Population structure and growth characteristics of oriental river prawn, *Macrobrachium nipponense* (De Haan, 1849) in Soon Lun Reservoir, Mandalay Region, Myanmar

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Abstract

Investigation on the population structure and growth characteristics of freshwater oriental river prawn, *Macrobrachium nipponense* was conducted in Soon Lun Reservoir of Myingyan Township, Mandalay Region, Myanmar from June 2009 to May 2010. This study was aimed to investigate size frequency distribution, length-weight relationship and condition factor from study area. A total of 2207 specimens including 955 (56.73%) males and 1252 (43.27%) females were collected. It was observed that the numbers of females were significantly different (p< 0.05) from males. The differences in size group between sexes indicated a sexual dimorphism in *M. nipponense*. The medium size class of male total length (TL) was 51-80 mm and female TL was 41-65 mm predominated throughout the study period. The correlation coefficient of male (r = 0.947), non berried female (r = 0.801) and berried female (r = 0.912) were strongly positive related (p<0.01). The value of coefficient (b) was 3.098 for male and 3.069 for non berried female indicate isometric growth and 3.424 for berried females show positive allometric growth. The mean monthly condition factor (K) ranged from 0.95 ± 0.11 – 1.49 ± 0.36 for males, from 0.99 ± 0.12 – 2.29 ± 0.27 for non berried females and 1.02 ± 0.11 – 1.81 ± 0.03 for berried females. The fluctuation
was observed in the mean monthly condition factor (K) for both males and females and better condition factors of *M. nipponense* were found in cold season for both sexes.

**Key words:** *Macrobrachium nipponense*, population structure, growth characteristic, Soon Lun Reservoir, Myanmar

**Introduction**

Freshwater prawns are decapod crustaceans belonging to the family Palaemonidae. The vast majority of freshwater prawn species of commercial interest belong to the genus *Macrobrachium* is found in tropical and subtropical regions of the world (Chace, 1992). About 240 species have been described in this genus (Wowor, et al., 2009). It is widely distributed and abundant macro-invertebrates in most aquatic system (Cook, Bunn, & Hughes, 2002).

Among this genus *Macrobrachium*, 48 species are consumed as food and hence they are economically important. About half of these species have been examined for their potential suitability for aquaculture. Over 130 species of *Macrobrachium* is characterized by a high ecological flexibility (Holthuis, 1980). It can be ecologically separated into two groups: most species are widely distributed and require a certain saline concentration (i.e., 10‰- 35‰) to complete their larval development, as euryhaline species; other are land-locked species, with limited distribution and complete their entire life cycle in freshwater (Shokita, 1979).

*Macrobrachium nipponense* belonging to land-locked species (Liu, Cai, & Tzeng, 2007) is commonly found in various kinds of inland water bodies in Japan, Korea, Vietnam, Taiwan and Myanmar (Cai & Ng, 2002). Interest on *M. nipponense* has been increased recently due to capability of reproduction naturally in all kinds of freshwater bodies and fast growth rate, tolerance for disease, longer breeding (compared
with *M. rosenbergii* the culture of prawn in freshwater. Thus it has become another important freshwater culture prawn species.

In Myanmar, 17 species of the genus *Macrobrachium* are revised and discussed. Among these, *M. nipponense* is reported from Myanmar for the first time. It is found in various kinds of inland water bodies (Cai & Ng, 2002).

In fisheries research, length-weight relationships are important for the estimation of weights where only length data are available and as an index of the condition factor of the fish (Haimovici & Velasco, 2000). Among its most frequent uses, Pauly (1993) noted the importance of Length-Weight Relationships (LWR) in the calculation of the fish’s average weight at a certain length class and the conversion of an equation of growth in length into an equation of growth in weight, besides morphological comparisons between populations of the same species.

Condition factor has been used as an index of growth and feeding intensity (Abowei, Davies, & Eli, 2009). Condition factor decreases with increase in length (Abowei, 2010) and also influences the reproductive cycle in fish. The condition factor referred to as K factor provides information on well being of a fish and is usually influenced by age of fish, sex, season, maturity stages etc. Fish specimens of a given length exhibiting higher weight are said to be in better condition (Anyanwu et al., 2007). The same principle is also applicable in the study of prawns in general as shown above.

In this study, the mathematical parameters of the relationship between the length and weight of fish furnish further information of the weight variation of individuals in relation to their length (condition factor, K). This factor estimates the general well-being in Soon Lun reservoir. The present study was conducted to examine the population structure
with emphasis on size frequency distribution, and growth characteristics such as the length-weight relationship and condition factor of *Macrobrachium nipponense*. Therefore, it was eager to investigate that whether there is a difference in size frequency distribution, growth characteristics such as length-weight relationship and condition factor between male and female.

**Materials and Methods**

**Study Area**

The present research was carried out in Soon Lun reservoir from June 2009 to May 2010. It is located in Myingyan Township, Mandalay Region and situated between 21°24'16.54" N and 21°25'26.74" N and 95°24' 40.56" E and 95°26' 13.07" E (Fig. 1).

![Fig. 1 Map of Soon Lun Reservoir (Source: Google Earth)](image)

**Collection of Specimens**

Samples of *Macrobrachium nipponense* were collected monthly from the study area and were captured by bamboo traps with the help of local fishermen. Specimens were preserved in 5% formalin immediately after collection and some were transported alive to the laboratory of Zoology Department, University of Mandalay for further analysis.
Identification of the Specimens

Specimens were identified according to Holthuis (1950), Jayachandran (2001), Cai and Ng (2002) and Salman, Page, Naser, and Yasser (2006).

Data Analysis

In order to work out the length frequency, approximately 200 to 400 specimens per month were randomly collected and their length taken and recorded. Altogether 13 length class sizes were determined with class interval of 4 mm within size classes. The data of length – frequency and comparison of the mean total length of males and females were also analyzed. Length and weight regression analysis and significance of regressions was assessed by Student’s t-test (Zar, 1996).

Total length of *Macrobrachium nipponense* from tip of the rostrum to the end of telson was measured to the nearest millimeter and total weight was taken by an electronic balance of 0.001g accuracy. To establish the length-weight relationship, the commonly used relationship $W = aL^b$ was applied (Ricker, 1975), where, $W$ is the weight (g), $L$ is the total length (mm), ‘$a$’ is intercept and ‘$b$’ is the growth coefficient. Expression of length weight relationship was transformed logarithmically $\log W = \log a+ b \log L$ based on LeCren (1951). The value of $b$ gives information on the kind of growth type: the growth is isometric if $b = 3$ and the growth is allometric: negative allometric if $b < 3$ and positive allometric if $b > 3$ (Pauly, 1984).

The condition factor (K) was calculated from data obtained from the length and weight measurement using the equation.

$$K= \frac{W}{L^3} \times 100$$  \hspace{1cm} (Ricker, 1975)

Statistical Analysis

All statistical analyses were performed using Microsoft Office Excel 2007).
Results

Number of Specimens Examined

A total of 2207 specimens (955 males and 1252 females) were examined. Total length of males ranged between 40-89 mm and that of females were 38-77 mm (Fig. 2 and 3).

Systematic Position and Description

Systematic position of *Macrobrachium nipponense* (De Haan, 1849) is followed after Jayachandran (2001).

- **Phylum**: Arthropoda
- **Class**: Crustacea
- **Subclass**: Malacostraca
- **Order**: Decapoda
- **Suborder**: Natantia
- **Section**: Caridea
- **Family**: Palaemonidae
- **Genus**: *Macrobrachium* Bate, 1868
- **Species**: *M. nipponense* (De Haan, 1849)
- **Common name**: Oriental river prawn
Population Structure

Total number of individuals collected for this study was 2207 in which 955 (43.27%) was males and 1252 (56.73%) were females (Fig. 4). Among 1252 females, 498 were non berried females (Fig. 5). The population structure in terms of size frequency distribution was made for both sexes of *Macrobrachium nipponense*. A total of 13 size classes were categorized. The total length (TL) ranges for male, non berried female and berried female were 38 - 94 mm, 32-70 mm and 38-77 mm respectively. The mean total lengths of male and female were 60.63±9.96 mm and 55.17±6.70 mm respectively. The mean total length of male was 5.5 mm longer than that of female and significantly different (p < 0.05). The medium size class for male (TL= 51-80) mm and for female (TL= 41-65) mm predominated the population throughout the study period. The overall size frequency distribution showed a modal size class for male and female of *M. nipponense* as 61-65 mm and 56-60 mm respectively. According to the size frequency distribution, there was significant difference between sexes. In males, the highest size class was indicated from 71-75 mm to 91-95 mm. In females, it was 41-45 mm to 56-60 mm. Percentage overall size frequency distribution of males and females were calculated by pooling the monthly recorded data (Table 1 and Fig. 6). Size frequency distribution of *Macrobrachium nipponense* in Soon Lun reservoir (June 2009-May 2010)
Fig. 4 Number of individuals (male and female) of *M. nipponense* collected during the study period

Fig. 5 Number of individuals (male, berried female and non berried female) of *M. nipponense* collected during the study period

Fig. 6 Size frequency distribution of *M. nipponense* (male and female) in the study area
Table 1 Size frequency distribution of *Macrobrachium nipponense* in Soon Lun reservoir (June 2009-May 2010)

| Size group (mm) | No. of Males | No. of Females | Total | Percentage |
|----------------|--------------|----------------|-------|------------|
|                | Male | Female | Male | Female |
| 31-35          |     - | 1       | 3    | 100 |
| 36-40          | 14   | 12      | 26   | 53.85 46.15 |
| 41-45          | 32   | 90      | 122  | 26.2 73.8 |
| 46-50          | 61   | 238     | 299  | 20.4 79.6 |
| 51-55          | 86   | 328     | 414  | 20.8 79.2 |
| 56-60          | 141  | 340     | 481  | 29.3 70.7 |
| 61-65          | 195  | 174     | 369  | 52.8 47.2 |
| 66-70          | 171  | 60      | 231  | 74.02 25.98 |
| 71-75          | 122  | 5       | 127  | 96.1 3.9 |
| 76-80          | 73   | 2       | 75   | 97.3 2.7 |
| 81-85          | 40   |         | 40   | 100 - |
| 86-90          | 16   |         | 16   | 100 - |
| 91-95          | 4    |         | 4    | 100 - |
| Total          | 955  | 1252    | 2207 | 43.27 56.73 |

Growth Characteristics

The growth characteristics were analyzed in terms of length-weight relationship and condition factor of the species. The linear regression of total length (TL) and total weight (TW) showed positive relationship for males ($R^2 = 0.896$ or $r = 0.947$), berried females ($R^2 = 0.832$ or $r = 0.912$) and non berried females ($R^2 = 0.642$ or $r = 0.801$). Therefore, correlation coefficient ($r$) of both sexes is strongly positive correlation ($p<0.01$). The growth coefficient $b$ was 3.098 for males and 3.424 for berried females and 3.069 for non berried females. This indicates positive allometric nature of growth.
for berried females and isometric growth for males and non berried females (Table 2 and Fig. 7-9).

The results of condition factor (K) were also determined for *M. nipponense*. Condition factor (K) was used as an indicator to evaluate variation in different months as well as in different size (length) classes. The monthly mean condition factor (K) ranged from (0.9536±0.1103–1.4971±0.3575) for males, from (0.9921±0.1154–2.2971±0.2677) for non berried females and (1.023±0.1085–1.8082±0.0272) for berried females. In males, the highest condition factor (K) (1.4971±0.3575) was recorded in January 2010; while the lowest result (0.9536±0.1103) in May 2010. In non berried females, the highest condition factor (K) (2.2971±0.2677) occurred in October 2009 while the lowest (0.9921±0.1154) in February 2010. In berried females, the highest values of K (1.8082±0.0272) was recorded in January while the lowest K value (1.023±0.1085) in June. The highest condition factor (K) in the entire study period for males and females were recorded in January, indicated that the growth phase of *M. nipponense* occurred during the cold season (Fig.10).
Fig. 7 Relationship between total length (mm) and body weight (g) of *M. nipponense* (male) in study area

Fig. 8 Relationship between total length (mm) and body weight (g) of *M. nipponense* (non-berried female) in study area

Fig. 9 Relationship between total length (mm) and body weight (g) of *M. nipponense* (berried female) in study area

Fig. 10 Fluctuation in the monthly condition factor (K) for male and female of *M. nipponense* in the study area
Table 2 Length-weight relationship of *Macrobrachium nipponense* in Soon Lun reservoir

| Sex          | N   | TL range (mm) | TW range (g) | a   | b   | R²  | r   | t    | Growth type |
|--------------|-----|---------------|--------------|-----|-----|-----|-----|------|-------------|
| Males        | 955 | 38 - 94       | 0.705 - 7.524| 0.0081 | 3.097 | 0.896 | 0.947 | 90.744** | Isometric   |
| Females (non berried) | 498 | 32 - 70       | 0.414 - 4.911| 0.012 | 3.069 | 0.642 | 0.801 | 29.845** | Isometric   |
| Females (berried) | 754 | 38 - 77       | 0.471 - 5.901| 0.005 | 3.424 | 0.832 | 0.912 | 61.064** | Positive Allometric |

N = Total number  
TL = Total length  
TW = Total weight  
a = intercept  
b = the growth coefficient  
R² = Coefficient of determination  
R = Correlation coefficient  
** = p < 0.01

Discussion

Cai and Dai (1999) reported that *Macrobrachium nipponense* is commonly found in various kinds of inland water bodies in main islands of Japan, Korea, China, Taiwan and Vietnam. Cai and Ng (2002) also recorded this species to be distributed in Shan State, Ayeyawady drain and Mu-Se of Myanmar although the occurrence of *M. nipponense* has not yet been recognized by Myanmar researchers.

The different body growth rates between males and females have been reported for many *Macrobrachium* species. Growth of *M. olfersi* and *M. iheringi* respectively studied by Mossolin and Bueno (2003) and Fransozo, Rodrigues, Freire, and Costa (2004) showed that males reached a greater total length than females as a function of the differences in growth rates and patterns of population structure between sexes.
In the present study, the difference in size of *M. nipponense* in the sampling area, the mean total length of male was 5.4 mm which was larger than that of the females. Males attained a greater size indicating a sexual dimorphism in *M. nipponense*. The overall size frequency distribution showed a greater abundance of females in the first size class and a larger number of males in the final class and a modal size class for male and female of *M. nipponense* as 61–65 mm and 56–60 mm respectively. The difference in growth for males and females was observed by Mantelatto and Barbosa (2005) who studied on *M. brasiliense* from São Paulo State, Brazil and Fransozo et al. (2004) on *M. iheringi* in the Botucatu region in Brazil. The differences in size group among sexes indicating an early preparation for reproduction in females compared to males. Furthermore, females seem to have a shorter life span or to grow less than males, as confirmed by the larger number of males in the final size classes (Fransozo et al., 2004).

The growth coefficient ‘b’ of length-weight relationship generally lies between 2.5 and 3.5 and the relation is said to be isometric when it is equal to 3, which reported for most aquatic organisms (Carlander, 1977; LeCren, 1951). Deekae and Abowei (2010) obtained the b values (2.11–3.13) from the length weight relationship (LWR) of *M. macrobrachion* in Luubara creek. Hence, its growth in the individual sexes is allometric (b values less than 3 and greater than 3). Waribugo (2005) reported that the growth pattern of *Nematopalaemon hastatus* and *Palaemon maculates* were isometric (b = 3).

In the present case, the estimated ‘b’ was 3.098 for male and 3.069 for non berried female. The growth pattern of both sexes indicated isometric nature. The value b was 3.424 for berried female, indicating the positive allometric growth. The value b in the present study represented that the prawn maintained constant body shape with proportionate increase in length and weight. Regression analysis showed a strongly
positive relationship of both sexes (r = 0.947 for males and r = 0.912 for berried female and r = 0.801 for non berried females). Similar trend was also observed on two M. macrobrachion by Abohweyere and Williams (2008) in Lagos – Lekki Lagoon System, Nigeria. A strongly linear relationship between length and weight of male as well as in ovigerous and nonovigerous females were also observed in M. palaemonoides from Taungthaman Lake, Mandalay Region according to Win Mar (2007). The variation in the values of b and r is understandable because length-weight relationship of a species could vary according to local factors such as salinity, temperature and species health, sex, stage of maturity, length range of the species, food and time of year season (Yakubu & Ansa, 2007).

The condition factor (K) is a measure of the suitability of the environmental factor for growth of the species (Abohweyere & Williams, 2008). According to Arimoro and Meye (2007), the condition factor (K) is used to compare the “condition of fatness” or well-being of the individuals of the species and also the condition factor (K) was used as an indicator to evaluate variation in the individuals in different months as well as in different size. They revealed that the monthly condition factor (K) of Macrobrachium dux, ranged from 1.43 to 2.37 and generally showed a monthly fluctuation with a peak in July. In the present study, the fluctuation was observed in the mean monthly condition factor (K) for both males and females. The lowest mean condition factor (K) (0.9536±0.1103) for male, (1.0233 ± 0.1085) for berried female and (0.9991 ± 0.0945) for non berried female were observed in May, June and May, respectively. The highest mean condition factor K (1.4971±0.3575) for male, (1.8082±0.0272) for berried female and (2.2971±0.2677) for non berried female were calculated in January, September and October respectively. Better condition factors of M. nipponense were found in cold season for both sexes.
Conclusion

The fluctuation of the mean monthly condition factor (K) for male and female prawns were observed. Medium size class, relationship between total length and total weight, and condition factor (K) in Soon Lun Reservoir may be considered to be suitable for growth factor.

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