Growth of *Armases rubripes* (Rathbun, 1897) in the estuary of the Lagoa dos Patos, Southern Brazil

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Abstract

This study reports findings on ontogenetic growth of *Armases rubripes* (Rathbun, 1897) in the estuarine region of the 'Lagoa dos Patos', Rio Grande do Sul State, southern Brazil. Comparisons between males and females are performed, and the results are discussed considering studies carried out with other species of grapsoid. Monthly samples were taken, from April 2002 to March 2004. Crabs were collected manually, during 30 minutes, by two people. The area sampled at each month was approximately 100 m^2. Crabs caught were taken to the laboratory, where individuals were measured (carapace width) and sexed. Modal groups were determined, for each sex, on monthly CW frequency distributions using the software PeakFit. Growth curves, based on the von Bertalanffy growth function (VBGF), were estimated for all cohorts determined. A total of 2207 individuals was collected (1218 males and 989 females). The largest male and female caught (April 2002) had 22 and 20 mm CW, respectively. The smallest crabs were caught in winter. Ten and nine cohorts were determined for the period of study, for males and females respectively. Maximum longevity was estimated in ca. 630 days, and the growth curves of males and females were not statistically different.

Key words: Growth curve, *Armases rubripes*, Crustacea, Sesarmidae.

Introduction

Armases rubripes (Rathbun 1897) (Crustacea, Sesarmidae) is an estuarine crab found in salt-marshes and mangroves of the Western Atlantic Coast, from Central America to Argentina (Melo, 1996), inhabiting cracks on the substrate, spaces among roots of *Spartina spp*, and burrows of other crabs (e.g., *Chasmagnathus granulatus)* (Capítoli *et al.*, 1977,1978).

Despite the wide geographic distribution of this species, few studies that have been published are mostly about its larval stages (e.g., Montú *et al.*, 1990; Luppi, 2003). In the estuarine region of the 'Lagoa dos Patos' (Patos Lagoon), while a preliminary study on the bioecology of *A. rubripes* by Capitoli *et al.* (1977) reported information regarding maximum sizes, fecundity, and diet, little is understood about the population dynamics, viz. ontogenetic growth, mortality and reproduction, of *A. rubripes*.

This study reports findings on ontogenetic growth of *A. rubripes* in the estuarine region of the 'Lagoa dos Patos', Rio Grande do Sul State, southern Brazil. Comparisons between males and females are performed, and discussed considering studies carried out with other species of grapsoid.

Material and Methods

Crabs were sampled from a salt marsh in the estuarine region of the Lagoa dos Patos (32° 09' 11" S 052° 06' 02" W). The location sampled is composed mostly by rocky substrate originated from a breakwater ('West Breakwater') located nearby. Monthly samples were taken,

from April 2002 to March 2004. At each sampling, crabs were collected manually, during 30 minutes, by two people in an area of approximately 100 m^2. Captured crabs were taken to the laboratory, where individuals were measured (carapace width, CW, using a caliper with 0.01mm accuracy) and sexed. Crabs smaller than 5.0 mm CW were considered juveniles.

Modal groups were determined, for males and females, on monthly CW frequency distributions using the software PeakFit (PeakFit v. 4.06 SPSS Inc. for Windows Copyright 1991-1999, AISN Software Inc.), in which peaks were fitted to the CW distribution by an automated least squares fitting procedure ("Auto fit Peaks I – residuals"). No data smoothing was utilized, and the default amplitude was used for fitting; the option "hidden peak fitting" was checked. Fitted Gaussian peaks were superimposed on the CW to assess if the fit matched the histogram. When artifactual modal groups were found (for instance, a modal group within another), these groups were deleted, and Gaussian peaks refitted. Only statistically significant fittings (F-test, a = 0.05) were utilized. Modal values determined in each CW frequency distribution were tentatively linked to visualize the modal progression. Growth curves, based on the von Bertalanffy growth function (VBGF), were estimated for all cohorts determined for males and females. Only cohorts with a statistically significant (F-test, a = 0.05) fitting, and biologically reasonable parameters estimates (i.e., it did not result in a spurious estimative of either K or asymptotic CW) were considered. Thereafter, cohorts data were pooled and the growth parameters were estimated for each sex. For the estimation of the pooled growth curve a constrained fit was performed, in which a known value of CW (CW of the crab 1 stage = 0.95 mm, from animals reared in laboratory -Vieira, pers. com.) was utilized to force the curve to have a realistic origin. Prediction limits (a = 0.05) for the pooled growth curves were estimated. The pooled growth curves for males and females were compared by a F-test (Cerrato, 1990). Longevity was calculated by the inverted von Bertalanffy equation using the 99% of the asymptotic CW as CW_i value (D'Incao & Fonseca, 2000).

Results

A total of 2207 individuals was collected (1218 males and 989 females). The largest male and female caught (April 2002) had 22 and 20 mm CW respectively. The smallest crab (2.0 mm CW) was caught in winter.

Ten and nine cohorts were determined for the period of study, for males and females, respectively (figs. 1 and 2). The growth curves estimated for males and females were not statistically different ($F_{calculated} = 1.89 < F_{(0.05)60,47} = 2.69$; P = 0.13), and a pooled growth curve for both sexes was estimated (table I, fig. 3). Maximum longevity was estimated in ca. 630 days (after the settlement of the crab 1 stage).

Discussion

There is no published information about ontogenetic growth of *A. rubripes* in the estuarine region of the Lagoa dos Patos. However, a previous study regarding bioecological aspects of this species (Capitoli *et al.*, 1977) found a maximum size (male, 18 mm CW) smaller than the observed in this investigation (male, 22 mm CW). Moreover, unlike data obtained in the present investigation, in which monthly mean CW of males was often larger than the mean CW of females, it has been previously reported a larger mean CW in females (Capitoli *et al.*, 1977). Possibly, these differences are related with a much larger sample size obtained in the present investigation.

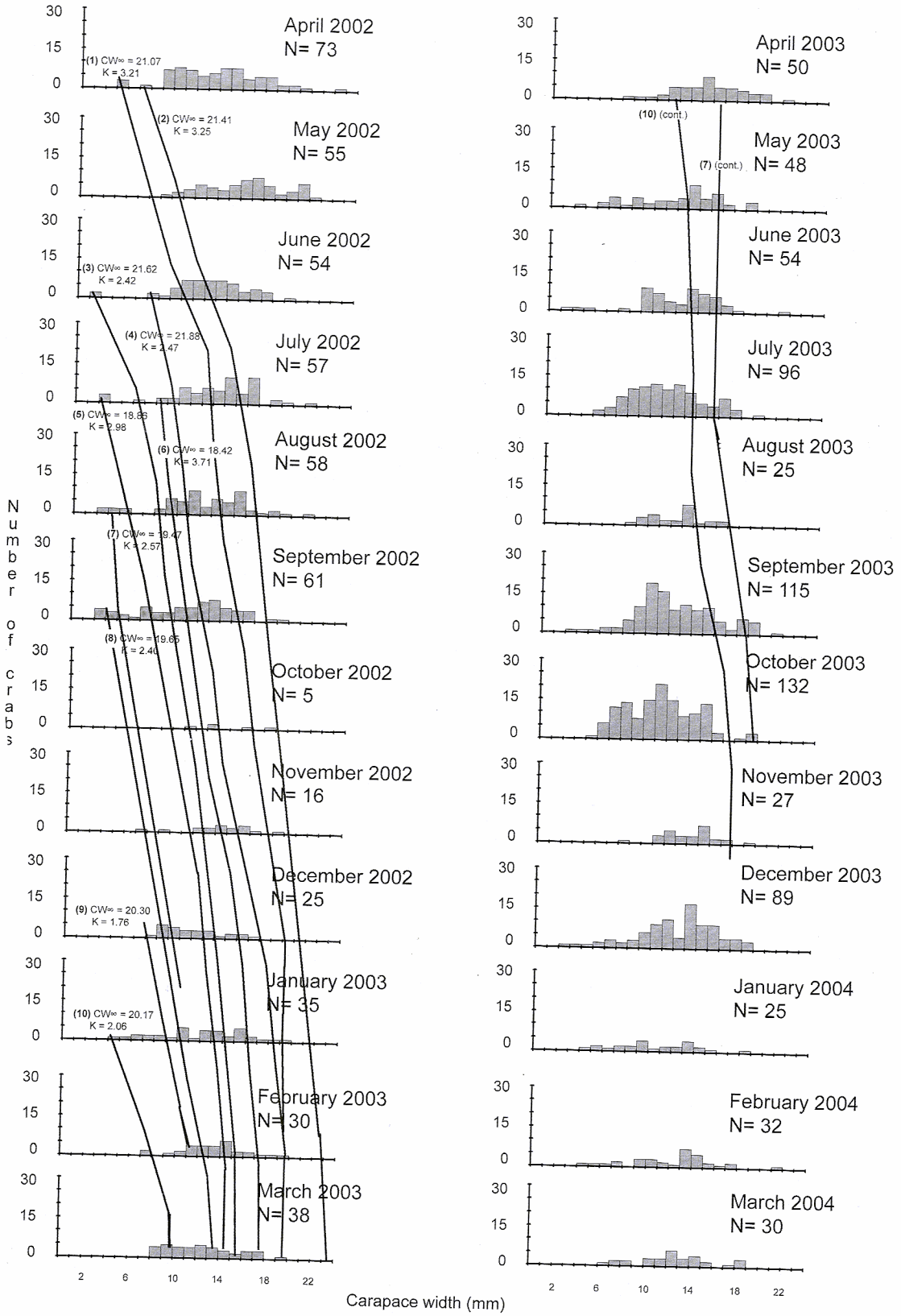

Figure 1: Males of *Armases rubripes*. Carapace width frequency histograms and cohorts determined, with its respective growth parameters for the period of study.

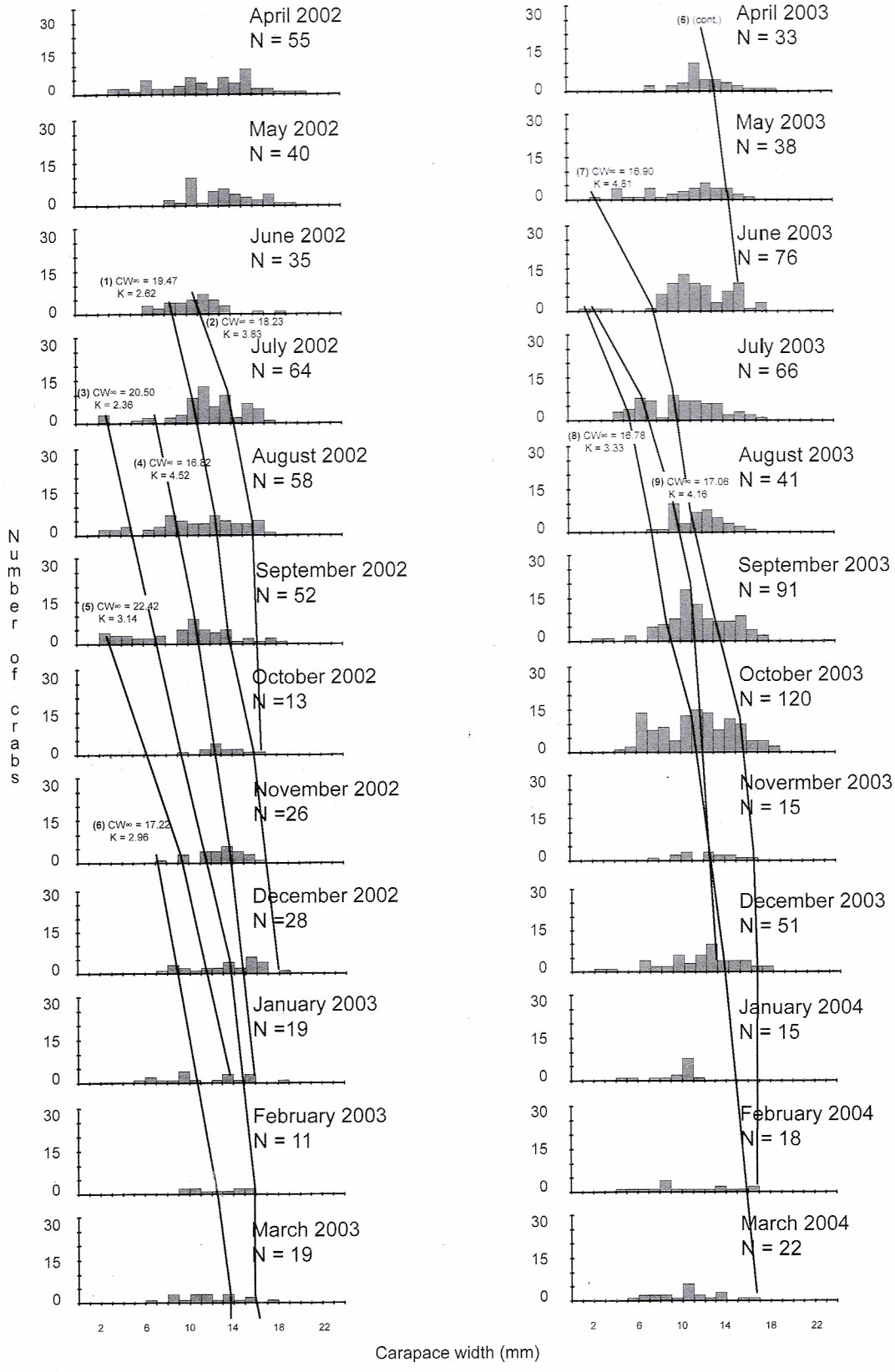

Figure 2: Females of *Armases rubripes*. Carapace width frequency histograms and cohorts determined, with its respective growth parameters for the period of study.

Table I: Parameters of the VBGF estimated for males, females, and sexes pooled. All VBGF fits were statistically significant, and all parameters, but t_0, were statistically different from zero. Growth curves for males and females were not statistically different. Figures in the brackets are the 95% confidence intervals.

	CW_∞ (mm)	K $(year)^{-1}$	t_0 (day)
Males	20.42 (19.13 - 21.71)	2.48 (1.99 - 2.97)	-3.76 (-14.45 - 6.92)
Females	18.46 (17.44 - 19.48)	3.03 (2.54 - 3.52)	-4.87 (-11.22 - 1.48)
Pooled	19.98 (19.08 - 20.88)	2.55 (2.21 - 2.89)	-6.08 (-12.69 - 0.53)

CW frequency histograms were clearly polymodal during the period of study. For this reason, modal progression became sometimes difficult to be determined. Nevertheless, in both years, recruitment pulses were identified in late winter/early spring. It allowed a better tracking of the respective cohorts. The low number of juveniles in these recruitment pulses is likely explained by biased sampling, as crabs were caught by hand (the smallest crabs are pretty difficult to catch). Despite the occurrence of recruitment pulses, brooding females were observed all year round, which explains the polymodality of the size histograms. It resulted in the observation of several cohorts during the period of study. Supporting evidence comes from laboratory rearing, which demonstrated that the crab 1 stage (mean CW = 0.95 mm) is reached 45 days after hatching (Vieira, pers. com.). Therefore, settlement of crab 1 stage is likely to be observed circa two months after hatching. Considering that the highest survival and the fastest development of larvae of *A. rubripes* occurs at a particular combination of temperature (20°C) and salinity (30) (Luppi *et al.*, 2003), and that the physical conditions are extremely variable in the estuarine region of the Lagoa dos Patos (Garcia, 1997), it would be expected a continuous reproduction in an attempt of maximizing the reproductive success.

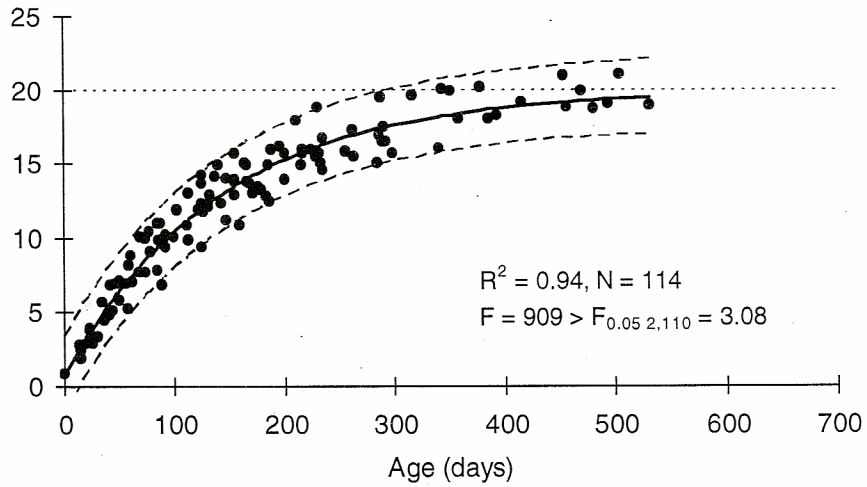

Figure 3: Pooled growth curve estimated using the VBGF, $CW_t = 19.98\ [1 - e^{-2.55(t - 6.08)}]$. 95% confidence limits (– – –) are shown. Horizontal dashed line represents the asymptotic CW.

The occurrence of polymodal histograms, and consequently, several cohorts in a year, is consistent with a life strategy of rapid growth, and high allocation of energy for early, and multivoltine (several broods in a season), reproduction (Pianka, 1994). In the light of these predictions, the growth curve estimated seems to be biologically significant. It has been proposed that the largest carapace lengths and the estimative of maximum longevity should be used (D'Incao and Fonseca, 2000) to verify whether the growth curve estimated is biologically related with the life cycle of a species.

The asymptotic CW estimated (19.98 ± 0.90 mm) is near to the maximum sizes observed (22 mm and 20 mm for males and females, respectively), which are inside the prediction limits estimated for asymptotic CW. It has been suggested that the asymptotic size, estimated by length-based methods, should be similar to the maximum observed length (Pauly, 1998). The maximum longevity estimated (630 days, ca. 21 months) was consistent with field observation. During the first year of sampling, it can be noted that the recruitment of new cohorts occurred in late autumn, and these cohorts persisted till spring of the second year. Therefore, length-frequency histograms suggest that *A. rubripes* likely may live longer than 1 year but shorter than 2 years. Moreover, the maximum longevity estimated is consistent with a short-lived crab with a r-strategy (Pianka, 1994) (see below). The smallest brooding females caught had circa 8 mm CW, which means an age (based on the growth curve and prediction limits estimated) of 70 ± 30 days (after the settlement of the crab 1 stage). Again, it would be consistent with the life strategy of a short-lived crab. Altogether, it seems that the growth parameters estimated reflect consistently the ontogenetic growth of *A. rubripes* in the wild.

Armases rubripes occurs at the same habitats than the grapsoid *Chasmagnathus granulatus*, Dana, 1851. It has been previously reported that *A. rubripes* is herbivore (Capitoli *et al.*, 1977), while *C. granulatus* is omnivore (D'Incao *et al.*, 1990). Therefore, it is unlikely that the interaction of populations of these species would be competition for food, but it is possible a competition for space.

It could be speculated that *A. rubripes* has some r-strategist traits when compared with *C. granulatus*. Supporting this idea, it was found a faster growth trajectory in *A. rubripes* than in *C. granulatus* (D'Incao *et al.*, 1993); it results that the average size at the onset of maturation of *C. granulatus* (16.5 mm CW) (Ruffino *et al.*, 1994) is equivalent to approximately 6 months of age (D'Incao *et al.*, 1993), while in *A. rubripes* the onset of maturation is thought to occur much earlier (brooding females are observed at 70 days of age). These pieces of information suggest the life history traits of populations of *A. rubripes* lead these populations to a higher productivity when compared with *C. granulatus*. Information about the reproductive and mortality processes of *A. rubripes*, which will be published elsewhere, will complete the understanding of the population dynamics of this species.

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