Journal of the Indian Fisheries Association
18, 1988, 517-528

LENGTH-WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR IN *MACROBRACHIUM* (HELLEX)

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ABSTRACT

The length-weight relationship was calculated for the freshwater prawn *Macrobrachium idae*. About 150 specimens of *M. idae* (males 50, females 50 and 50 junveniles) were utilised for this study. The length-weight relationship was assessed separately for males, females and indeterminants. The regression equation for males, females and indeterminants were subjected to analysis of covariance to find out any significant variations. The regression equation for males, females and indeterminants showed significant differences whereas it was insignificant for males and females. The variations in length-weight relation between sexes and indeterminants were compared and discussed. The relationship t between total length with carapace length and total length with rostral length were also determined. The correlation coefficient (r value) was found to be 0.9790 ($p < 0.001$) and 0.9566 ($p < 0.001$) for carapace length and rostral length respectively thus showing high degree of correlations. The relative condition ('Kn') was calculated for different months of the year (1983-84) and for different length groups. The variations in 'Kn' values for different seasons and for different length groups were also compared and discussed.

INTRODUCTION

The study of length-weight relationship is an important tool in fishery biology with two objectives : (1) to establish a mathematical relationship between two variables namely the length and weight so that if one is known, the other could be

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computed and (2) to know whether variations from the expected weight, for the known length groups are indications of fatness, general well being gonad development and suitability of environment (LeCren, 1951). The term length-weight relationship is applied to the first category and the term condition is referred to the second category.

In prawns, as in fishes, weight exhibits a cubic relationship with length and the length-weight relationship could be expressed by the hypothetical cube law $W = CL^3$, where 'W' is weight, 'L' the length and 'C' a constant. The formula holds good if the density and form are constant. Most fishes and prawns change their shape or form as they grow in length and in such cases the exponent may be altered (Martin, 1949). The formula therefore is modified as $W = aL^n$, where 'W' and 'L' are weight and length respectively, 'a' is a constant equivalent to 'c' and 'n' is another constant to be calculated empirically from the data. For an ideal fish which maintains its shape throughout, the value of 'n' will be '3'. (Allen 1938). The value of 'n' in the equation is normally between 2.5 and 4.0 (Hile, 1936; Martin, 1949).

The study of the relative condition factor ('Kn') provides valuable information on many interesting events in the life history of fish. The relative condition factor has an expectation of one and the deviation from one will yield information such as differences in the nutritive level and the effect of physico-chemical factors on the life cycle of organisms. Variations in condition factor have been attributed to various causes in the case of different animals (Thompson, 1943; Qasim, 1957; Black-burn, 1960). LeCren (1951) recommended a study of relative condition ('Kn') in preference to ponderal index (K) as in the former, the effect of length and other correlated factors are eliminated. The ponderal index calculated assuming the length-weight relationship obeys the cube law (Pantulu, 1962).

Studies on length-weight relationship and relative condition of *Macrobrachium* spp have drawn little attention in India. Data on the above aspects are available for *M. rosenbergii* (Bhimachar, 1965; Rajyalakshmi, 1962; Rao, 1967) and *M. malcolmsonii* (Ibrahim, 1962). The present detailed report is on the length-weight relationship and relative condition factor for *M. idae*.

MATERIAL AND METHODS

Macrobrachium idae was collected from Thambrabarani river system (Tamil Nadu) for a period of one year from January to

December, 1984. A total of 338 specimens ranging in size from 119 to 116 mm were used to study the length-weight relationship. The total length of the prawn was measured to the nearest millimeter from the tip of the rostrum to the tip of telson and the weight was taken to the nearest 0.01g. Specimens with damaged rostrum or telson were not considered. Monthly samplings were analysed to know the variations, if any, in the exponent. The linear equation was also fitted separately for males, females and juveniles. A total of 50 specimens in each category were examined and specimens measuring below 30 mm were considered as juveniles owing to the poor development of gonads.

The rostral length was measured from its anterior tip to its basal spine. A total of 100 animals ranging from 19-116 mm in total length were employed for studying the relationship betwen the rostral length and total length.

By expressing the parabolic equation, $W = aL^n$ into logarithmic form, the equation can be written as,

$$\text{Low } W = \text{Log}a + n \text{ Log } L$$

The estimates of parameters 'a' and 'b' for each category were obtained by the least square method.

The relative condition factor 'Kn' was calculated by the equation $Kn = \frac{W}{\overline{W}}$ (W - observed weight; $\overline{W}$ = calculated weight). 'Kn' was also calculated according to length groups and 5 mm class interval was chosen for the purpose.

RESULTS AND DISCUSSION

Length-weight relationship : The regression equation length-weight relationship is presented in Table 1. The combined regression for all the months is given below.

$$\text{Log } W = 2.5954 + 3.3483 \text{ Log}L.$$

(where Log W = weight in log mg and Log L = length in log mm).

The exponent value is more than 3 which indicates that growth in weight is greater compared to length.

The regression equation for males, females and juveniles separately is given below :

Males : $\text{Log } W = 1.1055 + 2.5292 \text{ Log } L$

TABLE 1 : REGRESSION EQUATION FOR LENGTH-WEIGHT RELATIONSHIP

Month	Regression equation
January	Log W = - 0.4495 + 2.2204 Log L
February	Log W = - 2.55 + 3.287 Log L
March	Log W = - 3.057 + 3.6061 Log L
April	Log W = - 1.9882 + 2.8544 Log L
May	Log W = - 1.2062 + 2.6244 Log L
June	Log W = - 1.796 + 2.8658 Log L
July	Log W = - 2.284 + 3.1493 Log L
August	Log W = - 2.1977 + 3.1006 Log L
September	Log W = - 2.4 + 3.30 Log L
October	Log W = - 2.3409 + 3.2921 Log L
November	Log W = 2.1601 + 3.0252 Log L
December	Log W = 2.2052 + 3.1878 Log L

Where W = weight in mg and

L = length in mm

TABLE 2 : REGRESSION DATA FOR THE LENGTH-WEIGHT RELATIONSHIP OF MALES AND FEMALES IN MACROBRACHIUM IDAE

Sex	D.F.	Sum of squares and products			b	Errors of estimates	
		X^2	XY	Y^2		D.F.	S.S.
Male	49	0.2708	0.6849	2.0389	2.5292	48	0.3067
Female	49	0.4479	1.4339	4.6043	3.2013	48	0.0138

TABLE 3 : TEST OF SIGNIFICANCE FOR MALES AND FEMALES IN MACROBRACHIUM IDAE

Source of variation	D.F.	Sum of squares	Mean squares	Observed F	Significance 5%	Significance 1%
Deviation from individual regression	96	0.3205	0.0033	23.12	23.12	6.90
Differences between regressions	1	0.0763	0.0763			
Deviation from total regression	97	0.3968	0.0796	S		

TABLE 4 : REGRESSION DATA FOR THE LENGTH-WEIGHT RELATIONSHIP OF MALES AND JUVENILES IN MACROBRACHIUM IDAE

Sex	D.F.	Sum of squares and products			b	Errors of estimate	
		x^2	xy	y^2		D.F.	S.S.
Male	49	0.2708	.6849	2.0389	2.5292	48	0.3067
Female	49	0.1781	0.5847	2.1080	3.2830	48	0.1884

TABLE 5 : TEST OF SIGNIFICANCE FOR MALES AND JUVENILES IN MACROBRACHIUM IDAE

Source of variation	D.F.	Sum of squares	Mean squares	Observed F	Significance 5%	1%
Deviation from individual regression	96	0.4951	0.0052			
Difference between regressions	1	0.0611	0.0611	11.75	3,94	6.90
Deviations from otal regression	97	0.5562	0.0663	S		

TABLE 6 : REGRESSION DATA FOR THE LENGTH-WEIGHT RELATIONSHIP OF FEMALES AND JUVENILES IN MACROBRACHIUM IDAE

Sex	D.F.	Sum of squares and products			b	Errors of estimate	
		x^2	xy	y^2		D.F	S.S.
Female	49	0.4479	1.4339	4.6043	3.2013	-	0.0138
Juveniles	49	0.1781	0.5847	2.1080	3.2830	48	0.1884

TABLE 7 : TEST OF SIGNIFICANCE OF FEMALES AND JUVENILES IN MACROBRACHIUM IDAE

Source of variation	D.F.	Sum of squares	Mean squares	bserved F	Significance 5%	1%
Deviation from individual regression	96	0.2022	0.002			
Differences between regression	1	0.0009	0.0009	0.45	3.94	6.90
Deviation from total regression	97	0.2031	0.003	NS		

TABLE 8 : REGRESSION DATA FOR THE LENGTH-WEIGHT RELATIONSHIP OF MALES, FEMALES AND JUVENILES IN MACROBRACHIUM IDAE

Sex	D.F.	Sum of squares and products			b	Errors of estimate	
		x^2	xy	y^2		D.F.	S.S.
Male	49	0.2708	0.6849	2.0389	2.5292	48	0.3067
Female	49	0.4479	1.4339	4.6043	3.2013	48	0.0138
Juveniles	49	0.1781	0.5847	2.1080	3.2830	48	0.1884

TABLE 9 : TEST OF SIGNIFICANCE OF MALES, FEMALES AND JUVENILES OF MACROBRACHIUM IDAE

Source of variation	D.F.	Sum of squares	Mean squares	Observed f	Significance	
					5%	1%
Deviation from individual regression	144	0.5089	0.0035			
Differences between regressions	2	0.0923	0.046	13.148	3.07	4.77
Deviations from otal regression	146	0.6012	0.0495	S		

The exponent value is less than 3 which indicates that the increase in length is more in relation to weight.

Females : Log W = 2.3576 + 3.2013 LogL.

In females, the exponent value is more than 3 indicating the increase in weight more in relation to length.

Juveniles : Log W = 2.5679 + 3.2830 Log L.

In juveniles, the exponent value is less than 3 indicating that increase in weight is relatively less compared to length.

The regression equations for males, females, and juveniles were subjected to analysis of covariance and the results are presented in Tables 2 to 9.

The regression equation for males when compared with females and juveniles, was not significant (Table 7). Sriraman (1978) observed significant difference on the regression equation of males with females. Significant differences were obtained when the regression equations of males, females and juveniles of *M. idae* (Table 9) were compared.

The regression equation for total length vs. carapace length and rostral length is given below,

Carapace length : Log Y = -0.4231 + 1.047 Log L. (where Log Y = carapace length in log mm and Log L = total length in log mm).

Rostral length : Log Y = 0.5935 + 1.008 Log L
(where Log Y = rostral length in log mm and Log L = total length in log mm).

The correlation coefficient (r) values were found to be 0.9790 ($P < 0.001$) and 0.9566 ($p < 0.001$) for carapace length and rostral length respectively, thus showing high degrees of correlation.

In the present study, the exponent values observed were 3 in all spawning months except in January in which more juveniles were encountered along with mature forms. The higher exponent values in spawning months (September - March) were due to gain in weight by mature and berried individuals. The condition of the prawn was high (see relative condition factor). Similar condition of higher weights during spawning months was also found to occur in certain other species of marine and freshwater prawns (Rao

1967). In the non-spawning months, the exponent values were mostly less than 3.

In the present study as well as in the earlier reports, the exponent value for *Macrobrachium* spp falls within the range of 2.2 - 4.0. In *M. rosenbergii*, the exponent values observed were found to vary from 3.193 (Rao, 1967) to 3.23 (Rajyalakshmi, 1962) in the Hooghly estuarine system. In *M. mirabile*, the exponent value was 3.02 (Rajyalakhsmi, 1962). In *M. malcolmsonii*, the exponent value was 3.17 (Rajyalakhsmi, 1962) and according to Ibrahim (1962), in the same animal, the exponent values for males and females were 3.388 and 3.800 respectively. In *M. vollenhoveni*, the exponent value was 3.011 for ovigerous females and 3.09 for both males and non-ovigerous females. Bhimachar (1965) stated that the exponent value for fresh-water prawns was higher than 3. However, in the present study. it fluctuated between 22.2 and 3.606. Similar varying values were also reported by Sriraman (1978).

The exponent values for carapace and rostral lengths observed were found to be 1. Comparing the exponent values for rostral and carapace lengths with the exponent values for the body length-weight relationship, it could be seen that the body weight increases at a higher rate with total length relative to carapace and rostrum. The exponent value observed in the present study for carapace length is close to the value observed by Rao (1967) for *M. rosenbergii*.

Relative condition factor: In the present study, the average 'Kn' was computed per month for the period and is presented in Table 10. The 'Kn' values were found to be more than 1 from September to March and a fall was observed from April to July indicating the postspawning phase and the spent condition in the breeding cycle. Thereafter, the rise in 'Kn' values noticed, might be due to the occurrence of more ripe individuals. The monthly oscillation in the 'Kn' values in *M. idae* influences our inference about the extended breeding season. The 'Kn' values calculated according to length groups show high values (more than 1) in the 50-60 mm length group when compared to other length groups. Such higher values may be attributed to the attainment of maturity. Such an interpretation appears reasonable in the case of prawns also, since in the present study, it has been found that the length at first maturity falls in the range of 45-50 mm. A similar observation has been made by Rao (1967) in *M. rosenbergii* from Hooghly the estuarine system.

TABLE 10 : RELATIVE CONDITION FACTOR IN *MACROBRACHIUM IDAE*

Month	Kn
January	1.025
February	1.090
March	1.010
April	0.9998
May	0.9775
June	0.9760
July	0.9950
August	0.9997
September	1.0236
October	1.0980
November	1.1830
December	1.1260

The 'Kn' values were found to fluctuate in the smaller individuals as these length groups represent mostly the juveniles, immature and maturing specimens. Such cyclic fluctuations may be due to the pattern of growth in prawns where the increment in length takes place during the short ecdysis phase of the intermost cycle. According to Passano (1960), immediately after moulting, due to the absence of hard covering, water uptake takes place due to imbibition and thus increasing the body volume and the relative condition. Thus the rise and fall in 'Kn' in the early length groups may be due to the increase in number of moulting thereby the increase in weight also. It is also known that factors other than spawning, such as food, mainly affect the relative condition. But in the present study, the amount of food ingested when compared to the body weight was so little that food did not play a major role in the condition as in teleostean fishes. Hence as suggested by Rao (1967), fluctuations in condition can be attributed to moulting which is more frequent in early length groups.

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