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LENGTH-WEIGHT RELATIONSHIPS OF THE *BREAM ABRAMIS BRAMA* (LINNAEUS, 1758) IN BENI- HAROUN DAM OF MILA CITY (NORTH-EAST OF ALGERIA)

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ABSTRACT

The study of fish growth is a valuable tool in providing good understanding on the general biology and growth of fish populations, in addition to the comparison of the same fish species populations living in remote geographic areas. Thus, the present work was designed to study the age and growth of *Abramis brama* species newly introduced in Beni-Haroun dam (Mila department, Northeast Algeria). Here, the study was conducted on sampling of 141 individuals from July 2015 to October 2016. The age of fishes was determined according to scalimetric method, since the fish sex was determined by macroscopic method, showing that the number of females is higher (97) than that of males (44). The growth study was performed according to the mathematical method of Von Bertalanffy (1938). Based on the results of the growth parameters (L∞=40 cm**;** K= 0.27; t0=0.55; Ø'= 2.49. Males L∞= 35.26 cm**;** K = 0.32; t0= -0.49; Ø'= 2.59, combined sexes L∞=40cm**;** K= 0.31; t0=-0.49 years, and Ø' = 2.69), *Abramis brama* can live up to five years. Moreover, the evolution of total fish weights in function of their size reveals a minor allometry (b<3) (with and without distinction of sex), while the other obtained values provide good fits to Von Bertalanffy growth model.

Key words: *Abramis brama*, growth, von bertallanffy model, Beni Haroun dam.

INTRODUCTION

The common bream (*Abramis brama*) or freshwater bream is widely distributed in central and western Europe extending from the north of the Pyrenees to the Urals, excluding the north part of Scandinavia (Kafemann et al., 1998). The species is also found spread from Asia, and Marmara basin (Turkey) to the East of Aral basin (Bruslé and Quignard, 2001). In Algeria this species, is considered as a new species introduced in Beni-Haroun dam since 2006, and is much appreciated by Algerian consumers (Stiti and Traore, 2017). Moreover, the bream is a freshwater fish frequently found in calm waters of lakes, ponds, lakes, reservoirs and channels, and considered as eurytopic, supporting mesohaline waters up to 10g/l, since its reproduction prefer very low haline freshwaters (< 3g/l) (Boucenna, 2017). Interestingly, the growth study contributes in describing an average change per time unit, whereas the growth of population or individual is usually represented by mathematical models (Sparre and Venema,1996)**,** including the mathematical model of individual growth based on length or weight as previously reported by Von Bertalanffy (1938). Hence, the growth parameter attributes practically in reasoned exploitation problems of animal populations, leading to get a maximum yield, and to clarify these easily calculable

parameters characterizing the overweight of specimens and their evolution over the years of life (Belhoucine, 2012). Therefore, this work was aimed to study the age through a direct reading of scales, and the estimation of biological growth parameters of *Abramis brama* in Béni-Haroun dam of Mila department (northeast Algeria).

MATERIALS AND METHODS

Study Area

Beni-Haroun dam (Mila department, northeast of Algeria) is located upstream Oued Kebir basin, and mainly intended for the supply of water for drinking (nearly 3 million inhabitants) and for irrigation (30.000 ha). The dam is at the head of a large hydraulic transfer system, comprising a gigantic pumping-station with a flow of 21 m^3/s over 700 m of difference in level, whose impact would affect five cities in the East of Algeria (Mila, Constantine, Oum El Bouaghi, Batna and Khenchela). Additionally, it is 114m in height downstream the bed, 100m in width at the base and 710m in length at the crest, and is a part of large program of surface waters mobilization and their inter-basin transfers in overcoming the strong hydraulic disparities (Mebarki et al., 2005). Its water impoundment has started from August, 2003, and its water storage capacity is 997.9 million m^3, which recently reached maximal value of one billion per m^3 (Mebarki et al., 2008; Mebarki, 2005) (Figure 1).

Sampling

A total of 141 *Abramis brama* fish individuals were sampled from Beni-Haroun dam of Mila city (northeast Algeria) during a period extended from July, 2015 to October, 2016 using monofilament gillnets. The total lenth in millimeter (TL, ±0.1 mm) was measured with an ichtyometer, and the total weights were determined by a precision balance (TW, ±0.01g). Also, the sex of fish samples was distinguished by naked eye based on morphology and colour of gonads. In this study, we have adopted the definition of sex ratio as the proportion of males and females in the population (Kartas & Quignard 1984).

Proportion of females = (F/F + M) x 100

Proportion of males = (M/F + M) x 100

Where: F: Number of females; M: Number of males.

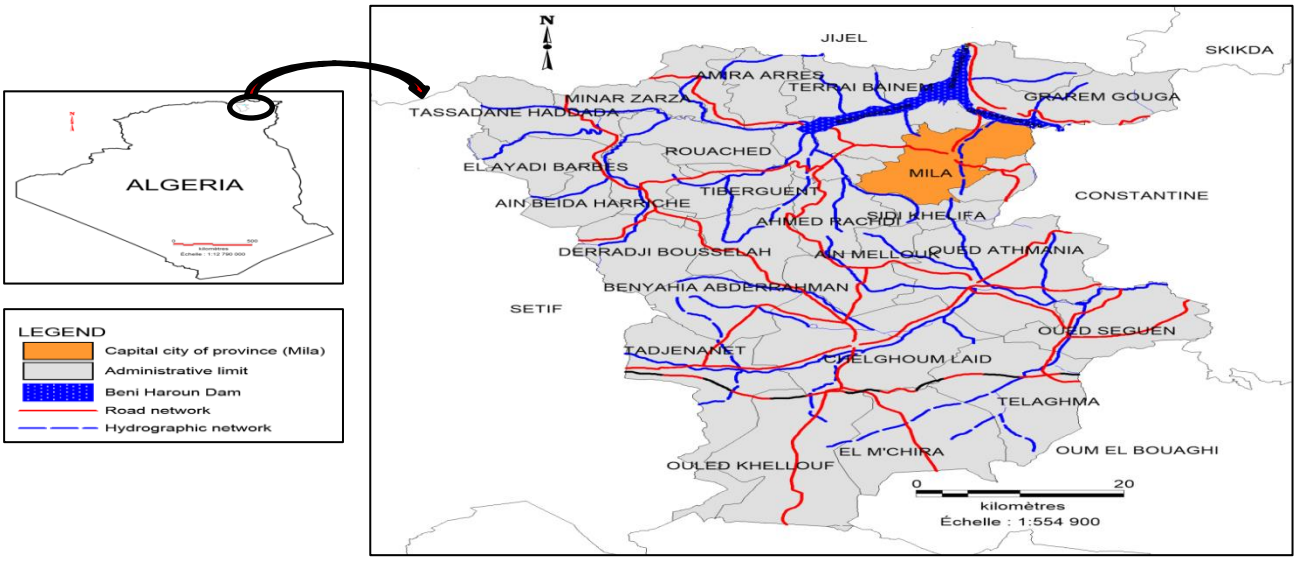


Figure 1: Geographical location of Beni-Haroun dam (Mila department, Algeria).

Detrmination of Fish Ages

The age was determined by a direct reading of the fish scales (scalimetry) taken from the lateral-dorsal part, where the scales appear to be the earliest growth stage (Boet and Louarn, 1985). Here, the fish scales were removed, cleaned with running water, rubbed between the thumb and forefinger to get rid of the tissue and mucus fragments that cover them, then observed under a binocular microscope (Bouhbouh, 2002). The samples were examined three times (observations and readings) to make a better estimate of the age of the studied fishes, and thus to reduce any errors in the analysis of scales.

Study of Growth

The evaluation of fish growth was conducted using a mathematical model of individual growth elaborated by Von Bertalanffy (1938). This model is commonly used by researchers because, at one part, it leads to account the observed fish species growth, and at the other part, it serves as a sub-model in more complex models, describing the dynamics of fish populations (Sparre and Vienema, 1996).

The mathematical model is described by the following formula:

$$\mathbf{TL=\infty L\ (1-exp^{-k(t-t_0)})}$$

Where, "TL" is the total length in function of age or time, generally expressed in years, since "∞L, K and t_0" characterize the performed adjustment, but they are recently defined as follow:

TL" is total length following time t (age), ∞L is the average length of fishes of very old age, and is called also asymptotic length of L when time "t" tend towards infinity, but it should not be confused with the maximum length actually reached by the studied species. Thus, it is possible to determine the asymptotic length value "∞L" by the empirical relation of Pauly (1985).

$$\mathbf{\infty L = L_{max}/0.95}$$

Where, K, is the constant of growth curvature parameter, exhibiting the slope of the adjustment line between the length of the instant growth, and **t0** is the initial condition parameter defined as the theoretical age, where the fish has zero length, and so this is not the case in reality.

Also**,** the **t_0 is** determined according to the following empirical equation (Pauly, 1979):

$$\mathbf{Log_{10}(-t0) = -0.3922-0.2752\times Log_{10}\infty L -1.038\times Log_{10} K}$$

The comparison of the growth parameters between the different populations of the same species, and between several species was performed by Phi prime Ø test ($cm.an^{-1}$) based on the following equation:

$$\mathbf{Ø'=Log\ K+2\ Log\ \infty L}$$

The growth parameters of Von Bertalanffy (1938), ∞L, K and t_0 were determined according to the method of Ford Walford (1946) using Statistica software (Ver, 8).

The Length-Weight Relationship

The data of the length-weight relationship were analysed by the following model:

$$\mathbf{TW= a\ TL^b}$$

Where, TW is the total weight (g), TL is the total length (cm), the constant a is) is the intercept of the regression, and b is the regression coefficient.

$$t_{obs} = \frac{|b^2 - b_0^2|\sqrt{n-2}}{2b_0 \times b\sqrt{1-r^2}}$$

- The b-value for each species was tested by t-test to verify if it was significantly different from the isometric growth (*b* = 3) If b = 3, the growth is allometric. If b>3, the weight grows faster than the cube length with a major allometry.
- If b < 3, the weight grows less quickly than the length cube, along with a minor algometry.

The condition factor (K)

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

$$K = TW / TLb$$

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

RESULTS

Size-Structuration and Sex Ratio of Abramis Brama Population.

The distribution of size frequencies of population individuals of *Abramis brama* was established with classes of 1 cm. Hence, among all captured fishes, two fish size classes; [25-26] and [26 -27] were found to be more important with frequencies close to 15.60 %. Males revealed a peak of frequencies (7.80 %) for the size class [23-24], meanwhile females revealed significant frequency values (12.76 %) for the size class [25-26].

Determination Fish Age

The scalimetric method promoted us to group all *Abramis brama* individuals into 5 age classes ranging from 1 to 5 years. The results showed that the total population and females dominate in the fourth class, respectively with frequencies (F %) of 46.09% and 31.20 %, and similarly in the fifth age class, but the frequencies of the total population and females were respectively, 34.04 % and 22.69%. Of note, the males are absent in the first age class.

Study of Fish Growth

In table 1, the slopes or **b** values of the relationship between size and weight is statistically different between sexes (F =7617.684, p < 0.0005).

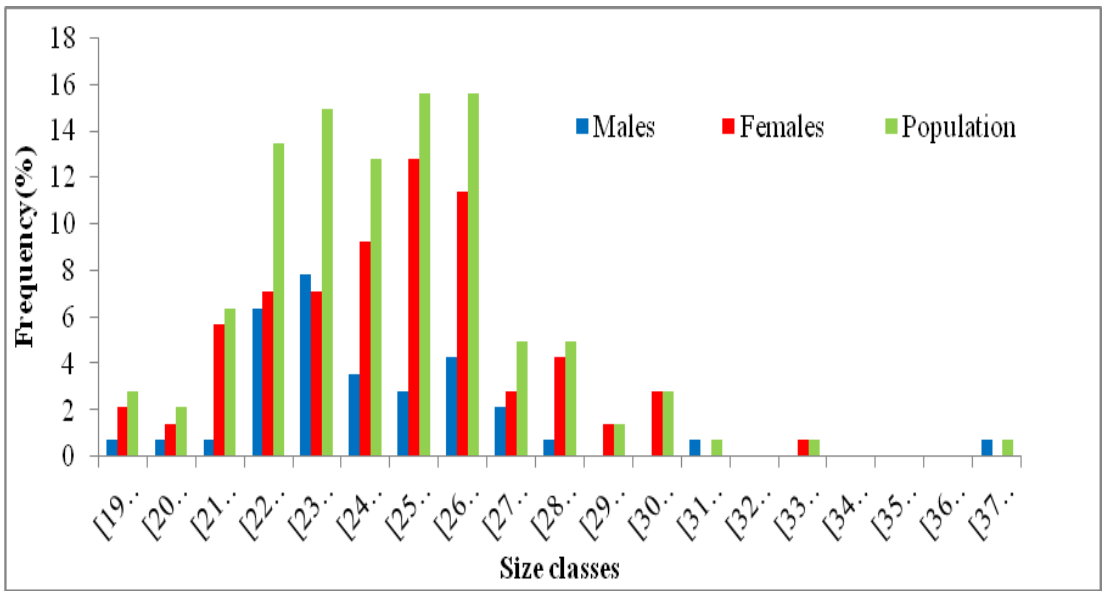


Figure 2: Size frequencies distribution of *A. brama* in Beni-Haroun dam.

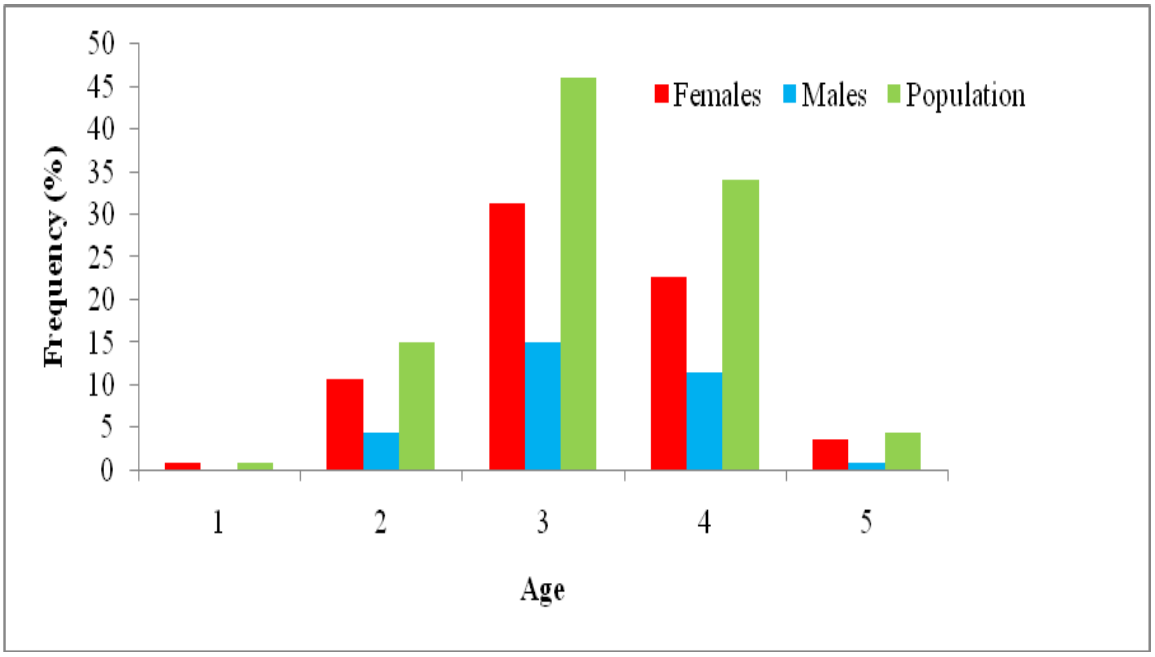


Figure 3: Composition of population age of *Abramis brama* population in Beni-Haroun dam.

Table 1: Growth parameters of Von Bertalanffy of *A. brama*

Parameters	L_{min}- L_{max}	L∞	K	t_0	Ø'	Equation
Both sex	19.5-38	40	0.31	-0.49	2.69	$Lt= 40(1-e^{-0.31(t+0.49)})$
Females	19.5-33.5	35.26	0.32	-0.49	2.59	$Lt= 35.26(1-e^{-0.32(t+0.49)})$
Males	19.5-38	40	0.27	0.55	2.94	$Lt= 40(1-e^{-0.27(t+0.55)})$

Table 2: Relationship parameters of size-weight in *A. brama*

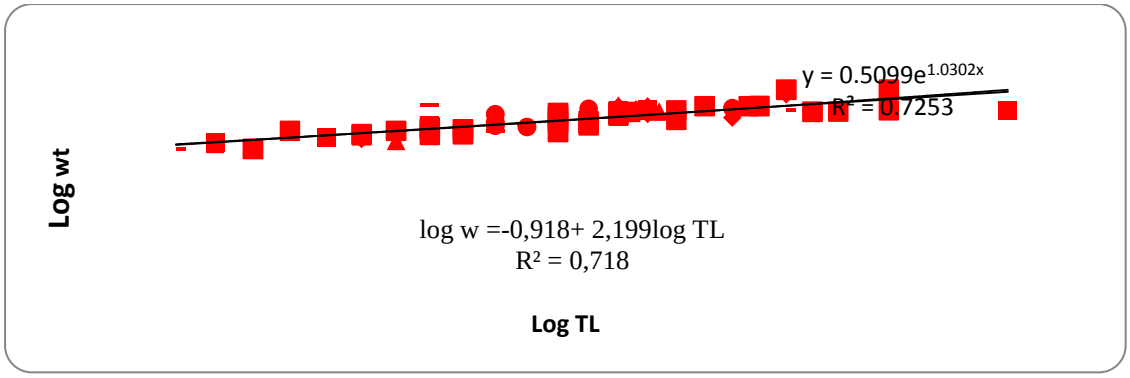
Sex	*N*	*a*	*b*	R^2	*t(obs)*	*Allometry*
Both	141	0.184	2.062	0.688	**8.08**	Minor
Females	97	0.120	2.199	0.71	**5.79**	Minor
Males	44	0.488	1.745	0.64	**6.19**	Minor

The Length-Weight Relationship

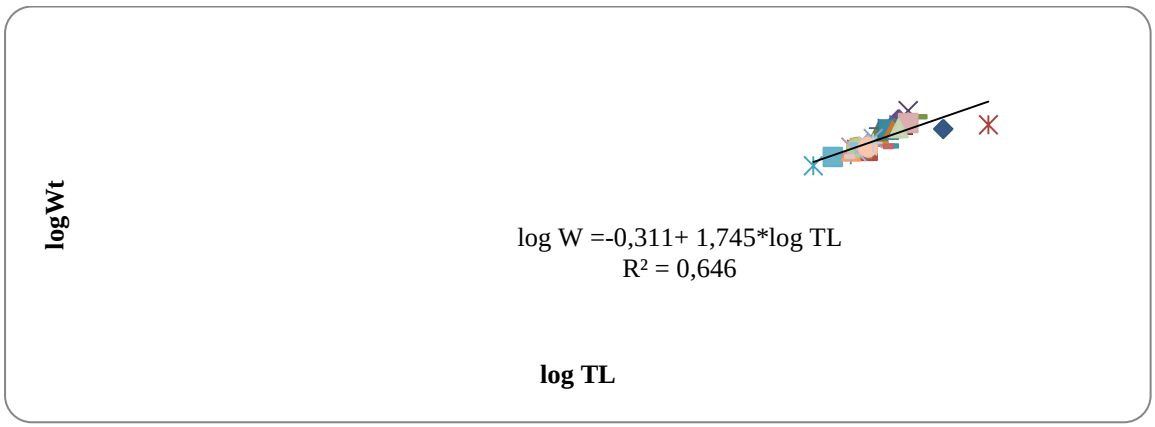
The results of the length-weight relationship (tables 2 and figure 3) revealed a minor allometry in all *A. brama* population (b < 3)

Seasonal Evolution of the Condition Factor "K"

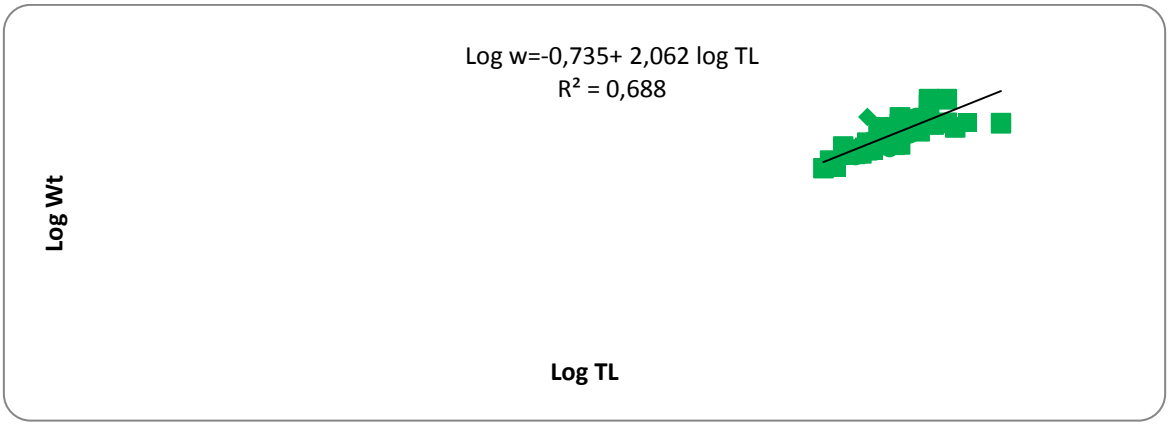
The condition factor (K) values are almost close in the both sexes, but even as they vary from 0.89 to 1.12 in females, and from 0.82 to 1.11 in males. There is a phase of good condition remarkable during summer with a peak estimated as 1.12 ± 0.50 in females, and a peak 1.11 ± 0.37 during Autumn in males. The Levene test showed no significant difference between K mean values during the five seasons (F =1.25, p > 0.05) (Table 3).



A



B



C

Figure 3: The length-weight relationship; *A- Females; B- Males; C- Combined sex of A. brama.*

Table 3: Seasonal evolution of condition factor (K) in *A. brama*

	Females	Males
Spring	0.89 ±0.13	0.96±0.14
Winter	1.04±0.34	0.82±0.01
Summer	1.12±0.50	1.07±0.12
Autumn	1.066±0.11	1.11±0.37

DISCUSSION

This work provides the first study of the *Abramis brama* growth in Beni-Haroun dam of Mila department (northeast Algeria), in addition to some other recent studies conducted on Cyprinidea in northeast of Algeria, like those carried out on *Cyprinus carpio* in Foum El khanga dam Fatiha et al., (2017), on common crucian in Beni-Haroun and Ain Eldalia dams of Souk-Ahras city (Khelifi, 2018), and those conducted on bream in Hammam Debagh dam of Guelma city (Chehidi and Saad, 2018; Loulou and Bitour, 2019).

Several authors have investigated the bream growth (Kangur, 1996; Specziar et al., 1997; Matenova et al., 1998; Tierney et al., 1999; Zivkov et al., 1999), and they reported four main growth types of the length, among which are those having standard asymptotic length (L∞ up to 59 cm), and are typical for cold water basins, where the initial growth increases when L∞ varies from 60 to 80 cm.

Moreover, the maximal size of samples was 38 cm for the males and 33.5 cm for females. About this, Loulou and Bitour (2019) have found that the maximal length of *Abramis brama* collected from Hammam Debagh dam was 49.47 cm for females and 34.73cm for males.

The asymptotic length values (∞L) for the combined sex and males are higher (40 cm) than that of females (35.26 cm). Chehidi and Saad (2018) have reported that the maximal size of all *A. brama* populations could reach 41.5cm, meanwhile the asymptotic size is 45.52cm, as well as the work of Sahtout et *al.*, (2017) conducted on *Cyprinus carpio* (Cyprinidae) in Foum El Konga dam has shown that the asymptotic length of females (58.28 cm) is higher than that of males (48.83 cm).

The variations in fish growth are overall, related to environmental conditions, including temperature, availability and food quality, predation and even the pond size (Holopainen et al., 1988; Szczerbowski et al.,1997).

The scalimetric method performed without distinction between the two sexes indicates that A. brama can live up to five years, and this result is in line with those reported by Loulou and Bitour (2019), proving that *A. brama* of Hammam El Debagh dam can live up to five years. Similarly, Chihedi and Saad (2018) have found in the same study area that the total population can live up to 6 years, and Khelifi et al., (2018) have found that the maximum longevity of *Carassuis carassuis* (Cyprinidae) is 7 years in the *Beni –Haroun* dam, and 5 years in the Ain El Dalia Dam (Souk Ahras). Mimeche et al., 2013 in the man-made lac in Algeria found that the overage age of *Luciobarbus callensis* men varied between 4-7 year.

Furthermore, the "K" growth coefficient recorded for the combined sex ($K=0.31$ years $^{-1}$) is close to that of females ($K=0.32$ years $^{-1}$), but is higher than that of males ($K= 0.27$ years $^{-1}$). Loulou and Bitour (2019) have reported that the condition index per year is almost similar in males (0.50) and females (0.49), and less important in the combined sex (0.35/ year).

The change in the pace of growth between males and females is affected by sexual maturity, and hence the difference in growth rate between males and females can be explained by the difference in metabolism and O_2 consumption between the two sexes (Pauly and Moreau, 1997). According to Godinho (2001), the difference in growth between the two sexes allows females to reach larger sizes than males of the same age.

Recent studies of fish growth using marking and recapturing techniques have shown that females grow faster than males from the age of two years old (Pontual et al., 2006; Mellon-Duval et al., 2010).

In this study, the values of performance index of the obtained growth were found to be close for males (2.69), females (2.59) and both sex (2.94),

indicating thus a good sampling and uniform selection of *A. brama* specimens. Loulou and Bitour (2019) have reported very similar performance index values for males (2.93), females (3.08) and both sex (2.77). Chehidi and Saad (2018) have reported that the growth performance values obtained in total population of *A. brama* in Hammam El Debagh dam was found as 2.76. Further, Bauot et al., (1994) suggested that the obtained results are not reliable only when the performance index values of growth are ranged between 2.65 and 3.32. The estimation of the performance index provides to be an indicator to reliability of results due to the similarity in the same species and genera.

The allometric coefficient values showed that the growth is evidenced by a minor allometry, where the *b* values in separate and both sexes were found to be inferior than 3, and this well-concords with those found by Loulou and Bitour (2019) who reported (male, female and both sexes) of the same species exhibit a minor allometry. In contrast, the work of Khalef et al., (2015) conducted on black bream, *Eumegistus illustris* (Bromidae family) have revealed that males present theoretical value **b** slightly superior than 3. The study of Chehidi and Saad, (2018) conducted on *A. brama* from Hammam El Dbagh dam revealed that the relationships relating size to weight are a minor alloemtry with inferior than 3, as well as Naima et *al.*, (2018) and Khelifi, (2018) have mentioned that the growth of *C. carassuis in Beni-Haroun* and Ain El Dalia dams are of minor allometric type for separate and combined sexes.

The length-weight relationship is variable in time under the effect of several biotic and abiotic factors, in particular, habitat, sex, season and maturity of gonads (Wootton, 1990).

The seasonal variations of condition coefficient (K) of *A. brama* in both sexes (male and females), even passing from season to other, meanwhile the lowest values were noticed during spring and winter, respectively in females and males. In this context, Naima et *al.*, al., (2018) have noticed in the same dam, the lowest **K** values during spring in *Carassuis carassuis*, since Fatiha et al., (2017) has observed in *Cyprinus carpio* maximum **"K"** values during winter and minimum values during summer. According to Deniz (2012) and Pauly (1994), the growth rate can be affected by temperature variations, salinity, fish dietary habits, pace growth change between males and females, and metabolism difference between both sexes and sexual maturity.

Table 5: Comparison between growth parameters of *Abramis brama* obtained from various data sources.

Area	Authors	**L∞ (cm)**	**K**	**Ø'**
Croatian Danube	Treer et al, 2003	57.7	0.087	5.67
Balaton Lake	Specziar et al, 1997	50.1	0.083	5.34
103 Populations	Zivkov et al, 1999	62.3	0.0986	5.95
Hammam El Dbagh dam (Algeria) **()**	Chehidi and Saad, (2018)	45.52	0.28	2.76
Hammam El Dbagh dam (Algeria)	Loulou and Bitour (2019)	49.47	0.35	2.93
Beni-Haroun dam	Present study	40	0.31	2.69

CONCLUSION

The present work investigating the growth of *Abramis brama* from Beni-Haroun dam leads to the following highlights:

-The scalimetric method reveals five classes of age.

-The growth parameters using Von Bertalanffy equation revealed different values of asymptotic length $_{\infty}$ **L,** K growth coefficient and performance index (**Ø'**) in both sexes.

-The length-weight relationship of *Abramis brama* population is evidenced by a minor allometry, and this is explained by the faster growth of size than weight.

Finally, it is interesting to elaborate on the following points:

-Increase sampling effort to provide a clear understanding of the entire population of common bream in the Beni-Haroun dam.

-Carry out further work on the growth of common bream (*Abramis brama*) throughout its distribution areas to answer several questions on its environmental dynamics.

-Carry out similar work on the growth of other Cyprinidae fishes, notably *Luciobarbus callensis, Carassuis carassuis* and *Cyprinus carpio*.

To study the same growth parameters of Cyprinidae fish under the effect of parasites.

AUTHORS CONTRIBUTION

Authors' contributions M T designed the study, extracted the data and wrote the study manuscript. R H and M C B contributed to data analysis and interpretation the manuscript. H B and N K read the manuscript and participated in the preparation of the final version of the manuscript. All authors read and approved the final manuscript.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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