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Length weight relationship and relative condition in *Cynoglossus macrostomus* Norman and *C.arel* (Schneider)

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Abstract

The length weight relationship (LWR) of *Cynoglossus macrostomus* and *C.arel* from along the south west coast of India was studied. The LWR for the first species was $W=0.000002194\ ^{3.16378}$ for males and $W=0.000002953\ L^{3.10734}$ for females. The LWR in *C.arel* was $W=0.000003211\ L^{3.05395}$ for males and $W=0.000006494\ L^{2.92315}$ for females.The 'r' value revealed very good correlation between length and weight. By testing the regression coefficients against the isometric growth value it was found that there was no significant variation between sexes of both the species. Both the species showed isometric growth. The relative condition (Kn) in *C.macrostomus* was studied for the first time. The analyses both size group wise and season wise indicated that the variations in Kn value are related to the maturity cycle and spawning in this species.

Introduction

Every fish grows in length and weight and the relationship (LWR) between these two has both theoretical and practical applications. The knowledge of this relationship has a vital role in the fishery. It not only helps in establishing the yield but also in converting one variable into the other as is often required during monitoring field measurements. Further, this relationship in the growth of the fish is important in that the knowledge of the size at which the fish increases rapidly in weight may be useful in fixing the harvesting time of the resource. The constantly dynamic nutritional, physiological, environmental and biological cycles derive the condition of the fish towards great many variations. Hence information on the relative condition factor also has obviously gained significance towards understanding the nutritional and biological cycle of the fish species. In India, the literature is replete with studies on the length weight relationship of almost all the commercially important fishes. However, studies incorporating the relative condition factor are limited. This is especially so in flatfishes. Studies on the LWR of flatfishes in India are limited to the works of Das and Mishra (1989) on *Psettodes erumei, Pseudorhombus arsius and Synaptura commersoniana;* Edwards *et al* (1971) on *Cynoglossus brevis, C.lida* and *C.puncticeps;* Victor (1978) and, Ferozkhan and Nandakumaran (1993) on *C.macrostomus;* and Seshappa and Chakrapani (1981) on *C.dubius, C.bilineatus and C.semifasciatus*. However, no studies have been carried out on the relative condition of these flatfishes. So also no information is available on the LWR of large growing flatfish like *C.arel.* The Malabar sole *Cynoglossus macrostomus* is the most dominant among the flatfishes

in India. Hence, a detailed study on the LWR and relative condition of this fish was undertaken. The LWR in *C.arel* also was investigated and the results of these studies are presented here.

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Material and methods

Samples of Malabar sole were drawn from the commercial trawl landings at Fisheries harbours at Kochi and Neendakara (Quilon) and from the minitrawls operated at Ambalapuzha (Alleppey) during 1994-96. A total of 340 males (61-161 mm TL) and 329 females (50-162 mm) were utilised for the study. Samples of the large-scaled tongue sole *C.arel* consisted of 124 males (160-293 mm TL) and 91 females (180-338 mm).

The LWR was calculated adopting the general exponential equation $W = a L^b$, where W is the weight in gram and L= the total length of the fish in mm. The constants 'a' and 'b' were calculated following the method of least squares. The linear equation was fitted separately for both sexes. Analysis of covariance was employed to test whether the 'b' values significantly differ at 5% level. The 't' test (Snedecor and Cochran, 1967) was used to test whether the regression coefficients significantly deviated from the expected cubic value.

Results

Malabar sole

The scatter diagram of observed values of weight (g) against total length (mm) and the fitted curve for males and females are given in figures 1 & 2. The LWR was found to be linear as discernible from the figures. The estimate of the parameters for male, female and pooled for sexes are:

Male	$W = 0.000002194\ L^{3.16378}$	(r=0.986311)
Female	$W = 0.000002953\ L^{3.10734}$	(r =0.969272)
Pooled	$W = 0.000002576\ L^{3.13309}$	(r= 0.978135)

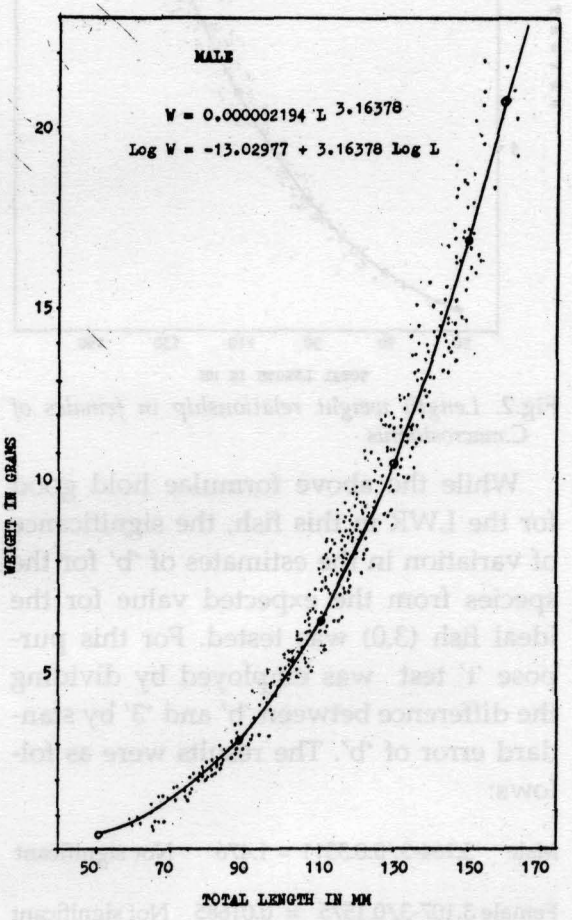

Fig.1 *Length weight relationship in males of C.macrostomus*

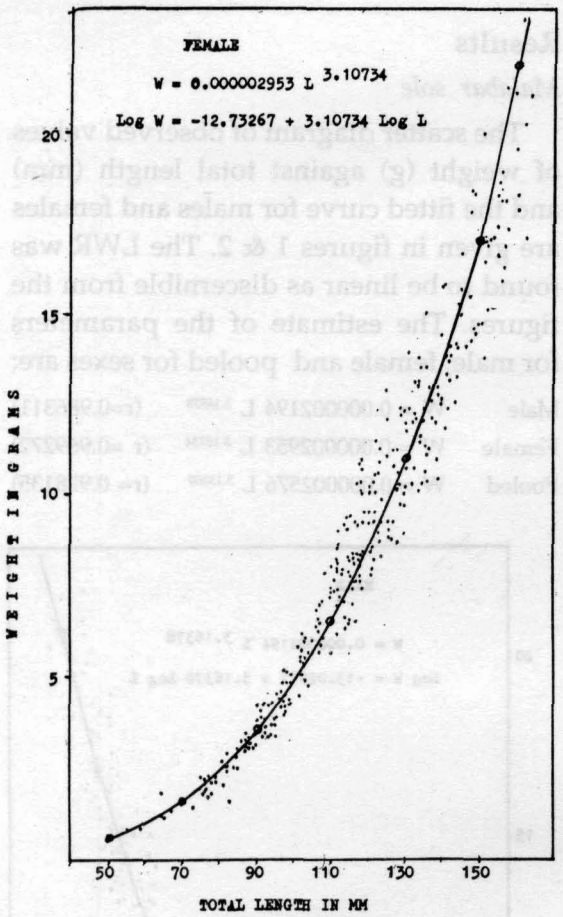

Fig.2. *Length weight relationship in females of C.macrostomus*

While the above formulae hold good for the LWR in this fish, the significance of variation in the estimates of 'b' for the species from the expected value for the ideal fish (3.0) was tested. For this purpose 't' test was employed by dividing the difference between 'b' and '3' by standard error of 'b'. The results were as follows:

Male 3.164-3/0.0.3511 = 1.476 Not significant

Female 3.107-3/0.1575 = 0.01685 Not significant

Pooled 3.137-3/0.1359 = 1.00806 Not significant

The values were not significant and the cube formula $W = aL^3$ is a proper representation of the LWR and that the growth in weight is isometric in both sexes of Malabar sole.

Large-scaled tongue sole

The LWR in *C.arel* also was worked out for the first time. The equations fitted to both sexes and the pooled were:

Male $W=0.000003211\ L^{3.05395}$ (r=0.9542)

Female $W=0.000006494\ L^{2.92315}$ (r=0.9558)

Pooled $W=0.000002576\ L^{2.97478}$ (r=0.9557)

The significance of variation in the estimates of 'b' for this species from the expected value for ideal fish (3.0) was tested by the 't' test and the results were as follows:

Male 3.054-3/0.00783 = 0.61025 N.S

Female 2.923-3/0.19193 = -0.7554 N.S

Pooled 2.975-3/0.0943 = -0.26499 N.S

In this species also the formula $W=aL^3$ is proper representation of the LWR. The growth is isometric in both sexes.

To test the equality of LWR between males and females, the analysis of covariance was carried out. The results for Malabar sole are given in Table 1 and that for *C.arel* in Table 2. The analysis revealed no significant difference between the relationship in respect of *C.arel*. However, in Malabar sole there was statistically significant difference between elevations among sexes. But for all practical purposes since there was no apparent difference in the mean values, a common LWR

Table 1 *Test of equality of regression lines (C.macrostomus)*

Source	DF	SS-X	SP	S-Y	b	DF	SS	MS	F
Male	340	14.9348	47.2505	153.6683	3.164	339	4.178	0.01233	
Female	329	13.0799	40.6435	134.4274	3.107	328	8.134	0.02480	
Total						667	12.313	0.01846	
Pld W	669	28.0147	87.8940	288.0960	3.137	668	12.335	0.01847	
Difference between slopes						1	0.022	0.02221	1.20
Between 1		0.1034	0.2026	0.3969					
W+B	670	28.1181	88.0966	288.4929	3.133	669	12.478	0.01865	
Difference between corrected means						1	0.143	0.14297	7.74

could be considered. It may be noted here that when the sample sizes are large even a small difference between the estimates may get magnified.

Relative condition in Malabar sole

The density of the fish is maintained as the same as that of the surrounding medium and hence changes in weight for length are due to changes in form or volume and not specific gravity. Such changes are analysed by the Condition factor (K) or Ponderal index (Thompson, 1943) which is given by the formula $K = 100*W/L^3$ where W = the weight and L= the length of the fish. Factors like age, sex, maturity, racial difference, food supply, degree of parasitation, environment and selection in sampling may affect K indirectly through the values of the exponent. Hence the Relative condition factor (Kn) as per the method of Le Cren (1951 was calculated. The Kn for the species was calculated based on 297 males and 229 females of the size range 60-160 mm. The seasonal variations in the Kn values were based on 412 males and 626 females. Since the predominance of pre-adults or juveniles may result in higher Kn values and also to prevent the influence of other

Table 2 *Test of equality of regression lines (C.arel)*

Source	DF	SS-X	SP	S-Y	b	DF	SS	MS	F
Male	123	1.0415	3.1805	10.6680	3.054	122	0.955	0.00785	
Female	90	1.1449	3.3466	10.7069	2.923	89	0.924	0.01039	
Total						211	1.879	0.00891	
Pld W	213	2.1863	6.5271	21.3749	2.985	212	1.889	0.00891	
Difference between slopes						1	0.009	0.00933	1.05
Between 1		0.0736	0.1955	0.5195					
W+B	214	2.2599	6.7226	21.8944	2.975	213	1.896	0.00890	
Difference between corrected means						1	0.008	0.00766	0.86

factors, only the most commonly occurring size groups in the fishery and those fishes above the size at first maturity were considered. Males of 100-147 mm and females 100-149 mm were analysed to study the seasonal pattern in the Kn values.

Relative condition in relation to size

The Kn values of different size groups give an idea about the variations in the condition of the fish during its growth. In Malabar sole the fluctuations in the Kn with increase in length of the fish are quite apparent (Fig3). The values in the females showed an increase from 0.95 in 60 mm length group to 1.2 in the 80 mm group. The same trend was noticed in males also but here the Kn value of 1.2 was observed in 70 mm size group. The point of inflexion for both sexes was found to occur at 95 mm. Subsequently the value reached a peak at 115 mm size group. The decrease in the value thereafter is an indication of the spawning. The next peak in the value was seen at 130 mm which was followed by a decline that pertained to the second spawning. The fish is nearly

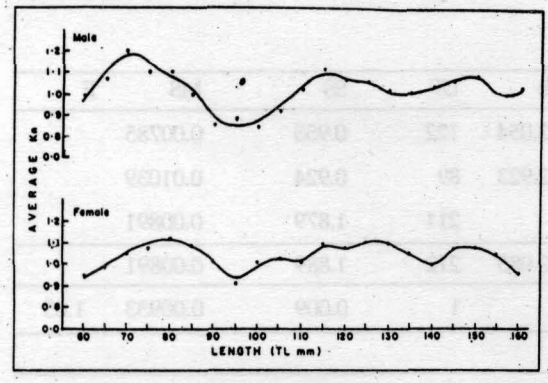

Fig.3 *Relative condition in various size groups of C.macrostomus*

two years old by this time (Jayaprakash and Inasu, 1998). Again the Kn value indicated a peak in 150mm-length group. A subsequent decrease in the values in both sexes indicated gonadal maturity and spawning.

Seasonal variation in Kn

The monthly fluctuations in Kn values are known to be influenced by many factors closely related to the sexual cycle. The increase or decrease in the values is due to a similar fate in the weight of gonads before and after spawning. The monthly values of Kn for both sexes were worked out from August 1994 to September 1996. Here, fishes of the size range 100-150 mm were considered through out the period (Fig.4) so that the mean length (120-

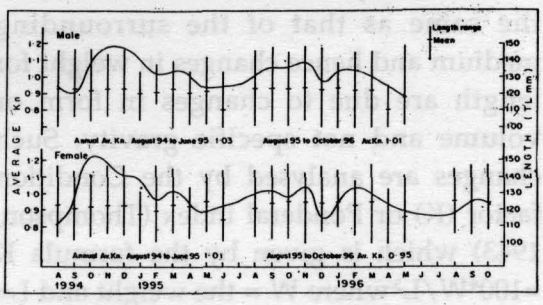

Fig.4. *Relative condition in C.macrostomus during different months*

125mm) was almost maintained during each month. The results indicated similarity in both sexes in the seasonal pattern of fluctuations in the values. The average value for the entire period was 1.01 and 0.95 for males and 1.03 and 1.01 for females during 1994-95 and 1995-96 respectively. The Kn value in females started to increase from August and reached a peak of 1.24 in October 1994 and then steeply

declined to 0.97 in February, again to an increase in March. Later, the value decreased to 0.89 in May and then increased in September 1995. In males also the seasonal fluctuation followed a pattern similar to the females.

The increase in the Kn value from August corresponded with the period of maturation of gonads as it was clearly associated with a rise in the gonado-somatic indices during these months. So also the increase from February indicated the maturation of gonads. The spawning in Malabar sole takes place during October-November and in March-April/May (Jayaprakash, 1999). The abrupt fall in the condition after October 1994, May 1995, November 1995 and February 1996 may be attributed to the increased metabolic strain of spawning.

Discussion

It may not be a surprise if one thinks that the flatfishes by their curious body shape may have a dissimilar pattern of growth in length and weight compared to other teleosts. The LWR in flatfishes too follow the cube law. Some of the earlier studies on flatfishes in India by Das and Mishra (1989), Edwards *et al* (1971) Victor (1978), Ferozkhan and Nadakumaran (1993), Seshappa and Chakrapani (1981) and the present study have shown this. The LWR in the large-scaled tongue sole *C.arel* is reported for the first time. So also the relative condition (Kn) in Malabar sole is reported for the first time. The variations in the Kn values in the various size groups and during different seasons are related to the sexual cycle in Malabar sole. Pantulu (1961) and Devaraj (1973) suggested that the increase in Kn values between different length groups of both sexes is related to the number of spawnings. The three peaks and the subsequent valleys observed in the Kn values of Malabar sole pertain to the three spawning during its lifetime. The initial point of inflexion on the curve showing an increase in Kn with increase in length is sure sign of the length at which the sexual maturity starts. The diminution of Kn or the point of inflexion at 95-99 mm could be considered as minimum size at maturity. This is in conformity with studies on maturity and spawning in this species (Jayaprakash, 1999).

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