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Age and growth of the sand lobster *Thenus orientalis* (Lund) from Bombay waters

P.V. KAGWADE[1] AND L.M. KABLI[2]

Bombay Research Centre of Central Marine Fisheries Research Institute, Mumbai - 400 023, India

ABSTRACT

Age of the sand lobster *Thenus orientalis* was determined by length frequency distribution using scatter diagram technique. Growth rates of males and females were identical till the first 2 years after which the former recorded higher rate of growth. Males upto 3 and females upto 4.5 years contributed to the commercial trawl catches. Growth parameters estimated by the von Bertalanffy's growth equation were: L_∞ = 368 mm, K = 0.1279 and T_0 = -0.7368 for males and L_∞ = 300 mm, K = 0.1690 and T_0 = -0.7 for females. The growth pattern was retrogressive geometric throughout the life in this species.

Introduction

Lobsters have very rigid exoskeleton and most of the work on their growth have been based on two factors, namely, the time between two ecdysis and the size increase gained at ecdysis. Thus, growth in these animals has been estimated by the combined effect of moulting frequency and size or weight increase per moult. Both these are, however, affected by several factors such as temperature, food, injury leading to regeneration and reproduction.

Making use of moulting frequency and size increase in captive lobsters, growth has been estimated by several workers in different lobsters. To mention some are the investigations by Thomas (1958), Hepper (1967), Ennis (1972) and McLeese (1972) in nephroid lobsters and Fielder (1964), Heydorn (1969), Berry (1971), Chittleborough (1974) and Newman and Pollock (1974) in spiny lobsters.

George (1967) has been the first to attempt growth studies in the Indian spiny lobster *Panulirus homarus* from the southwest coast by the length frequency and tagging methods. Mohamed and George (1971) subsequently, described its movement and estimated its growth rate based on tagging experiments on the same species. Kagwade (1987) made a comprehensive study on the age and growth of another spiny lobster, *Panulirus polyphagus* from the northwest coast, also by length frequency method.

A close survey of literature indicated that no work on the age and growth of the sand lobster, *Thenus orientalis* has so far been attempted. Since knowledge

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Present address : 1. 129, Akash Darshan, Vakola Masjid, Santacruz (E), Mumbai - 400 055.
2. Zoology Department, Bhavan's H. Somani College of Arts and Science, Mumbai - 400 007.

of age and growth is a prerequisite for stock assessment and for the management of any fishery, an attempt is made here to study the same in this export oriented and commercially important species of *T. orientalis*.

Material and methods

Weekly random samples of *T. orientalis* were drawn from the trawler landings at the landing centre New Ferry Wharf, Mumbai, for a period of 2 years from January 1985 to December, 1986. Each sample consisted of around 100 specimens. A total of 4,454 males in the size range of 41-277 mm and 4,784 females in the size range of 55-275 mm were measured for their total length which is the distance between the notch in the carapace in front and the posterior margin of the telson behind.

Lengths were grouped into 5 mm class intervals and monthly frequency polygons were plotted for each of the sexes. The progression of modes was not smooth due to long intermoulting periods. Hence, scatter diagram technique presented by Devaraj (1983) was used in the present study.

The modal lengths obtained in the length frequency distribution were plotted in the form of a scatter diagram with lengths in millimeter on the ordinate and time in months on the abscissa. The trend in the progression of modes through time was drawn by an eye fitted line. This line when extrapolated with reference to intermodal slopes, intersected the time axis to indicate the growth of the brood in successive months and also the time of brood origin. The lengths at age in months at each time interval as read along each of the curves were averaged to obtain growth of the lobster at successive time interval.

Results

Age

After going through a series of stages of phyllosoma during the development, the larva passes through puerulus stage in palinurids and nisto stage in scyllarids (Phillips and Sastry, 1980) before it enters into the normal adult stage. Nisto of *T. orientlis* has not been encountered in any of the collection during the course of this investigation. Information on the growth from phyllosoma to nisto to a normal adult is also absent. Hence, it is difficult to get an idea about the length at which the larval phase ends and the juvenile phase of the normal adult begins.

Prasad and Tampi (1960) have recorded the sizes ranging between 1.6 and 19.0 mm for the phyllosomae of the various *Scyllarus* species in the plankton samples. The phyllosomae attached to the pleopods in *T. orientalis* have been reported to be as big as 3.2 mm in length and these were nearly double the size of phyllosomae on the pleopods of the spiny lobster *Panuliurs polyphagus* (Kagwade and Kabli, 1991). The puerulus of *P. polyphagus* corresponding to nisto of *T. orientalis* has been believed to be transformed into a juvenile at the size of about 25 mm (Kagwade, 1987). The smallest *T. Orientalis* in the collection was 41 mm. Keeping in view the relative sizes of the phyllosmae of these two lobsters which though belonged to different genera, it was presumed that juvenile of *T.orientalis* might measure between 25 and 41 mm. As a matter of convenience, the length of 33 mm, the mid value of the above two lengths, was considered as the size when nisto was to transform into a juvenile and the age alloted to *T. orientalis* at this length was zero.

There were 16 eye-fitted curves, named alphabetically 'a' to 'p', in the scatter diagram for males (Fig. 1). Each of them represented a brood and most of them required extrapolation to a greater extent.

Fig. 1 shows the length attained by males at monthly intervals. Growth could be traced to 37 months. During this period the monthly increment noticed in the successive months was very small and ranged between 2.5 and 8.1 mm. Though there was a distinct trend towards decline in the growth increment with the increase in age by months, there were also some minor fluctuations. The average growth increments in successive months were extremely low. While they were often steady, sometimes they recorded higher increment than the ones during the preceeding and succeeding months. Such rises in the growth increments were noticed in the 10th, 12-13th, 16th, 19th, 27th and 36th months. The interval between two successive rises ranged from 2 to 9 months and the interval period widened with the advance in age. On the strength of these observations, the age at length data for male *T.*

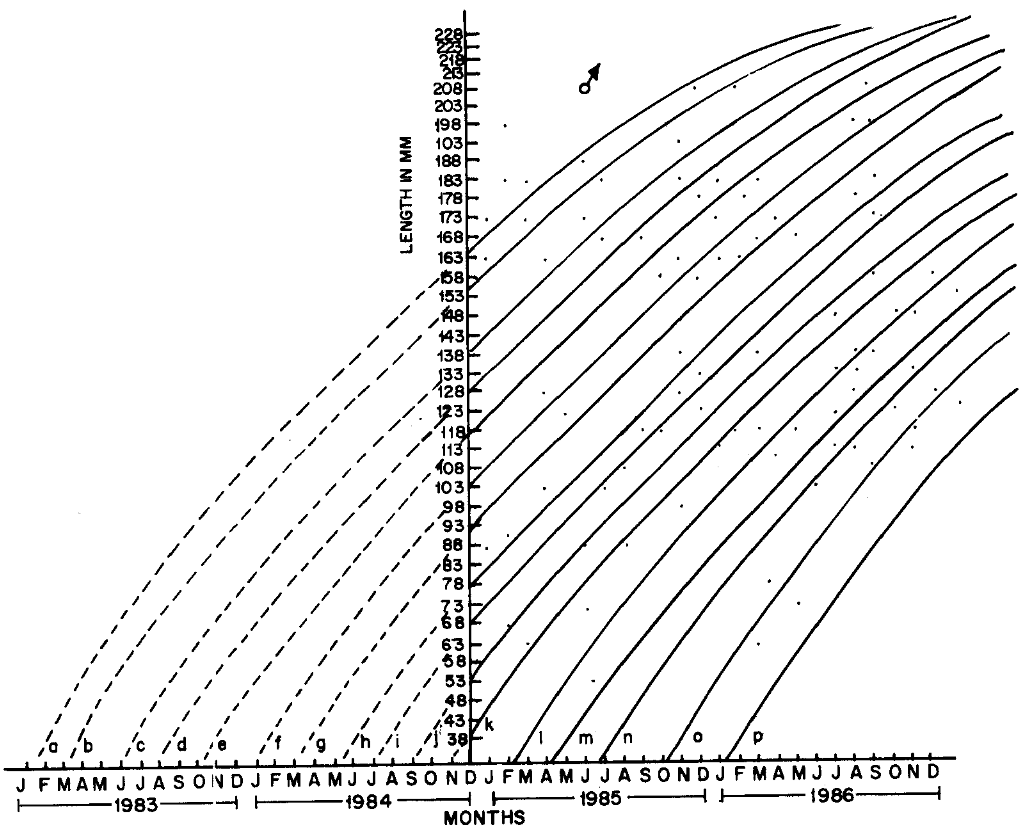

Fig. 1 Scatter diagram for monthly modes of male *T. orientalis* during 1984-'85.

orientalis was deduced to as follows:

Age in years	Length in mm	Age in years	Length in mm
0.5	75	2.0	166
1.0	109	2.5	192
1.5	138	3.0	213

The scatter diagram for females showed the progression of 19 eye-fitted curves by months and were named alphabetically from a' to r' (Fig. 2). As in the case of males the ordinate started at 33 mm, the age at which was considered to be zero. Most of the curves required extrapolation to a very great extent.

From Fig. 2 the growth for females, could be traced for 57 months. The average growth increments in the successive months fluctuated between 2.2 and 7.5 mm. As in the case of males, there was a conspicuous decline in the growth increment with the advance in age. The average growth increment was nearly steady for some months after which the increment suddenly rose up in the subsequent month to fall again thereafter. This pattern of rise and fall in the increment was more frequent with the females than with the males. The rises in growth increments were evident in the 12th, 15th, 19th, 21st, 24th, 27th, 32nd, 37th 39th, 43rd, 46th, 52nd, 54th

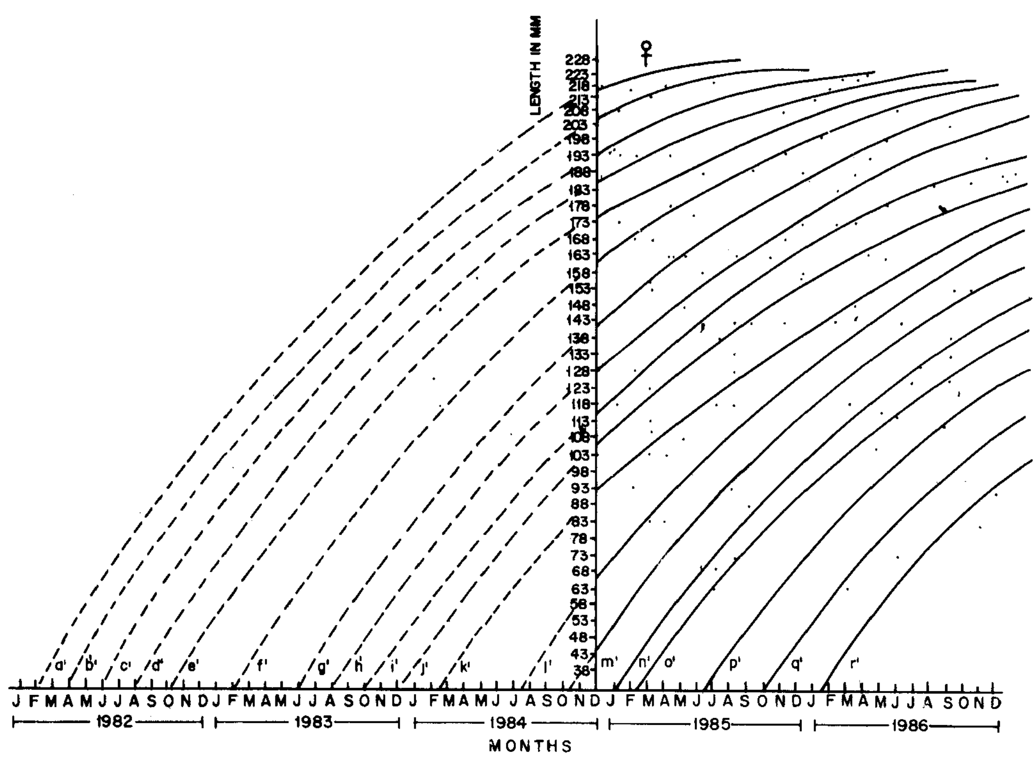

Fig. 2 : Scatter diagram for monthly modes of female *T. orientalis* during 1984-'85.

and 56th months and such rises took place at an interval of 2-6 months.

From these observations, the age at length data for female *T. orientalis* was deduced to as follows

Age in years	Length in mm	Age in years	Length in mm
0.5	75	3.0	203
1.0	110	3.5	219
1.5	138	4.0	231
2.0	165	4.5	242
2.5	185		

The age at length data were tested statistically and the correlation coefficients arrived at were 0.9995 for males and 0.9908 for females.

Growth

The growth parameters in the classic growth equation $L_t = L_\infty (L\text{-}e^{-K(t-to)})$ by von Bertalanffy (1938) were estimated arithmetically by Bagenal method (1955) and graphically by Ford-Walford method (Gulland, 1969). The values estimated by these two methods were very close to

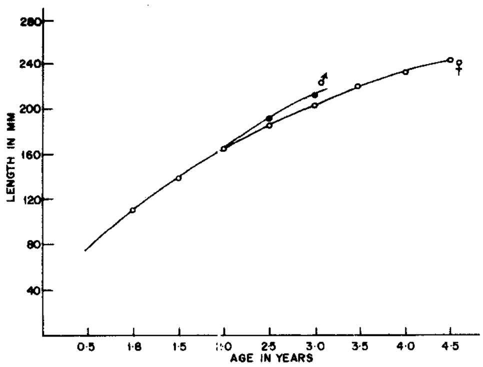

Fig. 3. Growth curves for male and female *T. orientalis*..

each other. However, for calculating the length at age, the values obtained by arithmatic method were used and they were:

L_∞ = 368 mm, K = 0.1279 and t_o = −0.7368 for males

and L_∞ = 300 mm, K = 0.1690 and t_o = -0.7 for females.

The fit for von Bertalanffy's growth appeared to be very good since the calculated values were very near the observed values. Fig. 3 shows the growth curves for males and females.

Recruitment

The spawning period of *T. orientalis* extended from September to April with high incidences of berried and spent individuals in November and March and an individual spawned twice in a year (Kagwade and Kabli, 1996).

In the present study small individuals measuring less than 60 mm entered the fishery in March and July may be the progenies of the spawners from the peak spawning periods. Figs. 1 and 2 indicated 4-5 broods entering the fishery in a year. The spawning period spreading over a period of 6-8 months coupled with spawning twice of an individual in a year must have resulted in the recruitment of 4-5 broods.

Discussion

The commercial catches of this species were comprised of males upto 3 years and females upto 4.5 years. Males were smaller in size than the females in the catches. The growth rates were found to be identical for both the sexes till they were two years old. Thereafter males recorded higher rate of growth than the females.

L_∞ of 368 mm was higher for males than of 300 mm for females. Since monitoring the catch of *T. orientalis* has been continued even after 1986, the largest male measuring 292 mm and the largest female measuring 297 mm in total lengths were collected in October and November 1988 respectively. The commercial catches were mainly comprised of males upto 210 mm (about 3 years) and females upto 230 mm (4 years). This suggested high mortality of larger individuals.

It has been an established fact that in crustaceans the duration of intermoult period increased and the moult increment decreased with the increase in size (Kurata, 1962; Berry, 1971; Ennis, 1972). Yet the growth pattern differs from species to species. Kagwade (1987) reported that in male *P. polyphagus* sometimes when the intermoult period extended to two months, the size increment after the ecdysis was nearly double. Similar jumps after some months in size increase have been met with more frequently in the present study in both the males and females of *T. orientalis*. However, the cumulative effect of all these over a longer period of about six months showed a declining trend in the halfyearly increase in size of this species.

Kurata (1962) gave a straight line relationship between linear dimensions before and after moulting in the growth of crustaceans and it was expressed as:

$$L_{(t+1)} - L_t = b\,(L_t - L_{t-1})$$

where L_t was the length at a given time.

The constant 'b' here suggested about the geometric growth pattern of the species in relation to moult increments at successive moulting. Kagwade (1987) by modifying the increments in terms of years found that 'b' equalled 1 in the juvenile phase of *P. polyphagus* when the successive annual increments remained constant at 60 mm and this type of growth has been termed as arithmetic growth. Thereafter, the successive increment decreased year after year and the value of 'b' was less than 1 in the adult phase and such a type of growth has been described as retrogressive geometric growth.

When the moult increments in the successive 1/2 year period were treated in a similar manner for *T. orientalis,* it was observed that the value of 'b' always remained less than 1. Thus, it followed retrogressive geometric growth pattern throughout its life. The growth pattern worked out for the months covering sudden jump in the size increments also indicated retrogressive geometric growth.

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