ISSN: 2347-5129
IJFAS 2014; 2(2): 115-125

www.fisheriesjournal.com
Received: 04-09-2014
Accepted: 03-10-2014

Mathialagan R.
Post Graduate and Research Department of Zoology, Government Arts College (Autonomous) Kumbakonam – 612 001, (Affiliated to the Bharathidasan University, Thiruchirappalli) Tamil Nadu, India.

Sivakumar R.
Post Graduate and Research Department of Zoology, Government Arts College (Autonomous) Kumbakonam – 612 001, (Affiliated to the Bharathidasan University, Thiruchirappalli) Tamil Nadu, India.

Rajasekaran N.
Post Graduate and Research Department of Zoology, Government Arts College (Autonomous) Kumbakonam – 612 001, (Affiliated to the Bharathidasan University, Thiruchirappalli) Tamil Nadu, India.

Chandrasekar S.
Post Graduate and Research Department of Zoology, Government Arts College (Autonomous) Kumbakonam – 612 001, (Affiliated to the Bharathidasan University, Thiruchirappalli) Tamil Nadu, India.

Correspondence:
Sivakumar R.
Post Graduate and Research Department of Zoology, Government Arts College (Autonomous) Kumbakonam – 612 001, (Affiliated to the Bharathidasan University, Thiruchirappalli) Tamil Nadu, India.

Length – frequency distribution and length-weight relationship of reba carp *Cirrhinus reba* (Hamilton, 1822 Cypriniformes: Cyprinidae) from Lower Anicut, Tamil Nadu, India

Mathialagan R., Sivakumar R., Rajasekaran N., Chandrasekar S.

Abstract
Length-frequency distributions and length-weight relationship of *Cirrhinus reba* were collected from Lower Anicut, Tamil Nadu. Samples were obtained during April 2010 - March 2011. Month-wise LWR and slope (b) values were assessed the negative allometric (A^-) growth (b<3). Followed by sex-wise LWR 'b' values for males, females and pooled sexes were found to be A^- growth. Seasonal LWR and values of 'b' could be expressed in A^- growth and the 'r' values was noticed significantly were not greater than 1 (r<1). Correlation co-efficient were noticed highly significant for month, sex and seasonal-wise with a good correlation between length and weight. Fulton's Condition factor (K) was also determined for month, sex and seasons. 'K' values showed some fluctuations for sex and seasons. Finally, ANCOVA was also applied separately for all the sexes were insignificant nature. So far, the length and weight differs of this species depending on their inherited body shape, sex, condition of individuals and reflected by the food.

Keywords: *Cirrhinus reba*, Growth type, Negative Allometric (A^-), Fulton's Condition factor (K), Analysis of Co-variance (ANCOVA).

1. Introduction
Cirrhinus reba (Hamilton, 1822) is locally known as Arainjan Kendai in Tamil (Lower Anicut region) and Reba Carp in English. It is one of the most popular food fishes widely distributed in India, Bangladesh, Pakistan, Nepal, Burma and Thailand [16, 17]. Nevertheless, wild population of this species could be declining due to heavily harvested. However, no qualitative and quantitative data are available. Since, commercial aquaculture productions of this species are most possible [5] one by way of the wild populations could be controlled. At present, *C. reba* can be a potential candidate for artificial culture in ponds and rivers, so it is essential to use study of the length-weight relationship is more essential one. In this context, study of the size structure in the riverine fishes revealed several ecological and life-history traits, such as river health, stock conditions and breeding periods of the fishes [2]. Moreover, the size structure of a fish population at any point of the living environment can be considered a 'snapshot' that reflects the interactions of the dynamic rates of recruitment, growth and mortality. In view of the length-weight relationship for this species and results will be more reliable. Besides, LWR may give an idea about the variations from the expected weight for a particular length of fish or fish populations based on fatness, general wellbeing or gonad development [7]. It also helps to evaluate the condition, reproduction history, life cycle and general health of fish besides useful in local and inter-regional morphological and life historical comparisons among fish populations. However, the LWR plays a vital role in fisheries biology, population dynamics and also important for comparative growth studies in fish population [7]. It helps to estimate the standing stock or biomass thereby establishing the yield by converting one variable into another and it's often done during field studies from different regions of trophic places. LWR in fish population were originally used to provide information on the condition of fish and to determine whether somatic growth was isometric or allometric [23]. Herein, fish are said to exhibit isometric growth when length increases in equal proportions with body weight for constant specific gravity.

In fishery biology, LWR are useful for conversion of growth-in-length equations to growth-in- weight or use in stock assessment models to estimate stocks, standing crop biomass and seasonal variations in fish growth can be tracked by this way [26]. However, the present examined samples to analyze the seasonal LWR and condition factor of this species were designated by making use of data that belong to the determined length and body weight. Like, the seasonal variations of growth in fishes in relation to size attained by the individual fish may vary because of variations in food supply, availability of food and these in turn may reflect variations in climatic parameters and supply of nutrients or degree of competition of the food. Thus, a change in fish size through a certain period of time may indicate a change in average age resulting from those factors [24]. Concerning the condition factor, it is used for fishery biology in order to compare the 'condition', 'fatness' or wellbeing of fish in such environment. Based on the hypothesis that, the heavier fish of a particular length are in a better physiological condition. Furthermore, the Fulton's condition factor (K) which provides some information regarding physiological state of the fishes, based on the assumption that individuals of a given body length are in better condition when their biomass is greater [1]. At present no published information are available on LWR aspect of this important food fish of *C. reba* from the study area and also in India. In this context, Hossain *et al.* (2013) [13] and IUCN (2012) reported that the freshwater fish *C. reba* going to threatened level in Northwestern Bangladesh and India. So far the current study was carried out at Lower Anicut reservoir in part of the fishery biology and growth assessment of the species. Hence, the objective of this study was to estimate the length–weight relationship and their results to carry out an assessment of the different statistical approach.

2. Materials and Methods

2.1 Study area

A branch of Cauvery namely Kollidam (Coleroon) river, Lower Anicut was selected for the present study (Figure 1) which is located 11º 08' 03'' N latitude and 79º 27' 05" E longitude. This study area is located 26 km from Kumbakonam on the way to Chennai. The river flows from west to east forming the northern boundary of this block whereas Cauvery river and Arasalar river flows at the central part of this block flanking at Kumbakonam. At Lower Anicut river areas concerning 500 peoples are involved in fishing activities throughout the year. They are operating the cast net and gill net through catamaran. Thermacole teppam and four wheeler rubber tube (floating device) are also used as a craft for catching of fishes. The fishery occupies a prominent place in the landing centre at Lower Anicut.

2.2 Biometrics sampling

Totally 375 individuals (males 205 and females 170) of *Cirrhinus reba* were collected from Lower Anicut, Tamil Nadu during April 2010 – March 2011. Specimens were kept chilled in an ice box immediately after capture and brought to the laboratory for further examinations. The specimens were mopped on filter paper to remove excess of water from their body surfaces. Total lengths (mm) were measured using a ruler nearest to mm as the distance from snout to tip of the caudal fin and total weight was measure nearest to g of each specimen. Total weight was calculated with the help of electronic balance (DIGI' Arts maximum=1000 g to d=0.5 g). Sex was determined by gross examinations of the stomachs. While, male and female fishes were differentiated and data were recorded after dissecting out the gonad. Afterwards the samples were preserved in 5% formalin and their abdomens were slit open to facilitate the preservation of their visceral organs. Damaged specimens were rejected.

2.3 Length-weight frequency distribution (LFD)

C. reba individuals were prepared on the basis of the total length-weight recorded from different size groups and to compute composition of the length. Length frequency analysis was used in this study through multiple length frequency data sets on the basis of total length of all individuals. LFD were aggregated into 10 mm interval length class by months were analyzed to separate different cohorts and estimate their growth pattern. Using observations of fish length frequency, equations for growth and survival, it is possible to determine values for the standing stock assessment [9]. Length-frequency distribution methods for each sex were conducted by histograms with normal curve. The LFD and descriptive statistics were conducted by SPSS, ver. 16.0.

2.4 Length-weight relationship (LWR)

Length – weight relationship was calculated by the least square method applying the Le Cren (1951) [23] formula $W=aL^b$ or its logarithmic form,

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

Where,

W	=	Weight (in g)
L	=	Length (in mm)
'a' and 'b' are	=	Constants

2.5 Fulton's Condition factor

The Fulton's Condition factor (K) was calculated employing the formula (Fulton, 1904).

$$K = 100\, W / L^b$$

Where,

K	=	Condition factor
W	=	Weight of fish (in g)
L	=	Length of fish (in mm)
b	=	Regression co – efficient

2.6 Statistical analysis

Bi-variate correlation (Pearson Correlation) were analyzed by SPSS, ver. 16.0 at $P<0.05\%$ level of the significant. In addition non-parametric correlation like, Kendall's tau-b and Spearman's rho test was used to support statistically between length and weight. Regression analysis and line parameters, a (intercept) and b (slope) was made with log-transformed measurement are calculated expressed in millimeters and growth plots were performed by scatter diagram being included in regression analyses. Paired sample t-test was used to compare between length and weight for sexes. Analysis of covariance (ANCOVA) (Snedecor and Cochran, 1967) was employed to analyze the significant difference if any, in the length-weight relationships between sexes at $P<0.05\%$ level.

Fig 1: Map showing the geographical location of Kollidam (Coleroon) river, Lower Anicut, Tamil Nadu

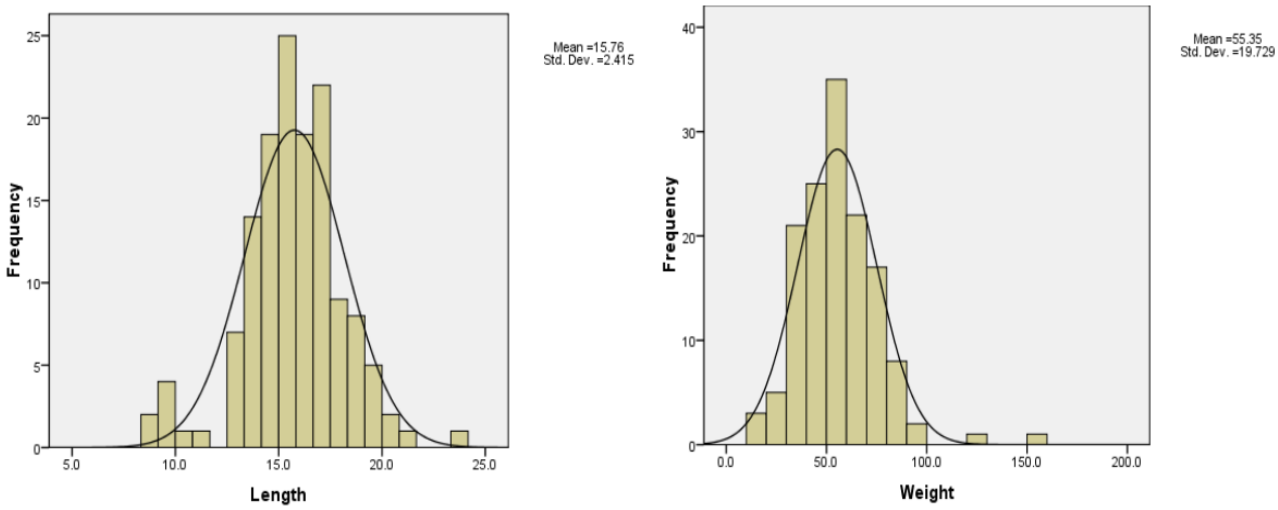

Fig 2a and 2b: Length-weight frequency distribution of male *Cirrhinus reba* during April 2010-March 2011.

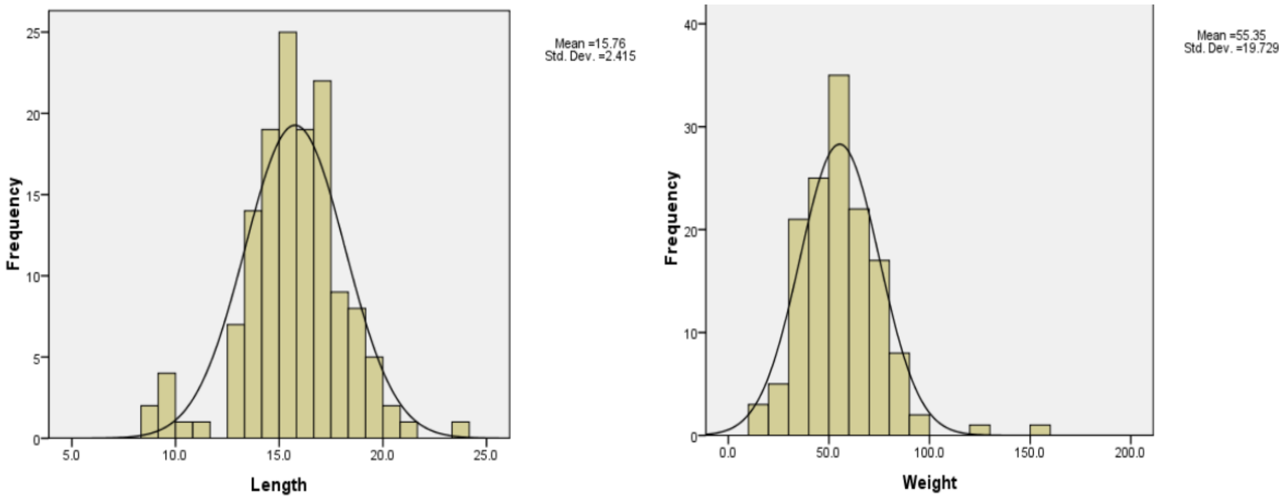

Fig 3a and 3b: Length-weight frequency distribution of female *Cirrhinus reba* during April 2010-March 2011.

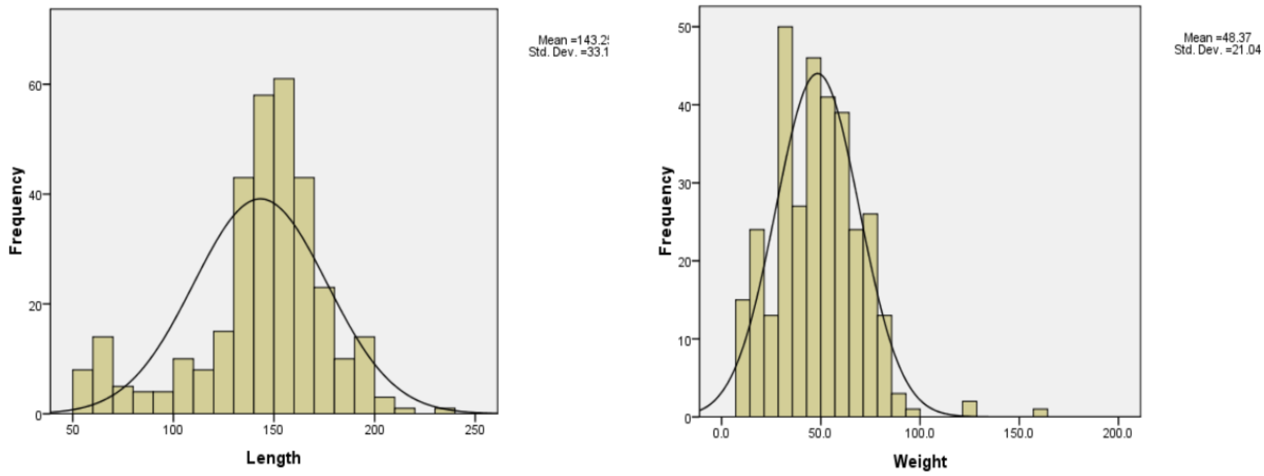

Fig 4a and 4b: Length-weight frequency distribution of pooled sexes *Cirrhinus reba* during April 2010-March 2011.

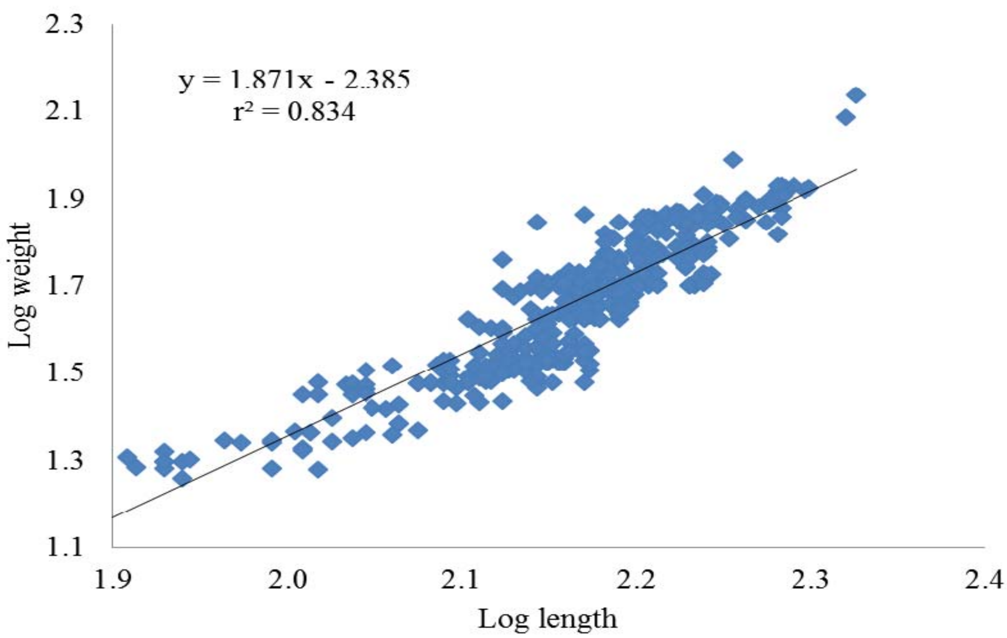

Fig 5a: Logarithmic length-weight relationship of male *Cirrhinus reba*.

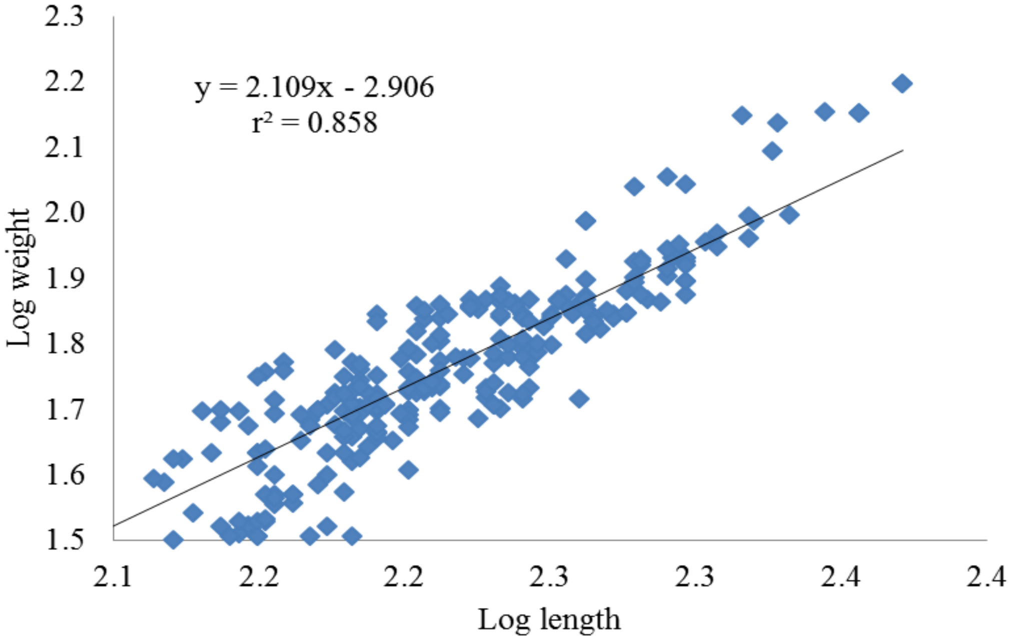

Fig 5b: Logarithmic length-weight relationship of female *Cirrhinus reba*.

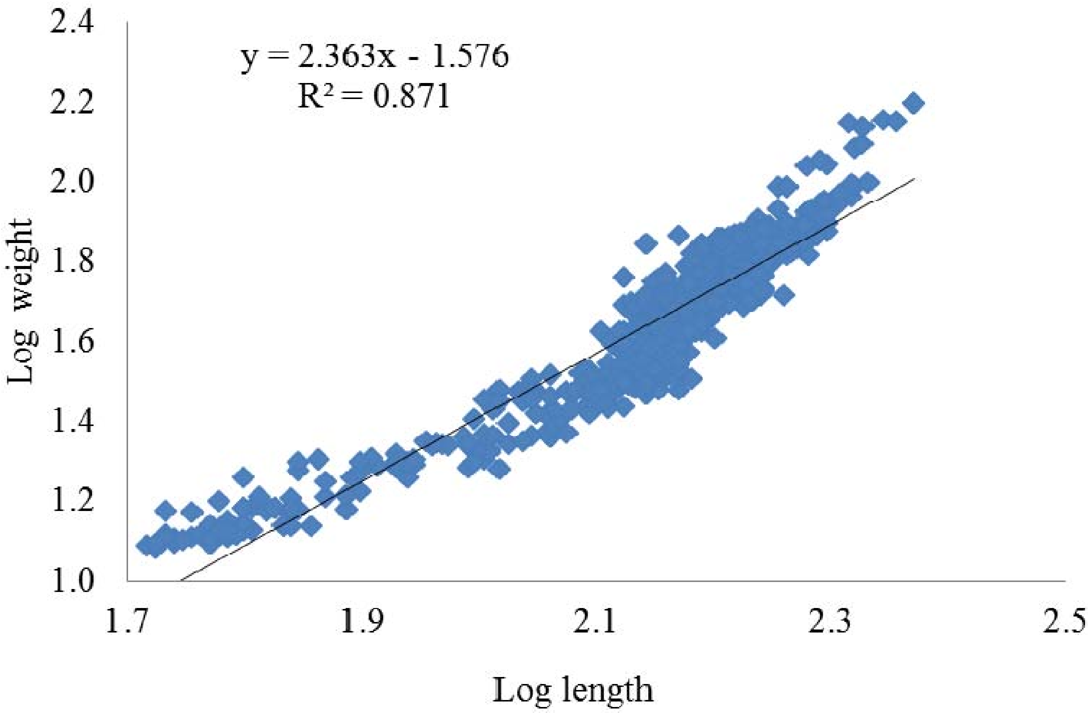

Fig 5c: Logarithmic length-weight relationship of pooled sexes *Cirrhinus reba*.

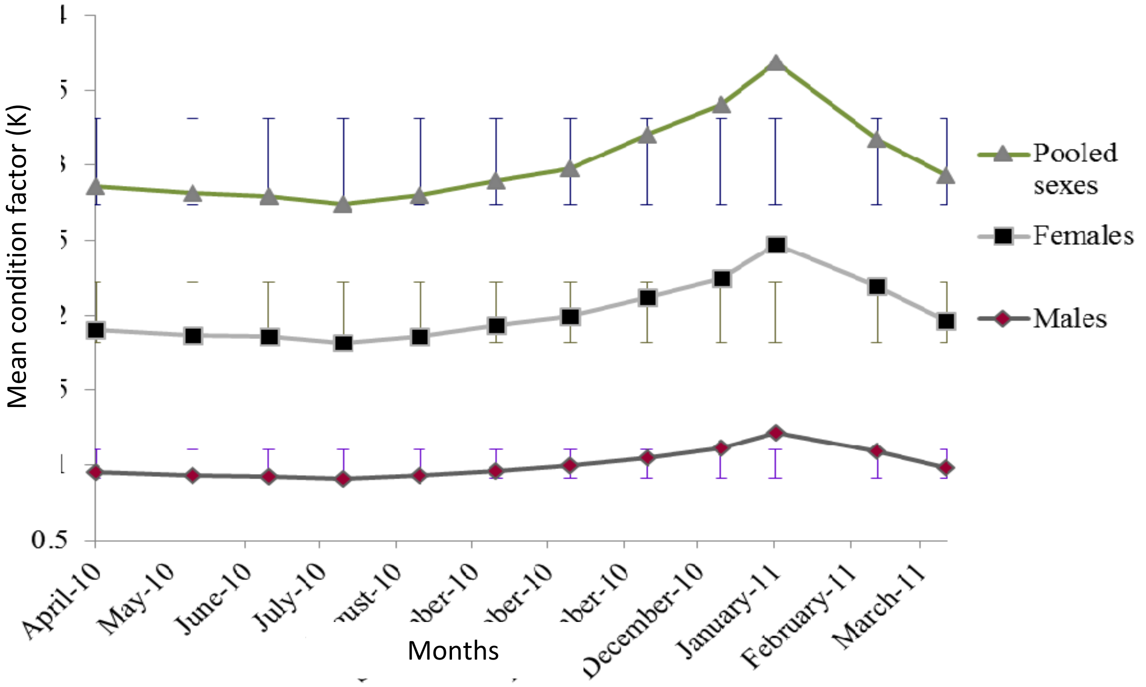

Fig 6a: Monthly mean condition factor (K) of males, females and pooled sexes *Cirrhinus reba*.

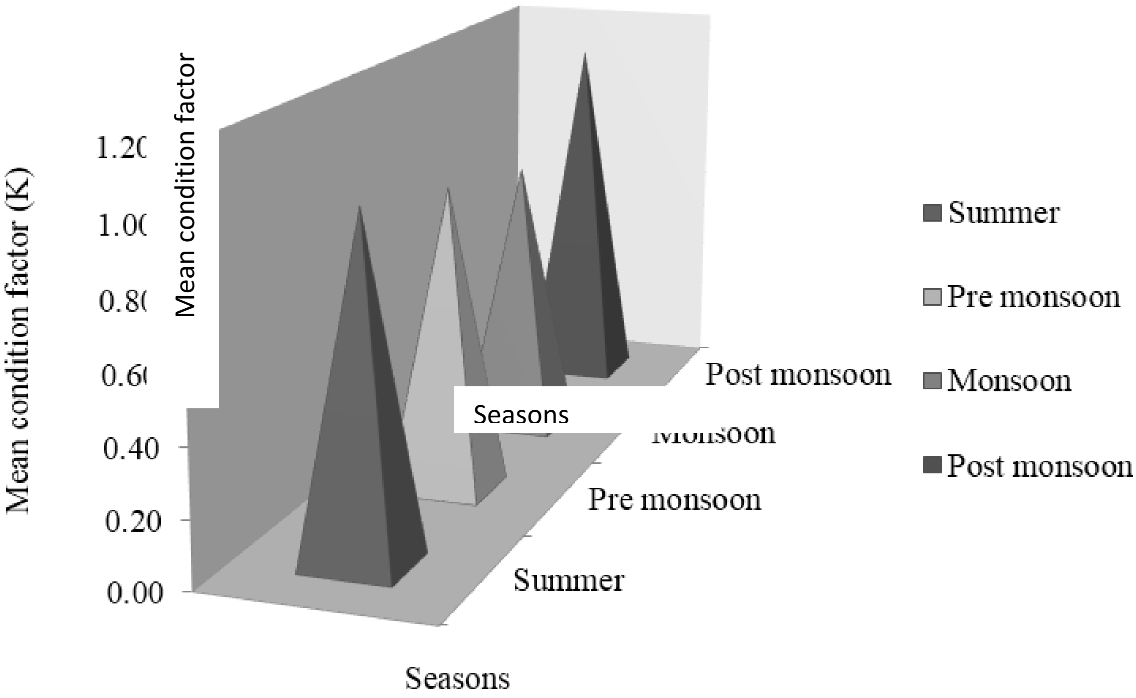

Fig 6b: Seasonal variations of mean condition factor (K) of *Cirrhinus reba* during April 2010-March 2011.

Table 1: Month-wise length-weight relationship and growth type of *Cirrhinus reba* during April 2010-March 2011.

Months	Logarithmic transformation	Intercept 'a'	Slope 'b'	Correlation Co-efficient 'r'	Non-parametric Correlation 'r'		Regression Co-efficient 'r^2'	Growth type
				PC	KC	SC		
April 2010	Log W=-2.378+1.855*Log L	-2.378	1.855	0.879^{**}	0.727^{**}	0.873^{**}	0.693	A^-
May' 10	Log W=-2.432+1.906*Log L	-2.432	1.906	0.890^{**}	0.717^{**}	0.852^{**}	0.806	A^-
June' 10	Log W=-1.724+1.583*Log L	-1.724	1.583	0.935^{**}	0.722^{**}	0.861^{**}	0.855	A^-
July' 10	Log W=-3.086+2.214*Log L	-3.086	2.214	0.922^{**}	0.726^{**}	0.871^{**}	0.848	A^-
August' 10	Log W=-3.678+2.446*Log L	-3.678	2.446	0.946^{**}	0.801^{**}	0.931^{**}	0.864	A^-
September' 10	Log W=-1.322+1.325*Log L	-1.322	1.325	0.934^{**}	0.895^{**}	0.975^{**}	0.932	A^-
October' 10	Log W=-1.078+1.211*Log L	-1.078	1.211	0.956^{**}	0.806^{**}	0.936^{**}	0.898	A^-
November' 10	Log W=-1.262+1.324* Log L	-1.262	1.324	0.749^{**}	0.650^{**}	0.807^{**}	0.587	A^-
December' 10	Log W=-1.499+1.491*Log L	-1.499	1.491	0.871^{**}	0.754^{**}	0.897^{**}	0.677	A^-
January' 2011	Log W=-2.141+1.789* Log L	-2.141	1.789	0.940^{**}	0.843^{**}	0.930^{**}	0.847	A^-
February' 11	Log W=-3.367+2.303*Log L	-3.367	2.303	0.963^{**}	0.844^{**}	0.952^{**}	0.910	A^-
March' 11	Log W=-3.799+2.479*Log L	-3.799	2.479	0.949^{**}	0.833^{**}	0.937^{**}	0.919	A^-

SD - Standard Deviation, SE of mean - Standard Error of mean, PC- Pearson Correlation, KC- Kendall's tau-b Correlation, SC - Spearman's rho Correlation, **Correlation is significant at the P<0.01 level, A^- - Negative allometric.

Table 2: Sex-wise descriptive statistics and length-weight relationship of *Cirrhinus reba* during April 2010-March 2011.

Sexes	Logarithmic transformation	Intercept 'a'	Slope 'b'	Correlation co-efficient 'r'	Np-C 'r'		Regression co-efficient 'r^2'	Growth type
				PC	KC	SC		
Males	Log W=-1.871+2.385*Log L	-1.871	2.385	0.895^{**}	0.768^{**}	0.920^{**}	0.834	A^-
Females	Log W=-2.906+2.109 *Log L	-2.906	2.109	0.887^{**}	0.717^{**}	0.886^{**}	0.858	A^-
Pooled sexes	Log W=-1.276+2.363*Log L	-1.576	2.363	0.895^{**}	0.801^{**}	0.938^{**}	0.871	A^-

SD - Standard Deviation, SE of mean - Standard Error of mean, PC- Pearson Correlation, Np-C- Non-parametric Correlation, KC- Kendall's tau-b Correlation, SC - Spearman's rho Correlation, **Correlation is significant at the P<0.01 level, A^- - Negative allometric.

Table 3: Seasons-wise descriptive statistics and length-weight relationship of *Cirrhinus reba* during April 2010-March 2011.

Seasons	Logarithmic transformation	Intercept 'a'	Slope 'b'	Correlation co-efficient, 'r'	Np-C 'r'		Regression co-efficient, 'r^2'	Growth type
				PC	KC	SC		
Summer-2010	Log W=-1.912+1.659 *Log L	-1.912	1.659	0.872^{**}	0.641^{**}	0.807^{**}	0.660	A^-
Pre-monsoon-2010	Log W=-0.605+1.045 *Log L	-0.605	1.045	0.838^{**}	0.850^{**}	0.959^{**}	0.561	A^-
Monsoon-2010	Log W=-1.300+1.637*Log L	-1.300	1.637	0.968^{**}	0.873^{**}	0.968^{**}	0.642	A^-
Post-monsoon-2011	Log W=-2.645+1.998* Log L	-2.645	1.998	0.833^{**}	0.636^{**}	0.812^{**}	0.678	A^-

SD - Standard Deviation, SE of mean - Standard Error of mean, PC- Pearson Correlation, Np-C- Non-parametric Correlation, KC- Kendall's tau-b Correlation, SC - Spearman's rho Correlation, **Correlation is significant at the P<0.01 level, A^- - Negative allometric.

Table 4: Analysis of Covariance for testing differences in regression equation of length–weight relationship of *Cirrhinus reba* during April 2010-March 2011.

Sources of Variation	DF	Sum of Squares	Mean Squares	Observed 'F'	5% 'F'
Deviation from individual regression	375	26879.99	69.637	0.78*	2.99
Differences between regression	2	109.61	54.805		
Deviation from average individual	373	26989.6			

D.F = Degrees of Freedom, *Insignificant at P>0.05 level.

3. Results

Length-weight frequency distribution (LFD) showed that male, female and pooled sexes of *C. reba* to illustrate histogram with normal curve (Figure 2a-4b). However, the LWR parameters were included logarithmic transformation of LWR, a-intercept, b-slope, correlation co-efficient 'r' (Pearson Correlation), non-parametric correlation co-efficient (Kendall's tau-b and Spearman's rho), regression co-efficient 'r^2' and growth pattern. When the empirical values of lengths were plotted against their respective weight on an arithmetic scale with smooth curves were obtained by LWR regression analysis. The exponent 'b' values for all the months ranged from 1.211 to 2.479. However, these values were not greater than 3 (b<3) among months. Besides, the present study value of 'b' for all months indicated negative allometric growth (A^-), indicating that the increase in length is not proportionate to increase in weight. The slope (b) values indicated that negative allometric growth (b<3) as the length becomes an irrelevant variable in relation to the weight. Correlation co-efficient 'r' ranging from 0.749^{**} to 0.963^{**} in different months were found to be highly significant (P<0.01) whereas the regression co-efficient 'r^2' revealed in high for all the months from 0.587 to 0.932 are indicating good linear regression were closed to 1 (r<1) and suggesting a good adjustment between length and weight among months (Table 1). Estimates of the length-weight equations were calculated separately based on sexes. The exponent 'b' (slope) values for all sexes ranged from 2.363 to 2.385 respectively in Table 2. The 'b' values were lesser than 3 (b<3) because growth is generally exhibited as negative allometric (A^-) for all the sexes as shown by the exponents (b) values. The scatter diagrams of length and weight relationship for all the sexes are shown in Figures 5a-5c. Correlation co-efficient 'r' for all sexes ranging from 0.887^{**} to 0.895^{**} which is highly significant at P<0.01 level. The 'r^2' values in total length-weight for all sexes were estimated from 0.858 to 0.871 at significant (r<1) nature. Analysis of covariance ANCOVA was employed to determine the significance differences in the length-weight relationships. The 'r^2' for Y and X are significantly different for all sexes during April 2010-March 2011 and the results are given in Table 4. Furthermore, the ANCOVA showed that the values of slopes (b) for males and females exhibit a significant interaction between length and weight (computed $F_{0.78} < 3.84$, P>0.05). Seasonal variations of the length-weight relationships (LWR) were calculated based on four distinct seasons *viz.* summer, pre-monsoon, monsoon and post-monsoon are there in a year. The equations of total length-weight relationship and their logarithmic transformation by seasonally are given in Table 3. The values of 'b' were ranged from 1.045 to 1.998 obtained from different seasons indicate that the fish growth as the length becomes an irrelevant variable in relation to the weight. Also, the fact that 'b' values were not greater than 3 (b<3) in each season, indicated that the growth in all sexes was strongly of negative allometric growth. The correlation co-efficient were highly significant (P<0.01; Table 3) for all instances indicating a good linear correlation close to 1 and suggesting a good adjustment between length and weight of each season. Month-wise mean condition factors (K) for males, females and pooled sexes of *C. reba* are shown in Figure 6a. Monthly K values of males ranged from 0.905± 0.021 to 1.221±0.583 similarly, the estimated K values for females ranged from 0.915±0.032 to 1.251±0.576 whereas, estimated K value for pooled sexes ranging from 0.921±0.045 to 1.212±0.081. The condition factor values were observed in low during July-2010 whereas, the K values were high during January 2011 for all the sexes respectively. Seasonal variations of mean condition factor were included the four types of seasons are summer, pre-monsoon, monsoon and post-monsoon. The seasonal variations of mean condition factor (K) during April 2010-March 2011. As it was seen here, the condition factors with seasonal fluctuations are showed in Figure 6b. Highest mean (K) condition factor values were recorded in post-monsoon (1.10±0.38) which was gradually decreased in summer (1.00±0.26) pre-monsoon (0.91±0.14) and monsoon (0.83±0.27) during April 2010-March 2011.

4. Discussion

The present study, an efficient sampling protocol was followed to include the widest possible ranges between length and weight, which were generally obtained with large samples. Variations in fish size (length-frequency) indicated that the fish population ranged from immature specimens to fully matured ones. However, the present work was compare to previous research findings on estimation of LWR in different fish species. In this context, this is a first study for *C. reba* on the parameters of LWR in Lower Anicut, Tamil Nadu which could serve as a tool for providing insight into growth strategies of this species. During the study, length-frequency distribution covered 375 specimens *C. reba* were collected with various length ranges were using from larger than 72 mm to smaller than 235 mm TL during the sampling period. However, some authors have reported the maximum size (length-frequency) of this species as 600 mm (Hamilton, 1822) [12]; 220 mm (Bhuiyan, 1964) [3]; 320 mm (Khan, 1986) [19]; 325 mm (Rahman, 1989) [30]; 300 mm (Talwar and Jhingran, 1991) [39]; 293 mm (Hussain, 1999) [15]; 225 mm (Narejo, 2006) [29]; 300 mm (Lashari *et al.,* 2007) [22]; 235 cm (Galib *et al.,* 2009) [8]; 184 mm (Muralidharan *et al.,* 2011) [28]; 234 mm (Hossain, 2013) [13] and the present study, maximum size of 235 mm was reported which is the first record in Lower Anicut, Tamil Nadu. These regional differences in total length perhaps depend on the ecological conditions in the areas of study. Furthermore, the effects of water temperature can be directly related to biological production rates and food availability, as well as to nekton and plankton species composition, both of which influence for fish growth, estimate the population parameters including asymptotic length and growth coefficient of fishes [43].

Like, exponent of the arithmetic form and slope of the regression line in the logarithmic form 'b' is the most important parameter in LWR [6]. For an ideal shape of fish, which maintains dimensional equality, When b = 3, the result in shape of fish grows isometrically as reported by Thomas *et al.* (2003) [40]. Values for 'b' less than 3.0 (b<3) shows that the fish becomes lighter (-ve allometric) or greater than 3.0 (b>3) indicates that the fish become heavier (+ve allometric) for a particular length as it increases in size [44]. Values of 'a' and 'b' (intercept and slope) differ not only in different species but also same within species depending on sex, maturity stage, feeding intensity etc. Like, such differences of 'b' can be described to one or a combination of the factors including difference in number of specimens examined, area/season effects and distinctions in the observed length-weight ranges of the specimens caught and in which duration of sample collection can be added [27]. The reasons for this month and sex-wise variation are said to be due to seasonal fluctuations of the environmental parameters, physiological conditions of the fish at the time of collection, sex, gonad development and nutritive conditions [6]. Herein, the present study was calculated the values of 'b' for length and weight were lower than 3, for all the months during April 2010-March 2011. However, the month-wise LWR study was observed by negative allometric growth (A^-) among months. Considering the 'b', for large specimens have a body shape that becomes more elongated otherwise the small specimens were in better nutritional condition at the time of sampling [6]. At present, the allometric model seems to be most appropriate describing for LWR in fishes and applies to vast majority of relationships between morphological characters and total lengths [18]. Month-wise mean condition factor of *C. reba* in different sexes were represented in this study. Besides, the variations of K showed in different months, it was noticed that the mean K was higher when the species was enter into maturing and maturation phase during January to March, while the spawning period June to July with the mean K showed was lower in nature. Females (1.251±0.576) had relatively higher mean K values than males (1.221±0.583) and pooled sexes (1.212±0.481) are also respectively. In both sexes were observed low mean K was obtained during April gradually decreased and finally attained low during July. However, the present investigation shows this fish attains sexual maturity and breeding season during April-August with peak in July for both sexes. There is no previous information on the condition factor of *C. reba* except Narejo (2006) [29]. Author are studied the relative condition factor of *C. reba* in Manchar Lake, Pakistan, with the condition factor of *C. reba* as 1.02±0.20, 1.03±0.18 and 1.01±0.20 for male, female and pooled sexes respectively, which are in accordance with the present study. Additionally, Le Cren (1951) [23] reported that the environmental factors, food supply and parasitism have great influence on the health of the fish population during spawning. Consequently, the present study were calculated the slope 'b' for all the sexes *C. reba* were ranging from 2.363 to 2.385 indicated that negative allometric (b<3) of *C. reba* which means they tend to become thinner as they grow larger. Besides, the male *C. reba* was found to surpass females for weight in relation to lengths as evidenced from the disparity in 'b'. Similar trend has been observed in Cyprinids species *Schizothorax richardsoni* [10]. In this context, earlier LWR reports are in compliance with the same species of *C. reba* the 'b' value altered from the present study positively allometric (males 3.40, females 3.74 and pooled sexes 3.32) were reported by Narejo (2006) [29] in Manchar Lake, Pakistan. Muralidharan *et al.* (2011) [28] recorded the LWR of b = 3.20 of *C. reba* from Cauvery River, south India. Hossain *et al.* (2013) [13] reported that the LWR 'b' values for male 3.227, female 3.647 pooled sexes from Ganges River, North Western Bangladesh. As a result, the earlier LWR study with negative allometric growth for some freshwater cyprinids were reported by Mansor Mat Isa *et al.* (2010) in *Crossocheilus oblongus* (b=2.885), *Chela sp.* (b=2.665), *Mystacoleucus marginatus* (b=2.704) and *Puntius schwanenfeldii* (b=2.864) in Kerian River Basin from Malaysia, had negative allometric which are in accordance with the present study. In previous studies were conducted in Lower Anicut, Tamil Nadu experienced a negative allometric growth, suggesting the space area and food supplies were insufficient throughout the year (Victor Raj *et al.,* 2014). The LWR in fishes can be affected by several factors including habitat, seasonal effects, degree of stomach fullness, gonad with stage maturity, food and environmental conditions such as temperature, salinity and seasonal variations [43].

Seasonal differences in LWR of *C. reba* showed the natural health and growth pattern based on the selectivity of feeding habits. There was an agreement between seasonal variation of low and high feeding habits which seems to be closely related with maturation of gonads, breeding and spawning period of the seasons. Low feeding activity during peak breeding may be attributed to fully developed gonads, permitting limited space to stomach below the vertebral column for less intake of food. The pronounced low feeding habits was noticed during monsoon and high post-monsoon. Variations of 'b' in LWR of *C. reba* as an indicator to food intake and growth pattern may differ according to such biotic and abiotic factors for water temperature, food availability and habitat type. Hence, the value of 'b' recorded in fall was significantly lower than 3 indicated that negative allometric growth during seasonally. However, adequate feeding and gonad development increases are also fish weight and 'b' values. Similarly, in accordance with the previous study supported to low feeding activity, probably due to an increased spawning activity by these fishes [36]. Seasonal differences in condition factors could be attributed to low feeding intensity and degeneration of ovaries during monsoon and high feeding during post-monsoon and summer for full development of gonads. Comparatively higher values of mean K during post-monsoon (after spawning) could be attributed to high deposition of fats as preparation for forthcoming breeding season. However, this study provides the information on LWR of *Cirrhinus reba* from Lower Anicut, Tamil Nadu. Besides, the length and weight are two indices that very important for fishery biology. There are so many information can be produced by collecting data on length and weight. It can be also used to estimating the age and growth rate of fish. The relationship between length and weight differs among species depending on their inherited body shape, sex, condition of individuals, reflected by the food availability and growth. So far, the condition of the species in Lower Anicut, was in a good condition since the variation in sizes and growth was higher.

5. Conclusion

In conclusion point of view, this is the first comprehensive study on the length-weight relationship of *Cirrhinus reba* from Kollidam River, Lower Anicut. The present research findings can provide the length and weight comparisons of the different sexes with indicating negative allometric growth. Sex-wise condition factor were good in throughout the study period. From the other studies such as habitats, availability of foods and other sources to facilitate the sustainable management of *C. reba* along with additional studies of other life-history, stock assessment and environmental parameters that deserve to be explored in future research.

6. Acknowledgement
I would like to thank Dr. S.Ajmalkhan, Emeritus Professor, CAS in Marine Biology Annamalai University, Parangipettai, Tamil Nadu for statistically standardizing the study of length-weight relationship with useful comments for the present research. I am very grateful to Dr. V.Ramaiyan, Former Director of CAS in Marine Biology, Annamalai University, for helping to improve this paper with his extensive suggestions. During this work, one of the author Dr. R.Mathialagan express his thanks to UGC – RGNF New Delhi – 110 058, for providing the financial assistance to the present research.

7. References

1. Anene A. Condition factor of four Cichlid species of a man-made lake in Imo State, Southeastern Nigeria. Turkish Journal of Fisheries and Aquatic Sciences 2005; 5:43-47.
2. Beyer JW. On the length-weight relationships. Part I: class. Fish Byte 1987; 5:11-13.
3. Bhuiyan AL. Fishes of Dacca, Asiatic Soc. Pak Dacca Publ 1964; 13:72-73.
4. Bhuiyan AS. Effect of living space on the growth of *Cirrhinus reba* (Hamilton-1822). Univ J Zool Rajshahi Univ 1989; 8:71-75.
5. Dewan S, Miah MJU, Mazumdar K *et al.* Types and amount of food taken by *Cirrhinus reba* (Hamilton) and its diel patterns of feeding. Bangladesh J Aquacul 1985; 6-7:39-44.
6. Froese R, Cube law. Condition factor and weight – Length relationships: history, meta- analysis and recommendations. Journal of Applied Ichthyology 2006; 22:241-253.
7. Fulton TW. The Rate of Growth of Fishes. Twenty-second Annual Report, Part III. Fisheries Board of Scotland, Edinburgh, 1904.
8. Galib SM, Samad MA, Mohsin ABM, Flowra FA, Alam MT *et al.* Present Status of Fishes in the Chalan Beel the Largest Beel (Wetland) of Bangladesh. Int J Ani Fish Sci 2009; 2(3):214-218.
9. Gallucci VF, Amjoun B, Hedgepeth JB, Lai H. Size-based Methods of Stock Assessment of Small-scale Fisheries. In: Stock Assessment: Quantitative Methods and Applications for Small-scale Fisheries. Ed by Gallucci, 1996.
10. Geol C, Bharat A, Pande V, Ali S, Rohit K. Length-weight relationship of snow trout (*Schizothorax richardsonii*) based on linear & nonlinear models from hill stream of Uttarakhand, India, 2011.
11. Gupta S. Some observations on the biology of *Cirrhinus reba* (Cuvier). J Fish Biol 1975; 7:71-76.
12. Hamilton F. An account of the fishes found in the river Ganges and its branches, Edinburgh & London, Fishes Ganges 1822; 8:1-405.
13. Hossain MY, Khatun MSTM, Jasmine S, Rahman MDM, Jahan MDS, Jewel AS *et al.* Life-history traits of the threatened freshwater fish *Cirrhinus reba* (Hamilton, 1822) (Cypriniformes: Cyprinidae) in the Ganges River. Northwestern Bangladesh Sains Malaysiana 2013; 42(9):1219-1229.
14. Hossain QZ. Induced breeding of the fish *Cirrhinus reba* by pituitary gland extract and survival of spawn in nursery ponds. J Asiat Soc Bangladesh (Sci.) 2001; 27:205-213.
15. Hussain MM. Fishes and fisheries of the river atrai in rajshahi with reference to its limnology, unpublished Ph.D. thesis, Department of Zoology, University of Rajshahi, Bangladesh, 1999.
16. Jayaram KC. The freshwater fishes of India, Pakistan, Bangladesh, Burma and Sri Lanka. Zool Surv India Calcutta 1981, 475.
17. Kapoor D, Ponniah AG, Dayal R. Fish Biodiversity of India, NBFGR Publication Lucknow, 2002, 234.
18. Karachle PK, Stergiou KI. Mouth Allometry and Feeding Habits in Fishes. Acta Ichthyologica et Piscatoria 2011; 41(4):265-275.
19. Khan IA. Fecundity of *Cirrhinus reba* (Hamilton-Buchanan) from Baigul reservoir in Uttar Pradesh. Indian J Anim Sci 1986; 56:711-716.
20. Lashari PK, Narejo NT, Mastoi AM, Mahar MA. Some morphometric characters and their relationship in carp, *Cirrhinus reba* (Hamilton-1822), from fishpond, District Jacobabad, Sindh. Proc Pakistan Congr Zool 2004; 24:179-184.
21. Lashari PK, Narejo NT, Laghari MY. Feeding Behavior of a Carp, *Cirrhinus reba* (Hamilton-1822) from Fishponds of District Jacobabad, Sindh, Pakistan. Pakistan J Zool 2010; 42(3):345-348.
22. Lashari PK, Narejo NT, Laghari MY, Mastoi AM, *et al.* Studies on the Gonado somatic Index and Fecundity of a Carp *Cirrhinus reba* (Hamilton-1822) from Fishponds of District Jacobabad, Sindh, Pakistan. Pakistan J Zool 2007; 39(2):95-98.
23. Le-Cren ED, The length - weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). J Anim Ecol 1951; 20:201-219.
24. Luff RM, Bailey GN, Analysis of size changes and incremental growth structures in African catfish *Synodontis schall* (Schall) from Tell el-Amarna, Middle Eygpt. Journal Archeological Sciences 2000; 27:821-835.
25. Isa MM, Rawi CSM, Rosla R, Anuar S, Shah M, Shah ASRM *et al.* Length – weight Relationships of Freshwater Fish Species in Kerian River Basin and Pedu Lake, Research Journal of Fisheries and Hydrobiology 2010; 5(1):1-8.
26. Morey G, Moranta J, Massut E, Grau A, Linde M, Riera F, *et al.* Weight-length relationships of littoral to lower slope fishes from the western Mediterranean. Fish Res 2003; 62:89-96.
27. Moutopoulos DK, Stergiou KI. Length-weight and length-length relationships of fish species from the Aegean Sea (Greece). J Appl Ichthyol 2002, 18:200-203.
28. Muralidharan M, Arunachalam M, Raja M. Length–weight relationships for fish species from Cauvery River at Hogenakal in South India. Journal of Applied Ichthyology 2011; 27(3):968-969.
29. Narejo NT. Length-Weight Relationship and Relative Condition Factor of a Carp, *Cirrhinus reba* (Hamilton) from Manchar Lake, Distt. Dadu, Sindh, Pakistan. Pakistan J Zool 2006; 38(1):11-14.
30. Rahman AKA. Freshwater fishes of Bangladesh, 1st edition, Zoological Society of Bangladesh, Department of Zoology, University of Dhaka, Dhaka-1000, 1989, 123-

124.
31. Rahman MA, Zaher M, Azimuddin KM. Development of Fingerling Production Techniques in Nursery Ponds for the Critically Endangered Reba Carp, *Cirrhinus reba* (Hamilton-1822). Turkish Journal of Fisheries and Aquatic Sciences 2009; 9:165-172.
32. Ranjan JB, Herwig W, Subodh S, Michael S. Study of the length frequency distribution of sucker head, *Garra gotyla gotyla* (Gray, 1830) in different rivers and seasons in Nepal and its applications. Kathmandu University Journal of Science, Engineering and Technology 2005; 1(1):1-14.
33. Rao NGS, Ray PO, Gopinathan P *et al.* Observations on the spawning *Cirrhinus reba,* (Hamilton) in the Cuavery and Bhavani Rivers. J Inland Fish Soc India 1972; 4:69-73.
34. Rothod N, Kshircaga R. Seasonal variation of trace elements in *Cirrhinus reba* (Hamilton-Buchanan). Bioscience Discovery 2011; 2(1):57-59.
35. Sarkar UK, Negi RS, Deepak PK, Singh SP, Srivastava SM, Dipak Roy *et al.* Captive breeding of vulnerable Indian carp *Cirrhinus reba* with Ovaprim for conservation of wild populations. 2004; 9(4):5-7.
36. Shamsan EF, Ansari ZA. Ecobiology and Fisheries of an Economically Important Estuarine Fish, S*illago sihama* (Forsskal). Thesis submitted for the degree of doctor of philosophy In Marine Science, Goa University, 2008.
37. Sivashanthini K. Reproductive Biology of the Whipfin Silver biddy *Gerres filamentosus* Cuvier, 1829 from the Parangipettai Waters (SE coast of India). Asian Fisheries Science 2008; 21:127-145.
38. Snedecor GW, Cochran WG. In: Statistical methods. The Lowa State University Press, Lowa, 1967, 593.
39. Talwar PK, Jhingran AG. Inland fishes of India and adjacent countries. Oxford-IBH Publishing Co. Pvt. Ltd., New Delhi. Vol.1. A.A. Balkema, Rotterdam. 1991, 541.
40. Thomas J, Venu S, Kurup BM, *et al.* Length-weight relationship of some deep sea fish inhabiting the continental slope beyond 250m depth along the west coast of India. NAGA, ICLARM Quarterly 2003; 26(2):17-21.
41. Verghese PU. Internal rhythm of sexual cycle in a carp *Cirrhinus reba* (Hamilton, 1822) under artificial conditions of darkness. J Inland Fish Soc India 1975; 7:182-188.
42. Raj MV, Sivakumar R, Mathialagan R. Food and feeding habit and length-weight relationship of the Asian striped catfish *Mystus vittatus* (Bloch, 1794) (Siluriformes: Bagridae) in Lower Anicut, Tamil Nadu. Indian Journal of Science 2014; 8(20):55-64.
43. Weatherley AH, Gill HS. The Biology of Fish Growth. London: Academic Press, 1987.
44. Zafar M, Mussaddeq Y, Akhter S, Sultan A. Weight – length and condition factor relationship of Thaila, *Catla Catla* from Rawal Dam, Islamabad, Pakistan. Pakistan Journal of Biological Sciences 2003; 6(17):1532-1534.