Vol. VII Fasc. 1 Szczecin 1977

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Fish ecology

PHYSICAL AND CHEMICAL FACTORS AFFECTING FISH DISTRIBUTION IN LAKE MANZALAH – EGYPT

FIZYCZNE I CHEMICZNE CZYNNIKI WPŁYWAJĄCE NA ROZPRZESTRZENIENIE RYB W JEZIORZE MANZALAH

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The fish distribution in Lake Manzalah, the largest of the Delta Lakes of Egypt, was studied and discussed in the light of the prevailing physical and chemical conditions. The lake-sea connection is of vital importance for the welfare of the lake and has a pronounced effect on the fish distribution.

Many marine forms like *Mugil cephalus, M. capito, Sciaena aquilla, Chrysophris aurata, Morone labrax, M. punctata* and shrimps can tolerate the brackish water of the lake during certain phases of their life.

Tilapia spp., namely *Tilapia aurea, T. galilaea, T. nilotica* and *T. zillii* being the principal fish in the lake have different degrees of salinity tolerance.

The tolerate limits of different ecological factors like salinity, temperature, pH and dissolved oxygen was determined for different species of fish.

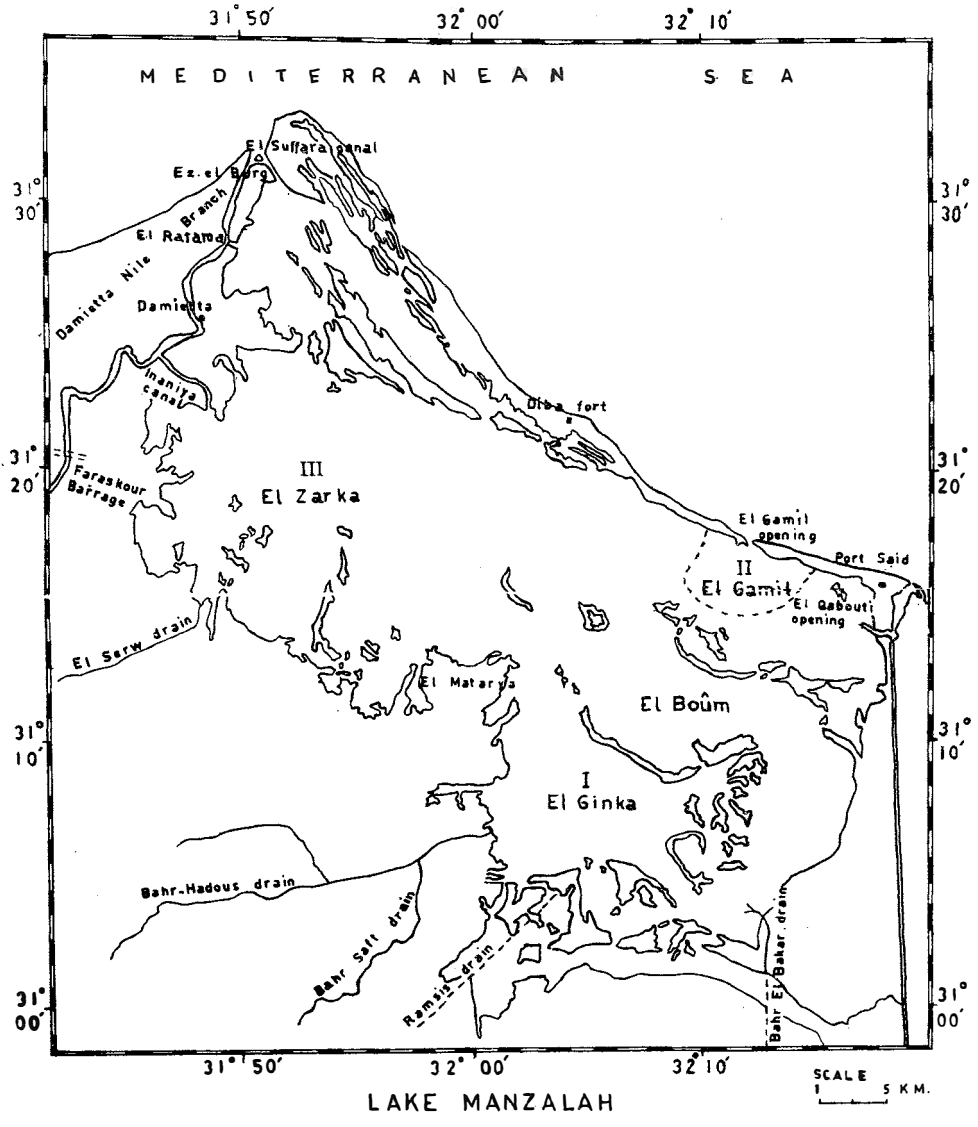
DESCRIPTION OF THE LAKE

Lake Manzalah is the largest of the Delta Lakes. It has an area of (1275 km^2). It is surrounded by the Mediterranean Sea to the North, the Suez Canal to the East and Damietta Branch of the Nile to the West. The southern shores of the lake form the North boundary of Dakahlia and Sharkia Governorates.

The lake is generally shallow, where the average water depth may not exceed 1.25 meters. Scattered in the lake are numerous islets of varying sizes which may be sandy, clayey or formed of *Cardium* shelles; these islets divide the lake into several basins.

The lake is connected with the Mediterranean Sea through an opening at El-Gamil, lying at a little distance to the West of Port Said. The lake is also connected with the Suez Canal through a lock at Rl-Kabouti, a few kilometers to the South of Port Said. This Lock permits the passage of fishermen's boats but no water is exchanged freely between the Suez Canal and the lake.

Three canals: El-Souffara, El-Ratama, and El-Enanyia join the lake with Damietta Nile branch north to Faraskour. Before the construction of the high dam at Aswan, these



canals permitted the inflow of the fresh Nile waters into the lake, but now the inflow of Nile waters into the lake ceased. Many big drains, e.g. Serw, Hadouse, Bahr Saft, and Bahr El-Bakar pour into the western and southern parts of the lake (Fig. 1).

The ecology of Lake Manzalah was studied by Montasir (1937), who studied the distribution of plants on the different types of islets in the lake. El-Maghraby et al. (1963) studied the ecology of zooplankton. El-Wakeel and Wahby (1970a) studied the hydrography and chemistry of the lake waters before the construction of the high dam at Aswan. They also studied (1970b) the distribution and chemistry of the bottom deposits. Wahby et al. (1972) studied the hydrography and chemistry of the waters after the construction of the high dam.

The present paper discusses the effect of the general ecological features and water characteristics on the fish distribution in the lake.

It is based on the results of the chemical analysis carried out in 1967 (Wahby et al. 1972) together with the results of 108 trips in the same year, in which the monthly distribution of fish was investigated in 41 stations covering all the area of the lake. These 41 stations were grouped in three regions:

I – the south-eastern region of the lake affected by drainage water.

II – the north-eastern region affected by the lake-sea connection.

III – the western region of the lake.

These regions coincide with those of the chemical studies to facilitate studying the effects of different ecological factors.

MATERIAL AND METHODS

108 trips were made to the different regions of the lake. In every trip the fishermen's boats were examined, every species of fish was identified and counted. The percentage species composition was calculated.

Different boats using different fishing gears were examined in every trip to eliminate, as far as possible, the effect of net selectivity.

FISHES IDENTIFIED IN THE LAKE:

Alestes dentex L.
Anguilla anguilla (L.)
Atherina spp. Artedi
Bagrus bayad Forsk.
Barbus bynni Forsk.
Caranx spps. Cuv.
Chrysophris aurata (L.)
Claries lazera C. et. V.
Callinectes sapidus Rathbun
Epinephelus spps.
Gobius niger L.
Hemirhamphus spps. Cuv.
Labeo niloticus Forsk.
Lates nilotica C. et V.
Lichia glaucus Risso
Metapenaeus monoceros Fabr.
Metapenaeus stebbingi Nobili
Morone Labrax L.

Morone punctata Bloch
Mugil auratus Risso
Mugil capito C. et. V.
Mugil cephalus Cuv.
Mugil saliens Risso
Mugil seheli Forsk.
Penaeus trisulcatus Leach.
Sardinella aurita C.et V
Sciaena aquilla Risso
Solea solea L.
Tilapia aurea (Steindachner)
Tilapia galilaea (Artedi)
Tilapia nilotica (L.)
Tilapia zillii (Gerv.)
Trichiurus spps. (L.)
Umbrina cirrosa Risso

THE EFFECT OF SALINITY VARIATIONS ON THE DISTRIBUTION OF FISHES IN LAKE MANZALAH

Salinity is one of the most important factors which affect the survival and distribution of fishes at different stages of their life. Many marine fish come near the estuaries to spawn so that the development of the eggs and early larval stages occur in water of low salinity. The effect of salinity may be direct by affecting the survival of fish or indirect by affecting the amount of plankton which constitute the main food of the early larval stages (Walford, 1946; Kandler, 1950 and Jensen, 1952).

The effect of salinity either on freshwater fish or on anadromous and catadromous fishes was studied by many investigators (Pyefinch, 1955; Black, 1957; Herbert et Mann, 1958; Parry, 1958–1960; Parry et al, 1959 and Kinne, 1958, 1963).

Lake Manzalah is connected to the sea at El-Gamil, the lake -sea connection exhibits a wide variation in salinity depending on change in the water level of the lake and the wind direction. Table (1) gives the fish distribution in the Gamil area in 1967, together with the maximum and minimum salinity observed in each mont.

Fishes of the family *Mugilidae* constiute about 15% of the total fish production. The fry and yearlings of the different species of this family enter the lake for breeding, growing and after attaining sexual maturity they migrate to the sea for spawning.

Mullets are of great importance to Lake Manzalah fisheries. Accordingly all conservational measures either in the sea or in the lake should be directed to the safeguard of the mullet fishery during the lake phase. The closing of the area of lake-sea connection for commercial fishing should continue or even be extended further in both directions. Such areas have proved very important as nursery grounds for fry and young mullet. It was also found that any disturbance in the area would frighten the fry and make them scatter in all directions without giving them any chance to shelter and feed (El-Zarka and Koura, 1965).

Morone labrax and *M. punctata* enter Lake Manzalah during certain phases of their life history. Their fry and young enter the brackish water of such lakes for feeding and growing and after attaining sexual maturity they migrate back to the sea during the winter months for spawning. During such spawning migrations the adults are subjected to intensive fishing in the lake by the unbaited long lines.

Table 1

Percentage distribution of fish in the North-eastern region during 1967

Species	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mugil capito	26.0	19.2	28.2	9.6	5.0	25.1	67.5	39.6	29.2	44.5	28.0	30.0
Mugil cephalus	6.2	3.8	5.2	19.1	15.0	11.7	0.5	4.3	6.6	5.0	13.1	12.4
Tilapia zillii	26.0	29.5	42.6	59.6	31.8	6.5	0.1	21.6	18.0	5.6	13.4	19.4
Tilapia nilotica	8.2	11.0	11.0	4.9	1.4	3.0	–	0.9	0.8	–	4.6	1.3
Tilapia galilaea	4.0	15.8	0.1	–	1.1	0.2	–	0.3	3.2	–	6.4	–
Tilapia aurea	4.3	0.7	–	2.5	4.3	4.6	–	6.0	3.3	9.2	13.0	11.7
Hemirhamphus	11.0	0.2	–	1.0	0.2	3.0	–	0.2	0.7	–	6.3	2.0
Prawns	6.0	4.0	2.3	1.1	22.6	1.8	8.0	2.0	12.0	10.0	5.8	4.4
Barbus bynni	2.4	–	–	0.1	0.2	–	–	–	–	–	–	0.3
Sciaena aquilla	1.0	1.0	4.3	–	–	0.4	0.1	1.0	1.0	7.7	0.2	1.0
Schilbe mistus	0.2	–	–	–	–	–	–	–	–	–	–	–
Morone punctata	3.5	2.6	1.0	–	6.0	7.7	5.0	2.7	9.4	3.3	–	6.0
Crabs	0.8	1.3	–	–	–	–	–	–	2.7	–	–	0.3
Morone labrax	0.4	1.2	0.5	–	3.0	2.0	–	–	–	0.3	3.4	0.8
Epinephelus spp.	0.2	–	–	–	–	–	–	–	–	–	–	0.1
Chrysophris spp.	1.0	3.8	0.3	–	4.8	10.0	7.5	8.4	2.2	2.0	0.2	0.2
Solea spp.	0.3	1.7	–	–	–	–	–	–	3.0	0.4	–	0.5
Atherina spp.	–	1.5	2.0	0.8	1.0	–	–	–	–	1.7	1.0	–
Bagrus bayad	–	0.3	0.2	–	–	2.0	–	–	–	–	2.0	–
Mugil saliens	–	1.6	–	0.5	1.8	19.0	10.5	9.1	–	9.5	1.2	3.4
Anguilla anguilla	–	0.3	–	–	–	–	–	–	–	–	1.0	0.4
Labeo niloticus	–	0.3	0.2	0.1	0.1	–	0.4	–	1.8	–	0.6	2.6
Gobius niger	–	–	1.6	–	–	–	–	–	–	–	–	0.2
Umbrina cirrosa	–	–	–	–	0.2	–	–	–	–	–	–	–
Sardines	–	–	–	–	1.0	2.2	0.6	0.5	2.0	–	–	–
Mugil auratus	–	–	–	–	–	–	0.3	1.1	–	–	–	–
Caranx spp.	–	–	–	–	–	–	0.1	–	–	–	–	–
Alestes dentex	–	–	–	–	–	–	–	0.2	–	–	0.1	0.3
Mugil seheli	–	–	–	–	–	–	–	2.1	–	–	–	–
Teuthis sigan	–	–	–	–	–	–	–	–	4.2	–	–	0.1
Trichirus spp.	–	–	–	–	–	–	–	–	–	0.2	–	–
Lichia glaucus	–	–	–	–	–	–	–	–	–	–	–	2.0
No of Fish examined	5000	5000	4800	5200	5600	6000	6000	5800	7000	7000	6000	6000
Minimum salinity ‰	3.5	5.2	1.8	2.0	3.4	7.5	11.29	10.0	7.6	3.21	2.84	2.52
Maximum „	9.37	8.85	7.23	17.27	26.3	39.0	34.2	28.83	22.14	11.22	16.60	29.70

Sciaena aquilla appear in the catch in most months, the maximum occurence being in October, during this month the ripe fish become easily available to lake fishermen while going out to the sea for spawning. It is thus a matter of discussion whether to allow ripe fish to move freely to the sea ot to be caught before having the chance for spawning.

Chrisophrys sp. is found in the catch in all months of the year with a peak in summer months (June, July and August).

Anguilla anguilla are only caught in Gamil area in winter months during stormy weather. In these days a salinity gradient is developed that assists the migration of eels to the sea.

Trichiurus sp. and *Teuthis sigan* are migrants from the Red Sea but can curvive the much lower salinity of Lake Manzalah.

Fishes of the genus *Tilapia* being the principal fish in Lake Manzalah constitute about 75% of the commercial catch in the lake. Different species of *Tilapia* exhibit different ranges of salinity tolerance. *Tilapia zilli* is the most dominat species in Gamil area, and hence the most salinity tolerant. *T. nilotica* and *T. galilaeae* are found in much less quantities. *T. aurea* is more salinity-tolerant than the last two species.

The shrimp catch from Lake Manzalah amounted to about 1.2% of the production in 1967, with two peaks in May and September-October. The two peaks coincide with the appearance of juveniles of the three species: *Penaeus trisulcatus* Leach; *Metapenaeus monoceros* Fab., and *Metapenaeus stebbingi* Nobili in the lake. Shrimp showed a wide range of salinity tolerance, being found in waters with salinity ranging from 3 – 35%. The capacity to osmoregulate in salinities hypo- or hyper-osmotic to body fluids may increase or decrease in various marine and brackish water animals as a function of temperature. A number of euryhaline crustaceans maintain their internal osmo-concentration more successfully near the lower and of their temperature range when under hypo- or hyper-osmotic stress.

Close to the lower or upper limits of the tolerated temperature range, osmo-regulation breaks down completely (Kinne, 1963). This effect of temperature on osmo-regulation may be the cause of the shrimp migration out of Lake Manzalah to the sea in December when the water temperature falls to 11°C which may be close to the lower limits of the tolerated temperature range (Table 1).

The catch in the two other regions of the lake, namely the south-eastern region and western regions affected by freshwater drainage is given in Tables (2) and (3). It consists mainly of *Tilapia spp.* and *Mugilidae* together with the freshwater fishes of minor importance as *Barbus bynni, Bagrus bayad* and *Labeo niloticus.* Marine forms like *Morone labrax, Morone punctata, Chrysophris aurata* and *Sciaena aquilla* are represented to a limited extent in the western region.

The north-eastern part of the lake due to its connection with the sea, and its wide salinity range, is the richest region as regard its fish composition. We find in this region 32 species of fish in comparison to 18 species in the South-eastern region and 23 species in the western region. The different species have a wider distribution in the North eastern region than in the South-eastern or western regions.

Table 2

Percentage distribution of fish in the South-eastern region

Species	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Tilapia zillii	65.1	27.4	13.7	35.9	31.4	68.5	16.0	37.0	16.2	8.5	1.9	6.0
Tilapia nilotica	10.5	45.5	80.3	32.0	31.7	6.6	4.0	5.6	4.0	2.3	6.0	0.7
Tilapia galilaea	0.3	6.8	0.7	0.4	–	–	–	12.0	0.2	–	0.2	–
Tilapia aurea	–	–	–	29.3	–	25.0	5.0	0.9	10.0	1.0	0.1	–
Mugil capito	9.3	11.7	3.0	–	2.2	–	75.0	29.0	66.0	76.0	68.0	66.0
Mugil cephalus	5.0	4.2	1.7	–	–	–	–	0.8	2.3	7.9	2.2	1.3
Mugil saliens	–	–	–	–	–	–	–	–	–	0.2	–	1.3
Hemirhamphus	0.8	–	–	–	–	–	–	–	–	–	–	21.0
Schilbe mystus	0.2	–	–	–	–	–	–	–	–	–	–	–
Labeo niloticus	1.6	2.1	0.5	1.5	–	–	–	–	–	–	–	1.3
Barbus bynni	6.4	–	–	–	1.0	–	–	–	–	0.2	–	–
Bagrus bayad	–	2.1	–	–	–	–	–	0.8	–	1.3	0.7	–
Alestes dentex	–	–	–	0.5	–	–	–	–	–	0.8	1.2	–
Lates nilotica	–	–	–	–	–	–	–	9.0	0.3	0.2	0.2	–
Clarias lazera	–	–	–	–	–	–	–	3.7	–	–	–	–
Anguilla anguilla	–	–	–	–	–	–	–	0.9	–	–	–	–
Prawns	–	–	–	–	–	–	–	–	1.0	0.8	18.2	–
Morone punctata	–	–	–	–	–	–	–	–	–	–	1.2	1.3
No. of fish examined	3000	3000	3800	3500	4000	4000	3800	5000	4000	5000	3800	4000
Minimum salinity %	1.46	1.51	0.57	0.49	1.69	1.98	1.24	1.19	0.85	0.95	0.99	0.00
Max. salinity %	2.80	2.80	2.38	1.95	2.73	4.66	4.13	3.60	2.71	2.65	1.86	1.99

Table 3

Percentage distribution of fish in the Western region

Species	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Tilapia zilli	41.4	44.7	53.4	67.5	71.7	62.2	29.3	16.4	8.6	8.4	18.0	8.5
Tilapia nilotica	17.1	16.0	23.1	6.0	1.0	–	0.7	3.0	0.7	1.0	1.0	1.7
Tilapia galilaea	35.0	12.3	14.1	2.5	0.3	–	7.0	4.0	1.6	1.8	0.6	–
Tilapia aurea	0.8	–	–	7.0	20.9	5.3	4.3	5.7	0.5	3.4	13.0	15.0
Mugil capito	3.3	8.3	8.4	15.0	1.6	20.8	18.0	45.6	44.1	60.0	37.0	55.0
Mugil cephalus	0.5	1.8	0.3	1.1	2.8	7.2	21.2	0.7	10.4	20.0	6.0	17.0
Mugil saliens	–	–	–	0.2	0.1	–	9.4	0.5	0.4	0.5	0.2	–
Morone labrax	0.1	14.2	–	–	–	4.0	9.6	–	0.4	0.1	0.6	–
Atherina sp.	0.8	–	–	–	–	–	–	5.6	–	–	–	–
Clarias lazera	0.1	–	–	–	–	–	–	–	–	–	–	–
Lates niloticus	0.3	–	–	–	–	–	0.1	–	–	1.7	–	–
Chrysophris sp.	–	0.1	–	–	0.4	–	0.1	9.6	–	–	–	–
Labeo nilotica	–	0.1	0.4	0.2	0.1	–	–	–	0.4	0.1	0.2	–
Alestes dentex	–	–	–	0.2	–	–	–	–	0.3	–	–	–
Prawns	–	–	–	–	1.0	–	–	–	19.5	1.0	6.0	–
Sciaena aquilla	–	–	–	–	–	–	0.5	–	–	–	–	–
Morone punctata	–	–	–	–	–	–	0.8	4.0	2.7	2.0	1.0	0.8
Mugil auratus	–	–	–	–	–	–	–	0.2	–	–	–	–
Hemirhamphus	–	–	–	–	–	–	–	5.0	6.0	–	–	–
Crabs	–	–	–	–	–	–	–	0.3	–	–	–	–
Bagrus bayad	–	–	–	–	–	–	–	–	–	–	14.0	–
Barbus bynni	–	–	–	–	–	–	–	–	–	–	1.7	–
No. of Fish exam.	2500	3000	3000	3500	3700	3000	4000	4000	4000	5000	4000	3500
Min. salinity ‰	4.37	3.07	1.89	1.80	1.62	2.33	4.66	3.83	3.21	2.05	2.20	2.19
Max. „ „	4.73	5.19	2.89	5.66	7.60	6.39	9.46	9.28	8.88	8.24	3.47	3.75

That is why we suggest that a second lake-sea connection is best opened west of El-Gamil to supply the western region with marine fishes and increase the fish production.

THE EFFECT OF TEMPERATURE VARIATIONS ON THE DISTRIBUTION OF FISH

The study of the sensitivity of fish to various temperatures has been carried out by many investigators (Fry et al 1942, Fry 1951, 1958; Hart, 1947, 1952; Baily, 1955; McCauley, 1958; Bishai, 1960; Blaxter, 1960).

Temperature not only affects the survival and distribution of fish but also their growth rate, rate of development, activity, activation of reproductive processes and susceptibility to diseases.

In Lake Manzalah, the smallest *Tilapia* (up to 4 cm) were distributed and aggregated in the shallow areas (depth of water less than 15 cm) which were used as nurseries for the small fry. On calm, warm days when the water temperature of these shallow areas ranged between 30–36°C young *Tilapia* were found in large numbers. On cold days, the water temperature follows that of the air and shallow water becomes colder than deep water. On these days it was noticed that young *Tilapia* became less numerous than in calm warmer days.

Bailey (1955) recorded a sudden mortality among fish in a Michigan Lake on a hot summer after noon. He noticed that the young of the less tolerant species had a greater heat resistance than the adults. The fact that the younger stages of fish are more heat resistant may explain the tendency of young fish to remain in warmer water while older fish nove into colder water (Table 2). This is in accordance with our observations on fry of *Tilapia* species in Lake Manzalah. Nevertheless many workers failed to demonstrante a significant correlation between size and temperature tolerance in the various species of fish they studied (Hart 1947, 1952; Brett 1952; Tsukuda, 1960).

The temperature in shallow inshore waters of lakes and in ponds may increase rapidly during summer. Naguib (1958) recorded temperatures as high as 45°C in the inshore water of Lake Qarûn rich in *Tilapia zillii* during August. In Lake Manzalah temperatures up to 36°C were recorded in the shallow water areas. If such high temperatures prevail for long periods (more than 24 hours) they will be fatal to the early larval stages, but older fishes will be able to escape by migrating to more deeper water.

Doudoroff (1942, 1945) has presented evidence that lethal cold can be more important than lethal heat as a factor limiting the distribution of marine fishes and as a hazard to some fishes in their native habitat. In Lake Manzalah, in exceptionally cold days when the water temperature decreased to below 10°C in January and February, mortality of *Tilapia* and *Lates nilotica* was observed.

Cridland (1962) showed that temperature has a considerable effect on both growth rate and the onset of sexual maturity of *Tilapia zillii.* Ben Tuvia (1960) mentioned that it

Table 4

Tolerated temperature, pH, and oxygen content ranges for the importent fish species in Lake Manzalah

Species of Fish	Month and region of maximum occurrence	Temperature range °C	pH range	Tolerated oxygen content (ml/L)
Mugil capito	July (N.E.) & (S.E.)	31.1	8.11 – 8.57	4.70 – 5.00
	October (Western)	20.8	–	4.82
Mugil cephalus	April, May (N.E.)	19.0 – 21.5	8.10 – 8.09	5.00 – 5.55
	July (Western)	31.1	8.34	5.02
Tilapia zillii	March, April (N.E.)	14.8 – 19.0	7.87 – 8.10	5.22 – 5.00
	January, June (S.E.)	11.3 – 26.0	8.26	5.07
	April, May (Western)	19.0 – 21.5	8.17	5.86
Tilapia nilotica	February, March (All regions)	14.0 – 14.8	8.2 – 7.80	6.19 – 5.22
Tilapia galilaea	February (N.E.) & (S.E.)	14.0	8.2 – 8.96	6.19 – 5.49
	February, February, March (Western)	11.3 – 14.8	7.8 – 8.28	4.98 – 5.59
Tilapia aurea	October, November & December (N.E.)	20.8 – 11.8	8.15 – 8.50	6.29 – 5.70
	April, June (S.E.)	19.0 – 26.0	7.86 – 8.26	5.07 – 5.43
	May (Western)	21.5	8.17	6.86
Morone labrax	May (N.E.)	21.5	8.1	5.35
	February and July (Western)	14.0 – 31.1	8.2 – 8.34	5.39 – 5.00
Morone punctata	May and June (N.E.)	21.5 – 26.0	8.1	4.70 – 5.55
Chrysophris	June, July & August (N.E.)	26.0 – 31.1	8.1 – 8.23	4.70 – 5.21
Prawns	May, September & October (N.E.)			
	and (Western)	24.5 – 20.8	8.1 – 8.15	4.82 – 5.86
Sciaena aquila	March, October (N.E.)	21.5 – 20.8	7.87 – 8.15	5.61 – 5.22
Mugil saliens	June, July & August (N.E.)	26.0 – 31.1	8.11 – 8.23	4.70 – 5.21

appears that the spawning of *Tilapia galilaea* in Lake Tiberias is affected by the weather. Bishara (1973) come to similar conclusions concerning the spawning of *Tilapia* species in Lake Manzalah. Kinne (1963) mentioned that once certain pre-requistis are given such as the appropriate physiological conditions, food and space, the time of reproduction (breeding season) of most marine or brackish water animals depends primarily on temperature. Other physical factors, like salinity, light and pressure or biological factors are usually less important. Also the results of Le Cren (1958) and those of Coble (1966) a strong growth-temperature relatioships.

The following Table (4) gives the most important species of fish, the month and region of maximum occurrence together with the temperature range tolerated during this period in Lake Manzalah.

EFFECT OF HYDROGEN–ION CONCENTRATION ON THE DISTRIBUTION OF FISH

There appears to be little work on the degree to which fish can detect and avoid water of abnormally low or high pH (Powers 1921, 1939, 1941;, Jones 1948; Collins 1952).

Bull (1940) concluded from his conditioned response experiments that marine teleostes were able to discriminate a reduction in pH of sea water between 0.04–0.06.

Doudorff (1957) pointed out that very young fish night be some-what more sensitive to extremes of pH than adults.

Bishai (1962) concluded that the response of salmon and brown trout alevins and fry to low pH caused by CO_2 or HCl depended on the age of the fish and not the species. Althought the fry showed a definite negative reaction to water of low pH, they were indifferent to alkaline water up to pH 9.8.

A critical review of voluminous pertinent literature (Doudoroff et Katz 1960) has led to the conclussion that most if not all the fully developed freshwater fishes can live indefinitely in waters with pH above 5.0 and up to 9.0 at least. This is the pH range found in Lake Manzalah. Much more extreme pH values, perhaps even below 4.0 and well above 10.0 can be tolerated for long periods by the most resistant species and for short periods by the more sensitive forms. In Lake Manzalah such extreme pH values were never met with.

The pH of Lake Manzalah waters is always on the alkaline side, ranging between 7.8 and 8.96. This pH seems to be very suitable for the survival of different species of fish either marine or freshwater. Young fish of *Tilapia* species were found to aggregate in shallow areas rich in water plants, having relatively high pH values.

In Table (4) the most important species of fish, the month and region of maximum occurrence, together with the pH range tolerated during this period, are given.

EFFECT OF DISSOLVED OXYGEN ON THE DISTRIBUTION OF FISH

In nature fish may encounter waters of low oxygen concentrations or waters where complete oxygen depletion is taking place. Various investigators have shown that fish are always present where the oxygen concentration is high enough to maintain their life and that fish tend to choose water of high oxygen concentration (Erikson and Tounsend 1940, Allan et al, 1958; Alabaster 1959 and Bishai 1962). Table (4).

Perhaps one of the best generalizations is that of Ellis et al, (1946) based upon several thousand field determinations made on inland waters in central United States, viz, that in general "dissolved oxygen at levels of 3 p.p.m or lower should be regarded as hazardous to lethal under average stream or lake conditions and that 5 p.p.m. or more dissolved oxygen should be presen in waters if conditions are to be favourable for freshwater fishes".

Injury of fish by abnormally high concentrations of dissolved oxygen has been reported (Doudoroff 1957), but Wiebe et McGavock (1932) have shown that young trout, various centrarchids and minnows can withstand very long exposure to concentrations varying from 20 to 34 p.p.m. or from two to more than three times the corresponding air saturation values without apparent harm.

In the plant belt covering vast areas of the Egyptian lakes, Wahby (1961) reported saturation values as high as 360%, in Lake Maryût. In Lake Manzalah oxygen saturation values in these plant areas was determined and found to be 280% saturation. *Tilapia* and other forms of fish thrived in these areas and used it as nursery grounds. In these clear, well oxygenated areas large quantities of *Tilapia* fry in which *Tilapia zillii* dominate were noticed. When the water got turbid due to stirring by wind or the activity of fishermen, the young fish in these areas were not confined to the shallowest waters, but were more widely distributed.

Consequently the young *Tilapia* became numerically less when turbid conditions prevailed. Welcomme (1964) noticed some indication that light was in part a controling factor in fish distribution. This is also in accordance with Lowe (1958) concerning the behaviour of *Tilapia nilotica* on Lake Albert beaches. In Table (4) the most important species of fish the month and regions of maximum occurrence together with the oxygen content tolerated during this period in Lake Manzalah, are given.

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FIZYCZNE I CHEMICZNE CZYNNIKI WPŁYWAJĄCE NA ROZPRZESTRZENIENIE RYB W JEZIORZE MANZALAH W EGIPCIE

Streszczenie

Jezioro Manzalah posiada powierzchnię 1275 km^2, można w nim wyróżnić 3 części: południowo-wschodnią o wodzie słodkiej, północno-wschodnią łączącą się z morzem i zachodnią. Północno-wschodni odcinek, łączący się z morzem wykazuje największy zakres zasolenia (1,8–35‰) i jest najobfitszy w różnorodne gatunki ryb. Występują w nim 32 gatunki, w porównaniu do 18 w południowo-wschodniej części i 23 w zachodniej.

W północno-wschodnim basenie gatunki z rodzaju *Tilapia* wykazują różną wrażliwość na zasolenie. *T. zillii* wykazuje największą tolerancję na zasolenie i jest dominującym gatunkiem. *T. nilotica* i *T. galilaea* występują w znacznie mniejszych ilościach, chociaż *T. aurea* jest więcej tolerancyjna w stosunku do dwóch ostatnich.

Temperatura jeziora, między 11°C a 36°C jest na ogół sprzyjająca rybom, z wyjątkiem dni bardziej chłodnych, kiedy spada poniżej 10°C w styczniu i lutym. Obserwowano wtedy śmiertelność wśród *Tilapia* i *Lates nilotica*.

Odczyn wody j. Menzalah jest alkaliczny i pH wynosi 7,8–8,96. Zdaje się, że jest to czynnikiem sprzyjającym dla przeżywania ryb, zarówno morskich jak i słodkowodnych.

Nie zaobserwowano objawów braku tlenu, a nawet w pasie porostu roślinności obserwowano przesycenie tlenem a *Tilapia* i inne gatunki ryb znajdują w nich dobre gatunki żerowania.

Саад Д. Вахбы, Набила Ф. Бисхара

ФИЗИЧЕСКИЕ И ХИМИЧЕСКИЕ ФАКТОРЫ, ВЛИЯЮЩИЕ НА РАСПРЕДЕЛЕНИЕ РЫБ В ОЗЕРЕ МАНЦАЛАХ (ЕГИПЕТ)

Р е з ю м е

Поверхность озера Манцалах составляет 1925 кв. км. В нём можно выделить три части: юго-восточную пресноводную, соединяющуюся с морем северо-восточную и западную. Северо-восточный участок, соединяющийся с морем, является засолённым наиболее (1,8-35%) и характеризуется обилием разных видов рыб. Здесь обитает 32 вида рыб, в то время как в юго-восточной части озера - 18, а в западной - 23 вида.

В северо-восточной части озера виды из рода Tilapia характеризуются разнообразной реакцией на солёность воды. T. zillii характеризуется наибольшей толерантностью к солёности и является здесь преобладающим видом. T. nilotica и T. galinaea встречаются в значительно меньшем количестве, а T. aurea более толерантна к данному фактору, чем два последних вида.

Температура воды в озере (от 11°C до 36°C) в общем благоприятна для рыб, за исключением более холодных дней, когда в январе и феврале температура падает ниже 10°C. В этот период наблюдалась смертность среди Tilapia

Реакция воды озера является щелочной и pH составляет 7,8-8,96. По всей вероятности это является благоприятным для выживаемости рыб фактором, как морских, так и пресноводных.

Не отмечалось признаков недостатка кислорода, а в зоне роста растительности наблюдалось перемещение кислорода. Tilapia и другие виды находят здесь необходимый для себя корм.

Received: 28 X 1976

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