PANAMJAS
Pan-American Journal of Aquatic Sciences

Interpopulational morphological analyses and fluctuating asymmetry in the brackish crab *Cardisoma guanhumi* Latreille (Decapoda, Gecarcinidae), on the Brazilian Northeast coastline

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Abstract. The brackish crab *Cardisoma guanhumi* Latreille, 1825 is an economically important species used for alimentation, commonly sold in open markets throughout Northern and Northeastern Brazil. It lives mainly in mangrove areas, which have been highly degraded because of misuse and inadequate settlement. In this study, morphometric data were obtained from segments and dorsal and ventral regions of 107 individuals from four brackish crab populations on Rio Grande do Norte coastline. The fluctuating asymmetry indexes and discriminant interpopulation morphological features in measurements at dorsal, ventral regions and pereiopods were defined. The presence of fluctuating asymmetry was found in the four first pairs of pereiopods and a correlation between sex and segments from the first pair of pereiopods and between population and segments in all pairs of pereiopods was observed. As for the discriminating model, the use of the eye cavity length variable allowed discriminating 82% of individuals. The results showed a strong correlation between variables and collection site, suggesting a natural grouping of individuals into two macroregions (Goianinha and Canguaretama, I; and Extremoz and Macau, II). The data show that this resource should not be exploited homogeneously, inasmuch as it apparently comprises structured populations of restricted range.

Key words: Guaiamum, blue land crab, morphometry, biological conservation.

Resumo. Análises morfológicas interpopulacionais e assimetria flutuante no caranguejo *Cardisoma guanhumi* Latreille (Decapoda, Gecarcinidae), na costa Nordeste do Brasil. O caranguejo *Cardisoma guanhumi* Latreille, 1825 é uma espécie economicamente importante, sendo explorado para alimentação e comercialização, em feiras livres no Norte e Nordeste do Brasil. Habita principalmente os manguezais, que se encontram em avançado estágio de degradação devido às formas inadequadas de uso e ocupação. Neste trabalho foram obtidos dados morfométricos da região dorsal, ventral e apêndices de 107 indivíduos de quatro populações do litoral do Rio Grande do Norte. Foram definidos os índices de assimetria flutuante, bem como padrões morfológicos interpopulacionais discriminantes em medidas da região dorsal, ventral e pereiópodos dos indivíduos. Foi demonstrada a presença de assimetria flutuante nos quatro primeiros pares de pereiópodos e correlação dos fatores sexo e segmentos no 1º par de pereiópodos e de população e segmento em todos os pares de pereiópodos. Quanto ao modelo discriminante, a utilização da variável comprimento da cavidade ocular, permitiu discriminar 82% dos indivíduos. Os resultados evidenciaram uma forte correlação das variáveis em relação à região de origem, sugerindo um agrupamento natural dos indivíduos em duas macrorregiões (Goianinha e Canguaretama, I; e Extremoz e Macau, II). Os dados indicam que este recurso não deve ser explorado de forma homogênea tendo em vista que representam, aparentemente, populações estruturadas e de âmbito restrito.

Palavras-chave: Guaiamum, caranguejo, morfometria, conservação biológica.

Introduction

Brazilian mangroves are distributed from Oiapoque (04°30'N; Amapá) to Laguna (28°30'S; Santa Catarina), comprising 6,800 Km along the coast and 25,000 Km² (Novelli 1989).

The State of Rio Grande do Norte is located in the Northeastern coast, encompassing about 400 km of seashore, with mangroves along its northern and northeast coastal zones. The northern seashore - estuarine zone of Mossoró river, Piranhas-Açu river - and the estuarine system Guamaré-Galinhos make up an area of 3,034 ha. The northeastern seashore - estuarine zone of Maxaranguape river, Ceará-Mirim river, Potengi-Jundiaí river, Piranhas river and the estuary–lagoon complex of Nísia Floresta, Papeba, Guaraíras and the estuaries Jacu and Curimataú–Cunhaú rivers – cover an area larger than 8,898 ha. The mangrove total area in Rio Grande do Norte is about 11,992 ha. On the northeastern seashore, more dense and larger mangrove areas can be found, such as the ones from Curimataú–Cunhaú river, with 3,100 ha and Potengi–Jundiaí river, with 1,530 ha. On the northern seashore, the biggest mangrove is located in the estuary of Piranhas–Açu river, with 1,230 ha, characterizing the Macau region (Souza 1996).

Special attention has been given to ecological studies in estuaries, and efforts have been developed for a better and a reasonable use of the natural resources found in such environment (Nascimento 1980). These surveys are justified since estuaries are among the most affected areas by both natural changes and human activities (IDEC 1993).

Along northeastern Brazil, particularly in Rio Grande do Norte, the mangroves are usually deforested for implantation of salt mines, shrimp farms and oil extraction. On the northern and northeastern shores, salt mines, sugar cane industries, fishing and *in natura* dumping of domestic and industrial sewage also contribute to their degradation status. Currently, the urban expansion and the growth of shrimp farming represent the most important causes of negative impacts on mangroves (Freire 1993). Nonetheless, they are considered environments of high diversity, with a rich and commercially exploited fauna, chiefly related to collection of mollusks and crustaceans.

The brackish crab *Cardisoma guanhumi* (Latreille 1825) has a semi-terrestrial, nocturnal and gregarious life mode and presents a wide geographic distribution (i.e. Florida, Bermudas, Gulf of Mexico, Antilles, Colombia, and Venezuela up to Brazil). In Brazil, this species can be found from Ceará state (3º45'47''S 38º31'23''W), until Santa Catarina (27º35'36''S 48º35'56''W).

It lives mainly in mangroves, where they build galleries open to receive sea water (Melo 1996). This species is economically important and commonly sold at large scale in open markets in northeastern Brazil. Although there are no specific populational records, the uncontrolled extractivism of this species incur the ecologic unbalance in some mangrove zones. Thereby, strategies of stock protection must be defined.

Morphological analyses were able to inform about distinct features of crustacean population and species (Sullivan 1998, Brian 2005). Some studies demonstrate that the expression of inter-population variability in the crab morphology has both environmental and genetic components that need to be accounted for in population-level research (Brian *et al* 2006) or product of ecogenesis (Daniels *et al* 1998, 2001).

Most individuals present bilateral symmetry and their random deviation are called fluctuating asymmetry (FA) (Møller 1998). The fluctuating asymmetry level provides relevant information about individual performance in relation to its development (Pravosudov & Kitaysky 2006) working as a useful tool to evaluate the quality or developmental instability of individuals in association with environment (Zakharov & Yablokov 1990, Li 2001, Petavy *et al*. 2006) and genetic stress (Leary & Allendorf 1989, Palmer 1996, Møller 1998). Some results suggest that traits with relaxation of selection for functionality exhibit higher FA (Crespi & Vanderkist 1997).

In the present work, we carried out morphological analyses within and among *Cardisoma guanhumi* populations from mangroves on the Brazilian Northeast coastline, in order to evaluate the presence of populational differences based on morphological analyses of locomotion and body structures and fluctuating asymmetry.

Materials and Methods

Samples of *C. guanhumi* (brackish crab) were collected alive in four mangrove areas – Macau (5º 06' 56" S - 36º 38' 08" W), Extremoz (5º 42' 20" S - 35º 18' 26" W), Goianinha (6º 15' 53'' S - 35º 12' 45'' W), and Canguaretama (06° 13' 13.4'' S - 35° 08' 32.7'' W), in Rio Grande do Norte State (Figure 1). After manual collecting, the animals were placed in tanks, separated by collection site, numbered according to the place they were collected and sex, and then preserved in plastic bags at -20º C for further measurements. The samples were randomly taken, comprising 107 adult individuals of both sexes, divided into four populations: Goianinha (G), with 27 individuals (14 ♂ and 13 ♀); Extremoz (E) with 29 individuals (13 ♂ and 16 ♀); Macau (M) with 31 individuals (21 ♂ and 10 ♀) and Canguaretama (C), with 20 individuals (16 ♂ and 4 ♀).

Dorsal and ventral regions, as well as segments, were measured in centimeters using a digital caliper (0.01mm precision). Absolute values for each individual were calculated based on the mean of two repeated measurements. The data were ordered in tables and further analyzed through statistical packages. All the measures (Figure 2) were obtained with replicates by the same person and the following nomenclature was used to identify the measures in this study:

Dorsal Region

CTL	Carapace total length
CTW	Carapace total width
CFW	Carapace final width
ECL	Eye cavity length
IOD	Inter orbital distance
MPW	Medial peduncle width

Ventral Region

ATL	Abdomen total length
ASW	Abdomen first suture width

Pereiopods

CW	First movable chela width
CJW	Width of the joining between the propodus and the movable chela thigh
CDL	Chela dactylus length
RMC/LMC	Right and left major movable chela
MW	2nd, 3rd and 4th pereiopod merus width
ML	2nd, 3rd and 4th pereiopod merus length

The fluctuating asymmetry (AF) was calculated as proposed by Palmer & Strobeck (1986), disregarding the influence of individual segment size, in which the mean inverse ponderate asymmetry was used: $AF_i=R_i-L_i/(R_i+L_i)/2$. Where L_i corresponds to the mean left segment and R_i the mean right segment.

This method was chosen because of the possibility to correct the measurements of each individual, once the sample is composed of heterogeneous elements. Initially, the mean of two measures was calculated (left and right side) for each sampled individual and then a Multivariate Analysis of Variance (MANOVA) test was applied on repeated measures about the response vector comparing different populations. The response vector comprised the width and length measurements (RCW, LCW, RCJW, LCJW, RCDL, LCDL, RMC, LMC, RMW, LMW, RML, LML) taken from the pair of pereiopods (1st, 2nd, 3rd and 4th). The first letters used in the measurements abbreviations above (R and L) correspond to right and left side, respectively.

The effects of population (G, E, MA and C), sex (male and female) and segment (CW, CJW, CDL, MC, MW and ML) and side (R and L) as well as the mean profile of measurements per population, sex and side were also analyzed. Complementary tests were incorporated in order to identify the morphometrical differences among the several groups studied. Variance analyses and the use of Pearson's correlation coefficient, besides discriminating function and main component analyses were employed to detect variation in quantitative characters and possible distinctive features among populations by using Statistica V7 (Statsoft).

Figure 1. Collection sites of *Cardisoma guanhumi* in Rio Grande do Norte State, Brazil.

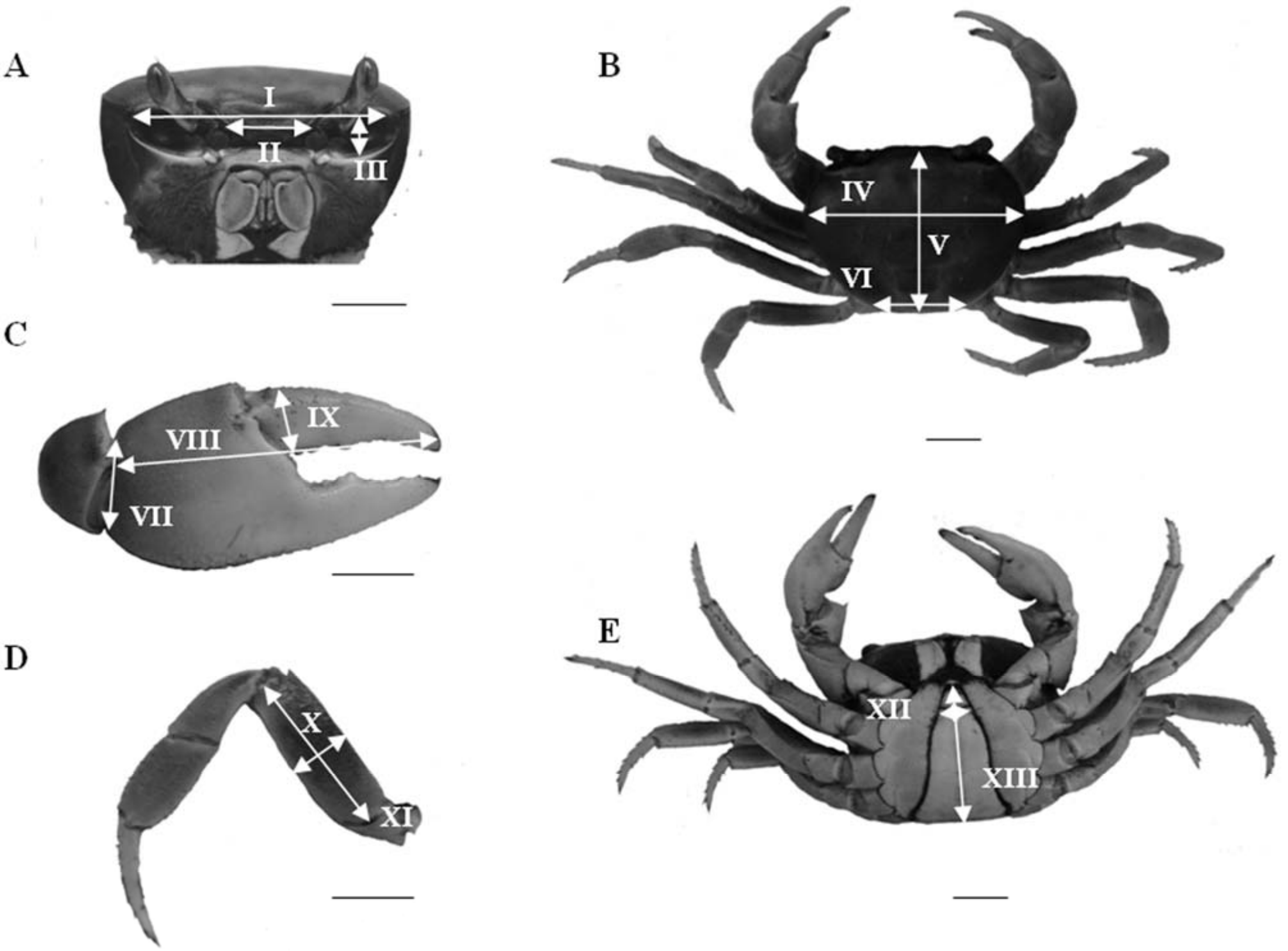

Figure 2. Corporal measures analyzed in *C. guanhumi* populations. Dorsal region. (A-I) Eye cavity length; (A-II) Inter orbital distance; (A-III) Medial peduncle width; (B-IV) Carapace total length; (B-V) Carapace total width; (B-VI) Carapace final width. Major chela. (C-VII) Width of the joining between the propodus and the movable chela thigh; (C-VIII) Chela dactylus length; (C-IX) First movable chela width. Pereiopod. (D-X) 2nd, 3rd and 4th pereiopod merus width; (D-XI) Merus length. Ventral region. (E-XII) Abdomen total length; (E-XIII) Abdomen first suture width. Bars = 2 cm.

Results

Fluctuating asymmetry analysis was performed in a sample of 107 individuals of brackish crab, distributed in four populations, from which two measurements were taken in each studied segment and side, resulting in a mean value. Aiming to measure the effects of *population*, *sex*, *segment* and *side*, besides estimate the mean measurements for each population and sex, a MANOVA model with repeated measurements was adjusted to the sample at issue, which results can be observed in Table I.

A significant effect of *population* and *segment* and their interaction was observed concerning the four first pairs of pereiopods. In addition, *sex* and its interaction with *segment* and *population* were also significant in the 1st pair of pereiopods. In all cases, *side* presented no significant effects, thus characterizing fluctuating asymmetry in the pairs of pereiopods.

Effect and factor-interaction tests by MANOVA, with repeated measures, were performed on the variables regarding individual's morphology. Information about dorsal and ventral regions was taken as demonstrated in Tables II and III.

Based on the results, a significant effect of population over all measurements can be suggested, revealing that populations of *C. guanhumi* present distinctive morphological characteristics.

The frequencies of the major movable chela in each body side and sex were established, as shown in Table IV.

Table IV shows that right-sided major chelas were present in 51.40% of crabs. In females, this structure occurred in a frequency of 45.7% on the left side. There was a regular distribution of this feature in females, giving rise to a proportion of 1:1 related to the body side, whereas in males this relation was 1:1.52. Some individuals presented symmetrical chelas, more frequent in females (10.8%), but this condition was not observed in Canguaretama sample.

Table I. Effect tests and interaction between factors, through MANOVA, with repeated measures, regarding 1st, 2nd, 3rd and 4th pereiopod pair.

Pereiopods	Factor	Factor Effect		Experimental Error		F test	P value *
		DF	MS	DF	MS		
1st pair	Population	3	5.446	96	0.241	22.535	0.000
	Sex	1	2.211	96	0.241	9.151	0.003
	Segment	2	158.292	192	0.036	4343.611	0.000
	Population x Segment	6	0.737	192	0.036	20.231	0.000
	Sex x Segment	2	0.709	192	0.036	19.476	0.000
2nd pair	Population	3	1.583	95	0.136	11.631	0.000
	Segment	1	474.191	95	0.116	4058.323	0.000
	Population x Segment	3	1.132	95	0.116	9.696	0.000
3rd pair	Population	3	2.124	94	0.128	16.496	0.000
	Segment	1	657.078	94	0.064	10126.206	0.000
	Population x Segment	3	0.989	94	0.064	15.242	0.000
	Sex x Segment	1	0.263	94	0.064	4.064	0.046
4th pair	Population	3	2.039	85	0.136	14.912	0.000
	Segment	1	518.278	85	0.077	6678.164	0.000
	Population x Segment	3	1.071	85	0.077	13.800	0.000

DF = Degrees of freedom; MS = Mean square; (*) significant if P <0.05.

Table II. Effect and interaction test between factors by MANOVA, with repeated measures, regarding the dorsal region.

Measure	Factors	Factor Effect		Experimental Error		F test	P value*
		DF	MS	DF	MS		
CTL	Population	3	4.234	99	0.212	19.931	0.000
	Sex	2	0.101	99	0.212	0.476	0.491
	Population x Sex	2	0.014	99	0.212	0.067	0.976
CTW	Population	3	4.642	99	0.251	18.478	0.000
	Sex	1	0.198	99	0.251	0.789	0.376
	Population x Sex	3	0.042	99	0.251	0.169	0.916
CFW	Population	3	0.607	99	0.035	17.221	0.000
	Sex	1	0.202	99	0.035	5.742	0.018
	Population x Sex	3	0.013	99	0.035	0.378	0.768
ECL	Population	3	2.854	99	0.134	21.200	0.000
	Sex	1	0.019	99	0.134	0.147	0.702
	Population x Sex	3	0.020	99	0.134	0.152	0.928
IOD	Population	3	0.242	99	0.017	13.844	0.000
	Sex	1	0.004	99	0.017	0.248	0.619
	Population x Sex	3	0.002	99	0.017	0.169	0.916
MPW	Population	3	0.005	99	0.000	15.423	0.000
	Sex	1	0.000	99	0.000	0.080	0.776
	Population x Sex	3	0.000	99	0.000	1.264	0.290

DF = Degrees of freedom; MS = Mean square; (*) significant if P <0.05. CTL = Carapace total length; CTW = Carapace total width; CFW = Carapace final width; ECL = Eye cavity length; IOD = inter orbital distance; MPW = Medial peduncle width.

Table III. Interaction tests between *population* and *sex* by MANOVA regarding body ventral region.

Measure	Factor	Factor Effect		Experimental Error		F test	P value*
		DF	MS	DF	MS		
ATL	Population	3	1.489	99	0.100	14.827	0.000
	Sex	1	0.876	99	0.100	8.728	0.003
	Population x Sex	3	0.006	99	0.100	0.068	0.976
ASW	Population	3	1.985	99	0.171	11.582	0.000
	Sex	1	41.378	99	0.171	241.427	0.000
	Population x Sex	3	0.424	99	0.171	2.475	0.065

DF = Degrees of freedom; MS = Mean square; (*) significant if P<0.05. ATL = Abdomen total length; ASW =Abdomen first suture width.

The correlation coefficient between the measures taken from dorsal (CTL, CTW, CFW, ECL, IOD and MPW) and ventral (ATL and ASW) regions of *C. guanhumi* was very high, indicating a correlation among all the variables. Table V shows significant correlation values among all the variables, except for first suture abdomen width, which presented a lower correlation than the others, however also significant.

This result suggests that it is possible to work with a single factor to infer the whole variance pattern. To test this hypothesis, a factorial analysis was performed, showing that the first seven features can properly represent the variables. In this case, the variable abdomen first suture should be excluded, because it is influenced by the sex of individual.

The communalities elicited from the variables showed the amount of the original variable behavior that is shared as a resulting factor behavior, named *size*. 97.4% of the *eye cavity length* variable behavior is shared with the elicited factor. Thus, the behavior of the elicited single factor represents 90.6% of the behavior of the seven original variables (Table VI).

Main component analyses

The largest individuals were observed in Extremoz sample and the smallest ones in Goianinha. Figures 3 and 4 show the pattern of variables separated according to the collection site. There was a wider variation range in individuals from Canguaretama, virtually in all variables, except for abdomen first suture width. The results suggest that individuals from Goianinha and Canguaretama compose a single group (macroregion I), without significant differences among them. Individuals from Macau and Extremoz would comprise another group (macroregion II).

Such differentiation allowed us to define a discriminating pattern between the macroregions. The specimens from macroregion I were smaller than those in the macroregion II. The discriminating model, using all the eight variables, classified correctly 83.2% of the original cases and 78.5% of cases in crossed validation. Using the stepwise procedure, we observed that it is not necessary to use all the original variables. A model using just the *eye cavity length* variable is able to classify correctly 82.2% of the original cases and 82.2% of cases in crossed validation. Thus, the origin of an individual, related to its macroregion, can be predicted by measurements of the *eye cavity length* in order to calculate the discriminant function values. If this value is higher than -0.0925, the specimen would belong to macroregion II (Extremoz and Macau); if lower, it would be related to macroregion I (Goianinha and Canguaretama).

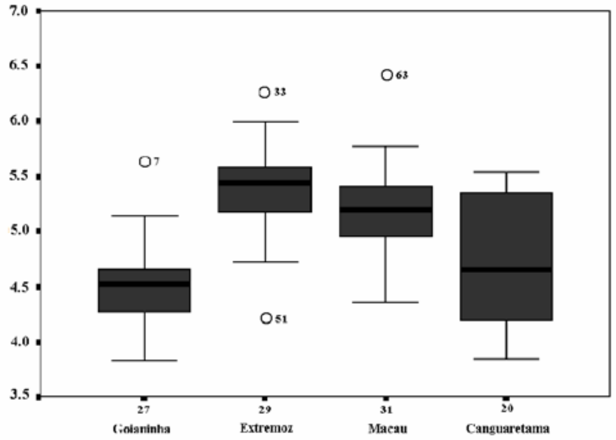

Figure 3. Morphological interpopulation analysis of the *carapace total length*.

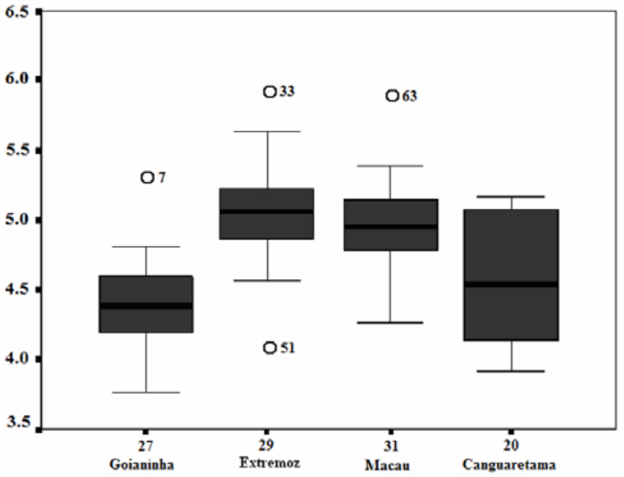

Figure 4. Morphological interpopulation analysis of the eye cavity length.

Discussion

The exoskeleton of crabs provides a rich source of biological information. Recent studies have detected extensive phenotypic variability in shore crabs within relatively restricted geographical areas (Bentley *et al*. 2002, Brian 2005, Lye *et al*. 2005). For example, specimens collected from locations around the coast of the UK have been found to differ in terms of their morphology (Brian *et al*. 2006).

The male crab uses the dominant chela as a sexual ornament and as a weapon, in addition to being a feeding structure (Mariappan *et al*. 2000). The lack of a predisposition to the occurrence of major chela in a specific body side in *C. guanhumi*, for both sexes, differs from previous reports on the crab *Carcinus maenas*, which showed a preferential occurrence of right-sided chelas (Sneddon & Swaddle 1999). These data show that the presence of a highly developed chela in *C. guanhumi* constitutes

Table IV. Distribution of major chela frequency in relation to sex in *Cardisoma guanhumi*.

Sex / Majorchela	Males	%	Females	%	Total	%
Right side	35	57.4	20	43.5	55	51.3
Left side	23	37.7	21	45.7	44	41.2
Symmetrical	3	4.9	5	10.8	8	7.5
Total	61	100.0	46	100.0	107	100.0

Table V. Pearson's correlation coefficient for all sampled elements.

		Carapace total length	Carapace total width	Carapace final width	Eye cavity length	Inter orbital distance	Medial peduncle width	Abdomen total length	Abdomen first suture width
Carapace total length	Coef	1	0.972	0.926	0.987	0.861	0.893	0.916	0.365
	Sig.	.	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Carapace total width	Coef	0.972	1	0.902	0.975	0.859	0.877	0.883	0.340
	Sig.	0.000	.	0.000	0.000	0.000	0.000	0.000	0.000
Carapace final width	Coef	0.926	0.902	1	0.925	0.809	0.838	0.96	0.605
	Sig.	0.000	0.000	.	0.000	0.000	0.000	0.000	0.000
Eye cavity length	Coef	0.987	0.975	0.925	1	0.877	0.89	0.915	0.391
	Sig.	0.000	0.000	0.000	.	0.000	0.000	0.000	0.000
Inter orbital distance	Coef	0.861	0.859	0.809	0.877	1	0.783	0.808	0.327
	Sig.	0.000	0.000	0.000	0.000	.	0.000	0.000	0.000
Medial peduncle width	Coef	0.893	0.877	0.838	0.89	0.783	1	0.821	0.372
	Sig.	0.000	0.000	0.000	0.000	0.000	.	0.000	0.000
Abdomen total length	Coef	0.916	0.883	0.96	0.915	0.808	0.821	1	0.625
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	.	0.000
Abdomen first suture width	Coef	0.365	0.34	0.605	0.391	0.327	0.372	0.625	1
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.

Table VI. Communality values elicited from *C. guanhumi* interpopulational samples.

Baselines	Initial	Elicited communalities	Factorial charge
Carapace total length	1.000	0.970	0.985
Carapace total width	1.000	0.944	0.972
Carapace final width	1.000	0.913	0.955
Eye cavity length	1.000	0.974	0.987
Inter orbital distance	1.000	0.808	0.899
Medium peduncle width	1.000	0.838	0.915
Abdomen total length	1.000	0.896	0.947

a sexual dimorphism between males and females, but its localization (right or left body side) appears to neither influence the adaptive coefficient nor the sexual selection in this species.

On the other hand, the presence of symmetric chelas in 4.9% of males and in 10.8% of females, representing 7.47% of all individuals, could be an effect of the genetic factors associated to development of this structure or to influence of sex-related genes. The lower frequency of this feature in males might represent a less adaptive condition, caused by a lower copulation, feeding or defense performance (intra and interspecific interactions).

Over the last two decades there has been a growing increase in the use of biological monitoring methods to investigate the environmental quality. The developmental instability of an organism can be measured according to fluctuating asymmetry, defined as a random deviation from perfect bilateral symmetry of morphological traits, caused by genetic and environment disturbances (Møller 1998). This procedure has been successfully applied to detect stress in natural populations (Palmer & Strobeck 1986, Leary & Allendorf 1989, Zakharov 1992, Palmer 1996, Møller 1999).

The asymmetry observed in the first pair of pereiopods showed a significant sex-related effect, without any significance of this factor over other pereiopods. The evidences of asymmetry observed in the 2nd, 3rd and 4th pairs of pereiopods reveal the interaction between asymmetry and *population* and *segment* as well as between both factors, with no significance related to sex. The association between asymmetry magnitude and *side* was not detected.

Studies on marine shrimp species have not been concordant when it comes to the association between fluctuating asymmetry and sex. Thus, while Maia (2002) evaluating fluctuating asymmetry levels in *L. schmitti*, observed a similar fluctuating asymmetry index among sexes, Silva (2001) verified that females of *L. vannamei* were more asymmetric than males.

Under a genetic point of view, high inbreeding rates have been associated to developmental instability increases in different organisms (Lacy 1996, Eldridge 1999). In crustaceans, the relationship between fluctuating asymmetry and endogamy remains poorly understood. Silva (2001) observed that highly endogamic broodstocks of the captive-reared marine shrimp, *Litopenaeus vannamei,* presented high asymmetry levels and a higher number of locomotion appendages. Fluctuating asymmetry was also found in locomotion appendages within wild populations of *Litopenaeus schmitti* from Northeastern Brazil (Maia 2002), however in a significantly lower level than that observed for the congeneric species *L. vannamei* under intense captive breeding.

Besides providing information about fluctuating asymmetry, population morphological studies like those carried out in crabs of the genus *Uca* (Filho 1990) or fish species (Smith 1973, Kerby 1979) can be helpful to define stocks as well as taxonomic status.

According to Reis (1988), the discriminating pattern among populations and species can be ascertained through discriminating functions using canonical variables. Another multivariate technique, the main component analysis, is more suitable to study evolutionary biology issues. Main component method basically analyses the relationship between a set of correlated variables, transforming them into a new set of noncorrelated variables, so-called the main components.

A morphometric discrimination study in two fish species of the genus *Leporinus* found a very high vectorial correlation coefficient among the elements (Reis *et al.* 1987). In this study, the two samples were regarded as a homogeneous group according to main component analysis, but the results indicated the presence of two distinct groups corresponding to *L. trifasciatus* and *L. macrocephalus.* Both species were completely discriminated by free-size independent components.

In the present study, the variation observed among *C. guanhumi* populations, allowed us to differentiate them into two groups represented by the samples from Goianinha and Canguaretama (macroregion I) and Extremoz and Macau (macroregion II). Different causes can be involved in the definition of a smaller body size in macroregion I, such as particular environmental conditions, pollution or a greater selective pressure (exploitation) on larger individuals.

The correlation between the differences in the level of morphological and genetic similarity in geographical distinct populations of crabs suggests that the phenotypic characteristics can be related to patterns of genetic variability (although this relationship is not necessarily causal) (Brian *at al*. 2006). So, the present result in *C. guanhumi* populations could also indicate the presence of independent and structured populational stocks, with a possible restricted gene flow, despite the absence of visible physical barriers among them.

As for the group classification, two factors have significantly contributed to the inclusion of an individual in one of the groups, *eye cavity* and *carapace total length.* These features can, therefore, be used as practical tools in the environmental monitoring and analyses of collected animals concerning biological conservation programs.

The populations that presented the higher size variation were those from macroregion I (Goianinha and Canguaretama) and, based on these data, it is possible to infer that the variation observed might be related to either overfishing (selective collection) or intrinsic biological characteristics of these populations.

Genetic analyses must be carried out in *C. guanhumi* populations as a complementary way to identify a possible phenotypic correlation with interpopulational genetic differ-rentiation, contributing to the establishment of exploitation and management policies of this natural resource.

Acknowledgements

We would like to thank CNPq, CAPES and Universidade Federal do Rio Grande do Norte for the financial support and for providing the facilities and proper conditions for the accomplishment of the present survey.

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Received June 2008
Accepted September 2008
Published online September 2008