.88	310 - 480	367.72
VI	3	40.2 - 48.8	41.78	451 - 830	510.34
C O M B I N E D S E X E S					
I	245	17.5 - 29.5	21.15	35 - 92	48.25
II	215	19.5 - 32.5	24.41	65 - 152	98.60
III	145	20.5 - 39.0	28.75	199 - 246	171.39

Fig.5 Actual and calculated lengths for different age groups of *Mugil saheli*

Fig.6 Actual and calculated lengths for different age groups of *M. capito*

$$Ln = a + Sn/s (L-a)$$

where, Ln = average length at n annulus
     L = average length of fish at capture
    Sn = average radius of annulu (n),
    S = average scale radius at capture, and
    a = correction factor (computed by length-scale relation).

Data available are given in Tables 3 and 4 for **M. seheli and M. capito** respectively. The calculated lenghts of the former species go slightly parallel with the actual ones which are generally slightly higher. For the male, the calculated lengths are 10.5, 13.0 cm and 14.76 cm. for age groups I, II and III respectively, denoting a respective increment of 10.5, 2.6 and 1.7 cm. In the female, the calculated lengths are 11.08, 14.47, 15.90 and 16.73 cm. with a length increment of 11.1, 3.4, 1.4 and 0.8 cm. for the successive age groups I-IV respectively. The calculated lengths for the combined sexes of age groups I, II and III are 10.73, 14.05 and 15.41 cm. with an increment of 10.73, 3.32 and 1.36 cm. respectively.

For **M. capito** (Table 4, Fig. 6), the length increment is 16.29, 4.76 and 3.74 cm for age groups I, II and III in the male, as the lengths attained are 16.29, 21.05 and 24.79 cm. respectively. In the female, the calculated lengths are 17.47, 22.14, 26.26, 30.25, 34.04 and 37.49 cm., thus corresponding to an increment of about 17.5, 4.5, 4.1, 4.0, 3.8 and 3.5 cm. for the successive age groups I-VI respectively. The calculated lengths of the combined sexes are 17.47, 21.95 and 26.54 cm., corresponding to an increment of 17.47, 4.48 and 4.59 cm. for age groups I, II and III respectively.

Thus, the growth increment decreases as the fish become older (Tables 3 and 4). The percentage of growth increment from the length calculated for the oldest age is the highest for the first age, decreasing abruptly in age group II and slightly as fish become older (Fig. 7).

C. Growth in W aght
a. Weight at capture
As shown in tables 1 and 2, the actual weight of each of the different age groups is not stable but covers a range which is generally wider in **M. capito** than in **M. seheli**. Thus, in the latter species, the mean actual weights are 25, 39 and 65 gm. for males of age groups I, II and III respectively and 28, 51, 69 and 85 gm. for females of age groups I-IV respectively and 26, 49 and 69 gm. for the combined sexes of age-groups I, II and III respectively, table 1, fig. 8. For **M. capito**, the means are 42, 98 and 180 gm. for males of age-groups I, II and III respectively, 49, 99, 169, 280, 368 and 510 gm. for females of the successive age groups I-VI respectively and 48, 99 and 171 gm. for the combined sexes of age groups I, II and III respectively, table 2, fig. 9.
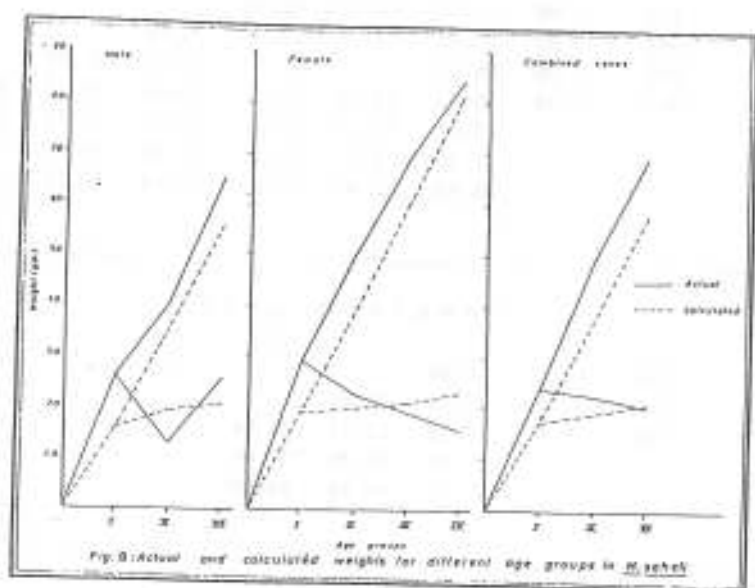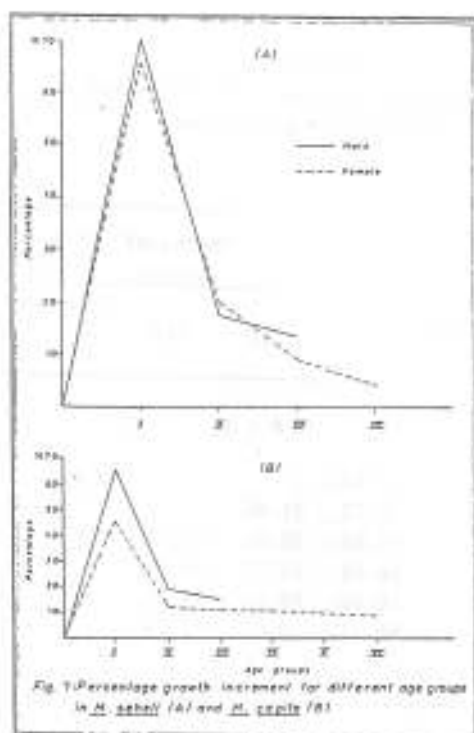
b. Calculated weights
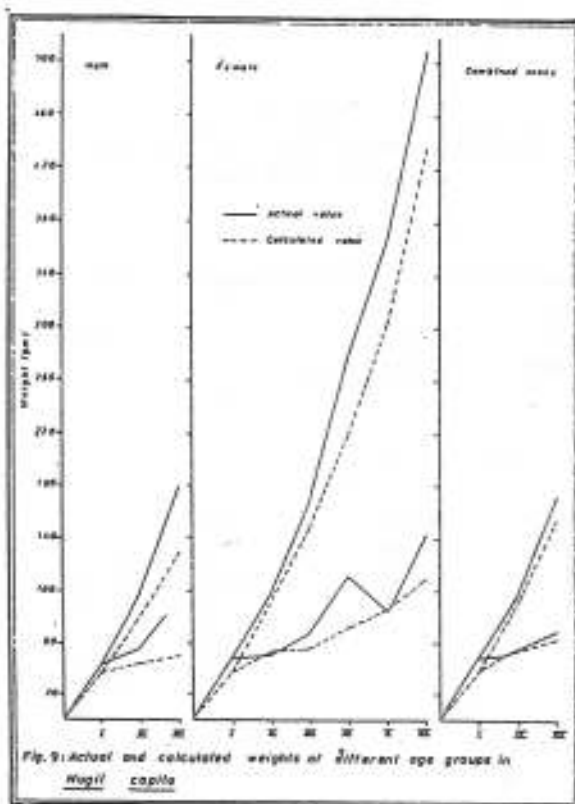The calculated weights were determined by applying the length-weight

Table 3
Calculated lengths (cm.) for different age groups in Mugil seheli.

Age groups	No of specimens	Size at capture	Years of Life			
			I	II	III	IV
M A L E						
I	114	11.25	10.59			
II	76	13.59	10.42	13.02		
III	13	15.54	10.53	13.16	14.757	
Mean			10.515	13.09	14.757	
Increment			10.515	2.575	1.667	
% increment			69.590	17.450	12.960	
F E M A L E						
I	51	13.46	11.430			
II	393	15.02	11.330	15.147		
III	176	15.94	10.630	14.286	15.997	
IV	084	16.50	10.950	13.990	15.840	16.730
Mean			11.085	14.470	15.905	16.730
Increment			11.085	03.385	01.435	00.825
% increment			66.260	20.230	08.580	04.390
C O M B I N E D S E X E S						
I	165	11.93	10.85			
II	469	14.79	11.18	14.802		
III	189	15.91	10.16	13.303	15.41	
Mean			10.73	14.050	15.41	
Increment			10.73	03.320	01.36	

Table 4
Calculated lengths (cm.) for different
age groups in **Mugil capito**.

Age group	No. of specimens	Size at capture	Years of Life					
			I	II	III	IV	V	VI
MALE								
I	35	19.36	16.93					
II	89	23.03	16.72	21.46				
III	40	25.54	15.92	20.65	24.79			
Mean			16.29	21.05	24.79			
Increment			16.29	04.76	03.74			
% increment			65.71	19.20	15.09			
FEMALE								
I	206	21.46	18.16					
II	123	25.40	17.65		22.37			
III	114	29.88	17.66	22.39	27.16			
IV	061	32.09	16.66	21.52	25.97	32.75		
V	042	34.88	16.67	21.42	25.72	31.52	35.89	
VI	003	41.75	18.03	23.02	26.24	28.62	32.22	37.49
Mean			17.47	22.14	26.26	30.25	34.04	37.49
Increment			17.47	04.67	04.12	03.99	03.79	03.45
% increment			46.60	12.46	10.99	10.64	10.11	09.20
COMBINED SEXES								
I	241	21.15	17.98					
II	212	24.41	17.21	21.99				
III	154	28.75	17.21	21.91	26.54			
Mean			17.47	21.95	26.45			
Increment			17.47	04.48	04.59			

Fig. 7:Percentage growth increment for different age groups
in _M. sehell_ (A) and _M. capla_ (B)

Fig. 8:Actual and calculated weights for different age groups in _M. sehell_

Fig. 9: Actual and calculated weights at different age groups in
Mugil capito

relationship to the mean calculated lengths in tables 3 and 4. On the whole,
the mean actual values are generally higher than the calculated values
of the respective age groups.

In **M. seheli,** the calculated weights are about 16,35 and 55 gm. for males,
as compared with 18,38 and 60 gm. for females and 17,36 and 57 gm. for
the combined sexes of age groups I, II and III respectively. Females of age-
group IV have calculated weight of 82 gm., table 5, fig. 8. Thus, the weight
increment becomes slightly higher as the fish become older, and estimated
for example as 18.1, 20.0, 21.6 and 22.5 gm. for females of successive age
groups respectively. In turn, the weight increment for the combined sexes
of age groups I, II and III are 17.14, 19.08 and 20.9 gm respectively.

On the other hand, for **M. capito,** the mean calculated weights are 36,81
and 131 gm for male's age groups I, II and III respectively. for female, the
calculated weights are 37, 92, 148, 220, 307 and 437 gm. for successive
age groups I - IV respectively. The mean calculated weights within the
limits of age groups of the combined sexes are 39, 90 and 154 gm for age

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Table 5
Calculated weight (gm.) for different
age groups in M. seheli.

Age group	No.of Specimens	Size at capture	Years of Life			
			I	II	III	IV
MALE						
I	102	25.28	15.92			
II	79	38.99	15.17	34.87		
III	14	65.41	15.64	35.85		
Mean			15.57	35.34	55.37	
Increment			15.57	19.77	20.03	
% increment			28.12	35.71	36.17	
FEMALE						
I	39	28.09	19.67			
II	356	50.66	19.19	43.30		
III	194	69.44	16.05	36.75	60.46	
IV	621	84.89	17.44	34.66	59.08	82.12
Mean			18.05	38.09	59.65	82.12
Increment			18.05	20.04	21.56	22.47
% increment			21.98	24.40	26.26	27.36
COMBINED SEXES						
I	141	26.04	16.96			
II	435	48.54	18.45	41.77		
III	208	69.17	16.02	35.68	57.12	
Mean			17.14	36.22	57.12	
Increment			17.14	19.08	20.90	

groups I, II and III respectively, table 6, fig. 9. Besides, the weight increment generally increases as the fish become older and is calculated as 37.2, 54.5, 66.2, 72.1, 86.4 and 130 gm for female's successive age groups I–IV respectively. In turn, within the common age groups (I–III), this increment is higher in the female than in the male.

In addition, the percentage contribution in fish weight is the lowest for age group I becoming higher as fish become older. For males of both species, the percentage is 27–28% for age group I, increasing to 34–36% for age group II and 36–38% for age group III. For female of **M. seheli,** the difference is not great as percentage increment is about 22% for age groups I and 37% for age group III. However, in **M. capito,** the percentage increment is about 9% for age group I, 12–13% for age groups II and III, 16% for age group IV, 20% for age group V and 30% for age group VI, table 6, fig. 10.
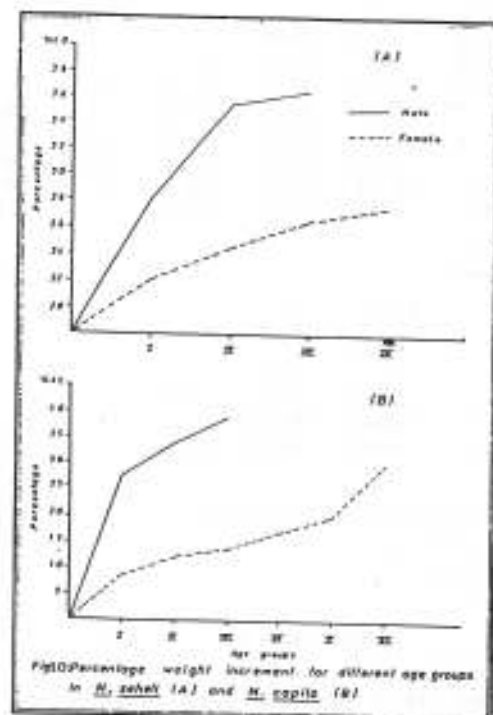

Fig.10 Percentage weight increment for different age groups in M. seheli (A) and M. capito (B)

Table 8
Calculated weights (gm.) for different age groups in Mugil capito.

Age group	No. of sp.	Size of capt.	Years of Life					
			I	II	III	IV	V	VI
MALE								
I	035	042.35	40.720					
II	089	097.67	39.080	85.44				
III	040	179.54	33.110	76.09	130.67			
Mean			35.809	80.64	130.67			
Increment			35.809	44.83	050.03			
% increment			27.400	34.31	038.29			
FEMALE								
I	206	049.25	42.57					
II	123	099.28	38.54	094.38				
III	114	168.54	38.61	094.61	162.67			
IV	061	280.41	31.28	084.65	139.61	275.03		
V	024	367.72	31.35	083.55	139.61	274.02	355.59	
VI	003	510.34	41.52	102.28	147.67	188.41	262.72	436.52
Mean			37.16	091.68	147.99	220.09	306.52	436.52
Increment			37.16	054.52	056.31	072.10	086.43	130.00
% increment			08.51	012.49	012.90	016.52	019.80	029.78
COMBINED SEXES								
I	241	048.25	42.30					
II	212	098.60	98.77	90.63				
III	154	171.39.	37.78	89.79	154.36			
Mean			34.98	90.21	154.36			
Increment			34.42	50.70	064.15			

DISCUSSION

The present work represents a part of studies directed to the mugilids of Lake Timsah and deals with age and growth of **Mugil seheli** and **M. capito.**

Generally speaking, the variation in the weight of the fish with the length has been extensively studied by the fishery or fish biologists. The relation between these two variables is represented by the formula $W = CL^n$. The

value of the exponent "n" lies between 2 and 4 and often close to 3 (Tesch 1968) and usually varies between the different species and between the different stocks, sexes, years of capture and different seasons for the same species (Hile 1936, Stroud, 1948, Jobes 1952... etc). For mugilids of Lake Timsah examined in the present work, the following equations were computed:

M. seheli Log W = -1.6704 + 2.8017 Log L
M. capito Log W = -1.8123 + 2.806   Log L
           (W = wt. ing., L = total length in cm.)

In turn, on the basis of other works, the value of "n" for **M. capito** is comparatively higher in some other water bodies of Egypt than in Lake Timsah (following table).

Comparison Between Log C and n in length-weight
equation for **M.capito** in different Egyptian Lakes.

Region	Author	Log C	n
Mediterranean Sea	Rafail (1968)	- 4.8998 ,	2.9144
Lake Mariut	El-Maghraby et al(1971)	- 2.2465	2.8715
Lake Borollus	El-Maghraby et al(1973)	-4.4244	2.8071
Lake Manzalah	Fayek (1973)	-4.9346	2.9287
Lake Timsah	Present work	-1.8123	2.8060

The condition factor or correlation coefficient (K) is used to compare the condition, fatness or well-being of fish. In the present studied mugilids, K values were low in the post-spawning period (January and February), becoming higher in the spring (March-June) which is followed by a decrease in July. K attains higher values in August-September period as the fish begin to feed vigorously. With October-December period, K becomes lower, apparently due to the fasting of fish as well as gonadal maturation. Furthermore, K values computed generally increased with length in both species in Lake Timsah. However, for **M. capito**, K decreases with length in Lake Manzalah (Fayek 1973) and in lake Borollus (El-Maghraby et al 1973).

The validity of scales for age-determination is the most widely used method in age and growth studies (Lagler 1956). The scales of **M. seheli** and **M. capito** are ctenoid and reliable for age determination as the annulus, as

a valid year-mark, appears in March/April period which agrees with the results of Kesteven (1942) and El-Maghraby et al (1973) for **M. capito**. In both species, the longivity of females is longer than the males. In other words, the oldest males belonged to age group III while the oldest females belonged to age group IV in **M. seheli** and age group VI in **M. capito**.

The length increment is the highest in the first year of life and becomes less as fish grow older. On the other hand, the percentage increment in weight shows an opposite pattern. For example, in **M. seheli** the males of age group II attain a length of 87% and a weight of 64% of those of age group III. In turn, the differences are wider in the female. Thus, in **M. seheli**, for age groups I–III respectively, the lengths from 66, 87 and 95% and the weights form the length of weight of age group IV. Besides, the female of **M. capito** reaches 70% of its final length or weight at age groups III and V respectively.

Comparison between **M. capito** of Lakes of Manzalah, Borollus and Timsah shows that the length or weight for both sexes of age group I is higher in Lake Timsah than in the other two Lakes. On the contrary, **M. capito** of age groups II and III, is longer or heavier in Lake Borollus than in either Lake Timsah or Lake Manzalah. For age group IV, the females of Lake Manzalah are longer and heavier than in Lake Timsah. Lastly, females of **M. capito** of age groups V and VI as revealed from the present work, appeared in Lake Timsah but not in the other two localities. Therefore, the maximum size of **M. capito** was recorded to be higher in Lake Timsah than in either Lake Manzalah or Lake Borollus and this may be probably due to a higher fishing intensity in the last two localities.

SUMMARY

1. Length-weight relation is described by the following equations:

Log W = -1.6704 + 2.8017 log L   **M. seheli**   and
Log W = -1.8123 + 2.8060 Log L   **M. capito**
(Where L = total length in cm. and W = weight in g.)

2. Condition factor (K) was low after the spawning season, and afterwards increased to reach its maximum during the spring. K was the lowest in summer but it restored some increase afterwards.

3. Scales of **Mugil** spp of Lake Timsah are reliable for age determination. A straight line relation was establised between total length and anterior scale radius.

4. For **M. seheli**, male's calculated total length is 10.5, 13.4 and 14.8 cm and calculated weight is 15.6, 35.3 and 55.4 gm. for age groups I, II and III respectively. For female, calculated length is 11.1, 14.5, 15.9 and 16.7

cm and calculated weight is 18.05, 38.1. 59.6 and 82.1 gm for age groups I-IV respectively. For combined sexes, calculated length is 10.7, 14.05 and 15.4 cm for age groups I, II and III respectively .

5. For **M. capito**, male's calculated total length is 16.3, 21.05 and 24.8 cm and calculated weight is 35.8, 80.6 and 130.7 gm for age groups I- III respectively. For female, calculated weight is 37.2, 91.7, 148, 220.1, 306.5 and 436.5 gm for successive years I-VI respectively. For combined sexes, calculated length is 17.5, 21.9 and 26.4 cm and the calculated weight is 39.4, 90.2 and 154.4 gm at the end of the age groups I, II and III respectively.

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