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Comparative Biology of the Pink Shrimp, Penaeus notialis (Perez-Farfante), and Giant Tiger Shrimp, Penaeus monodon (Fabricius), in the Lagos Lagoon, Nigeria

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Abstract
Eight hundred (800) specimens of pink shrimp, *Penaeus notialis* and giant tiger shrimp, *Penaeus monodon* collected from the Lagos Lagoon between February and May 2012.They examined with particular reference to size composition, growth pattern, distribution, sex, food and feeding habits. Some physico-chemical parameters Hydrogen – ion concentration; (pH), Dissolved oxygen; Salinity and Temperature of the environment were also studied. The air and surface water temperature ranged between 27.0^{o}C to 31.5^{o}C; mean value of 29.38±1.89 and 27^{o}C to 31^{o}C; mean 29.00±1.83 respectively. Hydrogen-ion concentration pH values ranged from 7.4 to 7.7. The salinity ranged between 15.6‰ to 20.1‰ with mean value of 17.78± 1.86 while the dissolved oxygen was between 3.9mg/l to 5.7mg/l; mean 4.65±0.82.The mean and standard deviation of carapace length of *P. notialis and P. monodon* specimens ranged from 2.583 ± 0.792 and 3.670 ± 1.255 while the mean and standard deviation of total length ranged from 8.898 ± 1.042 and 13.090 ± 1.326. The mean and standard deviation of total weight ranged from 4.237 ± 1.775 and 14.644 ± 4.060 respectively. The length-weight relationship reflected the common general increase in weight with increasing length. The shrimps exhibited a negative allometric growth. The condition factor (K) of the shrimps ranged from 0.51 to 0.69 and from 0.27 to 0.59 (male/female) in *P. notialis*, while i*n P. monodon* it ranged from 0.46 to 0.76 and from 0.57 to 1.00 (male/female) respectively. The sex ratio obtained for *P. notialis* sample was 1:0.27 while in *P. monodon* a sex ratio of 1:1.53 were observed which showed a significant difference from the expected 1:1 ratio. The food and feeding habit of *P. notialis* and *P. monodon* from the Lagos Lagoon showed that both species fed majorly on crustaceans, diatoms, filament algae and plant materials. But, *P. monodon* fed more on food items in term of quantity than the *P. notialis* especially on crustaceans. It was observed that the plankton, crustaceans and plant materials were the most preferred food, Percentage of frequency of occurrence of filament algae are the same in both species.
Keywords: *Penaeus notialis*, *Penaeus monodon*, Growth, Food and Feeding, Lagos Lagoon.

INTRODUCTION

The family Penaeidae is the largest of the super family Penaeoidea. Penaeidae, also known as penaeid shrimp or penaeid prawn, is a family of marine crustacean in the suborder Dendrobranchiata. It contains many species of economic importance, such as the tiger prawn, *Penaeus monodon*, white-leg shrimp, in marine settings, and in freshwater farms. Penaeids include the widespread tropical and subtropical prawns of the genera *Fenneropenaeus, Penaeus* and *Metapenaeus* (Richmond, 2002). Shrimp is an important seafood commodity representing a global industry with a market valued at over US $ 20 billion annually accounting for 19% of international trade (Islam *et al*., 2003). Captured shrimps accounted for 3,120,556 tonnes in 2008 declining from 3,307,856 tonnes in 2003 while shrimp culture has increased at the rate of 10% per annum over the last 10 decades increasing from 2,049,011 tonnes, in 2003 to 3,399, 103 tonnes in 2008 (FAO, 2009). The pink shrimp *P. notialis* resource is native to the West African region. The culture technology is not yet well developed but juveniles are common in the estuaries (Ebonwu *et al*., 2007b). While, tiger shrimp *P. monodon* is another shrimp although indigenous to the Indo-Pacific region is a new entrant to the Atlantic Ocean in the Gulf of Guinea area. Shrimp aquaculture technology is available in many countries with good market potentials; these species have a faster growth rate than *P. notialis.*

Penaeus monodon is the largest shrimp species globally and has the fastest growth rate among all penaeid species (Chemonics, 2002; ASEAN, 2003; Ravichandran and Pillai, 2004). Similarly the Giant prawn *Macrobrachium rosenbergii* is the most widely cultured prawn (Soundarapandian *et al*., 2008; El-Sherif *et al*., 2009). Nigeria is a maritime state with enormous water resources including fresh, brackish and marine waters. Members of the penaeid family especially *P. monodon* which is widely cultured occur in the coastal waters (Dublin-Green and Tobor, 1992; Ebonwu *et al.,* 2007a; Adetayo, 2008). *Penaeus monodon* although not indigenous to West African region but accidentally introduced has become well established in the coastal waters of Nigeria as fishing trawlers and local fishermen catch berried females all-year round (Ayinla *et al*., 2009a). Despite their palatability, high nutritive value and good price rate, there is still a death of information on their comparative biology; a knowledge of this will expose their dynamics and relationships. It will also provide a systematic insight into their mode and methods of culture.

MATERIALS AND METHODS

Description of the study area

The Lagos Lagoon and its coast was the study area for this project. The Nigerian coastline is between longitude 02° 53′ to 08° 14′ E and latitude 06° 21′ to 03° 55′N, covering a distance of 85 km and lies in between the Gulf of Guinea. Lagos coast is a narrow coastal shelf and lies between 14, 816 km and 27,780 km with a total area of 41,000 km^2. It is a marine environment and salinity is a major limiting factor to the growth of some organisms in the Lagos coast. It has supported decades of small scale fisheries which have shown sign of continuous decline (Solarin, 1998). The Lagoon characterized with seasonal fluctuation in salinity – high brackish water during the dry season (December – May), while freshwater condition exists in the rainy season (June- November) (Kusemiju, 1975; and Solarin, 1998). It receives freshwater from Lekki Lagos via Epe Lagos in the North- east, and discharges from Majidun, Agboyi and Ogudu creeks as well as Ogun River in the North- West (Soyinka, 2008; Lawal- Are et., al., 2010).

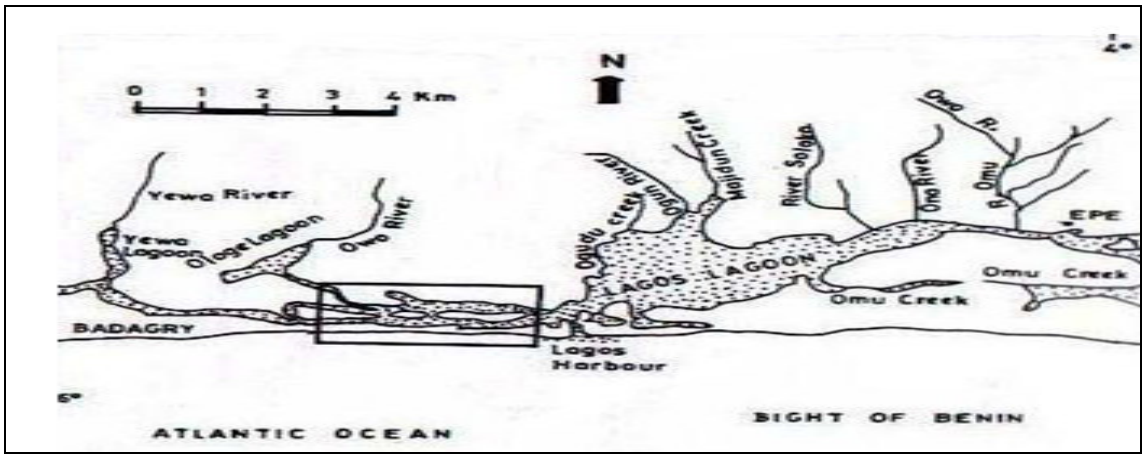

Figure 1: -Map of Lagos Lagoon **Source: - Adesalu and Nwankwo (2010).**

Collection of specimens

Specimens of *Penaeus notialis s*and *Penaeus monodon* were caught from the Lagos Lagoon by artisanal fishermen using cast net and sold to local market women at the Better Life Fish Market, Makoko area of the Lagos Lagoon from where they were obtained. 800 specimens of the shrimps were collected between the months of February and May 2012 and preliminary study was carried out. The specimens were preserved in ice at the point of collection and immediately transferred to the deep freezer at -20^{o}C in the Department of Marine Sciences laboratory, where they were kept prior to laboratory work.

Physico-chemical parameters

The physicochemical parameters such as temperature, hydrogen ion concentration (pH), salinity and dissolved oxygen were determined monthly between 7.00am and 8.30am using various biochemical methods.

Laboratory procedures

The specimens were preserved in a frozen ice chest at the point of collection and immediately transferred to the Department of Marine Sciences laboratory for analysis. They were stretched out and place on a measuring board. The total length (TL) was obtained by stretching out the curved shrimp and taking lengths from the tip of the rostrum to the end of the telson to the nearest 0.1cm (FAO, 1981). Each individual was sexed and the carapace length (CL) was obtained by cutting off the cephalothorax and taken measurements from the post orbital margin to the posterior margin of the carapace. This was measured to the nearest centimetre (Penn1980). The removed stomach was placed in a petri dish and the content was mixed with water to form a solution. With the aid of a dropper, the content was placed on a glass slide and observed under a binocular microscope to reveal the food items eaten by the shrimps. The stomach content was examined under microscope and the various food items were identified and counted individually using numerical and frequency of occurrence method.

Growth biology

The length and weight of the shrimps recorded were correlated into data in order to obtain the growth rate of the shrimps. The length-weight relationship is represented by the equation below

$$W = aL^b$$

Where W = weight of shrimp in grams (g)

L = length of shrimp in centimetres (cm)
a = regression constant
b = regression coefficient
Taking the log of $W = aL^b$
Log W = Log a + b Log L (Parsons, 1988).
Values of a, b and the correlation coefficient, r were obtained using the computer.

Condition factor (K)

Condition factor (k) depends on the degree of the well-being of a species using length weight relationship. The condition factor is an indicator to fish welfare in their habitat described (Gomiero and Braga, 2005). It is represented by letter K, when the fish is measured and weighed, as in the following equation. This 'k' value can be basically and directly interpreted as 'the higher the value, the better the condition of the fish. According to Weatherly and Gill (1987), condition factor, K can be used to determine the period of gonadal maturation and the observation of increase or decrease in feeding activities or population change possibly due to modifications in food resources.

Condition factor can be calculated by the equation below.

$$K = \frac{100W}{L^3}$$ ---------- (Gayanilo and Pauly, 1997).

Where K = condition factor
W = weight of the fish in grams (g).

The condition factor is useful for investigating effects of seasonal and habitat differences in shrimps.

Stomach analysis

Stomach contents have been used by many researchers to establish the food and feeding habits of fish. The stomach content of each individual shrimp was observed and recorded. The shrimp samples were beheaded and a pair of forceps was used to carefully remove the stomach from the head region of each shrimp sample. The state of fullness of each shrimp's stomach was recorded in the proforma as 0\4 1\4, 2\4, 3\4 and 4\4 representing empty stomachs, quarter-filled, half-filled, three-quarter filled and filled stomach respectively. Two methods were used to analyse the stomach content. The method used for the analysis of these stomach contents were numerical and frequency of occurrence method.

Method of Occurrence: The number of stomach in which each food item occurred was recorded. The results were then expressed as percentages of the total number of specimens with food. The merit of this method is that it gives estimates of the proportion of the population that feeds on a particular food item as well as the various types of organisms fed upon. For the demerits, the results are often biased by the accumulation within individuals of remains of certain food organisms which were resistant to digestion. This therefore tends to make the apparent frequency of such organisms greater than the actual frequency with which they were taken during successive feeding periods. Furthermore, this method fails to disclose the number of forage individuals involved.

Numerical Method: food items in each stomach are identified and counted. They were summed to give the total for each kind of food item in the whole sample and a grand total of all items are obtained. The total of each kind of food item was recorded and expressed as a percentage of the total number of all food items. The merit of this method is that it is easy to draw conclusions as to the relative significance of the different food items while the demerit is that organisms occurring in large numbers may not necessarily constitute the most important food item.

Reproductive biology

The sexes of the shrimps were observed and determined by the physical presence of the thelycum and the petasma for the female and male sexes respectively. On the female, the external organ lies between the 4th and 5th pairs of the periopods (walking legs) while the male external organ lies between the 1st pairs of pleopods. The male- female ratio statistical hypothesis of $H_0 = 1:1$ for male and female was tested using the Chi- square.

$$\chi^2 = \frac{\Sigma (\text{Observed} - \text{Expected})^2}{\text{Expected}}$$

Where χ^2 = Chi-square to be calculated and compared with χ^2 (1 d.f, 5%) tabulated value.

The maturity stages of the shrimps was determined based on microscopic examination of the gonads and classified using the four staged scaled defined by Sobrino (1998):

Stage I: Immature or virgin
Stage II: Developing
Stage III: Active developing
Stage IV: Spawning

Statistical analysis

Chi- square test was used to determine the population dynamics. Regression analyses of dependent variables were used after calculating their regression constant, regression correlation and correlation factors of the shrimps. Scatter diagrams were plotted for the specimens to illustrate the relationship between the total or carapace lengths and weight of the shrimps. The log of total or carapace lengths and weight were obtained and plotted in order to establish the relationship between them.

RESULTS

Morphometric parameters

The independent sample test showed that there is a statistically significant difference ($P < 0.05$) between mean Total length of *Penaeus notialis* (8.898 ± 1.042) and mean Total length of *Penaeus monodon* (13.090 ± 1.326). At P-value of 0.000 ($P < 0.05$) there is a significant difference between the carapace length of *P. notialis* (2.583 ± 0.792) and *P. monodon* (3.670 ± 1.255). The mean total weight of *P. notialis* (4.273 ± 1.775) and mean total weight of *P. monodon* (14.644 ± 4.060) showed a statically significant difference of $P<0.05$. While in group statistics analysis showed that *P. notialis* had mean total length of 8.898 ± 1.042 while *P. monodon* value was 13.090 ± 1.326. The carapace length of *P. notialis* was 2.583 ± 0.792 while *P. monodon* was 3.670 ± 1.255 and mean total weight of *P. notialis* was 4.237 ± 1.775 and *P. monodon* was 14.644 ± 4.060.

Physico – chemical parameters

The results of the monthly physico- chemical parameters in Lagos Lagoon are shown in Table 1 below.

Table 1: Physico – Chemical Parameters of Makoko Jetty in Lagos Lagoon From February – May, 2012

Months/Year	Air Temperature (^oC)	Surface Water Temperature (^oC)	Hydrogen ion concentration (pH)	Salinity ((‰)	Dissolved Oxygen (mg/l)
Feb' 12	27	28	7.5	17.4	4.1
Mar' 12	31.5	30	7.4	20.1	3.9
Apr' 12	30	31	7.7	18	4.9
May ' 12	29	27	7.5	15.6	5.7

Monthly catch, size composition and length frequency distribution

The monthly catch of the pink shrimp and giant tiger shrimps is shown in Table 2 below. The total number examined for carapace length distribution of pink shrimp was 400. The females constituted 87 (21.8%) while the males were 341 (85.3%). The carapace lengths ranged between 1.0cm and 7.9cm. The carapace length of the male, female and the combined sexes with the highest frequency of occurrence ranged between 2.0 - 2.4cm. While, in catch of giant tiger shrimp, the females constituted 124 (31.0%) while the males were 54 (13.5%). The carapace lengths ranged between 1.0cm and 7.9cm. The female, male and two sexes shrimp's carapace length with the highest frequency of occurrence ranged between 3.0-3.4cm.The carapace length, total length - frequency distributions of these species are graphically represented using line graphs in Figures 2 and 3 below.

Table 2: Monthly Catch in relation to sex of *P. notialis* and *P. monodon* in Lagos Lagoon from February-May, 2012.

MONTH	*Penaeus notialis*			*Penaeus monodon*		
	Males	Females	TOTAL	Males	Females	TOTAL
February, '12	69	31	100	49	51	100
March, '12	88	12	100	33	67	100
April, '12	75	25	100	39	61	100
May, '12	82	18	100	37	63	100

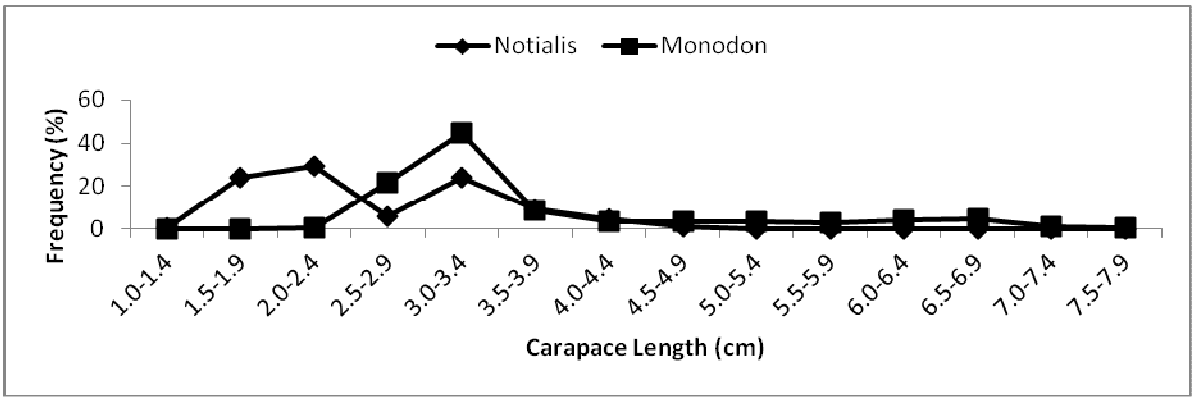

Figure 2: Carapace Length Frequency distribution of *Penaeus notialis and Penaeus monodon* (Combined sexes) in Lagos Lagoon from February – May, 2012.

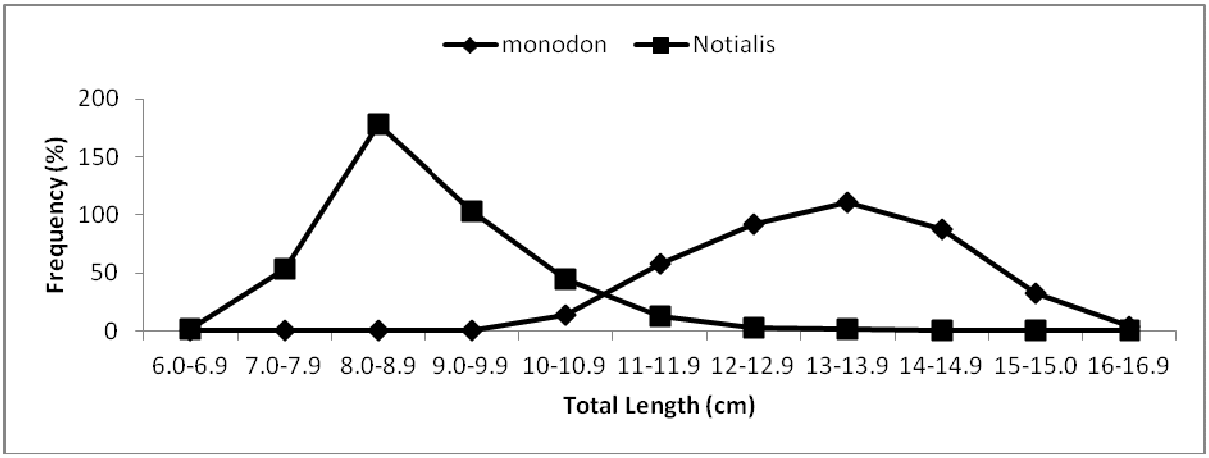

Figure 3: Total Length - Frequency distribution of *Penaeus notialis and Penaeus monodon* (Combined sexes) in Lagos Lagoon from February – May, 2012

The Carapace Length – Total Length Relationship

The carapace length- total length relationship was calculated for the 400 specimens of *P. notialis* and 400 for *P. monodon* collected from Makoko jetty, off Lagos Lagoon. The carapace length of the females ranged from 1.5cm and 4.4cm and the total length ranged from 7.6cm and 12.5cm while carapace length for the males ranged from 1.2cm and 4.6cm and total length ranged from 6.0cm and 13.8cm. The carapace length of *P. monodon* females ranged 2.3cm and 6.7cm and total length ranged from 10cm and 16.1cm while carapace length for males ranged from 2.3cm and 6.6cm and total length ranged 10cm and 15.5cm. The scatter diagrams of the carapace length against carapace weight for *P. notialis* and *P. monodon* are illustrated in Figures 4. 5, 6 and 7 below.

This relationship was determined using this formula:

Log TL = a + b log CL

Where TL = Total length of shrimp in centimetres (cm)

CL = Carapace length of shrimp in centimetres (cm)

a = Regression constant

b = Regression coefficient

The least square common fit of the transformed data gave the following linear equation:

Penaeus notialis:

Males: Log TL =0.872838 + 0.179933 Log CL

(n = 314 r = 0.478454)

Females: Log TL = 0.896872 + 0.157619 Log CL

(n= 86, r = 0.435393)

Combined sexes: Log TL = 0.874073 + 0.184569 Log CL

(n = 400 r = 0.492211)

Penaeus monodon:

Males: Log TL = 0.977919 + 0.234833 Log CL

(n = 158, r= 0.704646)

Females: Log TL = 0.99465 + 0.231294 Log CL
(n = 242, r = 0.594575)
Combine sexes: Log TL = 0.993877 + 0.222047 Log CL (n = 400, r= 0.634742)

The Carapace length – Total length relationship regardless of sex reflected a common general increase in total length with increasing carapace length. The values of the correlation co- efficient 'r' ranged between 0.435393 and 0.492211 in *P. notialis* while in *P. monodon* the values of the correlation co- efficient 'r' ranged between 0.594575 an0.704646 showing a very positive correlation between the carapace length and the total length in both species as seen in Figures 4, 5, 6 and 7 below.

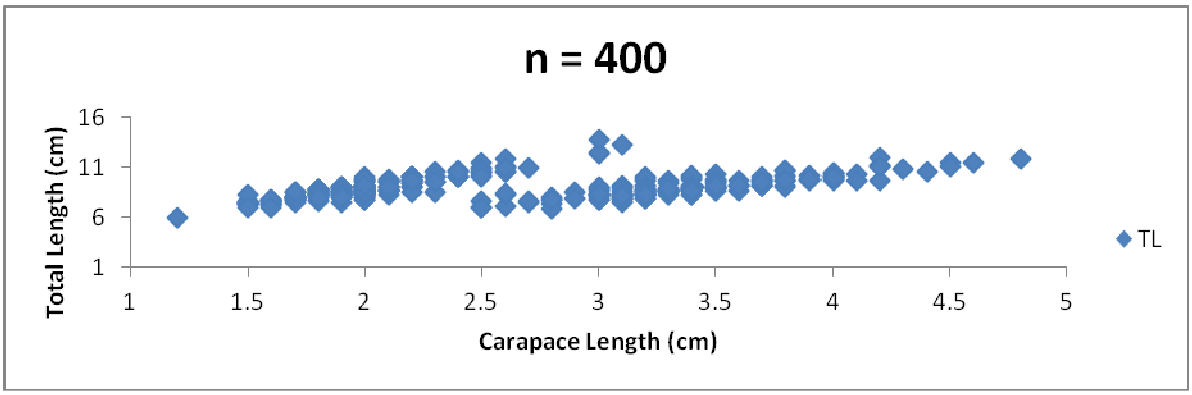

Figure 4: Carapace Length – Total Length of *P. notialis* (combined sexes) in Lagos Lagoon from February- May, 2012.

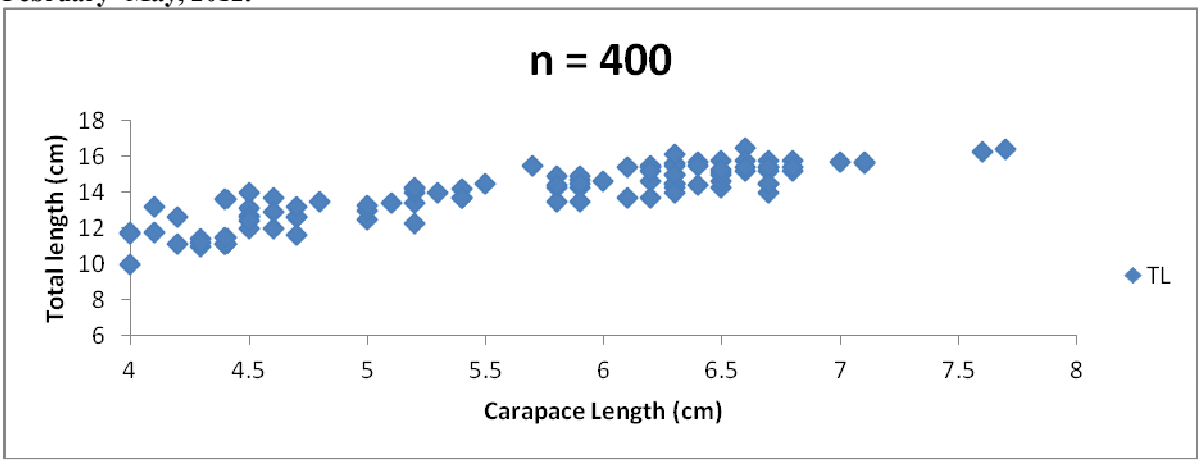

Figure 5: Carapace Length – Total Length of *P. monodon* (combined sexes) in Lagos Lagoon from February- May, 2012.

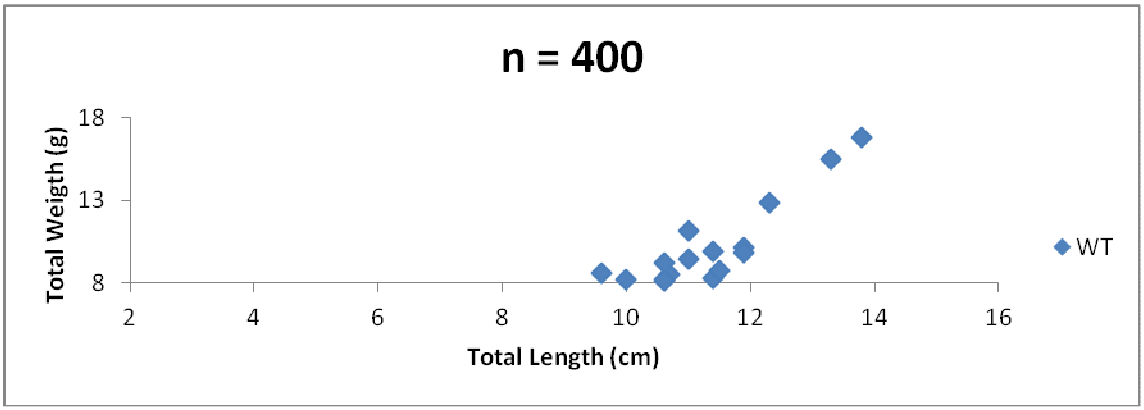

Figure 6: Total Length – Total Weight of *P. notialis* (combined sexes) in Lagos Lagoon from February- May, 2012.

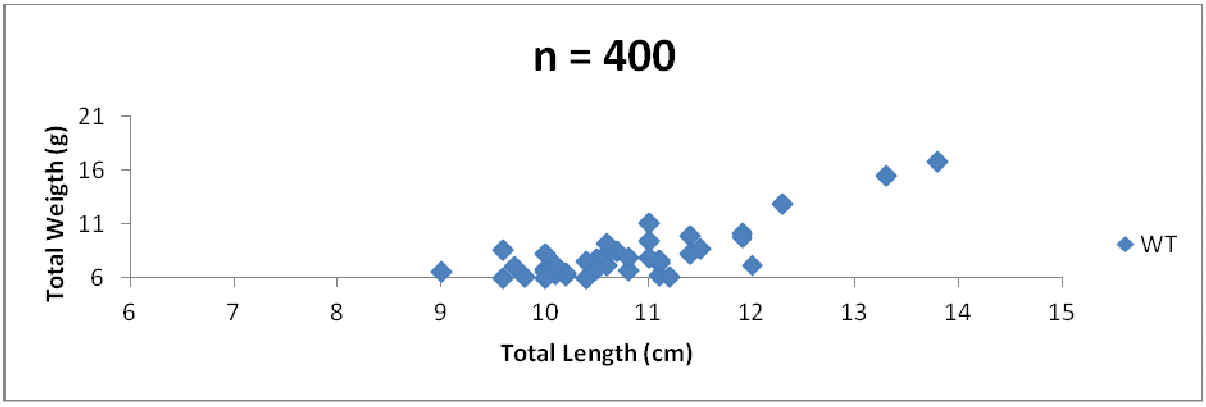

Figure 7: Total Length – Total Weight of *P. monodon* (Combined sexes) in Lagos Lagoon from February-May, 2012.

Total Length – Total Weight Relationship

The Length - Weight relationship was calculated for the 400 specimens of *P. notialis* and 400 for *P. monodon* collected from Makoko jetty, off Lagos Lagoon. The total weight of the females ranged from 3.08g and 11.14g and the total length ranged from 7.6cm and 12.5cm while total weight for the males ranged from 1.2g and 16.81g and total length ranged from 6.0cm and 13.8cm. While in *P. monodon,* the total weight of the females ranged 6.85g and 24.99g and total length ranged from 10cm and 16.1cm while total weight for males ranged from 5.3g and 24.27g and total length ranged 10cm and 15.5cm.

The length – weight relationship regardless of sex reflected a common general increase in total length with increasing carapace length. The values of the correlation co- efficient 'r' ranged between 0.766409 and 0.904822 in *P. notialis* while in *P. monodon* the values of the correlation co- efficient 'r' ranged between 0.714373 and 0.775906 showing a very positive correlation between the carapace length and the total length in both species

CONDITION FACTOR

The condition factor (k) which indicates the state or overall well-being of *Penaeus notialis* and *Penaeus monodon* was calculated for 400 specimens of *P. notialis* in females, males and combined sexes and examined in relation to size and shown in Tables 6 and 7. In *P. Notialis* samples the best condition factor was observed in males whose total length varied from 11.8 to 12.4cm. The K- values for female species ranged from 0.29 in size group of 12.5 – 13.1 and 0.59 in the size group of 7.6-8.9. The males species have their K- value ranged from 0.51 in the size group of 12.5 – 13.1 and 0.69 in the size group of 11.8- 12.4. For combined sexes, the K-values ranged between 0.42 in the size group of 12.5- 13.1 and 0.65 in the size group of 13.2- 13.8. In *P. monodon* samples, the condition factor was observed in males whose total length varied from 9.5 -10.4cm.

STOMACH ANALYSIS

Frequency of Empty Stomachs

The food and feeding habits of 800 specimens of the penaeids shrimps was examined. 209 (26.1%) of the specimens had empty stomachs. 116(29.0%) out of 400 *P. notialis* specimen had empty stomachs while 93(23.3%) out of the 400 *P. monodon* specimen had empty stomachs. The monthly variation of the empty stomachs in percentage is illustrated in Table 3 and 4. The highest percentage of empty stomachs in *P. notialis* (39.0%) was recorded in April, followed by 31.0% in March. While *P. monodon*, the highest percentage of empty stomachs (37.0%) was recorded in February, followed by (24.0%) in March and April.

Table 3: Monthly variation of empty stomachs in *P. notialis* in Lagos Lagoon from February to May, 2012.

Month/year	Number of specimens	Number of empty stomachs
February, '12	100	22
March, '12	100	31
April, '12	100	39
May, '12	100	24

Table 4: Monthly variation of empty stomachs in *P. monodon* in Lagos Lagoon from February to May, 2012.

Number of specimens	Number of empty stomachs
100	37
100	24
100	24
100	8

FOOD AND FEEDING HABITS

The main food items of *P. notialis* and *P. monodon* are represented in Figures 8 and 9 below. *Penaeus notialis* fed majorly on various types of algal filaments and diatoms accounting for 48.94% and 18.66% by frequency of occurrence method respectively while they accounted for 20.10% and 7.20% respectively in numerical method. The crustaceans are found in the stomachs in form of fragments and accounted for 16.55% by frequency of occurrence. The crustaceans are found in the pink shrimps in disassembled forms and they constitute about 5.10% in numerical method. Fishes fragments also occurred in the stomach of the pink shrimps in form of eggs and bones accounted for 13.03% by frequency of occurrence and 3.60% in numerical method. The plants materials observed in pink shrimp constituted 66.90% by frequency of occurrence method and 64.00% in numerical method. Unidentified materials and sand grains were also observed in the stomach of the pink shrimp. While in *P. monodon*, fed majorly on crustaceans and diatoms accounted for 57.98% and 57.33% by frequency of occurrence method respectively while they accounted for 2.50% and 22.50% in numerical method respectively. The algal filaments accounted for 17.26% by frequency of occurrence and 8.30% in numerical method. Fishes fragments also accounted for 15.64% by frequency of method and 2.20% in numerical method. The plants materials observed in *p. monodon* constituted about 94.14% by frequency of occurrence method and 64.40% in numerical method. Unidentified materials and sand grains were also observed in *P. monodon*.

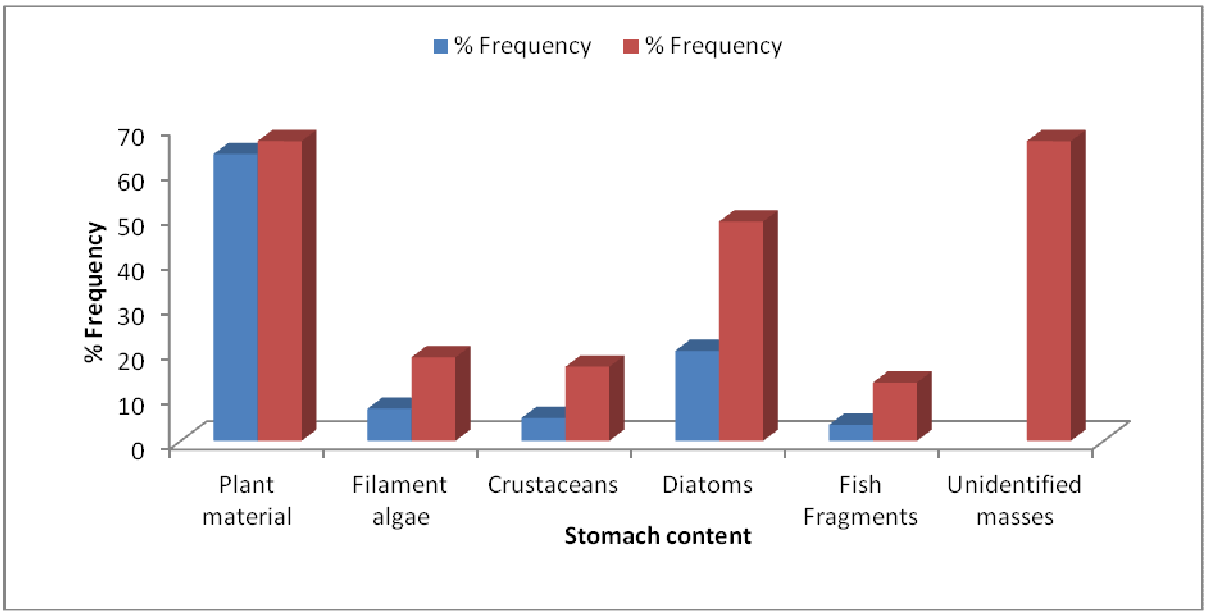

Figure 8: Summary of stomach content in *P. notialis* in Lagos Lagoon from February – May, 2012

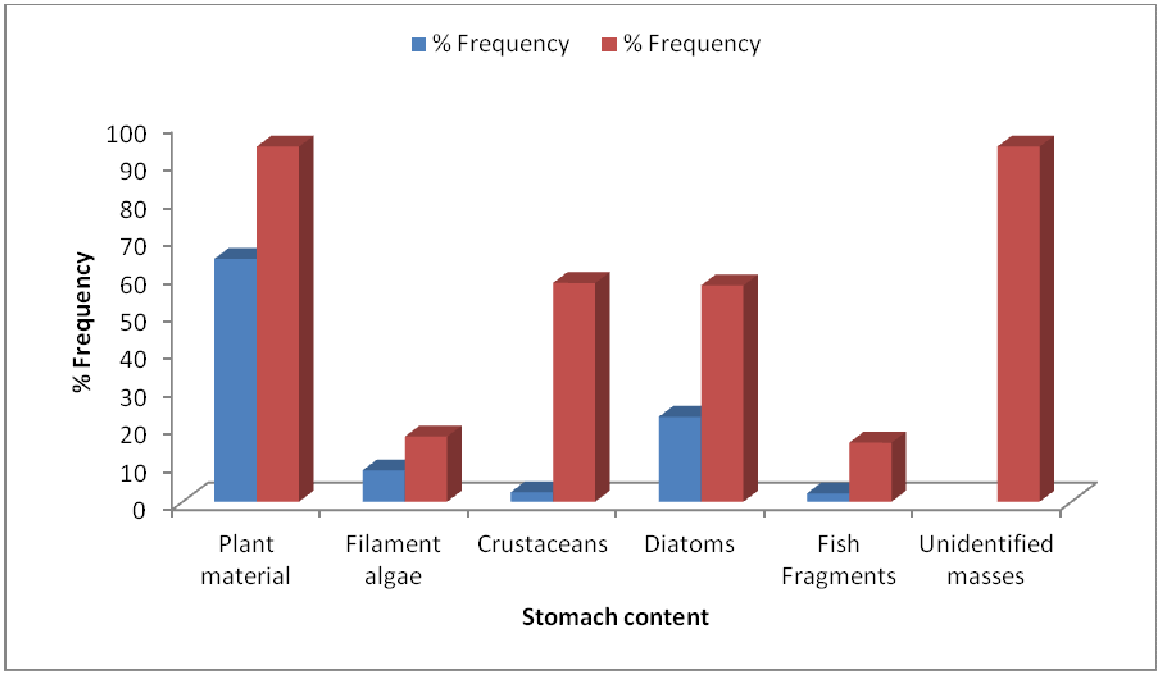

Figure 9: Summary of stomach content in *P. monodon* in Lagos Lagoon from February – May, 2012

REPRODUCTION BIOLOGY

Sex ratio

The sex ratio for each species was determined. In *P. monodon* samples, 400 specimens out of the 158 observed were males and 242 were females giving a sex ratio of 1: 1.53 (male/female). Chi – square (χ^2) was used to test if there was any significant difference in the sex of the Peneaid shrimps from the expected 1:1 ratio (male/female). In *P. notialis* the lowest value of 14.44 from the chi- square test was obtained in the month of February as against the tabulated value of 3.48, making it significant. The highest significant value was obtained in the month of March, giving a value of 57.76 as against the tabulated chi- square value of 3.84. While in *P. monodon*, lowest value of 0.04 from the chi- square test was obtained in the month of February as against the tabulated value of 3.84, making it insignificant. The highest significant value was obtained in the month of March, giving a value of 11.56 as against the tabulated chi- square value of 3.48. The variations in sex ratio of *P. notialis* and *P. monodon* off Lagos Lagoon from February to May, 2012 can be seen in Table 4 bellow.

Table 4: Variations in sex ratio of *P. notialis* and *P. monodon* in Lagos Lagoon from February to May, 2012.

Species	Male	Female	Ratio (male/female)	χ^2Chi –Square 1 d.f 5%
P. notialis	314	86	1: 0.27	129.96
P. monodon	158	242	1: 1.53	17.64

There was significant difference ($P<0.05$) observed for the males of peneaids as against the females ($P>0.05$) from expected ratio of 1: 1 in the Chi- square test. Chi – square test carried out to test if there was any significant difference in the sex ratio of *P. notialis* and *P. monodon* gave 129.96 and 17.64 at 1 d.f & 5% level. This shows that males penaeids shrimps are significantly more numerous than their females in the total number of shrimps sampled from Makoko jetty off the Lagos Lagoon.

DISCUSSION

Certain environmental factors associated with the distribution of the Penaeids in the Lagos Lagoon were investigated in this study from February to May, 2012 and fell within two marked seasons, rainy and dry season. The dry season was characterized by influx of sea water into the Lagoon and high evaporation, while the rainy season was characterized by influx of run-off water from the rivers and creeks and rains. The air and surface water temperatures, and salinity obtained showed a variation with seasons. The temperatures were generally lower during rainy season due to cloud cover while they were high during the dry season. These results are in similarity with those obtained by Adetayo and Kusemiju (1994) and Lawal – Are et al., (2010). The temperature ranges of Lagos Lagoon obtained between the periods studied were slightly different from the results reported by Dublin-Green (1990) who worked on physio-chemical parameters in Niger- Delta waters.

The variation of pH values of Lagos Lagoon observed in this study is in agreement with results of Dublin- Green (1990) in Bonny River, Niger- Delta where the highest value was recorded in the dry season and

lower values of pH in the rainy season. Similar trend was recorded by Ekeh and Sikoki (2003) in the New Calabar River and also by Ansa (2005) in Adoni flats of the Niger Delta area. The seasonality in pH of Lagos Lagoon water may be due to the influx and buffering effects (Oyema et al., 2007 and decay of debris in the area as well as imbalance level of H^+ ion inputs from surface run-offs during rains. However, the hydrogen ion concentration (pH) values recorded in this study were well within the preferred pH of 6.5 to 9.0 recommended by (Abowei, 2010).

The dissolved oxygen values recorded in this study were lower than the standard values (7.64mg/l and 8.38mg/l). The range of dissolved oxygen between 3.9mg/l recorded in March and 5.7mg/l in May was still within the acceptable limit of aquatic life (Abowei, 2010). This could majorly be due to the reduced amount of fresh water discharged into the Lagoon and high rate of evaporation. The temperature was generally lower during the rains due to cloud cover while they were high during the dry season. High salinity in the Lagoon coincided with the dry season while low salinity could be attributed to high fresh water discharge from the rivers and the rains. Similar observations on the ecological factors of the Lagos Lagoon have been made by previous investigations. The results of the study showed highest salinity of 20.1% and the lowest salinity of 15.6% was recorded in May and March, 2012 respectively. These results agreed with earlier observations by Adetayo and Kusemiju (1984) and it was attributed to the fact that the water of Lagos Lagoon becomes very turbid and salinity is generally reduced during the rainy season. Salinity has long been considered as a major factor affecting survival and growth of the penaeid shrimp. Tabb et al., (1992) reported that juvenile Penaeids moved to escape unfavourable conditions like sudden reductions in water temperature and salinity. Joyce (1985) however stated that the young peneaids shrimps tolerate a wide salinity range (1‰ – 23‰) in the Lagos Lagoon. More specimens of peneaids shrimps were caught in the dry season while its occurrence was very low during the rains. The onset of the rainy season causes influx of the run-off water from the rivers and creeks and low salinity initiated the migration of the peneaids into the sea. Extensive movements of peneaids shrimps from the estuaries to the offshore grounds takes place as maturity approaches. Juvenile peneaids spent from 2-6 months in the nursery grounds before migrating offshore. Juvenile pink shrimp and giant tiger shrimps observed in this study spent 4-6 months and attained a mean carapace length 2.6cm and 3.7cm in the Lagos Lagoon before they migrate back to the sea. The regression co-efficient 'b' was lower than 3 in both species indicating that the penaeids shrimps population in the Lagoon exhibited a negative allometric growth. The values of combined sexes 'b' of *P. notialis* and *P. monodon* were 0.1799 and 0.2348 for males and 0.1576 and 0.2313 for females respectively. Also, *P. notialis* and *P. monodon* combined sexes have correlation values of 0.4354 and 0.6347 showing a high correlation between the length and width of the shrimp.

Pauly (1984) stated that there was no theory that says that the cases of 'b' values can be expected to be above or below 3. However, Wotton (1992) provides a rough idea on this situation, indicating that allometric growth is negative ($b<3$) if the fish gets relatively thinner as it grows larger, and positive ($b>3$) if it gets Plumber as it grows. Thus some indication of the condition of fish population can be obtained from the length-weight equation. Allometric growth has been observed in other *Macrobrachium* species as was the case of *M. macrobrachion* (3.28) from the Cross River esturay (Enin, 1994), and other shrimp and fish species, 2.92 for *Nematopalaemon hastatus* (Enin, 1994), 2.92 and 2.97 for *Penaeus notialis* and *P. monodon* respectively (Yakub and Ansa, 2007); and 2.84 for female *Clarias gariepinus* (Anyanwu, et al., 2007).

The condition factor (K) an indicator of the environmental suitability for the resource, varied with size and sexes of the shrimp in the population. The condition factor in male *P. monodon* specimen decreased with increasing total length while in the *P. notialis* male specimen condition factor was unstable. On the other hand the condition factor of female *P. monodon* samples was decreased with increasing total length while the condition factor of female *P. notialis* was decreased with increasing in total length. The K- value of combined sexes of *P. notialis* and *P. monodon* ranged between 0.42 to 0.65 with the mean value of 0.58 and 0.46 to 0.88 with mean value of 0.64 was lower than what was obtained for *M. macrobrachion* (1.19) by Enin (1994) in the Cross River estuary. Bendito - Cecilio et al., (1997) stated that the allometric growth exhibited in 52 fish species analysed proved the indispensability of allometric condition factor in Itaipu reservoir, Parana, Brazil. The condition factor(K) of the penaeids shrimp was lower than that obtained in crabs (Lawal- Are, 2006). The observed sex ratio obtained in *P. notialis* and *P. monodon* were 1: 0.27 for males and 1: 1.53 of females respectively. While the chi- square values at 1 d.f and 5% significant level was 129.96 and 17.64. This is in agreement with Kusemiju (1975) that reported that there was significant difference in sex ratio from the expected ratio of 1:1 in the population of pink shrimps off Lagos coast. Statistical analysis showed that there was a significant difference ($p < 0.05$) from the expected 1:1 ratio. The males were more than the females. The difference in sex ratio and reduced number of female specimen in sample may have been due to reproduction migratory pattern. This was also in contrast with the report of Adetayo and Kusemiju (1994). The variation of the stomach contents of penaeid shrimp showed that they are planktonvores feeding majorly on phytoplankton and the stomach content also showed predatory tendency. There was distinct difference in the food item fed upon by the two species. It was discovered that *P. monodon* fed majorly phytoplankton, crustacean, diatoms, filament

algae, debris and sand. In *P. notialis* examined showed that diatoms and filament algae constitutes the most important food items accounting for 48.94% and 18.66% by frequency of occurrence method respectively while the numerical method accounted for 20.10% and 7,20% respectively, *P. monodon* on the other hand showed that crustaceans and diatoms constitutes the most important food items accounting for 57.98% and 57.33% by frequency of occurrence method respectively while the numerical method accounted for 2.50% and 22.50% respectively. Result indicates that *P. monodon* is more of a predator, slow-moving benthic macro invertebrates other than a scavenger or detritus feeder. Feeding behaviour of *P. monodon* appears to be associated with the tidal phase. Feeding activity (determined from stomach fullness) of female shrimps is significantly higher than that of males. Generally, some empty stomachs were observed during the period of study; this could be due to the fact that the shrimps might have completely digested their ingested food material before they were captured. This could be attributed to the duration of the sampling periods prior to their feeding periods.

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