TILAPIA FISHERIE IN LAKE MARIUT., AGE AND GROWTH OF *TILAPIA RILOTICA* L. IN THE ALKE

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INTRODUCTION

Tilapia is a freshwater fish of a very large family Cichlidae abounding in Africa including Madagascar and extending to Syria, India and Cylon in Asia. It is known also in central and south America. It is a prolific fish that reaches its first maturity when it is one year old. It is even of small size are acceptable and delicious for human consumption.

Tilapia is an important source of protein food for the Egyptians. It is abound in big quantities in the Nile, its tributiries and the Nile Delta Lakes. This fish provides about 70% of the total fish production in Egypt, i.e. about 24000 tons are caught annually in Egypt, (El-Zarka 1956). Therfore, Tilapia is of major importance to the fishery industry of this country.

Because of the importance of this fish, extensive research program has started in 1957 to survey the fisheries of Tilapia in the inland waters of Egypt. Various studies have been done on the Tilapia species, *Tilapia nilotica* L., *Tilapia galilaea* Art. *Tilapia zilli* Gerv. El-Zarka 1956, 1961, 1962 ; Jensen 1958 ; Imam and Hashim 1960; El-Bolock and Koura 1960; Elester and Jensen 1960; Rifaat, El-Zarka and Ezzat 1964; and Shaheen 1969.

The present paper is confined to the study of age and growth of *Tilapia nilotica* L. in Lake Maruit. Age and growth are extremely important in the practical fishery of a fish for solving such biological information as longevity, age at first maturity, catchable size, environmental suitability and other life history problems.

Studies were also completed concerning length-weight relationship and condition factors for the other Tilapia species of Lake Mariut as well as *Tilapia nilotica* L. of Lake Menzalah for studying the suitability of the different habitats.

Lake Maruit :

Lake Maruit now occupies a portion of the Mediterranean foreshore plain adjoining the city of Alexandria, at Latitude 31° 10″ N and Longitude 29° 55″ E. From the end of the nineteenth century it occupies an area of about 59 000 feddans. Since then the lake has been subjected to various changes which lead to considerable shrinkage of its total surface area as it is clear from Fig .I.

In the western end of the lake an area of about 10 000 feddans was separated by constructing the Maruit railway embankment. The southern margin of the lake has been dried up due to a gradual elevation of the lake bottom as a result of silting.

The northern-eastern section of the lake was separated in 1939 by the British Overseas Airwayes Cooperation transforming part of it into a hydro - aerdrome. The rest of this section has peen utilized for agriculture. The total area separated as such amounts to be about 15,000 feddans.

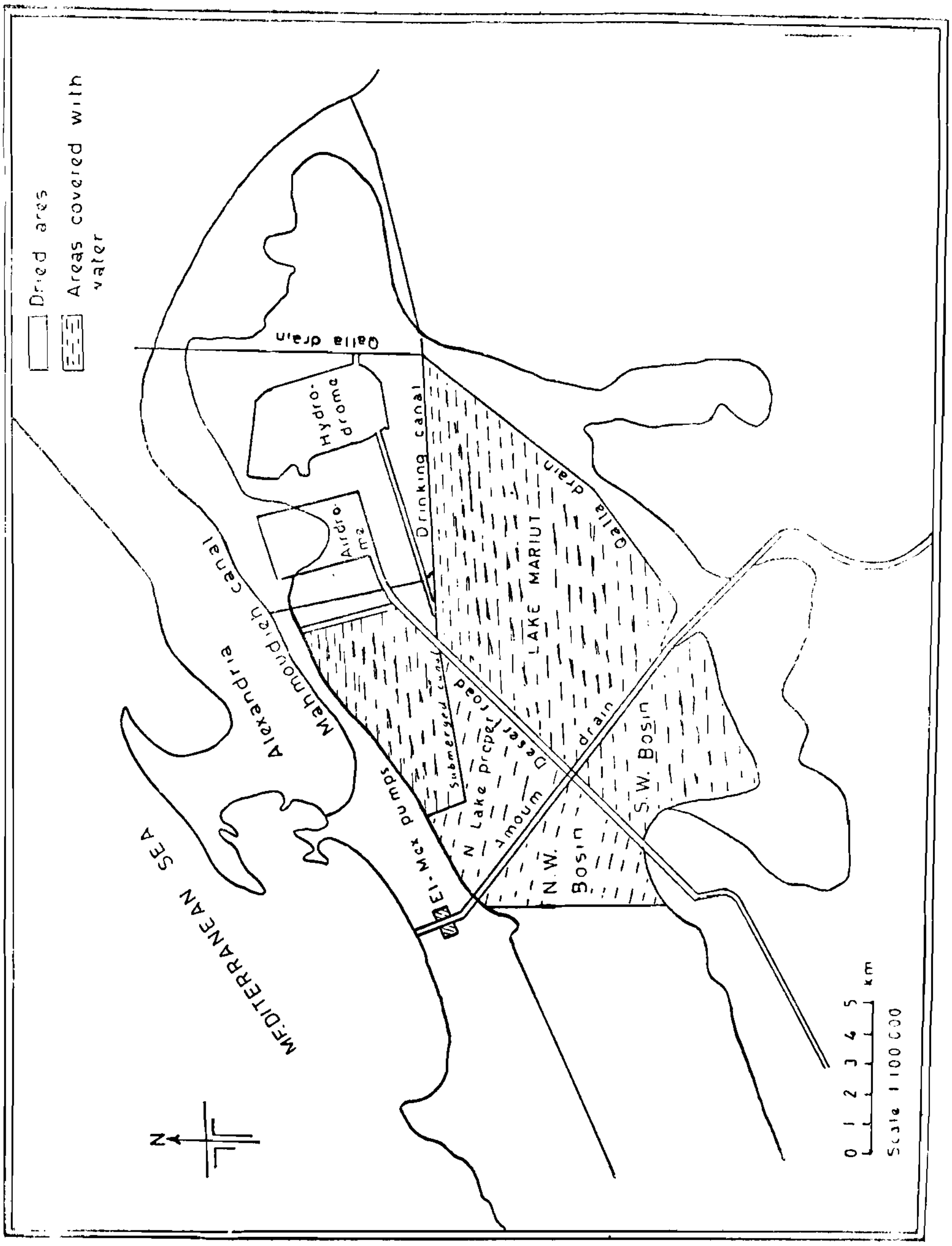

FIG. 1.—Lake Maruit in its recent time during this investigation.

The south-western section of the lake has been isolated by a road that runs parallel to the Umum drain, thus dividing the lake into an eastern section known as the "proper lake", and the western section (Fig. 1) After all this shrinkage of the lake area it occupied at the time of this investigation an area of about 25,000 feddans with depth not exceeding one meter.

The eastern section which is the lake proper had an area of about 15,000 faddans. It is surrounded by high ways from three sides and bordered by the Umum drain from the south west (Fig. 1). The desert road devides the lake proper intn two parts namely northern and southern parts. These two parts are connected with each other through the Moharrem Bey Bridge. There are deeper canals in this section running along the roads and the embankments with depths of about 3 meters.

The western section of the lake is very shallow than the eastern section and is densely covered with *Phragmites* and *Typha* especially near the Umum drain and is of an area about 10,000 feddans. This section is also divided by the desert road into northern and southern parts. The north part is almost triangular and is bordered from the west by the Desert Railway embankment, from the south by the desert road and from the east by the Umum drain. The south part on the other hand is bordered from the north by the Desert Road and from the east by the Umum Drain while the other borders are surrounded by dry land.

In 1892, when the irrigation system in the Beheira province was recognised, Lake Maruit was utilized as a drainage basin for the adjacent cultivated land and various drains have thus been designed to flow in it. Additional quantities of water are received into Lake Maruit from the foreshore plain to the west and also from the Maruit tableland to the south. Infilteration of salt water from the sea into the lake through gradual submergence of the northern ridges is also probable.

Since the lake has no connection with the sea, and in order to keep the water level in the lake lower than that of the cultivated land, powerful pumps was established at Mex to pump the water from a canal on the lake-side up into the sea canal to keep the lake level at about 10 feet below sea-level throughout the year. These pumps work from August to April, but during the rest of the year the evaporation power of the sun, estimated to have been 750,000 to 1,000,000 tons per day was considered sufficient to keep the lake at the required level'

COMMERCIAL FISH PRODUCTION

Fish production from Lake Mariut was available for the years 1920–1960 (Taple 1, Fig'2). Although the production had varied widely and almost erratically, two intervals (1921–1927) and (1928)–1941) were found to show opposite variations. The first period (1921–1927) had generally shown high production and the annual catch varied from 5,435 tons in 1924 to 3,819 tons in 1922. The average annual yield for the whole period (7 years) was 4,339 tons. On the other

TABLE 1.—TOTAL FISH CAUGHT AND THE CATCH OF TILAPIA SPP., MARINE AND NILE FISH AND THEIR PERCENTAGE WITH RESPECT TO THE TOTAL CATCH FROM LAKE MARIUT FOR THE PERIOD 1920–1960 (*Weight in Tons*)

Year	Total Fish Caught	Tilapia spp.		Marine fish (1)		Nile fish (2)		Level of the Lake
		weight	percent	weight	percent	weight	percent	
1920	1650							
21	2182	1824	83.6	161	7.4	196	9.0	-2.95
22	3780	3202	84.7	302	8.0	276	7.3	-2.81
23	4000	3264	81.6	388	9.7	348	8.7	-2.90
24	5435	3924	72.2	772	14.2	739	13.6	-2.85
1925	4300	2675	62.2	851	19.8	774	18.0	-2.85
26	3819	2310	60.5	861	22.5	648	7.0	-2.82
27	4587	3089	62.3	982	21.4	516	6.3	-2.94
28	1985	1179	59.4	534	26.5	271	14.1	-2.99
29	1041	504	48.4	366	35.2	171	16.4	-2.99
1930	832	588	70.7	147	17.7	97	11.6	-2.94
31	1003	692	69.0	176	17.5	134	13.5	-3.00
32	958	716	74.7	147	15.3	95	10.0	-3.12
33	817	592	72.5	143	17.5	82	10.0	-3.21
34	737	612	83.0	78	10.6	47	6.4	-3.18
1935	818	668	81.7	100	12.2	60	6.1	-3.18
36	1740	1536	88.3	136	7.8	68	3.9	-3.16
37	2211	2074	93.8	105	4.7	32	1.5	-3.12
38	1804	1690	95.7	92	5.1	22	1.2	-3.12
39	1449	1301	89.8	91	6.3	57	3.9	-3.15
1940	1603	1456	90.8	81	5.1	65	4.1	-3.04
41	1429	1318	92.2	60	4.2	51	3.6	-3.01
42	1703	1555	91.3	87	5.1	61	3.6	-2.88
43	1860	1665	89.5	102	5.5	93	5.0	-2.96
44	1936	1720	88.8	139	7.2	77	4.0	-2.97
1945	1971	1760	89.3	135	6.8	76	3.9	-2.89
46	1896	1318	69.5	378	19.9	200	10.6	-2.87
47	2233	1788	80.1	240	10.7	205	9.2	-2.88
48	2300	1914	83.1	198	8.6	184	8.3	-2.83
49	2104	1948	92.6	63	3.0	93	4.4	-2.87
1950	1712	1413	82.5	65	3.8	234	13.7	-2.86
51	1208	790	65.4	196	16.2	221	18.4	-2.97
52	1635	1375	84.1	133	8.1	127	7.8	-2.91
53	1566	1208	77.1	218	13.9	140	9.0	-2.89
54	1344	1093	81.3	171	12.7	79	6.0	-2.84
1955	2521	2348	93.1	119	4.7	54	2.1	-2.80
56	2817	2883	95.2	89	3.2	45	1.6	-2.72
57	1693	1599	94.4	60	3.5	34	2.0	-2.69
58	2536	2313	91.2	131	5.2	92	3.6	-2.84
59	2603	2426	93.2	113	4.4	64	2.5	-2.79
1960	3803	3508	92.2	197	5.2	98	2.5	-2.80

(1) Marine fish constituted : *Mugil cephalus, Mugil capito, Mugil saliens* and *Anguilla vulgaris.*
(2) Nile fish constituted : *Clarius anguillaris, Bagrus bayad, lates niloticus, Barbus bynni, Labeo niloticus and Alestes dentex.*

Fish yield in Lake Mariut is obtained from the cnsus made by the Coast Guards Administration.

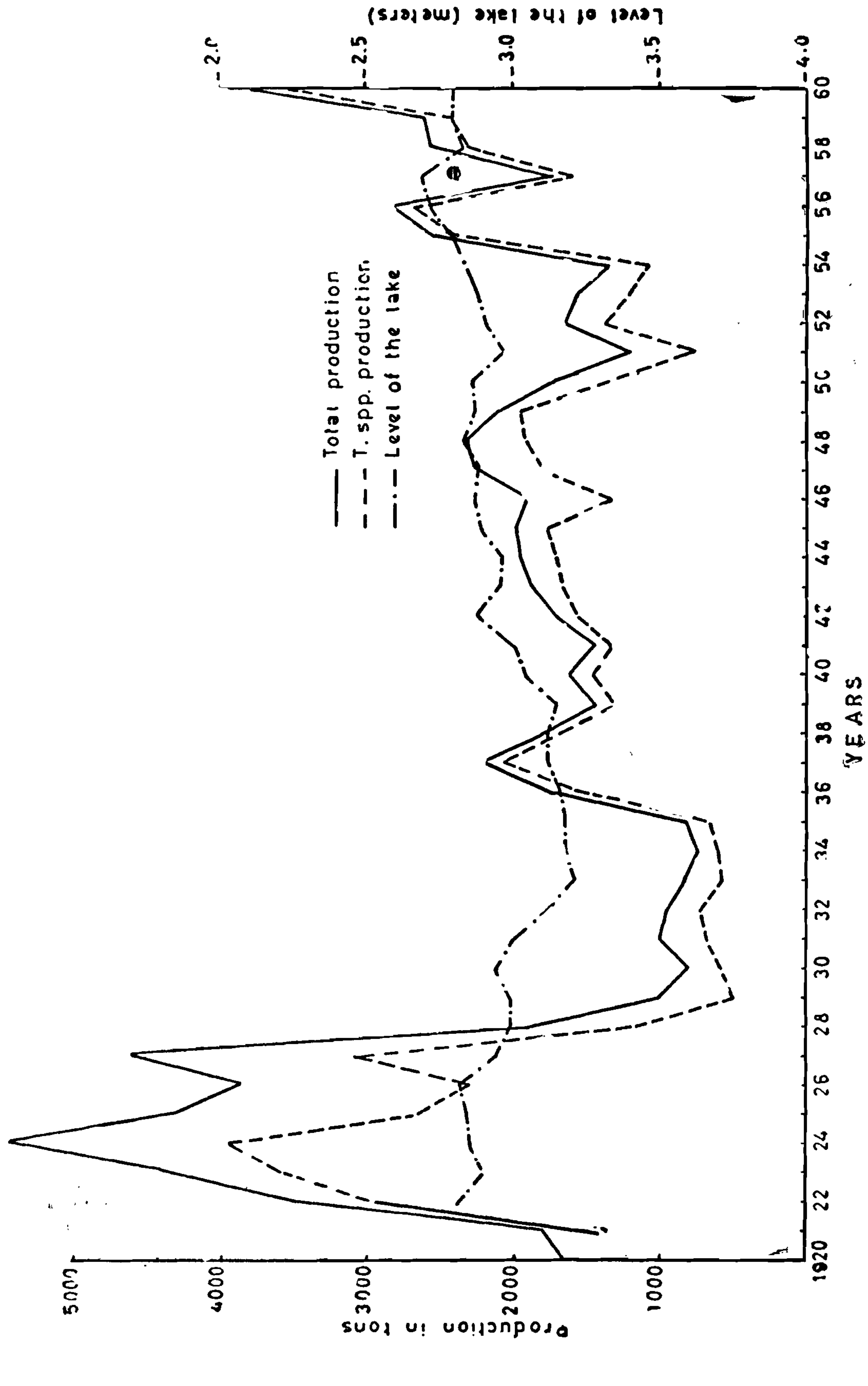

FIG. 2.—Total fish and Tilapia spp. caught from Lake Mariut in the period : 1920–1960

hand, in the second period (1928–1941), the annual production varied from 2,211 tons in 1937 to 737 tons in 1934 with an average annual yield for the whole period of 1,316 tons. It can be noticed that the commercial catch in the second period was far below that of the first period. Through the remaining period (1942–1960) the commercial fish production showed variation where the annual production for the whole period (19 years) estimated to vary from 3,803 tons in 1960 to 1,208 tons in 1951 with an average yield of 2,081 tons. During the period (1942–1960), the years (1950–1954) were characterized by lower production of 1,493 tons for the 5 years.

The major drop of the commercial catch through the period (1928–1941) had resulted from the lowering of the water level in the lake. This lowering was estimated to be 46 cm. between its highest level in 1921 which was -2.75 meters (below the sea level) and its lowest level in 1933 which was -3.21 meters (below the sea level). As a result of this, large areas of the lake perifery were dried thus depriving a great portion of the spawning ground of Tilapia. In addition the volume of water in the lake habitat has also decreased to half of its orignal value.

Land reclamation programs has also affected fish production after 1939 because of drying of large areas from the Lake. The slight progressive increase in fish catch from 1955 to 1960 was due to the intensity of fishing and to the increased number of boats in the lake. Nevertheless, the catch was noticed to be less than that of the earlier periods as an affect of shrinking of the lake area.

Tilapia Population

Genus Tilapia is the dominant fish in Lake Mariut, constituted more tha 90% of its total fish caught in recent years. Its average annual production in the period 1920 - 1960 was 1941 tons conistitued about 80% of the total catch of the Lake. Of this genus : *Tilapia nilotica* L., *Tilapia galilaea* Art., *Tilapia zilli* Gevr. and *Tilapia nilotica* (variety X)[1] are present in the Lake. The respective abundance of these species during the period of this investigation was shown in table 2, (Shaheen 1969.

1 Tilapia nilotica variety x considered to be a sub - species of Tilapia nilotica L. where further studies will be prepared.

TABLE 2.— PERCENTAGE IN NUMBER AND WEIGHT OF *Tilapia* SPECIES IN LAKE MARIUT (1958)

	% age T. nilotica L.	% age T. galilaea Art.	% age T. zilli Gerv.	% age T. nilotica var. x.
Number of *Tilapia* species : measured (12, 648).	18.0	6.8	30.2	45.0
Weight of *Tilapia* species : weighed (368.5 kilograms)	27.4	9.4	22.4	40.8

From this table it was found that the population of Tilapia species in Lake Mariut was dominated by *Tilapia nilotica* (variety ×) followed by *Tilapia nilotica* L., *Tilapia zilli* Gerv. and lastly *Tilapia galilaea* Art. represented by 40.8%, 27.4% 22.4 and 9.4% respectively of the total weight of Tilapia species.

MATERIALS AND METHODS

This study was based upon monthly samples of *Tilapia nilotica* L. collected from the catch of the experimental gears and nets used (traps and trammel nets) in Lake Mariut. These gears and nets were used with different mesh sizes to get as much range of sizes of fish as possible. In addition some selected samples were taken from the commercial catch to fulfil lengthes not caught by the experimental gears and nets. Sampling was proceeded from November 1957 to November 1959.

Total length (from the tip of the snout to the end of the caudal fin) of every fish examined were measured to the nearest millimeter using measuring borad. Also weight of the measured fish were determined to the nearest gram using one pan balance. ::

Age calculations was based on the measurements of the scales of the fish. The scales were taken from the left side of the fish below the lateral line and in the area of the pectoral fin. The location of the scales were consistent through out all the sampling procedure. This consistency was shown by Joris 1957; and by El-zarka 1959 to be a necessory precaution to avoid all kinds of discrepancies that might arise during growth calculations. The scales were cleaned in 10% solution of ammonia and mounted dry between two glass slides, then examined and measured under a binocular stereoscopic microscope.

LENGTH-WEIGHT RELATION AND CONDITION FACTOR

Weight in fishes may be considered as a function of the length. The mathematical relationship between length and weight of fish has been studied extensively If form and specific gravity were constant throughout life the relationship couldebe expressed by the well known cube law : $W=K L^3$ where W = weight, K=constant and L = length. This equation has been studied to describe the general length-weight relationship and thus serve as the basis for the calculation of unknown weights of fish of known length or vise-versa.

Unfortunately, this equation has met with indifferent success due to its failure to describe accurately the relationship of length to weight in many forms of fishes. The following more general equation has been proved to be a more satisfactory method of describing this relationship in fish :

$$W = K L^n$$

where W = weight, K and n = constants, and L = length.

In this equation, K and n are determined empirically, that is they are derived from data taken directly from specimens in large series (Beckman, 1948). Hile (1936) demonstrated that the exponent "n" can vary widely (he showed values from 1.34 to 3.68 for various samples and stocks of ciscoes). Hile (1936) & Le Cren (1951) discussed many of the equations and contraversies involved in the application of this relationship. This equation was proved by many authors in different countries and for many fish species to describe the general length-weight relationship more satisfactory (Hile & Jobes 1941, 1942; Jobes 1952; El-Zarka 1959, 1961, Koura & El-Bolock 1960; El-Bolock & Koura 1960).

The length-weight relation of fish shows a distinct fluctuations from season to season. Moreover, this variation is quite distinct between sexes and between fishes of different maturity. Because of these fluctuations a curve based on a particular collection of fish captured at one time may unsatisfactorily describes the length-weight relation at another time. For this reason it is important to have a simple curve that can best describe this general relation and help in the conversion between length and weight.

The general length-weight relation :

The determination of length-weight relationship of *Tilapia nilotica* L. of Lake Mariut was based on the combined data for all fish regardless of time of capture, sex and state of maturity (Table 3). The relationship is explained by the following equation:

$$W = 1.261 \times 10^{-5} L^{3.0762}$$

where W = weight in grams, and L = Total length in millimeters.

Since the value of exponent n = 3.0762 is so close to 3 we may say that the weight of *Tilapia nilotica* in Lake Maruit increased approximately as the cube of the length.

The logarithmic form of the above equation which was actually used in the calculation of weights in Table (3) can be written as follows

$$\log W = -4.8993 + 3.0762 \log.L$$

In the graphical representation of the length-weight relation (Fig. 3) the smooth curve represents the calculated weights and the dots the empirical ones. The agreement of the calculated and the empirical weights (Table 3) was satisfactory. The discrepancies were more pronounced among larger fish (more than 25 cms.) but on the whole, distribution of the disagreements had no particular trend.

TABLE 3.—LENGTH WEIGHT RELATIONSHIP OF *Tilapia niloitica* L. OF LAKE MARIUT. BASED ON COLLECTIONS OF 1957-59 SEXES COMBINED

Total length interval m.m.	Mid Point m.m.	Number of fish	Empirical weight	Calculated weight	K
78 — 87	82.5	20	10.50	9.9	1.87
88 — 97	92.5	71	15.10	14.1	1.91
98 — 107	102.5	127	20.70	19.3	1.92
108 — 117	112.5	250	28.00	25.7	1.97
118 — 127	122.5	250	35.45	33.4	1.93
128 — 137	132.5	170	44.40	42.6	1.91
138 — 147	142.5	119	56.20	53.3	1.94
148 — 157	152.5	87	67.20	65.6	1.89
158 — 167	162.5	51	78.70	79.8	1.84
168 — 177	172.5	45	93.80	95.8	1.83
178 — 187	182.5	26	117.50	114.0	1.93
188 — 197	192.5	16	134.20	134.4	1.88
198 — 207	202.5	15	154.70	157.0	1.86
208 — 217	212.5	16	178.60	182.1	1.86
218 — 227	222.5	13	201.90	209.7	1.83
228 — 237	232.5	15	243.20	240.2	1.94
238 — 247	242.5	16	261.90	273.3	1.84
248 — 257	252.5	6	285.80	309.4	1.78
258 — 267	262.5	6	364.20	348.7	2.01
268 — 277	272.5	15	374.70	391.4	1.85
278 — 287	282.5	4	436.00	437.1	1.93
288 — 297	292.5	5	483.00	486.5	1.93
298 — 307	302.5	7	513.60	539.5	1.86
308 — 317	312.5	7	526.70	596.3	1.73
318 — 327	322.5	4	634.70	656.9	1.89
328 — 337	332.5	4	700.00	721.3	1.90
338 — 347	342.5	2	785.00	790.5	1.95
Total.....		1367	Average K		1.89

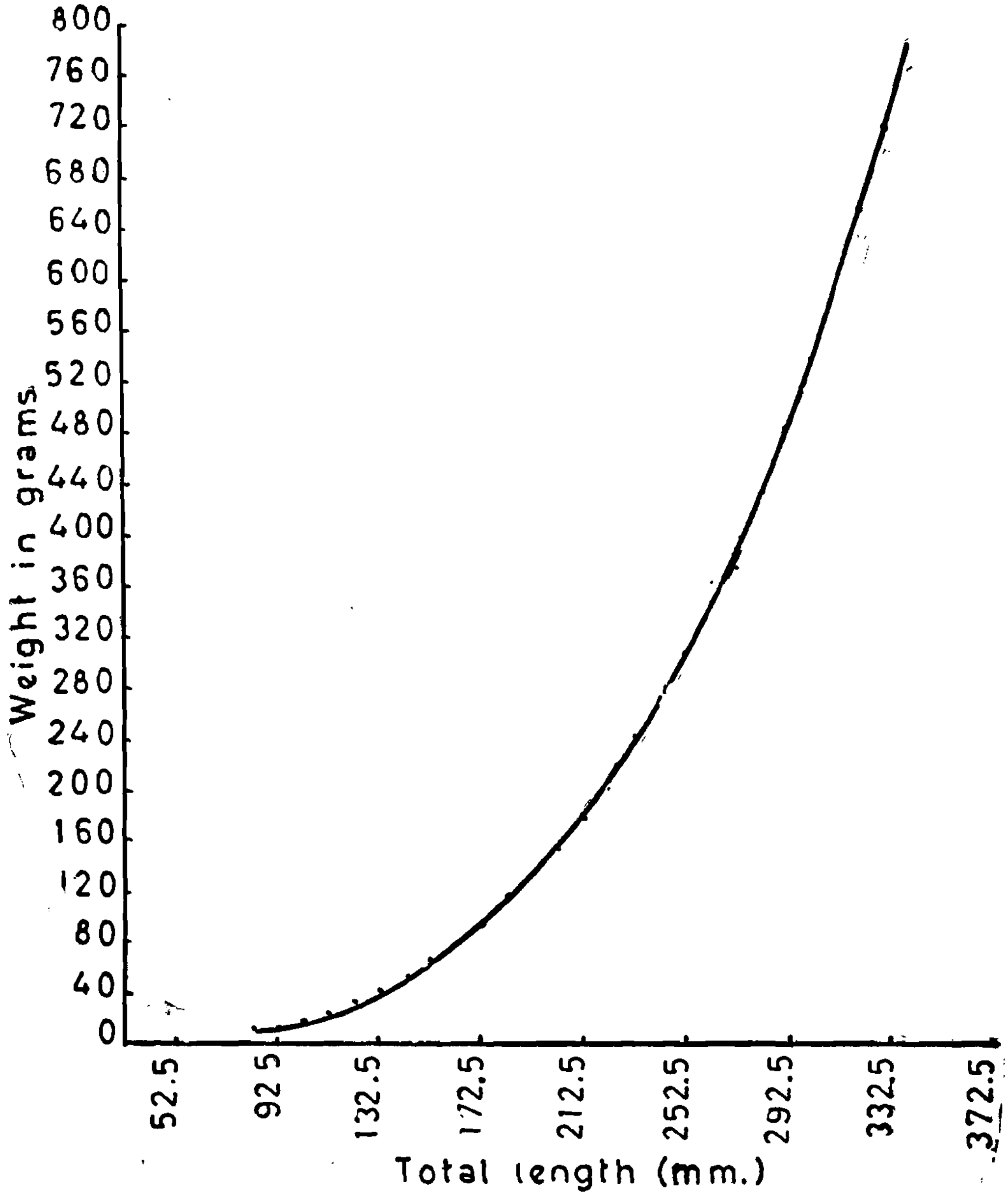

FIG. 3.—Length - weight relation of *Tilapia nilotica* L. from Lake Mariut. Smooth line represents calculated weights and dots represents emperical weights.

Comparison with length-weight of the other *Tilapia species* in Lake Mariut:

Data on the length - weight relation of *Tilapia galilaea, Tilapia zilli* and *Tilapia nilotica* (variety ×) from Lake Mariut during the period of this investigation are recorded in Table (4). The table was arranged to facilitate the comparison of weights of different Tilapia in the same lake.

The following length-weight equations from which weights were derived will clearly show the different degrees of deviation from the cube relationship between weight and length :

Tilapia galilaea Art. : $W = 7.153 \times 10^{-6} L^{3.1838}$

Tilapia zillki Gerv : $W = 6.799 \times 10^{-5} L^{2.7254}$

Tilapia nilotica (*variety x*) : $W = 2.142. \times 10^{-5} L^{2.9547}$

where W = weight in grams, and L = total length in millimeters.

From these equations it is evident that *Tilapia galilaea* increased in weight at a rate more than the cube of length (3. 1838). The rate of increase in weight of *Tilapia nilotica* and *Tilapia nilotica* (variety ×) were nearly equal to the cube of length (3.0762) and (2.9547) respectively. For *Tilapia zillii* the rate of increase in weight was less than the cube of length (2.7254).

In comparing the weights of *Tilapia nilotica* with other Tilapia species from Lake Mariut (Table 4), it is evident that *Tilapia nilotica* L. is heavier than *Tilapia galilaea* up to size group 188-197 mm. with a mean difference of 1.2 grams. *Tilapia galilaea* on the other hand started to be heavier and the difference in weight increased to 14,3 grams at size group 268-277 mm. total length.

Comparing with *Tilapia zillii* it was noticed that the weights of *Tilapia zillii* was little higher than that of *Tilapia nilotica* L. until size goups 108-117 mm. At higher sizes *Tilapia nilotica* L. started to be heavier than *Tilapia zillii* of the same length and the difference between weights reached its maximum at length group 198-207 mm (25.7 gm.)

Regarding *Tilapia nilotica* (variety ×) it was clear that *Tilapia nilotica* L. had higher weights in all length groups. The difference in weight increased progress ively from0.3 gm at lenght interval (88-97 mm). to 17.9 gm ag length interval (198-207 mm).

Comparison with length-weight relation of other lakes :

The only available data for comparison of lenght-weight relationof *Tilapia nilotica* L. from Lake Mariut and from Lake Manzalah. Table (5) is so arranged that weights of fishes of the same length in the two lakes oould be easily compared. Weights of fishes from Lake Mariut are heavier than those of similar lengths from Lake Manzalah in all size groups. The difference increases from 1.0 gram at length interval (78-87 mm). to the maximum of 31.7 grams at size group 268-277 mm. total length.

TABLE 4.— LENGTH WEIGHT RELATION OF *Tilapia nilotica* L., *Tiilapia gallaea* Art *Tilapia zillii* GERV., AND *Tilapia nilotica* (VARIETY*) FROM LAKE MARIUT (SEXES COMBINED)

Total lenghts interval mm.	Tilabia nilotica		Tilabia galilaea		Tilabia zilli		Tilabia nilotica variety*		Advantage weight over T. nilotica		
	No. of fish	Calc. wt.	No. of fish	Calc. wt.	No. of fish	Calc. wt.	No. of fish	Calc. wt.	T. G.	T. Z.	T. M.*
58 — 67	—	—	—	—	1	5.2	—	—	—	—	—
68 — 77	—	—	—	—	20	8.0	2	6.7	—	—	—
78 — 87	20	9.9	14	9.0	111	11.4	18	9.9	—0.9	+1.5	—
88 — 97	71	14.1	24	13.0	357	15.5	135	13.8	—1.1	+1.4	—0.3
98 — 107	127	19.3	48	18.0	533	20.5	405	18.7	—1.3	+1.2	—0.6
108 — 117	250	25.7	112	24.3	266	26.5	473	24.6	—1.4	+0.8	—1.1
118 — 127	250	33.4	143	31.8	110	33.4	399	31.7	—1.6	—	—1.7
128 — 137	170	42.6	93	40.8	37	41.3	114	39.9	—1.8	—1.3	—2.7
138 — 147	119	53.3	68	51.5	16	50.4	47	49.5	—1.8	—2.9	—3.8
148 — 157	87	65.6	47	63.9	5	60.6	14	60.5	—1.7	—5.0	—5.1
158 — 167	51	79.8	19	78.1	2	72.1	8	73.0	—0.7	—7.7	—6.8
168 — 177	45	95.8	11	94.6	1	84.8	3	87.1	—1.2	—11.0	—8.7
178 — 187	26	114.0	17	113.2	1	89.9	1	102.8	—0.8	—24.1	—11.2
188 — 197	16	134.4	9	134.2	1	114.4	—	—	—0.2	—20.0	—
198 — 207	15	157.0	9	157.6	1	131.3	1	139.1	+0.6	—25.7	—17.9
208 — 217	16	182.1	6	183.9	—	—	—	—	+1.8	—	—
218 — 227	13	209.7	5	212.5	—	—	—	—	+2.8	—	—
228 — 237	15	240.2	2	244.7	—	—	—	—	+4.5	—	—
238 — 247	16	273.3	1	279.9	—	—	—	—	+6.6	—	—

248 — 257	6	309.4	2	318.3	—	—	—	—	+ 8.9	—	—
258 — 267	6	348.7	2	360.1	—	—	—	—	+11.4	—	—
268 — 277	15	391.4	2	405.7	—	—	—	—	+14.3	—	—
278 — 287	4	437.1	—	—	—	—	—	—	—	—	—
288 — 297	5	486.5	—	—	—	—	—	—	—	—	—
298 — 307	7	539.5	—	—	—	—	—	—	—		—
308 — 317	7	596.3	—	—	—	—	—	—	—	—	—
318 — 327	4	656.9	—	—	—	—	—	—	—	—	—
328 — 337	4	721.3	—	—	—	—	—	—	—	—	—
338 — 347	2	790.5	—	—	—	—	—	—	—	—	—
Total : No. of Fish :	1367		6364		1462		1620				

TABLE 5.— LENGTH WEIGHT RELATION OF *Tilapia niloticà* L. FROM LAKE MARIUT AND FROM LAKE MANZALAH (SEX COMBINED)

Total length interval (mm)	Lake Mariut		Lake Manzalah		Advantage wt. of fishes from Lake Mariut over Lake Manzalah
	No. of Fish	Calc. Wt.	No. of Fish	Calc. Wt.	
48 — 57	—	—	23	2.2	—
58 — 67	—	—	87	3.9	—
68 — 77	—	—	239	5.9	—
78 — 87	20	9.9	243	8.9	+ 1.0
88 — 97	71	14.1	201	12.6	+ 1.5
98 — 107	127	19.3	133	17.3	+ 2.0
108 — 117	250	25.7	163	23.1	+ 2.5
118 — 127	250	33.4	301	30.1	+ 3.3
128 — 137	170	42.6	336	38.4	+ 4.2
138 — 147	119	53.3	303	48.2	+ 5.1
148 — 157	87	65.6	332	59.4	+ 6.2
158 — 167	51	79.8	137	72.4	+ 7.4
168 — 177	45	95.8	89	87.1	+ 8.7
178 — 187	26	114.0	73	103.8	+ 10.2
188 — 197	16	134.4	51	122.9	+ 11.5
198 — 207	15	157.0	44	143.3	+ 13.7
208 — 217	16	182.1	18	166.2	+ 15.9
218 — 227	13	209.1	15	191.9	+ 17.8
228 — 237	15	240.2	14	219.8	+ 20.4
238 — 247	16	273.2	8	250.3	+ 22.9
248 — 257	6	309.4	4	283.9	× 25.5
258 — 267	6	348.7	3	320.3	+ 27.4
268 — 277	15	391.4	1	359.7	+ 31.7
278 — 287	4	437.1			
288 — 297	5	486.5			
298 — 307	7	539.5			
308 — 317	7	596.3			
318 — 327	4	656.9			
328 — 337	4	721.3			
338 — 347	2	790.5			
Total number of Fish . . .	1367		2818		

The advantage of the weights of fishes from Lake Mariut over that from Lake Manzalah might be explained as due to high productivity of Lake Maruit water. Lake Mariut is an isolated body of water which receives a continous supply of rich drainage water. As a result of such condition, the salinity of the water from Lake Maruit is very low (2-5%) and the nutrient content is very high. The primary production of Lake Mariut was found to be the highest among the other lakes (Lake Mariut 46, 157; Lake Edkou 9, 405 and Nouzha Hydrodrome 4, 181 (Samaan 1966).

In contrast, Lake Manzalah is connected to the Mediterranean sea and it recieves a continuous supply of high saline and fresh drainage water comprising a salinity gradient in the lake. Higher salinities nearer to the lake-sea connection (15-25%) and lower ones away from such areas (2-5%). As a reslut of such mixtures of saline and fresh water nature, the productivity is accordingly affected.

Condition Factor :

The factor K is normally expressed under various definitions; coefficient of condition condition factor and lenght-weight factor. It has been widely used by fishery investigators to express the condition, relative robustness or "degree of well-being" of fishes regardless of the actual lenght-weight relationships. On this basis K has also been used as an adjunct to age and growth studies for indicating the suitability or lack of sutability of an environment for a species.

There are several methods of calculating this factor depending on the measurements used. Throughout this investigation the well known equation:

$$K = \frac{W \times 10^5}{L^3} \text{ was used}$$

where : W = weight in grams and L = Lenght in millimeters.
Low values indicate poor condition and the high values indicate good condition.

In the present study the condition factor (K) was determined for all specimens used in the lenght-weight analysis for *Tilapia nilotica* L. *Tilapia galialaea* Art., *Tilapia zillii* Gerv. and *Tilapia nilotica* (variety X). It is evident from Table (6) that the values of K did not vary significantly with the increase in length and fluctuations in these values have no particular trend. Comparison of the average value of K of the four Tilapia species indicate that *Tilapia nilotica* L. is in the best condition (average K is 1.89), while *Tilapia nilotica* (variety X) has the lowest one (average K is 1.171). In between these two extremes, *Tilapia galilaea* and *Tilapia zillii* show intermediate condition whioh are 1.84 to 1.82 for the two species respectively.

TABLE 6.— THE CONDITION FACTOR "K" OF *Tilapia nilotica* L. *Tilapia galilaea* ART., *Tilapia zillii* CUV AND *Tilapia* NILOTICA (VARIETY X) FROM LAKE MARIUT

Total length interval (mm)	Tilapia nilotica L.		Tilapia galilaea		Tilapia zilli		Tilapia nilotica (variety X)	
	No. of fish	K	No. of fish	K	No. of fish	K	No· of fish	K
58 — 67	—	—	—	—	1	2.05	—	—
68 — 77	—	—	—	—	20	2.34	2	2.10
78 — 87	20	1.87	14	1.71	111	1.98	18	1.76
88 — 97	71	1.91	24	1.76	357	1.93	135	1.73
98 — 107	127	1.92	48	2.05	533	1.82	405	1.60
108 — 117	250	1.97	112	1.94	266	1.84	473	1.61
118 — 127	250	1.93	143	1.94	110	1.84	299	1.68
128 — 137	170	1.91	93	1.86	37	1.76	114	1.61
138 — 147	119	1.94	68	1.85	16	1.93	47	1.65
148 — 157	87	1.89	47	1.81	5	1.73	14	1.67
158 — 167	51	1.84	19	1.74	2	1.63	8	1.60
168 — 177	45	1.83	11	1.75	1	1.58	3	1.75
178 — 187	26	1.93	17	1.75	1	1.66	1	1.65
188 — 197	16	1.88	9	1.67	1	1.67	—	—
198 — 207	15	1.86	9	1.74	1	1.51	1	2.12
208 — 217	16	1.86	6	1.78	—	—	—	—
218 — 227	13	1.83	5	1.68	—	—	—	—
228 — 237	15	1.94	2	1.87	—	—	—	—
238 — 247	16	1.84	1	1.95	—	—	—	—
248 — 257	6	1.78	2	1.96	—	—	—	—
258 — 267	6	2.01	2	1.96	—	—	—	—
268 — 277	15	1.85	2	1.97	—	—	—	—
278 — 287	4	1.93	—	—	—	—	—	—
288 — 297	5	1.93	—	—	—	—	—	—
298 — 307	7	1.86	—	—	—	—	—	—
308 — 316	7	1.73	—	—	—	—	—	—
318 — 327	4	1.89	—	—	—	—	—	—
328 — 337	4	1.90	—	—	—	—	—	—
338 — 347	2	1.95	—	—	—	—	—	—
Total number of fish and average K. .	1367	1.89	634	1.84	1462	1.82	1620	1.71

AGE DETERMINATION OF TILAPIA NILOTICA L.

The use of the scale method for age and growth studies of Tilapia species was proved to be valid (Halden 1935 ; Jensen 1958 ; Elster and Jensen 1960 ; El-Bolock and Koura 1960 1961; El-Zarka, 1961). The validity of age determination by counting the annulii was clearly established by Van Oosten (1929). However, certain difficulties in the interpretation of the scale markings were encountered. Regenerated scales were sometimes met with although they were easily detected while accessory rings occurred on some scales.

Body Scale Relations :

Growth calculations from scale measurements requires the establishment of a definite relationship between the growth of the scale and that of the body lenght. Various measurements were used for this purpose. Van Oosten (1923) found that the ratio of the scale diameter of Lake Huron whitefish to the lenght of fish is nearly constant. Again, the same author (1929) and Smith (1956) found a similar body-scale relationship for the Lake Herrings. Bennet, Thomson and Parr (19‹0) observed that the anterior radii of the Large-Mouth Bass, *Micropterus salmoides* scales increased in a straight line relationship with increase in body length. Ricker and Lagler (1942) observed a direct proportionality between anterior radii of scale and fork length of Large Mouth Bass. Carlander (1945) used the anterior scale radii for the study of body-scale relation of the Tullibee of Lake of the Woods. From a comparison of resluts of calculations from diameters and anterior radii, Van Oosten (1929) found that "... the diameter of a scale grows in lenght more nearly proportional with the body than does the anterior radius (and)..... that the diameter dimention is less variable than the anterior radius".

Since it was difficult to locate the annulii in the posterior field of the scale of *Tilapia nilotica*, the anterior scale radii had to be used in the present study. Thus, the relation between total length of the fish and the anterior magnified scale radius of *Tilapia nilotica* was determined to find out to what extent this relationshup deviates from direct proportionality. The data on the length and scale radii were grouped into one centimeter intervals. The mid point of the lenght and the mean scale radii for each lenght group were calculated as shown in Table 7.

The graphical representation (Fig 4) of the relation between body length and scale dimaeter - based on the sexes combined - indicated that the scale radii grow in direct proportion to that of the total length. A straight live relationship was fitted to the data by the method of least square using the following equation :

$$L = 13.54 + 515 \ S$$

where : L = total length in millimeters,
S = magnified scale dimater in millimeters

The direct proportionality between the increase in body length and increase in anterior scale diameter was supported by the nearly constant body scale ratio $\frac{L}{S}$ (Table 7) where the average of this ratio is 5.57. Generally this ratio though it showed slight individual variations had no clear trend.

TABLE 7.— Relation between total length (L) and the anterior interradial measurements of scales (S) of *Tilapia nilotica* L.

Total length interval (mm)	Mid point (mm) (L)	Number of fish	Average radius (S)	$\frac{L}{S}$
68 — 77	72.5	2	9.5	7.63
78 — 87	82.5	20	14.2	5.81
88 — 97	92.5	54	15.8	5.85
98 — 107	102.5	131	17.4	5.89
108 — 117	112.5	247	19.1	5.89
118 — 127	122.5	234	20.6	5.95
128 — 137	132.5	167	22.5	5.89
138 — 147	142.5	108	24.5	5.82
148 — 157	152.5	71	26.7	5.71
158 — 167	162.5	39	28.6	5.68
168 — 177	172.5	29	29.7	5.81
178 — 187	182.5	15	34.0	5.37
188 — 197	192.5	24	35.7	5.39
198 — 207	202.5	26	38.1	5.31
208 — 217	212.5	21	40.4	5.26
218 — 227	222.5	19	42.7	5.21
228 — 237	232.5	26	44.4	5.24
238 — 247	242.5	19	46.6	5.20
248 — 257	252.5	24	49.2	5.13
258 — 267	162.5	22	50.7	5.18
268 — 277	272.5	25	52.9	5.18
278 — 287	282.5	18	53.4	5.29
388 — 297	292.5	23	54.6	5.35
298 — 307	302.5	15	56.1	5.39
308 — 317	312.5	13	58.4	5.35
318 — 327	322.5	14	59.0	5.47
328 — 237	332.5	10	59.8	5.56
338 — 347	342.5	7	62.0	5.52
348 — 357	352.5	5	64.1	5.50
358 — 367	362.5	2	67.5	5.37
368 — 377	372.5	1	69.4	5.37
Total or average. . .		1431		5.57

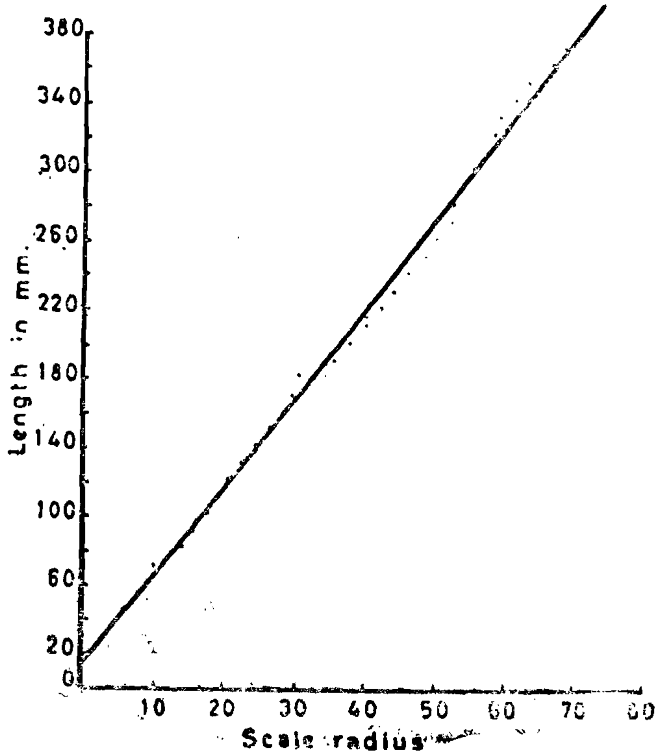

FIG. 4.—Relation between total length and scale length of *Tilapia nilotica* L.

Since the amount of intercept was quite significant, it was considered in the claculation of growth. Accordingly growth histories of *Tilapia nilotica* from Lake Mariut were computed using the following formula:

$$L_n = 13.54 + \frac{(L_{t - 13.54})}{S_t} \cdot S_n$$

where : L_n = calculated lenght at the end of n years.

L_t = total lenght of caputre.

S_n = scale radius to the n annulus.

S_t = total scale radius.

The amount of intercept of *Tilapia nilotica* from Lake Mariut (13.54 mm) is nearly of the same value as that of *Tilapia nilotica* from the Hydrodrome (near Lake Mariut) which is 13.00 mm (Jensen, 1958).

Growth in Length :

The average calculated length of *Tilapia nilotica* taken from Lake Mariut in the period from November, 1957 to March, 1958 and also from November, 1958 to March, 1959 are combined to give a best estimate of average condition (Table 8). The samples of these periods are chosen for the study of growth because their fishes were considered to have completed the full season's growth.

The calculated length for the different age groups show discrepancies which is quite noticeable, for *Tilapia nilotica* population in Lake Mariut. These discrepancies were previously discussed by many workers in full detail for other species and no need to repeat their explanations (Van Oosten, 1929; Jobes, 1952 Smith, 1956 and El-Zarka, 1959). The present comments will be limited therefore to those factors believed to be most important in Lake Maruit. Much of the disagreement can be attributed to biased samples and to the progressive elimination of the more rapidly growing individuals from the population. These two sources of discrepancy are interrelated. Hile (1936) found a higher natural mortality rate among rapidly growing ciscos of Silver Lake (North Wisconsin) then among the slow growing ones.

Segregation according to sex and size can lead to biased sampling and selective mortality at all times of year. Evidence is strong for segregation of sizes and ages for *Tilapia nilotica*. It is well known also that the fish of different sizes inhabit different regions of a lake and move from zone to zone as the fish grow (Lowe, 1959). Data are lacking as regards distribution and segregation by sex and by size in Lake Mariut, but undoubtedly it occurs. This segregation can lead both to biased samples and selective mortality since fishermen can be expected to concentrate their efforts on grounds occupied by the larger fish. Another factor that might be responsilbe for the difference in the calculated length from the different age groups was the inadequate representation of the old fish.

From the previous discussion, it is apparent that various factors change the growth characteristics of *Tilapia nilotica*, but it is not possible to rank these factors as to their relative importavce. The factors, doubtless operate together to bring about these consistant discrepavcies among the cdlculateu lenght of the different age groups.

The calculated length attained at the end of each year of life and annual increment of growth in length for *Tilapia nilotica* from Lake Mariut are shown in Table (8). In the bottom of this table two estimates of general growth are given; one based on the grand average calculated length and the second on the summation of the average annual increments of length. The grand average calculated length will not represent the typical growth of the fish population especially in the latter years of life. To avoid such a deviation, the general growth curve was thus based on the summation of the grand average annual increment of length. This procedure was proved very satisfactory by earlier investigators (Hile and Jopes, 1941, 1942; Jobes, 1952 and El-Zarka, 1959).

The general growth curve (Fig. 5) was constructed from the data of Table (8). From the curve, it is clear that the annual increments were the largest in the second year 128.8 mm., then decreased gradually in later years where it was 74.7 mm., 38.9 mm. and 33.0 mm. for the third fourth and fifth years of life respectively. Monthly increment of growth was formed to be correlated with temperature (Table 9-Fig. 6). In the period from June to Septemper when the temperature increased from 23.8°C, the growth attained its maximum values.

On the other hand, when the temperature were less (from April to May (18°C) and from Septemper to October (23.1°C) the rate of increase of growth was below that of the first period. The decline in temperature after October was reflected in that there was practically no change in the amount of growth until the next season's growth of the fish. Therefore the full season's growth is attained in October for *Tilapia nilotica* L. in Lake Maruit.

TABLE 8.— CALCULATED TOTAL LENGTH AT THE END OF THE DIFFERENT YEARS OF LIFE OF *Tilapia nilotica* L. IN LAKE MARIUT.

Age groups	Number of fish	Calculated length in mm. at end of year				
		1	2	3	4	5
II	141	82	208.4 126.4			
III	73	89	220.9 (131.9)	294.1 (73.2)		
IV	14	74	199.1 (125.1)	275.5 (76.4)	324 5 (39.0)	
V	2	73	216.0 (143.0)	304.5 (68.5)	342.5 (38.0)	375.5 (33.0)
Grand average* calc. length:		83.7	211.9	291.9	326.9	375.5
Increment of average		83.7	128.2	79.5	35.4	48.7
Grand average increment: of length . .		83.7	128.2	74.7	38.9	33.0
Sum of average increment*		83.7	212.5	287.2	326.1	539.1

(*) All grand averages are weighted.

TABLE 9.—MONTHLY INCREMENT OF GROWTH (IN MILIMETER) OF *Tilapia nilotica* L. FROM LAKE MARIUT.

Month	Age Group I		Age Group II	
	No. of Fish	Extra growth	No. of Fish	Extra growth
January,—1958	13	129.3	11	76.0
February	23	124.0	5	68.3
March	27	5.8	2	2.0
April	149	17.4	1	11.8
May	72	27.7	13	19.0
June	127	43.3	6	30.4
July	77	61.7	7	40.7
August	48	83.3	4	52.6
September	45	103.1	—	—
October	10	128.0	—	—
November.	21	127.6	10	78.1
Decmeber	18	126.3	13	72.2
January,—1959	26	124.0	11	73.5

(extracted from Table (4) Shaheen 1969.

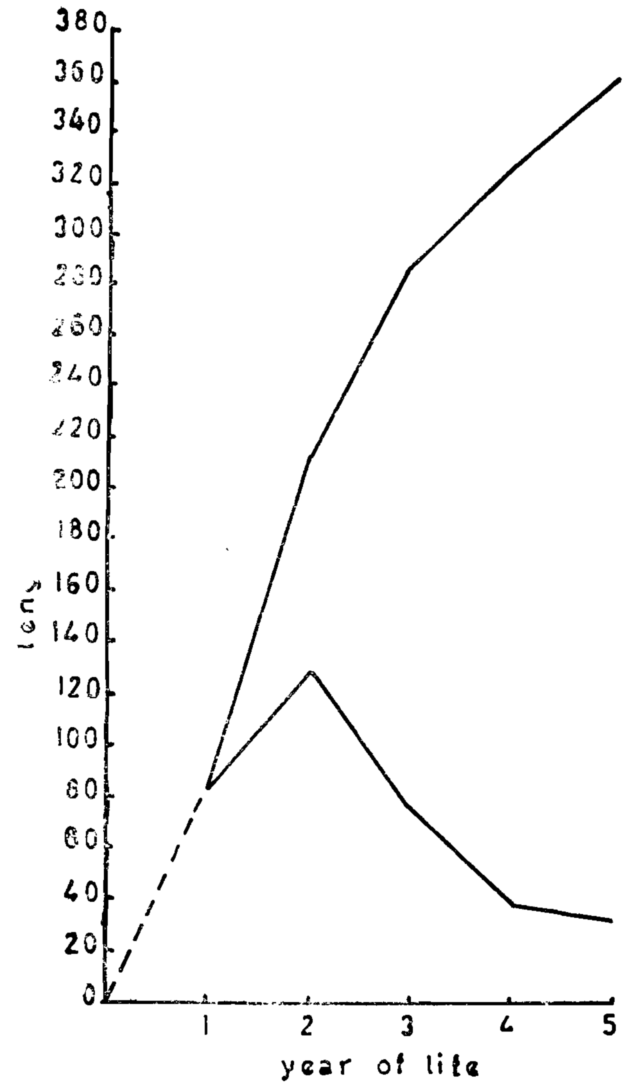

FIG. 5.—General growth in length and annual increments in length of *Tilapia nilotica* L. in Lake Mariut.

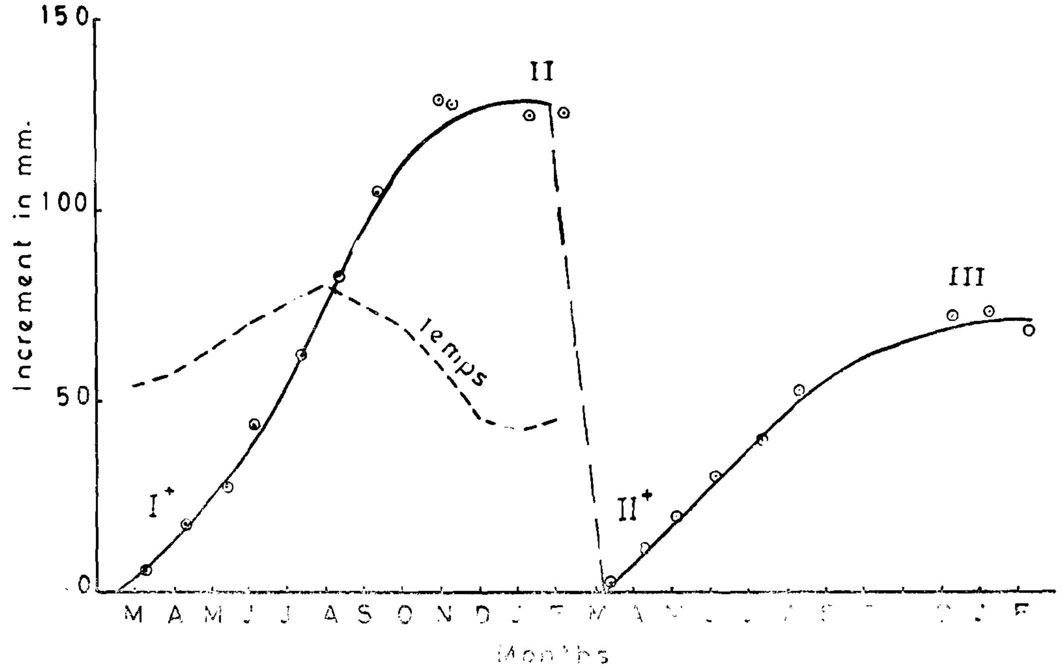

FIG. 6.—Average increments of growth of first and second year of *Tilapia nilotica* L. from Lake Mariut during the growing season with relation to the mean monthly air temperature.

Growth of the First Year :

The first year of life of *Tilapia nilotica* cover a wide range of size depending on the time of hatching during the spawning season. The length of the fish is apparently determined to a certain extent by the amount of the first year of growth. It is found that the calculated length of the first year of life for fishes of older age groups II, III, IV and V varies from 5 to 15 cm.

The variation in the length of fish during the first year of life is mainly due to the prolonged spawninn season of *Tilapia nilotica* (from April to August) Shaheen (1969). Thus a fish which hatches in April has the chance to make use of the whole growing season (From April to October). If hatching happens in May, the fish will undergo a growth period from May to October. Similarly a June and July hatching give the fish a short growing season (3 to 4 months).

The importance of establishing a relation between the time of hatching and fish length especially for fishes of age group O necessitates to put such relation in a descriptive curve (Fig 7). In formulating such a curve it was rather difficult to depend on the observed lengths of O group fishes which were collected during the spawning season. The lengths were overalpping and it was impossible to relate every length to its time of hatching. Hence the procedure adopted by El-Zakra (1962) for *Tilapia zillii* was applied in preparing Table (10) and the descriptive curve (Fig. 7). By this procedure it is possible to relate lengths of fishes of age group O to its appropriate time of hatching.

TABLE 10.— RELATION BETWEEN FIRST YEAR GROWTH AND TIME OF HATCHING OF *Tilapia nilotica* L. (SEXES COMBINED). (PERCENTAGE OF GROWTH IN PARENTHESIS)

Time of hatching	Amount of growth at the end of growing season (mm.)
April	(100) 83
May	(90.8) 75
June	(82.7) 69
July	(70.4) 58
August	(55.8) 46
September.	—

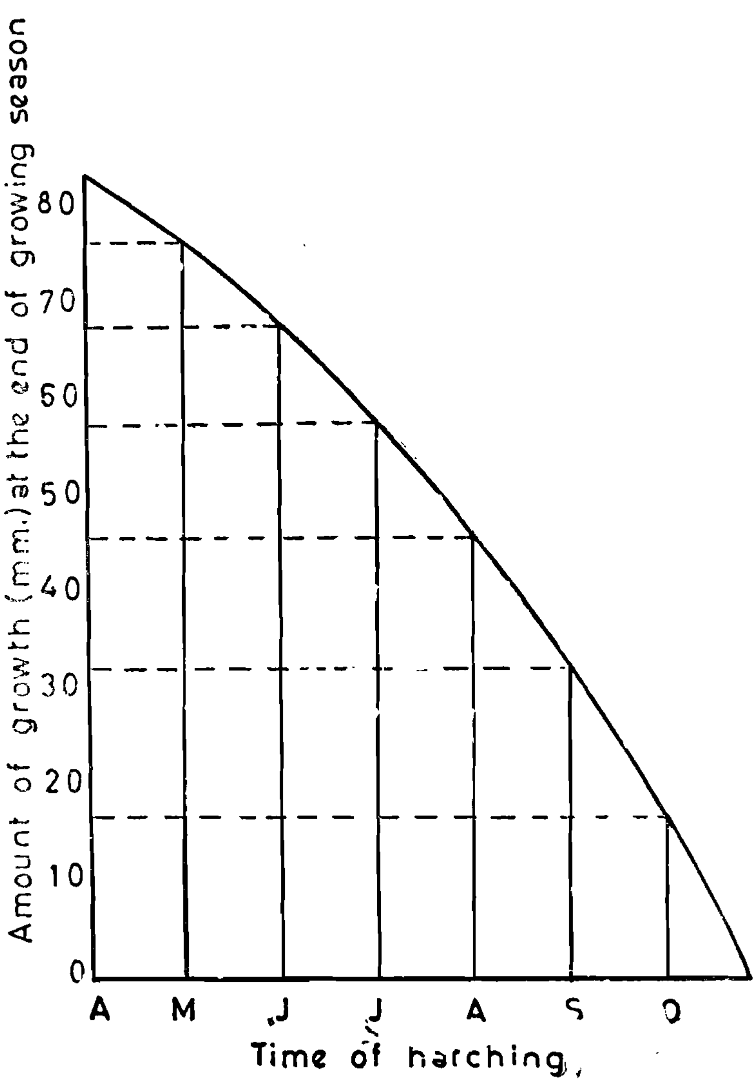

FIG. 7.—Relation between first year growth and time of hatchig (sexes combined)

Growth in Weight :

Estimates of growth in weight for the different years of life in Table (11) were obtained by applying the calculated lengths of (Table 8) to the length-weight equation

$$\text{Log W} = -4.8993 + 3.0762 \log \text{L}.$$

With growth in weight as with growth in lenght, the general growth is based on the sums of the grand average increments of weight (Table 11). The discrepancies among the calculated weights of the different age groups are similar to those previously described for the calculated lengths and no need to be repeated.

Graphical representation of data on caluclated weight at the end of each year of life and the actual growth increments (Fig. 8) indicated that the growth is much slower in the first and second years of life. The annual increment of weight increased in the successive years of life with little irregularity. The greatest wieght - increments was attained in the third year (301.4 grams) and the increments in fourth and fifth years vary from 252.5 to 258.5 grams respectively.

The annual increments of growth in length and that of weight (Table 12 and Fig. 9) followed the same trend especially during the early years of life. In latter years, on the other hand, the annual increment of weight did not undergo the sharp decline of length increment.

It was also noticed that the maximum annual increase in length was attained in the second year of life, while the highest value of weight increments was not reached until the third year. This trend of growth in length and weight was found to be the same as that of *Tilapia zillii* from Lake Qarun (El-Zarka, 1961).

TABLE 11.— CALCULATED WEIGHTS AT THE END OF DIFFERENT YEARS OF LIFE OF *Tilapia nilotica* L. IN LAKE MARIUT.

Age group	No. of Fish	Calculated weights in grams at end of year				
		1	2	3	4	5
II	131	9.7	171.4 (161.7)			
III	73	12.5	205.0 (192.5)	494.6 (289.6)		
IV	14	7.1	148.9 (141.8)	404.4 (255.5)	669.3 (264.9)	
V	2	6.8	191.4 (124.6)	550.5 (359.1)	790.5 (240.0)	1049 (258.5)
Grand av. calc. wt*		10.4	180.9	498.5	684.4	1049
Increment of Average		10.4 :	170.5	307.6	185.9	364.6
Grand av. increment of wt.		10.4	155.2	301.4	252.5	258.5
Sum of av. increment		10.4	165.6	467.0	719.5	978.0

* All grand averages are weighted.

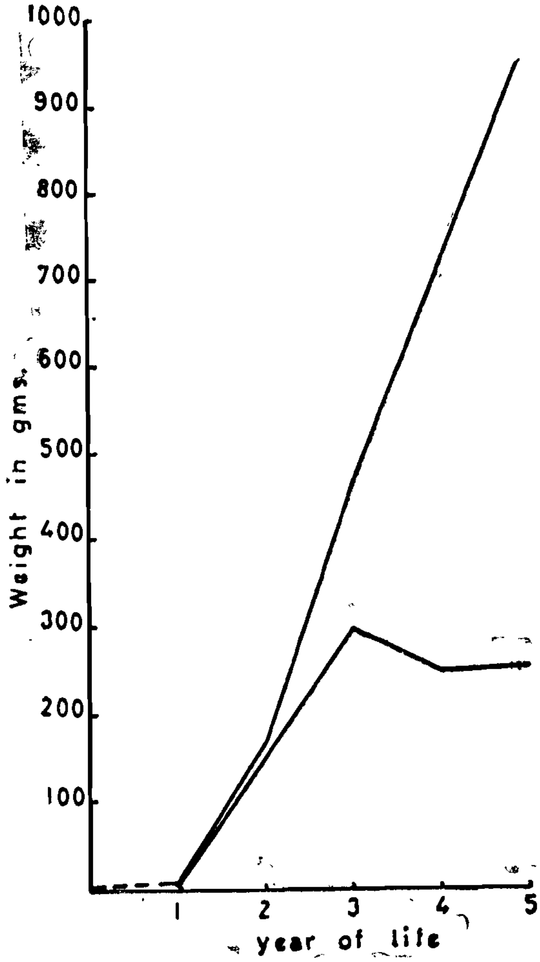

Fig. 8.—General growth in weight of *Tilapia nilotica* L. in Lake Mariut.

TABLE 12 — CALCULATED WEIGHTS (IN GRAMS) IN CALCULATED TOTAL LENGTH (IN MILLIMETERS) AND WEIGHTS AND LENGTH INCREMENTS OF *Tilapia nilotica* L. IN DIFFERENT YEAR OF LIFE.

	Calculated Total Length			Calculated Weight		
	Calc. length	Increment	% increase	Calc. weight	Increment	% increase
1	83.7	83.7	23.3	10.4	10.4	1.1
2	212.5	128.8	35.9	165.6	155.2	15.9
3	287.2	74.7	20.8	467.0	301.4	30.9
4	326.1	38.9	10.8	719.5	252.5	25.8
5	359.1	33.0	9.2	978.0	258.5	26.4

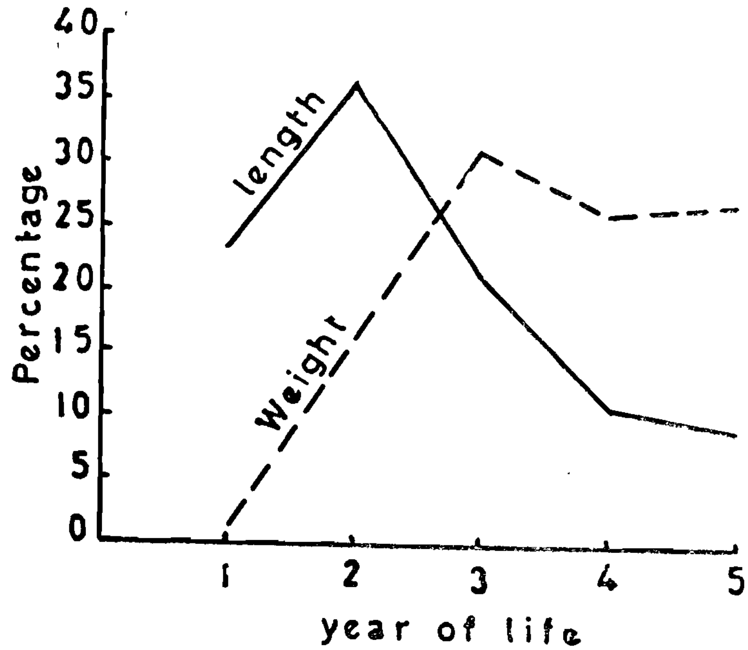

FIG. 9.—Percentage annual increase in length (solid line) and in weigh (broken line) of *Tilapia nilotica* L.

AGE COMPOSITION OF *TILAPIA NILOTICA* L. IN LAKE MARIUT.

Studying age composition of any fishery is rather important for its organisation. The variation of age groups from year to year and from season to season show the effect of fishing intensity on the fish stock.

The analysis of age composition of *Tilapia nilotica* population in Lake Mariut has based on fishes taken from the experimental gears (traps and trammel nets). The catch from the experimental gears with different mesh sizes can be considered to represent the commercial catch which reflects more clearly the actual condition of the fishery. The monthly collections of samples from November 1957 to Novemper 1958 gave a rather clear picture of its condition of the fishery. The number of specimens and percentage occurrence of each age group in the monthly collections are shown in (Table 13). The most important feature shown in Table) 13) and Figure (10) is the predominance of age group I in all the months. Those fishes of age group I were not exactly one year old but they were one year plus the current season growth which depend on the time of capture. It was stated in this study that the full season's growth was attained by October. Consequently the age of fishes was moved to the next higher age groups in November.

The dominant age group as seen from (Table 13) and Figure (10) was found to be of age group I. This age group dominated the cach through all the months where it ranges between 79.7% to 100%. Older fishes of age groups II and III constituted a small percentage where they were represented in the catch in all the

TABLE 13.— AGE DISTRIBUTION OF *Tilapia nilotica* L.
IN DIFFERENT MONTHS 1957-1958 (SEXES COMBINED)
(PERCENTAGE IN PARENTHESES)

Date of capture	No. of fish	Number and percentage in age groups			Average
		I	II	III	
November, 1957 . . .	59	55 (96.4)	1 (1.8)	1 (1.8)	1.02
December	219	212 (96.8)	5 (2.3)	2 (0.9)	1.04
January, 1958	140	137 (97.9)	3 (2.1)	—	1.02
February	113	111 (98.2)	2 (1.8)	—	1.01
March	119	102 (85.7)	16 (13.4)	1 (0.8)	1.15
April	174	159 (91.4)	11 (6.3)	4 (2.4)	1.11
May	148	118 (79.7)	19 (12.8)	11 (7.4)	1.28
June	160	139 (86.9)	13 (8.1)	8 (5.0)	1.18
July	95	88 (92.6)	5 (5.3)	2 (2.1)	1.09
August	50	49 (98.0)	— —	1 (2.0)	1.04
September	37	37 (100.0)	—	—	1.00
October.	7	7 (100.0)	—	—	1.00
November.	65	59 (90.8)	6 (9.2)	—	1.09
Total		1273 (92.1)	69 (5.7)	30 (2.2)	1.10

months except in September and October due to the scarcity of samples examined in these two months. The presence of these age groups varied between 1.8% and 13.4% with a mean of 5.7% for age group II and between 0.7% and 7.4% with a mean of 2.2% for age group III in the months of sampling.

When combining the 13 months random samples (Table 13) fishes of age groups II and III constituted 7.9% of the total number of fish. On the other hand the larger proportion of the fishes were represented by fishes of age group 1, 92.% of the total numper of the fish. So, generally speaking the fishery of *Tilapia nilotica* in Lake Mariut constituted maninly fishes of age group I through all the year round.

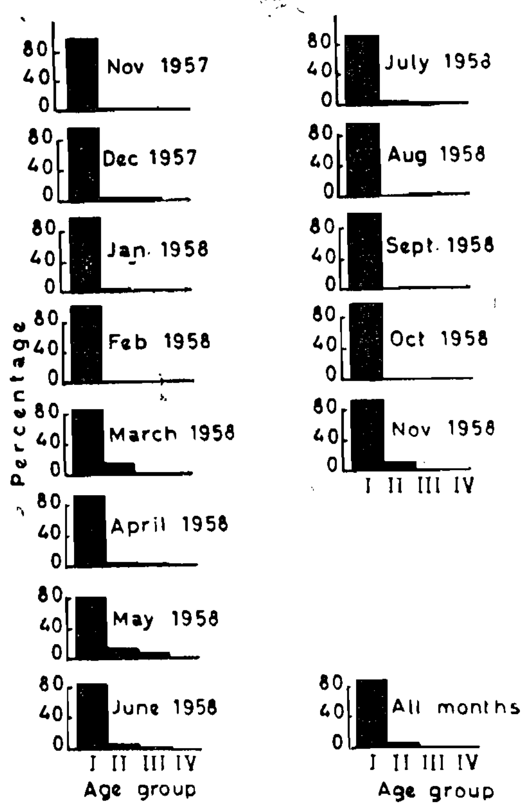

FIG. 10.—Age Composition of *Tilapia nilotica* L. of Lake Mariut on different dates of capture.

SUMMARY

1.— Tilapia is an important source of protein food for the Egyptians. It provides about 70% of the total fish production in Egypt. Because of the economical importance of this fish extensive research program has started in 1957 to survey its fisheries in the inland waters of Egypt. This study is confined to *Tilapia nilotica* L. in Lake Maruit.

2.— Lake Mariut is a shallow water area lies along the northern Mediterranean coast to the south of Alexandria, with depth about one meter. It has no direct connection with the sea, recieved drainage water from the adjcent cultivated lands. Its area was about 25,000 feddans.

3.— The mean annual commercial fish production of Lake Mariut in the period 1920-1960 was estimated to be 2208 tons. In the period 1920-1927 the annual fish production of the lake was estimated to be 4339 tons. In 1928-1941 this production was decreased to 1316 tons, then increased again to 2081 tons in 1942-1960. The fluctuations in the fish production of the lake were mainly due to the variation, of lake-level that varied between - 2.75 to -3.21 meters in different years. This was also due to the shrinkage of the lake area that decreased from 59000 feddans in its ancient time to 25000 feddans during this investigation.

4.— Tilapia. fisheries of Lake Maruit comprises *Tilapia nilotca* L., *Tilapia galilaea* Art., *Tilapia zilli* Gerv. and *Tilapia nilotica* (variety ×). The average annual produotion of this fish was 1741 tons constitutes about 80% of the total catch of the lake.

5.— The present study was based upon monthly samples taken from experimental fishing gears used for catching Tilapia in Lake Maruit as well as from the commercial catch. The period of collecting data extended from November 1957 to Novemper 1959.

8.— The fishery of *Tilapia nilotica* L. in Lake Mariut depends on age group I. In the combined 1957 - 1958 samples, age group I contributed 92.1% of its total catch, while older age group II and age group III conistituted only 5.7% and 2.2% respectively.

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