Length-Weight Relationship and Sex Ratio of Some Cyprinid Fish Species From Taungthaman Lake

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Abstract

The present study describe the length-weight relationships LWR condition factor (K), relative condition factor (K_n) and sex ratio of three cyprinid small indigenous fish species; *Amblypharyngodon atkinsonii*, *Puntius sarana* and *Puntius chola* from Taungthaman Lake, Mandalay Region. A total numbers of 252 *A. atkinsonii*, 220 *P.sarana* and 249 *P.chola* were collected from November 2015 to February 2016. In LWR ($W= aL^b$) values of exponent 'b' were observed to be 2.577, 2.519, 2.539 for male, female and combined of *A. atkinsonii*, 2.913, 2.751, 2.809 for male, female and combined of *P.sarana* and 2.684, 2.784, 2.746 for male, female and combined of *P.chola*. The correlation coefficient 'r' was observed to be 0.91, 0.905, 0.862 for male, female and combined of *A.atkinsonii*, 0.869, 0.9, 0.875 for male, female and combined of *P.sarana* and 0.85, 0.918, 0.914 for male, female and combined of *P.chola*. The values of k were 1.06 in *A.atkinsonii*, 1.48 in *P.sarana* and 1.37 in *P.chola* from pooled data. The values of K_n were observed to be 1.05, 1.06 for male and female of *A.atkinsonii*, 1.09, 1.05 for male and female of *P.sarana* and 1.07, 1.05 for male and female of *P. chola*. The sex ratio (M: F) were 1:5 in *A. atkinsonii*, 1:6.3 in *P.sarana* and 1:6 in *P.chola* from pooled data. Moreover, it is fluctuated between 1:4-1:9 in *A. atkinsonii*, 1:4-1:9.5 in *P.sarana* and in 1:3.8-1:5.3 in *P.chola* for different month. It can be concluded that the length-weight relationship of three small indigenous species in both sexes combined, indicates almost negative allometric pattern of growth in the study period. Throughout the study period females were predominant over males.

Keywords: length-weight relationship, condition factor, relative condition factor, sex ratio and cyprinid.

Introduction

The order Cypriniformes is the largest order of the freshwater fishes which is includes 2422 species (Nelson, 1984). The group consists of solely of freshwater fish and is widespread in tropical and temperate water of Europe, Africa, Asia and North America. The greatest diversity is in southeastern Asia. Members of this order are popular aquarium fishes, especially the minnows, barbs and loaches (Talwar and Jhingran, 1991). Cyprinidae is one of the largest family among the freshwater fishes which includes carps, (*Labeo rohita*, *Catla catla*, *Cirrhinus cirrhosus*, *Labeo calbasu* etc.), Barbs (*Puntius* sp.) and a large variety of minnows (*Esomus danricus*, *Amblypharyngodon mola* etc.) (Rahman, 2005).

The small indigenous species (SIS), which grow approximately at a length of 5-25 cm at maturity (Felts *et al*., 1996). *Amblypharyngodon atkinsonii* (Blyth, 1860), *Puntius sarana* (Hamilton & Buchanan, 1822) and *Puntius chola* (Hamilton, 1822) are small indigenous fish species of Myanmar. *Amblypharyngodon atkinsonii*, commonly known as Burmese carplet is a freshwater species. It is distributed in India and Myanmar (Talwar and Jhingran, 1991). It has high protein, vitamin and mineral contents.

The small fish *Puntius sarana* is a member of the family Cyprinidae, commonly known as 'olive barb'. It is a tasty, the most popular and favourite table fish among barb species having high nutritional and market value in Bangladesh as well as other Asian countries (Chakraborty *et al.*, 2006). *Puntius chola* is a fresh water fish and usually known as swamp barb. Its local name in Myanmar is Nga-khone-ma-myi-ni. It has commerical importance in fisheries and aquarium (Talwar and Jhingran, 1991).

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Small indigenous species (SIS) has been considered as an important source of food rich in protein, vitamin and minerals. Many SIS are eaten whole contributing calcium, phosphorus and vitamins to the human diet. Hossain and Afroze (1994) mentioned that among the fishing communities, small fish occupy an important position as a popular food item. They are usually caught by a large number of subsistence fishermen, which provide a major portion of the animal protein for them. Moreover, it also provides a substantial income for the small-scale fishermen. So, SIS is playing a vital role in diet and economy of the rural poor.

The study of the length-weight relationship of fishes forms an important base for fish biology. The statistical relationship between these two parameters has great significance with regard to their morphology, biology, nutrition, condition and growth rate. Further this relationship is useful in differentiating small taxonomic units, as variations within populations of different localities (Le Cren, 1951).

The weight-length relationships provide an opportunity to calculate an index commonly used by fisheries biologists to compare the condition factor or well being of a fish. This index is condition factor, K. Fish with a high value of K are heavy for its length, while fish with a low K value are lighter (Weatherly, 1972). Different values in K of a fish indicate the state of sexual maturity, the degree of food sources availability, age and sex of some species and the system of environment (Gomiero and Braga, 2005). Sex ratio on the other hand, is a comparison of the number of males and females in a population. According to Panthula (1961) sex ratio is an indicator of population behavior and fecundity. An understanding of the sex ratio of a fish in different months and seasons is essential for obtaining information on seasonal segregation of the sexes and also their differential growth.

The previous investigations of the length-weight relationship and condition factor have also been studied in some freshwater fishes from Mandalay markets (Khin Thida Myint, 1996) and in *Notopterus notopterus* (Khin Oo Haling, 1992). However, no information is available so far on the length-weight relationship and condition factor of this three fish species. Therefore the present work was undertaken to estimate the length-weight relationship and condition factor of the three fish species with the following objectives:

The specific objectives of the study were:

- to estimate the length-weight relationship of *Puntius sarana*, *Puntius chola* and *Amblypharyngodon atkinsonii* and
- to describe the condition factor, relative condition factor and sex-ratio of this three fish species from Taungthaman Lake.

Materials and Methods

Study Area and Study Period

Thaungthaman Lake is situated in Amarapura Township, Mandalay Region, and Central Myanmar. It lies between 21^{o} 53′ N to 21˚54′ N latitude and 96˚ 03′ E to 96^{o} 05′ longitude (Figure.1). The study period was from November 2015 to February 2016.

Collection of Data

Fish samples for three small indigenous fish species were collected monthly in fish landing places on the bank of Taungthaman Lake. Samples were obtained mainly from the catch of cast net (Kun) and beach seines (wun bu paik). After collection, the specimens were brought to the laboratory to measure the total length and body weight of individual fish. After measured they were categorized into three groups viz. males, females and combined. The sexes were determined by dissecting the body and directly observing the gonads.

Figure.1 Map of Taungthaman Lake,Amarapura Township, Mandalay Region (Source from Google)

Length-Weight Relationships (LWR)

A total of 252 specimens comprising 210 females and 42 males of *Amblypharyngodon atkinsonii*, 220 specimens comprising 190 females and
30 males of *Puntius sarana* and 249 specimens comprising 214 females and 35 males of *Puntius chola* were randomly collected to calculate the length-weight relation.

The LWR was estimated by using the equation $W = aL^b$ (Ricker, 1973), where "W" is the total weight in gram, "L" is the length in cm, "a" is the intercept of the length-weight relationship (constant) and "b" is the length exponent (slope) whose values were estimated from the logarithmic transform values of length and weight i.e. Ln W = Ln a+b Ln L the least square linear regression (Zar, 1984).

The analyzed samples were classified into the group i.e light, isometric and heavy. The light group (negative allometric) was determined when the value of b<3.0. In this group, the length growth is not proportionate to the increase in weight. When the weight gain is more than an increase in length, the first falls in heavy group (positive allometric) with b>3.0. The ideal value of b = 3.0 indicates the fish are having the isometric growth of equal increment of both parameters (Salam *et al.*, 2005).

The condition factor (K) was calculate by using a formula (Ricker, 1975)

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

Where K = condition factor
W= weight of fish (g)
L = Length of fish (cm)

Relative condition factor

The relative condition factor K_n were determined for different length groups using length and weight data following the equation given by (Le Cren, 1951)

$K_n = W/\hat{}W$

Where, K_n = relative condition factor
W = observed weight
^W = calculated weight derived from length weight relationship.

Calculation of male and female sex ratio

The collected male and female fishes were used to estimate the sex ratio. All fishes were dissected out by scissors starting from anus to lower jaw and the belly was opened to know the sex.

By counting the number of male and female fishes the sex ratio can be estimated by the following formula.

$$\text{Female ratio} = \frac{\text{No. of female fishes}}{\text{Total fish (Male + Female)}} \times 100$$

$$\text{Male ratio} = \frac{\text{No. of female fishes}}{\text{Total fish (Male + Female)}} \times 100$$

Significant was tested by chi-square test (χ^2). A chi-square test (χ^2) was used according to the following formula.

$$\chi^2 = \sum(O\text{-}E)^2/E$$

Where, O = observed of ratio

E = expected (predicted) of ratio (Sohal and Rohlf, 1995)

Observations and Results

Relation between Total Length and Body Weight

A total of 252 specimens comprising 210 females and 42 males were examined to determine the length- weight relationship of *Amblypharyngodon atkinsonii*. The total length of fishes ranged from 4 to 8.5 cm and weight ranged from 1.1 to 7.3 g. Length-weight regression was calculated separately for males, females and sexes combined (Figure. 2).

The regression equation obtained is as follows:

Ln W (male) = 2.577 Ln TL -3.802 (R^2 = 0.744, r = 0.862)

Ln W (female) = 2.519 Ln TL - 3.672 (R^2= 0.829, r =0.91)

Ln W (sexes combined) = 2.534 LnTL-3.705 (R^2 = 0.82, r = 0.905)

| The cubic or power curve equations obtained are as follows:

$$W \text{ (male)} = 0.022\ TL^{2.577}$$

$$W \text{ (female)} = 0.025\ TL^{2.519}$$

$$W \text{ (sexes combined)} = 0.024\ TL^{2.534}$$

The correlation coefficient 'r' between total length and weight was found to be 0.91(male), 0.905(female) and 0.862 (Sexes combined). The coefficient of determination R^2 = 0.829 (male), 0.82(female) and 0.744 (sexes combined) indicated that body weight was highly correlated with the total length fishes.In the present study, the exponential value of 'b' in length- weight equation of *A.atkinsonii* was found to be 2.577, 2.519 and 2.534 for male, female and sexes combined show slight variation and indicate negative allometric growth.

A total of 220 specimens comprising 190 females and 30 males were studied to determine the Length- weight relationship of *Puntius sarana*. The total length of fishes ranged from 8.7 to 15.7cm and weight ranged from 8.1 to 60.4g. The length-weight regression equations were derived separately for males, females and sexes combined (Fig. 2).

The regression equations obtained are as follows:

Ln W (male) = 2.913 Ln TL - 4.082 (R^2= 0.811, r =0.9)

Ln W (female) = 2.751 Ln TL -3.601 (R^2 = 0.756, r = 0.869)

Ln W (sexes combined) = 2.809 LnTL-3.757 (R^2 = 0.766, r = 0.875)

The cubic or power curve equations obtained are as follows:

$$W \text{ (male)} = 0.016\ TL^{2.913}$$

$$W \text{ (female)} = 0.027\ TL^{2.751}$$

$$W \text{ (sexes combined)} = 0.023\ TL^{2.809}$$

The value of correlation coefficient 'r' estimated for *Puntius sarana* was 0.9 (male), 0.869 (female) and 0.875 (sexes combined). The coefficient of determination R^2 = 0.811,

0.756, 0.766 for male, female and sexes combined respectively, which indicated that the relationship between length and weight of the fish was highly correlated.The value of exponent 'b' in length-weight equation of *Puntius sarana* was found to be 2.913, 2.751 and 2.809 for male, female and sexes combined respectively. The 'b' value of females and sexes combined indicated negative allometry and the 'b' value of males was very close to the isometric value of 3.

A total of 249 specimens comprising 214 females and 35males were investigated to determine the length- weight relationship of *Puntius chola*. The total length of fishes ranged from 6.2 to 11.5 cm and weight ranged from 3.1 to 22.7g. Length-weight regression was calculated separately for males, females and sexes combined (Figure .2).

The regression equations obtained are as follows:

Ln W (male) = 2.684 Ln TL - 3.637 (R^2 = 0.724, r = 0.85)

Ln W (female) = 2.784 Ln TL - 3.865 (R^2= 0.844, r =0.918)

Ln W (sexes combined) = 2.746 LnTL- 3.782 (R^2= 0.837, r = 0.914)

The cubic or power curve equations obtained are as follows:

$W (male) = 0.026\ TL^{2.684}$

$W (female) = 0.021\ TL^{2.784}$

$W (sexes combined) = 0.022\ TL^{2.746}$

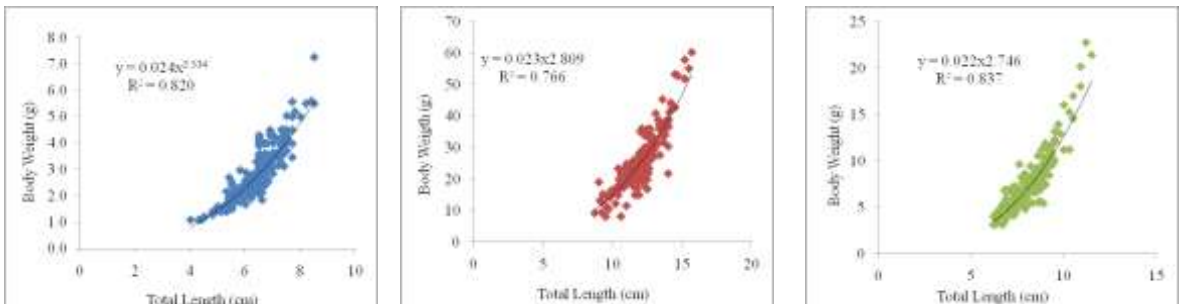
The correlation coefficient 'r' between total length and weight was found to be 0.85(male), 0.918 (female) and 0.914 (sexes combined). The coefficient of determination R^2 = 0.724 (male), 0.844 (female) and 0.837(sexes combined) indicated that the length-weight relationships of the fish was highly correlated. The value of exponent 'b' in Length-weight equation of *Puntius chola* was found to be 2.684, 2.784 and 2.746 for male, female and sexes combined respectively. The 'b' value of males, females and sexes combined indicated negative allometry.

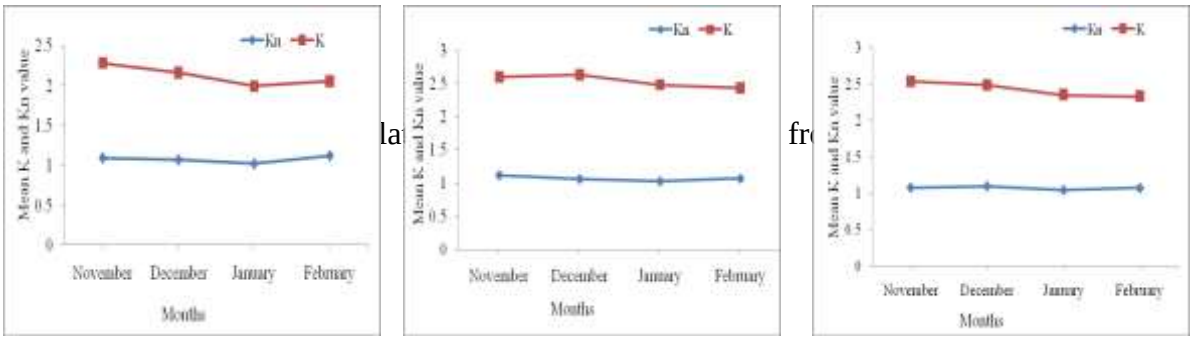
Condition factor

Condition factors are used to detected seasonal variations in the condition of fish, which may vary with food abundance and average reproductive stage of the stock.The condition factor (K) and relative condition factor (K_n) for all fish samples were calculated individually and presented as 2 cm interval of total size group (Table.2).The average monthly minimum and maximum values of K were observed 0.93-1.19 in *A. atkinsonii*, 1.36-1.57 in *P. sarana* and 1.26-1.46 in *P. chola*. The average monthly minimum and maximum values of K_n were observed 1.02-1.12 in *A. atkinsonii*, 1.03-1.12 in *P. sarana* and 1.04-1.09 in *P. chola* and (Figure .3).

The values of 'K' and 'K_n' show fluctuation in all size groups of both for males and females of three species.

In the present study, the 'K' value of male and female of three species was high in smaller group except the female of *P. chola* at size groups 11-13cm (Table .2). The sex-wise analysis of K_n values revealed that the mean Kn value in females (1.06) was higher than that of males (1.05) in *A. atkinsonii*. The mean K_n value of females (1.05) was lower than that of male (1.09) in *P. sarana* and the mean K_n value of females (1.05) was also lower than that of males (1.07) in *P. chola* (Table .1).





(A)*Amblypharyngodon atkinsonii* (B)*Puntius sarana* (C) *Puntius chola*

Figure.3 Monthly variations of mean Kn values of three species from

Sex Ratio

In this study the sex ratio among male and female fishes was calculated. The sex ratio was determined according to the number of male and female collected from the sample. The total male and female ratio was 1:5 in *A. atkinsonii,* 1:6.3 in *P. sarana* and 1:6 in *P. chola*. This study revealed that the monthly fluctuation of male and female of three species occurs in the catch, and the percentage of female is higher than that of the male, throughout the study period (Figure. 3). This means that females predominate over males. The sex ratio is not constant throughout the study months (Table .3) and (Fig. 4). Chi-square analysis of the sex ratio by month showed significant difference from the theoretical 1:1 sex ratio ($P<0.5$, χ^2 = 112 in *A. atkinsonii*, *P. sarana*; 116.36, *P. chola*; 122.98, df = 1).

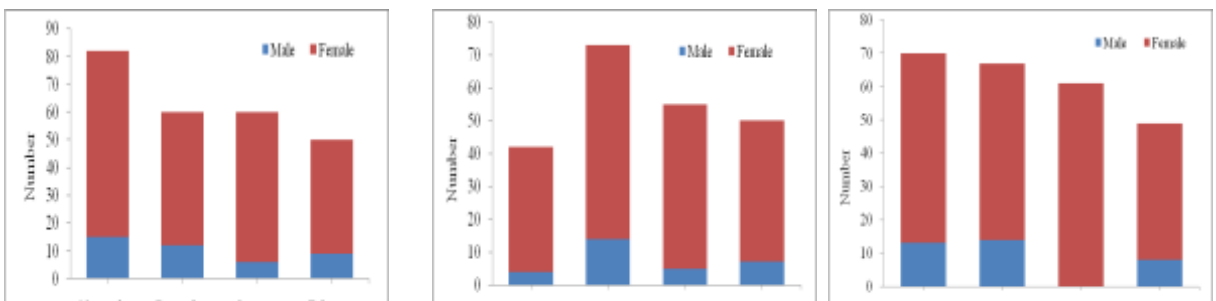


Table .1 Length-Weight relationships parameters, relative condition factors and condition factors of three species from Taungthaman Lake

Species	Sex	No of fish	Total Length		Body Weight		a	b	Kn	K
			Range (cm)	Mean ±SD	Range (g)	Mean ±SD				
Amblypharyngodon atkinsonii	Male	42	4.5-7.7	6.09 ±2.43	1.2-4.5	2.43±0.78	0.022	2.577	1.05	1.05
	Female	210	4.0-8.5	6.36 ±0.80	1.1-7.3	2.80 ±1.02	0.025	2.519	1.06	1.06
	combined sex	252	4.0-8.5	6.31±0.78	1.1-7.3	2.74 ±0.99	0.024	2.534	1.07	1.06
Puntius sarana	Male	30	9.1-14.0	11.46±1.20	8.1-39.1	21.39 ±7.08	0.016	2.913	1.09	1.38
	Female	190	8.7-15.7	11.98±1.28	9.2-60.4	26.37 ±9.33	0.027	2.751	1.05	1.49
	combined sex	220	8.7-15.7	11.91±1.28	8.1-60.4	25.69±9.21	0.023	2.809	1.06	1.48
Puntius chola	Male	35	6.2-9.7	7.20±0.88	3.1-13.9	5.55 ±2.4	0.026	2.684	1.07	1.44
	Female	214	6.4-11.5	8.01 ±0.98	3.4-22.7	7.23 ±3.06	0.021	2.784	1.05	1.35
	combined sex	249	6.2-11.5	7.89 ±1.01	3.1-22.7	6.99±3.03	0.022	2.746	1.09	1.37

Table .2 Mean relative condition factor and condition factor for different size groups of three species from Taungthaman Lake

Species	Size group (cm)	No. of fish		Observed weight (g)		Calculated weight (g)		Kn		K	
		M	F	M	F	M	F	M	F	M	F
Amblypharyngodon atkinsonii	3-5	3	11	1.37	1.3	1.32	1.29	1.03	1.01	1.25	1.3
	5-7	37	162	2.42	2.58	2.29	2.49	1.05	1.03	1.04	1.06
	7-9	2	37	4.25	4.25	7.87	4.14	0.54	1.03	1.01	0.99
Puntius sarana	7-9	_	2	_	10.86	_	9.73	_	1.12	_	1.55
	9-11	11	43	15.67	17.89	13.97	17.11	1.12	1.05	1.42	1.57
	11-13	16	113	22.48	25.64	21.95	25.24	1.02	1.02	1.35	1.57
	13-15	3	27	36.6	38.44	31.57	36.87	1.14	1.04	1.38	1.46
	15-17	_	5	_	55.47	_	52.08	_	1.07	_	1.53
Puntius chola	5-7	20	54	4.52	4.49	4.17	4.11	1.08	1.09	1.5	1.46
	7-9	7	124	5.78	6.80	5.66	6.59	1.02	1.03	1.36	1.37
	9-11	_	18	_	12.81	_	11.89	_	1.08	_	1.34
	11-13	_	2	_	22.06	_	11.61	_	1.90	_	1.51

Table .3 Monthly distribution of sex ratio and chi-square (χ^2) value of three species from Taungthaman Lake

Species	Month	No. of fish	Male Obs. Value		Female Obs. Value		Ratio of male and female	$\chi 2$ (male+female)	df	Level of significance
			No	%	No	%				
Amblypharyngodon atkinsonii	November	82	15	18.3	67	81.7	1: 4.5	32.96	1	p<0.05
	December	60	12	20	48	80	1: 4	21.60	1	p<0.05
	January	60	6	10	54	90	1: 9	38.40	1	p<0.05
	February	50	9	18	41	82	1: 4.5	20.48	1	p<0.05
	Total/ Avg	252	42	16.6	210	83.4	1: 5	112	1	p<0.05
Puntius sarana	November	42	4	9.5	38	90.4	1: 9.5	27.52	1	p<0.05
	December	73	14	19.2	59	80.8	1: 4	27.73	1	p<0.05
	January	55	5	9.9	50	90.9	1:10	36.81	1	p<0.05
	February	50	7	14	43	86	1: 6.1	25.92	1	p<0.05
	Total/ Avg	220	30	13.6	190	86.4	1: 6.3	116.36	1	p<0.05
Puntius chola	November	70	13	18.5	57	81.4	1: 4.3	27.65	1	p<0.05
	December	67	14	20.8	53	79.1	1: 3.8	22.70	1	p<0.05
	January	61	_	_	61	100	_	_	_	_
	February	51	8	19.5	41	84.3	1: 5.3	13.20	1	p<0.05
	Total/ Avg	249	35	14	212	86	1: 6	122.98	1	p<0.05

Discussion

The present study has provided information on length-weight relationships, condition factor and sex ratio of *Amblypharyngodon atkinsonii* (Burmese carplet), *Puntius sarana* (olive barb) and *Puntius chola* (swamp barb) form Taungthaman Lake. The length-weight relationships of *A. atkinsonii*, *P. sarana* and *P .chola* were studied from November 2015 to February 2016. In the present study the value of exponent 'b' were observed to be 2.577, 2.519 and 2.534 for male, female and combined sex of *A.atkinsonii* respectively that is lower than cube exponent value (b=3). This indicates that the weight of the fishes were lower a compared to the cube of its length which shows negative allometric growth. Similar findings were given by Alam *et al*. (2014) who reported 2.86 value of 'b' for mola carplet (*A. mola*).

The exponential value 'b' was found to be 2.913, 2.751 and 2.809 for male, female and combined sex of *P.sarana*. The growth of male was isometric because the values of b were very close to 3 (b = 3), which indicates that, the weights of fishes either tend of increase or decrease in proportion to the cube of length while female and combined sex were negative allometric, which indicates that, the increase in length is not in accordance with increase in weight. Similar findings were given by Sani *et al*. (2010) who reported 3.52 value of 'b' for *P. sarana*.

In *P. chola*, the value of exponent 'b' were also found to be 2.684, 2.784 and 2.746 for male, female and combined sex respectively which shows negative allometry. Salam *et al*, (2005) reported the exponential value of 'b' for *P. chola* (2.8) which coincides with the present study. It was clearly indicated form the results of the present study that three species having value of lower than 3 form 'b' (b <3) indicates negative allometric growth expect the male of *P. sarana*. Pauly *et al*, (1997) reported that value of 'b' ranged between 2.5 to 3.5, which suggest that the results of the present study coincide with these observations.

Furthermore, the r values of length-weight relationships of three small indigenous species were relatively high. High correlation 'r' proved a strong relationship between the length and weight in this species (Ahemad and Irman, 2005).

The condition factor expresses the condition of a fish, such as the degree of well being relative robustness, fatness in numerical terms. In the present study, monthly variation of K and K_n value was not distinctly difference. The fluctuation in the value of K and K_n in fish has been mainly assigned to dependency on many factors such as feeding intensities, fish size and availability of fish (Le Cren, 1951). The value of K and K_n in all size groups of both male and female of three species decrease with increasing size except the female of *P. chola* at size groups 11-13cm and male of *P. sarana* at size groups 13-15cm. The declining trends of K value with increase of length are reported to be a good indication of length at which sexual maturity starts (Harts, 1946).

In the present study the mean K_n was 1.06 for female and 1.05 for male of *A. atkinsonii*. Similarly, the mean K_n was 1.05 for female and 1.09 for male in *P.sarana* and the mean K_n was 1.05 for female and 1.07 for male in *P. chola*. According to (Le Cren (1951); Dar *et al*., 2012) ' K_n ' greater than one indicated good general condition of fish. Alam *et al*, (2014) studied the condition of five freshwater fishes and only the *A.mola* was found to have value (0.97). Bhuiyan & Biswas (1982) reported K_n value for *P. chola* (1.001). A number of factors (eg.sex, seasons. environmental conditions, stress and availability of food) are also affecting the condition of fish.

Change of sex ratio corresponding to the body length is an important parameter which may be directly related with growth rate, natural and fishing mortalities (Roomiani *et al.*, 2014). The sex ratio indicates the comparison between males and females in a population.

In this study, the total sex ratio of *A. atkinsonii* was M: F = 1:5, 1:6.3 in *P. sarana* and 1:6 in *P. chola*. This sex ratio was changed between different months, but female predominate males. Dominace of females over the males complies with the results of Amin *et.al* (2005)

(male to females 1:5.09). A similar observation was reported by Azadi and Mamun (2004) in *A. mola* with a male-female sex ratio of 1:2.078. Gogoi (2014) also reported that sex ratio of *A. mola* was M: F = 1:1.953 of *A. atkinsonii.*

Monthly variation in sex ratio of *A. atkinsonii* was (1:4 to 1:9) and females were more numerous in January, in *P. sarana* was (1:4 to 1:9.5) and more females were caught in November and in *P. chola* was (1:3.8 to 1:5.3) and more females were caught in February.

From the above finding it can be concluded that the length-weight relationship of three small indigenous species in both sexes combined, indicates almost negative allometric pattern of growth in the study period, the increase in length is not in accordance with increase in weight. However the male of *P. sarana* followed isometric pattern of growth. From the study on sex ratio it was observed that during the study period, most of the fishes (in random sampling) were females. These parameters have been very useful to evaluate the well-bLake of populations, their biology as well as other small indigenous fish species of Myanmar for scientific management of fisheries and stock assessment.

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