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Monthly Frequency Occurrence, Sex-ratio, Length-weight Relationship and Condition Factor of Native Fishes Caught in a Tropical Floodplain Rivers of Cameroon, Central Africa

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Authors' contributions

This work was carried out in collaboration between all authors. Author CTT wrote the protocol, performed the statistical analysis and wrote the first draft of the manuscript. Authors MD, GT and PZ have collected and collated data. Authors MK, TEE and JT have read the manuscript. Authors MTET and JT managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To evaluate the aquaculture potential of the native fishes from the Mbô Floodplain (MF) Rivers for their domestication and preservation the genetic diversity.
Study Design: Descriptive research.
Place and Duration of Study: Laboratory of Applied Ichthyology and Hydrobiology, Department of Animal Productions, Faculty of Agronomy and Agricultural Sciences, the University of Dschang-Cameroon, between October 2008 and October 2009.
Methodology: A total of 449 fishes measured 11.50 to 50.50cm (mean: 24.60±5.70 SDcm) total length (TL) and 8 to 1300g (mean: 169.18±111.01 SDg) total weight (W), were used for the analysis. Taxonomic identification was performed. The TL and the W were measured using an ichtyometer and electronic balance respectively. The sex of the fish was determined by macroscopic examination of genital papilla or the gonads after dissection. Fishes were counted by species, sexes and months. For data analysis, descriptive statistics, Chi-square test, t-test, general linear model, and the statistical significance of r^2 were performed using SPSS 20.0 software at 5% and 1% significance levels.
Results: Four families with four species were determined: Clariidae (*Clarias jaensis*), Cyprinidae (*Labeo camerunensis* and *Labeobarbus batesii*), Cichlidae (*Tilapia camerunensis*). All fish species were a higher size. The allometry coefficient b ranged from 2.01 (*Labeo camerunensis*) to 3.12 (*C. jaensis*) (mean=2.58±0.50 SD). All species sampled have more females than males indicate the number of both females and males for possible relative sex percentages. Fish species shows positive and negative allometric growth. The higher K factor was recorded in the Cichlidae family and the lower in Clariidae. However the majority of fish species showed a good well-being.
Conclusion: All fish species show a positive aquaculture potential. Then they could be domesticated and preserved genetic diversity. This study, however, need further work to validate reliability.

Keywords: Bio-ecology; endogenous fish; domestication; floodplain; Cameroon.

1. INTRODUCTION

The domestication of new species of fish aquaculture inherent diversification is a recurring issue [1]. All cultured aquatic species have been domesticated since the early twentieth century [2]. These diversification of species produced corresponds to situations and varied objectives, including: the need to cover traditional markets (niche market) for which demand is not satisfied, using species with very high growth potential in order to reduce production costs and the risks associated with cycle times rearing [3], as well as the necessity to eliminate the use of the wild fingerlings for domestication purposes [4]. This control of the life cycle of a species requires its bio-ecological study (natural habitat) [5]. Bio-ecological studies have been carried out on many aquatic species in the world's water bodies [6-9]. In Africa, the ichthyofauna of many rivers has already been studied [10-17]. In Cameroon, to our knowledge, apart from some morphological characteristics of African carp *Labeobarbus batesii* [18,19], data on the bio-ecology for fish species from water bodies is still lacking. This lack of knowledge on the Cameroonian species has been largely responsible for the introduction into the country of alien species like the common carp (*Cyprinus carpio*), African catfishes (*Heterobranchus longifilis and Clarias gariepinus*), and Tilapia (*Oreochromis niloticus*) whose breeding cycles were controlled [20-24]. This practice has an immediate production without having to undertake research on native species still unknown, both the

biological point of view as that of their aquaculture potential. Mbô Floodplain (MF) has many important rivers whose fisheries resources play a significant role in the economy and nutritional status of the local populations. This area is devoid of commercial exploitation due to local enforcement of traditional fishing regulations [25]. There is a little knowledge about the biology of most of the species captured. It is therefore important to understand the basic features of the demography of these fishes for future research. As a first approach to the study on the biology of native fish species in the Mbô Floodplain, this study estimates the monthly frequency occurrence in the captures, sex-ratio, length-weight relationship, and the condition factor K of fish species.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out in the Mbô Floodplain (MF) located in Cameroon (Central Africa). This Floodplain (NL 5º10'-5º30', EL 9º50'-10º10'; altitude: 700 m) is located between the Littoral and West regions of Cameroon. MF has a hot and humid climate characterised by two seasons: The dry season (mid-november to mid-March) with temperatures ranging between 18 and 30ºC and relative humidity of 49%; and the rainy season the rest of the year having temperature that oscillate between 17 and 26ºC. The average rain fall is 1860mm and the relative humidity is 98%. The Rivers of the MF come down from the Bambouto Mount (Menoua River), Manengouba Massif (Nkam River and Black Water River), and several other streams (such as Metschie and Mfouri) from the Bana Massif (Fig. 1). They all emptied their contents into the Atlantic Ocean through Wouri River [19,26].

2.2 Fish Samples and Data Analysis

Fishes were surveyed once every month from October 2008 to October 2009. Fishes were collected by modern fishing gear and method (passive). Taxonomic identification was performed according to [27]. Fishes were counted; the relative percentages of individual species expressed as the ratio of number fish species per total number of fishes caught in the months evaluated. The total length (horizontal distance from tip of snout to hinge tip of caudal fin) was measured using an ichtyometer to nearest 0.1cm. The body weight was measured using electronic balance (Sartorius Competence) to the nearest 0.01g. The sex of the fish was determined by macroscopic examination of genital papilla (in Clariidae family) and number of genital openings: three (anus, oviduct and urethra) for female and only two (anus and urethra) for male (in Cichlidae family), or the gonads after dissection for species without sex dimorphism (Cyprinidae family).

The length-weight relationship was established in the form of $W=aTL^b$ [28] with a, the regression constant and b, the allometry coefficient. TL=total length (cm) and W=body weight (g). The Fulton's condition factor K was calculated using the formula: $K=W/TL^b$ X100 [29].

Data collected were collated and analysed using descriptive statistics (mean, standard deviation and percentage). Sex-ratio of the fish was studied using Chi-square root test (χ^2). The statistical significance of r^2 (determination coefficient) was estimated and the b value tested using the t-test to verify if it was significantly different from the isometric (b=3.0) [30]. The Fulton's condition factor K between fish species was compared using the general linear

model. All the analyses were performed using SPSS 20.0 software at P=.05 and P<.001 significance levels.

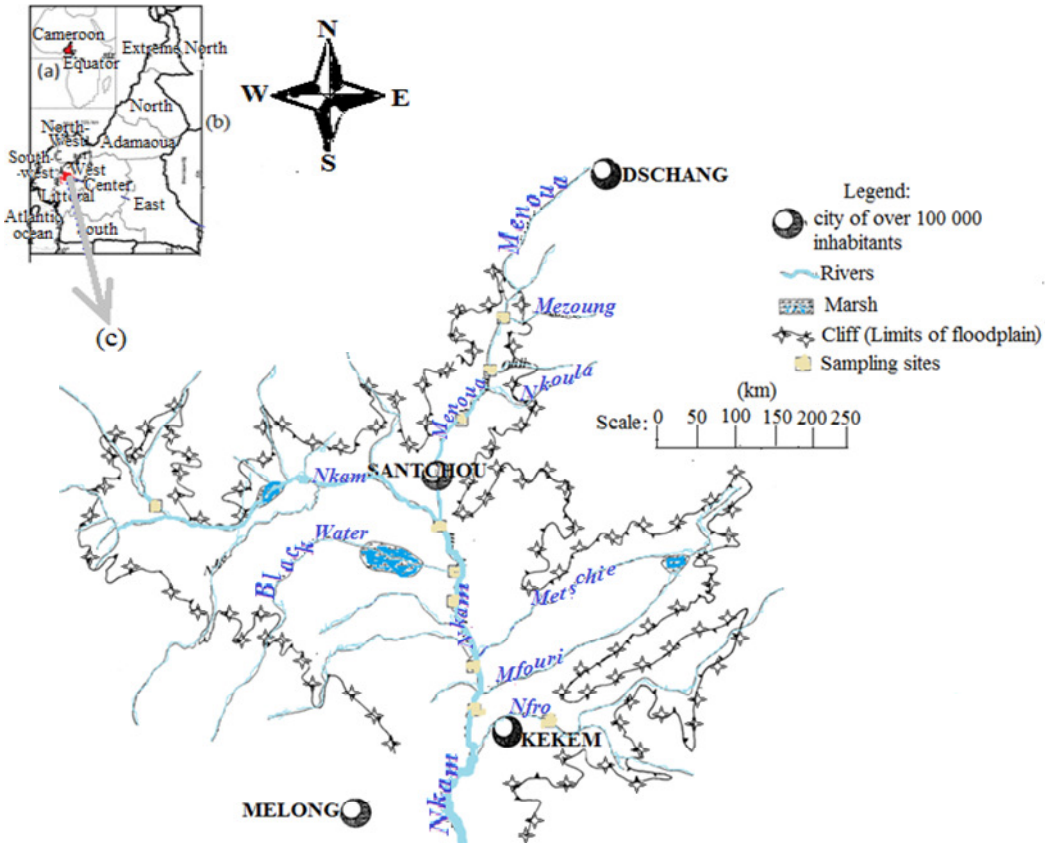

Fig. 1. Study area: (a) Africa, (b) Cameroon, (c) Mbô Floodplain (Adapted from [26])

3. RESULTS AND DISCUSSION

3.1 Morphometric Characteristics and Sex-ratio

A total of 449 fishes were sampled and measured 11. 50 to 50.50 cm (mean: 24.60±5.70 SD cm) total length (TL) and 8 to 1300g (mean: 169.18±111.01 SDg) total weight (W) (Table 1), were used for the analysis. The minimum sample size was 24 fishes (*Labeo camerunensis*), and the maximum was 244 fishes (*Labeobarbus batesii*). The maximum sizes recorded (MSR) in all species are more than 25cm. All species were of large size and indicating that they are all domesticable. According to [4] large size is an indicator of rapid growth. This is an important zootechnical parameter.

Table 1. Total length, weight, sex ratio and relative percentage of sampled native species from Mbô Floodplain Rivers (October 2008- September 2009)

Family/species and status	Relative percentage		Total length (cm)			Weight (g)			Sex-ratio			
	N	%	Min	Max	Mean	Min	Max	Mean	M	F	M:F	χ^2
Cyprinidae												
Labeo camerunensis (Tshibawabwa, 1997),endogen)	24	5.34	16.3	28.50	23.74±3.29	19.5	69.50	137.95±39.78	11	13	0.85:1	0.071
Labeobarbus batesii (Boulenger, 1903), (Endogen)	244	54.34	17	50.50	25.80±4.67	70	1300	190.08±125.67	84	125	0.67:1	0.282
Clariidae												
Clarias jaensis (Boulenger, 1909), (Endogen)	98	21.83	11.50	47	25.57±7.85	8	355.15	146.48±104.15	43	55	0.78:1	0.460
Cichlidae												
Tilapia camerunensis (Lönnberg, 1903), (Endogen)	83	18.48	12	30	20.08±3.21	60	445.30	143.54±66.73	41	42	0.98:1	0.085

N=number of fish, %=relative percentage for each species in catches, Min=minimum, Max=maximum, M=male, F=female, M: F=sex-ratio, X^2=chi-square test, P=.05, ±=standard deviation

Sex-ratio of the four species examined is showed in (Table 1). All species sampled have more females than males: A total of 244 specimens of *L. batesii* were sampled out of which 35 fingerlings, 84 males and 125 females, giving a sex- ratio of 1 female to 0.67 male. 43 males to 55 females were sampled for *C. jaensis*, giving a sex-ratio of 1 female to 0.78 male. The difference between the males and females were significant (P<0.001) in these species. The females were also predominant over the males for *Labeo camerunensis* (giving a sex-ratio of 0.85 M: 1F and *Tilapia Camerunensis* (giving a sex-ratio of 0.98 M: 1F. However, this showed no significant difference (P=0.001) between the males and females for the two species.

Preponderance of female specimens over the male in this study had been recorded in populations of other fishes elsewhere in Africa: *Labeo parvus* (1 M:1.5 F), *Eutropius micropogon* (1 M: 2.5 F), *Synodontis obesus* (2 M: 4 F), *Parachenoglanis guttatus* (1 M: 5.1 F), *Distichodus rostratus* (1 M:3 F), *Calamoichthys calabaricus* (1 M: 2 F), *Hepsetus odae* (1 M : 1.8 F) in Nigeria [11]. The authors suggested that sex disparity could be a result of the differential survival of certain environmental conditions. [11,12] described it as a mechanism for regulation in fishes. Females could possibly emigrate from spawning areas towards feeding grounds located where they are caught. Contrarily of our results, it was pointed out that in African water bodies it is common that the populations of male fish dominates because they generally present more growth than females without this representing a risk situation for fishery [11,12].

3.2 Monthly Frequency Occurrence in the Catch

The monthly frequency of sampled species is shown in (Fig. 2). Number of sampled fishes was recorded. The total number of fish species caught fluctuated in the Mbô Floodplain Rivers in all months. *L. batesii* predominant catches followed respectively by *C. jaensis, T. camerunensis* and *L. camerunensis.* The highest number of fishes caught was recorded in year 2009 on December (52), January (65), September (58) and October (68) while the lowest number was recorded in February (9). *L. batesii* and *C. jaensis* occurred abundantly throughout the months of August to January; and feebly throughout the rest of months (February to July). *T. camerunensis* was rarely on a few months. *L. camerunensis* occurred only in four months of dry season: abundantly in November and December and feebly in February and March. These results are different to those reported by [19] in the same area with fish farmers in ponds and lakes. His studies showed that *C. jaensis* was most abundant. The presence of Cyprinidae was not pointed out. This signifies that they are a rheophilous species and not rustics such as others, and characteristically prefers running water in rocky habitats as *Labeo parvus* [31]. Cichlidae and Clariidae are sufficiently abundant, as they can live anywhere (in ponds or in the rivers).

The results also indicate that freshwater fishes showed a monthly fluctuation in abundance in number of individuals. The fluctuation in abundance in terms of number also revealed a seasonal trend with a peak towards the rainy season and the mid dry season for *L. batesii* and Clariidae family, or the dry season for *L. camerunensis.* This fluctuation suggests that the season changes in the habitat probably favoured the growth and development of the species hence the large number in the field at this period of the year. Similar monthly fluctuation in number or abundance has been reported for the Clariidae family in the same area by [19]. As for the biology, knowledge of fish habitat should then be taken in consideration in domestication process.

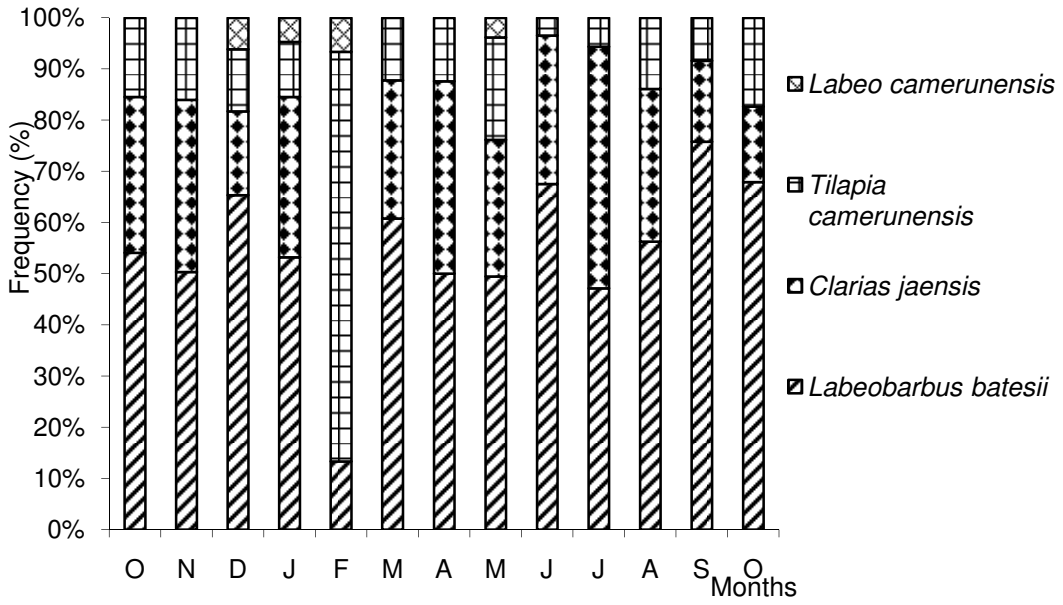

Fig. 2. Monthly frequency of occurrence in the catch of native fish species from the Mbô Floodplain Rivers (October 2008 – October 2009)

3.3 Length–weight Relationships (LWR) and K Factor

The length –weight relationship characteristics and condition factor K of the four fish species examined are presented in (Table 2). The coefficients of determination (R^2) of the LWR regressions ranged from 0.84 to 0.95 and were all highly significant (P<0. 001). All length – weight relationships were highly significant (P<0.001). Similar results were reported by [32] in fish species caught in Kuantan Coastal Water. In this study, the b value ranged from 2.01 in *L. camerunensis* to 3.12 in *C. jaensis* (mean=2. 58±0.50). Similar results were reported by [31] in Oueme River in Benin, [11] in several fin-fish species in Cross River in Nigeria and [33] from the River Ganga in India. These results are in accordance with the range of values for this parameter usually encountered in fish, between 2.0 and 4.0 or 2.5 and 4.0 according to [11] and [14]. As of late [34] confirmed that the b exponent should normally fall between 2.5 and 3.5. [31] demonstrated that b values less than 2.5 or greater than 3.5 are mostly caused by samples with narrow size ranges. It can explained the lower value (b=2.01) obtained for *L. camerunensis* in this study. We consider our results to be an adequate estimation of the length-weight relationships, since the b parameter falls within the expected range of 2.5 to 3.5.

Native fishes in the Mbô Floodplain Rivers showed two types of growth: Negative allometric growth was recorded for Cyprinidae family (*L. camerunensis* and *L. batesii*) and *T. camerunensis.* These results indicated that the growth in length is more substantial than the growth in weight. Positive allometric growth recorded for *C. jaensis*, indicate that the growth in weight is greater than the growth in length. Allometric growth has been also recorded for fish species captured from the basin of River Casin and its tributaries [35] and from Kuantan Coastal Water [36].

Except the catfish *Clarias jaensis*, native fish species caught in the Mbô Floodplain Rivers have b values lower than the hypothetical isometric value (b=3). These species have therefore recorded the negative allometric growth. Yet this floodplain having dense vegetation provides abundant food resources and many aquatics animals as insects, crustaceans, protozoa, nematoda worms, and some others invertebrates [37] that support rapid growth in fishes. Consequently all fish species should be healthy. This would probably be due to many stresses, e.g competition for food, reproduction and habitat caused by the presence of alien species, or environmental factors in this area.

In comparison, b values between the species in the Mbô Floodplain and populations elsewhere, [14] reported an isometric growth for *C. gariepinus* and *P. obscura* in Lake Hlan in Benin. [9] and [16] reported isometric growth respectively for *Labeo senegalensis* in Burkina Faso and for *Distichodus rostratus* in Ivory Coast. An isometric growth was reported for *O. niloticus* in Kenya and Burkina Faso; a negative allometric growth was reported for *C. gariepinus* in Soudan [9]. The same author obtained a positive allometric growth for *C. gariepinus*, negative allometric growth for *Heterotis niloticus* and isometric growth for *Gymmarchus niloticus* and *Protopterus annectens* in Burkina Faso. Tiogué (unpubl. data) in year 2008 and [17] reported respectively a positive allometric (b=3.13) and isometric (3.00) growth for *L. batesii* in this floodplain. Length-weight relationships of fish are affected by many factors including number of specimens examined, fishes size range, season, habitat, gonad maturity, sex, diet, health, preservation techniques and the waters experiencing different climate and environmental variables [38,39,14,35,36]. In this study, environmental or habitat factors were not analysed. However, more research is needed including analyzing environmental or habitat factors to understand the cause of this variation b value in the floodplain.

Condition factor K varied from 0.487 (*C. jaensis*) to 23.50 (*L. camerunensis*). All fish species showed a good fatness with the exception of the catfish *C. jaensis*. This should be due to the accidental introduction of her sister *Clarias gariepinus* in the plain since 1990 (Personal. observation); this foreign Clarid has become established in the Mbô Floodplain Rivers [27] and even threaten to remove endogenous species that is becoming increasingly rare in the catches. Condition factor K is a quantitative parameter that indicates the state of the fish (fatness, maturity and spawning gonadal development and general well-being of the fish) and determines present and future population success by influencing growth, reproduction and survival [34]. The Fulton's K condition <1 expresses a nasty state of health of the animal; on the contrary, K value>1 expresses its good well- being. All carp showed a K factor greater than 1, showing that they are in their natural milieu.

Table 2. Length-weight relationships parameters in native fish species caught in the Mbô floodplain rivers (October 2008 – October 2009)

Species	N	r^2	a	b	Growth type	Mean K factor
Clarias jaensis	98	0.90	0.0045	3.12^{a}	Allometric positive	0.487 ± 0.191^{d}
Labeo camerunensis	24	0.84	0.5433	2.01^{d}	Allometric negative	23.50 ± 3.14^{a}
Labeobarbus batesii	244	0.95	0.0166	2.84^{b}	Allometric negative	1.702 ± 0.191^{c}
Tilapia camerunensis	83	0.85	0.1140	2.36^{c}	Allometric negative	11.59 ± 2.27^{b}

(a,b,c,d) = superscript letters in the same column are significantly different (P=.001), N=sample size, r^2 =coefficient of determination, a and b=estimated parameters of the length-weight relationships, LWR= length-weight relationship, ± =standard deviation

4. CONCLUSION

L. batesii (Cyprinidae) is the predominantly and abundantly species in the Mbô Floodplain streams. Endogenous fish species in the Mbô Floodplain shows two types of growth: Positive and negative allometric. All species sampled have more females than males. The majority of species showed a significantly higher K factor, thus implying a good healthy in their living environment. All species were of large size, indicative of a rapid growth and then the positive aquaculture potential. Species should be domesticated and preserved the genetic diversity. These potentials, however, need further work in other biological aspects of the sampled species and families such as the reproductive strategies, age, natural habitat and feeding habits of fish species, to validate reliability.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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