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Length-weight relationship and relative condition factor of *Stolephorus commersonii* (Lacepede, 1803) exploited along Kerala coast

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Original Article

Abstract

The length-weight relationship and relative condition factor of *Stolephorus commersonii* was calculated to assess the significance of allometric factor and the well being. The study was carried out by using the data collected from ring seine and purse seine catches during the year 2010-2011. The length of species in catches ranged from 5 to 14.6 cm with a mean length of 9.24 ± 1.83 cm and the weight ranged from 1 to 25g with an average weight of 6.64 ± 3.96 g. Length-weight relationship calculated for male, female and pooled are $W = 0.0070\ L^{3.02}$, $W = 0.\ 00756\ L^{2.99}$ and $W = 0.\ 0073\ L^{3.006}$ respectively. The relative condition factor (Kn) estimated separately for male and female showed monthly fluctuation. The highest Kn values were observed in February and August and the lowest in June for both the sexes.

Keywords: *LW relationship, relative condition factor, Stolephorus commersonii*

Introduction

Anchovies are one of the major pelagic resources of Kerala coast. Among the group, *Stolephorus* commonly known as white bait are dominant in the catch along south west coast of India. Length-weight relationship (LWR) studies of fishes provide a mathematical relation between the two variables, which is useful to assess the quality (well-being) of individuals in a population. It helps to estimate the weight corresponding to a given length of a fish and to convert the catch data of a species from weight to numbers in order to obtain the abundance of the stock in space and time (Froese, 2006). In general, an increase in length of the fish implies that there is an increase in the body weight. LWRs of fish can be used to estimate the weight from the length of individuals, length classes or length frequency distribution in a population (Petrakis and Stergiou, 1995; Martin-Smith, 1996).

Basically, 'condition factor' represents the quality of individuals, which is actually the result of the interactions between biotic and abiotic factors and their effect on the physiological condition of fish. Therefore, 'condition factor' represents the status of well-being of individuals in a fish population (Angelescu *et al.*, 1958). The relative condition factor ('Kn') provides an important measure of different life cycle stages of fishes and valuable for the management of fishery resources in an ecosystem.

Commerson's anchovy, *Stolephorus commersonii* is the second major species in the anchovy group (Genus - *Stolephorus*) exploited along the Kerala coast with a maximum length 15.5

cm (CMFRI, 2012). Their body length ranges from 6.7 - 14.7 cm, the dominant size range being 11.2 -12.7 cm (Luther, 1979). Several studies have dealt with the fishery and LWR of anchovies such as *E. devisi*,. *S. waitei, S. bataviensis* from Indian waters (Puthran, 1990; Luther *et al.*, 1992; Rao, 1988 a, 1988 b; Nair, 1999; Gopakumar *et al.*, 2000). However, there is no information available so far on the L-W relationship and relative condition factor of commerson's anchovy and the present study forms first of its kind from the Kerala coast.

Material and methods

A total of 1180 specimens of commerson's anchovy (males 575 and females 605) caught by Ring seine and Purse seine units at fortnightly intervals during 2010-2011 from Munambam and Kalamukku fishing harbours (Lat-9º59'49.93"N.Long-76º02'30.73"E), Kochi (Kerala) were used for the study.

Length-weight relationship (LWR)

The length-weight relationship was calculated by the Cube law separately for male and female. The relationship between length and weight can be expressed by Cube law, $W = CL^3$. Le Cren (1951) modified the equation in to a non-linear type equation as $W = aL^b$ where,

W = Weight (g) of fish in grams
L = Total length of fish in centimeters

a = Exponent describing the rate of change of weight with length.
b = The slope of the regression line (also referred to as the allometric coefficient)

When expressed logarithmically, the above equation becomes a straight line of the formula

$\log W = \log a + b \log L$

Significance of variation in the relation between the male and female was tested by Analysis of Covarinace (Snedecor and Cochran, 1967). The significance of differences in the 'b' value from the expected value of 3 (isometric growth) was tested by Bailey's t-test (Zar, 2005) by the formula,

$t = (b-3)/sb$
b = regression coefficient of log transformed data
sb = standard error of b

The relative condition factor (Kn), introduced by Le Cren (1951) was calculated using the formula:

$Kn = W/WA$

where W is the observed weight and WA the estimated weight.

Results

Length Weight Relationship

The difference in length and weight of male and female *S. commersonii* was found to be minor. Length and weight of the fish varied from 5 - 14.6 cm (av. 9.24 ± 1.83 cm) and 1 - 25g (Av. 6.64 ± 3.96 g), respectively. The LWRs of Commerson's anchovy were as follows:

Male: Log W= -4.95 + 3.16 log L (R^2 =0.893)
Female: Log W= -4.88 + 2.99 log L (R^2 =0.896)

The corresponding parabolic equation can be expressed as follows:

Male: $W = 0.0070\ L^{3.16}$
Female: $W = 0.00756\ L^{2.99}$

The curves for LWR were calculated separately for male and female and are presented in Fig.1a and b, which display a linear relationship between the length and weight. The coefficient of determination for males and females were 0.893 and 0.896, respectively, which indicates a significant relation between the length and weight of the species ($P<0.001$). The Analysis of co variance (ANCOVA) showed that there is no significant difference in LWR between male and female ($P>0.001$). So there is no need of separate curve to fit the correlation, hence a common equation was derived by pooling the data (Fig.1 c). Details of ANACOVA have shown in Table 1.

Pooled: Log W= -4.915 + 3.006 log L (R^2 =0.898)
Pooled $W = 0.0073\ L^{3.006}$

The significance of variation of the estimates of regression coefficient value 'b' from 3 was tested using t - test (Table 2). The b values were very close to 3 and the variations were insignificant, confirming the isometric growth of the fish. The value of male, female and unsexed is given below.

Male : 0.579 $P<0.05$ not significant
Female : 0.146 $P<0.05$ not significant
unsexed : 0.228 $P<0.05$ not significant

Relative condition factor (Kn)

The monthly values of relative condition factor (Kn) of male

Table 1. Analysis of co-variance (ANCOVA) on the regression of length-weight relationship in male and female of Commerson's anchovy. P-value <0.05 and <0.01 indicate significance at 5% and 1% levels, respectively

Deviation from Regression							
	df	b	df	SS	MS	F	P
Male	575	3.03	574	19.75	0.0398		
Female	605	3.04	604	21.2	0.045		
Pooled	1180	3.03	1179	40.96	0.042		
Difference between slopes			40.96	0.0003	0.0003	13.28	0.00028
Difference between adjusted means			1	0.0014	0.0014	21.67	0.00004

Table 2. Statistical details showing number of Commerson's anchovy studied (n), intercept (log a), regression coefficient (b), standard error of b (sb), correlation coefficient (R^2) and results of Bailey's t-test on 'b'

	n	Log a	b	sb	R2	t	growth
Male	575	0.00523	3.16	0.045	0.893	0.579	isometric
Female	605	0.0075	2.9	0.041	0.896	0.146	isometric
Pooled	1180	0.0073	3	0.029	0.898	0.228	isometric

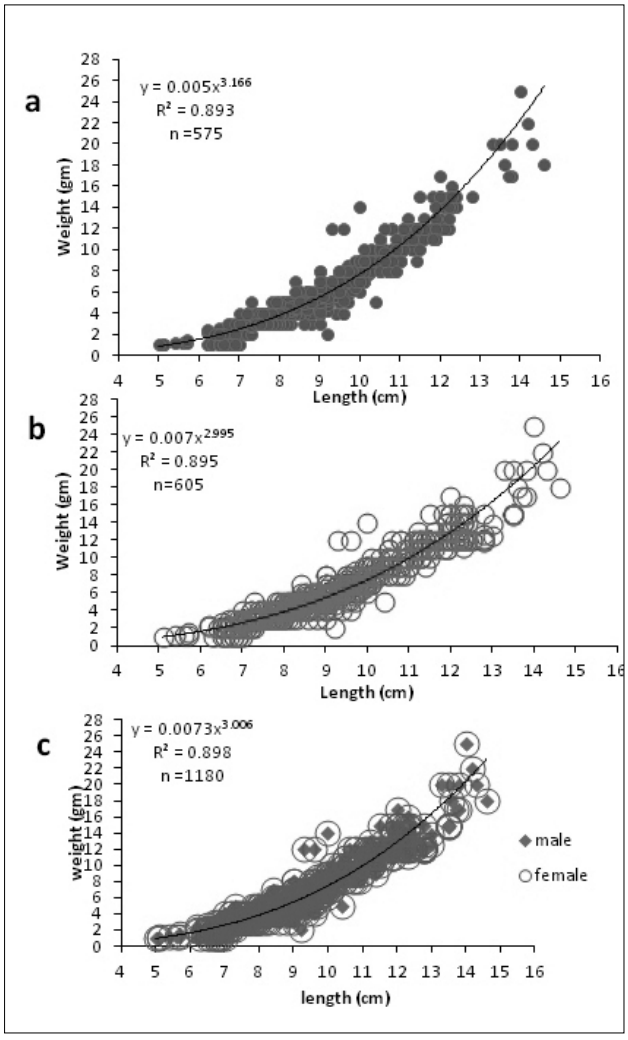

Fig. 1. Length-weight relationship of commerson's anchovy (a) male, (b) female and (c) pooled

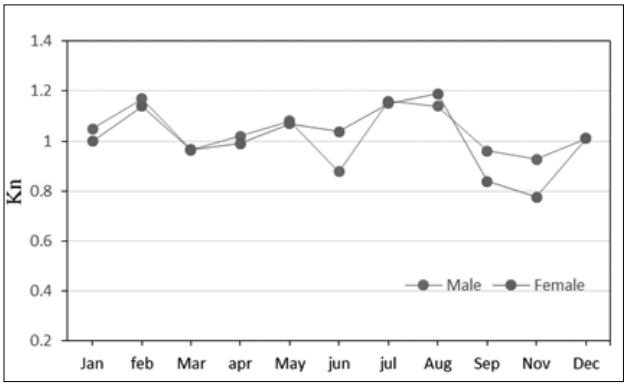

Fig. 2. Month-wise relative condition factor (Kn) of Commerson's anchovy

and female Commerson's anchovy are presented in Fig. 2. The (Kn) showed the highest value of male and female in February (1.19 and 1.18, respectively) and August (1.18 and 1.95, respectively) and the lowest in June (0.88 and 0.78, respectively). For both sexes, Kn value was found to be less than 1 in March, April, September and November.

Discussion

The LWR of an ideal fish precisely follow the cub law, and according to Wootton (1990), the value of exponent 'b' in the cube law will become exactly 3 if the fish retains the same shape and specific gravity and grows isometrically during their life time. Allen (1938) reported that such an ideal fish with a 'b' value 3 is very difficult to observe in the natural environment. In other words, a majority of fishes for which LWRs were calculated in the past, 'b' value was either less than or greater than 3, representing negative or positive allometric growth, respectively.

The change in 'b' value mostly reflects the change in the body form when the weight of the fish gets affected by environmental factors like temperature, food supply, spawning conditions and other factors like sex, age, fishing time and area and fishing vessels (Ricker, 1973; Bagenal and Tesch, 1978). Wootton (1990) showed that 'b' value less than 3 indicates that the fish becomes lighter (negative allometric) while values greater than 3 indicate that the fish becomes heavier (positive allometric). In essence, the change in specific gravity and body form during growth are found to cause a deviation from the isometric growth of the fish.

The present LWR study on Commerson's anchovy showed a significant coefficient of determination (R^2) varying from 0.893 to 0.898. The b value of male, female and pooled data were 3.16, 2.99 and 3, showing that Commerson's anchovy follows the cube law and isometric growth. The maximum length of Commerson's anchovy recorded in the present study was 14.6 cm. Hoedt (1994) reported that Commerson's anchovy attains a maximum length of 15.8 cm from Clevel and Bowling green Bays, North Queensland. Similar to the present study, Rao (1988a) observed no significant difference in length between the male and female of *E. devisi*, and suggested a combined LWR. Rao (1988b) reported a significant difference in the slope between sexes in *S. bataviensis* and concluded that the weight of the fish increases at a rate lower than the cube of its length.

Nair (1999) described the biology of *E. devisi*, *S. waitei* and *E. punctifer* along the Kerala coast and reported a significant difference in the length-weight relationship between males and females in *E. devisi*, and *S. waitei*. He also reported an isometric growth pattern in *E. devisi* and *S. waitei* and a significant variation in 'b' value in the case of the first two species. Doddamani *et al.* (2001) reported an allometric growth for *S. bataviensis* from the Mangalore area. The relative condition factor (Kn) equal or greater than 1 indicates that the fish is in good growth condition, which is usually employed as a tool to assess the growth status of a fish (Sachidanandamurthy and Yajurvedi, 2008). The fluctuations in the monthly Kn values depend on several factors like feeding, environmental condition, maturity and spawning.

The present study showed fluctuations in Kn values of Commerson's anchovy during different months. Rao (1988a) obtained low Kn values for *E. devisi* at Mangalore in October and February, which coincided with the commencement and completion of their major spawning period. Nair (1999) observed random fluctuations in Kn values for *E. devisi*, *S. waitei* and *E. punctifer* in different months even within the peak spawning season, indicating no correlation with spawning activity and fluctuation in the Kn values. The observed irregular fluctuation in Kn value of anchovy could be due to their protracted spawning period, as indicated in the study of Nair (1999). February-October, March-May are the peak spawning period of Commerson's anchovy (Luther *et al.*, 1992), but in the present study it was observed that the Kn value of the female during these months were greater than 1.This conveys that the decrease in the relative condition factor of the species cannot be linked to the spawning period, as observed by Basilon *et al.* (2006) in the case of European anchovy along the Strait of Sicily.

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