International Journal of Agricultural Sciences and Natural Resources
2014; 1(4): 81-87
Published online October 20, 2014 (http://www.aascit.org/journal/ijasnr)


**Keywords**
Pink Shrimp,
*Penaeus notialis*,
Lagos Lagoon

Received: August 30, 2014
Revised: October 08, 2014
Accepted: October 09, 2014

# Biology of the pink shrimp, *Penaeus notialis* (Perez-Farfante) in Lagos Lagoon, Nigeria

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## Citation
Adelugba Taiwo, Edah Bernard. Biology of the Pink Shrimp, *Penaeus notialis* (Perez-Farfante) in Lagos Lagoon, Nigeria. *International Journal of Agricultural Sciences and Natural Resources.* Vol. 1, No. 4, 2014, pp. 81-87.

## Abstract
Studies on some aspects of biology of the pink shrimp *Penaeus notialis* were analysed. 400 specimens of this shrimps, *P. notialis* were collected from Lagos Lagoon between February and May 2012, and examined with particular reference to size composition, growth pattern, distribution, sex, food and feeding habits. The mean and standard deviation of carapace length ranged from 2.583 ± 0.792 while the mean and standard deviation of total length and total weight ranged from 8.898 ± 1.042 and 4.237 ± 1.775 respectively. The shrimps exhibited a negative allometric growth for length-weight relationship. Condition factor (K) of the shrimp ranged from 0.51 to 0.69 and from 0.27 to 0.59 (male/female) respectively. Sex ratio obtained was 1:0.27. The food and feeding habit of *P. notialis* from the Lagos Lagoon showed that it fed majorly on crustaceans, diatoms, filamentous algae and plant materials. It was observed that filamentous algae, plankton, crustaceans and other plant materials were its most preferred food.

## 1. Introduction

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*., 2005). 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 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, Atlantic white shrimp and Indian prawn. Many prawns are the subject of commercial fishery, and farming, both in marine settings, and in freshwater farms. Lateral line-like sense organs on the antennae have been reported in some species of Penaeidae. At 210 metres per second (760 km/h), the myelinated giant interneurons of pelagic penaeid shrimp have the world record for impulse conduction speed in any animal. Penaeids include the widespread tropical and subtropical prawns of the genera *Fenneropenaeus*, *Penaeus* and *Metapenaeus* (Richmond, 2002). At least 19 species from seven genera occur in the western Indian Ocean region. The majority of the species occur over mud or sand bottoms in shallow coastal areas, with juveniles entering mangrove forests. Some portion of the life cycle is spent in the open ocean, resulting in the development of two fisheries: an artisanal

fishery, which centres on the capture of penaeids within estuaries and during migrations from the estuaries to the sea, and a larger-scale commercial trawling fishery in the deeper waters offshore (King, 1995).

*Penaeus notialis* (Perez-Farfante, 1969) is distributed along the West African coast from Mauritania to Angola (East Atlantic) and in the Greater Antillers from Cuba to the Virgin Islands and on the Atlantic coast of Middle and South America from South Mexico to Brazil. Penaid shrimps are found throughout the tropics, where they are one of the most valuable fishery resources, particularly in areas where conditions are favourable such as the Gulf of Mexico, some part of West Africa and in Southeast Asia from the West coast of India to the Gulf of Carpentaria (Garcia, 1988). Their order of importance in the inshore shrimp fishery of Nigeria is *Penaeus notialis, Parapenaeopsis atlantica, Parapenaeus longirostris*. Their economic importance has been described by (Adetayo and Kusemiju, 1994). The broad objective of this study is to describe the biology of the pink shrimp taking into account its growth pattern, size composition, food and feeding habits and sex ratio.

## 2. Materials and Method

### 2.1. 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).

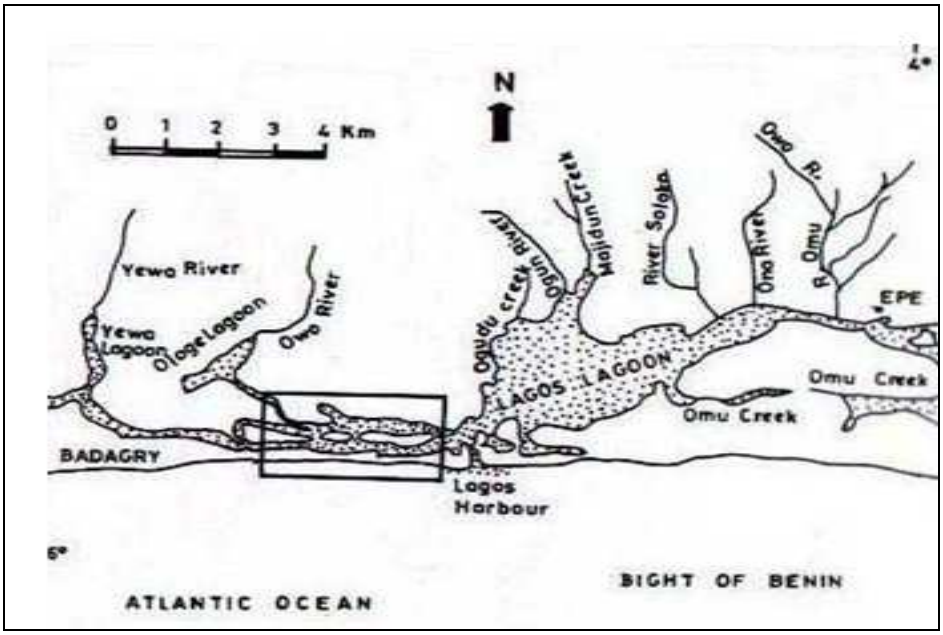


***Figure 1.*** *Map of Lagos Lagoon Source: - Adesalu and Nwankwo (2010).*

### 2.2. Collection of Specimens

Specimens of *Penaeus notialis* were caught from the Lagos Lagoon by artisanal fishermen using cast net.

Four hundred (400) specimens of the pink shrimps (*Penaeus notialis*) were collected between February and May 2012. 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.

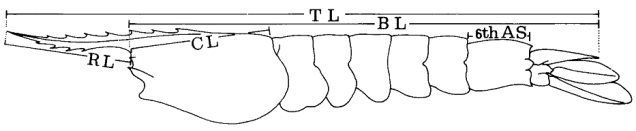


***Figure 2.*** *Method of measurement of P. notialis*

### 2.3. Laboratory Probe

The preserved shrimps were taken out of the deep freezer and allow to thaw. Excess water was removed from the specimen using tissue paper and lengths of each specimen were obtained using a measuring board while the weight of each specimen was determined by zeroing the weighing balance before the specimens were placed on it one after the other. All measurements obtained were recorded.

The samples 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 telsonto 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. (Penn, 1975a).

### 2.4. 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 $W = aL^b$

$$\text{Log } W = \text{Log } a + b \text{ Log } L \text{ (Parsons, 1988).}$$

Values of a, b and the correlation coefficient, r were obtained and recorded.

### 2.5. 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

$$K = \frac{100W}{L^b} \quad \text{(Pauly, 1984)}$$

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

Where K = condition factor, W = weight of the fish in grams (g), L= length of the fish in centimetres (cm). b = the value obtained from the length-weight

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

### 2.6. Stomach Analysis

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.

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. Each stomach was studied as a unit in order to provide information on individual variations.

### 2.7. 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.

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

Where $\chi^2$ = Chi-square to be calculated and compared with $\chi^2$ (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 et al 1994):

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

### 2.8. Statistical Analysis

All data resulting from the experiment were presented as means ± SD and analysed by one way analysis of variance (ANOVA) using the SPSS (statistical Package Computer, Software 2004 version Chicago Illinoise, USA).

## 3. Results

### 3.1. Morphometric Parameters

Results for mean values of morphometric parameters of *Penaeus notialis* off Lagos Lagoon is shown in Table 1 below

***Table 1.*** *Mean value of morphometric parameters of P.notialis in Lagos Lagoon from February – May, 2012.*

| Species | Mean± SD | | |
|---|---|---|---|
| | **Total Length (cm)** | **Carapace Length (cm)** | **Total Weight (g)** |
| *Penaeus notialis* | 8.898 ± 1.042 | 2.583± 0.792 | 4.237 ± 1.775 |

### 3.2. Monthly Catch, Size Composition and Length Frequency Distribution

400 shrimps of *Penaeus notialis* were examined in this study. The monthly catch of the pink shrimp is shown in Table 2 below. In catch, the females constituted 87 (21.8%) while the males were 341 (85.3%). 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 2.0- 2.4cm.

### 3.3. Carapace Length – Total Length Relationship

The carapace length of the females ranged between 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 scatter diagrams of the carapace length and total length and carapace weight against total length are illustrated in Figures 3, 4, 5, 6, 7, 8. The log carapace length and log total length relationship of *P. notialis* is illustrated in Figures 9. While, the total length and total weight relationship is represented in Figure 10 below.

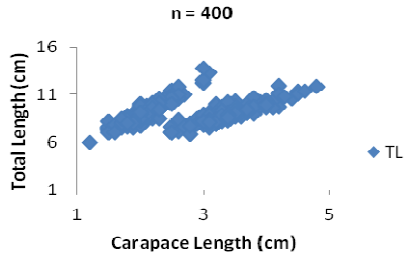


***Figure 3.*** *Carapace Length – Total Length of P. notialis (combined sexes) in Lagos Lagoon from February- May, 2012.*

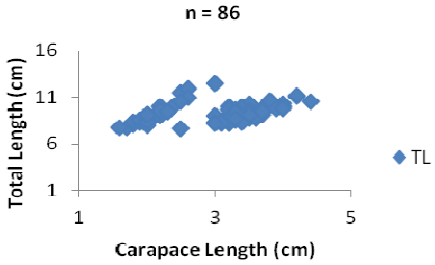


***Figure 4.*** *Carapace Length – Total Length of P. notialis (Females) in Lagos Lagoon from February- May, 2012.*

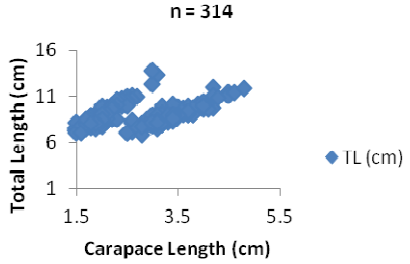


***Figure 5.*** *Carapace Length – Total Length of P. notialis (males) in Lagos Lagoon from February- May, 2012.*

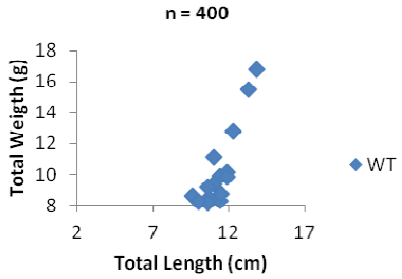


***Figure 6.*** *Total Length – Total Weight of P. notialis (combined sexes) in Lagos Lagoon from February- May, 2012.*

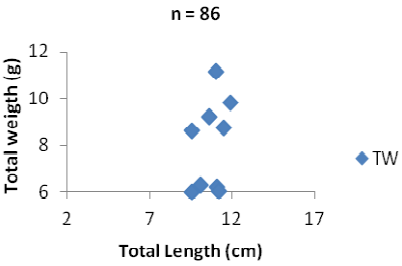


***Figure 7.*** *Total Length – Total Weight of P. notialis (females) in Lagos Lagoon from February- May, 2012.*

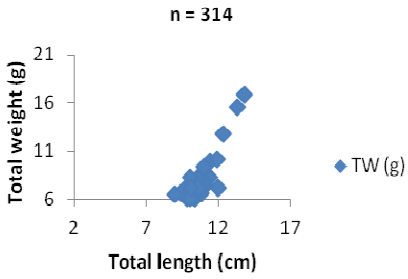


***Figure 8.*** *Total Length – Total Weight of P. notialis (males) in Lagos Lagoon from February- May, 2012.*

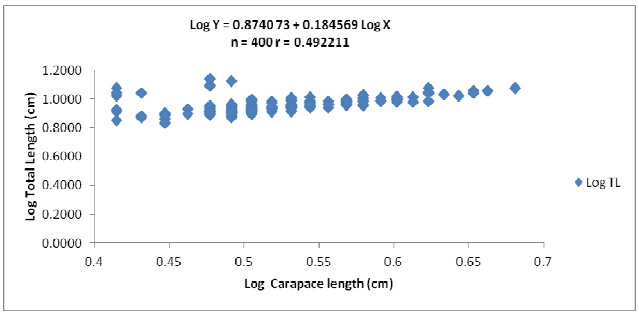


***Figure 9.*** *Scatter diagram showing Log carapace length – Log total length in P. notialis (combined sexes) in Lagos Lagoon.*

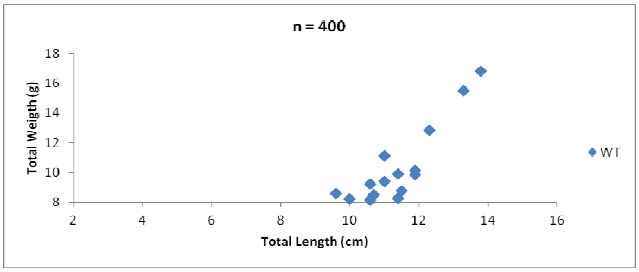


***Figure 10.*** *Total Length – Total Weight of P. notialis (combined sexes) in Lagos Lagoon from February- May, 2012.*

This relationship was determined using this formula:

$$\text{Log TL} = a + b \log CL$$

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:

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)

In 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.

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

| | ***Penaeus notialis*** | | |
|---|---|---|---|
| | **Males** | **Females** | **Total** |
| February, '12 | 69 | 31 | 100 |
| March, '12 | 88 | 12 | 100 |
| April, '12 | 75 | 25 | 100 |
| March, '12 | 82 | 18 | 100 |

## 3.4. The Total Length – Total Weight Relationship

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. The scatter diagrams of the log total length against log carapace length are illustrated in Figures 11, 12.

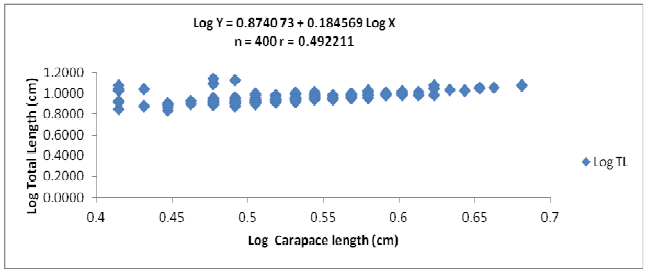


***Figure 11.*** *Scatter diagram showing Log carapace length – Log total length in P. notialis (combined sexes) in Lagos Lagoon.*

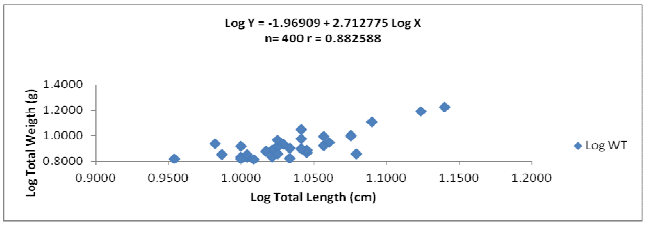


***Figure 12.*** *Scatter diagram showing Log Total Length – Log Total Weight in P. notialis (combined sexes) in Lagos Lagoon*

## 3.5. Condition Factor

The condition factor (k) which indicates the state or overall well-being of *Penaeus notialis* was calculated. 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.

## 3.6. Food and Feeding Habits

*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. Some crustaceans are found in their stomachs in form of fragments and accounted for 16.55% by frequency of occurrence and 5.10% in numeric value. Fish fragments also occurred in the stomach of the pink shrimps in form of eggs and bones accounting 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. The percentage frequency chat shown in Figure 13 bellow.

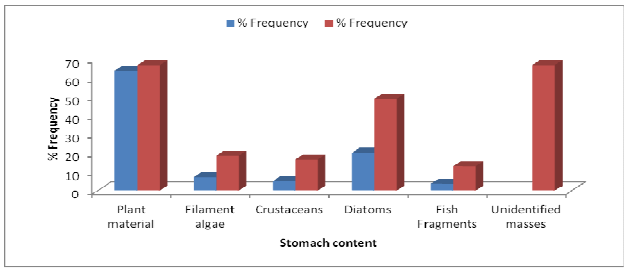


***Figure 13.*** *Summary of stomach content in P. notialis in Lagos Lagoon from February – May, 2012*

## 3.7. Sex Ratio

Out of the 400 species observed in *P. notialis*, 314 were males and 86 were females giving a sex ratio of 1: 0.27 (male/female). Chi – square ($\chi^2$) 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). 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 at ($p < 0.05$). 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.

## 4. Discussion

Juvenile peneaids spent from 2-6 months in the nursery grounds before migrating offshore. Juvenile pink shrimp observed in this study spent 4-6 months and attained a mean carapace length 2.6cm in the Lagos Lagoon before they migrate back to the sea. The regression co-efficient 'b' was lower than 3 in this species indicating that the penaeid shrimps population in the Lagoon exhibited a negative allometric growth. The value of sexes 'b' of *P. notialis* was 0.1799 for males and 0.1576 for females respectively. Also, the combined sexes had a correlation values of 0.4354 indicating 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 estuaray (Enin, 1998), and other shrimp and fish species, 2.92 for *Nematopalaemon hastatus* (Enin, 1994), 2.92 for *Penaeus notialis* (Yakub and Ansa, 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. Condition factor of *P. notialis* male specimen was unstable. condition factor of female *P. notialis* decreased with increasing in total length. The K- value of combined sexes of *P.notialis* ranged between 0.42 to 0.65 with the mean value of 0.58 which is lower than (1.19) obtained for *M. macrobrachion* 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 observed sex ratio obtained in *P. notialis* was 1: 0.27 of male and 1: 1.53 of female 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) who 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 from 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 it is planktonvores feeding majorly on phytoplankton and the stomach content also showed predatory tendency. Examined specimens showed that diatoms and filamentous algae constituted the most important food items accounting for 48.94% and 18.66% by frequency of occurrence method respectively while numerically it accounted for 20.10% and 7,20% respectively. Some empty stomachs were observed during the period of study, this could be due to complete digestion of food ingested before they were captured. In conclusion, this study revealed that the environmental conditions of *P. notialis* in the Lagos lagoon are not very favorable. This could be due to both biotic and abiotic factors which may include competition with other aquatic close relatives which share the same resources and also anthropogenic factors.

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