Original Research Paper

Age and Growth of Muricid Gastropods *Chicoreus virgineus* (Roading 1798) and *Muricanthus virgineus* (Roading 1798) from Thondi Coast, Palk Bay, Bay of Bengal

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ABSTRACT

Age and growth of the C*hicoreus virgineus* (Roading 1798) and M*uricanthus virgineus* (Roading 1798) species were determined using different methods such as size frequency method, probability plot method and Von Bertalanffy's growth equation. Using Peterson's method, male of *Chicoreus virgineus* was found to attain a maximum length of 7.25cm and the female a length of 10.2cm in the 4th year. In *Muricanthus virgineus* male and female attained a length of 8.5cm and 11.4cm respectively in 4th year. The results of probability plot method revealed that the male of *Chicoreus virgineus* reached a maximum length of 8.55cm, and the female 10.35cm in the 4th year. However, in *Muricanthus virgineus,* the maximum length of 9.4cm in male and 11.00cm in female were found in 4th year. Using Von Bertalanffy's equation, *Chicoreus virgineus* male was found to attain a length of 8.85cm, and the female a length of 10.35cm while the male of *Muricanthus virgineus* calculated as 9.4cm, and the female 11.00cm of lengths in 4th year.

INTRODUCTION

Age and growth of animals are interrelated phenomena which denote the duration of life spent by the individual (age) and the increase in its volume of mass (growth) during the corresponding period of its life history. Carnivorous gastropods of the family Muricidae are found literally all around the world and in both hemispheres. The distribution and habits of gastropods are influenced considerably by the environmental conditions which vary not only with latitude but also with habitat. The influence of the habitat on the shape of the shell in marine gastropod has been studied by several workers. Thivakaran (1988) studied the population, age structure, growth and longevity of the gastropod *Littorinids* sp. The variation in characteristics of the shell in different populations of *Nucella lapillus* (Moore 1936, Staiger 1957, Largen 1971, Crothers 1971, 1973, 1974) and the growth of *Urosalpinx cinerea* populations occurring in English waters (Cole 1941) have been documented earlier.

The age and environmental variations have profound influence on the shell growth in molluscs (Wilbur & Owen 1964). In temperate molluscs, the growth lines on the shell are valuable indicators of age, but in tropical waters, such variations in growth lines are not discernable. The body form and shell of muricids may be substantially modified by environmental conditions and its substratum. Knowledge of the age and growth refers to the relative length and weight of the individuals. Present

investigation was also undertaken to provide information on the stocking policy, grouping of the year classes, the dominant year groups, the environmental suitability, and the fluctuations in the rate of growth. Studies on age and growth also reveal the age of sexual maturity and the age at which marketable size is attained for commercially important gastropods.

MATERIALS AND METHODS

In the present study, the species of *Chicoreus virgineus* and *Muricanthus virgineus,* occurring in Thondi (Lat. 07°15.607'N; Long. 76°10.350'E) coast of Palk Bay, Bay of Bengal. These gastropods occupy approximately the littoral zone where they occur in habitats which is well protected from wave action. Care was taken to collect representatives of different size groups of both the species. The shells were measured with the help of vernier caliper to the nearest 0.1mm. The method of determining growth and longevity in this study is by size frequency analysis of both shell length and weight. The growth rate was also determined using the probability plot method (Harding 1949, Cassie 1954) and Von Bertalanffy's growth curve (Von Bertalanffy 1938). The vertical distance from the apex to umbilical base of the shell is defined as length. Width is taken as the maximum dimension at right angles to the length of the shell in transverse plane. The length and width of the operculum was also measured. To find out weight, the soft parts were removed from the shell, blotted to remove the excess moisture and then weighed to the nearest 0.1mg using a single pan electric balance.

RESULTS

Length frequency method: Peterson (1891) has demonstrated that the statistical classification of the multimodal length distribution of a population can be used effectively to study the different age groups. By this method, the average size of few earlier classes can be traced.

The length frequency histograms for both the species for the study period (January 2006 to December 2006) are shown in Figs. 1-4. A length frequency study on the shells of *Chicoreus virgineus* male clearly indicated a shell growth of 0.5 cm in 7 months with an average rate of 0.71 cm per month. Thus, the shell growth of *Chicoreus virgineus* male by this method at the end of 12 months is 0.85 cm. The mode at 5.6-6.0 cm was traced to 6.1-6.5 cm recording a growth of 0.5 cm in 3 months with an average growth rate of 0.16 cm per month. Thus, the 1st year recorded a growth of 2.0 cm, which, when added to the growth of 0 year (0.85cm) showed a total growth of 2.85 cm at the end of 1st year. The mode at the size 6.5-7.0cm traced to 7.1-7.5 cm was recording 0.5 cm growth in 5 months with an average growth rate of 0.1cm per month and an year growth of 1.2 cm. This 2nd year growth, when added to the growth of previous years, a total shell size of 4.05cm. The mode of the size group 7.6-8.0 cm was traced to 8.1-8.5cm recording 0.5cm growth in 3 months with an average growth rate of 0.72 cm per month, i.e., in 3rd year they recorded a growth of 2.0 cm, which when added to the growth of previous year, gave a total shell size of 6.05cm. The mode at the size group 9.1-9.5cm was traced to 9.6 to 10.0 cm recording 0.5cm growth in 5 months with an average growth rate of 0.1cm per month. In the 4th year, the recorded growth is 1.2 cm, which when added to the growth of 3rd year, showed a total shell size of 7.3 cm.

In *Chicoreus virgineus* female, the mode in the size group of 4.6 to 5.0 was traced to 5.1 to 5.5 cm recording a growth of 0.5 cm in 3 months with an average growth rate of 0.16 cm per month. So at the end of the year, the calculated size of the shell is 2.0 cm. In the 1st year, the mode in the size group of 5.6-6.0 was traced to 6.1-6.5 cm recording a growth of 0.5cm in 4th months at an average growth rate of 0.12 cm per month. Thus, the calculated growth during first year is 1.5cm, which when added to

the 0 year (2.0cm), showed growth of 3.5 cm at the end of 1st year. For the 2nd year growth, the mode at 6.6-7.0 was traced to 7.1-7.5 cm recording a growth of 0.5cm in 4 months. The growth rate for the 2nd year could be calculated as 0.125cm per month and the calculated size attainable after the completion of 2nd year is 5.0cm. For the 3rd year, the mode of 6.5 to 7.0 cm was traced to 7.6-8.0 cm indicating 1.0 cm growth in 3 months with an average growth rate of 0.33 per month. Thus, the calculated size after the completion of 3rd year is 9.0 cm. The mode at 7.6-8.0 was traceable up to 8.6-9.0 cm recording a growth of 1.0 cm in 10 months. The growth rate for the 4th year, thus, could be calculated and the size attainable after the completion of 4th year is 10.2cm.

In *Muricanthus virgineus* male, length frequency study clearly indicates the shell growth of the 0 year as 0.5 cm in 4 months, 1st year, 0.5cm in 4th months, 2nd year 0.5cm in 6 months, 3rd year 0.5cm in 4 months and 4th year 0.5cm in 6 months at an average growth rate of 0.125cm, 0.125cm, 0.083cm, 0.125cm and 0.25 cm per month respectively during 0, 1, 2, 3 and 4th year. The growth of *Muricanthus virgineus* male by this method by 0 year, 1st, 2nd, 3rd and 4th year is 1.5cm, 1.5cm, 1.5cm, 1.0cm, 1.5cm and 3.0cm respectively. Thus, in the 4th year *Muricanthus virgineus* male recorded a growth of 3.0 cm, which when added to the growth of 0 year, 1st , 2nd, 3rd year, showed a growth of 1.5, 3.0, 4.0, 5.05 and 8.5cm at the end of the 0 year, 1st, 2nd, 3rd, and 4th year.

The length frequency study on the shells of *Chicoreus virgineus* and *Muricanthus virgineus* females clearly indicated the growth of 0 year as 0.5cm in 12 months 1st year as 0.5cm in 8 months, 2nd year as 0.5cm in 5 months, 3rd year as 0.5cm in 8 months and 4th year as 0.5cm in 3 months with average growth rates of 0 year, 1st, 2nd, 3rd and 4th years as 0.45cm, 0.062cm, 0.2cm, 0.062 cm and 0.166 cm per month respectively. The shell growth of *Muricanthus virgineus* female by this method at the end of 0 year, 1st , 2nd 3rd and 4th year is 5.5cm, 0.75cm, 2.4cm, 0.75cm and 2.0cm respectively. Thus, in the 4th year *Muricanthus virgineu*s female recorded a growth of 2.0cm, which when added to the growth of 0 year, 1st,2nd, 3rd year, showed a total growth of 5.5, 6.25, 8.65, 9.4 and 11.4 cm at the end of the 0 year, 1st, 2nd, 3rd and 4th year.

Probability plot method: This method was used for *Chicoreus virgineus* and *Muricanthus virgineus* as certain year classes may not be represented in the catches and overlapping of distribution of older size group is likely to yield erroneous results in the Peterson method. The probability plot to separate the polymodal length frequency distribution is applied in order to find out the modal lengths at different year classes. This method was originally described by Harding (1949) and later improved by Cassie (1954). The cumulative percentage of different size groups of different months were plotted on an arithmetic probability paper and the points of inflection were noted. Different size groups of different broods can be sorted out with high accuracy by this method.

In this method, males of *Chicoreus virgineus* were found to attain a length of 4.55, 6.2, 7.2, 8.5 and 8.85 cm in the 0 year 1st,2nd, 3rd and 4th year respectively (Fig. 5) and in females 5.05, 6.2, 7.45, 8.4, 9.62 and 10.35cm in the 0 year, 1st, 2nd, 3rd, 4th and 5th year respectively (Fig. 6). In *Muricanthus virgineus* the males were found to attain length of 4.82, 6.15, 7.75, 8.8, and 9.4cm in the 0 year, 1st, 2nd, 3rd and 4th year respectively (Fig. 7), and the females 5.75, 6.9, 8.6, 9.9 and 11 cm in the 0 year 1st, 2nd, 3rd and 4th year (Fig. 8). The life span of both the species appears to be from 4 to 5 years and the males and females are not found to have the different growth rates.

Von Bertalanffy's growth curve: The mathematical equation derived by Von Bertalanffy (1938) was used to calculate the length of animals at any given time. This Bertalanffy's equation has been used to describe growth of a species in various forms (Beverton & Holt 1957, Fabens 1965). This mathematical expression is useful in interpretation and also in production computation (Pantalu 1963,

Kamal 1969). Since growth is the net result of metabolism, a growth curve in length fits well with the growth rate of many species (Beverton 1954, Beverton & Holt 1957). By this equation, length for different years was calculated and plotted along with the observed length of the same period, which showed a general agreement in growth pattern. This equation gives a linear relationship in growth pattern. This equation gives a linear relationship between length (L) at a time 't' and (t + x) is expressed as:

Lt = L 1 –e^{-k} (t-to)
Lt + Length of age 't'
L = asymptote of the growth curve in length
E = base of natural logarithm
K + Coefficient of catabolism
t = age of the animal
to = arbitrary origin of the growth curve
The equation can be written as
Lt + 1 = L (1^{-e}k) + e^{-klt}

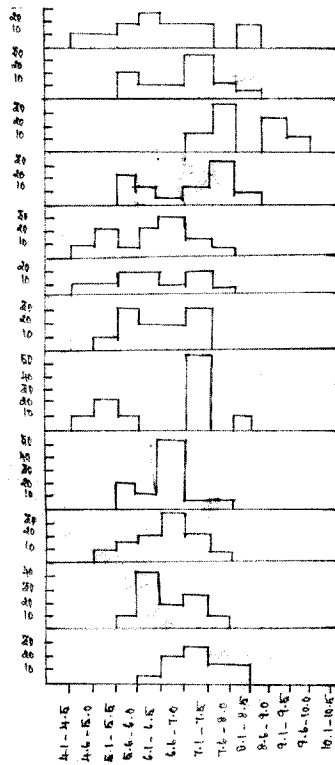This is a linear equation in terms of Lt and Lt + 1 as shown below:

Fig. 1: Length frequency histograms for
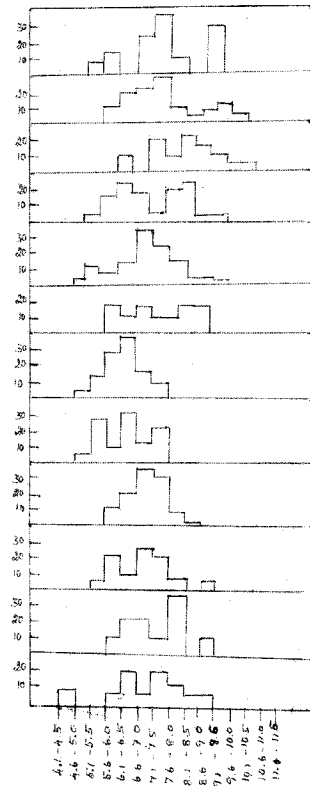*Chicoreus virgineus* - Male.

Fig. 2: Length frequency histograms for
Chicoreus virgineus - Female.

Lt + 1 = a + b Lt

Where,

 a = L (1-e-k) and

 b + e-k

By the method of least square analysis, values of 'b' and 'a' were calculated for *Chicoreus virgineus* and *Muricanthus virgineus*. The value 0 + 'k' can be determined from e-k by using the formula.

K = log e; b + log 1/e^{-k} + log e   ... (4)

The t$_o$ can be calculated using the formula

t$_o$ + 1/k log e L-log e (L-Lt)

Using the above equation, the asymptotic length of males of *Chicoreus virgineus* was found to be 10.3 cm, and of females to be 20.7 cm. In *Muricanthus virgineus* the maximum attainable length was found to be 12.61 cm in males and 13.96 cm females. The age at the origin of the growth curve for male *Chicoreus virgineus* was 1.7012 and for female it was 3.3871. The coefficient of catabolism for males of *Chicoreus virgineus* was 0.3383 and for females it was 0.0823. In *Muricanthus virgineus*, the age at the origin of the growth curve was 2.1607 and 3.3756 and the coefficient of catabolism was 0.2229 and 0.0428 for males and females respectively. In the present study, the age and the corresponding length of animals obtained from the probability plot method were used to construct Von Bertalanffy's growth curve. The Von Berfalanffy's equation for growth in both the species may be given as follows.
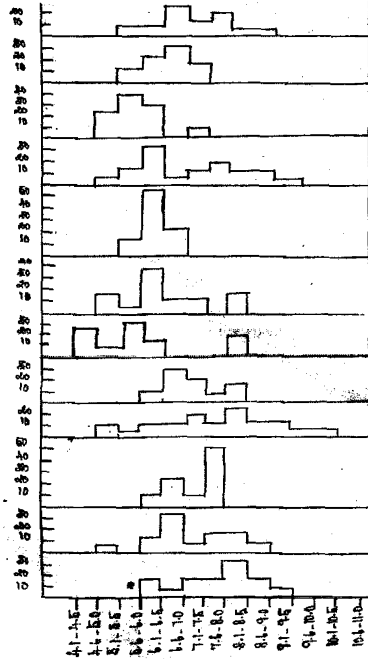
Chicoreus virgineus

Fig. 3: Length frequency histograms for
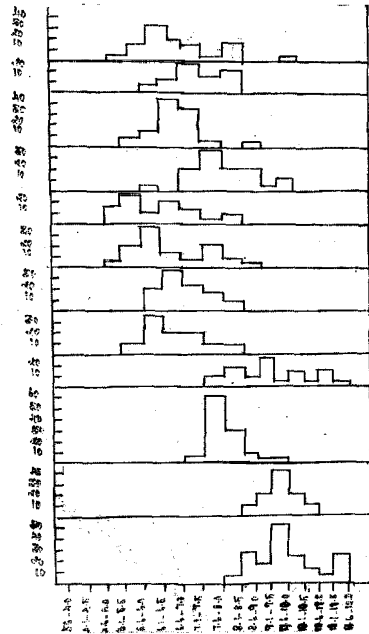*Muricanthus virgineus* - Male.

Fig. 4: Length frequency histograms for
Muricanthus virgineus - Female.

Male

$Lt = 10.3575 (1-3^{-0.3383} (t + 1.7102)$

Female

$Lt = 20.7580 (1-3^{-0.8823} (t + 3.3871)$

Muricanthus virgineus

Male

$Lt = 12.6104 (1-3^{-0.2229} (t + 2.1607)$

Female

$Lt = 38.9565 (1-3^{-0.0428} (t + 3.7559)$

The length calculated for different years using this equation was plotted along with the observed length for the same period, which showed a general agreement in growth curves and it can be observed that male *Chicoreus virgineus* attained a length of 4.55, 6.21, 7.40, 8.25 and 8.85 cm in the 0
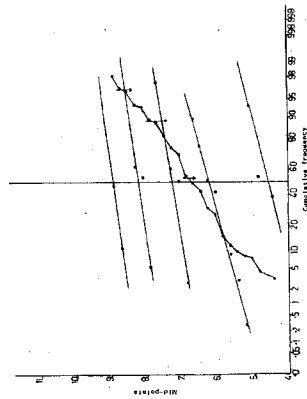

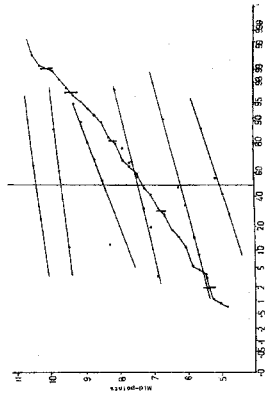Fig. 5: *Chicoreus virgineus* - Male.
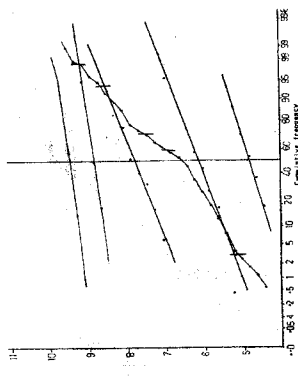

Fig 6: *Chicoreus virgineus* - Female.

Fig.7: *Muricanthus virgineus* - Male.
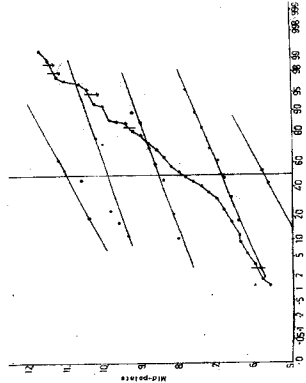

Fig.8: *Muricanthus virgineus* - Female.

year, 1st and 2nd, 3rd and 4th year respectively (Fig. 9). The females recorded a growth of 5.05, 6.29, 7.43, 8.48, 9.45 and 10.35 cm in the 0 year, 1st, 2nd, 3rd, 4th and 5th year respectively (Fig. 10). In *Muricanthus virgineus,* males attained a length of 4.81, 6.37, 7.62, 8.61 and 9.4 cm in the 0 year, 1st, 2nd 3rd and 4th years (Fig. 11), and the females 5.78, 7.17, 8.50, 9.78 and 11 cm in the 0 year, 1st, 2nd, 3rd, 4th and 5th year respectively (Fig. 12).

DISCUSSION

Growth of *Chicoreus virgineus* and *Muricanthus virgineus,* calculated using the above methods, is presented in Table 1. Both the species have almost similar growth rates and life span.

Several investigators, both in tropical and temperate waters, have found that growth pattern was not uniform throughout the year and in the early stage, growth rate is faster than the later part (Rajagopal 1982, Kamala 1983, Kanakasabai 1985). Various factors are known to influence growth (Wilbur & Owen 1964). In some gastropods, such as *Nerita fulguarans, Nerita peloronta* and *Nerita versicolor,*
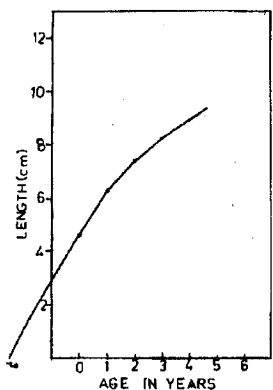

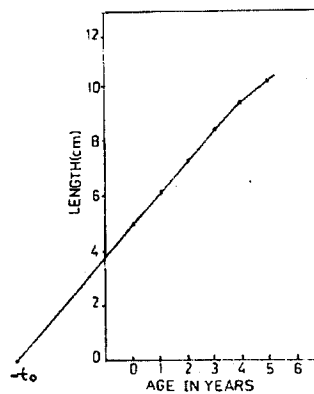Fig. 9: *Chicoreus virgineus*-Male.
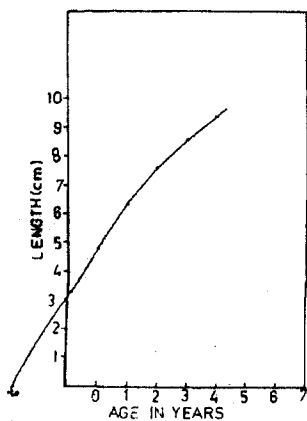

Fig 10: *Chicoreus virgineus*-Female.

Fig.11: *Muricanthus virgineus*-Male.
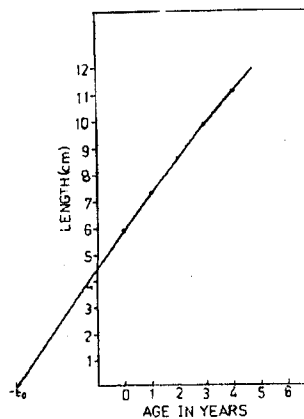

Fig.12: *Muricanthus virgineus*-Female.

Table 1: Growth estimated for *Chicoreus virgineus* and *Muricanthus virgineus* employing different methods.

Methods	Length at 0 year cm		Length at 1st year cm		Length at 2nd year cm		Length at 3rd year cm		Length at 4th year cm		Length at 5th year cm	
	Male	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*
Peterson's Method												
Chicoreus. virgineus	0.85	2.0	2.85	3.5	4.05	5.0	6.05	9.0	7.25	10.2	-	-
Muricanthus virgineus	1.5	5.5	3.0	6.25	4.0	8.65	5.05	9.4	8.5	11.4	-	-
Probability method												
Chicoreus. virgineus	4.55	5.05	6.2	6.2	7.2	7.45	8.5	8.4	8.55	9.62	-	10.35
Muricanthus virgineus	4.82	5.75	6.15	6.9	7.75	8.6	8.8	9.9	9.4	11.00	-	-
Von Bertalanffy's												
Chicoreus. virgineus	4.55	5.04	6.21	6.29	7.40	7.43	8.25	8.48	8.85	9.45	-	10.35
Muricanthus virgineus	4.81	5.78	6.37	7.17	7.62	8.50	8.61	9.78	9.4	11.00	-	-

growth was found to be slow during winter but rapid during summer, parallel with the seasonal changes (Kolipinski 1964). *Littorina* sp. from tropical and temperate waters, exhibited remarkable variations in growth, size and life span. Moore (1937) recorded a maximum growth of 27.5 mm with a life span of 4-5 years for *Littorina littence* and a life span of 5-6 years with a maximum height of 18.5 mm in *Littorina sukatilis* (Moretean 1976). Stella et al. (1992) recorded that *Chicoreus ramosus* attained a length of 107.7, 163.7, 205.0, and 235.3 in the 1st, 2nd, 3rd and 4th year respectively. This species was found to have a life span of 4-5 years. In the present investigation both the species were found to have a life span of more than 4 years. This increased growth rate of these species may be due to increased food availability and the combined effect of hydrobiological factors in their habitat. Besides, the northeast monsoon is said to have considerable influence on the growth rate of this gastropod.

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