ASPECTS OF THE REPRODUCTIVE BIOLOGY OF THREE WEST AFRICAN PRAWNS IN THE MANGROVE CREEKS OF THE CROSS RIVER ESTUARY, SE NIGERIA.

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Abstract
Some aspects of the reproductive biology of the three dominant species in the *Macrobrachium* fishery of the Cross River Estuary namely *M. macrobrachion*, *M. vollenhovenii* and *M. equidens*, were studied. Due to the difficulties associated with identifying the onset of maturity of *Macrobrachium* males, only the females were used in the study. The size at massive maturation (TL_m in mm) for *M. macrobrachion* was 68.83 (CI: 66.63-71.10 mm) at a corresponding age of 6.61 (CI: 6.28-6.96) months. TL_m for *M. vollenhovenii* was 106.74 (CI: 102.82-110.81), at a corresponding age of 7.42 (CI: 7.01-7.82) months, while TL_m for *M. equidens* was 59.09 (CI: 57.50-60.72), at the age of 7.70 (CI: 7.39-8.03) months. Average fecundity for *M. macrobrachion*, *M. vollenhovenii* and *M. equidens* were 2490 (range 270-4710), 23,943 (range 1744-46,141), and 2359 (range 400-4318) eggs per female, respectively. The larger females had more eggs than the smaller ones. Understanding of the reproductive biology of these biological species is indispensable for efficient management of their resources.

Introduction

Studies of the genus *Macrobrachium* in the tropics and subtropical regions of the world range from biology (life history, reproduction and feeding behaviour), to assessment of its fishery and aquaculture potentials.

Ogawa and Kakuda (1986) studied some aspects of the biology of *M. nipponense* in Lake Kojima, Japan, and reported that the males attained a maximum total length of 63 mm in a lifetime of 40-45 months, while the females reached 57 mm in 28-34 months. Barros (1995) estimated the size at first maturation for *M. olfersii* to be 9.5-10.0 mm carapace length. Studying the fecundity of female *M. vollenhovenii* in the Cross River Estuary, Udo and Ekpe (1991) reported that larger females had higher number of eggs. The reproduction, sex ratio and longevity of *M. potuina* in the Sapucaia stream, Brazil, were studied by Souza and Fontoura (1996). They found average fecundity of this species to be 47.4 eggs, with a size at first maturation of 8.5-9.0 mm total length at the age of one year. The species had a longevity of one year three months, and a sex ratio (male: female) of 1:0.82. Fecundity of *M. jelskii* ranged from 10-56 eggs, while the number of eggs per female of *M. amazonicum* in Venezuela ranged from 102 to 903 (Gamba 1997). Marioghae (1982) found a sex ratio (male: female) of 1:1 and 1: 1.4 for *M. vollenhovenii* and *M. macrobrachion* respectively, in the Lagos lagoon. The present study focused on the size at massive maturation, sex ratio and fecundity of three *Macrobrachium* species in the Cross River Estuary. Due to the difficulty associated with identifying the onset of maturation of *Macrobrachium* males, only the females were considered in this study.

Materials and Methods

Female *M. Macrobrachion*, *M. Völlenhovenii* and *M. Equidens* used for this study were obtained from the landings of artisanal shrimp fishers on the coast of Calabar River. The proportion of egg-carrying/berried females for each length class in the samples was determined and used to estimate the size at massive maturation following the method of Udupa (1986). This method allows the calculation of confidence intervals for the estimate. The formulas are given below:

$$\ln TL_m = X_k + X/2 - [X \square P_i] \quad (1)$$

where: TL_m = total length (mm) at massive maturation;
X_k = ln of size at which 100% of specimens are mature;
X = average ln size increment;
P_i = ratio of mature specimens (Mi) to total number (Ni) in size group i
Ln = naturallogarithm

95% confidence interval was calculated as follows:

$$95\%\ CI = \text{anti-log}\ (\ln TL_m \pm 1.96\ v X^2 \square P_i (1 - P_i)/(Ni\ 1)) \quad (2)$$

Corresponding age at massive maturation was computed using the re-ordered form (or inverse) of VBGF using the expression of Mackay and Moreau (1990), thus:

$$ti = (1/K)^* \ln [1\ \ (L_i/L_\infty)] + t_o \quad (3)$$

Where: ti = age of i length L_i
$t_o = 0$

Samples of berried females were collected in June, one of the months of peak reproductive activity, being guided by Pauly (1984). Individual body weight and total length were measured. Eggs were extracted onto an absorbent paper and the weight (g) was noted. Then, 2-3 sub-samples were collected from the egg mass and weighed. Each sub-sample was then counted, and the mean number of eggs per unit weight was multiplied with the total egg mass weight to give an approximate number of eggs, which was later used as a measure or index of fecundity. Sex ratio for the three species was computed as a proportion of their number within the sampling period.

Results

The computational procedures for size at massive maturation ((TL_m in mm) for the three species (*M. macrobrachion*, *M. völlenhovenii*, and *M. equidens*) are presented in Tables 1, 2 and 3 respectively. Average size at massive maturation for *M. macrobrachion* was 68.83 mm (CI: 66.63 71.10) at a corresponding age of 6.61 (CI: 6.28 6.96) months.
TL_m for *M. vollenhovenii* was 106.74 (CI: 102.82-110.81), at a corresponding age of 7.42 (CI: 7.01-7.82) months, while TL_m for *M. equidens* was 59.09 (CI: 57.50-60.72), at the age of 7.70 (CI: 7.39-8.03) months.

Average fecundity for *M. macrobrachion*, *M. vollenhovenii* and *M. equidens* were 2490 (range 270-4710), 23,943 (range 1744-46,141), and 2359 (range 400-4318) eggs per female, respectively (Table 4). The larger females had more eggs than the smaller ones.
The overall male: female ratio were 1:2.15 for *M. macrobrachion*, 1:1.47 for *M. vollenhovenii* and 1:1.74 for *M. equidens*.
Table 1: Calculation of size at massive maturation (TL_m) for *M. macrobrachion* females. ML_i = midlength of size group i; N_i = total no. in size group i; M_i = no. of mature specimens in size group i; $P_i = M_i/N_i$

Table 3: Calculation of size at massive maturation (TL_m) for *M. Equidens* females. ML = middlength Of size group i; N_i = total no. in size group i; M_i = no. of mature specimens in size group i; $P_i = M_i/N_i$

ML_i	$lnML_i$	N_i	M_i	P_i	$lnML_{i+1} - lnML_i$	$1 - P_i$	$P_i * 1 - P_i / N_i - 1$
42.5	3.7495	103	11	0.107	0.1112	0.893	0.00094
47.5	3.8607	153	34	0.222	0.1001	0.778	0.00114
52.5	3.9608	109	32	0.294	0.091	0.706	0.00192
57.5	4.0518	130	66	0.508	0.0834	0.492	0.00194
62.5	4.1352	127	80	0.630	0.0769	0.370	0.00185
67.5	4.2121	103	67	0.650	0.0715	0.350	0.00223
72.5	4.2836	59	34	0.576	0.0667	0.424	0.00421
77.5	4.3503	39	27	0.692	0.0625	0.308	0.00561
82.5	4.4128	21	15	0.714	0.0588	0.286	0.01021
87.5	4.4716[a]	13	13	1.000	-	0.000	-
Sum		857	379	5.393	0.7221	4.607	0.03005
Mean					0.08023333[b]		

Result: TL_m (in mm) = 59.09 (CI : 57.50 60.72)

Table 4: Fecundity estimation for the three *Macrobrachium* species.

Species	Range of TL (mm)	Range of F	Average F	N
M. equidens	46 - 74	400 - 4,318	2,359	19
M. macrobrachion	52 - 72	270 - 4,710	2,490	22
M. Vollenhovenii	66 - 130	1,744 - 46,141	23,943	21

Range of TL = range of total length
Range of F = range of fecundity (no. of eggs)
Average F = average fecundity
N = no. of specimens (shrimps) measured

Discussion

The reported respective sizes at massive maturation for the three species are higher than the estimated size at full recruitment (L_{50}), which was 50.65 mm for *M. macrobrachion*, 73.41 mm for *M. vollenhovenii*, and 42.82 mm for *M. equidens* (Nwosu 2000). Garcia (1996) cautions that such a situation is not healthy for any fishery, apparently due to the potential danger of growth overfishing. Adjusting the mesh size to allow more shrimp escape and reproduce before capture would be a positive management option.

Fecundity studies of fishes and shellfishes provide useful knowledge of their egg-production capacity. For instance, it helps for stock evaluation and its renewability potential. *M. vollenhovenii* was the largest of the three species under study. It had a range of fecundity of 1,744 46, 141 for a size range of 66 130 mm (total length). Previous studies reported 12,000 45,000 eggs for a size range of 76 113 mm (Miller 1971), and 1,100 170,000 eggs for a size range of 54.5 135 mm (Udo and Ekpe 1991). This species ranks among the highest in fecundity for the genus *Macrobrachium*. The fecundity of *M. macrobrachion* (270 4,710 eggs) and *M. equidens* (400 4,318 eggs) in this study are better than that of *M. jelskii* (10 56 eggs) (Gamba 1997), which is considered to have low fecundity.

The male: female ratios obtained in this study compares with other studies reported for the genus, which showed female dominance. For instance, Barros (1995) reported sex ratio of 1:1.98 for *M. olfersii*, Inyang (1984) recorded 1:1.11 for *M. felicinium*, and 1:1.4 and 1:1 for *M. macrobrachion* and *M. vollenhovenii* in the Lagos lagoon, respectively (Marioghae 1982). However, Souza and Fontoura (1996) found a reverse of this trend, recording a male dominance of 1:0.82 for *M. Potuina*. The understanding of the reproductive biology of these prawns is important clue to effective management measures.

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