PRODUCTION OF HYBRIDS BY CROSSING FEMALES OF TILAPIA NILE AND MALES OF TILAPIA ZANZIBAR UNDER VARIOUS SEXUAL RATIOS[1]

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RESUMO

No presente trabalho é descrito um estudo comparativo de cultivo monossexual entre fêmeas de tilápia-do-Nilo, **Oreochromis niloticus** e machos de tilápia-de-Zanzibar, **O. hornorum**, em várias proporções sexuais dos reprodutores. As proporções sexuais testadas foram as seguintes: 1 fêmea: 1 macho, 2 fêmeas: 1 macho, 3 fêmeas: 1 macho, 4 fêmeas: 1 macho e 5 fêmeas: 1 macho. Durante o período de cultivo entre 60 e 90 dias o melhor índice de sobrevivência observado foi a proporção dos reprodutores, de 1:1. A produção total da estocagem dos tanques, com o mesmo número de reprodutores, mostrou variação no número de alevinos obtidos sob as mesmas condições no fim do período de 24 meses, provavelmente devido ao canibalismo e predação. A produção média anual nessa proporção foi de 564.724 alevinos/ha/ano. Na proporção sexual 5:1, foi observada a segunda maior prolificidade do experimento. A pesquisa foi concentrada também sobre a produção de alevinos híbridos, todos 100% machos.

PALAVRAS-CHAVE: Piscicultura, híbridos de tilápia, proporção sexual.

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SUMMARY

The present paper describes the comparative study of monosexual culture between the nile tilapia (female), **Oreochromis niloticus** and the zanzibar tilapia (male), **O. hornorum** including the sex ratios of the breeders the survival rate the production of fay. The tested sex ratios were as follows: 1 female:1 male, 2 female:1 male, 3 females: 1 male, 4 females: 1 male and 5 females: 1 male. During the rearing period between 60 and 90 days the best survival rate was observed using the 1:1 proportion of the breeders the total production of the ponds stocked with the same number of breeders under similar/equal/conditions showed differences in the number of the harvested fingerlings at the end of 24 months period, due to losses from cannibalism and predation. The average productivity of the fingerlings achieved a value of 564,724/ha/ys with a sex ratio of 1:1. Using the sex ratio of 5:1 the next best result was observed. The research has been concentrated on the number of the all-male hybrid fingerlings as well.

KEY WORDS: Tilápia hybrids, sex ration.

INTRODUCTION

The most important problem of tilapia hybridization is to produce enough fingerlings to increase the expansion of this activity in the Northeast of Brazil.

In spite of the good results in the fields of research and farming, two problems ocurred, such as an unequal production of number of fingerlings and the ocasional appearance of the undesirable spawning in the hybridization ponds.

SILVA[8] accomplished, but did not publish the results of the experiments in which he designed a system to produce 100% males of fingerlings and the most advantageous proportions of female and male breeders.

The best results were obtained when LOVSHIN[4] in his preliminary studies pointed

1 Paper presented at the International Symposium on Tilapia in Aquaculture in Tiberias, Israel, May 8-13, 1983. Supported by Convênio CNPq/PCPC/SUDENE/DNOCS.

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out that the broodstock which is used for more than one spawning season should be replaced after the 3rd to 4th hybridization cycles as well as in the age 14th to 17th months (they are ready to spawn at the age of 5 to 6 months) to avoid the reduction in fingerling production.

The average number of hybrid fingerlings produced in a 350 m^2 pond using 50 females of **O. niloticus** and 50 males of **O. hornorum** reached a value of 2,700 in a 2.5 months period.

LOVSHIN[2] recomended that the spawning ponds should be drained after 3 months to avoid backcrossing with the females of **O. niloticus** but recently the recomended spawning period was reduced to 2.5 months as there have been found same matured, hybrids before 3 months. During transferring the hybrid fingerlings to the nursery ponds at the size of 25 to 50, the stock should be checked to determine whether all-male hybrids have been produced.

HICKLING[1] reported first the possibility of producing all-male hybrids. An attempt to produce a sterile hybrid with superior growth potential by crossing **O. mossambicus** with **O. hornorum** (this fish was originally classified as **O. mossambicus** (Zanzibar strain).

It was a surprise as well as a satisfaction for him to produce all-male hybrids by crossing the two species mentioned above.

These hybrids were not "mules" or sterile, but were fertile and capable of erable spawning.

The purpose of the experiment is to compare the use of different sex ratios of breeders females of **O. mossambicus** and males of **O. hornorum** such as 1:1, 2:1; 3:1; 4:1 and 5:1.

Our target was to determine the ratio which shows, the best results per female per area in the production of all-male hybrid fingerlings.

MATERIALS AND METHODS

Fourteen concrete tanks, each with an of 33m^2 and located on campus of Rodolpho von Ihering Ichthyological Research Center (Pentecoste, Ceará, Brazil) were used.

The tanks of these were stocked with one female of **O. niloticus** and one male of **O. hornorum**. The remaining 4 tanks were stocked with females of nile and males of zanzibar tilapias as follows: 2:1, 3:1, 4:1 and 5:1.

The ratio of 1:1 was repeated 10 times and the average of the results were used.

Fourteen males were used with an average weight of 70.7g, while the number of females was 24 with average weight 43.1g. All fishes were measured for total length in centimetres caudal fin ray, and were weighted in gramme, before they were stocked.

All the tanks were monitored daily to observe the building of the nest and possible spawning.

The fingerlings were kept in the tank until they reached a size of 3cm, and than they were collected with a 0.5 to 1.0mm mesh net. After this they were counted and stocked to another tank.

The differences in the size of fingerlings during the same conditions was due to different spawnings.

An important fact has been observed, that there were never more than two spawnings in the same tank. At the end of the work, the pond was drained to collect the rest of the fingerlings. After this the ponds were filled and stocked again for a fresh spawning.

The breeders and fingerlings were fed with babaçu cake, **Orbignia martiana**, Barb. Rodr., and palm nut which contains 21 percent of protein. The feeding rate of this feed was 3%/biomass/day.

There was one feeding a day, 5 times per week which took place in the early morning. A sampling was done each month when 10 percent of the fingerlings were weighed, and measured. The recalculation of the feeding rate was based on the results of these samplings.

At the end of experiments the ponds were drained. The experiment was divided in eight cycles, each cycle lasted 3 months.

RESULTS AND DISCUSSION

At the end of the experiment the total number of fingerlings were 40,468 in the 13-14 ponds, where different sexual ratios have used.

The best results were observed in the case of the 1:1 sex ratios where the production of hybrid fingerlings/female/month reached an average value of 155. The calculation of this average was based on replicates.

In case of Cichlids, there is a tendency for the males to choose the females of their preference and "pair off". The chances of spawning in these cases are almost certain.

The variation in the number of fingerlings/tank, ranged from 0 to 976 fingerlings/female/month (6^{th} cycle, couple D), although the methodology was the same in all treatments (Table 1).

This is a subject which should be studied further, because the development of the intensive hybrid culture used by the farmers depends on it.

PRUGININ[6] found that there are many species of tilapia which are suitable for hybridization; PRUGININ et al[7]; WOHLFARTH and HULATA[9], noted that the most frequently used crosses are: **S. niloticus** x **S. aureus**; **S. mossambicus** x **S. hornorum**.

However Israel is a country with variable warm conditions. In the winter the low water temperatures restrict the use of **S. aureus** and the **O. nilotics**.

Since the sex determination was clearly defined (JALABERT, 1971; AVTALION, 1982), cited by MIRES[5], there is a claim to produce a broodstock which is usable for commercial purposes maintaining a selected pure line.

In the 14^{th} tank couple A, the crossing was almost perfect, because there was only one cycle where the couple didn't spawn. The total production of this pond was 10,835 fingerlings in 8 cycles with and average of 451/fingerlings/female/month (Table 1).

An exception was made to one semester, the average production of the 10 treatments were always more than 50 fingerlings/female/months, reaching a level of 342 fingerlings/female/month, in the 5^{th} cycle as shown in table 2.

Each 3 month cycle had an average production of 465 fingerlings which is equal to 1,863 fingerlings/year in $33m^2$ area. According to this the estimated production could be 564,724 fingerlings/ha/year.

These data show better results than those obtained by Lovshin (unpublished). The comparison among the different sex ratios gave the following results: 25 **O. niloticus** females x 25 **O. hornorum** males the average result 1,532 fingerlings with 64 females. 50 **O. niloticus** females x 25 **O. hornorum** males gave an average of 2,159 fingerlings with 88 females. 25 O. niloticus females x 5 **O. hornorum** males resulted in an average of 699 fingerlings with 30 females during 80 days of the experiment. There were no data in the case of the 2:1 ratio as the breeders died. In the case of the ratio 3:1 there was only one spawning resulting in 303 fingerlings/cycle. LOVSHIN et al[3]. applied the same ratio which resulted in 304 fingerlings/$350m^2$/4 months.

Until the third spawning cycle there was no fingerling production in the case of the 4:1 ratio. After this in 3 following cycles there was a peak of fingerling production reaching a maximum of 715 fingerlings in the 6^{th} cycle. There were no comparative data in the literature of then phenomenon. The ratio of the 5:1 resulted in 4 spawnings during the 8 cycles, and the spawnings in the 1^{st} year had better results than in the 2^{nd} year. The production of the fingerlings in the 1^{st} and the 2^{nd} year was 292 and 123, respectively.

CONCLUSIONS

In the present study we have concluded the following:

1. There 40,468 fingerlings were produced using various sex ratios in 13-14 ponds;
2. There was considerable variation in the number of fingerlings/tank during each cycle of all treatments;
3. The best results were obtained in the case of 1:1 sex ratio of the breeders;

TABLE 1 Hybrids fingerlings productions, per cycle in three months, obtained between male of **Oreochromis hornorum** x female of **O. niloticus** with sex ration of 1:1 Ichthyological Research Center (Pentecoste, Ceará, Brazil). 1983.

SPAWING PERIOD	FINGERLINGS PRODUCTIONS (COUPLE/POND)											
	A / 14		B / 15		D / 18		E / 19		F / 20		G / 22	
	Total	P/F/M	Total	P/F/M	Total	P/F/M	Total	P/F/M	Total	P/F/M	Total	P/F/M
1st Cycle 02/11/77	677	222	665	221	0	0	401	133	524	174	0	0
2nd Cycle 02/02/78	980	326	725	241	0	0	520	173			0	0
3rd Cycle 02/05/78	1,015	338	0	0	1,646	548	746	248			0	0
4th Cycle 02/08/78	1,666	555	0	0	0	0	827	275			0	0
Average P/C 1st/yr	1,082	360	347	15	411	137	623	207	131	43	0	0
5th Cycle 02/11/78	2,091	697	149	49	1,713	571	0	0			1,699	566
6th Cycle 02/02/79	1,804	601	0	0	2,928	976	0	0				
7th Cycle 02/05/79	0	0	0	0	1,322	440	0	0	—		0	0
8th Cycle 02/08/79	2,612	870	0	0	1,240	413	0	0			0	0
Average P/C 2nd/yr	1,627	542	37	12	1,800	600	0	0			424	141
Total P/Cycle	10,853		1,539		8,849		2,494		524		1,699	
Average P/8 Cycle	5,426	451	769	64	4,424	369	1,247	104	262	22	849	70

OB.: P - production, F - female; C - Cycle and M - month.

TABLE 1 - Hybrids fingerlings production, per cycle in three months, obtained between male of **Oreochromis hornorum** x **female** of **O. niloticus** with sex ration of 1:1 Ichthyological Research Center (Pentecoste, Ceará, Brazil). 1983.

SPAWING PERIOD	FINGERLINGS PRODUCTIONS (COUPLE/POND)									
	H / 23		/ 24		J / 25		L / 17		Average	
	Total	P/F/M	Total	P/F/M	Total	P/F/M	Total	P/F/M	Total	P/F/M
1st Cycle 02/11/77	0	0	0	0	0	0	118	39	237	79
2nd Cycle 02/02/78	341	113	0	0	0	0			256	85
3rd Cycle 02/05/78	98	32	0	0	0	0			350	116
4th Cycle 02/08/78	0	0	0	0	987	329			348	16
Average P/C 1st/yr	109	36	0	0	246	82	29	10	297	99
5th Cycle 02/11/78	2,113	704	1,425	475	1,088	362			1,028	342
6th Cycle 02/02/79	1,834	61	25	8	1,174	391			776	259
7th Cycle 02/05/79	0	0	0	0	0	0			132	44
8th Cycle 02/08/79	833	227	63	21	1,216	405			596	199
Average P/C 2nd/yr	1,197	385	378	126	869	289			633	211
Total P/Cycle	5,219		1,513		4,465		189		37,273	
Average P/8 Cycle	2,609	217	756	63	2,232	186	59	5	1,863	155

OB.: P - production, F - female; C - Cycle and M - month.

TABLE 2 Hybrids fingerlings production, per cycle in three months, obtained cross between male of **Oreochromis hornorum** x female of **O. niloticus** in sex rations of, 1:1 (average was repeated 10 times): 1:3; 1:4; 1:5. The experiments was done in ponds at the "Rodolpho von Ihering" at Ichthyological Research Center (Pentecoste, Ceará,Brazil).

SPAWING PERIOD	SEXUAL RATIO							
	1 1		1 3		4		1 5	
	Total	P/F/M	Total	P/F/M	Total	P/F/M	Total	P/F/M
1st Cycle 02/11/77	237	79	303	34	0	0	0	0
2nd Cycle 02/02/78	256	85			0	0	407	27
3rd Cycle 02/05/78	350	116			0	0	760	50
4th Cycle 02/08/78	348	116			168	14	0	0
Average P/C 1st/yr	297	99	75	8	42	3	292	119
5th Cycle 02/11/78	,028	342			270	22	263	17
6th Cycle 02/02/79	776	259			715	59	229	15
7th Cycle 02/05/79	132	44			0	0	0	0
8th Cycle 02/08/79	596	199			0	0	0	0
Average P/C 2nd/yr	633	211			246	20	123	8
Total P/Cycle	3,727		383		1,153		,659	
Average P/8 Cycle	1,863	155			576	12	829	14

OB.: P - production, F - female; C - Cycle and M month.

4. The 1:1 ratio gave the best productivity with 564,724 fingerlings/ha/year; and
5. The 2nd best result was given by the 5:1 proportion of the experiment.

ACKNOWLEDGEMENT

Many thanks are due to Dr. GYULA KOVÁCS, Aquaculture Engineer of the Fish Culture Research Institute, H-5541 Szawas, Hungary, and his most competent technical assistence in the preparation of the revision, corrections, criticisms, and ideas in the present report.

BIBLIOGRAPHICAL REFERENCES

1. HICKING, C.F. The Mallaca tilapia hybrids, J. Genet., 57: 1-10, 1960.
2. LOVSHIN, L.L. & SILVA, A.B. Culture of monosex and hybrid tilapias. Ghana FAO/CIFA Symposium on Aguaculture in Africa, Ghana, 1975, 16p.
3. LOVSHIN, L.L. et al. Método para obtenção de híbridos machos de tilápia Sarotherodon hornorum x Sarotherodon niloticus fêmeas. Inf. Téc. DNOCS, dezembro de 1978.
4. LOVSHIN, L.L. Progress report on fisheries development in Northeast Brazil. Project AID-1152, Tark Order 2, International Center for Aquaculture, Auburn Univ., Alabama, 1980.
5. MIRES, D. Current techniques for the mass production of tilapia hybrids as practiced at Ein Hamifratz Fish Hatchery. Bàmidgeh. Haifa 35(1): 3-8., 1983.
6. PRUGININ, Y. Report to the government of Uganda on the experimental fish culture project in Uganda 1875-76. FAO/UNDP Reports on Fisheries TA. Nr, 2446. 1967. 19p.
7. PRUGININ, Y. et al. All male broods of T. nilotica x T. Aurea hybrids. Aquaculture, 6: 11-21, 1975.
8. SILVA, A.B. et al. Observation préliminaires sur l'obtention d'hybrides tous males des espécies Tilápia hornorum et Tilápia nilotica. Centre Technique Forestier Tropical. Notes et Documents, 7: 1-8, 1973.
9. WOHLFARTH, G.W. & HULATA, G.I. Applied genetics of tilapias, ICLARM Studies and Reviews, 6:26, 1982.