



Estimation of selected biological parameters of the Purple Mangrove Crab *Goniopsis pelii* (Herklots 1851) from a tropical mangrove swamp in Nigeria

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Abstract. The Purple Mangrove Crab, *Goniopsis pelii* is one of the more elusive crab species inhabiting most of the microhabitats in the mangrove ecosystem of Southern Nigeria. This study was carried out to investigate the size composition, growth pattern, diets, and reproductive biology of *G. pelii* from Abule-Eledu mangrove swamp in Lagos Lagoon, Nigeria. A total of 116 specimens were studied. Data revealed that the carapace length and total weight ranged from 2.5 to 4.9 cm (3.72 ± 0.39) and from 11 to 37 g (23.90 ± 4.21) respectively. The crab exhibited negative allometric growth pattern ($b < 3$), and the carapace length-weight relationship was positively correlated ($r = 0.577-0.900$). The condition factor (K) ranged from 3.5-8.0 (male), 3.2-7.5 (female) and 3.4-8.0 (sexes combined). The highest K-values were recorded for the smaller size group (2.5 - 2.9 cm). In terms of sex, the male has the higher K-value (8.0). Identified food particles included plant materials, algae, detritus, diatoms, and protozoa. The sex ratio was 1:0.57 (male: female), and was significantly different from the theoretical ratio of 1:1. Fecundity ranged between 1.9 and 2.8 million eggs with egg diameter ranging from 0.26 to 0.38 mm. Crabs with partial gonad development were predominant in the mangrove, while adults with fully ripe gonads were encountered occasionally throughout the study period. In this study, the reproductive indices and body conditions are indicators of a viable population.

Keywords: allometric growth, crab feeding, reproductive biology, Lagos Lagoon.

1 Introduction

Mangroves are salt-tolerant, characteristically complex plant communities occurring in sheltered coastline areas in the tropical and subtropical intertidal regions such as bays, estuaries, lagoons, and creeks (Venkataraman 2007). One of the more elusive crab species occurring in brackish water environments in Nigeria is the Purple Mangrove Crab (*Goniopsis pelii* Herklots, 1851), inhabiting almost every microhabitat in the mangrove ecosystems. The Purple Mangrove Crab populations are dependent on mangroves for shelter and food, hence any impact that significantly alters the



mangrove ecosystem may affect them. Although the mangrove crab does not really constitute a food item for the coastal communities, they play a major ecological role in the mangrove ecosystem through processing fallen leaves for feeding (Usese *et al.* 2018). In Nigeria, mangroves are threatened by anthropogenic activities such as pollution and dredging as well as natural phenomenon like sea level rise (Lawal-Are *et al.* 2019)

The Purple Mangrove Crab is a brightly colored crab, having a dark carapace with white spots, and hairy red legs with white or yellow spots. Female crab has a wide abdomen for egg storage, while males have thin abdomen covering the gonopods. Most mangrove crabs are amphibious in habit and can be found around the intertidal areas with moist/ wet muddier regions of the mangrove (Moruf and Lawal-Are 2018). Crabs are mainly opportunistic feeders, while some are scavengers with plant-derived detritus comprising the main food consumed. In common with other benthic detritus feeding invertebrates, crabs are not indifferent to cannibalism when kept in captivity and even in the wild (Hill and O'Keefe 1992). Generally, crabs retain the ability to eat different things but tend to be best adapted for particular diets. According to Feller and Sitnik (1996), mangrove crabs have been observed feeding on mangrove propagules, insects, and organic material with special affinity for a foraging existence. They will eat anything that gets washed upon shores or in mangrove such as algae, carrion, seaweeds, debris and anything small enough to be grasped with the chelae, because their chelae and gastric mill are non-specialized (Moruf and Ojetayo 2017). However, mangrove crabs might have been overlooked as they are certainly able to shred leaf litter very effectively (Dobson *et al.* 2002). This combined with the general abundance and high biomass makes them potentially important in the dynamics of energy resources in mangrove ecosystems (Hill and O'Keefe 1992).

Purple Mangrove Crab provides food for other species and reduces the insect population within the mangrove ecosystem. By eating the leaf litter and organic material around the mangrove roots, mangrove crabs contribute to nutrient cycling (Moruf and Ojetayo 2017). As little is known about the mangrove crabs of lagoon creeks in Lagos, this paper bears significance to provide baseline data on the biology of the Purple Mangrove Crab in the Abule-Eledu mangrove swamp of Lagos Lagoon, with particular emphasis on size composition, growth pattern, condition factor, feeding habits and reproductive biology.

2 Materials and Methods

2.1 Study site

The study was carried out in the mangrove swamp bordering the Abule-Eledu Creek (Figure 1), which forms part of the many sluggish tidal creeks that drain into the Lagos Lagoon, Nigeria (GPS coordinates: 60 31.015'N, 3023.948'E, elevation: 14ft (4.27m) above sea level.

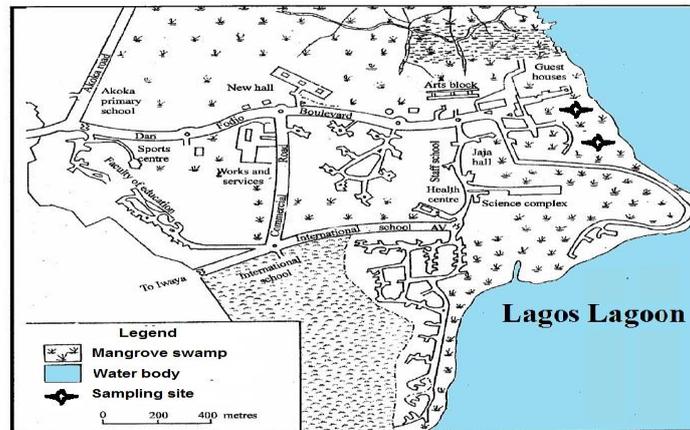


Fig. 1. Map of study location in mangrove swamps of Abule-Eledu Creek, Nigeria

2.2 Sample collection

Random sampling was carried out between 17.00 and 19.00 hours on monthly bases from March to July 2017. A total of 116 specimens of *G. pelii* (Figure 2) were caught from the mangrove swamps of Abule-Agege Creek using baited traps (Emmanuel 2009) and hand-picked using protective rubber gloves. Specimens were identified using published taxonomic keys (Schneider 1990) and immediately transported to the laboratory for further analysis.



Fig. 2. Purple Mangrove Crab (*Goniopsis pelii*) (collected from mangrove swamps of Abule-Eledu Creek, Nigeria)

2.3 Morphometric measurements

The length of the crab was measured to the nearest 0.1cm using a Vernier caliper and plotted against their respective frequencies. The total weight was measured in grams using Sartorius top loading balance (Model: DT1001A). The length-weight relationship of the crabs is represented using the equation (Pauly 1983) as follows:

$$W = aL^b$$

where, W= body weight (g), L= carapace length (cm), a= regression constant (intercept), and b= regression coefficient (slope).

The relationship was logarithm transformed into a straight-line (Parsons 1988) by

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

Condition factor (K) of each crab was determined using the formula (Bannister 1976) by,

$$K = 100 \times \left(\frac{W}{L^b}\right)$$

2.4 Stomach content analysis

The cardiac stomach of each specimen was dissected, and the contents were extracted into a petri dish. The extracted contents were mixed with a little water and examined under a binocular microscope for the food types using the numerical and occurrence methods (Cortés 1998).

2.5 Reproductive biology

The sex was distinguished using the species conspicuous external morphological features, i.e. T-shaped abdomen of the male and the triangular or rounded aprons of the female (Schneider 1990). Sex ratio was tested for any deviation from the expected 1:1 ratio using Chi-square analysis. In fecund females, egg mass attached to the underside of the abdomen was removed for fecundity estimation. Fecundity was calculated as the number of eggs carried externally by the female. It was estimated by the gravimetric method (Kumar *et al.* 2000) from the ovaries at Stage III. The diameters of eggs per berried females (sub sample) were measured using an ocular micrometer. Gonadal development was determined using the criteria of Lawal-Are (2010) given below:

Stage I:	No gonad development
Stage II:	Partial gonad development
Stage III:	Gonads extending in carapace, which are orange in colour
Stage IV:	Ripe running bright red gonads

2.6 Data analysis

Data were analyzed using Microsoft Excel 2010 and SPSS software. Test for goodness of fit was determined statistically using chi-square (χ^2) test on sex ratios of the species.

3 Results and Discussion

3.1 Size composition

Amongst mangrove macrobenthos, crabs are one of the most significant groups in terms of species, numbers and total biomass. Monthly abundance of *G. pelii* revealed

that the highest occurrence was at the onset of wet season with 23.3 % in May, while the lowest number was recorded in July 2017 (Figure 3).

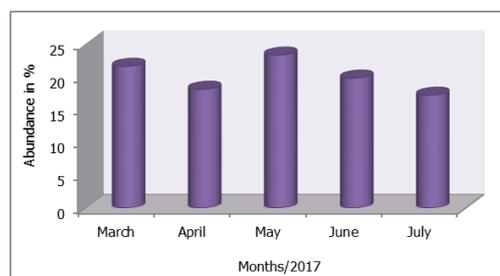


Fig. 3. Monthly collection of *G. pelii* (N= 116) from the mangrove swamp of Abule-Eledu Creek, Lagos Lagoon

The crabs with carapace length between 3.50 cm and 3.90 cm was the most frequently occurring size group, with the length frequency polygon showing a unimodal size distribution during the sampling period (Figure 4). This report conformed to the work of Onadeko *et al.* (2015) on brachyuran crabs of the same study area, which showed the highest abundance in May of the year.

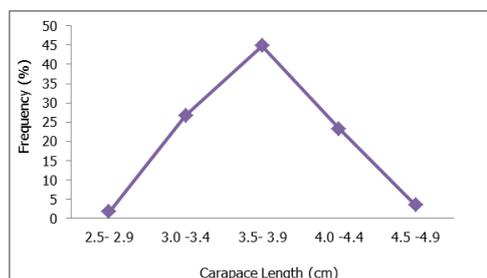


Fig. 4. Carapace length frequency distribution of *G. pelii* (N= 116) from the mangrove swamp of Abule-Eledu Creek (March- July 2017)

3.2 Growth pattern

The growth pattern of the crabs was based on the length/weight relationship. The carapace length was between 2.5 and 4.9 cm and total weight between 11 and 37 g. The carapace length-total weight of the crabs was transformed into a logarithm form as shown below:

Male <i>G. pelii</i> :	$\text{Log TW} = 0.5299 + 1.4271 \text{ Log CL}$
Female <i>G. pelii</i> :	$\text{Log TW} = 0.649 + 1.1988 \text{ Log CL}$
Combined sexes:	$\text{Log TW} = 0.148 + 2.1217 \text{ Log CL}$

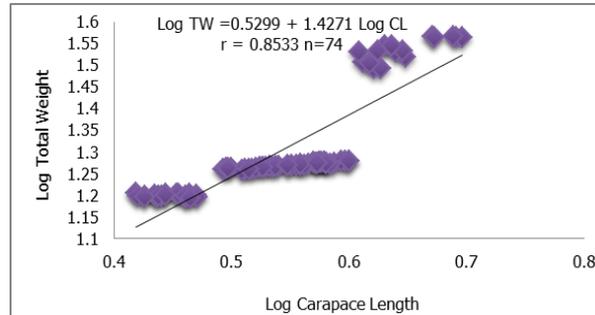


Fig. 5. Relationship of Log carapace length/Log Total Weight of male *G. pelii* from mangrove swamp of Abule-Eledu Creek (March - July 2017)

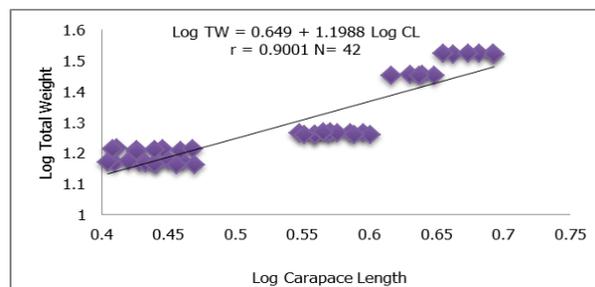


Fig. 6. Relationship of Log carapace length/Log Total Weight of female *G. pelii* from mangrove swamp of Abule-Eledu Creek (March - July 2017)

According to Figures 5, 6, and 7, the values of 'b' were 1.4271, 1.1988 and 2.1217 for the males, females and combined sexes respectively. These values showed that *G. pelii* exhibited a negative allometric growth pattern ($b < 3$). The correlation coefficient (r) was 0.8533 for the males, while 0.9001 for females and 0.5773 for combined sexes of *G. pelii*, showing correlation between the carapace length and weight.

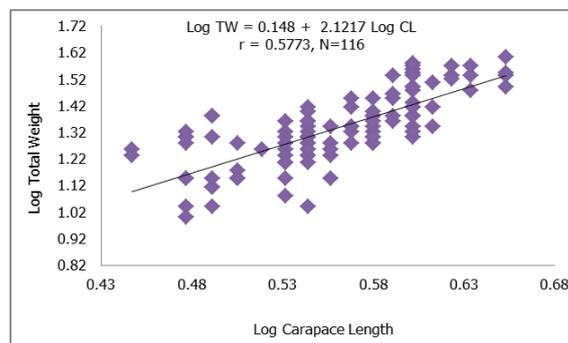


Fig. 7. Relationship of Log carapace length/Log Total Weight of *G. pelii* from the mangrove swamp of Abule-Eledu Creek (March - July 2017)

The relationships between the length and weight suggest that the crab weight could be estimated from its length regardless of the developmental stages. Another co-occurring mangrove crab, the Hairy Mangrove Crab, *Sersema huzardii* shows positive relationships between length and weight (Lawal-Are and Nwankwo 2011). Similarly, Moruf and Lawal-Are (2017a) reported a positive correlation for portunid crabs of Lagos Coast, suggesting that the higher the carapace length the more weight an individual possesses.

3.3 Condition factor

The variations in condition factor (K) by size and sex of *G. pelii* from the Abule-Agege Mangrove Swamp are presented in Table 1. The K-values ranged from 3.5- 8.0 (male), 3.2 -7.5 (female) and 3.4 - 8.0 (combined sexes). The highest K-values were recorded for the small size (2.5-2.9 cm) group, while in terms of sex; the male had the higher K-value (8.0).

Table 1: Condition factor by sex and size of *Goniopsis pelii*.

Carapace length (cm)	Male				Female				Combined Sex			
	N	CL (cm)	W (g)	K	N	CL (cm)	W (g)	K	N	CL (cm)	W (g)	K
2.5- 2.9	18	2.7	15.7	8	11	2.7	14.8	7.5	2	2.7	15.7	8
3.0-3.4	16	3.1	18.2	6.1	8	2.9	16.2	6.6	31	3.1	17.5	5.9
3.5- 3.9	24	3.7	18.8	3.7	12	3.5	18.2	4.3	52	3.7	18.6	3.7
4.0-4.4	11	4.2	33	4.5	5	4.2	28.2	3.8	27	4.2	30.7	4.1
4.5-4.9	5	4.7	36.6	3.5	6	4.7	33.4	3.2	4	4.7	35	3.4
	74				42				116			

N = Number of crabs, CL = Carapace length, W = Total weight, K = condition factor

In studies of population dynamics, high 'k' values of a crab show favorable environmental conditions such as habitat and prey availability. It was observed from this study that the small - sized group had the highest condition factors, indicating successive growth as a result of molting activity. The older the crab, the more difficult it is for the crab to molt. On the average, the condition factors of the male *G. pelii* were higher than that of its female.

3.4 Stomach contents

Of the 116 examined specimens of *G. pelii*, 14 (12%) of these had empty stomachs. The stomach contents consisted mainly of plant materials, filamentous algae, detritus, diatoms and protozoa. Plant materials showed the highest numerical count (50.1%) and formed the most important food item, occurring in 97.1% of the crabs examined. Diatoms and detritus occurred in 92.2% and 85.3% of the stomachs respectively (Figure 8). *G. pelii* can be considered as herbivore-scavenger species as its diet contained a wide range of plant materials, filamentous algae, detritus, diatoms and protozoa. Except for protozoa, the broad spectrum of the food items ingested by *G.*

pelii is of plant-origin while detritus is regarded as debris of any kind. This report is similar to what was recorded by Eteobong *et al.* (2016) on diet composition of *G. pelii* from South West Nigeria. The feeding habits of mangrove crabs play a vital role in the preservation of wetland environments by sifting through the sands, and they aerate the substrate and prevent anaerobic conditions.

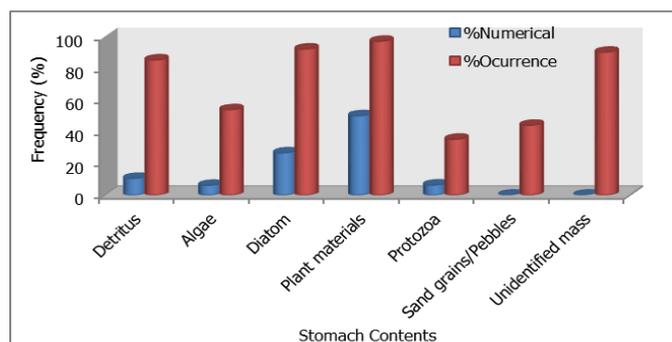


Fig. 8. Stomach content of *G. pelii* from the mangrove swamp of Abule-Eledu Creek

3.5 Reproductive biology

A total of 74 males and 42 females of *G. pelii* were examined giving a sex ratio of 1:0.57 (male: female) which was significantly different ($P < 0.05$) from the expected and theoretical ratio of 1:1. This is in contrary to the report of Eteobong *et al.* (2017) who reported more female than male *G. pelii* in Lagos Lagoon. Environment factors can influence the sex ratio of aquatic organism either directly or indirectly (Moruf *et al.* 2018)

Fecundity was determined using 18 mature females (3.6- 4.9 cm carapace length and 18.6-35.0 g weight) obtained only during the months of March and April. The fecundity ranged from 1.9 to 2.8 million eggs with egg diameter ranging between 0.26 and 0.38 mm. Crablets with partial gonad development (Stage II) were predominant in the mangrove while ripe males and females (Stage IV) occurred occasionally throughout the study period (Table 2).

Table 2: Percentage occurrence of different maturity stages of gonads of *G. pelii* from the mangrove swamp of Abule-Eledu Creek (March – July 2017).

Gonad Stages	Male		Female	
	Number	% occurrence	Number	% occurrence
Stage I	6	8.1	4	9.5
Stage II	41	55.4	20	47.6
Stage III	25	33.8	16	38.1
Stage IV	2	2.7	2	4.8
Total	74		42	

Fecundity in *G. pelii* was low when compared with what was reported in brachyuran species like *Callinectes sapidus* (mean of 3.2 million eggs) (Guillory *et al.* 1996) and *Portunus validus* (mean of 3 million eggs) (Moruf and Lawal-Are 2017b). According to Shields *et al.* (1990), variations in fecundity in crab might be caused by several ecological factors including habitat and biological constraints. The egg diameter of *G. pelii* ranged from 0.26 to 0.38mm with a mean of 0.30mm. This result compared well with a study on a different species of estuarine crab, by Lawal-Are (2010) who reported an egg diameter range of 0.25 to 0.35mm with a mean of 0.25mm for *Callinectes amnicola* in the Lagos Lagoon.

4 Conclusions

Goniopsis pelii exhibits sexual dimorphism with males attaining larger sizes than females. As revealed by allometric growth, the crab weight can be estimated from its length. Reproductive biology and conditions of the species are indicators of viable population. The present study has provided baseline data which will serve as a useful source of information in the management and conservation of mangrove ecosystem resources. Further studies could assess reproductive activity using macroscopic and microscopic observations of gonad characteristics, trends of gonad indices, size at first sexual maturity, differences in the monthly sex ratio, estimation of Gonado-somatic Index etc.

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