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Growth of the Hermit Crab *Clibanarius vittatus* (Bosc, 1802) (Crustacea, Anomura, Diogenidae) at São Vicente, São Paulo, Brazil

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ABSTRACT

The present study analyzed the growth of males and females of the hermit crab Clibanarius vittatus *(Bosc, 1802), at São Vicente, São Paulo, Brazil. Monthly collections were made from May/2001 through April/2003, at the Pescadores Beach in São Vicente. The 2,501 crabs caught were identified and sexed and the carapace shield length (CSL) was measured. For the seasonal growth study, the population was divided into 5mm size classes (CSL) and analyzed by the Bertalanffy method, with the aid of the program Fisat II. The mean sizes of the 703 males and 1,798 females were 8.94±1.80 and 6.61±1.13 mm, respectively. A season al growth pattern was observed, with males reaching an asymptotic size (14.92 mm) larger than that of females (13.85 mm). Males began the growth process approximately five months before the females. This growth pattern probably helped to reduce intraspecific competition for the shells, because the males reached larger size and made the smaller shells available to the females.*

Key words: Growth, Anomura, *Clibanarius*, Crustacea, hermit crab

INTRODUCTION

Like other arthropods, the crustaceans have discontinuous growth, which is directly related to the molt process. Hermit crabs are decapod crustaceans that have the abdomen decalcified and use shells of gastropod molluscs for the protection. Thus, they require progressively larger shells as they grow. This need for shells can impede, or retard the growth (Markham, 1968; Fotheringham, 1976a and Fotheringham, 1976b), because there are often no shells available of an appropriate size for the hermit crabs. Angel (2000), studying *Pagurus longicarpus* (Say, 1817), recorded this negative effect caused by the too-tight shells. Studies of the growth in anomurans, although still few, are highly important for understanding the population aspects (recruitment, maturation, reproduction) and the influence of the shells on the biology of the animals. The method of Bertalanffy (1938) is the most-often used to describe crustacean growth, relating the size and age of the individuals in the population.

Studies on the hermit crabs included those of Manjón-Cabeza and García Raso (1994 and 1998) carried out on *Cestopagurus timidus* (Roux, 1830) and *Diogenes pugilator* (Roux, 1829) in Spain. On the Brazilian coast, Turra and Leite (2000) described the growth of the hermit crabs *Clibanarius vittatus* (Bosc, 1802), *Clibanarius sclopetarius* (Herbst, 1796) and *Clibanarius*

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antillensis (Stimpson, 1859) on the coast of São Sebastião, and Mantelatto et al. (2005) studied the growth of *Pagurus brevidactylus* (Stimpson, 1859).
The present study analyzed the growth of the males and females of the hermit crab *Clibanarius vittatus* (Bosc, 1802) in the region of São Vicente, São Paulo, Brazil.

MATERIAL AND METHODS

The hermit crabs were captured by two people during ten minutes at low tide, monthly from May 2001 to April 2003, at the Pescadores Beach (23º 58' 21'' S - 46º 23' 35'' W). All the individuals were sexed and their carapace shield length (CSL) was measured with a caliper to the nearest 0.1 mm. For the growth analysis, the animals were separated according to sex, using size classes of 5 mm CSL. The sampled hermit crabs were grouped in 3-month due to low monthly number of individuals, therefore, monthly analyses of the cohort was insufficient for the better statistical analyses.
To estimate the recruitment period and the Bertalanffy (1938) curve, the program FISAT II (Gayanilo et al., 2002) was used. The analyses of the modal progression were performed according to the routine proposed by Bhattacharya, with subsequent analysis of the progression of the means. Following equation was used for the seasonal growth [$L_t = L_\infty\{1\text{-}e^{-k(t\text{-}to)\text{-}(CK/2\pi)[sen2\pi(t\text{-}WP+0,5)\text{-}sen2\pi(to\text{-}WP+0,5)]}\}$, where L_t was the size of the individuals at time t, L_∞ corresponded to the asymptotic size, k was the growth constant, t_o was the initial sample, C was the amplitude of seasonal growth, and WP was the estimate of the annual period of the least growth (both the parameters varied between 0 and 1)]. The parameters were obtained by the Appeldoorn's method. To compare the growth between the sexes, was used the *ø'* Index of Munro and Pauly (1983) as modified by Sparre (1987).

RESULTS

A total of 2,501 individuals were collected: 703 males (8.94±1.80 mm CSL) and 1,798 females (6.61±1.13 mm CSL). The percentage of the continuous recruitment was low, although the recruitment intensity increased from December through March, resulting in an annual cohort. There were six coexisting cohorts for both the sexes (Fig. 1).
The parameters of the Bertalanffy curve are shown in Table 1. The males reached a size at L_∞ (14.92 mm) higher than that of the females (13.85 mm). In both the sexes, there was a strong seasonal influence (C) on the growth. In Fig. 1, this influence (WP) is clearly evidenced by a higher growth rate in the period between July and February and between November and April for the males and females, respectively. Also, there was a reduction in the growth rate with increasing size in both the sexes (Fig. 1).

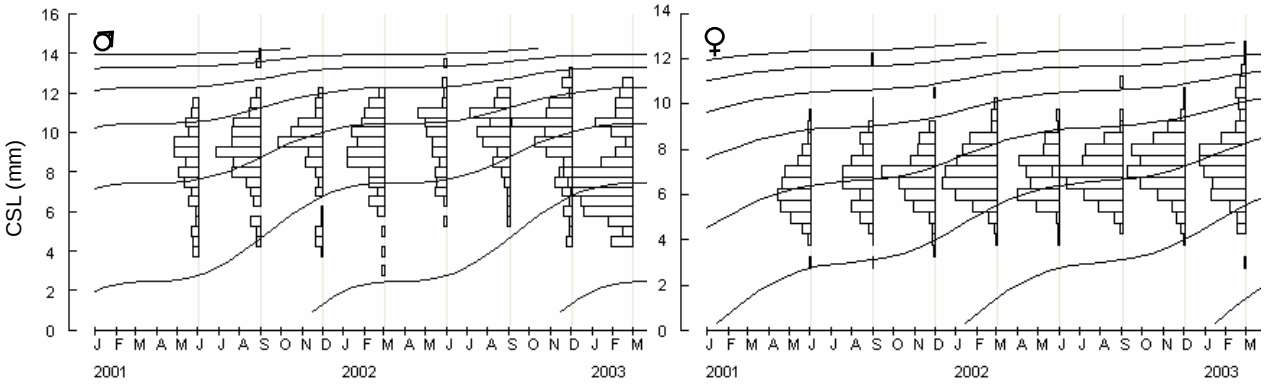

Figure 1 - *Clibanarius vittatus*. Size-frequency distributions and Bertalanffy curves for males and females collected at São Vicente, São Paulo

DISCUSSION

The population studied showed lower growth constants (k) and larger maximum asymptotic sizes (L_∞) and longevity than other populations of the same studied by Turra and Leite (2000). This resulted in similarity in growth among these populations, as shown by the $ø'$ index (Table 1). Nevertheless, in the present study, *C. vittatus* showed proportionally higher growth than observed in other hermit crabs of smaller size, *Cestopagurus timidus* (L_∞ = 3.25 mm; k = 0.041; $ø'$ = 0.84) and *Diogenes pugilator* (L_∞ = 4.70-5.08mm; k = 0.14-0.27; $ø'$ = 1.15-1.53), studied by Manjón- Cabeza and García-Raso (1994 and 1998, respectively). The low percentage recruitment recorded in this study was probably a function of the migration of the ovigerous females to higher-salinity locations. As Lowery and Nelson (1988) observed, higher-salinity waters were necessary for the development of the eggs of *C. vittatus*. In laboratory experiments, Young and Hazlett (1978) found that salinities of 25 to 35 ‰ were optimal for the metamorphosis of larvae into the juvenile crabs in this species. As described by Sant'Anna et al. (2006), the mean salinity in this estuarine region (28.42±4.50‰, varying from 20 to 35‰), was inside the result of Young and Hazlett (1978); however, throughout the year the salinity was variable, below this limits.

Growth was similar for the males and females, as observed for *D. pugilator* by Manjón-Cabeza and García-Raso (1998). The difference between the sexes in the growth period observed in the present study must be related principally to the competition for the shells among the animals. According to Sant'Anna et al. (2006), the males and females in this region used mainly shells of *Stramonita haemastoma* (Linaneus, 1767) with intense competition between the same-sized females and males for the available resource. In this situation, because the males reach a larger size and begin their growth period approximately five months before the females, the males made available smaller shells and, thus, reduce the intraspecific competition for the shells.

The relationship between the hermit crabs and shells is complex, i. e., the shell form may case modifications in the format of the body (Blackstone, 1985), to affect its survival, fecundity and growth (Angel, 2000). However it has been supported that the males of *C. vittatus* reach bigger size than females (Lowery and Nelson, 1988; Reigada and Santos, 1997; Sant'Anna et al., 2006). The shell utilized by males and its pattern of growth indicated that they could be limited for the absence of bigger shells in the environment and, therefore, used bigger shells when they were available. This was observed to the results of Sant'Anna et al. (2005) whose described big size males using shells of the terrestrial gastropod *Achatina fulica* Bowdich, 1822, that was bigger and lighter than *S. haemastoma* shells, and possibility the males continued the growth rate.

Table 1 - Parameters of the Bertalanffy curve (L_∞ = asymptotic size (mm), k = growth constant, C = amount of seasonal growth, *WP* = estimate of annual period of least growth, *Long*= longevity (months), *Recruit* = recruitment period, $ø'$ = index of Munro and Pauly, 1983).

Species	Sex	L_∞	k	C	*WP*	*Long*	*Recruit*	$ø'$	Reference
C. vittatus	males	14.92	0.51	0.98	0.23	60	Dec-Mar	4.73	present study
	females	13.85	0.40	0.77	0.57	66	Dec-Mar	4.34	
C. vittatus	-	10.67	0.96	1.0	0.7	42	May-Jun	4.69	Turra and Leite (2000)
C. antillensis	-	7.39	0.60	1.0	0.9	48	Feb-Jun	3.49	
C. sclopetarius	-	12.70	0.65	0.9	0.78	47	Apr	4.65	

RESUMO

O presente estudo teve como objetivo analisar o crescimento de machos e fêmeas do ermitão *Clibanarius vittatus* (Bosc, 1802), da região de São Vicente, São Paulo, Brasil. Foram realizadas coletas mensais de maio/2001 a abril/2003, na Praia dos Pescadores em São Vicente. Os 2.501 animais capturados foram identificados, determinados quanto ao sexo e mensurados quanto ao seu comprimento de escudo cefalotorácico (CEC). Para o estudo sazonal do crescimento, a população foi dividida em classes de tamanho de 5mm de (CEC), e analisada pelo método de Bertalanffy, com o auxílio do software Fisat II. Foram obtidos 703 indivíduos machos e 1.798 fêmeas, com média de tamanho de 8.94±1.80 e 6.61±1.13mm, respectivamente. Constatou-se um padrão de

crescimento sazonal, com machos atingindo um tamanho assintótico (14.92mm) superior ao das fêmeas (13.85mm), além de iniciarem o processo de crescimento aproximadamente cinco meses antes destas. Desta forma, é provável que este seja um padrão que auxilia na diminuição da disputa intra-específica por conchas, uma vez que os machos atingiram maior tamanho e estariam disponibilizando conchas menores para as fêmeas.

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