Journal of the Indian Fisheries Association
30, 2003, 73-79

STUDIES ON LENGTH-WEIGHT RELATIONSHIPS OF *GERRES FILAMENTOSUS* CUVIER FROM THE ESTUARIES OF THE SOUTHERN KARNATAKA COAST*

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ABSTRACT

Random samples of *Gerres filamentosus* Cuvier from the Netravathi-Gurpur, Mulky, Kallayanapura, Mabukala and Kundapura estuaries of the southern Karnataka Coast were collected in the years 2000, 2001 and 2002, and length-weight relationships for each estuary were derived using multiple linear regression technique with one dummy variable. Hence, combined or sex-wise length-weight relationships were obtained after testing for homogeneity and isometric growth condition of fishes for each estuary by t-test. The extent of closeness of length-weight relationships between sexes and among estuaries for different years is explained by a trend line graph. The whole process of multiple linear regression analysis with one dummy variable is a better substitute for the analysis of covariance technique.

Keywords: *Gerres filamentosus*, estuaries, length-weight relationships, multiple linear regression technique

INTRODUCTION

The study of the length-weight relationship of any species forms an important component for use in yield models. Many references are available on length-weight relationships of marine species, and studies on estuarine fishes of Indian coast are rare with regard to stock assessment and related aspects like estimation of population parameters, length-weight relationship, spawning biology, and recruitment pattern. No references are available on length-weight relationships of *Gerres filamentosus* Cuvier along the Indian Coast except for Kurup and Samuel (1987) who have studied the length-weight relationship, relative condition factor and spawning biology of *G. filamentosus* of Vembanad Lake. An attempt was made in the present investigation to study the length-weight relationships of *G. filamentosus* in five estuaries of the southern Karnataka Coast, which stretches from Talapady to Byndoor.

* Forms a part of the project on the stock assessment of commercially important estuarine fishes from the Southern Karnataka Coast

MATERIAL AND METHODS

In the present study, random samples of *G. filamentosus* were collected from Netravathi-Gurpur, Mulky, Kallyanapura, Mabukala and Kundapura estuaries for a period of about three years from April 2000 to December 2002. The fish were caught by different types of gear like cast nets, surface gill nets and drift nets with varying mesh sizes from 20 to 60 mm. This species is abundant in the estuaries of the southern Karnataka Coast, which is supported by another species *G. abbreviatus*. Landings of other species like *G. setifer, G. oblongus* and *G. oyena* were very scarce during the period. It was estimated by the authors that the contribution of the Family Gerridae to the total estuarine fish landings of the Southern Karnataka Coast was in the range of 12 to 15% in a year. A total of 2214 specimens were measured for total length (distance from tip of snout to tip of lower caudal fin) and body weight from five estuaries of which the present study is based on 985 male and 1011 female *G. filamentosus*. The remaining 218 specimens were indeterminates in the whole sampled lot. The length-weight relationships were derived using multiple linear regression equation of the form:

$$Y = A_0 + A_1 + A_1D + B_0X + B_1(DX),$$

where, D = 0, if fish is female

= 1, if fish is male

D = Dummy variable

A_0 = Common intercept of basic log length-weight relationship (of female fish since D = 0)

A_1 = Difference in the 2 intercepts (of female and male log length-weight relationships)

B_0 = Regression coefficient (of female log length-weight relationship since D = 0)

B_1 = Difference in the 2 regression coefficients (of female and male log length-weight relationships)

X = Log length

Y = Log weight

Draper and Smith (1998) have explained in detail the theoretical aspects of multiple linear regression of the above type. While fitting the above multiple linear regression equation on D (sex), X (log length) and DX (joint variation of sex and length), the coefficients A_0, A_1, B_0 and B_1 were tested for departure from zero using the test statistic:

t = (coefficient - 0)/Standard error of the coefficient

Here, the coefficients A_0 and B_0 were always found to be significant. If A_1 and/or B_1 were significant, the separate length-weight relationships in the logarithmic form were derived by inserting D = 0 for females and D = 1 for males in the fitted multiple linear regression equation as:

$Y = A_0 + B_0X$ for females and $Y = (A_0 + A_1) + (E_0 + B_1) X$ for males

If both A_1 and B_1 were not significantly different from zero, there was no significant difference in the intercepts and regression coefficients of the two length-weight relationships. Hence, the combined length-weight relationship for males and females for each estuary was derived as the average of the individual length-weight relationships as:

$$Y = A_0 + A_1/2 + B_0X + B_1X/2$$

The coefficient B_0 was tested for isometry using the test statistic:

$$t = (B_0 - 3)/\text{Standard error of } B_0$$

Further, when B_0 was tested for isometric growth by t-test, the result was extended to see whether regression coefficients of the two sexes were the same based on the significance of B_1. Accordingly, if both the null hypotheses $B_0 = 3$ and $B_1 = 0$ were accepted, there was no significant difference in the two regression coefficients of males and females (since $B_1 = 0$), and both the regression coefficients exhibited isometric growth. Thus, multiple linear regression analysis with one dummy variable is a better substitute for the analysis of covariance technique of Snedecor and Cochran (1968) to test for the homogeneity of length-weight relationships and to derive pooled length-weight relationship in fishes. Graphical method of comparison of log obesity (A) and growth condition (b) values of male and female relationship among estuaries for each year and among years for each estuary were made to know the extent of closeness of relationships instead of mere graphic representation of the length-weight relationship ($w = al^b$) which does not give more information on the length-weight relationship. MINITAB software was used for fitting the multiple linear regressions with one dummy variable. All test statistic values were compared with the critical value of 1.96 at $p = 0.05$.

RESULTS AND DISCUSSION

Homogeneity and Isometry of Length-weight Relationships

Table 1 gives the multiple linear regressions of Y on X and DX for Netravathi-Gurpur, Mulky, Kallyanapura, Mabukala and Kundapura estuaries in the years 2000, 2001 and 2002. The goodness of fit of these multiple linear regressions with one dummy variable is indicated by R^2 values. It can be seen from Table 1 that there was no significant difference in the length-weight relationship of males and females of *G. filamentosus* in all the estuaries excluding Mulky in 2000, and Netravathi-Gurpur and Mabukala estuaries in 2001, since in these estuaries, A_1 and B_1 coefficients are significantly different ($p < 0.05$). The growth condition of *G. filamentosus* in the five estuaries of the Southern Karnataka Coast varied from 2.5409 (Mabukala Estuary in 2002) to 3.7947 (Kallyanapura Estuary in 2000). In most of the estuaries, there was isometric growth in all the three years indicating proportional weight in *G. filamentosus* as cube of its length with more or less uniform body shape. Individual length-weight relationships for males and females are also shown in Table 1 for each estuary, though combined length-weight would be desirable to compare the extent of closeness of relationships.

Comparison of Growth Condition and Log Obesity Values

On the perusal of multiple linear regressions in Table 1, it is obvious that in

Table 1. Multiple linear regression equations, log length-weight relationships and other details of *Gerres filamentosus* from five estuaries of the southern Karnataka Coast in 2000, 2001 and 2002

Year	Estuary	Sample size	Multiple linear regression equation	Individual relationship	Combined relationship	R^2
2000	Netravathi-	72	Y = -1.4625 – 0.0907 D + 2.7100 X + 0.0888 DX*	Y = -1.4625 + 2.7100 X	Y = -1.5079 + 2.7544 X	92.7
	Gurpur		(11.84) (0.45) (2.6952) (0.50)		Y = -1.5532 + 2.7988 X	
	Mulky	192	Y = -2.1284 + 1.0088 D + 3.2245 X – 0.8835 DX	Y = -2.1284 + 3.2245 X	-	92.8
			(19.32) (7.36) (2.3698) (7.03)	Y = -1.1196 + 2.3710 X		
	Kallyanapura	34	Y = -2.6193 – 0.0937 D + 3.6864 X + 0.1083 DX*	Y = -2.6193 + 3.6864 X	Y = -2.6662 + 3.7406 X	96.7
			(12.41) (0.31) (3.8454) (0.43)	Y = -2.7130 + 3.7947 X		
	Mabukala	92	Y = -1.8328 – 0.0947 D + *3.0036* X + 0.0993 DX*	Y = -1.8338 + *3.0036* X	Y = -1.8802 + *3.0583* X	91.0
			(12.33) (0.37) (0.0268) (0.43)	Y = -1.9275 + *3.1029* X		
	Kundapura	77	Y = -1.8652 – 0.0584 D + *3.0003* X + 0.0446 DX*	Y = -1.8652 + *3.0003* X	Y = -1.8944 + *3.0286* X	88.7
			(10.66) (0.24) (2.0019) (0.20)	Y = -1.9236 + *3.0449* X		
	Pooled	467	Y = -1.9816 + 0.1343 D + *3.1250* X – 0.1025 DX*	Y = -1.9816 + *3.1250* X	Y = -1.9145 + *3.0768* X	92.4
			(11.32) (1.03) (1.1200) (1.06)	Y = -1.8473 + *3.0225* X		
2001	Netravathi-	278	Y = -1.7675 + 0.2120 D + *2.9222* X – 0.1718 DX	Y = -1.7675 + *2.9222* X	-	95.0
	Gurpur		(25.62) (2.34) (1.2838) (2.12)	Y = -1.5555 + 2.7504 X		
	Mulky	253	Y = -2.8318 + 0.0738 D + *2.9654* X – 0.0634 DX*	Y = -1.8318 + *2.9564* X	Y = -1.7949 + *2.9317* X	81.9
			(13.09) (0.38) (0.3463) (0.36)	Y = -1.7580 + *2.8930* X		
	Kallyanapura	68	Y = -1.9903 + 0.1874 D + *3.1436* X – 0.1682 DX*	Y = -1.9903+ *3.1436* X	Y = -1.8966 + 3.0515 X	96.8
			(18.83) (1.18) (1.5030) (1.16)	Y = -1.8029 + *2.9754* X		
	Mabukala	152	Y = -2.2589 + 0.3323 D + 3.4018 X – 0.3323 DX	Y = -1.2589 + 3.4018 X	-	96.2
			(25.43) (2.91) (4.4769) (3.05)	Y = -1.9266 + *3.0695* X		
	Kundapura	82	Y = -1.8616 – 0.1856 D + *3.0238* X + 0.1571 DX*	Y = -1.8616 + *3.0238* X	Y = -1.9544 + *3.1014* X	94.9
			(14.02) (1.03) (0.1965) (0.96)	Y = -2.0472 + *3.1809* X		
	Pooled	833	Y = -1.8498 + 0.1203 D + *2.9939* X – 0.1053 DX*	Y = -1.8498 + *2.9939* X	Y = -1.7897 + *2.9413* X	93.0
			(40.11) (1.94) (0.1500) (1.86)	Y = -1.7295 + *2.8886* X		
2002	Netravathi-	341	Y = -1.7442 – 0.0774 D + *2.8916* X + 0.0820 DX*	Y = -1.7442 + *2.8916* X	Y = -1.7829 + *2.9326* X	92.2
	Gurpur		(22.63) (0.72) (1.4910) (0.81)	Y = -1.8216 + *2.9731* X		
	Mulky	147	Y = -1.7272 + 0.2549 D + *2.8592* X – 0.2310 DX*	Y = -1.7272 + *2.8592* X	Y = -1.5998 + *2.7437* X	93.6
			(22.17) (1.83) (1.8798) (1.81)	Y = -1.4723 + *2.6282* X		
	Kallyanapura	53	Y = -1.3859 – 0.5346 D + 2.5929 X + 0.4429 DX*	Y = -1.3829 + 2.5929 X	Y = -1.6532 + 2.8144 X	87.8
			(7.20) (1.22) (2.1934) (1.02)	Y = -1.9204 + *3.0358* X		
	Mabukala	86	Y = -1.3723 – 0.1882 D + 2.5409 X + 0.2027 DX*	Y = -1.3723 + 2.5409 X	Y = -1.4664 + 2.6423 X	89.4
			(12.38) (0.84) (4.2549) (0.95)	Y = -1.5605 + 2.7436 X		
	Kundapura	69	Y = -2.0068 – 0.0230 D + *3.1740* X + 0.1080 DX*	Y = -2.0068 + *3.1740* X	Y = -2.0183 + *3.2280* X	94.8
			(16.37) (0.12) (1.4733) (0.10)	Y = -2.0298 + *3.2820* X		
	Pooled		Y = -1.6206 – 0.1157 D + 2.7796 X + 0.1080 DX*	Y = -1.6206 + 2.7796 X	Y = -1.6785 + 2.8336 X	91.4
			(34.97) (1.62) (5.0200) (1.59)	Y = -1.7363 + 2.8876 X		

*Indicates combined length-weight relationship for males and females.

Figures in parentheses indicate the t-values for testing the significance of coefficients from zero.

In the fifth column, the length-weight relationship for males and females are in alternate rows.

B_0 and b values in italics indicate isometric growth.

each of the multiple linear regressions of *G. filamentosus,* the coefficients A_1 and B_1 are almost equal and opposite in sign. That is, $A_1 = -B_1$ or $-A_1 = B_1$. Accordingly, the difference in the regression coefficients of the sexes was almost equal to the difference in the log obesity values, which are found to be true for individual length-weight relationships of males and females. Further, growth conditions (b values) were directly proportional to log obesity (A values). This is found to be true for all the length-weight relationships of *G. filamentosus* in all the estuaries for any year irrespective of the type of growth condition in the fish. In other words, the growth condition of *G. filamentosus* is dependent on the slenderness of the fish. This fact is obvious from Table 1. Kurup and Samuel (1987) have derived the length-weight relationships of *G. filamentosus* as: log w = -1.3224 + 2.8740 log l and log w = -1.2874 + 2.8381 log l for males and females, respectively, in Vembanad Lake. These relationships indicate a negative allometric growth condition in *G. filamentosus.* These relationships support the findings of the present study that A is inversely proportional to b in any length-weight relationship, and the coefficients, B_1 = +0.0359 and A_1 = -0.0350 are approximately same and opposite in sign.

Trend Line Graph of b and A Values

Fig. 1 is drawn to indicate the growth conditions, and log obesity values between the males and females of *G. filamentosus* in the form of trend line graphs in different estuaries instead of non-linear representation of length-weight relationships of the form $w = al^b$ which do not show the extent of homogeneity or otherwise of length-weight relationship of the sexes. Fig. 1 shows the variation in B_1 and A_1 values of each estuary in the three years to know the extent of homogeneity of length-weight relationships. When pooled length-weight relationships for males and females of *G. filamentosus* in each year are derived, it is noted that the average growth condition of *G. filamentosus* in the estuaries of the Southern Karnataka Coast has declined successively for the three years by about 11% in females and 4% in males on an average, which requires further investigations.

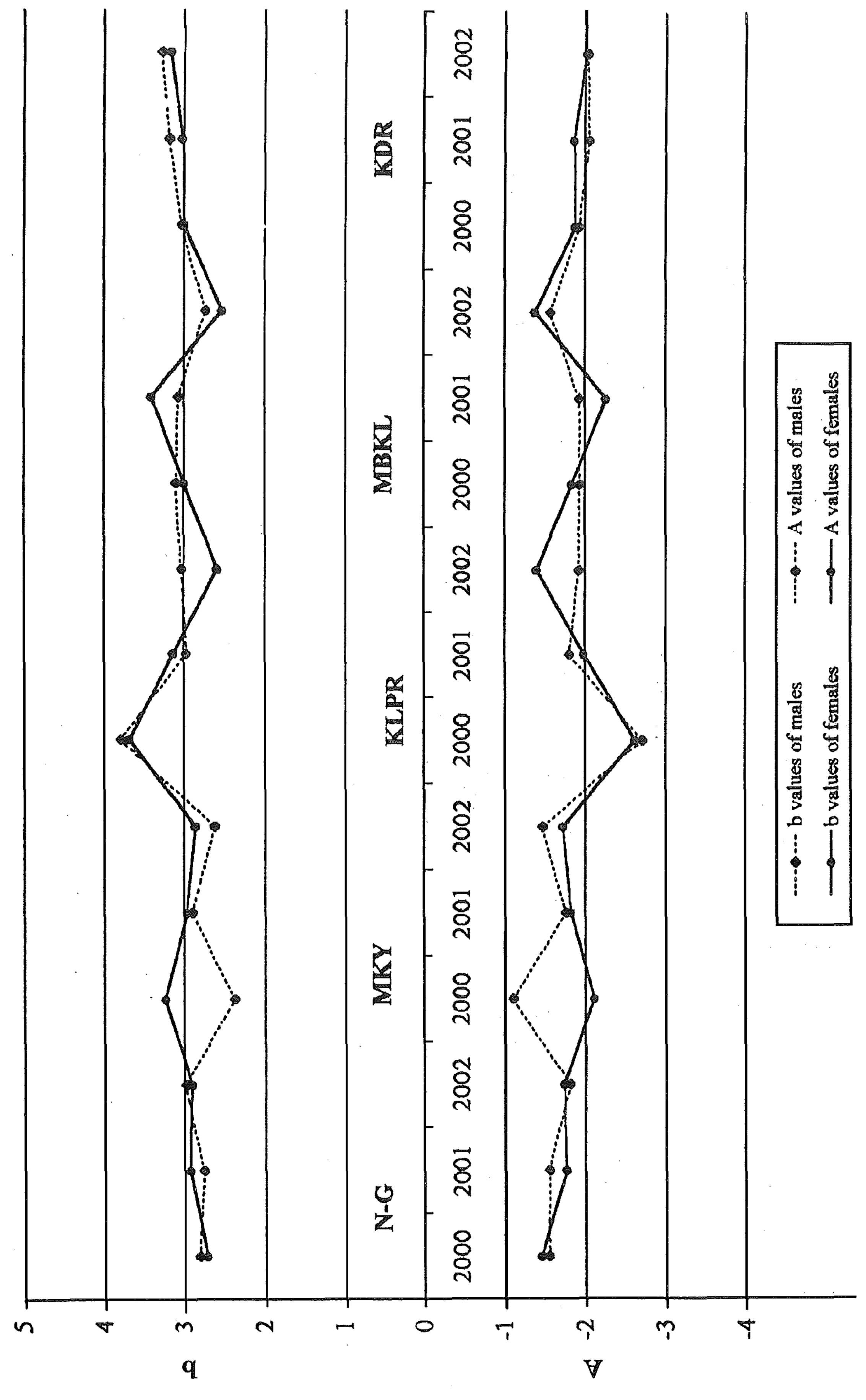
CONCLUSION

From the present studies, it can be seen that there is more or less uniform growth condition in *G. filamentosus* in all the estuaries. Comparison of b values in the length-weight relationships of male and female fish with the test on isometric growth using the multiple linear regression analysis with one dummy variable instead of analysis of covariance technique is acceptable to any species.

ACKNOWLEDGEMENTS

The authors express their great sense of gratitude for the financial help rendered by the Indian Council of Agricultural Research, New Delhi, to carry out the present work.

Fig. 1. Trends of b and A values in the length-weight relationships of Gerres filamentosus *in different estuaries in the years 2000, 2001 and 2003*



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