

Age and growth of Jhinga prawn *Metapenaeus affinis* Milne Edwards (Decapoda, Penaeidae) in Mumbai waters

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ABSTRACT

The results of the studies on age and growth of *Metapenaeus affinis*, one of the dominant species of penaeid shrimps in the coastal waters off Maharashtra are presented. From monthly size-frequency data, the growth parameters for males and females were estimated employing modal progression and computer based FiSAT software package using ELEFAN program, Bhattacharya method, Gulland-Holt plot, Faben's method, Appeldoorn's method and von Bertalanffy plot. The estimates obtained by Bhattacharya analysis and Gulland-Holt plot were: $L_{\infty} = 162$ mm, $K = 2.25$ for males and $L_{\infty} = 204$ mm, $K = 1.91$ for females. Males and females were found to attain 145 mm and 174 mm at the end of one year and their life spans were 1.16 and 1.4 years respectively.

Key words : *Metapenaeus affinis*, Jhinga prawn, Age, Growth, Mumbai coast

Introduction

One of the most important characteristics of the dynamic state of a population is growth. However, unlike fishes, direct estimation of growth in natural populations of crustaceans is difficult, as they do not have bony structures that record imprints of seasonal variations. The difficulties are more pronounced in tropical organisms, which exhibit continuous recruitment with broods appearing throughout the year (Pauly *et al.*, 1984). Methods of recording growth by tagging and recapture often interfere with moulting in crustaceans; as a result, growth is impaired (Garcia and Le Reste, 1981). However, several indirect methods employing length-frequency data have been developed (Banerjee and George, 1967; Pauly and David, 1981; Wetherall *et al.*, 1987), which allow estimation of age and growth even in the case of penaeid shrimps in tropical waters which exhibit continuous spawning and recruitment.

Metapenaeus affinis is one of the dominant and highly valued penaeid shrimps along the coastal waters of Maharashtra (Ramamurthy, 1994; Deshmukh *et al.*, 2001). Although biology, including the age and growth of the species along the west coast of India has been described previously (Subrahmanyam, 1963; Mohamed, 1967; Ramamurthy *et al.*, 1975; Achuthankutty and Parulekar, 1986; Paralkar, 1990), the results obtained in the present attempt were widely different. Age and growth of the

species has also been described by Vibhasiri (1988) in the Gulf of Thailand and by Mathews (1989) from Kuwait in the Persian Gulf. The present paper describes the growth of the species in detail, estimating the growth parameters using different length based methods.

Materials and methods

The catch of *M. affinis* in Mumbai was monitored for a period of one year from December 1999 to November 2000. Landings by shrimp trawlers at New Ferry Wharf and Versova as well as hand-operated trawlers at Versova were recorded. About 100 random specimens from each landing centre were measured for length and weight. There were no landings in June and July at Versova due to the closure of fishing during monsoon.

From the random samples, sexes were segregated and the shrimps were measured for total length (tip of rostrum to tip of telson to the nearest millimeter). Weights of the samples were taken with single pan spring balance. The length measurements were grouped into 5 mm size classes and the number of individuals in a size class noted down separately for males and females. The length frequency so obtained was raised to the total catch of the species for the day of sampling. The raised frequency for each sampling day was again raised to the monthly estimated total catch of the species.

The month-wise length frequency data was used to estimate the growth parameters in von Bertalanffy growth equation by the 'modal progression analysis' (Banerji and George, 1967) in which modal size was determined instead of modal class. The month-wise modal sizes were plotted and progressions of distinct modes followed for 3-4 months. From the modal progressions, change in size per month ($\Delta L/\Delta t$) was calculated and further used to estimate VBGF parameters L_{∞} and K , by Gulland and Holt plot (Gulland and Holt, 1959).

Month-wise length frequency data were analysed by ELEFAN (Pauly and David, 1981), Powell-Wetherall method, Bhattacharya method, Gulland and Holt plot, Faben's method, Appeldoorn's method and von Bertalanffy plot included in FiSAT software by Gayanilo *et al.* (1996). The von Bertalanffy plot enabled estimation of growth parameters L_{∞} , K and t_0 by non-linear regression method considering seasonalised and non-seasonalised growth.

Growth parameters thus obtained were used in von Bertalanffy growth equation to estimate the age of the species. The growth performance indices ϕ and ϕ' given by Pauly and Munro (1984) and incorporated in FiSAT were also calculated.

Results

A total of 2,687 males in the size range 65 - 150 mm and 4,913 females in the size range 66 - 190 mm were

examined from New Ferry Wharf and Versova landing centers for the growth studies.

Modal progression analysis

Progression of modal lengths from initial to final sizes, their increments and the growth rates per month are given in Table 1. By using Gulland and Holt plot with regression of rate of growth ($\Delta L/\Delta t$) against mean length (L), VBGF growth parameters obtained were:

$$\text{Males: } L_{\infty} = 152.7 \text{ mm, } K = 2.01 \quad (r = 0.35)$$

$$\text{Females: } L_{\infty} = 211.1 \text{ mm, } K = 2.47 \quad (r = 0.59)$$

ELEFAN

The growth parameters obtained from the restructured length frequency were $L_{\infty} = 160$ mm and $K = 2$ for the males and 198 mm and $K = 2.5$ respectively for the females.

Powell-Wetherall plot

The method estimated L_{∞} and Z/K instead of K , where 'Z' is the total mortality coefficient. The L_{∞} and Z/K were 157 mm and 4.806 for males and 198 mm and 2.472 for females respectively.

Gulland and Holt plot

From the month-wise length-frequency of the two sexes, modes were resolved into normal distributions by Bhattacharya method and their mean sizes and standard

Table 1. Progression of modal lengths in males and females of *M. affinis*

Sex : Male						
S. No.	L1 (in mm)	L2 (in mm)	Change in length	Change in time	$\Delta L/\Delta T$	Mean length
1	120.2	129.49	9.29	2	4.65	124.85
2	109.2	116.37	7.17	1	7.17	112.79
3	104.98	120.85	15.87	2	7.94	112.92
4	106.19	115.66	9.47	2	4.74	110.93
5	99.72	109.06	9.34	1	9.34	104.39
6	109.06	114.24	5.18	1	5.18	111.65
7	114.24	121.01	6.77	1	6.77	117.63
Pooled	-	-	63.09	10	6.31	
Sex : Female						
S. No.	L1 (in mm)	L2 (in mm)	Change in length	Change in time	$\Delta L/\Delta T$	Mean length
1	100.87	129.47	28.6	2	14.3	115.17
2	129.47	146.29	16.82	1	16.82	137.88
3	175	180	5	1	5	177.5
4	85	103.87	18.87	1	18.87	94.435
5	90.29	106.85	16.56	1	16.56	98.57
6	104.8	123.64	18.84	1	18.84	114.22
7	105.95	123.99	18.04	1	18.04	114.97
8	75.08	104.7	29.62	1	29.62	89.89
9	85.26	109.87	24.61	1	24.61	97.565
Pooled	-	-	176.96	10	17.96	

deviations were obtained. The growth increments per unit time calculated using these curves, were employed by the program to get the Gulland and Holt plot and shown in Fig. 1a and 1b for males and females respectively. For males, the estimates of VBGF parameters were: $L_{\alpha} = 162$ mm, $K = 2.25$ ($r = 0.88$) and for females $L_{\alpha} = 204$ mm, $K = 1.91$ ($r = 0.83$).

Faben's method

The data requirements for both Faben's method as well as Appeldoorn's method are the same as Gulland-Holt plot (1959). The parameters were:

$$\text{Males: } L_{\alpha} = 160.69 \pm 6.45, K = 2.33 \pm 0.32$$

$$\text{Females: } L_{\alpha} = 200.03 \pm 8.89, K = 2.06 \pm 0.26$$

Appeldoorn's method

The estimates of growth parameters for males and females, in addition to standard errors of the estimates, and seasonality parameters such as Winter point (WP) and seasonality constant (C) were:

$$\text{Males: } L_{\alpha} = 160.66 \pm 6.91, K = 2.34 \pm 0.34, \\ \text{WP} = 0.635 \pm 0.0, C = 0.0 \pm 0.071$$

$$\text{Females: } L_{\alpha} = 197.03 \pm 8.16, K = 2.11 \pm 0.25, \\ \text{WP} = 0.29 \pm 0.12, C = 0.103 \pm 0.062$$

von Bertalanffy plot

Growth parameter estimates together with their standard errors obtained by plotting length against age by considering non-seasonalised growth were:

$$\text{Male: } L_{\alpha} = 160.04 \pm 3.69, K = 2.37 \pm 0.19, t_0 = 0.009 \pm 0.018$$

$$\text{Female: } L_{\alpha} = 195.27 \pm 7.17, K = 2.14 \pm 0.21, t_0 = 0.013 \pm 0.015$$

Despite various length based methods followed in the present study, the estimated growth parameters (Table 2) L_{α} and K were in the narrow range of 152.60-162.03 mm and 2.0-2.37 for males and 195.3-210.9 mm and 1.91-2.14 for females respectively. However, the estimates obtained by the von Bertalanffy plot following seasonalised growth were not in accordance with the values obtained by other methods and standard errors of the estimates were improbable, therefore these values were not taken into consideration. It was also seen that the values obtained by Gulland and Holt plot lay in the range of confidence limits of rest of the methods. Therefore, for all practical purposes values obtained by Gulland and Holt plot were used for calculating age and growth of the species.

Tables 3 shows month-wise lengths estimated for males and females using these growth parameters as well as those reported earlier by Pauly *et al.* (1984), Achuthankutty and Parulekar (1986) and Paralkar (1990) for the same species. It is seen that males attain 69.7 mm, 109.4 mm, 132.0 mm, 144.9 mm and 152.3 mm and females 77.5 mm, 125.5 mm, 155.3 mm, 173.8 mm and 185.3 mm at the end of three, six, nine, twelve and fifteen months and at the end of three, six, nine, twelve and fifteen months respectively. Therefore, the largest male observed (150 mm) in the catch was 1.16 years and the largest female (190 mm) was 1.4 years.

Growth performance index

Growth performance index (ϕ) of male and female prawns were calculated using the growth parameters obtained by Gulland-Holt plot. In order to work out ϕ , W_{α} was computed using respective length-weight

Table 2. Growth parameters of *M. affinis* obtained by various methods

Method	Sex	L_{α}	K	t_0	C	WP	r	Rn
Modal Progression	M	152.6	2.01				0.59	
	F	210.9	2.47				0.76	
Gulland & Holt Plot	M	162.03	2.25				0.88	
	F	204.55	1.91				0.83	
Faben	M	160.69±6.45	2.33±0.32					
	F	200.03±8.89	2.06±0.26					
Powell-Wetherall	M	157.62	Z/K = 4.81					
	F	198.38	Z/K = 2.472					
Appeldoorn	M	160.66±6.91	2.34±0.34		0	0.64		
	F	197.03±8.16	2.11±0.25		0.1	0.29		
ELEFAN 1	M	160	2					0.164
	F	198.38	2.5					0.134
von Bertalanffy Plot Non seasonalised	M	160.04±3.69	2.37±0.19	0.009				
	F	195.27±7.17	2.14±0.21	0.013				
Seasonalised	M	204.59±575	1.09±6.43	-0.19				
	F	239.96±253	1.26±2.69	-0.04				

Table 3. Size of male and female *M. affinis* using growth parameters reported by different authors.

Author	Achuthankutty & Parulekar (1986)		Paralkar (1990)		Present study	
	Male	Female	Male	Female	Male	Female
Age in months						
3	60.8	47.4	27.0	30.8	67.5	77.5
4	73.7	58.5	35.1	40.1	82.8	96.1
5	84.8	68.8	42.8	49.1	95.5	112.0
6	94.5	78.4	50.2	57.6	106.0	125.5
7	102.8	87.3	57.2	65.7	114.7	137.1
8	110.05	95.5	63.9	73.4	122.0	146.9
9	116.3	103.2	70.2	80.8	128.0	155.3
12	130.5	123.0	83.4	101.1	140.5	173.8

relationships of the sexes (Leena, 2003) with $W_{\alpha} = 27.18$ g for males and 65.18 g for females:

Male : $\phi = 1.3081$, $\phi' = 2.7712$

Female : $\phi = 1.4918$, $\phi' = 2.9024$

Discussion

The earlier investigation on the age and growth by Subrahmanyam (1963) pointed out that, *M. affinis* is a slow growing species with a lifespan of about three or more years. Later, Mohamed (1967) described growth of the species from Bombay (Mumbai) and stated that the species grows about 10 mm per month in the first year, so as to attain 120 mm on completion of one year of life. Pauly *et al.* (1984) analysed the same length-frequency data reported by Mohamed (1967) and estimated growth parameters of the species L_{α} and K as 175 mm of 1.2 respectively. However, Pauly *et al.* (1984) did not consider differential growth (Garcia and Le Reste, 1981) exhibited by the sexes; nevertheless the estimated growth is slow as the prawns would attain 122.3 mm in first year and 159.1 mm in second year and may take more than three years to reach the observed maximum size.

Ramamurthy *et al.* (1975) estimated sex-wise growth parameters of the species from Mangalore waters and stated that males would reach 95, 140 and 160 mm and females 100, 145 and 170 mm at the end of 1, 2 and 3 years respectively. The growth coefficients reported appear to be far lower (0.84 and 0.72) than that estimated in the present study. Similarly, Achuthankutty and Parulekar (1986) reported L_{α} at 156 mm and 202 mm, K 1.73 and 0.89 and t_0 1.7 and 0.17 for males and females respectively in Goa waters. Although length asymptotes of the sexes in both the investigations are comparable to the present study, the growth coefficients are widely different, almost half in the case of female in the latter which suggests that males would attain larger size than females in the first year and females would exceed the size of males later. Vibhasiri (1988) estimated growth parameters as L_{α} 150 mm and 174 mm and K 0.85 and 0.84 for male and female respectively from

Gulf of Thailand. Similarly, Mathews (1989) reported slightly higher growth for the species from Kuwait waters with K values 1.09 and 1.22 and L_{α} of 162 mm and 182 mm for males and females respectively. The estimate of L_{α} less than 150 mm for males and in the range of 174-183 mm for females are lower, since males in the range 156-160 mm and females in 186 - 190 mm were frequently collected during the present study. While studying the species in Mumbai waters, Paralkar (1990) gave L_{α} as 193 mm for males and 235 mm for females and growth coefficients 0.6 and 0.56 respectively which suggest that the prawns would barely reach 100 mm in one year and the lifespan would be more than 3 years. However, the results obtained by various methods in the present study indicated that *M. affinis* is a fast growing species with asymptotic lengths 162 mm and 204 mm and the growth coefficients 2.25 and 1.9 estimated for male and female respectively indicating that the age of the largest prawn was about 1.4 years. Rao and Krishnamoorthy (1990) working on *M. monoceros*, a species closely related to *M. affinis*, estimated L_{α} as 178 mm and 207 mm and K as 1.68 and 1.62 for male and female respectively, which are comparable to the present study.

Pauly *et al.* (1984) compared the growth patterns of various penaeid prawns by computing growth performance indices (ϕ') and showed that the growth performance index of *M. affinis* falls in the same range as the species belonging to the genus *Penaeus* that are the fastest growing penaeid shrimps. The high growth performance index observed in the present study for the species confirms the above observation.

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