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EFFECT OF SUDDEN CHANGES IN TEMPERATURE AND SALINITY ON DIFFERENT SIZES OF *TILAPIA Spp.*

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Abstract

The effect of sudden changes of temperature and salinity on three different sizes of *Tilapia Spp.* was evaluated. Fish caught from the Nile river was subjected to different temperatures and salinities.

Large fish responded faster than small fish when the temperature dropped from 20 to 4, 8, 10°C. However, small fish responded faster when temperature rose to 35 and 40°C. Mortality rate was 100% when the Tilapia were switched to either 4°C or 40°C.

In the salinity experiments, the large fish were more sensitive to the high salinity. The mortality rate was 100%, when the fish were quickly subjected to 40, 45, 50% NaCl.

It is suggested, because of these findings, that :

A- *Tilapia Spp.* should be acclimated gradually to the different temperatures and salinities when transferring them from one place to another.

B- Transfer operation could be done during autumn and spring when the fluctuation in temperature in natural water is less.

INTRODUCTION

In Egypt, the culture of fish is being widely supported to help provide additional food resources. One type of fish being raised is the Tilapia, a mixture of closely related species, indigenous to the Nile River. One question that fish cul-

turists are faced with is the tolerance of *Tilapia* of different sizes and species to the effects of transfer to water of varying salinities and temperatures as they are moved about during the culture process.

Maar *et al.* (1966) stated that *Tilapia* can withstand a difference of 5.6-8.4°C about the acclimation temperature. Bishai (1965) reported unique results from *T. niloticus* in Egypt where the fry are more tolerant to temperature than either larvae or adults. Nevertheless *T. niloticus* is quoted by Kirk (1972) to be tolerant and reproduce at salinity from 13.5-29% in the Great Bitter Lakes of Egypt.

On the other hand, a great loss in poductions can occur when the fish are subjected to extreme changes in temperature or salinity. Lotan (1960) found that, *T. niloticus* cannot withstand a sudden transfer to above 70% sea water.

Yashaw (1960) showed that a drop in temperature to 5 and 7°C is dangerous for *T.nilotica* survival during winter. Hauser (1977) found that, mortality occurs in *T. zillii* if the water temperature rises above 37.5°C or drops to 11.2°C.

The present studies were carried out to determine the susceptibility of the different sizes of Tilapia Spp. from the lower Nile to various temperatures and salinity levels.

MATERIALS AND METHODS

Three different sizes group of *Tilapia sp.*, total lengths 7-9 cm, 9-11 cm and 11-13 cm, were selected from fish caught from Nile River in January 1981. These fishes were comprised *T.Nilotica* and *T. Zillii* with each size group having a mixture of both species. The fish were transferred to the laboratory in 100-litre plastic containers, which were filled with water from the river (16°C, 4.5%). Fish were acclimated to freshwater 1.4% (tap water and 20°C). According to Beamish (1970) optimum temperature prefered by Tilapia occurs between 20 and 25°C. The acclimatization was carried out for five weeks in aquaria (dimensions 50 cm X 120 cm with water level 50 cm).

The aquaria were treated with potassium permanganate 1: 100.000 for 0.5 hour three times during acclimatization as prophylactic. Two series of experiments

were conducted: One with different temperatures : 4, 8, 10, 30, 40°C and constant salinity of 1.4%, the other experiment with different levels of salinity 5, 10, 20, 25, 30, 34, 40, 45, 50% and constant temperature of 20°C.

Water in the experimental containers was brought to the required temperature and salinity before the introduction of the fish. High tempertaure control was achieved using 0.75-kw heaters. Low temperature was obtained by the use of ice trays from a refrigeration unit. Sodium chloride (98% purity) was used to obtain the required levels of salinities during the experiments. According to Chervinski (1975) under laboratory conditions, substitution of sea water by salt water for fish acclimatization is technically feasible.

Five fish randomly selected from each length group were used in each experiment. The fish were transferred directly from the acclimated aquaria to the experiemental containers for two hours of observation. At the end of the two hours, surviving fish were returned to the acclimaed aquaria and further observed for survival rate.

Behaviour response of the fish and mortality in relation to sudden changes in temperature and salinity were recorded. During the experiment the water was constantly aereated and no feed was added.

RESULTS AND DISCUSSION

A sudden change in temperature from 20°C to 4°C caused cold stupor in all the fish within 3 minutes of the transfer. Large fish were affected faster than the small fish. Mortality was 100% after one hour (Table 1). Table 2 shows that the mortality rate was 20% after one hour exposure at 8°C, and the remaining 80% restored their normal movement when they were transferred to their adaptated acquaria (20°C).

Table 3 shows that a sudden temperature drop from 20°C to 10°C did not cause any mortality. Nevertheless, the smaller fish lost their equii librium, while the larger fish became semi paralyzed. After 2 hours the fish recovered completely.

Table 1. Observed behaviour and time to mortality for five *Tilapia* spp. acclimatized to 20°C after transfer to 4°C.

Temp. °C	Length of the fish (Number)			No. of dead fish	Mortality %
	7-9 cm (1)	9-11 cm (2)	11-13 cm(2)		
20	Normal	Normal	Normal	--	--
4	No change	Semi paralysis floating on side Movement of the gills and fins only	complete paralysis	--	--
4		All fish are paralysed		--	--
4	" "	" "		--	--
4	" "	Dead	Dead	5	100

Table 2. Observed behaviour and time to mortality for five *Tilapia* spp. acclimatized to 20°C after transfer to 8°C.

Temp. °C	Length of the fish (Number)			No. of dead fish	Mortality %
	7-9 cm (1)	9-11 cm (2)	11-13 cm(2)		
20	Normal	Normal	Normal	--	--
8	------	Semi paralysis with	paralysis	--	--
8	semi paralysis with trying to jump from once in a while very weekly semi paralysis	Movement to the pectoral fins Laying in one side		--	--
			Dead	1	20%
20	Movement to the pectoral and dorsal fins	Movement to the pectoral and dorsal fins	--	--	--
20	Recovered	Recovered			

Table 3. Observed behaviour and time to mortality for five *Tilapia* spp. acclimatized to 20°C after transfer to 10°C.

Temp. °C	Length of the fish (Number)			No. of dead fish	Mortality %
	7-9 cm (1)	9-11 cm (2)	11-13 cm(2)		
20	Normal	Normal	Normal	--	--
8	Lying on their back		Semi paralysis movement to the pectoral fin	--	--
4	Normal body position without swimming		" "	--	--
10	Attempt to swin and to jump		" "	--	--
10	Normal body position without swimming		" "	--	--
20	Recovered	Recovered	" "	--	--

A sudden increase in temperature from 20°C to 30°C had no affect on survival rate nor on fish activity (Table 4). An increase in temperture to 40°C affected the fish and the mortality was 100% after one hour and 40 minutes (Table 5). Smaller fish were affected faster than the larger fish.

Tables 6-15 present the results obtained in the second series of experiments when the fish were exposed to different ranges of salinities. At a constant temperature, the survival rate was 100% when fish were transferred from 1.4% to 5, 10, 15, 20, 25, 30 and 35% NaCl. However, the mortality rate was 100% with transference to 40, 45 and 50 % salinities.

The above results showed that *Tilapia* sp. are affected by sudden changes in temperature and salinity, and small fish tolerate transference to low temperature better than large fish.

Respectively, the drop in the temperature from 20 to 8 and 10°C did not appear to harm fish and all fish remained viable. This result concurred with Yashaw (1960), who observed that when the temperature dropped was to 7.5, 8, 17 and 10°C, the survival rates of *T. nilotica* and *T. galliluea* were 100%.

On the other hand, observations here showed that the small fish were more sensitive when they were exposed to high temperature, 30°C and 40°C.

However, behaviour of the fish was affected at temperatures 8, 10 and 30°C. This concurs with Kutty and Sukumaran (1975) who indicated that lower and higher critical temperatures of swimming, failure was obtained at 17.4, 18.8, 19.8°C and 39.7, 37°C. Mortality rate was 100% on the extreme level of temperatures 4°C and 40°C.

This result almost agreed with the finding of Hauser (1977). He recorded that the death of *T. Zillii* occurred at water temperature above 39°C and below 11.2°C.

In salinity experiments, the large fish were tolerant to the high level of salinity. Maximum salinity tolerance for all sizes occurred between 20 and 35%.

The mortality rate ws 100% when fish were subjected to 40, 45, 50% NaCl

Table 4. Observed behaviour and time to mortality for five *Tilapia* spp. acclimatized to 20°C after transfer to 30°C.

Temp. °C	Length of the fish (Number)			No. of dead fish	Mortality %
	7-9 cm (1)	9-11 cm (2)	11-13 cm(2)		
20	Normal	Normal	Normal	--	--
30	Normal	Normal	Normal	-	--
30		All fishes are less in activity than in their normal environment (20°C)		--	--
30		All fishes are normal		--	--
20		" "		--	--
20		" "		--	--

Table 5. Observed behaviour and time to mortality for five *Tilapia* spp. acclimatized to 20°C after transfer to 40°C.

Temp. °C	Length of the fish (Number)			No. of dead fish	Mortality %
	7-9 cm (1)	9-11 cm (2)	11-13 cm(2)		
20	Normal	Normal	Normal	--	--
40	Abnormal movement up and down attempt to jump	Normal	Normal	--	--
40	Paralysis	Semi Paralysis weak movement	Semi paralysis weak movement		
40	Died	Paralysis	paralysis	2	40%
40	Died	Dead	Dead	5	100%

Table 6. Observed behaviour and time to mortality for five *Tilapia* spp. acclimatized to 1.4% after transfer to 5% NaCl.

Salinity %	Length of the fish (Number)			No. of dead fish	Mortality %
	7-9 cm (1)	9-11 cm (2)	11-13 cm (2)		
1.4	Normal	Normal	Normal	--	--
5	all fish are normal with attempts to jump out				
5	All fish are normal in activity and movement				
5	" "	--	--	--	--
1.4	" "	--	--	--	--

Table 7. Observed behaviour and time to mortality for five *Tilapia* spp. acclimatized to 1.4% after transfer to 10% NaCl.

Salinity ‰	Length of the fish (Number)			No. of dead fish	Mortality %
	7-9 cm (1)	9-11 cm (2)	11-13 cm(2)		
1.4	Normal	Normal	Normal	--	--
10	All fish are normal in activity and movement				
10	" "	" "	" "	" "	" "
1.4	" "	" "	" "	" "	" "

Table 8. Observed behaviour and time to mortality for five *Tilapia* spp. acclimatized to 1.4% after transfer to 15% NaCl.

Salinity ‰	Length of the fish (Number)			No. of dead fish	Mortality %
	7-9 cm (1)	9-11 cm (2)	11-13 cm (2)		
1.4	Normal	Normal	Normal	--	--
15	All fish are normal	" "	" "	" "	" "
" "	" "	" "	" "	" "	" "
" "	" "	" "	" "	" "	" "
1.4	" "	" "	" "	" "	" "

Table 9. Observed behaviour and time to mortality for five *Tilapia* spp. acclimatized to 1.4% after transfer to 20% NaCl.

Salinity %°	Length of the fish (Number)			No. of dead fish	Mortality %
	7-9 cm (1)	9-11 cm (2)	11-13 cm(2)		
1.4	Normal	Normal	Normal	--	--
20	All fish are normal they attempt to jump out				
20	Normal		" "	" "	" "
1	Normal with less	" "	" "	" "	" "
"	activity. " "	" "	" "	" "	" "
"		" "	" "	" "	" "
1.4	Normal	Normal	" "	" "	" "

Table 10. Observed behaviour and time to mortality for five *Tilapia* spp. acc limatized to 1.4%° after transfer to 25% NaCl.

Salinity %°	Length of the fish (Number)			No. of dead fish	Mortality %
	7-9 cm (1)	9-11 cm (2)	11-13 cm (2)		
1.4	Normal	Normal	Normal	--	--
25	Normal, Less in activity with atte- mpts of jumping out	" "	" "	" "	" "
" "	Increased in jumping out with opening mouth up on the surface	" "	" "	" "	" "
" "	" "	" "	" "	" "	" "
1.4	Normal (recover) with less activity	" "	" "	" "	" "

Table 11. Observed behaviour and time to mortality for five *Tilapia* spp. acclimatized to 1.4% after transfer to 30% NaCl.

Salinity ‰	Length of the fish (Number)			No. of dead fish	Mortality %
	7-9 cm (1)	9-11 cm (2)	11-13 cm(2)		
1.4	Normal	Normal	Normal	--	--
30	Normal		" "	" "	" "
30	Less in activity , swimming on the surface opening thier mouths				
30	" "		" "	" "	" "
"	Opening the surface		" "	" "	" "
"	" "		" "	" "	" "
1.4	Normal (recover)		" "	" "	" "

Table 12. Observed behaviour and time to mortality for five *Tilapia* spp. acclimatized to 1.4% after transfer to 35% NaCl.

Salinity ‰	Length of the fish (Number)			No. of dead fish	Mortality %
	7-9 cm (1)	9-11 cm (2)	11-13 cm (2)		
1.4	Normal	Normal	Normal	--	--
35	Not very active				
	Swimming on the surface with less activity opening the mouth frequently. They attempt to jump out				
1.4	Normal with slow activity			"	"

Table 13. Observed behaviour and time to mortality for five *Tilapia* spp. acclimatized to 1.4% after transfer to 40% NaCl.

Salinity %o	Length of the fish (Number)			No. of dead fish	Mortality %
	7-9 cm (1)	9-11 cm (2)	11-13 cm(2)		
1.4	Normal	Normal	Normal	--	--
40		Attempt to jumpt out			
40		Slow movements swim on the surface. Opening the mouth frequently.			
40	Paralysis one dead and one paralysed	Dead	Dead	1	80%
1.4	Dead	Dead	Dead	5	100%

Table 14. Observed behaviour and time to mortality for five *Tilapia* spp. acclimatized to 1.4% after transfer to 45% NaCl.

Salinity %o	Length of the fish (Number)			No. of dead fish	Mortality %
	7-9 cm (1)	9-11 cm (2)	11-13 cm (2)		
1.4	Normal	Normal	Normal	--	--
45	All the fish were swimming at the surface. Jumping out				
45	"		Paralysis		
45	Paralysis	Paralysis	Paralysis		
45	Paralysed	2 Dead	Dead	3	60%
45	Dead	Dead	Dead	5	100%

Table 15. Observed behaviour and time to mortality for five *Tilapia* spp. acclimated to 1.4‰ after transfer to 50‰ NaCl.

Salinity ‰	Length of the fish (Number) 7-9 cm (1)	9-11 cm (2)	11-13 cm(2)	No. of dead fish	Mortality %
1.4	Normal	Normal	Normal	--	--
50	Swimming at the surface immediately and they attempt to jump out. They are less active afterwards.				
50	" "	" "	Paralysis		
50	Paralysis	Dead	One dead	2	40
50	One dead	Dead	Two dead	4	80
50	All dead	Dead	Dead	5	100

and survival time decreased correspondingly. Whitfield (1976) reported that the survival time decreased markedly for both temperature and salinity levels above 37°C and 19% for *T. randalli.*

In conclusion the transfer of *Tilapia* spp. with all sizes from one place to another should be done in the autum and spring seasons when temperature range between 20-30°C. when fluctuations in the water temperature does not reach critical levels (4°C, 40°C) for the fish.

Tilapia of all sizes should be acclimated gradually before transference of operations for building up heat and salinity resistance. Lotan (1960) stated that, by gradual adaptation, *T. nilotica* were able to withsatnd salinities of 1.5 times more than that of sea waer. Also, Chervinski and Lahav (1976) showed that *T. aurea* acclimated to 28°C for 2 weeks began to die when temperature dropped to 11°C,and those acclimated to 18°C began to die at 9°C. Mires and Shak (1974) reported that the survival rate of *M.cephalus* was higher when they were transferred gradually through a range of salinity from 2.64% Cl to 90% Cl.

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تأثير التغيرات المفاجئة في درجات الحرارة والملوحه على أحجام مختلفة من سمك البلطى

فاطمة النمكى

المعمل المركزى لبحوث الأسماك - مركز البحوث الزراعية - الجيزة .

فى هذا البحث تم اختيار تأثير التغيير المفاجئ لدرجات الحراره والملوحه المختلفة على أحجام لسمك البلطى.

وقد صيد السمك من نهر النيل وتم تعريضه لدرجات مختلفة من الحراره والملوحه وقد لوحظ أن السمك الكبير حجما تأثير اسرع من المسك الصغير عندما انخفضت درجة الحراره من ٥٢٠م إلى ٨,٤ ، ٥١٠ م .

وعلى الجانب الأخر فان السمك الصغير تأثير اسرع عندما ارتفعت درجة الحرارة الى ٣٥-٥٤٠م وكانت نسبة النفوق ١٠٠٪ عندما تعرض السمك الى درجة الحراره ٥٤ م أو ٥٤٠ م.

أما فى تجربة الملوحة فان السمك الكبير كان اكثر حساسية للملوحة العالية وكان معدل النفوق ١٠٠٪ عندما تعرض السمك فجاه الى درجات تركيز ٤٠ ، ٤٥ ، ٥٠٪ كلوريد صوديوم.

وكنتيجة لهذه النتائج تقدمنا بالمقترحات الأتية :-

١. من المفروض اقلمة سمك البلطى تدريجيا لدرجات الحراره والملوحة المختلفة عند نقله من مكان إلى آخر.

٢. من الافضل اجراء عملية النقل خلال الربيع والخريف عندما يكون التغير فى درجات الحراره اقل.