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Biodiversity of a Mangrove Swamp Ecosystem: Size Composition and Growth Pattern of Land Crabs as an Ecological Indicator

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Abstract

Samples of *Cardisoma armatum* and *Cardisoma guanhumi* collected from the Lagos Lagoon mangrove area of the University of Lagos and were studied for their size composition and growth pattern, also a comparative analysis was done on both crabs. The carapace length of *Cardisoma armatum* and *Cardisoma guanhumi* examined ranged from 2.50 cm to 9.30 cm and 2.50 cm to 9.20 cm respectively while their carapace-width examined ranged from 2.70 cm to 9.40 cm and 2.80 cm to 9.40 cm respectively. The total weight of the *Cardisoma armatum* ranged between 96.00 g and 290.00 g while *Cardisoma guanhumi* ranged between 4.70 g and 295.00 g. The carapace length-total weight relationship of the two crabs showed low correlation value of 0.3378 and 0.2113 respectively. The Statistical t-test between right and left chelipeds variation and between the carapace length and carapace width of *Cardisoma armatum* and *Cardisoma guanhumi* showed that there was no statistical significance ($p>0.05$) between carapace length of both crabs, there was statistical significance ($p<0.05$) between carapace weight of both crabs collected in February, March, June and July. There was statistical significance ($p<0.05$) between the right and left chelipeds of the both crabs. This research study indicates almost similar biological features for both species.

Keywords: Crustacean; Size composition; Length-weight relationship; Mangrove ecosystem; Marine ecosystem

Introduction

Crabs belong to the brachyuran infraorder family comprising more than 6,793 species peculiarly known for their ten legged creature (decapod) [1]. Crabs have flourish to be a predominant icon in the invertebrate fauna because of its ubiquitoes existence in almost all part of the world oceans including freshwater, marine even on land [2], caught in marine, coastal and lagoon fishery [3]. In Nigeria, *Geryon maritae* (deep water crab), *Ocypode africana* (ghost crab), *Goniopsis pelii,* and *Sesarma sp.* (mangrove crabs), *Uca tangerii* (fiddler crabs), *Callinectes latimanus, C. amnicola, C. pallidus* and *C. marginatus* (swimming crabs), *Cardiosoma armatum* and *Gecarcinus weileri* (land crabs) are common crab species found in brackish and marine environments [4].

The mangrove crabs have been found in mangrove habitat of the Lagos Lagoon, which have been subjected to reclamation by anthropogenic activities, however it has played ecological role in the mangrove ecosystem where it has helped to clean up the mangrove areas by its feeding habits on the fallen leaves [5]. Land crabs are omnivorous [6].

Cardiosoma is a genus of Land crabs. Young individuals are often very colorful with a purple-blue Carapace and orange-red legs and exibit colour change as old age is reached [7]. There have been difficulties in the classification of these two crabs. The aims of this research are to provide baseline data on distribution, abundance and length-weight relationships in order make comparison of population differences based on morphological analyses of the two crabs species: *Cardiosoma armatum* [8] and *Cardiosoma guanhumi*.

Materials and Methods

The study site for this project is the coastal/Mangrove area of University of Lagos Lagoon front which is located opposite the Lagos Lagoon, the geographical platform of 6° 26'N and 6° 39'N and longitude 3° 29'E and 3° 50'E (Figure 1). The lagoon is the largest of the four lagoon systems of Gulf of Guinea and is located at south western Nigeria. The mangrove swamp connects to the Lagos lagoon by tidal creek.

Crabs species were collected at the mangrove part of Lagos Lagoon along University of Lagos. They were caught with hand between 7pm and 11pm to allow for precise readings and analysis of the samples. The collection was done randomly and was collected over a period of six months on weekly bases between February and July, 2012. The crabs were collected at two different stations within the mangrove swamp. A total of 858 crabs were collected from the site and were preserved immediately in a deep freezer in the laboratory prior to examination.

The crabs were removed from the freezer and allowed to thaw. Excess water was removed from the specimens using filter paper. The carapace length of the crab was measured using a simple vernier caliper. The carapace width was also. Total weight, weight of left and right chelipeds were measured to the nearest tenth of a gram using Sartorious Top Loading Balance (Model 1106); the results were recorded in a proformer for each specimen before dissection. Each crab was dissected by removing the carapace and the stomach transferred into a Petri-dish containing little water. The stomach content was then poured into a small bottle and 4% formalin was added for preservation and labeled. The stomach contents were later examined under the microscope and the various food items identified and counted individually.

The relationship between the carapace length-frequency distribution was established for each month and the cumulative (summary for the six months) worked out. Specimens were collected randomly in each of the six months. The crabs were examined to obtain their size composition and abundance.

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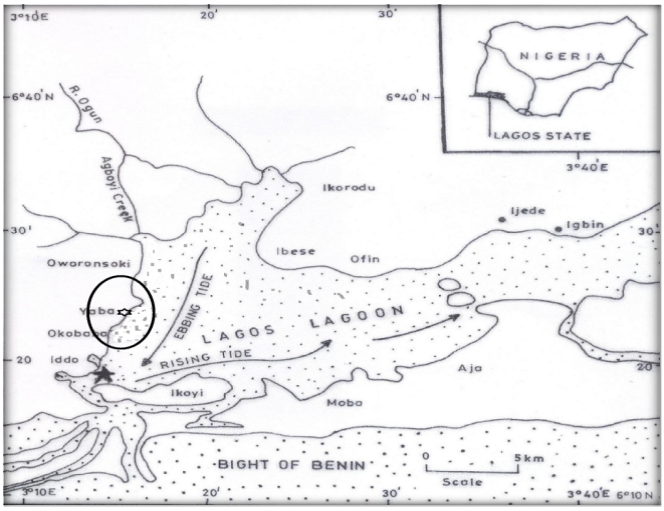


Figure 1: Map showing the sampling location.

For the growth pattern, data for the carapace length-weight relationship and carapace width – weight relationship were compiled. The carapace length-weight relationship was expressed by the equation:

$W = aL^b$

Where W = weight of crabs in grams.

L = length of the carapace in cm.

a = regression constant.

b = regression coefficient.

The equation was transformed to a linear relationship as

Log Wt = Log a + b Log L

Scatter diagram of log weight – log length were plotted to illustrate these relationships.

The invert relationship was obtained using the equation below as reported by Barnes, 2001.

Y = a + bx

Where: Y = Fecundity estimate

X = Carapace width (cm)/weight (g)

a = Regression constant

b = Regression coefficient

Results

Size Composition of *Cardiosoma armatum* and *Cardiosoma guahunmi*

418 and 440 specimens of *Cardiosoma armatum* (Figure 2) and *Cardiosoma guanhumi* (Figure 3) (Tables 1-3) were studied respectively making a total of 858 species of crabs collected and studied. The specimens were studied for the length and width frequency distributions between the months of February to July, 2012. The carapace length of *Cardiosoma armatum* and *Cardiosoma guanhumi* examined ranged from 2.50 cm to 9.30 cm and 2.50 cm to 9.20 cm respectively while their carapace width were examined ranging from 2.70 cm to 9.40 cm and 2.80 cm to 9.40 cm respectively. The largest specimen of *Cardiosoma armatum* and *Cardiosoma guanhumi* weighed 290.00g and 295.00g respectively. While the smallest collected in the same month weighed 9.60 g and 4.70 g.

They were studied for length and width frequency distributions, frequency distribution between February – July, 2012 (Figures 4-7). The carapace length frequency polygon of *Cardiosoma armatum* and *Cardiosoma guanhumi* showed distinct size groups. The size group 6.5-7.4 cm was abundant with 25% for and 28.7% for *Cardiosoma armatum* and *Cardiosoma guanhumi* respectively.

Growth Pattern of *Cardiosoma armatum* and *Cardiosoma guahunmi*

The total weight of the *Cardiosoma armatum* ranged between 96.00 g and 290.00 g while *Cardiosoma guanhumi* 4.70 g and 295.00 g were for the combined sex, the carapace length of *Cardiosoma guanhumi* ranges between 2.80 cm to 9.40 cm and carapace length of the *Cardiosoma armatum* ranges from 2.70 cm and 9.40 cm for the combined sex (Figures 8-11). This result showed increase in length with increase in weight.

The carapace length-total weight of the two crabs was transformed into a logarithm form. The Log length - Log weight relationship showed a linear relationship between the length and weight of the crab. This carapace length-Total weight relationship was determined using the formula below:

Figure 2: *Cardiosoma armatum*.

Month	Number Collected					
	Cardiosoma armatum			*Cardiosoma guanhumi*		
	Female	Male	Total	Female	Male	Total
February	26	30	56	24	36	60
March	29	33	62	34	41	75
April	33	37	70	27	34	61
May	31	38	69	41	37	78
June	39	39	78	40	40	80
July	39	44	83	39	47	86
Total	197	221	418	205	235	440

Table 1: Monthly Collection of and from Lagos Lagoon mangrove swamps (February-July, 2012).

Carace length	Frequency	%	Frequency	%
2.5-3.4	20	4.8	5	1.1
3.5-4.4	51	12.2	34	7.7
4.5-5.4	59	14.1	78	17.7
5.5-6.4	93	22.2	115	26.1
6.5-7.4	120	28.7	118	26.8
7.5-8.4	63	15.1	68	15.5
8.5-9.4	12	2.9	22	5.0
Total	418	100.0	440	100.0

Table 2: Carapace Length Frequency Distribution and from the Lagos Lagoon mangrove swamps (February, July, 2012).

Carapace width	Frequency %			
2.5-3.4	43	10.3	12	2.7
3.5-4.4	49	11.7	39	8.9
4.5-5.4	55	13.2	87	19.8
5.5-6.4	111	26.6	126	28.6
6.5-7.4	108	25.8	110	25.0
7.5-8.4	44	10.5	48	10.9
8.5-9.4	8	1.9	18	4.1
Total	418	100.0	440	100.0

Table 3: Carapace width Frequency Distribution of and from the Lagos Lagoon mangrove swamps (February-July, 2012).

Figure 3: *Cardiosoma guanhumi.*

Log TW = a + b Log CL

Where, W = Total weight of crab in grams (g)

CL = Carapace length of crab in grams (cm)

a = regression constant

b = regression coefficient

The value of length – weight relationship for *C. armatum* and *C. guanhumi* are given as follows;

The Total length – weight relationship for *Cardiosoma armatum* of the least square common fit of the transformed data got the following linear equation.

Female: Log TW = 1.7744 + 0.4573 Log CL (r = 0.3384, n = 197)

Male: Log TW = 1.9786 + 0.2205 Log CL (r = 0.2646, n = 221)

Combined (sex): Log TW = 1.8777 + 0.3378 Log CL (r = 0.2046, n = 418)

The values of b were less than 3 in both sexes of *Cardiosoma armatum* which also indicated a positive isometric growth. The values were 0.4573, 0.2205 and 0.3378 for male, females and combined sexes respectively.

The carapace length – weight relationship for *Cardiosoma guanhumi* of the least square common fit of the transformed data gave the following linear equation;

Female: Log TW = 1.9999 + 0.1038 log CL (r = 0.0266, n = 205)

Male = Log TW = 1.9327 + 0.2134 log CL (r = 0.0590, n = 235)

Combined sex = Log TW = 1.9095 +0.21125 log CL (r = 0.0577, n = 440)

Statistical analysis of *Cardiosoma armatum* and *Cardiosoma auahunmi*

T-test statistical analysis was conducted; there is no statistical significance for carapace weight of Cardiosoma armatum and *Cardiosoma guanhunmi* and collected in April and May respectively. No statistical significance was observed for the Carapace left chelae of *Cardiosoma armatum* and *Cardiosoma guanhunmi* and for the month of February. The statistical t-test analysis for the carapace right chelae of and for the month of March and May are not statistically significant (Tables 4-7).

Discussion and Conclusion

Size frequency was presented by Lawal-Are and Nwankwo [3] for Hairy Mangrove Crab, *Sersema huzardii* while Akin-oriola [2] also reported the Maximum carapace length of 6.0 cm in and 7.0 cm in *Cardiosoma armatum* and 7.0 cm in *Callinectes pallidus* respectively from Badagry creek. There was only one predominant generation of crabs sampled and the specimens belonged to the same year of class in this case, in their first year of life.

It was observed that there was very low distribution in the 8.5-9.4 cm (1.9%) of *Cardiosoma armatum*, which was contrast to Hartnoll [9], on mangrove crab of *Johngarthria lagostoma* in the size 90-80 cm size group. The ranges in the data obtained were due to the collection methods of the crabs, differences in the habitat terrain and topography of the area.

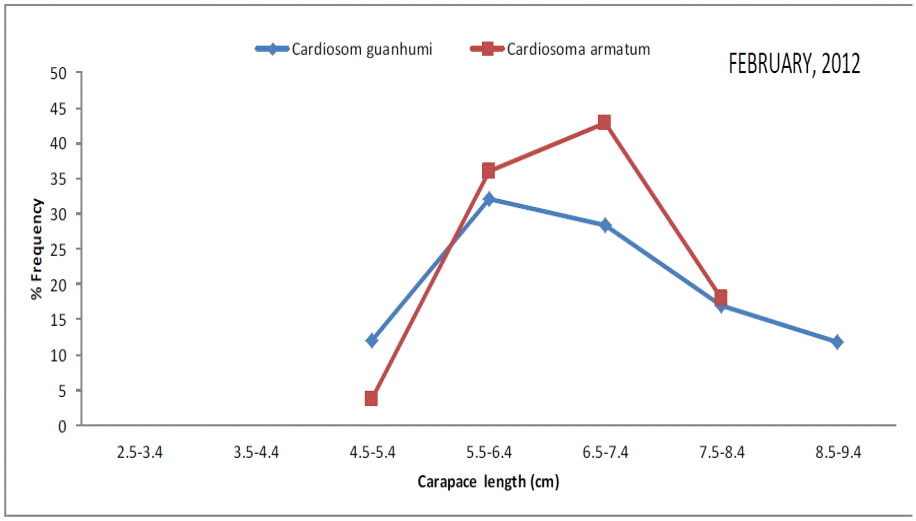
The monthly distribution of the two crabs *Cardiosoma armatum* and *Cardiosoma guanhumi* and for the month of July showed greater distribution pattern with 83 in July, 2012 for *Cardiosoma armatum* and 86 in July, 2012 for *Cardiosoma armatum* respectively, these conformed to the work of Akin-oriola [2] where the increase in number of crabs caught in June and July and the size group of 4.0-4.9cm showed the highest distribution pattern in May, September and November.

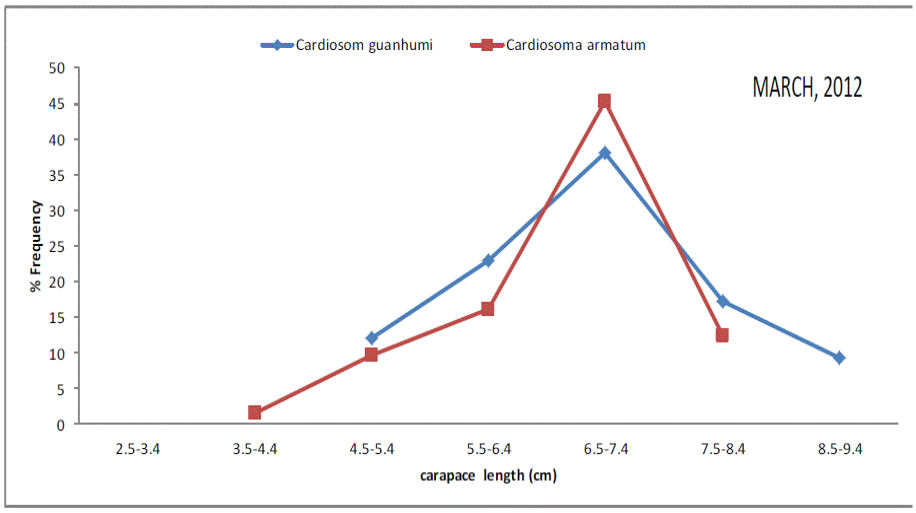
Cardiosoma armatum in the Gulf of Guinea showed a maximum carapace length of 9.5, Akin-oriola [2] this is in agreement with the present study which also conform with the work of Atar [3,10]. The logarithmic form of carapace length–weight relationship of both crab species showed low b value *Cardiosoma armatum* showed a positive isometric growth with values 0.4573, 0.2205 and 0.3378 for male, female and combined sexes respectively while length-weight relationship for *Cardiosoma guanhumi* was 0.1038, 0.2134 and 0.2113 for male, female and combined sexes respectively, this value are supported by Turner [11].

However females of both crabs showed a lower b value of 0.2205 and 0.2113 for *Cardiosoma armatum* and *Cardiosoma guanhumi* respectively, this is scientifically attributed to the slower rate of growth of female crabs and the great amount of energy invested in the reproductive process at the expenses of growth by females [11]. Observations of higher b value of *Cardiosoma armatum* over *Cardiosoma guanhumi* were linked to the higher population and standing stock biomass and condition indices [11].

The overall low symmetrical or isometric growth of b values was less than 3 and its due to the recruitment stock in biomass which is invariably due to the peculiarity of coastal dwelling land crabs to show irregular recruitment pattern with uncertainty of returning to a small land mass after the planktonic Laval phase [12].

The condition factor for the *Cardiosoma armatum* and *Cardiosoma guanhumi*, and has a high k values for both crabs respectively, though *Cardiosoma guanhumi* had a higher condition factor k than *Cardiosoma armatum*, this is obviously related to the relative difference in habitat condition and adequate prey inclusion. This is supported by the works of Lawal-Are [3] with k-values of *Sersema huzadii* from a tropical estuarine lagoon.





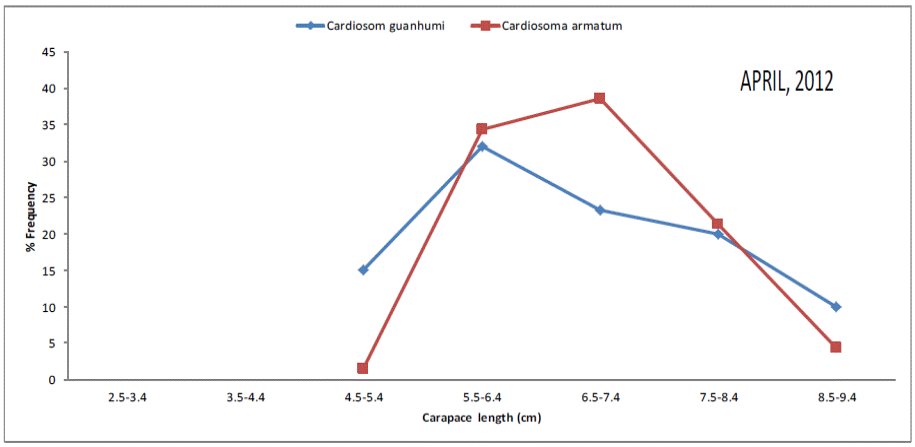
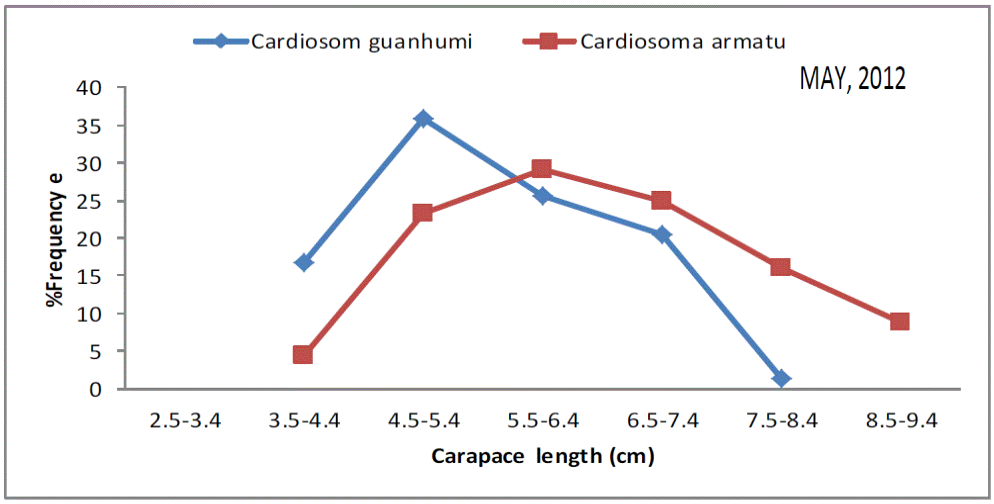
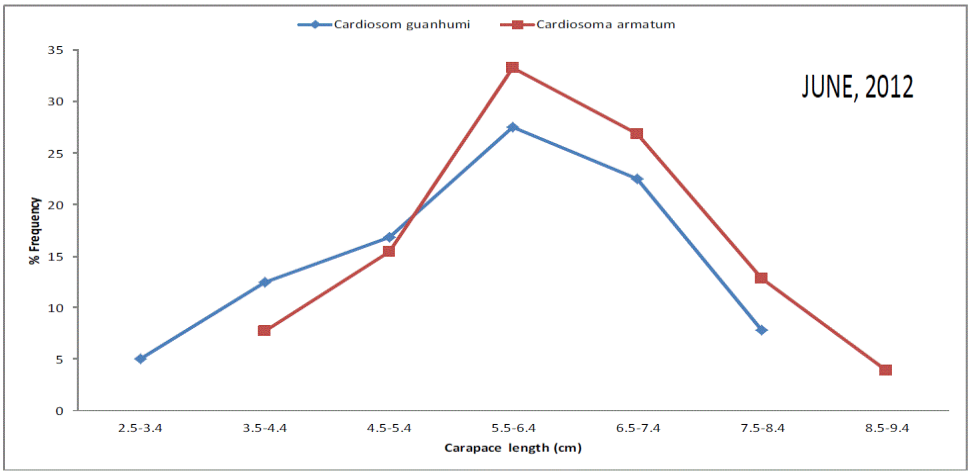


Figure 4: Monthly Carapace length frequency distribution of Male *Cardiosoma armatum.*





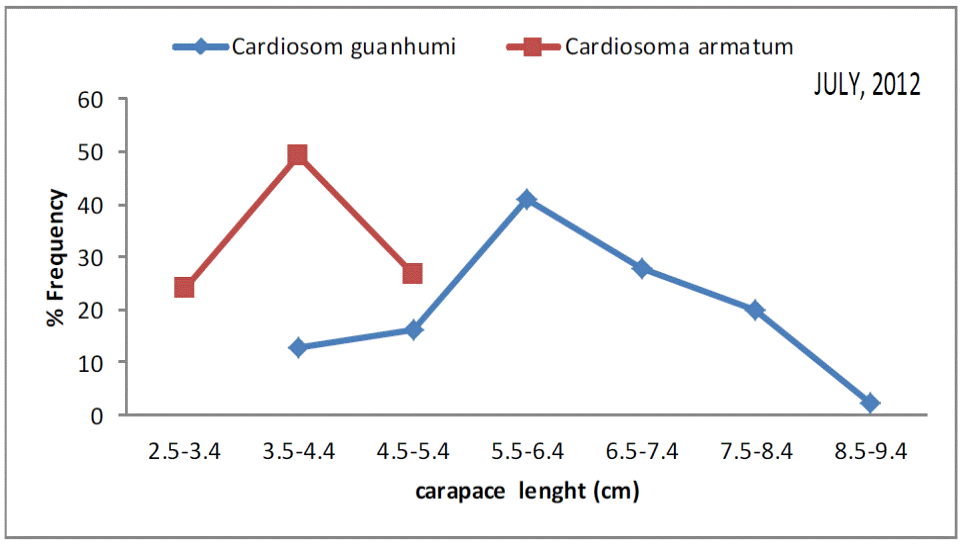


Figure 5: Monthly Carapace length frequency distribution of Male *Cardiosoma armatum* and Male *Cardiosoma guahunmi* from Lagos Lagoon mangrove swamps (May- July, 2012).

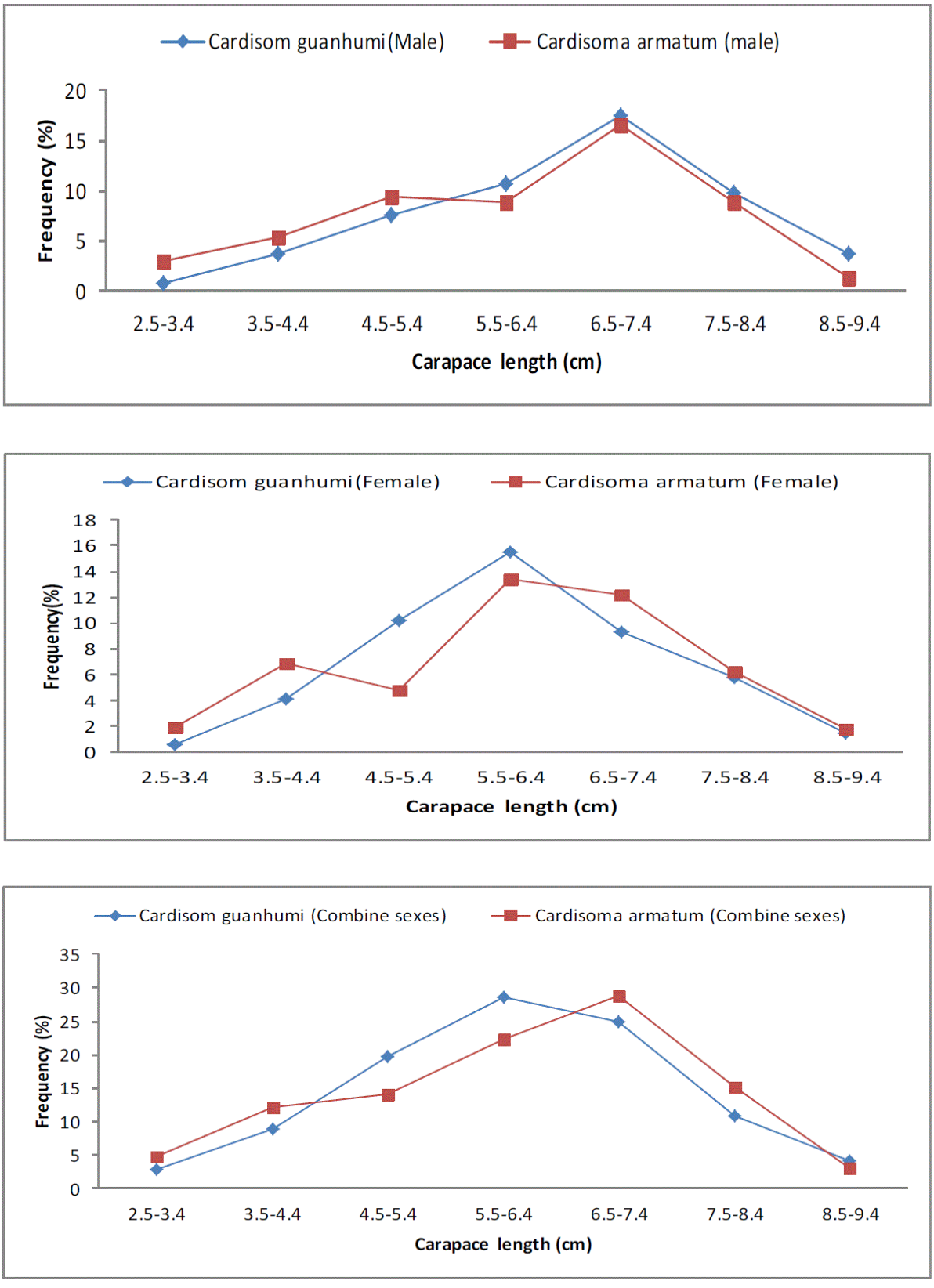
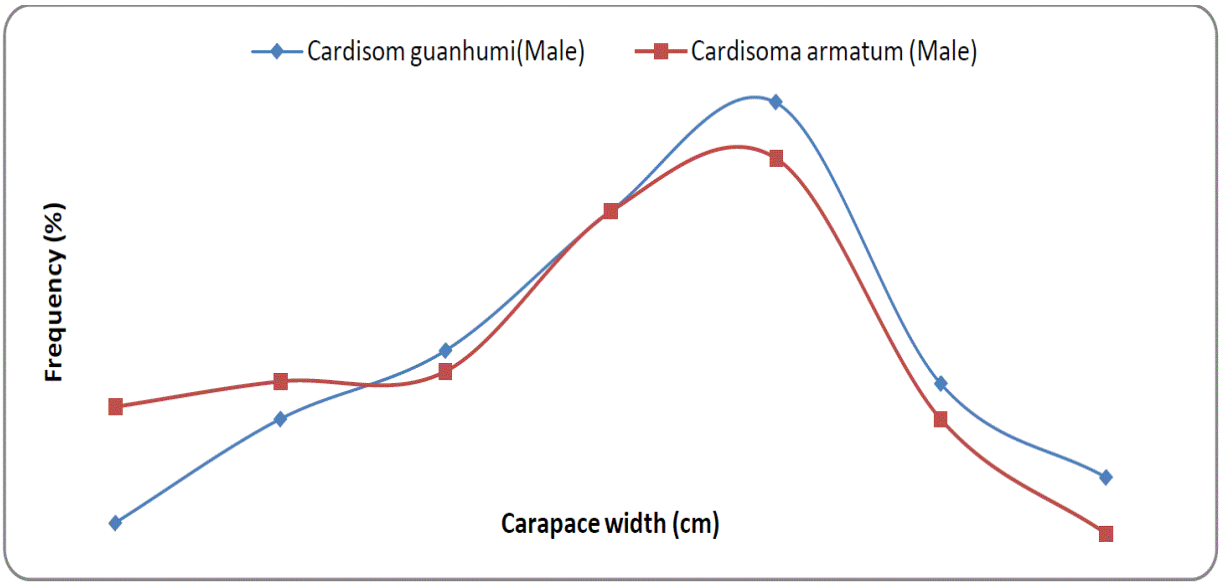
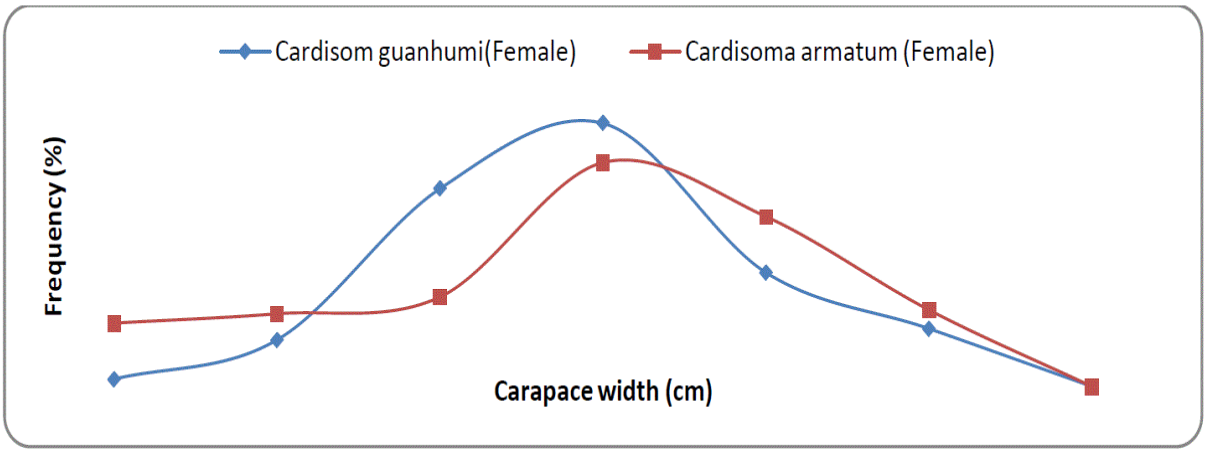


Figure 6: Carapace length frequency distribution of Male, Female and combined sexes of *Cardiosoma armatum* and *Cardiosoma guahunmi* from Lagos Lagoon mangrove swamps (February- July, 2012).





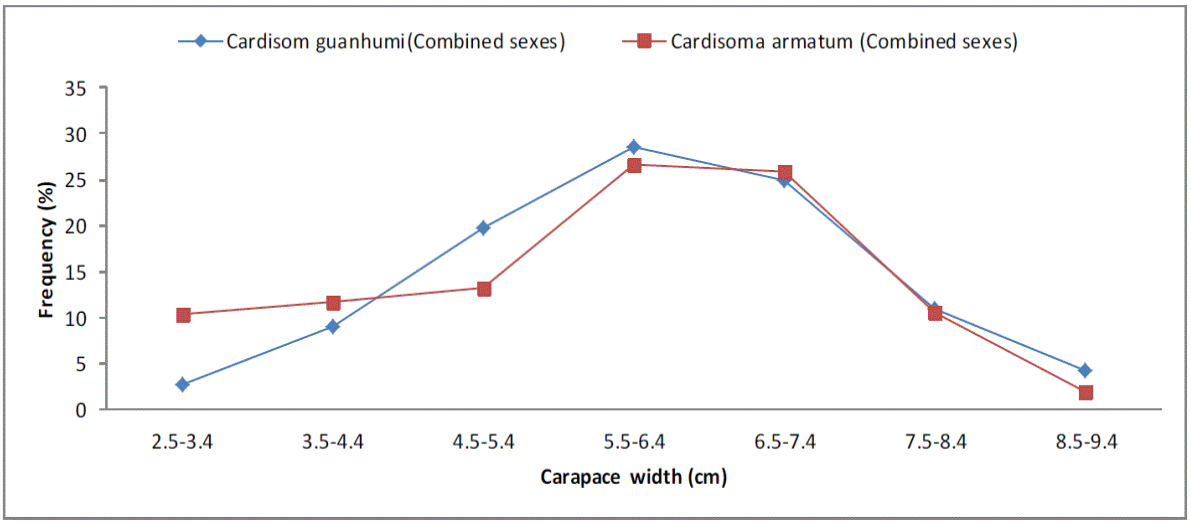


Figure 7: Carapace width frequency distribution of Male, Female and combined sexes of *Cardiosoma armatum* and *Cardiosoma guahunmi* from Lagos Lagoon mangrove swamps (February- July, 2012).

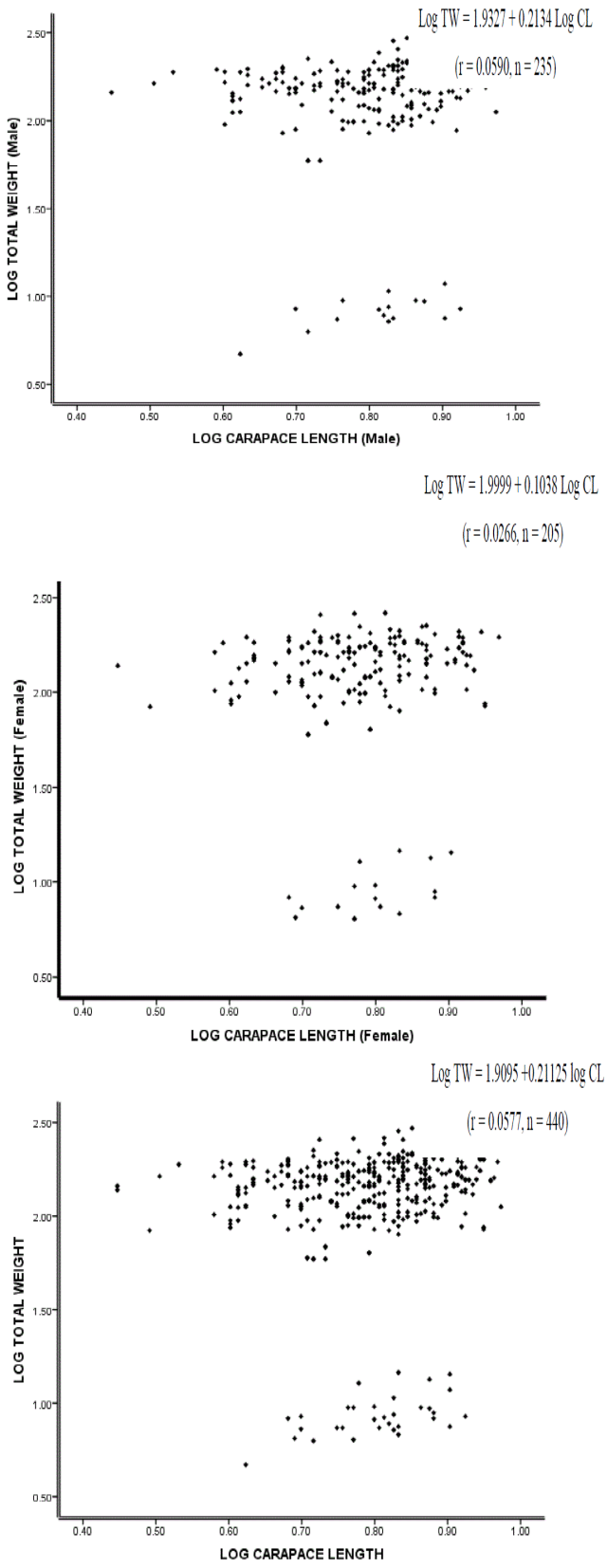


Figure 8: Log Total Weight against Log Carapace Length of *Cardiosoma guanhumi* from Lagos Lagoon mangrove swamps (February- July, 2012).

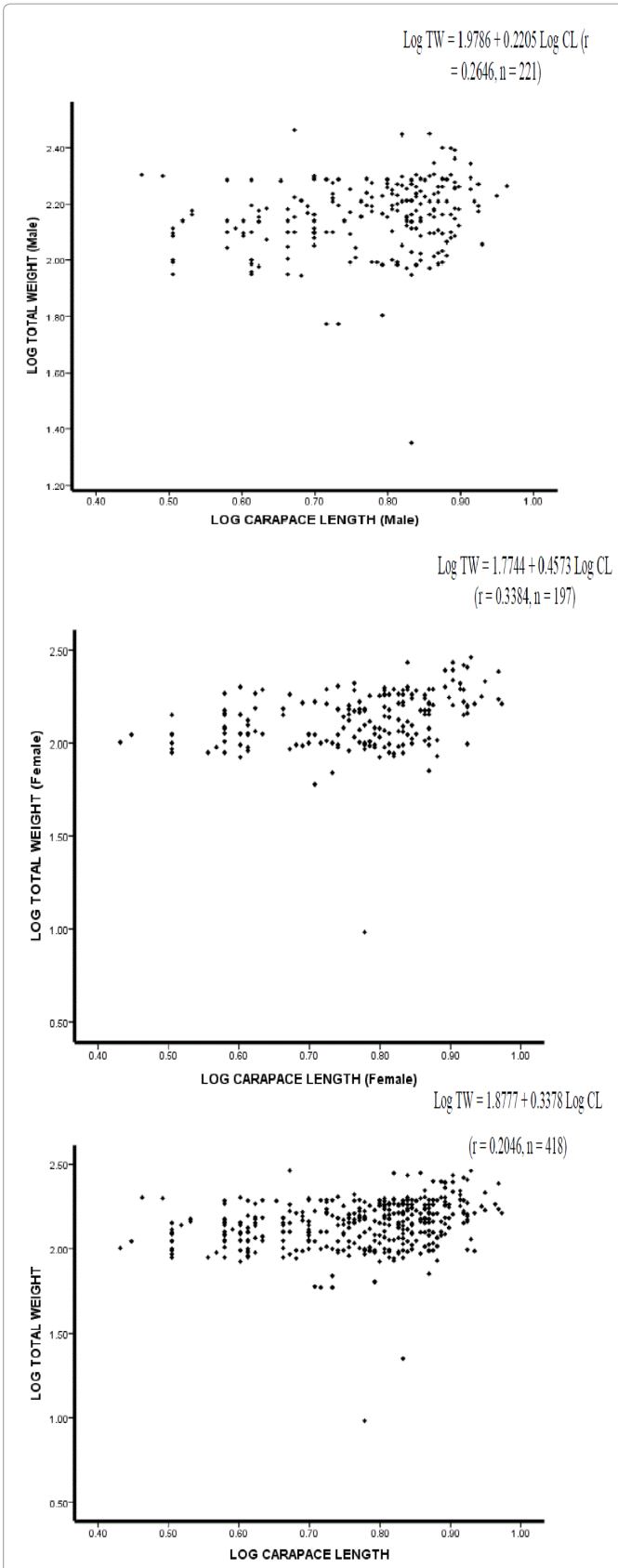


Figure 9: Log Total Weight against Log Carapace Length of *Cardiosoma armatum* from Lagos Lagoon mangrove swamps (February- July, 2012).

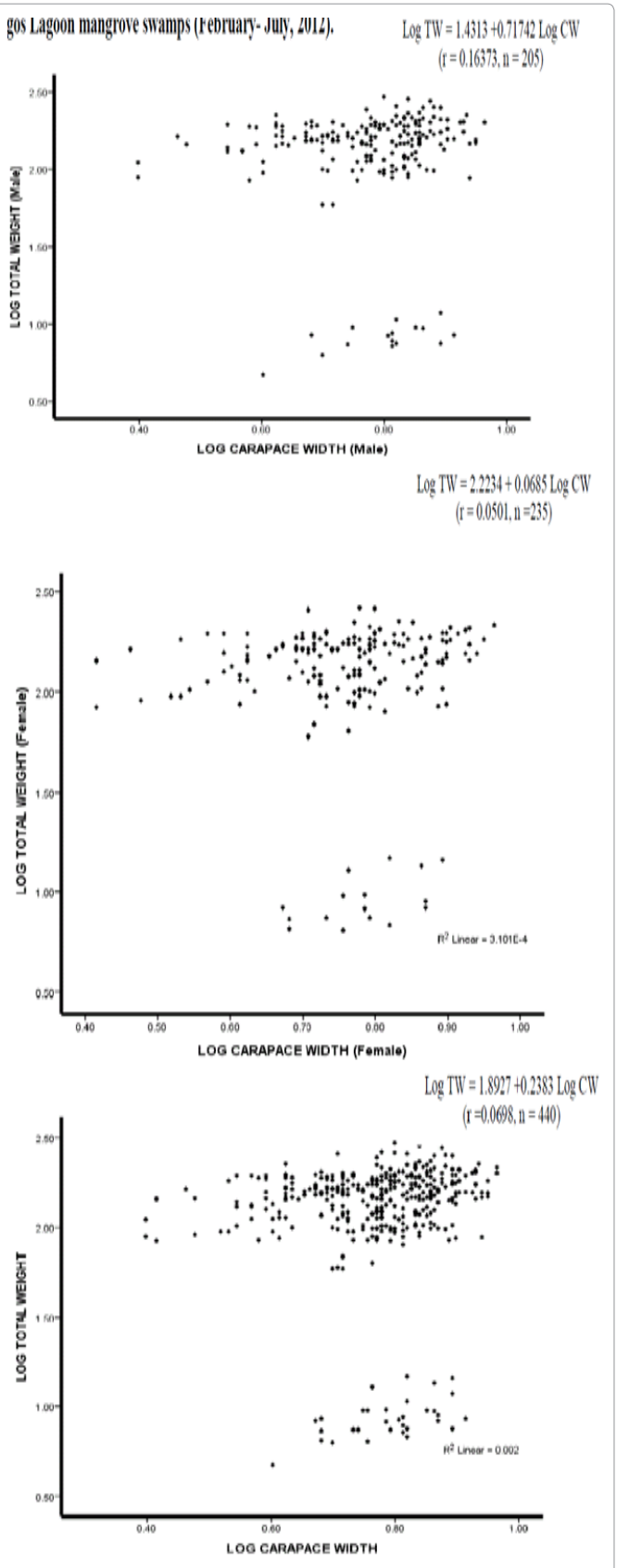


Figure 10: Log Total Weight against Log Carapace Width of *Cardiosoma guanhumi* from Lagos Lagoon mangrove swamps (February- July, 2012).

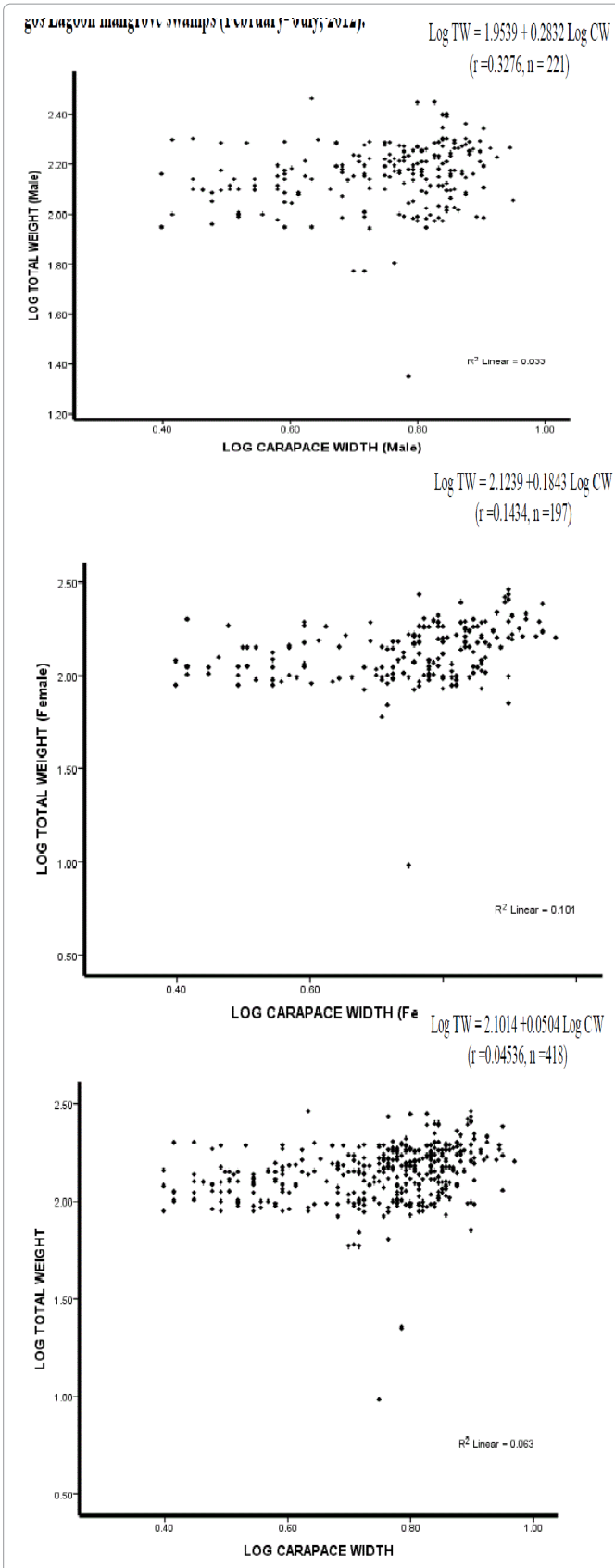


Figure 11: Log Total Weight against Log Carapace Width of *Cardiosoma armatum* from Lagos Lagoon mangrove swamps (February- July, 2012).

Period		
Feb	159.34 ±7.65[a]	141.58 ±6.12[b]
Mar	153.76 ±5.96[a]	118.58 ±5.60[b]
April	155.48 ±4.42[a]	149.19 ±5.83[a]
May	161.83 ±3.39[a]	167.53 ±4.44[a]
June	97.22 ±8.81[a]	164.56 ±3.46[b]
July	141.96 ±4.78[a]	124.79 ±3.33[b]
In each row, means with a common letter are not significantly different (P > 0.05).		

Table 4: T-test For Carapace Weight for and from the Lagos Lagoon mangrove swamps (February- July, 2012).

Period		
Feb	10.22 ± 0.24[a]	9.35 ± 6.08[b]
Mar	10.45 ± 0.311[a]	10.32 ± 0.28[a]
April	9.21 ± 0.32[a]	9.73 ± 0.31[a]
May	8.32 ± 0.23[a]	8.22 ± 0.24[a]
June	8.75 ± 0.24[a]	9.20 ± 0.22[a]
July	9.15 ± 0.26[a]	9.24 ± 0.05[a]
In each row, means with a common letter are not significantly different (P > 0.05)		

Table 5: T-test for Carapace Left Chelae for and from the Lagos Lagoon mangrove swamps (February- July, 2012)

Period		
Feb	9.84 ± 0.18[a]	9.91 0.21[b]
Mar	9.80 ± 0.22[a]	9.76 ± 0.28[a]
April	7.94 ± 035[a]	10.28 ± 0.29[b]
May	6.98 ± 0.23[a]	7.17 ± 0.23[a]
June	7.04 ± 0.26[a]	8.19 ± 0.25[b]
July	8.39 ± 0.25[a]	10.13 ± 0.21[b]
In each row, means with a common letter are not significantly different (P > 0.05)		

Table 6: T-test For Carapace Right chelae for and from the Lagos Lagoon mangrove swamps (February- July, 2012).

Class range		
2.4 - 3.4	3.16 ±0.17[a]	3.06 ±0.26[a]
3.5 – 4.4	4.01 ±0.18[a]	4.12 ±0.16[a]
4.5 – 5.4	4.98 ±0.28[a]	5.05 ±0.24[a]
5.5 – 6.4	6.01 ±0.29[a]	5.99 ±0.26[a]
6.5 – 7.4	6.96 ±0.29[a]	6.94 ±0.29[a]
7.5 – 8.4	7.92 ±0.32[a]	7.96 ±0.31[a]
In each row, means with a common letter are not significantly different (P > 0.05)		

Table 7: T-test for Carapace Length for L and from the Lagos Lagoon Mangrove swamps (February- July, 2012).

The stomach content analysis carried out on *Cardiosoma armatum* and *Cardiosoma guanhumi* from the Lagos Lagoon, Unilag Water front, indicated that the percentage empty stomach of *Cardiosoma armatum* and *Cardiosoma guanhumi* were 66(5.79%) and 53(2.05%) respectively. The result was in conformity with Lawal-Are and Bilewu, [8] for *Portunis validus* off Lagos's coast Nigeria, the percentage empty stomach content was lowest in March and April for both *C. armatum* and *C. guanhumi*, this is due to the low environmental condition at the period of collection.

Both crabs showed leaf preference because of the flora associated to their habitat, they showed high level of omnivorous feeding habit, as shown in the stomach content analysis indicated that they both feed on plant materials, crustaceans, fish fragments (bone and scales), sand grains and unidentified items, this support the work of Micheli [13] for *Cardiosoma carnifex* and *Sesarma mainerti*. Fish fragments and crustacean found in their stomach content was attributed to the inter migration to shallow part of coastal water. The wide opportunistic feeding pattern of *Cardiosoma armatum* and *Cardiosoma guanhumi* was due to their accidental predatorship [8]. The large amount of sand grains discovered was attributed to the burrowing nature of the crabs and inherent soil habitat.

The cumulative sex ratio of both crabs *Cardiosoma armatum* and *Cardiosoma guanhumi* showed that males are higher than female; the large number of males in both crab species conforms [3] *Sersema huzadii* which is a mangrove crab. According to De-Rivera, in a population of the California fiddler crab [14], Mensurative studies revealed there were almost twice as many adult males as females, mating occurred across half of the days within the breeding season, and females had much longer individual reproductive cycles than males. Hence more males than females were available for mating on each breeding day. Perhaps as a consequence, males spent a large proportion of their time fighting with neighbors and rapidly waving their large claws when females passed by.

Statistically the chi-square for male female ratio of both crabs showed no significance for male of both crab species and the females, based on the research of Male crabs were more abundant than females [15]. T-test statistical analysis to show statistical comparison between the two crabs *Cardiosoma armatum* and *Callinectes pallidus* for carapace length, weight and chelae was reported by Akin-oriola [2], the result showed accordance with the present research.

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