Asian Fisheries Science 2(1989):239-247.
Asian Fisheries Society, Manila, Philippines

https://doi.org/10.33997/j.afs.1989.2.2.009

Effect of Age on the Fecundity of the Tilapia *Oreochromis spilurus*

M. RIDHA and E.M. CRUZ
Mariculture and Fisheries Department
Food Resources Division
Kuwait Institute for Scientific Research
P.O. Box 1638, 22017 - Salmiya, Kuwait

Abstract

The effect of broodstock age on the reproductive potential of the tilapia *Oreochromis spilurus* was studied in brackishwater (3-5 ppt) during the 1987 spawning season (April-September). Spawners of three different year classes (Year Classes I, II and V) were stocked in 2-m^3 fiberglass tanks; mean weights of females were 33.9, 174.1 and 683.3 g, respectively. The fecundity of the offspring of young females was compared with that of the same females three years later.

Results showed significant differences in fecundity between the three year classes ($P < 0.01$). Year Class I had a higher fecundity rate (60 seeds [eggs and fry]/kg female/day) than Year Classes II and V (27 and 2 seeds/kg female/day, respectively). The peak spawning period occurred in the first three months of the spawning season (April-June).

The recovery rates of swim-up fry from eggs or from yolk sac fry in Year Class I were not significantly different from that of Year Class II. The recovery rate of swim-up fry from sac fry in both year classes was higher than that of swim-up fry from eggs. The recovery rates for Year Class V were not determined due to the low fecundity and poor quality of the seeds.

The offspring of young females had a higher fecundity rate (196 seeds/kg female/day) than that of old females (60 seeds/kg female/day).

It is recommended that spawners of Year Class I and possibly Year Class II be used to produce seeds for culturing tilapia. Older spawners should be discarded as unproductive.

Introduction

Many studies have been conducted on the fecundity of *Oreochromis aureus, O. niloticus* and *O. mossambicus* (Riedel 1965; Lee 1979; Hughes and Behrends 1983; Payne and Collison 1983; Peters 1963; Siraj et al. 1983; Snow et al. 1983; Watanabe and Kuo 1985). The relatively limited information available on *O. spilurus* has come mainly from the Mariculture and Fisheries Department,

Kuwait Institute for Scientific Research, Kuwait (Al-Ahmad et al. 1986, 1988).

O. spilurus was imported from Kenya in 1982 to study its culture under Kuwaiti conditions. Initial observations indicated that the fecundity of one-year-old and two- to three-year-old spawners did not differ significantly (Al-Ahmad et al. 1988). The same spawners, however, showed a sharp decrease in fecundity two to three years later (Ridha, unpublished data). This study assesses, therefore, the effect of age on the fecundity of *O. spilurus*.

Materials and Methods

Experimental Design and Broodstock Management

Three different year classes of *O. spilurus* broodstock were used: 1) Year Class I, one-year-old fish produced during the 1986 spawning season; 2) Year Class II, two-year-old fish produced during the 1985 spawning season; 3) Year Class V, five-year-old spawners (original stock). Year Classes I and II spawners were offspring of Year Class V. Each year class represents one treatment and each treatment was triplicated. Broodstock were stocked from 4 to 7 April 1987 in nine 2 m x 2 m x 0.5 m fiberglass tanks with a sex ratio of 1 male to 3 females. The average weights at stocking for females of Year Classes I, II and V were 33.9, 174.1 and 683.3 g, respectively, and 62.4, 302.0 and 974.8 g for males of Year Classes I, II and V, respectively. The numbers of breeders in each tank were as follows: Year Class I, 80; Year Class II, 40; and Year Class V, 16. As the fish grew, the number of broodstock in Year Classes I and V were reduced to half on 23 and 24 May 1987.

The broodstock were fed daily with 4.5 mm Aqualim Seabream pelleted feed containing 45% crude protein at a rate of 2.5% of their body weight. The amount of feed was adjusted monthly after broodstock weighing. Water temperature in each spawning tank was recorded daily. The experiment lasted for 161 days for Year Classes I and II, and 63 days for Year Class V. The experiment for Year Classes I and II was terminated on 12 and 15 September, respectively; while that of Year Class V was terminated earlier (7 June) because of poor spawning performance.

To study the effect of age on total fecundity per season of a group of spawners, data on the fecundity of Year Class V breeders during

the 1987 spawning season were compared with the fecundity of the same breeders during the 1984, 1985 and 1986 spawning seasons.

Seed Collection

Seed collection in each tank began 14 days after stocking and was carried out once a week during April and fortnightly thereafter to minimize the handling stress on the broodstock. Before seed collection, wastes were siphoned from the bottom of all tanks to minimize contamination of collected seeds. Water level was lowered to a depth of 10 cm and an anesthetic mixture of equal volumes (10 ml) of quinaldine, ethyl alcohol and acetone was added gradually to the tank to minimize stress and premature spitting of seeds by the brooding females. The collected seeds were sorted into eggs, yolk sac fry and swim-up fry. The eggs and yolk sac fry were incubated in 1.0-l hatching jars. After yolk absorption, the swim-up fry were removed from the incubation jars, weighed in bulk, counted and then stocked in 0.5-m^3 circular fiberglass tanks.

Recovery Rates

In this study, the hatching rate of *O. spilurus* eggs was not determined. However, recovery rates of swim-up fry from two stages of seeds (eggs and yolk sac fry) were determined. The recovery rate from eggs refers to the percentage of swim-up fry produced from the eggs and the recovery rate from yolk sac fry refers to the percentage of swim-up fry produced from the yolk sac fry.

Statistical Analysis

Seed production (fecundity) was expressed in number of seeds per kg female per day. Data on the average fecundity for the whole season as well as for each month were subjected to a one-way analysis of variance and Duncan's New Multiple Range Test.

Results and Discussion

Initial and final data on broodstock are presented in Table 1. The study shows that the average growth rate of the females of Year

Table 1. Stocking and harvesting of *O. spilurus* broodstock during 1987 spawning season. Data are means of three tanks.

	Year Class I	Year Class II	Year Class V
Stocking			
Date	4 April 1987	7 April 1987	5 April 1987
Females			
Number	60*	30	12*
Total weight (g)	2,083.4	5,222.8	8,200.2
Mean weight (g)	33.9	174.1	683.3
Males			
Number	20*	10	4*
Total weight (g)	1,248.9	3,019.9	3,899.3
Mean weight (g)	62.4	302.0	974.8
Harvesting			
Date	12 Sept. 1987	15 Sept 1987	7 June 1987
Duration (days)	161	161	63
Females			
Number	27	29	6
Total weight (g)	2,889.0	7,388.8	4,267.9
Mean weight (g)	107.3	254.7	711.3
Males			
Number	10	10	2
Total weight (g)	1,273.3	3,525.4	1,833.7
Mean weight (g)	127.3	352.5	916.8
Average growth rate (g/fish/day)			
Females	0.45	0.50	0.44
Males	0.40	0.31	-0.92
Survival rate (%)			
Females	90	98	100
Males	100	100	100

*Number of males and females were reduced to half after 50 days.

Classes I, II and V was 0.45, 0.50 and 0.44 g/day, respectively. The males grew at a lower rate - 0.40 and 0.31 g/day for Year Classes I and II, respectively. The average growth rate of Year Class V males was negligible and decreased in one of the replicates. The average survival rates of the females of Year Classes I, II and V were 90, 98 and 100%, respectively. The average survival rate of males in three different year classes was 100% (Table 1).

Total Fecundity Per Season

Effect of Age on Fecundity. The results for six months (April-September 1987) of the spawning season are presented in Table 2. Statistical analysis showed a highly significant difference ($P < 0.01$) in the average fecundity among the three treatments (Year Classes I, II and V). The highest seed production was obtained from Year Class

Table 2. Whole season fecundity of three year classes of *O. spilurus* broodstock during six months of the 1987 spawning season. Data are means of three tanks.

Year Class	Replicate	Total female wt. (kg)	Total no. of seeds	Duration (days)	Fecundity (seeds/kg/day)	Average fecundity (seeds/kg/day) ± S.E.
I						
	1	2.514	28,009	161	69	
	2	2.360	24,906	161	66	60[a] ± 7.9
	3	1.999	14,335	161	45	
II						
	1	6.358	38,271	161	38	
	2	6.252	18,634	161	19	27[b] ± 5.7
	3	6.407	24,695	161	24	
V						
	1	6.808	1,647	63	4	
	2	6.799	1,363	63	3	2[c] ± 1.2
	3	6.871	0	63	0	

Means having a different letter in a column are significantly different at 5% level using Duncan's New Multiple Range Test.

I spawners (60 seeds/kg female/day), followed by Year Class II (27 seeds/kg female/day). The fecundity of the older brooders (Year Class V) was poor (2 seeds/kg female/day). The results indicate that Year Class I females have greater fecundity than Year Class II and Year Class V females, suggesting a decrease in fecundity with age. Similar results were reported by other authors. Hughes and Behrends (1983) and Siraj et al. (1983) showed that Year Class I females of *O. niloticus* had higher fecundity than Year Class II and III females. Watanabe et al. (1985) indicated that older females of *O. niloticus* released fewer eggs per unit weight than did younger females.

Effect of Age on the Fecundity of a Single Group of Spawners (Comparison with Previous Years). It was mentioned earlier that the five-year-old breeders were carried over from the 1984, 1985 and 1986 spawning experiments. The fecundity of these spawners decreased with age. Fecundity for 1984, 1985, 1986 and 1987 was 236, 183, 40 and 2 seeds/kg female/day, respectively. Riedel (1965) reported that in *O. mossambicus,* beyond a certain size (age) of females, egg production may even totally cease.

Reproductive Potential of O. spilurus *Offspring.* Results from this study together with those obtained in 1984 suggest that the offspring of younger females tend to have higher fecundity than that of older females. For instance, in 1984, the offspring of two-year-old parents produced 196 seeds/kg female/day. But in 1987, the offspring of the same parents, then five years old, produced much fewer - 60 seeds/kg female/day. This indicates that parental age is an important factor in establishing a good broodstock.

Monthly Fecundity

Monthly seed production from Year Classes I and II is summarized in Table 3.

Year Class I. Statistical analysis showed significant differences ($P < 0.05$) in the mean fecundity between months of the spawning season. Seed production was highest in April (118 seeds/kg female/day) and lowest in August (3 seeds/kg female/day). Seed production during May, June, July and September was lower than in April, ranging from 49 to 76 seeds/kg female/day. The sharp drop in seed producing during August can be attributed to high water temperature (36.0°C) in the spawning tanks. The mean monthly temperatures of the spawning tanks are presented in Table 3.

Table 3. Mean monthly temperature and fecundity of Year Classes I and II of *O. spilurus* broodstock in groundwater during the 1987 spawning season. Data are means of three tanks.

Month	Temperature (°C)	Mean fecundity (seeds/kg/day) Year Class I	Year Class II
April	28.0	118^{a}	45^{a}
May	32.0	50^{bc}	63^{a}
June	33.0	76^{ab}	38^{ab}
July	34.0	49^{bc}	7^{c}
August	36.0	3^{c}	2^{c}
September	34.0	49^{bc}	17^{bc}
Mean ± S.E.		58.0 ± 10.6	29.0 ± 6.0

In each column, means followed by the same letters are not significantly different at 5% level using Duncan's New Multiple Range Test.

Year Class II. There was a significant difference ($P < 0.0015$) in the mean fecundity between months of the spawning season. Seed production during July, August and September ranged from 2 to 17 seeds/kg female/day and were significantly lower than those during April, May and June. The peak production was in May (63 seeds/kg female/day) followed by April and June (45 and 38 seeds/kg female/day, respectively).

As in Year Class I, the lowest seed production in Year Class II was also in August (2 seeds/kg female/day). This supports the contention that high temperature might have a deleterious effect on spawning. In both year classes, seed production was highest during the first three months of the spawning season: April, May and June, when temperature ranged from 28 to 33°C. The optimum temperature range for spawning in most species of tilapia is between

25.0 and 29.0°C (Rothbard and Pruginin 1975; Wohlfarth and Hulata 1983). Mironova (1977) reported that to stimulate reproduction in tilapia, an increase in water temperature to 28.0-31.0°C is needed. From the present study, *O. spilurus* can spawn efficiently at high temperatures but above 34.0°C, spawning nearly stops.

Recovery Rates

The mean recovery rates of swim-up fry from eggs of Year Classes I and II were 23.0 and 42.0%, respectively (Table 4). For Year Class V, recovery rates were not determined due to low fecundity and poor quality of the seeds. Although the results show that the recovery rate of fry from eggs in Year Class II was almost twice that from Year Class I, the statistical analysis showed no significant difference between the two groups. This is because of high variations within treatments (between replicates of the same treatment).

Table 4. Recovery rates and mean percentage of eggs, sac fry and swim-up fry in seeds collected from Year Classes I and II spawners during the 1987 spawning season. Data are means of three tanks.

		Year Class I	Year Class II
Recovery rate of swim-up fry from eggs (% ± S.E.)		23.00 ± 2.9	42.00 ± 10.5
	N*	29	21
Recovery rate of swim-up fry from sac fry (% ± S.E.)		83.17 ± 8.3	90.17 ± 6.6
	N	19	27
Eggs in the seeds (% ± S.E.)		74.40 ± 1.4	44.40 ± 5.0
	N	32	29
Sac fry in the seeds (% ± S.E.)		13.95 ± 1.0	27.66 ± 1.3
	N	32	29
Swim-up fry in the seeds (% ± S.E.)		11.66 ± 2.2	27.94 ± 5.5
	N	32	29

*Number of replicates per treatment.

The hatchability of eggs varies with different tilapia species. For example, in *O. niloticus,* the hatching rate ranged between 78.4 and 94.3% (Lee 1979), and 78.3 to 87.5% (Siraj et al. 1983). The latter stated further that hatchability in large fish (Year Class III) was higher than in small ones (Year Classes II and I). Watanabe et al. (1985) obtained a lower hatching rate of 51.6 and 54.2% for these age groups. In *O. aureus,* the hatching rate ranged between 74 and 96.2% (Lee 1979). Berrios-Hernandez (1983) indicated that in *O. aureus*

eggs, the mean hatching rate ranged between 81.2 and 87.8%. If the hatching rate of *O. spilurus* eggs in this study was determined as sac fry from eggs, the results would agree with figures in the literature.

As expected, the recovery rates of swim-up fry from sac fry in Year Classes I (83.17%) and II (90.17%) were higher than that from eggs (Table 4).

The mean percentage of eggs, sac fry, and swim-up fry in the seeds from the brooding females of Year Classes I and II is presented in Table 4. Seeds of Year Class I were composed of 74.4% eggs, 13.9% sac fry and 11.7% swim-up fry. Seed composition in Year Class II was 44.4% eggs, 27.7% sac fry and 27.9% swim-up fry.

It is recommended that spawners of Year Class I, and possibly Year Class II, be used to produce seeds for aquaculture. Older spawners should be discarded as unproductive.

References

Al-Ahmad, T.A., K.D. Hopkins, M. Ridha, A. Al-Ahmed and M.L. Hopkins. 1986. Tilapia culture in Kuwait. Kuwait Institute for Scientific Research, Report No. KISR2122.

Al-Ahmad, T.A., M. Ridha and A.A. Al-Ahmed. 1988. Reproductive performance of the tilapia *Oreochromis spilurus* in seawater and brackish groundwater. Aquaculture 73:323-332.

Berrios-Hernandez, J.M. 1983. Comparison of methods for reducing fry losses to cannibalism in tilapia production. Prog. Fish. Cult. 45(2):116-118.

Hughes, D. and L. Behrends. 1983. Mass production of *Tilapia nilotica*, p. 394-401. *In* L. Fishelson and Z. Yaron (comps.) Proceedings of the International Symposium on Tilapia in Aquaculture, 8-13 May 1983, Nazareth, Israel. Tel Aviv University, Israel.

Lee, J.C. 1979. Reproduction and hybridization of three cichlid fishes *Tilapia aurea* (Steindachner), *Tilapia hornorum* (Trewavas) and *Tilapia nilotica* (Linnaeus) in aquaria and plastic pools. Auburn University, Alabama. Ph.D. dissertation.

Mironova, N.V. 1977. Energy expenditure on egg production in young *Tilapia mossambica* and the influence of maintenance conditions on their reproductive intensity. J. Ichthyol. 17:627-633.

Payne, A.I. and R.I. Collison. 1983. A comparison of the biological characteristics of *Sarotherodon niloticus* (L.) with those of *S. aureus* (Steindachner) and other tilapia of the delta and lower Nile. Aquaculture 30:335-351.

Peters, H.M. 1963. Fecundity, egg weight and oocyte development in tilapia (Cichlidae, Teleostei). Translated and edited by D. Pauly. 1983. ICLARM Translations 2, 28 p. International Center for Living Aquatic Resources Management, Manila, Philippines.

Riedel, D. 1965. Some remarks on the fecundity of Tilapia (*T. mossambica* Peters) and its introduction into middle Central America (Nicaragua) together with a first contribution towards the limnology of Nicaragua. Hydrobiologia 25:357-388.

Rothbard, S. and Y. Pruginin. 1975. Induced spawning and artificial incubation of tilapia. Aquaculture 5:315-321.

Siraj, S.S., R.O. Smitherman, S. Castillo-Gallusser and R.A. Dunham. 1983. Reproductive traits for three year classes of *Tilapia nilotica* and maternal effects on their progeny, p. 210-218. *In* L. Fishelson and Z. Yaron (comps.) Proceedings of the International Symposium on Tilapia in Aquaculture, 8-13 May 1983, Nazareth, Israel. Tel Aviv University, Israel.

Snow, J.R., J.M. Berrios-Hernandez and H.Y. Ye. 1983. A modular system for producing tilapia seed using simple facilities, p. 402-413. *In* L. Fishelson and Z. Yaron (comps.) Proceedings of the International Symposium on Tilapia in Aquaculture, 8-13 May 1983, Nazareth, Israel. Tel Aviv University, Israel.

Watanabe, W.O. and C.M. Kuo. 1985. Observations on the reproductive performance of Nile tilapia *(Oreochromis niloticus)* in laboratory aquaria at various salinities. Aquaculture 49:314-323.

Wohlfarth, G.W. and G. Hulata. 1983. Applied genetics of tilapias. ICLARM Studies and Reviews 6, 26 p. International Center for Living Aquatic Resources Management, Manila, Philippines.

Manuscript received 16 January 1989 ; accepted 3 May 1989