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LENGTH-WEIGHT RELATIONSHIP AND OTHER DIMENSIONAL RELATIONSHIPS OF *METAPENAEUS MONOCEROS* (FABRICIUS)

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ABSTRACT

Based on the length and weight data of *Metapenaeus monoceros* (Fabricius) collected from trawl landings at Cochin Fisheries Harbour during 1991-92, the relationship between total length and total weight and other dimensional relationships have been worked out. These relationships are significantly different between males and females and hence, separate equation for each sex is given in this account.

INTRODUCTION

GROWTH is manifested as an increase in size of the prawn and as such is best measured in terms of its volume or weight. But, it is usually gauged from observation of its linear dimension, ie., total length. It has been mathematically proved that there is a fairly constant relationship between total length and weight of the individuals of the species. Therefore, when a knowledge of the growth in volume of weight is required, it is usually calculated from length-weight relationship. The length-weight relationship is also needed for studies on maturity and yield estimates by analytical models. As prawns are exported as 'headless' variety, to find out, the toal length and total weight from tail weight alone, the relationship between toal length and tail weight; and between total weight and tail weight are needed. For comparison of data from different sources the relationship existing between total length and carapace length is required.

George (1959) studied the length-weight relationship of juveniles of *M. monoceros* from Cochin backwaters. Hall (1962) gave the carapace length-weight relationship of some penaeid prawns while studying their biology. Rao (1967) and Thomas (1975) gave the length-weight relationship of *P. monodon* and *P. indicus* from Chilka lake and *P. semisulcatus* from Mandapam respectively. Rao (1992) gave this relationship in *P. indicus* from Visakhapatnam. The length-weight relationship in *M. monoceros* for males and females separately was compared between seasons in northern part of Egypt (Bishara, 1976). Length-weight relationship in some common prawns from western India ocean *(P. indicus, P. semisulcatus, P. latisulcatus* and *M. monoceros)* were studied by Ivanov and Krylov (1980). Length-weight relationship of *Parapenaeopsis hardwickii* was given by Sukumaran and Rajan (1981). Lalitha Devi (1987) observed the length-weight relationship of *P. monodon, M. monoceros* and *M. dobsoni* from Kakinada coast. Length-weight relationship and other dimensional relationships of *M. monoceros* from Kakinada coast were given by Rao (1988). Rajyalakshmi (1961) and Sukumaran *et al* (1993) observed the length-weight relationship of *M. brevicornis* from Hooghly Estuary and of *M. dobsoni* from different landing centres of India respectively. Relationship between total length and carapace length of three commercial species of penaeid prawns was observed by Ramamurthy and Manickaraja (1978) from Mangalore coast. Studies on the length-weight relationship and other dimensional relationships for males and females separately, covering the entire length range of *M. monoceros* along the west coast, is made for the first time and the details are given here.

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MATERIAL AND METHODS

Samples of *M. monoceros* collected from trawl catches landed at Cochin Fisheries Harbour during 1991-1992 were utilised for the studies on length-weight relationship. The details on total length, carapace length, total weight, tail weight were collected from samples in fresh condition. The moisture from the fresh specimens were removed using a dry cloth, and the weight of individual prawn was taken to the nearest 0.1 gm. After sex-wise sorting out, the total length from the tip of rostrum to tip of telson was measured to the nearest millimeter keeping the abdomen fully streched. The carapace length was measured from orbital notch to the posterior margin of carapace along the mid-dorsal line using vernier calipers. Data collected for the two year period (1991-92) were pooled to represent all available size groups in the trawl fishery.

Weight may be considered as a function of length. This relationship of length and weight follows approximately the cube law relationship expressed by the formula $K = W/L^3$, where W = weight and L = length. As the prawn is continuously prone to change its bodily proportions during life, a simple cube law expression does not hold good throughout the life history and growth of the prawn (Kunju, 1978). Therefore a more satisfactory formula for the expression of the relationship is $W = AL^b$ where W = weight, L = length, 'a' and 'b' are constants and expressed logarithmically as $Log\ W = a + b\ Log\ L$. When the data for total length-total weight and total length-tail weight were plotted on a graph paper, an exponential relationship was observed between these parameters. Therefore logarithmic transformation was adopted for these relationships, as $Log\ W = a + b\ Log\ L$. The relationships between total weight and tail weight as well as the total length and carapace length were found to be linear and they were calculated by the method of least squares on the basis of individual measurements. To learn whether the regression of different parameters are significantly different between males and females, analysis of covariance (Snedecor and Cocharan, 1968) was employed. The data analysed are given in Tables 1-8.

RESULTS

Total length-total weight relationship

A total of 217 males ranging in total length from 56 to 152 mm and 260 females ranging in total length from 52 to 187 mm were measured to study the total length-total weight relationship of *M. monoceros*. When total length and total weight were plotted it was observed that a single equation would not fit the data for both males and females together. Therefore the estimates were made separately for males and females. However, it was noticed that a single equation would fit the data for entire length range of the same sex. The raw sums of squares and products of Log total length and Log total weight for males and females are shown in Table 1. The analysis of

TABLE 1. *Raw sums of squares and products for total length-total weight relationship of* M. monoceros.

Sex	N	S X	S Y	S XY	S X2	S Y2
Male	217	431.8700	176.5502	357.1872	861.5074	160.6689
Female	260	534.0243	269.0380	562.5526	1100.0332	309.8153

S = Summation

covariance showed that a significant difference existed between the regression coefficients of males and females (Table 2). Hence separate equation was calculated for each sex and given here.

TABLE 2. *Comparison of the regression lines of the total length-total weight relationship of* M. monoceros

Source	Corrected sums of squares and products				Regression coefficient	Deviation from regresssion		
	d.f	S x2	S xy	S y2		d.f.	S.S.	M.S.
Males	216	2.0065	5.8197	17.0285	2.9004	215	0.148905	0.000693
Females	259	3.1795	9.9648	31.4251	3.1341	258	0.194643	0.000754
Pooled (within)						473	0.343548	0.000726
combined	475	5.1860	15.7845	48.4536	3.0437	474	0.410708	0.000866
Between slopes						1	0.067160	0.067160
Between sexes	1	0.4808	1.6678	5.7856				
Total	476	5.6668	17.4523	54.2392	-	475	0.490563	
Between adjusted means						1	0.079855	0.079855

Males :

$$Log\ W = -4.9587 + 2.9004\ Log\ L\ (r = 0.9956)$$

Females :

$$Log\ W = -5.4025 + 3.1341\ Log\ L\ (r = 0.9969)$$

The exponential form of equations are:

$$\text{Males} : W = 0.000010998\ L^{2.9004}$$

$$\text{Females} : W = 0.000003958\ L^{3.1341}$$

where '*W*' is total weight and '*L*' is total length. The calculated curves of total length and total weight for males and females are shown in Fig. 1 and 2 respectively.

Total length-tail weight relationship

A total of 157 males in the size range of 71-152 mm and 187 females in the size range of 52-168mm of the brown shrimp were taken up for studies to find out the relationship between total length and tail weight. It was noticed again that a single equation would not fit the data for both sexes together and hence the estimates were made separately for males and females. A single equation was observed to fit to data for the entire length range of the same sex. The raw sums of squares and products of Log total length and Log tail weight are given in Table 3. The analysis of covariance showed that significant differences existed between sexes and hence separate equation was calculated for males and females (Table 4). The equations for total length and tail weight relationship for *M. monoceros* landed at Cochin Fisheries Harbour during 1991-92 are as follows.

TABLE 3. *Raw sums of squares and products for total length-tail weight relationship of* M. monoceros

Sex	N	S X	S Y	S XY	S X2	S Y 2
Male	157	319.1951	121.4367	249.2705	649.7101	101.5470
Female	187	384.8944	164.6472	344.6169	793.9980	163.4957

S = Summation

Males :

Log $y = -5.6076 + 3.1391$ *Log* $\times$ $(r = 0.9900)$

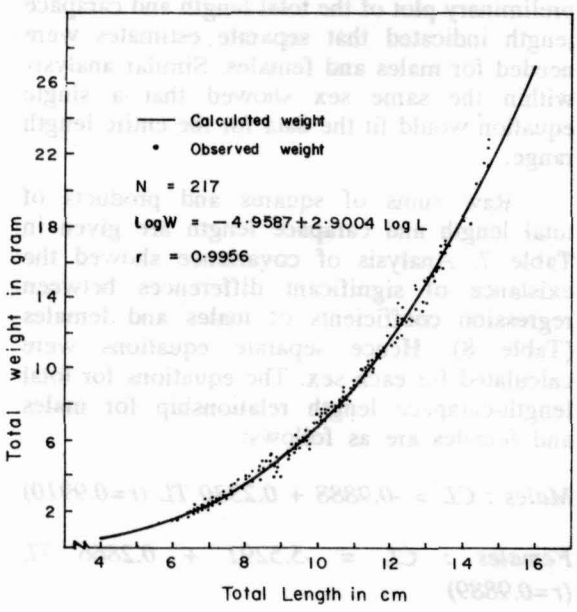

FIG. 1. *Relationship between total length and total weight in males of* M. monoceros.

Females :

Log $y = -5.7240 + 3.2090$ *Log* $\times$ $(r = 0.9962)$

The exponential form of equations are

Males : $y = 0.000002468 \times^{3.1391}$

Females : $y = 0.000001888 \times^{3.2090}$

where '*y*' is tail weight and 'x' is total weight.

Total weight-tail weight relationship

A total number of 157 males (size range 71-152 mm) ranging in total weight from 1.4 to 23.0 gm and 187 females (size range 52-168 mm) ranging in weight from 1.2-36.5gm were taken for this study on total weight-tail weight relationship. A preliminary plot of the data for males and females separately showed a linear relationship. The raw sums of squares and products of total weight and tail weight are presented in Table 5. The analysis of covariance indicated that significant differences existed between the regression lines of males and females (Table 6). The equations for the relationship between total weight and tail weight for males and females are as follows:

TABLE 4. *Comparison of the regression lines of the total length-tail weight relationship of* M. monoceros

Source	Corrected sums of squares and products				Regression coefficient	Deviation from regression		
	d.f.	S x2	S xy	S y2		d.f	S.S.	M.S
Males	156	0.7578	2.3788	7.6179	3.1391	155	0.150640	0.000972
Females	186	1.7857	5.7303	18.5294	3.2090	185	0.140904	0.000762
Pooled (within)						340	0.291544	0.000857
Combined	342	2.5435	8.1091	26.1473	3.1882	341	0.294144	0.000863
Between slopes						1	0.002600	0.002600
Between sexes	1	0.0541	0.2298	0.9768				
Total	343	2.5976	8.3389	27.1241	-	342	0.354292	
Between adjusted means						1	0.060148	0.060148

Comparison of slopes : F = 3.03 (d.f. = 1,340) not significant at 1% level.
Comparison of elevations : F = 69.70 (d.f. = 1,341) significant at 1% level.

Males :

$Y = -0.2093 + 0.7181 \times (r = 0.9956)$

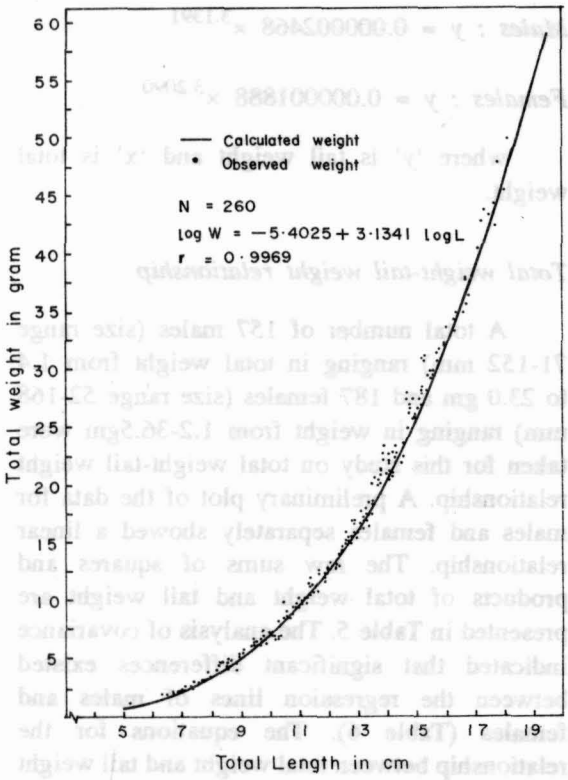

FIG 2. *Relationship between total length and total weight in females of* M.monoceros.

Females :

$Y = 0.0499 + 0.6891 \times (r = 0.9959)$

where '*Y*' is the tail weight and '*X*' is the total weight.

Total length-carapace length relationship

A total of 152 males ranging in total length between 56 and 152 mm and 260 females in the size range of 52-187 mm were analysed to find out the relationship between total length and carapace length of *M. monoceros*. A preliminary plot of the total length and carapace length indicated that separate estimates were needed for males and females. Similar analysis within the same sex showed that a single equation would fit the data for the entire length range.

Raw sums of squares and products of total length and carapace length are given in Table 7. Analysis of covariance showed the existance of significant differences between regression coefficients of males and females (Table 8). Hence separate equations were calculated for each sex. The equations for total length-carapace length relationship for males and females are as follows:

Males : CL = -0.9888 + 0.2330 TL (r=0.9910)

Females : CL = -5.5291 + 0.2866 TL (r=0.9889)

Where '*CL*' is carapace length and 'TL' is total length.

DISCUSSION

The earliest study on length-weight relationship of *M. monoceros* in India was by George (1959). Based on the length and weight of 175 juveniles of *M. monoceros* (size range 25-105 mm) collected mainly from Cochin backwaters he derived a common equation for both sexes as $W = 0.01989\ L^{2.7603}$. However it was observed in the present study that males and females require different equations for length-weight relationship. Bishara (1976) provided data on males and females separately as well as by seasons while studying this relationship in *M. monoceros* from northern

TABLE 5. *Raw sums of squares and products for total weight tail-weight relationship of* M. monoceros

Sex	N	S X	S Y	S XY	S X2	S Y2
Male	157	1509.70	1051.30	12297.64	17564.57	8625.29
Female	187	2550.80	1767.10	32439.00	46889.38	22489.63

S = Summation

Egypt and observed seasonal changes in condition of *M. monoceros*, Ivanov and Krylov (1980) based on the collection of *M. monoceros* from Zambezi delta in western Indian Ocean at depth range around 25 m gave the equation for length and weight relationship for males

TABLE 6. *Comparison of the regression lines of the total weight-tail weight relationship of* M.monoceros

Source	Corrected sums of squares and products				Regression coefficient	Deviation from regression		
	d.f	S x2	S xy	S y 2		d.f	S.S.	M.S.
Males	156	3047.41	2188.42	1585.60	0.7181	155	14.041825	0.090592
Females	186	12094.83	8334.62	5791.01	0.6891	185	47.573300	0.257153
Pooled (within)						340	61.615125	0.181221
Combined	342	15142.24	10523.04	7376.61	0.6949	341	63.664832	0.186700
Between slopes						1	2.049707	2.049707
Between sexes	1	1382.46	945.83	647.09				
Total	343	16524.70	11468.87	8023.70	-	342	63.798817	-
Between adjusted means						1	0.133985	0.133985

Comparison of slopes : F = 11.31 (d.f. 1,340) significant at 1% level.
Comparison of elevations : F = 0.72 (d.f. 1,341) not significant at 1% level.

TABLE 7. *Raw sums of squares and products for total length-carapace length relationship of* M. monoceros

Sex	N	S X	S Y	S XY	S X2	S Y2
Male	236	22908	5106	524358	2346864	117210
Female	259	30244	7236	901956	3730544	218692

S = Summation

TABLE 8. *Comparison of the regression lines of the total length-carapace length relationship of* M.monoceros

Source	Corrected sums of squares and products				Regression coefficient	Deviation from regression		
	d.f.	S x2	S xy	S y2		d.f.	S.S.	M.S.
Males	235	123234.9155	28729.8305	6738.6610	0.2331	234	40.858225	0.174608
Females	258	198885.5599	56992.3552	16531.0116	0.2866	257	199.365612	0.775742
Pooled (within)						491	240.223837	0.489254
combined	493	322120.4754	85722.1857	23269.6726	0.2661	492	457.421639	0.929719
Between slopes						1	217.197802	217.19780
Between sexes	1	47843.8806	15335.2804	4905.1274				
Total	494	369964.3560	101057.4661	28174.8000	-	493	570.488155	
Between adjusted means						1	113.066516	113.066516

Comparison of slopes : F = 443.94 (1,491) Significant at 1% level.
Comparison of elevations : F = 121.61 (1,492) significant at 1% level.

and females separately as well as combined for both sexes. Rao (1988) gave length-weight relationship and other dimentional relationships on *M. monoceros* collected from trawl catch at Kakinada during 1974 and observed that male was heavier than female upto 77 mm after which females became heavier than males due to maturation process. The present study also revealed the same trend and females in general becomes heavier than males from 80 mm onwards due to gonad formation which is heavier than males. Further *M. monoceros* (both males and females) from Kerala coast was found to weigh more than their counterparts from Kakinada coast.

Ramamurthy and Manickaraja (1978) did not observe any differences between juveniles and adults in the carapace length and total length relationship in *P. stylifera, M. dobsoni* and *M. affinis* and gave one regression equation alone, for each sex for these species. Ivanov and Krylov (1980) also gave a single equation each for males and females of *M. monoceros* for comparing total length and carapace length. However, Rao (1988) comparing the total length and carapace length of this species stressed separate relationship for juveniles and adults for both sexes based on the inflection in liner relationship at 100 mm in males and 110 mm in females. Such prominent inflection based on size was not noticed in the present study when comparing the total length and carapace length of males and females of *M. monoceros* and hence one common equation each for males and females was calculated.

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