Journal of Aquaculture and Fish Health Vol. 10(3) - September 2021
DOI : 10.20473/jafh.v10i3.24439

Growth of African Catfish (*Clarias gariepinus*) in Illizi South-East Algeria

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Received : 2021-01-09
Accepted : 2021-03-09

Keywords :
Algeria, Catfish, Conservation, FiSAT II Software, Growth

Abstract

These observations are intended to provide information on the growth of the African catfish (*Clarias gariepinus*) living in the Oued Takhamalte-Illizi South-East Algerian. The basic data are the frequencies of the fish sizes resulting from the experimental fisheries carried out in October 2019 in Oued Takhamalte South-East of Algeria. The ELEFAN I program incorporated into FiSAT II software was used. The Powell-Wetherall method provides an L∞ of the order of 53.84 cm and a Z/K of 3.254 with a correlation coefficient R = - 0.944. This asymptotic length is greater than the maximum observed value (Lmax = 50 cm) and the Taylor approximation (L max/0.95 = 52.63 cm). The corresponding K value (0.28/year) seems the most suitable for the growth of a species, for this we opted for the parameters obtained by the sub-program « area of equal responses» of the program ELEFAN I (L∞ = 53 cm and K = 0.28/year) for the continuation of our study. The reduced gap test proves that there is a significant difference between the observed slope (b = 2.41) and the theoretical slope (P = 3), which makes it possible to affirm that the height-weight relationship in both sexes of *C. gariepinus* shows minor allometry, meaning that the weight grows slower than the cube of length.

INTRODUCTION

The most common relationships that have been established and used for the majority of fish are those that relate weight to body length (in the majority of cases, total body length (TL) and, in some cases, standard length (SL) and/or fork length (FL). This weight (w) - length (TL) relationships are of the power type; $W = a.L^b$ (Binohlan and Pauly, 2000; Froese and Pauly, 2011). Fish length and weight are very important morphometric traits that can be used for taxonomy and fish stock assessment (Goel *et al.*, 2011). A variation in the weight or length of an individual or group of fish indicates overall well-being and gonad development (Mathur and Bhatara, 2007).

Knowledge of age and the growth process is a fundamental aspect of studying the demography and dynamics of animal populations, and especially of fish (Philippart, 1972, 1977; Panfili and Ximenes, 1994; Lalèyè, 1995; Panfili *et al.*, 2002; Santana *et al.*, 2006). Several methods are likely to be used for the study of age in fish, each study has advantages and disadvantages. In the case of the African catfish of the southeast of Algeria, we applied the model of study of the fishing exploitation: that is that of Von Bertalanffy. This study aimed to provide information on the growth of the African catfish (*Clarias gariepinus*) living in the Oued Takhamalte-Illizi South-East Algerian.

METHODOLOGY

Place and Time

This study was carried out in October 2019 in Oued Takhamalte South-East of Algeria.

Research Materials

The taxonomic identification of the 50 females and 34 males examined revealed that the samples were *Clarias gariepinus*. The ELEFAN I program incorporated into FiSAT II software was used to process the growth parameter data.

Research Design

The fish samples (84) were kept in plastic tanks, immersed in water, transported to the Laboratory of Sciences and Technics of Animal Production (LSTAP), Abdelhamid Ibn Badis University, Mostaganem, Specimens were transported to the laboratory for biometric measurements.

Work Procedure

The FiSAT software identifies local maximas, frequency distributions of sizes, which by assumption represent the average lengths, of fish of different ages. Then the user searches, in successive steps, for the growth curve that best takes into account these different maxima while obeying the general equation of Von Bertalanffy (1938) including the expression of seasonal variations in growth speed. Von Bertalanffy's equation is of the form (Pauly and Gaschutz, 1979):

$$Lt = L\infty\left(1 - e^{(-k(t-t0))}\right) \quad (1)$$

Where:

exp = exponential function
Lt = average length of the fish at age t
L = asymptotic length, that is, the average length that would be reached at an infinite age if growth were to take place according to equation (1)
K = growth coefficient, indicating the speed at which the curve approaches the asymptote, it is also called the "stress factor"
t0 = the age for which Lt = 0 (i.e., the x-axis of the intersection of the curve with the age axis)

K and t0 are constants.

A preliminary estimate of L∞ is obtained using the Powell-Wetherall method (Wetherall, 986). The association of the fixed values of L∞ with ranges of values of K (Elefan 1 K-scan procedure), allows to obtain values of K. The value of the coefficient K chosen corresponding to the highest value of normalized adjustment Rn, with:

$$Rn = 10^{\frac{ESP}{ASP}}/10$$

The theoretical age t0 at zero sizes was obtained by the equation of:

$$\log 10(-to) = -0.392 - 0.275 * \log 10\ L\infty - 1.038 * \log 10\ K$$

Data Analysis

It is often useful to be able to accurately assess the weight of a fish knowing its size. To do this, there is a simple relationship that links length to mass, and is written as (Sparre & Venema, 1996):

$$W = a \times L^{b}$$

Where:

W = body weight of the fish
L = total length
a = constants
b = constants, which represents an allometric coefficient, and when: b < 3: minor allometry; b = 3: isometry; b > 3: major allometry.

However, the type of allometry is confirmed by the t-test (Schwartz, 1992), based on the comparison of a calculated slope (P0 = b) with a theoretical slope (P = 3):

$$t = \frac{|P_0 - P|}{SP_0}$$

Where:

$$SP_0^2 = \frac{\left(\frac{S_y}{Sx}\right)^2 - P_0{}^2}{n - 2}$$

If t < 1.96: the difference is not significant; if t ≥ 1.96: the difference is significant. The value of W∞ is obtained from the equation:

$$W_\infty = a \times L_\infty^b$$

Where a and b are those of the height-weight relationship. The calculations were made using the software Statistica 5.0 and Microsoft Excel.

RESULTS AND DISCUSSION

Comparison of Average Sizes

To compare the effect of sex on the size of *C. gariepinus*, a comparison of the mean sizes of males and females was made by using the Pauly (1979) test of the narrow t-gap. All length measurements of 84 individuals sampled from *C. gariepinus* were used to calculate average sizes by sex. The males have a total length (LT) which varies between 35.5 and 47 cm with an average size of 40.32 cm; on the contrary, in the females, the size oscillates between a minimum of 34 and a maximum of 50 cm, whose average size is 39.24 cm.

The results of the narrow gap test recorded in (Table 1) show that there is no significant difference between the mean sizes of males and females at the 5% risk rate, indicating that sex does not affect the growth of *C. gariepinus*, this leaves us to consider the mixed-sex, for the study of the growth of our species.

Table 1. Statistical test results.

C. gariepinus	Male	female	t	P-value
Ltmoy	40.323	39.244	1.470	0.146
N	34	50		

All measurements of 84 individuals of *C. gariepinus* were allowed to group these sizes in a frequency distribution table by sex with a 2 cm pitch using the software Statistica 5.0 (Table 1). Figure 1 represents the polygons of size (expressed in %) established by sex. The analysis of this distribution shows a distribution, tri-modal for both sexes, with three more distinct and distinct modes in males than females. These modes occur at 39, 43, and 47 cm in males (Figure 1) and 37, 47, and 51 cm in females (Figure 2).

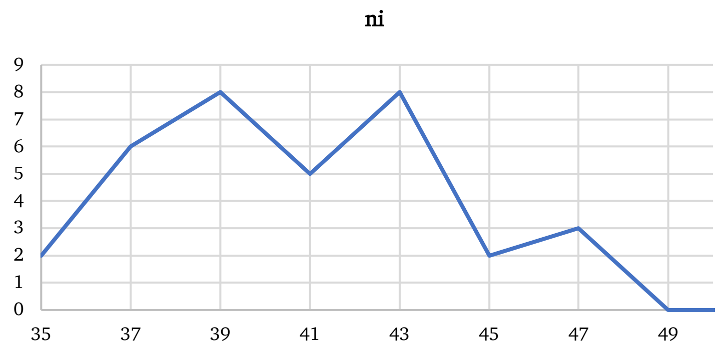


Figure 1. Size polygon analysis in males of *C. gariepinus*.

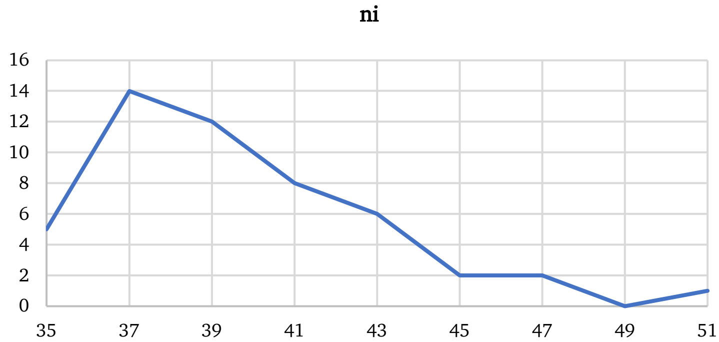


Figure 2. Size polygon analysis in females of *C. gariepinus*.

Analysis of Size Structures

To provide an overview of the stock of *C. gariepinus*, we analyzed the size structures of 84 individuals caught using indirect methods to estimate the linear growth parameters L∞ and k. The distribution of size frequencies was analyzed by the Powell (1979) - Wetherall (1986) method and ELEFAN I using the FISAT II software (version 1.2.0). The resulting curves of the Powell-Wetherall method are shown in (Figure 3). This method provides a L∞ of the order of 53.84 cm and a Z/K of 3.254 with a correlation coefficient R = - 0.944. This asymptotic length is greater than the maximum observed value (Lmax = 50 cm) and the Taylor approximation (L max/0.95 = 52.63 cm).

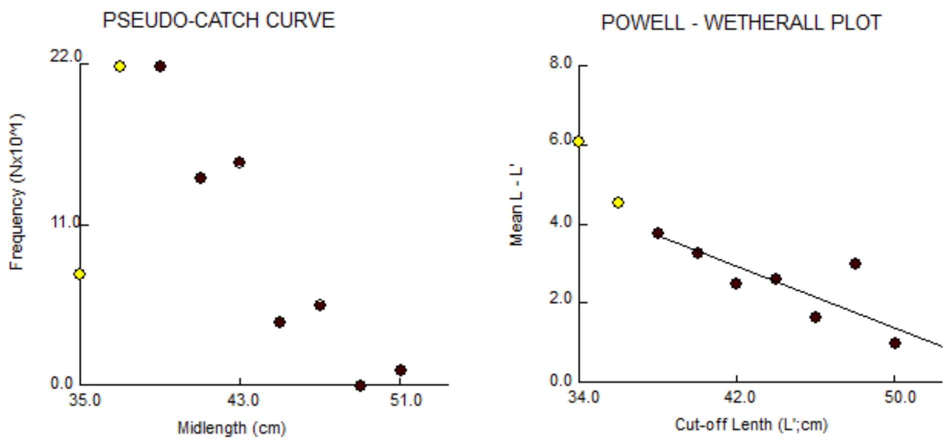


Figure 3. Powell's method size-frequency distribution (1979) - Wetherall (1986).

The resulting L∞ value was introduced into the ELEFAN I program to obtain a corresponding K value. (Figure 4) (K-Scan Label) shows the behavior of the "scores" for this asymptotic length. The most appropriate K value for the estimated asymptotic length (L = 53.84 cm) is 0.31 years^{-1}. This value corresponds to the highest score (Rn = 1). The K-Scan label also provides two data: the SS starting sample (1), and the SL starting length (46 cm). These are the two coordinates used to locate a growth curve in the ELEFAN I routine.

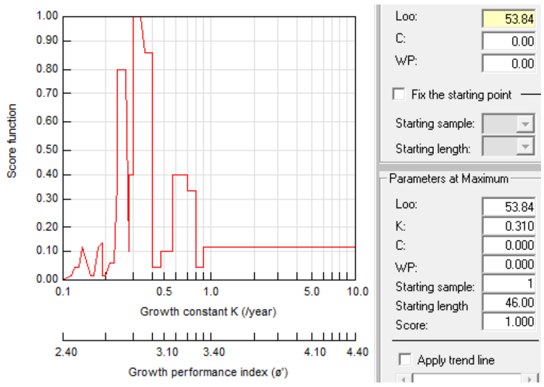
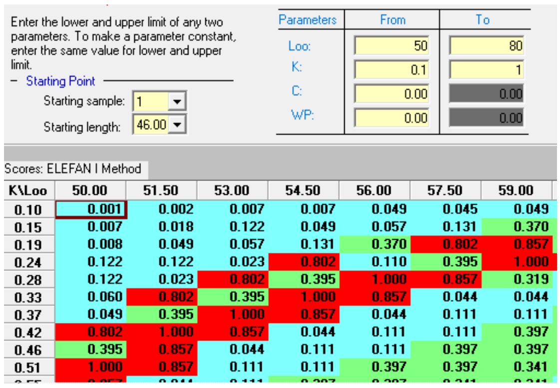


Figure 4. Variation of Rn as a function of K obtained by ELEFAN I for *C. gariepinus*.

The ELEFAN I program has a sub-program called "Area of Equal Responses", which shows a table with all values of K and L∞, and the corresponding ESP/ASP values within a predefined range of L/K values. This range is limited based on previously estimated data in the same region. The best Rn values are highlighted, allowing the selection of the best combination of growth parameters (Figure 5).



K\Loo	50.00	51.50	53.00	54.50	56.00	57.50	59.00
0.10	0.001	0.002	0.007	0.007	0.049	0.045	0.049
0.15	0.007	0.018	0.122	0.049	0.057	0.131	0.370
0.19	0.008	0.049	0.057	0.131	0.370	0.802	0.857
0.24	0.122	0.122	0.023	0.802	0.110	0.395	1.000
0.28	0.122	0.023	0.802	0.395	1.000	0.857	0.319
0.33	0.060	0.802	0.395	1.000	0.857	0.044	0.044
0.37	0.049	0.395	1.000	0.857	0.044	0.111	0.111
0.42	0.802	1.000	0.857	0.044	0.111	0.111	0.397
0.46	0.395	0.857	0.044	0.111	0.111	0.397	0.397
0.51	1.000	0.857	0.111	0.111	0.397	0.397	0.341

Figure 5. ELEFAN I with a subprogram called "Area of Equal Responses".

The analysis in Figure 5 shows that the set of the highest scores (colored in red) corresponds to several pairs of L/K values. However, the couple L∞ = 53 cm and K = 0.28 yr^{-1} seems the most appropriate, given that the estimated L∞ value is greater than the maximum observed value (Lmax = 50 cm) and the Taylor approximation (Lmax/0.95 = 52.63 cm) and very close to the asymptotic length estimated by the Powell-Wetherall method suggested by Pauly and Moreau (1997) for a good estimate of L∞. The corresponding K value (0.28/year) seems the most suitable for the growth of a species. For this, we opted for the parameters obtained by the sub-program «area of equal responses» of the program ELEFAN I (L∞= 53 cm and K = 0.28/year) for the continuation of our study. Table 2 summarises the growth parameters obtained by the different methods used for *C. gariepinus* (the parameters L∞ and K are shown in bold).

Table 2. Summary of estimated growth parameters for *C. gariepinus*.

L_{max}obs	L_{max}/0.95	Powell-Wetherall		ELEFAN I			
				K-scan		Area of equal responses	
		L∞	z/K	L∞	K	L∞	K
50	52.63	53.84	3.254	53.84	0.31	**53**	**0.28**

Estimation of Asymptotic Weight W∞

Table 3 represented by Figures 6, 7, and 8, presents the results of the height-weight relationship of *C. gariepinus*. This relationship was made from 84 individuals and allows us to calculate the asymptotic weight (W) of our species.

Table 3. Height -to- weight parameters.

Species	Gender	a	b	R^2	W∞ (g)
C. gariepinus	Male	0.05	2.46	0.90	877.88
	Female	0.05	2.49	0.91	939.08
	The sexes combined	0.06	2.42	0.89	899.27

The reduced gap test shows that there is a significant difference between the observed slope (b = 2.46) and the theoretical slope (P = 3), which means that the height-weight relationship in the male of *C. gariepinus* shows minor allometry, meaning that the weight grows slower than the cube of length (Figure 6).

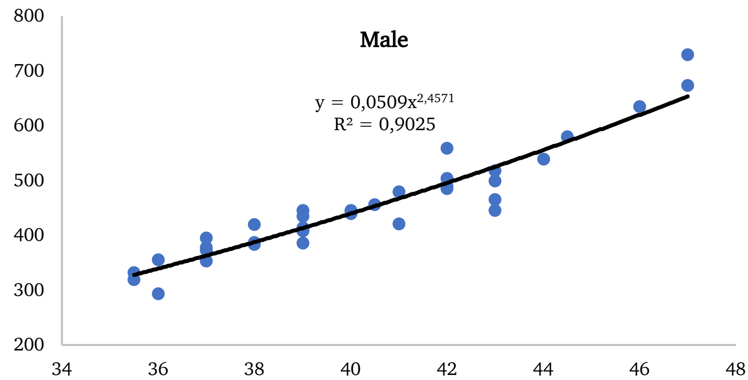


Figure 6. Trend curve, power type, of the relationship male height weight *C. gariepinus*.

The reduced deviation test shows that there is a significant difference between the observed slope (b = 2.48) and the theoretical slope (P = 3), which means that the height-weight relationship in females C. gariepinus shows minor allometry, indicating that the weight is growing slower than the length cube (Figure 7).

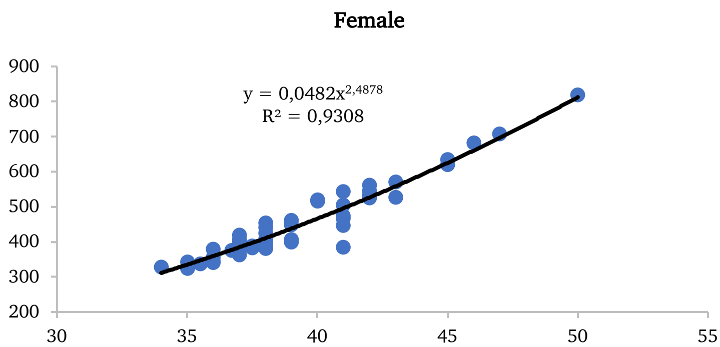


Figure 7. Trend curve, power type, of the size-weight relationship of females *C. gariepinus*.

The reduced gap test proves that there is a significant difference between the observed slope (b = 2.41) and the theoretical slope (P = 3), which makes it possible to affirm that the height-weight relationship in both sexes of C. gariepinus shows minor allometry, meaning that the weight grows slower than the cube of length (Figure 8). The coefficient of determination (R2) is estimated at 0.90

and 0.91 for males and females respectively, indicating that the weight of the female is better estimated by its length than that of the male.

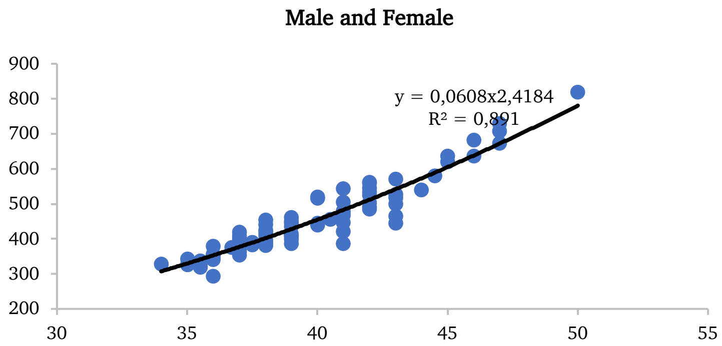


Figure 8. Trend curve, power type, of the male (M) and female (F) weight relation of *C. gariepinus*.

Given the drop in catches in the marine fisheries due to depletion of the fish stock, aquaculture remains the only viable alternative to increase fish production to meet the protein needs of an ever-growing world population. In Algeria, the main family of catfish of commercial interest is the Claridae family, which is represented by two main indigenous species well identified in this research and which only need to be popularized with the aquaculturists of the great Algerian South as part of the future development plans of Aquaculture.

Indeed, Von Bertanlanffy's Demographic and Growth Parameters, see theoretical maximum lengths (L = 53cm) are close within the same family which is the case of the species *C. gariepinus* studied in our case, and move away from those reported in Benin at Delta de l'Ouémé by Chikou (2006) for the same species that are of the order of $L\infty$=66.08 cm. A slightly weak K growth factor with a value of 0.28 yr^{-1}, in the species of Southern Algeria, remains identical to that mentioned in Benin. Moreover, the same author argues that the growth factor remains low in Clariidae than in Mochokidae and Schilbeidae, and closely depends on environmental and habitat conditions. The size-weight relationship of fish provides several insights, including their growth patterns and life-cycle stages. These statistical data are often important in determining population structure and their interaction with the habitat where they live (Behmene *et al.*, 2020).

Contrary to our study, the growth of *C. conger* in the Algerian basin was carried out by analyzing age structures and size structures. The growth parameters used are those obtained by the ELEFAN I method, carried out using FISAT II software, weight growth shows major allometry in *C. conger* (b = 3.4), whose weight grows faster than the cube of the length (Daoudi *et al.*, 2020).

The high positive correlations of (R) observed in males, females and the combined sexes of *C. gariepinus* in our study mean that as the length of the fish increases, its body weight also increases. This could be attributed to the availability of quality and quantity of food and planktonic production resulting from the water body of Oued Takhamalte-illizi or inhabited the target catfish. The development of gonads and the production of eggs in the female at a mature age gives it the advantage over the male, suggesting an indication of dietary intensity, in turn reflecting higher growth rates in female fish compared to males reported in the literature (Anwa-Udondiah and Pepple, 2012; Haimovici and Velasco, 2000; Anyanwu *et al.*, 2007). The high weight value of females recorded in this study may be related to their ability to feed on anything in order to meet their physiological needs for egg development (Solomon, 2016).

CONCLUSION

The reduced gap test proves that there is a significant difference between the observed slope (b = 2.41) and the theoretical slope (P = 3), which makes it possible to affirm that the height-weight relationship in both sexes of *C. gariepinus* shows minor allometry, meaning that the weight grows slower than the cube of length. This shows that the study of growth is a key step in the management of fish stocks and fisheries management.

ACKNOWLEDGMENT

The Authors thank the Directorate-General for Scientific Research and Technological Development of Algeria for its support and encouragement of University Research and Training Projects [PRFU/D00L03UN270120180001].

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