## Title: Size frequency distribution, length-length and weight-length relationships, and condition factor of eight fish species of Nkam River, coastal Cameroon

#### Abstract

To assess the aquaculture potential of endogenous species in their habitat for domestication and preservation, the growth performances of fish caught in the Nkam River was analyzed by family, species, sex and month. A total of 160 fishes were collected by quantitative sampling for 3 months from April to June 2016. It appears that two families of fish were recorded: the Cyprinidae (Labeo sanagaensis) and the Cichlidae (Tilapia cameronensis, Sarotherodon galilaeus sanagaensis, Sarotherodon nigripinnis dolloi, *Tylochromis* sudanensis, Hemichromis elongatus, Tylochromis trewavasae and Chromidotilapia gutheri gutheri). L. sanagaensis recorded the highest relative abundance (30%) against 3.13% (C. gutheri gutheri). Large fish were recorded in the majority of species in males, except in T. trewavasae and H. elongatus. The average total length was  $23.71 \pm 8.31$  cm and the average total weight was  $266.11 \pm 200.96$  g. Size frequency distribution of fish was bimodal with a large mode at 20 cm and a small at 36 cm. Small fish were abundant in catches especially in S. nigripinnis dolloi and C. gutheri gutheri. The allometric coefficient b of the weight-length relationship averaged  $3.01 \pm 0.87$ . The fish presented three types of growth: isometric, positive and negative allometric, and the condition factor K was greater than 1. It was concluded that these fish species could in general be potential candidates for domestication.

Key words: Biocharacterization, endogenous species, domestication, Nkam River; Cameroon.

#### 1. Introduction

Fishing is declining worldwide because of the depletion of stocks and poor practices of irresponsible fishing [1]. Faced with this situation, the development of aquaculture appears as the only alternative for the increase of fish production in order to satisfy the protein needs of populations [1]. This development is accompanied firstly by a mastery of breeding existing species and then a diversification of farmed species. A diversification based on the domestication of native species in the farming areas concerned, would adapt better to local markets while promoting a more integrated economy territories [2]. The domestication of new fish species, inherent in aquaculture diversification, is a recurring issue. In this context, the use of native species constitutes a comparative advantage over exotic species, particularly for the supply of broodstock and fry [3]. The hydrographic potential of Cameroon is enormous [4]. Despite the abundant diversity of Cameroon's fishery resources associated with its geoclimatic diversity, the main species raised are imported (Cyprinus carpio, Oreochromis niloticus, Clarias gariepinus, Heterobranchus longifilis, Heterotis niloticus) [5]. The introduction of non-native species can lead to invasions, a problem that remains the second leading cause of biodiversity loss worldwide [6,7].

In Cameroon, the best knowledge of endogenous species for domestication is likely to overcome to limit the constraints of adaptation, pledge of the Millennium prescription for the preservation and enhancement of endogenous biodiversity [6, 8, 7]. According to Tiogué et al. [9], endogenous species found in several agro-ecological zones of Cameroon may be important potential candidates for aquaculture. The Nkam River appears as an element of this set, and like any other river a natural reservoir for many fish species [10]. However, to our knowledge, no bioecological study has ever been carried out on the endogenous aquatic species of the Nkam River of Littoral Cameroon. This work provides information on length, weight, size frequency distributions, the parameters of the length-length and weight-length relationships, and the condition factor K of some fish species of this river depending of the endogenous and exogenous factors.

#### 2. Materials and methods

#### 2.1. Study Area

This study was conducted from April 12 to June 28, 2016 at CREVS (Cameroon Reptiles and Ecosystems Valorization Society) located in the District of Yabassi, Department of Nkam, Coastal Region of Cameroon. The canton of Yabassi is between 4 ° 27 '320' 'LN and 9 ° 58' 139 " LE. It has an average altitude of 48 m. The climate is characterized by high humidity and 2 seasons: a dry season that runs from mid-November to mid-March and a rainy season from mid-March to mid-November [11]. The temperature generally varies between 23 ° C and 29 ° C, the hottest month being February. It is a very rainy area with an annual rainfall of between 2900 and 3000 mm and a humidity between 67 to 87%. The maximum precipitation is between July and August, while the months of December and January are the least rainy [11].

#### 2.2. Animal Material and essay Conduct

160 fish specimens were collected once a week from April to June 2016 from fishermen. These fishermen used artisanal fishing methods (gill nets beach-type). The collected fish were transported in coolers to the CREVS site, and then identified by families, genera and species using the identification key of Stiassny *et al.* [12]. Length measurements were made using an ichthyometer to within 0.1 cm from the anterior end of the muzzle to the base of the caudal fin for the standard length (SL), and up to its peak for the total length (TL). The total weight (TW) of each fish was measured using an electronic scale (SF-400) accuracy of 1g and a range of 7000g. The fish were grouped by family, species and sex (male, female, undetermined).

#### **2.3. Studied parameters**

#### - Relative abundance of fish (Ra)

It was calculated according to the formula:

Ra = (Number of fish of a given species / Total number of fish collected) X 100

#### - Morphometric characteristics of fish by sex, species and family

#### - Size frequency distribution of fish

#### - Total length / standard length relationship

It was established by linear regression using the least squares method [13] and the equation was as follows:

T L= a + b SL, with a = ordered at the origin and b = slope of the regression line

#### - Total weight / total length relationship

It has been established in the form:  $TW = a LT^{b}$  [14],

With a = the regression constant, b = regression coefficient or allometric coefficient, TL = total length (cm) and TW = total weight (g).

#### - K factor

It was calculated according to the formula used by Tiogué et al. [8]:

K (%) = TW / (TL) <sup>b</sup> x 100, Where b is the allometric coefficient of the total weight / total length relationship

#### 2.4. Statistical analyzes

Descriptive analysis (means, standard deviations, percentages) was used. The t-student test was used to compare the values of the allometric coefficient b with the isometric value b = 3. The one-way analysis of variance was used to compare the K-factor between species, and when the differences were significant, the Tukey Test was used to separate the means. All of these analyzes were done using SPSS version 20.00 software at the 5% probability level. The Microsoft Excel 2013 spreadsheet was used to highlight tables and graphs.

#### 3. Results and discussion

#### 3.1. Results

#### 3.1.1 Relative abundance of fish species caught in the Nkam River by species

The relative abundance of some Cichlidae and Cyprinidae species of the Nkam River is shown in Figure 1. It follows that seven (07) species of Cichlidae (*Sarotherodon* galilaeus sanagaensis, Chromidotilapia gutheri gutheri, Tylochromis trewavasae, Tilapia cameronensis, Tylochromis trewavasae, Hemichromis elongatus and Sarotherodon nigripinnis dolloi) and a single species of Cyprinidae (*Labeo sanagaensis*) have been identified. Relative abundance varied from 3.13 % (*Chromidotilapia gutheri gutheri* and *Tylochromis trewavasae*) to 30 % (*Labeo sanagaensis*).



Figure 1: Relative abundance of some species of Cichlidae and the Cyprinidae *Labeo sanagaensis* of the Nkam River, Coastal Cameroon.

#### 3.1.2. Morphometric characteristics of the species caught in the Nkam River by

#### family, species and sex

Table 1 showing morphometric characteristics of Nkam fish species caught by family, species and sex. It follows that the average maximum size observed  $(33.02 \pm 6.73 \text{ cm TL})$  and  $476.81 \pm 176.29 \text{ g TW}$  was recorded in the Cyprinidae *Labeo sanagaensis* and the mean minimum size observed  $(16.06 \pm 1.38 \text{ cm TL})$  and  $75.50 \pm 20.83 \text{ g TW}$  in the Cichlidae *Hemichromis elongatus*. In the Cichlidae family, the mean maximum size recorded was  $24.28 \pm 2.80 \text{ cm}$  *in Tilapia cameronensis*, and the minimum average size  $(16.08 \pm 1.64 \text{ cm TL})$  and  $75.50 \pm 20.83 \text{ g TW}$  has been registered in *Hemichromis elongatus*. Considering sex, males recorded significantly (P < 0.05) large sizes compared to females, except in Cichlidas *Tylochromis trewavasae* and *Hemichromis elongatus* where the reverse was observed.

	Morphometric	Sex				
Family / Species	characteristics	Ν	Male	Female	Undetermined	_ Total
Cichlidae						
Sarotherodon nigripinnis dolloi	Mean TL (cm)	20	17.05±3.19	17.52±1.94	12.30	16.98±2.89
	Meam weight TW (g)		118.41±81.41	120.42±42.98	35	114.95±69.10
	Mean TL (cm)	25	20.72±4.73	18.52±3.13	11.70±0.34	18.67±4.63
Saroineroaon gaillaeus sanagaensis	Meam weight TW (g)		225.54±148.85	145.90±59.59	37.33±4.50	167.92±102.78
Tilapia cameronensis	Mean TL (cm)	28	24.15±3.23	24.47±2.12		24.28±2.80
	Meam weight TW (g)		292.47±122.65	289.45±72.79		291.28±104.30
	Mean TL (cm)	3	20.60	22.55±1.62		21.90±1.60
Tylochromis trewavasae	Meam weight TW (g)		143	192.50±41.71		176.00±41.07
<i>T</i> 1 1 1 1 1	Mean TL (cm)	16	18.30±3.01	17.48±2.86	12.83±0.46	16.86±3.22
1 ylochromis suddhensis	Meam weight TW (g)		103.00±45.95	88.62±42.93	31.66±2.88	82.43±45.84
	Mean TL (cm)	3	16.00	14.40	14.10	21.90±1.60
Chromiaoiliapia guineri guineri	Meam weight TW (g)		87	53	47	62.33±21.57
<b>H</b> · I · I /	Mean TL (cm)	8	16.06±1.38	17.50±0.14	13.40	16.08±1.64
nemicriromis elongalus	Meam weight TW (g)		72.00±15.21	98.50±13.43	47	75.50±20.83
Total -	Mean TL (cm)	103	20.22±4.55	19.76±3.88	12.60±0.88	19.37±4.57
	Meam weight TW (g)		192.86±135.35	166.09±95.28	37.33±6.57	167.93±120.19
Cyprinidae						
Labeo sanagaensis	Mean TL (cm)	48	$34.56 \pm 7.51$	$31.04 \pm 5.09$		$33.02{\pm}~6.73$
	Meam weight TW (g)		525.25±205.46	414.52±104.47		476.81±176.29
T-4-1	Mean TL (cm)	151	25.12±8.90	23.52±6.60	12.60±0.88	23.71±8.31
10(a)	Meam weight TW (g)		305.83±226.20	248.90±153.16	37.33±6,57	266.11±200.96

**Table 1:** Morphometric characteristics of fishes caught in the Nkam River by family, species and sex.

TL = total length; TW= Average weight N = number of fish; max = maximum; min = minimal

#### 3.1.3 Size frequency distribution of fish species caught in the Nkam River

#### 3.1.3.1 Size frequency distribution of the total fish population caught

The size frequency distribution of the total population of captured fish is presented in Figure 2. The latter is bimodal, with a large mode corresponding to 20 cm and a small mode located at 34 cm. However, the majority of fish caught were small size (10 to 20 cm)



Figure 2: Size frequency distribution of the total population of fish species caught in the Nkam River

## 3.1.3.2 Size frequency distribution of fish by species in the Nkam River

Size frequency distribution of the fish caught by species is shown in Figure 3. It appears that *S. nigripinnis dolloi* and *T. cameronensis* have a uni-modal distribution, compared to other species. However, fish with a total length of 16 to 18 cm are more abundant in *S. nigripinnis dolloi* than *T. cameronensis* who recorded the greatest number of fish between 24 and 26 cm. *Tylochromis sudanensis and Chromidotilapia gutheri gutheri* are the species in which the small specimens were significantly (P<0.05) more abundant compared to larger sizes. On the contrary, large sizes were significantly (P<0.05) abundant in *Labeo sanagaensis. Tylochromis trewavasae* was the only species where the sizes are abundantly comparable (P > 0.05).



Figure 3: Size frequency distribution of fishes caught in the Nkam River by species

## 3.1.3.3 Monthly Frequency Occurrence of Fish by Species and Family in the Nkam River

Figure 4 shows the monthly frequency occurrence of fish by species and family in the Nkam River. It shows that all species were significantly (P < 0.05) abundant in May and

less abundant in June. In Cichlids (Figure 4a), *Chromidotilapia gutheri gutheri*, *Tilapia cameronensis* and *Sarotherodon nigripinnis dolloi* were only present during the first two months of the dry season, and totally absent during the last rainy month. *Tylochromis trewavasae* and *Tylochromis sudanensis* were present throughout the study but in very low numbers. As for *Hemichromis elongatus*, it began to appear during the month of May in low numbers with the arrival of rains. *Chromidotilapia gutheri gutheri* appeared only during the month of May and was poorly represented. The monthly frequency occurrence of *Labeo sanagaensis* is shown in Figure 4b. As a result, the greatest number of fish appeared at the beginning of the rains (April and May).





Cichlidae, (b) Cyprinidae.

# 3.1.4 Morphometric Relationships and Condition Factor K of the Fish species from Nkam River

# 3.1.4.1 Total Length - Standard Length Relationship of Fish by Family and Species in the Nkam River

The total length - standard length relationship of fish species caught by family and species is presented in Table 2. It shows that the coefficient of determination  $R^2$  of the total length - standard length relationship in all species was highly significant (P <0.01), except in *Tilapia cameronensis* (P > 0.05). This coefficient varied from 0.731 (*Tilapia cameronensis*) to 0,999 (*Chromidotilapia gutheri gutheri*).

**Table 2:** Total length - Standard length relationship (LLR) of fish by family and species in

 the Nkam River

Family/Species		LLR parameters						
	Ν	Equation: TL = a + b SL	$\mathbf{R}^2$	a	b			
Cichlidae								
Sarotherodon nigripinnis dolloi	20	TL = 1.211 SL + 1.043	0.987	1.043	1.211			
Sarotherodon galilaeus sanagaensis	25	TL = 1.187 SL + 1.252	0.984	1.252	1.187			
Tilapia cameronensis	28	TL = 0.648 SL + 11.998	0.731	11.998	0.648			
Tylochromis trewavasae	3	TL = 1.407 SL - 2.440	0.992	-2.440	1.407			
Tylochromis sudanensis	16	TL = 1.216 SL + 0.505	0.997	0.505	1.216			
Chromidotilapia gutheri gutheri	3	TL = 1.588 SL - 3.383	0.999	-3.383	1.588			
Hemichromis elongatus	8	TL = 1.05 SL + 2.778	0.935	2.778	1.05			
Total	103	TL = 1.138 SL +2.101	0.950	2.101	1.138			
Cyprinidae								
Labeo sanagaensis	48	TL = 1.243 SL + 1.531	0.977	1.531	1.243			
Total	151	TL = 1.273 SL + 2.279	0.980	0.279	1.273			

TL= total length; SL = standard length; N = number of the sample; r = Coefficient of determination; a = significance threshold; b = Allometric coefficient. LLR= length-length relationship

### 3.1.4.2 Total weight - total length relationships, growth type, and condition factor K

#### depending on family and species

The total weight-Total length relationship, growth type, and condition factor K for each family and fish species are shown in Table 3. It appears that the weight-length relationship was highly significant (P <0.01) whatever the species and the family considered. The coefficient of determination ( $R^2$ ) of the weight-length relationship varied from 0.883 to 0.999 and was highly significant (P <0.01). However, these two parameters were strongly correlated in all species (r > 0.93). The coefficient of allometry b was less than 3 in *Sarotherodon galilaeus sanagaensis*, *Hemichromis elongatus* and *Labeo sanagaensis*, (P < 0.05); b was greater than 3 in *Tylochromis trewavasae*, *Tylochromis sudanensis* and *Chromidotilapia gutheri gutheri* (P < 0.05) and b was equal to 3 in *Sarotherodon nigripinnis dolloi* and *Tilapia cameronensis* (P > 0.05), thus indicating respectively three types of growth: negative and positive allometric, and isometric.

The condition factor K has generally been greater than 1 in all species. K factor varied from 1.398 (*Labeo sanagaensis*) to 2.236 (*Sarotherodon galilaeus sanagaensis*). *Sarotherodon nigripinnis dolloi, Sarotherodon galilaeus sanagaensis* and *Tilapia cameronensis* recorded a significant higher (P < 0.001) coefficient of condition K than others

		L	WR Para	ameters				- Type of growth	K Factor
Family/Species	N	Equation : TW = aTL <sup>b</sup>	R <sup>2</sup>	r	a	b	P value		
Cichlidae									
Sarotherodon nigripinnis dolloi	20	$TW = 0.021TL^{3.003}$	0.932	0.965	0.021	3.003	P > 0.05	Ι	2.158±0.292 <sup>a</sup>
Sarotherodon galilaeus sanagaensis	25	$TW = 0.034 TL^{2.851}$	0.986	0.992	0.034	2.851	P < 0.05	A-	2.236±0.216 <sup>a</sup>
Tilapia cameronensis	28	$TW = 0.024 TL^{2.925}$	0.885	0.940	0.024	2.925	P > 0.05	Ι	1.962±0.225*
Tylochromis trewavasae	3	$TW = 0.011TL^{3.114}$	0.999	0.999	0.011	3.114	P < 0.05	A+	1.655±0.017 <sup>t</sup>
Tylochromis sudanensis	16	$TW = 0.009 TL^{3.179}$	0.990	0.994	0.009	3.179	P < 0.05	A+	1.529±0.109 <sup>t</sup>
Chromidotilapia gutheri gutheri	3	$TW = 0.0001TL^{4.817}$	0.999	0.999	0.0001	4.817	P < 0.05	A+	1.858±0.235 <sup>t</sup>
Hemichromis elongatus	8	$TW = 0.065TL^{2.529}$	0.883	0.939	0.065	2.529	P < 0.05	A-	1.786±0.188 <sup>t</sup>
Total	103	$TW = 0.018 TL^{3.009}$	0.948	0.973	0.018	3.009	P > 0.05	Ι	1.975±0.325
Cyprinidae									
Labeo sanagaensis	48	$TW = 1.249TL^{1.689}$	0,899	0,948	1,249	1,689	P < 0.05	A-	1.398±0.546 <sup>t</sup>
Fotal	151	$TW = 0.099 TL^{2.436}$	0.936	0.967	0.099	3.013	P > 0.05	Ι	1.791±0.488
Nkam River.									

Tableau 3: Total weight - total length relationship (LWR), growth type, and condition factor K based on family and fish species of the

N = number of the sample; TW= total weight; TL = total length;  $R^2 =$  Coefficient of determination; r = Coefficient of correlation; a = significance threshold; b = allometric coefficient; A + = Allometric positive; I = Isometric, A - = Negative Allometric;.

#### **3.2 Discussion**

# Relative abundance and size frequency distribution of fish species caught in the Nkam River

Of the two families of fish caught (Cichlidae and Cyprinidae), the maximum relative abundance of 30% recorded in *Labeo sanagaensis* was highlighted by Tah *et al.* [15] in the tropical reservoirs of Côte d'Ivoire, which has identified a significant number of *Labeo coubie* and *Sarotherodon galilaeus*.

Results on the size frequency distribution of fish show that most species are large size. According to Tiogué et al. [9] all large-sized fish species could grow rapidly in captivity. These large sizes were mostly recorded in males, except in Tylochromis trewavasae and Hemichromis elongatus. This could be explained by the fact that in one species, one sex grows faster than the other, thus characterizing a sexual dimorphism. There is a monthly fluctuation in abundance both in number and size of individuals. This can be explained by the fact that the fishing techniques used only catch fish of a certain size, or when the life expectancy of this species is very short and the fish die quickly [9, 16]. The predominance of small size specimens in the captured fish population, according to Tiogué et al. [9], shows that these species would undoubtedly be more appreciated by the populations and would consequently be much more fished. Chromidotilapia gutheri gutheri is in the same situation because small sizes are more abundant. All other species recorded both small and large sizes. Similar results have been reported by Chikou [13] on a study of the demography and fishing exploitation of six catfish species in the Ouémé delta. According to this author, the high number of small fishes would come from the reproduction of larger ones that are outnumbered. The variation in number and size

according to the different species of fish studied, would be due to the change of season. According to Chikou [13], Cichlidae are widely present in rivers during the recession, thus justifying migratory movements of food. The monthly distribution of fish frequencies according to species and family shows that the flood would contribute to the disappearance of fish species in this ecosystem because like Cichlidae, Cyprinidae were less abundant in June. These results can be explained by the fact that the flood period corresponds to the spawning period in fish in the tropics, and during this period the fish migrate to the spawning grounds [5]. Tiogué *et al.* [8] have reported similar results in the Mbô Floodplain in *Tilapia camerunensis. Hemichromis elongatus* began to appear during the month of May in low numbers at the beginning of the rains. Indeed, this species appears in large numbers in marshes during floods (Observ Pers).

# Length -Length and Weight -Length Relationships, Condition Factor K and Growth Type of fish species from Nkam River

The length-length relationship does not have much biological value in itself, but it allows the missing data to be corrected and the results expressed in one or other of the length or weight [13]. According to the same author the total length is often used for its ease and speed of measurement. The standard length has the advantage of avoiding errors due to tail fins accidentally damaged in gear fisheries or in intra or interspecific fights and which distort the measurement of total length [13]. Moreover, according to Kirankaya et al. [17] the length-length relationships (LLR) are also important in fishery management. In ichthyological researches different types of fish length measurements are utilized. For instance, standard length (SL) is used in systematic studies, whereas total length (TL) and fork (FL) length are commonly used for estimation of fish growth [17]. Length measurements of fishes should be standardized to facilitate comparison of different populations; therefore, LLR in different populations should be known [17]. According to Moutopoulos and Stergiou [18], LLR is also important for comparative growth studies.

The coefficient of determination  $(\mathbb{R}^2)$  of the total weight - length relationship varied from 0.883 to 0.999 and was highly significant. Similar results were obtained by Tiogué et al. [8] on the native fish species of the Mbô Floodplain in Cameroon.

The value of the regression coefficient b gives information on the type of fish growth [19]; this ranged from 1.689 (Labeo sanagaensis) to 4.817 (Chromidotilapia gutheri gutheri), an average of  $3.013 \pm 0.815$ . This average is in the range of the literature which places it between 2.5 and 3.5 [19, 20, 8]. These authors have shown that a value of b less than 2.5 or greater than 3.5 is usually caused by closely related sample sizes, the number of samples examined, the season, the habitat, the maturity of the samples, gonads, sex, diet, health and physicochemical changes in water. This would explain the b values obtained in Labeo sanagaensis (1,689) and Chromidotilapia gutheri gutheri (4,817) in this study. The values of b significantly greater than 3 show that growth is in favour of weight (positive allometry); the values of b significantly less than 3 indicate that the growth is in favour of the length (negative allometry) and a value of b comparable to 3 means that the growths in size and weight are in equilibrium, (thus an isometric growth). Comparing the value of b fish species studied in the Nkam River with those of other populations in Africa, we note that Tiogué *et al.* [8] have reported a negative allometry in Labeo camerunensis and Tilapia camerunensis in the Mbô Floodplain, [15] recorded a negative allometry in Hemichromis fasciatus, Chromidotilapia gutheri and Sarotherodon *galilaeus*; a positive allometry in *Labeo parvus* and an isometry at *Labeo coubie* in two reservoirs in Ivory Coast.

The condition factor of the species studied showed a monthly variation and was greater than 1 during the duration of the study, thus justifying the well-being of this population. The value of this coefficient depends on the physiological state of the fish, especially sexual maturity, egg-laying, environmental factors and the availability of food in the stream [21]. The condition factor is based on the assumption that fish with a high weight and a certain size are in better condition. According to Ujjania et al. [22], a value of K greater than 1 is synonymous with good fish nutrition and favorable environmental conditions; whereas K less than 1 implies that the fish is not overweight in its biotope.

#### Conclusion

At the end of this study on the relative abundance, size frequency distributions lengthlength and weight-length relationships, and condition factor K of fish species from the Nkam River, *Labeo sanagaensis* and *Tilapia cameronensis* are the two species that were predominant in the catches during the study. Size structure analysis reveals a highly significant difference between the sizes of the fish species caught. *S. nigripinnis dolloi* was the only species to have been captured at very small sizes. All other species were caught at both large and small sizes. Maximum sizes were observed in Cyprinidae *Labeo sanagaensis* (33.02  $\pm$  6.73 cm TL and 476.81  $\pm$  176.29 g TW) and the Cichlidae *Tilapia cameronensis* (24.28  $\pm$  2.80 cm TL and 291.28  $\pm$  104.30 g TW), while the minimum size observed was recorded in *Hemichromis elongatus* (16.06  $\pm$  1.38cm TL and 75.50  $\pm$  20.83 g TW). Larger sizes were recorded in males except in Cichlids *Tylochromis trewavasae*  and *Hemichromis elongatus*. The species caught in this ecosystem showed three types of growth: negative allometric, positive allometric and isometric. All morphometric characteristics of fish were strongly correlated. The condition factor K was greater than 1 for all species regardless of the family, thus informing the well-being of the fish population in an environment conducive to their growth. The species studied may well be potential candidates for domestication (And accordingly for aquaculture).

#### **Ethics statement**

Experimental protocols used in this study strictly conformed with the internationally accepted standard ethical guidelines for laboratory animal use and care as described in the European Community guidelines; EEC Directive 86/609/EEC, of the 24th November 1986 (EEC,1986).

#### Data availability

The data used in this study are available from the corresponding author

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