Sex and growth rate of *Oreochromis andersonii* x *Oreochromis mossambicus* hybrids using high-protein pellets in an intensive production unit

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Received July 1991; accepted December 1992

ABSTRACT

Male *O. andersonii* and female *O. mossambicus* were successfully cross-fertilized and male hybrid fish were obtained. The growth rates of the hybrids were the same as those of the parent species. Maximum growth from 11,67 g to 82,0 g occurred within 97 days. The maximum individual daily mass increase was 0,90 g. The hybrids were fertile and six back-crosses (with female *O. mossambicus*) were obtained.

INTRODUCTION

Overpopulation caused by the high fecundity of tilapias under conditions of commercial production has long been a problem (Balarin 1979; Caulton 1980; Trewavas 1983). Several solutions have been investigated, one being the use of monosex culture. Male fish grow faster and larger than females, and are therefore the better choice for aquaculture (Balarin 1979; Caulton 1980).

Several methods of producing all-male populations are available (Balarin 1979). The three most commonly used methods are (a) hand sorting of young fish according to sex, which is time consuming, (b) sex reversal of female fry using hormones, and (c) interbreeding of closely related species resulting in male monosex cultures. A search for interspecific crosses yielding all-male hybrids was initiated by Hickling's Malacca Tilapia hybrids (Pruginin *et al.* 1975).

The existing literature concerning hybrids between *O. andersonii* and *O. mossambicus* is conflicting and poorly documented (Wohlfarth & Hulata 1981). Balarin (1979) stated that, according to Thingrav and Gopalakrishnan (1974) crosses between *O. andersonii* and *O. mossambicus* were unsuccessful in producing all-male progeny. However, Thingrav and Gopalakrishnan (1974) themselves stated only that hybrids of *O. andersonii* and *O. mossambicus* were obtained under experimental cultivation in Zimbabwe. A hybrid between *O. andersonii* and *O. mossambicus* has also been found under natural conditions in Zimbabwe (Wohlfarth & Hulata 1981), but no mention is made of hybrids between these two species by Trewavas (1983). It is clear from the literature that very little is known about the hybridisation of *O. andersonii* and *O. mossambicus*.

The aim of this study was to produce hybrids from male *O. andersonii* and female *O. mossambicus*, and to determine whether all male progeny could be obtained. Growth studies were conducted to compare the rates of growth of the hybrids and the parent species.

MATERIALS AND METHODS

Water analysis was done every second week with a HACH DR/EL 4 spectrophotometer to determine the NH_3, NO_2, NO_3, anorganic PO_4 concentrations and pH levels. Dissolved oxygen (O_2) was determined with a YSI 54A oxygen meter and water temperature with a THIES thermograph.

One male *O. andersonii* and seven female *O. mossambicus* were placed in an aquarium (1000 x 600 x 600 mm) in the hatchery at the Fresh Water Fish Institute, Hardap Dam, Namibia. After breeding, the females were transferred to separate aquaria to secure the incubation and hatching of the eggs. The females were returned to the original aquarium after all the fry were swimming outside their mouths.

Two of the crosses were divided into four groups for the growth studies. On 10 of March 1989 four production tanks of 1 m^3 were stocked at densities of 61, 28, 58 and 61 fry per tank. At the start of the study all the fish were tranquilized with MS 222 Sandoz (Methanesulfonate of Meta-Aminobenzoic Acid Ethyl-Esther) and the total length and weight of each fish were determined. This procedure was followed every second week to determine food requirements, calculated from data provided by Gaigher and Geyser (1984). The fish were fed on pellets with a 38% protein content. The experiment was terminated after 97 days and all the fish were individually sexed.

RESULTS

The water quality parameters during the experiment were:
pH (6,7 - 7,1), NO_3 (0,9 - 1,9 mg/l), NO_2 (0,008 - 0,048 mg/l), NH_3 (0 - 0,11 mg/l), PO_4 (0,4 - 1,2 mg/l), O_2 (4,0 - 5,1 mg/l) and temperature (26,0 - 28,5°C)
All four groups of hybrid fish consisted only of males (N = 188). Stocking dates, fish densities, growth rates,

TABLE 1. Stocking dates, fish density, growth rates and mortalities of the hybrids in the hatchery.

DATE	N fish	AVERAGE ORIGINAL MASS (g)	DAILY INDIVIDUAL MASS INCREASE (g)	DAILY INCREASE AS % OF ORIGINAL MASS	FOOD CONVER.
GROUP 1					
10.03.89	61	10,90	—	—	—
13.03.89	61	15,46	0,46	2,25	2,70
11.04.89	60	22,61	0,40	1,45	3,33
29.04.89	59	30,10	0,44	1,30	3,79
10.05.89	58	38,12	0,67	1,58	2,94
23.05.89	57	47,15	0,69	1,38	3,48
06.06.89	56	56,20	0,70	1,17	2,94
17.06.89	56	63,23	0,80	1,19	2,69
GROUP 2					
10.03.89	28	11,67	—	—	—
13.03.89	28	19,31	0,64	4,17	1,51
11.04.89	28	31,30	0,67	2,69	1,93
29.04.89	27	46,60	0,90	2,35	1,55
10.05.89	27	54,70	0,68	1,35	3,56
23.05.89	27	62,51	0,65	1,13	3,09
06.06.89	26	71,80	0,72	1,03	2,92
17.06.89	26	82,00	0,85	1,14	3,10
GROUP 3					
10.03.89	52	9,50	—	—	—
13.03.89	51	14,35	0,40	3,42	2,11
11.04.89	51	20,61	0,35	2,03	3,21
29.04.89	51	29,90	0,55	2,16	2,45
10.05.89	51	37,60	0,64	1,89	2,44
23.05.89	50	44,12	0,50	1,20	3,22
06.06.89	48	50,10	0,46	0,95	3,61
17.06.89	48	57,00	0,69	0,82	3,03
GROUP 4					
10.03.89	61	10,80	—	—	—
13.03.89	61	16,71	0,49	3,67	2,01
11.04.89	61	22,60	0,33	1,66	3,44
29.04.89	59	30,40	0,46	1,73	2,81
10.05.89	59	38,00	0,63	1,90	2,50
23.05.89	58	46,91	0,68	1,60	2,80
06.06.89	58	55,10	0,63	1,22	3,00
17.06.89	58	62,00	0,79	1,33	2,58

mortalities and t- value's are summarised in Table 1 and Table 2. The daily individual mass increase and the daily increase as a percentage of original mass decreases with an increase in body mass (Table 1). The most rapid individual daily growth of 0,90 g took place during April in group 2. The average individual mass increase of 0,730 g in group two is higher than that of the other groups which was found to be 0,594, 0,513 and 0,573 g for group one, three and four respectively. The average food conversion of group two is also better than those of the other groups. The mathematical expression of the growth rates of the four groups are:

Group 1. $M = 7{,}086 + 0{,}550T$; $r = 0{,}989$
Group 2. $M = 9{,}770 + 0{,}731T$; $r = 0{,}999$
Group 3. $M = 7{,}071 + 0{,}500T$; $r = 0{,}996$
Group 4. $M = 7{,}826 + 0{,}533T$; $r = 0{,}990$

where M = mass and T = time.

The growth rate of group two was significantly different to the other groups from day 50 (Table 2). The mortality rate of the hybrids was low (6,9%) and mortalities were probably caused by handling (Table 1).

DISCUSSION

All the water quality parameters were in the range suitable for normal growth of tilapia (Van Zyl 1988).
The crosses between male *O. andersonii* and female *O. mossambicus* produced all-male hybrids. These hybrids are fertile and therefore cannot be used freely in Namibia for aquaculture, because they could enter natural systems and threaten the genetic integrity of indigenous species.

It is apparent that the high stocking density of group one, three and four negatively influenced the growth rate of the hybrids. Due to the low stocking densities, the growth

TABLE 2. t-value's of the growth rates of the different groups from day 50.

Groups	t-Value
Group 2 X Group 1	
Time (Days)	
50	DF = 83, t = 3,677, p < 0,001
61	DF = 83, t = 3,538, p < 0,001
73	DF = 82, t = 2,920, p < 0,001
86	DF = 78, t = 3,033, p < 0,001
97	DF = 78, t = 3,400, p < 0,001
Group 2 X Group 3	
Time (Days)	
50	DF = 75, t = 4,953, p < 0,001
61	DF = 75, t = 4,714, p < 0,001
73	DF = 75, t = 4,454, p < 0,001
86	DF = 71, t = 5,208, p < 0,001
97	DF = 71, t = 5,556, p < 0,001
Group 2 X Group4	
Time (Days)	
50	DF = 84, t = 4,573, p < 0,001
61	DF = 84, t = 4,492, p < 0,001
73	DF = 83, t = 3,712, p < 0,001
86	DF = 82, t = 3,899, p < 0,001
97	DF = 82, t = 5,520, p < 0,001

rate of group two represents the optimal or near optimal growth rates that can be obtained in the hatchery. Although the growth rate of group two is better than that of the parent species, the growth rates are not significantly different (DF = 14, t = 1,206, p> 0,05; DF = 14, t = 1,097, p > 0,05, Van Zyl 1988). The food conversion is the same as that of the parent species. The hybrids tested did not show any signs of heterosis for growth and food conversion. According to Pruginin *et al.* (1975) reasons for this could be: (a) The hybridisation test was based on a small number of parents. Furthermore, intraspecific genetic variation could also contribute significantly to the results. (b) Dominance including heterosis, is a variable function of environment and may change from additivity to heterosis in the same hybrid when grown in diverse environments.

For the best economical advantage of the hybrids it is necessary to do more progeny tests of paired matings of large samples between *O. andersonii* and *O. mossambicus*.

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