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Length – length, weight –weight and length –weight relationships, and condition factor of Mormyridae (Actinopterygii: Teleostei) in the Upper Sanaga River (Central Region of Cameroon)

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Abstract

The study on the morphometric characteristics and condition factor K of Mormyridae was conducted between May and August 2017 in the Upper Sanaga River, Central Region of Cameroon for their sustainable management and domestication. For this purpose, 125 fish specimens were collected from local fishermen, they were weighed and measured. The results showed that Length – length (TL / SL, TL / FL and SL / FL) and weight –weight (TW / EW) relationships were highly significant regardless of the sex for the four species of Mormyridae (*Campylomormyrus phantasticus, Mormyrops anguilloides, Mormyrus macrophtalamus, Mormyrus tapirus)* identified in this river. Coefficients of determination were significantly high and close to 1 (R^2 > 0.90) in the four species except for the TL/FL relationship (R^2 = 0.85). The coefficient of determination (R^2) of the Weight-Length (TW / TL) relationship was relatively average and varied from 0.62 to 0.69. It was comparable between species. Whatever the species and the sex considered, the coefficient of allometry b was lower than 3 thus showing a growth of negative allometric type. The K condition factor was less than 1 and ranged from 0.42 to 0.51 regardless of the species, sex month considered.

Key words: Mormyridae, morphometric characteristics, growth, Upper Sanaga River, Cameroon

Introduction

The Mormyridae or Elephantfishes are the most important fish species in south and center Regions of Cameroon (Mitongo, 2016). Endemic of Cameroon, Mormyrids are noted for their large cerebellums and their use of electricity and sound (Stiassny *et al.,* 2007). These fish species are of considerable economic importance and contribute significantly to national food security, provide employment and revenue to the larger proportion of Monatalé population (Ngo, 2015). This fisheries exploitation is, however, not without negative consequences on the stock of this fish family, as its overexploitation. As such, a rational management of these resources requires an in-depth knowledge of its biology and ecology. Knowledge on their biology is important for management and sustainable exploitation of the stock. According to Olapade and Tarawallie (2014), the knowledge of the state of exploitation of a given resource is important and necessary for a proper management of that population.

Length-weight relationships (LWRs) are used for estimating the weight corresponding to a given length, and condition factors are used for comparing the condition, fatness or well-being of fish, based on the assumption that heavier fish of a given length are in better condition (Froese, 2006). According to Froese (2006), the value of exponent b indicates the direction and rate of change of form or condition, and the larger difference from 3.0 indicates the larger change in condition or form. Length-weight relationships are also originally used to provide information on the condition of fish and may help determine whether somatic growth is isometric or allometric (Gurkan and Taşkavak, 2007). Different values in condition of a fish indicate the state of sexual maturity, the degree of food sources availability, age and sex of some species. Knowledge of length-weight relationship helps in estimating the standing stock or biomass there by establishing the yield by converting one variable into another as is often done during field studies, calculating condition indices, comparing the ontogeny of fish population from different regions and in trophic studies (Petrakis and Stergiou, 1995 ; Olapade and Tarawallie, 2014). Although length-weight conversion factors are of fundamental importance in fisheries science (Birecikligil *et al*., 2016). These relationships are also an important component of FishBase (Froese and Pauly, 2015).

Despite the works done by Mitongo (2016) and Nzana (2016) on *Mormyrops nigricans* at Dja River in Southern Cameroon, and Ngo (2015) on Mormyridae family at Upper Sanaga River in Centre Region of Cameroon available data from scientific analysis and resource surveys conducted in Cameroon is not yet exist for this fish family. The findings from this study contributed first information on morphometric characteristics and K factor of the Mormyridae family from the Upper Sanaga River of Cameroon and could be useful for their sustainable management options. Therefore, the present study aims to provide information on the length-length, length-weight, and weight-weight relationships and condition factor K of Mormyridae species from the upper Sanaga River in Cameroon.

Material and methods

Study zone

The study was carried out between May and August 2017, in the Central Region of Cameroon, Department of Lékié at Monatélé; in the upper part of the Sanaga River. The geographical coordinates were as follows: 4°5'30 " and 4° 9'10" NL and: 11° 10'30"and 11° 20'44"EL, average altitude of 560 m. The temperature oscillated between 22 ° and 32 ° C and was on average 25.1 ° C. The climate was humid equatorial type with four seasons of unequal duration (Bitja-Nyom and Pariselle, 2015; https://fr.climate-data.org › Afrique › Cameroun › Centre › Monatélé II): a long dry season from December to March, a small rainy season from April to June, a short dry season from July to early August, and a large rainy season from late August to November. The rainfall varied between 1500 and 2000 mm per year (with an average of 1750 mm) and the relative humidity varied between 49 and 85.50% (Bitja-Nyom and Pariselle, 2015; https://fr.climate-data.org › Afrique › Cameroun › Centre › Monatélé II).

Biological material

This family has been chosen as a result of fishermen complaints about the decline of species in their catches. 125 specimens of mean total weight 103.14 ± 37.83 g and of mean total length 27.47 ± 4.84 cm were monthly selected from fishery products of Lékié fishermen. The species were fished by artisanal fishing techniques, using gillnets, beach seines, longlines and bottom trawls. They were then transported in a cooler to the Laboratory of Applied Ichthyology and Hydrobiology at the University of Dschang.

Data collection

The fish were then grouped by species, then weighed individually using a precision Sartorius Expertise electronic scale 0.01g for total weight (TW) and eviscerated weight (EW). The total (TL), standard (SL) and fork (FL) lengths were obtained using an ichthyometer calibrated to within 0.1 cm. The sex of the fish was determined after dissection followed by a naked eye examination of the gonads. Individuals with whom this method did not distinguish sex were considered to be indeterminate sex or immature.

Studied parameters

Regressions

• The total length-standard length (TL / SL), total length-fork length (TL / FL) and total weight-eviscerated weight (TW / EW) relationships were determined by linear least squares regression, using the following equations:

TL = a + b SL, TL = a + b FL, SL = a + FL and TW= a + b EW (Chikou, 2006),

where a = ordered at origin and b = slope of the regression line, TL = total length, SL= standard length, f

L= fork length, TW = total weight and EW = eviscerated weight

Length-weight relationship (TL/TW): It was established according to the formula used by Stergiou and Moutopoulos (2001):

$TW = a (TL)^b$ Where TW = Total fish body weight (g), TL = Total fish length (cm), a = originally ordered and b = Allometric coefficient.

K condition Factor was determined by the formula used by Tiogué *et al.* (2010) and Tiogué (2012):

$K (\%) = TW / (TL)^b \times 100$ Where b is the allometric coefficient of the length-weight relationship

Statistical analysis

Descriptive statistics: mean, standard deviation and percentage were used. The student's T test was used to compare the values of the coefficient b of the weight-length relationship with the isometric value 3. The one-way analysis of variance (ANOVA I) was used to compare species and sex between each species. When the differences were significant, they were separated by Duncan's multiple test. Regressions were established between the parameters. SPSS Version 20.0 software was used for these analysis at the 5% probability level.

Results

Length-Length Relationships in Mormyridae of the Upper Sanaga River:

-Total length / standard length (TL / SL) Relationships according to the species and sex of Mormyridae

TL / SL relationship in Mormyrids by species and sex (Table 1) shows that: the coefficients of determination (R^2) were significantly high ($P < 0.01$) regardless of the species and sex considered. Thus, the regression lines were different for each factor of variation considered and were of linear type. These regressions were generally highly significant ($P < 0.01$).

Table 1: Total Length / Standard Length (TL / ST) Relationship of Mormyridae in Upper Sanaga River by species and sex

		TL/SL relationship parameters			
Species	**Sex**	**N**	**R^2**	**Equation :TL = a SL+ b**	**P Value**
Campylomormyrus phantasticus (Cp)	♀	17	0.866	TL= 0.7817 SL + 2.4142	P < 0.01
	♂	8	0.994	TL= 1.000 SL -0.8362	P < 0.01
	I	12	0.909	TL= 1.507 SL – 14.552	P < 0.01
	Total	37	0.986	TL= 0.927SL – 0.9272	P < 0.01
Mormyrops anguilloides (Ma)	♀	8	0.985	TL= 0.981 SL- 2.8507	P < 0.01
	♂	7	0.995	TL=1.002 SL+ 3.3618	P < 0.05
	I	7	0.927	TL=0.916 SL+ 0.7704	P < 0.05
	Total	22	0.915	TL= 0.982 SL-2.3794	P < 0.05
Mormyrus macrophtalamus (Mm)	♀	16	0.944	TL= 1.002 SL + 3.3619	P < 0.01
	♂	4	0.945	TL= 1.113 SL +2.432	P < 0.01
	I	10	0.972	TL= 0.961 SL- 2.204	P < 0.01
	Total	30	0.918	TL= 0.987 SL +2.5025	P < 0.01
Mormyrus tapirus (Mt)	♀	18	0.935	TL= 0.923 SL – 1.042	P < 0.01
	♂	4	0.988	TL = 0.940 SL+ 1.230	P < 0.01
	I	14	0.994	TL = 0.694 SL+ 6.465	P < 0.01
	Total	36	0.948	TL = 0.8309 SL + 2.333	P < 0.01
Total		125	0.997	TL =0.949 SL- 1.373	P < 0.01

N = Number of fish, R^2 = Coefficient of determination, TL = Total length, SL= Standard length, a = originally ordered, b = slope of the regression line. P < 0. 01 = highly significant, ♀= Female, ♂= male, I= Immature

-Total length / Fork length (TL/ FL) Relationships according to the species and the sex of the Mormyridae of the Upper Sanaga River

The total length (TL) and fork length (FL) relationship in Mormyridae (Table 2) shows that regardless of the species, the coefficient of determination (R^2) was significantly high ($P < 0.01$) except in immature individuals where it was average. A highly significant difference ($P < 0.01$) between the slopes of the regression lines was observed between species and sexes.

Table 2: Total Length / Fork Length (TL / FL) Relationship of Mormyridae in the Upper Sanaga River by Species and Sex

		TL/FL relationship parameters			
Species	**Sex**	**N**	**R^2**	**Equation : TL = a FL + b**	**P value**
C. phantasticus	♀	17	0.994	TL= 0.916 FL + 0.112	P < 0.01
	♂	8	0.997	TL= 1.011 FL + 2.061	P < 0.05
	I	12	0.607	TL= 1.104 FL + 3.863	P < 0.01
	Total	37	0.865	TL=0.949 FL + 0.357	P < 0.01
M.anguilloides	♀	8	0.982	TL= 0.992 FL +2.237	P < 0.01
	♂	7	0.925	TL=0.934 FL+12.5	P < 0.01
	I	7	0.786	TL= 0.646 FL +11.52	P < 0.01

	Total	22	0.869	TL= 0.874 FL +2.868	P < 0.01
M. macrophtalamus	♀	16	0.948	TL= 0.986 FL + 1.998	P < 0.01
	♂	4	0.934	TL= 2.5 FL + 19	P < 0.01
	I	10	0.773	TL= 7.579 FL+220.39	P < 0.01
	Total	30	0.996	TL= 3.997 FL +130.06	P < 0.01
M. tapirus	♀	18	0.915	TL= 0.973 FL+ 1.333	P < 0.05
	♂	4	0.902	TL = 2.5 FL+ 42.5	P < 0.01
	I	14	0.703	TL = 0 .275 FL + 18.283	P < 0.01
	Total	36	0.838	TL = 0.702 FL + 6.969	P < 0.01
Total		125	0.845	TL = 0.266 FL+20.192	P < 0.01

N =

Number of fish, R^2 = Coefficient of determination, TL = Total length, FL = Fork length, a = ordered at origin, b = slope of the regression line. P < 0.01 = highly significant, ♀ = female, ♂ = male. I = immature,

-Standard length / Fork length (SL / FL) Relationship of Mormyridae in the Upper Sanaga River according to species and sex

The SL / FL relationship for Mormyridae by species and sex is presented in Table 3. It shows that the coefficients of determination (R^2) were significantly (P < 0.01) high and closed to 1 (> 0.90), with the exception in immature of *Mormyrus macrophtalamus*. Thus, the regression lines were different for each factor of variation considered and were of linear type.

Table 3: Standard Length / Fork Length (SL/FL) Relationship of Mormyridae by Sex and Species in the Upper Sanaga River

		SL/FL relationship parameters			
Species	**Sex**	**N**	**R^2**	**Equation : SL = a FL+ b**	**P value**
C. phantasticus	♀	17	0.987	SL= 1.04 FL + 0.219	P < 0.01
	♂	8	0.998	SL= 1.02 FL+ 0.833	P < 0.05
	I	12	0.939	SL= 1.10 FL + 3.863	P < 0.01
	Total	37	0.964	SL=1.04 FL+ 0.363	P < 0.01
M. anguilloides	♀	8	0.999	SL= 1.01 FL +0.647	P < 0.01
	♂	7	0.973	SL= 1.76 FL+0.589	P < 0.01
	I	7	0.985	SL= 1.02 FL +0.34	P < 0.01
	Total	22	0.993	SL= 1.01 FL +0.48	P < 0.01
M. macrophtalamus	♀	16	0.977	SL= 0.97 FL+ 1.55	P < 0.01
	♂	4	0.931	SL= 3.5 FL+ 17	P < 0.01
	I	10	0.693	SL= 9.29 FL+232.45	P < 0.01
	Total	30	0.903	SL= 4.623 FL +131.12	P < 0.01
M. tapirus	♀	18	0.997	SL= 1.103 FL + 1.583	P < 0.05
	♂	4	0.924	SL = 1.230 FL + 35.5	P < 0.01
	I	14	0.988	SL= 0.22 FL + 20.05	P < 0.01
	Total	36	0.970	SL = 0.69 FL+ 8.65	P < 0.01
Total		125	0.995	SL = 0.289 FL+20.4	P < 0.01

N = Number of fish, R^2 = Coefficient of determination, SL = Standard length, FL = Fork length, a = original order, b = slope of the regression line. P < 0.01 = highly significant, ♀ = Female, ♂ = Male, I = Immature,

-Total weight / eviscerated weight (TW / EW) relationship according to the species and sex of the Mormyridae of the Upper Sanaga

The TW / EW relationship in Mormyridae in the upper Sanaga River (Table 4) was of linear type. The coefficient of determination (R^2) was significantly high (P < 0.01) regardless of the species and sex considered; except in females of *Mormyrus tapirus*. The regression lines were different for each variation factor considered. These regressions were highly significant and were all linear (P < 0.01).

Table 4: Total weight / eviscerated weight (TW / EW) relationship of Mormyridae in the Upper Sanaga River according to species and sex

		TW/EW relationship parameters			
Species	**Sex**	**N**	**R^2**	**Equation : TW= a EW + b**	**P value**
C. phantasticus	♀	17	0.985	TW= 0.872 EW + 1.7448	P < 0.01
	♂	8	0.993	TW= 0.938 EW +2.07	P < 0.01
	I	12	0.992	TW= 0.9586 EW – 3.032	P < 0.05
	Total	37	0.971	TW= 0.8886 EW +1.3617	P < 0.01
M. anguilloides	♀	8	0.995	TW= 0.9946 EW + 9.855	P < 0.01
	♂	7	0.994	TW= 0.9931 EW +9.0277	P < 0.01
	I	7	0.993	TW= 0.9357 EW + 0.7936	P < 0.01

	Total	22	0.994	TW= 0.9802 EW +6.6039	P < 0.01
M. macrophtalamus	♀	16	0.939	TW= 0.7995 EW +9.0934	P < 0.01
	♂	4	0.997	TW= 0.899 EW + 0.438	P < 0.01
	I	10	0.996	TW= 0.947 EW – 3.756	P < 0.01
	Total	30	0.982	TW= 0.9252 EW – 2.1798	P < 0.01
M. tapirus	♀	18	0.759	TW= 1.6752 EW +68.12	P < 0.01
	♂	4	0.998	TW= 0.9695 EW +4.6652	P < 0.01
	I	14	0.989	TW= 0.968 EW + 6.153	P < 0.01
	Total	36	0.859	TW= 1.0282 EW + 8.789	P < 0.01
Total		125	0.978	TW= 0.9272 EW +5.397	P < 0.01

N = Number of specimens, R^2 = Coefficient of determination, TW = Total weight, EW = Eviscerated weight, a = ordered at origin, b = slope of the regression line. P < 0.01 = highly significant, ♀ = Female, ♂ = Male, I = Immature

Weight-length relationship and condition factor K of Mormyridae in the Upper Sanaga River

-Weight-length (TW / TL) relationship, growth type and condition factor K of Mormyridae in the Upper Sanaga River

The total weight - total length relationship, growth type and condition factor K of Mormyridae captured in the upper Sanaga River as presented in Table 5, shows that: The coefficient of determination (R^2) was relatively low and varied from 0.62 to 0.69, was comparable (P > 0.05) between Mormyridae species. Whatever the species considered, the allometric coefficient (b) was less than 3 thus giving a negative allometric growth. The condition factor K was less than 1 and varied from 0.42 to 0.54. It was significantly (P < 0.05) low in *M. anguilloides* compared to other species.

Table 5: Total weight - Total length (TW / TL) relationship, growth type and condition factor K according to species in Upper Sanaga River Mormyridae

Species of Mormyridae	LWR Parameters						Type of growth	K Factor
	N	Equation	R^2	a	b	ts		
Cp	37	$TW= 0.166\ TL^{2.91}$	0.62	0.166^{b}	2.91^{a}	0.042	A-	$0.50±0.09^{a}$
Ma	22	$TW = 0.435\ TL^{2.65}$	0.69	0.435^{b}	2.65^{ab}	0.303	A-	$0.42±0.13^{b}$
Mm	38	$TW = 0.921\ TL^{2.41}$	0.66	0.921^{a}	2.41^{b}	0.320	A-	$0.54±0.13^{a}$
Mt	27	$TW= 1.810\ LTL^{2.81}$	0.62	1.810^{a}	2.81^{a}	0.045	A-	$0.51±0.20^{a}$
Total	124	$TW = 0.438\ TL^{2.63}$	0.65	0.438	2.63	0.400	A-	$0.50±0.14^{a}$

Cp = *C. phantasticus*, Ma = *M. anguilloides*, Mm = *M. macrophthalamus*, Mt = *M. tapirus*, N = number of specimens, TW = Total weight, TL = Total length, LWR= length – weight relationship, R^2 = Coefficient of determination, a = Regression constant, ts = t-test, b= Allometric coefficient, A- = negative allometry, (a, b): the numbers in the same column with the same letters are not significantly different (P >0.05).

-Evolution of the condition factor K as a function of the month and sex of the Mormyridae of the Upper Sanaga River

The evolution of the condition factor (K) as a function of month and sex in Mormyridae of the Upper Sanaga River (Table 6), shows that whatever the species considered, the condition factor K was less than 1. The mean values of this parameter were comparable (P > 0.05) between the different months and species.

Table 6: Evolution of Condition Factor K depending on Month and Sex

Species of Mormyridae	Condition factor K (%)							
	N	May	N	June	N	July	n	August
C. phantasticus	6	$0.58±0.17^{a}$	6	$0.55±0.7^{a}$	2	0.50±0.10Na	6	$0.50±0.20^{a}$
M. anguilloides	5	$0.40±0.16^{a}$	6	$0.46±0.10^{a}$	3	0.40±0.10Na	1	0.28 Na
M.macrophtalamus	1	0.51 Na	5	$0.40±0.12^{a}$	9	$0.50±0.13^{a}$	4	$0.53±0.19^{a}$
M. tapirus	1	0.20 Na	2	0.50±0.10Na	4	$0.40±0.10^{a}$	3	$0.50±0.10^{a}$
Total	13	$0.46±0.10^{a}$	19	$0.50±0.10^{a}$	18	$0.48±0.10^{a}$	14	$0.54±0.12^{a}$

N = Number of specimens, (a) = numbers in the same column with the same letter are not significantly different (P > 0.05), Na = not applicable

Discussion

As the results reported by Gaygusuz *et al.* (2006) on 42 marine and freshwater fish species from Turkish Waters and Birecikligil *et al*. (2016) of fishes in Nevşehir Province, Kızılırmak River Basin (Turkey), the present study provides for the first time Lenght-Lenght

relationships parameters for Elephantfishes in Cameroon.

The relationships between total length (TL) and standard length (SL), total length (TL) and fork length (FL); the standard length (SL) and length at the fork (FL) on the one hand and on the other hand, between the total weight (TW) and the eviscerated weight (EW), are often established by linear least squares regressions (Chikou, 2006). According to this author, these commonly measured relationships, do not have much biological interest in themselves. They make it possible to correct the missing data or to easily interpret the results expressed in one or the other of these lengths or weights. In this study, total and standard lengths on the one hand and total and eviscerated weights on the other hand were strongly correlated. The coefficients of determination (> 0.90) of the TL / SL and TW / EW relationships were comparable to those reported by Tiogué (2012) in *Labeobarbus batesii* from the Mbo Floodplain in Cameroon and those of Usman *et al.* (2016) in grey eel catfish *Plotosus canius* from the coastal waters of Port Dickson, Peninsular Malaysia. Similarly standard and fork lengths were strongly correlated (R^2 > 0.99); While relationship between TL and FL gave lowest regression coefficient (R^2 = 0.84). These results were similar to those reported by Usman *et al.* (2016) in gray eel catfish *Plotosus canius* in Malaysia (both in male (0.87) and female (0.81).

Length-weight relationships are important in fisheries science, notably to raise length-frequency samples to total catch, or to estimate biomass from underwater length observations. In this study, total length was moderately correlated (R^2 = 0.62 to 0.69) with Mormyridae body weight. These results are contrary to the work reported on other species: 0.94 for *Labeobarbus batesii* from the Mbo floodplain in Cameroon (Tiogué, 2012 ; Tiogué et *al.,* 2010), 0.90 for *Labeo coubie* from the Cross River in Nigeria (Offem *et al.,* 2009), 0.95 for *Labeo senegalensis* from the Ouémé basin in Benin (Montchowui *et al.,* 2010), 0.85 to 0.98 for fish caught in the centre of Black Sea in Turkey (Kalayei *et al.,* 2007), 0.88 for *Pseudotolithus senegalensis* (Valenciennes, 1833) in Sierra Leone (Olapade and Tarawallie, 2014), 0.64 to 0.95 for syngnathid fishes of the Aegean Sea in Turkey (Gurkan and Taşkavak, 2007), 0.81 to 0.98 for fishes in Nevşehir Province, Kızılırmak River Basin (Turkey) (Birecikligil *et al.,* 2016) and 0.95 for the gray eel catfish *Plotosus canius* from the coastal waters of Port Dickson in, Peninsular Malaysia (Usman *et al.,* 2016).

The value of the regression coefficient b which gives information on the type of fish growth (Montcho *et al*., 2009) has generally varied from 2.41 to 2.91. This range is consistent with those usually reported and accepted by the literature and which would place this value between 2.50 and 3.50 (Pauly and Gayanilo, 1997) or between 2.50 and 4.00 (Offem *et al*., 2009) or between 2.00 and 4.00 (Montchowui *et al*., 2009). Similar results have been reported for syngnathid fishes (2.42 to 3.54) of the Aegean Sea, Turkey (Gurkan and Taşkavak, 2007); in 11 Tunisian fish species (2.67 to 3.37) (Cherif *et al*., 2008), in African carp *Labeobarbus batesii* (2.45 to 3.62) in the Mbo Floodplain in Cameroon (Tiogué *et al*., 2010; Tiogué, 2012), and 2.73 to 3.14 of fishes caugth in Nevsehir Province, Kızılırmak River Basin (Turkey) (Birecikligil *et al*., 2016).

The LWRs were found lowerly significant with all “r” values being < 0.90. According to Froese (2006), this implies that cube law cannot be applied to Mormyrids species in upper Sanaga River. However, whatever the species considered, the allometric coefficient (b) is less than 3, thus showing a negative allometric growt, therefore fish grow much longer in length than in weight. In addition, Arslan *et al*. (2004) explain these deviations by the fact that b would depend on biotic and abiotic factors, especially food availability and habitat type. Also, Wooten (1998) explained that difference in b values can be attributed to the combination of one or more factors such as number of specimens examined, area/seasonal effect, habitat, degree of stomach fullness, gonadal maturity, sex, health and general fish condition, preservation technique, and differences in the observed length ranges of the specimens caught.

The low values of condition factor K recorded in this study show that these Mormyridae are stressed in their natural habitat, probably due to the effects of overfishing. This could also be due to the lack of prey in this biotope, but mainly for the activities of the people in this area. Indeed, the high Sanaga became for several years, a source of sand which supplies several cities of the country, in particular populations of the west Cameroon and Yaounde, political metropolis of the country for civil engineering constructions (houses, bridges, roads ...). This could also be explained by the fact that fish would be caught during their period of sexual rest. However, according to several authors (Stergiou and Moutopoulos 2001, Chikou, 2006) condition factor K varies with species, location, and season. This variation would be due not only to the general nutritional condition brought about by seasonality or other environmental circumstances, but also to the different stages of gonad maturation. Similarly Radkhah and Eagderi (2015) reported that low condition values indicate less favorable environmental conditions. The growth conditions for the upper Sanaga in Monatélé appeared to be more unfavourable for Mormyrids species.

Conclusion

At the end of this study on the morphometric characteristics and condition factor K of the Mormyridae of the Upper Sanaga, the main conclusions are as follows:

- Four species of Mormyridae were captured in the Upper Sanaga: *Campylomormyrus phantasticus, Mormyrops anguilloides, Mormyrus macrophtalamus* and *Mormyrus tapirus*
- Length-length and weight-weight relationships were significant with significantly high coefficients of determination in these animals; except the total length-fork length relationship which showed a lower coefficient of determination (0.85).
- Total length was moderately correlated (R^2 = 0.62 to 0.69) to the body weight of Momyridae. The allometric coefficient b was less than 3 and

ranged from 2.41 to 2.91; thus giving to these fish a negative allometric growth.

- Condition Factor K was low and ranged from 0.42 to 0.51 between species and in any given month, indicating that fish do not grow well in natural habitat.
- It was recommended to conduct this study for a period of at least 12 months, to be able to conclude on the K-factor values

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