RELATIVE GROWTH OF *GONIOPSIS CRUENTATA* (CRUSTACEA, BRACHYURA, GRAPSIDAE), ON THE UBATUBA REGION, SÃO PAULO, BRAZIL

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ABSTRACT

Relative growth analyses had specially focused the determination of size at sexual maturity by means of evidencing the puberty molt. Description of relative growth patterns in *Goniopsis cruentata* (Latreille, 1803), and the estimation of the onset of morphological sexual maturity was studied. Monthly surveys were conducted from June 1992 to July 1993. Crabs were hand captured by three people during 1 h sample effort, in an estuarine area in the Ubatuba region, São Paulo, Brazil (23°29'24"S; 45°10' 12"W). Measurements of carapace width and length (CW and CL), abdomen width (AW), chelar propodus height (CPH) and gonopod length (GL) in males, were recorded. Regressions were performed according to the general relative growth formula $y= a.x^b$. A student's t-test was applied to evaluate statistically the allometric growth constant (b). Different population groups were considered: young and adult males, young, pre-pubertal and adult females. The morphometric relations of the carapace showed a tendency to isometry. In females the abdominal width grow in positive allometry: young b= 1.35; pre-pubertal b= 1.58 and adult b= 1.38. In males, the growth of gonopod showed a positive allometry, for youngs (b= 1,64) and an isometric relation in adult phase (b= 0,957). This trend reflects an energetic budget allocation biased towards reproduction rather than growth purposes after the puberty molt.

KEYWORDS. Grapsidae, *Goniopsis*, allometric growth, puberty molt.

INTRODUCTION

Literature devoted to relative growth in Brachyura approach the mathematical theory and the principles of allometry (Huxley, 1950; Teissier, 1960; Hartnoll, 1982), besides the aspects related to the determination of size at the onset of sexual maturity (Weymouth & MaCkay, 1934; Gore & Scotto, 1983; Haefner, 1990). Observed variability in growth patterns between mature and immature growth phases and within sexes are a result of relative development

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differences of certain structures (HARTNOLL, 1974).

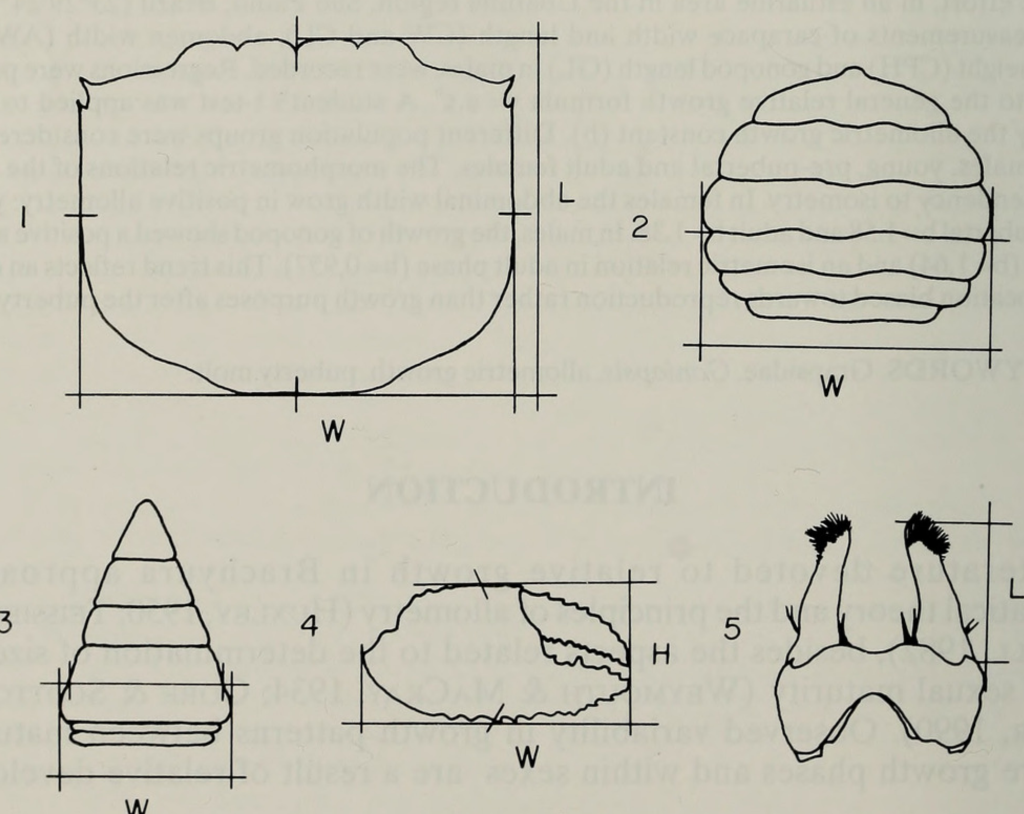
Relative growth studies of brachyurans from São Paulo State Coast, emphasized the attainment of sexual maturity, e.g. PINHEIRO & FRANSOZO (1993) who studied the portunid *Arenaeus cribrarius* (Lamark, 1818), MANTELLATO & FRANSOZO (1994) on *Hepatus pudibundus* (Herbest, 1785), HIYODO & FRANSOZO (1995) reagarding the spider crab *Acantonyx scutiformis* (Dana, 1851) and SANTOS **et al.** (1995) on *Portunus spinimanus* Latreille, 1819.

The present study intended to describe the relative growth patterns of *Goniopsis cruentata* (Latreille, 1803). Also, the transition interval between immature and mature growth phases in allometric relationships were assessed, as an attempt to estimate the size at the onset of morphological maturity.

MATERIAL AND METHODS

According to MELO (1996) the geographical range of *Goniopsis cruentata* is restricted to the Occidental Atlantic, from Florida (USA), Bermuda, Gulf of Mexico, Central America, South America; in Brazil, the species was recorded from Fernando de Noronha to Santa Catarina State.

During this study, monthly samples from June 1992 to July 1993 were conducted in a mangrove area, located between Comprido and Escuro rivers (23° 29' 24" S, 45° 10' 12" W), Fortaleza Bay, Ubatuba, SP. Crabs were hand captured by three people during 1 h sample effort collections, and placed in individual bags which were freezed afterwards and defrosted prior to laboratory analyses. A vernier caliper was used to measure the carapace width (CW), length (CL), abdomen width (AW) and chelar propodus height (CPH) in all crabs. The gonopod length of males was measured with the aid of a stereomicroscope provided with a camera lucida (figs. 1-5).



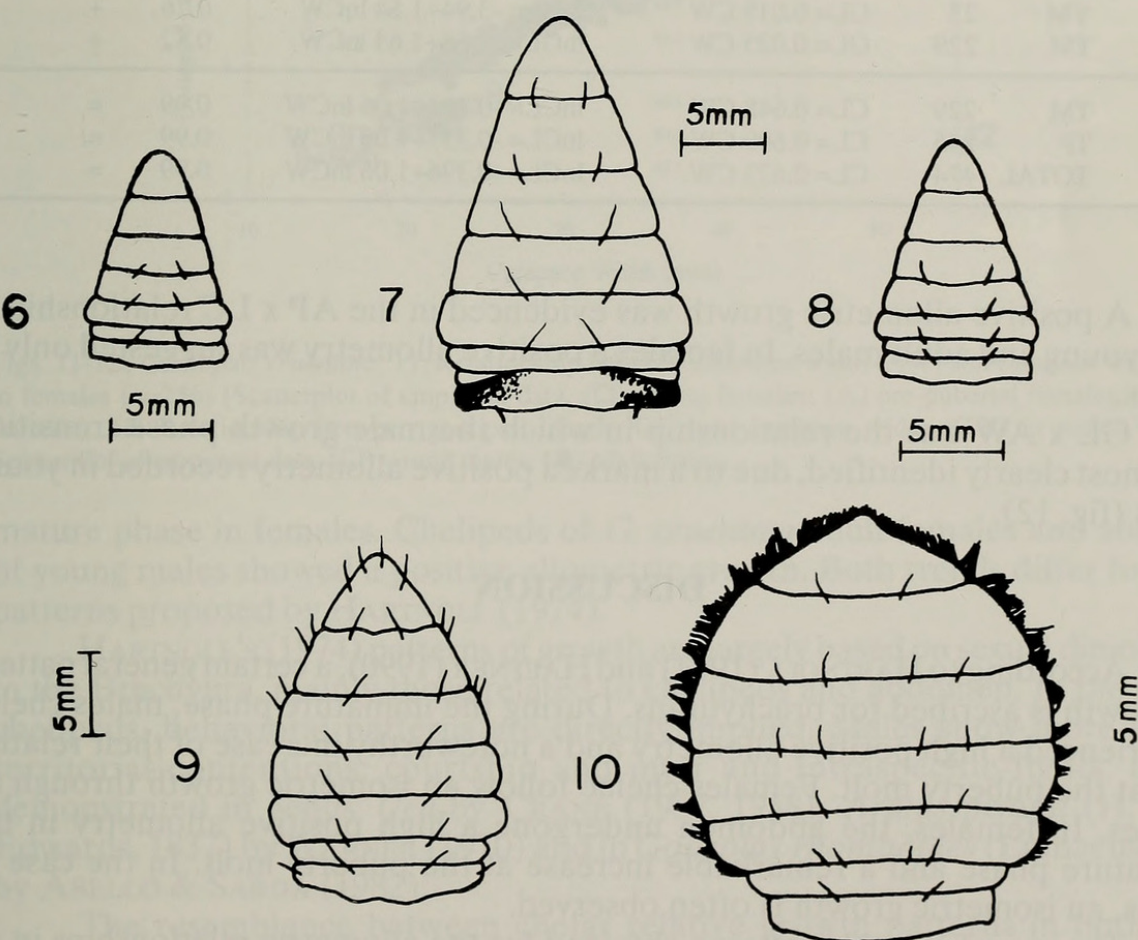
Figs. 1-5 . *Goniopsis cruentata*, measurements: 1, length and width (L,W) of carapace; 2, width of female abdome; 3, width of male abdome; 4, height and width (H,W) of propodus; 5, lenght of gonopod.

The general relative growth formula, **y= a.x**^{b} (HUXLEY, 1950; TEISSIER, 1960; HARTNOLL, 1974, 1982) was used, in which **(y)** represents the dimension under analysis (dependent variable), **(a)** is the intersection, **(b)** the allometric growth constant and **(x)** a dimension regarded as size (independent variable). The relative growth coefficient, **(b)** was statistically evaluated in all resulting relationships by means of a student's t-test at the 5% significance level.

RESULTS

A total of 474 crabs were obtained during the study period. In order to analyze the relative growth relationships, males were differentiated in young and adult, and females were distinguished in young, pre-puberal and adult, regarding their abdominal external morphology (figs. 6-10, tab. I).

Carapace growth, as expressed in the CW x CL relationship, is isometric and continuous in all relationships performed, suggesting that a single allometric relationship must be applied for each sex. AW x CW relationships evidenced a positive allometric growth in all female groups (fig.11). In males, a positive allometry was only recorded in the young, while adults presented an isometric abdominal growth.



Figs. 6-10 . *Goniopsis cruentata*, shape of abdome: 6, young male; 7, pre-pubertal female; 8, young female; 9, adult male; 10, adult female.

Table I. Regression analysis of the morphometric data of *Goniopsis cruentata*, on the Ubatuba region, SP/ Brazil. (AM= adult male; YM= young male; TM= total male; AF= adult female; PPF= pre-pubertal female; YF= young female and TF= total female) (AW= abdome width; PH= propodus heigth; GL gonopod length; CL= carapace lenght. (=) isometry (+) positive alometry.

Variable	Group	N	y=a.x^b	lny=lna+b.lnx	r^2	Alometry
AW	AM	206	$AW=0.442\ CW^{0.964}$	lnAW=-0.816+0.964 lnCW	0.96	=
	YM	23	$AW=0.182\ CW^{1.50}$	lnAW= -1.70+1.25 lnCW	0.92	+
	TM	229	$AW=0.321\ CW^{1.06}$	lnAW= -1.14+1.06 lnCW	0.97	=
	AF	207	$AW=0.165\ CW^{1.38}$	lnAW= -1.80+1.38 lnCW	0.83	+
	YF	13	$AW=0.147\ CW^{1.35}$	lnAW= -1.92+1.35 lnCW	0.91	+
	PPF	25	$AW=0.078\ CW^{1.58}$	lnAW= -2.54+1.58 lnCW	0.83	+
	TF	245	$AW=0.106\ CW^{1.50}$	lnAW= -2.25+1.50 lnCW	0.93	+
PH	AM	206	$PH=0.058\ CW^{1.51}$	lnPH= -2.85+1.51 lnCW	0.90	+
	YM	23	$PH=0.138\ CW^{1.21}$	lnPH= -1.98+1.21 lnCW	0.95	+
	TM	229	$PH=0.365\ CW^{1.46}$	lnPH= -2.67+1.46 lnCW	0.94	+
	AF	232	$PH=0.134\ CW^{1.22}$	lnPH= -2.00+1.22 lnCW	0.83	+
	YF	13	$PH=0.210\ CW^{1.03}$	lnPH= -1.56+1.03 lnCW	0.93	=
	TF	245	$PH=0.127\ CW^{1.24}$	lnPH= -2.06+1.24 lnCW	0.92	+
GL	AM	206	$GL=0.272\ CW^{0.957}$	lnGL= -1.30+0.95 lnCW	0.94	=
	YM	23	$GL=0.019\ CW^{1.64}$	lnGL= -3.94+1.64 lnCW	0.76	+
	TM	229	$GL=0.025\ CW^{1.63}$	lnGL= -3.68+1.63 lnCW	0.82	+
CL	TM	229	$CL=0.648\ CW^{1.06}$	lnCL= -0.434+1.06 lnCW	0.99	=
	TF	245	$CL=0.699\ CW^{1.05}$	lnCL= -0.337+1.05 lnCW	0.99	=
	TOTAL	474	$CL=0.673\ CW^{1.06}$	lnCL= -0.396+1.06 lnCW	0.99	=

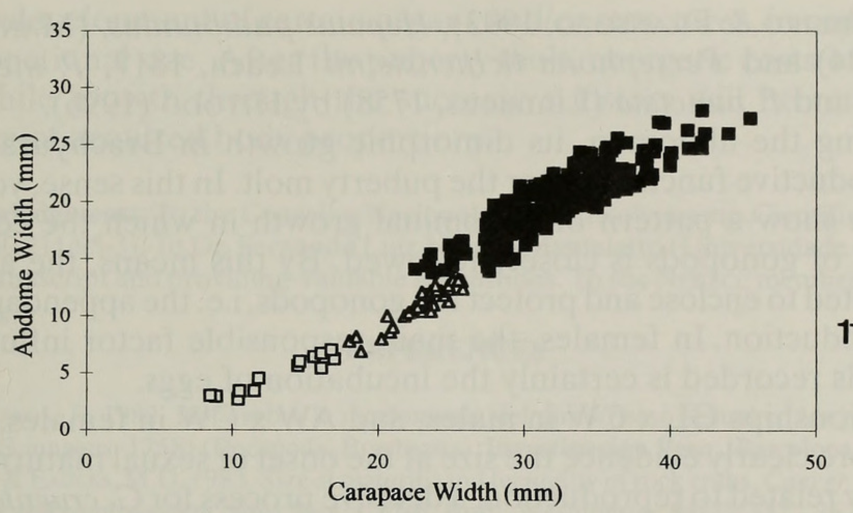
A positive allometric growth was evidenced in the AP x LC relationship in both young and adult males. In females a positive allometry was suggested only in adults.

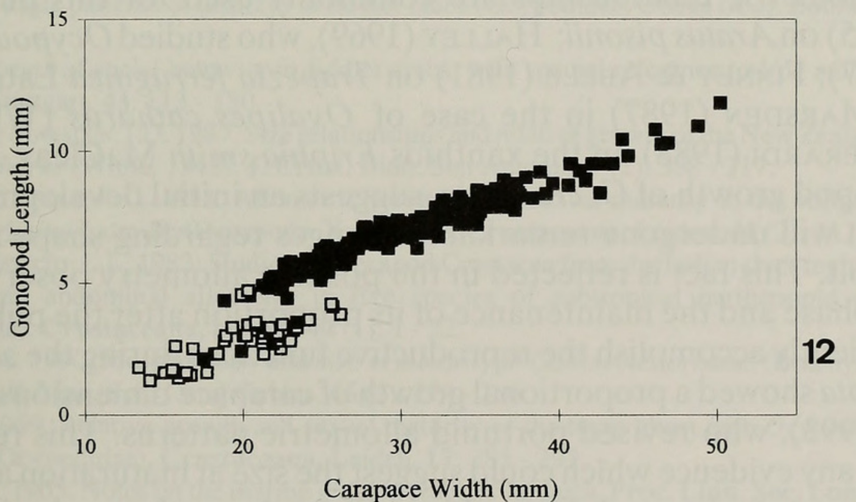
GL x AW was the relationship in which the male growth phase transition was most clearly identified, due to a marked positive allometry recorded in young crabs (fig. 12).

DISCUSSION

According to HARTNOLL (1974) and HAEFNER (1990), a certain general pattern of growth is ascribed for brachyurans. During the immature phase, males chelae experienced a high positive allometry and a noteworthy increase of their relative size at the puberty molt. Females chelae follow an isometric growth through all phases. In females, the abdomen undergone a high positive allometry in the immature phase and a remarkable increase at the puberty molt. In the case of males, an isometric growth is often observed.

The morphometric patterns obtained for the allometric relationships in *G. cruentata* are similar to those proposed by HARTNOLL (1974) for brachyuran crabs, except for some differences concerning the immature phase in males and the





Figs. 11-12. *Goniopsis cruentata:* 11, Relationship between abdomen width (AW) and carapace width (CW) in females (n=256) (Scatterplot of empirical data. (□) young females; (△) pre-pubertal females; (■) adult females). 12, Relationship between gonopod length (GL) and carapace width (CW) in males 9n=268). Scatterplot of empirical data. (□) young males; (■) adult males.

mature phase in females. Chelipeds of *G. cruentata* adult females and abdomen of young males showed a positive allometric growth. Both trends differ form the patterns proposed by HARTNOLL (1974).

HARTNOLL's (1974) patterns of growth are largely based on sexual dimorphism in the Brachyura, mainly those related to chelipeds and abdomen. In the case of chelipeds, behavioral patterns are directly implied. Males show more intense territorial contentions, courtship and inter and intraspecific fights, as well demonstrated in genus *Uca* by CRANE (1957, 1958), *Aratus pisonii* (H. Milne Edwards, 1837) by WARNER (1970) and in *Goneplax rhomboides* (Linnaeus, 1758) by ABELLÓ & SARDÁ (1982).

The resemblance between chelar relative growth patterns in both sexes suggests that behavioral displays in males and females should be similar, which could explain the parity of the allometric values obtained. This supposition is supported by similar morphometric data obtained by other authors, e.g. *Arenaeus* *cribrarius*, (PINHEIRO & FRANSOZO, 1993), *Hepatus pudibundus*, (MANTELATTO & FRANSOZO, 1994) and *Persephona lichtensteinii* Leach, 1817, *P. mediterranea* (Herbst, 1794) and *P. punctata* (Linnaeus, 1758) by HIYODO (1996).

Concerning the abdomen, its dimorphic growth in Brachyura is usually related to reproductive functions after the puberty molt. In this sense, young males of *G. cruentata* show a pattern of abdominal growth in which the concomitant transformation of gonopods is closely followed. By this means, the abdomen is continuously fitted to enclose and protect the gonopods, i.e. the appendages directly related to reproduction. In females, the main responsible factor influencing the allometric levels recorded is certainly the incubation of eggs.

The relationships GL x CW in males, and AW x CW in females, are surely those which more clearly evidence the size at the onset of sexual maturity, because they are directly related to reproduction, a decisive process for *G. cruentata* success. This sort of allometric relationships are commonly used for this purpose, e.g. HARTNOLL (1965) on *Aratus pisonii*; HALLEY (1969), who studied *Ocypode quadrata* (Fabricius, 1787); FINNEY & ABELE (1981) on *Trapezia ferruginea* Latreille,1825; DAVIDSON & MARSDEN (1987) in the case of *Ovalipes catharus* (White,1843); VANNINI & GHERARDI (1988) on the xanthids *Eriphia smith* MaCleay, 1838.

The gonopod growth of *G. cruentata*, suggests an initial development of this structure which will undergone remarkable changes regarding shape and size at the puberty molt. This fact is reflected in the positive allometry observed during the immature phase and the maintenance of its proportion after the puberty molt, in order to efficiently accomplish the reproductive functions during the adult phase.

G. cruentata showed a proportional growth of carapace dimensions as verified by PINHEIRO (1993), who revised portunid allometric patterns. This relationship did not showed any evidence which could suggest the size at maturation attainment, or indicated an eventual sexual dimorphism. From the analyses obtained, it can be concluded that the size at the onset of maturity in males and females is slightly different. It may occur between 20 and 24 mm CW in males and 18 and 29 mm CW in females.

Size ranges as those observed herein are common, and may be due to intrinsic plasticity of organisms or influenced by environmental factors such as temperature, pluviosity, photoperiod, food availability and others (CAMPBELL & EAGLES, 1983). Likewise, differences of size at sexual maturity between sexes are not unusual and have been verified in other species, e.g. *Trapezia ferrugina* studied by FINNEY & ABELE (1981); in *Sesarma reticulatum* (Say, 1817) by SEIPLE & SALMON (1987) and for *Callinectes ornatus* Ordway, 1863, by HAEFNER (1990). This feature is certainly associated to species-specific reproductive strategies, in which the available number of mature females is maximized.

It is admitted that the growth pattern of *G. cruentata* tends to a positive allometry during the immature phase of development, a trend that was not applied to all mature relationships. This fact suggests that differences in the allometric levels should be concentrated in the young-adult transition range. Therefore, energy partitioning should be biased towards reproduction after the puberty molt. In contrast, during the immature phase the energetic budget is mainly directioned towards the development of certain organs and/or structures, in order to attain an adequate functional size. After the puberty molt, energetic costs of reproduction increase, while growth through the successive instars will be restricted to the maintenance of acquired body proportions.

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