The Zoologist Vol. 6: 45-54 (2008)

THREE MORPHOTYPES OF *MACROBRACHIUM MACROBRACHION* (DECAPODA, PALAEMONIDAE): PRELIMINARY RESULTS OF ANALYSIS OF MORPHOLOGICAL CHARACTERS, WITH PARTICULAR EMPHASIS ON THE SPINES OF THE ROSTRUM

***Akintola, S.L.[1]; Kumolu-Johnson, C.A.[1]; Whenu, O.O.[1]; Anetekhai, M.A.[1] and Ajibade, M.A.[2]**

[1]Fisheries Department, Faculty of Science, Lagos State University, Ojo, Lagos State
[2]Zoology Department, Faculty of Science, Lagos State University, Ojo, Lagos State
**Corresponding Author*

Abstract

This study examined morphological variations in the population of *Macrobrachium macrobrachion* (Brackish water Prawn). Morphology of the rostrum is well known to be important in taxonomy of decapods as the shape and morphology varied widely within species. Comparative position of the dorsal spines (i.e spine after the apical teeth) and ventral spines on the rostral aperture of the small sized adult *Macrobrachium macrobrachion* was investigated. The study showed that this species belong to the category of highly variable species. Rostrum of all the specimens shared suits of characters equal or slightly longer than antennal scale, and tip which are slightly curved or occasionally strongly upward. However, observations aided with the hand lens (10 x) and running of pin along the edges of the rostrum showed small but constant specific differences in the relative position and occurrence of the first dorsal spine against that of the ventral spines. The total lengths recorded for the morphotypes were 7.62±1.11cm, 7.48±0.90cm, and 7.44±0.91cm respectively for MTI, MTII and MTIII while body weights for MTI= 4.83±3.07, MTII= 4.33±2.12, and MTIII= 4.24±1.83. Sex ratios were in the order of 1:6.296, 1:5.382, 1: 5.350 respectively for MT I, II and III in favour of the females. Proximity matrix analysis using UPGMA are Euclidean distance (similarity or dissimilarity) amongst the three groups identified. The finding open up a high feasibility in the application of the relative position of the spines on the rostrum of adult prawns to gain a better understanding of phenotypic differences in species and stocks.

Keywords: Rostrum, Morphotypes; *Macrobrachium macrobrachion*.

Introduction

The Brackish River prawn, *Macrobrachium macrobrachion* supports important subsistence fisheries of the West Coast of Africa (Holthius, 1980). Powell (1982) noted that the species often constitute 80% of the total catches of the genius *Macrobrachium* landed in the Lagos lagoon system. Substantial population of traditional artisanal fishers living in the coastal region of Nigeria depend on the fisheries to meet their dietary protein requirements.

Powel (1982) stated inter alia that the species had little mention in previous works as a result of identification problems hence it was often referred to as *Macrobrachium* spp. This species although referred to as a monotypic species in previous work showed consistent differences in the morphological composition of individuals within population stocks.

Problems of taxonomic status are not peculiar to *M. macrobrachion* as many species of the genus *Macrobrachium* are known to exhibit high level of morphological differentiation. Successful freshwater invertebrate with well developed good dispersal ability against the constraints imposed by the physical nature as well as arrangement of the riverine systems are known to have high levels of population subdivision (Hughes and Hillyer, 2003). There are possibilities of mixed species of the genus in many countries arising from the migratory nature of the species of genus *Macrobrachium* as well as their wide dispersion.

Relying on the comparative position of the spines on the dorsal and ventral sides of the rostrum this study opens interesting prospects in the use of the relative position of the immovable teeth on the rostrum of adult prawns in meristic and morphometry techniques employed in identification study. The work is also instructive for fieldworkers carrying out identification studies in the subject matter. Based on this technique it is hypothesised that *M. macrobrachion* is of three morphological types.

Materials and Methods

Study area

The Badagry Creek is located on 2˚42´& 3˚23´E, 6˚23´& 6˚28´N and situated on the Osa lagoon a part of the continuous lagoon that stretches from Port Novo to Lagos (Fig. 1). It is estimated to be more than 51km from Lagos and bounded in the north by the Egbado plateau and in the west by River Yewa via Ologe lagoon. In the south it is bounded by the Atlantic Ocean and in the east by the expanse of the mangrove swamp. The climate is dominated by the rainy season which last from April to October during which the rainfall is heavy owing to the coastal location. The rain is marked by two peak periods generally between May to July and September to October. Rainfall is usually heavier during the first period (52%) creating serious flash floods which are aggravated by the characteristics poor surface drainage conditions of the coastal lowlands. The annual rainfall in Badagry is about 1636.1 mm.

The soil in Badagry is light grey sandy type; and vegetation are found over the low lying plains and marshes near the lagoons and creeks .The vegetation is made up of woody plants, shrubs, and oil palm trees in the sandy areas, while the marshy areas are covered by mangrove swamp forests. Also the mean monthly temperature fluctuates around 30^0C.The highest temperatures occur from November to December and February to March when there is a short dry season in which there are little or no rains. The lowest temperatures occur in the middle of the first peak of the rainy season. The relative humidity is high throughout the year and may not be less than about 70-80 % around Lagos and other lagoon and seaside locations. The consequence of the humid conditions is that it promotes the rapid growth of dense vegetation and a large population of zooplanktons in the mixed waters of the lagoons and creeks (Abegunde, 2002).

The Badagry creek has been known to be part of the 260 Km-long lagoon systems stretching from Cotonou in Republic of Benin to the Niger Delta. It centered in Lagos, Nigeria with depth of a little more than 1 m (Web, 1958).

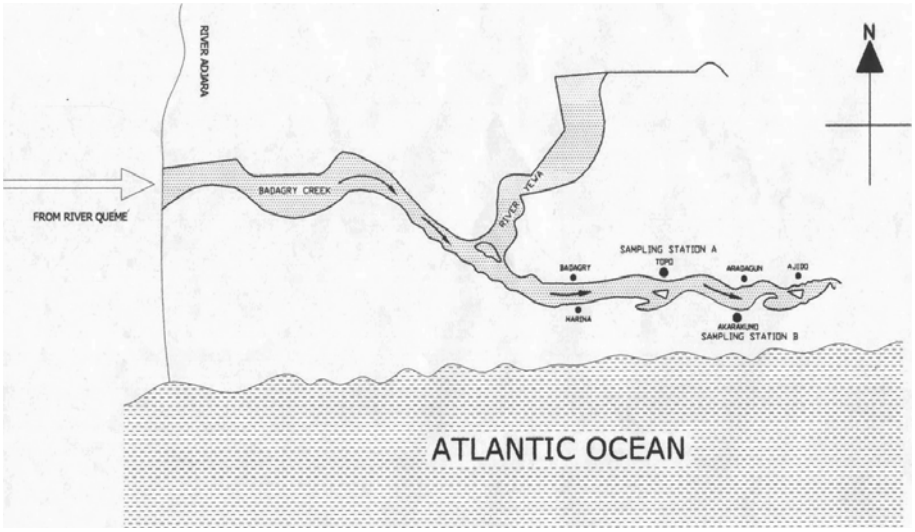


Figure 1: Badagry Creek Showing the Sampling Stations Topo (A) and Akarakumo (B)

Sampling

The prawns were caught (in the period in which brackish condition prevailed in the creek) from June to October, 2003-2004 by fisher folks using cast nets and indigenous barrier traps: with non-return valve at two important landing centres on the creek namely Akarakumo and Topo. Upon collection, the fresh prawns were placed in ice chest and then transferred into -80ºC freezer, randomly selected and thawed sufficiently when required for analyses.

Study species: M. macrobrachion

The freshwater prawn family Palaemonidae is found throughout the world in a variety of habitats (Lee and Fielder, 1983) for reason of their being euryhaline. *M. macrobrachion* is one of the two largest species of the genus *Macrobrachium* in Nigerian waters (Marioghae, and Ayinla 1995).

Identification

The prawn was identified using morphological traits reported in Holthius, (1980) and Powell, (1982). Sex determination was easily achieved since most of the female were berried in spite of their small size.

Meristic and Morphometry Study

Measurements were taken for total length (from the tip of the rostrum to the extremity of telson), rostral length (from the tip to the posterior margin of the orbit), and carapace length (from the posterior margin of the orbit to the posterior margin of the arapace), using the measuring board, and vernier caliper. Measurements were taken to the nearest tenth of a centimeter. The body, abdominal, and cephalothorax weights were measured to the nearest hundredth of a gram using a top- loading Mettler balance (Model PE 1000). The dorsal and ventral spines were counted.

Analysis of Rostrum

Each specimen was held against lighted background and observation for the occurrence of the first dorsal spine (i.e those after the apical teeth) against those on the ventral side of rostrum a hand lens (10x) fixed at a point as well as running of pin along the edges of the rostrum. The angles corresponding to the relative position in which the dorsal and ventral spines align to each other was measured

using a protractor with one degree precision.

Statistical Analyses

Analysis of Variance (ANOVA) was performed to test for variations in the meristic and morphometry characteristics among the morphotypes. The General Linear Model (GLM) univariate measurement was carried out to check for influence of dorsal and ventral spine as basis of identification of the prawn into morphotypes. The data were further subjected to Hierarchical Clustering Analysis. All statistical analyses were carried out using the SPSS version 11 package.

Distance (Or Similarity) Matrix

The (dis)similarities between types were analysed by calculating Euclidean Distances for the identified groups using the Unweighted Pair Group Clustering Method.

Results

Morphotypes

Phenotypic data were acquired for 4010 specimens of *M. macrobrachion*. Meristic and morphometric data did not deviate significantly from the relatively small size reported particularly for the total length (Table1). Based on comparative relative position of dorsal and ventral spines of the rostrum, three morphotypes of the genus were identified for both sex and sampling stations. There were marked differences amongst the morphotypes (MT). MT I had the first dorsal spine occurring perpendicularly to the first ventral spine, MT II consist of those having the first dorsal spine at 30-45˚ to the first ventral spine and MT III were those with the second dorsal spine occurring at 90˚to those on the second ventral spine (Fig. 2a,b,c).

Meristic and Morphometric Data

Table 1 showed the meristic and morphometry of the groups. The MT I specimen were the biggest especially in term of total length, body weight and weight of the abdomen. The spination number for dorsal and ventral spines on the rostrum ranged from 8-14 and 4 -7 respectively. Similarly, MT I showed the widest variation and the highest value in the number of dorsal spine. MT III had the highest value and range in the case of the number of ventral spine. Generally, no significant differences (P>0.05) were recorded in the total length, body weight and weight of the abdomen in the years of study for the three morphotypes in the two locations.

Population structure

The females predominate over the males in the three morphotypes identified in this study. The sex ratios were 1:6.296, 1:5.382, 1: 5.350 respectively for MT I, II and III. In term of stock relative abundance, MT II was the highest representing 43.00% (n=1460) (Figure 2). The order of occurrence of other morphotypes were 32.00% (n=1090) and 25.00% (n=850) for MT III and MT I each.

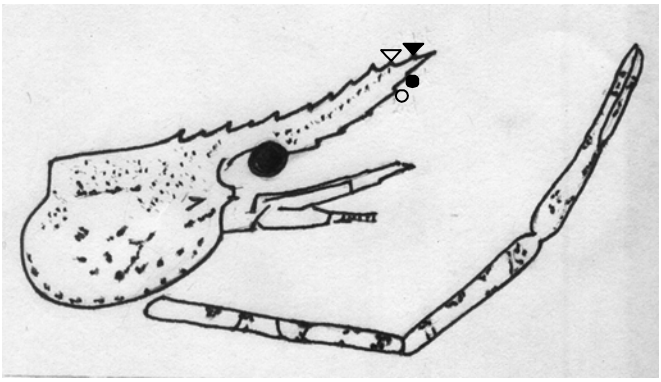


Fig. 2a: Morphotype I of *M. macrobrachion x*

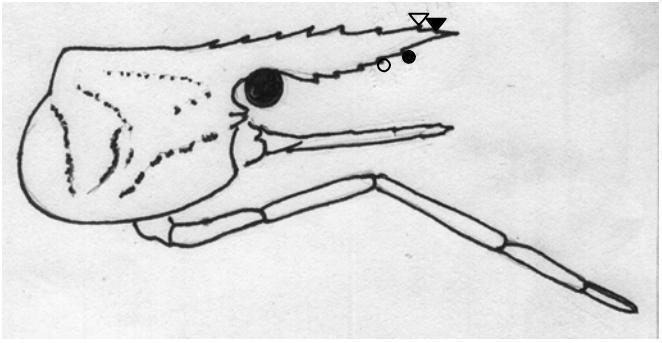


Fig. 2b: Morphotype II of *M. macrobrachion x*

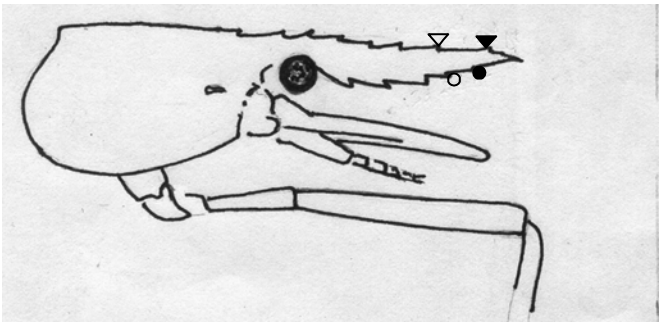
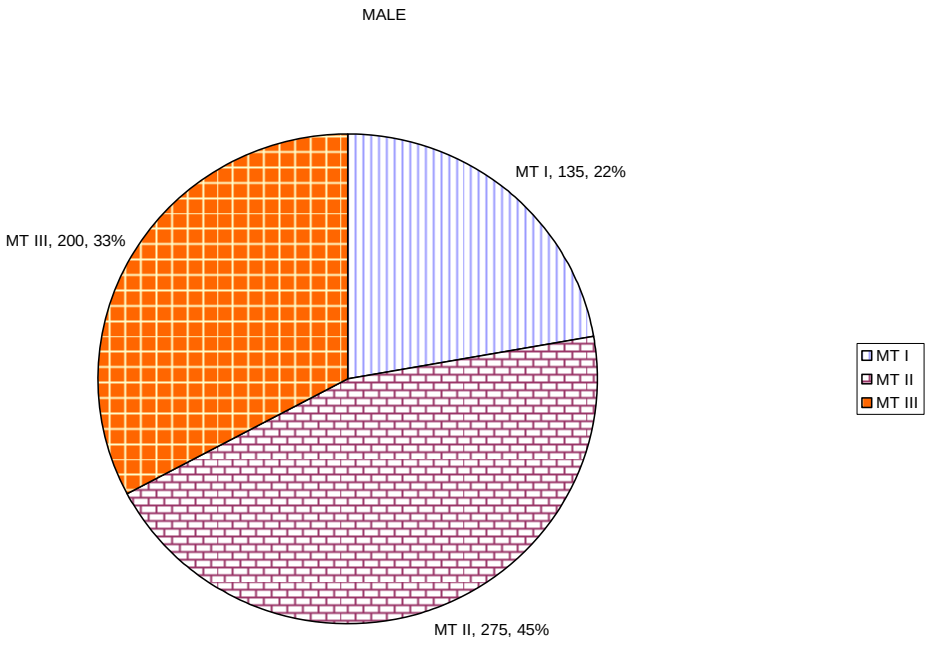


Fig. 2c: Morphotype III of *M. macrobrachion*

Table1: The meristic and morphometric values of the morphotypes of *M. macrobrachion*

	Morphotype I		Morphotype II		Morphotype III	
Meristic and morphometry parameters	Mean	Range	Mean	Range	Mean	Range
Total length (cm)	7.62±1.11^{ab}	4.00-12.20	7.48±0.90^{ab}	4.50-11.50	7.44±0.91^{ab}	4.90-14.00
Body weight (g)	4.83±3.07^{ab}	0.63-22.29	4.33±2.12^{ab}	0.65-18.56	4.24±1.83^{ab}	0.71-17.20
Rostral length (cm)	1.80±0.32^{a}	0.95-2.95	1.77±0.27^{a}	0.90-2.95	1.80±0.95^{a}	1.00-2.70
Carapace length (cm)	1.64±0.35^{a}	0.80-3.30	1.57±0.29^{a}	0.90-2.80	1.56±0.28^{a}	0.90-2.60
No. of Dorsal Spine	9.64±0.99^{a}	8-14	9.26±0.66^{a}	7-11	9.04±0.78^{a}	7-12
No. of Ventral Spine	5.33±0.55^{a}	4 -7	5.27±0.49^{a}	3-6	5.42±0.72^{a}	4-9
Weight of the cephalothorax (g)	2.28±1.65^{a}	0.26-12.57	2.13±1.41^{a}	0.25-12.30	2.02±1.16^{a}	0.08-12.02

N.B Numbers with a letter are significantly different (P<0.0001) between types. Double letters indicate no significance difference (P>0.05) between the years of study.



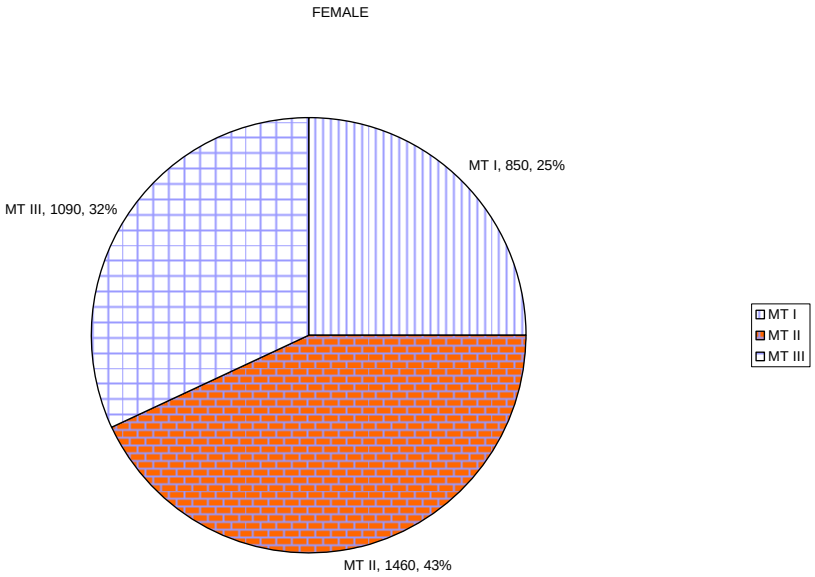


Figure 3a, b Sex distributions of morphotypes of *M. macrobrachion* in Badagry Creek

Univariate measurements

The meristic and morphometric variables namely, total length, body weight, rostral length and carapace length were treated as random variables while the number of dorsal and ventral spine were treated as covariates. The two groups of variables and morphotypes treated as the

(P=0.001). The total length and weight bear no significant effects in the classification of the prawn into morphotypes (P=0.076, 0.100). The partial Eta Squared values were higher in the number of dorsal spine and number of ventral spine and had interactive effects on the morphotypes respectively with values of 0.050, 0.031and 0.018. Lower values were obtained for total, rostral and carapace length, and body weight.

Morphotypes analyses

Classification results of dissimilarities (Euclidean distances) between the morphotypes, based on the SPSS dependent variable were nested in a GLM. Both number of dorsal spine (Type III Sum of Squares=100.797, df=7, F=29.336, P=0.001) and number of ventral spine (Type III Sum of Squares=62.265, df=5, F=25.371, P=0.001) had significant effects on the classification into morphotypes (model R^2=0.121) with significant interaction amongst the two variables proximity matrix, were ordinated through the Hierarchical Cluster Analysis (Table 2). The comparison of the morphotypes (using the meristic and morphometry data as variables) showed no grouping or clustering of samples between locations, whereas the morphotypes comparison (Table 1) revealed some separation among the morphotypes with large overlaps between these clusters. Morphotypes III were far off from others in both male and female (Table 2). The dissimilarities between the morphotypes are supported by dendrogram derived by the UPGMA method (Fig. 3 and Fig.4).

Table 2: Proximity Matrix showing the Euclidean distance (similarity or dissimilarity) in female and male morphotypes of *M. macrobrachion*

	Female			Male		
Case	MT I	MT II	MT III	MT I	MT II	MT III
MT I	.000	132.718	171.711	.000	20.761	51.340
MT II	132.718	.000	113.602	20.761	.000	41.264
MT III	171.711	113.602	.000	51.340	41.264	.000

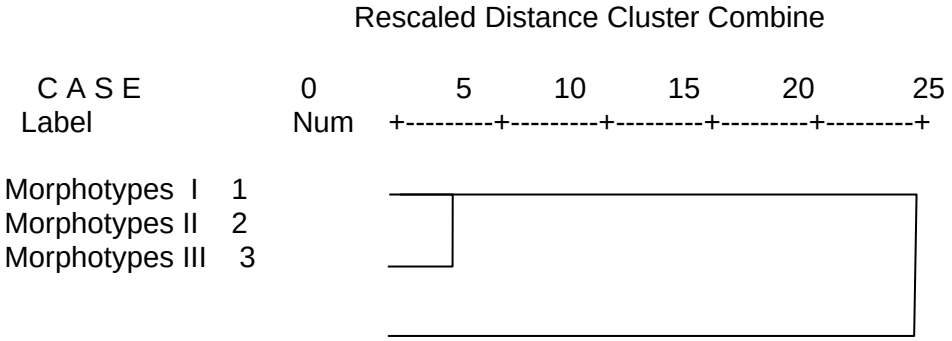


Fig.3: Dendrogram showing clusters from the morphotypes of Female *Macrobrachium macrobrachion*

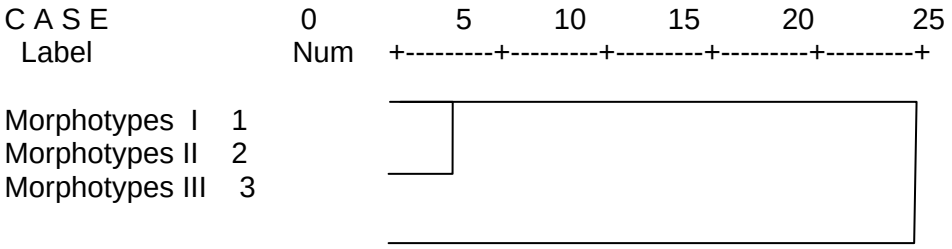


Fig.4: Dendrogram showing clusters from the morphotypes of Male *M. macrobrachion*

Discussion

The result from this study showed and confirms the usefulness in the order of arrangement of the spination of the dorsal and ventral teeth on the rostrum in identifying the prawn. The wide difference in the range observed in the number of dorsal and ventral spine amongst the morphotypes is indicative of the importance of the fixture in the measurement of the phenotypic differences in population of prawn. Also, the relatively small adult size recorded for the prawn in spite of the high significance difference ($P<0.05$) between morphotypes confirms the small size usually attained by the species.

Observed significant differences ($P<0.0001$) in the meristic and morphology of the rostrum and the carapace length as

against the insignificant differences ($P>0.05$) in the total length, body weight and weight of the abdomen among the morphotypes in the years of study further suggest an underlining influence the rostrum characteristics have on the arrays of the population.

The presence of the morphotypes in males and as well as in females (ninety-nine percent berried) suggests the possibility of each morphotypes being arrays of localized populations from different aquatic environments coming to the creek to breed during the breeding period and disperse afterwards. The prawns were found only during periods of brackish condition but not in freshwater condition (June-October). Climatic oscillation resulting in changed hydrological flood regimes had been observed to be capable of modifying levels of connectivity between populations of aquatic species (Carini, and Hughes, 2004).

The proximity matrix as well as the Euclidean distances showed great level of relatedness as distance between the morphotypes is relatively not far from one another suggesting a quite narrow difference amongst morphotypes or restricted gene flow resulting in differed phenotypic characteristics seen in the rostrum. Species belonging to multiple taxonomic groups are known to exhibit common spatial patterns of evolutionary subdivision occasioned by their being subjected to the same environmental history (Avise, 2000).

When data are collected for individual populations or species or any other subdivision it is possible to ask the question to what extent do the groups differ from each other. Morphotype, I and II showed closer phenotypic similarities while morphotype III showed more difference from others for both male and female of *M. macrobrachion* as seen in the dendrograms and proximity distance.

Morphotypic variations had been established in species of the genus *Macrobrachium* such as *M. rosenbergii* (Ra'anan and Cohen, 1985; Kuris et al. 1987). Such efforts were based on the morphology (coloration and spination) of the chelipeds. Observations from this study showed that significant variations (P=0.0001) in the morphology of the rostrum do occur within populations of a given species. Thus, differences in the morphology of the rostrum may be important in classification of the prawns into morphotypes beyond the present limiting of its use to defining species only.

The pattern of morphotypic development in the species was not established in this study. Such may be difficult compared to having the prawns monitored from a rearing unit (prawn farming is not yet established in Nigeria). Natural population of male *M. rosenbergii* showed wide variability (Karplus et al., 2000). The number of dorsal and ventral spines of the rostrum showed retrocession among the morphotypes in relation to phase progression. Karplus et al. (2000) reported obligatory progression in the morphotypes of *M. rosenbergii.* Furthermore, the relative adult size of the specimens ruled out the possible morphotypic differentiation based on pre-puberty or puberty molt reported by Hartnoll (1982) to be common attributes of the crustaceans.

The existence of these morphotypes has great implications in future development of aquaculture. The selection and management of broodstock must consider the sequence in the relative sizes attained (MT I> MT II> MT III) since prawns of bigger sizes reproduces better amongst many other enviable characteristics. Management processes compatible with the growth characteristics of the morphotypes have been developed for *M. rosenbergii* (Karplus et al., 2000; Tidwell et al., 2001).

In conclusion, while this study has only make a foray into the use of the observed small but constant difference in the arrangements of both dorsal and ventral spines of the rostrum in the taxonomy of the prawn, it has restricted the scope to suggesting that each morphotypes is of the same species. This is because of lack of study as to the level of possible gene isolation making it difficult to suggest divergence in the population to the extent of reproductive incompatibility.

References

Abegunde, M.A.A (2002). Aspect of the Physical Environment of Lagos. In History and People of Lagos state. (Eds. Adefuye, A; Agiri, B and Osuntokun, J.) *Lantern Publications limited*. 6-15p.

Avise, J. (2000). Philogeography. The History and formation of Species*, Harvard University Press:* Cambridge, MA, USA.

Carini, G., and Hughes, J.M. (2004). Population Structure of *Macrobrachium australiense* Decapoda:Palaemonidae) in Western Queensland, Australia: the role Contemporary and Historical Processes. *Nature*, Vol 93, No 4 pp 350-363.

Hartnoll, R.G. (1982). Growth. In: Bliss, D.E. (Ed.), The Biology of Crustacea. Embriology, Morphology and Genetics. *Academic Press,* New York, pp. 111 – 196.

Holthius, L.B. (1980). FAO Species Catalogue Vol. 1 Shrimp and prawns of the World. An Annotated Catalogue of species of Interest to Fisheries. *FAO Fisheris synopsis*. No. 125, vol. 1 261pp.

Hughes, J.M. and Hillyer, M. (2003). Pattern of connectivity among populations of *Cherax destructor (*Decapoda : Parastacidae) in Western Queensland, Australia. *J Marine Freshwater Res* 54: 1-10. Article.

Karplus, I., Malecha, S., Sagi, A., (2000). The biology and management of size variation. In: New, M.B.,Valenti, W.C. (Eds.), Freshwater Prawn Culture: the Farming of *Macrobrachium rosenbergii.* Blackwell, Oxford, pp. 254– 289.

Kuris, A.M., Ra'anan, Z., Sagi, A., Cohen, D., (1987). Morphotypic differentiation of male Malaysian giant prawns, Macrobrachium rosenbergii. *Journal of Crustacean Biology* 7, 219– 237.

Lee, C.L and Fielder, D.R. (1983). Agonistic behaviour and development of dominance hierarchies in the freshwater prawn, *Macrobrachium australiense* Holthius, 1950 (Crustacea:Palaemonidae). *Behaviour* 83: 1-17 *Macrobrachium amazonicum*. *Aquaculture,* 236 (2004) 297–307.

Marioghae, I.E. and O.A. ,Ayinla (1995). The reproductive biology and culture of *Macrobrachium vollenhovenii* (Herklots, 1857) and *Macrobrachium macrobrachion* (Herklots, 1851) in Nigeria. Technical Paper No 100 *African Regional Aquaculture Centre/Nigerian Institute for Oceanography and Marine Research* 16p.

Powell, C.B., (1982). Fresh and brackish water shrimps of economic importance in the NigerDelta. In Ita, E.O (ed). *Proc. 2nd Conf. Fish. Soc. Nigeria*. Pp 254-285.

Ra'anan, Z., Cohen, D. (1985). Ontogeny of social structure and population dynamics in the giant freshwater prawn, *Macrobrachium rosenbergii* (De Man). In: Wenner, A., Schram, F.R. (Eds.), *Crustacean Issues* 2: Crustacean Growth. A.A. Balkema, Rotterdam, pp. 277– 311.

Statistical Package for Social Science, SPSS (2001). SPSS for Window, Release 11 Standard Version, Copyright SPSS Incorporation, 1989-2001.

Tidwell, J.H., Coyle, S.D., Arnum, A.V., Weibel, C., D'Abramo, L., (2001). Use of artificial substrates to maximizing production of freshwater prawns *Macrobrachium rosenbergii* in temperate climates. *World Aquaculture* 32, 40– 42 (+ 60).

Webb, J.E. (1958). The lagoons of the Guinea coast. *Phil. Trans. Roy. Soc.* 241,307-18

*Dr. Akintola, S.L email: drsilfa@yahoo.com, Tel: 08038100507.