

Growth curve of *Balloniscus glaber* Araujo & Zardo (Crustacea, Isopoda, Oniscidea) from Parque Estadual de Itapuã, Rio Grande do Sul, Brazil ¹

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ABSTRACT. Based on field data, this study presents the growth curve of *Balloniscus glaber* Araujo & Zardo, 1995, a terrestrial isopod species found in Parque Estadual de Itapuã (PEI), Rio Grande do Sul, Brazil. Specimens were monthly sampled, from May 2004 to April 2005, at PEI. Captured individuals were sexed, their cephalothorax width was measured, and the growth curve was described according to von Bertalanffy's model. Male and female growth curves are described by the equations: $W_t = 2.256[1 - e^{-0.00394(t+91.128)}]$ and $W_t = 2.588[1 - e^{-0.00301(t+101)}]$, respectively. Curves show differential growth between males and females, with females reaching higher W_{∞} , and a slower growth rate than males. Based on these curves, life span was estimated.

KEY WORDS. Life span; terrestrial isopods; Neotropical Region; von Bertalanffy.

RESUMO. Curva de crescimento de *Balloniscus glaber* Araujo & Zardo (Crustacea, Isopoda, Oniscidea) no Parque Estadual de Itapuã, Rio Grande do Sul, Brasil. Esse estudo, baseado em dados de campo, esse estudo apresenta a curva de crescimento de *Balloniscus glaber* Araujo & Zardo, 1995, um isópodo terrestre encontrado no Parque Estadual de Itapuã (PEI), Rio Grande do Sul. Os espécimes foram coletados mensalmente, de maio de 2004 a abril de 2005, no PEI. Os indivíduos capturados foram sexados e tiveram o cefalotórax mensurado e a curva de crescimento descrita a partir do modelo de von Bertalanffy. As curvas de crescimento para machos e para fêmeas são descritas pelas equações: $L_t = 2,256[1 - e^{-0,00394(t+91,128)}]$ e $L_t = 2,588[1 - e^{-0,00301(t+101)}]$, respectivamente. As curvas apresentam crescimento diferencial entre machos e fêmeas, com fêmeas atingindo maior L_{∞} mas com uma taxa de crescimento menor do que os machos. Com base na curva foi estimada a longevidade dos animais. **PALAVRAS-CHAVE.** Longevidade; isópodos terrestres; Região Neotropical; von Bertalanffy.

Estimating animal age is an essential tool for the analysis of population dynamics, demographics, and life history. One approach to obtain this estimate is to relate age with the size of an animal's structure, which is often obtained by building growth curves (McQUEEN & CARNIO 1974, HADDAD & VERANI 1984). The von Bertalanffy's model (VON BERTALANFFY 1938) has been successfully used for the study of the growth of peracarid crustaceans, of amphipods (DIAS & SPRUNG 2004) as well as of terrestrial isopods (Isopoda, Oniscidea) (ARAUJO & BOND-BUCKUP 2004).

ACHOURI *et al.* (2003) studied growth rates of *Porcellionides pruinosus* (Brandt, 1833) (Porcellionidae) at Garat Nâam (Kasserine, Tunisia), where they found different lifespan and growth rates among cohorts in a natural population. Females born in the spring took 2.5 months to reach sexual maturity, whereas cohorts born in late summer and autumn took 3.5 months. In Brazil, ARAUJO & BOND-BUCKUP (2004) studied a natural population of *Atlantoscia floridana* (van Name, 1940)

(Philosciidae), and built a growth curve based on the size of animals captured monthly in the field. Later, ARAUJO & BOND-BUCKUP (2005) used the von Bertalanffy's method to analyze the age structure of males and females in a natural population of the same species.

McQUEEN & CARNIO (1974) studied the growth of *Porcellio spinicornis* (Say, 1818) (Porcellionidae) based on weight of individuals raised in the laboratory, whereas HADDAD & VERANI (1984) described the growth curve of *Balloniscus sellowii* (Brandt, 1833) (Balloniscidae) based on the body length, instead of weight, in isopods obtained in laboratory.

The southernmost Brazilian state, Rio Grande do Sul, harbors many endemic Neotropical isopod species (ARAUJO & ZARDO 1995, ARAUJO 1999, LOPES & ARAUJO 2003, ARAUJO & LOPES 2003, ARAUJO & QUADROS 2005). One of these species, *Balloniscus glaber* Araujo & Zardo, 1995, (Balloniscidae), belongs to the Rio Grande do Sul threatened species list (BOND-BUCKUP *et al.*

2003) due to its restricted geographical distribution. This species was recently recorded in Parque Estadual de Itapuã (ALMERÃO *et al.* 2006), and QUADROS & ARAUJO (2007) provided the first information on its ecological traits.

This study aimed at describing the von Bertalanffy growth curve of *B. glaber* based on field data.

MATERIAL AND METHODS

This study was carried out in the Parque Estadual de Itapuã (PEI) (30°22'S 51°02'W), located in the city of Viamão, Rio Grande do Sul, Brazil (Fig. 1). PEI is a remnant of the natural landscape of this region, and is destined for conservational



Figure 1. Map of Rio Grande do Sul, showing Parque Estadual de Itapuã, the site of sampling.

purposes (RIO GRANDE DO SUL 1997). The climate in this region is Köppen's Cfa type (STRAHLER 1974).

Individuals of *B. glaber* were monthly captured from May 2004 to April 2005, following the sampling design described by ARAUJO & BOND-BUCKUP (2005). An area of 216 m² within a semi-deciduous forest was chosen, based on a previous study (ALMERÃO *et al.* 2006). Twelve samples containing soil and litter were extracted from this area with a round bottomless recipient of 707 cm². Samples were hand-sorted in the laboratory, and then left in a Berleze's funnel extractor for 72 h. Individuals were separated in mancas (ARAUJO *et al.* 2004a), males and females (ARAUJO *et al.* 2004b), preserved in ethanol at 70%, and measured under a stereomicroscope. According to ARAUJO & BOND-BUCKUP (2004), cephalothorax width was used as a measure of size, as body-length measurements may vary within wide ranges, depending on body contraction after death (SUTTON 1968).

Von Bertalanffy's growth function (VBGF) is described by the equation $W_t = W_\infty[1 - e^{-k(t-t_0)}]$, where W_t is cephalothorax width (in mm) for a given age t (in days); W_∞ is the maximum mean cephalothorax width (in mm); k is the growth rate, and t_0 is a parameter related to age at length zero (also in days) (VON BERTALANFFY 1938).

Histograms were organized based on absolute size-frequency with 0.09 mm intervals for the mode calculation (performed using PeakFit 4.12 – SeaSolve Software Inc.[®]). Cohorts were manually depicted by observing the modal displacement along months. Since cohorts are better identified by following a period of intense appearance of mancas in the population, which in our case only occurred from November 2004 (Fig. 2), we decided to repeat May 2004 to April 2005 histograms, totaling an interval of 18 months. Then, chosen modes were fitted in a linear regression using the method of Ford-Walford for unequal time intervals among monthly samplings (WALFORD 1946). In this regression, we considered Manca II as size at t_0 , because Manca I can be considered as the last intramarsupial stage (ARAUJO & BOND-BUCKUP 2004). The resulting coefficients a and b were used to obtain k , W_∞ , and t_0 in the following manner (FABENS 1965): $k = -b$; $W_\infty = -a/b$; $t_0 = k^{-1} \cdot \ln[\sum(W_\infty - W_t) \cdot e^{(-kt)} / \sum W_\infty \cdot e^{(-2kt)}]$.

Growth curves were separately calculated for males and females. After that, curves were linearized by the method of ALLEN (1976), using $W_t = a - b \cdot r^t$, where $a = W_\infty$; $b = W_\infty \cdot e^{kt_0}$ and the regression coefficient r was calculated as $(e^{-k_{males}} + e^{-k_{females}}) / 2$. Linear regressions were compared using ANCOVA for a 95% confidence interval (SNEDECOR & COCHRAN 1967). Life span was estimated based on PINHEIRO & TADDEI (2005).

RESULTS

We obtained 1391 individuals, consisting of 191 mancas (I, II, and III), 410 males, and 790 females. The size of the Manca II individuals was about 0.68 mm. The monthly frequency histograms are shown in figure 2.

The modes used for building the curves (Tab. I) were chosen based on the coefficient of the fitted regression, and on the closeness of the resulting W_∞ with the maximum cephalothorax width observed in nature (W_{max}).

Table I. Mode values (cephalothorax width in millimetres) obtained for males and females of *Balloniscus glaber*, chosen for the VBGF.

Males		Females	
Day	Mode value	Day	Mode value
1	0.680	1	0.680
60	0.996	99	1.175
130	1.301	335	1.958
244	1.710	518	2.220
366	1.910	701	2.400
549	2.060	–	–

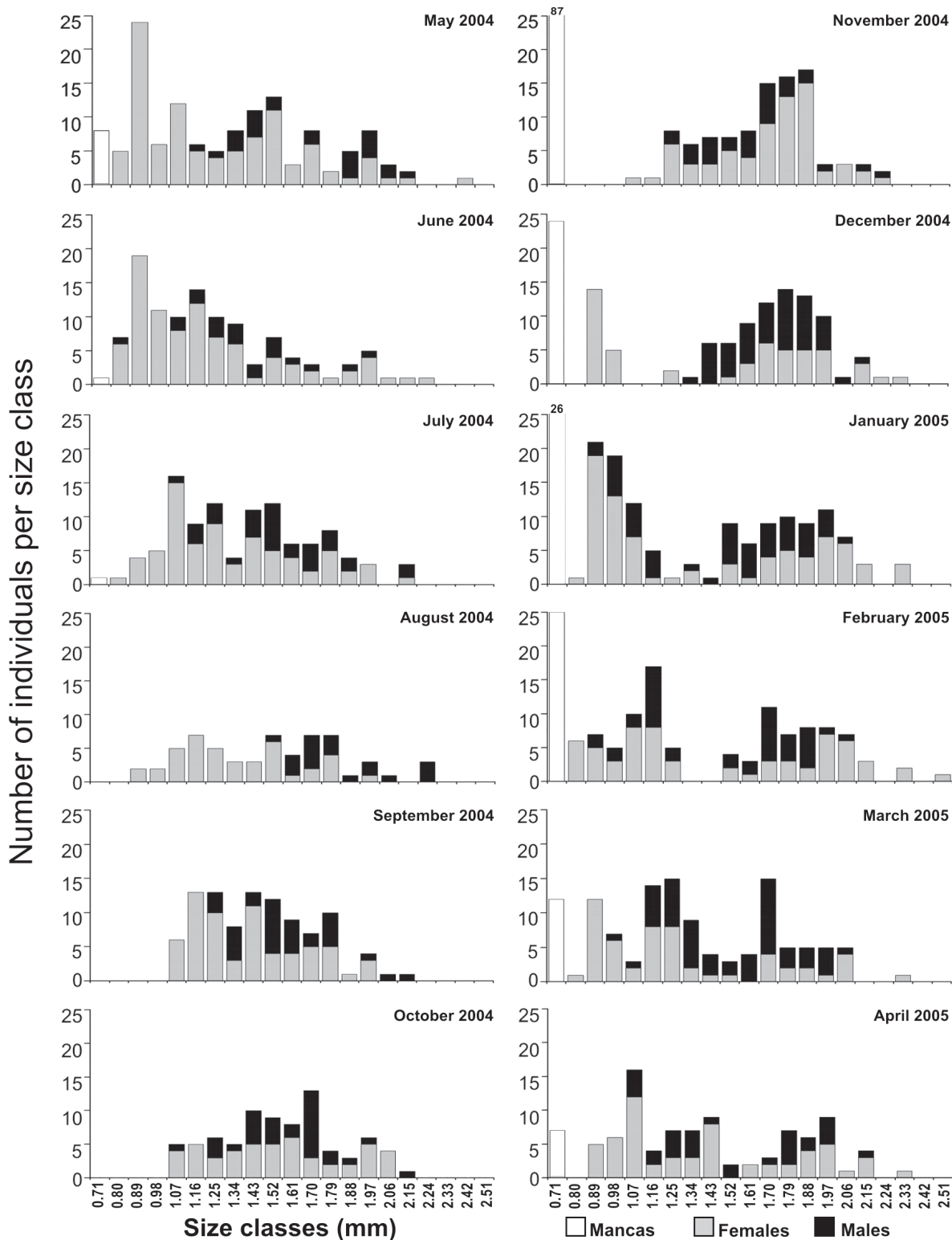


Figure 2. Frequency distribution of *Balloniscus glaber* cephalothorax width (mm) in Parque Estadual de Itapuã, Rio Grande do Sul, from May 2004 to April 2005.

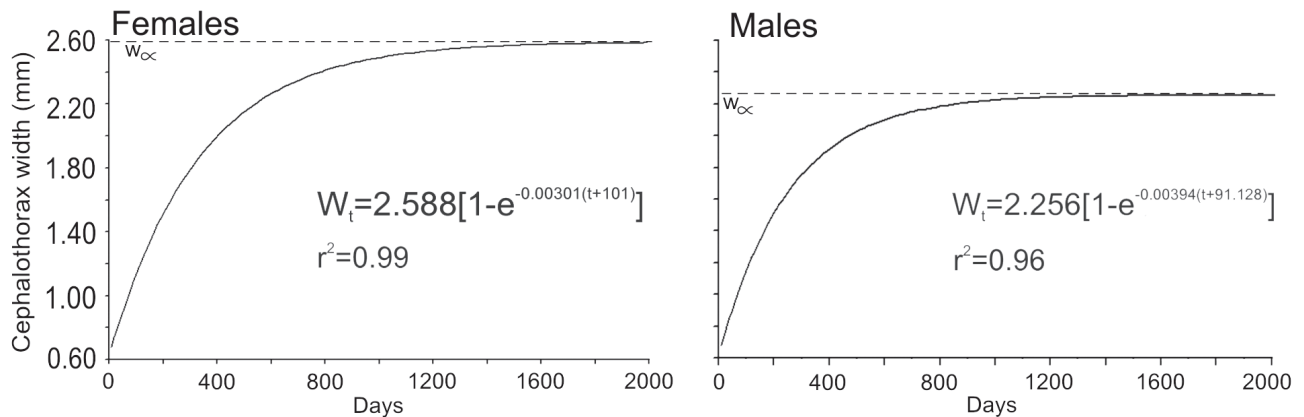


Figure 3. *Balloniscus glaber* growth curve in Parque Estadual de Itapuã, Rio Grande do Sul, from May 2004 to April 2005. W_t represents the cephalothorax width (mm) of the individuals in time t ; W_∞ is the maximum mean cephalothorax width, t is the age (days), and r^2 is the coefficient of determination of the transformed regression (WALFORD 1946).

The curves for females and males (Fig. 3) are described by the following equations: $W_t = 2.588[1 - e^{-0.00301(t+101)}]$ for females, and $W_t = 2.256[1 - e^{-0.00394(t+91.128)}]$ for males. According to these equations, females W_∞ was 2.58 mm, and the W_{max} was 2.47 mm. For males, W_∞ was 2.25 mm, whereas W_{max} was 2.22 mm.

After the linearization of male and female curves (Tab. II), a significant difference between the intercept ($F = 153.75$, $\alpha 0.05$, d.f. 1.13) and the slope ($F = 16$, $\alpha 0.05$, d.f. 1.12) was verified. This finding indicates a dimorphic body size between the sexes, as well as different growth rates, that supports the separated treatment of the curves, as performed in another study (ARAUJO & BOND-BUCKUP 2004). Life span was estimated as 28 months for males, and 36 months for females.

DISCUSSION

Dimorphic body size between males and females is a common feature of most terrestrial isopods species. As there often is a clear positive relationship between fecundity and female size (WARBURG 1993), females generally attain the largest size. This is true for several species, including Philosciidae (ARAUJO & BOND-BUCKUP 2005), Armadillidiidae (PARIS & PITELKA 1962, AL-DABAGG & BLOCK 1981), and Porcellionidae (NAIR 1998). Females achieve larger sizes at the expense of slower growth rates, and therefore live longer than males. On the other hand, males grow faster and begin to reproduce earlier than females (ACHOURI *et al.* 2003, ARAUJO *et al.* 2004b). *Tylos ponticus* Grebnicki, 1874 (Tylidae) is an exception, which males achieve a larger size and live longer than females (DIAS & SPRUNG 2003).

Von Bertalanffy's curve evidences the exponential-like growth pattern during the initial stages of terrestrial isopods. Growth rate is a key life history trait for terrestrial isopods (DANGERFIELD 1997). WARBURG (1993) points out that a large percentage of isopods die within their first month of life outside the brood pouch. As their mortality rates tend to decline as

Table II. *Balloniscus glaber* in Parque Estadual de Itapuã, Rio Grande do Sul, Brazil, from May 2004 to April 2005. Values of cephalothorax width and r^t used to linearize the growth curve of males and females, according to ALLEN's (1976) method.

Age (days)	r^t	Cephalothorax width (mm)	
		Males	Females
120	0.6563	1.274	1.257
210	0.4793	1.567	1.573
300	0.3505	1.773	1.814
390	0.2566	1.917	1.998
480	0.1882	2.018	2.138
570	0.1382	2.089	2.245
660	0.1016	2.139	2.326
750	0.0748	2.174	2.388
840	0.0583	2.198	2.436

body size increases (DIAS & SPRUNG 2003), it is an advantage to minimize the time they remain small (DANGERFIELD 1997). *Balloniscus glaber* growth was slower than its congeneric, *B. sellowii*, and both species grew slower than *A. floridana*.

Most results of isopods' VBGF suggest that life span is slightly longer than two years. ACHOURI *et al.* (2003) estimated 11 to 14 months for *P. pruinosus*. ARAUJO & BOND-BUCKUP (2004) found a life span of about 28 months for *A. floridana* females, and 18 months for males. However, analyzing the age structure of the field population, ARAUJO & BOND-BUCKUP (2005) found that the percentage of males older than 1 year was only 0.1%, whereas 1% of the females reached the 2nd year.

Von Bertalanffy's model was adequate for the description of *B. glaber* growth curve, as it matched the general patterns of terrestrial isopods, and thus it is a valuable tool for the interpretation of their life history and population dynamics.

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