INFLUENCE OF CONSTANT TEMPERATURE ON THE GROWTH OF NILE TILAPIA, *Sarotherodon niloticus* (PISCES, CICHLIDAE) [1]

Hitoshi Nomura [2]

INTRODUCTION

The purpose of aquiculture is to produce protein of animal (fishes, crustaceans, mollusks etc.) and plant (algae) origin, at low cost. In fishculture it is convenient to find the ideal and cheapest food for each species of fish.

In 1976, the University of Delaware promoted an international conference of nutrition in aquiculture.

Only CRIDLAND (1962) made experiments with a species of tilapia, *Tilapia zillii*. keeping it at laboratory, in water at constant temperature.

This work was carried out with Nile tilapia, *Sarotherodon niloticus*, kept in aquaria and tanks with water temperature maintained at three constant degree centigrades. The fishes were fed with proteins of plant and animal origin.

MATERIAL AND METHODS

In laboratory, 12 glass aquaria, each one measuring 60 x 35 x 25 cm, numbered 1 to 12, were used. Water of aquaria numbered 9 to 12 was kept at approximately 20ºC, in a refrigerated room; those numbered 1, 4, 5 and 8, at approximately 23ºC, and those numbered 2, 3, 6 and 7, at approximately 26ºC. Each one received 6 fishes.

---

[1] Paper presented at the International Symposium on Tilapia in Aquaculture, Nazareth, Israel, May 18-23, 1983.

[2] Escola Superior de Agricultura "Luiz de Queiroz", USP, Piracicaba

Outside the laboratory, four cement tanks were installed, each one measuring 77 x 64 x 48 cm, with 250 liters capacity. Initially, each tank received 21 fishes, kept at environment temperature. Water temperature was taken daily, at 10:00h and15:00h. All fishes were measured and weighed at the beginning of experiment, operation repeated monthly.

Food used comprised 25% fish meal, 25% soybean flour, 25% bovine blood flour and 25% wheat flour, given once a day at 10:00h, at the rate of 3% of biomass, monthly adjusted.

RESULTS

Tanks - Table I shows the mean size in weight (g) and total length (mm) at the beginning of the experiment, together with the monthly growth occurred with those parameters; also shows the mean water temperature taken at 10:00h and 15:00h.

It can be seen that, during the first month, the fishes of the four tanks showed a small initial growth, probably because they did not ingest the food, which was new to them.

Table II shows the total growth recorded during the 116 days of experiment, together with the daily growth in weight and total length. That daily growth was practically the same in the fishes at tanks 2 to 4, and smaller in tank 1. This difference is probably due to the fact that 60% of the fishes were females in tank 1, and 40% in tanks 2 to 4 (males grow faster than females).

Aquaria - Table III shows the mean size in weight (g) and total length (mm), and the mean temperature (ºC).

The same initial small growth, shown with fishes kept in tanks, was noted. In this case it was easily seen that they were not used to ingest that type of food, because of the residues in the bottom of aquaria. In order to get better oxygenation, water was changed weekly.

LE I - Growth of Nile tipalia kept in tanks in 1981.

k.	Nr. of fishes	Date	Mean weight (g)		Mean light (mm)		Tempr.	
			Initial	Monthly growth	Initial	Monthly growth	Morn.	Aft.
	21	24-8	41.4		128.9			
				6.2		6.9	22.6	22.4
	18	24-9	47.6		135.8			
				14.1		12.3	23.0	23.3
	13	27-10	61.7		148.1			
				10.1		7.2	24.0	24.9
	11	20-11	71.8		155.3			
				16.3		8.2	24.6	25.2
	11	18-12	88.1		163.5			
	21	24-8	45.7		138.9			
				7.8		6.3	22.7	22.9
	16	24-9	53.5		145.2			
				11.0		11.4	23.2	23.3
	15	27-10	64.5		156.6			
				18.7		7.9	24.0	25.0
	13	20-11	83.2		164.5			
				15.2		8.2	24.8	25.5
	13	18-12	98.4		172.7			
	21	24-8	42.1		130.1			
				6.2		6.6	23.2	23.5
	18	24-9	48.3		136.7			
				13.5		13.2	22.9	23.0
	16	27-10	61.8		149.9			
				17.5		9.8	23.8	24.7
	12	20-11	79.3		159.7			
				14.1		8.0	24.8	25.5
	12	18-12	93.4		166.7			
	21	24-8	45.9		139.9			
				9.3		7.8	23.1	23.7
	15	24-9	55.2		147.7			
				14.0		10.3	23.8	24.1
	14	27-10	69.2		158.0			
				14.2		7.2	24.9	26.0
	13	20-11	83.4		165.2			
				18.6		9.0	25.2	26.1
	13	18-12	102.0		174.2			

TABLE II - Daily growth in weight (g) and total length (mm) of the fishes kept in tanks for 116 days in 1981.

Tank nº	Total growth		Daily growth	
	Weight	Length	Weight	Length
1	46.7	34.6	0.40	0.30
2	52.7	33.8	0.46	0.29
3	51.3	36.6	0.44	0.32
4	56.1	34.3	0.49	0.30

Table IV shows the total growth recorded during the 116 days of experiment, together with the daily growth in weight and total length, and the mean temperature. It can be seen that at temperature around 20ºC, daily growth was smaller than those recorded at 23 and 26ºC. It is also evident that monthly growth in weight and length of those fishes kept in tanks is higher than those of aquaria.

DISCUSSION

Tanks - Growth in weight of those fishes kept in tanks 2 to 4 was almost the same, but smaller for those of tank 1, due to larger number of females, which grow less than males, while growth in total length showed small variation, the same occurring with the daily growth. Similar results were obtained by SHELL (1967) in U.S.A.: in 28 days fishes showed daily growth in weight of 0.31, 0.43, 0.49 and 0.57g, giving food at the proportion of 1, 2, 3 and 4% of the biomass. His diet was composed of 35% peanut flour, 35% soybean flour, 15% fish meal, 15% distiller's dry solubles, and 20% finely ground beef liver.

PETEL & HIRIGOYEN (1980) associated tilapia with swines. Daily growth in weight was 0.53g, close to the ones obtained in the [illegible]

BLE III - Growth of Nile tilapia kept in aquaria in 1981.

uarium nr.	Nr. of fishes	Date	Mean weight(g) Initial	Mean weight(g) Monthly growth	Mean length (mm) Initial	Mean length (mm) Monthly growth	Mean temp.
1	6	24-8	23.0		105.0		
	4	24-9	28.2	5.2	111.7	6.7	
	4	24-10	38.3	10.1	120.9	9.2	
	4	24-11	50.8	12.5	130.7	9.8	23.1
	4	18-12	62.2	11.4	139.8	8.9	
2	6	24-8	25.0		110.0		
	6	24-9	30.7	5.7	116.0	6.0	
	6	24-10	41.8	11.1	125.8	9.8	
	6	24-11	55.3	13.5	136.8	11.0	26.2
	6	18-12	67.7	12.4	146.5	9.7	
3	6	24-8	27.5	6.0	113.0	5.9	
	6	24-9	33.5	11.9	118.9	9.5	
	5	24-10	45.4	13.8	128.4	11.7	26.2
	5	24-11	59.2	12.2	140.1	10.2	
	5	18-12	71.4		150.3		
4	6	24-8	27.1		115.3		
	6	24-9	33.1	6.0	121.4	6.1	
	6	24-10	43.3	10.2	130.6	9.2	
	6	24-11	56.6	13.3	140.7	10.1	23.2
	6	18-12	69.7	13.1	150.3	9.6	

Cont.

LE III - Cont.

arium r.	Nr. of fishes	Date	Mean weight (g) Initial	Monthly growth	Mean length (mm) Initial	Monthly growth	Mean temp.
5	6	24-8	28.8		114.2		
	6	24-9	34.6	5.8	120.2	6.0	
	5	24-10	45.6	11.0	129.7	9.5	
	5	24-11	59.0	13.4	140.1	10.4	23.1
	5	18-12	71.9	12.9	150.7	10.6	
6	6	24-8	26.7		113.5		
	5	24-9	31.7	5.0	119.8	6.3	
	5	24-10	42.9	11.2	129.1	9.8	
	5	24-11	57.4	14.5	140.3	11.2	26.0
	5	18-12	70.5	13.1	151.2	10.9	
7	6	24-8	31.0		120.5		
	6	24-9	38.1	7.1	127.3	6.8	
	5	24-10	48.3	10.2	136.9	9.6	
	5	24-11	62.1	13.8	147.4	10.5	26.0
	5	18-12	74.1	12.0	156.8	9.4	
8	6	24-8	28.6		115.5		
	4	24-9	34.4	5.8	122.3	6.8	
	4	24-10	43.9	9.5	131.5	9.2	
	4	24-11	57.0	13.1	141.9	10.4	23.0
	4	18-12	69.8	12.8	152.0	10.1	

Cont.

LE III - Cont.

arium r.	Nr. of fishes	Date	Mean weight (g) Initial	Mean weight (g) Monthly growth	Mean length (mm) Initial	Mean length (mm) Monthly growth	Mean temp.
9	6	24-8	32.0		124.0		
	5	24-9	36.9	4.3	130.1	5.9	
	5	24-10	45.0	8.1	139.0	8.9	
	5	24-11	54.1	9.1	147.0	8.0	20.2
	5	18-12	63.3	9.2	153.0	6.0	
0	6	24-8	25.8		107.7		
	6	24-9	31.4	5.6	113.4	5.7	
	6	24-10	38.0	6.6	121.5	8.1	
	6	24-11	46.2	8.2	129.4	7.9	20.1
	6	18-12	55.7	8.5	139.1	9.7	
1	6	24-8	23.0		108.0		
	5	24-9	28.1	5.1	113.5	5.5	
	5	24-10	36.3	7.2	122.0	8.5	
	5	24-11	45.0	8.7	131.5	8.5	20.3
	5	18-12	53.8	8.8	139.5	8.0	
2	6	24-8	24.5		110.0		
	6	24-9	30.0	5.5	115.5	5.5	
	5	24-10	36.4	6.4	123.2	7.7	
	5	24-11	44.9	8.7	132.4	9.2	20.0
	5	18-12	53.2	8.3	140.0	7.6	

ABLE IV - Daily growth in weight (g) and total length (mm) of the fishes kept in aquaria, at variable temperatures, during 116 days, in 1981.

uarium nr.	Total weight	Growth length	Daily growth Weight	Length	Mean temperature (ºC)
1	39.2	34.6	0.33	0.30	23.1
2	42.7	36.5	0.37	0.32	26.2
3	43.9	37.3	0.38	0.32	26.2
4	42.6	35.0	0.37	0.30	23.2
5	43.1	36.5	0.37	0.32	23.1
6	43.8	37.7	0.38	0.33	26.0
7	43.1	36.3	0.37	0.32	26.0
8	41.2	36.5	0.36	0.32	23.0
9	30.7	29.0	0.26	0.25	20.1
10	29.9	31.4	0.26	0.27	20.1
11	30.8	31.5	0.27	0.27	20.3
12	28.7	30.0	0.25	0.26	20.0

other experiments, the same authors showed double gain in three of them, and thrice in another one.

Feeding Nile tilapia with hemiptera, YASHOUV & CHERVINSKI (1960) obtained daily growth of only 0.25 g. YASHOUV & CHERVINSKI (1961) and McBAY (1961) showed that hemiptera is common in their natural diet.

In Africa, PLANQUETTE & PETEL (1976) obtained good growth feeding tilapia with chicken flour: daily growth of 1.09g. In another experiment, the same authours used rice bran and obtained daily growth of 0.66g. They also used brewery yeast plus rice bran and obtained daily growth of 0.65g. With palm-tree tart they obtained daily growth of 1.39g, and with brewery pulp, 2.84g. According to them, best results were achieved in the following order: brewery pulp, palm-tree tart, chicken flour, rice bran, and rice bran plus brewery yeast.

PLANQUETTE (1976) showed that the growth rate of Nile tilapia is affected by its density. He conducted three experiments: one with 650 fishes and 65.5kg of chicken flour; the second one with 1,300 fishes and 131kg; the third one with 2,600 fishes and 262kg. The daily growth was, respectively: 1.57g, 1.16g and 0.78g.

MORISSENS (1979) reared males and females separately. After 64 days, males grew 1.3g daily, and females, 0.79g.

Aquaria - Sexes were not separated. MORISSENS (1979) showed that males grow faster than females, also shown by MICHA (apud Bard et al., 1974). This may explain the difference noted in aquaria 9 to 12, at the same temperature.

As to the difference observed in daily growth in weight and total length of the fishes kept in tanks and aquaria, it is another proof that in a confined environment, growth is smaller, because the fishes need large space for their movement, activating their musculature and ingesting more food. Says STERBA (1973, 2: 744):"... to 50 cm, remaining considerably smaller in captivity", referring to Nile tilapia.

DENZER (1966) showed that juvenile Nile tilapia does not resist to temperatures below 11ºC and above 42ºC, and that rate of respiration is 98 movements at 20ºC,

ference of growth of the fishes kept at those temperatures, ingesting less food in the first case and more in the third one.

McBAY (1961) noted that the ideal temperature for the spawning of Nile tilapia is between 23.5 and 25.0ºC, which means that those temperatures are indicated for the rearing of that species. In Israel, YASHOUV (1960) noted that spawning starts at 20ºC; below 10ºC, movement ceases, dying if exposed for several hours at 5ºC; from 14ºC start feeding.

Our data is in accordance with those obtained by CRIDLAND (1962) with *Tilapia zillii* that with low periodic light, growth rate is affected by temperature, beeing higher up to 31ºC and lower below 19.8ºC. At high temperatures, Nile tilapia reaches maturity sooner.

CONCLUSIONS

The experiment showed that:

1. in aquaria, growth rate in weight and total length of Nile tilapia is smaller than those kept in tanks, where space for swimming is larger, and consequently, higher metabolism;

2. in aquaria, with water at 20ºC temperature, growth of Nile tilapia is smaller than those kept at 23 and 26ºC.

ACKNOWLEDGEMENTS

The author thanks "Fundação de Amparo à Pesquisa do Estado de São Paulo" (FAPESP), who sponsored the research.

LITERATURE CITED

BARD, J., P. DE KIMPE, J. LEMASSON & P. LESSENT, 1974. **Manual de Piscicultura para a América e a África Tropicais**, Centre Technique Forestier Tropical, No-

CRIDLAND, C.C., 1962. Laboratpry experiments on the growth of *Tilapia* spp. The effect of light and temperature on the growth of *T. zillii* in aquaria. **Hydrobiol.** 20(2): 155-166.

DENZER, H.W., 1966. Studies on the physiology of young tilapia. **FAO World Symp. Warm-Water Pond Fish. Cult.**, Rome, V/E-6: 1-10.

McBAY, L.G., 1961. The biology of *Tilapia nilotica* Linnaeus. **Proc. Fift. Ann. Conf.**, South Assoc. Game and Fish Commis., October, 22-25: 208-218.

MORISSENS, P., 1979. Un premier test d'élevage de porcs associé à la pisciculture de *Tilapia nilotica* à la station de Bouaké (Côte d'Ivoire). **Not. Doc. Peche et la Pisc.**, Nouv. sér., (19): 27-50.

PETEL, C. & J.P. HIROGOYEN, 1980. Contribution à l'étude de la méthode d'élevage associé porcs-poissons: nouveaux tests d'élevage de porcs associé à la pisciculture de *Sorotherodon niloticus* (Linné, 1757), à la station de Bouaké (République de Côte d'Ivoire). **Not. Doc. Peche et la Pisc.**, Nouv. sér., (21): 45-56.

PLANQUETTE, P., 1976. Influence de la densité d'empoissonnement sur l'utilisation d'aliments par *Tilapia nilotica*. **Not. Doc. Peche et la Pisc.**, Nouv. sér., (12): 13-20.

PLANQUETTE, P. & C. PETEL, 1976. Quelques donnes sur la valeur nutritive de certains produits utilises comme aliments pour l'élevage intensif de *Tilapia nilotica*. **Not. Doc. Peche et la Pisc.**, Nouv. sér., (12). 21-29.

SHELL, E.W., 1967. Relationship between rate of feeding, rate of growth and rate of conversion in feed ing trials with two species of tilapia, *Tilapia mossambica* Peters and *Tilapia nilotica* Linnaeus. Proc. World Symp. Warm-Water Pond Fish. Cult., Rome, **FAO Fish Rep.** (44), 3: 411-415.

STERBA, G., 1973. **Freshwater fishes of the world.** Translated and revised by Denys W. Tucker, Studio Vista Ltd., London, 2: 457-877.

UNIVERSITY OF DELAWARE, 1976. **Proceddings of the First International Conference on Aquaculture** Nutrition, Delaware, 323p.

YASHOUV, A., 1960. Effect of low temperature on *Tilapia*

YASHOUV, A. & J. CHERVINSKI, 1960. Evluation of various food items in diet of *T. nilotica*. **Bamidgeh** 12(3): 71-78.

YASHOUV, A. & J. CHERVINSKI, 1961. The food of *Tilapia nilotica* in ponds of the Fish Culture Research Station at Dor. **Bamidgeh** 13(2): 33-39.