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Sex and Size Composition of *Uca tangeri and Perisesarma huzardii* as Environmental Parameters for Mangrove Ecosystem, Cameroon

Longonje N. Simon

Department of Environmental Science, University of Buea, P.O. Box 63 Buea, Cameroon
E-Mail: nlongonje@yahoo.com

ABSTRACT

Baseline ecological studies of mangroves are important for monitoring, management and conservation of mangrove ecosystems. This study determined the sex and size composition of two abundant crab species in the Cameroon Estuary mangrove. The samples were collected from four zones located from landward fringes to seaward edge of estuary mangrove for six months (April-September, 2015). Standard excavation and crab catching methods were used for data collection. A total of 726 crabs were collected, 434 females (60.3%) and 292 males (39.7%). *Perisesarma huzardii* (Sesarmidae) was the dominant species with 73.6%, whilst *Uca tangeri* (Ocypodidae) constituted 26.4% .The carapace width (CW) range for *Uca tangeri* was 0.26 to 5.6 cm and for *Perisesarma huzardii* 0.0.1 to 5.5 cm. The total weight of the *Uca tangeri* ranged between 0.5 g and 64.1g while *Perisesarma huzardii* ranged between 0.45g and 38.8g. Both species showed a similar growth pattern, with positive allometric growth. However, allometric coefficient (b) of *Perisesarma huzardii* was higher for both sexes. This could indicate different strategies for growth and reproduction between the two species. An increase in the allometric growth coefficient of the secondary sexual appendages could anticipate the relative size at the onset of sexual maturity. Both species could be better described by a bimodal rather than a unimodal distribution. This study indicates almost similar biological features for both species and that both crabs are important spotlight for mangrove habitat.

Key Words: Crabs; Size Composition; Length-Weight Relationship; Mangrove Ecosystem; Ecological Values

INTRODUCTION

Mangroves provide food and habitat resources for many organisms (Robertson and Blaber 1992), with the exception of the trees, mangrove crabs are probably the most prominent and significant biotic components of mangrove ecosystems in terms of species richness and their ecological engineering role (Macintosh 1984, Lee 1998, Skov and Hartnoll 2001, Hartnoll et al. 2002). Globally, an estimated 275 species from 6 families of crabs are associated with mangrove forests (Lee 1998) and their distribution is influenced by biotic and abiotic factors, such as water salinity, temperature, food availability and preference, sediment properties, vegetation type, interspecific competition and predation (Frith and Brunenmeister 1980, Ewa-Oboho 1993). The most common crabs in mangroves are either Fiddler crabs (Family Ocypodidae, genus *Uca*) or Sesarmid crabs (Family Grapsidae, subfamily Sesarmidae) (Jones 1984).

The ecological role of crabs in terms of the functioning of the mangrove ecosystem is thought to be significant (Lee 1997). Energy assimilated by crabs plays a significant role in nutrient recycling (Macintosh 1984), crabs aerate the soil by burrowing (Micheli et al. 1991), increase nutrient content by burying organic matter, decrease toxic sulphide and ammonium concentrations within the sediment (Smith at al. 1991), reduce pore water salinity by flushing water through burrows (Stieglitz et al. 2000) and create a microhabitat for other fauna (Gillikin et al. 2001).

All mangrove crabs have some degree of behavioural, morphological, physiological and biochemical adaptation to their habitat (Burggren and McMahon 1988). Behavioural adaptation can be catego-rised into isophasic and isospatial. Isophasic behaviour is when crabs move to or away from favourable or unfavourable conditions, whilst isospatial is when crabs remain in the same area during unfavourable conditions, usually taking refuge (Vannini and Ruwa 1994, Vannini and Cannicci 1995). Burrowing by isospatial species might be one of the most important behavioural adapta-tions, because the process creates a microclimate that protects it from predators and temperature and water stress (Macnae 1968, Pinder and Smits 1993).

Mangrove crabs also show a variety of feeding strategies. Predatory crabs, such as portunids have large, powerful chelae capable of crushing large shells (Houbrick 1991). *Uca* species, scooped up small portions of sediment with it small chelae and pass it into the bucal cavity where the food is sorted by the mouthparts. During this process, the crab ingests sand particles into the bucal cavity, where the organic matter is removed and the cleaned sand particle is discharged in pseudofecal pellets. Water is pumped from the brachial chamber into the buccal cavity to assist the sorting process (Miller 1961).

Arboreal species are well adapted to life in trees, having a flat carapace, a relatively long walking leg carpus and propodus and a short dactylus (Hartnoll 1988). Many crabs are adapted to intertidal life by being able to take up soil capillary water via setal tufts located between the walking legs (Greenaway 1988). By rapidly pumping the scaphognathite, the crab is able to build a negative pressure in its brachial chamber and suck water in via the setal tufts.

Mangrove crabs have evolved a ranged of physiological adaptations to the demanding mangrove environment. These include respiratory compensation for environmental change, osmotic and ionic regulation and water balance. Many crabs inhabiting the mangrove are also subject to considerable temperature variation (Malley 1977), and need to maintain their body tempera-ture within a suitable range, while simultaneously conserving water and regulating salts. Tropical crabs do not experience low temperature stress, but high temperatures might cause desiccation in species inhabiting the upper littoral zone, affecting heart rate and haemolymph flow (De Wachter and McMahon 1996). Changes in haemolymph oxygenation resulting from variations in temperature have not been well documented in land crustaceans (Burggren and McMahon 1988). Oxygen uptake increases as temperature rises, but little is known of the changes in the haemolymph oxygen transport mechanisms that are needed to deliver the extra oxygen to the tissues (Burggren and McMahon 1988).

Crabs can maintain the preferred solute concen-trations of their tissue fluids in different media (Green-away 1988). Sublittoral species usually have body fluids similar in concentration and composition to seawater. They can withstand reduced salinities, but show no ability to regulate the concentration of their extra-cellular fluids which thus remain isosmotic with the medium (Greenaway 1988). Crabs showing this pattern of osmo-regulation are termed osmoconformers. In contrast, osmoregulators, are capable of regulating the concen-tration of their haemolymph in water with solute concen-trations of seawater and higher. In dilute media, lost salts are replaced by absorbing ions from the water by means of ion-transporting enzymes (ATPases) in the gill epithelium and excess water is removed by increasing the rate of urine output (Greenaway 1988).

The mangrove ecosystem provides leaf litter and sediment organic matter, which is the primary food resource for most crabs (Macintosh 1988, Alongi et al. 1993). The main food source of grapsid crabs is leaf litter supplemented with algae and animal matter (Robertson 1991, Cannicci et al. 1999), whilst *Uca* species feed mainly on organic matter and portunid crabs are carnivorous but may supplement their diet with leaves and algae (Cannicci et al. 1998). Crabs are also important bio-indicators of ecosystem health. In mangroves, they are ecologically significant (Lee 1997, Robertson et al. 1992), and probably a keystone species, as their removal alters ecosystem structure and function (Smith et al. 1991).

Despite the vital role played by crabs in the mangrove ecosystem, data on crabs in some areas remain patchy. For Africa, there have been several studies of East Africa mangrove crabs (Hartnoll et al. 2002, Vannini et al. 1995), but, to my knowledge, Cameroon mangrove crabs and their role in the ecosystem have not been investigated.

Measurement of the size-frequency is one of most widely used method for growth pattern especially in the wild. This method gives more information about the ecological status of the species in the mangrove habitat (Vogt 2012). The mangrove of Cameroon estuary plays an important role on the diversity of the crab species, though various impacts have pose alarm on the environment which also affects the distribution of other important fauna and flora community of the ecosystem. The aim of this research is to provide baseline informa-tion on the relevance of using size and growth of *Uca tangeri and Perisesarma* species as ecological parameter of mangrove ecosystem and make comparison of the population differences based on morphological analyses of the two crab's species

MATERIALS AND METHODS

This study was carried out in the Cameroon Estuary mangrove (3° 83' - 4° 10' N and 19° 25' - 10° 00' E) (Figure 1). It is a large forest of approximately 1,750 km^2, and has an equatorial climate characterised by two main seasons: the rainy season from March to October (8 months) and the dry season from November to February (4 months), an annual average precipitation of 1,500mm to 3,000mm and high temperatures ranging from 24°C to 27°C (Longonje 2015).

The Cameroon mangrove is biologically diverse, it inhabit different species of fishes birds and many endangered species, such as marine turtles (*Lepidoshelys olivacea,*), dwarf crocodile (*Crocodylus cataphractus*), and West African manatee (*Trichechus senagalensis*) (CWCS 1997).

Crabs species (Figure 2) were collected from four mangrove zones. **Zone 1 (landward fringe):** This area is disturbed by human and consequently supports sparse mangrove trees. **Zone 2 (mangrove forest):**This area is dominated by dense mangrove trees of varying size and height **Zone 3 (seaward edge of mangrove forest)** :This is the seaward edge of the mangrove forest. It is dominated mangrove dense forest. **Zone 4 (mudflat)**: This is muddy area, completely exposed at low tide with isolated stands of mangrove trees.

Sampling was conducted every fortnight in each zone from April 2015 to September 2015 at low tide

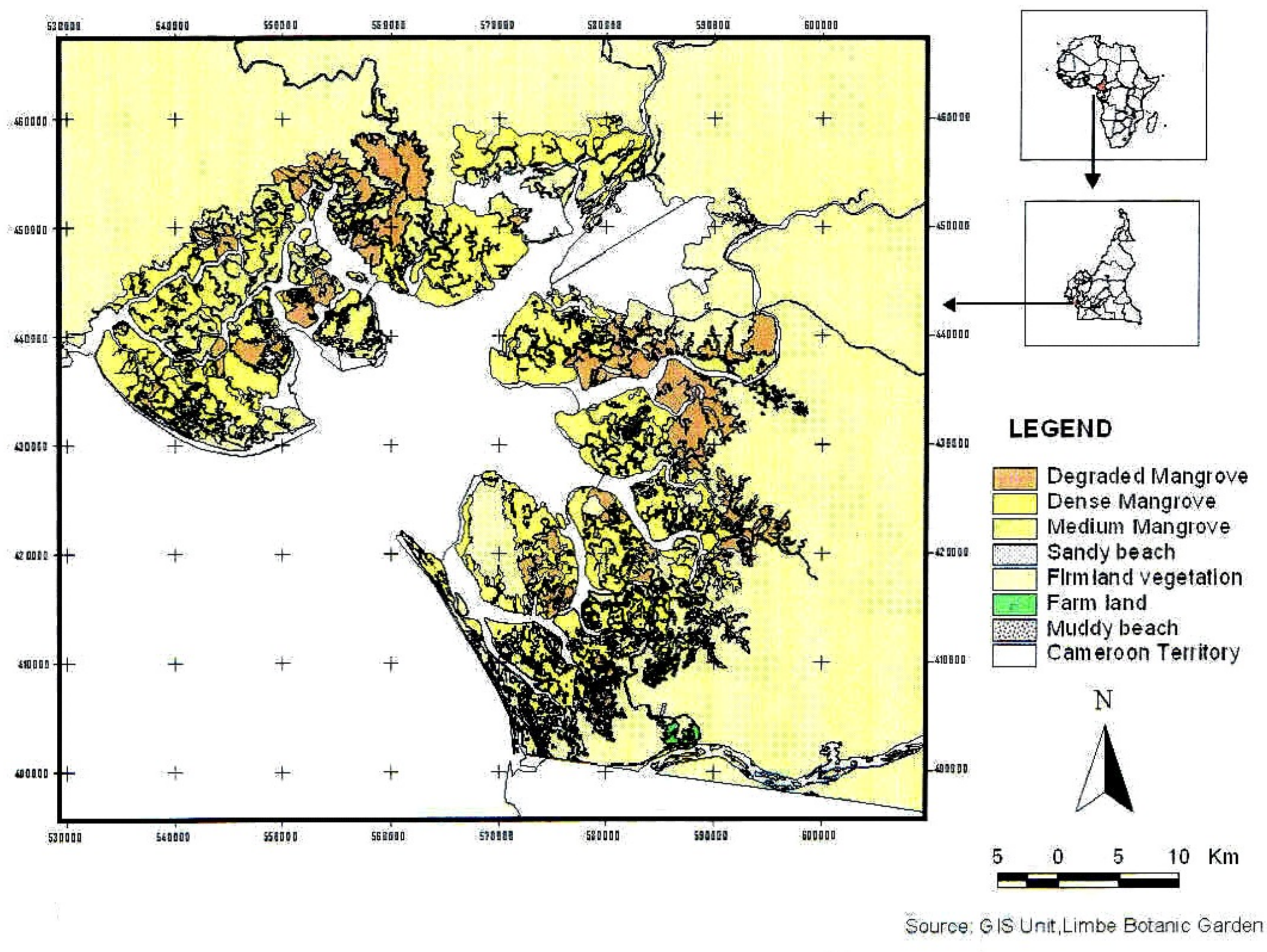

Figure 1. Location of the study area showing mangrove forest type in the Cameroon Estuary (Longonje 2008)

Figure 2. (Left) *Uca tangeri* and (Right) *Perisesarma huzardii*

when crabs are more active and the crab species recorded. Crabs were collected on the surface and $1m^2$ quadrats were randomly placed and excavated to a depth of 30 cm by each collector. This excavation method is thought to offer a more reliable estimate of crab density (Joana et al. 2003).

The crabs were sedated in iced water for a few minutes, washed and stored in 70% alcohol, later identified. The following body dimensions were measured with a digital caliper (0.01 mm): carapace width (CW), weight (wet weight) and sex. All the specimens collected were stored carefully to ensure that no appendages was lost due to stress, and identified with the aid of field keys (Crane 1975, FAO 1990, Cannicci et al. 2001).

Size Comparison

The mean size of CW of both species were compared between . Data were log transformed for all comparisons, but the variances remained heterogeneous (P = 0.01). Sex ratio was analysed using descriptive statistic and chi-square test. The community structure was analysed using the Bray–Curtis similarity measure followed by multidimensional scaling (MDS).

Allometric Growth Comparison

The relative growth analysis of the crab dimensions was based on the allometric equation (Huxley 1950):

$$Y = aCW^b$$

where Y = dimension (body structure), b =slope, which represents the relative growth rate of the body structure, and a = line intercept in the y axis.

The parameters of the equation describing the relationship between the different variables were estimated by a linear regression on the log-log transformed morphometric data, i.e. the linearized equation

$$\ln y = \ln a + b^* \ln x.$$

To determine whether the relationship deviates from linearity ($b > 1$ – exponential increase; $b < 1$ – exponential decrease; $b = 1$ – isometry), a t-test was used. If the body structure of the crabs grows more or less proportionally with a unit increase in size, then the slope should be greater or smaller than the unity, respectively (Baeza and Asorey 2012).

RESULTS

Population Composition

A total of 726 crabs were collected, 436 females (60.3%) and 287 males (39.7%) (Table 1). *Uca tangeri* (Ocypodidae) was the dominant species with 73.8%, while *Perisesarma huzardii* (Sesarmidae) constituted 26.2% of the total sampled crabs. *Uca tangeri* dominated the mudflat in zone four, whilst *Perisesarma huzardii* dominated zone one (disturbed young forest). Low stress value in MDS ordination indicated that the community structure is well represented by the zones. The carapace width (CW) range for *Uca tangeri* was 0.1 to 5.5 cm and *Perisesarma huzardii* 0.2 to 5.6 cm (Figures 3-4). Both crab species were studied for weight and width frequency distributions (Table 2). The carapace width frequency polygon of *Perisesarma huzardii and Uca tangeri* showed distinct size groups.

Table 1. Number of crabs collected

Months	April			May			June			July			August			September		
Species	Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total
Perisesarma huzardii	21	15	**36**	11	9	**20**	23	16	**39**	37	10	**47**	9	16	**25**	15	10	25
Uca tangeri	39	34	**73**	53	31	**84**	47	28	**75**	74	46	**120**	53	42	**95**	56	31	**87**
Total	**60**	**49**	**109**	**64**	**40**	**104**	**70**	**44**	**114**	**111**	**56**	**167**	**62**	**58**	**120**	**71**	**41**	**112**

Table 2. The frequency distribution of carapace width and weight of *Perisesarma huzardii* and *Uca tangeri*

	Perisesarma huzardii		*Uca tangeri*			*Perisesarma huzardii*		*Uca tangeri*	
Carapace width	Frequency	%	Frequency	%	Weight (g)	Frequency	%	Frequency	%
0.1-1.4	61	13.7	76	26.7	0.5-10	324	73.5	272	95.4
1.5-2.4	210	47.4	150	52.6	11-20	64	14.5	10	3.5
2.5-3.4	115	26	50	17.5	21-30	24	5.4	2	0.7
3.5-4.4	41	9.3	8	2.8	31-40	22	5	1	0.4
4.5-5.4	14	3.6	1	0.4	41-50	2	0.5		
Total	**441**	**100**	**285**	**100**	51-60	3	0.6		
					61-70	2	0.5		

The size group 1.5-2.4 cm was abundant with 47% and 52.6% respectively and the weight frequency polygon of *Perisesarma huzardii and Uca tangeri* showed distinct size groups. The size group of 0.5 to 10g was abundant with 73.5% and 95.4% respectively.

Both species were better described by a bimodal rather than a unimodal distribution (Figures 3-4). *Perisesarma huzardii* shows a bimodal distribution with the highest modal size of 2.0 to 2.3 cm carapace width, and *Uca tangeri* shows a bimodal distribution with highest modal size of 1.5 to 1.75 and 2 to 2.3cm carapace width.

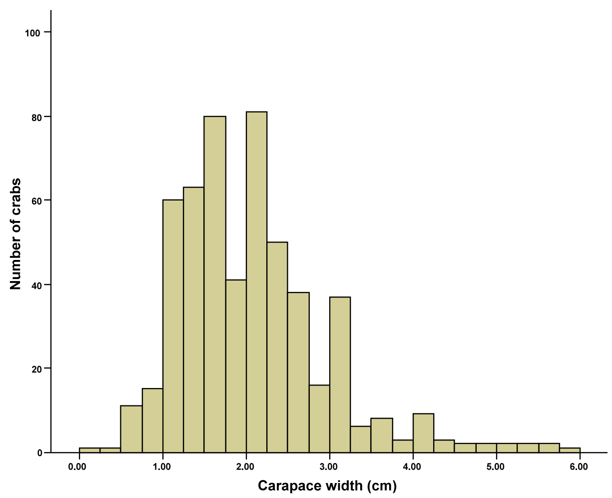

Figure 3. Size (carapace width) frequency distribution of *Uca tangeri,* all zones combined

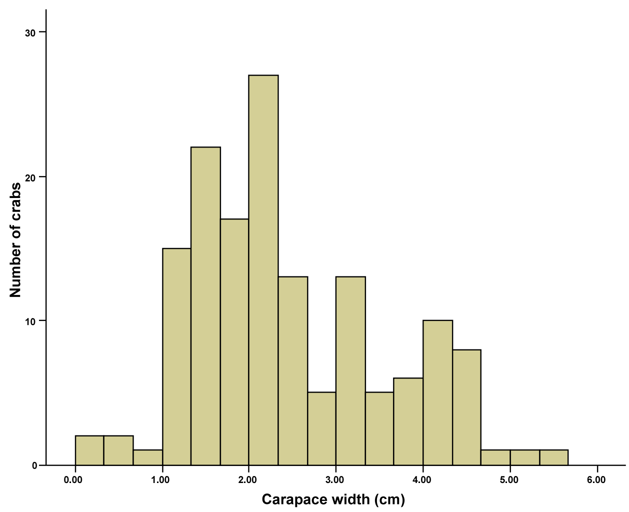

Figure 4. Size (carapace width) frequency distribution of *Perisesarma huzardii*, all zones combined

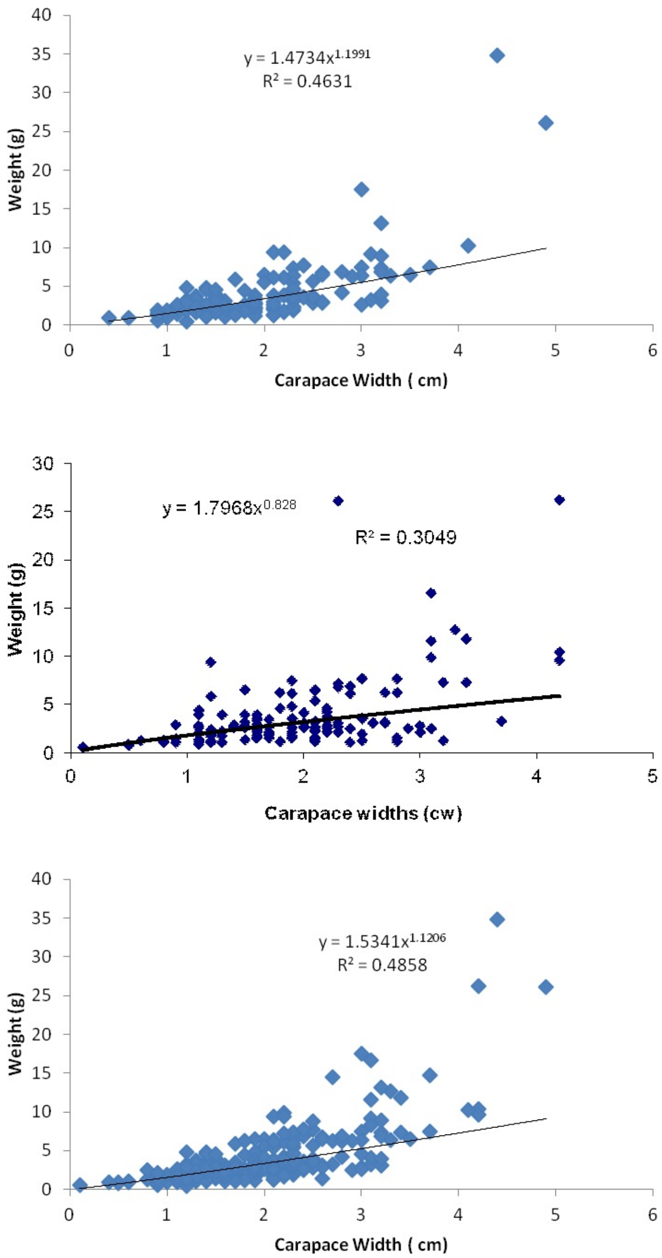

Figure 5. Relationship between body weight against Carapace width of (a) Male, (b) Female and (c) Combined for *Uca tangeri*

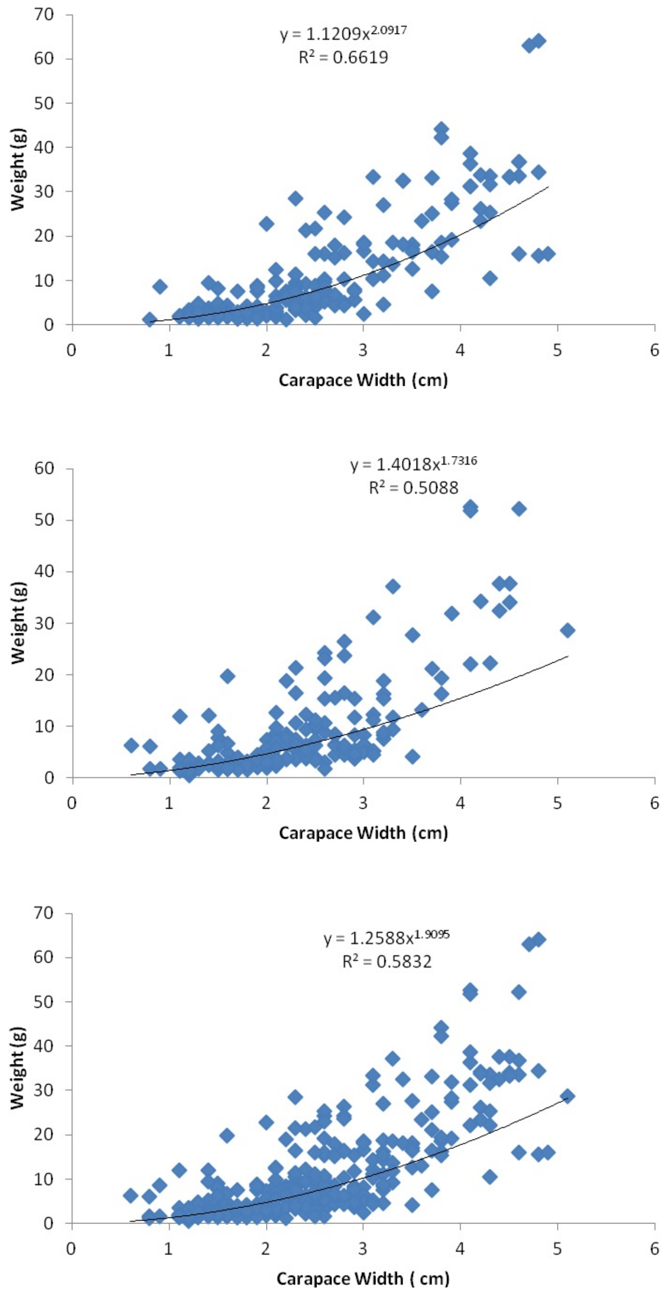

Figure 6. Relationship between body weight against Carapace width of (a) Male, (b) Female and (c) Combined for *Perisesarma* sp.

Relationship Between Carapace Width and Weight

The total wet weight of the *Uca tangeri* ranged between 0.45 g and 38.8g while *Perisesarma huzardii* ranges between 0.5g and 64.1g for the combined sex. The carapace width for *Uca tangeri* range between 0.1 to 5.5 cm, and *Perisesarma huzardii* ranges between 0.2 to 5.6 cm for the combined sex.

Both species showed a similar growth pattern, with positive allometric growth (Figures 5 and 6). However, allometric coefficient (b) of *Perisesarma huzardii* was higher for both sexes. This could indicate different strategies for growth and reproduction between the two species. An increase in the allometric growth coefficient of the secondary sexual appendages could anticipate the relative size at the onset sexual maturity (or RSOM), and consequently change the longevity and the life-time investment in reproduction (Anger and Moreira 1998).

DISCUSSION

The biology and distribution of some mangrove crabs, including *Uca tangeri*, *and Perisesarma huzardii* was studied by Ngo-Massou et al. 2014 in the Wouri River Estuary of Douala. The carapace width for Uca *tangeri* ranged from 0.35 cm to 4.05 cm which is low when compared to 0.26 to 5.6 cm of the present study and the weight ranged from 0.28g to 8.26g which is low when compared to 0.5g to 64.1g of the present study. The carapace width for *Perisesarma huzardii* ranged from 0.22cm to 3.81 cm which is low when compared to 0.1 cm to 5.5 cm of the present study and the weight ranged from 0.32 g to 8.23 g which is low when compared to 0.45 g and 38.8 g of the present study. These values may be due to the sample size and the richness of the ecosystem of estuary mangrove.

The species *Uca tangeri*, *and Perisesarma huzardii* are abundant macro benthic crustacean in Cameroon estuary. In both species males were larger than females. This is common for brachyurans (Litulo 2005, Hirose et al. 2013) and is probably related to sexual selection based on the reproductive behaviour of these crabs.

According to Mantelallo et al. (2003), sexual dimorphism is a result of females being smaller with reduced somatic growth compared to males because they devote more energy to gonad development. Also larger male crabs are more successful in copulating with females, and win more intra-specific fights (Henmi 2000).

Fiddler crabs (*Uca tangeri*) were abundant in this study, and show marked sexual dimorphism. Females have two isomorphic feeding claws, whilst males have a small claw and a hypertrophied one, which, according to Rosenberg (1997), contributes to about 40% of the individual's total body weight. The main claw of the male is used for fighting and intimidates opponents (intra-sexual selection) and is used in a waving display to attract females to the male's burrow for mating (inter-sexual selection) (Crane 1975). Males with larger claws have the advantage in male-male competition (Crane 1975) and females prefer and visit males with larger claws more often (Latruffe et al. 1999).

Both species showed positive allometric pattern, (see Figures 5 and 6). However, males of both species showed a higher allometric coefficient (b). This could indicate different strategies for growth and reproduction between species. An increase in the allometric growth coefficient could anticipate the relative size at the onset sexual maturity, and consequently change the longevity and the life-time (Hartnoll 1982).

The analysis of the two crabs, *Uca tangeri*, *and Perisesarma* huzardii for the size and growth parameter indicate the ecological richness of the mangrove ecosystem. The significant amount of size and the abundance including the frequency of the two crabs greatly expose that the crabs have influenced the vegetation which is attributed to the estuary ecosystem. This research has served as a baseline for the use of crustaceans to monitor the ecological significance of the Cameroon estuary mangrove.

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