THE GREY MULLET FISHERY OF LAKE BOROLLUS

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ABSTRACT

The total fish production of lake Borollus decreased gradually front 15,253 tons in 1966 to 12,898 tons in 1968. This marked decrease was probably due to the cessation of the fertile Nile water from reaching the lake, after the construction of the Aswan High Dam. In 1967, the total fish catch of lake Borollus was 13, 500 tons, of which the grey mullet constituted 16% (2125 tons) : of this *M. capito* was 1564 tons (73.5%), *M. cephalus* comprised 550 tons (26%) and *M. saliens* 11 tons (0.5%).

INTRODUCTION

The brackish shallow water lakes located at the northern perifery of the Nile Delta namely ; Manzala, Borollus, and Edku, form the most important fishing grounds in Egypt. Their importance has recently been considerably increased by the declination of the Egyptian Mediterranean sea fisheries that has resulted after the construction of the Aswan High Dam.

The coastal Delta lakes give about 60% of the total Egyptian fish production. The grey mullet contributes about 20% of the lake fisheries. Due to the importance of the mullet fishery, a research programme was started in 1967 to survey the mullet fishery of the Northern Delta lakes, and to gain information necessary for the management and development of such important fishery.

LAKE BOROLLUS

Lake Borollus is situated at the northern part of the Nile Delta. It is connected with the Mediterranean Sea by a strait (Boughaz El-Borollus). It receives fresh water supply from six drains and one fresh water canal, all of which join the lake at its southern part. The lake is about 465 km^2 (130000 feddans). Its depth varies between 0.5 & 2.0 metres. Due to its shallowness, the wind affects the movement of water and the degree of its transparency. The chlorosity of the lake water varies between 0.2% & 21%. It gradually increases from east, west and south to the north towards the lake-sea connection. The highest water temperature is recorded in August (29.1°C) while the lowest is in February (14.2°C).

The main fish species captured all over the year are the *Tilapia* and mullet species. The *Tilapia* fishery contributes about 65% and the mullet about 20% of the total fish catch of Lake Borollus. The distribution of fishes in the lake is greatly affected by the chlorosity variation. Out of the mullet species, only *Mugil capito* and *M. cephalus* survive all over the lake, while *M. saleins*, *M. auratus*, and *M. chelo* are found only at the lake-sea connection.

MATERIALS AND METHODS

The fish samples and hydrographic observations used in this study were collected from 10 stations distributed allover the lake. The water temperature was monthly recorded and the chlorosity was also determined at each station.

The biological data of mullet were collected monthly from the commercial catch, obtained either from the fishing boats, or from fish markets. A total number of 13107 fish were collected through a period extending from Jaunary, 1967 to March, 1968. The species composition of the collected fish was as follows :

Species	No. from fishing boats	No. from fish markets
Mugil cephalus . . .	2678 fish	5350 fish
Mugil capito	2131 ,,	1825 ,,
Mugil saliens . . .	447 ,,	456 ,,
Mugil auratus	26 ,,	85 ,,

The length and age composition of the mullet population in Lake Borollus was gained from random samples taken directly from the fishing boats. This is believed to be more representable than if the samples were taken from the fish markets. In the latter, sorting of fish into different size grades do not allow accurate estimation of the fish population.

Experimental fishing operations were carried out in both the open and vegetative areas. Different experimental trammel nets of mesh sizes 14, 16, 18 and 20 mm. are used in fishing mullet for the purpose of determining net selectivity.

A typical experimental trammel net is composed of three separate layers fastened together from above and below. To the upper and lower edges of the net, floats and weights are attached. The height of the net is 75 cm., and its length is 25 meters. The net is made of cotton fibres. Each set group of trammel nets was formed from two nets of the same mesh size.

A total number of 4365 fish were collected during the period of investigation. The number of fish captured according to different nets was as follows :

Trammel net mesh size (mm)	No. of fish captured
14	690
16	805
18	13212
20	1245
20 —fixed.	304

COMMERCIAL FISH CATCH

The main sources of data were taken from the fish catch received in the fish markets which are distributed allover the lake. These data were recorded daily by the coastguards and compiled monthly. At the end of the year the total quantity gives the total fish yield of the lake.

Unfortunately, the methods of recording the fish yield adopted by the coastaguards do not differentiate the species constituents. The fishes are mostly recorded under their generic names; thus the different *Tilapia* species are grouped under one category namely Bolti and the mullet catch is mostly grouped under two categories which are Tobar (*M. capito*) and Bouri (*M. cephalus*). It must also be mentioned that the mullet fish are generally grouped under these two categories according to their size and not according to their species. The big sizes are grouped under the name of Bouri, while the small sizes are grouped under the name of Tobar, regardles of their species.

Total mullet catch :

The total mullet catch of lake Borollus as compared with the total fish yield, together with that of the other two important Delta lakes (Manzala & Edku) during the period from 1962 to 1968 is shown in Table 1 (Egyptian Fishery statistics, 1962 — 1968). It is obvious that the percentage annual catch of mullet from lake Borollus varied, between 16 & 29% in the years from 1962 to 1967, before the complete construction of the Aswan High Dam. In Lake Edku, the total catch of mullet varied between 6 & 7%, while that of lake Manzala varied between 6 & 17%.

TABLE 1.—TOTAL FISH AND MULLET PRODUCTION (TONS) IN THE THREE DELTA LAKES IN THE PERIOD FROM 1962-1968.

(PERCENTAGES BETWEEN PARANTHESIS)

Year	Lake Manzala		Lake Borollus		Lake Edku	
	Total Fish Production	Total Mullet Production	Total Fish Production	Total Mullet Production	Total Fish Production	Total Mullet Production
1962	24808	2127 (16.6)	8228	2417 (29.2)	3514	243 (6.6)
1963	22570	2458 (10.9)	8756	2471 (28.3)	4542	382 (8.4)
1964	24880	1492 (6.0)	10234	2439 (23.9)	7100	476 (6.7)
1965	25638	1505 (5.9)	10525	2560 (23.4)	7476	516 (6.9)
1966	27188	1554 (5.7	15253	3463 (21.6)	5740	350 (6.1)
1967	27740	2060 (7.4)	13515	2125 (15.8)	5106	132 (2.6)
1968	26980	1957 (7.3)	12898	1973 (15.3)	5100	122 (2.4)

TABLE 2.—SEASNOAL PRODUCTION OF MULLET (TONS) IN LAKE BOROLLUS.

Year	Winter		Spring			Summer			Autumn	
	M. cap.	M. ceph.	M. cap.	M. ceph.	M. sal.	M. cap.	M. ceph.	M. sal.	M. cap.	M. ceph.
1962	250	92	270	123	4.6	446	283	5.4	698	245
1963	275	120	250	143	4.3	415	299	5.7	703	285
1964	613	203	284	159	3.4	231	243	4.6	439	211
1965	296	120	321	148	5.6	421	284	7.5	683	275
1966	342	118	396	119	6.6	544	402	8.5	1075	276
1967	251	98	281	73	4.8	382	217	6.2	650	163
1968	251	73	219	50	4.9	373	181	6.1	661	157

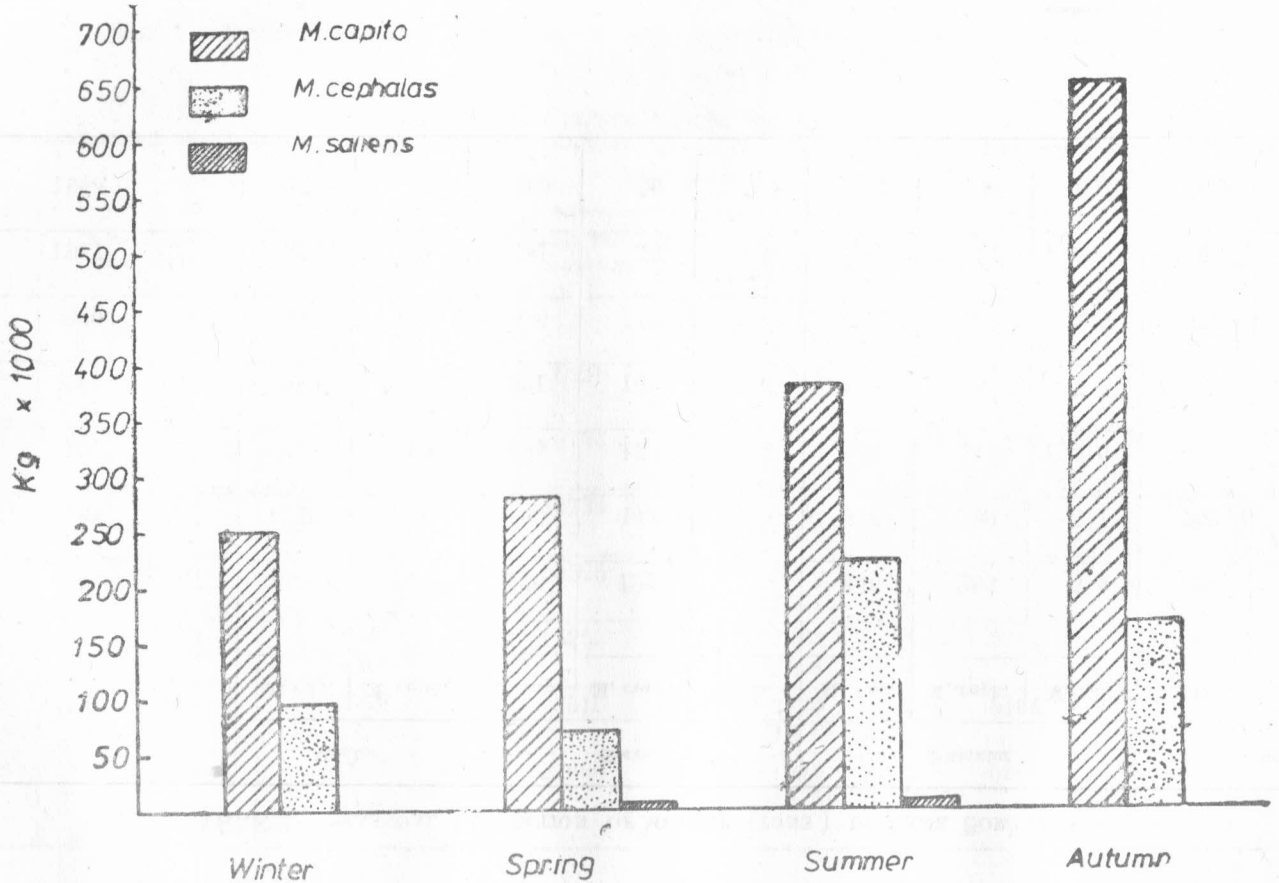

Fig. (1).—Seasonal production of grey mullet from lake Borollus during 1967.

The cessation of the Nile flood to pour into the lakes began from the autum of 1967. The total mullet catch of lake Borollus dropped from 16% in 1967 to 15% in 1968. It is clear that the cessation of the fertile water has some effects upon the total fish catch of 1968, as well as upon the total fish catch of 1967 (the year of flood cessation). The difference between the total catch of 1966 & 1967 in lake Borollus was 6%, in lake Edku was 3%, while there was no observed change in the catch of lake Manzala.

In order to analyse the mullet catch of the lake into the different species components, the most imporatnt fish markets were put under observation (about 20 fish shops), and an average of four of them are chosen for sampling daily so that the catch of each market was analysed to its species constituents about eight times monthly. This was carried out for one complete year (January-December, 1967), and it was possible to estimate the catch of the grey mullet under its three most important species, namely : *M. capito*, *M. cephalus* and *M. saliens*. The total fish catch of lake Borollus in 1967 was 13500 tons, of which the grey mullet constituted 2125 tons (16%); of this, *M. capito* was 1564 tons (73.5%), *M. cephalus* comprised 550 tons (26%), and *M. saliens* 11 tons (0.5%). Other mullet species were neglected due to their small amounts which can not affect the total fish yield.

Seasonal fluctuation of the mullet catch :

The total catch of the three important mullet species in lake Borollus is subjected to seasonal variations. These are shown in Table (2) and graphically represented by the histograms (Fig. 1). From the table and graph it is obvious that the flourishing of each species in the catch is generally connected with its sexual maturity.

M. capito is dominant in the mullet catch throughout the year. When the fish is fully ripe, it swarms and migrates from the lake to the sea. Its accessibility in the nets operating in the lake greatly increases in November and December when the fish is sexually ripe. The catch was about 650 tons in Autumn, and this was equal three times its production in any others season.

The breeding season of *M. cephalus* is rather long, extending from June to September, hence its production reached a maximum during summer, represented by nearly 216 tons as compared with 70 tons or less in other seasons.

The fishery of *M. saliens* extends from late Spring to the beginning of Autumn, but a maximum fishing is recorded in September (6 tons). During that interval the fish leaves the area of the lake-sea connection where it is localised and migrates to the sea.

TABLE 3.—LENGTH FREQUENCY DISTRIBUTION OF THE DIFFERENT MULLET SPECIES FROM THE FISHING BOATS DURING 1967.

Length (mm)	M. capito		M. cephalus		M. saliens		M. auratus	
	No.	%	No.	%	No.	%	No.	%
100	7	0.3	9	0.3	4	0.7	—	—
110	3	0.1	11	0.4	7	1.3	—	—
120	21	1.0	18	0.7	9	1.7	—	—
130	61	2.9	35	1.3	24	4.5	—	—
140	143	6.6	42	1.6	36	6.7	—	—
150	226	10.5	58	2.2	45	8.4	1	3.8
160	315	14.6	94	3.5	62	11.5	2	7.7
170	323	15.0	119	4.4	77	14.3	2	7.7
180	220	10.2	165	5.5	76	14.1	4	15.4
190	262	12.1	205	7.6	77	14.3	4	15.4
200	114	5.3	277	10.3	45	8.4	5	19.2
210	109	5.1	299	11.1	21	3.9	3	11.5
220	89	4.2	349	13.0	18	3.3	2	7.7
230	97	4.5	378	13.1	18	3.3	2	7.7
240	84	3.8	208	7.7	12	2.2	1	3.8
250	23	1.1	149	5.5	5	1.0	—	—
260	22	1.0	77	2.9	2	0.4	—	—
270	12	0.6	59	2.2	—	—	—	—
280	4	0.2	38	1.4	—	—	—	—
290	4	0.2	29	1.1	—	—	—	—
300	5	0.2	22	0.8	—	—	—	—
310	4	0.2	22	0.8	—	—	—	—
320	2	0.1	18	0.7	—	—	—	—
330	—	—	17	0.6	—	—	—	—
340	2	0.1	17	0.6	—	—	—	—
350	—	—	12	0.4	—	—	—	—
360	—	—	6	0.2	—	—	—	—
370	—	—	8	0.2	—	—	—	—
380	—	—	2	0.1	—	—	—	—
390	—	—	2	0.1	—	—	—	—
400	—	—	1	0.05	—	—	—	—
Total	2131	—	2687	—	538	—	26	—

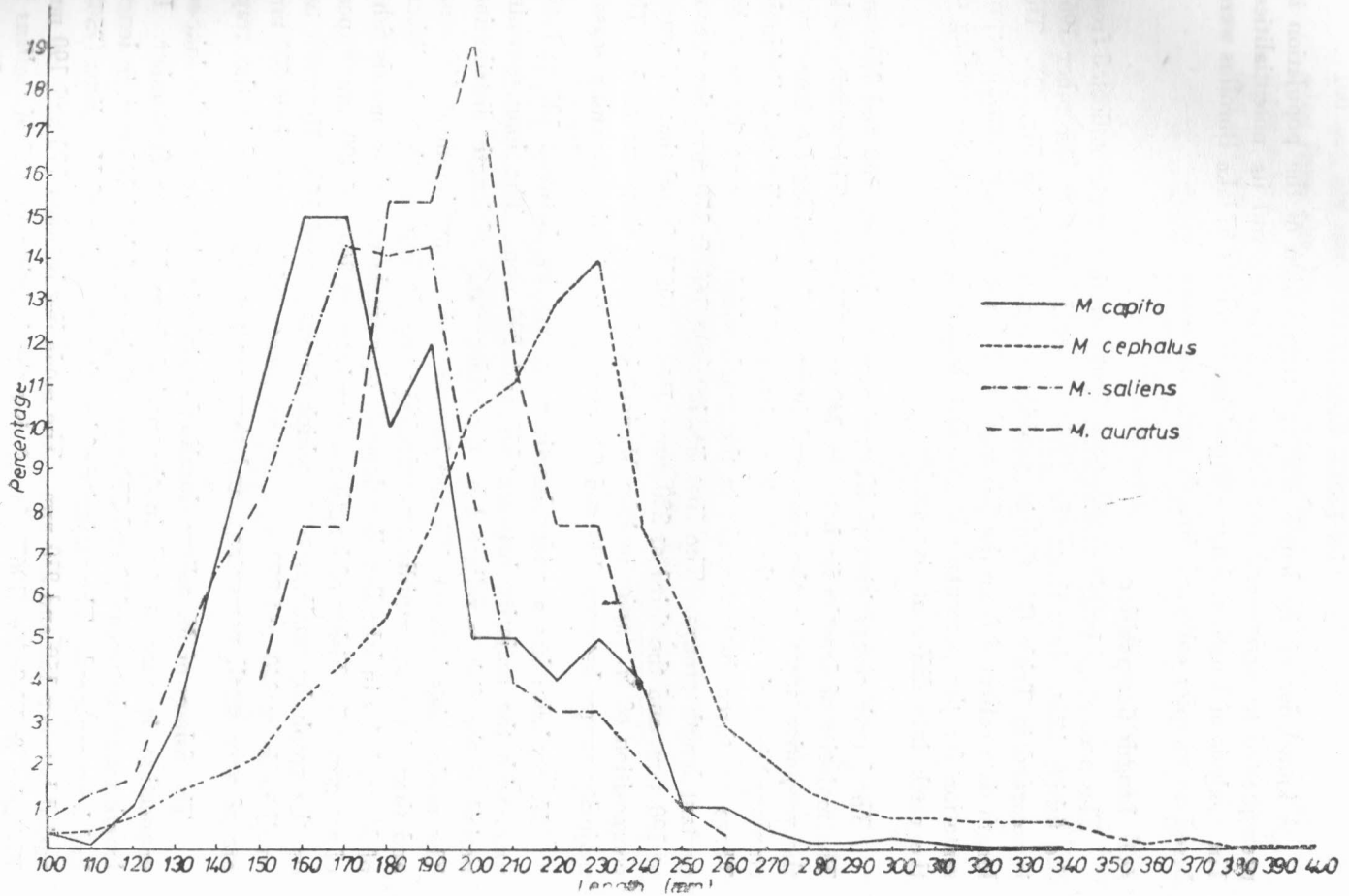

Fig. (2).—The length frequency of the different mullet species from the fishing boats in Lake Barollus during the period of investigation.

LENGH AND AGE COMPOSITION OF MULLET IN LAKE BOROLLUS

A knowledge of the length and age composition of the population is prerequested to understand any commercail fishery and its potentialities. The analysis of length and age composition of mullet in lake Borollus were based on samples collected directly from the fishing boats.

(a) Length Composition

The percentage length composition of the mullet species collected from the fishing boats throughout the period from January to December 1967 is recorded in Table (3), and is graphically represented in Fig. (2). The length data collected from the fish markets did not give any accurate representation for the percentage length distribution because of the sorting of the catch into different size grades.

The length composition of *M. capito* ranges between 100 and 340 mm. The majority of lengths lie between 140 and 250 mm. This species seeks the vegetative areas in the lake, and because of the illegal trammel nets employed in such areas, the catch consists mostly of small size individuals. There are three distinct peaks in the graph which represent the most important length groups. The first lies between 160 & 170 mm, the second at 190 mm. and the third at 230 mm. Paget (1921) found that the length composition of *M. capito* in lake Mariout had more than one mode. The majority ranges between 100 and 230 mm. except in the spawning season.

M. cephalus has a wider length range varying between 100 and 440 mm., with the majority between 150 and 290 mm. The long spawning period of the fish is reflected by the wider range of length distribution. The mode exists between 200 and 240 mm. with a maximum at 230 mm., and then decreases rapidly towards 260 mm. It appears that the fishery of *M. cephalus* in lake Borollus depends on a single year class, mostly fishes ef age group I. Fishes of length ranging between 300 and 400 mm. appear on the groph by small amounts, which do not exceed 1%. However, two small peaks at 340 and 370 mm. are apparent. Fishes more than 400 mm. are of very small percentage, and they are not represented in the graph

The fishery of *M. saliens*, localised mainly in the area of the lake-sea connection, is concentrated in the period from May to September. Its length ranges between 100 and 270 mm. Only one fish of 302 mm. in length had been captured. The majority of length compostion of *M. saliens* (75%) varied between 150 and 210 mm. The mode lies between 170 and 190 mm. El-Zarka & El-Sedfy (1967) found that the length range of *M. saliens* in lake Quarun lies between 140 and 250 mm., but the majority ranges between

160 and 180 mm. Rafail (1968) studied the *M. saliens* collected by beach seine from the Egyptian Mediterranean water and found that there were three modes at 130, 175 and 215 mm. in the length range recorded which lied between 100 and 250 mm.

M. auratus collected by the cast nets at the lake-sea connection has a length range of 150-240 mm. with a mode at 200 mm. Its presence in the deep channel at the lake-sea connection, where the water current is stronger, makes its fishing difficult, except for trawling. It is thus difficult to regard this data as representing the true length distribution of *M. auratus* in lake Borollus.

(b) **Age Composition :**

The study of age groups of mullet population in lake Borollus was based on samples collected throughout the year 1967. The percentage composition of the age groups of the mullet species is given in Table (4), and is graphically represented in the histograms (Fig. 3).

TABLE (4) — AGE COMPOSITION OF MULLET SPECIES IN LAKE BOROLLUS DURING 1967

Age group	*M. capito*		*M. cephalus*		*M. saliens*		*M. auratus*	
	No.	%	No.	%	No.	%	No.	%
0	171	8.0	115	4.6	44	7.9	—	—
I	1804	84.8	2467	91.6	475	85.5	25	96.0
II	148	6.9	105	3.9	18	4.3	1	4.0
III	8	0.3	—	—	1	2.3	—	—
Total	2131	—	2678	—	538	—	26	—

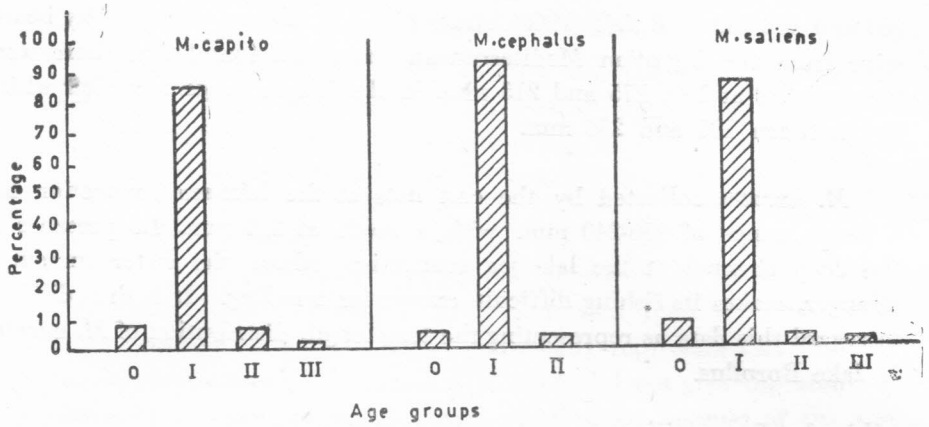

Fig. (3).—The Age composition of the different mullet species from the fishing boats in Lake Borollus during the period of investigation.

It is obvious that the fishery of these species depends all the year round on fishes of age group I which dominate the catch (more than 80%). The percentage occurrence of the small age groups increases in the catch after the spawning season of the species. Thus it increases in autumn for *M. cephalus*, and in winter for *M. capito*. The appearance of *M. saliens and M. auratus* at the lake-sea connection is confined to a short time of the year. On the other hand, the percentage of age group II of *M. capito* increases during the spawning migration, *i.e.*, in autumn, while age group II of *M. cephalus* only appears in the catch in summer.

MONTHLY LENGTH FREQUENCY DISTRIBUTION OF MULLET IN LAKE BOROLLUS

1.—*Mugil capito* :

Since it was found that there is no appreciable difference between the length frequency of males and females, the length frequency distribution of *M. capito in* lake Borollus was based on data of the two sexes combined. The data covering a period of 12 months (from January to December, 1967) are given in Table (5), and graphically represented in Fig. (4).

From the graph, it is obvious that the population of the small size individuals shows a clear modal distribution in January, February and March. These smaller size groups, well represented in those months, could be regraded as the immature fish which remains in the lake after the spawning migration of the mature fish to the sea in the previous autumn. In March, the large fishes of 210 &240 mm., shown in the graph, may represent the returned mothers after performing their spawning in the sea.

TABLE 5.—LENGTH FREQUENCY OF *Muqil capito* IN LAKE BORLLUS DURING 1967.

Length (mm)	January		February		March		April		May		June		July		August		September		October		November		December	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
140	8	2.5	11	2.4	16	6.2	13	3.9	19	5.8	4	0.8	2	0.6	18	4.7	12	3.7	8	1.5	8	1.6	15	4.6
150	73	22.8	89	19.8	52	20.2	26	8.0	29	8.8	22	4.5	14	3.9	30	7.8	33	10.3	26	4.8	21	4.2	56	17.3
160	97	30.3	219	28.7	61	23.6	98	30.0	44	13.3	40	8.1	12	3.2	38	9.8	38	11.8	70	12.9	35	7.1	59	18.3
170	67	20.9	114	25.8	79	30.0	88	27.0	30	9.1	69	14.0	26	7.3	41	10.6	34	10 6	70	12.9	38	7.7	55	17.0
180	48	15.0	59	13.1	30	11.6	56	17.1	94	28.5	91	18.5	48	13.6	46	11.9	36	11.2	64	11.8	60	12.1	42	13.0
190	16	5.0	25	5.6	7	2.7	33	10.1	34	10.3	80	16.3	101	28.5	75	19.4	64	19.9	53	9.8	58	11.7	19	5.9
200	9	2.8	14	3.1	3	1.1	9	2.8	18	5.5	106	21.5	41	11.6	53	13.7	9	2.9	42	7.8	62	12.5	10	3.1
210	2	0.6	6	1.2	7	2.7	—	—	—	—	30	6.1	47	13.3	42	10.9	22	6.9	60	11.1	50	10.1	18	5.6
220	—	—	2	0.2	—	—	1	0.3	12	3.6	21	4.3	20	5.6	11	2.8	30	9.3	50	9.2	36	7.3	6	1.9
230	—	—	—	—	1	0.6	—	—	—	—	6	1.2	23	6.7	15	3.9	20	6.2	28	5.2	42	8.5	15	4.6
240	—	—	—	—	1	0.6	1	0.3	4	1.2	13	2.6	14	3.9	12	3.1	15	4.7	17	3.1	25	5.0	8	2.5
250	—	—	—	—	—	—	—	—	8	2.4	6	1.2	2	0.6	2	0.5	2	0.6	19	3.5	33	6.7	7	2.2
260	—	—	—	—	—	—	—	—	8	2.4	2	0.4	2	0.6	3	0.8	4	1.2	10	1.8	12	2.4	6	1.9
270	—	—	—	—	1	0.6	2	0.6	8	2.4	—	—	—	—	—	—	—	—	10	1.8	9	1.8	4	1.2
280	—	—	—	—	—	—	—	—	14	4.2	2	0.4	2	0.6	—	—	2	0.6	12	2.4	2	0.4	2	0.6
290	—	—	—	—	—	—	—	—	6	1.9	—	—	—	—	—	—	—	—	2	0.4	4	0.8	1	0.3
300	—	—	—	—	—	—	—	—	2	0.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	320	—	449	—	258	—	327	—	330	—	492	—	354	—	386	—	321	—	541	—	495	—	323	—

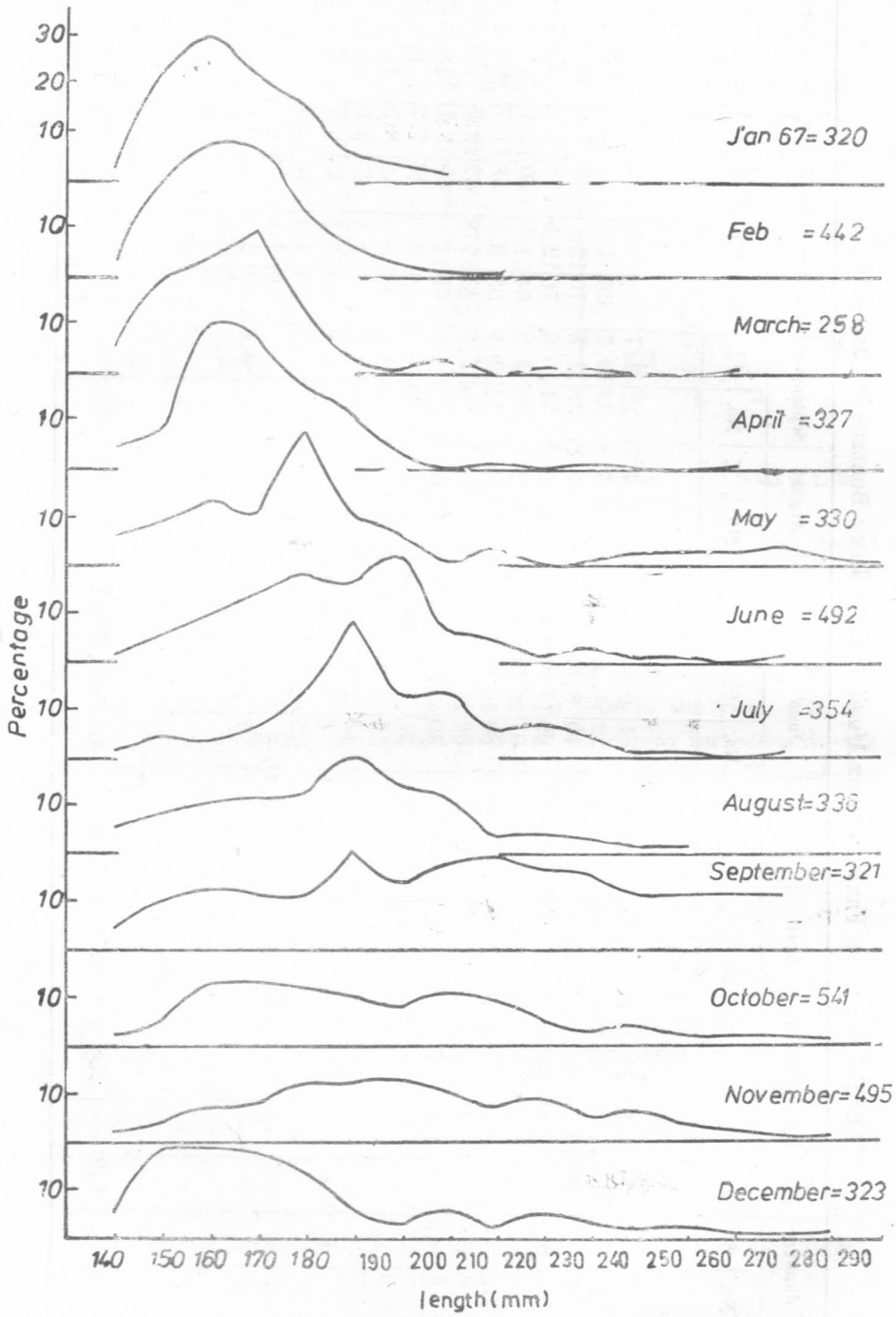

Fig. (4).—The length frequency of *Mugil capito* in Lake Borollus during 19 .

The prominent peak which is obvious until June, smooth down to be replaced by other modal peaks in July and August at 190, 200 and 220 mm. This is due to the increase in the water temperature and the movement of the fish from the vegetative areas to the open water.

In September, all the length groups are well represented in the samples due te extensive fishing, so that there is no well identified modal distribution of length groups. The mature fish starts to swarm in the open water, coincident with the ripeness of its gonads. In October and November, the older length groups not only loose their modal identity but also decrease in number, since they migrate to the sea. In December, a well developed mode of younger individuals at 150—170 mm. appears repeating the same condition as in January.

It is possible to follow the monthly growth increment of length from the shift in the modal distribution of the length frequency. Starting from the mode of January at 160 mm., it shows a slight increase until April (170 mm). In May, the significant increase in the value of mode is very clear and reaches 190 mm. In June and July, further pronounced increases in the mode value also take place (200 and 210 mm. respectively). In the mean time, the growth of the juvenile fish could be detected from other modes at 165, 180 and 190 mm. in May, June and July respectively.

2.—*Mugil cephalus* :

The length frequency distribution of *M. cephalus* in lake Borollus for the year 1967 is given in Table (6) and graphically represented in Fig. (5). As has been observed for all the mullet species, it was found that the spawning season controls all the movements and the presence of the species in the lake.

Rather prominent modes of small fish are represented in January, February, March and April. They represent young immature individuals in which the monthly increment of growth in length is very small. In May the small immature fish are still represented in the samples.

The summer catch exhibits an increase in the percentage of large fishes. In June large mature fishes appear mixed with smaller fishes and they from a distinct but small mode at 300 and 320 mm. These large mature fishes persist in July, August and September, while the smaller individuals decrease considerably, because fishing is concentrated at that period on the larger mature fish swarming in the lake. They represent the fully ripe individuals leaving the lake to spawn in the sea. From October till December, the younger individuals appear in the catch again.

TABLE 6.—Monthly Length Frequency Distribution of

Length (mm)	January		February		March		April		May		June	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
100	1	1.2	7	3.5	4	1.8	2	0.5	2	0.9	4	1.3
110	2	2.3	18	8.9	7	3.2	17	4.3	7	2.2	3	1.0
120	2	2.3	28	13.8	13	5.7	21	5.3	18	8.3	8	2.5
130	7	8.0	30	14.9	17	7.4	38	10.0	14	6.5	29	9.1
140	5	5.7	33	16.3	24	10.4	42	11.3	12	5.6	15	4.7
150	12	14.0	29	14.4	32	9.6	32	8.0	5	2.3	13	4.1
160	6	6.8	12	6.0	36	15.6	52	13.0	8	3.7	7	2.2
170	5	5.7	9	4.5	20	8.7	34	8.5	5	2.3	23	7.2
180	2	2.3	14	7.0	2	0.9	12	3.0	4	1.9	19	6.0
190	2	2.3	3	1.5	9	3.5	10	2.5	4	1.6	22	6.9
200	2	2.3	3	1.5	7	3.3	5	1.3	10	4.6	36	11.3
210	1	1.2	3	1.5	7	3.3	22	5.5	13	6.0	17	5.3
220	—	—	3	1.5	12	5.2	8	2.0	24	11.1	10	3.3
230	3	3.4	2	1.0	11	4.8	26	6.5	23	10.6	11	3.4
240	2	2.3	1	0.5	11	4.8	10	2.5	12	5.6	12	3.8
250	2	2.3	1	0.5	3	1.2	4	1.0	13	6.0	8	2.5
260	2	2.3	2	1.0	4	1.7	16	4.0	8	3.7	5	1.6
270	1	1.2	—	—	3	1.2	5	1.3	7	2.2	3	1.0
280	3	3.4	1	0.5	3	1.2	3	0.8	6	2.2	4	1.3
290	2	2.3	—	—	4	1.8	1	0.5	6	2.2	8	2.5
300	1	1.2	1	0.5	1	0.5	8	2.0	1	0.5	15	4.7
310	5	5.7	1	0.5	2	1.0	3	0.8	2	1.0	15	4.7
320	1	1.2	—	—	6	2.6	3	0.8	1	0.5	10	3.1
330	4	4.6	1	0.5	2	1.0	3	0.8	2	1.0	8	2.5
340	3	3.4	—	—	1	0.5	4	1.0	2	1.0	2	0.6
350	1	1.2	—	—	—	—	2	0.5	1	0.5	2	0.6
360	4	4.6	—	—	—	—	2	0.5	1	0.5	2	0.6
370	1	1.2	—	—	—	—	1	0.3	1	0.5	3	0.9
380	2	2.3	—	—	—	—	3	0.8	1	0.5	2	0.6
390	—	—	—	—	—	—	3	0.8	1	0.5	2	0.6
400	1	1.2	—	—	—	—	2	0.5	2	1.0	1	0.3
410	—	—	—	—	—	—	—	—	—	—	1	0.3
420	2	1.2	—	—	—	—	—	—	—	—	—	—
430	—	—	—	—	—	—	—	—	—	—	—	—
404	1	1.2					1	0.3	—	—	—	—
450	—	—	—	—	—	—	—	—	—	—	—	—
460	—	—	—	—	—	—	—	—	—	—	—	—
470	—		—	—	—	—	—	0.3	—	—	—	—
							1					
Total .	88	—	202	—	231	—	934	—	216	—	320	—

Mugil cephalus IN LAKE BOROLLUS DURING THE YEAR 1967.

July		August		September		October		November		December	
No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
—	—	—	—	—	—	—	—	3	1.3	—	—
—	—	—	—	—	—	3	0.9	3	1.3	1	1.3
—	—	—	—	—	—	2	0.6	5	2.1	—	—
—	—	—	—	—	—	11	3.3	7	3.0	4	5.1
—	—	—	—	3	0.9	24	7.2	8	3.4	6	7.7
13	3.8	15	3.7	2	0.6	11	3.3	13	6.5	5	6.4
16	4.7	13	3.2	7	2.0	5	1.5	34	14.3	5	6.4
12	3.5	16	4.0	9	2.6	8	2.4	19	8.0	4	5.1
8	2.3	18	4.0	8	2.2	10	3.0	13	5.5	4	5.1
14	4.1	14	3.5	3	0.9	14	4.2	9	3.8	—	—
10	3.0	18	4.4	8	2.2	26	8.2	8	3.4	—	—
10	3.0	27	6.7	9	2.6	18	5.4	3	1.3	—	—
7	2.1	15	3.7	14	3.9	13	3.9	8	3.4	—	—
4	1.2	13	3.2	9	2.6	2	0.6	9	3.8	—	—
11	3.2	12	3.0	19	5.4	9	2.7	2	0.8	7	9.6
11	3.2	18	4.4	29	9.0	3	1.0	9	3.8	16	20.0
21	6.2	24	5.9	4	1.1	7	2.1	9	3.8	12	15.4
15	4.4	12	3.0	2	0.6	8	2.4	10	4.2	3	3.9
10	2.9	10	2.5	18	5.1	3	0.9	15	6.3	1	1.3
10	2.9	5	1.3	13	3.7	14	4.2	15	6.3	3	3.8
10	2.9	7	1.7	9	2.6	15	4.5	14	5.9	1	1.3
25	7.3	6	1.5	24	6.8	25	7.5	5	2.1	2	2.6
15	4.5	1	0.4	13	3.7	14	4.2	3	1.4	—	—
12	3.5	9	2.2	8	2.2	9	2.7	2	0.8	—	—
7	2.1	18	4.4	14	3.8	14	4.2	1	0.4	—	—
12	3.5	23	5.7	4	1.1	22	6.6	5	2.1	1	1.3
9	2.6	27	6.7	14	3.9	9	2.7	2	0.9	1	1.3
8	2.3	18	4.4	14	3.8	12	3.6	1	0.4	—	—
7	2.1	13	3.2	21	6.0	10	3.0	1	0.4	—	—
9	2.6	12	3.0	24	6.8	4	1.2	1	0.4	1	1.3
9	2.6	9	2.2	17	4.8	3	0.9	1	0.4	1	1.3
17	5.0	7	1.7	13	3.7	4	1.2	1	0.4	—	—
9	2.6	6	1.5	4	1.1	—	—	—	—	—	—
13	3.8	8	2.0	4	1.1	—	—	—	—	—	—
7	2.1	3	1.0	8	2.2	—	—	—	—	—	—
—	—	3	1.0	3	1.0	—	—	—	—	—	—
—	—	2	0.6	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
341	—	405	—	351	—	332	—	238	—	78	—

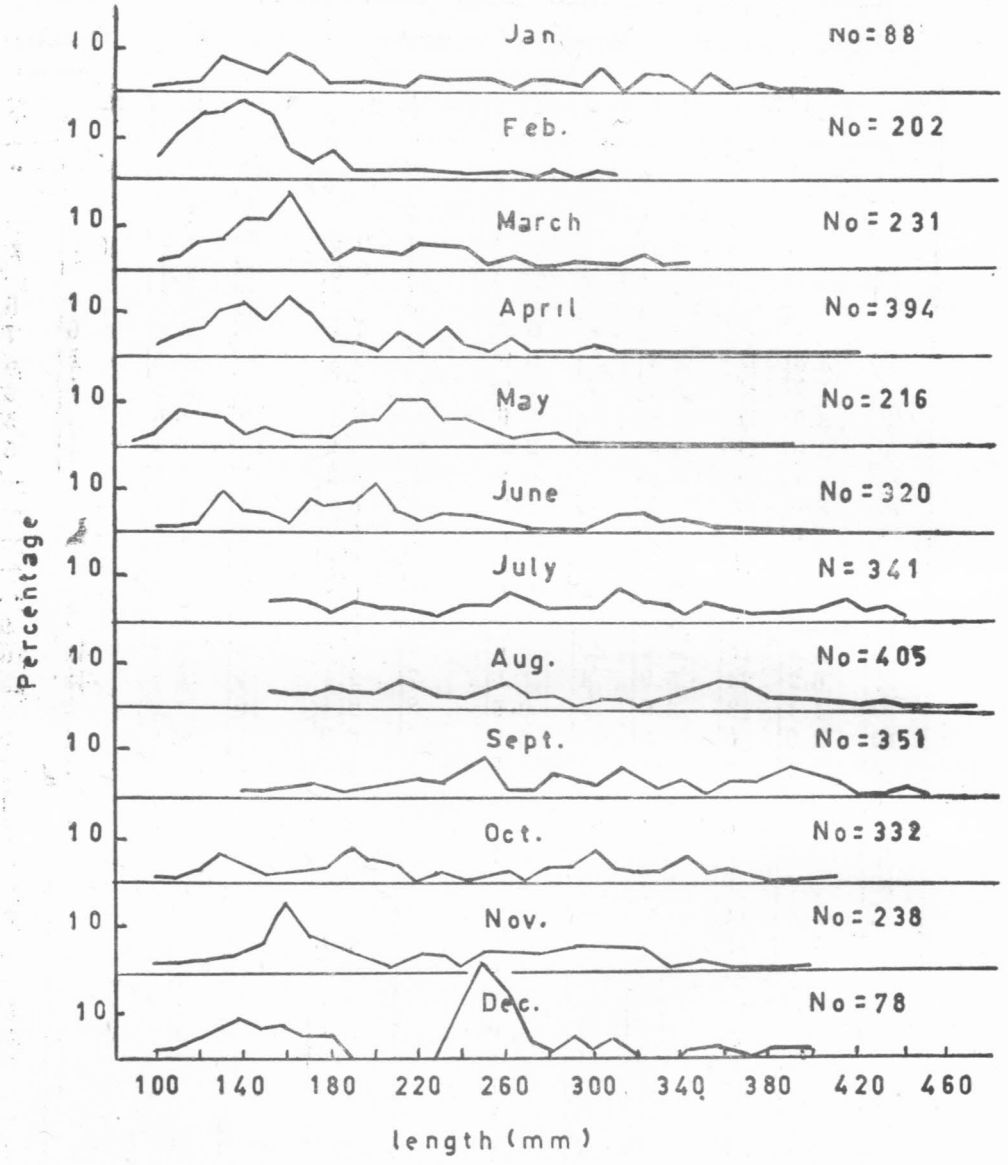

Fig. (5).—The length frequency of *Mugil cephalus* in lake Borollus during 1967.

TABLE 7.—LENGTH FREQUENCY OF MULLET SPECIES CAPTURED BY THE EXPERIMENTAL TRAMMEL NET 20 MM

Length (mm)	Open water				Vegetative water			
	M. capito		M. cephalus		M. capito		M. cephalus	
	No.	%	No.	%	No.	%	No.	%
140	4	4.59	11	2.25	16	2.61	4	4.12
150	5	5.74	27	6.02	33	5.38	4	4.12
160	10	11.48	24	5.36	57	9.29	7	7.21
170	13	14.94	29	6.47	92	15.01	13	13.04
180	16	18.39	44	9.80	98	15.98	24	24.74
190	11	12.64	33	7.35	98	15.98	16	16.49
200	7	8.04	45	10.04	73	11.90	10	10.30
210	5	5.74	38	8.48	59	9.62	6	6.15
220	4	4.59	40	8.92	46	7.50	6	6.15
230	3	3.44	33	7.35	19	3.10	3	3.08
240	3	3.44	28	6.25	11	1.79	2	2.05
250	2	2.29	35	7.81	4	0.65	1	1.03
260	1	1.17	18	3.96	2	0.34	1	1.03
270	1	1.17	12	2.64	1	0.17	—	—
280	1	1.17	9	1.98	1	0.17	—	—
290	1	1.17	8	1.79	1.	0.17	—	—
300	—	—	6	1.32	1	0.17	—	—
310	—	—	5	1.35	1	0.17	—	—
320	—	—	3	0.66	—	—		—
Total . . .	87	—	448	—	613	—	97	—

It is difficult to follow the monthly growth increment from the graph, because of the less distinct length groups represented in it.

3.—*Mugil saliens* :

It is difficult to assess the monthly length distribution pattern for *M. saliens*, since the fish is confined to the area of the lake-sea connection, and its stay is short (from May to September). From the observations recorded for the catch collected, it was found that the unimodal distribution is represented in the whole catch. It is characterized by two distinct size groups, the first is nearly at 150 mm., and the second at 190 mm. These two values may characterise two distinct broods for the fish, which breeds twice, one in spring and the other in Autumn.

EXPERIMENTAL FISHING WITH NETS OF VARIOUS MESH-SIZES IN DIFFERENT AREAS

From the analysis of the catch captured by the net of 20 mm. mesh size, it was found that the percentage composition of any catch of mullet depends on the nature of the station in which fishing takes place. The total catch captured by the 20 mm. net in the open and vegetative areas is recorded in Table (7).

In the open water, *M. cephalus* forms the major constituent (82%), while *M. capito* comes next (16%). *Tilapia* species which were entangled in the lower pockets of the net gives (2%). The catch collected by the same net from the vegetative areas gave opposite results. *M. capito* is the dominant species with 83%, while *M. cephalus* gives 13%. The *Tilapia* species entangled in the lower part of the net constitutes 4%.

The minimum length captured by this net was 140 mm, which is the minimum legal length for mullet in lake Borollus. The big sizes of the meshes give the chance for fishes of small sizes to escape and in turn rises the efficiency of the net for big fishes.

When several sets of nets of the wide mesh size are operating together, the catch increases considerably. This is frequently done during the migration season by the local fishermen in the following manner: Four boats operate setting their nets to form a semiclosed circle. Two boats remain inside the circle with men beating the water by sticks to frighten the fish, and so it dashes towards the nets. The other two boats stay outside the circle ready for collecting the nets.

TABLE 8.— LENGTH FREQUENCY OF MULLET CAPTURED BY EXPERIMENTAL TRAMMEL NETS OF DIFFERENT MESH SIZES

Length (mm)	Trammel net 18 mm				Trammel net 16 mm				Trammel net 14 mm			
	M. capito		M. cephalus		M. capito		M. cephalus		M. capito		M. cephalus	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
90	—	—	—	—	—	—	—	—	—	—	6	5.35
100	—	—	—	—	46	6.49	—	—	64	11.07	7	6.25
110	32	2.99	9	4.24	118	16.66	5	5.15	111	19.20	22	19.74
120	83	7.54	21	9.9	173	24.43	13	13.14	183	31.66	36	32.10
130	149	13.54	36	16.98	226	31.92	18	18.55	99	17.12	18	16.05
140	174	15.89	41	19.33	89	12.57	25	25.77	68	11.76	12	10.70
150	311	28.27	57	26.88	31	4.37	19	19.58	35	6.05	7	6.25
160	182	16.54	23	18.84	19	2.68	12	12.37	18	3.14	4	3.56
170	97	8.89	11	5.18	6	0.88	5	5.44	—	—	—	—
180	20	1.89	7	3.3	—	—	—	—	—	—	—	—
190	14	1.47	3	1.4	—	—	—	—	—	—	—	—
200	12	1.29	2	0.94	—	—	—	—	—	—	—	—
210	7	0.68	1	0.5	—	—	—	—	—	—	—	—
220	6	0.55	1	0.5	—	—	—	—	—	—	—	—
230	1	0.20	—	—	—	—	—	—	—	—	—	—
Total	1100	—	212	—	708	—	97	—	578	—	112	—

Trammel nets of mesh sizes 18, 16 and 14 mm. cannot work in the open water because they depend mainly on fishes of small sizes which are usually found in the vegetative areas. More lead is added to the lower line so that the net can presist the pressure of the weeds and stand vertically in the water.

From Table (8) it is evident that more than 78% of the total catch captured by the 18 mm. net belongs to *M. capito*, 15% to *M. cephalus* and 6% to *Tilapia* species. More than 66% of the total *M. capito* catch are of small size fish less than 150 mm., while in the case of *M. cephalus* it was found that 85% of the catch has small sizes (less than 160 mm.).

The results obtained from the nets of 16 and 14 mm. mesh sizes, gave even smaller lengths than those captured from the previous 18 mm. net. The smallest length of mullet captured by these nets is 90 mm., and more than 90% of the total catch is less than 150 mm. The blocking of the meshes of the nets by the small size fishes prevents it from capturing big sizes.

The operation of the trammel net in the normal way by setting it freely in the water, is diffictlt in the area at lake-sea connection due to the rapidly flowing currents. Modification of this net was tried by decreasing its height to 40 cm., and not using cork and lead. The whole net was fixed by bamboo in a circular trap with the lower line embedded at the bottom. The net was connected with a straight set of one layer net fixed also on bamboo. The two nets were of 20 mm mesh. The catch captured by this net is shown in Table (9). From the results obtained, it was found that 80% were of *M. saliens*, 12% of *M. capito* and 8% *M. cephalus*. This net was operotes in the period from May to September.

The mullet catch is not evenly distributed throughout the year. Maximum yield of *M. capito* is procured in Autumn, that of *M. cephalus in* Summer, while *M. saliens* gives maximum yield in September.

The length distribution of mullet in lake Borollus during 1967 showed a marked differentiation according to the place, from which the samples were taken. Data obtained from the fishing boats reflect nearly the true length distribution of mullet in the lake. The length range of *M. capito* varied between 100 and 345 mm, that of *M. cephalus* varied between 100 and 400 mm. The length range of *M. saliens* at the lake-sea connection varied between 100 and 270 mm, and that of *M. auratus* varied between 150 and 240 mm.

TABLE 9.—LENGTH FREQUENCY OF MULLET SPECIES CAPTURED BY FIXED TRAMMEL NET (20 MM.) IN THE LAKE-SEA CONNECTION.

Length (mm)	*M. capito*		*M. cephalus*		*M. saliens*	
	No.	%	No.	%	No.	%
130	3	12	—	—	19	11.95
140	7	28	—	—	35	22.01
150	6	24	—	—	18	11.32
160	6	24	—	—	18	11.32
170	2	8	—	—	14	8.80
180	1	4	—	—	9	5.66
190	—	—	—	—	8	5.04
200	—	—	—	—	8	5.04
210	—	—	—	—	6	3.77
220	—	—	—	—	7	4.40
230	—	—	2	12.5	5	3.14
240	—	—	5	31.25	5	3.14
250	—	—	5	31.25	3	1.89
260	—	—	3	18.75	2	1.26
270	—	—	1	6.25	2	1.26

The length ranges receorded from the collecting centers give only a true record for the presence of a species, but did not give any representation for their length distribution in the lake due to the sorting of fish into different size grades.

The age composition of mullet in lake Borollus was considered for *M. capito*, *M. cephalus* and *M. saliens*. It was found that for *M. capito* age groups I, II and III were present *M. cephalus* was represented by age groups O, I and II. Four age groups (O, I, II and III) were recorded for *M. saliens*, whose distribution is limited to the area of the lake-sea connection.

The fishing of mullet in lake Borollus was mainly carried out by trammel nets of different mesh sizes, according to the season and area. Different trammel nets of mesh sizes 14, 16, 18 and 20 mm were used in experimental fishing. The trammel net of 20 mm mesh is the legal net and it is suitable for fishing big sizes. It gives the chance for small fish to pass through its wide meshes. The other nets of 14, 16 and 18 mm mesh sizes are illegal and were not suitable for fishing in the open waters. The majority of their catch consisted of *M. capito* ,which is abundant in the vegetative areas of the lake.

REFERENCES

EGYPTIAN YEAR BOOK OF FISHERY STATISTICS(1962-1968).—Coastaguards-Fishery Department. U.A.R.

EL-ZARKA, S. and H.M. EL-SEDFY (1970).—The biology and fishery of *Mugil salines* Risso of lake Quarun, U.A.R., Bull. Inst. Ocean. Fish., U.A.R., Vol. I.

HUSSEIN K.A. (1969).—The mullet fishery of *Mugil saliens* in lake Edku and adjacent Abu-Kir Bay. M. Sc. Thesis, Faculty of Science, Alexandria University,

PAGET, G.W. (1921).—On the spawning period and rate of growth of *Mugil cephalus* and *M. capito* with a note on the age composition of the catch. Rep. Fish. Egypt.

RAFAIL, S.Z. (1968).—Investiagtions of mullet fisheries by beach seine on the U.A.R. Mediterranean coast. Gen. Fish. Coun. Medit., 7.