Oceanological and Hydrobiological Studies

International Journal of Oceanography and Hydrobiology

Volume 55, No. 2 June 2026
pages (145-157)

ISSN 1730-413X
eISSN 1897-3191

Age structure and growth dynamics of the endemic Algerian barbel, *Luciobarbus callensis* (Valenciennes, 1842) in Foum El Khanga Dam, northeastern Algeria

by

Sarra Guerfi[1,*], Amel Allalgua[1], Imen Boucenna[1], Sarra Kouadria[2], Chouaib Siouda[3] and Nouha Kaouachi[1]

DOI: **https://doi.org/10.26881/oahs-2026.1.13**
Category: **Original research papers**
Received: **March 11, 2026**
Accepted: **May 3, 2026**

[1]Laboratory of Aquatic and Terrestrial Ecosystems, Faculty of Natural and Life Sciences, University of Souk Ahras, B.P. 1553, Annaba Road, Souk Ahras, Algeria.
[2]Faculty of Natural and Life Sciences, Mohamed Cherif Messaadia University, Souk Ahras, Algeria
[3]Research Laboratory in Plant Production Biotechnology Saad Dahlab University of Blida 1

Abstract

This study provides initial insights into the age structure and growth patterns of the Algerian barbel, *Luciobarbus callensis* (Valenciennes, 1842), in Foum El Khanga Dam (Northeastern Algeria). For this purpose, a monthly sampling was conducted throughout 2024, yielding a total of 185 specimens (129 males and 56 females). Subsequently, age was estimated using scalimetric analysis, and growth was described via the Von Bertalanffy model. Results revealed six age classes (1–6 years), among which individuals aged 3 and 4 years were the most frequent, accounting for 34.59% of the sample. Total lengths ranged from 24.20 to 55.70 cm, with a predominance of the [30–35] cm size class. Regarding growth modeling, the estimated parameters were $L_\infty = 58.63\,\text{cm}$, $K = 0.39\,\text{year}^{-1}$, and t_0 = -0.35. In addition, the length–weight relationship exhibited negative allometry (b = 2.30), indicating that linear growth outpaces weight gain in this environment. In conclusion, these findings establish a preliminary biological baseline for this endemic cyprinid. Despite the localized nature of the study, these data offer a necessary scientific starting point for future monitoring and the management of fish resources in the region's artificial reservoirs.

Key words: *Luciobarbus callensis,* Von Bertalanffy model, Population dynamics, Northeastern Algeria

* Corresponding author: *sa.guerfi@univ-soukahras.dz*

online at www.oandhs.ug.edu.pl

1. Introduction

The continental ichthyofauna of Algeria, though characterized by moderate species richness compared with other African regions, holds major biogeographical and ecological significance due to its high level of endemism (Mimeche et al., 2013). Algerian inland waters host approximately 67 fish species distributed across 45 genera and 27 families, comprising 47 native and 20 introduced species (Azeroual, 2000; Mouaissia, 2018). Within this hydrobiological framework, the family Cyprinidae is the most diverse and abundant taxonomic group, occurring in nearly all freshwater systems, from northern coastal rivers to semi-arid reservoirs and inland lentic ecosystems (Kara, 2012).

Cyprinids are of paramount importance in North African freshwater ecosystems, where hydrological variability and increasing dam regulation strongly influence community structure (Mimeche et al., 2013). Ecologically, their dominance reflects a high degree of resilience to environmental fluctuations and an efficient capacity to exploit trophic resources in newly created artificial habitats (Allalgua et al., 2025; Mimeche et al., 2018). As opportunistic omnivores, they contribute substantially to energy transfer and trophic functioning within aquatic food webs (Babaci et al., 2024). Furthermore, Cyprinidae constitutes a major component of inland fisheries in Algeria, providing an affordable and essential source of animal protein for rural communities, thereby underpinning local food security and supporting recreational fishing and inland aquaculture development (Juffe-Bignoli, 2012; Sahtout et al., 2017).

Among this family, the Algerian barbel, *Luciobarbus callensis* (Valenciennes, 1842), stands out as one of the most emblematic native cyprinids of the Maghreb ecoregion (Kara, 2012; Saadi & Sebaa, 2022). Far beyond its role as a taxonomic representative, *L. callensis* is a primary socio-economic resource characterized by high biomass, year-round availability, and significant market demand due to its good flesh quality (Juffe-Bignoli, 2012). The species' strategic value is formally recognized in Algerian fisheries legislation through Executive Decree No. 04-86 (18 March 2004), which mandates a minimum legal catch size of 15 cm to protect spawning stocks and ensure sustainable exploitation (Allalgua et al., 2025).

While historically a lotic species, the Algerian barbel has demonstrated remarkable ecological plasticity by successfully colonizing lentic habitats created by large dams (Mimeche et al., 2018). This transition from riverine to reservoir ecosystems imposes substantial constraints including altered thermal stratification, oxygen depletion, and modified trophic dynamics, which may alter life-history strategies and growth patterns (Mimeche et al., 2013; Vieira, 2023). Such adaptability explains the dominance of barbels in Mediterranean reservoirs, where they exploit novel trophic niches and may maintain recruitment through connectivity with tributary inflows (Mimeche et al., 2013).

Age and growth analyses are fundamental tools in fisheries science, providing critical insights into stock productivity, demographic regulation, and harvest sustainability (Guettaf et al., 2019). While various calcified structures record growth variations (Vieira, 2023), scales remain a preferred tool for endemic cyprinids due to their reliability, ease of collection, and nondestructive nature (Meunier, 1979; Rachedi & Derbal, 2022). The concentric deposition of scale material effectively reflects alternating somatic growth periods, allowing for the accurate reconstruction of individual growth histories (Panfili et al., 2002).

Despite its importance, investigations into the growth dynamics of Algerian barbel in Algeria are restricted to a few hydrosystems (Berrouk et al., 2020; Morsi et al., 2015; Mouaissia et al., 2026; Penczak & Molinski, 1984), leaving significant spatial gaps across its range. This lack of data is particularly problematic in artificial reservoirs, where regulated hydrological regimes may produce demographic responses that differ markedly from natural environments (Froese, 2006; Vieira, 2023). Currently, no data exist regarding the population characteristics of the Algerian barbel in the Foum El Khanga Dam (Souk Ahras), despite the reservoir's ecological and local fishery importance.

Therefore, the objective of the present study was to provide the first comprehensive assessment of the population biology of the Algerian barbel in the Foum El Khanga reservoir. By applying a sclerochronological approach, we analyzed sex ratio, age structure, somatic growth (von Bertalanffy model), and allometric patterns (LWR). The objective is to establish a demographic baseline to support the sustainable management of this species in semi-arid dam ecosystems.

2. Materials and methods

2.1. Study area

The Foum El Khanga Dam is located in northeastern Algeria (Wilaya of Souk Ahras), at the outlet of the Oued Cherf sub-watershed (36°12′49″N, 7°24′42″E). This sub-basin drains an area of 1735 km^2 and represents the upstream segment of the major

Seybouse watershed. The reservoir is strategically positioned at the boundary of three provinces: Souk Ahras, Guelma, and Oum El Bouaghi (Fig. 1). The dam is geomorphologically enclosed by several mountainous massifs, notably Djebel Tiffech and Ras El Alia to the north, and Djebel Sidi R'ghis to the west. The region experiences a semi-arid climate with a mean annual rainfall of approximately 356 mm · year^{-1} (Gherbi, 2020).

In terms of hydrochemistry, the waters of Foum El Khanga are characterized by high natural mineralization. This is reflected in elevated levels of electrical conductivity, chlorides, calcium, and sulfates, primarily linked to the regional lithological context (Allalgua et al., 2017). Currently, the reservoir serves a vital socio-economic role by providing irrigation water for 3742 ha of agricultural land across the plains of Zouabi, Sedrata, and Bir Bouhouche (ANBT, 2014). The reservoir also supports a fish community dominated mainly by cyprinid species, including Algerian barbel, Common carp, *Cyprinus carpio* (Linnaeus, 1758), and Crucian carp, *Carassius carassius* (Linnaeus, 1758), which coexist under the same environmental conditions and contribute to the ecological functioning of the system (Allalgua et al., 2015).

2.2. Sampling strategy and fish collection

To assess the population structure of Algerian barbel in the Foum El Khanga reservoir, including sex ratio (SR), size distribution (total length [TL] and body mass), and age composition, a monthly sampling program was carried out throughout 2024. To minimize gear size-selectivity and ensure representative coverage of the population, a multi-gear approach was adopted, combining cast nets with six multi-mesh monofilament gillnets (mesh sizes: 20, 25, 30, 35, 40, and 45 mm). During each sampling campaign, the gillnets were deployed at different stations across the reservoir and left overnight for a standardized soaking time of approximately 12–15 hr, covering dusk and dawn periods of peak cyprinid activity. This fishing effort was maintained consistently throughout the study to account for spatial and temporal variability in fish distribution.

After retrieval in the early morning, captured specimens were immediately placed in isothermal containers and transported to the laboratory for processing. Morphometric data, including TL and total body mass, were recorded for each specimen, and species identification was performed using standard taxonomic keys (Fischer et al., 1987; Lévêque et al., 1990, 1992). The final dataset used for growth analysis comprised 185.

2.3. Sex determination

The sex of each specimen was determined with macroscopic examination of the gonads following dissection. Identification relied on morphology, coloration, and the degree of vascularization. Ovaries

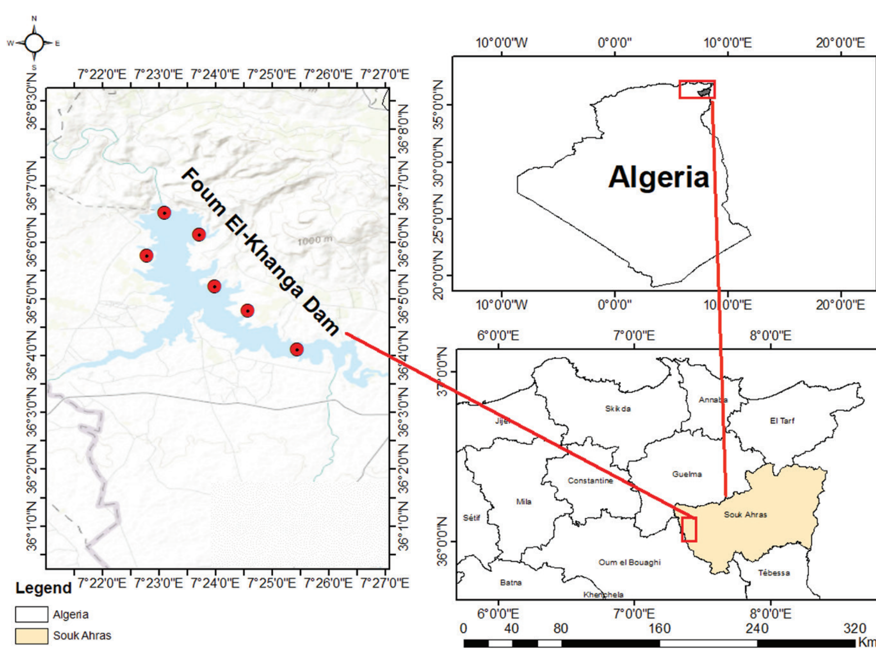

Figure 1

Localization of sampling areas (original source).

were characterized by a granular texture, distinct vascularization, and a pinkish hue, whereas testes exhibited a smooth, milky-white appearance with no visible vascularization. This diagnostic approach remained consistent across all examined species (West, 1990).

2.4. Age determination

Fish age was determined using scalimetric analysis following the method given by Lea (1910), a nondestructive approach widely recognized for its reliability in endemic cyprinids (Meunier, 1979; Mimeche et al., 2013). For each specimen, three to seven scales were carefully removed from specific regions to ensure optimal readability: beneath the left pectoral fin (Chaoui et al., 2006; Rachedi & Derbal, 2022) or from the latero-dorsal area above the lateral line (Mimeche et al., 2013).

Prior to microscopic examination, scales were cleaned to remove epidermal residues, dried mucus, and pigments, which can obscure annuli (Jjearld, 1983). Cleaning was performed by immersion in a 5% potassium hydroxide (KOH) solution, followed by thorough rinsing with distilled water to remove any residual chemical agents (Tesch, 1971).

A strict selection protocol was applied: only clear, well-defined, and nonregenerated scales were retained. Age was assigned by identifying and counting annual growth rings (annuli). In the semi-arid conditions of the Foum El Khanga reservoir, particular attention was paid to distinguishing true winter annuli from supplementary 'false rings' or stress marks. These false rings, often induced by high summer temperatures or hydrological stress, were identified by their incomplete deposition and lack of continuity around the scale focus. To ensure accuracy and minimize overestimation, age was only validated when ring patterns were consistent across at least three different scales from the same individual. Any specimens showing ambiguous or non-circumpolar markings were excluded from the final growth analysis.

2.5. SR

The SR represents a critical demographic parameter that influences both the growth rate and the evolutionary trajectories of wild populations (Donelson & Munday, 2015; Wedekind, 2012, 2017). The SR also provides essential information for assessing reproductive potential and estimating the stock size of fish populations (Stratoudakis et al., 2006).

In this study, the SR was analyzed to evaluate the population structure of Algerian barbel (Kartas & Quignard, 1984). The SR was calculated according to Vazzoler (1996) using the formula:

$$SR = \frac{M}{F}$$

where M represents the number of males and F the number of females.

Deviations from the expected 1:1 SR were tested statistically using the Chi-square (χ^2) test to verify significant differences between the observed SR and the commonly expected equilibrium (Sokal & James Rohlf, 1987).

2.6. Age and growth modeling

Fish growth was modeled using the Von Bertalanffy growth function (VBGF) (Von Bertalanffy, 1938), which describes growth as a dynamic balance between anabolic and catabolic processes (Daget & Le Guen, 1975). The linear growth is expressed by the following equation:

$$L_t = L_\infty \cdot \left(1 - e^{-K(t - t_0)}\right)$$

where: LT = total length (cm) at age t, L_∞ = asymptotic length (cm), K = growth coefficient, defining the rate at which L_∞ is approached, and t_0 = theoretical age at zero length,

To ensure model convergence, the initial estimate of the asymptotic length (L_∞) was calculated based on the maximum observed length (L_{max}) according to the empirical relationship:

$$L_\infty = \frac{L_{max}}{0.95}$$

The theoretical age at zero length (t_0) was estimated using Pauly's empirical equation (1979):

$$log_{10}\left(-t_0\right) = -0.392 - 0.275 \cdot log_{10}\left(L_\infty\right) - 1.038 \cdot log_{10}\left(K\right)$$

Growth parameters were estimated separately for males, females, and pooled sexes. The growth performance index (φ') was calculated to compare growth efficiency (Pauly & Munro, 1984):

$$\varphi' = 2 \cdot log_{10}\left(L_\infty\right) + log_{10}\left(K\right)$$

2.7. Length–weight relationship

The Length–weight relationship (LWR) was determined using the power equation (Ricker, 1975):

$$W = a \cdot L^b$$

To estimate the parameters *a* and *b*, the equation was linearized through natural logarithmic transformation:

$$log\ W = b\ log\ \mathrm{TL} + Log\ a$$

where: W = total body weight (g), TL = total length (cm), a = intercept (condition factor), and b = allometric coefficient.

To determine the growth type, the null hypothesis of isometry (H_0: b = 3) was statistically tested using a two-tailed Student's *t*-test (Dagnelie, 1975). The observed t-statistic (t_{obs}) was calculated as follows:

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

Where: b_0 = 3 (expected value for isometry); n: number of pairs (W, L), and r: correlation coefficient.

The null hypothesis H_0: $b = 3$ is rejected when $t_{obs} \geq t_{1-\alpha/2}$ with α = 0.05 at n-2 degrees of freedom.

Based on the results of this test, growth was classified into one of three categories:

- Isometric growth (b = 3): Weight increases proportionally to the cube of length, maintaining the same body shape.
- Negative allometric growth (b < 3): Length increases faster than weight, meaning the fish becomes slimmer as it grows.
- Positive allometric growth (b > 3): Weight increases faster than length, meaning the fish becomes stouter (heavier) as it grows.

2.8. Weight growth dynamics

Weight growth was modeled by combining the LWR parameters with the VBGF (Von Bertalanffy, 1938), yielding the following equation:

$$W_T = W_\infty \cdot \left(1 - e^{-K(t-t_0)}\right)^b$$

where: W_T = body weight at age t (g), $W_\infty = a \cdot L_\infty^b$ = asymptotic weight (g), K = growth coefficient, t_0 = theoretical age at zero length, b = allometric coefficient.

2.9. Data processing and statistical computing

During the initial biometric examination, the total wet body weight (W) of each whole (ungutted) specimen was recorded to provide a baseline characterization of the catch.

To standardize measurements and account for potential biases induced by varying stages of gonadal maturation or food intake, the somatic weight (eviscerated weight, We) was utilized for all biometric analyses. All statistical operations and modeling were performed using R version 4.3.3 (R Development Core Team, 2022).

The distribution of the dataset was initially assessed for normality using the Shapiro–Wilk procedure. To explore sexual dimorphism in growth, the regression parameters of the length–weight relationships for both sexes were compared through an analysis of covariance (ANCOVA), as suggested by Zar (2010) for biological data.

This comparative analysis was facilitated by the rstatix and broom computational libraries (Kassambara, 2023), while data manipulation followed the tidy data principles (Wickham et al., 2019).

High-quality figures and diagnostic plots were produced using the latest iteration of the ggplot2 package (Wickham et al., 2019). For all inferential tests, the threshold for statistical significance was maintained at α = 0.05.

3. Results

3.1. SR

The studied population, represented by a sample of 185 individuals of Algerian barbel, was structured as follows: 129 males (69.72%) and 56 females (30.27%) (Table 1). The overall SR for the annual cycle was 2.30:1 (M: F), consistently biased toward males throughout the whole sampling period.

3.2. Population size structure

3.2.1. Length-frequency distribution

The length-frequency distributions of specimens collected from Foum El Khanga Dam ranged from 24.20 cm to 55.70 cm (mean TL = 34.62 ± 4.03 cm). For the entire catch, the most frequent individuals were concentrated in the 30–35 cm range (F = 45.41%). Males showed a peak at the 33–36 cm mark (F = 50.39%). In contrast, the highest frequency for

Table 1

Percentage of sexes of Algerian barbel.

Dam	Sex	Effectives	Percentage (%)	Female-to-male ratio (%)
Foum El-Khanga dam	F	56	30.27	43.41
	M	129	69.72	

females (F = 44.64%) was shifted toward larger sizes, specifically within the 35–40 cm range, while their overall distribution extended up to 55.70 cm (Fig. 2).

3.2.2. Age determination

The scalimetry method allowed the classification of all Algerian barbel specimens collected from Foum El Khanga Dam into six age classes (1–6 years) (Fig. 3). The third and fourth age classes were the most dominant for the total population (F = 34.59%), males (F = 34.88%), and females (F = 33.93%).

3.3. Growth study

3.3.1. Linear growth

In this study, the linear growth of both sexes and the combined population of Algerian barbel was examined using the von Bertalanffy (1938) growth model. The growth parameters L_∞, K, t_0, and the growth performance index ϕ' calculated for this species are presented in Table 2 and Fig. 4.

It appears from the table that the growth rate K of male Algerian barbel is higher than that of females

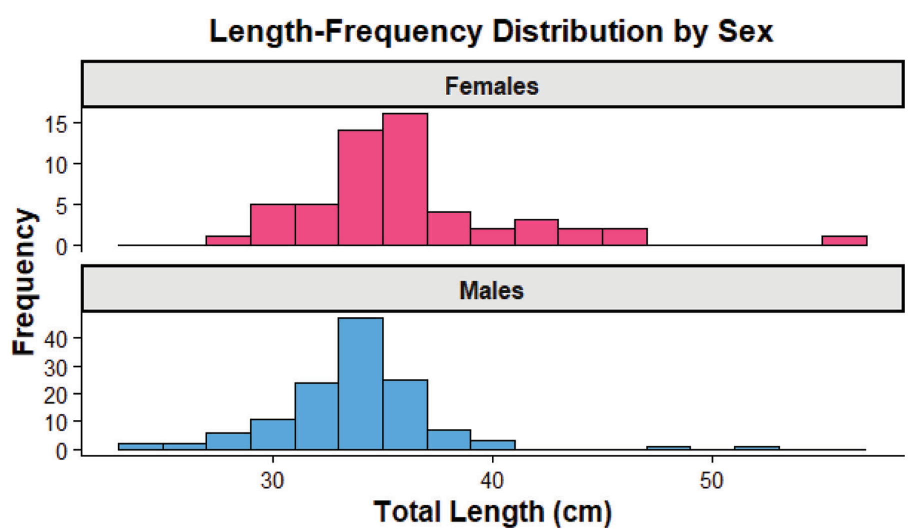

Figure 2

Length-frequency distribution by sex of the Algerian barbel population of Foum El Khanga Dam.

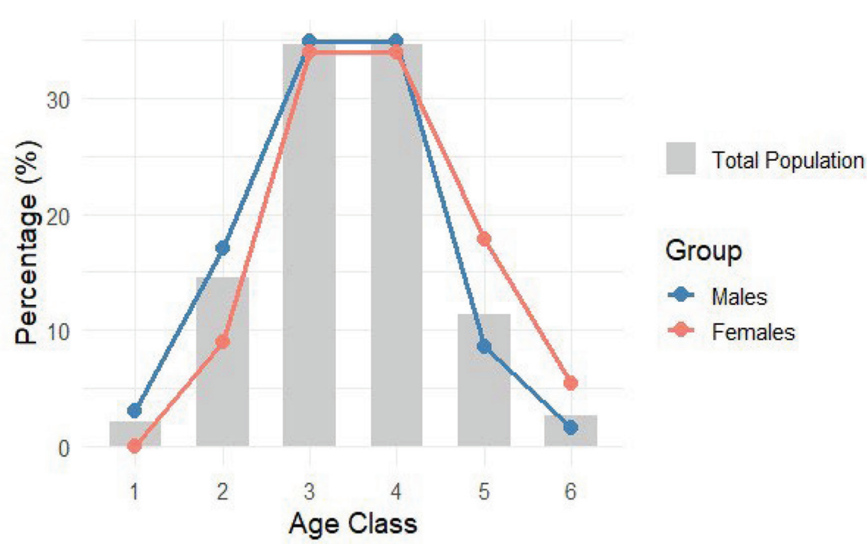

Figure 3

Age composition of Algerian barbel.

Table 2

Parameters of the Von Bertalanffy linear growth equation of both sexes and the combined sex of Algerian barbell.

Dam	Sex	L∞	K	t_0	Φ′	L_{min}	L_{max}	Equation
Foum El-Khanga Dam	M	54.73	0.38	−0.37	3.05	24.2	52	$TL = 54.73\ (1\text{-}e^{-0.38\ (t+0.37)})$
	F	58.63	0.07	−2.09	2.38	28.1	55.7	$TL = 58.63\ (1\text{-}e^{-0.07\ (t+2.09)})$
	M + F	58.63	0.39	−0.35	3.12	24.2	55.7	$TL = 58.63\ (1\text{-}e^{-0.39\ (t+0.35)})$

M, Males; F, Females; L∞, asymptotic length (cm), K: growth coefficient; t_0, theoretical age at zero length; Φ′, The growth performance index; L_{min}, minimum length; L_{max}, maximum length; TL, total length (cm).

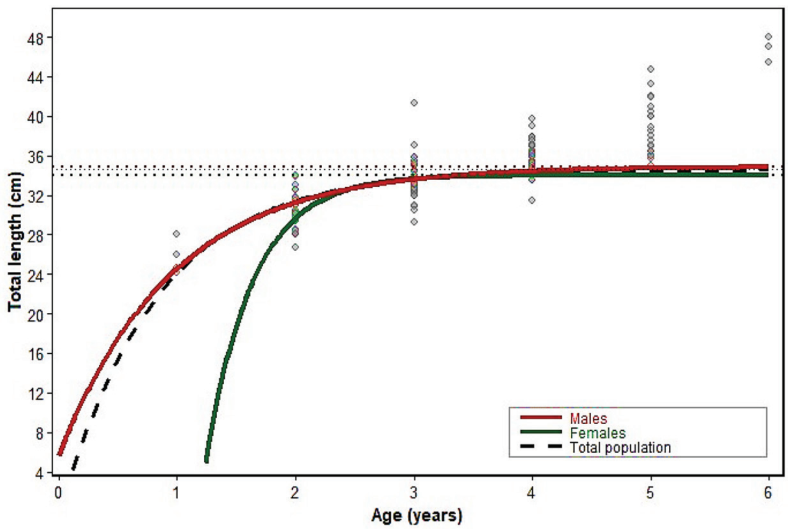

Figure 4

Age–length growth patterns of Algerian barbel from Foum El Khanga based on the von Bertalanffy growth model.

(K = 0.38 and 0.07, respectively). Furthermore, females have an asymptotic length L_∞ of 58.63 cm and a t_0 of 2.09 years^{-1}, whereas for males $L_\infty = 54.73$ cm and $t_0 = 0.37$ years^{-1}. Similarly, the growth parameters for the combined sexes are: $L_\infty = 58.63$ cm, K = 0.39 years^{-1}, and $t_0 = 0.35$ years^{-1}. The values of the growth performance index (ϕ′) calculated for females are higher than those for males.

The calculated asymptotic lengths closely match the observed maximum lengths. The asymptotic lengths (L_∞) obtained for the total population ($L_\infty = 58.63$ cm), females ($L_\infty = 58.63$ cm), and males ($L_\infty = 54.73$ cm) are higher than the maximum lengths, which were $L_{max} = 55.70$ cm for the total population, $L_{max} = 55.70$ cm for females, and $L_{max} = 52$ cm for males, respectively.

3.3.2. Relative growth

In Algerian barbel, we established “TL–eviscerated weight relationships” in order to eliminate the bias that the viscera could introduce on the actual weight of the fish (Table 3). The Log (TL)–Log (TP) equations are all linear in form (Fig. 5).

According to Table 3, there was a significantly high correlation between TL and eviscerated weight for male specimens (R^2 = 90%; p = 0.001) and for the combined sexes (R^2 = 92%; p = 0.001). In contrast, females exhibited the highest significant correlation coefficients ($R^2 = 96\%$; $p = 0.001$).

In Foum El Khanga Dam, the estimated b values were below three for males, females, and the combined sexes. This indicates negative allometric growth between eviscerated weight and length, meaning that length increases faster than weight.

The slopes, or b values, of the TL–eviscerated weight relationship differed statistically between sexes (ANCOVA on the TL–weight relationship: F = 1.97; $p = 0.021$).

3.3.3. Absolute weight growth

Knowing the adjustment parameters (L_∞, K, and t_0) of the Bertalanffy growth equation and the allometric

Table 3

Size-weight relationship parameters for both sexes and the combined sex of Algerian barbell.

Area	Sex	N	*a*	*b*	R^2	t_{cal}	Allometry	Equation
Foum El-Khanga Dam	M	129	0.177	2.17	0.895	11.46(+)	Minor	$W = 0.177TL^{2.17}$
	F	56	0.06	2.46	0.9606	7.39(+)	Minor	$W = 0.06TL^{2.46}$
	M + F	185	0.109	2.30	0.924	13.19(+)	Minor	$W = 0.109TL^{2.30}$

M: Males; F, Females; N, sample size; *a*, intercept; *b*, slope; R^2, coefficient of determination; t_{cal}, *t*-test calculated.

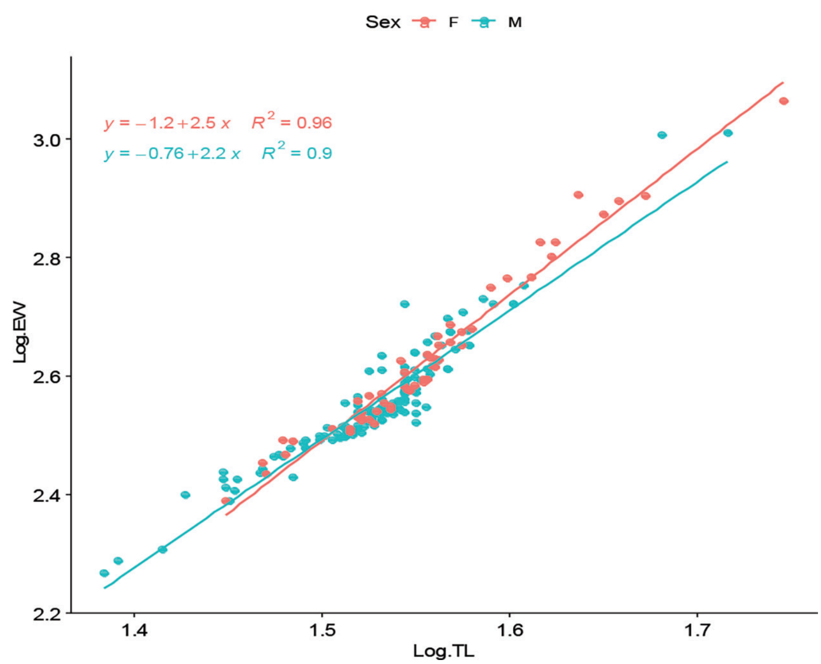

Figure 5

Length–weight relationship of both sexes of Algerian barbel. TL, total length.

coefficient (*b*) relating fish length to weight, the absolute growth models for Algerian barbel in Foum El Khanga Dam are presented in Table 4.

According to Table 4, the asymptotic weights (W_∞) obtained for the total population ($W_\infty = 1270.87$ g), females ($W_\infty = 1341.92$ g), and males ($W_\infty = 1046.94$ g) are higher than the maximum total weights sampled, which were $W_{max} = 1159$ g, $W_{max} = 1159$ g, and $W_{max} = 1025$ g, respectively.

3.3.4. Theoretical absolute weight growth curves

The TL–weight relationship showed a clear positive trend for males, females, and the combined sample (Fig. 6). Observed values were closely aligned with the fitted curves, indicating an adequate model fit. Females displayed greater body mass than males at equivalent lengths, with differences increasing toward larger size classes. The curve for the total population was intermediate between those of both sexes. The estimated allometric coefficient (*b* = 2.30) indicates negative allometric growth.

4. Discussion

For many ichthyologists, data on fish age and growth are essential for understanding species' life-history traits and population dynamics. Indeed, growth is one of the major processes in fish biology and a key component in length-structured models (Chen et al., 2003).

In the present study, linear and weight growth of the Algerian barbel from Foum El Khanga Dam (Souk Ahras) was examined using the Von Bertalanffy (1938) model, applied to each sex separately as well as to the combined sexes.

As described by Panfili et al. (2002), the concentric deposition of scale material records the progression

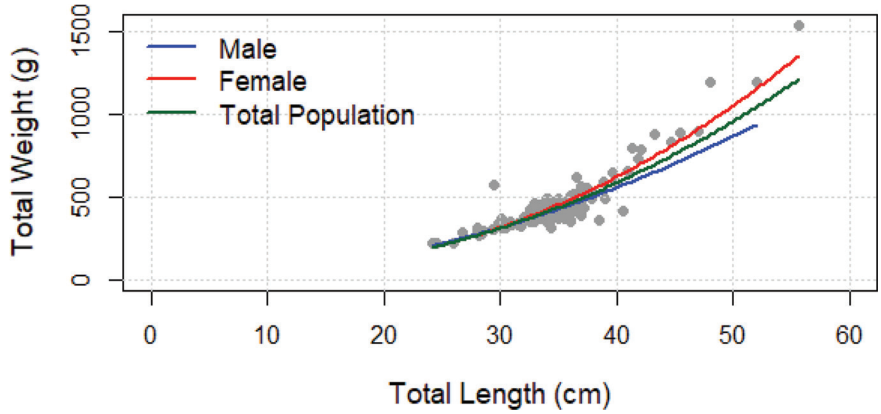

Figure 6

Theoretical weight growth curve of Algerian barbel.

Table 4

Parameters of the Von Bertalanffy weight growth equation for both sexes and the combined .sex of Algerian barbell.

Sex	Foum El-Khanga Dam
M	$W_T = 1046.94\ (1\text{-}e^{-0.38\ (t+0.37)})^{2.17}$
F	$W_T = 1341.92\ (1\text{-}e^{-0.07\ (t+2.09)})^{2.46}$
M + F	$W_T = 1270.87\ (1\text{-}e^{-0.39\ (t+0.35)})^{2.30}$

M, Males; F, Females; W_T = body weight.

of life stages, reflecting the alternation between rapid and slow growth periods.

Research on fish age can sometimes be challenging, but it represents a fundamental step in any population dynamics study. For the Algerian barbel, age was easily determined using scalimetry. This direct method provided very satisfactory results (Arrignon, 1976; Meunier, 1988).

The maximum age determined in Foum El Khanga Dam (Souk Ahras, Algeria) did not exceed 6 years for either males or females. A total of 185 specimens (56 females and 129 males) were used for age-class determination, with TLs ranging from 24.20 cm to 55.70 cm and a dominance of the 3- and 4-year age groups.

In contrast, our results show higher TLs (TL at 6 years) than those reported in other regions of Algeria, including Beni Haroun Dam in Mila by Berrouk (2020) (TL max = 46 cm at 7 years), El-K'sob Dam in M'Sila by Mimeche et al. (2013) (TL max = 37 cm at 13 years), and Hamiz Reservoir by Oueld Rouis et al. (2012) (TL max = 46 cm at 8 years), but lower than those from Ouldjet Mellegue Dam in Tebessa by Allalgua et al. (2025) (TL max = 59 cm).

Morsi et al. (2015), in rivers of northern Algeria (El-Harrach), reported that the age of Algerian barbel ranged from 1 to 7 years. Similar results were obtained in Beni Haroun Dam by Berrouk et al. (2020) for the same species. In Ouldjet Mellegue Dam, Allalgua et al. (2025) reported a lifespan of 1–6 years for both sexes, with TLs ranging from 20 to 59 cm.

At El-K'sob Dam in M'Sila, Mimeche et al. (2013) reported a maximum age of 13 years for females and 12 years for males. Similarly, Kraiem (1994) indicated that the maximum age of Algerian barbel reaches 14 years in Tunisian reservoirs (Sidi Salem and Jemine Dams). These differences in age distribution may be attributed to fish activity, diet, and ecological characteristics of the lakes (Alp & Balik, 2000).

The asymptotic length of the total population ($L\infty$ = 58.63 cm) is greater than the maximum observed TL (TL = 55.7 cm). The same holds true for females ($L\infty$ = 58.63 cm) and males ($L\infty$ = 54.73 cm), which exceed the maximum observed TLs of 55.7 cm and 52 cm, respectively. Comparisons of Von Bertalanffy growth parameters for various Algerian barbel populations are summarized in Table 5. Estimates of growth parameters using the Von Bertalanffy model vary depending on the region and the applied method. Indeed, the asymptotic length has no intrinsic biological value, as it fluctuates depending on the size of the individuals examined.

The growth coefficient (K) recorded in Foum El-Khanga Dam for the total population (K = 0.39 years^{-1}) and males (K = 0.38 years^{-1}) is higher than that observed for females (K = 0.07 years^{-1}). Our results are comparable to those reported by Brahmia et al. (2016) in Oubeira Lake (K = 0.78 years^{-1}) and Hajiahmadian et al. (2018) in Gamsiab Reservoir (Iran) for Mangar (*Luciobarbus esocinus*) (K = 0.76 years^{-1}). However, the

Table 5

Comparison of Von Bertalanffy growth parameters (L∞, *K*, t_0, and Ø′) for Algerian barbel across different regions.

Sites	Authors	Sexe	L∞	*K*	t_0	Ø′
Allal El Fassi Reservoir (Morocco)	Bouhbouh (2002)	M + F	33.25	0.100	−3.29	/
		M	29.55	0.100	−4.03	/
		F	32.73	0.105	−3.99	/
El Harrach River (Algeria)	Morsi et al. (2015)	M	26.249	0.23	0.281	/
		F	23.158	0.31	0.213	/
Beni Haroun Dam (Algeria)	Mouaissia (2018)	M + F	57.08	0.195	−1.08	2.80
		M	43.09	0.323	−1.01	2.78
		F	56.69	0.160	−1.06	2.71
Ouldjet Mellegue Dam (Algeria)	Allalgua et al. (2025)	M + F	62.10	0.87	−0.15	3.52
		M	51.05	0.57	−0.25	3.17
		F	62.10	1.41	−0.09	3.73
Foum El Khanga Dam	Our study	M + F	54.73	0.38	−0.37	3.05
		M	58.63	0.07	−2.09	2.38
		F	58.63	0.39	−0.35	3.12

M, Males; F, Females; L∞, asymptotic length (cm); *K*, growth coefficient; t_0, theoretical age at zero length; Φ′, The growth performance index.

lower values observed in our study dam are consistent with the findings of Mouaissia (2018) in Beni Haroun Dam (Mila, Algeria) and Bouhbouh (2002) in Allal El Fassi Reservoir (Morocco).

According to Deniz (2012), growth rate is influenced by variations in water salinity and temperature, as well as by the feeding habits of fish. Similarly, the higher growth rate observed in males compared to females near sexual maturity can be explained by metabolic differences between the sexes, such as differences in oxygen consumption (Pauly, 1993) and/or differences in energy allocation between reproduction and somatic growth (Rijnsdorp & Ibelings, 1989).

Furthermore, the growth performance index (Ø′) showed high values (3.12) for the total population, 3.05 for males, and 2.38 for females. These values are close to those reported in Algeria by Allalgua et al. (2025) (Ø′ = 3.52) but slightly higher than those obtained by Mouaissia (2018) in Beni Haroun Dam (Ø′ = 2.80). Differences in growth performance index values for the same species may result from various factors affecting growth efficiency and longevity (Wootton, 1990). Growth is also directly linked to biological production rates and food availability (Elizarov, 1965).

The length–weight relationship provides very useful information in studies of biology, population dynamics, and species management. For all the length–weight curves, the experimental points are arranged approximately around the theoretical curve, which can be explained by the fact that the correlation coefficient values are high. When the relationship is established with eviscerated individuals, the correlation coefficient is better. The relative growth, or TL–weight relationship of Algerian barbel in Foum El-Khanga Dam, is of negative allometry in the total population with $b = 2.30$, in females $b = 2.46$, and in males $b = 2.17$, indicating that the increase in individual length is faster than that of weight. This coefficient is lower than the Bayesian reference value reported in FishBase for the species ($b = 2.99$; range 2.82–3.16), which is derived from genus-level body shape models rather than population-specific field measurements. This discrepancy likely reflects the particular ecological conditions of Foum El Khanga Dam, including trophic constraints, seasonal hydrological variability, and the reservoir's semi-arid environmental context, which may favor linear growth over mass accumulation. Such divergence from the generalized FishBase estimate further highlights the phenotypic plasticity of the Algerian barbel under artificial lentic conditions.

Our results agree with those of Berrouk et al. (2020) and Mimeche et al. (2013) for the same species, and with Hajiahmadian et al. (2018) for Mangar. In contrast, Mouaissia (2018) reported that relative growth is positive in female barbels and isometric in male barbels in other Algerian reservoirs (Lake Oubeira; Beni Haroun Dam). Allalgua et al. (2025) in Ouldjet Mellegue Dam and Morsi et al. (2015) in Oued El-Harrach showed, respectively, that weight increases at the same rate as length in Algerian barbel (isometric).

Variations in the type of allometry from one region to another could be attributed to differences in age, maturity, sex, and environmental conditions (Bagenal & Tesch, 1978). Geographical location, combined with environmental conditions and parasitic pathologies, is a factor that can affect the value of *b* (Bagenal & Tesch, 1978; Le Cren, 1951; Tesch, 1971; Wootton, 1998). These differences are likely related to the maturation processes, the release of sexual products, and trophic conditions, as observed by Furnestin (1950).

5. Conclusion

This study provides a reservoir-specific insight into the life-history traits of Algerian barbel in Foum El Khanga Dam, addressing a significant gap in the ichthyological knowledge of northeastern Algeria. The observed population structure reflects a dynamic and environmentally shaped life-history strategy, typical of artificial lentic ecosystems in semi-arid regions.

Overall, growth patterns indicate a negative allometric relationship ($b < 3$), suggesting an adaptive allocation of energy favoring longitudinal growth over somatic mass gain. This pattern is consistent with ecological plasticity and likely represents a response to fluctuating environmental conditions and resource availability in the reservoir system. In addition, growth parameter estimates provide a useful baseline for assessing population performance and productivity in regulated aquatic ecosystems.

From a management perspective, these findings highlight the importance of adopting ecosystem-based fisheries management approaches to ensure the sustainability of native fish populations under increasing environmental stress. Integrating locally derived biological reference points into regulatory frameworks, such as Executive Decree No. 04-86, would improve the effectiveness of conservation and exploitation strategies.

Future research should focus on (i) reproductive ecology and connectivity between the reservoir and tributary systems within the Oued Cherf watershed, (ii) trophic interactions and parasitic pressures influencing energy allocation and growth, and (iii) the relationship between environmental variability (physicochemical parameters and sediment dynamics) and population responses. These directions are essential for enhancing predictive capacity and supporting adaptive management of Algerian barbel populations in North African reservoir ecosystems.

References

Allalgua, A., Guerfi, S., Kaouachi, N., Boualleg, C., Boucenna, I., Barour, C., Menasria, A., & Bensouilah, M. (2015). L'infestation de *Cyprinus carpio* (Cyprinidés) peuplant le barrage Foum El-Khanga (Souk Ahras, Algérie) par les monogènes parasites. *Bulletin de la Société zoologique de France, 140*(3), 217–232.

Allalgua, A., Kaouachi, N., Boualleg, C., Ayari, A., & Mourad, B. (2017). Caracterisation Physico-Chimique Des Eaux Du Barrage Foum El-Khanga (Region De Souk-Ahras, Algerie). *European Scientific Journal, 13*(12), 258–275. https://doi.org/10.19044/esj.2017.v13n12p258

Allalgua, A., Mouaissia, W., Menasria, A., Boualleg, C., Bensouilah, M., & Kaouachi, N. (2025). Age and growth of the fish *Luciobarbus callensis* (Cyprinidae) in the Ouldjet Mellegue dam (Algeria, Tebessa). *Applied Ecology and Environmental Research, 23*(2), 2195–2209. https://doi.org/10.15666/aeer/2302_21952209

Alp, A., & Balik, S. (2000). Growth conditions and stock analysis of the carp (*Cyprinus carpio*, Linnaeus 1758) population in Gölhisar Lake. *Turkish Journal of Zoology, 24*(3), 291–304.

Arrignon, J. (1976). *Aménagement écologique et piscicole des eaux douces*. Gauthier Villars, Paris 4 :340.

Azeroual, A. (2000). *Monographie des poissons des eaux continentales du Maroc: systématique, distribution et écologie* [Thèse de doctorat, Université Mohammed V].

Babaci, S., Chaibi, R., & Mimeche, F. (2024). Study of the diet of *Luciobarbus callensis* at Soubella dam and Oued l'Ham in the M'Sila region (Algeria). *South Florida Journal of Development, 5*(12), e4883–e4883. https://doi.org/10.46932/sfjdv5n12-084

Bagenal, T. B., & Tesch, F. W. (1978). Age and growth. In T. B. Bagenal (Ed.), *Methods for assessment of fish production in fresh waters* (3rd ed., pp. 101–136). Blackwell Scientific Publications.

Berrouk, H., Sahtout, F., & Boualleg, C. (2020). Biological parameters of *Luciobarbus callensis* populates Beni-Haroun dam, north-eastern Algeria. *Biodiversitas, 21*(12), 5691–5697. https://doi.org/10.13057/biodiv/d211214

Bouhbouh, S. (2002). *Bio-écologie de Barbus callensis (Valencia 1842) & Barbus fritschi (Günther 1874) au niveau du réservoir Allal El Fassi (Maroc)* [Thèse de doctorat, Université Sidi Mohamed Ben Abdellah] (p. 164).

Brahmia, S., Barour, C., Abbaci, S., Boualleg, C., & Bensouilah, M. (2016). Environmental parameters and parasitism in common carp (*Cyprinus carpio* Linnaeus, 1758) caught from Oubeira Lake (North-East of Algeria). *Research Journal of Fisheries and Hydrobiology, 11*(4), 27–36.

Chaoui, L., Kara, M. H., Faure, E., & Quignard, J. P. (2006). Growth and reproduction of the gilthead seabream *Sparus aurata* in Mellah lagoon (north-eastern Algeria). *Scientia Marina, 70*(3), 545–552. https://doi.org/10.3989/scimar.2006.70n3545

Chen, Y., Hunter, M., Vadas, R., & Beal, B. (2003). Developing a growth-transition matrix for the stock assessment of the green sea urchin (*Strongylocentrotus droebachiensis*) off Maine. *Fishery Bulletin, 101*(4), 737–745.

Daget, J., & Le Guen, J. C. (1975). *Les critères d'âge chez les poissons. Problème d'écologie: La démographie des populations de vertébrés* (pp. 253–289). Masson et Cie.

Dagnelie, P. (1975). *Théorie et méthodes statistiques (Vol. 2)*. Les presses agronomiques de Gembloux.

Deniz, I. (2012). *Age and growth properties of Carassius gibelio (Cyprinides) living in Aksu River Estuary (Antalya-Turkey). Review of Hydrobiology*, 5(2),97-109.

Donelson, J. M., & Munday, P. L. (2015). Transgenerational plasticity mitigates the impact of global warming to offspring sex ratios. *Global Change Biology, 21*(8), 2954–2962. https://doi.org/10.1111/gcb.12912

Elizarov, A. A. (1965). *Long-term variations of oceanographic conditions and stocks of cod observed in the areas of west Greenland. Labrador and Newfoundland*. Published in: International Commission for the Northwest Atlantic Fisheries (ICNAF), Special Publication No. 6, pp. 827–831.

Fischer, W., Schneider, M., & Bauchot, M. L. (1987). *Fiches FAO d'identification des especes pour les besoins de la pêche. Méditerranée et Mer Noire (Zone De Pêche 37), Révision 1, (Vol. 2)*. FAO (Food and Agriculture Organization of the United Nations).

Froese, R. (2006). Cube law, condition factor and weight–length relationships: History, metaanalysis and recommendations. *Journal of Applied Ichthyology, 22*(4), 241–253. https://doi.org/10.1111/j.1439-0426.2006.00805.x

Furnestin, J. (1950). Premiéres observations sur la biologie de la sardine marocaine. *Rapports et Proce's-verbaux des Reunions. Conseil International pour l'Exploration de la Mer, 126*, 57–61.

Gherbi, C. (2020). *Etude minéralogique et géochimique de la salinité des roches et des sols du bassin versant d'Oued Cherf: Influence sur la pollution du barrage et des terrains agricoles*. [Thèse de Doctorat en science, UNIVERSITE BADJI MOKHTAR-ANNABA]. Faculté des Sciences de la Terre. 219.

Guettaf, M., Rachedi, M., Gueroui, Y., Bousbia, A., Chelaghmia, M. A., & Maoui, A. (2019). Age and growth of common bream, *Abramis brama* (L.), caught at Hammam Debagh Reservoir (Guelma, northeast Algeria). *Fisheries & Aquatic Life, 27*, 149–158. https://doi.org/10.2478/aopf-2019-0017

Hajiahmadian, M., Rabbaniha, M., Ghafari Farsani, H., Gerami, M. H., & Shahbazi Naserabad, S. (2018). Age, growth and spawning season of *Luciobarbus esocinus* Heckel, 1843 in Gamasiab River, Iran. *Iranian Journal of Fisheries Sciences, 17*(1), 194–207. https://doi.org/10.22092/IJFS.2018.115610

İnnal, D. E. N. İZ. (2012). Age and growth properties of *Carassius gibelio* (Cyprinidae) living in Aksu river Estuary (Antalya-Turkey). *Review of Hydrobiology, 5*(2), 97–109.

Jjearld, A. (1983). Age determination. In L. A. Nielsen & D. L. Johnson (Eds.), *-Fisheries techniques* (pp. 301–324). American Fisheries Society.

Juffe-Bignoli, D. (2012). *Assessment of the socio-economic value of freshwater species for the northern African region*. IUCN.

Kara, H. M. (2012). Freshwater fish diversity in Algeria with emphasis on alien species. *European Journal of Wildlife Research, 58*(1), 243–253. https://doi.org/10.1007/s10344-011-570-576

Kartas, F., & Quignard, J. P. (1984). *La fécondité des poissons téléostéens* (p. 121). Masson.

Kassambara, A. (2023). *rstatix: Pipe-friendly framework for basic statistical tests*. R package version 0.7.2.

Le Cren, E. D. (1951). The length–weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). *The Journal of Animal Ecology, 20*(2), 201–219. https://doi.org/10.2307/1540

Lea, E. (1910). On the methods used in the herrings investigations. *Publications de Circonstance du Conseil Permanent International pour l'Exploration de la Mer (Copenhague)*, *53*, 7–175. https://doi.org/10.1093/icesjms/s1.66.1

Lévêque, C., Paguy, D., Teugels, G.G. (Eds.). (1990). *Faune des poissons d'eaux douces et saumâtres de l'Afrique de l'Ouest. Tome I. Faune tropicale, XXVIII*, MRAC-Tervuren/ORSTOM-Paris.

Lévêque, C., Paguy, D., Teugels, G.G. (Eds.). (1992). *Faune des poissons d'eaux douces et saumâtres de l'Afrique de l'ouest. Tome II. Faune tropicale, XXVIII*, (pp. 385–902). MRAC-Tervuren/ORSTOM-Paris.

Meunier, F. J. (1979). Etude histologique et microradiographique du cartilage hémal de la vertèbre de la carpe, *Cyprinus carpio* L.(Pisces, Teleostei, Cyprinidae). *Acta Zoologica, 60*(1), 19–31. https://doi.org/10.1111/j.1463-6395.1979.tb00595.x

Meunier, F. J. (1988). Determination de l'age individuel chez les Osteichthyens a l'aide de la squelettochronologie: historique et methodologie [scalimetrie, otolithometrie, marque de croissance, annuli, ligne d'arret de croissance]. *Acta Oecologica Oecologia Generalis, 9*(3), 299–329.

Linnaeus C. 1758 – Systema Naturae per Regna tria Naturae, secundum Classes, Ordines, Genera, Species, cum characteribus, differentiis, synonymus, locis. T.1. Editio decimata reformata. Laurentii Salvii,Holmiae. 4 + 824 p

Mimeche, F., Biche, M., Ruiz-Navarro, A., & Oliva-Paterna, F. J. (2013). The population structure, age and growth of *Luciobarbus callensis* (Cyprinidae) in a man-made lake in the Maghreb *(NE Algeria)*. *Limnetica, 32*(2), 391–404. https://doi.org/10.23818/limn.32.29

Mimeche, F., Zedam, A., Chafaa, S., Mimeche, H., & Biche, M. (2018). Étude saisonnière du régime alimentaire du barbeau *Luciobarbus callensis* (Valencienne 1842) dans le réservoir de K'sob (M'Sila, Algérie). *Revue des sciences de l'eau, 31*(2), 163–171. https://doi.org/10.7202/1051698ar

Morsi, A., Mimeche, F., & Biche, M. (2015). Age structure and growth of Algerian barbell *Luciobarbus callensis* (Valenciennes, 1842) (Cyprinidae) in El-Harrach River (North of Algeria). *AACL Bioflux, 8*(4), 475–484.

Mouaissia, W. (2018). *Contribution à l'étude de la biologie (croissance, structure morphométrique, reproduction et régime alimentaire de l'espèce du poisson Barbus callensis (Cyprinidés) dans le barrage de Béni-Haroun (l'Est Algérien)*. [Thèse de Doctorat, Université Mohamed El Cherif], Messaadia, Souk-Ahras, Algérie.

Mouaissia, W., Allalgua, A., Zaidi, R., & Kaouachi, N. (2026). Morphometric analysis of Algerian barbel *Luciobarbus callensis* (Valenciennes, 1842) in Beni Haroun dam (NorthEast of Algeria). *Egyptian Journal of Aquatic Biology & Fisheries, 30*(1), 1565–1580. https://doi.org/10.21608/ejabf.2026.448167.7170

ANBT. 2015**.** National agency for water resources hydraulics. Department of Water Chemistry and Dam Soil, Agence Nationale des Barrages et Transferts/National Agency of Dams and Transfers, Algeria.

Oueld Rouis, S., Oueld Rouis, A., Micha, J. C., & Arab, A. (2012). Biologie de la reproduction du Cyprinidae, *Barbus callensis* dans le lac de barrage Hamiz (Algérie). *Tropicultura, 30*(2).

Panfili, J., De Pontual, H., Troadec, H., & Wright, P. J. (2002). *Manual of fish sclerochronology* (pp. 464–p+). Ifremer-IRD coedition.

Pauly, D. (1979). Theory and management of tropical multispecies stocks. *ICLARM studies and reviews, 1*, 35.

Pauly, D. (1993). Fishbyte section editorial. *Naga, ICLAM Guart, 16*(1993), 26.

Pauly, D., & Munro, J. L. (1984). Once more on the comparison of growth in fish and invertebrates. *Fishbyte, 2*(1), 1–21.

Penczak, T., & Molinski, M. (1984). Fish production in Oued Sebaou, a seasonal river in North Algeria. *Journal of Fish Biology, 25*(6), 723–732. https://doi.org/10.1111/j.1095-8649.1984.tb04918.x

Rachedi, M., & Derbal, F. (2022). Scalimetry and reproduction of the comber *Serranus cabrilla* (Linnaeus, 1758) (Teleostei, Serranidae) from the Gulf of Annaba (Algeria, Mediterranean). *Life and Environment, 72*(1/2), 1–8. https://doi.org/10.57890/VIEMILIEU/2022.72.1/2:1-8

Ricker, W. E. (1975). Computation and interpretation of biological statistics of fish populations. *Bulletin of the Fisheries Research Board of Canada, 191*, 1–382.

Rijnsdorp, A. D., & Ibelings, B. (1989). Sexual dimorphism in the energetics of reproduction and growth of North Sea plaice, *Pleuronectes platessa* L. *Journal of Fish Biology, 35*(3), 401–415. https://doi.org/10.1111/j.1095-8649.1989.tb02992.x

Saadi, T., & Sebaa, W. K. (2022*). Contribution à l'étude bio-écologique de Luciobarbus setivimensis (Valenciennes, 1842) (Cyprinidae) dans l'hydro-système de la région d'Ain Zada (Bordj Bou Arréridj)* [*Mémoire de master en production et nutrition animale,* Université Mohamed Boudiaf - M'Sila].

Sahtout, F., Boualleg, C., Khelifi, N., Kaouachi, N., Boufekane, B., Brahmia, S., Mouaissia, W., & Bensouilah, M. (2017). Study of some biological parameters of *Cyprinus carpio* from Foum El-khanga Dam, Souk-Ahras, Algeria. *AACL Bioflux, 10*(4), 663–674.

Sokal, R. R., & James Rohlf, F. (1987). *Introduction to biostatistics* (2nd ed., p. 363). Freeman and Co.

Stratoudakis, Y., Bernal, M., Ganias, K., & Uriarte, A. (2006). The daily egg production method: Recent advances, current applications and future challenges. *Fish and Fisheries, 7*(1), 35–57. https://doi.org/10.1111/j.1467-2979.2006.00206.x

Tesch, F. W. (1971a). Age and growth. In: W. E. Ricker (Ed.), *Methods for assessment of fish production in fresh waters* (pp. 98–130). Oxford: Blackwell Scientific Publications.

Tesch, F. W. (1971b). Age and growth. In W. E. Ricker (Ed.), *Methods for assessment of fish production in fresh waters* (pp. 98–130). Oxford: Blackwell Scientific Publications.

Tsikliras, A. C., Stergiou, K. I., & Froese, R. (2013). Editorial note on reproductive biology of fishes. *Acta Ichthyologica et Piscatoria, 43*(1), 1–5. https://doi.org/10.3750/AIP2013.43.1.01

Vazzoler, A. E. A. M. (1996). *Biologia da Reprodução de PeixesTeleósteos: Teoria e Prática. Maringá* (p. 169). EDUEM.

Vieira, A. R. (2023). Assessment of age and growth in fishes. *Fishes, 8*(10), 479. https://doi.org/10.3390/fishes8100479

Von Bertalanffy, L. (1938). A quantitative theory of organic growth (inquiries on growth laws. II). *Human biology, 10*(2), 181–213.

Wedekind, C. (2012). Managing population sex ratios in conservation practice: How and why. *Topics in conservation biology, 2*, 81–96. https://doi.org/10.5772/37601

Wedekind, C. (2017). Demographic and genetic consequences of disturbed sex determination. *Philosophical Transactions of the Royal Society B: Biological Sciences, 372*(1729). 20160326. https://doi.org/10.1098/rstb.2016.0326

West, G. (1990). Methods of assessing ovarian development in fishes: A review. *Australian Journal of Marine and Freshwater Research, 41*(2), 199–222. https://doi.org/10.1071/MF9900199

Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, L. D., François, R., Grolemund, G., Hayes, A., Henry, L., Hester, J., Kuhn, M., Pedersen, T. L., Miller, E., Bache, S. M., Müller, K., Ooms, J., Robinson, D., Seidel, D. P., Spinu, V., … Yutani, H. (2019). Welcome to the tidyverse. *Journal of Open Source Software, 4*(43), 1686. https://doi.org/10.21105/joss.01686

Wootton, R. J. (1990). *Ecology of teleost fishes*. Chapman and Hall.

Wootton, R. J. (1998). *Ecology of teleost fishes* (2nd ed.). Kluwer Academic Publishers.

Zar, J. H. (2010). *Biostatistical analysis* (5th ed., p. 944). Prentice-Hall/Pearson.