GENETIC AND ENVIRONMENTAL FACTORS AFFECTING PROPAGATION OF SOME CICHLIDAE

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SUMMARY

*Three Tilapia species belongs to family Cichlidae named [Oreochromis niloticus (O. niloticus) and Oreochromis aureus (O. aureus) and Sarotherdon galilaeus (S. galilaeus) and the cross of the first two [O. aureus male * O. niloticus female] were stocked in earthen ponds (225 m^2) to evaluate the effect of crossing in Tilapia in comparison with different genotypes, through measuring of reproductive and growth performance traits. The main results could be summarized as follows:-Females only in both O. niloticus and O. aureus performed mouth brooding of eggs, while both sexes of S. galilaeus did the parental care. O. niloticus and aureus and their crossbred had more spawns (4 spawns) than S. galilaeus (3 spawns).*

Although, O. niloticus had the highest number of fry produced (1705.5±71.63) and S. galilaeus had the lowest (272.5±11), crossing improved vigor with 39.95%. There was a marked increase of both the total number of male and female frys during the first and second spawns.

Not only the spawn affected the sex, but also the genotype. Males of the crossbred genotype had the highest ($P< 0.05$) total number of frys (486.33±64.77).

There was a significant gradual decline effect of spawn on total body weight of produced fry, average final body weight and length of both male and female frys.

The superiority of the crossbred (vigour) over the parental lines was extremely high during the three spawns for the fry male/female ratio (> 1703.7%), and the highest for the total weight of fry produced during the second spawn (97.4%).

INTRODUCTION

Tilapia culture, in Egypt is an old practice. They can grow in high densities and survive low dissolved oxygen and high ammonia level for longer period than other fish. Females are mouth brooding, they can produce several hundred to several thousands of frys through the breeding season.

They have multiple spawns during the year, that might result in suppression of growth and yield reduction in cultured populations as a result of overcrowdness and nutritional competition. (Omar, 1998).

Numerous alternatives have been proposed, including production of crossbreds (Hickling, 1967), manual sexing, and separation of the sexes (Lovshin and Dasilva, 1976), culture in cages (Ofori, 1988), and physiological (hormonal) sex reversal (Mair and Little, 1991). The most suitable method in Egypt would be probably the production of crossbred hybrids, because it is cheap and does not need special hatcheries.

Hulata et al. (1983) attributed the increase of total production yield of the pond to rapid growth rate of males than females and increased hybrid vigour. Wohlforth et al. (1983) added that crossbreds (hybrids) improve marketability and tolerance of tilapia. Moreover, Varadaraj et al. (1994) found that survival and growth of frys and sex reversing potency were significantly influenced directly or indirectly by temperature, feeding rate and photoperiod.

Therefore, the present study was conducted to evaluate the crossing in Tilapias in comparison with different genotypes through measuring of reproductive and growth performance traits.

MATERIALS AND METHODS

Fish stock:-

Three apparently healthy breeder Tilapia species [O. niloticus, O. aureus and S. gallilaeus] were obtained from lake El-Borlus on May, 1997. They were sexed, and those having an average body weight of 100±5 grams were kept and assigned randomly to form the following treatment groups: I- O. niloticus (4 males and 4 females), II- O. aureus (4 males and 4 females), III- O. aureus (4 males) and O. niloticus (4 females), and IV- S. galilaeus (4 males and 4 females). Each group was stocked in earthen pond (225 m^2) with an average water depth 0.8 meter. The experimental hatching ponds were constructed as an area from a private fish farm belongs to Kafr-El-Sheikh province (El-Feran). Construction, irrigation, drainage , networks (to prevent contamination), soil aeration, and fertilization with chicken manure, were done according to Stickney (1979).

Breeder management:-

The turnover rate of water exchange was twice a day. Breeding (Spawning) was allowed naturally until the end of the experiment. Feeding was carried at the rate of 3% of live body weight (3 times daily). The diet composition (Pandian, and Varadraj, 1988) and its chemical composition (A.O.A.C., 1975) are presented in Table 1. The water quality (Physico-chemical characteristics) measurements: organic matter (Attia, 1964) salinity (Swingle, 1969), chloride content (Marriott, 1974), dissolved oxygen concentration (D. O.) and hardness (A.P.H. A., 1975), transparency (Hamza, 1985), temperature and pH value (Orion Research Model 201, Hach. Comp. USA) were estimated twice a week (Table, 2).

Studied traits:

A:-Reproductive characteristics which include:

Reproductive behaviour (Buccal cavity examination for mouth brooding of eggs in each male and female).

Fry male to female ratio; Number of spawn (Fry production)

Spawning frequency per month. ; Number of fry produced .

Average / and number of fry produced per female / and per spawn.

B-Growth characteristics which include:-

Average final weight of frys (grams).

Average final length of frys [length of fish in Cm from snout to the end of the caudal fin].

Condition factor (K) [Higgs et al., 1982) which relates fish body weight (W) to its length (1) $K = 100 * W/L^3$.

Vigor percentage (H% - Jayaprakas et al., 1988).

$$H\,\% = 100\left[\frac{\text{Mean of crossbred} - \text{Mean of parental stock}}{\text{Mean of parental stock}}\right]$$

Statistical analysis:-

Data were analyzed using SAS (1996), General linear Model Procedure (GLM). The Student's t-test was used to determine the significant difference between different genotypes. Correlation coefficients were, also, estimated on overall basis by GLM procedure.

RESULTS AND DISCUSSION

Reproductive parameters:-

Parental care:-

Examination of the buccal cavities of both males and females of each genotype revealed that females only in both O. niloticus and O. aureus performed the mouth brooding behaviour of eggs. On the other hand, both male and female mouth brooding of eggs was performed by S. galilaeus. These observations agree with those reported by Stickney (1979) and Fitzsimmons (1997) who indicated that Tilapia species females pick up the eggs in their mouth and carry them until hatching.

Number of spawns and Spawning frequencies:

O. niloticus, O. aureus, as well as their cross had four spawns with 0.89 spawn/month, but S. galilaeus had only 3 spawns, with 0.67 spawn/month (Table, 3). These findings indicate lower reproductive capacity of the last one and proving that crossing had no effect on the number of spawns and their frequency, which was closely related to the genotype of the parental lines (Baroiller et al., 1997). However, Otubsin (1988) recorded higher spawning frequency (1.9 spawn / month) by O. niloticus. The difference in reproductive cycle in the present results could be attributed to the environmental conditions and methods of management.

Number of fry produced:

The genotype of the broodstock has a significant effect ($P < 0.05$) on the number of fry produced from different genotypes, average per female, and spawn, average performance per spawn, as well as per female body weight per spawn (Table 3). The highest least square means of number of fry produced was 1705.5 ± 71.63 (pure O. niloticus), while the lowest was 272.5 ± 11 (pure S. galilaeus). Although crossing of O. niloticus females with O. aureus males decreased the number of fry to 1532.5±60.2 ($P < 0.05$), it improved the vigour (over the average of the parental lines) with 39.95%. The same amount of improvement was achieved for the average number of fry per female per spawn, and the number of fry produced per female body weight (Vigour 39.94 - 39.96%), but it was higher for the average number of fry per spawn (62.19%), and the least per female (29.26%). These results are in agreement with those found by Otubsin (1988) who recorded the previous pattern for the parental stock, but a decline in the amount of vigour (< 8 – 17%) , which could be attributed to the differences in number of broodstocks, and / or method of management (time, duration, or environment).

Growth parameters:

The effect of spawn, sex and genotype interaction on total number and weight of fry produced, average final body weight and total length of frys, and condition factor are presented in Table (4). There was a marked increase ($P< 0.05$) of both total number of female and male frys produced during the first and second spawn: 92.75±30.9; 134.88±51.95; 185.5±47.6 and 302.63±97.75, respectively. However, there was a significant ($P< 0.05$) decrease in the produced fry females (15.5%) and males (17.4%) during the 3rd spawn, which was interpreted by Popma and Masser (1999), due to change of photoperiod and ambient temperature.

Not only the spawn affected the sex, but also, the genotype. The highest least square mean of the total number of frys was 486.33±64.77 for males of crossbred genotype III (Table 4), and the lowest (58.3±2.96) was associated with S. galilaeus females. A finding showing that crossing was a good tool for production of all male population (Sheton, 2001).

There was a significant gradual decline effect of spawn on total weight of produced fry, average final weight and length for both male and female frys. The male frys at first spawn ($P< 0.05$) had the heaviest total weight (4923 ±1393.9), average final weight (24.6±1.5) and the highest final length (10.76±0.21).

As for the females, they were almost one third the value of males for all the previous traits, being the lowest for all the parameters in the third spawn. These results indicate that males had higher growth rate than females (Fitzimmons, 1997 and Touyeni, et al., 1997).

The genotype has no significant effect on the sex for the average final length of frys (6.2 – 8.32) and condition factor (2.26 – 3.01). A finding that disagree with that of Ishak (1985) who recorded better condition factor and longer length of males than females in the different genotypes. On the other hand, the male frys of the crossbred (Genotype III), had the heaviest ($P< 0.05$) total weight (8762.5±1682.7) and average final weight (16.52±4.09). Moreover, The female frys of S. galilaeus had the lowest values for the total weight (533±32.2), and those of O. aureus were the lowest for average final weight (8.31±1.52) (Jayaprakas et al., 1988).

Effect of Crossing:-

The effect of spawn sequence on the different genotypes and their crossbred (vigour) for the fry growth parameters are presented in Table (5). The total number of fry produced was found to be affected with the spawn sequence, being the highest at the second spawn by O. niloticus line (380.8±9.2).

The corresponding crossbred mean was 360.3±98.7, with a subsequent vigour 57.3%, compared to 18.9 and 17.7% in the first and 3rd spawns. These results may be accounted to the different stages of ovarian activities in the different genotypes as a result of change in photoperiod and/or temperature throughout the duration of the rearing period (Baroiller et al., 1997).

There were a gradual significant decline due to spawning in all their fry growth parameters (total body weight, average final total length, and average final weight). It was maximized in the first spawn of O. niloticus pure line (4996.0±603; 10.06±0.62; 20.1±4.12) than the other two spawns (Table 5). However, the superiority of the crossbred (vigour) over the parental lines (O. niloticus and O. oureus) did not follow the same pattern. It was the highest for the total weight of fry produced (97.4%) during the second spawn, the average final length (15.39%) and weight of frys (22.95%) during the 3rd spawn.

Moreover, the hybrid (crossbred mean) fry male / female ratio was extremely high during the three spawns (19.3 – 20.65) and low for the two parental lines (0.97 – 1.17), with subsequent very high vigour percentage exceeding 1703.7%. These results are in agreement with those reported by Hickling (1963) and Jayaprakas et al. (1988) who indicated that the growth rate of crossbred frys (O. niloticus females and O, aureus males) was higher than both parental lines.

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Table 1: Basal diet composition and its chemical composition.

Basal Diet composition		Chemical composition	
Ingredients	%		
Fish meal	35	Moisture	10.9
Rice bran	34	Crude protein	27.97
Wheat flour	30	Ether Extract	8.67
Sod. Chloride	0.5	Total carbohydrates	38.68
Additives (Commercial)	0.5	Ash	13.77
		Metabolic energy (M. E. M. Cal/Kg)	3.344
		Calorie / Protein ratio	83.65

Table 2: Water quality measurements through the experimental period.

Item		Mean
Water temperature	°C	22
pH. Value		7.9
Dissolved oxygen	mg/L	6.5
Organic matter	mg/L	260
Chloride Content	mg/L	365
Salinity	mg/L	605
Total hardness		870
P.P.M.		50
Transparency		

Table 3: Least square means ± standard errors of the number of spawns and fry production between different genotypes and their vigour percentages.

Genotypes	*Oreochromis*			Sarotherodon Galilaeus	Vigur %
	Niloticus I	aureus II	hybrid* III	IV	
-Number of spawns	4	4	4	3	
-Number of fry produced	1705.5±71.63[a]	484.5±38[b]	1532.5±60.2[c]	272.5±11[d]	39.95
-Average number of fry produced per female	426.4±14.88[a]	121.13±11.3[b]	383.13±6.3[c]	68.13±3.8[d]	29.26
-Average number of fry per female per spawn	142.13±1.63[a]	40.38±3.8[b]	127.7±2.0[c]	22.69±1.09[d]	39.94
-Average number of fry per spawning	568.5±6.5[a]	61.5±1.5[b]	510.9±8.5[c]	90.82±5.2[d]	62.19
-Fry production (Kg)	2.53±0.25[a]	0.71±0.01[b]	2.47±0.195[a]	0.405±0.05[d]	52.47
-Number of fry produced per female.	1421±16[a]	403.8±37.5[b]	1277±50.0[c]	227.05±12.5[d]	39.96

*This hybrid is a result of crossing male O. aureus and female O. niloticus.
a-d Means having the same letters between different genotypes are not significant (P> 0.05).

Table 4: Effect of spawn, sex, and genotype on fry growth parameters.

Treatment	Total No. of fry produced	Total weight of fry produced	Average final weight	Average final length	Condition factor
Spawn * Sex					
1st * Males	185.50±47.6^{a}	4923±693.9^{a}	24.6±1.5^{a}	10.76±0.21^{a}	1.95±0.01^{a}
1st * Females	92.75±30.9^{d}	1178.9±404.8^{b}	12.4±0.38^{c}	8.88±0.06^{b}	1.77±0.04^{d}
2nd * Males	302.63±97.75^{b}	4527±575.2^{a}	13.2±0.93^{b}	7.08±0.08^{c}	3.67±0.15^{c}
2nd * Females	134.88±51.95^{c}	1311±530.1^{b}	9.4±0.36^{d}	6.69±0.06^{d}	3.13±0.05^{b}
3rd * Males	250.0±58.77^{a}	1325±363.7^{b}	5.1±0.27^{e}	4.02±0.12^{e}	**
3rd * Females	114.0±37.43^{c}	553±201.5^{b}	4.9±0.37^{e}	3.91±0.18^{e}	**
Genotype * Sex					
I * Males	294.6±31.41^{a}	4684±543.1^{a}	15.82±4.02^{a}	7.44±1.31^{a}	3.01±0.61^{a}
I * Females	274.5±31.65^{a}	2621±487.8^{c}	9.42±1.42^{c}	6.60±0.91^{b}	2.49±0.40^{a}
II * Males	81.83±6.46^{c}	1018±223.5^{d}	13.88±3.83^{b}	7.19±1.3^{a}	2.78±0.48^{a}
II * Females	79.67±5.97^{c}	655±111.4^{d}	8.31±1.52^{d}	6.2±0.79^{a}	2.53±0.36^{a}
III * Males	486.33±64.77^{b}	8762.5±682.7^{b}	16.52±4.09^{a}	7.64±1.26^{a}	2.98±0.58^{a}
III * Females*	-	-	-	-	-
IV * Male	58.0±4.08^{c}	822.3±189.7^{d}	13.81±2.48^{b}	8.32±0.88^{a}	2.47±0.33^{a}
IV * Female	58.3±2.96^{c}	533±32.2^{d}	9.48±0.85^{c}	7.65±0.66^{a}	2.26±0.38^{a}

**Due to high male: Female ratio 20 : 1 this interaction was neglected.
* Non estimate due to very small size (weight & length).
a-e different letters between treatments are significant (P< 0.05).

Table 5: Effect of crossing male O. aureus and female O. niloticus on fry growth parameters means.

Trait	Genotype Spawn	O. niloticus	O. aureus	Parental mean	Crossbred mean	Vigour %
No. of fry	First	245±16.4^{a}	66.8 ±2.1^{b}	155.9	185.3±46.4^{a}	18.9
	Second	380.8±9.2^{a}	77.3±3.2^{b}	229.1	360.3±98.7^{a}	57.3
	Third	277±1.83^{a}	98.3±2.96^{b}	187.7	220.8±75.1^{a}	17.7
Total weight of frys	First	4996.8±603^{a}	1282.5±218.2^{b}	3139.7	5063.8±779^{a}	61.3
	Second	4792.8±618.8^{a}	834.8±93.7^{b}	2813.8	5554.3±908^{a}	97.4
	Third	1166.8±16.3^{a}	392.3±20.1^{b}	779.6	1258.5±656^{a}	61.4
Average final length of frys	First	10.06±0.62^{a}	9.76±0.64^{b}	9.91	10.14±0.02^{a}	2.32
	Second	6.99±0.11^{a}	6.79±0.11^{a}	6.89	7.13±0.13^{a}	3.48
	Third	4.0±00^{a}	3.54±0.0^{a}	3.77	4.35±0.03^{a}	15.39
Average final weight of fry	First	20.1±4.12^{a}	18.5±3.77^{b}	19.31	20.83±4.17^{a}	7.90
	Second	12.5±1.43^{a}	10.8±0.93^{b}	11.64	13.15±1.53^{a}	12.97
	Third	5.3±0.03^{a}	4.0±0.14^{b}	4.64	5.7±0.06^{a}	22.95
Fry male / female ratio	First	1.17±0.22^{a}	0.97±0.09^{a}	1.07	19.3±2.18^{b}	1703.7
	Second	1.06±0.07^{a}	1.08±0.13^{a}	1.07	20.65±1.9^{b}	1929.9
	Third	1.03±0.6^{a}	1.04±0.09^{a}	1.035	20.07±3.27^{b}	1939.1

a-b different letters between genotypes within spawn are significant (P< 0.05).

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