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Impact of Parasitic Helminths on the Growth of *Luciobarbus callensis* (Valenciennes, 1842) (Cyprinid fish) Populating Beni Haroun Dam (East of Algeria)

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ABSTRACT

This study was carried out for the evaluation of the parasitic fauna of the autochthonous species Luciobarbus callensis (Valenciennes, 1842) synonym of Barbus callensis Valenciennes, 1842 belonging to the Cyprinid. This species has been widely distributed in the rivers of Algeria, and was studied for the first time in the Beni Haroun dam. The samples were obtained using a trammel net during the years of 2015-2016. On a total of 168 specimens examined, the biometric and anatomical measurements have shed light on a multitude aspects related to the growth and development of fish studied in relation to the infestation by endohelminth parasites. The evaluation of parasite indices according to size, sex and seasons showed that all the specimens of this fish species were likely to be parasitized, but with varying degrees.

Keywords: *Luciobarbus callensis, Helminth parasites, Beni Haroun Dam, Parasitic index Growth*

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1. INTRODUCTION

Parasites can induce serious stress on aquatic organisms (Lemly et al., 1984) and the result of parasitism is always physiological performances on the development and also the immune response of the host (Combes ,2001, Barber et al., 2000, Prager ,1989).

In some studies, it has been reported that infested fish by parasites suffer from decreased condition index, reduced growth, reproductive disorders, and reduced shelf life (Adlard and Lester, 1995). Therefore, the pests can take an active part in the dynamic control of the host population. Indeed, in some cases, the impact of parasitism on the dynamic fish populations led to important economic losses especially in livestock (Bouhbouh, 2002).

Despite the current and future importance of fresh water ichtyofauna in Algeria, few studies have been devoted to its parasite-fauna with the exception of: (Loucif, 2009, Meddour et al., 2010, Chaibi, 2014, Allalgua et al, 2015, Boucenna et al., 2015, Djebbari et al., 2015, Brahmia, 2016).

The aim of this work was to characterize the Luciobarbus callensis (Valenciennes) (synonymy of Barbus callensis) population for the first time in the Beni Haroun dam in eastern Algeria, to evaluate the epidemiological parameters of the identified endoparasites, and their dynamics according to different factors including: season, class size and sex; and examine the impact of parasite Helminths on the growth of this Cyprinid fish.

2. MATERIALS AND METHODS

This study was conducted at Beni haroun dam. The dam has been characterized by 120m high and 960 million m3, it is a large strategic hydraulic complex in Algeria, located in the province of Mila in North-Eastern -Algeria, it is located downstream of the confluence of Oued Rhumel and Oued Endja (north-west of El-Grarem region, wilaya of Mila) to about forty kilometers north of Constantine (NAFD, 2007). To the south of it, a large urban center (Constantine, Batna, Khenchela) [Mebarki, 2005, Mouaissia et al., 2017), covering about 3.929 ha of surface area (Fig. 1) is located.

A total of 168 freshwater Luciobarbus callensis (Valenciennes) (Cyprinidae) were collected from Beni Haroun dam between June 2015 and June 2016. The fish samples were transported alive in a good condition to the laboratory of Plant Biomolecules and Plant Improvement (University Larbi Ben M'Hidi, Oum El Bouaghi, Algeria). After the identification of the host species, the size (length/weight), age and sex of the fish were determined. Then, the collected fish samples were dissected; the body cavity was opened on the abdominal side by scissors from the anus towards the mouth. The intestine and other internal organs were taken out of the body cavity and placed in petri dishes with saline solution (0.8%NaCl).

The internal organs of each fish were also examined for parasites or cysts. The endohelminth parasites detected in each fish were then stored in 70–80% alcohol. Nematodes were examined as temporary wet mounts between a slide and a coverslip in glycerine, and Cestodes which have been mounted as permanent whole mounts on slides in Canada balsam.

Data analysis

The prevalence, which means the intensity and abundance of selected parasites was analyzed according to (Bush et al., 1997) for determining the relationships between the factors such as the host's sex, length, season, and parasitic infection.

Three biological parameters were used to analyze the impact of parasitism on the biological performances of Luciobarbus callensis. For comparing the growth rate of unparasitized and parasitized specimens, the model of Von Bertalanffy (1938) the size/weight relationship was used:

$Wt = a\ Lt\ b$

Where: a: is constant, Lt: is the total length of fish (cm), b: is the coefficient of allometry.

The condition factor (K) of the experimental fish was estimated according to the following relation (Gomiero and Bragan, 2005):

$K = Wt / Ltb$

Where: Wt : is the total weight of fish (g), Lt : is the total length of fish (cm), b : is the slope of regression line considered equal to 3).

The growth parameters were identified using Fishparm Software (Prager et al., 1989). The age was determined by scalimetry. The slopes of the equations were compared using a covariance analysis (ANOVA) carried out by the software of Statistica 08.

3. RESULTS AND DISCUSSION

Seasonal variation of sex ratio

In the fish samples of the Beni Haroun dam, a predominance of the male sex during summer and autumn has been noted because the sex ratio values were greater than 1; however, during the rest of the year; winter and spring, when the sex ratio values were less than 1, a predominance of the females has been noted (Fig. 2).

Proportions of size classes effective for Luciobarbus callensis

Harvested individuals showed that sizes varied from 20 to 41 cm. In addition, it was noted that more than 43% of barbels were between 30 and 35 cm in size; the two classes [35-40] and [25-30] represented respectively 37.50% and 12.5%; the specimens of the size class [20-25] represented 3.57% of the population; As for the great barbels, their proportions remained less than 3% (Fig. 3).

Enumeration of census parasites

The identification of the harvested helminthes parasites collected from the barbel (141 individuals) showed the predominance of Nematodes (61%) compared to Cestodes (39%) (Fig. 4).

Distribution of parasites according to size

The results of this study showed that the prevalence values varied slightly between the two types of parasites in the three mean size classes. The maximum value of the prevalence was found in Nematodes and Cestodes in size class of [20-25 cm] (29% and 23.80% respectively), Nematodes were absent in great and small individuals (Fig. 5). The highest parasitic loads of Nematodes were also noted in individuals between 25 and 30 cm (4 and 1 parasites per infested and examined fish respectively), while for the Cestodes, the highest values were recorded in the size class of [30-35 cm] (3 and 1 parasites per infested and examined fish, respectively) (Fig. 5).

Distribution of parasites according to sex and season

Parasite infestation rates were higher in females than males in all the seasons. The prevalence in the male individuals ranged from 6.66% to 27.58% and in females from

9.09 % to 38.46%. The absence of Cestodes in winter and Nematodes in autumn in males was noticed. The maximum prevalence of the Nematodes was recorded in spring in females (38.46%) and the maximum prevalence of the Cestodes was recorded in autumn in males (27.58%) (Fig. 6).

The highest parasitic load values for nematodes were observed in winter in males, and in autumn in females (7 and 6 parasites per infected fish, respectively and 2 parasites per examined fish) and for Cestodes in autumn in females (3 parasites per infected fish and1 parasite per examined fish) (Fig. 6)

Relative growth (length / weight) of fishes Luciobarbus callensis

The results reported in Table1 showed that there was a positive correlation (all R2 values are greater than 0.59) between the total length and total weight of both sexes, and the combined sex of the parasitized and unparasitized fish. The estimated values of b (coefficient of allometry) were less than 3, which showed a negative allometry between the weight and length in all of the different categories (males parasitized and unparasitized, females parasitized and unparasitized, parasitized and unparasitized specimens (combined sex) (Table. 1).

Linear growth

The linear growth curve obtained by the Von Bertalanffy method through comparing the growth of parasitized and unparasitized specimens showed that the growth was almost identical in both categories, and that infestation by endohelminth parasites was completed as early as the 5th year of their life (Fig. 7)

Fulton condition factor

The results obtained from this factor in the parasitized individuals and unparasitized in the different categories, showed that the most important values were noted in the female unparasitized fish (K=1.83). The registered weight difference differed slightly between the parasitized and unparasitized males (Kc= 0.26 and K= 0.22 respectively) and between the combined sex parasitized and unparasitized fish (K = 0.27 and K = 0.26 respectively) (Table. 1).

4. DISCUSSION

The characterization of 168 individuals of the Luciobarbus callensis population of the Beni Haroun dam showed that: the sex ratio was predominantly male during summer and autumn, and female during winter and spring coinciding with the period of breeding. In Morocco, the predominance of males was marked in Luciobarbus callensis (Bouhbouh, 2002) in spring, and during the rest of the year, the sex ratio was in

favour of females. In the barbel population inhabiting Hamiz dam (Ould-Rouis et al., 2012), the predominance of females was reported during the spring period, while for the population harvested in lake Oubeira, the predominance of female was noted for four months of the year (January, February, October and November), the gender equality was reported during two months of the year (July and August), and the predominance of males was noted during the remaining six months (Brahmia, 2016).

The size of this population varied between 20 to 41 cm, the small and large individuals only represented 3.57% and 3%; respectively, and the rest of the individuals were of average size (between 25 and 40cm). Comparing the sizes of individuals collected in the Oubeira lake (northeastern of Algeria) (Brahmia, 2016) during the study period, the barbels ranged in size from 10 to 38 cm (average size 23.39 ± 6.93), 65% of the individuals were of average size between 17 and 31cm, and the proportion of the big specimens remained below 11%. The size of Barbus genus in three wadis: Mellah, Taadmitand Tadjmout (east of Algeria) did not exceed 14 cm (Chaibi, 2014).

The observations of the morpho-anatomical characters of parasitic endohelminths harvested from the digestive tracts showed the predominance of the class of Nematodes (61%) compared to the class of Cestodes (39%). On the other hand, in Luciobarbus callensis of lake Oubeira, the Nematode Anisakis sp presented more than 10% whereas the Cestodes : Bothriocephalus acheilognathi and Ligula intestinalis presented more than 6% and 0,01%; respectively of all the harvested parasites (Brahmia, 2016).

The study of parasitism according to the size classes of the examined fish made it possible to assert that all the individuals were affected by the Cestodes parasites. On the other hand, it was the barbs with the average size that were affected by the nematodes, whereas the small size ones were excluded.

Moreover, at the level of Taadmit wadi (Chaibi, 2014), all size classes of Barbus genus could be affected by the parasites with varying degrees, with the exception of small individuals (≤ 5 cm). The specimens of great size class [12-14 cm] were the most infested, and included the greatest number of parasites. However, in lake Ayame (Ivory Coast) (Blahoua et al., 2009) and lake Manzalah (Hamdia, 1991), the Tilapia parasites became higher in the big fishes compared to the smaller sizes.

In Oued Boufekrane (Morocco) (Cherghou et al., 2002), the medium-sized fish's population had the highest parasitic infestation rates. It seemed to be related to their life cycle: the veracity of individuals in these size classes in their diets increased their fish food activity, and Luciobarbus callensis followed a seasonal rhythm (summer and spring were the seasons when fish had the intense food activity (Bouhbouh, 2002). Because of the great contact of the fish during the period of reproduction, the transmission of parasites increased among them (Ramdane, 2013). The changes in the parasitic load of Nematodes and Cestodes according to the size classes of Luciobarbus callensis showed the existence of a parasitic correlation between the size of the host and the infestation by the Nematodes with respect to the Cestodes, this finding was in agreement with those in Morocco (El Hilali et al., 1996).

Generally speaking, the study of the parasitic fauna related to the sex of the examined fish showed that the females represented the most vulnerable part to the parasitic aggressions mainly by the Nematodes where there was a clear predominance of this class in females throughout the year. In addition, the highest infestation values were recorded in males with a higher total number of parasites than females, which indicated a strong tendency in males. Besides, the vulnerability of females could be explained by the dynamics, the behaviour and the physiological state of the females in general, and the pregnant ones in particular; however, the higher sensitivity of females to the infection has been a hypothesis that has always been raised (Bonds, 2006). Tilapia females represented the most vulnerable part of the population to parasitic aggression (Chaibi, 2014). However, on parasites of Sarothero donmelanotheron of lake Ayame (Côte d'Ivoire), Blahoua et al. (2009) found that there was no significant difference between parasite indices and fish sex. The rate of parasitism increased independently from the sex of the host in Trachinotus ovatus in the coast of Mehdia (Tunisia) (El Madhi and Belghyti 2006).

The study of allometry in healthy and parasitized Luciobarbus callensis showed that there was no influence of parasitism on the growth of individuals (allometrie minorante for all groups of healthy and parasitized fish). Indeed, the lack of difference in the growth of weight relative to the size between the specimens of non-parasitized and parasitized fish could be explained by the higher food intake by the parasitized specimens as suggested for cardinal fish [Östlund & Nilson, 2005). These results matched with the results of several authors who had not shown a direct influence of parasites on length-weight relationships (Herrera & Cubilla, 1985, Hajji et al., 1994). Euzet & Combes (1980) considered the parasite and its host as biological entities, and they declared that the host adapts to the presence of parasites by developing strategies to overcome energy losses.

In both groups of healthy and parasitic barbels, the two growth curves were not different; concluding that the parasitism therefore had no effect on barbel growth in both sexes. These results were consistent with (Hajji et al., 1994), who have also reported that there was no difference between length-weight relationship and the age of parasitized and unparasitized fish.

On the other hand, the condition factor (K) appeared to vary according to the parasite infestation in both sexes including healthy or parasitized Luciobarbus callensis. Indeed, in this study, the high values of K were recorded in the non-parasitized females compared to the parasitized females (1.83 and 0.32 respectively). The K values were higher in healthy individuals than in parasitized individuals (Affandi, 1986). Rossi & Villani (1980) observed that there was a strong relationship between the condition factor (K) and the physiological and trophic state of each studied individual. In their studies, the K varied according to the sex and the degree of sexual maturity, and the values were higher in females than in males (like the results of this study). The seasonal variation in the condition coefficients was mainly related to the availability of food in the environment and also the reproduction (Kraïem, 1980, Benabid, 1990).

5. CONCLUSION

A sample of 168 individuals of Luciobarbus callensis inhabiting the Beni Haroun Dam was characterized by a total size between 20 and 41 cm and a sex ratio in favor of males during the summer and autumn, and females during the winter and spring.

The study of helminth endoparasites collected in the gastrointestinal tract revealed the predominance of nematodes (61%) compared to Cestodes (39%). The evaluation of parasite indices as a function of biotic and abiotic factors showed that all the size classes were affected by Cestodes parasites. Medium-sized barbels were more infested by Nematodes, small and large individuals were excluded. The highest parasite infestation rate was observed in spring by nematodes in females, while males were more infested in autumn by Cestodes.

In terms of the effect of parasitism on linear and relative growth, the growth curves and allometry studies on healthy and parasitic Luciobarbus callensis were similar (minorante allometry for all the healthy and parasitized groups of fish).

Parasitism had no effect on barbel growth for both sexes. On the other hand, parasitism had a negative effect on fish overweight; the condition coefficient (Kc) appeared to vary depending on the parasitic infestation in both healthy and parasitized sexes of Luciobarbus callensis. The higher values of Kc were recorded in unparasitized females compared to the parasitized females (1.83 and 0.32; respectively).

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Appendix:

Table 1. Parameters of relationship length/weight and condition index of parasitized specimens and unparasitized of both sexes and sex combined of *Luciobarbus callensis*

Relationship parameters size / weight	N	a	b	r	R^2	Allometry	Equation	K ($g.cm^{-3}$)
Males parasitize	26	3.04	2.07	0.95	0.90	Minorante	$P_T=3.04\ L_T^{2.07}$	0.26
Males un-parasitized	70	3,07	2.12	0.96	0.92	Minorante	$P_T=3.07\ L_T^{2.12}$	0.22
Females parasitized	22	3,01	2.02	0.91	0.82	Minorante	$P_T=3.01\ L_T^{2.02}$	0.32
Females un-parasitized	50	2,74	1.56	0.84	0.71	Minorante	$P_T=2.74\ L_T^{1.56}$	1.83
Combined parasitized sex	48	3.04	2.06	0.93	0.87	Minorante	$P_T=3.04\ L_T^{2.06}$	0.27
Combined un-parasitized sex	120	3.06	2.09	0.93	0.86	Minorante	$P_T=3.06\ L_T^{2.09}$	0.26

(N, number of fish; a, constant; b, coefficient of allometry; r, index of correlation; R^2, Coefficient of determination; W_T, total weight; L_T, total length; K, condition factor)

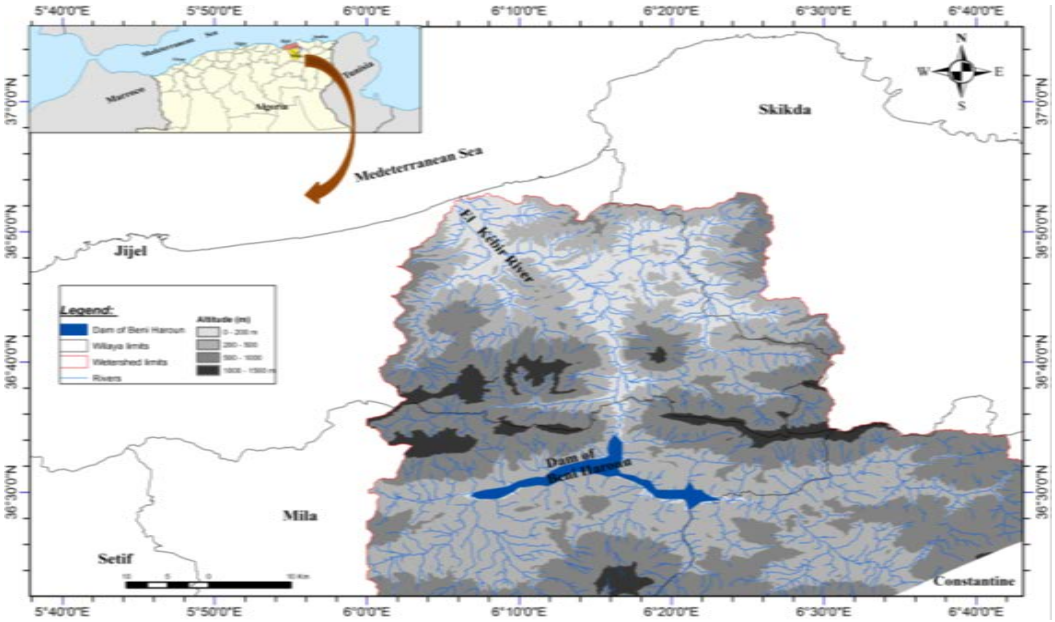


Figure1. Map of sampling site (Dam of Beni Haroun)

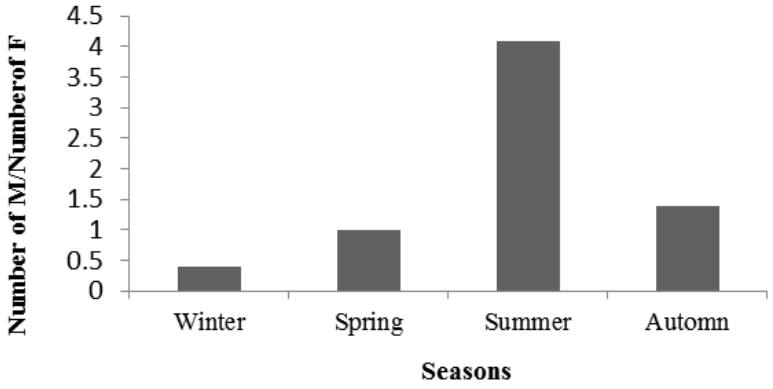


Figure 2. Seasonal variation of sex ratio values in *Luciobarbus callensis* from Beni Haroun dam (M: male, F: female)

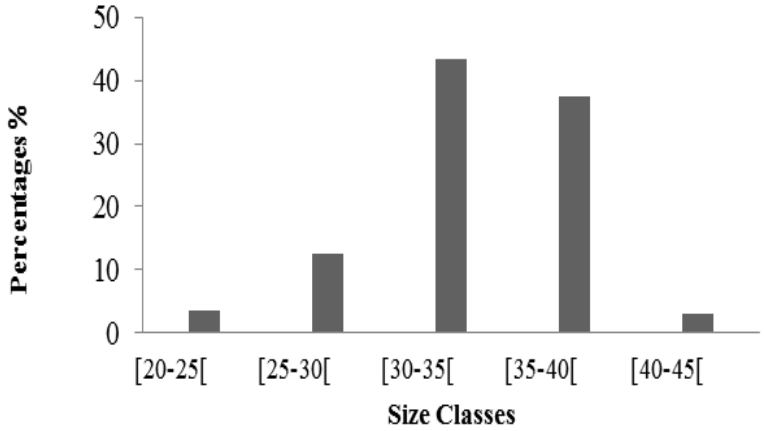


Figure 3. Proportion of individuals of different size classes of the collected barbel population

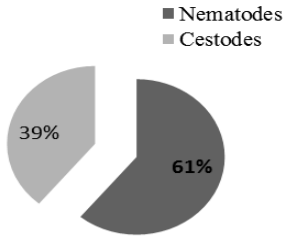
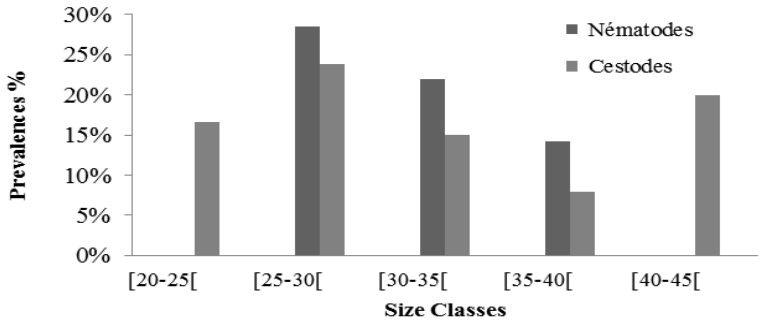
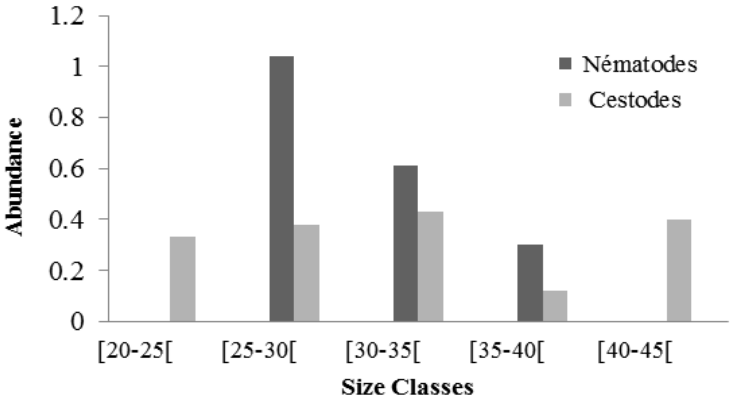


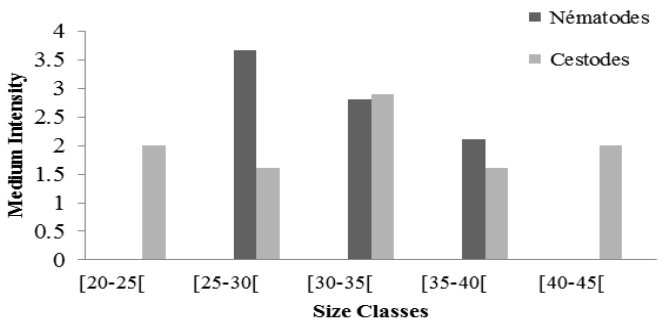
Figure 4. Proportions of census parasites in *Luciobarbus callensis* from Beni Haroun dam



(a)

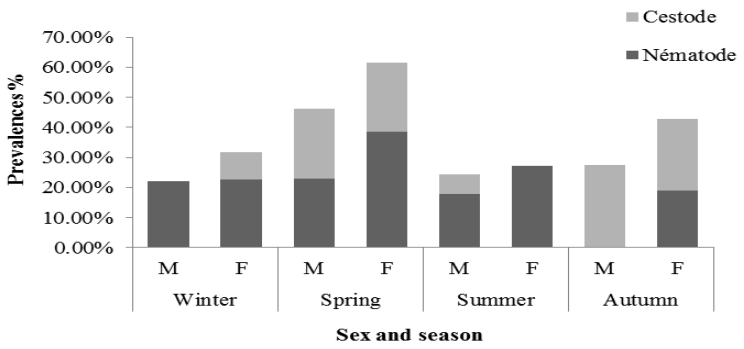


(b)

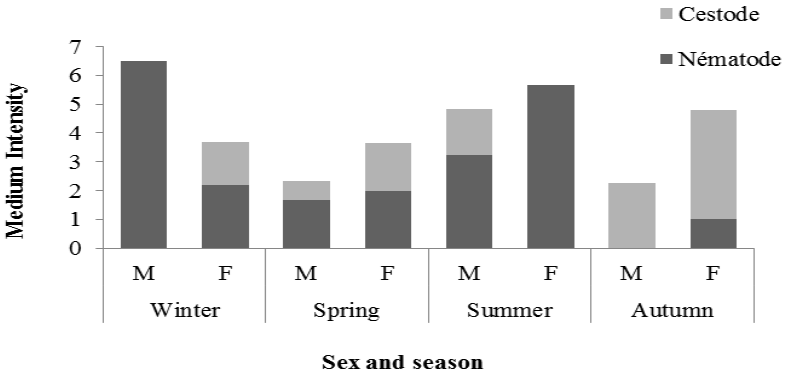


(c)

Figure5. (a , b & c). Epidemiological index of parasites by size class in Luciobarbus *callensis*



(a)



(b)

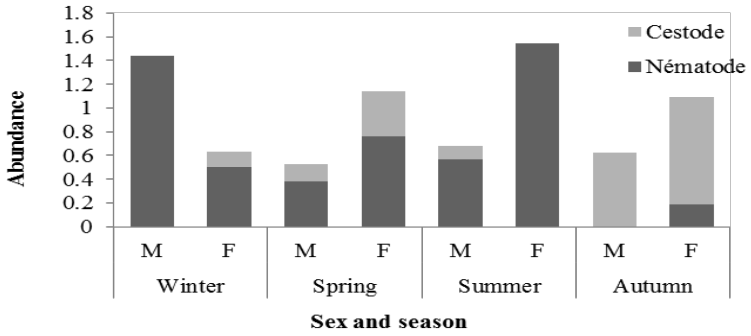


Figure 6. (a, b, & c) Seasonal epidemiological indexes by sex in *Luciobarbus callensis* (M: Male; F: Female)

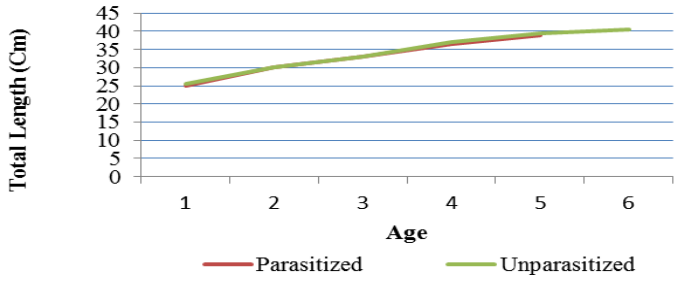


Figure7. Theoretical curve of the linear growth of the parasitized and unparasitized specimens of *Luciobarbus callensis*