Aspects of the growth and reproductive characteristics of *Labeo coubie* (Ruppell 1832) in Upper Benue River, Nigeria

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Abstract

Labio coubie is an ecologically and economically important fish of River Benue, thus the length-weight relationship, condition factor and fecundity of the fish were investigated in order to provide information essential for its sustainable management. Fish specimens were collected monthly from sampling stations at Jimeta, Yola, Adamawa State between September, 2017 and February, 2019. A total of 849 specimens were collected and their standard length, body weight and fecundity measured. Regression analysis of the length-weight relationship produced positive allometric growth coefficient, the values of regression coefficient (b) in males, females and combined sexes were 4.02, 3.52 and 3.34, respectively. Condition factor obtained ranged from 2.35-3.38 (mean=2.54±0.22), 2.36-2.78 (mean=2.52±0.11) and 2.36-3.00 (mean=2.53±0.14) for males, females and combined sexes, respectively. Fish condition factor was generally not significantly different ($p>0.05$) between seasons. The fecundity of *L. coubie* ranged between 33,331eggs and 596,250 eggs (mean 78,017±165,667eggs). The mean values of condition factor showed that *L. coubie* was in a good state of wellbeing in the habitat during the period of study. These results confirm the suitability of upper River Benue for survival of *Labeo coubie*. There is however need for a systematic closed fishing regime to be employed in order to make way for sustainable growth *of L. coubie* fisheries in the river.

Keywords: Positive allometry, growth pattern, stock assessment, maturity, energy allocation

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Introduction

Studies on length-weight relationship and condition factor are prerequisites to understanding natural populations of fish species, which is needed for proper conservation and exploitation (Osho and Usman 2019). A knowledge of the growth pattern and condition of wellbeing of a fish goes a long way in easing the crucial work on its stock assessment and provides a base for further studies of its biology.

Fecundity is a unique index of reproductive performance of a female fish, with which adequate management can have positive influence on species propagation. It is a measure of the number of ripe eggs in the female fish prior to spawning (Ikpi and Okey 2010). Knowledge of the total number of eggs produced in a season could be used to estimate fish population for adequate stock assessment and management. It especially allows fishery personnel to take necessary measures to manage species that are more vulnerable to overfishing (Abobi *et al* 2015). Fecundity is also important in fish taxonomy and racial studies (Rahman and Miah 2009). According to Ganias (2018), fecundity measurements are valuable in the appraisal of biomass of ecologically or socially important species.

Labeo coubie is an important species inhabiting tropical freshwater rivers in Senegal, Gambia, Ivory Coast, Liberia, Democratic Republic of Congo, Gabon and Nigeria (Ayotunde *et al* 2007; Olufeagba and Okomoda 2016). In Nigeria, *L. coubie* inhabits major freshwater rivers, such as Cross River (King 1996; Ikpi *et al* 2012; Okogwu and Ugwumba 2010), River Kwa Ibo, River Imo (Okogwu *et al* 2021) and Benue River (Olufeagba and Okomoda 2016). *Labeo* species constituted about 10.3% of the total catch collected in randomly-selected villages along the northern and southern banks of River Benue and 8% relative proportion by weight (FAO 2017). *Labeo coubie* is characterized by good taste and it is a rich source of protein. In addition, it has a good potential as ornamental fish. Till date, relatively little information is available on the fisheries of the African carp. More importantly, research on stock assessment, biology, ecology, habitat status, threats, monitoring and potential conservation measures are necessary to get better understanding of this fish species. The aim of the study is to investigate the length-weight relationship, the condition factor and fecundity of *L. coubie* in Upper Benue River at Jimeta, Adamawa State, Nigeria.

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Materials and methods

The study area is located in a part of the Upper Benue River, at Jimeta, Girei Local Government Area of Adamawa State. Two sampling stations were selected on River Benue located within 9° 16′N - 9° 19′ N and 12° 26′E - 12° 29′E, which serve as the fish landing sites for fishermen fishing in the study area (Figure 1). Fish specimens were collected from the landing sites at the River Benue, located at Girei Local Government Area of Adamawa State and samples were taken from September, 2017 to February, 2019. The fish were caught using cast nets, lift nets, dip nets and traps.

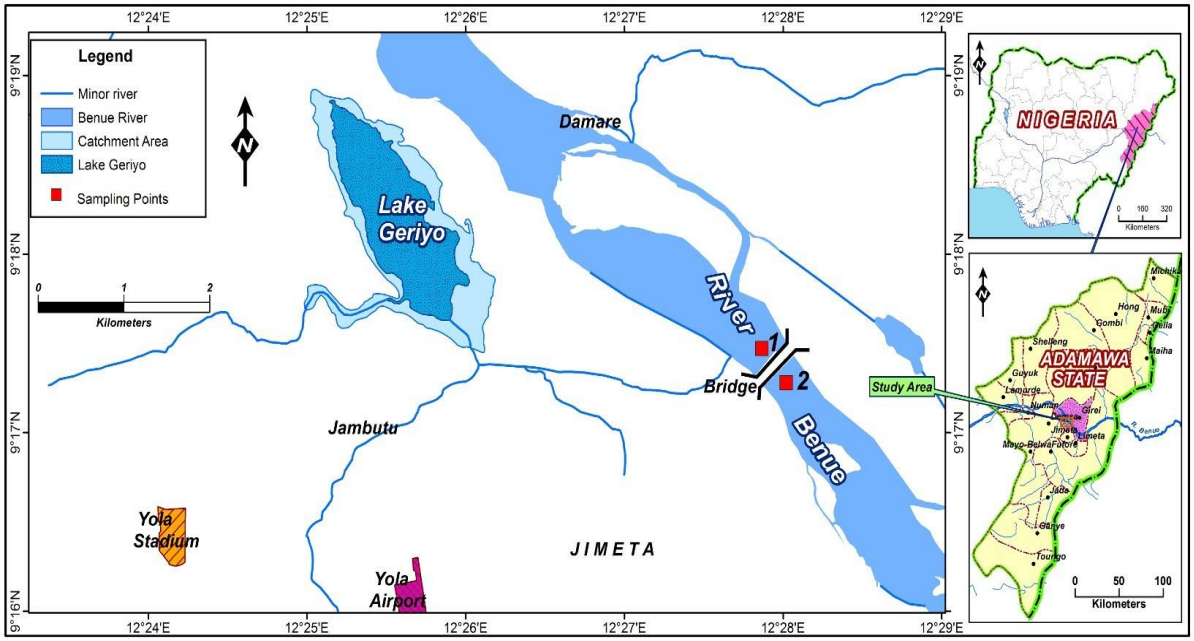

Figure 1. Map of Upper River Benue showing sampling stations

A total of 849 specimens were sampled for this study. They were transported in plastic tanks with ice packs to the laboratory of Department of Fisheries, Modibbo Adama University of Technology (MAUTECH), where morphometric measurements of the fish were taken. The standard length and weight of the specimens were measured using measuring board and digital weighing machine (model KERRO BL 5002), respectively. Length-weight relationship of fish was estimated from the equation:

$W = aL^b$ (Pauly, 1984)

The relationship was transformed into a linear form:

$\log W = a + b \log L$

Where W=weight of fish (grams); L=standard length of fish (cm); a=regression constant (Y-intercept); b=allometric coefficient (slope).

Fulton's condition factor (K) was calculated monthly using the formula by Bagenal and Tesch (1978) as follows:

$K = 100W/L^3$

Fecundity was determined using gravimetric sub-sampling wet method described by Bagenal (1978). Ovaries of females in stage III (mature and spawning-capable) were used to determine fecundity according to the criteria of Jhingran and Pullin (1985). The ovaries were removed and weighed after removing excess water on filter paper. One gram of egg mass was weighed and placed in a petri dish. The number of eggs in this mass was counted. An estimate of the total number of eggs in the ovaries was then made by extrapolation from the total number of eggs in 1.0g.

Fecundity = number of eggs in 1.0g × mass of the ovaries

Data analysis

One-way analysis of variance was used to test the differences in means of condition factor (K) between sexes and between months. Pearson's correlation coefficient and regression analysis were used to determine the relationship and nature of relationship between standard length (SL) and weight (W) of fish specimens.

Results

Graphical representations of the regression equations of the length-weight relationship of male, female and combined sexes of *L. coubie* are presented in Figure 2. From the regression equation, transformed into linear form, Y = bx + a, regression constant 'a' are -6.814, -5.3153 and -4.7552 for males, females and combined sexes of fish, respectively. Allometric coefficient 'b' values were 4.0281, 3.5246 and 3.3499 for males, females and combined sexes, respectively. All the three values are greater than 3, hence the fish showed positive

allometric growth. High correlation values of r^2 = 0.89, 0.93 and 0.97 for mean values of standard lengths and weights of *L. coubie*, were recorded. The equations Y = 4.0281x – 6.814 and Y = 3.5246x – 5.3152 were used to estimate the weight of a fish of known length, for males and females, respectively.

Condition factor was generally not significantly different, p> 0.05, between the sexes of *L. coubie* in the present study. The only month in which significant difference p<0.05 was observed is December, 2017. The fecundity of gravid *L. coubie* ranged between 33,331eggs and 596,250 eggs, with a mean of 139,751 (Figure 4). Relative fecundity varied from 2.09 eggs/g to 124.22 eggs/g and 120 eggs/cm to 12,045.5 eggs/cm.

Labeo coubie in the present study had multiple GSI peaks in December 2017, April 2018, July 2018 and November 2018. The female exhibited the most prominent peak in July 2018 (Figure 5). The lowest mean GSI, 0.19 and 0.28 for males and females, respectively, were observed in October, 2018, while the highest values, 1.17 and 8.71 were observed in July, 2018.

Discussion

Labeo cuobie exhibited positive allometric growth in upper River Benue. Allometric growth is observed when the dimensional growth rates of fish with respect to length and width or size are not the same (Bolarinwa 2017). This indicates that the fish grows heavier with slight increase in length. Positive allometry is common in fish that are elongated and slightly rounded. Thus, it is expected that *L. coubie* with this body shape would exhibit positive allometric growth pattern. This is possibly the reason for the overfishing of immature fish, which could lead to recruitment failure.

The results of this study differ from previous studies on River Benue and other Nigerian rivers. For example, Olufeagba and Okomoda (2016) estimated 'b' values of 3, indicative of isometric growth, for male *L. coubie* and 2.63 indicating negative allometric growth pattern for females in Lower Benue River. The same study also gave values with insignificant positive deviation from the allometric coefficient 'b' of 3.07 and 3.04 for *Labeo senegalensis*, males and females, respectively. In another study, Ayoade (2011) reported a negative allometric growth pattern in the smallest studied size group ('b'<3) and isometric pattern ('b' = 3) for other groups of *Labeo ogunensis* in Asejire Lake. However, our results were similar to Laleye (2006) that estimated 'b' greater than 3 in *Labeo parvus* in Queme river. Konan *et al* (2017) reported an isometric growth pattern for *L. coubie* in coastal rivers. The differences in the slope of length-weight regression analysis 'b' and in essence the growth

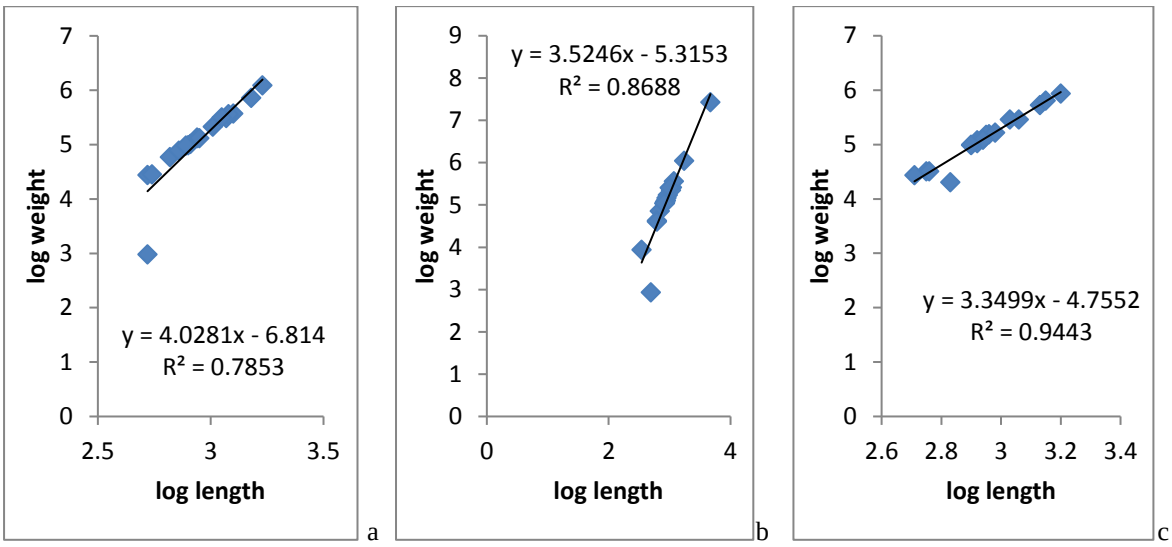

Figure 2. Length-weight relationship curves of *L. coubie*

Table 1: Length-weight equation characteristics and condition factor, K of *L. coubie* in Upper Benue river

Sex	L-W equation	b value	Correlation (r^2)	Mean condition factor, K	P value
Male	Y = 4.0281x-6.814	4.0281	0.89	2.54 ± 0.22	0.11
Female	Y=3.5246x-5.3153	3.5246	0.93	2.52 ± 0.11	
Combined sex	Y=3.3499x-4.7552	3.3499	0.97	2.53 ± 0.14	

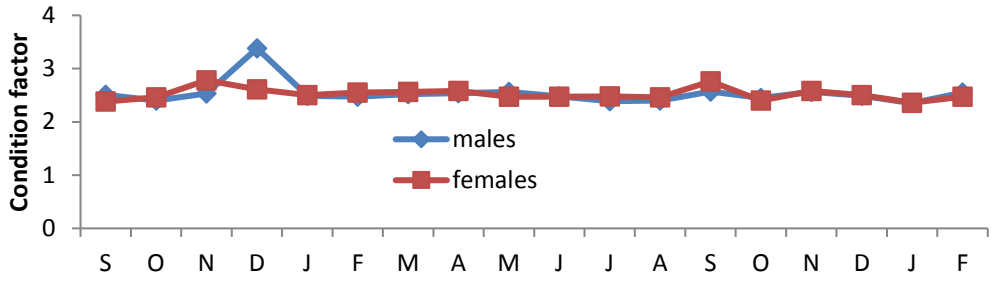

Figure 3. Condition factor of male and female *L. coubie* in Upper Benue River

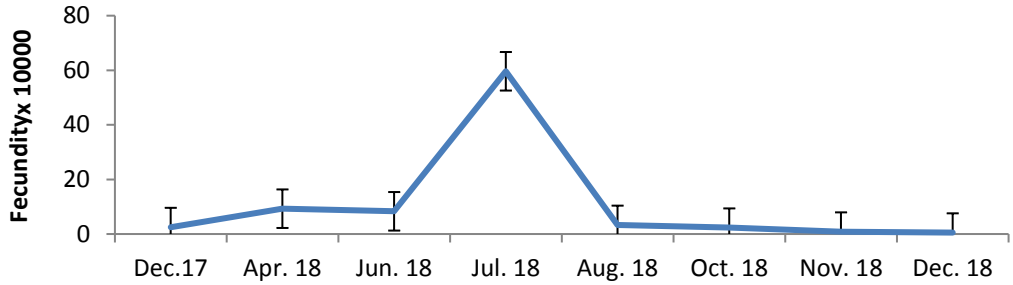

Figure 4. Mean fecundity of *Labeo coubie* in Upper Benue River

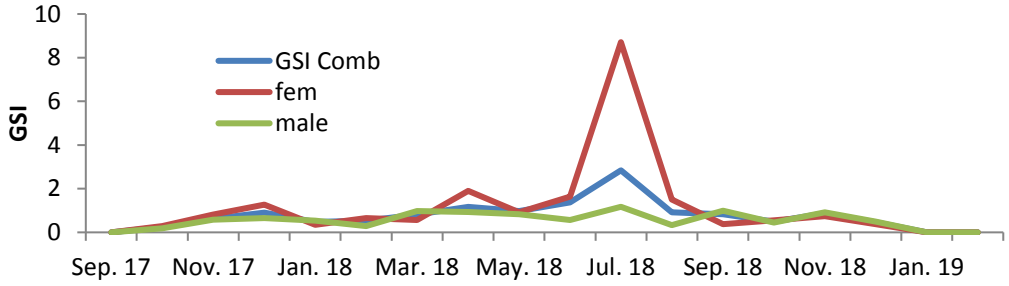

Figure 5. Gonadosomatic indices of *Labeo coubie* (a-females, b-males, c-combined sexes)

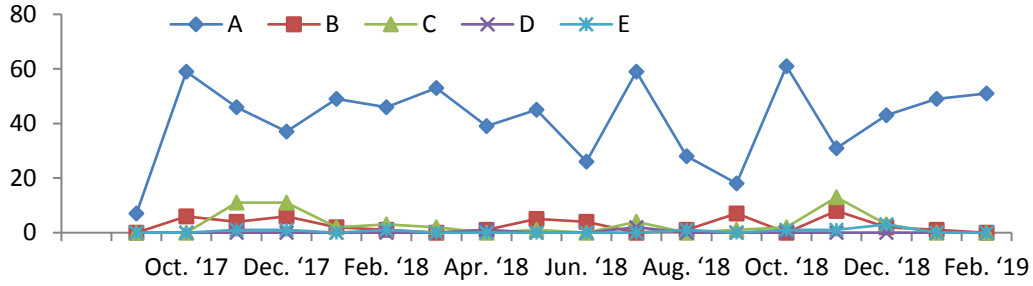

Figure 6. Proportions of different cohorts of *Labeo coubie* in monthly samplings
A-Immature, B- maturing, C- mature and spawning-capable, D- spawning, E- spent fish

pattern of fish can be related to factors, such as size and age of fish, species, water condition or parameters, stage of maturity (Weatherly and Gill 1987), food availability (Mommsen 1998) and sex of fish.

The mean values of condition factor, K recorded for *L. coubie* in Upper Benue River in the present study were greater than 1 (i.e.2.54±0.22 and 2.52±0.11) for males and females, respectively. This implies that the species is in satisfactory condition of wellbeing, necessary to support moderate somatic growth and possibly, reproduction. These results are in accordance with those of Olufeagba *et al* (2016), who also observed mean K values ranging from 2.12 to 2.45, for *L. coubie* and *L. senegalensis* in Lower Benue River. Ayoade (2011) reported mean values of 1.1 for *L. ogunensis*, Adadu *et al* (2014) observed mean value of 1.84 for *L. coubie* in Lower Benue river, while Ikape and Solomon (2018) reported 0.73 for the fish in the same section of River Benue. Lower values of K, less than 1, were also reported by Ikpi *et al* (2012) for *L. coubie* in Agbokim Waterfalls. Differences in values of condition factor of fish can be linked to factors, such as food availability space, sex and physiological condition of fish and season (Mommsen 1998). Thus, in most gravid fish species, priority is given

to energy allocated to metabolism and reproduction (Barron *et al* 2012; Rodrigues *et al* 2013). More energy is spent on metabolism, gonad maturation, and production of eggs and sperm during the spawning season than on growth. This usually coincides with the rainy season. This causes a reduction in the condition factor of the spawning fish.

Intermittent increase in the quantity of ripe ova and consequently the gonadosomatic indices were observed in the periods between December 2017 and November 2018. According to Dorostghoal *et al* (2009) and Tiogue *et al* (2013), multiple GSI peaks could characterize a fractional multiple spawning, which might advantageously reduce the effects of larval crowding, predation and unfavourable environmental conditions on eggs and larva. This reproductive strategy of the African carp could be responsible for the high fecundity and subsequently high population of young immature fish in the river (Figure 6).

The high GSI values obtained for the female fish can be ascribed to the weight of eggs, which occupy a considerable portion of the abdomen during the breeding season. Shinkafi and Ipinjolu (2012) stated that the GSI of female fish is usually higher than that of the male counterpart. Increase in GSI in male and female *L. coubie* could also be triggered by the commencement of the rainy season in April. Availability of abundant food substances, such as plankton and detritus could have contributed to high GSI value of *L. coubie* in this study. In addition, increase in GSI of African carp during the period, February-October 2018 could be attributed to high water temperatures, which sometimes reached 31.1°C.

In order to emphasize its importance as an indicator of gonadal development, GSI of *L. coubie* in this study was observed to increase with gonad development. Factors which may facilitate the development of fish gonad and hence GSI include photoperiod, water temperature and species factor (Nikolsky 1963). Although, there was a few number of peaks in GSI observed for *L. coubie* in the present study, there occurred a more prominent one in July, when higher population of fish, males and females were found with ripe gonads. It thus suffices to say that July is the peak of breeding season for *L. coubie* in upper Benue River. Gadekar (2013) stated that the peak of GSI usually coincides with the breeding season of fish during the rainy season. Occurrence of smaller peaks in December, 2017, April, 2018 and November, 2018 indicates that *L. coubie* in this river breeds not only in the supposed spawning season but do have multiple spawning periods. This could have led to the availability of young fish – fingerlings and juveniles, throughout the year, which makes *L. coubie* a suitable candidate for aquaculture (Dorostghoal *et al* 2009).

Conclusion

This study examined some aspects of growth and reproductive characteristics of *L. coubie* in upper Benue River. Regression analysis of the length-weight relationship showed that the species increases more in width or body weight than in length, i.e., has a positive allometric growth, $b > 3$. The Fulton's condition factor is favourably high throughout the year, 2.39-3.38. Fish exhibited fairly high mean total fecundity, characteristic of the species (78,017±165,667 eggs). With these findings, *L. coubie* can be said to be in good state of wellbeing in this river. However, there is a need for systematic closed fishing regime to be implemented on the river in order to curb overfishing of the species.

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