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Reproductive Biology of African River Prawn Macrobrachium vollenhovenii (Crustacea, Palaemonidae) In the Lower Taylor Creek, Niger Delta, Nigeria

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Abstract. The sex ratio, Gonadosomatic Index (GSI) and fecundity of *M. vollenhovenii* in the Lower Taylor Creek, Niger Delta, Nigeria were studied between June 2008 and May 2010. The sex ratios showed that *M. vollenhovenii* deviated significantly from the ratio 1:1 and males dominated in *M. vollenhovenii* (X^2 = 68.65, df = 1, P < 0.001). There were no monthly and seasonal variations in the GSI means (P > 0.05), even though there were peaks in September 2008 and January 2009. However, there were significant differences in the GSI values of the size classes (P < 0.05). The 8–9cm size class had the highest GSI value. The overall fecundity of *M. vollenhovenii* ranged from 11, 402 eggs (TL = 6.70cm) to 56,481 eggs (TL = 11.40cm) with a mean of 24,765±3144 eggs (P < 0.001). The correlations of fecundity–total length, fecundity–gonad weight and fecundity–body weight relationships of all the species were positive and gonad weight gave the best predictive values.

Key words: Basket traps, baits, shrimps, Biseni, Gbarain, Nigeria.

Introduction

The African River prawn, *Macrobrachium vollenhovenii* (HERKLOTS, 1857) is endemic to eastern Atlantic, with viable fishery in most of the countries in the West African sub – region (NWOSU & WOLFI, 2006). WILLFUHR-NAST *et al.* (1993) had recommended this species for aquaculture cultivation, as an equivalent of the now widely cultured *Macrobrachium rosenbergii,* de Man, 1879 (FAO, 2000). In the Lower Taylor Creek, the species is an important component of the *Ingo* trap fishery, constituting about 52% by weight of the total catch (KINGDOM, 2012). Little is known about the biology or ecology of the prawn in this creek. This is the situation in most rivers in the Niger Delta, a problem earlier identified by POWELL (1983).

This paper aims to provide information on aspects of the reproductive biology of *M. vollenhovenii* in the Lower Taylor Creek, in order to manage it sustainably.

Materials and Methods

The study was carried out in the Lower Taylor Creek (a freshwater creek) in the Niger Delta, situated between 5° 01'N; 6° 17'E and 5° 02'N; 6° 18'E (Fig. 1). Sampling was carried out bi–weekly for twenty-four months (June 2008 – May 2010) using two sets of basket traps at all the stations. The traps, which were made from canes, measured 31 – 62cm in length, a mouth ope-

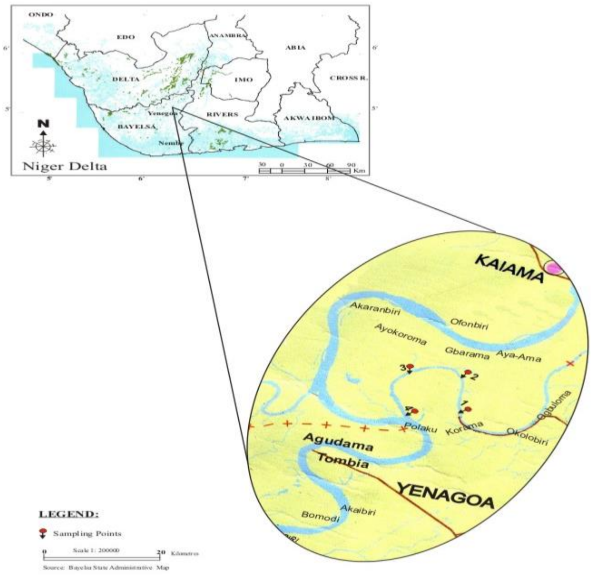

Fig. 1. Map of Niger Delta Showing Bayelsa State and the Taylor Creek Study Area

ning of 3 - 4cm in diameter and rectangular mesh sizes of about 3 by 0.5cm.

Specimens for the study of the reproductive biology were obtained from the samples of *M. vollenhovenii* caught for each month. The total length (from tip of rostrum to tip of telson) of the shrimp was measured in centimeters (cm) with a plastic ruler and individual weights taken in grams (g) using a digital balance (Ohaus; Scout Pro Model SPU 402). The sex of each specimen was determined by visual observation of the base of the fifth pair of periopods (HART *et al.*, 2003). In males, the base of the fifth pair of periopods approximates to the middle while that of females is wide. The weights of the ripe eggs were taken in grams and counted. The numbers of male and female specimens were recorded from the specimens collected. The deviation from the 1:1 ratio was tested using the chi-square test. Monthly ratios were estimated and seasonal and yearly variations of sex ratios were also tested for deviation from the 1:1 ratio with the chi-square test.

The gonadosomatic index (GSI) was determined (KING, 1995) as:

$$GSI = 100 \times \frac{Gm}{Tm},$$

where: Gm = Mass of Gonad,
Tm -= Total mass of fish.

Mean monthly values were computed and plotted to ascertain monthly, seasonal and yearly variation. Means also were computed for size classes and test of significant differences between males and females tested.

Fecundity (absolute fecundity), which is the total number of eggs in the ovaries of a fish prior to spawning (BAGENAL, 1978) was estimated by direct counting of spawnable eggs from the ovigerous females. Whole ovaries were carefully detached for each selected individual with forceps and assessed separately. Total weight of each ovary was determined using digital Ohaus balance, Scout Pro Model SPU 402. A sub – sample of the ovary was weighed and the eggs in each sample were spread on a filter paper and counting was done with the aid of stereomicroscope and hand – held tally counter. The number obtained was then extrapolated to determine the total number of eggs in the ovary.

Relative fecundity (RF) was obtained as the number of eggs per unit length (cm) or the number of eggs per unit weight (g) of shrimps. Scatter diagrams of fecundity against total length, body weight and gonad weight were plotted using linear regression technique and the best predictive equation for fecundity computed as logarithm transformation of the equation (BAGENAL, 1978):

$$F = ax^b$$

i.e. $\log F = \log a + b \log x$,

where: a=constant; b=exponent; F=fecundity; x=total length, total body weight, gonad weight.

Results

The sex ratios of *M. vollenhovenii* are given in Table 1.The overall sex ratio of *M. vollenhovenii* estimated from 341 sexually discernable shrimps was 1:0.38 male/female. The sex ratio deviated significantly from the ratio 1:1 (X^2 = 68.65, df = 1, P < 0.001).

Gonadosomatic index. Monthly GSI values for *M. vollenhovenii* are shown in Fig. 2. There was no significant variation in both

Table 1. Seasonal variation of mean monthly sex ratio of *M. vollenhovenii* in the Lower Taylor Creek

Month/Season Year	Numbers M	F	Sex ratio M:F
June 2008	22	5	1:0.23***
July 2008	11	10	1:0.91
August 2008	8	6	1:0.75
September 2008	20	32	1:1.60
October 2008	6	2	1:0.33
November 2008	1	2	1:2.00
December 2008	3	7	1:2.33
January 2009	4	6	1:1.5
February 2009	7	2	1.0.29
March 2009	14	4	1:0.29*
April 2009	14	2	1:0.14**
May 2009	10	4	1:0.40
June 2009	17	4	1:0.24**
July 2009	18	1	1:0.06***
August 2009	5	1	1:0.20
September 2009	13	1	1:0.08***
October 2009	4	0	1:0.00
December 2009	8	1	1:0.13*
January 2010	13	0	1:0.00
February 2010	16	2	1:0.13***
March 2010	9	1	1:0.11**
April 2010	15	0	1:0.00
May 2010	9	1	1:0.11**
Dry 2008	4	9	1:2.25
Wet 2008	67	55	1:0.82
Dry 2009	33	13	1:0.39**
Wet 2009	81	13	1:0.16***
Dry 2010	28	3	1:0.08***
Wet 2010	24	1	1:0.04***

*P < 0.05; **P < 0.01; ***P < 0.001

monthly and seasonal GSI means (P > 0.05), even though there were peaks in September 2008 and January 2009. However, there was significant difference in the GSI values of the size classes (P < 0.01). The 8 – 9cm size class had the highest GSI value (Table 2).

Fecundity. The ranges, mean monthly and seasonal fecundity of *M. vollenhovenii* are given in Table 3. The overall fecundity of *M. vollenhovenii* ranged from 11, 402 eggs (TL = 6.70cm) to 56,481 eggs (TL = 11.40cm) with a mean of 24,765±3144 eggs. There were both monthly and seasonal variations in the fecundity (P < 0.001). The eggs per centimetre body length (2495 ± 240 eggs/cm) was higher than the eggs per gram body weight (2115±132 eggs/g).

Fecundity/ total length, fecundity/gonad weight and fecundity/body weight relationships of *M. vollenhovenii* in the Lower Taylor Creek are shown in Figs. 3 to 5 respectively. The relationships of this population expressed in linear regression are as follows:

$F = 1.26TL^{3.16}$ ($r = 0.89$; $r^2 = 0.79$; $P < 0.001$)

$F = 4.21GW^{3.06}$ ($r = 0.94$; $r^2 = 0.89$; $P < 0.001$)

$F = 3.48BW^{0.84}$ ($r = 0.84$; $r^2 = 0.68$; $P < 0.001$)

The correlations were all positive and gonad weight also had the best predictive value of 0.94.

Table 2. Mean GSI values of different size classes of *M. vollenhovenii* in the Lower Taylor Creek

Size classes	Sample size	Range	Mean ±S.E
6.00 - 7.00	1*	-	22.28 ± 0
7.00 - 8.00	1*	-	16.20 ± 0
8.00 - 9.00	5	10.55 - 15.57	12.92 ± 0.79[a]
9.00 - 10.00	8	7.49 – 12.14	9.11 ± 0.62[b]
10.00 – 11.00	1*	-	6.77 ± 0
11.00 – 12.00	3	6.73 – 8.05	7.42 ± 1.02[b]

*Sample with < 2 specimens was not included in analysis

Discussion

Sex ratio. The sexes of *M. vollenhovenii* in this study were not fairly distributed as MARIOGHAE (1982), and MARIOGHAE & AYINLA (1995) reported. The dominance of male *M. vollenhovenii* over females in this study is similar to the observation of MWANGI (1984). The seasonal variation of sex ratio observed in *M. vollenhovenii* may be associated with breeding activities. OLATUNDE (1978) reported that during breeding season, more females are expected to associate with males, particularly in a situation where there are few males in the population. However, this was not the case with *M. vollenhovenii,* which had more males in the population; a situation also reported for some fish species like *Sierrathrissa* *leonensis* (THYS VAN DEN AUDENAERDE, 1969) in the Nun River and Taylor Creek (OTOBO, 1995). REYNOLDS (1974) had already posited that partial segregation of ripe forms, either through habitat preferences or through school formation, could render one sex more vulnerable to capture than the other.

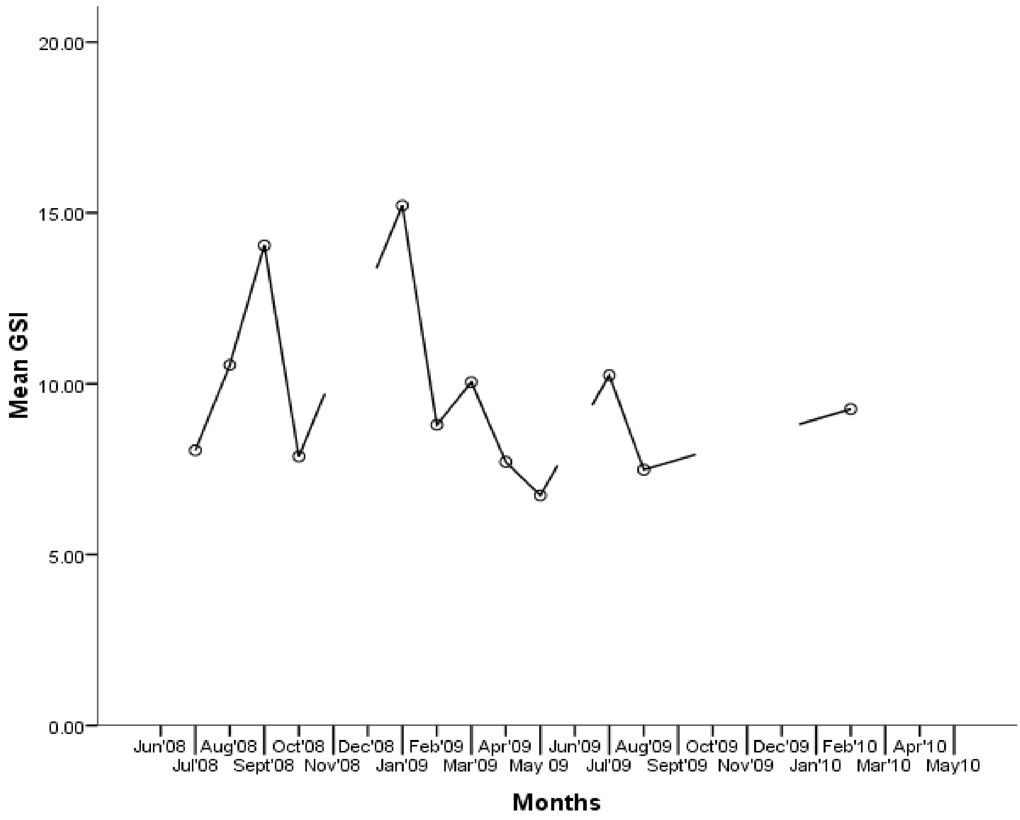

Fig. 2. Mean monthly Gonadosomatic Index (GSI) of *M. vollenhovenii* in the Lower Taylor Creek

Table 3. Monthly and Seasonal variation of fecundity of *M. vollenhovenii* in the Lower Taylor Creek

Month/Year	Sample size	Range	Fecundity Mean ±S.E	Relative Fecundity	
				Mean egg number/cm	Mean egg number/g
Jul-08	1*	-	56481 ± 0	4954 ± 0	3344 ± 0
Aug-08	1*	-	16425 ± 0	1888 ± 0	1805 ± 0
Sep-08	5	13528-20677	17270 ± 8817[b]	1973 ± 311[a]	2363 ± 233[a]
Oct-08	1*	-	18665 ± 0	2007 ± 0	1336 ± 0
Jan-09	2	11482-16041	13760 ± 6234[b]	1675 ± 492[a]	2163 ± 368[a]
Feb-09	3	18006-49145	35200 ± 5090[a]	3266 ± 402[a]	2175 ± 300[a]
Mar-09	1*	-	17210 ± 0	1851 ± 0	1616 ± 0
Apr-09	1*	-	22467 ± 0	2292 ± 0	1561 ± 0
May-09	1*	-	52326 ± 0	4550 ± 0	2689 ± 0
Jul-09	1*	-	25125 ± 0	2513 ± 0	2076 ± 0
Aug-09	1*	-	24828 ± 0	2483 ± 0	1549 ± 0
Feb-10	1*	-	17527 ± 0	1845 ± 0	1546 ± 0
Season					
Dry	7	17527-49145	23310 ± 4489[a]	2321 ± 355[a]	1779 ± 265[a]
Wet	12	11482 -56481	27480 ± 2719[a]	2704 ± 215[a]	2098 ± 160[a]
Overall	**19**	**11482 -56481**	**24765 ± 3144**	**2495 ± 240**	**2115 ± 132**

*Samples with < 2 specimens were not included in analysis

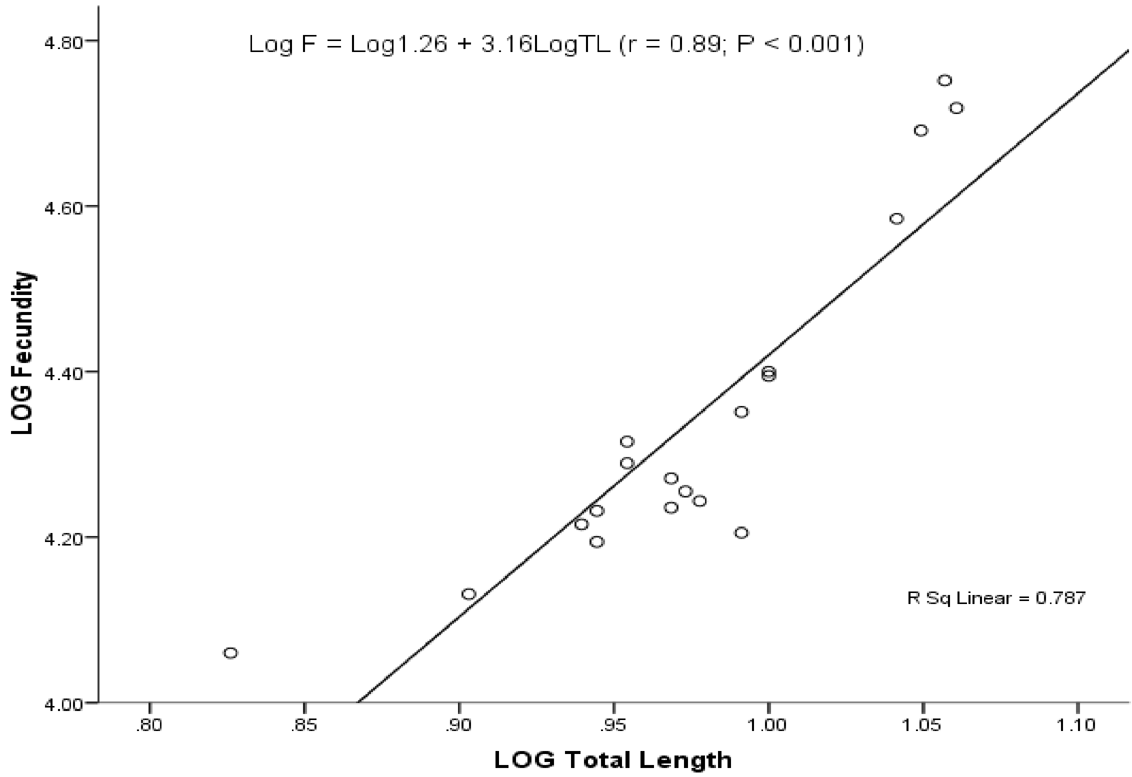

Fig. 3. Relationship of Fecundity and Total length of *M. vollenhovenii* in the Lower Taylor Creek

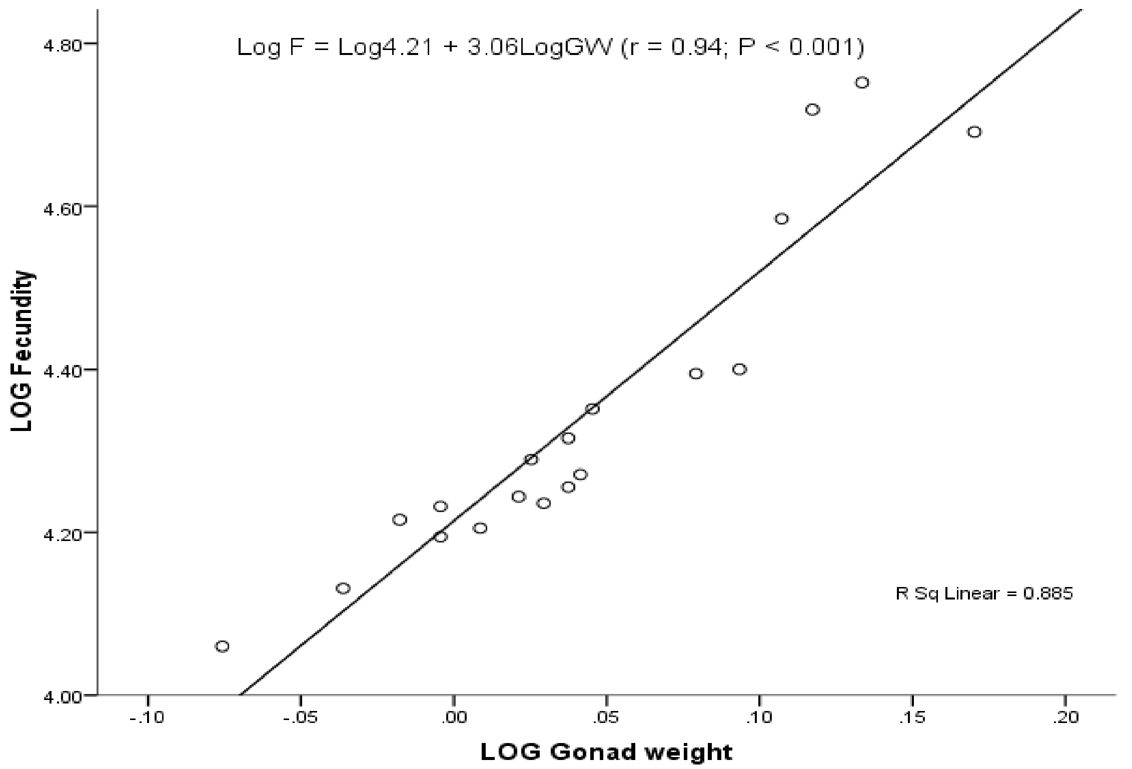

Fig. 4. Relationship of Fecundity and Gonad weight of *M. vollenhovenii* in the Lower Taylor Creek

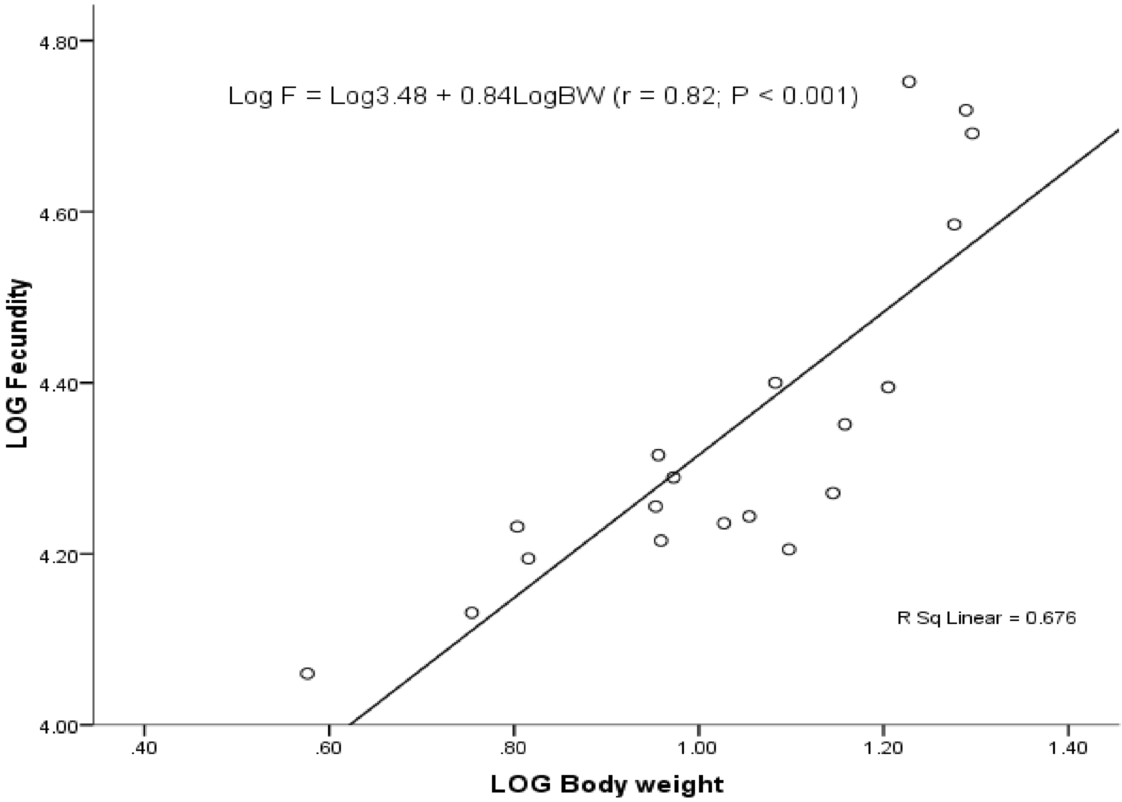

Fig. 5. Relationship of Fecundity and Body weight of *M. vollenhovenii* in the Lower Taylor Creek

Gonadosomatic index. The absence of significant variability in the mean monthly and seasonal GSI for *M. vollenhovenii* may mean all year round reproductive pulses (KINGDOM & ALLISON, 2011), a situation also observed by POWELL (1983) and ENIN (1998).

Fecundity. The absolute fecundity values obtained for *M. vollenhovenii* were highly variable. This situation had been reported by KHMELEVA & GOLOUBEV (1986), who observed that many crustaceans have highly variable absolute fecundity values, even in females of similar size. Various authors have reported the fecundity of *M. vollenhovenii*. VILLE (1970) reported 300 – 1, 000; MILLER (1971) reported 12, 000 – 45, 000, while ANETEKHAI (1986) reported 49, 979 401, 212, with a mean of 173,940 eggs per female. A range of 11,402 to 56,481 eggs per female was estimated in this study. The differences in the absolute fecundity of *M. vollenhovenii* in this study from those of other areas may be due to differences in environment, food supply (BAGENAL, 1978) and egg sizes (BEACHAM & MURRAY, 1993).

The Fecundity/total length relationships showed an increase in number of eggs produced with increasing female size; a situation also observed by ALBERTONI *et al,* (2002) in *M. acanthurus* (EIGMANN, 1836), HART *et al*. (2003) in *M. felicinum* (HOLTHUIS, 1949) and DEEKAE & ABOWEI (2010) in *M. macrobrachion* (HERKLOTS, 1851). The increase of fecundity with body size seems to be a rule that is applicable to many crustaceans (UDO & EKPE, 1991; LLODRA *et al*. 2000). COURTNEY *et al.* (1996), who reported on the decline in number of eggs with an increase in the size of *Penaeus plebejus* and found out that this could possibly be due to ovarian senescence in large (old) females have documented contrary opinion. The increase in the number of eggs with increase in female size of prawns suggests that there are differences in the pattern of allocation of food energy by the prawns at different sizes (TEIKWA & MGAYA, 2003). Usually, in larger individuals, who have low growth rates, much of the energy is devoted to egg production while smaller individuals devote large fraction of their energy to growth rather than egg production. The slopes were all within the range of 2.3–5.3 calculated for a variety of species by BAGENAL (1978). However, gonad weight was the best predictor of fecundity for all species; similar to the observation of ALBERTONI *et al.* (2002) for *M. acanthurus* in a tropical coastal lagoon.

The eggs per centimeter body length was higher than the eggs per gram body weight. Similar situations were also found in the Silver catfish, (*Chrysichthys nigrodigitatus* LACEPEDE, 1803)in Cross River, Nigeria (EKANEM, 2000) and Sharpnose mullet, (*Liza saliens* RISSO, 1810) in Gorgan Bay – Miankaleh Wildlife Refuge, the Southeast Caspian Sea (PATIMAR, 2008). A possible reason for this difference may be as a result of the growth pattern.

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