Brazilian Journal of Biological Sciences, 2017, v. 4, No. 7, p. 157-163.
ISSN 2358-2731
http://dx.doi.org/10.21472/bjbs.040716

Comparative morphometric characters of gladiator swimming crab *Callinectes pallidus* (Rochebrune, 1883) (Crustacea: Decapoda) from two coastal areas in Lagos Southwest Nigeria

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Abstract. The present study compared the morphometric characters of *Callinectes pallidus* (Rochebrune, 1883) (Crustacea: Decapoda) collected from two coastal areas in Lagos, Nigeria, as a measure of investigating the degree of susceptibility of the species to environmental stress. Thirteen different morphometric characters (distances) which included eye cavity length (ECL), inter-orbital distance (IOD), medial peduncle width (MPW), carapace total length (CTL), carapace total width (CTW), carapace final width (CFW), width of the joining between the propodus and the movable chela thigh (PCT), chela dactylus length (CDL), first movable chela width (FMW), 2nd, 3rd and 4th pereiopod merus width (PMW), merus length (ML), abdomen total length (ATL) and abdomen first suture width (AFW) were measured with precision calliper with an accuracy of 0.01 mm. Differences in mean morphometric distance were tested with T-test and Z-test while the standardized values were examined with fisher's linear discriminant function. 12 morphometric characters except MPW showed a significance different ($p < 0.05$) for male crabs between the sites while FMW only indicated no sites differences ($p > 0.05$) in female crabs examined. All the statistical tools employed clearly shown a great distinction in the growth of the crabs across the two sites. Therefore, this preliminary study concluded that *C. pallidus* from site 2 (Agbara) are more susceptible to environmental stress. However, further research is required to identify these environmental stressors.

Keywords: Crabs; Growth; Susceptible; Environmental stress.

Received
May 7, 2017

Accepted
June 27, 2017

Released
June 30, 2017

Open Acess
Full Text Article

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Introduction

Callinectes pallidus (Rochebrune, 1883) (Crustacea: Decapoda) is an economically viable crab in Nigeria which is often in abundance for sales in the open markets throughout the coastal towns of Lagos, southwest, Nigeria. This species inhabits both estuaries and inshore waters, habitats often susceptible to contamination from anthropogenic sources (Davis et al., 2005). Studies have been carried out on *C. pallidus* from different water bodies in Nigeria, which divulged its growth pattern per sex and its ability to bioaccumulate toxicants and endocrine disrupting

chemicals. Such reported studies include the work of Aruke et al. (2012), Aderinola et al. (2013), Daka and Ugbomeh (2013), Clarke et al. (2013).

However, to the best of our knowledge, no findings up to date, has been reported in Nigeria on the morphometric characters of *C. pallidus* from Iwaya (in Lagos Lagoon) and Agbara (in Ologe Lagoon). Therefore, this preliminary study aims at comparing the morphometric distances (characters) of *C. pallidus* from Iwaya and Agbara, as a possible measure of the degree of susceptibility to environmental stress.

Materials and methods

Study areas

The study site 1 (Iwaya) in Lagos Lagoon and site 2 (Agbara) in Ologe Lagoon are as shown in Figure 1. Iwaya is a highly populated town, located east of Lagos Lagoon and it's surrounded by several other densely populated towns such as Surulere, Yaba, Ijora and Kirikiri. The Lagoon is the main channel of waste disposal for Iwaya people. Majority of the people at Iwaya are Ilajes whose occupations are either traders, artisans, fish mongers or fishermen.

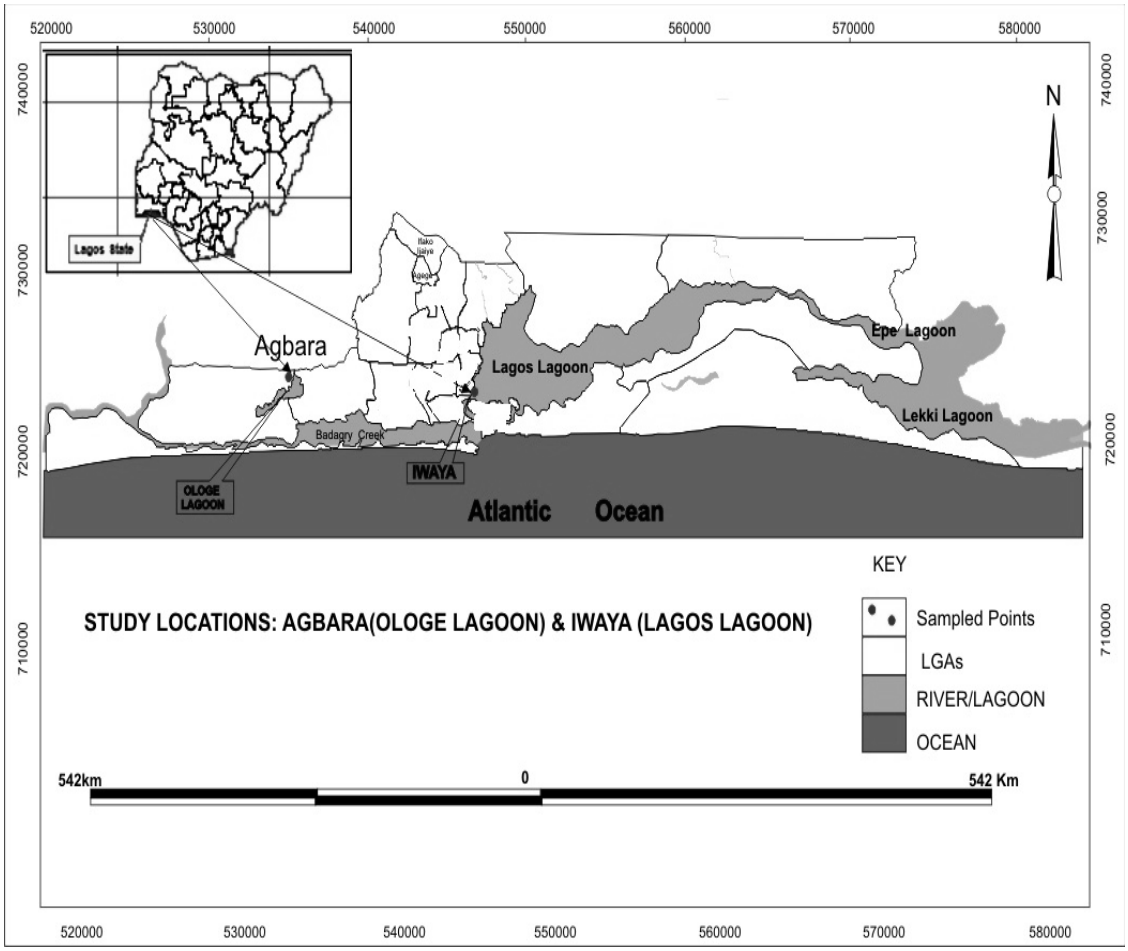

Figure 1. Map of Lagos Lagoon complex showing site 1 (Iwaya) and site 2 (Agbara).

Agbara, site 2, is an industrial area as well as residential with fewer population in comparison to Iwaya. It is located at the West of Ologe Lagoon along Badagry express way. Most of the population are industrialist while fewer are Ogus and Ewes fisher-folks.

Collection of specimens

A total of 560 specimens of *C. pallidus*, consisting of 280 male and 280 female crabs at each site were randomly and purposively collected alive from fisher folks at Iwaya water side (In Lagos Lagoon) and Agbara water side (In Ologe Lagoon) between April and October, 2012.

Specimens were sorted (purposively) by sex using the observation of the characteristics abdomen shapes and the appearance of the first 2 pairs of pleopod (modified of gonopods in males). Samples were frozen soon after collection and defrosted after four days for laboratory analyses, to ensure that all crabs were analysed following a similar period of freezing.

Measurement of the morphometric characteristics

Measurements generally followed the description by Duarte et al. (2008). Thirteen (13) different morphometric characters were measured and these included: Eye Cavity Length (ECL), Inter-Orbital Distance (IOD), Medial Peduncle Width (MPW), Carapace Total Length (CTL), Carapace Total Width (CTW), Carapace Final Width (CFW), Width of the joining between the Propoduc and the Movable Chela Thigh (PCT), Chela Dactylus Length (LDL), First Movable Chela Width (FMW), 2nd, 3rd and 4th Pereiopod Merus Width (PMW), Merus Length (ML), Abdomen Total Length (ATL) and Abdomen First suture Width (AFW). All the morphometric distances (characters) were measured with measuring tape and precision calliper with an accuracy of 0.01mm.

Statistical analysis

The differences of means morphometric distances of the crabs between the two sites were tested with t-test at significant level of $p < 0.05$, while the degree of significance were validated through Z-test.

The carapace total length was used as a standard length to determine the coefficient of variation of other morphometric characters for the two sites.

Because the goal of morphometrics is the study of size and shape variation, one of the basic steps often required is standardization for size (Avsar, 1994). Thus, the raw data were standardized according to description of Avsar (1994) to bring all the variables into proportions with one another and to be approximately equivalent to adjust for the disparity in the variable sizes. Afterward, the standardized values were tested with Fisher's Linear discriminant function and Wilk's Lambda statistics.

Results

Table 1 showed that the differences in the morphometric distances of male *C. pallidus* from Iwaya against the males from Agbara were statistically significant ($p < 0.05$) for 12 morphometric distance with the exemption of MPW ($p > 0.05$). Furthermore, the distinction in the morphometric distances of the females *C. pallidus* from Iwaya against the females from Agbara were not significant ($p > 0.05$) only for IOD, CTW, CFW and ATL.

The Z-test affirmed that all the 12 morphometric distances recorded among the male crabs are highly significantly different but MPW is greatly insignificantly different. Similarly, the differences in the morphometric distances among the female crabs of the two sites are highly significantly different except in FMW which showed that the two samples are marginally different.

Table 1. Summary of the morphometric measurements of *Callinetes pallidus* from Iwaya and Agbara.

Morphometric Characters	Iwaya		Agbara	
	Male (n = 140)	Female (n =140)	Male (n = 140)	Female (n =140)
ECL	54.84 ± 0.51	50.78 ± 0.47	49.53 ± 0.39	47.08 ± 0.39
IOD	24.08 ± 0.22	23.48 ± 0.25[a]	22.11 ± 0.36	18.23 ± 0.25[a]
MPW	16.67 ± 0.29[a]	17.52 ± 0.25	19.24 ± 0.28[a]	16.23 ± 0.30
CTL	108.84 ± 0.90	116.04 ± 0.97	102.29 ± 1.67	98.30 ± 1.62
CTW	63.00 ± 0.52	65.08 ± 0.54[a]	52.9 ± 0.91	47.00 ± 0.74[a]
CFW	36.04 ± 0.33	41.50 ± 0.34[a]	27.94 ± 0.54	31.00 ± 0.57[a]
PCT	11.94 ± 0.43	11.14 ± 0.27	9.82 ± 0.47	7.87 ± 0.19
CDL	33.92 ± 0.49	29.20 ± 0.55	24.88 ± 0.63	21.15 ± 0.09
FMW	8.14 ± 0.19	8.24 ± 0.17	5.59 ± 0.15	7.46 ± 0.27
PMW	18.66 ± 0.35	16.45 ± 0.29	12.35 ± 0.30	12.30 ± 0.27
ML	44.30 ± 0.57	34.74 ± 0.63	32.20 ± 0.93	26.69 ± 0.42
ATL	45.80 ± 0.38	45.88 ± 0.39[a]	38.64 ± 0.63	36.69 ± 0.45[a]
AFW	41.38 ± 0.38	42.26 ± 0.40	34.52 ± 0.64	34.30 ± 0.51

ECL = Eye Cavity Length, IOD = Inter Orbital Distance, MPW = Medial Peduncle Width, CTL = Carapace Total Length, CTW = Carapace Total Width, CFW = Carapace Final Width, PCT = Width of the Joining Between the Propodus and the Movable Chela thing, CDL = Chela Dactylus Length, FMW = First Movable Chela Width, PMW = 2nd, 3rd and 4th Pereiopod Merus Width, ML = Merus Length, ATL = Abdomen Total Length and AFW = Abdomen First Suture Width.

The summary of the ratios of other morphometric distances in Carapace Total Length (CTL) of *C. pallidus* from the sites are presented on Table 2. The ratio for the male crabs from the sites were distinct from one another with the exclusion of $\frac{ECL}{CTL}$, $\frac{IOD}{CTL}$, and $\frac{AFW}{CTL}$.

Also apart from $\frac{IOD}{CTL}$, $\frac{CFW}{CTL}$, $\frac{ATL}{CTL}$ and $\frac{AFW}{CTL}$ that are not distinct between the female crabs from the two sites, other ratios are very distinct.

Table 2. The ratios of other morphometric distances in carapace total length of *Callinetes pallidus* from Iwaya and Agbara

Morphometric Ratio/Variation	Male		Female	
	Iwaya	Agbara	Iwaya	Agbara
ECL:CTL	1:2	1:2	1:2	1:2
IOD:CTL	1:5	1:5	1:5	1:5
MPW:CTL	1:7	1:5	1:7	1:6
CTW:CTL	1:2	1:2	1:2	1:2
CFW:CTL	1:3	1:4	1:3	1:3
PCT:CTL	1:9	1:10	1:10	1:12
CDL:CTL	1:3	1:4	1:4	1:5
FMW:CTL	1:13	1:18	1:14	1:13
PMW:CTL	1:6	1:8	1:7	1:8
ML:CTL	1:2	1:3	1:3	1:4
ATL:CTL	1:2	1:3	1:3	1:3
AFW:CTL	1:3	1:3	1:3	1:3

ECL = Eye Cavity Length, IOD = Inter Orbital Distance, MPW = Medial Peduncle Width, CTL = Carapace Total Length, CTW = Carapace Total Width, CFW = Carapace Final Width, PCT = Width of the Joining Between the Propodus and the Movable Chela thing, CDL = Chela Dactylus Length, FMW = First Movable Chela Width, PMW = 2nd, 3rd and 4th Pereiopod Merus Width, ML = Merus Length, ATL = Abdomen Total Length and AFW = Abdomen First Suture Width.

The fisher's linear discriminant function coefficient of the two sites (Iwaya and Agbara) is shown in Table 3. All the morphometric distances except PMW and PCT had a very high coefficient for both sites. The test of equality of the group means through Wilk's Lambda is presented in Table 4. The smaller values of Wilk's Lambda indicate the variables are better at discriminating between groups. The table also suggests that MPW is least at discriminating between groups while CTL and CTW are the best.

Table 3. Fisher's linear discriminant functions coefficient.

	Site	
	Site 1	**Site 2**
ECL	215.575	224.665
IOD	31.212	26.551
MPW	68.120	72.339
CTL	135.883	117.211
CFW	87.972	70.476
PCT	-20.778	-22.893
CDL	61.986	46.698
FMW	38.427	33.869
PMW	13.921	9.066
ML	53.248	38.401
ATL	58.458	50.068
AFW	54.883	48.982
(Constant)	-648.931	-531.285

Table 4. Tests of Equality of Group Means.

	Wilk's Lambda	**F**	**df1**	**df2**	**Sig.**
ECL	.774	162.479	1	558	.000
IOD	.718	219.124	1	558	.000
MPW	.984	9.272	1	558	.002
CTL	.434	726.248	1	558	.000
CTW	.434	726.248	1	558	.000
CFW	.512	531.311	1	558	.000
PCT	.818	124.336	1	558	.000
CDL	.460	654.908	1	558	.000
FMW	.890	68.856	1	558	.000
PMW	.575	412.994	1	558	.000
ML	.532	489.979	1	558	.000
ATL	.724	212.900	1	558	.000
AFW	.600	371.487	1	558	.000

The accuracy of the model in separating site 1 from site 2 was cross validated as shown in Table 5. And this result showed that 98.4% of the cross-validated grouped cases are correctly classified while 1.6% are wrongly classified.

Table 5. Classification results[a,c].

		Site	Predicted Group Membership		Total
			Site 1	Site 2	
Original	Count	Site 1	280	.0	280
		Site 2	9	271	280
	%	Site 1	100.0	.0	100.0
		Site 2	3.2	96.8	100.0
Cross-validated[b]	Count	Site 1	280	.0	280
		Site 2	9	271	280
	%	Site 1	100.0	.0	100.0
		Site 2	3.2	96.8	100.0

[a]98.4% of original grouped cases correctly classified; [b]Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases than that case; c. 98.4% of cross validated grouped cases correctly classified.

Discussion

The results of the morphometric distances of male *C. pallidus* from Iwaya being significantly greater than the males counterpart from Agbara, agreed with the report of Brian et al (2006), Davis et al. (2005) and Møller (1998) that environmental disturbances can induce changes in same organism. The outstanding chela dimensions such as chela dactylus length (CDL) and the first movable chela width (FMW) of the male crabs from Iwaya which grew better than those males from Agbara also supported the report of Masunari and Swiech-Ayoub (2003).

Similarly, highly significantly bigger females recorded at Iwaya against Agbara also buttressed the findings of Aderinola et al. (2013) which reported that the females *C. pallidus* from Ojo Creek (a habitat often reported to be subjected to less anthropogenic disturbance) have viable morphometric distances. The ratios of the other morphometric distance to the carapace total length of the male and female *C. pallidus* from the two sites which revealed that those crabs from Iwaya grew better than crabs from Agbara, was also similar to the report of Brian (2005).

98.4% of the cross-validated grouped cases being correctly classified in this study suggest that there is a clear distinction between the *C. pallidus* from the two sites. And this current finding was similar to the report of Murta (2000) and Tudela (1999). The Wilk's Lambda analysis which affirm that all the variables except MPW discriminate significantly between groups, also indicate a relatively high degree of variance in the means of the crabs from the two sites. And this similar result has been reported by Bolles and Begg (2000). The lowest coefficient recorded in PMW and PCT for both sites as shown by fishers discriminant function coefficient analysis, implies that these two morphological features are not strong enough to differentiate crabs of one site from the other.

In summary, this present study has provided important morphometric information that showed a distinct variation between *C. pallidus* from two coastal areas in Lagos, Nigeria. Therefore, it could be concluded that *C. pallidus* from site 2 are more susceptible to environmental stress. However, further research is pertinent to investigate these environmental stressors.

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