Online ISSN: 2588-3526

Journal of Wildlife and Biodiversity

Volume 7 (4): 63-74 (2023) (http://www.wildlife-biodiversity.com/)

Short Communication

The impact of parasitic Helminths on length-weight relationship and condition factor of two fish species from Lesser Zab River at Altun-Kupri/ Kirkuk Province, Iraq

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Received: 05 January 2022 / Revised: 25 February 2023 / Accepted: 27 February 2023/ Published online: 27 February. Ministry of Sciences, Research, and Technology, Arak University, Iran.

How to cite: Hathal, B.A., Nawwab Al-Deen, F.M., Bilal, S.J. (2023). The impact of parasitic Helminths on length-weight relationship and condition factor of two fish species from Lesser Zab River at Altun-Kupri/ Kirkuk Province, Iraq, Journal of Wildlife and Biodiversity, 7(4), 63-74. **DOI**: https://doi.org/10.5281/zenodo.8068085

Abstract

A total of 193 fishes from the Lesser Zab River in Altun-Kupri/ Kirkuk Province, Iraq were investigated, belonging to two families namely Cyprinidae (*Luciobarbus xanthopterus* Heckel, 1843) and Siluridae (93 *Silurus triostegus* Heckle, 1843) for the impact of parasites helminths on length-weight relationships and condition factor. Three species of helminth parasites were recovered from host fish, namely: Cestoda, Nematode and Acanthocephala. The association between helminthic parasitic infection with length-weight relationship (LWR) and condition factor in two fish species were studied. The results showed that the growth of both fish species exhibited negative allometry because the regression coefficient "b" obtained was <3. The statistical analysis showed that there was a significant difference between infected and uninfected fishes in the b value. Moreover, significantly ($p< 0.05$) the highest "b" value (2.2042 in *L. xanthopterus* and 2.8666 in *S. triostegus*) was recorded in uninfected fish. Condition factor (K) for the infected and uninfected fishes of both fish species were also determined in the current study. The result showed that the condition factor of both fish species was low, but the K factor of uninfected *L. xanthopterus* was higher (K<1.50) than that of uninfected *S. triostegus* (K<0.7). It is indicated that *L. xanthopterus* performed better than *S. triostegus* in the study areas. The statistical analyses showed that the K factor in both uninfected *L. xanthopterus* and *S. triostegus* fishes was significantly ($p<0.05$) higher than in infected fishes.

Keywords: *Luciobarbus xanthophores*, *Silurus triostegus*, Cestoda, Nematoda, Acanthocephala

Introduction

Fish is important food and nutritional resource, especially for rural economies and populations in developing countries (Shaukat, 2008). In addition, fishes are very important parts of a healthy diet as they have a high dietary value, which places them apart from other types of animal products, Its protein is of high quality, containing complete amino acid composition, which is a valuable resource for the living organism. Fish meat has a high fraction of vital vitamins such as vitamins A and D, in addition to prime mineral salts and unsaturated fats (Adeniyi et al., 2010; Pal et al., 2018). There are many groups of fish in Iraqi waters, which have different food habits. One of the most important commercial fish families is known as Cyprinidae, and the other important family of freshwater fishes is known as catfish (Heckel and Russegger, 1843).
Fish growth and its evidence are one of the most important factors for studying, increase in body length gives evidence of fish age, which is a very important factor to determine the age of reaching sexual maturity and sex differentiation according to the development of testis or ovaries (Poulin, 1996). A growth study is also important to compare the growth of fish species in different environments (Tandon and Johal, 1996).
On the other hand, studying length-weight relation is an important quantitative trait in fish biology, which can be used to predict weight from length measurements made in the yield assessment (Am et al., 2018; Hathal, 2020). Studying of Condition factor (K) is important to show the degree of the well-being of the fish in their environment, it is also a good indicator to monitor the physiological state of the fish (Le Cren, 1951; Bichi and Yelwa, 2010, Dan-Kishiya, 2013). Growth is affected by many factors such as feeding, conditions of temperature, photoperiod, gonad development, and water pH and salinity (Alfei et al., 1994; Baroiller and D'Cotta, 2001), as well as by parasitic infections (Hathal et al., 2020). Therefore, the current research investigated the potential impact of helminth parasites on length-weight relationship and condition factor for the first time in Iraq, including two species (*L. xanthopterus* and *S. triostegus,* Heckel, 1843) from Lesser Zab River at Altun-Kupri/ Kirkuk Province, Iraq.

Materials and methods

Description of the sampling area: The Lesser Zab River is a longest tributary of the Tigris River with a length of 400 km, between latitudes 34º-36º south to north and longitude 43º-46º west to the east. It is the main source of drinking water for the people in the cities that covered it especially in the study location (Altun- Kupri) (Wright, 2007). Collection and examination of fishes: A total of 193 fishes belonging to two species (100 *Luciobarbus xanthopterus* and 93 *Silurus triostegus)* were collected from Lesser Zab River in Altun-Kupri by using cast netting and gill nets twice a month during the term from October, 2019 until the end of March, 2020. Fishes were transferred a live in cool boxes to the laboratory were identified according to Coad (2010), and the scientific names followed Fish base (Froese and Pauly, 2023). The total body length (TL), standard length (SL), body depth were measured to the nearest centimetres (in cm), as well as, weight to nearest gram (g) (Bagenal, 1978). Fishes were examined, externally and internally for parasites detection following to Amlacher (1970).
Length-weight relationship, was calculated by using the methods described by Le Cren (1951) and Dan-Kishiya (2013).

$W = aL^b$

W = weight of fish in grams, L = Total length of fish in millimetre,

a: Intercept, b: Regression Coefficient (were estimated by linear regression).

Light infection= fish host infected with one parasite

Severe infection= fish host infected with more than 2 parasites

The statistical analysis was done using Graph Microsoft Excel 2010.

Condition factor (K)

Condition factor was calculated by using the method described by (Worthington and Ricardo, 1936)

$K= W*100/ L^3$

K= Condition factor

W =weight of fish in grams

L = Total length of fish in millimetre.

Light infection= fish host infected with one parasite

Severe infection= fish host infected with more than 2 parasites

The relative condition factor (Kn) was calculated according to the following equation by Le Cren (1951):

$Kn = W/ aL^b$

where, W is the observed weight, and aL^b is the calculated weight from the length-weight relationship.

Statistical analysis

For testing the differences in prevalence, mean intensity and abundance of infection between sexes (male and female) and length groups in the two fish species, chi-square analysis was used, and the data was analysed by completely randomized design (CRD). All statistical analysis was performed at the significant level of 0.05.

Results and discussion

The current study is conducted to determine the effect of parasites on growth of fish collected from Lesser Zab River in Altun-Kupri district. A total of 193 fishes were collected and inspected for helminths (monogeneans, digeneans, cestodes, nematodes, and acanthocephala). Two different families, Cyprinidae (*Luciobarbus xanthopterus* Heckel, 1843; 100 specimens) and Siluridae (*Silurus triostegus* Heckel, 1843; 93 specimens) were investigated to study the impact of parasite infection on the fish growth. Moreover, these two fish species have different environments, food, and feeding habits (Hussain et al., 2008; Coad, 2010; Mohamed and Al-Jubouri, 2020).

Length – weight relationship with the parasite infection

The Length-weight LWR relationship and its association with the parasite's infection of the two studied fish species, *L. xanthopterus* and *S. triostegus* are presented in Table 1.

Table 1. Mean length-weight regression analysis of infected and uninfected fish species in the study areas

Fish host	Status	No. of fish	a	b	r	Type of growth
L. xanthopterus	Uninfected	24	0.0032	2.2042	0.9689	Negative allometric
	Light infected	30	0.0012	2.0465	0.9556	Negative allometric
	Severe infected	46	0.0136	1.7762	0.9526	Negative allometric
	x^2=6.0258, df=2, p=0.0490, (p>0.05)					
S. triostegus	Uninfected	20	2E-05	2.8666	0.9922	Negative allometric
	Light infection	25	1E-05	2.7994	0.9854	Negative allometric
	Severe infection	48	2E-05	2.7882	0.9865	Negative allometric
	x^2=7.4542, df=2, p=0.0236, (p>0.05)					

Key x2=Chi square, df= degree of freedom, p= probability level

The LWR allows to determine the level of fish weight increase with length increase and vice versa, and to analyse the growth pattern by the allometric coefficient of the studied species. Inconsistency in the value of "b" which was previously presented in early studies by Fulton (1904) and also by Fontoura et al. (2010), is identified between different populations of the same or even different species of fishes because of variations in conditions related to ecological conditions of habitats, environment, food availability, season, physiology. The length-weight relationships (LWR) parameters are vital and valuable tools in fish biology, fisheries assessment, and other components of fish population dynamics to habitat conditions.

The allometric coefficient b varied significantly (P< 0.05) in this study between different levels of parasitic infections in the two fish species (light or sever infection). *L. xanthopterus* had b value of 2.2042 for uninfected fish and (2.0465, 1.7762) for light and severe infection respectively (Table 1) (Fig. 1, 2, 3).

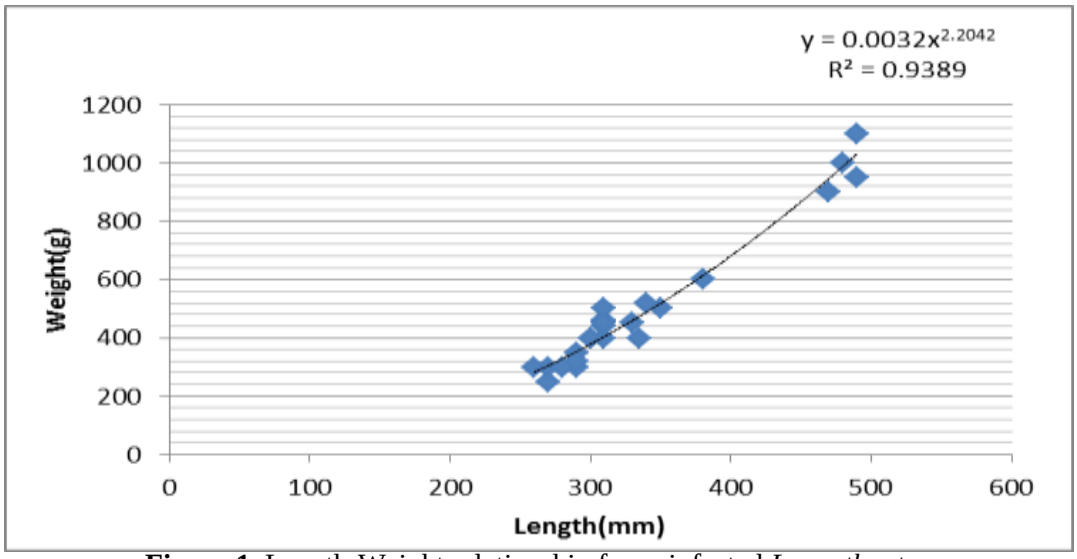

Figure 1. Length-Weight relationship for uninfected *L. xanthopterus*

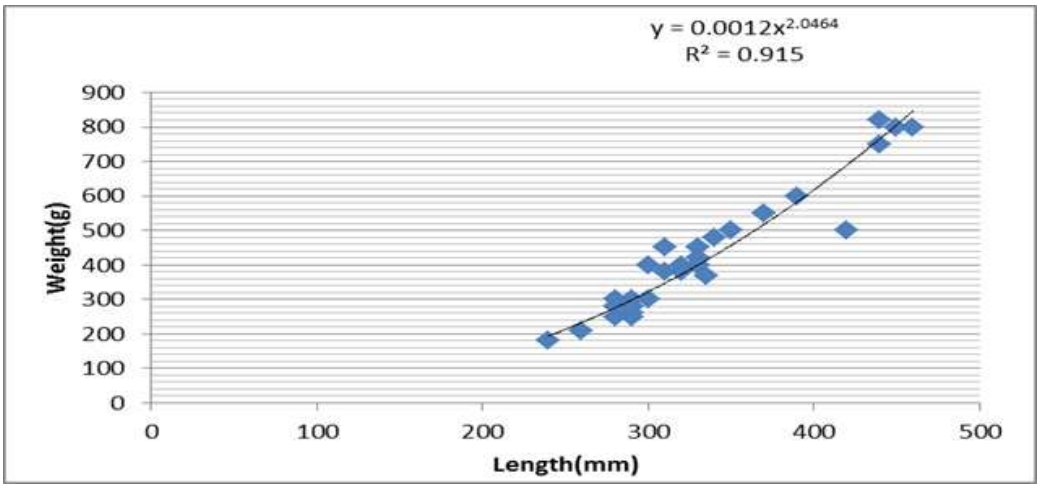

Figure 2. Length-Weight relationship for light infected *L. xanthopterus*

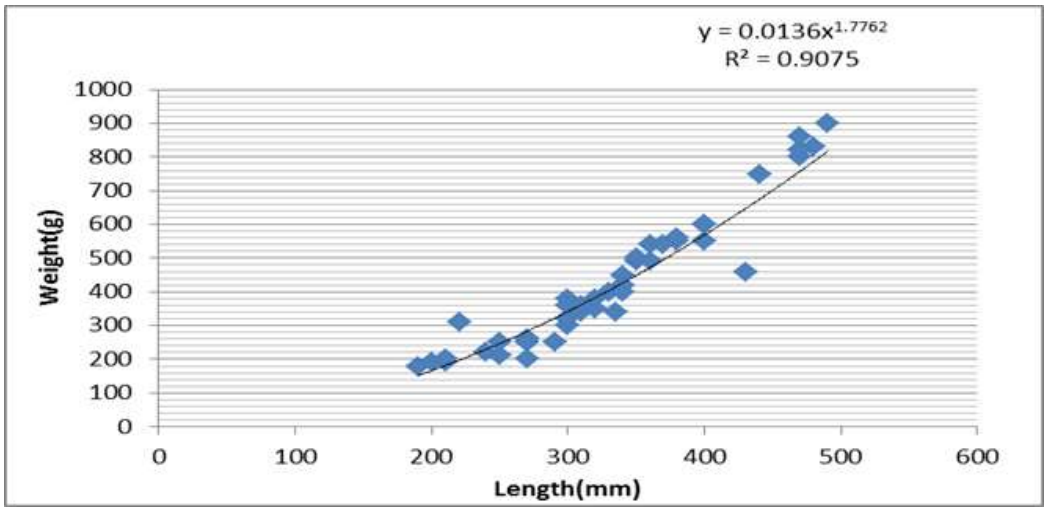

Figure 3. Length-Weight relationship for severe infected *L. xanthopterus*

While in *S. triostegus*, b value was 2.8666 for uninfected fish and 2.7994, 2.7882 for light and severe infected fishes respectively (Table 1) (Fig. 4, 5, 6).

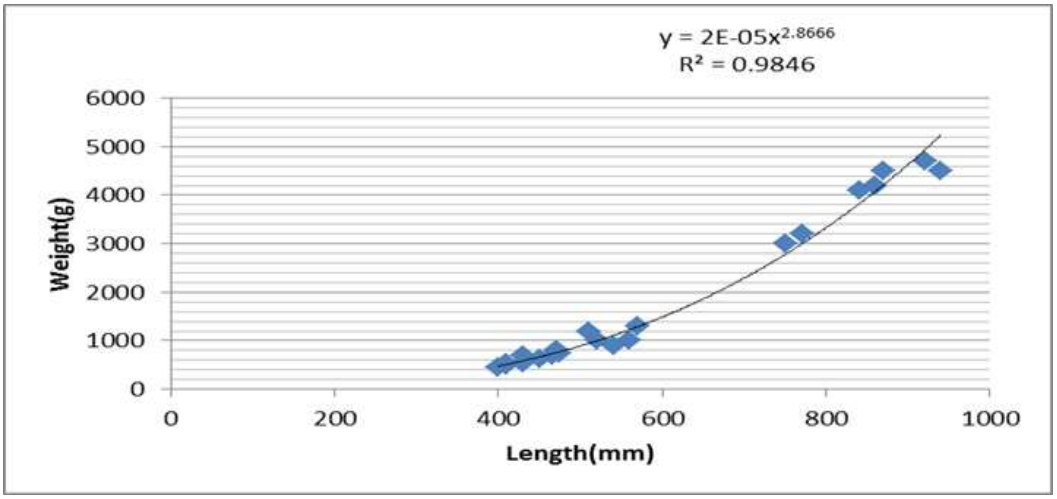

Figure 4. Length-Weight relationship for uninfected *S. triostegus*

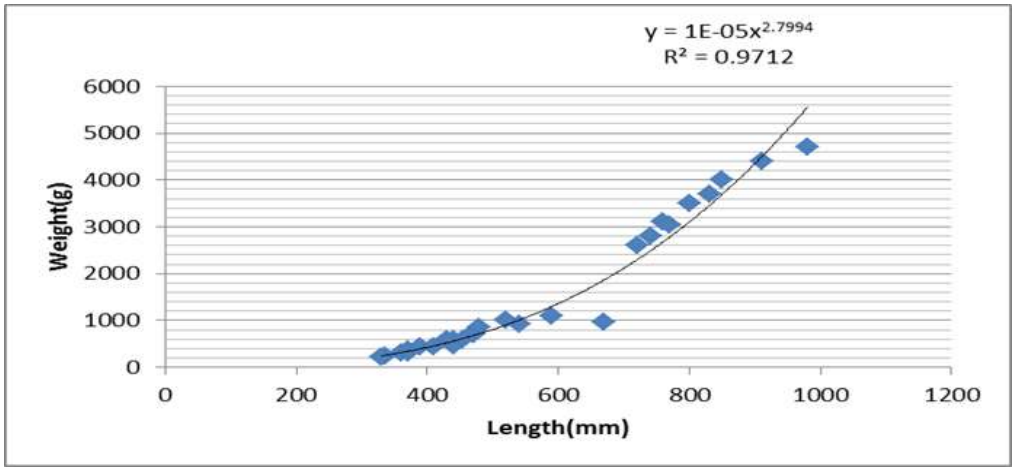

Figure 5. Length-Weight relationship for light infected *S. triostegus*

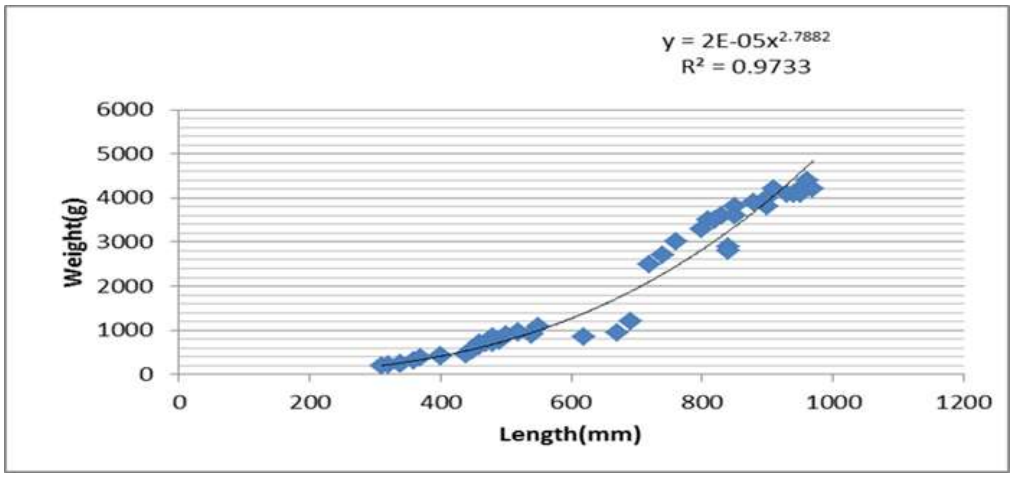

Figure 6. Length-Weight relationship for severe infected *S. triostegus*

Examination of the uninfected, light and severe infected fishes showed that 'b' values were less than 3, which indicated that both fish species displayed negative allometric growth pattern. It is well known that the parameter "b" in LWR equation ($W = aL^b$) is the regression slope (coefficient indicating isometric b= 3 or allometric growth (negative $b < 3$) or (positive $b > 3$) (Bagenal, 1978).

Length-weight relationship LWR is vital in fisheries biology for evaluating the growth rate of fish species in environment and it allows estimation of typical weight of the fish for a certain length group (Beyer, 1987). Additionally, LWR used to explain the specific water environment suitability for growth of certain fish species (Kulbicki et al., 2005, King et al., 2007). This relationship is used also to assess the welfare of individuals and to determine possible differences between distinct biological units *(*stock units) for different fish species.

Studies on the length-weight relationship and condition factor have been well documented in numerous freshwater fishes in Iraq including, for example, *L. xanthopterus* in Al-Diwaniya River, middle of Iraq (Mohamed and Al-Jubouri, 2020) and *S. triostegus* in Darbandikhan reservoir (Rasheed, 2012). However, those studies have been carried out in order to get some

information about population dynamics and biological characteristics of uninfected fish resources in the studied area. Since internal parasites can cause swollen abdomen in fishes, it contributes to either pseudo weight or length of fishes that lead to small growth and consequent decrease in the length of the fish. Information on the length-weight characteristics and condition factor of parasite-infected fishes in the studied fish species of the current study are very dispersed and negligible. Therefore, this part of study was carried out to identify the possible effect of helminth parasites on the length-weight relationship and condition factor of the two examined fish species.

The obtained results of the present study showed that the growth of the studied fish is negative allometric b< 3. This means that the fishes do not grow equally, or the fish becomes thinner with the increase in the length due to many reasons such as poor environmental conditions of the surrounded area, stressful events such as overcrowding fish of the same species, limited food supplies, and the natural changes in the environment (Huntingford et al., 2006)

The finding of the present study is inconsistent with research showing isometric growth length-weight relationship for different fish including *L. xanthopterus* and *S. triostegus* collected from Darbandikhan Reservoir, Kurdistan region, Iraq (Rasheed, 2012). In addition, the length-weight relationship for *L. xanthopterus* in the Al-Diwaniya River, middle of Iraq was studied by (Mohamed and Al-Jubouri, 2020), who reported positive allometric growth during spring and summer seasons. In addition (Hashemi et al., 2012), reported isometric power length-weight relationship for *S. triostegus* from Shadegan Wetland in Khuzestan Province (Iran) from November 2008 to October 2009. All the mentioned studies reported length-weight relationship for fish species without considering the health issue regarding parasites infection, however from author knowledge no study was carried out to investigate helminth parasites, length-weight relationship (LWR) and condition factor (K) interaction in *L. xanthopterus* and *S. triostegus* fishes in Iraq. This study for the first time investigated the relation between parasitic infection and length-weight relationship for two different fish species in Iraq. The result of the current study is in agreement with other studies worldwide which indicated that most of infected fish species with helminths have negative allometric growth (Kaur et al., 2013; AM et al., 2018).

Table (1) shows that significantly (p> 0.05) highest "b" value (2.2042 in *L. xanthopterus* and 2.8666 in *S. triostegus*) was recorded in uninfected fish, compared to the lowest "b" values in severe parasite infected fishes in both of the fish species (1.7762, 2.7882) respectively. This result is owing to effect of the parasites on the host living habits, as infected fish need more energy because the parasite causes a stress on the fish. In addition, parasites affect metabolic rates of their hosts, and their energetic demands should affect their hosts since parasite energetic expenditures to the host also included repair and defense. Consequently, host metabolic level and body size should be directly affected by parasitism in terms of providing energy or space resources for the parasite individuals especially in intensive infection (Hechinger, 2013), as it is obvious in the results of the current study. There was strong and highly significant correlation between the length and the weight of all the species with the parasite's infection (r>0.9) (Table 1). Additionally, the infected fishes have been shown to exhibit low body condition, poor growth and prefer smaller food particles (Pegg et al., 2015). All of these conditions made the growth of fish poor.

Condition factor (K) and (Kn)

The variations in the mean total length, body weight and condition factor and relative condition factor for the infected and uninfected of the studied fish (*L. xanthopterus* and *S. triostegus*) are presented in Table (2).

Table 2. Mean condition factor of infected and uninfected fish species in the study areas.

Fish host	Status	No. of fish	Mean total length (cm)	Mean weight (g)	Mean condition factor (K)	Relative mean condition factor (Kn)
L. xanthopterus	Uninfected	24	33.64	501.66	1.30	1.29
	Light infection	30	33.21	425.10	1.23	1.21
	Severe infection	46	33.01	424.66	1.13	1.09
	x^2=6.1442, df=2, p=0.0415, (p>0.05)					
S. triostegus	Uninfected	20	61.13	1974.09	0.69	0.66
	Light infection	25	57.14	1583.88	0.64	0.62
	Severe infection	48	64.29	1985.45	0.59	0.56
	x^2=7.1643, df=2, p=0.03462, (p>0.05)					

Key x^2=Chi square, df= degree of freedom, p= probability level

The mean total length was 33.64 cm for uninfected *L. xanthopterus* and 33.21, 33.01 cm for light and severe infected *L. xanthopterus* respectively. While 61.13 cm length was recorded for uninfected *S. triostegus* and 57.14, 64.29 cm for light and severe infected *S. triostegus.* Regarding mean weight, they were 501.66, 425.10, 424.66 g for uninfected, light infected and severe infected *L. xanthopterus* respectively, compared to 1974.09, 1583.88, 1985.45 g respectively in *S. triostegus.* Mean condition factor (K) was 1.30 for uninfected *L. xanthopterus* and 1.23, 1.13 for light infected and severe infected *L. xanthopterus,* compared to 0.69 for uninfected *S. triostegus* and 0.64, 0.59 for light infected and severe infected *S. triostegus* respectively. The condition factor comparison confirmed that the condition factor of infected fish in both of *L. xanthopterus* and *S. triostegus* was significantly ($p< 0.05$) higher in uninfected than infected fish.

However, significantly ($p> 0.05$) lowest condition factor was recorded for severely infected fish compared to lightly infected fish for both species. The result of the condition factor also showed that the condition factor of *L. xanthopterus* was higher (K<1.50) than that of *S. triostegus* (K<0.7). This indicated that *L. xanthopterus* is healthier than *S. triostegus* in the study area.

The relationship of length-weight can be used to estimate the condition factor (K) of different fish species. The condition factor is used in order to compare the condition and fatness or wellbeing of fish in their habitat (Ahmed et al., 2011). This factor is based on the proposition that heavier fish of an exact length are in a better physiological condition, it is also a useful key for monitoring of age, growth rates and feeding intensity of fish (Bagenal, 1978; Ndimele et al., 2010). Condition factor is strongly affected by biotic and abiotic conditions of environment, it can also use directory to examine the status of the aquatic ecosystem where fish live (Anene, 2005). Generally, the results obtained from the current study showed that the condition factor

generally was low, but it was significantly lower in severe infected fishes in both of *L. xanthopterus* and *S. triostegus* compared to uninfected or even lightly infected fishes. Low condition factor in infected fish might be attributed to the reason that parasites compete with the fish host for energy, food, and cause stress on the fish. The lowest recorded condition factor in severe infected fish may belong to accumulation of more than one type of parasites and with the increased number of parasites would that compete with the fish for diet resources (Weekes and Penlington, 1986; Revenga, 1993; Nur et al., 2020). In addition, the present study was carried out during the months from August - March with lowest feeding activity, all mentioned studies above recorded that the condition factor value was lowest in winter and autumn because of decreased feeding activity, using stored energy in body to develop and grow gonads and also for vital activities (Al-Habbib et al., 1986). Low condition factor of *S. triostegus* compared to *L. xanthopterus* was reported in this study, this result might be due to unavailability of food for *S. triostegus,* since it is considered as strictly specialized feeders since its predator species (Hussain et al., 2009). In addition, authors recorded that cestoda has inhibitory effect on host proteolytic enzymes (Izvekova et al., 2017; Frolova et al., 2019). This result means that cestoda inhibit the digestion of proteins which is the main content of *S. triostegus* (piscivorous) food by preventing proteinase secretion, consequently reducing the growth rate of *S. triostegus*. Interestingly, it was noted the stomach of most of *S. triostegus* in the present study was empty, may be because of the lowest feed activity of this fish during winter and autumn seasons when the current study was carried, that made growth and condition factor of this fish low (Al-Amari et al., 2013).

Conclusions

The study of Length-Weight relationship (LWR) of *S. triostegus* and *L. xanthopterus* shows that the fish growth type in Lesser Zab River is allometric negative regardless to the parasitic infection. While the condition *factor K* of both fishes shows that the fish are in moderate condition indicating how the condition of the river environment is not fully healthy for fish growth. The effect of helminth parasites on length-weight ratio and condition factor of the studied fishes was obviously connected in the current study and this could be attributed to the relatively high level of infection and mean intensities of these parasites observed in the study areas. This study has contributed to the acknowledgments on the effect of the parasites on fish growth in this economically important area. This could provide fishery management scientists an index to carry out future ecological studies in this region.

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