Some aspects of the reproductive biology of Gymnarchus niloticus Cuvier, 1829 (Knifefish) in Lekki Lagoon, Nigeria

Opadokun I.O and Ajani E.K.

Abstract
Studies were conducted on the gonad morphology, gonadosomatic index (GSI), fecundity and egg size of Gymnarchus niloticus in Lekki lagoon. 420 fish samples comprising of 150 females and 270 males were examined giving a female to male ratio of 1:1.8. Gonad morphology revealed unpaired gonad in both sex. Fecundity ranged between 750 to 1291 with a mean of 925.61 ± 106.90SD and it correlated significantly (P<0.05) with gonad weight (r=0.63) and standard length (r=0.64). Mean oocyte diameter was 5.41 ± 1.29 mm and it had significant relationship (P<0.05) with total weight (TW), gonad weight (GW) and maturity stage (MS). Fully matured gonads were observed from May to July and November to January while spent gonads were found in August and September. Mean GSI were 1.928 ± 0.304SD and 0.007 ± 0.164SD in female and male respectively.

G. niloticus in Lekki Lagoon exhibited gonochoristic reproductive strategies having low fecundity but large ova with iteroparous life history.

Keywords: Reproductive biology, Morphometric measurement, Gymnarchus niloticus, Lekki lagoon.

1. Introduction
Reproduction is one of the basic biological features that enable continuity of any species [23]. Comprehensive knowledge of reproductive strategies employed by a species in response to environmental factors will determine the degree of survival of that species in such environment. Fecundity, derived from the word fecund, generally refers to the ability to reproduce [24] and when used in relation to fish it refers to the number of ripe eggs in an ovary prior to spawning [19]. As the body weight of fish increases, the number of eggs produced would also increase due to continuous growth of fish after fecundity has stabilized [11].

Gymnarchus niloticus is the only member of the family Gymnarchidae in the order Osteoglossiformes [20]. While most Osteoglossiformes breed during the rainy season and gonad maturation is triggered by decreasing water conductivity in elephant fishes [7], reproduction in knifefishes is not well known. Although, breeding behaviour of G. niloticus has been reported by some authors [5, 15, 20, 21], a detail study of its gonad morphology, fecundity, sex ratio, reproductive season and other reproductive traits in Lekki lagoon are yet to be documented, hence this study.

2. Materials and Methods
2.1 Study Area
The fish samples were collected from Lekki lagoon which is situated in the eastern part of Lagos State, Nigeria. (Fig. 1) Lekki lagoon covers an area of nearly 247 km² and lies between longitude 4° 00’ and 4° 15’E and latitude 6° 22’ and 6° 37’N [10]. The lagoon is fed by River Oni in the North-east while Rivers Oshun and Saga flow into the North western parts [9, 12].

2.2 Fish Samples
A total of 420 samples of G. niloticus were collected from Lekki lagoon on monthly basis for 24 months with assistance of artisanal fishermen using fishing traps, cast and gill nets of various mesh sizes. The fish were transported on an ice chest to the laboratory of National Institute of Oceanography and Marine Research (NIOMR), at Badore in Ajah, Lagos State Nigeria where the morphometric measurements were carried out.
Sex of fish was determined by dissection and examination of the gonads since this was impossible via visual examination of the fish. Only matured gonads (Stages III and IV) were used for fecundity analysis. Matured gonads were carefully excised from the body cavity and weigh to the nearest grams using a top loading balance. The mature ovaries were preserved in 4% formalin for 24 hours. During this period, the jar was shaken repeatedly to separate the eggs from the ovarian tissue and assist in the penetration of the preservative. After 24 hours, the 4% formalin fluid was decanted and replaced by water in order to clean the eggs. Fecundity of each fish was obtained by actual count of all the eggs in the sample [4]. The relationship between fecundity and fish length/weight was described by the equation:

\[ F = aX^b \]

Where:

- \( F \) is Fecundity
- \( X \) is body length in centimeters or body weight in grams
- \( b \) is the slope of the graph of \( F \) versus \( X \)
- \( a \) is the intercept [13, 19]

The logarithmic transformation of the equation is

\[ \log F = \log a + b \log X \]

The diameters of the eggs in each ovary were measured by using a graduated Vernier caliper. The mean diameter of the eggs was obtained by measuring a total of 250 eggs that were randomly selected [18].

The maturity stages of the ovary were classified as follows using the modified Kesteven’s scale as described by [1]:

- Stage I Immature, inactive
- Stage II Ripening
- Stage III Maturing
- Stage IV Mature (Ripe)
- Stage V Spent

The gonadosomatic index (GSI) was calculated for each gonad as described by [14] using the equation:

\[ \text{GSI} = \frac{\text{Weight of gonad (g)} \times 100}{\text{Body weight (g)}} \]

3. Results

A total number of 420 fish samples were analyzed of which 150 (35.71%) were females, and 270 (64.29%) were males, giving a ratio of 1:1.8 which was significantly different (\( P<0.05 \)) from the expected 1:1 ratio of many species. Fish that had immature gonads (Stages I and II) were found in February to April with a peak in April for female and February for male \( G. \) niloticus. Fish that were still developing (Stage III) occurred in April to May and September to October. Fully matured gonads (Stage IV) were observed from May to July and November to January. Fish with spent gonads (Stage V) were found in August and September (Fig. 2 and 3).

Fecundity ranged between 750 to 1291 eggs with a mean of 925.61 ± 106.90 eggs in females of standard length range of 63.00 to 130.50 cm. The relationship between fecundity (\( F \)) and weight (\( W \)) and fecundity and standard length (\( SL \)) are presented by the equation below:

\[ \log F = 710.79 + 0.06 W \] and

\[ \log F = 175.89 + 7.34 SL \]

Fecundity had a significant correlation (\( P<0.05 \)) with both somatic weight (\( r = 0.627 \)) and standard length (\( r = 0.637 \)) of fish. The gonadosomatic index (GSI) for females ranged between 1.25% and 2.34% with a mean of 1.93 ± 0.30% while it ranged between 0.007% and 0.164% with a mean of 0.072 ± 0.037% in males \( G. \) niloticus. Ova diameter ranged between 3.3 and 8.2 mm with a mean of 5.41 ± SD1.29 mm and it had significant relationship (\( P<0.05 \)) with total weight, gonad weight and maturity stage.
Fig 2: Stages of gonad maturation in female *G. niloticus*

Fig 3: Stages of gonad maturation in male *G. niloticus*

Table 1: Length, weight, fecundity, egg diameter and gonadosomatic index for *Gymnarchus niloticus*

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<th>Std length (cm)</th>
<th>Weight (g)</th>
<th>Log weight</th>
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Plate 1: Adult *Gymnarchus niloticus* (2.5 kg)
4. Discussion

Gymnarchus niloticus was found to possess an unpaired gonad. This means that male has only one testis and female possess single ovary. An unpaired gonad has been reported also in Notopterus notopterus and Heterotis niloticus respectively [6, 22]. Otherwise most fish exhibit a paired gonad structure [8].

There were more male than female G. niloticus in this study. Ratio of 1:1.8 (almost twice), a departure from the theoretical 1:1 ratio expected in nature [19] could be a reproductive strategy to ensure that there are enough males to fertilize very small quantity of eggs being layed by G. niloticus. The extended breeding period of 6 months (May to July and November to January) could be a strategy to ensure that G. niloticus offspring reach a relatively bigger size that places them in a better position to predare on fry and fingerlings of other fish species that would breed later in the year when rain becomes stable. An extended intense reproduction period of 8 months was reported for Sarotherodon melanotheron in Onah lake, Nigeria [17]. It has been observed that breeding of most tropical fishes coincided with rainy season when physicochemical conditions of the aquatic environment are favourable [16], although continuous all year round breeding has been reported in some tropical fish species like Pseudotolithus senegalensis and P. typus [2].

The fecundity of G. niloticus recorded in this study varied between 750 and 1291 with an average of 925.61 eggs suggesting that the species has low fecundity. Earlier works [15, 20] recorded an average of 1000 eggs as fecundity for G. niloticus. Low fecundity characterizes species that exhibit high parental care [26]. An average fecundity of 2991 eggs was also reported for Mormyrus rume at Lekki lagoon [9] whereas a higher fecundity (7,130 to 73,000 eggs) was recorded for Synodontis schall in Lake Kainji [25]. The significant correlation (P<0.05) of fecundity with both somatic weight (r = 0.627) and standard length (r = 0.637) suggests that fecundity increases with increase in weight and length of G. niloticus. An earlier work [11] reported that number of eggs produced increased as the body weight of fish increased, while some authors reported insignificant correlation in the length and fecundity [8, 10, 23].

The mean GSI value in this study indicates that the species invest 1.93% of its body weight in egg production; however, it
fluctuates even among fish of similar sizes. Higher GSI value of 13% was reported for *S. eupterus* in River Rima, North-West Nigeria.\(^{23}\)

5. **Conclusion**

*Gymnarchus niloticus* in Lekki Lagoon exhibited gonochoristic reproductive strategies having low fecundity but large ova with iteroparous life history. They are small brood spawner with asynchronous breeding strategy. This study revealed that *G. niloticus* has an unpaired gonad in both sexes and also provided baseline information on some aspects of reproductive biology of *G. niloticus* in Lekki lagoon.

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7. **References**


