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The Study of Analysis of Covariance of Morphometric Relationships of *Metapenaeus Brevicornis* (H. Milne Edwards)

Dr. Durga S. Patkar
Assistant Professor, Ramnarain Ruia Autonomous College, L.Nappo Road, Dadar (East), Matunga, Mumbai-400019. Maharashtra.

ABSTRACT: In order to make quantitative comparisons between shrimps of different sizes, sexes, origin and species a number of different measurements have been used in the past mainly for fisheries management or aquaculture purposes. These include carapace length (including and excluding rostrum), body length, total length, total weight, tail weight and meat weight. Length-weight of a species are always related to each other (Le Cren, 1951). Several factors like, maturity, feeding, parasites, pathogens *etc*. are known to influence length- length, length-weight and weight- weight relationships.

An analysis of covariance combines the principle of ANOVA with the principle of regression. A chief advantage of this technique is that the independent variables can be of any data level. It is often used to adjust for initial differences between or among groups. In other words, one of its chief purposes is to eliminate systematic bias.

KEYWORDS: Analysis of Covariance, Carapace Length, Meat Weight, Morphometric Relationships, Total Length, Total Weight, Tail Weight.

INTRODUCTION

In fishes, linear dimensions such as total length, standard length, and caudal length or furcal length are used as “standard” for denoting the size of fish in various biological and population studies. In crustaceans, particularly in case of prawns, total length and carapace length is considered as a standard dimension of size.

But many times, the rostrum and telson get damaged while handling them. So it becomes difficult to measure the total lengths of prawns. In addition, the tail of the prawn (abdomen) tends to become curved and the arthrodial membrane between the abdomen and the cephalothorax becomes loose resulting in variations in the total lengths of prawns. Therefore, Mistakidis (1957) and Hall (1962) suggested that in the case of prawns, carapace length should be taken as a standard measure of size. The total length can vary due to elasticity of the prawn, which depends on its degree of decomposition and method of preservation (Garcia and LeReste, 1981).

The carapace length can be a more precise dimension, but the range of carapace length is limited and therefore it is necessary to use Vernier callipers for the measurements. However, the use of Vernier calliper in the field is not practicable, therefore, most of the workers consider total length as a standard measure of size. Nevertheless, many investigators report the size of prawns in either carapace length or total length. Therefore it becomes necessary to find out the relationship between total length and carapace length. Many dimensional relationships from various body parts such as pereiopods, rostral size and genital organs are also used for quantitative comparisons of various species of prawns to establish their characters (Holthuis and Miquel, 1984).

Many times dimensional relationships are used in the fishing industry for the conversion of ‘raw’ weight into ‘processed’ weight. In the case of prawns, it is necessary to know the conversion of total weight into either tail weight or meat weight. In order to obtain these conversion factors, relationships between total length-carapace length, total length- total weight, total length- tail weight, total lengthmeat weight, total weight- tail weight, total weight- meat weight and tail weight- meat weight are required.

In prawns, various morphometric measurements were used to establish specific characters of the species (Kubo, 1949). In case of *M. brevicornis*, Rajyalakshmi (1961, 1981) reported length- weight relationship and total length- carapace length relationship from Hooghly- Malah estuary. However, there is no information on such dimensional relationships for the species from Mumbai waters.

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It was noticed that at the landing centres, the males and females of *M. brevicornis* are sorted out as they fetch different prices. The males of the species are generally lean and smaller in size so they fetch much less price than females and are sold in local markets. The females are bigger in size, fetch better prices and are sold to exporters.

MATERIAL AND METHODS

Weekly samples of *M. brevicornis* were collected from the trawlers operated at New Ferry Wharf. Similarly, fortnightly samples were collected from dol nets operated at New Ferry Wharf and monthly samples were collected from hand operated trawlers from Versova landing centre. The samples were brought to the laboratory and preserved in 10% formalin. The length measurements were taken with the help of a divider on a scale graduated at 1.0 mm. Total lengths of prawns were measured from the tip of the rostrum to the tip of the telson up to nearest millimetre. The carapace length is measured from the orbital notch to the posterior mid dorsal margin of the carapace.

After taking lengths, the prawns were blotted dry and weighed on an electronic balance up to the nearest milligramme. The tail weight was noted after removing the 'head' *i.e.* cephalothorax, and meat weight was noted after removing the exoskeleton of the remaining part of the abdomen. All morphometric dimensions of prawns were measured as suggested by CMFRI (1995).

The data were pooled together and the different relationships were obtained by regression analysis by the method of 'least squares' based on individual measurements.

In order to find out the difference between length-weight relationships of males and females, analysis of covariance was carried out using the 'F' test.

RESULTS

A total of 983 males and 1,598 females ranging from 43-109 mm and 35-153 mm respectively were measured for the various relationships.

It is seen that the values obtained are significant at 1% as well as 5% significance levels. Therefore, common expressions for different dimensional relationships for males and females can not be used. The details of analysis of covariance for both males and females are given in the following tables
below.

Table I. Analysis of covariance-total length and carapace length

Sex	*N*	*∑X*	*∑Y*	*∑X2*	*∑Y2*	*∑XY*
Males	983	77043	17099	6213345	306382.5	1376807
Females	1598	155698	36320	16201916	894614	3799071
Total	2581	232741	53419	22415261	1200996.5	5175678

Corrected sums

Sex	*d.f.*	*∑X2*	*∑Y2*	*∑XY*	*d.f.*	$\sum Y^2 - \frac{(\sum XY)^2}{\Sigma X^2}$
Males	982	175070.48	8950.353	36666.352	981	1297.636
Females	1597	1031786.3	69118.13	260302.94	1596	3797.108
Total						5094.744
Total	2579	1206856.8	78068.483	296969.29	2577	4993.733
Difference						101.011

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Test of significance

Sources of Variation	*d.f.*	*S.S.*	*M.S.*	*F*	*Remarks*
Between sexes	1	101.011	101.011	51.09	The value is significant at 1% and 5% significance level.
Within sexes	2577	5094.744	1.977		

Table II. Analysis of covariance-total length and total weight

Sex	*N*	*∑X*	*∑Y*	*∑X2*	*∑Y2*	*∑XY*
Males	983	1855.283	505.819	3507.699	306.223	970.95
Females	1598	3151.823	1247.196	6240.598	1173.222	2528.45
Total	2581	5007.106	1753.015	9748.297	1479.445	3499.4

Corrected sums

Sex	*d.f.*	*∑X2*	*∑Y2*	*∑XY*	*d.f.*	$\sum Y^2 - \frac{(\sum XY)^2}{\Sigma X^2}$
Males	982	6.097	45.945	16.283	981	37.459
Females	1597	24.085	199.819	68.54	1596	148.791
Total						186.25
Total	2579	30.182	245.764	84.823	2577	7.379
Difference						178.871

Test of significance

Sources of Variation	*d.f.*	*S.S.*	*M.S.*	*F*	*Remarks*
Between sexes	1	178.871	178.871	2484.319	The value is significant at 1% and 5% significance level.
Within sexes	2577	186.25	0.072		

Table III. Analysis of covariance-total length and tail weight

Sex	*N*	*∑X*	*∑Y*	*∑X2*	*∑Y2*	*∑XY*
Males	983	1855.283	336.62	3507.699	159.739	651.277
Females	1598	3151.823	953.039	6240.598	753.259	1945.439
Total	2581	5007.106	1289.659	9748.297	912.998	2596.716

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Corrected sums

Sex	*d.f.*	*∑X2*	*∑Y2*	*∑XY*	*d.f.*	$\sum Y^2 - \frac{(\sum XY)^2}{\sum X^2}$
Males	982	6.097	44.466	15.951	981	38.816
Females	1597	24.085	184.871	65.708	1596	146.789
Total						185.605
Total	2579	30.182	229.337	81.659	2577	8.404
Difference						177.201

Test of significance

Sources of Variation	*d.f.*	*S.S.*	*M.S.*	*F*	*Remarks*
Between sexes	1	177.201	177.201	2461.125	The value is significant at 1% and 5% significance level.
Within sexes	2577	185.605	0.072		

Table IV. Analysis of covariance-total length and meat weight

Sex	*N*	*∑X*	*∑Y*	*∑X2*	*∑Y2*	*∑XY*
Males	983	1855.283	204.939	3507.699	88.176	402.685
Females	1598	3151.823	772.755	6240.598	567.73	1591.044
Total	2581	5007.106	977.694	9748.297	655.906	1993.729

Corrected sums

Sex	*d.f.*	*∑X2*	*∑Y2*	*∑XY*	*d.f.*	$\sum Y^2 - \frac{(\sum XY)^2}{\sum X^2}$
Males	982	6.097	45.45	15.89	981	41.948
Females	1597	24.085	194.044	66.897	1596	162.092
Total						204.04
Total	2579	30.182	239.494	82.787	2577	12.415
Difference						191.625

Test of significance

Sources of Variation	*d.f.*	*S.S.*	*M.S.*	*F*	*Remarks*
Between sexes	1	191.625	191.625	2425.633	The value is significant at 1% and 5% significance level.
Within sexes	2577	204.04	0.079		

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Table V. Analysis of covariance-total weight and tail weight

Sex	*N*	*∑X*	*∑Y*	*∑X2*	*∑Y2*	*∑XY*
Males	983	3584.881	2401.374	15565.44	6917.29	10364.96
Females	1598	12696.966	8162.5604	144346.3	61279.12	91125.25
Total	2581	16281.847	10563.934	159911.74	68196.41	101490.21

Corrected sums

Sex	*d.f.*	*∑X2*	*∑Y2*	*∑XY*	*d.f.*	$\sum Y^2 - \frac{(\sum XY)^2}{\Sigma X^2}$
Males	982	2491.817	1050.965	1607.442	981	15.307
Females	1597	43462.104	19584.882	26269.335	1596	3752.109
Total						3767.416
Total	2579	45953.921	20635.847	27876.777	2577	3725.11
Difference						42.306

Test of significance

Sources of Variation	*d.f.*	*S.S.*	*M.S.*	*F*	*Remarks*
Between sexes	1	42.306	42.306		The value is significant at 1%
Within sexes	2577	3767.416	1.462	28.937	and 5% significance level.

Table VI. Analysis of covariance-total weight and meat weight

Sex	*N*	*∑X*	*∑Y*	*∑X2*	*∑Y2*	*∑XY*
Males	983	3584.881	1768.129	15565.44	3769.344	7631.159
Females	1598	12696.966	6335.59	144346.3	35314.88	71138.94
Total	2581	16281.847	8103.719	159911.74	39084.224	78770.1

Corrected sums

Sex	*d.f.*	*∑X2*	*∑Y2*	*∑XY*	*d.f.*	$\sum Y2 \frac{(\sum XY)2}{\Sigma X^2}$
Males	982	2491.817	588.994	11183.008	981	28.069
Females	1597	43462.104	10196.169	20799.284	1596	255.105
Total						283.174
Total	2579	45953.921	10785.163	21982.292	2577	269.822
Difference						13.352

Test of significance

Sources of Variation	*d.f.*	*S.S.*	*M.S.*	*F*	*Remarks*
Between sexes	1	13.352	13.352	121.382	The value is significant at 1% and 5% significance level.
Within sexes	2577	283.174	0.11		

DISCSSION

Rajyalakshmi (1961) gave two different relationships for *M. brevicornis*, one for 0- year group and another from an older group but in each case the two sexes were combined and a common relationship was given. *stylifera, M.dobsoni* and *M. affinis* and gave different regression equation for each sex. Rao (1988a) gave a sex wise relationship for both juveniles and adults of *M. monoceros.* While working on the same prawn, Nandakumar (1998) also gave separate relationships for the two sexes.

In *M. brevicornis,* males are tiny and slender, while females are relatively stout and bulky in nature, therefore the disproportionate rise in weights of females can not be attributed to the maturation process of females alone. The sexual maturity of males of the prawn commences by the union of petasmal endopodites when they reach about 56-60 mm and develop the spermatophores in the terminal ampulae when they are about 58 mm in size. It is likely that after the petasmal union, most of the energy is diverted to the gonad development and sexual behavior such as chasing mates, rather than the somatic body growth, as a result they remain thin and slender. Furthermore, the gonads of males in the case of prawns never grow remarkably large unlike in the case of females. The feeding intensity of males was also found lesser than the females, which may support that males, unlike females do not spend time in foraging but in sexual behaviour such as searching and chasing the mates.

Therefore, in the present study also, all the mentioned morphometric relationships are calculated separately for each sex and found positively correlated to each other and so can be beneficial for aquaculture practices and also for fish processing units.

The present work also showed that for males and females different equations should be used, as both the relationships were significantly different at 1% and 5% level of significance. However, it was not possible to compare the results with previous work reported by Hall (1962) and Rajyalakshmi (1961) as the two sexes were not treated separately by them.

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