



RESEARCH PAPER

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Interrelationships between morphometric variables and total weight in male fish *Chondrostoma regium* (Heckel, 1843) evaluated by path analysis in Ghamasiab river Kermansha, Iran

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Key words: Path analysis, *Chondrostoma regium*, direct effect, indirect effect.

doi: <http://dx.doi.org/10.12692/ijb/3.12.120-126>

Article published on December 09, 2013

Abstract

The objective of this study was to verify which morphometric measures and their ratios are more directly associated with the Total weight yields in male fish of *Chondrostoma regium*. A total of 153 samples of male fish (*Chondrostoma regium*) from Ghamasiab River with average total weight of 73.47 g \pm 2.81 g. were sampled, weighed, measured, and studied for morphometric and their ratios and processing yield analysis. The morphometric measures taken were: total weight (TW g), total length (TL mm), standard length (SL mm), and fork length (FL mm). For completeness, the following morphometric ratios were calculated: SL/TL, FL/TL and FL/SL. the phenotypic correlations analysis between total weight and morphometric measurements and their ratios showed that total weight was significant positively correlated with other morphometric measurements. The TL (0.950**), SL (0.952**), FL (0.941**) and ratios SL/TL (0.246**) was highly positively significantly correlated with total weight. These correlations were later deployed in direct and indirect effects through path analysis, and the direct and indirect contributions of each variable were measured in percentage terms. The SL, FL measures by the direct effect and TL measures and TL/SL ratios by the indirect effect were important for determining the total weight of male fish in this species.

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Introduction

The genus *Chondrostoma* (*Cyprinidae*, *Cypriniformes*) contained about 26 species of which 2 are known for Iran including *Chondrostoma regium* (Heckel, 1843) and *C. cyri* (Kessler, 1877). The king nase, *C. regium* is a subtropical fresh water fish native to Tigris-Euphrates basin and the Mediterranean basins of South-eastern Turkey, Syria, Iraq and the northern Levant (Coad, 2009; Gumus, 2001). In Kermanshah this species found in Ghamasiab River and other waters of Kermansha province (Wossughi, 1987; Biokani *et al*, 1995). To the best knowledge of the authors, there is no prior information on morphometric variables for this species in Kermanshah. Thus, basic information is needed to develop population models for the conservation and management of king nase stocks (King, 1995; Charo-karisa *et al*, 2007). Correlation of body yields with morphometric measurements has been the subject of several studies for some fish species (Diodatti *et al*, 2008; Freato *et al*, 2005; Rafael *et al*, 2011). However, this simple correlation only makes it possible to evaluate the direction and magnitude of the association between two characters, without providing necessary information concerning the direct and indirect effects of a group of characters in relation to a dependent variable of major importance (Abbaspour *et al*, 2011, Ahmadi *et al*, 2011 and Cruz, 2001). Path analysis" is a device that a breeding researcher can use to break the correlation of direct and indirect effects (Carneiro, 2008; Cruz *et al*, 2003) through basic variables such as body yields, and explanatory variables such as morphometric ratios and measures, providing a better understanding of the reasons for the associations between these traits (Silva *et al*, 2009; Costa *et al*, 2011). This study used path analysis of the phenotypic correlations to verify which morphometric measures and ratios would be more directly associated with total weight of *C. regium*. Lawson *et al* (2011) Length-Weight Relationships and Morphometry for Eleven (11) Fish Species from Ogudu Creek, Lagos, Nigeria were studied. Rohollah Abbaspour *et al* (2010) Comparative Survey of

Morphometric-meristic Male and Female Anjak Fish (*Schizocypris brucei*, Annandale and Hora, 1920) of Hamoun Wetland in South East Iran were studied. Iqbal Mir *et al* (2011), Length-Weight Relationship and Condition Factor of *Schizopyge curvifrons* (Heckel, 1838) from River Jhelum, Kashmir, India were studied.

The aim of this study is a study interrelationships between morphometric variables and total weight in male fish *Chondrostoma regium* (Heckel, 1843) evaluated by path analysis in Ghamasiab river Kermansha, Iran.

Materials and methods

Materials

Fish samples were monthly collected in Gamasiab river was performed using by Cast net and Gillnet invarious mesh sizes of (1,2,3,4,5)cm and by 10,20,30,40 m length between August 2010 to July 2011. Gamasiab River in Kermanshah province 90 km long river (34°25' 39' N and E 47° 31' 02') its catchment area is over 12,000 square kilometers (Rahimzade *et al*, 2003). This river during the warm months of the year (late April to early November) with increasing temperature and decreasing rainfall has the lowest water volume (Biokani *et al*, 1995). The water temperature ranges from 8 °C to 32 °C throughout the year.

Methods

A total of 309 individuals (153 males) were sampled. Fish samples were preserved into formaldehyde 10% and taken to laboratory. The studied morphometric variables were: total weight (TW g), total length (TL mm), standard length (SL mm), fork length (FL mm) measured. For completeness, the following morphometric ratios were calculated: SL/TL, FL/TL and FL/SL (Lawson *et al*, 2010). The phenotypic correlation coefficients were computed and the path coefficient analysis was performed using phenotypic correlations to assess direct and indirect effects of morphometric and their ratios on total weight by SAS

9.2, PATH 2, IBMSPSS STATISTICS20, statistical software's.

Results and discussion

The Spearman's rank correlation coefficient between total weight and morphometric measurements were calculated (Table 1). The results indicated that TL, SL, FL, GW and OV had a significant ($P < 0.01$) positive correlation with Total weight. This result reported by other authors: Nasri-tajan and Taati (2010) reported correlation coefficient (0.74) between Total weight and total length in (*Cynoglossus arel*), Johari *et al.* (2010) reported correlation coefficient (0.967) between Total weight and total length in female black fish (*Capoeta capoeta*), Nasri-tajan and Taati (2010) report correlation coefficient (0.94) between Total weight and fork length in female (*Scardinius erythrophthalmus*), Rafael *et al.* (2012) reported that body measurements were effective in the estimation of weight and body yield in Round fish (species and hybrids of the *Colossoma* and *Piaractus* genera), Sang *et al.* (2009) also report that body

measurements were effective in the estimation of weight and body yield in catfish *Pangasianodon hypophthalmus*, Charo-Karisa *et al.* (2007) found significant phenotypic correlations between body measurements and weight of tilapia (Charo-karisa *et al.*, 2007). Rutten *et al.* (2004) observed phenotypic correlation of height and width with body weight for tilapia, Barbosa *et al.* (2008) indicated standard length as the measure most correlated with live weight, for tilapia, Freato *et al.* (2005), working with piracanjuba *Brycon orbignyanus*, suggests that standard length, height and body circumference, taken at the insertion of the dorsal fin, are the most suitable for determining the weight of this species, finding a correlation coefficient of respectively, for these measurements. The "stepwise" procedure resulted in the inclusion of the following morphometric measures in the path analysis for each response variable studied: Total weight = SL, GW and TL. The equation of total weight achieved in this study: Total weight = 1008.58 + 7.32 standard length - 1240.03 SL/TL - 5.66 total length.

Table 1. Spearman's rank correlation between Morphometric measurements and Total weight.

| Variable | TW | TL | SL | FL | SL/TL |
|----------|---------|---------|---------|---------|-------|
| TW | 1 | | | | |
| TL | 0.950** | 1 | | | |
| SL | 0.952** | 0.993** | 1 | | |
| FL | 0.941** | 0.984** | 0.991** | 1 | |
| SL/TL | 0.246** | 0.208* | 0.319** | 0.318** | 1 |

Morphometric measurements: Total weight (TW), total length (TL), standard length (SL), fork length (FL). **, significant at the 1% probability levels, respectively, *, significant at the 5% probability levels, respectively.

Table 2 . Multiple Linear Regression and Analysis of morphometric and ratios with total weight.

| Source of variation | Degree of Freedom | of Means squares | Variable | Coefficients | Adjusted R Square |
|---------------------|-------------------|------------------|------------|--------------|-------------------|
| Regression | 3 | 51444.23 ** | (Constant) | 1008.58 ** | |
| Residual | 142 | 87.39 | SL | 7.32 ** | 0.906 |
| | | | SL/TL | -1240.03 ** | 0.099 |
| | | | TL | -5.66 ** | 0.924 |

Morphometric measurements: Total weight (TW), total length (TL), standard length (SL) and fork length (FL). ** = significant at the 1% probability levels, respectively.

Table 3. Correlation coefficients direct and sums of the indirect effects, and percentages of direct and indirect effects of morphometric and ratios with total weight female fish *Chondrostoma regium* in Ghamasiab River.

| Variables | Correlation coefficient | P value | Direct effects | Sums of indirect effects | % direct effects | % indirect effects |
|-----------|-------------------------|---------|----------------|--------------------------|------------------|--------------------|
| TL | 0.992 | 0.000 | -10.04 | 11.04 | 47.65 | 52.35 |
| SL | 0.990 | 0.000 | 9.35 | -8.36 | 52.79 | 47.21 |
| FL | 0.988 | 0.000 | 2.77 | -1.78 | 60.87 | 39.13 |

| | | | | | | |
|-------|-------|-------|-------|------|-------|-------|
| SL/TL | 0.882 | 0.000 | -1.16 | 2.04 | 36.25 | 63.75 |
|-------|-------|-------|-------|------|-------|-------|

Morphometric measurements: Total weight (TW), total length (TL), standard length (SL) and fork length (FL).

Johari *et al.* (2010) reported the equation of total weight in female black fish (*Capoeta capoeta*):
Total weight: $-11.78 + 3.107 \text{ total length}$.

Nasri-tajan and Taati. (2010) report the equation of total weight in female (*Cynoglossus arel*):
Total weight: $0.494 \text{ total length}^{1.589}$.

And Nasri-tajan and Taati. (2010) report the equation of total weight in female (*Scardinius erythrophthalmus*):

Morphometric measurements
Total weight: $0.0000056 \times \text{fork length}^{3.205}$.

Table 4. Estimates of direct and indirect effects, obtained by path analysis, between the morphometric and ratios and total weight *Chondrostoma regium* in Ghamasiab River.

| Effects | TL | SL | FL | SL/TL |
|--------------------|---------|-------|-------|--------|
| Direct | -10.044 | 9.351 | 2.765 | -1.162 |
| In direct by TL | | 9.347 | 2.763 | -1.075 |
| In direct by SL | -10.040 | | 2.765 | -1.086 |
| In direct by FL | -10.036 | 9.350 | | -1.091 |
| In direct by SL/TL | -9.287 | 8.735 | 2.596 | |

Morphometric measurements: Total weight (TW), total length (TL), standard length (SL) and fork length (FL).

morphometric and ratios with total weight

The highest correlation coefficient between the morphometric variables and weight of fish was observed to be the total length (TL) and standard length (SL) with a value of 0.952 (Table1). However, the measures with the highest direct effect percentage for weight were FL (60.87%) and SL (52.79%), while SL, with the highest correlation coefficient, presented a large percentage of indirect effects (52.79%), particularly for (Table 3), indicating that total length (TL) and standard length (SL) is important in determining weight, but should not be considered singly. The positive direct effects in order had a standard length (9.35) and fork length (2.77) and the negative direct effects had a total length (-10.04). The positive sums of indirect effects in order had a total length (11.04) and SL/TL ratios (2.04). The negative sums of indirect effects had a standard length (-8.36) and fork length (-1.78). The heights percentage of direct effects in order had a fork length (60.87), standard length (52.79) and total length (47.65) and the heights percentage of indirect effects in order had a SL/TL ratios (63.75), total length (52.35) and standard length (47.21). Rafael *et al.* (2012) reported that body measurements were effective in the estimation of weight and body yield in Round fish (species and hybrids of the *Colossoma* and *Piaractus* genera). Serafini. (2010), evaluating the performance, along with morphometric and carcass traits, of *tambaqui*, *pacu* and their hybrids, observed a superiority for the final weight of *tambaqui* and the hybrid *tambacu* in comparison with *pacu*. Serafini. (2010) observed that fish with a higher carcass percentage (*tambaqui* and *tambacu*) also have the largest head measures, reinforcing the path analysis results, i.e., fish with larger head size, or with heads longer than the body height are those with highest carcass yield (Serafini *et al.*, 2010; Crepaldi *et al.*, 2008). Sang *et al.* (2009) also reported that body measurements were effective in the estimation of weight and body yield in catfish (*Pangasianodon hypophthalmus*). The interpretation of results was based on the following criteria: if an independent variable (x) does not present a significant correlation coefficient with the dependent variable (y), this

indicates that it is not determining the variation in y, regardless of any presence or absence of any high direct effect on y; if an independent variable (x) has a significant correlation and high direct effect on the dependent variable (y), this indicates that it is determining the variation of y; and, if the independent variable (x) show a significant correlation but low direct effect on the dependent variable (y), this indicates that it should not be used alone as a determining factor for y (Loures *et al.*, 2001).

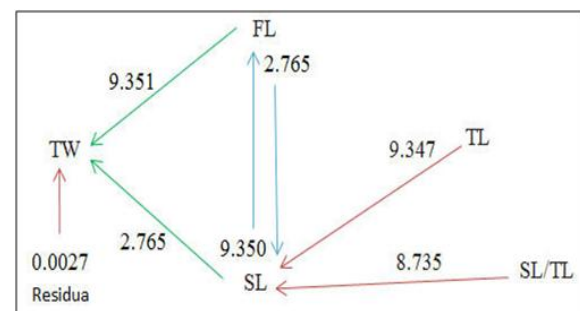


Fig. 1. Path Diagram of Some Morphometric and ratios total weight after low effect.

Conclusions

Correlation coefficients direct

The standard length and fork length measurements by the direct effect and total length measures and SL/TL ratios by the indirect effect were are important for determining the total weight of male fish *Chondrostoma regium*. In addition, this morphometric could be used in breeding programmers as a measure of direct selection for fish with better total weight traits, but first, it is necessary to conduct a genetic study to provide information about the heritability and genetic correlation of this variable with the total weight.

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