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THE REPRODUCTIVE CHARACTERISTICS OF MUDSKIPPER PERIOPHTHALMUS BARBARUS (LINNAEUS 1760) (TELEOSTEI, GOBIIDAE) IN THE ESTUARINE SWAMPS OF THE IMO RIVER, NIGERIA

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ABSTRACT

Between December 2007 and September 2008, aspects of the reproductive characteristics of the mudskipper *Periophtalmus barbarus* were studied using samples (n = 1802) obtained from the Imo River estuary. The overall sex ratio was not different from unity but analysis of ontogenic variation showed that males dominated in 5, 8, 10 and 11 cm total length size classes, while females were preponderant in the 6, 7 and 9 cm total length size class. The number of males was not higher than the number of females during the dry and wet seasons. The smallest mudskipper with incipient gonad was 8.0 cm total length. The median size at maturity was 8.9 cm total length. From the patterns of monthly variation in mean gonado-somatic index (GSI), it was concluded that the species breeds year-round, with at least, one major peak (August to December) and one minor peak (May) in a year. Length-weight allometric relationship for pooled data was $W = 17.8\ L^{2.60}$ with a dry season b value of 2.64 and a wet season b value of 2.55. The monthly variation in mean hepatosomatic index (HSI) showed that the pattern of variation in mean HSI was a reverse of that of the mean GSI. The implication of this is that the species draws down on the energy reserves in the liver for the recrudescence of the gonad. A trade-off was apparent in the body's use of resources for gonadal recrudescence. Consequently when the mean hepatosomanic index was low, mean gonad somatic index was high. A major peak of GSI occurred from August to December while a minor peak occurred in May.

KEY WORDS: Reproduction, Mudskipper, Imo River, Nigeria

INTRODUCTION

The genus *Periophthalmus* contains only one species *Periophthalmus barbarus* (synonym = *P. papilio*), which lives in burrows in intertidal saline swamps in estuaries, creeks and lagoons. Mudskippers are the best, and probably the only, known example of resident intertidal fish. It occupies a salient ecological niche and is a valued component of some artisanal catches being exploited either for use as baits in hook and line fisheries, for human consumption or for use in traditional medicinal preparations where aphrodisiac properties are attributed to its flesh (Clayton 1993, Etim 2002).

Tuegels *et al.* (1992) as well as King and Udo (1997) considered *P. barbarus* in southern part of Nigeria as an endangered species. Etim et al (1996) using computer-supported length-based models investigated the population dynamics of the mudskipper in the Cross River system and Etim *et al*. (2002) elucidated the dynamics of exploited population of this species in the Imo River estuary. The variations in patterns of condition index and other reproductive indices have been shown to follow seasonal patterns which have been linked to reproductive cycles in different fish species e.g. tilapia (King 2004), dab fish (Htun-Han 1978), and gold fish (Delahaunty and Vlaming 1980). In this work, aspects of the reproductive biology of *P. barbarus* were studied using samples that were obtained from the Imo River estuary. The aim was to establish the seasonal patterns of the different reproductive indices of condition and relate them to the reproductive cycle of the mudskipper in the Imo River. This knowledge will help in the management of the fisheries stock and in the understanding of the ecology of the species.

Materials and Methods

The Imo River estuary is located in the tropical rainforest zone. From December 2007 to September 2008, monthly samples of the specimens were obtained from the artisanal fishers in Ikot Abasi (longitude 6° 50′ E and 7° 40′ E and latitude 4° 25′ N and 6° 25′ N), Akwa Ibom State, Nigeria. There are two major climatic seasons in the area – the wet (April to September) and the dry (October to March) seasons.

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The samples were fixed in formalin and transported to the laboratory for analysis. The morphology of external genitalia was used in sexing the fish (Udo 1995 and 2002). Total length, head length; pelvic length, standard length, body weight were measured. All weight measurements were done to the nearest 0.1 centimetre and all weight measurements were done to the nearest 0.1 gramme. Each specimen was dissected and the liver weight, gonad weight was measured. Gonadsomatic index was computed as the weight of the gonad expressed as a percentage of the total weight. Hepatosomatic index was calculated as the weight of liver expressed as a percentage of the body weight. Condition index was determined as the body weight expressed as a percentage of the cube of the total length.

The monthly means of each of these indices were separately plotted against the time of sample collection to give the pattern of seasonal variation (Etim *et al.* 2002). Length-frequency distribution of the entire 1,802 specimens were plotted to delineate size-classes; linear regression was used to analyze allometry and to parametize the coefficient of length-weight relationship, t-test was used to test the difference in means for a given pair-wise data, and chi-square was used to confirm whether the sex ratio deviated from a 1:1 ratio.

RESULTS AND DISCUSSION

Sample Size: The sampling covered a period of 10 consecutive months (December 2007 to September 2008) during which a total of 1,802 specimens of *P barbarus* were collected. From the 1,802 specimens collected, 299 were purposely selected (about 30 for each month) to cover all available length classes for that month. The analysis of gonad, liver and condition indices were based on these subsamples. There were instances where specimens of some *P. barbarus* were difficult to sex reliably because of the underdevelopment of the sex organ. These often occurred in specimens less than 5 cm. Such specimens were classified as immature. Both sexes occurred over the entire size classes (Fig. 1). No colour dimorphism was noticed among the sexes. Females and males of the same length were not necessarily different in weight, in head length, or in pelvic length (t-test: $P > 0.05$) (Table 1).

Sex Ratio: From the subsamples (n = 299) examined, 161 (53.85%) were males and 138 (46.15%) were females, consequently the overall male to female ratio was 1:0.81, which was not significantly different from unity ($\chi^2 = 1.77$, df = 1, $P > 0.05$) (Table 2). There were also more males than females within size classes 5, 8, 10 and 11 cm total length; and the reverse was true for size classes 6, 7 and 9 cm (Fig. 1). There were more males than females in December, January, March, April and June (Fig. 3). During dry season a total of 155 specimens were collected; out of these 89 (57.42%) were males and 66 (42.58%) were females with a resultant sex ratio of 1:1.05 ($\chi^2 = 0.107$, df = 1, $P > 0.05$). There was no significant difference in mean weight per length class between sexually mature females and similarly-sized males (Table 3). Etim *et al.* (2002) found out that in a sample of 1,013 collected, there were more females (61.9%) than males (38.1%). Males were found to be about the same in number in both the wet and dry season samples. The numerical preponderance of one sex over the other may signal a difference in sex-related mortality or longevity.

Ontogenic onset of Reproduction: The smallest fish with incipient gonad was 8 cm TL. Majority of sexually active individuals measured 9 and 10 cm TL. The median size at maturity was 8.95 cm, which was almost the same as the mean size for the subsample which was 9.8 cm. Etim *et al.* (2002) obtained a median size at maturity of 10.2 cm for females and 10.5 cm for males, while Hoda (1986) got a value of 7.0 cm and Mutsadi and Bal (1970) got a value of 9.6 cm.

Teporaral variations in reproductive indices: Fig. 4 depicts the monthly variation in mean values of gonadosomatic, condition and hepatosomatic indices. Fig. 5 illustrates the variation in pooled (male + female) data. Here, the overall pattern of variation implies a year-round breeding with peak (GSI = 0.695) between August and December, that is dry season perod. A smaller peak was also observed in May (GSI = 0.359). The variation in monthly mean hepatosomatic index showed that there was a trade-off between HSI and GSI; when the mean liver weight was high, the mean gonad weight was low. Similar observation had been made by Htun-Han (1978) and Delahaunty and Vlaming (1980) that during gonad recrudescence there exist an inverse relationship between gonad and hepatic development. In such a case, the fish draws down on energy reserve from the liver for use in gonad development.

Etim et al (2002) had shown that the species spawns once in a year during the dry season. In the Indian coast of Bombay, the mudskipper *Boleophthalmus dussumeri* spawns once in a year from July to September (Mutsadi and Bal 1970) just as *B. dentatus* on the Indian coast of Jodia which spawns from January to February (Soni and George 1986). But *B. dussemeri* have been shown to spawn twice in a year on the Indian coast of Karachi (Hoda 1986) and on the northern Arabian coast (Hoda and Akhtar 1985)

Allometry: Using all the 299 specimens in the pooled subsamples, the allometric length-weight relationship elucidated took the form

$$\text{Log } W = 2.60 \log L - 15.57,\ r = 0.961$$

The monthly variations in the allometric coefficients are given in Table 4. The seasonal patterns in these relationship showed that in dry season the equation took the form:

$$\text{Log } W = 2.6 \log L - 16.65,$$

And in the wet season the relationship was

$$\text{Log } W = 2.55\text{s Log } L - 15.082$$

Etim *et al.* (1996) obtained a value of b = 2.94 for samples obtained from the Cross River while Etim *et al.* (2002) had a value of b = 2.9 for the Imo River population.

Table 2 : Monthly variation in sex-ratio of *P barbarus.*

Month	**Male**	**Female**	**M:F**	**% male**	**% female**	**calc. $\aleph^2$**
Dec.'07	20	9	1:0.45	69.0	31.0	4.17 *
Jan. '08	18	12	1:0.67	60.0	40.0	1.20 ns
Feb. '08	15	15	1:1	50.0	50.0	-
Mar. '08	18	12	1:0.67	60.0	40.0	1.20 ns
Apr. '08	17	13	1:0.76	56.7	43.3	0.53 ns
May '08	15	15	1:1	50.0	50.0	-
Jun. '08	16	14	1:0.88	53.3	46.7	0.13 ns
Jul. '08	15	15	1:1	50.0	50.0	-
Aug. '08	15	15	1:1	50.0	50.0	-
Sep. '08	12	18	1:0.67	60.0	40.0	1.20 n

*Remark: P = Level of significance; * - P<0.05; ns – not significant at P =0.05*

Table 3. Size variation in the body weight (BW) in *P barbarus*

Length	males mean(BW)	SD	males mean(BW)	SD	mean differences(X)	Ex^2
6	2.10	1.31	2.59	0.37	-0.49	0.240
7	4.27	0.77	4.08	0.77	0.19	0.036
8	5.83	0.96	6.53	0.90	-0.7	0.45
9	8.30	0.89	7.97	1.04	0.33	0.109
10	10.72	1.48	11.29	1.11	-0.57	0.335
Total					**0.248**	**1.2**

TABLE 4. Variations in monthly length–weight relationship of the *P barbarus.*

Months	**N**	**a**	**b**	**r**
Dec. 2007	30	-13.98	2.40	0.93
Jan. 2008	30	-18.97	2.94	0.98
Feb. 2008	30	-15.20	2.55	0.97
Mar. 2008	30	-20.44	3.14	0.98
Apr. 2008	30	-11.69	2.16	0.97
May 2008	30	-15.19	2.57	0.98
Jun. 2008	30	-15.69	2.65	0.93
Jul. 2008	30	-17.11	2.80	0.98
Aug. 2008	30	-15.78	2.63	0.98
Sep. 2008	30	-11.64	2.12	0.91

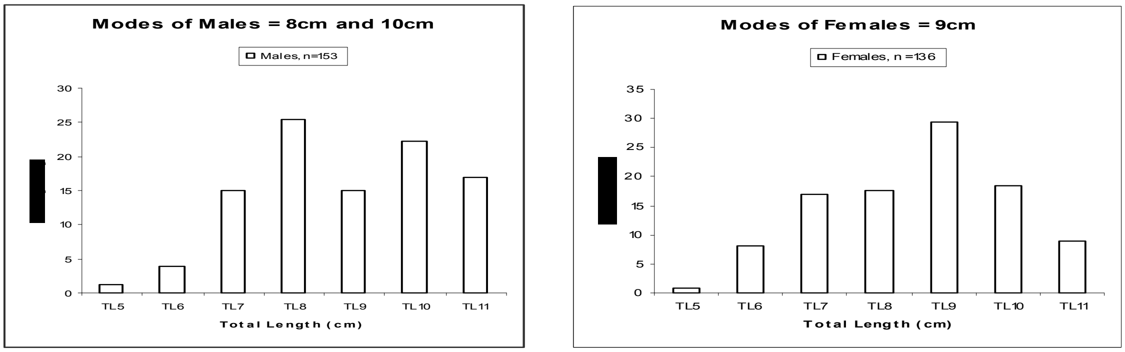
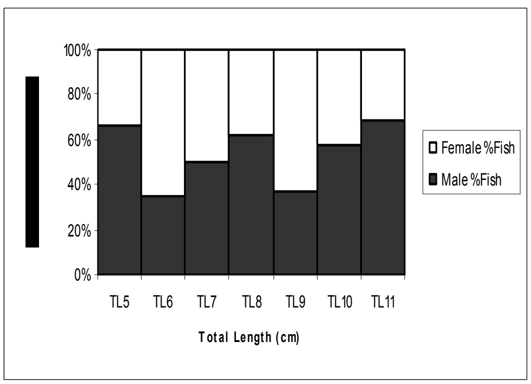


Fig.1. size structure of male and female population of *Periophthalmus barbarus* in Imo River estuary, Nigeria.



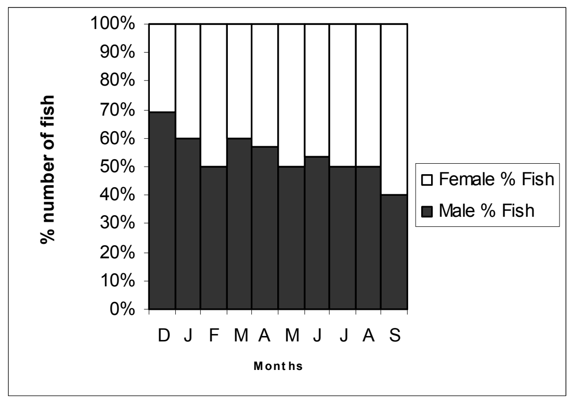
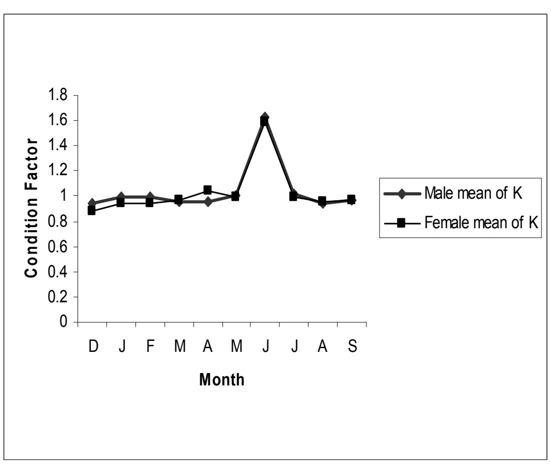


Fig. 2

Fig. 3

Fig. 2. Variation in sex- ratio with size of Periophthalmus barbarus in Imo River estuary.

Fig. 3. Monthly variation in sex- ratio of Periophthalmus barbarus in Imo River estuary.



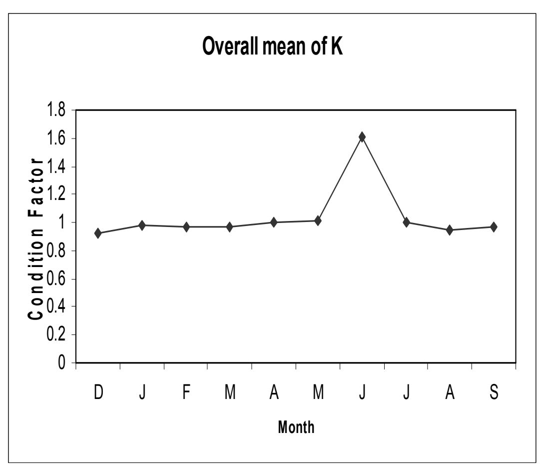


Fig 4a

Fig 5a

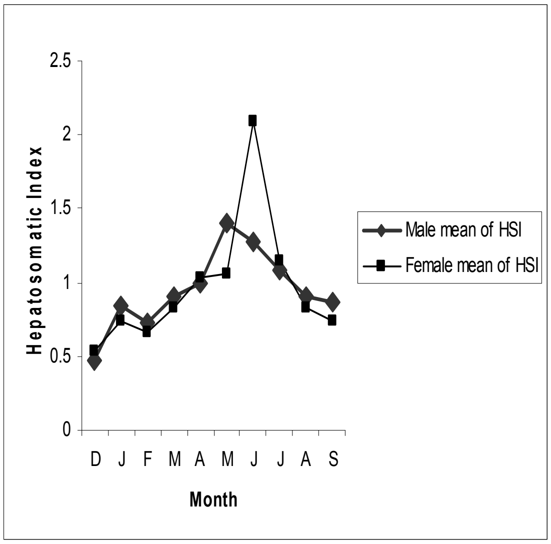


Fig 4b

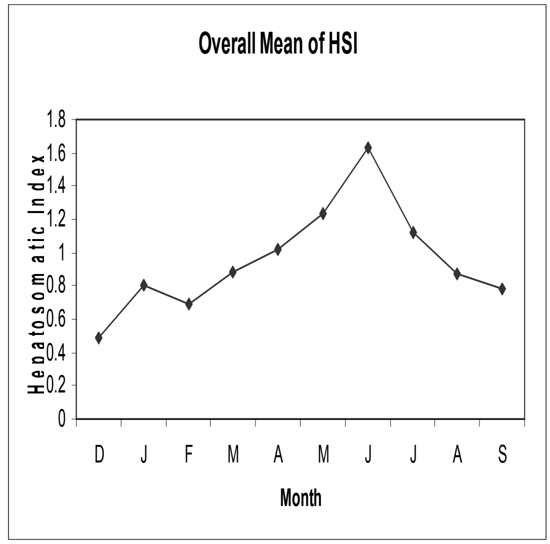


Fig. 5b

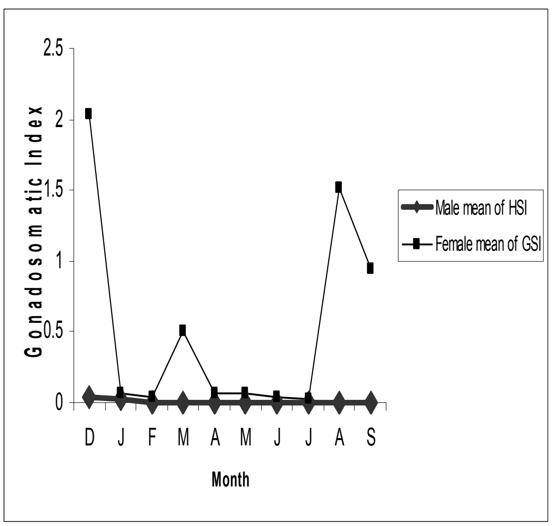


Fig. 4c.

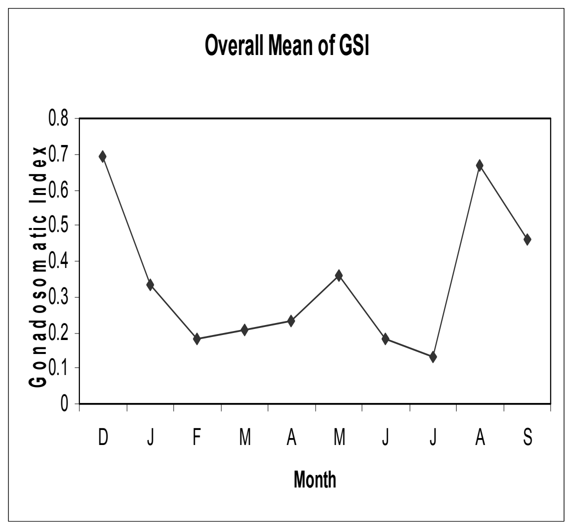


Fig. 5c.

Fig. 4. Monthly variations in condition index (4a), hepatosomatic index (4b), and gonadosomatic index (4c) for the mudskipper *P. barbarus*

Fig. 5. Pooled monthly variations in reproductive indices of the mudskipper *P. barbarus*

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