FECUNDITY AND EGG SIZE VARIATION IN *TILAPIA ZILLII* (GERVAIS) AND *TILAPIA MARIAE* (BOULENGER) FROM LEKKI LAGOON, NIGERIA.

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(Received: June, 2011; Accepted: October, 2011)

ABSTRACT

Tilapia zillii and *Tilapia mariae* collected from the landings of fishermen operating on Lekki Lagoon between February and November, 2000 were examined for fecundity and egg size. Fecundity was determined using the wet weight method while egg size was measured under a binocular microscope with the aid of a standardized calibrated eye piece. Graphical comparisons of Gonadosomatic Index (GSI), Absolute Fecundity (AF), and Relative Fecundity (RF), were made by standardizing fish to common weight. ANOVA result showed that *T. zillii* had significantly higher GSI ($P = 0.01$), AF ($P < 0.01$) and RF ($P < 0.01$), than *T. mariae*, which indicates that *T. zillii* allocates a higher percentage of its energy to egg production. This greater reproductive success was advanced as a possible reason for its higher population than *T. mariae* in the lagoon. A maximum mean egg size of 2.29 mm observed in both species was larger than those reported for the great lakes of East Africa. The *T. zillii* and *T. mariae* populations in the Lekki Lagoon may thus be considered to fall nearer the k-extreme of the r/k MackArthur and Wilson life history style continua than those of the great lakes of East Africa.

Keywords: Fecundity, Egg Size, Gonadosomatic Index, Parental Care, *Tilapia zillii, Tilapia mariae*

INTRODUCTION

Parental care is not a wide-spread reproductive behaviour in fishes as it occurs in only 21% of bony fish families (Clutton-Brock, 1991: cited by Balshine-Earn, 1997). However, parental care is a well-developed reproductive behaviour in the family Cichlidae, the family to which the tilapias belong. Trewavas (1982) classified the tilapias into three genera: *Tilapia, Sarotherodon* and *Oreochromis.* This classification was based mainly on an evolutionary gradation in parental care pattern among them. While all the members of the three genera modify a portion of the substratum in which eggs are laid and fertilized, only the eggs of the genus *Tilapia* hatch in the nest. The males of *Sarotherodon* (Uniparental paternal mouth brooders) and the females of *Oreochromis* (Uniparental maternal mouth brooders) pick up the fertilized eggs and incubate them in their mouths. Whatever the role of each sex in brood care, this care had been observed to contribute greatly to the reproductive efficiency of these species (Jalabert and Zoar, 1982; Balshine-Earn, 1997). This explains why tilapias usually constitute a dominant group of the fish fauna wherever they occur.

Parental care patterns have significant relationship to fecundity and egg size. Species that show parental care are characterised by low fecundity and large egg size while those that do not show parental care generally have high fecundity and small egg size. The reason why some species have evolved a strategy of producing many small eggs, and others the opposite strategy of fewer, larger ones is not clearly understood. The relationships between these characters and implication for the species have been summarized by Bone *et al.* (1995).

Apart from parental care, environmental factors such as availability and quality of food, intensity of predation and other density-dependent factors (Hartmann and Quoss, 1993), size of the inhabited water bodies, length of the breeding season and number of broods produced per year

(Nokes and Balon, 1982), time or season of spawning (Kazakov, 1981; Jobling, 1995), and distance of migration to the spawning ground (Becham and Murray, 1993) also affect fecundity and egg size.

Most previous comparative reports on fecundity and egg size variation in tilapias have been carried out on specimens collected from different water bodies. In such cases, it is difficult to ascertain the extent to which environmental factors have caused variations in fecundity and egg sizes in those species. Comparative works on fecundity and egg size should, therefore, take the effects of these environmental factors into consideration.

The red-bellied tilapia, *Tilapia zillii* and the spotted tilapia, *Tilapia mariae* are two tilapias in Lekki Lagoon. Fryer and Iles (1972) reported that both species are open substrate spawners. Since they have similar reproductive behaviour, and are from the same water body, they provide a good situation for a comparative study of fecundity and egg size. The fecundity and egg sizes of *T. zillii* and *T. mariae* have been separately reported (Jegede and Fawole, 2005; Jegede, 2008). The present work serves to compare their fecundities and egg sizes as they relate to the observed difference in their population in Lekki Lagoon. A description of Lekki Lagoon has been presented in Jegede, (2008).

MATERIALS AND METHODS

Sampling and Laboratory Procedure: Specimens of *T. zillii* and *T. mariae* were randomly collected from the landings of local fishermen operating on Lekki Lagoon. Samples were collected fortnightly from February to November, 2000. The total (TL) and standard (SL) lengths were measured to the nearest 0.10cm. Total weight (TW) was measured to the nearest 0.10g. Each fish was then dissected and the ovary preserved in labeled bottles of Gilson's fluid pending fecundity estimates and egg size measurements. The weight of eviscerated fish and ovary weight were measured to the nearest 0.10g using a digital electronic balance. The sex and stage of gonad development was classified following Dadzie, (1974). Condition Factor (CF), Gonadosomatic index (GSI), and Relative Fecundity (RF) were

calculated from the formula $CF = \frac{\text{total weight (g) x 100}}{\text{total length 3 (cm3)}}$, $GSI = \frac{\text{Total Egg Weight (g)}}{\text{Evicerated Weight (g)}}$

and $RF = \frac{\text{absolute fecundity}}{\text{eviscerated weight (g)}}$

respectively (Chigbu and Sibley, 1994).

Absolute Fecundity (AF) was estimated using the wet weight method described by Bagenal and Braun, (1978). Egg size measurement was carried out on 1,200 eggs from 55 ovaries of *T. zillii* and 25 ovaries of *T. mariae*. Fifteen randomly selected eggs from each ovary were measured to the nearest 0.01mm under a binocular microscope with the aid of a standardized calibrated eye piece. Corrections were made for shrinkage as a result of preservation in Gilson's fluid by dividing the observed egg sizes by a factor of 0.936. (Jegede and Fawole, 2005; Jegede, 2008).

Statistical Analysis: Difference between the observed and expected sex ratio was subjected to Chi-square test. Variations of GSI, AF and RF with size were determined by regressing weight on each of these parameters. The resulting equation was used to standardize the fish to common weight. Comparison of growth and female reproductive parameters of the two species was made using Analysis of Variance (ANOVA). Weight was used as covariate in the ANOVA analysis to reduce the effect of differences in the sizes of the two species.

RESULTS

Sex Ratio: The 508 specimens collected were made up of 413 specimens of *T. zillii* and 95 specimens of *T. mariae*. Out of the 413 specimens of *T. zillii*, 189 were males while the females were 224 giving a male: female ratio of 1: 1.19. *T. mariae* were made up of 43 males and 52 females which gave a male: female ratio of 1: 1.21. Chi-square test showed no significant difference between the observed and the expected ratio of 1:1 in both species. (*T. zillii:* ^{2} = 2.97, d.f. =1, P 0.05, *T. mariae*; ^{2}= 0.85, d.f. = 1, P 0.05)

Stages of Gonad Development: Only four stages of gonad development were observed in the two species. *T. mariae* in stages II, III, IV and V, were 18, 6, 20 and 8 respectively while *T. zillii* in similar stages were 102, 36, 42, and 44. Since all specimens examined were sexually matured, no fish in stage I was encountered. Fish with ripe gonads were found in the samples throughout the period of sampling.

Condition Factor (CF): CF describes the state of 'well-being' of fish. The range and mean CF of *T. mariae* were 1.77-2.60 and 2.05 ±0.07 respectively. No seasonal or sexual variation in CF was observed. *T. zillii* had a condition factor range of 1.11-2.50 with a mean condition factor of 1.76 ±0.21.

Gonadosomatic Index (GSI): GSI varied with fish size and stage of gonad development being higher in fish with matured gonads. GSI was higher in *T. zillii* than in *T. mariae* ($P < 0.05$; Table 1). Figure 1 shows the relationship between gonadosomatic index and total weight in the two species standardized to common fish weight. General pattern of decrease in GSI with increase in weight was observed in both species.

Table 1. Comparison of Some Growth and Reproductive Parameters of Female *Tilapia zillii* and *Tilapia mariae* Collected from Lekki Lagoon between February and November, 2000

	Tilapia zillii		*Tilapia mariae*			
PARAMETER	RANGE	LSMEAN ±E (n_1)	RANGE	LSMEAN ±E (n_2)	Fcal.	P
Total Length (cm)	15.00-21.60	17.83 ±27 (35)	15.30-22.00	19.10 ±0.33 (24)	8.85	0.00**
Total Weight (g)	47.40-189.80	105.87 ±5.94 (35)	80.50-265.00	155.58 ±7.17 (24)	28.49	0.00**
Condition Factor (gcm^{-3})	1.40-2.27	1.84 ±0.03 (35)	1.61-2.52	2.14 ±0.04 (24)	41.03	0.00**
Gonadosomatic Index	0.98-8.78	4.60 ±0.28 (35)	1.68-6.37	3.66 ±0.34 (24)	4.55	0.04*
Absolute Fecundity	1025 -3314	2071.77 ±102.99 (35)	1093-3545	2101.08 ±124.37 (24)	7.48	0.00**
Relative Fecundity (gcm^{-2})	11.00-39.00	22.77 ±0.98 (35)	7.00-26.00	15.79 ±1.18 (24)	20.68	0.00**
Egg Size (mm)	1.14-2.29	1.76 ±0.05 (35)	1.28-2.29	1.86 ±0.06 (24)	2.57	0.11 NS

N_1 = Sample size for *T. zillii*, n_2 = Sample size for *T. mariae*, NS = Not significant, * Significant, ** Highly significant, df = 57.

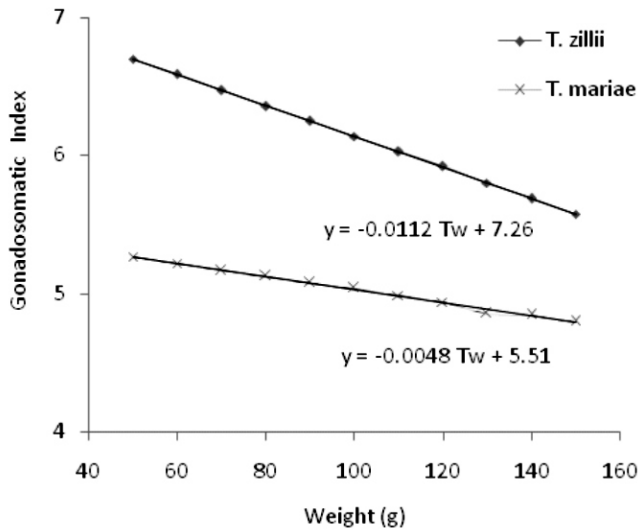

Fig. 1: Gonadosomatic Index of *T. zillii* and *T. mariae* Standadized to Common Weight

Absolute and Relative Fecundity: The Absolute and Relative Fecundity of *T. zillii* was significantly higher than that of *T. mariae* ($P < 0.01$; Table 1). The relationship between AF and RF and standardized total weight in the two species are presented in Figures 2 and 3 respectively. AF showed positive correlation while RF showed negative correlation with weight.

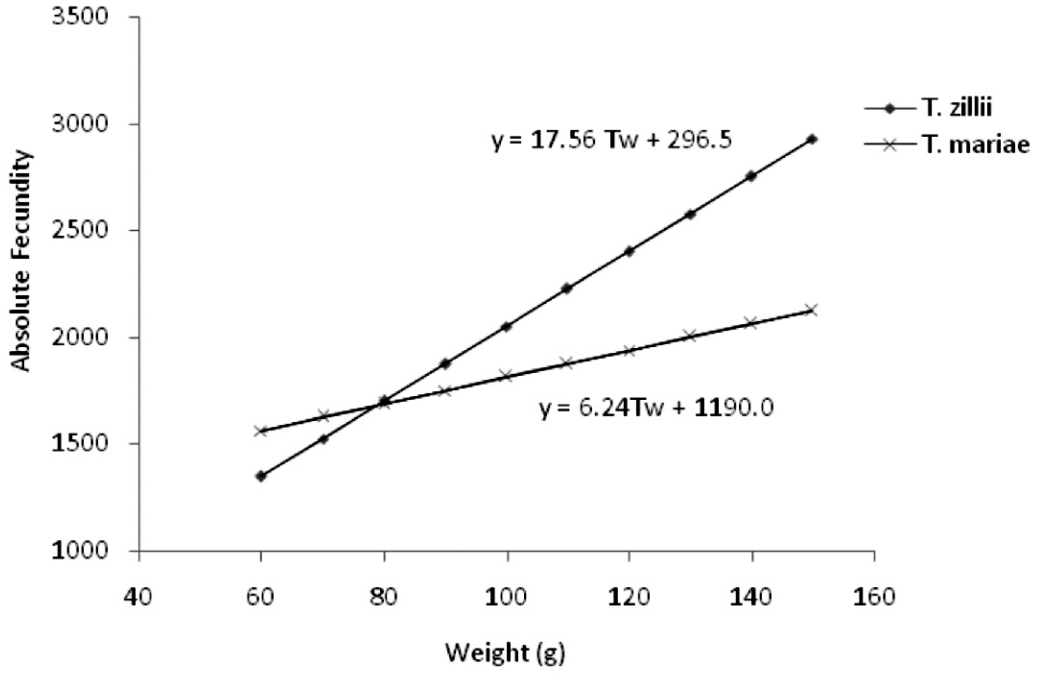

Fig. 2: Absolute Fecundity of *T. zillii* and *T. mariae* Standardized to Common Weight.

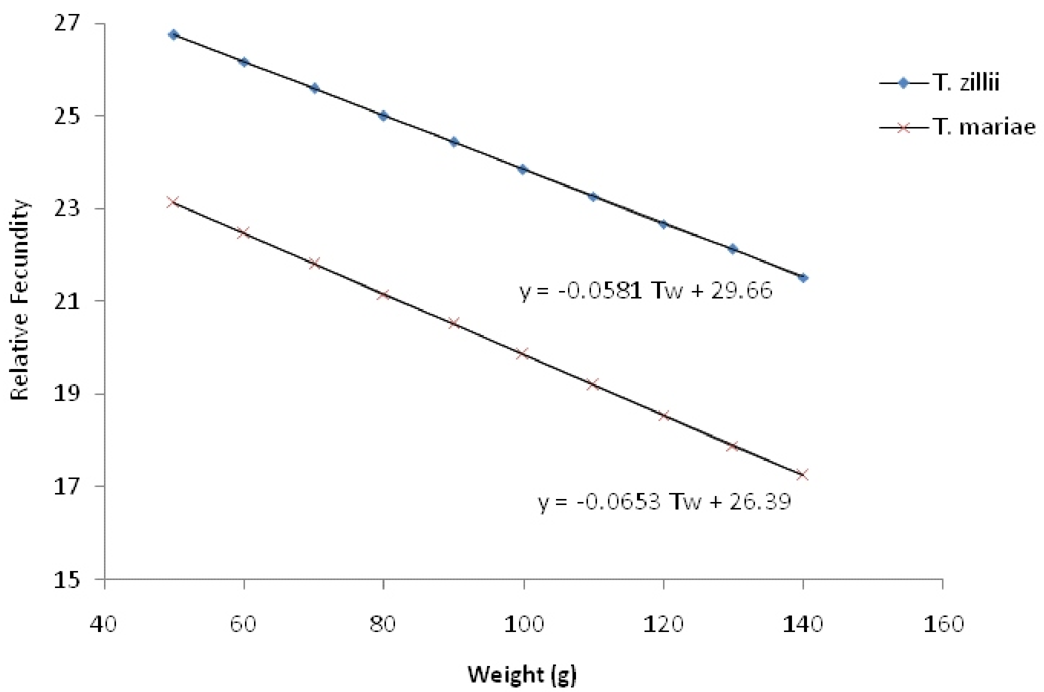

Fig. 3: Relative Fecundity of *T. zillii* and *T. mariae* Standardized to Common Weight.

Egg Size: Egg diameter ranged from 1.29mm - 2.53mm in *T. zillii* and from 1.37mm - 2.38mm in *T. mariae*. The largest egg of 2.53mm was recorded in *T. zillii* weighing 85.40g while 2.39mm was the largest egg diameter recorded in *T. mariae* of 145.20g. The respective average egg diameters in these two specimens were 2.29 ±0.13mm and 2.29 ±0.10mm. Another specimen of *T. zillii* weighing 101.10g also had mean egg diameter of 2.29 ±0.10mm. There appeared not to be any relationship between egg size and weight in the two species.

DISCUSSION

The higher CF factor ($P < 0.01$) exhibited by *T. mariae* may not be an indication of a better state of 'well being' than *T. zillii*. Rather it could be as a result of differences in the morphology of the two species; *T. maria*e being deeper bodied than *T. zillii*. Lack of marked seasonal variation in CF recorded in both species may be due to the relatively stable environmental condition in Lekki Lagoon. Salinity in the lagoon ranged from 0.05‰ -0.30‰ (Kusemiju, 1981). Unlike Lagos Lagoon, Lekki Lagoon experiences little tidal influence (Fagade, 1978). It was observed that frequent perturbation due to anthropogenic activities such as sand mining, sand filling, domestic and industrial pollution is also minimal in the Lagoon.

The male: female ratio of 1:1 observed in the two species is consistent with the general trends among *Tilapia* species. Trewavas (1983) observed that tilapias notably Tilapia and Sarotherodon species that exhibit monogamous breeding behaviour show little variation in sex ratio. The presence of mature gonads throughout the sampling period suggests that these species breed throughout the year in the lagoon.

The higher GSI ($P < 0.05$), AF ($P < 0.01$) and RF ($P < 0.01$; Table 1), recorded in *T. zillii* shows that it is very much more fecund than *T. mariae*. This suggests that *T. zillii* allocates more of its resources to egg production than *T. mariae*. King and Etim (2004) also observed that the fecundity of *T. mariae* from Iba Oku Stream was lower than those of related substrate spawners. It thus appears that *T. mariae* contrary to the general trends among *Tilapia* species (substrate spawners) exhibits low fecundity. The general pattern of decrease in GSI and RF (Figs. 1 and 3) with increase in weight in both species could imply that lesser proportion of the fish resources is allocated to egg production in larger and probably older fishes.

Fryer and Iles (1972) reported 1.80mm and 2.00mm as the maximum diameters of the eggs of *T. mariae* and *T. zillii* respectively, suggesting that *T. zillii* produces larger eggs than *T. mariae*. If the two species were collected from different water bodies, ecological, rather than genetic or behavioural factors could be responsible for the observed differences in their egg sizes. The maximum egg sizes (1.80mm and 2.00mm) recorded for *T. mariae* and *T. zillii* respectively (Fryer and Iles, 1972; *Trewavas, 1983*) may imply that the populations of *Tilapia* species in the great lakes of East Africa exhibits smaller eggs than those in Lekki Lagoon. Fagade *et al.* (1984) recorded 3.60mm as the maximum egg diameter of *S. galilaeus* from International Institute of Tropical Agriculture (IITA) Lake, while Fawole and Arawomo (2000) observed that the average egg diameter of *S. galilaeus* from Opa Reservoir was 2.49 ±1.80mm. These were also bigger than the maximum diameter of 2.20mm observed by Fryer and Iles, (1972). Fawole and Arawomo (2000) were of the opinion that *S. galilaeus* in Opa resorvoir produces larger eggs than those of the great lakes of East Africa. The comparatively larger eggs recorded in these species further confirms that tilapias in Nigerian waters produce large eggs. Populations of tilapias in Nigerian waters may fall nearer the k- extreme of the r/k MackArthur and Wilson life history style continua (i.e. k-selected) than those of the great lakes of East Africa. A species is said to be k-selected, if it shows parental care, have low fecundity and large egg size. Those that employ the opposite strategy of producing many but smaller eggs are examples of r- selection (MackArthur and Wilson, 1967). Egg size has been found to increase with fish size in some species (De Martini, 1990, 1991; L'abee-Lund and Hindar, 1990). No relationship between egg size and fish weight was observed in this work. The three species that had the largest egg weight were less than the mean weight of all the fish sampled.

Unlike in Iba Oku stream, and other small streams in Niger Delta in which *T. mariae* appears to be highly successful (Kings and Etim, 2004), population of *T. mariae* in Lagos Lagoon complex appears to be less successful. Fagade (1969) observed that *T. mariae* was less successful than *T. guineensis* and *Sarotherodon melanotheron* in the Lagos Lagoon. In Lekki Lagoon, apart from *Sarotherodon melanotheron* that appears occasionally in the catch during the dry season, *T. mariae* is the least abundant tilapiine fish in Lekki Lagoon (Pers. Obs). Fagade (1978) suggested that the relatively lack of success of *T. mariae* in Lagos Lagoon complex was due to its lesser adaptability to life in the open waters of lagoon. Though many factors could be responsible for the apparent lack of success of *T. mariae* in Lagos Lagoon complex, the higher GSI recorded in *T. zillii* in this work indicates that *T. zillii* allocates more of its resource to egg production. Fecundity and egg size results have further shown that the higher energy allocated to egg production in *T. zillii* was not geared towards the production of larger eggs but towards the production of more eggs. Since both *T. zillii* and *T. mariae* in Lekki Lagoon have the same egg size, the higher fecundity exhibited by *T. zillii* puts it at a vantage position in terms of potential abundance. This may partly account for the observed greater population of *T. zillii* in the lagoon.

ACKNOWLEDGEMENT

We appreciate the contribution of Dr. I. T. Omoniyi, Department of Aquaculture and Fisheries Management, University of Agriculture, Abeokuta, Nigeria for reviewing the manuscript and offering useful suggestions.

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