

# ON THE BIOLOGY OF THICK-LIPPED GREY MULLET (*MUGIL CHELO* CUV.)

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## INTRODUCTION

Preliminary study is being made on the biology of *M. chelo* Cuv. in Çanakkale region (on the Dardanelles strait) dealing with their size, age, growth rate, spawning period, fluctuations in Mugil stocks and other related problems.

## Material and Method.

For this investigation samples have been obtained completely from Çanakkale fish market from february 1959 to may 1960. Landseine, trap net, trammel net had used for catching. We have adopted as the length of the fish LCF. Total body weight measured by 5 g sensibility. In addition to whole weight, the weight of gonads were taken from 0,1 g.



FIG. 1. — Early winter spawned *M. chelo* 20,3 cm in length, 2 years old.



FIG. 2. — Late winter spawned *M. chelo* 28,6 cm in length, 3 years old.

In order to determine the gonadal development we have also measured diameter of eggs as 1 unit = 12.5  $\mu$ . Scales which situate under the pectoral fin, cross sections of the spiny rays of the first dorsal fin and otolith of sagitta were used for age determinations. The otolith has roughly rectangulaire shape. Its translucent (winter) and opaque (summer) zones are well distinguished and the translucent zone is always broader than that of the opaque zone.

Date \ Age	I	II	III	IV	V	VI	VII	VIII	IX
22/I/59				35.2 490.0	38.0 695.0				
18/III/59			26.1 230.0	35.7 500.0					
24/IV/59			32.2 320.0	35.2 586.0	40.7 850.0				
20/V/59		24.2 150.5	29.8 266.0	36.1 670.0			50.0 1750.0		
29/VI/59		23.9 210.0							
15/VII/59		17.8 76.5		37.4 567.5	42.3 930.0	44.8 1185.0			
20/VIII/59			30.1 380.0						
25/IX/59			32.1 340.0						
13/X/59				37.9 590.0				55.0 2900.0	
17/XI/59		22.4 156.0	33.2 350.0	36.7 680.0					
9/XII/59		26.6 205.0	31.0 320.0	36.4 600.0	43.8 1190.0	46.3 1291.0		54.5 2330.0	59.2 3330.0
26/I/60	15.1 60.0	26.3 210.0	31.0 310.0	35.8 431.0					
28/II/60		23.2 230.0	28.0 280.0						
26/III/60				37.9 728.0	45.1 1227.0	48.5 1355.0	53.6 1900.0	56.0 2010.0	57.0 3050.0
19/IV/60		25.0 240.0	31.5 300.0	36.9 580.0	43.6 1010.0	50.5 1520.0			
19/V/60				37.8 533.0					
Mean Length (cm)	15.1	23.6	30.5	36.6	42.2	47.5	51.8	55.2	58.1
Mean weight (g)	60.0	185.0	309.5	580.0	983.6	1337.8	1825.0	2713.3	3190.0
Growth (cm)	8.5	6.9	6.1	5.6	4.9		4.7	3.4	2.8

TABLE I. — Mean length and weight per age of *M. chelo* from Çanakkale.

But we used cross ray sections and scales as a control material especially for older specimens because there is a good agreement among them. On the otolith, first translucent zone has showed variations because *M. chelo* spawns in winter months. Early winter spawners have reveals a large translucent zone around the nucleus of the otolith and late spawners have characterized with narrow winter zone, (fig. 1 and 2). During the summer months the fish grows rather rapidly in first year according to the other years (tabl. I). We have regarded the otolith with one translucent and one opaque zone in I year old.

The body length of samples were from 12-59 cm and their weight changed between 20-3330 g. In this study we examined 310 specimens and among them 54,5 % were males and 45,5 % were females.

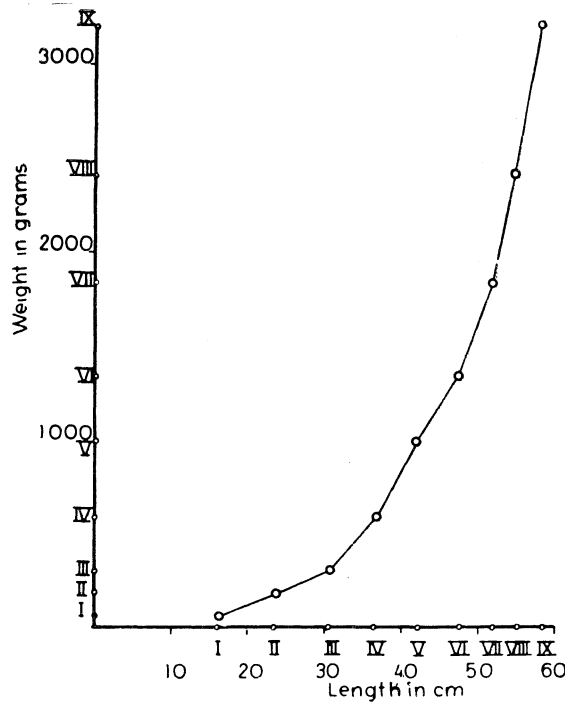


FIG. 3. — Weight-Length-Age Relation in *M. chelo* from Çanakkale.

### Increase in Weight.

For *M. chelo* the curve of mean values of weight to length relation is smooth but there is rather a considerable variation between the non spawning and spawning fish. No consistent differences are apparent between non spawning fish length-weight ratios for both sexes. But there is a greater increase in body weight of mature fish and this increase is more pronounced in the females than the males, especially female fish longer than 45 cm. These differences have occurred because of the changings in gonads weight. When the fish is near to spawn its gonads weight in firstly ripened fish become 20 % to the total weight and this ratio increase roughly 10 % for fish longer than 50 cm.

The relation between the mean length and weight to the ages are shown in table I. Figure 3 shows the mean length and weight calculated for various age groupes. In early life of *M. chelo* from I to III years of age, there is a low ratio between weight to length. Weight increase as a function of length at these ages. But later on when the fish become mature for the first time and through the older ages the weight increase more rapidly than former years.

### Annual growth.

The mean length obtained each year at the time of annuli formation are : 15,1, 23,6, 30,5, 36,6, 42,2, 47,5, 51,8, 55,2, and 58,1 cm respectively for the first, second etc. years (tabl. I).

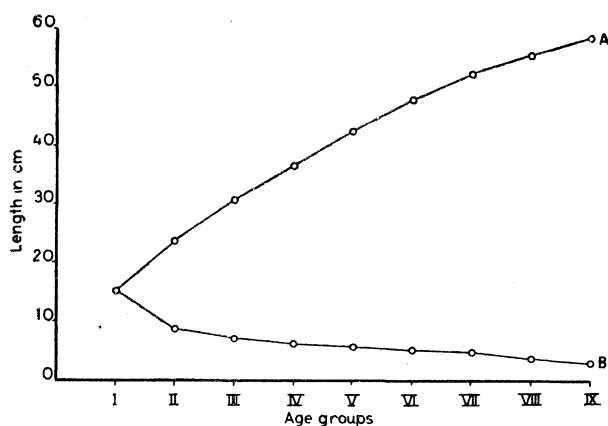


FIG. 4. — Mean growth of *M. chelo* (line A), and the annual increment (line B).

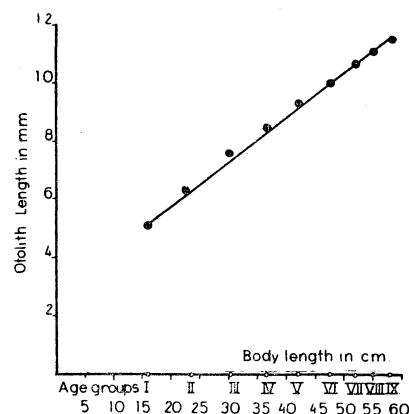


FIG. 5. — Body length-age relation of the otolith of *M. chelo*.

Figure 4, line A reveals that growth is proceeding along normal line. The annual growth is rapid in first year which the fish make its main growing in the time of first opaque zone formation, and from second year slows down according to the ages as indicated in figure 4, line B. The annual growth from one to nine years are : 15,1, 8,5, 6,9, 6,1,

Age Groups	I	II	III	IV	V	VI	VII	VIII	IX
Length : cm	12.0	15.1	23.4	30.2	38.1	50.7	50.7	53.5	57.1
	18.0	30.2	35.5	39.8	47.2	53.8	53.8	56.0	59.2
Weight : g	20.0	60.0	350.0	350.0	780.0	1110.0	1440.0	2270.0	3050.0
	90.0	3380.0	860.0	860.0	1435.0	1540.0	2100.0	2630.0	3330.0

TABLE II. — Minimum-Maximum Length (cm) and Weight (g) per age groups (locality :Çanakkale).

5,6, 4,9, 4,7, 3,4 and 2,8 respectively. Table II reveals the minimum and maximum lengths and weights for ages from I to IX. The individuals which we studied 21 % of them belonged to the age group of III and 25 % to the group of IV.

Figure 5 reveals the relation between the length of the otolith and the length of the body according to the ages. There is a decrease on the length of the otolith when the fish becomes older than VI years.

### Sexual maturity.

In an empirical table which is best suited for actual development of the gonads of *M. chelo* it can be given in VI stages for both sexes and the following table is based on macroscopic aspect and the size and characteristics of eggs.

#### *Stages of gonads in females and males.*

*Stage O.* Glassy ovariums rounded, lying along the blood vessels.  $\frac{1}{2}$  body cavity in length. A few mm. in width. Transparent small eggs with a visible nucleus in the center. Maximum diameter of eggs : 75  $\mu$ .

Testes colourless, thin, lying along the blood vessels. One half of the body cavity in long.

*Stage I.* Ovariums in the same length as stage O but greater in width. Granulation begins in the center of eggs, transparency decrease, nucleus disappear. Minimum and maximum diameter of eggs : 87.5-200  $\mu$ .

Testes whitish, has assumed a definite male gonad appearance. The same length as stage O but width increase.

*Stage II.* An increase in granulation of eggs. Among these pre-opaque eggs transparency eggs still often seen. Minimum and maximum diameter of eggs : 200-375  $\mu$ .

Testes whitish, 5-10 mm in width.

*Stage III.* Ovariums fill half of the body cavity. Eggs can be seen separately. Granulated, heavy granulated and opaque eggs together. Minimum and maximum diameter of opaque eggs : 375-650  $\mu$ .

Testes fill half of the body cavity, whitish.

*Stage IV.* Ovariums fill the body cavity entirely. Mostly opaque eggs can be seen in the ovarium but translucent (opaque eggs with hyaline walls) and transparent eggs with one oil globe can be observed. Minimum and maximum diameter of eggs : 625-1090  $\mu$ .

Testes white and sticky. Milts can be expressed with a little pressure.

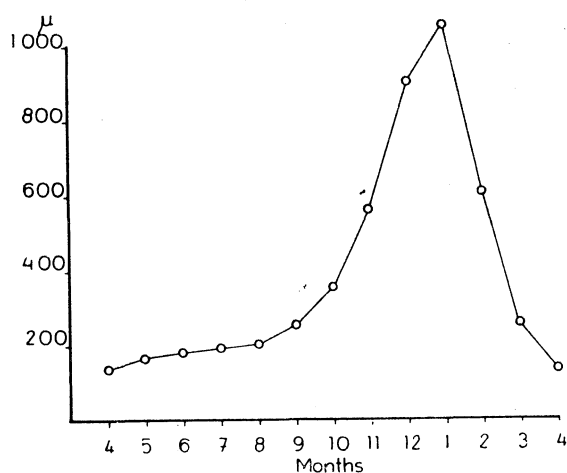


FIG. 6. — Monthly increasing in diameter of eggs of *M. chelo*.

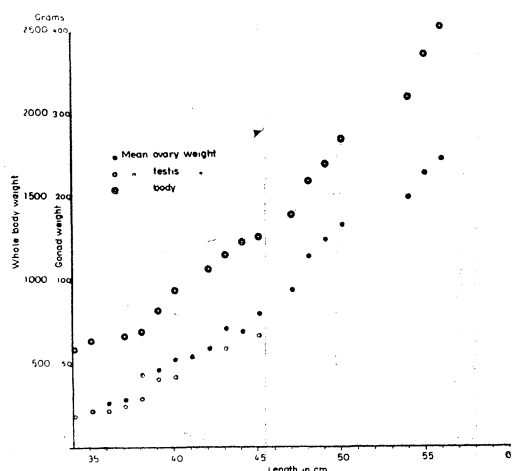


FIG. 7. — Whole Body Weight-Gonad Weight Relation on both sexes.

*Stage V.* Ovary flaccid, some residual eggs remain. Transparency eggs with a nucleus begin to increase again.

Testes flaccid, dirty milk in colour.

### Spawning time.

Smaller fish than 30 cm are characterized by small gonads for both sexes through the whole year. These are immature fish. In both sexes among mature fish we observed the stage I from april 1959 till october 1959. In females for the first time in the spawning season of 1959/60 we have observed pre-opaque eggs in october and opaque eggs in november. But on 17/XI/1959 we examined males between 36,5-37,5 cm in length and 22,2-26,3 g in weight of gonads in stage IV which means the beginning of the spending period for males. On 3/XII/1959 we examined females between 45-59 cm in length and 65-281 g in gonad weight in stage IV. During january and february we studied with 45 gonads in stage IV in two sexes. And we could be examined stage V for both sexes for the first time in the spawning period on 2/III/1960 and 17/III/1960. For females the stage V are changed between

Length (cm)	Female			Male		
	Number of Fish	Mean Gonad weight g	Gonasomatic Ratio	Number of Fish	Mean Gonad weight g	Gonasomatic Ratio
34				2	20.2	3.31
35				1	23.9	3.68
36	6	28.3	4.55	4	22.2	3.12
37	7	30.2	4.41	4	26.3	4.02
38	4	45.8	6.74	2	30.2	4.65
39	2	48.2	5.60	6	42.2	5.08
40	5	54.9	5.57	2	43.2	5.02
41	3	50.4	4.80			
42	2	60.5	5.26			
43	8	75.3	5.90	1	60.0	5.33
44				1	70.6	6.86
45	6	80.2	6.46			
46						
47	1	95.0	7.28			
48	3	130.5	8.88	1	87.0	7.25
49	5	150.3	9.11			
50	2	169.8	10.57			
51						
52	1	176.3	9.74			
53	3	200.3	10.78			
54	4	209.0	10.71			
55						
56	2	248.0	10.93			
57						
58						
59	1	281.0	11.29			

TABLE III. — Mean Weight of gonads in stage V and their gonasomatic ratio =  $\frac{100 \times \text{Gonad weights.}}{\text{Body weight}}$

36,5-58,0 cm and 3,8-17,2 g. in gonad weight which the gonads were completely in spent with flaccid ovary or just in the end of spending period. Male in stage V were between 36-43,5 cm in length and 1,2-11,2 g in gonad weight. In april many gonads showed

the beginning of stage I. But on 18/IV/1960 we observed one male fish 43 cm in length and 77,6 g in gonad weight which the gonad was a very typical one of the stage IV.

Connected with these stages of gonadal development increasing in the diameter of eggs through the spawning season, can be seen from figure 6, which there is a slow increasing in mean diameter of eggs between april 1959 and september 1959, changing between 160-225  $\mu$ . But from october to december 1959 the diameter of eggs have showed a rapid

Years	1	2	3	4	5	6	7	8	9	10	11	12	Total	%
1950				108	23	45	81	140	170	93	409	270	1318	1.3
%				8.0	1.7	3.3	6.0	10.4	12.6	6.9	30.5	20.1		
1951	892	1169	385	403	310	196	656	420	291	152	125	2626	7625	7.5
%	11.7	16.3	5.0	5.2	3.9	2.5	8.6	5.5	3.8	2.0	1.6	34.4		
1952	2965	751	1205	191	374	149	384	262	239	613	169	3867	11171	10.9
%	26.5	6.7	11.1	1.7	3.3	1.4	3.4	2.3	2.1	5.4	1.5	34.6		
1953	3486	3030	3803	2255	271	59	94	164	198	382	2645	11245	27635	27.1
%	12.6	10.9	13.7	8.1	0.9	0.2	0.3	0.6	0.7	1.3	9.5	40.6		
1954	1337	1549	8443	1523	332	64	158	362	445	209	247	701	15374	15.1
%	8.6	10.0	54.9	9.9	2.1	0.4	1.1	2.3	2.8	1.3	1.6	4.5		
1955	534	1629	367	194	200	170	135	145	167	368	190	267	4371	4.3
%	12.2	37.2	8.3	4.4	4.5	3.9	3.0	3.3	3.8	8.4	4.3	6.1		
1956	379	862	703	800	262	400	145	411	624	1418	972	1385	8363	8.2
%	4.5	10.3	8.4	9.5	3.1	4.7	1.7	4.9	7.4	16.9	11.6	16.5		
1957	2928	2695	972	884	331	131	104	319	402	408	445	2415	12037	11.8
%	24.3	22.3	8.0	7.3	2.7	1.0	0.8	2.6	3.3	3.3	3.6	20.0		
1958	649	1013	278	811	397	148	278	261	493	601	312	474	5817	5.7
%	1.1	17.4	4.7	13.9	8.5	2.5	4.7	4.4	8.4	10.3	5.3	8.0		
1959	707	1192	1850	1576	638	185	161	194	218	215	419	768	8123	7.9
%	8.7	14.6	22.7	19.4	7.8	2.2	1.9	2.3	2.6	2.6	5.1	9.4		

TABLE IV. — *Monthly landings of M. chelo at Çanakkale from 1950 to 1959.*

increase and the diameters have changed between 350-900  $\mu$ . The peak for the diameter of eggs is in january 1960 which the mean diameter was 1025  $\mu$  and from february 1960 to march 1960 there is a decrease in diameter of eggs which it means spawning. In april 1960 the mean diameter of eggs were again 125  $\mu$ , and all mature fish gonads were in stage I. (The individuals which are used for the purpose of measuring the diameter eggs were not uniform.)

According to the stages of gonads and the time of increasing and decreasing of diameter of eggs, showed that the period of sexual activity for *M. chelo* mainly extending from the beginning of december to the middle of march. But there were signs which revealed that spawning can be begin in november and prolonged to april. The indications from these results are : Males mature for the first time when they are 34 cm in length, and females 36 cm. It is impossible yet to say whether all fish mature at these lengths or some proportion of them delay their first maturity until the following year. And in our cases, we observed gonad of the males in the middle of november at stage IV and females in the same stage at the beginning of december. According to this situation males ripen first and females then. But this result needs more study chiefly because of the lack of the examining groups.

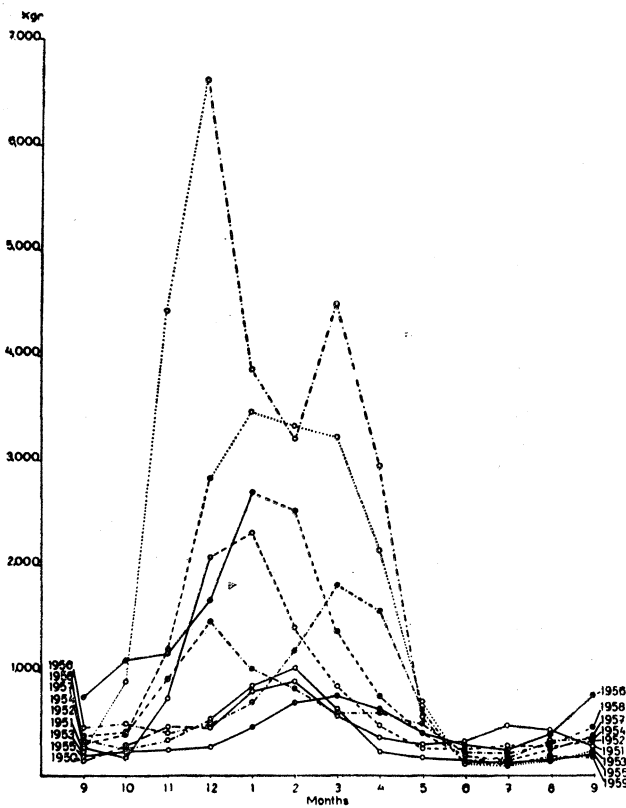


FIG. 8. — Seasonal occurrence of Mullet in Çanakkale fish market between the period of 1951-1959. (Graphs are smoothed values according to the formula of  $v = a + 2b + c$ .

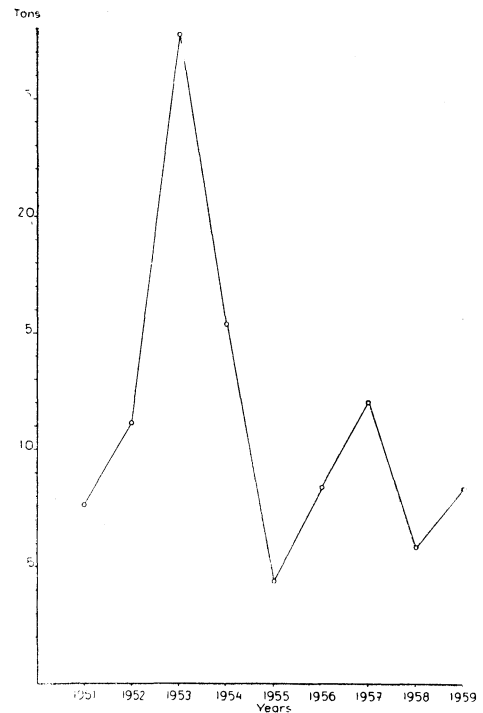


FIG. 9. — Alternative yearly occurrence of Mullet in Çanakkale waters during the period of 1951-1959.

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As it is seen from table III, gonads have shown an exponential relation to the length but the weight of mature gonads as a proportion of total weight increase slightly with body length. Because in firstly ripened fish, the weight of gonad is 20 % to the total weight and this ratio increase roughly to 10 % for the fish mature than once. Figure 7 reveals the increment of gonad weights in both sexes according to their whole body weight. As it is seen from the graph, female gonads are heavier than males when the fish becomes longer than 40 cm in length.

### Spawning area.

*M. chelo* has lived in coastal lagoons of Turkey. During the middle of autumn it begins to migrate for spawning from lagoons to the sea in dense shoals and the shoals



of travelling fish which contain mature fish appear in surroundings of Çanakkale in October. The weight evidence of gonads and the place of captured fish at Çanakkale and adjacent waters indicate that spawning of *M. chelo* occurred at sea rather near the coast during the beginning of winter. Because fish containing in their gonads both ripe and the spent stages are caught in coastal waters.

### Landing statistics.

The available Mullet statistics from Çanakkale fish market are for the years of 1950-1959 (table IV). The seasonal occurrence of mullets in Çanakkale waters can be seen from figure 8. The best fishing season for mullets are among the months of October and March. The shoals of *M. chelo* at these times of the year may consist of mostly mature, nearly ripe fish and their spawning migration begin from their fourth year. Between the months of May and October there is an obvious decrease in catching and the shoals at this time of the year mainly consist of immature *M. chelo*.

Figure 9 reveals the yearly alternative occurrence of Mullet in Çanakkale waters during the period of 1951-1959. According to this figure the worst fishing year is in 1955. From 1955 till 1959 there is an irregular decrease in Mullet catching. There is evidence from reports of fishermen that Mullet are becoming scarce. The statistics of Çanakkale are available from 1950. Inadequacy of statistics on the commercial fishery of Mullet have caused difficulties on the estimation of fluctuations. We do not know what was the history of the fishery prior to 1950. The answer of these questions is to be found only in fuller statistics.

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