

## Growth of Penaeid Prawns in Goa Waters

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Length-weight relationship and absolute growth were determined for 4 commercially important species of penaeid prawns, viz. *Metapenaeus dohsoni*, *M. affinis*, *Penaeus merguensis* and *Parapenaeopsis stylifera*, occurring in Goa waters. In all the cases, exponent values suggested a deviation from isometric growth. Difference in exponent values between the sexes of individual species was not significant for juveniles of any species and adults of *P. merguensis* but was highly significant for adults of the other species. Absolute growth was derived separately for the sexes using Bertalanffy growth model. Only in the case of *M. dohsoni*, female was outgrowing male throughout the life but males of other 3 species registered a faster growth in the initial stage. However, longevity and size attainment of females were greater than males of the respective species. *P. merguensis* and *M. affinis* were found to be the two relatively fast growing species.

Growth studies of commercially important penaeid prawns are not only essential for understanding their biology and population dynamics but also for the management of their resources and for selection of candidate species for culture fishery. Some information on the length-weight relationship<sup>1-5</sup> and age and growth<sup>1-4,6-11</sup> of penaeid prawns is available from Indian waters. However, there is no information on these aspects on the commercially important penaeid prawns of Goa, viz. *Metapenaeus dohsoni* (Miers), *M. affinis* (Milne-Edwards), *Penaeus merguensis* De Man and *Parapenaeopsis stylifera* (Milne-Edwards). These prawn species form the bulk of the penaeid prawn landings in Goa.

### Materials and Methods

Adult specimens were collected at fortnightly interval from Jan. 1981 to Feb. 1982, from the commercial shrimp trawlers operating in the coastal waters of Goa. Juvenile specimens of 3 species (except *P. stylifera* which is purely a marine species) were collected from stake nets operating in the Mandovi estuary during the same period with the same frequency. Both adults and juveniles were sexed species-wise and the total length from tip of rostrum to tip of telson (cm) and the respective weight (g) after blotting the specimen dry, were noted.

### Results

**Length-weight relationship**—The exponential equation,  $W = aL^b$  can be expressed in logarithmic form as  $\log W = \log a + b \log L$ , which otherwise is the linear regression function,  $Y = a + bX^{1,2}$ . Regression equations were derived for juveniles and

adults of each species, separately for the sexes, by least square analysis. Exponent values (Table 1) for both sexes of juveniles of *M. dohsoni*, *M. affinis* and adult males of *M. dohsoni* were  $< 3$  whereas it was  $> 3$  for all others. The exponents in the regression when tested against the exponent in the isometric growth by *t* test<sup>1,3</sup> (Table 1), it was found that 'b' values were significantly different from 3, for all the species suggesting a deviation from isometric growth. The weight increase was found to be at a lower rate than cube of length in the case of juveniles of *M. dohsoni*, *M. affinis* and adult males of *M. dohsoni* whereas it was at a higher rate in all other cases. Deviation from isometric growth was well pronounced in juveniles and adults of *P. merguensis*.

To find out whether there was any significant difference between the exponent values of male and female of individual species, they were subjected to analysis of co-variance (F). The difference was not significant for juveniles of all the species and adults of *P. merguensis*. It was, however, highly significant for *M. dohsoni* (F 32.22; df 1, 684;  $P < 0.001$ ), *M. affinis* (F 8.47; df 1, 319;  $P < 0.01$ ) and *P. stylifera* (F 11.29; df 1, 532;  $P < 0.001$ ).

**Absolute growth**—Absolute growth in length was separately estimated for the sexes by Bertalanffy growth model<sup>1,4</sup> as modified by Beverton and Holt<sup>1,5</sup>. For this purpose, the statistical value of each model length was calculated by probability plot technique<sup>16</sup> from the monthly length frequency distribution to avoid overlapping of modes. Monthly increase in length was determined and the rate of monthly growth was calculated by taking the mean of modes of successive months. This was used for estimating the

absolute growth. Ford - Walford plot<sup>17</sup> was employed for determining  $L_{\infty}$  (asymptotic length); 'k' (catabolic constant) was calculated by plotting the natural logarithmic values of  $(L_{\infty} - L_t)$  against age in months ( $L_t$  is length at age t) where the slope of the regression line gave the estimate of 'k'; and 't<sub>0</sub>' (theoretical age when length is zero) was calculated from the equation

$$t_0 = \frac{a - \log_e(L_{\infty})}{k}$$

The growth equations thus derived are given in Table 2 along with the maximum observed length and

the age to attain the maximum observed length. Growth was computed for 36 months (Figs 1 and 2).

*M. dohsoni*— Female of this species grew faster than male throughout the life (Figs. 1a-b) and attained the maximum observed length of 121 mm in 31 months as against 32 months taken by male to attain the maximum observed length of 117 mm. The female grew at the rate of 8.8 and 1.2 mm month<sup>-1</sup> in the 1st and 2nd y respectively which for male was 7.2 and 2.1 mm month<sup>-1</sup> respectively.

*M. affinis*— Unlike *M. dohsoni*, male of this species grew faster than female initially registering a growth rate of 10.9 mm month<sup>-1</sup> in the 1st y whereas it was

Table 1 — Length-Weight Relationship of Penaeid Prawns, Correlation Coefficient (r), Deviation (t) from Isometric Growth and Total Number of Specimens (N)

Stage	Sex	Regression equation	r	t	N
<i>M. dohsoni</i>					
Juvenile (40-70 mm)	F	logW = -2.12 + 2.88 logL	0.99	3.00*	192
	M	logW = -2.05 + 2.77 logL	0.95	3.28*	169
Adult (150-121 mm)	F	logW = -2.31 + 3.13 logL	0.99	4.33†	381
	M	logW = -2.01 + 2.76 logL	0.91	3.00†	309
<i>M. affinis</i>					
Juvenile (40-85 mm)	F	logW = -2.09 + 2.92 logL	0.98	2.00‡	196
	M	logW = -2.06 + 2.89 logL	0.99	3.67†	164
Adult (80-181 mm)	F	logW = -2.47 + 3.29 logL	0.99	9.67†	156
	M	logW = -2.43 + 3.24 logL	0.99	8.00†	167
<i>P. merguensis</i>					
Juvenile (40-106 mm)	F	logW = -2.71 + 3.49 logL	0.98	12.25†	115
	M	logW = -2.62 + 3.39 logL	0.99	9.75†	192
Adult (80-194 mm)	F	logW = -2.74 + 3.53 logL	0.99	13.25†	241
	M	logW = -2.79 + 3.58 logL	0.99	14.50†	190
<i>P. stylifera</i>					
Adult (150-129 mm)	F	logW = -2.57 + 3.32 logL	0.97	5.33†	295
	M	logW = -2.77 + 3.58 logL	0.97	9.67†	241

F = female, M = male; P values: \* < 0.01, † < 0.001, ‡ < 0.05

Table 2 — Growth Equation Derived for Penaeid Prawns Using Bertalanffy Growth Model, Observed Maximum Length and Age

Species	Sex	Growth equation	Observed maximum length (mm)	(Age month)
<i>M. dohsoni</i>	F	$L_t = 121.7 [1 - e^{-0.1675(t + 0.1163)}]$	121.0	31
	M	$L_t = 122.4 [1 - e^{-0.0976(t + 0.4124)}]$	117.0	32
<i>M. affinis</i>	F	$L_t = 202.6 [1 - e^{-0.0142(t + 0.5942)}]$	181.0	30
	M	$L_t = 156.8 [1 - e^{-0.1439(t + 0.4094)}]$	139.0	15
<i>P. merguensis</i>	F	$L_t = 254.8 [1 - e^{-0.0591(t + 0.6815)}]$	194.0	28
	M	$L_t = 184.1 [1 - e^{-0.0981(t + 0.4794)}]$	162.0	22
<i>P. stylifera</i>	F	$L_t = 139.7 [1 - e^{-0.0906(t + 0.2468)}]$	129.0	29
	M	$L_t = 99.2 [1 - e^{-0.1984(t + 0.7136)}]$	98.0	22

F = female; M = male

ACHUTHANKUTTY & PARULEKAR: GROWTH OF PENAEID PRAWNS

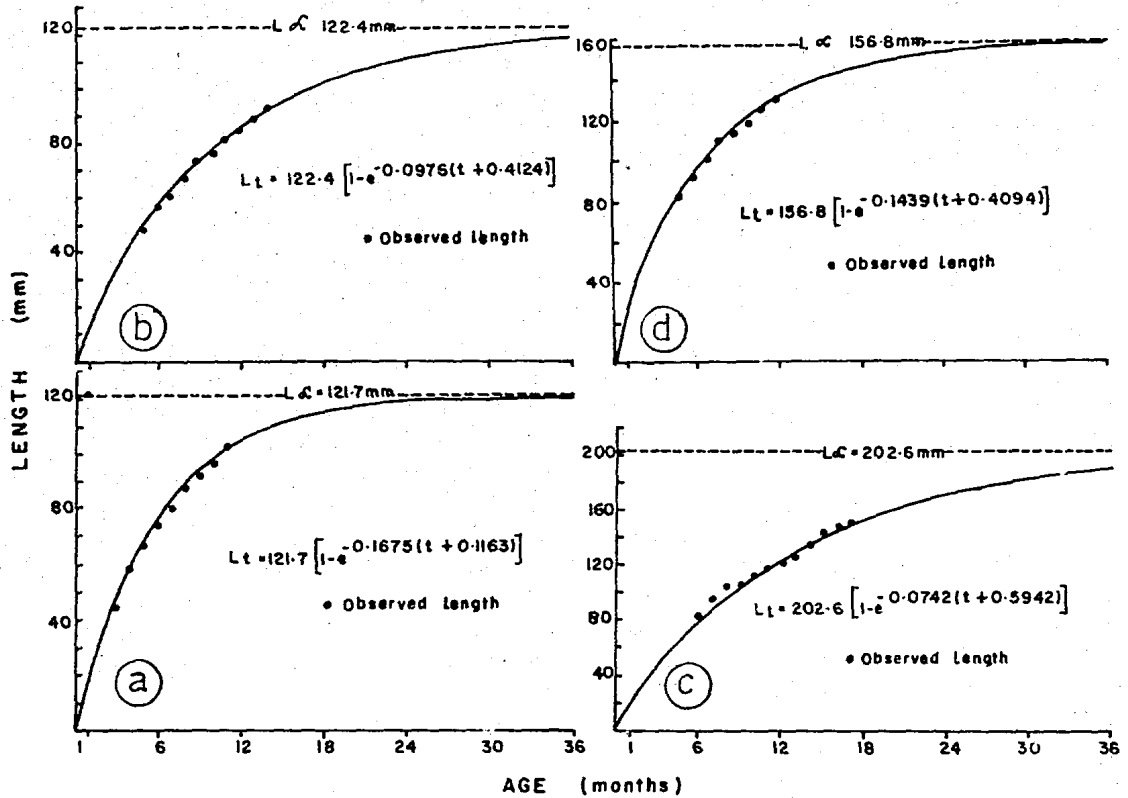


Fig. 1 — Growth curve for *M. dobsoni* female (a) and male (b) and *M. affinis* female (c) and male (d)

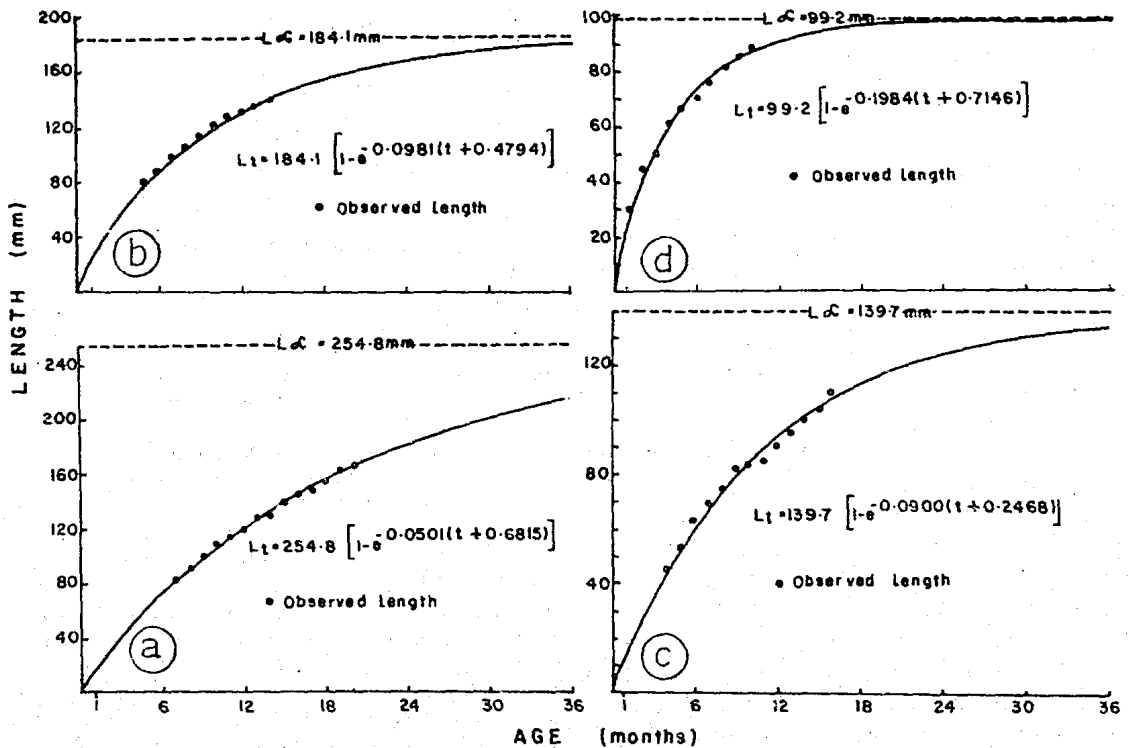


Fig. 2 — Growth curve for *P. merguensis* female (a) and male (b) and *P. stylijera* female (c) and male (d)

10.3 mm month<sup>-1</sup> for female. The rate of growth for 2nd y was 1.8 mm month<sup>-1</sup> for male and 3.9 mm month<sup>-1</sup> for female (Figs 1c-d).

*P. merguensis*— For 17 months, male grew relatively faster than female attaining 151 mm as against 149.7 mm for the latter. Growth was at the rate of 10.8 and 3.1 mm month<sup>-1</sup> for male and 10.0 and 5.1 mm month<sup>-1</sup> for female, respectively for 1st and 2nd y (Figs 2a-b).

*P. stylifera*— During the first 11 months, male registered a faster growth and attained 89.5 mm which for female was 88.9 mm. Rate of growth in the 1st y was 7.6 and 7.8 mm month<sup>-1</sup> and in the 2nd y, 0.6 and 2.5 mm month<sup>-1</sup>, respectively for male and female (Figs 2c-d).

### Discussion

Although significant variation from isometric growth is found to be rare in an ideal organism which maintains its shape without any change<sup>15</sup>, Hile<sup>18</sup> opined that the value may lie anywhere between 2.5 and 4, the latter by and large, was found to be true for the species presently studied. Deviation from isometric growth was observed in all the cases, but in most of the cases, especially adults, it was significantly > 3, indicating that the weight increase was at a faster rate than the cube of length. Analogous results were reported for both sexes of *Penaeus duorarum*<sup>19</sup>. It appears that the development of gonads might have resulted in increase of weight faster than cube of length in adults of these species.

Sexual difference does not seem to influence the exponent values to any significant extent during the juvenile phase as can be inferred from the results of the analysis of covariance. This may be because no major physiological changes related to gonad development occur during the juvenile stage and hence the weight increase is more or less similar in both sexes. The significant difference noted in the exponent values between the sexes of adults further confirms that attainment of maturity may be the prime factor responsible for this difference.

While reviewing the various mathematical expressions for determining the growth of penaeid prawns, Garcia and Le Reste<sup>20</sup> opined that a mathematical model using the basic data will give the best possible expression of growth than the length frequency method and that Bertalanffy growth model is the most widely used one which is also very reliable and accurate than any other growth model. Banerji and George<sup>9</sup> and Kurup and Rao<sup>10</sup> have also demonstrated the superiority and reliability of this model over the progression of modes in the length frequency distribution for determining the growth of penaeid prawns. Growth rates of several species of

penaeid prawns were estimated using the Bertalanffy growth model<sup>19,21-24</sup>.

Differential growth between the sexes, as observed in the species presently studied, were reported earlier for several species of penaeid prawns<sup>1-3,6-11</sup>. However, in most of the cases, where growth was determined by Peterson method<sup>1-3,6-7</sup>, the females were reported to outgrow males throughout the life, which in the present study was found to be true only in the case of *M. dobsoni*. The initial growth of males of the other 3 species was at a faster rate than females. Similar results were reported for the penaeid prawns occurring in Ambalapuzha waters along the southwest coast of India<sup>10</sup>. It appears that early attainment of sexual maturity in males as compared to females may be responsible for impairing the growth of the former thereby reversing the trend of growth. It is also true that the longevity and size attainment by females of all the species so far studied were considerably greater than males. The growth studies revealed that *P. merguensis* and *M. affinis* are the fast growing species and are suitable candidate species for prawn farming.

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