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Morphometric relationship and growth of the 'ridge back shrimp' *Solenocera choprai* (Decapoda/Crustacea) from Mangalore (southwest coast of India)

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'Ridge back shrimp', *Solenocera choprai,* caught from a depth of 70 to 100 m off Mangalore, has been contributing substantially to the commercial fishery of the coast from 1993 onwards. During 2002, the species formed > 50% of the total shrimp landing of Mangalore fisheries harbour (2746 t). Since it is a non-conventional species to commercial fishery, the detailed information about the biology and population characteristics of the species is reported for the first time. The present paper deals with the morphometric relationship like length-weight relationship and carapace length-total length relationship of the species which will be useful in studying the population dynamics of the species. The life span of *S. choprai* is about 30 months and males and females attain a total length of 66 mm and 83 mm at the end of 12 months, 88 mm and 109 mm at the end of 24 months respectively. The results of the study will help in formulation of strategies for the management of this resource in terms of regulation of mesh size and fishing pressure.

[**Key words**: Shrimp, *Solenocera choprai,* length-weight, morphometric relationship, growth parameters, Mangalore]

Introduction

Growth studies form the basis for calculations leading to knowledge of mortality, recruitment and other fundamental parameters of the population. These parameters are the prerequisites for evolving effective management strategies for the judicious exploitation of the fishery resources. *Solenocera choprai,* Nataraj, 1945 is a penaeoid shrimp belonging to the family Solenoceridae (order: Decapoda; class: Crustacea) and is widely distributed in the Indo-Pacific. Along Mangalore coast (southwest coast of India), this species forms an important component of the shrimp fishery and are caught from a depth of 70 to 100 m (Fig. 1). During 2002, the estimated landing of this species at Mangalore fisheries harbour was 2746 t, which formed more than 50% of the total shrimp landing. It is commercially important species which have a local demand as well as export market. Increased commercial exploitation has lead to more fishing pressure on this species and proper study on its biology is essential to regulate exploitation for the proper management and conservation of the resources.

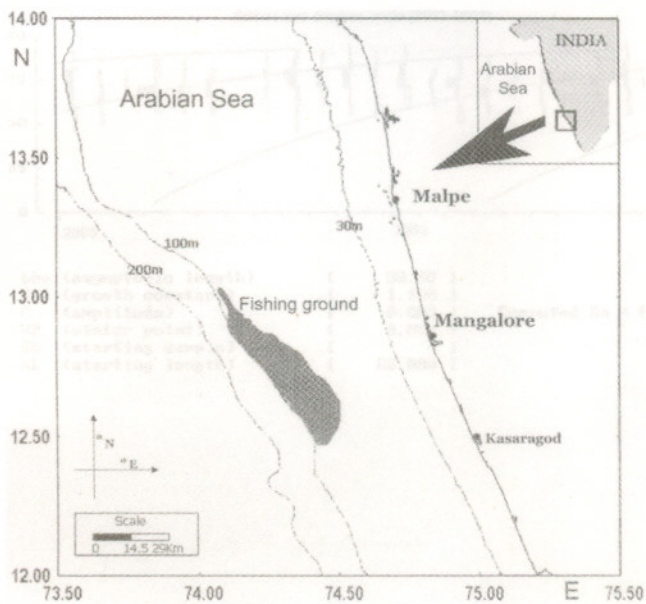

Fig. 1—Geographical position of the study area.

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For length measurements of shrimps and lobsters, various authors have used either total length or carapace length or both. For comparison of the data from different sources, the relationship existing between total length and carapace length is required and in the present study, relationships between (1) total length and total weight (2) carapace length and total weight and (3) carapace length and total length of *S. choprai* are derived and presented. Total length- carapace length, total length-weight relationships of *S. crassicornis* (earlier identified as *S. indica*) from Indian waters were studied by Kunju[1] and Sukumaran[2] respectively. However information on the morphometric relationship and the growth of *S. choprai* has not been reported from any part of the world and the present study is a pioneering attempt in this direction.

Materials and Methods

Samples of *Solenocera choprai* were collected twice a week from the commercial trawl catches at Mangalore and Malpe fisheries harbours during January 2003 to December 2004. Shrimps were washed thoroughly in seawater and excess water from the body was removed using a blotting paper. The total length, carapace length (± 0.1cm) and total weight (± 0.01g) were recorded for males and female separately. Juveniles were landed occasionally in crushed form with loss of body fluid and appendages, hence juveniles could not be considered for the study. To minimize the deviation in values due to weight increase during maturation process of females, those with fully matured ovary were excluded from the study[3]. The total length was measured from tip of the rostrum to the tip of the telson, to the nearest millimeter, keeping the abdomen fully stretched. Carapace length was measured with vernier calipers from orbital notch to the posterior margin of the carapace along the mid dorsal line.

The linear equation ($\log W = \log a + b \log L$) was fitted for males and females separately with the log transformed data. Regression analysis was performed to determine the constants a and b and relationship between length and weight. The correlation coefficient (r) was determined to know the strength and pattern of association between the two variables. Similarly the relationship between total length and carapace length was also regressed using linear relationship as $Y = a + bX$ suggested by Ivanov & Krylov[3]. Analysis of covariance[4] was performed to test the significant difference in the relationship between the sexes at 1% level.

Data on length-frequency distribution for growth studies were collected twice a week from commercial trawl catches of Mangalore and Malpe fisheries harbours for a period of two years from January, 2003 to December 2004. The length frequency data (total length) were grouped into 5 mm class interval (Table 1). Growth parameters of males and females were determined separately and length at age of males and females were calculated using von Bertalanffy's growth formula.[5]

Monthly length frequency data were analysed using the ELEFAN I module of FiSAT software[6] to get a preliminary estimate of L_∞ and K. These growth parameters were further refined and re-estimated using the data corrected for gear selection. By using L_∞ and K derived from ELEFAN I routine, t_0 was calculated by Pauly's equation[7].

$$\log(-t_o) = -0.392 - 0.275 \log(L\infty) - 1.038\, K,$$

The growth parameters were tested for their reliability by comparing them with the available growth studies of the same species or related species. Longhurst & Pauly[8] empirically derived equation for growth performance index (phi prime index, Φ'),

$$\Phi' = \log_{10} K + 2\log_{10} L_\infty ,$$

Table 1—Annual length-frequency distribution of males and females of *S. choprai*, sampled from Mangalore and Malpe fisheries harbours during 2003-2004

Length-frequency (mm)	Male		Female	
	2003	2004	2003	2004
< 50	1	0	0	0
51-55	2	1	1	0
56-60	26	31	12	26
61-65	215	194	96	57
66-70	268	372	166	63
71-75	376	497	233	144
76-80	413	202	221	219
81-85	201	120	305	298
86-90	25	43	294	214
91-95	2	3	311	164
96-100	0	0	111	76
101-105	0	0	30	20
> 106	0	0	1	5

where, L_∞ is the asymptotic length (total length) fish can attain and K the annual growth coefficient.

The equation was modified by Dall *et al.*[9] for shrimps and lobsters, in which K is expressed in weekly basis and L_∞ is expressed as carapace length (mm). This equation is used for calculating growth performance index in the present study.

Results

Total length-total weight relationship

The slope and elevation of regression lines between male and female derived through analysis of covariance indicated a significant variation in slope and elevation. The slope ($F = 114.66$; *df*, 1and 709; $P < 0.01$) and elevation ($F = 30.92$; *df*, 1 and 710; $P < 0.01$) differed indicating a significant variation in the growth pattern between sexes.

The regression equations for the length-weight relationship of males (n = 347) and females (n = 365) were calculated as under:

Males : $\log W = -4.72466 + 3.18531 \log L$ ($r = 0.985448$)

Females : $\log W = -3.79389 + 2.76114 \log L$ ($r = 0.984467$)

where W is the total weight (g) and L is the total length (in cm).

The total length-weight relationship for males and females in is as follows

Males : $W = 0.008874\ L^{3.18531}$

Females : $W = 0.022508\ L^{2.76114}$

Carapace length-weight relationship

The data on the carapace length and total weight of the shrimps also analysed using the formula used for the total length-total weight relationship. The regression equation between male and female was tested for equality through analysis of covariance indicated that there is a significant variation in slope ($F = 56.99$; *df*, 1 and 709; $P < 0.01$) and elevation ($F = 12.64$; *df*, 1 and 710; $P < 0.01$).

The regression equations for the carapace length-weight relationship of males and females were calculated as under:

Males : $\log W = 0.178143 + 2.260825 \log CL$ ($r = 0.980195$)

Females: $\log W = 0.411057 + 2.005492 \log CL$ ($r = 0.977403$)

The carapace length-weight relationships for males and females are as follows

Males : $W = 1.194996\ CL^{2.260825}$

Females : $W = 1.508412\ CL^{2.005492}$

Total length-carapace length relationship

A preliminary plot of the total length and carapace length indicated that a separate estimate was required for males and females. The regression equations between male and female were tested for equality through analysis of covariance indicated a significant variation in slope ($F = 34.98$; *df*, 1 and 709; $P < 0.01$) and elevation ($F = 15.74$; *df*, 1 and 710; $P < 0.01$).

The equation for total length-carapace length relationship for males and females are as follows.

Males : $TL = 21.6895 + 2.718222\ CL$ ($r = 0.995892$)

$CL = -7.75017 + 0.364871\ TL$

Females : $TL = 23.88158 + 2.605482\ CL$ ($r = 0.995209$)

$CL = -8.83451 + 0.380137\ TL$.

Estimation of growth parameters

Preliminary estimation of L_∞ was made using the Powell-Wetherall plot. Based on this, the automatic search routine, response surface analysis and scan of K values provided in the ELEFAN submenus of FiSAT were run to get the best fit of L_∞ and K. For males, L_∞ obtained by Powell-Wetherall method was 97.3 mm and $Z/K = 3.87$. The L_∞ obtained from ELEFAN I with highest R_n value (0.211) was 99.0 mm (28.0 mm CL) and $K = 1.10\ yr^{-1}$ (Fig. 2). In the case of females, L_∞ obtained by Powell-Wetherall method was 117.9 mm and Z/K 4.89. ELEFAN I showed $L_\infty = 120$ mm (36.8 mm CL) and $K = 1.18\ yr^{-1}$ (Fig. 3) with a highest R_n value (0.206).

By using the values L_∞ and K from ELEFAN I method as inputs, t_0 was calculated for males and females by Pauly's equation[7]. The calculated t_0 value for males and females were -0.045 and -0.039 respectively.

By using von Bertalanffy[5] growth curves derived from the estimated growth parameters, the life span of *S. choprai* male is about 32 months (94 mm) and for females it is around 30 months (114 mm) (Fig. 4). It is also observed that male attains a total length of 66 mm (16 mm *CL*) at the end of first year and 88 mm (24 mm *CL*) at the end of second year. Similarly females attain a total length of 83 mm (23 mm *CL*) at the end of first year and 109 mm (33 mm *CL*) at the

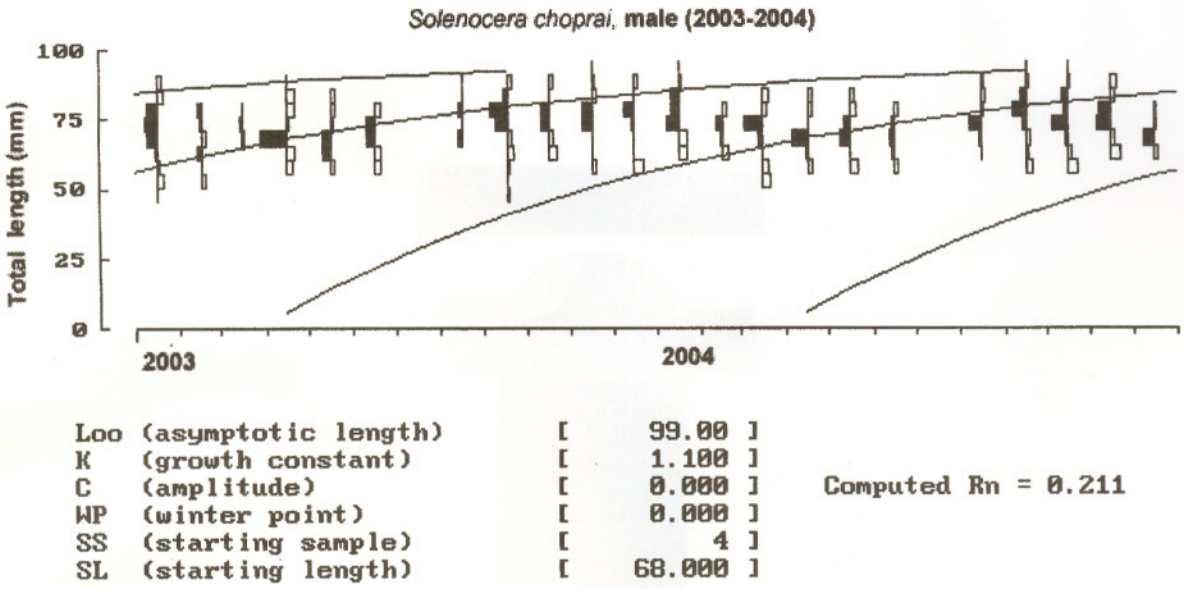

Fig. 2—Estimate of L_∞ and K of *S .choprai* (male) using ELEFAN I method.

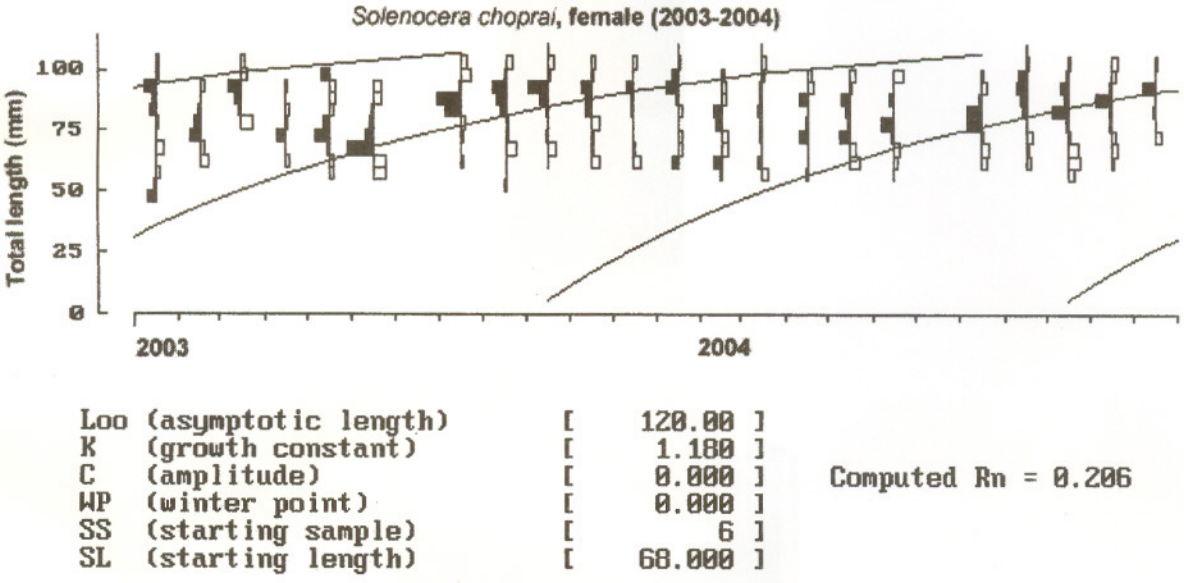

Fig. 3—Estimate of L_∞ and K of *S .choprai* (female) using ELEFAN I method.

end of second year. By using the equation described by Dall *et al.*[9], growth performance index ,Φ' derived for males and females were 1.22 and 1.49 respectively.

Discussion

There is no previous record of morphometric relationships of *S. choprai*. However length-weight relationship of *S. crassicornis* was studied[2] in Indian waters. It was observed[2] that males and females require different equations for length weight relationship in which 'b' value, the slope of the length weight relationship, $W= a*L^b$, varied widely in males and females. Length-weight relationship studies on *S. melantho*[10] from Kagoshima Bay of Japan, showed significant difference in slopes and elevation in the regression plots for length- weight relationship for males and females. In the present study significant differences between slopes and elevations of (1) total length and total weight, (2) carapace length and total

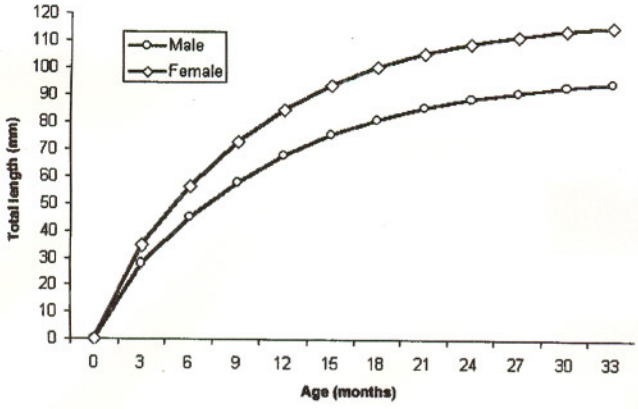

Fig. 4—The VBG curve for male and female *S. choprai* using estimated growth parameters.

weight and (3) carapace length and total length prevailed between sexes. The pattern of weight increment also differs in females as in the case of *S. melantho*[10]. Similar higher 'b' values for males were also reported in green shrimp, *Penaeus latisulcatus*, deepwater shrimps *Penaeopsis balssi, Parapenaeus sextuberculatus* and *Aristaemorpha foliacea* from Indian Ocean[3].

Like morphometric studies, apart from a report on the size distribution of the species, growth studies on *S. choprai* is not reported from any part of the world. Aravindakshan & Karbhari[11] reported that the major catch of *S. choprai* off Bombay coast was constituted by shrimps of the size range < 100 mm and largest female recorded was measuring 125 mm.

For the present study, L_∞ values derived by ELEFAN I, 99 mm (*CL*, 28.0 mm) for males and 120 mm (*CL*, 36.8 mm) for females were selected for the age and growth studies of *S. choprai*. ELEFAN I method is described as more reliable and highly recommended method for studying single species dynamics in a multi species context[12-13], which is very much relevant to tropical trawl fishing scenario. These values are found reasonable since these values are not far away from or less than the maximum length obtained in the fishery (94 mm for male and 114 mm for females).

Kunju[1] reported that the females of *S. crassicornis* have a faster growth rate than males, similar to the findings of the present study. Index of growth performance, Φ', which combines L_∞ and K is used to give an expression of the growth potential of the species. It is stated that the index showed considerably low variability than original K and L_∞ within a genus[9]. During the present study the Φ' estimated for males and females were 1.22 and 1.49 respectively, and the same for S. *melantho*[10] (calculated from L_∞ and K values) were 1.26 and 1.50 respectively, which are almost identical to the present study.

Longevity of *S. melantho*[10] was reported to be around 36 months and 24 months in *S. acuminata*[14]. In the present study longevity of *S. choprai* was estimated as 30 months. It is estimated that male and female *S. choprai* attain a length of 66 and 83 mm at the end of 12 months and 88 and 109 mm at the end of 24 months respectively. During the study it was also observed that highest number of males caught belong to >71 mm size group and highest number of females belongs to >81 mm size group. It can be deduced that the fishery of *S. choprai* along Mangalore-Malpe coast is constituted mainly by 1+ year class. However catch during the second year showed (Table 1) shifting of modal size towards smaller size groups in both males and females indicating reduction in mean size, which warrants an in depth monitoring of the stock as far as sustainability of the fishery is concerned.

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