

## Length-weight and length-length relationships and condition factor of *Alburnus mossulensis* (Heckel, 1843) from the Persian Gulf basin

<sup>1</sup>Hamed Mousavi-Sabet, <sup>2</sup>Sara Abdollahpour, <sup>3</sup>Ammar Salehi-Farsani, <sup>4</sup>Saber Vatandoust, <sup>2</sup>Hamid F. Langroudi, <sup>2</sup>Hamid R. Jamalzade, and <sup>1</sup>Akbar Nasrollahzadeh

<sup>1</sup> Department of Fisheries, Faculty of Natural Resources, University of Guilan, Sowmeh Sara, Guilan, Iran; <sup>2</sup> Department of Fisheries, Tonekabon Branch, Islamic Azad University, Tonekabon, Iran; <sup>3</sup> Department of Fisheries, Science and Research Branch, Islamic Azad University, Tehran, Iran; <sup>4</sup> Department of Fisheries, Babol Branch, Islamic Azad University, Mazandaran, Iran. Corresponding author: S. Abdollahpour, anahitaabdollahpour@gmail.com

**Abstract.** The length-weight and length-length relationships and condition factor for *Alburnus mossulensis* is described from 325 specimens collected between January 2011 and December 2011 in Gamasiab River, the Tigris River drainage, the Persian Gulf basin, west of Iran. The maximum standard length recorded for males and females were 14.5 cm and 15.5 cm, respectively. The length-length relationship between the total length (TL), fork length (FL) and standard length (SL) for *A. mossulensis* was found to be highly significant ( $r^2 > 0.96$ ,  $p < 0.001$ ). The value of "b" of the length-weight relationship was 3.172 which indicated a positive isometric growth trend of this species. The males and females condition factors (K) varied from  $0.32 \pm 0.02$  to  $2.01 \pm 0.14$  and  $0.20 \pm 0.02$  to  $2.51 \pm 0.21$ , respectively. The means of the K value were significantly high in April, May and Jun. The two-way ANOVA indicated significant differences in K value among months.

**Key Words:** length-weight relationship, length-length relationship, Gamasiab River, condition factor.

**Introduction.** Thirty-eight species are presently recognized in the European and Western Asian genus *Alburnus* (Bogutskaya 1997; Bogutskaya et al 2000; Freyhof & Kottelat 2007; Kottelat & Freyhof 2007; Özulug & Freyhof 2007). Iran is an important geographic area and zoogeography in the Middle East. The cyprinid genus *Alburnus* has seven confirmed species recorded from Iranian waters. The Zagros Mountains in Iran have a series of rivers draining westward and southward to the Tigris River or to the head of the Persian Gulf. *Alburnus mossulensis* has been recorded from these rivers.

Indeed, the knowledge on quantitative aspects such as length-weight relationship, length-length relationship, condition factor, growth and recruitment are important tools for the adequate management of any fish species (King 2007; Ndome et al 2012). The length-weight (LWR) and length-length (LLR) relationships have been applied for basic uses for assessment of fish stocks and populations (Ricker 1968). The length-weight relationships also helps to figure out the condition, reproduction history, life history and the general health of fishing species (Nikolsky 1963; Wootton 1992; Pauly 1993; Wootton 1990) and is also useful in local and interregional morphological and life historical comparisons in species and populations. The length-weight relationship of fish is an important fishery management tool. It is important estimating the average weight at a given length group (Beyer 1987) and it is also useful for converting length observations into weight estimates to provide some measure of biomass (Froese 1998). It is necessary to use standard measures for all populations to render the results more reliable when making comparisons between populations. Therefore, the length-length relations of species under various environmental conditions should be known. The length-

length relationship is also of great importance for comparative growth studies (Moutopoulos & Stergiou 2002). In fisheries studies, fish length can often be measured more rapidly and easily than mass. The knowledge of the length-weight relationship makes it easier to determine the mass where only the length is known. In the field, the tail flukes are often cut, which makes it difficult to measure the total length accurately. Knowing the standard length will enable us figure out the total length. The well-being state of the fish can be inferred with a condition factor (Le Cren 1951), which is used for comparing the condition, fatness or well-being of fish (Tesch 1968), assuming that heavier fish of a given length are in better condition. Condition factor has been used as an index of growth and feeding intensity (Fagade 1979). Condition factor also influences the reproductive cycle in fish (Welcome 1979). Keeping in view that the basic requirements for the sustainable management of the fisheries is the assessment of the fish populations, the present study was initiated. The aim of the present study is to determine the length-weight and length-length relationships and condition factor of males and females of *A. mossulensis*, the species caught in Gamasiab River in 2011.

**Material and Method.** Fishes were collected monthly from January 2011 to December 2011 by electrofishing in Gamasiab River (34°22'249"N, 047°54'729"E) in Kermanshah region in western Iran. The total length (TL), standard length (SL) and fork length (FL) of fish were measured ( $\pm 0.1$  cm), weighted ( $\pm 1$  g) with an electronic balance, and the sex was assigned by examining the gonads.

The length-weight relationships for weight were calculated using the equation,  $W=aL^b$  (Ricker 1979), where 'a' is a coefficient related to body form and 'b' is an exponent indicating isometric growth when equal to 3. The statistical significance level of  $r^2$  was estimated by linear regressions on the transformed equation,  $\text{LogBW}=\text{loga}+b*\text{logSL}$ . The length-weight relationship between males and females were calculated separately. Moreover, TL vs FL; FL vs SL; and SL vs TL relationships were calculated by linear regressions. The fish monthly condition factor (K) was calculated with equation  $K= W/aTL^b$  (Le Cren 1951). All statistical analyses were evaluated at  $p<0.05$  significance level.

**Results.** A total of 325 specimens of *A. mossulensis* were examined. The maximum SL and weight of *A. mossulensis* recorded in this study was 15.5 cm and 54.6 g. The minimum and maximum standard length and weight in different months are shown in Table 1. It was determined that 43.7% of the samples were females ( $n=142$ ) and 56.3% males ( $n=183$ ).

**Length-weight relationship.** Monthly length-weight relationships for males, females and the total sample population were determined and shown in Table 1. Analysis of covariance revealed significant differences between sexes for the slopes (b) of the regression lines ( $p<0.001$ ).

**Length-length relationship.** Length-length relationships and the coefficient of determination  $r^2$  are given in Table 2. In this study the length-length relationships in *A. mossulensis* was found to be highly correlated (in all cases:  $r^2>0.96$ ,  $p<0.001$ ).

**Condition factor.** The males and females condition factors (K) varied from  $0.32\pm 0.02$  to  $2.01\pm 0.14$  and  $0.20\pm 0.02$  to  $2.51\pm 0.21$ , respectively. The means of the K value were significantly high in April, May and Jun (Figure 1). The two-way ANOVA indicated significant differences in K value among months.

Table 1  
Monthly descriptive statistics and estimated parameters of length-weight relationships for both sexes of *A. mossulensis* in Gamsaiab River from January 2011 to December 2011

| Month    | Sex | N   | Standard length |          | Total weight |           | Relationship parameters |       |                |
|----------|-----|-----|-----------------|----------|--------------|-----------|-------------------------|-------|----------------|
|          |     |     | Range           | Mean±SD  | Range        | Mean±SD   | a                       | b     | r <sup>2</sup> |
| Jan      | M   | 13  | 8.5-13.0        | 11.9±1.8 | 6.7-23.4     | 13.2±5.1  | 2.045                   | 3.002 | 0.937          |
|          | F   | 11  | 8.0-14.5        | 12.0±1.2 | 8.3-28.9     | 14.5±4.2  | 2.152                   | 3.103 | 0.928          |
| Feb      | M   | 15  | 7.0-13.5        | 11.6±1.0 | 6.3-24.2     | 12.9±4.5  | 2.225                   | 3.212 | 0.963          |
|          | F   | 12  | 8.0-14.0        | 11.7±1.3 | 8.1-26.8     | 13.6±4.5  | 2.205                   | 3.132 | 0.926          |
| Mar      | M   | 12  | 7.5-13.0        | 11.7±1.5 | 6.6-34.7     | 25.9±7.7  | 2.163                   | 3.129 | 0.972          |
|          | F   | 13  | 7.5-14.5        | 12.2±1.6 | 10.5-44.8    | 29.1±8.7  | 1.452                   | 2.538 | 0.939          |
| Apr      | M   | 14  | 9.0-14.0        | 11.8±1.2 | 18.2-38.6    | 28.4±5.9  | 2.034                   | 3.046 | 0.942          |
|          | F   | 13  | 8.5-15.5        | 12.6±0.9 | 15.6-47.5    | 29.1±6.6  | 1.893                   | 3.011 | 0.909          |
| May      | M   | 16  | 11.0-14.5       | 12.8±0.8 | 20.3-43.0    | 31.7±6.1  | 1.610                   | 2.662 | 0.954          |
|          | F   | 15  | 10.0-14.0       | 12.1±1.4 | 17.0-54.6    | 30.3±11.2 | 0.945                   | 2.115 | 0.837          |
| Jun      | M   | 19  | 8.5-14.0        | 11.3±1.4 | 9.5-39.5     | 24.2±7.3  | 2.345                   | 3.246 | 0.972          |
|          | F   | 11  | 9.5-13.0        | 11.5±1.1 | 16.2-39.2    | 27.2±6.5  | 1.905                   | 2.898 | 0.981          |
| Jul      | M   | 17  | 9.0-13.5        | 11.4±1.0 | 8.8-30.7     | 15.1±5.9  | 2.135                   | 3.112 | 0.928          |
|          | F   | 12  | 8.5-14.0        | 11.8±1.5 | 9.1-28.9     | 14.7±7.4  | 2.097                   | 3.108 | 0.933          |
| Aug      | M   | 18  | 9.0-14.0        | 11.0±1.2 | 7.9-27.4     | 14.8±6.2  | 2.227                   | 3.234 | 0.949          |
|          | F   | 12  | 8.0-15.0        | 12.0±1.3 | 8.5-33.4     | 14.9±9.3  | 2.211                   | 3.187 | 0.917          |
| Sep      | M   | 12  | 10.0-14.0       | 11.9±1.2 | 15.3-40.0    | 25.0±7.3  | 1.727                   | 2.742 | 0.951          |
|          | F   | 11  | 10.5-15.0       | 12.5±1.4 | 16.9-53.8    | 31.3±10.8 | 1.421                   | 2.520 | 0.893          |
| Oct      | M   | 13  | 9.5-14.5        | 11.8±1.6 | 9.3-38.6     | 24.8±6.8  | 2.233                   | 3.225 | 0.955          |
|          | F   | 9   | 9.0-15.5        | 12.7±1.5 | 15.1-39.2    | 23.5±8.4  | 2.218                   | 3.189 | 0.934          |
| Nov      | M   | 16  | 8.5-13.0        | 10.9±1.1 | 7.2-18.4     | 12.7±4.6  | 2.116                   | 3.011 | 0.927          |
|          | F   | 11  | 7.5-14.0        | 12.1±1.3 | 7.1-18.8     | 12.9±3.6  | 2.129                   | 3.128 | 0.936          |
| Dec      | M   | 18  | 8.0-11.0        | 9.4±1.1  | 5.9-19.5     | 11.7±4.0  | 1.948                   | 2.846 | 0.964          |
|          | F   | 12  | 8.0-11.5        | 9.9±1.1  | 7.1-18.8     | 12.9±3.8  | 2.001                   | 2.883 | 0.935          |
| Over all | M   | 183 | 7.0-14.5        | 11.5±1.2 | 6.3-43.0     | 20.0±5.9  | 2.239                   | 3.176 | 0.924          |
|          | F   | 142 | 7.5-15.5        | 11.9±1.3 | 7.1-54.6     | 21.2±7.1  | 2.138                   | 3.110 | 0.945          |
|          | A   | 325 | 7.0-15.5        | 11.7±1.2 | 6.3-54.6     | 20.6±6.4  | 2.218                   | 3.172 | 0.938          |

M: male, F: female, A: all sexes, N: number of individuals, a: intercept, b: slope, r<sup>2</sup>: coefficient of determination.

Table 2  
Length-length relationships between total length (TL), fork length (FL) and standard length (SL) of *A. mossulensis* in Gamsaiab River from January 2011 to December 2011

| Sex    | Equation | N   | a      | b      | r <sup>2</sup> |
|--------|----------|-----|--------|--------|----------------|
| Male   | TL=a+bFL | 183 | 1.0370 | 0.4811 | 0.9806         |
|        | FL=a+bSL |     | 1.0330 | 0.6229 | 0.9729         |
|        | SL=a+bTL |     | 0.8934 | 0.5149 | 0.9600         |
| Female | TL=a+bFL | 142 | 1.0318 | 0.5904 | 0.9896         |
|        | FL=a+bSL |     | 1.0444 | 0.4587 | 0.9733         |
|        | SL=a+bTL |     | 0.8947 | 0.5316 | 0.9649         |
| All    | TL=a+bFL | 325 | 1.0356 | 0.5174 | 0.9843         |
|        | FL=a+bSL |     | 1.0370 | 0.5627 | 0.9731         |
|        | SL=a+bTL |     | 0.8939 | 0.5220 | 0.9623         |

N: number of individuals, a: intercept, b: slope, r<sup>2</sup>: coefficient of determination.

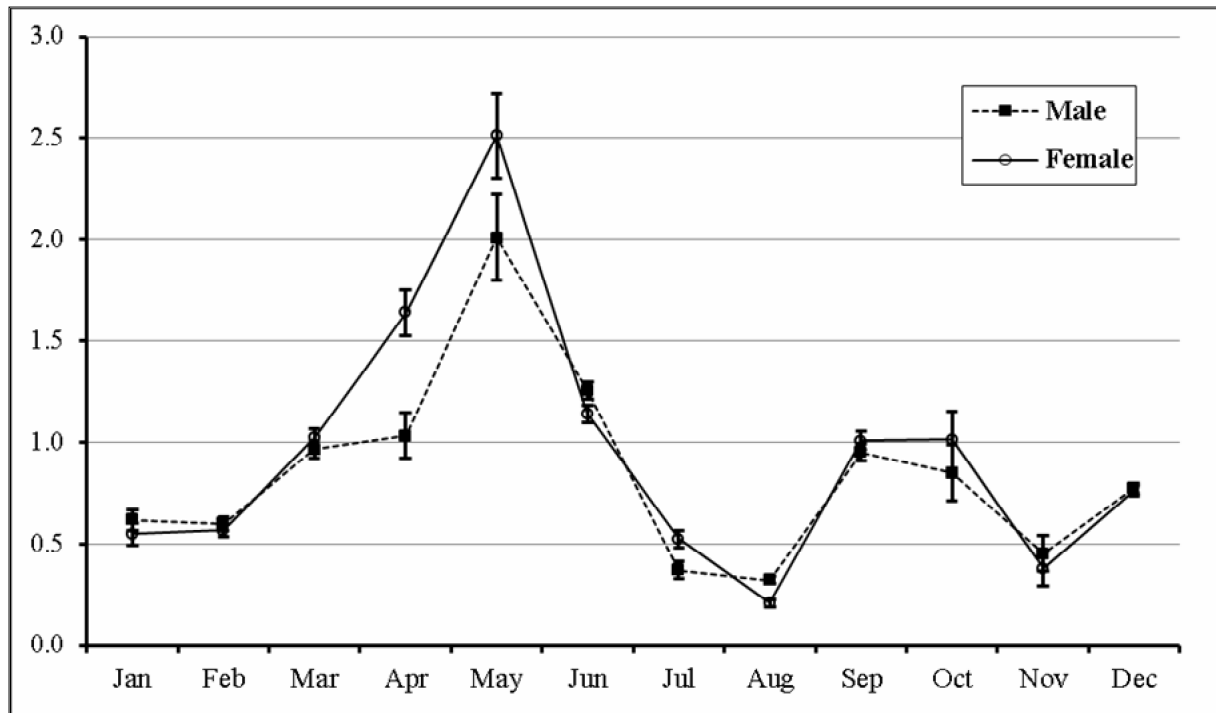


Figure 1. Variation of female and male condition factors (mean  $\pm$  SE) of *A. mossulensis* in Gamsaiab River from January 2011 to December 2011.

**Discussion.** Several researchers have made estimations on length-weight and length-length relationships in different fish species. Le Cren (1951) has stated that the length-weight relationship in fishes are probably related to the seasonal variation since fat and water content of fish may vary according to temperature. The change in 'b' value shows allometric growth of the body due to the influence of numerous factors such as seasonal fluctuations, changes in physiological condition during spawning periods, gonad development, sex, physicochemical conditions of the environment and nutrition conditions of the environment (Sinha 1973). The reported exponent values for 'b' for different fishes ranged between 2.5 to 4.0 (Hile 1936; Martin 1949) and 2 to 4 (Bagenal & Tesch 1978; Koutrakis & Tsikliras 2003). Sekharan (1998) have also observed an inter specific for 'b' that remains constant at '3.0' for an ideal fish. In the present fish sample, the calculated values for 'b' for length and weight were higher than 3, i.e., 3.110 and 3.176 which were of expected range and indicated that the growth is nearly isometric in *A. mossulensis*. Le Cren (1951) states that the length weight relationship in fishes is probably related to the seasonal variations as fishes do not retain the same shape or body contour throughout the year. So there should be slight change in slope values in different seasonal studies. The values of coefficient of determination ' $r^2$ ' calculated for all relationships viz., TL-Wt, and TL-SL, FL-TL and SL-FL in *A. mossulensis* (Tables 1 and 2) were 0.938 and 0.962, 0.984 and 0.973, respectively which are highly significant ( $p < 0.001$ ).

Wootton (1992) however opined that  $b < 3$  indicates that the fish gets relatively thinner as they grow larger while  $b > 3$ , it is plumper as it grows larger. Regression coefficients obtained from length-weight relationships (L-W) which are indicative of isometric or allometric growths differ not only between species but sometimes also between stocks of same species. The development of fish involves several stages, each of which has its own length-weight relationships. There may also be differences in the relationships due to sex, maturity, season and environmental conditions (e.g. pollution). *A. mossulensis* in the study was observed to be in good condition, as the value of "k" was higher than one. A number of factors (e.g. sex, seasons, environmental conditions, stress, preservation, maturity, sex, availability of food) also affect the condition of fish.

**Conclusions.** In the present study an important contribution is the provision of base-line data on the length-weight and length-length relationships and condition factor of the *A. mossulensis*, which are important tools for the adequate management of the fish stocks and populations.

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Authors:

Hamed Mousavi-Sabet, Department of Fisheries, Faculty of Natural Resources, University of Guilan, Sowmeh Sara, Guilan, Iran, e-mail: mousavi-sabet@guilan.ac.ir  
 Sara Abdollahpour, Department of Fisheries, Tonekabon Branch, Islamic Azad University, Tonekabon, Iran, e-mail: anahitaabdollahpour@gmail.com  
 Ammar Salehi-Farsani, Department of Fisheries, Science and Research Branch, Islamic Azad University, Tehran, Iran e-mail: ammar\_1631@yahoo.com  
 Saber Vatandoust, Department of Fisheries, Babol Branch, Islamic Azad University, Mazandaran, Iran, e-mail: s.vatandoust@gmail.com  
 Hamid Faghani Langroudi, Department of Fisheries, Tonekabon Branch, Islamic Azad University, Tonekabon, Iran, e-mail: hamid\_faghani1@yahoo.com  
 Hamid Reza Jamalzade, Department of Fisheries, Tonekabon Branch, Islamic Azad University, Tonekabon, Iran, e-mail: hamidreza\_jamalzadeh@yahoo.com  
 Akbar Nasrollahzadeh, Department of Fisheries, Faculty of Natural Resources, University of Guilan, Sowmeh Sara, Guilan, Iran, e-mail: nasrolla2003@yahoo.com

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