ASPECTS OF THE BIOLOGY OF THE TIGER SHRIMP *Penaeus monodon* (FABRICIUS) OFFSHORE THE NIGER DELTA AREA OF NIGERIA

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ABSTRACT
The growth pattern, food habits and sex ratio of Penaeus monodon, an invasive shrimp in the Niger Delta of Nigeria were investigated. The total length of the examined specimens ranged from 19.5 cm to 34.4 cm (carapace length, 3.3 cm to 7.9 cm) and weighed 51.5 g to 303.4 g. The shrimps exhibited allometric growth with regression coefficient (b) of 2.89 for females and 2.95 for males. There was high correlation between length and weight of the shrimps with correlation coefficient (r) ranging between 0.8722 and 0.8822. The condition factor ranged between 0.58 and 0.79 and was higher in the females. The shrimps fed mainly on crustaceans and molluscs. Algae and diatoms were also encountered in the stomachs. The sex ratio was 1:1.36 (male/female) which was significantly different from the expected 1:1 sex ratio ($p < 0.05$).The tiger shrimps attained bigger sizes and fed on the young of the indigenous pink shrimp, Penaeus notialis. It may soon displace the native pink shrimp.
Keywords: Invasive shrimp, growth pattern, food habits, sex ratio

INTRODUCTION

The tiger shrimp, *P. monodon*, the largest amongst penaeid species occurs mainly in Southeast Asian waters, the Indo - west Pacific from eastern coast of Africa and Arabian Peninsula (Motoh, 1985). It is a new entrant to the Gulf of Guinea along the West African coast and especially in the Niger Delta area of Nigeria (Anyanwu *et al.*, 2011; Nwosu, 2009). Previous survey by Longhurst (1964), Bayagbona *et al.* (1971), Kusemiju (1975), Ajayi (1982), Ajayi and Talabi (1984), Adetayo and Kusemiju (1994) recorded only *P. notialis* as the only commercial penaeid shrimp in the Niger Delta and the rest of the Nigerian coast *P. monodon* was also not listed by Ajayi and Anyanwu (1997) in their review of marine fisheries of Nigeria.

The invasion by *P. monodon* of the Niger Delta area and the Nigerian marine coastal environment may have its own ecological problems especially possible displacement of the naturally occurring pink shrimp, *P. notialis*. Although the source of *P. monodon* to Nigeria is presently speculative (as escapees from Gambian, Senegalese or Cameroonian shrimp farms, natural sources are ruled out (Nwosu, 2009).

Aspect of the food habits of the tiger shrimp has been documented by Marte (1980) who noted that the food consisted mainly of crustaceans (small crabs and shrimps) and molluscs. The results indicated that *P. monodon* was more of predator of slow-moving benthic macroinvertebrates. FAO (2007), documented the habitat and biology of *P. monodon* and noted that it matures and breeds only in tropical marine habitats and spends its larval, juvenile, adolescent and sub-adult stages in coastal estuaries, lagoons, or mangrove areas serving as a predator on benthic organisms. Similar life history pattern, distribution, and ecology has been documented for the native *P. notialis* in the Niger Delta by Longhurst (1965), Bayagbona *et al.* (1971), and Lagos coastal area by Kusemiju (1975), Adetayo and Kusemiju (1994).

The main objective of this study was to provide information on the biology of this invasive penaeid species in the Niger Delta area of Nigeria with particular reference to the growth pattern, food habits and sex ratio.

MATERIALS AND METHODS

Six hundred (600) specimens of *P. monodon* were collected between October 2010 and February 2011 from Karflex Trawling Company based in Lagos. The company carried out its shrimping operations in the Niger Delta off the Bonny/New Calabar Estuary, off Brass River Estuary and off Benin River Estuary (Fig 1).

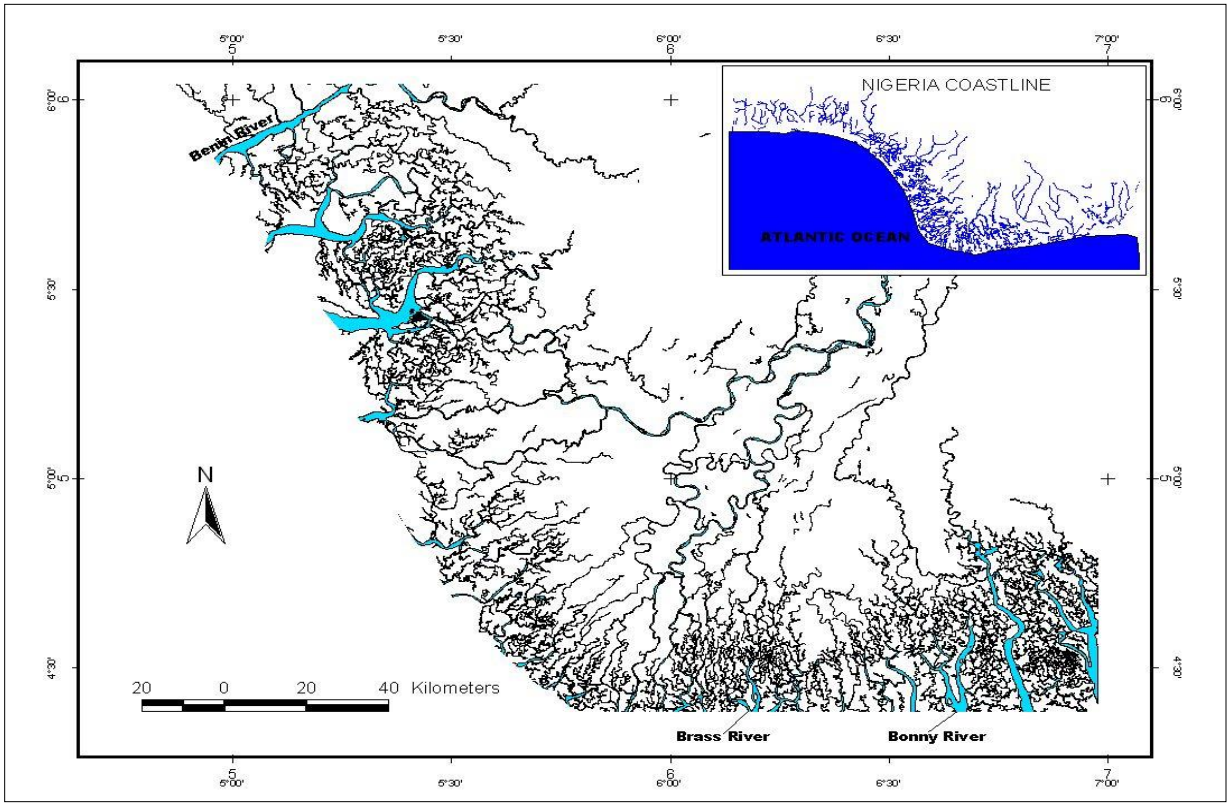

Fig 1: Shrimp sampling stations in the Niger Delta - off the Bonny/New Calabar Estuary, off Brass River Estuary and off Benin River Estuary

The gear employed in trawling was a 21m shrimp trawl with a 2m overhang. The wing and body panels of the trawl were constructed of 50 mm mesh-size nylon twines while the cod-end had a mesh-size of 44 mm. Fishing was done mostly at night at depth of 15 to 40 m . Trawling lasted 2-3 hours. At the end of each haul, the tiger shrimps were sorted, packed in 2 kg cartons and refrigerated at -20°C. Random samples of the tiger shrimps were collected from the company's base at Apapa, Lagos after each monthly landing. The samples were immediately transferred to the laboratory in an ice chest. In the laboratory, the shrimps were labelled and stored in a deep freezer (-20 °C) prior to analysis. A total of 600 tiger shrimps were studied.

In the laboratory, the tiger shrimps were counted and the sex of each noted. A thelycum was present in the female and absent in the male. The following data were taken for each shrimp specimen:

- Total length measured from the orbital notch to the posterior end of the telson, with the shrimp slightly extended on the measuring board;
- Carapace length measured from the orbital notch to the posterior edge of the carapace
- Total weight to the nearest tenth of a gramme on a Sartorius top loading balance (Model 1106).

The total length/weight relationship as graphically determined was expressed by

Log W = log a + b log L……. (Parsons, 1988).

where W = weight of shrimp in g, L = total length in cm, a = regression constant and b = regression coefficient.

The condition factor (K) of the shrimp was det ermined using the formula:

$$K = \frac{100W}{L^b} \quad \text{……. (Bannister, 1976)}$$

where W = weight of the shrimp in g, L = total length in cm, b = regression coefficient.

For the food analysis, the stomach of each specimen was dissected out and the contents examined under a binocular microscope. The food

analysis was by the numerical and frequency of occurrence methods (Hyslop, 1980; Adetayo and Kusemiju, 1994).

RESULTS

Growth Pattern

The total length of the 600 *P. monodon* examined ranged from 19.5 cm to 34.2 cm (carapace length, 3.3 cm to 7.9 cm) and weighed 51.5 g to 304.4 g. The length/weight relationship of the shrimps is shown in Figs 2, 3 and 4. The length/weight relationship values for the male, female and combined sexes were given as follows:

For Males:

Log W =Log 2.0495 + 2.888L

(n = 254, r = 0.8772)

For Females:

Log W = Log 2.1263 + 2.9535L

(n = 346, r = 0.8822)

For Combined Sexes:

Log W = Log 2.0822 + 2.9173 Log L

(n = 600, r = 0.8774)

The shrimps exhibited allometric growth with regression coefficient (b) of 2.89 for males, 2.95 for females and 2.92 for the combined sexes. There was a high correlation between length and weight of the shrimps with correlation coefficient (r) ranging between 0.8722 and 0.8822.

The condition factor (K) which indicated the state or overall well-being of the shrimp is given in Table 1. The k-values ranged between 0.58 and 0.79 and were higher in the females.

Table 1: Condition factor (K) by sex and size for *P. monodon* off the Niger Delta coast

Total Length (cm)	Male				Female				Combined Sex			
	N	TL (cm)	TW (g)	K	N	TL (cm)	TW (g)	K	N	TL (cm)	TW (g)	K
19.5 - 20.4	4	19.9	56.0	0.71	4	20.0	59.9	0.75	8	20.0	58.0	0.73
20.5 - 21.4	7	21.0	62.5	0.67	10	21.0	66.5	0.72	17	21.0	64.5	0.70
21.5 - 22.4	9	21.9	74.5	0.71	11	22.0	72.7	0.68	20	22.0	73.6	0.70
22.5 -23.4	12	22.9	80.1	0.67	18	23.0	77.8	0.64	30	23.0	79.0	0.65
23.5 - 24.4	18	23.9	80.8	0.59	22	23.9	84.3	0.62	40	23.9	82.6	0.60
24.5 -25.4	11	25.0	96.6	0.62	26	24.8	94.8	0.62	37	24.9	95.7	0.62
25.5 - 26.4	16	25.9	101.2	0.58	23	26.0	112.8	0.64	39	26.0	107.0	0.61
26.5 - 27.4	17	26.9	117.4	0.60	14	26.9	123.9	0.64	31	26.9	120.7	0.62
27.5 - 28.4	16	27.8	132.6	0.62	17	27.9	132.0	0.61	33	27.9	132.3	0.61
28.5 - 29.4	5	29.0	159.2	0.65	15	29.0	160.5	0.66	20	29.0	159.9	0.66
29.5 - 30.4	7	30.0	181.9	0.67	7	29.9	210.2	0.79	14	30.0	196.1	0.73
30.5 - 31.4	1	30.5	199.8	0.70	1	31.0	233.8	0.78	2	30.8	216.8	0.75
31.5 - 32.4	2	31.8	220.3	0.69	1	31.9	257.8	0.79	3	31.9	239.1	0.74
32.5 - 33.4	2	33.1	264.7	0.73	0	0.0	0.0	0	2	33.1	264.7	0.73
33.5 - 34.4	2	33.8	284.6	0.74	2	34.1	303.4	0.77	4	34.0	294.0	0.75

Food Habits

Six hundred (600) specimens of *P. monodon* were examined for food and feeding habits. 106 (17.7%) of the shrimps had empty stomachs.

The summary of stomach contents is given in Table 2. The stomach contents consisted mainly of algae, diatoms, crustaceans, molluscs, detritus and unidentified mass. The crustaceans (mainly shrimp parts) occurred in 82.3% of the stomachs. Molluscs (mainly barnacles) occurred in 63.6% of the stomachs.

Reproductive Biology

Of the 600 tiger shrimps examined, 254 were males and 346 were females giving a sex ratio of 1:1.36 (male/female). The sex ratio was significantly different from the expected 1:1 ratio ($p < 0.05$).

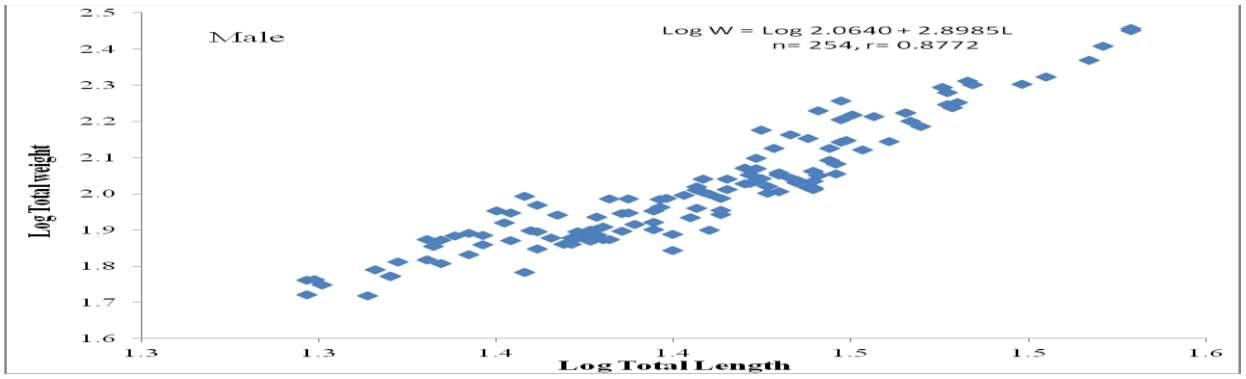

Fig 2: Log length/log weight relationship of Male *Penaeus monodon* from Niger Delta area

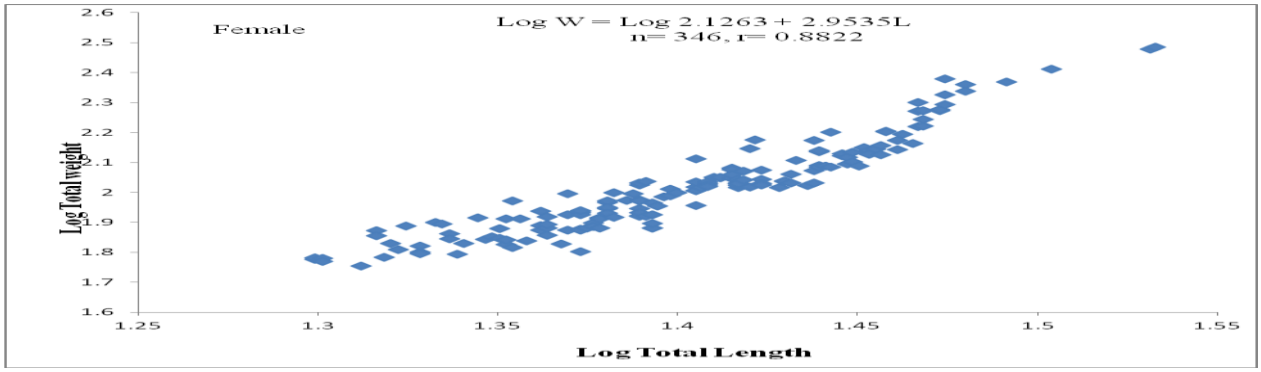

Fig 3: Log length/log weight relationship of Female *Penaeus monodon* from Niger Delta area

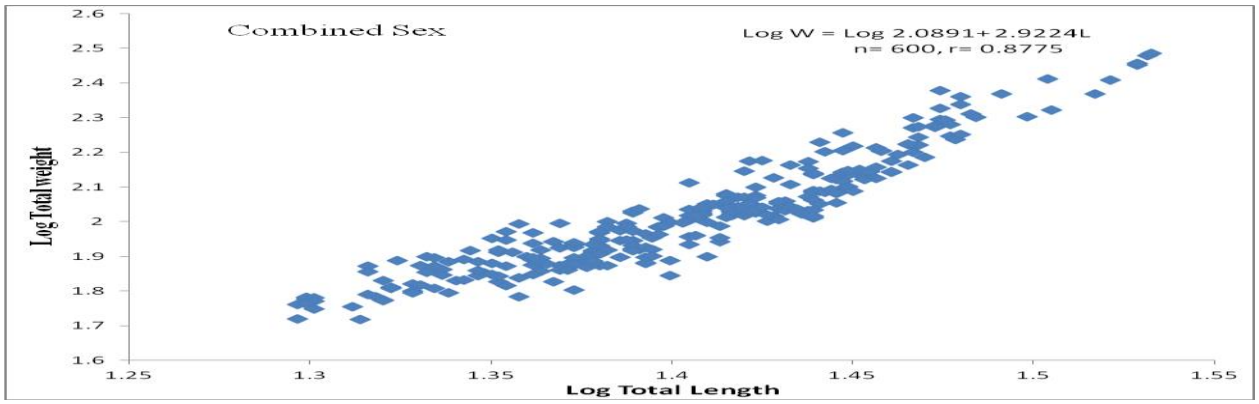

Fig 4: Log length/log weight relationship of *Penaeus monodon* (Combined sexes) from Niger Delta area

Table 2: Summary of the stomach contents of *P. monodon* off the Niger Delta area (Oct. 2010 – Feb. 2011)

Stomach Contents	Numerical Method		Occurrence Method	
	Number	%	Number	%
Algae	1040	24.3	430	87.0
Diatoms	1534	35.8	464	94.0
Crustaceans (shrimp parts)	990	23.1	406	82.2
Molluscs (barnacles)	720	16.8	314	63.6
Detritus	-	-	470	96.8
Debris	-	-	426	86.2
Unidentified mass	-	-	426	86.2

DISCUSSION

Medium and large tiger shrimps were obtained in the trawl hauls ranging in size up to 34.2 cm total length (carapace length 7.9 cm) and weighing up to 303.4 g. Similarly sizable tiger shrimps were recorded by Anyanwu *et al.* (2011) with size of up to 36.0 cm (carapace length 12.2 cm) and weighing of up to 312.1 g. *P. notialis* in this area on the other hand achieved total length of 24.2 cm (carapace length 5.5 cm) and weight of 193.2 g (Bayagbona *et al*., 1971; Kusemiju, 1975). Yakub and Ansa (2007) reported that in the Buguma Creek in the Niger Delta, in terms of biomass, *P monodon* significantly outweighed *P. notialis*.

P. monodon examined exhibited high allometric growth with b (correlation coefficient) values ranging between 2.89 and 2.95. Similar values were obtained for *P. monodon* in the Buguma Creek by Yakub and Ansa (2007). The correlation coefficient (r) in the tiger shrimps (0.8722 for male, 0.8822 for female) was very high indicating that there was linear relationship between length and weight in *P. monodon*.

The condition factor (K) for the tiger shrimps ranged from 0.58 to 0.79 and was higher in the females. Yakub and Ansa (2007) obtained k-values of 0.803 for small tiger shrimps in the brackish water Buguma Creek but also indicated that *P. notalis* had a better condition factor of 0.876 in this environment.
The tiger shrimps fed mainly on crustaceans (mostly parts of pink shrimps thus predating on the native penaeid shrimps), molluscs (mainly barnacles). Algae, diatoms, detritus and debris also formed appreciable part of the stomach contents. The feeding result agreed with the documentation by Marte (1980) who noted that *P. monodon* was more of predator of slow-moving benthic macroinvertebrates.

The males were significantly more numerous than the females, with a sex ratio of 1:1.36 which differed significantly from the expected 1:1 ratio.

The similarity in the life history and ecology of *P. monodon*, the invaders and the native pink shrimp, *P. notalis* raises several problems. There is competition for space and food with *P. monodon* feeding on *P. notalis* parts. *P. monodon* may soon displace the native *P. notalis* completely in Nigerian estuaries, lagoons and offshore marine waters.

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