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TILAPIA FISHERIES IN LAKE MANZALA, EGYPT.

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ABSTRACT

Growth rates of four Tilapia species (**Tilapia zillii, Oreochromis nilotica, O. galilaea** and **O. aurea**) found in Lake Manzala are low in comparison to those of other Egyptian Lakes. Growth rate is also slower now than it was during the 1960's. This is attributed to overstocking in the high eutrophic southern and eastern sectors and to high salinity in the northern sector of the Lake.

INTRODUCTION

Biological and life history considerations of key commercial fish species play an important role in the formulation and assessment of fisheries management and development policy. On the other hand, life history parameters of a given species are not static and to some extent are a function of the existing environment and fishery regime (e.g. growth rates, population structure and size at first maturity are affected by environmental conditions and the degree of exploitation stress).

Lake Manzala is a dynamic aquatic system that has evolved from a brackish to a more freshwater state over the past 50 years. The pace of this change has greatly accelerated during the last 10 to 15 years. Comprehensive biological studies of tilapia species were carried out during the 1960's (Bishara, 1973). While such extensive field and laboratory work in this area were not within the scope of this study, nor was it deemed necessary, but effort was concentrated on specific key biological aspects (e.g. comparison of age and growth between lake regions).

Area of Study

Lake Manzala, the biggest of the Egyptian Delta lakes, is situated in eastern Nile Delta between the Damietta Branch and the Suez Canal (Fig. 1). The Mediterranean Sea is immediately north of the narrow coast which separates the two water bodies. The total area of the Lake is approximately

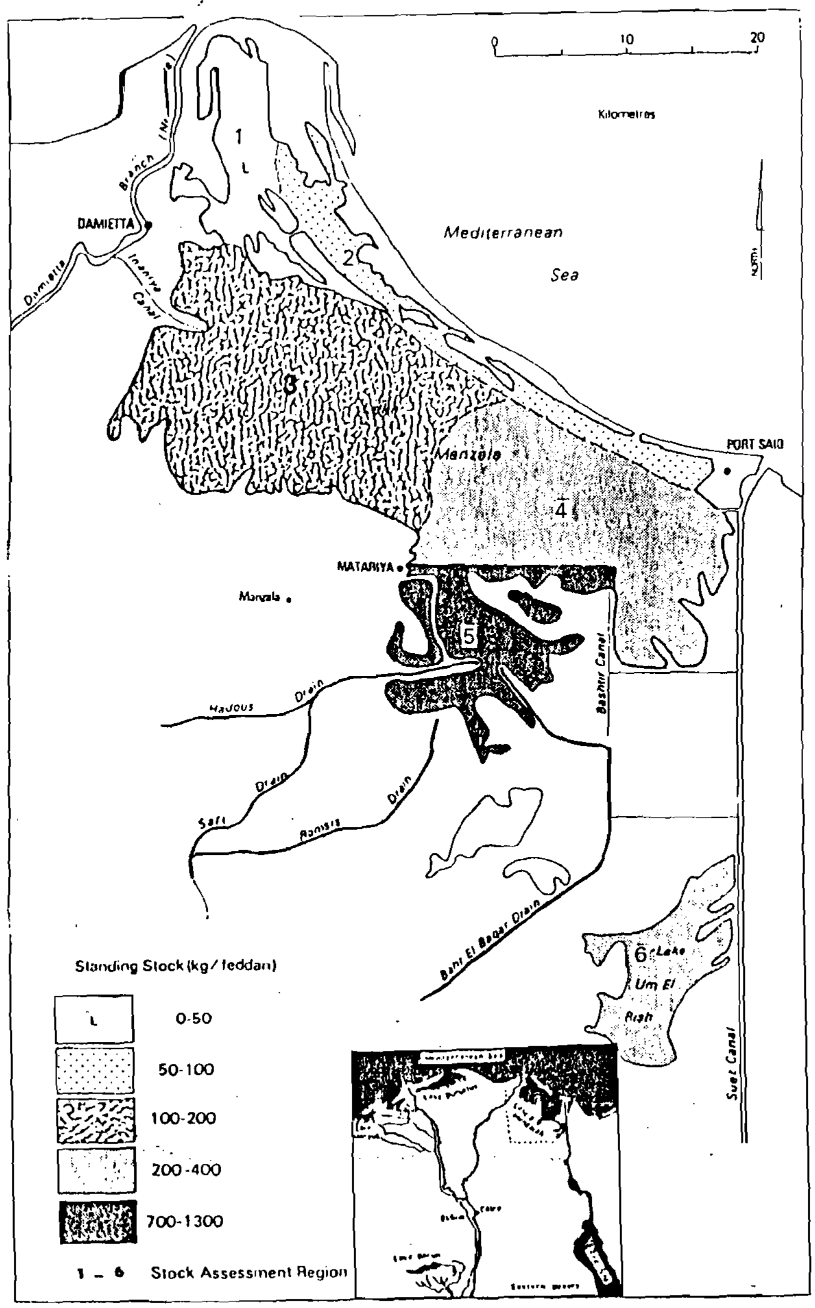

Fig. 1
Fish Standing Stock Densities

280,000 feddans and the depth of water rarely exceeds two meters. Lake Manzala is characterized by low salinities in the south and west (near the outlets of the drains and canals), brackish waters over most of the rest of the area and saline waters in the extreme northwest. Nutrients from the major drains have created eutrophic conditions in the southern parts of the Lake closest to the outlets. The eutrophic conditions have changed the aquatic biota lending to a less diverse but highly productive system (Tilapia - based fishery).

MATERIAL AND METHODS

Age determinations were made from fish scales using conventional techniques. Scale samples were taken from the pectoral located between the lateral line and the insertion of the dorsal fin. Total lengths to the nearest millimeter and weights to the nearest gram were taken in the field from fresh specimens.

RESULTS AND DISCUSSION

Four species of Tilapia are found in Lake Manzala; **Oreochromis nilotica, O. aurea, O. galilaea** and **Tilapia zillii. O. nilotica** comprised 63% of the Tilapia catch while **T. zillii** was less than 10%.

Variations in size and Growth Within Year Classes

The recruitment of Tilapia species on Lake Manzala is almost continuous during the summer period of May to September. The four species concerned are reported to spawn 3 to 6 times a year (Balarin. 1979). The extended reproduction period is reflected in pronounced size variation within year classes for all species, (Table 1). Juveniles and fry (2 to 4 cm length) were abundant during the winter months. On the other hand, young-of-the-year from early spawnings may reach a size of 12 to 19 cm by the end of the first growing season. These fish would fall into the medium (10-16cm) commercial size category and would be completely recruited to the fishery by the end of the summer.

Some reports indicate that this size variation within year classes is reduced in subsequent year classes due to differential growth (Balarin, 1979), i.e. smaller fish grow faster in later years. Preliminary analysis indicates that the size variation does not change much with time for Lake Manzala species (Table 2). This Table is based on simple minimum and maximum sizes. The degree of dispersion with a year class might be a better indicator. Bishara (1973) reported that year 1 fish resumed growth earlier in spring than older year classes. During the present study, small specimens were observed to feed much actively than larger fish during the winter in both field and laboratory conditions. Higher winter mortality among late hatched fry might be an important factor in the reduction of year class size variation.

TABLE (1)

Growth of Tilapia Species in Lake Manzala Region.

Species	No. of Fish	Mean Total Length (cm) At Age l_n			
		l_1	l_2	l_3	l_4
Oreochromis nilotica					
Region 1+2	13	6.1	12.8	26.7[1]	30.2[1]
3	2	-	-	-	-
4	79	7.3	13.6	16.3	-
5	124	8.4	15.2	17.3	-
6	31	9.2	15.6	18.5	-
Total Number	249				
Mean		7.8	14.3	19.7	30.2[1]
Oreochromis aurea					
Region 1+2	21	6.2	9.9	12.4	15.2
3	22	5.2	9.8	-	-
4	88	6.3	15.4	13.4	-
5	94	7.2	12.2	14.5	-
6	42	5.4	10.7	13.7	-
Total Number	267				
Mean		6.0	11.6	13.5	15.2
Oreochromis galilaea					
Region 1+2	11	4.7	10.1	-	-
3	47	6.6	11.7	11.7	-
4	25	5.4	9.0	-	-
5	109	6.5	11.7	13.7	15.6
6	1	-	-	-	-
Total Number	193				
Mean		5.8	10.6	12.7	15.6
Tilapia zillii					
Region 1+2	37	5.0	8.3	10.2	-
3	9	4.9	10.4	-	-
4	81	4.9	8.9	10.9	12.5
5	107	5.3	10.0	11.6	-
6	35	5.5	9.7	11.5	12.2
Total Number	269				
Mean		5.1	9.4	11.1	12.4

NOTE :

1 Based on a sample size of one.

TABLE (2)

Bank in Bank-Calculated total lengths for Tilapia Species in Lake Manzala , During 1979 to 1980.

Species	Range in Back-Calculated Length (cm) at Age l_n			
	l_1	l_2	l_3	l_4
Oreochromis nilotica	4-16	6-18	10-20	---
O. aurea	3-13	7-17	10-17	12-14
O. galilaea	3-19	7-17	9-16	14-16
Tilapia zillii	2-12	5.13	7-14	---

Condition Factor

A comparison of condition factors by region (Table 3) reveals the following trends:

- Condition factors tend to be high in the most saline regions (1, 2 and 6).
- Conditions for **O. nilotica** and **O. aurea** are relatively low in region 5 in comparison with the other two species.
- Condition of all fish species with the exception of **O. aurea** is well below the Lake mean.

A tendency for some Tilapia species to grow relatively faster in brackish than in freshwater environments has been reported by several authors (Balarin, 1979). Such a phenomenon would likely be reflected in higher condition factrors.

Length-Weight Relationships

Length-weight relationships for Lake Manzala Tilapia species may be summarized as follows:

where Y = weight in grams and X = length in mm;

Oreochromis nilotica $\log Y : -1.6842 + 2.9838 \log x$
Oreochromis aurea $\log Y : -1.6339 + 2.8969 \log X$
Oreochromis galilaea $\log Y : -1.6323 + 2.9393 \log X$
Tilapia zillii $\log Y : -1.6814 + 2.9819 \log X$

TABLE (3)

Summary of Mean Condition Factors For Tilapia Species By Region.

Region	Species			
	O. nilotica	O. aurea	O. galilaea	T. zillii
1+2	---	2.19	---	2.02
3	1.77	1.93	2.07	1.98
4	2.00	1.82	2.01	1.98
5	1.90	1.78	2.05	2.05
6	2.17	1.91	2.23	2.19
Mean	1.96	1.93	2.09	2.04

NOTE

Condition Factor (CF) $= \frac{\log 10 \text{ weight (gms)} \times 10^5}{\text{length (cm)}^3}$

Comparison With Growth in Other Egyptian Lakes

A comparison of key population parameters among systems can be an effective method of fisheries assessment. Growth of Tilapia species in Lake Manzala under present conditions is well below that reported for the same species in other Egyptian systems. (Tables 4 to 7). Growth is also slower now than it was during the 1960's according to Bishara (1973). Some areas of Lake Manzala (mainly the southern sector as well as the eastern sector) have become more eutrophic in recent years due to increased nutrient loading from the large agricultural drains. The Tilapia fishery has responded. Stocks are now at very high levels (1000 Kg/feddan in the southern sector), and yields are more than doubled. The southern sector may now be regarded as equivalent to a semi-intensive pond culture system. The problems of reduced growth and stunting resulting from overrecruitment and high stock densities in such enriched conditions are well known (Fryer and Iles, 1972).

Harvesting practices tend to continuously remove the largest fish and in this way select for the fastest growing fish. An intensively exploited fishery (such as the open fishery on Lake Manzala) should evolve towards a slower growing stock. Silliman (1975) found that after 3 generations selective fishing for large specimens induced genetic changes resulting in the slower growth of male **Tilapia mossambica.**

TABLE (4)

Summary of Age and Growth Data for **Oreochromits nilotica** in Egyptian Lakes.

Lake	Mean length (cm) at Age l_n						Age at First Maturity	Size at First Maturity (Length in cm)	Sample Period	Source
	l_1	l_2	l_3	l_4	l_5	l_6				
Manzala	7.8	14.3	19.7	30.2	---	---	1	11-12	1979-1980	Present Study
Manzala	10.8	16.9	21.0	22.7	25.9	---	1	12	1967-68	Bishara, 1973
	9.9	14.6	18.0	19.7	20.0	---	1	9	---	---
Nasser	7.9	22.2	26.1	35.7	41.8	43.6	---	---	---	Payne & Collinson, 1979
Tahrir Drain	6.3	11.7	17.8	19.5	22.2	---	---	---	---	Payne & Collinson, 1979
Mariut	11.1	22.1	26.5	30.7	---	---	---	---	---	Payne & Collinson, 1979
	8.4	21.2	20.2	32.7	---	---	---	---	---	El-Zarka et al
	9.2	20.5	25.7	28.8	30.7	31.7	1-2	20	---	1966, Jensen, 57
Beteha, Syria	9.9	16.4	20.4	27.5	---	---	---	---	---	El-Bolock and Koura, 1961
Nouzha	9.2	20.5	25.7	28.8	---	---	---	---	---	El-Bolock and Koura, 1958
Hydrodrome	9.2	20.5	25.7	28.8	---	---	---	---	---	

TABLE (5)

Summary of Age and Growth Data For **Oreochromis aurea** in Egyptian Lakes.

Lake		Mean Length (cm) at Age l_n						Age at First Maturity	Size at First Maturity (Length in cm)	Sample Period	Source
		l_1	l_2	l_3	l_4	l_5	l_6				
Manzala		6.0	11.6	13.5	15.2	---	---	1	8-9	1979-80	Present Study
Manzala	•	10.6	16.1	19.3	22.0	26.0	---	1	11	1967-68	Bishara, 1973
	•	9.1	13.1	16.8	16.8	19.3	---	1	10		
Mariut		11.1	16.8	17.9	---	---	---	---	---	---	Payne & Collinson, 1979
Taberias		10.6	---	---	---	---	---	2	19	---	Ben-Tuvia, 1960

TABLE (6)

Summary of Age Growth Data for *Tilapia zillii* in Egyptian Lakes.

Lake	Mean Length (cm) at Age l_n						Age at First Maturity	Size at First Maturity (Length in cm)	Sample Period	Source
	l_1	l_2	l_3	l_4	l_5	l_6				
Manzala	5.1	9.4	11.1	12.4	---	---	1	5.0	1979-80	Present Study
Manzala	7.0	13.0	16.5	19.4	21.5	---	1	8	1967-68	Bishara, 1973
	6.2	11.8	14.9	17.8	20.3	---	1	7		
Mariut	7.2	13.3	18.4	21.1	23.3	24.3	1-2	13	---	Jensen, 1957
Qarun	6.0	---	---	---	---	---	---	7	---	
	6.1	13.5	18.0	19.7	20.8	---	1	6	---	El-Zarka,1961
Quarun	8.0	14.9	19.8	23.3	25.9	27.7	---	---	---	Bishara, 1973
	5.9	12.3	16.8	19.8	21.8	23.2	---	---	---	
Tahrir Drain	8.6	---	---	---	---	---	---	---	---	Payne & Coll-inson, 1979
Barrage Farm	8.5	13.8	17.8	21.2	24.3	---	1+	---	---	Bolock & Koura 1960
	8.2	13.1	16.4	19.9	22.8	---	+1	---	---	
Beteha Syria	7.2	12.7	16.0	18.2	20.2	---	---	---	---	Bolock & Koura, 1961

TABLE (7)

Summary of Age and Growth Data for **Oreochromis galilaea** in Egyptian Lakes.

Lake	Mean Length (cm) at Age l_n						Age at First Maturity	Size at First Maturity (Length in cm)	Sample Period	Source
	l_1	l_2	l_3	l_4	l_5	l_6				
Manzala	5.8	10.6	12.7	15.6	---	---	---	10-11	1979-80	Present Study
Manzala	° 8.7	13.5	17.9	22.4	24.3	---	1-2	15	1967-68	Bishara, 1973
	° 7.1	12.2	16.4	20.0	21.3	---	1-2	14		
Mariut	8.3	21.6	25.3	27.7	28.1	29.8	1-2	---	---	Jensen, 1957
Beteha,	9.1	20.6	26.6	31.5	33.4	34.7	---	---	---	Bolock and
Syria	9.1	20.6	26.6	31.5	33.4	34.7				Koura, 1961
Tiberias	° 13.8	---	---	---	---	---	2	23	---	Ben-Tuvia,
	° 13.9						2	22		1960

Differential Growth Rates Among Sexes

The male sex of all four Tilapia species grows faster on Lake Manzalah (Table 4 to 7) and elsewhere (Bardach et al., 1972; Fryer and Iles, 1972; Balarin, 1979). The Lake Manzalah open fishery selects for male Tilapia, a phenomenon which may be size-related. Males represented less than 50% of the standing stock for all species while the commercial catch was more than 50% males. In the most intensively exploited species, **Oreochromis nilotica**, the difference was the greatest. Only 22 % of the standing stock consisted of males while 69% of the commercial catch was males.

El-Zarka (1961) reported that female **T. zillii** from Lake Qarun became increasingly dominant in older age classes and suggested this might be due to size-sex selective fishing mortality.

Age and Size at Maturity

Lake Manazala Tilapia mature earlier and at a smaller size than did the same species of other Egyptian Lakes (Tables 4-7). The bulk of the Tilapia matures during the second growth season (i.e. at the end of the first year). **T. zillii** matures at the smallest size and may exhibit developing gonads at 5 cm in length. **O. nilotica**, the largest species matures at around 11 to 12 cm. in length.

Bardach et al. (1972), Fryer and Iles (1972), Balarin (1979) and others have pointed out that in ponds Tilapia mature much earlier (3 - 6 months) and at a smaller size. In such situations, Tilapia also tends to produce larger number of smaller eggs. This increases in reproductive capacity in response to environmental stresses (e.g. unstable environmental conditions in eutrophic environments, predation or exploitation stress), usually results in overstocking and stunting. Such a situation may exist in Lake Manzala (especially in the southern sector).

Spawning Seasons

According to Fryer and Iles (1972) water temperature of 20°C or higher are necessary to initiate reproduction activity in Tilapia.

Lake Manzala reaches this temperature iun late March or early April which corresponds with the startof the reproductive season.

All species appear to spawn more than once during the four or five month season which ends in September to October. Spawning activity for **O. nilotica** appears to peak in Spring (April to May) with a definite mid-summer full in July. This pattern is less pronounced in **O. aura** and **O. galilaea,** while **T. zillii** appears to spawn activily throughout the summer.

Feeding Habits

Oreochromis species have fine gill rakers and are generally planktophagous while **Tilapia** species have fewer gill rakers and are mainly herbivores feeding on macroplant material.

Stomach content analysis for three Lake Manzala species (Table 8) have generally confirmed Balarin's pattern (1979) regarding the dietary attributes of the four species. However, **O. nilotica** and **O. aura** may be somewhat more omnivorous than sometimes thought. The marine benthic polychaete **Neris** was found in the majority of stomachs examined. Laboratory experiments indicated that all three species would readily consume such items as small shrimp, bread, ground-up fish and vegetable matter. The macrophyte **Potamogeton** which is common all over the Lake was readily consumed, but **Ceratophyllum** was not eaten.

The bulk of the phytoplankton ingested by the **Oreochromis** species consisted of diatoms, especially **Navicula**. Diatoms are regarded as a prime phytoplanktonic fish food and comprise more than 80% of the standing crop of phytoplankton in the Lake.

Effect of Salinity of Tilapia Distribution in the Lake

Increased salinity affects basic life processes at different levels of salinity. **T. zillii** is definitely the most salinity tolerant of Lake Manzala species and can reproduce, and grow at sea water salinities (i.e. 40 000 mg/l). Oreachromis species appear to rank as follows in terms of salinity tolerance: **O. aurea, O. nilotica, O. galilaea.** On Lake Manzala, Oreochromis species do not do well and are not abundant when salinities exceed 5000 to 8000 mg/l for extended periods (i.e. in regions 2 and 6) and are virtually absent at salinities over 15000 to 20000 mg/l (i.e. region and the northern coastal strip of region 2).

TABLE (8)

Stomach Contents of Tilapia Species From Lake Manzala During JUne 1979.

Diet Item	Percentage Occurrence		
	O. nilotica	**O. aurea**	**T. zillii**
Neris sp.	80	45	80
Detritus	60	6	67
Fish Scales	---	16	13
Macrophytes	---	10	33
Phytoplankton	60	61	---
Zooplankton	20	10	7
Insect Larvae	---	---	7
Protozoans	---	3	7
Foraminifera	---	6	---
Digested Food	13	42	27

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