

MATURATION AND GROWTH CURVES OF *MACROBRACHIUM*
CARCINUS (LINNAEUS) (CRUSTACEA, DECAPODA,
PALAEMONIDAE) FROM RIBEIRA DE IGUAPE RIVER,
SOUTHERN BRAZIL

Wagner C. Valenti¹
Jeanette de T.C. de Mello²
Vera L. Lobão³

ABSTRACT. In this paper, female *Macrobrachium carcinus* (Linnaeus, 1758) maturation curve, weight/length relationship, length and weight growth curves were studied. Prawns were captured, by traps, in Ribeira de Iguape river (24°S and 47°W), southern Brazil. There were used 207 females. It was observed that *M. carcinus* presents several spawnings during its life cycle and reproductive period goes on, at least till six years old. Weight/length relationship can be represented for the equation $W = 8.73 E^{-3} L^{3.28}$. Expressions obtained for length and weight growth curves are $L_t = 21.0 (1 - e^{-0.493t})$ and $W_t = 190 (1 - e^{-0.493t})^{3.28}$, respectively. Asymptotic maximum length and asymptotic maximum weight are nearly attained at six and eight years old, respectively.

KEY WORDS. Crustacea, *Macrobrachium*, maturation, growth, prawn

Macrobrachium carcinus (Linnaeus, 1758) is a large decapod crustacean found naturally in Antilles and Atlantic America, ranging from Florida to southern Brazil, inhabiting the bottom of fresh and brackish waters (HOLTHUIS 1952, 1980; BOND & BUCKUP 1989). This is a species of commercial interest exploited by fishery in several countries and has been studied for aquaculture purposes (LING & COSTELO 1976; HOLTHUIS 1980; RABANAL 1982; CHAUVIN 1992).

Reproduction and growth studies are central topics of fishery biology and autoecology (WEATHERLEY 1972; PAULY 1980), being also fundamental to assess the potential for culture or natural stock exploitation of a species. Both for practical applications and theoretical reasons, growth must be expressed by means of curves or models that give a generalized description of its pattern (BEVERTON & HOLT 1957; BAGENAL 1978; PAULY 1980).

1) Departamento de Biologia Aplicada, Faculdade de Ciências Agrárias e Veterinária e Núcleo de Estudos de Biologia, Ecologia e Cultivo de Crustáceos, Centro de Aquicultura, Universidade Estadual Paulista, Rodovia Carlos Tonanni Km 5, 14.870-000 Jaboticabal, São Paulo, Brasil. Bolsista do CNPq.

2) Departamento de Biologia, Instituto de Biociências, Universidade de São Paulo, Caixa Postal 11461, 05422-970 São Paulo, São Paulo, Brasil.

3) Seção de Aquicultura, Instituto de Pesca, Av. Francisco Matarazzo 455, 05131-900 São Paulo, São Paulo, Brasil. Bolsista do CNPq.

In this paper, female *M. carcinus* maturation curve, weight/length relationship, length and weight growth curves were studied.

MATERIAL AND METHODS

From August 1978 to May 1979 and in January/February 1983 207 females of *M. carcinus* were captured in Ribeira de Iguape river (24°S and 47°W), São Paulo, southern Brazil. They were catch by traps (0.5cm mesh) using fish flesh bait. For each prawn, total length (measured from rostrum tip to telson tip), total weight and the gonad weight were determined. Gonads were weighed to the nearest 0,1 milligram.

Weight (W) / length (L) relationship was fitted by linear regression, applied after the logarithmic transformation of the data grouped in classes of 0.5cm. It was represented by:

$$W = a L^b \quad (1)$$

where *a* and *b* are constants.

Maturation curve was determined by plotting mean gonad weight against total weight (grouped in classes of 10g), obtaining in this way, the mean weights in each spawning (SANTOS 1972). Corresponding mean lengths were achieved by means of the weight/length relationship and with these data the length growth curve was estimated, according SANTOS (1972).

In a previous paper (VALENTI *et al.* 1986), we demonstrated that this population presented a periodic annual reproductive cycle, that is, the spawnings were separated by an almost constant period corresponding to one year.

Therefore, we could use the Ford-Walford method (WALFORD 1946), plotting the mean length at one spawning ($L_t + \Delta t$) against the mean length at the preceding spawning (L_t). Linear relationship obtained suggests that, in this species, growth can be represented by the von Bertalanffy's model (BERTALANFFY 1938), which may be represented in the following form:

$$L_t = L_\infty \{ 1 - e^{-K(t-t_0)} \}$$

Where: L_t = the mean length at age *t*; L_∞ = the asymptotic maximum length reached by the animal; *K* = growth coefficient; t_0 = parameter related to the animal's length at birth (L_0).

Rearranging this expression we have:

$$t_0 = t + (1/K) \ln \{ (L_\infty - L_t) / L_\infty \}$$

At birth $t = 0$ ($L_t = L_0$) and so:

$$t_0 = (1/K) \ln \{ (L_\infty - L_0) / L_\infty \}$$

Thus, in species like *M. carcinus*, whose length at birth (L_0) is negligible in relation to the maximum length attained, $t_0=0$ and therefore the expression above can be reduced to:

$$L_t = L_\infty (1 - e^{-Kt}) \quad (2) \quad (\text{SANTOS 1978})$$

With the mean spawning lengths and the L_∞ value (estimated by means of Ford-Walford method) we determined the parameter K and the age (t_1) at the first spawning showed in maturation curve as follows:

Being t' the period between each spawning and the first, the age at each spawning (t) will be:

$$t = t_1 + t' \quad \text{for } t' = \{ 0, 1, 2, 3, 4 \} \quad (3)$$

Substituting (3) in (2) we have:

$$L_t = L_\infty \{ 1 - e^{-K(t_1 + t')} \}$$

$$\ln \{ (L_\infty - L_t) / L_\infty \} = -Kt_1 - Kt' \quad (4)$$

Using the L_t values and their corresponding t' values we estimated the coefficients of the expression (4) by linear regression, and obtained K and t_1 values.

Weight growth curve was fitted by deductive method according Santos (1978). From (1) and (2) we have:

$$W_t = a \{ L_\infty (1 - e^{-Kt}) \}^b$$

$$W_t = a L_\infty^b (1 - e^{-Kt})^b$$

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RESULTS

Weight (W)/length (L) relationship and linear relationship obtained by plotting $\ln W$ against $\ln L$ are showed in figures 1 and 2, respectively.

It can be noted in figure 3 that the mean gonad weight increases as the prawn grows until the spawning starts, decreasing after that due to egg laying. This process is repeated successively until the end of the animal reproductive life.

M. carcinus presents several spawnings during its life cycle. According to figure 3, they occur when the animal presents a mean weight of 55; 95; 125; 145 e 165g. The weight intervals decrease between the spawnings point out the asymptotic growth. From the weight/length relationship these values were converted to female mean length at each spawning (Table I).

Linear relationship resulting of Ford-Walford method is presented in figure 4.

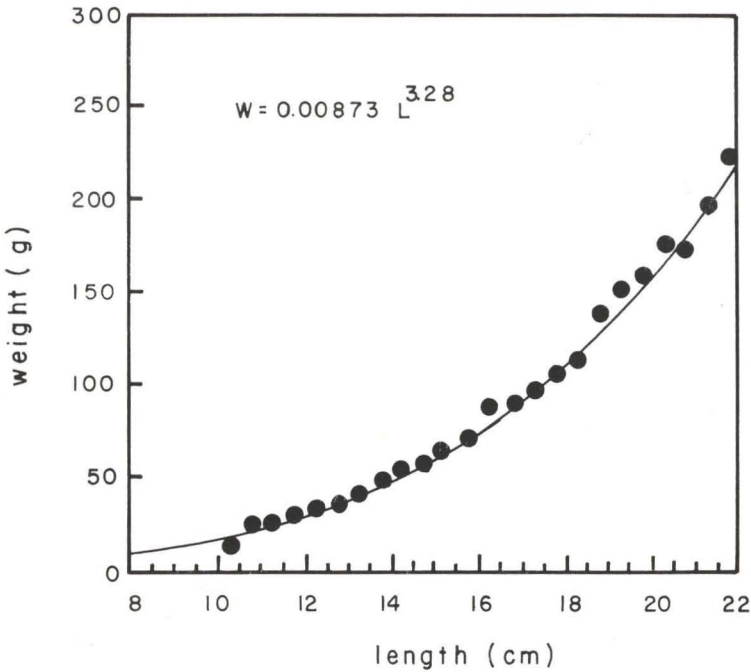


Fig. 1. Length/weight relationship fitted for *M. carcinus* females.

Table I. Mean spawning lengths (L_t), period between each spawning and the first (t') and corresponding $\ln[(L_\infty - L_t) / L_\infty]$ values.

L_t (cm)	t' (years)	$\ln[(L_\infty - L_t) / L_\infty]$
14.4	0	- 1.159
17.0	1	- 1.661
18.5	2	- 2.133
19.4	3	- 2.582
20.1	4	- 3.164

Using the L_t values and their corresponding t' values (Table I) we obtained the following expression:

$$\ln \{ (L_\infty - L_t) / L_\infty \} = - 1.15 - 0.493 t' \quad (5)$$

From (4) and (5) we have:

$$- K t_1 = 1.15 \text{ and } - K = - 0.493$$

Therefore $K=0.493$ and $t_1=2.33$ (it must be an integer because the reproductive cycle in this population is a periodic annual one (SANTOS 1972)).

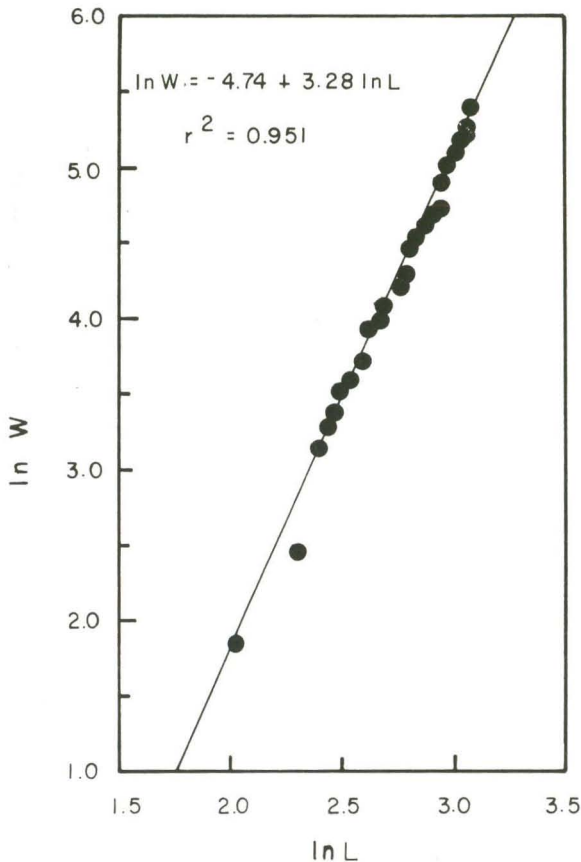


Fig. 2. Relationship between natural logarithms of the length (L) and weight (W) in *M. carcinus* females.

Figures 5 and 6 show, respectively, the length and weight growth curves of *M. carcinus* female with their equations.

DISCUSSION

The estimated mean maximum length for females of *M. carcinus* from Ribeira de Iguape river was 21.0cm. The length of those females becomes close enough to that asymptotic value from six years old on (Fig. 5).

The length growth curve estimated in our work is in agreement with data obtained by LEWIS *et al.* (1966) both in natural populations and in culture, which indicates that in this species, growth from 2.0 to 11.0cm needs a period of 14 months.

The estimated mean maximum weight for females of *M. carcinus* was 190g. From eight years old on, females' weight becomes close enough to this value

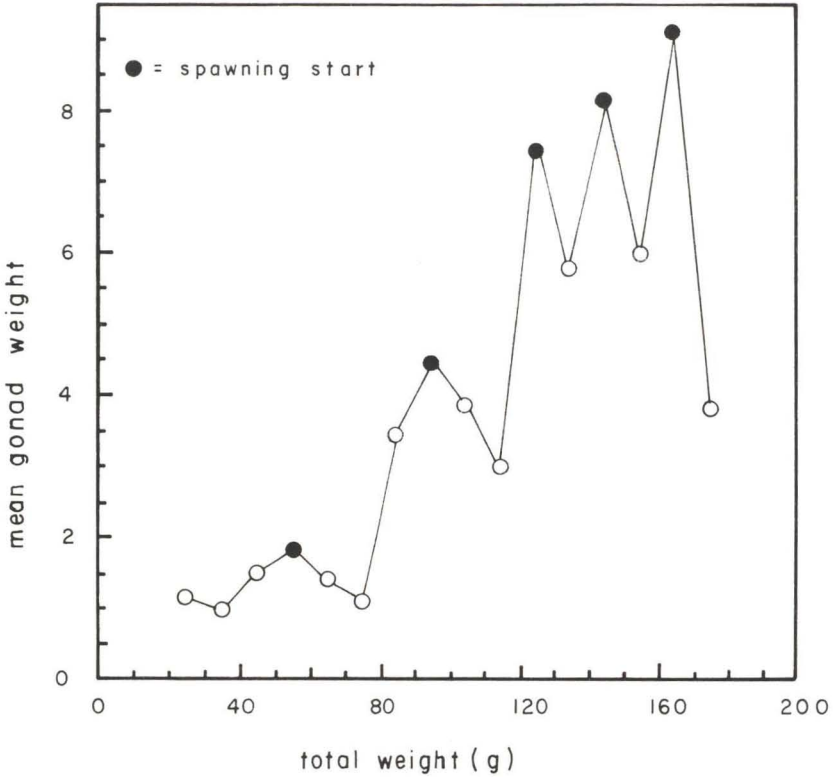


Fig. 3. Maturation curve obtained for *M. carcinus* females.

(Fig. 6). It may be observed in figures 5 and 6, that the increase in weight is small, from the age when the individuals practically attain the mean maximum length.

Figures 3 and 6 suggest that *M. carcinus* reproductive life go on, at least animals attain six years old.

Comparison of *M. carcinus* growth curves with that of other species belonging to the same genus, is very difficult, firstly due to the small number of quantitative nature articles available in the literature and secondly due the heterogeneity of methods applied. Nevertheless, we could observe that *M. carcinus* effective growth period is longer than that for small species like *M. amazonicum* (Heller, 1862) (GUEST 1979), *M. potiuna* (Müller, 1880), *M. borellii* (Nobili, 1896) (BOND & BUCKUP 1983) and *M. acanthurus* (VALENTI *et al.* 1987).

M. carcinus presents an L_{∞} value similar to or even higher than that of tropical species of great commercial interest, like *Penaeus schmitti* Burken, 1936 (NEIVA *et al.* 1971), *Penaeus brasiliensis* Latreille, 1817 and *Penaeus paulensis* Pérez Farfante, 1967 (MELLO 1973). However, its growth rate is much smaller than that of the mentioned species, being comparable to that of some lobsters, which last several years to come close to the maximum length, as for example

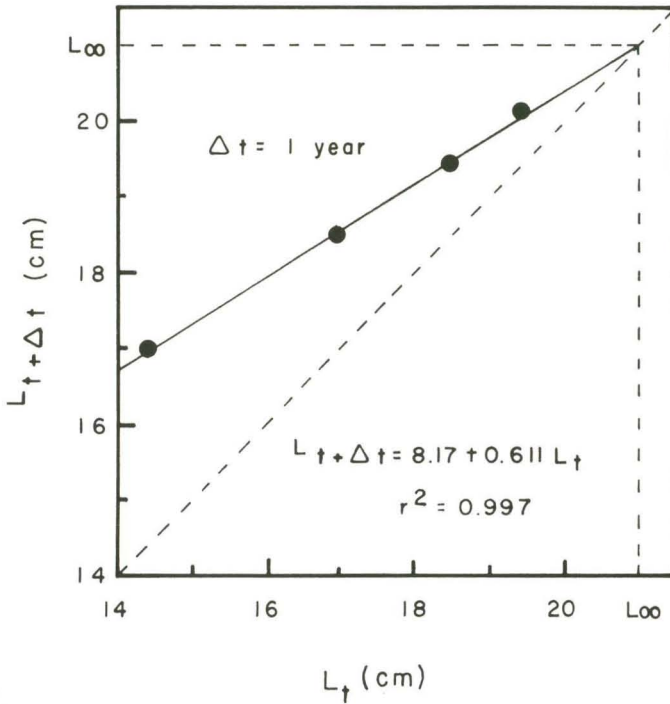


Fig. 4. Relationship between the mean length at one spawning ($L_t + \Delta t$) and the mean length at the preceding spawning (L_t) obtained for *M. carcinus* females (Ford-Walford transformation).

Panulirus argus (Latreille, 1804) (SANTOS *et al.* 1964; IVO 1975) and *P. laeviscauda* (SANTOS & IVO 1973).

The estimation of age and growth in crustaceans, is hampered by the absence of hard structures with periodic marks, due to the lost of the tegument in succeeding molts which also makes impossible the application of marking methods (RAJYALAKSHMI 1966; HARTNOLL 1982). Moreover, many species migrate seasonally and present a stratified distribution in relation to age, which makes difficulty the utilization of length frequency distribution methods (RAJYALAKSHMI 1966; MAUCHLINE 1977). So, the application of the maturation curve method to obtain the growth curve, presented in this work, may be of great interest in population studies of those animals.

Finally, we must point out that we could only obtain the growth curves for females as a result of the methodology applied in this work. However, we observed in the various analyzed samples that males and females presented similar lengths, being not characterized any evident sexual dimorphism in relation to body length, as it usually occurs in other species of *Macrobrachium* genus.

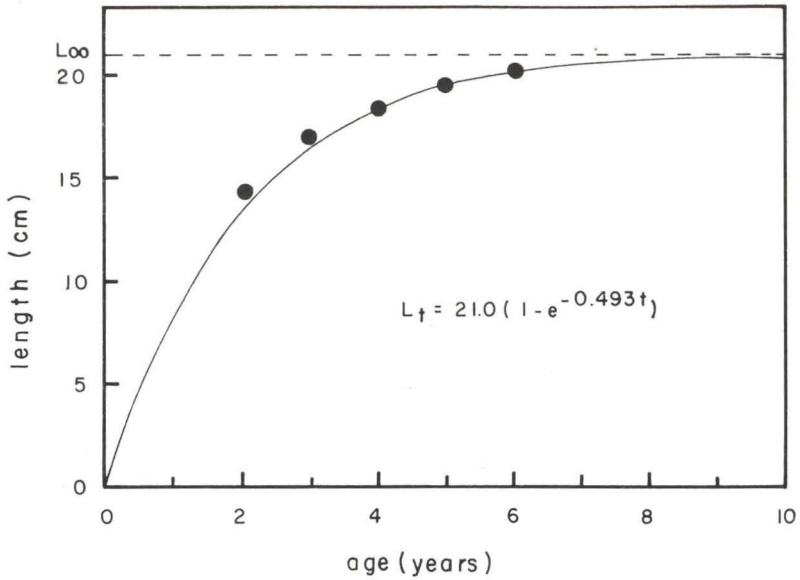


Fig. 5. Length growth curve fitted for *M. carcinus* females.

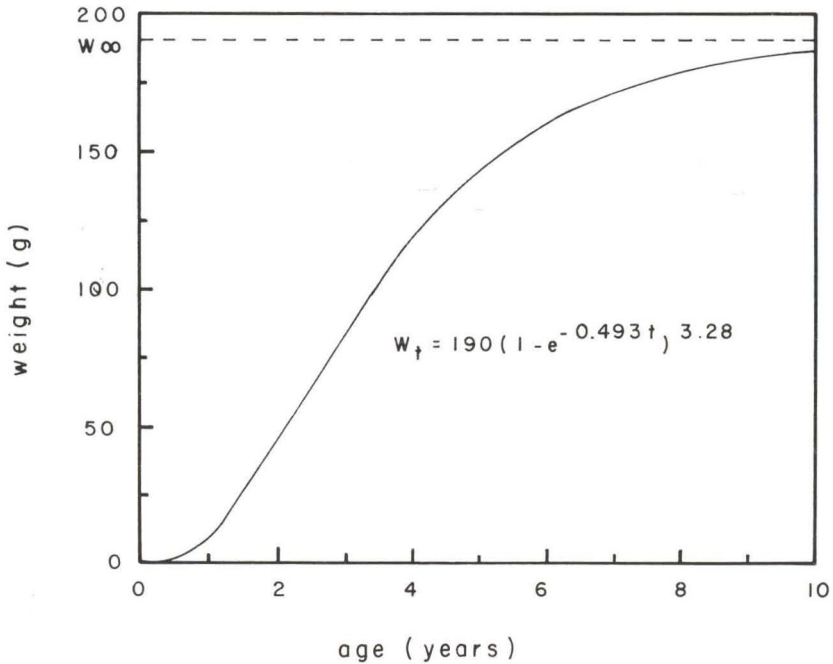


Fig. 6. Weight growth curve obtained for *M. carcinus* females.

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