Available online at www.scholarsresearchlibrary.com

Scholars Research Library

Annals of Biological Research, 2013, 4 (3):138-142
(http://scholarsresearchlibrary.com/archive.html)

ISSN 0976-1233
CODEN (USA): ABRNBW

Maternal size affects fecundity of saline-tolerant tilapia *Oreochromis mossambicus* (Peters) in freshwater tanks

Asaad H. Mohamed[1,2*], Rex Ferdinand M. Traifalgar[2] and Augusto E. Serrano. Jr.[2]

[1]Department of Fisheries and Wildlife Sciences, Sudan University of Science and Technology, Khartoum- Sudan
[2]Institute of Aquaculture, College of Fisheries and Ocean Sciences, University of the Philippines Visayas, Iloilo-Miagao, Philippines

---

ABSTRACT

*The aim of this study was to determine the effects of maternal size on egg production in saline-tolerant tilapia O. mossambicus. Female broodstocks were taken from the ponds, kept in concrete tanks and classified into size groups: small-sized (20.1-26 g), medium-sized (26.1 – 32.0 g) and large-sized group (32.1 – 38.0 g) and allowed to be paired with male broodstocks in a ratio of 3 females to 1 male. They were fed a commercial diet containing 30% crude protein. Fecundity, relative fecundity, weight of gonads and Gonadosomatic Index (GSI) were determined. Fecundity of O. mossambicus were in the range of values reported by other investigators. Fecundity and relative fecundity of saline-tolerant O. mossambicus were influenced by the maternal body size; the relationships of fecundity with total body weight and with gonad weight were linearly correlated.***

Key words: maternal body size, fecundity, relative fecundity, *O. mossambicus*, gonadosomatic index

---

INTRODUCTION

In general, the fecundity, larval development and fry survival of tilapia are severely affected under high salinity conditions [20]. Although salinity exposure of the broodfish as early as the spawning stage does improve the salinity tolerance of the fry, fecundity of the broodstock is adversely affected. An alternative approach is to spawn the fish in freshwater and hatch the eggs in saline waters [24]. In *O. niloticus*, hatching rates in salinities from 0 to 15 g L^{-1} were almost similar to those of freshwater-spawned and hatched eggs but above 15 g L^{-1} salinity inflicted heavy mortality. Still another alternative approach demonstrated in *O. niloticus* is to hatch the eggs in lower salinities (15-18 g L^{-1}) and to transfer the fry to higher salinities (> 32 g L^{-1}) at the size of maximum tolerance [23, 25].

The problem in the seed supply of tilapia is partly attributed to the low fecundity and asynchronous spawning between females in the same environment (Tsadik and Bart, 2007). Even in tanks which is a more controlled spawning environment, natural fry production will decrease rapidly after an initial peak in spawning because of asynchronous spawning [8]. Improvement in spawning synchrony in Nile tilapia broodstock management include stocking density [2] and dietary protein levels [9, 19, 26] among a number of factors. This suggests that fecundity is highly influenced by body size since stocking density and dietary protein levels directly affect growth.

The aim of this study was to determine the effects of maternal size on the reproductive performance of saline-tolerant tilapia *O. mossambicus.*

MATERIALS AND METHODS

The reproductive performance of *O. mossambicus* were evaluated at the Brackishwater Center of the University of the Philippines Visayas from February to March 2006. Experimental facilities were located at Leganes, Iloilo, Philippines.

Experimental facilities

Nine breeding units used were hapas (1 m^3 fine-meshed breeding nets) suspended in three 3 x 3 x 1 m concrete tanks and 1.2-L clear plastic jars for egg incubation. Water was from a freshwater reservoir tank supplied by gravity to the experimental facilities, supplied with aeration by airlift method.

Experimental fish and design

Broodstocks were taken from the ponds of the research center and kept in concrete tanks. Tilapia female (n=36) broodstocks were visually identified by examining their urogenital papillae and were conditioned for 2 weeks during which they were fed commercial feeds intended for tilapia (30% crude protein) at 5% body weight. Females which were ready to spawn where then selected by visual examination of their morphological characteristics. The selected female tilapias were randomly distributed and paired with male tilapias at a ratio of 1 male to 3 female in each hapa net. Three hapa nets were installed per concrete tank (3 x 3 x 1 m) in a total of 3 tanks containing a total of 36 tilapia breeders. Each replicate (i.e. one hapa net) of a weight class had the same male to female ratio. To determine whether the size of the spawners will have an effect on egg production, female spawners were classified into size groups, namely small-sized (20.1-26 g), medium-sized (26.1 – 32.0 g) and large-sized group (32.1 – 38.0 g).

Prior to pairing, variation in the total weight of tilapia breeders for each hapa net were intentionally minimized (Table 1). The tanks were located outdoor, filled with freshwater and followed a natural photoperiod and ambient temperature (28.5 -31.0^{o}C). Freshwater was used since the reproductive performance as well as survival of eggs in seawater is much better than in seawater. On the 10th day following pairing, 18 female tilapias out of the total 36 fish were sacrificed, weight and total length measured. Ovaries were excised and weighed and the number of eggs was counted to determine the total fecundity for each fish. Fecundity was estimated from total counts of eggs in the ovaries of the fish in the most advanced stage of development [16]. Relative fecundity, expressed as the number of eggs per 100 g^{-1} body weight (bw), was determined by dividing the total number of mature eggs produced with the total bw of the particular female spawner in g multiplied by 100. The weight of the gonad relative to the total body weight, i.e., the Gonadosomatic Index (GSI) was calculated as: GSI = (weight of the ovary/total bw of the fish) x 100.

The remaining fish in the outdoor hapa nets were checked for spawning and mouth brooding on a daily basis. Eggs were collected from each female, manually counted and transferred into artificial incubators that were supplied with aeration by airlift. An incubator was a clear plastic jar (1.2-L capacity) with a wide mouth that enabled convenient placement and removal of eggs and fry and a narrow bottom. Potassium permanganate ($KMNO_4$) solution was added every 12 h to distinguish and discard bad eggs (white-colored eggs) from the good ones (brown in color). Dead eggs and fry were counted before discarding. Tilapia fry were allowed to hatch in the incubators (about 3 days post-spawning) and transferred to small basins until complete yolk absorption (about 8 d post-spawning) after which they were transferred into nursery tanks.

Data analysis

To determine whether significant differences exists between fecundity, relative fecundity, GSI, fry parameters of different sizes of *O. mossambicus* fingerlings, one way analysis of variance (ANOVA) was performed. Survival rates and GSI were arcsined transformed before performing one-way ANOVA. When significant differences between treatments exist, the Duncan's Multiple Range Test as a post hoc test was performed [7]. Simple correlation analysis (R^2) was used to determine the degree of relationship between the weights of female broodstock and gonad with fecundity.

RESULTS AND DISCUSSION

The results obtained show that all of the *O. mossambicus* broodstock had a high adaptability for spawning under the conditions of the experiment in hapa nets inside concrete tanks, with a high survival rate, sexual maturation and natural spawning.

Fecundity of *O. mossambicus* in scientific literature vary widely stemming probably from factors such as feeds, time of year and other factors. In the present study, fecundity increased with fish size from a mean of 1465 eggs in small-sized female (median= 23.28 g) broodstock to 4105 eggs for large-sized female (median=35.15 g) broodstock (Table 1). Hora and Pillay [11] state that the female tilapia lays 75-250 eggs at a time. Other works report fecundity of tilapia from 80 to 1000 eggs per female [15]; 80 to 800 eggs for female tilapia measuring 8 cm to 15 cm, respectively [3]; 180-300 eggs and 350-500 eggs for a 6-month old and 8-month old tilapia female, respectively [15]; 360-1,775 eggs per female *O. mossambicus* with 20-32 cm length range and 145-538 g weight range [4]. Measurements made by Jaspe and Caipang [12] reveal a fecundity for saline-tolerant *O. mossambicus* to be about 550-570 eggs female^{-1} with weight range of 30-70 g. In the present study, we noted a higher fecundity of 488 to 1368 eggs female^{-1} with a median weight range of 23.28 to 35.15 g. The fecundity range was higher and wider than those reported by Jaspe and Caipang [12] and could be an indication of a better conditions of various factors that affect egg production.

Riedel [18] observes that the relative fecundity of *O. mossambica* range from 660 to 1,754 eggs 100 g^{-1} bw while that of Hatikakoty and Biswas [10] range from 546 to 1,550 eggs 100 g^{-1} bw. In the present study a higher relative fecundity was observed (2,096 to 3,092 100 g^{-1} body weight) than those reported. This may be an indication that the method of allowing the saline *O. mossambicus* to be paired with the male in freshwater could be a much favorable condition, in addition to feeding commercial feed containing 30% protein, for the proper production of eggs in this tilapia strain. The effect of salinity on egg production and hatchability of fry in tilapia have mixed results from various studies. In the Nile tilapia, reproductive performance of *O. niloticus* females were comparable at freshwater and brackishwater (12 ppt) conditions and increasing the salinity to full seawater resulted in the failure of hatching [22]. In contrast, fry production of *O. mossambicus* was higher in brackishwater (8.9-15.2 ppt) than in freshwater [21].

Total fecundity increased with increasing body size of female broodstock but the relative fecundity was significantly higher in bigger-sized *O. mossambicus* female broodstock (Table 1). These results did not agree with those of Jaspe and Caipang [12] who find that there was no significant differences in total fecundity in all the size groups of *O. mossambicus*. Furthermore, they report that relative fecundity decrease with increasing size of female broodstocks.

Gonadosomatic index (GSI) increased with increasing size of the female parent (R^2=0.96), this finding might be due the spawning frequency during the time of the study which was higher during the dry season than during the rainy season. Seasonal fluctuations in reproductive intensity seemed to be related to productivity of O. mossambicus. Generally, in any given environment, seasonal variations in relative fecundity have been observed. Fagade *et al.* [6] suggest the fluctuation may be due to differential abundance of food, and fish species could exhibits wide fluctuation in fecundity among member of the same species, size and age.

Physical parameters of the hatched fry and survival were not correlated with the fecundity or body weight of the female parent (analysis not shown). The fry body weight and length did not significantly vary in small, medium or large female parent. However, survival rate of the hatched fry was significantly better in those produced by the large female parent than did those by small and medium parents (Table 1).

Table 1. Fecundity and fry parameters (Mean ± SD) between different female weight classes (n= 3).

Size	Weight Class (g) of female broodstocks	Fecundity (no. of eggs female^{-1})	Rel. fecundity (100 g^{-1} bw)	Fry Body weight (mg)	Fry length (mm)	GSI %	Survival Rate %
Small	20.1-26.0	488^{a}	2096^{b}	7.7 ± 0.32^{a}	8.5 ± 0.22^{a}	0.183^{a}	70^{a}
Medium	26.1-32.0	594^{b}	2090^{b}	7.6 ± 0.13^{a}	8.5 ± 0.12^{a}	0.289^{b}	79^{a}
Large	32.1-38.0	1368^{c}	3092^{a}	7.8 ± 0.40^{a}	8.8 ± 0.35^{a}	0.359^{c}	88^{b}

Fecundity varied between maternal size groups which is in agreement with previous reports [14, 17]. It was linearly correlated with the female body weight (R^2=0.94) and with the weight of the gonad weight (R^2=0.71) (Figure 1), which is in agreement with the finding of Peters [17] that finds high significant correlation between female weight and spawn size tested in blue tilapia. However, this finding is in contrast with the findings of Desprez *et al.* [5]

which demonstrated that the fecundity in *Oreochromis aureus* is not correlated with the body weight and the fecundity does not increase systematically with the age of fish.

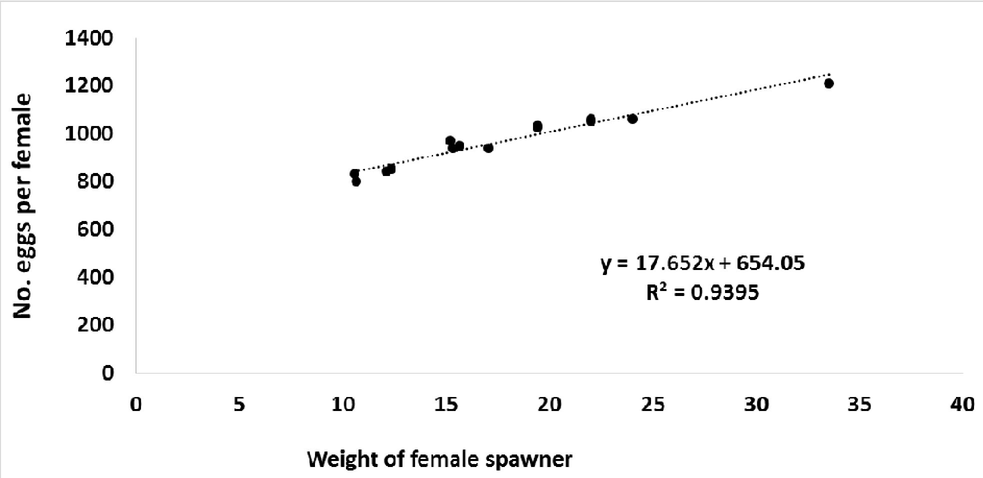

Figure 1. Relationship of weight of *O. mossambicus* female spawner with the number of eggs spawned female^{-1}.

The relationship between fecundity and female's gonad weight significantly varied among treatments (*P*<0.05); the weight of the gonad is linearly correlated with fecundity (Figure 2).

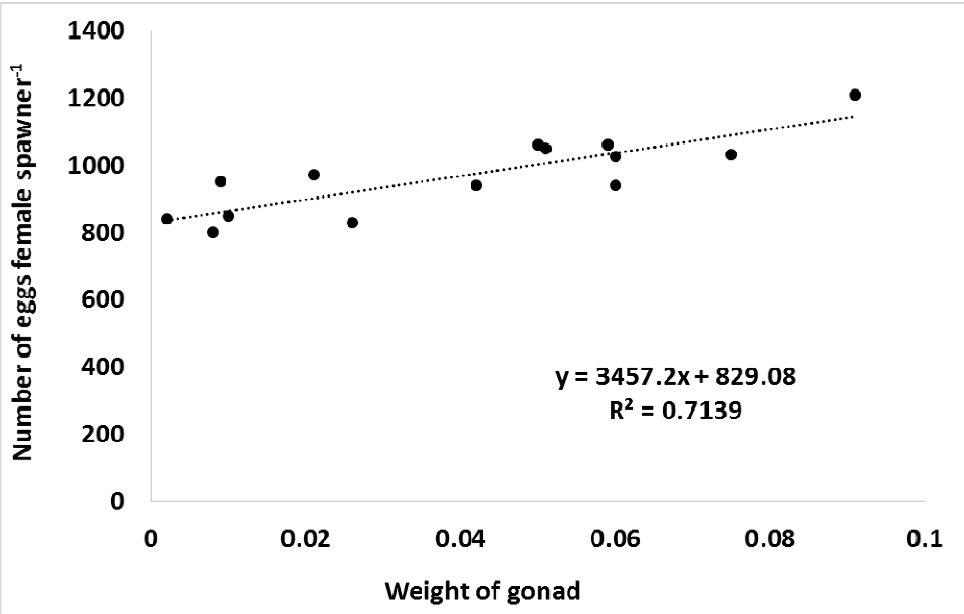

Figure 2. Relationship of the weight of gonads to the number of eggs spawned female^{-1} spawner.

One probable factor was nutrition which could affect the fecundity of *O. mossambicus*. Size and age also affect the egg number [13]. It seemed that in *O. mossambicus*, size as a single factor could probably be used to predict reproductive efficiencies of the females with respect to weight class. In general, using large size females to improve productivity is advisable for tilapia culture. Although fecundity varies greatly in individuals of one species of the same weight, length and age, in many species it increases in proportion to the size of fish [13].

In conclusion, fecundity of the saline-tolerant O. mossambicus were in the range of the values reported by other investigators. Fecundity and relative fecundity of saline-tolerant *O. mossambicus* were influenced by the maternal body size; the relationships of fecundity with total body weight and with gonad weight were linearly correlated.

Acknowledgements
This study was apart funded and supported by the Ministry of High Education and Scientific Research, Training and Extension Administration through the efforts of Sudan University of Science and Technology, Khartoum – Sudan, under Scholarship Grant Permit NO: 156/17A/5A/2009-2013. Many thanks are expressed to the research staff of the Brackishwater Aquaculture Center of the Institute of Aquaculture, College of Fisheries and Ocean Sciences, U.P. Visayas particularly to Mr. Alex Gustilo.

REFERENCES

[1] T.J. Aureli, General notes: Spawning frequency and fecundity of blue tilapia, **1988**, Dept. of Agriculture, University of Arkansas: Pine Bluff, Arizona, USA.
[2] A. Bautista, M.H. Ma Carlos, and A.I. Son Antonio, *Aquaculture*, **1988**, 73:85-89.
[3] P. Chimitz, *FAO Fish. Bull.*, **1955**, 8(1):16 - 17.
[4] S.S. De Silva and J. Chandrasoma, *Env. Biol. Fishes*, **1980**, 5:253-250.
[5] D. Desprez, P. Bosc, J.F. Baroiller, and C. Mélard, *Aquaculture*, **2008**, 277:73-77.
[6] S.O. Fagade, A.A. A., and A.A. N., *Arch- Hydrobiol.*, **1984**, 100:493-500.
[7] K.A. Gomez and A. Gomez, Statistical procedures for Agricultural Research, 2nd ed**1984**, New York, USA: John Wiley and Sons Inc.
[8] R.D.I. Guerrero and L.A. Guerrero, *Aquaculture*, **1985**, 47: 257-261.
[9] R.M. Gunasekera, K.F. Shim, and T.J. Lam, *Aquaculture*, **1996**, 146:121-134.
[10] G. Hatikakoty and S.P. Biswas, *Environ. Biol. Fishes*, **2002**,
Available: http://ag.arizona.edu/azaqua/ista/ista6/ista6web/pdf/112.pdf.
[11] S.L. Hora and T.V.R. Pillay, Handbook of fish culture in the Indo-Pacific region, in *FAO Fish. Biol.* **1962**. p. 204.
[12] C.J. Jaspe and C.M.A. Caipang, *Curr. Res. J. Biol. Sci.*, **2011**, 3(4):404-409.
[13] R.H. Lowe-McConnel, Fish Communities in Tropical Fresh Waters. Their Distribution, Ecology, and Evolution,**1975**, Longman, London.
[14] D.J. Macintosh, T.I. Varghese, and G.P. Satyanarayana Rao, *J. Fish Biol.*, **1985**, 26:87-94.
[15] N.V. Mironova, *Voprosy Ikhtiologii (Transl. for Am. Fish. Soc.By Scriptatechnica, Inc.)*. **1969**, 9:506 - 514.
[16] M. Njiru, J.E. Ojuok, J.B. Okeyo-Owuor, M. Muchir, M.J. Ntiba, and I.G. Cowx, *Afr. J. Ecol.*, **2006**, 44:30-37.
[17] H.M. Peters, *ICLARM Translations*, **1983**, 2:28.
[18] D. Riedel, *Hydrobiologia*, **1965**, 25:357-388.
[19] A.O. Siddiqui, Y.S. Al-Hafedh, and S.A. Ali, *Aquac. Res.*, **1998**, 29:349-358.
[20] A.V. Suresh and C.K. Lin, *Aquaculture*, **1992**, 106:201-226.
[21] R.N. Uchida and J.E. King, *US Fish Wildlife Serv. Fish Bull.*, **1962**, 62:21-25.
[22] W.O. Watanabe and C.-M. Kuo, *Aquaculture*, **1985**, 49(3-4):315-323.
[23] W.O. Watanabe, C.-M. Kuo, and M.-C. Huang, *Aquaculture*, **1985a**, 47:353-367.
[24] W.O. Watanabe, C.-M. Kuo, and M.-C. Huang, *Aquaculture*, **1985b**, 48: I59-176.
[25] W.O. Watanabe, L.J. Ellingson, B.L. Olla, D.H. Ernst, and R.I. Wicklund, *Aquaculture*, **1990**, 87:311-321.
[26] K.L. Wee and N.A. Tuan. in The Second International Symposium on Tilapia in Aquaculture. ICLARM Conference Proceedings. **1988**. Manila, Philippines: Department of Fisheries, Bangkok, Thailand and International Center for Living Aquatic Resources Management.