AGE AND GROWTH, LENGTH-WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR OF *PENAEUS SEMISULCATUS* DE HAAN

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ABSTRACT

Attempts have been made to determine the age and growth of *Penaeus semisulcatus* by the method of length-frequency analysis and the results were verified by using von Bertalanffy's equation. Males showed a growth of 2 mm carapace length per month from seventh to eighth month of age. Females had a higher growth rate viz., 3.5 mm per month at the same period. Male prawns reached the estimated carapace length of 26.2 mm at one year and 29.4 mm at two years while the size of females at ages of one and two years were 38.16 mm and 41.08 mm respectively. There was no significant variation between the length-weight relationship through the different months of an year while the values exhibited definite difference between sexes. The relationships for the year 1967-1968 for males and females were found to be $W = 0.9093\ L^{2.9541}$ and $W = 1.5492\ L^{2.4242}$ respectively. The relative condition factor in both the sexes changed in the various seasons, showing peaks, denoting attainment of sexual maturity. This is followed by troughs and alternating smaller peaks and shallower troughs representing the cyclic gonadial development. These changes were more pronounced during the spawning seasons.

INTRODUCTION

Determination of age and growth of *Penaeus semisulcatus* de Haan was made by Peterson's method. Since the spawning in this species is prolonged, the modes tend to overlap as the growth slows with age. So, a size group could be traced only as far as possible after its entry into the commercial fishery. The average monthly growth rate in different stages, and from this, the approximate values at various ages were computed.

MATERIAL AND METHODS

Ramdon samples were collected from the catches by mechanised boats at Mandapam from April 1967 to March 1969. After separating the sexes, total length from the posterior margin of the orbit to the posteromedian margin of the carapace were taken.

For using the carapace length, which was found to be more reliable and easy to measure, as a measure of growth, it was essential to find out its relationship to the total length and, therefore, the carapace lengths were arranged in 2-mm groups and their average was plotted against the average of total lengths (Fig. 1). The relationship was found to be a straight line by the method of least square. The relation of the total length to carapace length was as follows:

$T = 3.2231 + 3.4802\,C$, where T is total length and C carapace length.

The carapace lengths were grouped into 2-mm groups and the data for each month were pooled to avoid any errors due to false sampling, and the progression of modes was traced.

For length-weight relationship, carapace length was taken to the nearest millimetre and each specimen was weighed in grams. During the first year 759 prawns (366 females ranging in length from 22 to 49 mm and 393 males, from 15 to 38 mm) and in the second year 512 prawns (260 females ranging in length from 24 to 50 mm and 252 males from 19 to 46 mm) from Mandapam were made use of in the study.

The general parabolic equation $W = aL^n$ can be written as $\log W = \log a + n \log L$ which is in the same form as the equation, $Y = A + BX$, where A corresponds to log a; B to n; Y to log W and X to log L. This linear

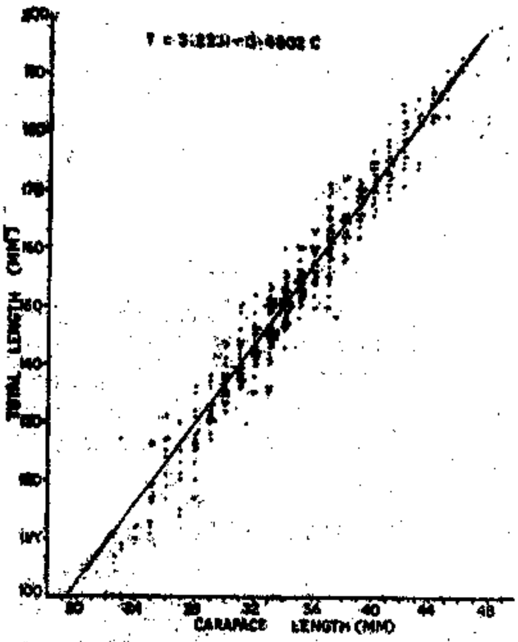

FIG. 1. Relationship between carapace length and total length of *P. semisulcatus*.

equation was applied in the case of data collected during the two years separately, for both sexes. The values of parameters A and B were calculated by the method of least square. Analysis of covariance was employed to test whether the regression of Y and X are significantly different for the two sexes and between the various months of the year.

The relative condition factor Kn was calculated by the method of Le Cren (1951) using the formula Kn = W | $\bar{W}$, where W is the observed weight and $\bar{W}$ calculated weight. The geometric means of Kn was computed for each month by taking the average. The Kn was calculated only for mature prawns as only very few immature specimens were encountered in the samples. The relative condition factor was determined for both the sexes.

Age and Growth

Females

The length-frequency curves are drawn for each month for the period, from April 1967 to March 1969 (Fig. 2). During the year 1967-1968 female prawns exhibited two modes in most of the months. The mode at 29-30 mm in April 1967 remained same in succeeding months; but, increased to 33-34 mm in June and 37-38 mm in July. This modal size was maintained during the months of August and September. In October, the mode increased further to 39-40 mm and remained same in November. The progression of this mode could not be traced in December to January, although, in February the dominant size was 43-44 mm. The progression of modes in the second year also was more or less of the same pattern. Thus, it is seen that the growth rate in females was more than that of males. This seems to be in agreement with the larger size of the females.

On tracing the progression of modes in females in a sequential manner, the mean values of each month showed that the average growth (from 30 mm in the earliest month to 33.5 mm in the next month) was 3.5 mm. As the growth in earlier months would be faster in all animals, the age at 30-mm carapace length could not be more than 7 months. Therefore, at 12 months age the carapace length attained was 38.2 mm and at 19 months 41.5 mm.

The lengths at 12 months and 24 months were computed using Bertalanffy's equation and compared with the values obtained by Peterson's method. The estimated lengths at 12 months and 24 months were 38.16 mm and 41.08 mm respectively.

Males

During all the months of the first year, males showed only one conspicuous mode except in January 1968 when two modes were seen at 25-26 mm and 29-30 mm respectively. In April 1967, 25-26 mm was the only modal size which remained same in succeeding months also. But, in June, the mode increased to 27-28 mm. This dominant size was maintained up to August, and in September and October the mode progressed to 29-30 mm, beyond which the modes could not be traced. But, in November a mode at 25-26 mm was observed which in December 1967 increased to 27-28 mm. This mode could be traced to the next month in which the higher one of the two modes was 29-30 mm. The smaller mode in January 1968 at 25-26 mm did not progress in the next month; but increased to the next size group in March. During the next year the single modes were recognised in all the months. The mode at 25-26 mm in April 1968 increased to 29-30 mm in October, showing an increase in carapace length by 4 mm during 5 months.

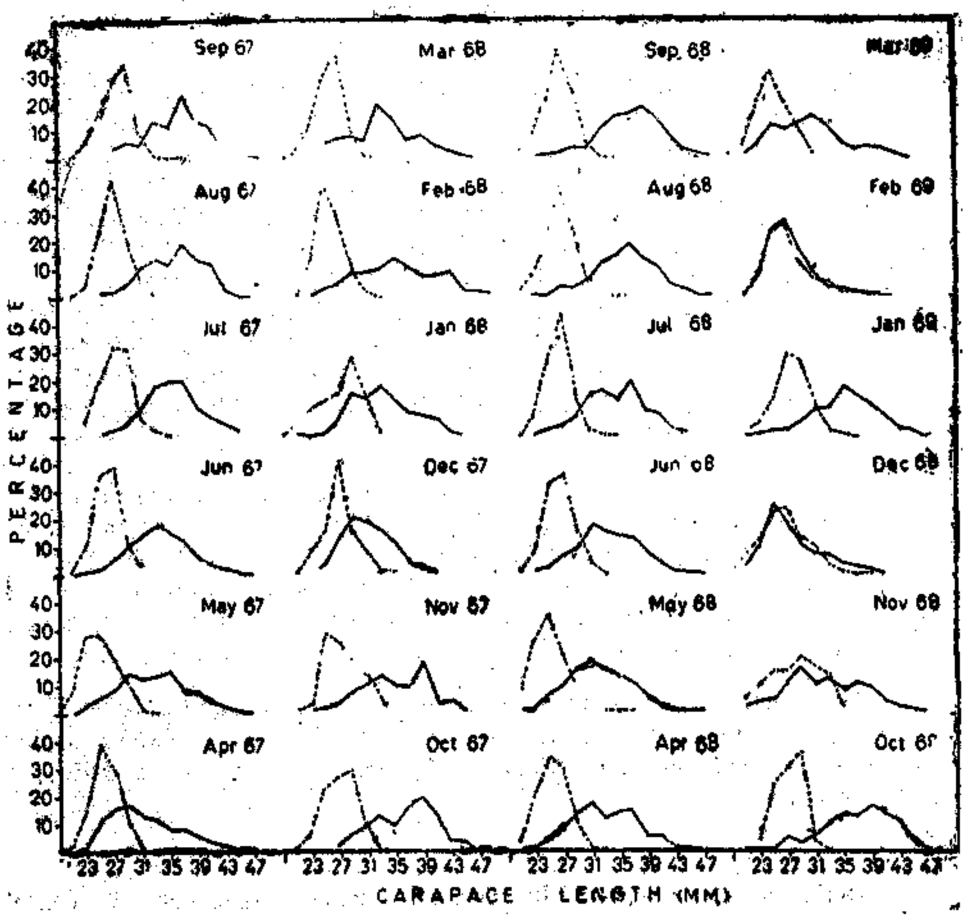

FIG. 2. Length-frequency distribution of *P. semisulcatus* for the years, April 1967 to March 1969.

Tracing the progression of modes in the sequential manner as before, the mean values for each month showed an average increase of 2 mm in carapace length from 25.5 to 27.5 mm during the period of one month. Since growth during the earlier months would be higher, it can be presumed that these prawns attain a size of 27.5 mm in 12 months and 29.5 mm in 14 months.

The same method was followed for males also and the values were computed using Bertalanffy's equation. The values obtained for carapace lengths at age 12 and 24 months for males were 26.2 mm and 29.36 mm, respectively. These values agreed well with the lengths for corresponding ages arrived at by the analysis of mode of different months by Peterson's method.

The length-frequency data showed that (1) the size group above 45-46 mm were represented only by females; (2) females formed the higher sizes in the samples examined during the various months; (3) the first year-class had a size range greater than the second year-class; (4) overlapping of various sizes existed and (5) July to October had more larger size groups than other months.

LENGTH-WEIGHT RELATIONSHIP

The raw sums of squares and products of log length-log weight data for the females during the various months of the year 1967-1968 are given in Table 1. Table 2 gives the corresponding corrected sums of squares and products and the regression coefficient B for each case and the deviation from the regression. The analysis of covariance (Table 3) shows that there is no significant difference between the regression coefficients of different months of the first year. Hence, the data for the entire year was pooled and the combined length-weight relationship was fitted for each year.

Similarly, analysis of covariance was employed to determine whether there was any significant difference between the regressions of Y and X for the two sexes for the year 1967-1968. The Tables 4, 5 and 6 present the data

TABLE 1. *Raw sum of squares and products for various months of the year 1967.*

Months	n	Sum X	Sum Y	Sum XY	Sum X^2	Sum Y^2
June	32	17.8919	49.9391	28.0301	10.0505	78.3050
July	26	14.6094	39.8245	22.5486	8.2720	61.4359
August	19	10.1774	28.1183	15.1508	5.4921	41.8356
September	33	18.5862	51.2920	29.2034	10.5921	80.5585
October	32	16.6351	46.8315	24.3814	8.6670	68.6480

showing that it was significant at 5% level. Therefore, general relationship between Y (log W) and X (log L) were calculated for the two sexes separately for the two years.

TABLE 2. *Corrected sum of squares and products for the various months of the year* 1967.

Months	d.f.	X^2	XY	Y^2	B	Sum of Squares	d.f.
June	31	0.0468	0.1081	0.3702	2.3098	0.1205	30
July	25	0.0630	0.1712	0.4363	2.7174	0.3898	24
August	18	0.0405	0.0892	0.2230	2.2025	0.0268	17
September	32	0.1218	0.3118	0.8352	2.5599	0.0370	31
October	31	0.0193	0.0362	0.1108	1.8756	0.1040	30
	137	0.2914	0.7165	1.9755	2.4588	0.6971	136

TABLE 3. *Analysis of covariance between the months.*

Source of Variation	d.f.	Sum of Squares	Mean Squares	F
Deviation from individual regressions	132	0.6778	0.0051	1.06 (Value from table at 5% level 5.65)
Difference between regressions	4	0.0193	0.0048	
Deviation from average regressions	136	0.6971		

TABLE 4. *Raw sum of squares and products for the two sexes* 1967-1968.

Sex	Number of Prawns	Sum X	Sum Y	Sum XY	Sum X^2	Sum Y^2
Male	393	169.6171	484.8761	214.1367	74.8533	616.1896
Female	366	194.4622	540.6870	290.6460	104.7112	808.2966

TABLE 5. *Corrected sum of squares and products for the two sexes.*

Sex	d.f.	X^2	Y^2	XY	B	Sum of Squares	d.f.
Males	392	1.6473	17.9585	4.8663	2.9541	3.5829	391
Females	365	1.3900	9.5468	3.3696	2.4242	1.3783	364
	757	3.0373	27.5053	8.2359	2.7161	5.1729	756

TABLE 6. *Analysis of covariance between the sexes.*

Source of Variation	d.f.	Sum of Squares	Mean Squares	F
Deviation from individual regressions	755	4.9612	0.0066	32.03* (Value from table at 5% level 3.85)
Difference between regressions	1	0.2117	0.2117	
Deviation from average regressions	756	5.1729		

* Significant

The equations for length-weight relationship for the two years are as follows:

Females:

1967-1968	$W = 1.5492\ L^{2.4242}$
1968-1969	$W = 1.2100\ L^{2.6536}$

Males:

1967-1968	$W = 0.9093\ L^{2.9541}$
1968-1969	$W = 0.9822\ L^{2.6536}$

The corresponding logarithmic equations may be represented as:

Females:

1967-1968	$\log W = 0.1900 + 2.4242 \log L$
1968-1969	$\log W = 0.0927 + 2.6536 \log L$

Males:

1967-1968	$\log W = \bar{1}.9587 + 2.9541 \log L$
1968-1969	$\log W = \bar{1}.9922 + 2.8953 \log L$

The observed values of length and weight of *P. semisulcatus* for the year 1967 were plotted for both sexes (Figs 3 and 4) and the curve fitted based on the calculated values. From the figure it can be seen that the curve fits well with the scatter diagram. In the same manner logarithmic values of observed lengths and corresponding weights were plotted (Figs 3 and 4) and the stright line fitted, which clearly showed the linear relationship between the two variables.

Hall (1962) used the formula $W = k.C^{a}$ where W is weight and C the carapace length; k a constant and a an exponent to be determined and the

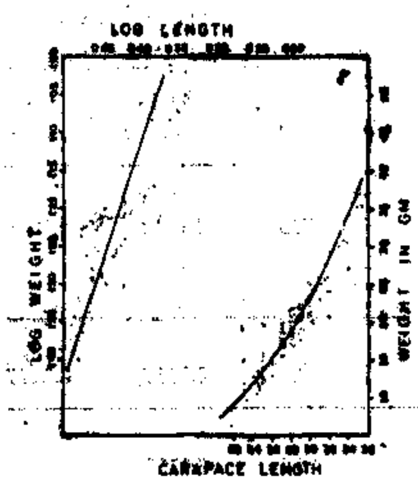

FIG. 3. Relationship between observed and logarithmic values of the length-weight of *P. semisulcatus* males.

length-weight relationship calculated for the same species of prawn from Singapore prawn ponds was $W = 1.0009\ C^{1.727}$. The relationship is comparable to that arrived at during the present studies, although the number of specimens examined by Hall was much less.

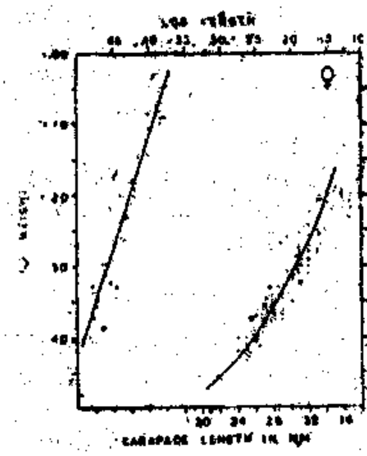

FIG. 4. Relationship between observed and logarthmic values of *P. semisulcatus* females.

RELATIVE CONDITION FACTOR

The mean value for Kn was plotted for each month (Fig. 5). Similarly, the mean values for Kn was plotted against the carapace length (Fig. 6). It is seen from the graphs that the fluctuations in the relative condition, with reference to lengths, seems to be more or less same in both sexes. The higher peak

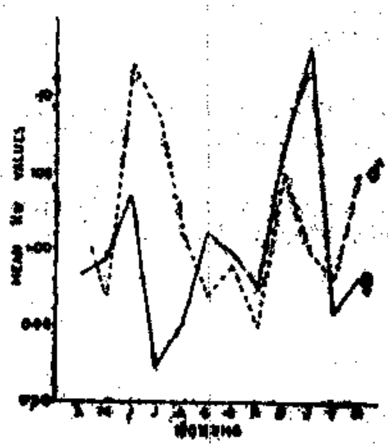

FIG. 5. Monthly fluctuations in the mean Kn values of *P. semisulcatus*.

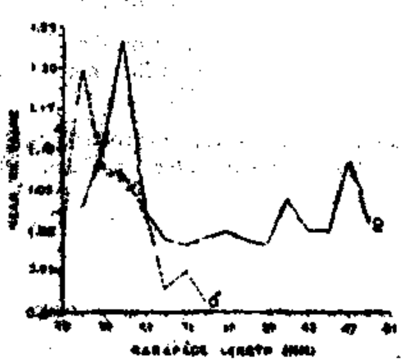

FIG. 6. Mean Kn values of *P. semisulcatus* at different size groups.

is at 21-22 mm carapace length, followed by a trough at 23-24 mm. The peak at 25-26 mm is not well marked. But the trough at 29-30 mm is quite clear. The highest peak at 21-22 mm indicates the increase in relative condition when the prawns attain maturity. The subsequent peaks represent the cyclic gonadial development and spawning. Similar changes in relative condition has been observed by Rao (1967) in the giant freshwater prawn, *Macrobrachium rosenbergii* and Pantalu (1962) in fishes. Studies on the food and feeding of the species have shown that the weight of food ingested by the prawns is negligible in comparison with the body weight. Therefore it is quite evident that food cannot affect the Kn value. The graph (Fig. 5) shows two peak-spawning seasons during one year, one in June|July and the other in December|January. This agrees with the conclusions arrived at by me while studying the maturity stages of this species (Thomas 1975).

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