Original Article

Bulletin of Environment, Pharmacology & Life Sciences
Volume 1, Issue 3, February 2012: 61 - 66
Journal's URL: www.bepls.com
Online ISSN 2277-1808
[Received 12 January 2012; Revised 27 January; Accepted 29 February 2012]

Length Weight Relationship (LWR) and Growth estimation of *Lates calcarifer* (Bloch) in Chilika Lagoon, India

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ABSTRACT
Lates calcarifer, a commercially important fish species of Chilika Lagoon for which the length-weight relationship (LWR) and growth features was studied. The equation estimated from the LWR were, $y = 7E\text{-}05x^{2.683}$ (n=62) for male, $y = 9E\text{-}05x^{2.661}$ (n=66) for female and $y = 8E\text{-}05x^{2.669}$ (n=128) for both sexes. The computed growth coefficient (b) was 2.683, 2.661 and 2.669, where the regression coefficient (r^2) was 0.988, 0.964 & 0.976 for male, female and both the sexes respectively. For growth estimation, a total, 1232 individual of L. calcarifer, were measured with their body length (FL) during the period of June 2008 to May 2009. Different cohorts were identified through multiple length frequency analysis on the fork length and the growth curves were estimated. The estimated growth parameters of von Bertalanffy equation i.e., L∞ (cm), K, and t0, was 118.5cm, 0.15, -0.39 respectively.
KEY WORDS: *Length-Weight relationship, growth estimation, von Bertalanffy equation, Lates calcarifer, Chilika Lagoo*

INTRODUCTION

Length-weight relationship (LWR) has the important role in fishery resource management [1,2] and also useful for comparing life history and morphological aspects of populations inhabiting different regions [3]. These data are needed to estimate growth rates, length and age structures, and other components of fish population dynamics [4].The Length-Weight Relationship (LWR) is an important tool to analyze fish populations. Its applications range from simple estimates of an individual's weight to indication of fish body condition factor or inferences regarding sexual development [5]. Knowledge on this relationship also helps to identify energy investments for growth or reproduction as a natural cyclic phenomenon of natural populations [6].
Estimates of growth drive size and age structured stock assessment models [7], and is related to life history traits such as natural mortality (M) and age or length at maturity [8]. Age and growth determinations are important in studying longevity, age at first maturity, catchable size and other life history problems in fishes [9]. Age with growth parameters of fishes constitutes essential data to control the dynamic of ichthyologic populations. They give an important indication on the fishery resource management and on the level of their exploitation [10]. The relationship between the biological changes and growth, mortality and longevity has been studied by Alm [11] and Pauly [12]. Using data in Fish-Base, Froese and Binohlan [13] have likewise demonstrated that size and age at sexual maturity are strongly correlated with growth, maximum size and longevity.
Lates calcarifer (Local name "Bhekti") is the most popular and top-most commercial value in the region. But this species becomes gradually scarce in the lagoon year by year since 2000. Despite such a wide distribution throughout the country and having high commercial value, knowledge pertaining to the growth parameters of this species is very limited. But for Chilika lagoon, there has not been attempted for such type of investigations till today. So, the present paper is the first attempt to document studies relating to the length weight relationship and growth estimation for a large number of samples in the lagoon which will help for the future management of the stocks.

MATERIALS AND METHODS

Study area

Chilika Lagoon, the largest lagoon of India lies in the east coast of India, situated between latitudes 19°28' and 19°54' North and longitude 85°05' and 85°38' East. It is designated as an important Ramsar site (No.229) of India on 1st October 1981. The water spread area of the lagoon varies between 906 km2 to 1165 km2 during summer and monsoon respectively. The estuarine lagoon is a unique assemblage of marine, brackish and fresh water eco-systems. The lagoon is divided into four ecological sectors namely, the southern sector, the central sector, the northern sector and the outer channel area. Basically, the northern sector is fresh water dominated zone and central sector is a brackish water zone. The southern sector is a higher saline area. The outer channel is marine in nature with saline water but during monsoon, the water becomes fresh water due to discharge of flood water to the sea.

Length-Weight Relationship (LWR)

For length and weight analysis, fish samples were collected from the fishing boats. Collected samples were caught by khonda nets (fixed nets), gill nets and drag nets. After collection, samples were transported to the research laboratory in polythene bags for measurement of length and weight. Fork length (FL) and body weight (BW) were measured to the nearest 0.1cm and 0.01g respectively of the fresh samples. All total 128 fish samples were used to measure both length and weight for LWR. Length-weight relationship was estimated by the equation $W = aL^b$, where 'W' is body weight (g), 'L' is length (cm), 'a' and 'b' are two constant.

Growth

The commercially important fish species, i.e. *L. calcarifer* were measured with their total length (cm) for fish by using a measuring board at the fish landing centers of Balugaon in the central sector and Kalupadaghat in the northern sector of Chilika Lagoon. From June 2008 to May 2009, in total, 1232 individual of Bhekti samples were measured and the length data was recorded in the sampling format at those fish landing centers. The length composition data of those five species were used in this study. Multiple length frequency data sets on total length of the species, aggregated into 2-cm interval by month, were analyzed to separate different cohorts and estimate their growth. Parameters on growth curve, occurrence rate of each cohort, and the standard deviation of length (σ) in each cohort were simultaneously estimated by maximizing the log-likelihood function composed of the multinomial statistical model after Yamakawa and Matsumiya [14]. By using this model, we analyzed multiple length frequency data sets simultaneously and obtained accurate and stable parameter values consistently. The σ was assumed to be constant irrespective of age and size of shell. No discrimination was made between males and females.

RESULTS

Length-Weight Relationship (LWR)

Length-weight relationship (LWR) of *Lates calcarifer* estimated in Chilika lagoon and the equation found $y = 7E\text{-}05x^{2.683}$ (n=62) for male and $y = 9E\text{-}05x^{2.661}$ (n=66) for female. Here the computed growth coefficient (b) was 2.683 and 2.661, where the regression coefficient (r^2) was 0.988 and 0.964 for male and female respectively. Finally putting together all the data, LWR for the species was estimated. The estimated equation for both the sexes, $y = 8E\text{-}05x^{2.669}$ (n=128), in which condition factor ('a' value), growth co-efficient ('b' value) and regression co-efficient (r^2) was 8E-05, 2.669 and 0.976 respectively (Table-1).

Growth

The multiple length frequency analysis on *L. calcarifer*, five cohorts were detected (Fig. 2). The cohort with 33.6cm TL in June grew to 44.5cm TL by the next May. The estimated growth parameters for the fish species, *L. calcarifer* is shown in Table-2, and the von Bertalanffy growth equations are as follows.

$$L_t = 116.9\ (1\text{-exp}\ [-0.15\{t\text{-}0.38\}])$$

The asymptotic length (L_{inf}) was fixed to 116.9cm, considering the largest individual observed during the study period. K value is estimated as 0.15 and t0 is -0.38 (table-2).

DISCUSSION

The calculated 'b' value for *Lates calcarifer* is 2.683 and 2.613 for male and female and 2.669 for both sexes, are all within the limits for most fishes [15,16]. The b values are often 3.0 and generally between 2.5 and 3.5. As the fish grows, changes in weight are relatively greater than changes in length, due to approximately cubic relationships between fish length and weight. The b values in fish differ according to species, sex, age, seasons and feeding [17,18]. In addition, changes in fish shape, physiological conditions, and different amounts of food available, life span or growth increment can all affect the b growth exponent [19-21]. The variations in 'b' value may also depend upon various factors like number of specimen examined, condition of places of sampling, sampling season etc [22]. Even though the change of *b* values depends primarily on the shape and fatness of the species, also depends upon various factors like temperature, salinity, food (quantity, quality and size), and stage of maturity

[23,24]. But these factors were not accounted for the present study. The length-weight relationship presented here may facilitate fish biologists to derive weight estimates for fishes that are measured but not weighed.

Fig.1: Chilika lagoon showing the four ecological sectors and fish landing centers.

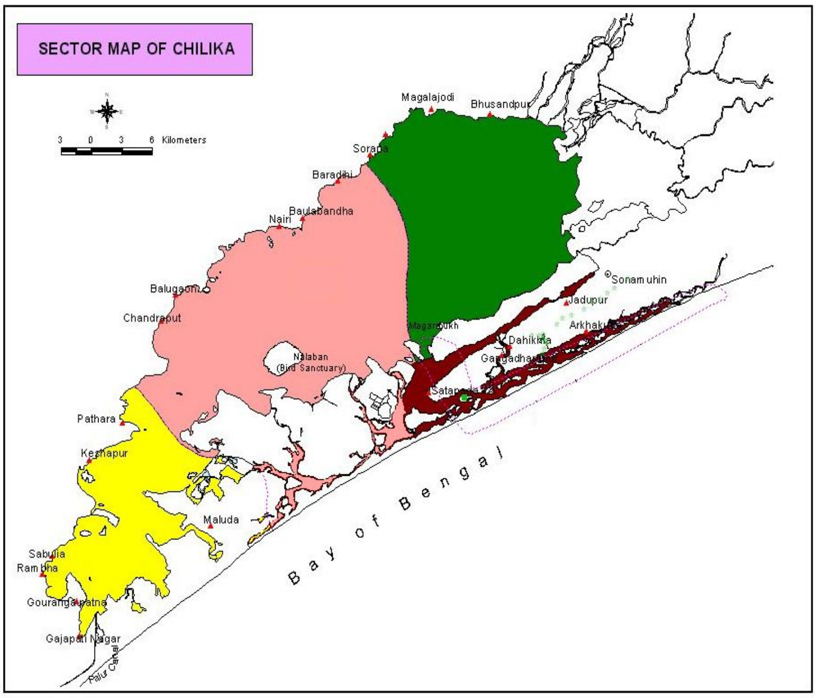

Table-1: Estimated parameters of LWR of *L. calcarifer* in Chilika lagoon.

Sex	N	TL/FL	Length(mm)	Weight(gm)	$W=aL^b$	b value	r^2
M	62	TL	201-534	121-1516	$y = 7E\text{-}05x^{2.683}$	2.683	0.988
F	66		197-506	127-1536	$y = 9E\text{-}05x^{2.661}$	2.661	0.964
B	128		197-534	121-1536	$y = 8E\text{-}05x^{2.669}$	2.669	0.976

Table-2: Estimated growth parameters *L. calcarifer* in Chilika Lagoon.

Parameters	Estimated values
Length type	TL
L∞ (cm)	116.9
K (1/year)	0.15
t0 (year)	-0.38

Table-3: Growth parameters of the fish species *L. calcarifer* studied by other authors.

L∞ (cm)	Length type	K (1/y)	t0 (years)	Sex	Country	Locality	Source
86.8	TL	0.30	-0.53	-	Australia	West Alligator River	Davis and Kirkwood (1984)
143.0	TL	0.13	-1.26	-	Australia	Mary River	Davis and Kirkwood (1984)
145.0	TL	0.13	-1.27	-	Australia	Norman River	Davis and Kirkwood (1984)
160.0	TL	0.09	-2.01	-	Australia	South Alligator River	Davis and Kirkwood (1984)
178.0	TL	0.09	-1.76	-	Australia	East Alligator River	Davis and Kirkwood (1984)
113.0	TL	0.19	-	-	PNG	Daru	Pauly (1978)

Table-2 shows the results of the previous studies on the growth estimation of *L. calcarifer* studied in the other locations of different countries. Concerning the growth parameters, L∞ and K value are 116.9cm and 0.15 respectively. The L∞ value in the present value differs from the values obtained by other studies. But all the reported studies were experimented outside India. Differences noted in L∞ may be attributed to variation in habitat, temperature, and possibly, differences in feeding habits [25].

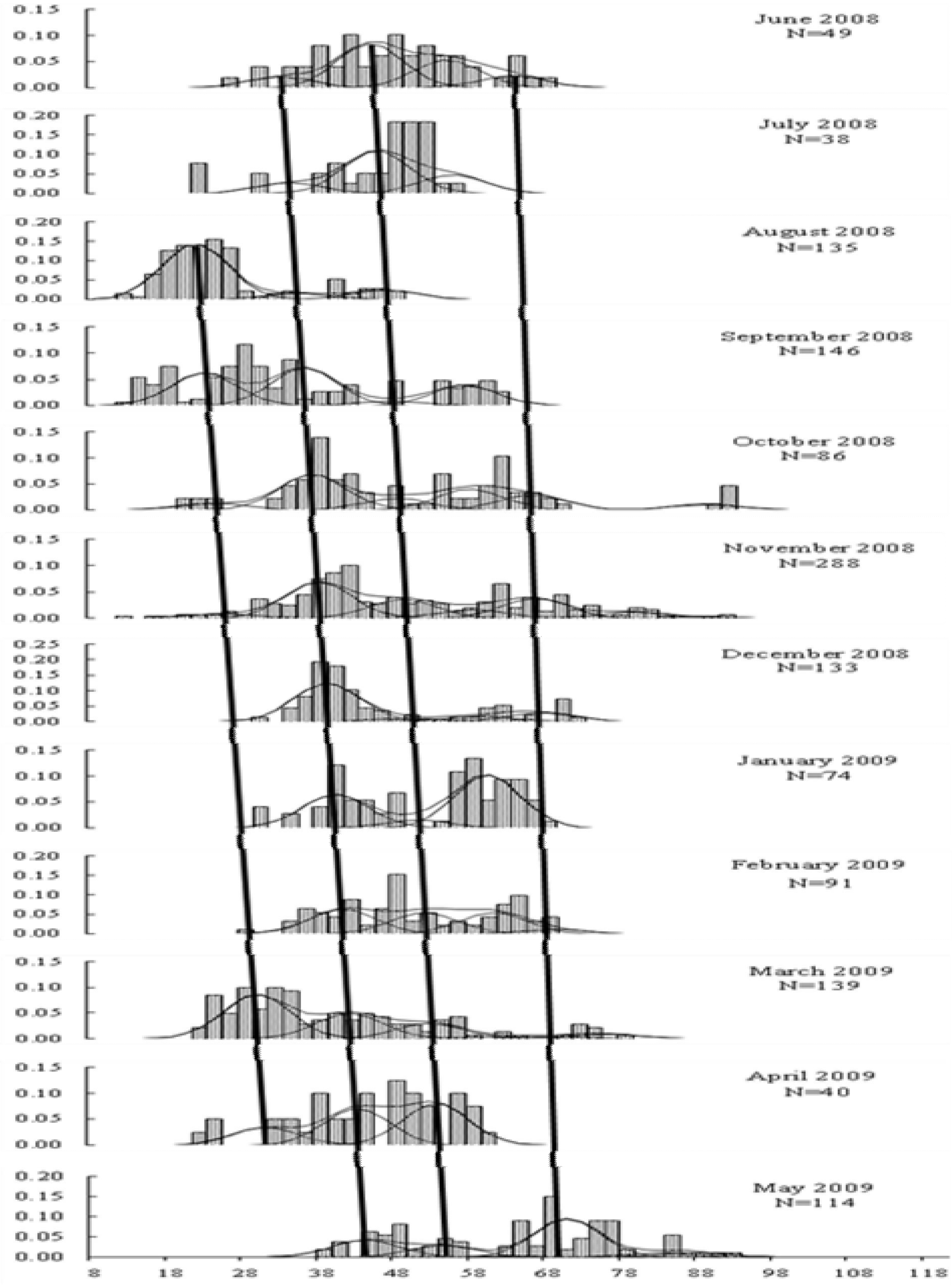

Fig. 2: Monthly frequency distributions of fork length of *L. calcarifer* and the estimated composition of cohorts and growth curves; N = total number of fish measured each month

This may also be occurred due to the overexploitation of natural stocks by over fishing and the deteriorated environmental conditions.

The K-value (0.15 yr^{-1}) estimated by this study is similar to averages of the other studies, but differs greatly from the value reported from West Alligator river of Australia (table-3). The value of t0 is varying greatly from other studies.

Variations in fish growth in terms of length and weight can be explained as an adaptive response to different ecological conditions [26,27]. This variation may be due to different stages in ontogenetic development, as well as differences in condition, length, age, sex and gonadal development [17]. Geographic location and some environmental conditions such as temperature, organic matter, quality of food, time of capture, stomach fullness, disease, parasitic loads [18], temperature, organic matter, quality of food and the water system in which the fish live [27,20,21] can also affect weight at- age estimates.

This paper provides the information on the length-weight relationship and growth of *L. calcarifer* in Chilika Lagoon. This information is required by most of models of stock assessment to estimate fishing mortality, population of cohorts and other biology of stocks.

ACKNOWLEDGMENT

We are very much thankful to Japan International Cooperation Agency (JICA) and Chilika Development Authority (CDA) for financial assistance and hearty thanks to Chief-executive, CDA and Dr K. S. Bhatta, Scientist of CDA for their co-operation, help, comments and valuable suggestions throughout the study period. Also sincere thanks to Mr. R. Routray, of Wetland Research & Training Centre and Mr. M. Maharana, P. Pradhan, and Binod Lima, CDA staffs at fish landing centers, for helping in measuring fish samples.

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