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FULL PAPER TAM MAKALE

LENGTH-WEIGHT RELATIONSHIP OF SPINY EEL *Macrognathus pancalus* (Hamilton-Buchanan) FROM UPPER ASSAM, INDIA

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Abstract:

Length-weight relationship of *Macrognathus pancalus* had been carried out from two different waterbodies of upper Assam during 2009-2011. The pool data for the co-efficient of regression (b) was recorded as 1.408 in juveniles; 2.977 in males; 3.034 in females. It reveals that females have better growth than males and juvenile. The 'b' for males was found to be minimum (1.408) in 6-9 cm and maximum (3.024) in15-18 cm whereas, for females the lowest (1.807) in 9-12 cm and highest (3.202) in >15 cm groups. In different seasons, the 'b' value ranged from 2.982 (pre-monsoon) to 3.253 (winter) for males while for females, from 2.825 (post-monsoon) to 3.571 (winter). It indicates that both the sexes did not follow the cube law (b=3). The higher condition factor 'K' for males (4.622) and females (4.362) were observed in 9-12 cm and lower values for males (4.128) and for females (3.961) were recorded in 12-15 cm and >15 cm length group. The maximum (4.282) and minimum (3.686) of 'K' for males were recorded in post monsoon and pre-monsoon while in female, the maximum (4.376) in monsoon and minimum (3.913) in winter. It reveals that the species were in good conditions. The 'r' values for in all cases were found to be highly correlated between length and weight.

Keywords: *Macrognathus pancalus*, Length-weight, Condition factor, Assam, India

Introduction

In fisheries research, length-weight relationships (LWR) are important for the estimation of weights where only length data are available and as an index of the condition factor or general well being and gonad development of the fish (Pauly, 1993; Petrakis & Stregiou, 1995; Goncalves *et al*., 1997; Haimovici & Velasco, 2000). Basic information on such as parameters that relate weight to length of fish is of great importance in studies on the evaluation of fish stocks (Entsua-Mensah *et al*., 1995) and fisheries biology (Vazzoler, 1996). Furthermore, seasonal variations in fish growth can be tracked in this way (Ritcher *et al*., 2000). LWR is universal that growth of fishes or any other animal increases with the increase in body length.

The condition factor, often referred to as K factor provides information on wellbeing of a fish and is usually influenced by age of fish, sex, season, maturity stages etc. It is compares the wellbeing of a fish and is based on the hypothesis that heavier fish of a given length are in better condition (Bagenal & Tesch, 1978). Condition factor has been used as an index of growth and feeding intensity (Fagade, 1979). Fish specimens of a given length, exhibiting higher weight are said to be in better condition (Anyanwu et al., 2007).

Information available on the length-weight relationship and condition factor of spiny eel was reported by some workers; Lazarus & Reddy (1986) in *Macrognathus aculeatus* (Bloch) while Froese & Binohlam (2000) in *Mastacembelus pancalus*. Pazira *et al*. (2005) reported on the age structure and growth properties of *Mastacembelus mastacembelus* in southern Iran. Serajuddin (2005) studied the relationship between length and weight and condition factor (Kn) of *Mastacembelus armatus* (Lacepede) from of Uttar Pradesh. Hossain *et al*. (2006) carry out the first comprehensive description of the length–weight relationships (LWRs) and length–length relationships (LLRs) of *Macrognathus aculeatus* and *M. pancalus* from the Mathabhanga River, southwestern Bangladesh. Again, Ahirrao (2008) studied the length-weight relationship of *Mastacembelus armatus* (Lace'pede) from Maharashtra. Further, Oymak *et al*. (2009) reported preliminary information on length-weight relationship and growth of *Mastacembelus mastacembelus* from Turkey. More recently, Abujam and Biswas (2014) studied on the length-weight relationship and condition factor of *Macrognathus aral* from upper Assam, India.

Macrognathus pancalus are found in India, Pakistan, Bangladesh, Sri Lanka, Myanmar, Nepal, Thailand, Malaysia and southern China (Talwar & Jhingran, 1991; Serajuddin, 2005; Froese & Paully, 2006). The spiny eels are regarded a delicious, as excellent food fishes and occasionally kept as pets in aquarium and widely accepted fish in the Asian sub-continent (Nelson, 1994; Narejo *et al*., 2002/2003). Moreover, the species has also gained importance for its ornamental value as an indigenous aquarium fish in India and is being exported to America, Europe and other Asian countries in recent years (Sugunan *et al*., 2002 and Tripathi, 2004). The spiny eel is economically important and palatable as a table fish and demand for the fish almost always exceeds its supply, particularly in northern and eastern India where people relish alive and less bony fish (Serajuddin, 2005). *M. pancalus* fetches higher market price (Rs. 200-260/-per Kg) as food fishes in particularly local markets of upper Assam and NE India as well especially when sold alive. However, no work has been reported so far from this region, hence, the present investigation has taken up from different waterbody of upper Assam, India.

Materials and Methods

Fish samples for the present study were mostly collected monthly from Maijan wetland (27º30′ 14.4″ N and 94º58′ 04.8″ E) of Dibrugarh and Guijan Ghat (27º34′ 39.4″ N and 94º19′ 29.60″ E) of Tinsukia Districts of Assam between 2009 and 2011. Maijan wetland is an oxbow lake and its elevation ranged from 86 to 102 m. The maximum and minimum depth is 9 and 3 m respectively. The water body is completely surrounded by tea garden and there is a small connecting channel with the Brahmaputra River. The beel (wetland) covering total an area of 134 ha. The Guijan ghat is just located at Brahmaputra River. Altogether 467 specimens of *M. pancalus* (Figure 1) were collected for calculation of length-weight relationship. The total length, weight, sex and maturity of gonad were recorded and then preserved in 10% formalin for subsequent analysis.

Figure 1. Specimen of *M. pancalus*

Length-weight relationship and condition factor (K):

Length-weight relationship: The length-weight relationship was calculated by the allometric growth formula as used by Ricker (1973) and Pauly, (1983) in the form of: $W = aL^b$; where 'W' stands for weight, 'L' for length, 'a' is a constant and 'b' the exponent. The equation was transformed into a logarithmic as suggested by Le Cren (1951) and expressed as: Log W = Log a + b Log L; where 'a' is a constant being initial growth and 'b' is the growth coefficient. The values of 'a' and 'b' were determined empirically. The observed average weight of the species has been plotted against the average observed length to examine the nature of parabola. The regression of log-weight on log-length has been calculated by the method of "least squares" by grouping the sample data. The data are first graphed at 4 cm interval and the relationship is calculated for different life stages. Correlation of co-efficient (r) for length and weight has also been calculated.

Condition factor: Individual variations from general length-weight relationship have been studied under the general name condition (Le Cren, 1951). Changes in condition factor (K) or 'ponderal index' has been calculated by using the following formula (Pauly, 1984 and Wooton, 1992).

$$\mathbf{K = \frac{W \times 10^3}{L^3}}$$

Where; K = condition factor, W = Mean weight of the fish (g) and L=Mean length of the fish (cm). The number 10^3 is a factor to bring the ponderal index (K) to near unity (Carlander, 1970).

Results and Discussion

***Length-weight relationship of juvenile, male and female of spiny eel*:**

The logarithmic regression equations of *M. pancalus* may be represented as pooled data are as follows:

Juvenile: Log W= -0.848+1.408 Log L (r= 0.479),

Male: Log W= -2.411+2.977 Log L (r= 0.865)

and

Female: Log W= -2.449+3.034 Log L (r = 0.885)

It is clear that b values of *M. pancalus* are more or less and very close to the regression line and hence it can be assumed that there is a close relationship between length and weight. The 'b' value for the juvenile was lower than that male and female (Figure 2A-C). This shows that a juvenile is lighter in weight in relation to its length than male and female. The exponential value 'b' of the pooled equation of the length-weight relationship for male and female was found to be slightly deviate from the cube law (b=3), indicating an allometric pattern of growth. The correlation coefficient 'r' shows a very high degree of correlation between length and weight of male and female. The regressions 'b' was highly significant, with the coefficient of correlation 'r' ($p<0.001$). A similar observation was also recorded in *Macrognathus aral* (Abujam & Biswas, 2014). The variations in the exponential values 'b' might be due to composite culture and certain environmental conditions (Lakshman; 1967; Narejo *et al*., 2003).

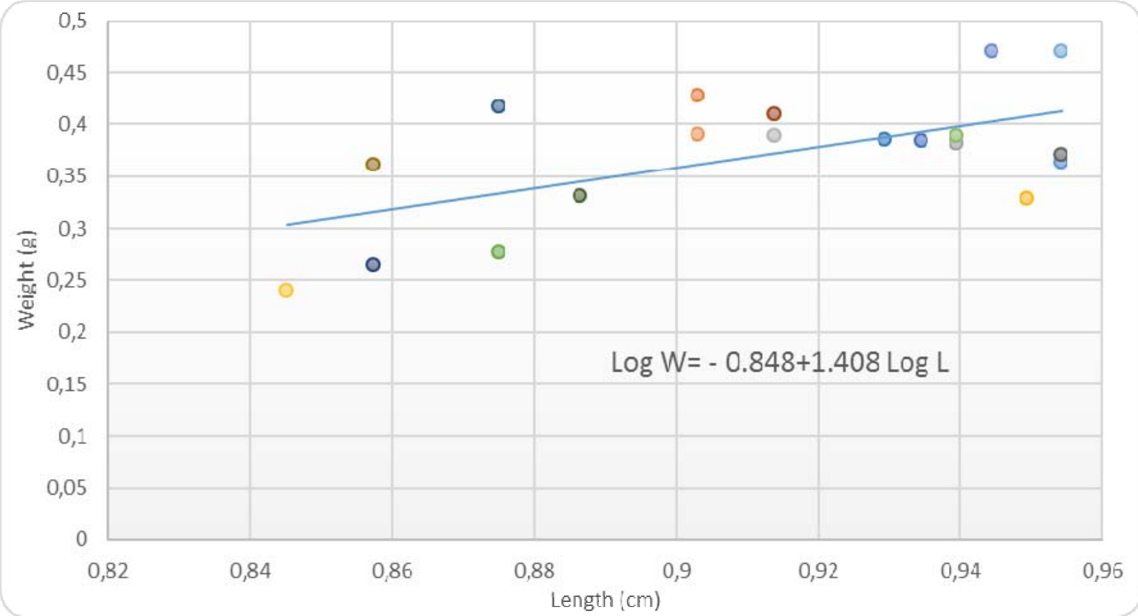

Figure 1(A). Length-weight relationship in juvenile of *M. pancalus* (6-9cm)

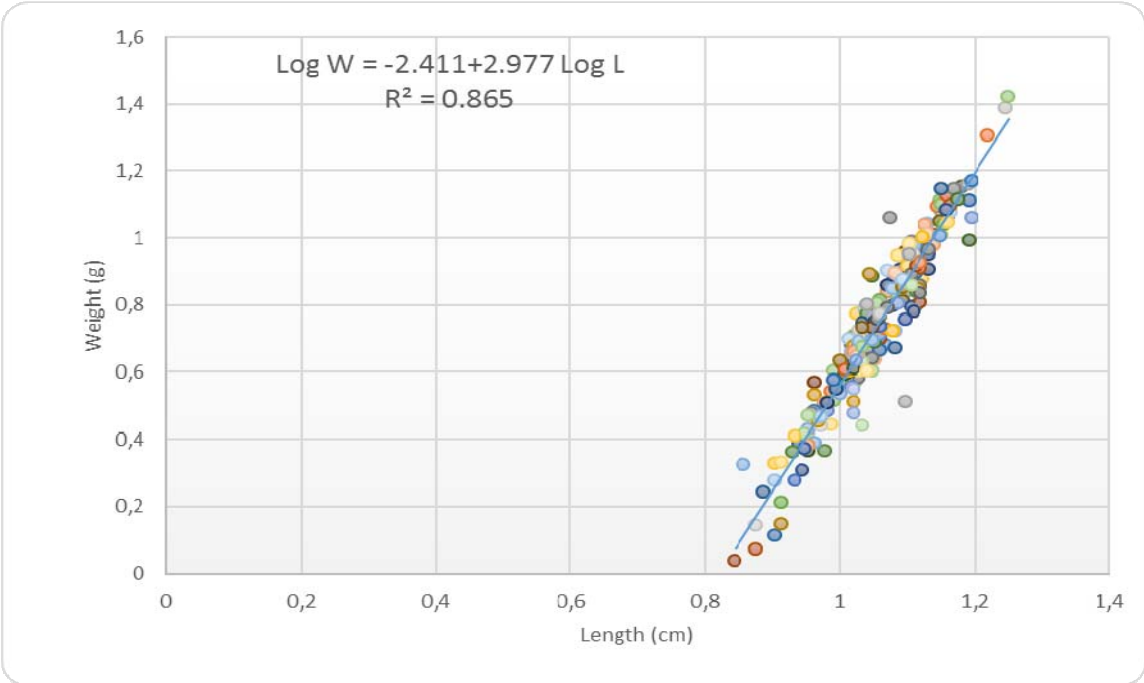

Figure 2(B). Length-weight relationships in male of *M. pancalus*

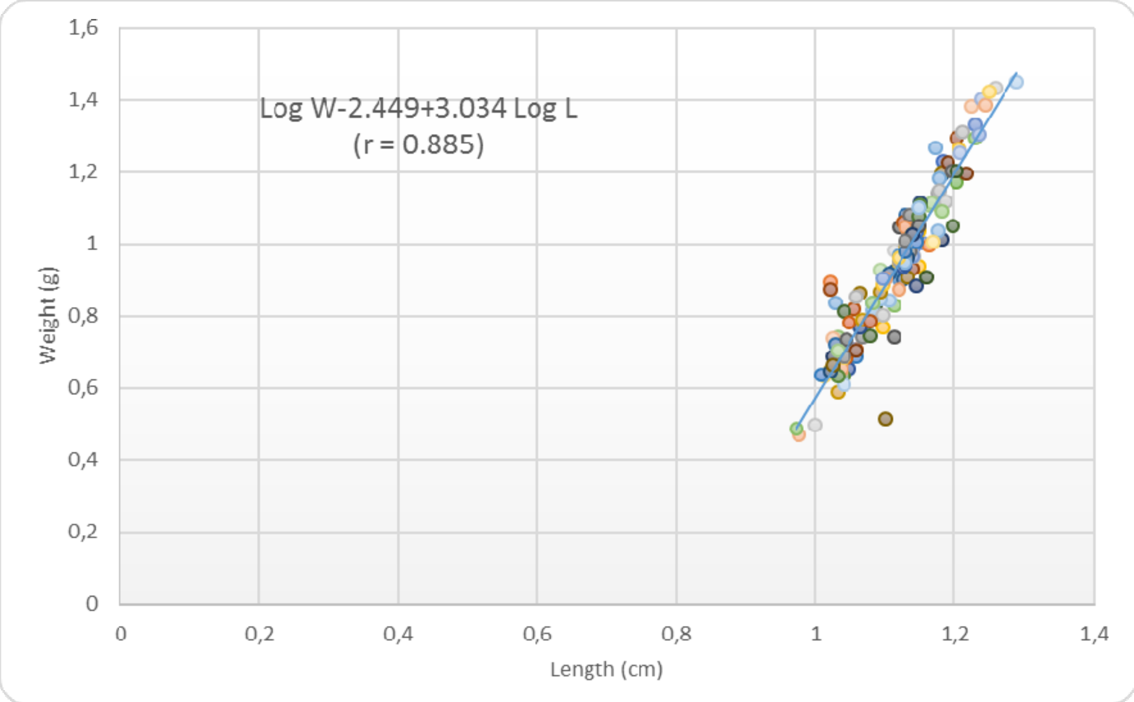

Figure 2(C). Length-weight relationships in female of *M. pancalus*

***Length-weight relationship of spiny eel at different length groups*:**

A linear relationship between the log weight and log length and as well as condition factor in different size group was established for both sexes of *M. pancalus* (Table 1). The coefficient of regression (b) was ranged from 1.408 to 3.024 for males and from 1.807 to 3.202 for females. The coefficient of correlation (r) values for different length groups were ranged between 0.451 and 0.648 for males and 0.560 and 0.744 for females. The higher 'K' value for males (4.622) and females (4.362) were observed in 9-12 cm length group and lower values for males (4.128) and for females (3.961) were recorded in 12-15 cm and >15 cm length group.

A positive linear relationship was found in different length groups of *M. pancalus*. The exponential value 'b' was significantly higher than '3' in certain higher length groups of the species while, 'b' value was less than '3' in most of the length groups. In overall, both the sexes showed poor growth rate but they were very close to the ideal value '3'. The regression coefficient 'b' is significantly different from '3' suggesting a deviation from the so called cube law and it reveals that the fish didn't follow the cube law. Thakur & Das (1974) stated that the value of an exponent significantly greater than '3' or less than '3' denoted that it did not maintain the isometric (b=3) pattern of growth. This means that if the exponent is less than 3, the species becomes lighter for its length as it grows larger and if greater than 3, the species becomes heavier for its length as it grows longer.

Tesch (1968) also reported that value of regression coefficient 'b' might be in between 2.0 and 4.0. However, Wootton (1992) provides a rough idea on this situation, indicating that allometric growth is negative (b<3) if the fish gets relatively thinner as it grows larger and positive (b>3) if it gets plumber as it grows. The regression co-efficient for isometric growth is '3' and values greater or less than '3' indicate allometric growth (Gayanilo & Pauly, 1997). The short length groups of the species were determined when the value of b<3.0 in both sexes. In this group, the growth in length is not proportionate to the increase in weight and indicating negative allometric growth. When the weight gain is more than an increase in length, the fish falls in heavy length group with b> 3.0 and indicates positive allometric growth. Though the "b" value depends primarily on the shape and fatness, other factors like temperature, food quality, quantity and food size, sex, time of year and stage of maturity also contribute its fluctuation (Pauly, 1984; Sparre, 1992; Cherif *et al.*, 2008).

Table 1. Length-weight relationship and K factor at different size groups of *M. pancalus*

Length group (cm)	Sex	b	r	K	Regression equation (Log W=Log a + b Log L)
6-9	M	1.408	0.451	4.137	Log W= - 0.848+1.408 Log L
9-12	M	2.233	0.648	4.622	Log W= - 1.566+2.233 Log L
12-15	M	2.563	0.553	4.128	Log W= - 1.694+2.563 Log L
15-18	M	3.024	0.526	4.146	Log W= - 2.465+3.024 Log L
9-12	F	1.807	0.560	4.362	Log W= - 1.139+1.807 Log L
12-15	F	2.611	0.694	4.160	Log W= - 1.951+2.611 Log L
>15	F	3.202	0.744	3.961	Log W= - 2.663+3.202 Log L

Table 2. Length-weight relationship and K-factor of *M. pancalus* in different seasons

Seasons	Sex	'b'	'r'	'K'	Regression equation (Log W=Log a + b Log L)
Winter (Dec-Feb)	M	3.253	0.945	4.258	Log W=- 2.684+ 3.253 Log L
	F	3.571	0.875	3.913	Log W=- 3.059+ 3.571 Log L
Pre-monsoon (Mar-May)	M	2.982	0.897	3.686	Log W=- 2.443+ 2.982 Log L
	F	3.163	0.895	3.924	Log W=- 2.608+ 3.163 Log L
Monsoon (Jun-Aug)	M	3.193	0.758	3.831	Log W=- 2.654+ 3.193 Log L
	F	2.994	0.931	4.376	Log W=- 2.404+ 2.994 Log L
Post-monsoon (Sep-Nov)	M	3.146	0.947	4.282	Log W=- 2.563+ 3.146 Log L
	F	2.825	0.966	3.966	Log W=- 2.215+ 2.825 Log L

Key: b = Coefficient of regression, r = Coefficient of correlation (Pearson), K = condition factor.

Length-weight relationship of spiny eel at different seasons:

The length-weight relationship was also calculated for different seasons (winter, pre-monsoon, monsoon and post-monsoon) to see the seasonal impact on the relationship (Table 2). The 'b' value ranged from 2.982 (pre-monsoon) and 3.253 (winter) for males while it was recorded as 2.825 (post-monsoon) and 3.571 (winter) for females. The coefficient of correlation 'r' value ranged from 0.758 to 0.947 for males and from 0.875 to 0.966 for females. Again, the average maximum and minimum K values ranged from 4.282 (post monsoon) to 3.686 (pre-monsoon) for males while in female, the maximum values (4.376) and minimum (3.913) were recorded during monsoon and winter respectively (Table 2). As a whole, the value of mean condition factor (K) was recorded as 4.014 ±0.387 (male) and 4.045 ±0.403 (female).

As far as seasons are concerned, the positive allometric growth (b>3) was observed in winter in both the sexes of *M. pancalus* while the negative allometric growth (b<3) were recorded in pre-monsoon (male) and post monsoon seasons (female). The more or less value of 'b' was found in pre-monsoon, monsoon and post-monsoon seasons in both male and female. It is evident from the results that the value of regression coefficient of *M. pancalus*, tends to be higher during winter and lower during monsoon seasons. According to Bagenal & Tesch (1978a) and Goncalves *et al*. (1997) the 'b' value may change seasonally and even daily and also between habitats. Hence, it can be suggested that the LWRs is affected by different factors like age, sex, maturity, temperature, diet and habitats. Again, the cube law is not confirmed for all fishes because growth causes for the change of their shape (Ali, 1999; Abujam & Biswas, 2014).

A high degree of positive coefficient of correlation 'r' between length and weight has been observed in different length group and seasons. From the results, it can be suggested that the length and weight of female of *M. pancalus* are slightly better correlated than the male. The intercept 'a' of all the length groups and seasonal was negative which indicates a perfect linear relationship between the variables. Higher values of ‘b’ (>3) were reported in carps (Bhatnagar, 1972; Khan, 1972). While exponential values ‘b’ less than 3 were reported in major carps (Rao & Rao, 1972; Pathak, 1975; Kulshrestha *et al*., 1993). The LWR shows that the values of ‘b’ was found to be less than 3 in different species and even in the same species from different water bodies (Khan, 1988; Yousuf *et al*., 1992).

***Condition factor (K) at different length groups*:**

During the present study the value of K showed fluctuations in all length groups of males and females (Figure 3). The maximum value of ‘K’ for males and females were recorded in 9-12 cm length group and that of minimum for males were recorded in 12-15 cm and for females in >15 cm length groups. According to Welcome (1979), condition factor decreases with increase in length and also influences the reproductive cycle in fish. It has been observed that the high ‘K’ value of males and females was observed in lower length group and the sharp decline in ‘K’ value in both sexes in higher length groups, might be due to approach of breeding season and subsequent release of gonadal product. Rao & Rao (1972) and Desai (1973) also reported that the decrease in ‘K’ in the higher length group of species with irrespective of sexes may be associated with sexual maturity or spawning phase. The decrease in condition factor with increasing length of both the species might be due to slower growth as it is expected that most of the energy derived by the fish has been channelized for gonadal development (Abujam & Biswas, 2014).

Monthly fluctuations of condition factor (K):

The highest ‘K’ value for males was observed in February and lowest in June while in females, the highest and lowest values were recorded in July and March respectively (Figure 4). As a whole, the average maximum and minimum of ‘K’ were recorded during post monsoon and pre-monsoon for males while in female, the maximum and minimum were recorded during monsoon and winter respectively. The values of the ‘K’ vary according to seasons and are influenced by environmental conditions (Braga, 1986). It has been observed that the females were better condition (mean K=4.045) than male (mean K=4.014). The values of ‘K’ indicated that the species were ideal fish and as well as they were in healthy condition. The variations in the ‘K’ may be attributed to different factors, such as environmental condition, degree of parasitisation, food availability and the gonadal maturity as has also been suggested by some workers (Jhingran, 1972; Bashirullah, 1975). Similar observations have also been reported by Jhingran (1972) and Dasgupta (1991) in *Tor putitora* and Abujam & Biswas (2014) in *M. aral*.

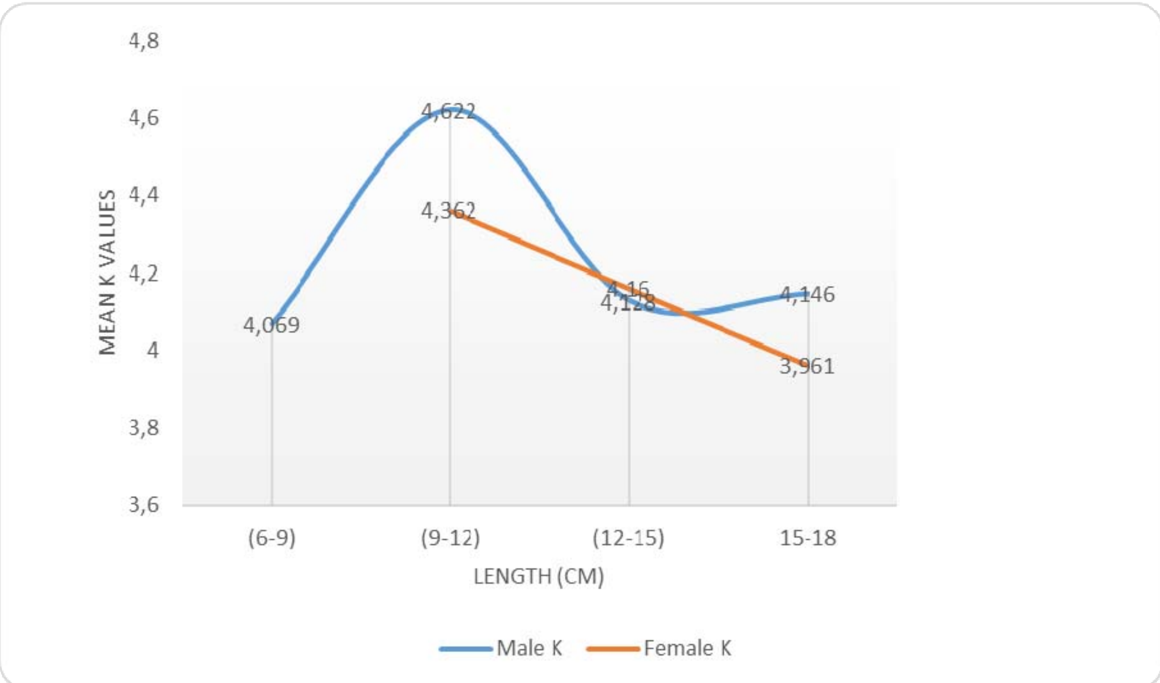

Figure 3. Condition factor (K) at different length group in *M. pancalus*

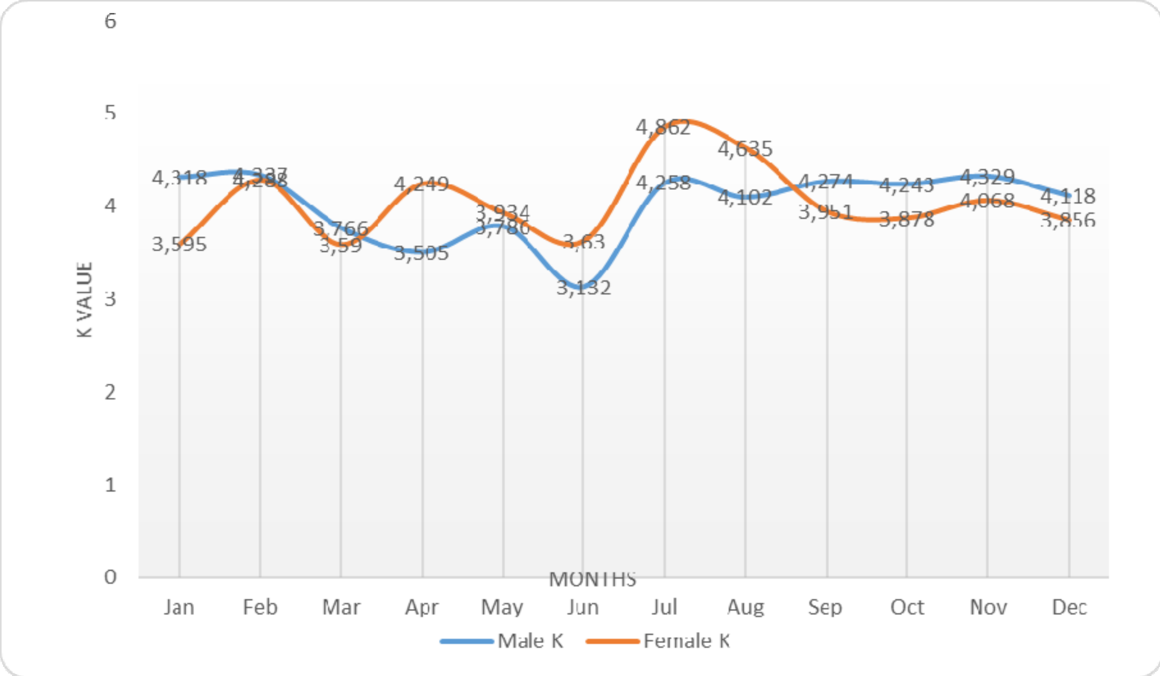

Figure 4. Monthly condition factor (K) for *M. pancalus*

Conclusion

The positive allometric growth was observed in longer length group and negative allometric growth was in shorter length group. Again, the positive and negative allometric growth was also recorded in seasons. In overall, the growth coefficient (b) calculated from LWR for both the sex was varied and the growth did not follow the typical 'cube law' in different length group and seasons. The 'r' value in respect of length and weight indicated that in all the cases this relationship was positive in different length group as well as in different seasons. The 'K' value was above the ideal value and indicated that the species were in good conditions in their natural habitats.

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