

Length-Weight Relationship and Condition Factor of Endemic Fish *Phoxinellus pseudalepidotus* (Cyprinidae) from Mostarsko Blato (Neretva River Basin, Bosnia and Herzegovina)

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Abstract

*The aim of the present study was to describe the length-weight relationship and condition factor of *Phoxinellus pseudalepidotus*, a freshwater fish endemic to the Neretva River Basin, which was classified by the IUCN as vulnerable. Fish sampling was carried out in 2009 by gill nets and „krtol“, traditional fishing tool in the area of Mostarsko Blato (Neretva River Basin, Bosnia and Herzegovina). In order to analyze the length-weight relationship and condition factor, a total of 1200 fish were sampled. Since this is an endemic species, most of the specimens were taken back into the water, after performing the length and weight measurements by using standard equipment. The length-weight relationship was described by the equation: $W = a L^b$, while the condition factor was determined by using the equation: $K = 100 (W/L^3)$. Values of the regression coefficient „b“ obtained for the length-weight relationship were respectively 0.491 for the entire population, 0.491 for females and 0.489 for males, having r^2 values, respectively 0.837, 0.843 and 0.821. General condition of the fish was found to be good, as indicated by the mean values of condition factor (1.11 for females and 1.08 for males), which was higher than 1. The present studies provide first-hand information about growth pattern and relative conditions of *P. pseudalepidotus* from its in-situ habitat.*

Keywords: *Phoxinellus pseudalepidotus*, endemic fish, Mostarsko Blato, Bosnia and Herzegovina, length-weight relationship, condition factor

1. Introduction

A significant place in ichthyofauna of Bosnia and Herzegovina is occupied by endemic species, most of which have a very narrow area of distribution. In waters of Bosnia and Herzegovina, 40 endemic species were detected so far, many of them widespread only in some locations. Diversity of species, particularly of endemic species classifies Bosnia and Herzegovina into a group with the highest ichthyological diversity among European countries. That fact can primarily be attributed to geographical position and isolation from other European river systems, complex geological history and climatic features (Glamuzina et al., 2010).

P. pseudalepidotus (Bogutskaya & Zupančič, 2003) is a small-sized (< 15,0 cm TL) cyprinid endemic freshwater fish distributed in Mostarsko Blato in the Neretva catchment area in Bosnia and Herzegovina. In addition, it is considered to be distributed more widely in the River Neretva basin (Bogutskaya and Zupančič, 2003). Some authors considered this fish from the Mostarsko Blato as *Phoxinellus alepidotus* because of morphological similarity between *P. alepidotus* and *P. pseudalepidotus* (Heckel and Kner, 1858; Seeley, 1886 (as *Paraphoxinus alepidotus*); Vuković and Ivanović, 1971 (as *Paraphoxinus alepidotus*); Kottelat, 1997). Also, Zupančič and Bogutskaya (2002) discovered undescribed species similar to *P. alepidotus* which appears in Mostarsko Blato. *P. pseudalepidotus* inhabits streams or shallow canals with little current and clean water (Crivelli, 2006; Bogutskaya and Zupančič, 2003). During unfavorable periods, it lives in underground waters (Markotić et al., 2013; Markotić, 2013). This endemic fish was classified by the IUCN as vulnerable (Crivelli, 2006). It is endangered because of the extremely limited range of distribution, river system regulation and influence of non-indigenous species (Mihinjač et al., 2014).

Weight-length relationships (WLR) are used for estimating the weight corresponding to a given length, and condition factors are used for comparing the condition, fatness, or well-being (Tesch, 1968) of fish, based on the assumption that heavier fish of a given length are in better condition. Both concepts have been used in fisheries research since the beginning of the 20th century (Froese, 2006).

The usual starting point in fisheries' work is determination of growth quality, the basis of which is the weight-length relationship (WLR) of the target species.

Lizama et al. (2002) said that condition factor in species, provides information that tow population living in certain feeding, density, climate and other condition; when determining the period of gonadal maturation; and when following up the degree of feeding activity of a species to verify whether it is making good use of its feeding source (Weatherley, 1972).

The aim of the present study was to elucidate the length-weight relationship and condition factor in *P. pseudalepidotus*. The study related to length-weight relationship is also important for understanding the population dynamics. The condition factor was determined with the objective of expressing the condition of the fish in numerical terms i.e., degree of well-being, relative robustness, fatness etc.

According to Wotton (1991), fish showing b value > 3 indicates that it is becoming heavier in comparison to its length, meanwhile b value < 3 indicates that it is becoming lighter in comparison to its length. Finally, if b value remains exactly at 3, the fish is retaining an isometric growth.

2. Materials and Methods

2.1. Study Area

Mostarsko Blato (43°19'55"N 17°41'53"E) is a closed karstic field in the Neretva River catchment area, SW Bosnia and Herzegovina. The area of Mostarsko Blato is characterized by sub-Mediterranean climate, i.e. temperately warm humid climate with hot summers (Cfa), according to Köppen's climatic classification. In general, winters are mild and rainy, while summers are hot and relatively dry (there is no specific minimum like in Csa climatic zones, such as the neighboring littoral and insular part of Southern Croatia). Pluviometric regime is maritime, with most of precipitation concentrated in autumn and winter (primary maximum), and in April and May (secondary maximum). The influence of the Adriatic Sea comes from three sides, southeast, east and south. The strongest inflow of air comes through the Neretva River valley, and over low Varda ridge, which separates lower alluvial plain of Mostarsko Blato from higher Mostarsko Blato Polje (Field). This inflow relieves the influence of colder air that comes from northern mountains. During autumn, winter and spring, the most part of the Field is flooded, but during summer almost all water springs dry out (Studija izvodivosti HE Mostarsko Blato, EP HZHB, Salzburg, 2000).

The area of Mostarsko Blato, through which the Lištica River flows, is surrounded by limestone hills: Orlovac, Mikuljača, Virača, Trtla and Varda. The field is flooded on average 5-6 months during the year. In addition to permanent water sources in Mostarsko Blato, significant amounts of periodic water of Rivers Ugrovača, Orovnik, Mokašnica and a number of small torrents, are active during major rainfall seasons. In order to reduce the floods, the tunnel Varda was built in the year of 1947. Except for the Varda tunnel, water from Mostarsko Blato is managed also by the following sink holes: Krenica, Košina, Renkovača, Kruševo, and the Velika jama (Great Hole). These sink holes are important for *P. pseudalepidotus* life cycle (Bogut et al., 2007).

2.2. Sampling

Fish sampling was carried out from Jan. 2009 to Dec. 2009 by gill nets (7 m length and 0.7 m height, with a 7 mm mesh size) and „krtol“, traditional fishing tool in the area of Mostarsko Blato (Neretva River Basin, Bosnia and Herzegovina) covering the dry season (summer) and wet season (autumn, winter and spring). In order to analyze the length-weight relationship and condition factor, a total of 1200 fish were sampled. All samples were weighed and total lengths were measured to the nearest 0.1 g and 0.1 cm, respectively. Since this is an endemic species, most of the specimens were taken back into the water, after performing the length and weight measurements by using standard equipment. The study area with sampling sites is shown in Image 1.

2.3. Length-Weight Relationship and Fulton's Condition Factor Analysis

The relationships between length and weight (LWR) of the fish samples were calculated using the equation $W = a L^b$. The values of constant a and b were estimated using the least-square method applied to the log transformed data as $\log W = \log a + b \log L$ (Ricker 1973), where W (g) is the body weight of the fish, L (cm) is the total length, a is the intercept of the regression curve and b is the regression coefficient. Constants a and b were obtained by analyzing regression of logarithmically transformed data for the entire population, and separately for males and for females. The variability of individual mass is explained by the variability of the total length of specimens and is expressed by the coefficient of determination R^2 (Sokal and Rohlf, 1995).

Under the term condition, the physical bodily state is presumed, and is the consequence of length-weight relationship. Condition is expressed by the values of condition factor. The condition index was calculated using a cubic or Fulton's condition factor (Ricker, 1975): $K = 100 W L_t^{-3}$, where K is the value of the condition index, W - the mass of the fish and L_t - the total length of the fish.

3. Results

In the total number of analyzed individual fish, the range of the total body length ranged from 2.7 to 11.5 cm. The average total length for the population is 6.4 ± 0.8 cm. Females have an average length of 6.5 ± 0.9 cm, and males 6.4 ± 0.6 cm, while the range between the minimum and maximum lengths is higher in females (2.7 to 11.5) than in males (3.3 to 8.5). The minimum recorded mass for the population is 0.1 g and the maximum recorded mass is 15.0 g. The average total mass for the population is 3.1 ± 1.2 g. The largest and smallest mass was recorded for females. The minimum recorded mass for females *P. pseudalepidotus* amounted to 0.1 g, and maximum was 15.0 g. For males, the minimum recorded mass was 0.2 g and maximum was 8.0 g. The average mass for females was 3.3 ± 1.4 g and for males 2.9 ± 0.9 g. It can be concluded that females also dominate body mass, which is also to be expected because the mass increases proportionally with the length of the body, but with the mass of gonadals in spawn.

The obtained length and weight relationship equations for the entire population, i.e. for the total sample amount:

$$W = 0,1198 \times L_t^{0,4918} \quad r^2 = 0,8373$$

$$W = 0,1174 \times L_s^{0,6015} \quad r^2 = 0,8456$$

The growth of the entire population of *P. pseudalepidotus* was negatively allometric, with constants $b = 0.4918$ and $b = 0.6015$ when the standard length was used in the calculation (Image 2).

The length-weight relationship for females and males was calculated separately.

For females, the obtained equations obtained are as follows:

$$W = 0,1213 \times L_t^{0,4914} \quad r^2 = 0,843$$

$$W = 0,1162 \times L_s^{0,6028} \quad r^2 = 0,8469$$

It arises therefrom that the growth of *P. pseudalepidotus* females was negatively allometric, with constants $b = 0.4914$ and $b = 0.6028$ when the standard length was used in the calculation (Image 3).

For males, the obtained equations obtained are as follows:

$$W = 0,1203 \times L_t^{0,4891} \quad r^2 = 0,8217$$

$$W = 0,1188 \times L_s^{0,5997} \quad r^2 = 0,8382$$

The growth of *P. pseudalepidotus* males was also negatively allometric, with constants $b = 0.4891$ and $b = 0.5997$, when the standard length was used in the calculation (Image 4).

It is evident from Image 5 that the average monthly movements of the condition factor (K) for females were 0.9 (September) to 1.28 (January) and for males 0.92 (September) to 1.25 (May). The average annual value of the condition factor (K) for females *P. pseudalepidotus* was 1.11, and for males 1.08. For females, it was noted that the condition factor (K) was highest in January, April and May, and then decreased continuously until September, after which it was gradually increasing again. A similar trend is observed for males in females, with the condition factor (K) being highest in February, April and May, after which it continually decreases until September, and then begins to increase again. In females and males of *P. pseudalepidotus* the maximum value of the condition factor was immediately before and after the spawn season. Thus, *P. pseudalepidotus* females and

males are in the best condition form just before and after the spawn season. There is no statistically significant difference between the average values of the condition factor between males and females (Man-Whitney U test at significance level $p < 0.05$). No statistically significant difference was found in the condition factor by months in females (Kruskal-Wallis test, $H = 11.00$, $p = 0.443$) nor in males (Kruskal-Wallis test, $H = 11.00$, $p = 0.443$).

4. Discussion and Conclusion

The length-weight relationship and condition of *P. pseudalepidotus* have not been subject to research so far. The results of this study are the first data regarding the characteristics of growth and condition of this species.

The status of vulnerability of *P. pseudalepidotus* (vulnerable species, VU) is the main reason for this research, and the results obtained can be applied in the planning of scientifically-based protection for this species in the area of Mostarsko Blato in Bosnia and Herzegovina.

In order to compare the obtained results, data were taken from different sources. Knowledge of biology and ecology of the two most related species, *P. alepidotus* and *Phoxinellus dalmaticus*, are very scarce and insufficient. Therefore, the data from this study were compared with other fish taxa from related endemic species from the Dinaric karst area - *Telestes* and *Delminichthys*. Namely, despite the taxonomic difference, these are all species which take up very similar, if not identical, ecological niches and live in almost equal ecological conditions and in very similar habitats.

The values of regression coefficients b in this study were not within the expected range 2.5 – 3.5, as suggested by Froese (2006). Values of the regression coefficient 'b' obtained for the length-weight relationship were respectively 0.491 for all population, or 0.601 when the standard length of the body was used in the calculation, 0.491 for females, or 0.602 when the standard length of the body was used in the calculation, and 0.489 for males or 0.599 when the standard length of the body was used in the calculation. For the *Delminichthys adspersus*, the regression factor was $b = 2.9233$, or $b = 3.0883$ when the standard length of the body was used in the calculation. Given the total length of the body, there was a slight negative allometric growth ($b < 3$), while almost perfect isometric growth ($b = 3$) was observed with respect to the standard length of the body (Franičević and Tičina, 2003). Also, based on the length and weight data given by Aganović and Kapetanović (1971), Franičević and Tičina (2003) calculated the regression factor for *Telestes metohiensis* and *Delminichthys ghetaldii*. For species *T. metohiensis*, the regression factor is $b = 3.0892$, which indicates almost isometric growth ($b = 3$). For the species *D. ghetaldii*, the regression factor is $b = 2.7036$ which indicates a negative allometric growth (Franičević and Tičina, 2003). The regression factor b for *Telestes ukliva* includes 3.0348 (Zanella, 2003).

The condition factor, i.e. condition factor (K), represents the physical state of the fish organism i.e. its "thickness". The higher the body mass of the fish of the same length, the better the general condition, i.e. fish condition (Bagenal, 1978). In general, seasonal variations in the condition factor are influenced by the development of gonadals, feeding-related activities and several other factors (Doddamani et al., 2001). The average monthly condition factor (K) for *P. pseudalepidotus* females was from 0.9 (September) to 1.28 (January) and for males from 0.92 (September) to 1.25 (May). The average annual value of the condition factor (K) for females of *P. pseudalepidotus* was 1.11, and for males 1.08. In females and males of *P. pseudalepidotus* the maximum value of the condition factor was immediately before and after the spawn season. Low condition factor was notes in September for both sexes. After September the condition factor increased again in

accordance with the growth of the gonadals. By means of this research it was found that there was no statistically significant difference in the condition factor between the sexes. The published data on the condition exist for *D. adspersus*, widespread in Crveno jezero (Red Lake) near Imotski. Considering the total length (Lt), the condition factor in the analyzed individuals of *D. adspersus* ranged from 0.84 to 2.09, while the mean value for the sample was 1.34 ± 0.08 . Taking the standard length (Ls) into consideration, the condition factor was within a range of 1.48 to 3.0, with a mean value of 2.21 ± 0.12 (Franičević and Tičina, 2003). The average value of the condition factor for *T. ukliva*, in the Cetina River, is 1.11 (Zanella, 2003).

The present studies provide first-hand information about growth pattern and relative conditions of *P. pseudalepidotus* from its in-situ habitat.

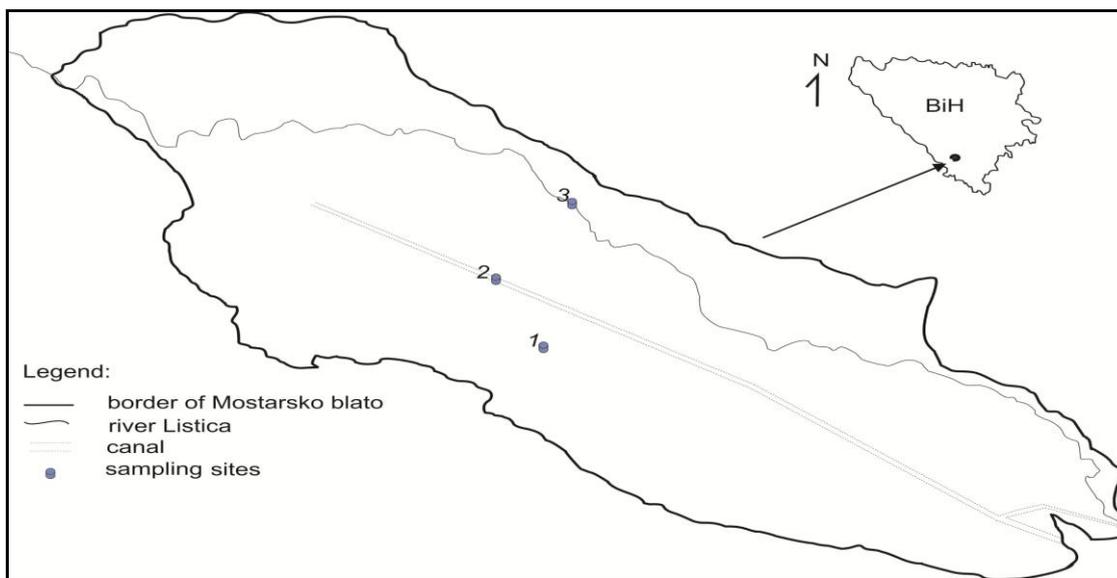


Image 1. Map of the researched area, showing the location of the sampling sites: 1. Pisak, 2. Međurić, 3. Pološki Gaz

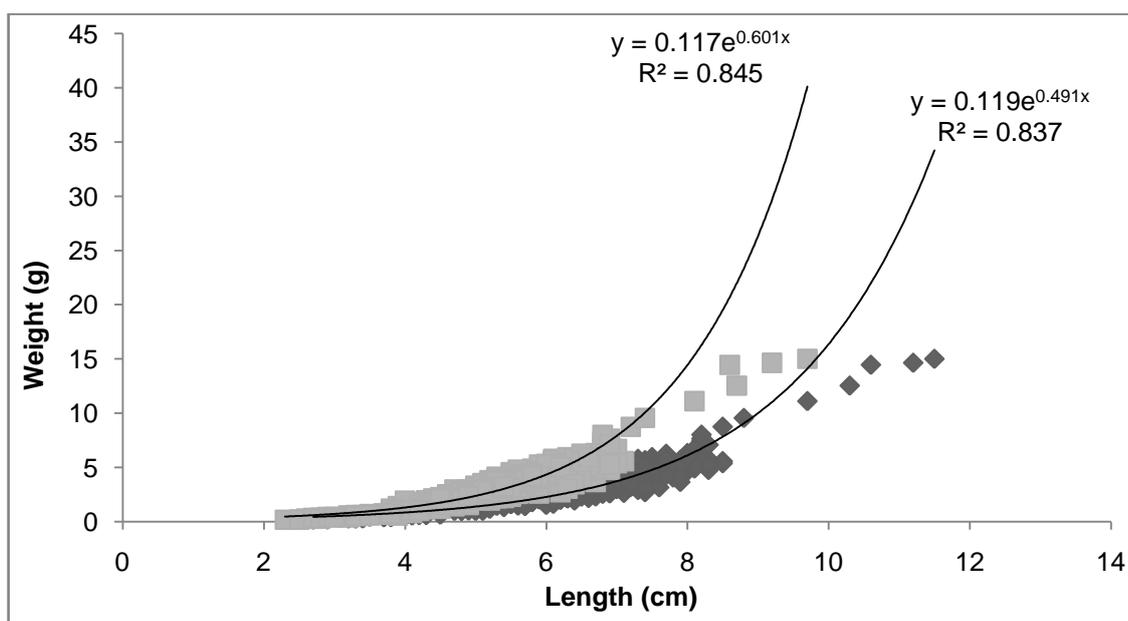


Image 2. Length-weight relationship for *Phoxinellus pseudalepidotus* population (Cyprinid species in Bosnia and Herzegovina) in the area of Mostarsko Blato during 2009

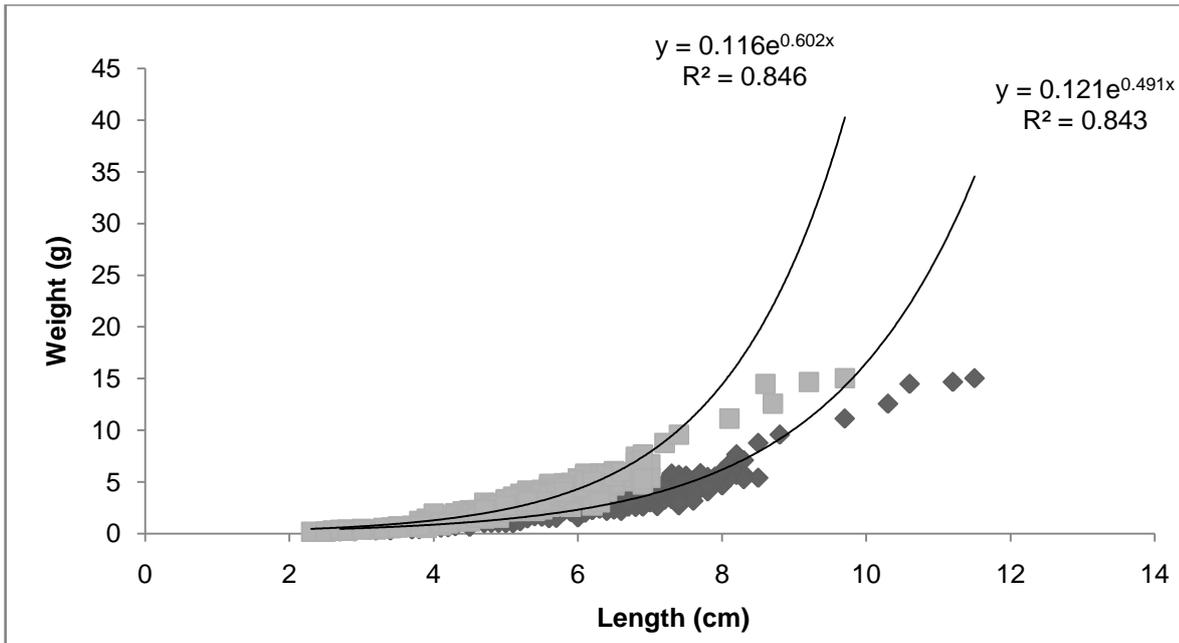


Image 3. Length-weight relationship for females of *P. pseudalepidotus* in the area of Mostarsko Blato during 2009

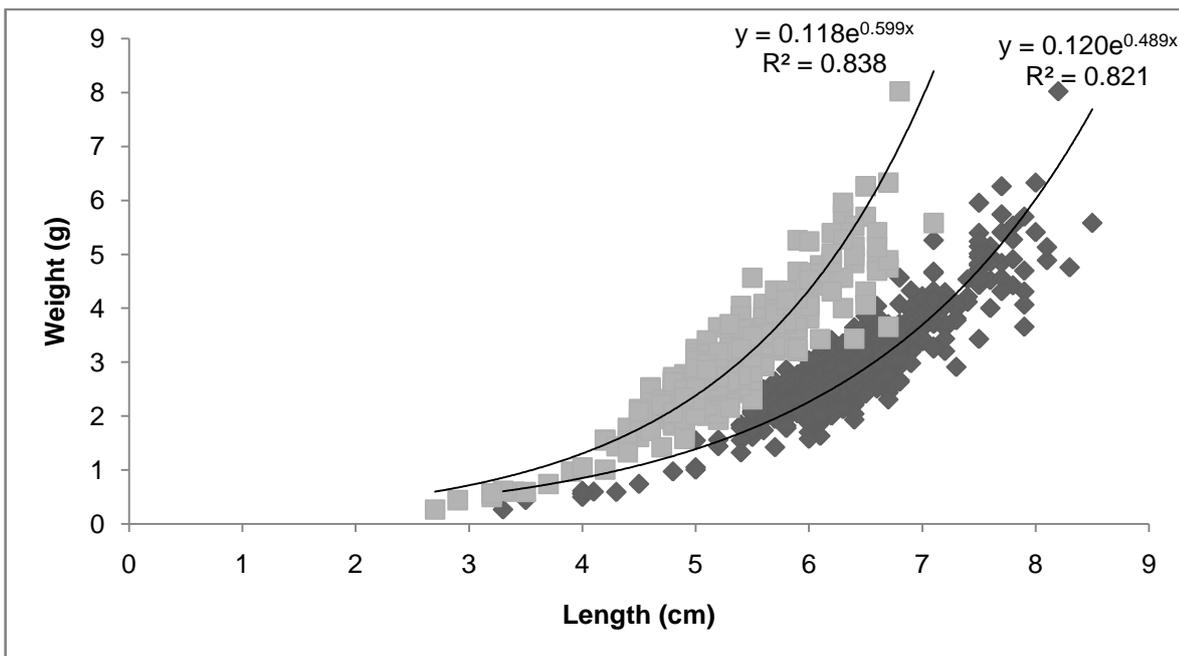


Image 4. Length-weight relationship for males of *P. pseudalepidotus* in the area of Mostarsko Blato during 2009

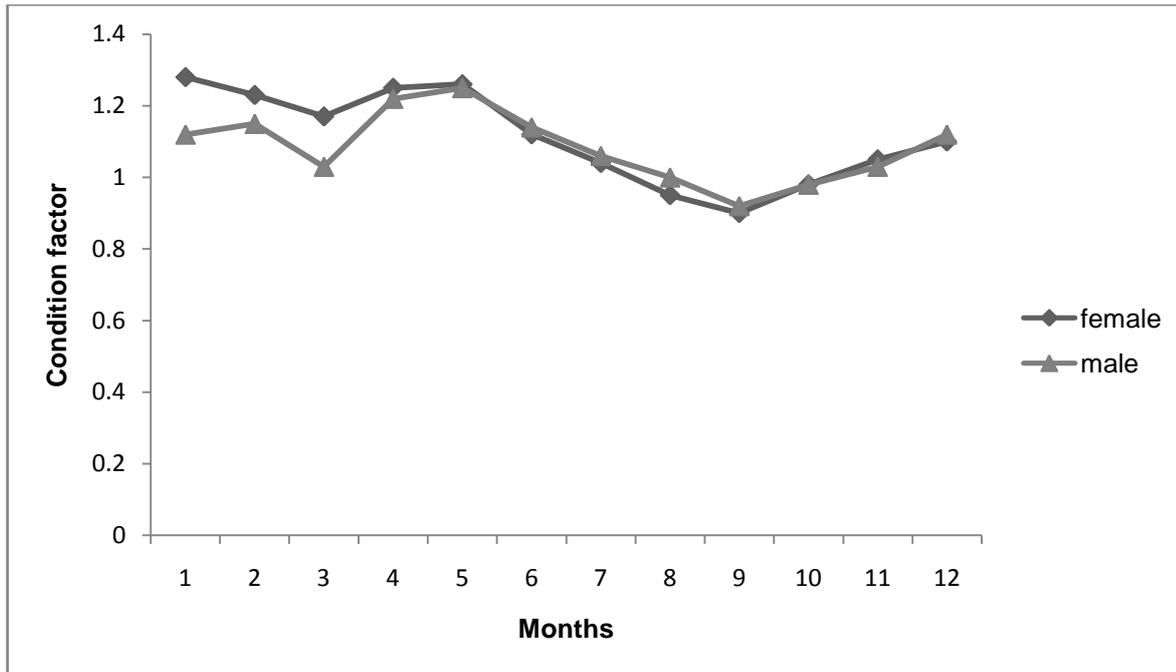


Image 5. Condition factor of the *P. pseudalepidotus* in the area of Mostarsko Blato during 2009

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