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HABITAT DIVERSITY AND SPECIES RICHNESS OF BRACHYURAN CRABS OFF UNIVERSITY OF LAGOS LAGOON COAST, AKOKA, NIGERIA.

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ABSTRACT

The habitat diversity and species richness of brachyuran crabs of the University of Lagos Lagoon Coast were investigated from seven study sites. Six crabs species were collected and identified namely; *Callinectes amnicola* (Lagoon crab), *Uca tangeri* (Fiddler crab), *Ocypoda africana* (Ghost crab), *Sesarma huzardi* (Hairy mangrove crab), *Goniopsis pelii* (Purple mangrove crab) and *Cardiosoma armatum* (Land crab). The land crab *Cardiosoma armatum* showed the highest occurrence of all six species and was observed in all the study sites. *Uca tangeri* and *Ocypoda africana* showed low occurrence and low abundance where they occurred while *Callinectes amnicola* was the least occurring species. Site A had the highest species richness (0.7239) followed by Site B (0.7072), both having the lowest elevations of 13.72m and 11.58m respectively. The highest number of species was recorded at site A and B that had five species each. One crab species was each observed at Sites D and E which was the lowest, however these sites were located on higher elevations which were 21.03m and 18.29m respectively. The number of crab holes per site also followed similar pattern with sites A and B having the highest numbers recorded, $18.7x10^1$ and $17.2x10^1$ respectively and sites D and E having the lowest, $0.8x10^1$ and $0.2x10^1$ respectively. *C. armatum* had the greatest carapace length and heaviest weight, while *C. amnicola* the longest carapace width. The difference in mean length between left and right chelae of *U. tangeri* was pronounced when compared to other crab species. It was observed that high amount of oxygen, neutral or near neutral p^H, relatively high salinity (6-8$^0/_{00}$) and lower temperatures were preferred by these species of crabs. These physiochemical characteristics were present at most sites hence the relative high abundance of crabs within the University of Lagos campus.

Key words: habitat diversity, species richness, brachyuran crabs, physicochemical and abundance.

INTRODUCTION

Brachyuran crabs are a diverse group of crustaceans alive today. Among benthic communities, they are important members because a number of species are present for human consumption and a tremendous variety of species contribute to the complexity and functioning of tropical ecosystems (Hendrickx, 1995). Crabs are mostly marine, although there are some freshwater and brackish water forms occupying the littoral, supra littoral and even up shore zones. They were found at even 6000 m depths to seas shore and are dominant in many estuarine habitats where salinity and temperatures can fluctuate dramatically daily (Ng et al., 2008). Many species actively forage on land and several species have become semi-terrestrial (Adamezewska *et al*, 1997; Morris & Van Aardt, 1998; Cumberlidge, 1999). Tropical and subtropical regions have more number of crab species compared to temperate and cold regions (Fransozo and Negreiros-Fransozo, 1996; Boschi, 2000a).

Crabs, together with other macro-benthic invertebrates, constitute the link between the unavailable nutrients in detritus and useful protein materials in fish and shellfish. Most benthic organisms feed on debris that settle on the bottom of the water and in turn serve as food for a wide range of fishes (Adebisi, 1989; Ajao and Fagade ,1990; Oke, 1990; Idowu and Ugwumba, 2005). They also accelerate the breakdown of decaying organic matter into simpler inorganic forms such as phosphates and nitrates (Gallep *et al*., 1978). All forms of aquatic plants, which are the first link of several food chains existing in aquatic environment, can utilize the nutrients. These organisms therefore form a major link in the food chain as most fishes, birds and mammals depend directly or indirectly on them for their food supply (Barnes and Hughes, 1988).

The West African fiddler crab (*Uca tangeri*) is a species of fiddler crab that lives in the eastern Atlantic Ocean. It is the largest species in the genus *Uca*, with a carapace up to 50 millimetres (2.0 in) wide, and up to 25 mm (1.0 in) long. The males have one claw much larger than the other, which they use for communication. The carapace is violet to black, or sometimes yellowish in females, while the appendages are yellowish brown. The range of *Uca tangeri* extends from southern Portugal southwards to Angola; it is the most abundant crab in the Gambia (Hartnoll 1988). Certain aspects of fiddler crab *Uca sp* such as morphology have been studied extensively especially with regard to asymmetry. Gibbs (1974), Williams and Heng Poon Kum (1981) reported the occurrence of right-handedness in male of *Uca burgesi* and *Uca vocans* respectively while Jones and George (1982) noted the position of the major chelae in some Australian species of *Uca* as an aid for taxonomic grouping of the genus.

The mangrove crabs (Sesarmidae) are the dominant species of crabs in the mangrove swamps. They live beneath drift and high-tide mark in the estuaries and lagoons (Cannicci *et. al.*, 1995). They are amphibious in habit and can be found round intertidal areas with moist/wet muddier regions of the mangrove (Gillikin, 2004). While the mangrove crab does not constitute a food item for the coastal communities, 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 (Dahdouh-Guebas *et. al.*, 1999; Olafsson *et. al.*, 2002). Similarly another mangrove crab, *Goniopsis pelii* had the acute toxicity of crude oil assessed against it by Ekwu, *et al.*, (2012). It was observed that *G. pelii* was not an early warning indicator for oil toxicity but its

response during spills could serve as a good indicator of adverse impact.

Ocypode ghost crabs are found in tropical and subtropical regions throughout the world in sandy beaches, rubble flats, and in estuarine areas (Karleskint *et al.,* 2009). They construct simple to complex deep burrows in soft sandy and/or muddy substrates. They are nocturnal and are generalist, scavengers and predators of small animals (Rathbun, 1918; Garber, 2006). Most species have pale-colored bodies that blend in well with the sand (Poore & Ahyong, 2004), though they are capable of gradually changing body coloration to match their environment and the time of day (Stevens *et al.*, 2013).

Gifford (1962) described the genus *Cardiosoma* as circum-equatorial, with different species on the East and West coast of each continent. Fischer *et al* (1981) described the genus *Cardiosoma* as important members of the fauna of many tropical, coastal and estuarine areas while Longhurst (1958) observed that *Cardiosoma* occurred in colonies in the more consolidated mangrove mudflats of the supratidal zone of creeks and estuaries. Cuesta & Anger (2005) conducted rearing experiments of the complete larval development of *C. armatum*. It was observed that the zoeal stages are fairly euryhaline, zoea I to IV tolerating a salinity range of 15-45‰ and 15-35‰ during later development which suggests that the adults

may live in brackish or even fresh water habitats, while a successful larval development is possible only in estuarine or coastal waters with higher salinities.

MATERIALS AND METHODS

Description of Study Sites

Crabs make up 20% of all marine crustaceans caught and farmed worldwide, with over 1½ million tonnes being consumed annually (Cumberlidge 1999). Some important and valuable edible crab that have been studied include *Cancer pagurus* from Britain and Europe coasts, the blue crab *Callinectes spadius* of the Atlantic coast and the lagoon crab *Callinectes amnicola* from Nigeria (Lawal-Are and Kusemiju, 2000). *Callinectes amnicola* is abundant all year round especially in shallow shaded sud-tidal water where it is caught in large quantities (Chinadah et al., 2000). It is one of the most important economic swimming crabs present in the brackish wetland and lagoons in Nigeria (Solarin, 1988; Defelice *et al*., 2001). The species is generally cherished source of protein and minerals in human diet and animal feeds (Emmanuel, 2008) and the most important food organism caught in the coastal (inshore) fishery and lagoons in West Africa (Lawal-Are and Kusemiju, 2000). Aspects of the biology of lagoon blue crab, *Callinectes amnicola*, showing the size, composition, growth pattern and food habits was studied by Lawal-Are and Kusemiju, (2003).

The University of Lagos campus is situated along the Lagos Lagoon with a coastline of over one kilometre. Along with mangrove swamps, a conducive habitat is formed hosting a diversity of brachyuran crabs. The aims of this study is to determine the species diversity of brachyuran crabs along University of Lagos Lagoon coast and the physicochemical characteristics of the habitats as it affects species diversity and abundance.

Seven different study sites (each about $625m^2$) located along the Lagoon coast and within the University of Lagos campus were surveyed (Figure 1). Each sample location

and altitude was georeferenced with a Magellan Sport Track global positioning system (GPS) with accuracy of a metre. Site A had little vegetation and a few trees around located on latitude 6^0 31.228'N and longitude 3^0 24.044'E with an altitude of 12ft (3.66m) above sea level. Part of the study site extended about 5m into the lagoon. Site B was a swampy land area on the periphery of Abule-Agege creek located on latitude 6^0 30'N and longitude 3^0 24'E with an altitude of 10ft (3.058m) above sea level. Dominant floras on the site were *Phoenix reclinata, Eleasis guinensis, Panicum maximum* (Guinea grass), *Paspalum sp.* (Elephant grass) and *Raffia hookeri* (Raffia palm). Site C was a swampy area located on latitude 6^0 31.015'N and longitude 3^0 23.948'E with an altitude of 14ft (4.27m) above sea level. It comprised of marshy soil, trees, grasses and plants like *Alchornea cordifolia.* Site D was located close to a cultivated farm land on latitude 6^0 30.423'N and longitude 3^0 25.833'E with an altitude of 19ft (5.79m) above sea level. It was characterised by relatively dry soil and fewer species with little or no flora present. Site E was a cultivated farmland on latitude 6^0 33.788'N and longitude 3^0 23.465'E with an altitude of 21ft (6.40) above sea level. Site F was a swampy waste land located on latitude 6^0 31.138'N and longitude 3^0 23.636'E with an altitude of 17ft (5.18m) above sea level. Site G was a cultivated farmland on latitude 6^0 31.152'N and longitude 3^0 33.202'E with an altitude of 15ft (4.57m) above sea level.

Collection of Specimen and Morphometric Measurement

Each site was visited weekly at night for 14 weeks. The crabs were caught using trap with bait and hand-picked with protective rubber gloves. The specimens were stored in ice-chest before being taken to the laboratory for further analysis. Sixty specimens (10 of each species) were used for morphometric analysis. The width and length of the crab's carapace were measured using Vernier calliper to the nearest 0.1cm. The width was taken when the carapace was measured from side to side at the base of the largest spines. The length was measured along the midline of the shell from the edge of the carapace between the rostrums to the posterior edge of the carapace. The fronto-orbital length was measured as the distance between the left and right orbit at the anterior region of the crab. The length of the right and left cheliped were also measured using the Vernier calliper. The weights were measured in grams using an electronic balance (OERTLING 30TD).

Physicochemical Parameters

The pH of water samples from each site was measured using a Jenway pH meter (Model 970) to an accuracy of 0.1. Buffer solution 7 was used to calibrate the equipment. Temperature was measured using a mercury-in-glass thermometer calibrated in degrees centigrade (^{0}C). The thermometer was immersed into the water body on site to a depth of about 5cm for 2minutes. The value was read off the thermometer immediately to avoid error. It was also held up in air at each site to determine temperature of air. A Hannah microprocessor (HI 9835) was used to measure conductivity. Dissolved oxygen was measured using the Jenway DO meter (model 970). The probe was dipped in the water body and read off to the nearest 0.01mg/l. Total Dissolved Solids (TDS) was also measured using a Hannah microprocessor (HI 9835). Probe was immersed into water and readings recorded off the metre. Salinity was measured in percentage sodium chloride (%NaCl) using a Hannah microprocessor. The probe was dipped in the water body and read off.

Soil Analysis

Moisture content, total organic carbon and total organic matter analysis were carried out on soil samples from each site in the laboratory. The moisture content was determined using gravimetric method. About 2g of each soil sample was weighed into a dried crucible of known weight. The soil was then dried in the oven at 105^0C for 2hours. The crucible and its content were allowed to cool in a desiccator and crucible + (plus) dried soil sample was weighed. This was repeated until a constant weight was achieved. The difference in weight of the crucible + (plus) soil (W_2) and the crucible + (plus) dried soil (W_3) was used to calculate the percentage moisture content of the soil as follows:

% Moisture content = $(W_3-W_2) \times 100 / (W_2-W_1)$

Where : W_1 = weight of dried crucible

W_2 = weight of dried crucible + soil

W_3 = weight of dried crucible + dried soil

Species richness was measured by applying the Shannon weaver's index;

$$H = -\sum_{i=1}^{s} P_i \ln P_i$$

Where H = Shannon's index

P_i = proportion of individuals = n/N

In = natural logarithm

n = number of individuals in a species

N = total number of individuals in the sample

Total Organic Carbon and Total Organic Matter were determined by titrimetry (Walkley - Black Method, 1934). About 1g of each soil sample was weighed into a conical flask and 10ml of $K_2Cr_2O_7$ and 20ml of concentrated H_2SO_4 were added. The mixture was adequately mixed by gently swirling the flask and was left to stand for 30minutes. 100ml of distilled water was then added followed by 6 drops of ferroin indicator. The mixture was titrated to a reddish brown end point. A blank containing all reagents used in equal measure without the soil sample was also titrated to the same end point. %TOC and %TOM were subsequently calculated.

Measurement of Number of Crab Holes

At each site (25m x 25m), quadrat sampling was carried out to ascertain the number of crab holes. The sites were divided into grids and the co-ordinates to be sampled were randomly selected. The quadrat (1m x 1m) samples were replicated a number of times to ensure that the data represented an unbiased picture of each site.

Diversity of Crabs

RESULTS

Species of Crabs Collected

At the end of the study, six crab species were collected and identified, namely *Callinectes amnicola* (Lagoon crab) – Plate 1, *Uca tangeri* (Fiddler crab) - Plate 2, *Ocypoda africana* (Ghost crab) - Plate 3, *Sesarma huzardi* (hairy mangrove crab) - Plate 4, *Goniopsis pelii* (Purple mangrove crab) - Plate 5 and *Cardiosoma armatum* (Land crab) - Plate 6.

Occurrence and Abundance

The terrestrial crab *Cardiosoma armatum* showed highest occurence of all six species. It was found across all the study sites as shown in Table1. The Sesarmine species, *Sesarma huzardi* showed higher abundance in site B. The fiddler crab *Uca tangeri* and ghost crab *Ocypoda africana* showed low occurrence and low abundance where they occurred. *G. pelii* was only observed at site B, while *C. amnicola* was found only in Site A.

Sites A and B have the highest species richness of 0.7239 and 0.7072 respectively, whereas Sites D and E had the lowest (0). Similarly, Sites A and B have the highest number of crab holes of 18.7 x 10 and 17.2 x 10 respectively (Table 2). Also these sites (A and B) had the greatest number of crab species observed, each with five species seen. However, the two sites had the lowest elevation recorded; Site A (3.66m) and B (3.05m). Alternatively, Sites D and E had the lowest number of crab species observed which a single species each was seen. The two sites had the highest elevation; D (5.79m) and E (6.40m) as shown in Table 2.

Morphometry

Morphometric analysis of 60 representative organisms (ten of each species) of the six species observed shows variations in morphology especially in carapace size and handedness as shown in Table 3. *C. armatum* had the greatest carapace length and heaviest weight, while *C. amnicola* the highest carapace width. It was observed that the difference in mean length between left and right chelae of *U. tangeri* was pronounced when compared to other crab species as shown in Fig 2.

Physicochemical Analysis of Habitat

The physicochemical analysis of water and soil samples collected from the study sites are shown in Table 4. Lower values of temperature were recorded for air and water at Sites A and B, while higher values of the other physicochemical properties were recorded when compared to other sites. Sites D and E (with highest elevations) had higher values of temperature while lower values of other physiochemical parameters were recorded.

The relationship between some physicochemical parameters and species richness of study sites is shown in Fig. 3. With lower temperatures, there were greater species richness, dissolved oxygen, p^H and salinity. However there was a reduction when there was an increase in temperature, especially at sites with higher elevations.

DISCUSSION

The land crab *Cardiosoma armatum* shows highest occurrence of all six species being able to tolerate and survive in all the study sites ranging from the coastal Site A to the relatively dry and farmed Sites D and E and the extremely polluted Site F although it was most abundant in the wetter areas (Sites A, B and C) being amphibious. The tolerance of this crab conforms to Warner (1977) observation that land crabs are excellent hyper-osmoregulators. This species also exhibit high tolerance to polluted environments as the Lagos Lagoon is being increasingly polluted (Ajao, 1996 and Akpata *et al*, 1996).

The fiddler crab *Uca tangeri* and ghost crab *Ocypoda africana* were observed to inhabit the supralittoral zones of Sites A and B. The ghost crab was scarcely observed because it quickly runs into its burrow at the slightest vibration. The fiddler crabs, especially the males, are not as fast probably due to their

large sized right cheliped. *U. tangeri* was however, more abundant in the mangrove habitat of site. The occurrence of these crabs in the zones is probably due to the fact that they have the affinity for foraging existence. They eat anything that gets washed upon the shore or in the mangroves like carrion, seaweeds, algae or anything small enough to be grasped with the chelae. Their chelae and gastric mill are not specialized (Duro-Ishola, 1982).

The mangrove crabs, *S. huzardi* and *G. pelii* are restricted to their swampy, highly marshy environment covered with mangrove vegetation. They are most abundant in Sites B and C which are mangrove swamps.

The crabs found also differ based on their morphology. *C. armatum* was largest in size and *U. tangeri* was smallest based on all morphometric parameters. *C. armatum* and *C. amnicola* had similar length of carapace but different width. *C. amnicola* is a swimming species while *C. armatum* a terrestrial species burrows. The smaller width helps its burrowing behaviour. According to Pauly *et al.*, (2001), increased terrestriality is accompanied by greater inflation and posterior narrowing of the carapace as the branchial chamber becomes modified for air breathing.

Heterochely was observed in some species of crabs especially in males of *U. tangeri.* Some had their arm being even bigger in length and diameter than *C. armatum* which was also observed by (Huxley and Callow, 1933; Rhodes, 1986 and Rosenberg, 1997). The females showed homochely. The Sesarmine species and ghost crab exhibited homochely. *C. armatum* and *C. amnicola* showed heterochely in most specimens although a few were homochels. Heterochely here did not correspond with sex or size (age) thus the average lengths and diameters of right and left chelipeds was not significantly different among the various species. Tsuchida *et al.*, (2000) observed that the bythogravid crab, *Austinograea williamsi* exhibited heterochely, with the large chelae (the crusher type) and the sharper and smaller chalae (the cutter type). They observed that sixty percent of males had a right crusher and a left cutter while the others including females had two cutters. The attainment of the crusher chelae is necessary because crabs tend to be aggressive both interspecifically and intraspecifically in field and laboratory environments. This maybe as a result of territorialism and or its reproductive behaviour.

Crabs found in University of Lagos, Akoka campus did not vary much in behaviour despite their morphological differences as they are all runners and burrowers except for the lagoon crab, *C. amnicola* which is a swimmer thus having a characteristic paddle like ‘feet’ on the hind pair of pereiopods as against pincers in other species as sighted by Oyenekan (1992) who reported that there are slight differences in morphological characteristics of runners and swimmers.

Some species are better adapted than others to certain conditions in which some physiochemical properties are absent or much reduced as one moves away from the aquatic and swampy areas to the dryer parts of the campus. Thus, a trend is formed from sea level upwards to the sand filled and ‘man occupied’ areas of the campus. This is evident in the variety and variability of crab species supported by the different study sites and number of holes found per study site. Sites A and B had the highest species richness and these sites were located on the lowest elevations that had the highest number of crab holes. The higher the elevations, the lower the number of holes, hence lower species richness. It is evident that areas further away from the lagoon had higher elevations. Sites D and E were

located at higher sites, therefore had lower species diversity and abundance of crab species. But however, reports from Schlacher *et al.,* (2010) showed that the Ghost crab (*Ocypoda cordimana*) had a greater abundance in higher elevations due to attraction at camp sites owing to trophic subsidy from food scraps left by tourists. According to Pauly *et al.,* (2011), level of terrestriality varies substantially among crabs, from species that lives strictly intertidally to those that have lost all connections with the sea.

From the results obtained from physicochemical analysis of soil and water samples from study sites, it was observed that high amount of dissolved oxygen, neutral or near neutral pH, relatively high salinity (6-8$^{0}/_{00}$), and lower temperatures are preferred by crabs since Sites A, B and C with these properties had higher species richness and abundance Soils with higher moisture, organic carbon and organic matter are also preferred especially by the mangrove species which had corresponding abundance with high values of these parameters in Site A-B. The aforementioned might also be the reason for presence of crabs in site F considering the degree of pollution.

Total Dissolved Solids (TDS) and conductivity of water obtained from various sites shows a distinct trend as crab abundance is highest when values are neither too high nor too low. They featured highest in site F which also had high organic matter content in the soil. These features are probably as a result of pollution of this site. Crab abundance was comparatively low here alongside sites D & E having the least species richness. Sites A, B and C showed high abundance of crabs with Site B being the highest with a corresponding high values in both TDS and conductivity. This condition may be suitable for the existence of the crabs as they obtain their nutritional requirements from the organic matter from the soil.

Nevertheless, presence of crabs in all sites shows that crabs (especially the terrestrial crab *C. armatum* which was present in all seven study sites) are tolerant species that can survive adverse conditions as pointed out by Pinder and Smiths (1993) who worked on the respiratory and ionic conditions and physiological responses of *C. guanhumi* to hypercapnia. Thus there is a relatively high abundance of crabs within the University of Lagos campus.

CONCLUSION

Six different species of crabs observed at the University of Lagos Lagoon Coast were accustomed to different habitats ranging from the neritic area of the lagoon, to the shoreline, mangrove swamp and relatively drier soil. The effect of the varying physicochemical parameters present in the habitats appears to contribute to their variety and variability, giving them a reducing diversity trend away from moisture, dissolved oxygen and organic matter rich ecosystems within the campus. Of the six species, *Cardiosoma armatum* was the most tolerant and most abundant and known to be the most economically important alongside *Callinectes amnicola.* It is pertinent to note that conservation efforts should be made to protect these crabs. Some species of these crabs are hunted on a daily basis and there is a risk of local extinction.

TABLES

Table 1: Occurrence of the different species found during sampling of sites in course of the experiment.

SPECIES	SITES ($625m^2$)							TOTAL
	A	B	C	D	E	F	G	
C. armatum	95	82	88	17	13	30	8	333
S. huzardi	56	97	117	-	-	10	12	292
G. pelii	-	52	-	-	-	-	-	52
U. tangeri	29	32	-	-	-	-	-	61
O. africana	32	23	-	-	-	-	-	55
C. amnicola	39	-	-	-	-	-	-	39
TOTAL	251	286	198	17	13	40	20	922

Table 2. Relationship between Species Richness, number of crab holes, number of crab species observed and site elevation per study site.

SITES	Species Richness per Site (x10)	Number of Crab Holes per Site (x10)	Number of Species Found	Elevation(m)
A	7.239	18.7	5	3.66
B	7.072	17.2	5	3.05
C	1.891	15.7	2	4.27
D	0	3.2	1	5.79
E	0	0.8	1	6.40
F	2.711	4	2	5.18
G	3.338	2.2	2	4.57

Table 3: Relationship between mean carapace length and width, fronto-orbital length and weight of specimens

SPECIES	Carapace Length(cm)	Carapace Width (cm)	Weight (g)	Fronto-Orbital Width (cm)
C. armatum	4.8±0.34	5.5±0.27	72.83±3.09	2.4±0.15
S. huzardi	2.3±0.24	3.2±0.18	37.50±1.94	2.0±0.08
G. pelii	3.8±0.27	4.2±0.21	60.44±3.01	2.2±0.18
U. tangeri	3.6±0.30	4.8±0.32	52.39±2.44	1.2±0.08
O. Africana	4.0±0.24	4.9±0.28	63.85±2.89	1.4±0.14
C. amnicola	4.8±0.16	6.8±0.42	53.20±2.17	1.7±0.20

Table 4: Physicochemical analysis of water and soil samples from study sites.

SITES	TEMP. (^{0}C)		TDS	Salinity ($^0/_{00}$)	Condt. (millisecs)	pH	DO (mg/l)	Moisture Content (%)	Total Organic Carbon (%)	Number of Crabs	Total Organic Matter (%)
	Air	Water									
A	28	26	14.32	6.25	28.68	7.1	5.53	3.55	3.87	251	6.69
B	29	27	16.54	7.54	31.51	7.3	3.29	4.24	5.25	286	9.82
C	29	26	6.42	2.51	12.83	7.5	3.77	4.56	5.42	198	10.31
D	32	28	1.84	0.69	3.68	7.2	0.14	0.45	0.60	17	1.04
E	30	28	0.28	0.50	2.64	6.9	0.07	0.97	1.34	13	2.32
F	29	27	20.82	3.04	40.32	3.4	0.04	2.41	5.57	40	13.3
G	30	28	0.13	0.43	1.12	6.7	0.06	1.03	1.24	20	2.15

FIGURES



Figure 1: Map showing study sites.



Plate 1: *Callinectes amnicola* (Lagoon/Swimming crab)



Plate 2: *Uca tangeri* (Fiddler crab)



Plate 3: *Ocypoda africana* (Ghost crab)



Plate 4: *Sesarma huzardi* (Hairy mangrove crab)



Plate 5: *Goniopsis pelii* (Purple mangrove crab)



Plate 6: *Cardiosoma armatum* (Land crab)

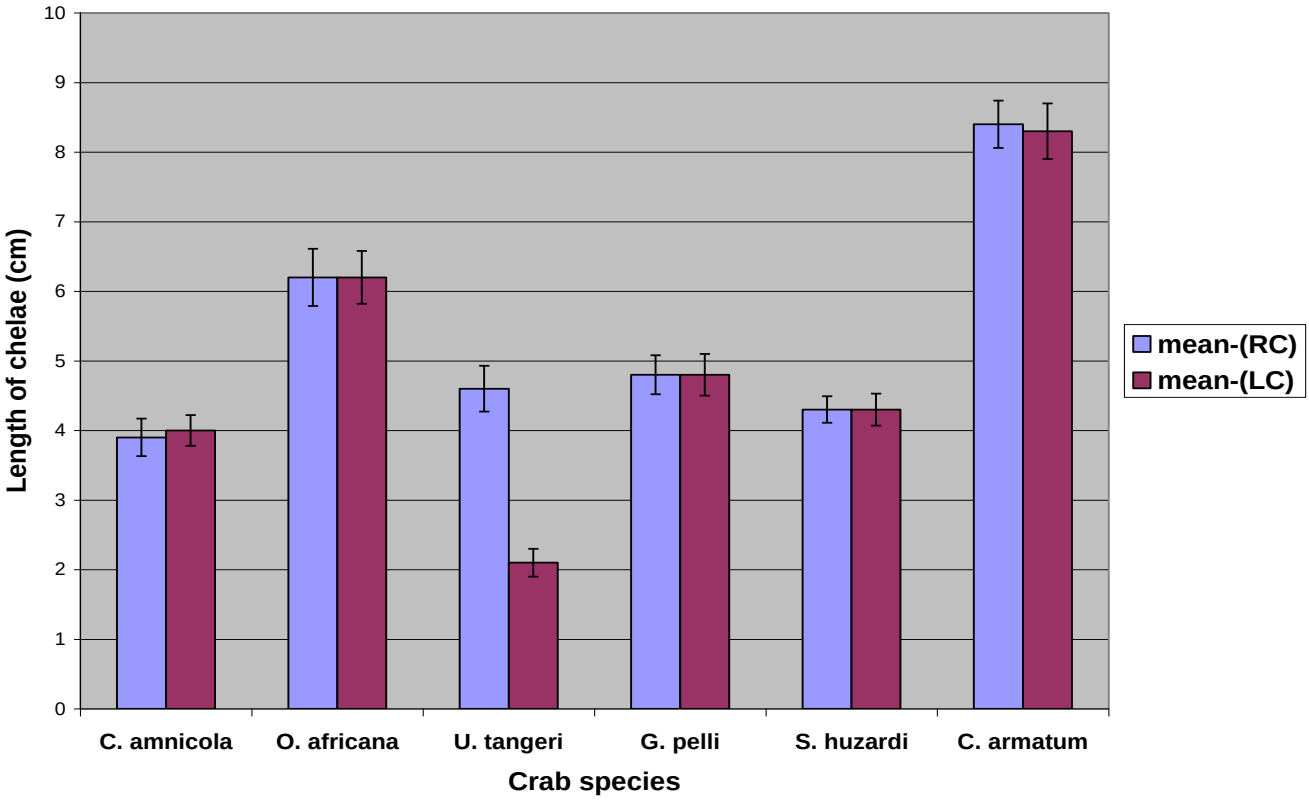


Fig. 2: Mean length between left and right chelae of specimens.

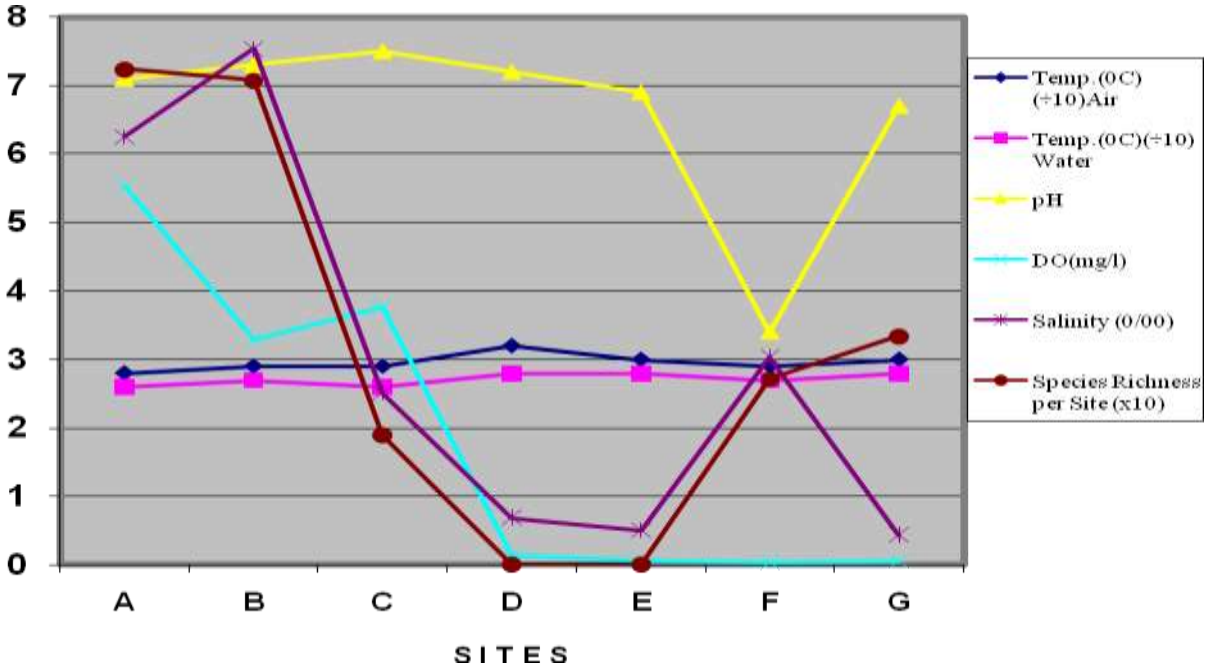


Fig 3: Relationship between some physiochemical parameters and species richness of study sites.

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