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Aspects of the Reproductive Strategy of *Pseudotolithus Elongatus* (Teleostei: Sciaenidae) in the Cross River Estuary, Nigeria

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Abstract
Spawning and fecundity of *Pseudotolithus elongatus* were studied in the Cross River estuary, Nigeria. Spawning periodicity was based on the presence of ripe and running oocytes in each month. Fecundity was determined by weighing and subsampling. Breeding reached maximum during the dry season (December - February) and during the rains (July and August). Mean absolute fecundity was 90,519 ± 59,310 eggs (range 38,500 – 226,720). It increased with fish standard/total length, total weight and ovary weight. The observed a-seasonality in breeding ensures the continuous replacement of individuals removed by heavy fishing pressure and other causes of mortality. Both the breeding pattern and the fecundity dynamics of *P. elongatus* are strategies adopted to enhance the optimization of its reproductive success.

Keywords: Reproductive strategy, spawning, fecundity, Pseudotolithus elongatus

Introduction
Fish stocks are renewable natural resources which get replenished from incessant cropping by fisher folks through reproduction [1]. The reproductive strategy of a fish species embodies an aggregate of reproductive attributes which it manifests so as to maximize its reproductive success in the form of off-springs; such attributes include *inter alia*, size at first maturity, fecundity and breeding seasonality [2]. The genus *Pseudotolithus* consists of a large and varied family of fishes closely related to the snappers but differing in that the spinous dorsal fin is short and the adipose tissue is much longer than the anal fin, which has only one or two spines. They consist of Croakers, Drums, Meagres and Weakfishes; about 70 genera and 270 species are known, with 14 species occurring along the Gulf of Guinea in the coast of Africa [3]. The Croakers constitute an abundant and commercially important fish in Nigerian inshore waters. One of the most economically important and dominant species in the Nigerian coastal waters is *Pseudotolithus elongatus* [4]. This species is exploited by both industrial and artisanal fisheries. It is euryhaline and the most common of the croakers in the Cross River estuarine ecosystem [5]. Due to high fishing pressure, the collapse of the stock of this species in the Cross river estuary had long been expected [6]. However, this species continues to feature prominently in the landings from the estuary (per. observ.), an indication of its resilience. This study examined some aspects of the reproductive attributes that contribute to the sustenance of this highly sought after species. It will not only add to the existing information on *P. elongatus* but will also provide a baseline data for the species in the Ibaka (James town) axis of the Cross river estuary which has been designated for the establishment of a deep sea port by the government of Akwa Ibom state, Nigeria (where this study was conducted).

Materials and Methods
The Cross River estuary is the largest estuary in the Gulf of Guinea [7] occupying a total of 54,000 km^2 [8]. It is a relatively high productive system in terms of fish catch [7] supporting a wide range of shell and fin fishes [9]. The mean annual fish catch from the artisanal fisheries of this system within Nigeria is 65,000 tones (t) making it one of the most productive of the medium size river systems in tropical Africa [7]. The climate is tropical and consists of two seasons namely, the wet and dry seasons. The wet or rainy season which is of longer duration starts from March and last until October while the dry season extends from November to February. However, due to the effect of the hot humid moisturized air mass (attributable to the area's proximity to Guinea coast), rainfall is expected in every month of the year [10]. A short dry period of harmattan occurs between December and February [11].

Sample Collection

Samples of *Pseudotolithus elongatus* were obtained from boat landings at James Town beach for twelve consecutive months. The specimens collected were transported in ice-chests to the laboratory, where they were weighed to the nearest 0.1g after blotting dry with absorbent paper and measured to the nearest 0.1cm standard length (SL) and total length (TL). Sex of each specimen was determined by dissection and macroscopic examination of the gonad. The gonads were removed, blotted dry with filter paper and weighed. They were thereafter classified into six stages for females and four for males using a modified version of Longhurst scale (1965), thus:

Female:

Stage 1: Ovary transparent and turgid with slight vascularization (developing)

Stage 2: Ovary opaque, membrane firm and vascularised, oocytes not visible to the unaided eye (maturing)

Stage 3: Ovary contents granular, membrane transparent, small and medium sized oocytes visible (matured)

Stage 4: Median and large oocytes clearly visible. Ova ripe but does not run out on application of slight pressure to the vent (ripe)

Stage 5: Ovaripe an running from vent on pressure (running)

Stage 6: Ovary spent and resting (resting stage)

Male:

:Stage1: Testis milky white and rounded in some sections (matured)

Stage 2: Testis milky white (but brighter than stage 1) and flattened (ripe)

Stage 3: As stage 2, but sperm running from vent on pressure (running)

Stage 4: Testis spent, translucent, especially at the edges (spent).

The breeding peak was delineated based on the percentage of maturity stages 4 (ripe) and 5 (running) in females and stages 2 and 3 in males.

Fecundity estimates

Gonads were blotted dry with filter paper and weighed to the nearest 0.001g using a Mettler balance. Ripe ovaries were preserved in Gilson's fluid [12] for 1-2 months during which they were periodically agitated to ensure separation of eggs from ovarian tissues. At the end of the storage period, the Gilson's fluid was decanted and the eggs dried at room temperature on a filter paper within a petri dish for about an hour, weighed and subsampled [13]. The subsamples were weighed using a Mettler balance and counted. Fecundity defined as the number of ripening eggs in the ovary before spawning was calculated as follows [4]:

$$\text{Fecundity} = \frac{\text{Ovary weight x Number of eggs in subsample}}{\text{Weight of subsample}}$$

Relationship between fecundity (F) and each of the independent variables (X_i) consisting of the body weight, total length, Standard length, Ovary weight and condition index were determined by the expression:

$$F = aX_i^b$$

Where, a = constant, and b = regression coefficient, both of which were evaluated by least square regression analysis using double log transformed data based on the formula:

$$\text{Log } F = \text{Log } a + b \log X$$

Results

Maturity Size and Breeding Seasonality

The monthly percentage frequency of *P. elongatus* in each developemental stage (Table 1) showed that majority of the females with ripe ovary (stage v) were found in February (44.5 %) and December (27.7%).Females with ripe ovary also occurred in January (25.0 %), August (25.0%), July (18.8 %) and May (5.6%). No gravid, ripe or running ovaries were found in September-November and April. Gravid females (stage iv) were, however, found in March (28.6%).Running ovary were observed only in July (3.0 %) The highest number of males with stage 111 (ripe testes) were found in October (50.0%) and January (12.5 %).The smallest matured female had a total length of 22.5cm and weighed 91.8g while the smallest matured male had a total length of 17.5cm and weighed 40.7g.The largest female specimen encountered was 36.4cm(Table 2)

Table 1: *Monthly percentages of P.elongatus by developmental stage in Cross River Estuary*

		MALE			FEMALE				
	N	**I**	**II**	**III**	**II**	**III**	**IV**	**V**	**VI**
May	36	11.1	11.1	5.6	44.4	16.7	5.6	5.6	-
June	34	47.1	23.5	-	23.5	-	5.9	-	-
July	32	40.6	18.8	-	18.8	-	-	18.8	3.0
August	36	66.7	-	-	8.3	-	-	25.0	-
September	31	38.7	38.7	9.7	12.9	-	-	-	-
October	36	33.3	-	50.0	16.7	-	-	-	-
November	30	40.0	20.0	-	40.0	-	-	-	-
December	36	5.6	16.7	-	50.0	-	-	27.7	-
January	32	-	-	12.5	12.5	-	50.0	25.0	-
February	36	-	11.1	-	22.2	11.1	11.1	45.5	-
March	35	14.3	17.7	11.4	14.3	14.3	28.6	-	-
April	36	33.3	16.7	-	33.3	16.7	-	-	-

Fecundity

The fecundity of *P. elongatus* ranged from 38500 to 226720eggs. The mean fecundity was 90519. ± 59310 eggs.

Relationship with body weight: Average fecundity per gram total weight was 342 ± eggs (range 192-604 eggs) for fish weighing 138.0 -393.0g (Mean =2648 ± 98.7g).Fecundity increased with total body weight ($r = 0.664$, $p < 0.05$); about 44.1 % of the variation (r^2) in fecundity was attributable to changes in total weight.

Relationship to length: Mean fecundity per standard length was 3 543 ± 1820 eggs cm^{-1} (range 1 878-7 738 eggs/cm) for fish of 19.5 – 29.8 cm SL (Mean 24.5 ± 4.13cm).There was a significant increase in fecundity with standard length ($r=0.769, p<0.05$) with 59.1 % of the variation in fecundity being associated with differences in standard length. Fecundity relative to total length was 2852 ± 1513 eggs/cm (range 1498-6351) for fish of length 24.6 -36.4 cm TL. (mean 30.5 ± 4.7 cm TL).Fecundity significantly increased with total length ($r = 0.763$, $p<0.05$) with 58.2% of the variation in fecundity being linked to changes in total length.

Relationship to ovary weight: Average fecundity per gram ovary weight was 145377 ± 4952 eggs (range 8383 – 23373 eggs) for ovaries weighing 2.35 – 13.36g (mean 6.60 ± 3.67).There was a significant positive correlation between fecundity and ovary weight ($r= 0.825, p<0.05$) with 68.1% of the variation in fecundity being accounted for by changes in ovary weight.

Relationship to condition index (K): Average fecundity relative to condition index was 112511 + 76218 (range 27547 – 275146) for fish of condition index 0.54 – 1.71 (mean =0.90 ± 0.34).Fecundity correlated positively with K ($r = 0.593$, $p< 0.05$), 35.2% of the discrepancy in fecundity being attributable to K. The regression equation for the relationship between fecundity and the above mentioned independent variables are shown in table 3.

Table 2: Maximum and minimum sizes at maturity with weight of Pseudotolithus elongatus from Cross River Estuary

	MALE	FEMALE
Size of smallest mature specimen	17.5 cm (TL)	22.5 cm(TL)
Weight of smallest mature specimen	40.7 g	91.8 g
Size of largest mature specimen	28.3 cm (TL)	36.4 cm (TL)
Weight of largest mature specimen	161.5g	393.8g

Table 3: Regression equations for the relationship between fecundity and total weight, standard length, total length, ovary weight and condition factor in P. elongatus from the Cross River Estuary.

Variables	Functional equations
Equations ($F=ax^b$)	$F= 2.496 (Wt)^{0.988}$
Total weight(Wt	$F=1.498(SL)^{2.455}$
Total length(TL)	$F=0.955(TL)^{2.662}$
Ovary weight(W)	$F=4.339(W_o)^{0.737}$
Condition factor(K)	$F=4.765(K)^{0.265}$

Discussion

Major spawning peak in the dry season months of February and December, shows that this species breed more in the dry season. However, another period of heightened spawning between July and August suggest that both heavy rains and dry season are favourable for fry survival with consequent increase in total reproductive output. The aseasonal breeding pattern observed in this study may be indicative of year-round breeding. Iteroparity in this species has been established by [14]. Protracted breeding in *P elongatus* ensures the replacement of individuals removed by the heavy fishing pressure and other causes of mortality [2]. The peak dry season breeding activity of this species corresponds to a period of profound availability of its preferred food-shrimps [5]. Thus they is enough food for both the spawning fish and the new offsprings to subsist on. The size of the smallest matured female fish recorded in this study is relatively large. Earlier report by [14] indicated that the smallest matured females of the species in qua iboe river estuary and Imo river estuary were 21.4cm and 18.8cm respectively. This report establishes that larger fishes are bound to produce more eggs. The relatively large size at maturity of the species in this study may be seen as a positive reproductive trait. The high fecundity of *P elongatus* ensures that in spite of the fluctuating physicochemical ambience of the Cross River estuary, a majority of the newly spawned fish have a huge chance of survival.

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