LENGTH – WEIGHT RELATIONSHIP

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3. LENGTH – WEIGHT RELATIONSHIP

3.1. INTRODUCTION:

Commercial aquarists culture freshwater ornamental fishes in concrete tanks as it is not possible to culture them in the open water system owing to many constraints and one such is harvesting problem. Growth of such fish in captive condition can be studied with the knowledge of Length-weight relationship which has various practical applications in fishery biology. The most common among a variety of body measurements in fishes are total length and wet weight measurements. Aquaculturists and industry practitioners whose profits depend on biomass(harvested from culture ponds or offshore waters) which is commonly recorded as body weight, whereas taxonomists, ecologists and others from the research sector prefer length measurements which are more easily measured in the field and are not subject to wide variations.

The mathematical relationship between length and weight is a practical index of growth, maturity, gonadal development and general well being of the fish (Le Cren, 1951). Relationships that allow interconversions among the various length and weight parameters are needed, e.g., to compare growth parameters (Dall *et al.,* 1990), especially for commercially important species. Further, the relationship studies give important information on fishery assessment for predicting weight from length recorded in field assessment (Garcia *et al.,* 1998).

Even though many studies on length-weight relationship have been conducted by various Indian workers on different species like *Notopterus notopterus* (Kalita and Rath, 1998), *Aplocheilus lineatum* (Madasamy, 2001), *Catla catla* (Jhajria, 2003), *Cyprinus carpio* (Saran and Mohan, 2004), *Clarias gariepinus* (Nath, *et al.,* 2006), *Channa punctatus* (Haniffa *et al.,* 2006) and *Cirrhinus mrigala* (Mohan and Singh, 2003) very little information is available for the ornamental freshwater fishes and hence the present study has been conducted on the experimental fish, *Puntius conchonius*. However, a report on the relationship of fish length-brain length and fish weight-brain weight in *Puntius conchonius* is available (Pankaj *et al.,* 2005) and this study is restricted with a small number (31) of samples. In the present study, only the length-weight relationship of *Puntius conchonius* with more number of samples is highlighted.

The mathematical relationship between length and weight of fish furnishes further information on the weight variation of individuals in relation to their length (condition factor, k). This factor estimates the general well-being of the individual and is frequently used in three cases:

1. Comparison of two or more cospecific populations living in similar or different conditions of food, density or climate, among others;
2. Determinations of the period and duration of gonadal maturation; and
3. Observation of increase or decrease in feeding activity or population
changes possibly due to modifications in food resources
(Weatherly and Gill, 1987).

The weight of a normal fish has a linear relationship with body length and generally the length weight relationship could be expressed by a hypothetical cube, $W=CL^3$, where, 'W' is the weight, 'C' is a constant and 'L' Length. This formula holds good to an ideal fish which maintains the same shape as it grows. However, it is not always true (Allen, 1938). Most of the fishes change their shape and form as they grow and so the exponent value may be altered (Martin, 1949). Consequently, the hypothetical formula can be modified as $W=aL^n$; where 'W' and 'L' are weight and length respectively; and 'a' is a constant equivalent to 'C' and 'n' is another constant to be calculated empirically i.e., from the data. However, it has been observed that there is no significant variation from the isometric growth (n=3) (Beverton and Holt, 1957). The value of 'n' is normally between 2.5 and 4.0 (Hile,1936 and Martin, 1949) and for an ideal fish it is 3.

In general, a growth model in fish follows the "cube law" and hence, the use of Fulton's condition factor (CF) or the isometric factor (K=W/L6) attributes to the weight length exponent 'b', a value equal to 3 (Gulland, 1983). In this case the body form maintains a constant proportion to length (Weatherley and Gill, 1987). However, Braga (1986) states that Fulton's condition factor is adequate for the comparison of fish of the same size, while the allometric condition factor, which occurs when b=3, is valid for the study of any range of length at the same stage of development. According to Vazzoler (1996) it is inadvisable to use Fulton's condition factor and the determination of the value of 'b' is necessary in the use of the allometric condition factor so that result may be reliable.

3.2. MATERIALS AND METHODS:

A total of three hundred specimens was selected for this study out of seven hundred specimens reared throughout the study period.

The total length or the length of the fish from the tip of the lower jaw after closing the mouth to the tip of the longest caudal fin ray was measured accurately to the nearest millimeter after keeping the fish against a standard graph sheet kept under a glass slide. Specimens with mutilated caudal fins were rejected as suggested by Seshappa and Bhimachar (1951). The measurements were made in fresh condition, as and when the fishes were collected. Besides the length, the individual weight was also recorded. An electronic balance was used for this purpose to obtain an accuracy of 10mg. For tracing the regression line, first a scatter diagram was drawn with the data which was obtained to be linear, then the method of least squares ($y = a + b X$) was applied in which Y is dependent variable (weight) and X is the independent variable (Length), a = intercept and b= slope or the regression Co-efficient. The co-efficient of correlation (r) and coefficient of determination (r^2) were also calculated.

The statistical relationship between the length and weight of fishes were derived by using the formula-

$$W=aL^n$$

Where,

W = Weight of fish in grams

a = constant

L = Length of fish in cm

b = regression coefficient

For practical purpose, this relationship is usually expressed in its logarithmic form (Le Cren, 1951). The parabolic equation $W=aL^n$ is expressed in logarithmic form as follows:

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

$$\text{i.e., } Y = a + bX$$

Where,

a = Log a

b = **n**

Y = Log W; **and** **X=** Log L

Condition factor was calculated using the formula –

$$CF = \frac{W}{L^3} \times 100$$

Where,

W = body weight (g)

L = total length (cm)

CF = condition factor

Relative condition was estimated by the formula-

$$Kn = \frac{W_0}{\hat{W}}$$

Where,

W_0 = observed weight

$\hat{W}$ = calculated weight

Kn = relative condition

Regression analysis and Pearson's correlation coefficient were carried out using the software Microsoft-sigma excel program.

3.3. Results and Discussion:

The general formula depicting the relationship between Length and weight of 298 specimens of *Puntius conchonius* for males, females and combined (including immature) was worked out separately and found as follows:

Males Log W = -2.0254 + 3.1762 Log L

Females Log W = -2.0291 + 3.220 Log L

Combined Log W = -2.0399 + 3.223 Log L

The arithmetic transformations of the above mentioned values are as follows:

Males $W = 0.0094\ L^{3.1762}$ (r=0.957)

Females $W = 0.0935\ L^{3.220}$ (r=0.957)

Combined $W = 0.00912\ L^{3.223}$ (r=0.951)

The females have significantly higher b value than males, meaning a greater change in weight corresponding to a unit change in length. The co-efficient of correlations between length and weight of male and female *Puntius conchonius* were found to be 0.947 and 0.934 respectively and which were highly significant. The 'b' value is slightly higher in male than female, indicates variation in the rate of increments in length and weight between the two sexes.

Mean Length values of the studied males and females *Puntius conchonius* were 4.72 and 4.45cm, respectively. Mean weight values were 1.5 and 1.37g respectively for males and females. The observed weight shows increasing trend with the increase in body length in both male and female fish group (Fig. II-1 to II-6.). The parabolic appearance of the scattered diagram between length and weight confirmed the applicability of cube law on the species as observed by Hanumanth Rao (1974), and Nath *et al.,* (2006). The logarithmic values of observed length and weight were plotted and regression line fitted to the data, which showed a straight-line relationship (Fig. II-1 to II-6). Since the weight of a fish varies with the cube of its length, provided the shape and specific gravity remains the same, any change in the shape of relative plumpness will cause a change in the value of 'a' in the general equation. Fishery biologists have used this fact to describe the condition of general well being of a fish. Fishes do change shape as they grow (Martin, 1949), so in most fishes this relationship can be expressed by the general equation $W=aL^b$ (Hile, 1936).

Hile (1936), Martin (1949) and Le Cren (1951) pointed out that the value of the constant 'b' varies from 2.5 to 4 and for an ideal fish it is 3. The values of regression coefficient (b) in male (3.1762), female (3.220) and combined (3.223) groups of *Puntius conchonius* reflect that the length-weight relationship does not exactly follow the cube law, which may be due to the changes of the specific gravity of the fish (Rounsefel and Everhart, 1953). There are also reports of significant deviation of Length-weight relationship either lower or higher from the cube law in other fish species studied (Sultan, 1981; Gowda *et al.,* 1987; Pandey, 1995 and 1998; Sivakami, 1987, Kulshreshta *et al.,*1993 and Madasamy, 2001).Agarwal and Saxsena (1979) recorded the value of 'b' as 2.18 for *Catla.* Basheer *et al.*, (1993) observed 'b'value for C. *punctatus* to be 2.9419. Pandey (1995) recorded the 'b' value for *Catla* to be 2.9665 from the river Padma. Amin *et al.*, (2001) reported 2.878 as the 'b' value of *Tenualosailisha* from the coastal region of Chittagong while Mohan and Jhajhria (2001) reported the value of 'b' as 2.967.

The values of condition factor (CF) were observed to range from 0.730 to 2.016, 0.536 to 2.815 and 0.536 to 2.9155 in male, female and combined groups of *Puntius conchonius* respectively. The average values of relative condition (Kn) in male and female fish groups were 0.9917 and 1.0397 respectively. This seems to be close to 1, which is the optimum value. The rise in 'Kn' value is attributed to full development of the gonad and the fall to the stomachfull (Venkataramani *et al.*, 2005). However, Sengupta *et al.*, (2006) have reported the mean 'CF' value as 3.291 and 6.074 in Gangetic fishes, *Eutropichthys vacha* and *Bagarius bagarius*, respectively and attributed this to their robust health. According to Le Cren (1951), the condition factor is affected by length as well as several other factors like environment, food supply, degree of parasitism, and above all, the sexual cycle. The high/optimum values of CF and Kn in different length groups indicated a general well being and adaptability of the fish *Puntius conchonius* in tank culture system in Indian climate condition.

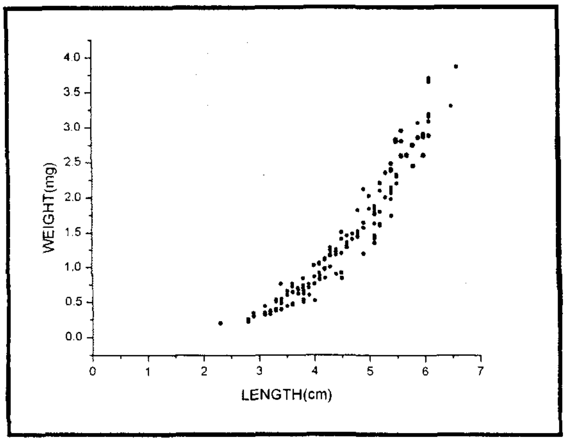

Fig. II-1. Relationship between length and weight of female fish.

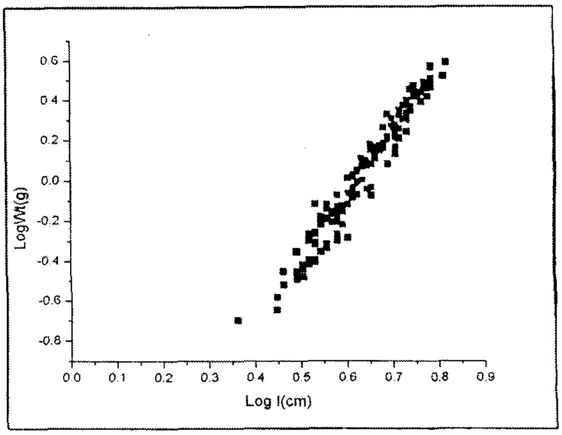

Fig. II-2. Relationship between log length and log weight of female fish.

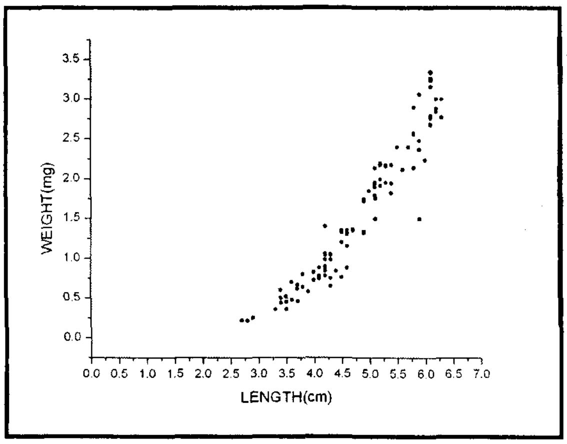

Fig. II-3. Relationship between length and weight of male fish.

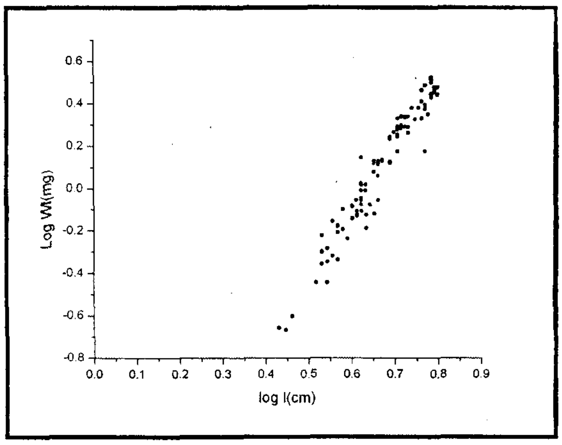

Fig. II-4. Relationship between log length and log weight of male fish.

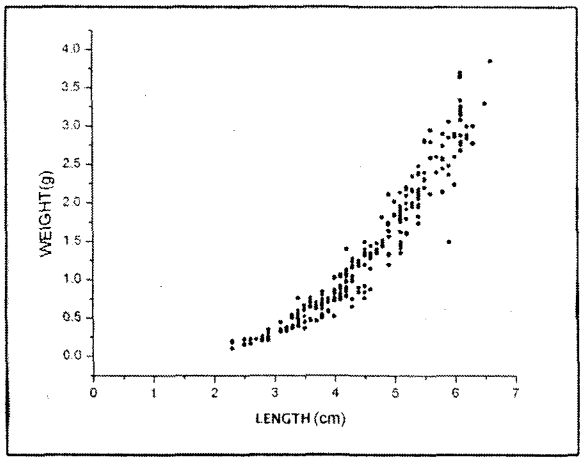

Fig. II-5. Combined relationship between length and weight of fish.

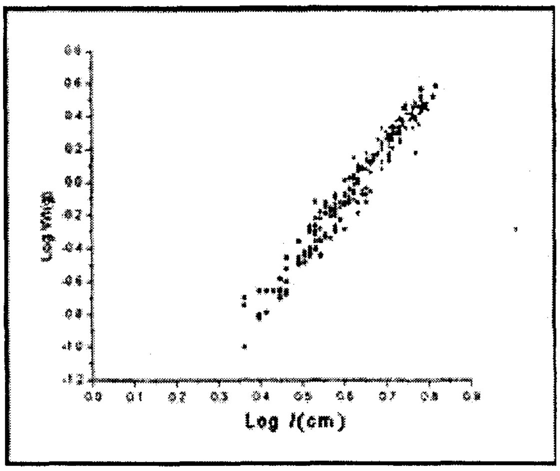

Fig. II-6. . Combined relationship between log length and log weight of fish.