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Estimation of Dietary Composition and Fecundity of African Carp, *Labeo Coubie*, Cross River, Nigeria

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ABSTRACT: Dietary composition and aspect of reproductive biology (fecundity and sex ratio) of African carp was investigated for 12 months. Specimens were collected from artisenal fishermen, measured for Length (cm) and weight (g), examined for genital papilla in the male and the stomach removed for food analysis. The main food categories were crustaceans, rotifers, insects, worms, plant parts and mud. The index of relative importance (IRI) values indicated that 13 out of the 21 food items were major diet components. The prominence of detritus in the diet indicated that *L. coubie* is a bottom feeder and is euryphagus. Fifty eight (58) 28.6% out of the 205 females had matured gonads. Absolute fecundity ranged from 679 to 15073 eggs. The relative fecundity ranged from 40 to 793eggs/ Length (cm) and 64 to 286 eggs/ weight (g). Spawning was between the months of May through August. The Length – Weight yielded significant results for female than male indicating that, females were in better condition than the males. The overall sex ratio of *L. coubie* was 1:1.67 in favour of females. The wide food range and high fecundity made *L. coubie* suitable for pond culture. @ JASEM

African carp, *Labeo coubie* (Ruppel, 1832) is one of the common species of fishes of the family Cyprinidae found in Nigeria, West Africa. It is a highly valued food fish in Cross River, Nigeria and other West African countries (Ayotunde *et al*; 2007). Of the four species recorded in Africa, *L. coubie* is the commonest and can grow to about 700mm in length and 10kg in weight (Idodo-umeh 2005). Food and feeding habits have been known to vary for individual fish with respect to size, age, life history stage, kinds of food available, season, time of the day, as well as locality in which they are found . Similar investigations in the tropics had shown that the natural food of fish tend to vary quantitatively and qualitatively with seasons of the year (Ugwumba and Adebisi, 1992, Ekpo 1993). Factors like size, age, sex, life history stage, time of feeding and food available, had also been identified as being equally important in affecting the food quality of fishes in the tropics (Araoye and Jeje, 1999; Ezenwaji, 1999, 2002; Owolabi, 2005). The study of dietary habits based on stomach content analysis, is widely used in fish ecology as an important means of investigating trophic relationship in the aquatic communities (Arendt *et al*., 2001) and in the creation of trophic models as a tool to understanding complex ecosystems (Lopez-Peralta and Arcila 2002).

Fecundity is a measure of the number of ripe gonads in a fish prior to spawning and had been reported by Olatunde (1999) in *Physailia pellucida* and Ekanem (2000) in *Chrysichthys nigrodigitatus,* King (1997) in Nigerian fish populations, Allison, *et al* (1998) in *Cynoglossus canariensis* and *C. goreensis* and Ikomi and Sikoki (2003) in *Brycinus longipinnis*. The knowledge of fecundity and sex ratio is essential in studies on population dynamics aimed at proper management of Nigerian fisheries resources (Allison *et al*., 1997; Ekanem, 2000) and rational utilization of stock (Morales, 1991). In spite of its commercial value to the people of central Cross River there is still paucity of information on *L. coubie* in Nigerian waters especially on some aspects of biology such as reproduction and stomach content analysis. The maturation of the gonads of *L. coubie* had been investigated by Baijot *et al*., (1997) and reported that in August, the eggs of some females can flow on abdominal pressure, further more the breeding activities of some species including *L. senegalensis* is markedly seasonal and takes place from May through October. Condition factors of different populations of the same species give some information about food supply and the timing and duration of breeding. The condition factor can also be used in assessing the well-being of fish (Taiwo and Aransiola, 2001).

The genus *Labeo* has been found to be a typical example of fish without strict feeding habit. It is regarded as omnivore, because of its ability to use just any food material present in its habitat. Many food types ranging from insects, planktons, mollusks, mud and crustaceans have been observed in their stomachs (Ayotunde *et al*., 2007).

MATERIALS AND METHODS

Study area: The Cross River system is located at 7^o 30' – 10^o 00' E and 4^o 00'-8^o 00' N. It covers an area of 54,000 km^2, 39,500 km^2 of which lie within Nigeria and 14,500 km^2 in the Republic of Cameroon. The river is subject to seasonal flooding, with the flooding occurring between July and October. The total area liable to flooding in Cross River basin is 8,303 km^2 and Cross River estuary is relatively highly productive in terms of primary and secondary production. There is a high dependence on tertiary production that militates against the optimal exploitation of the estuary, because low net energy

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output is realized at high trophic level (Offem *et al*., 2008).

Sampling: Samples of *L. coubie* for the study were collected twice monthly for the period of 12 months (October 2006- September 2007) from catches landed by artisenal fishermen using gill nets of different mesh sizes. A total of 328 specimens were sampled and their total length (to the nearest cm) and weight (to the nearest g) of each specimen was measured after adhered water was removed with blotting papers following the procedure of (King, 1995). The specimens were then preserved in 10% formaldehyde for subsequent analysis. Sexes were determined based on the possession of a genital papilla by the male and binocular dissecting microscope was used for some small specimens.

Dietary composition: Guts of each specimen were dissected out and its contents emptied into separate Petri dishes with the items identified to the lowest taxonomic level according to the method described by Ugwumba, and Adebisi (1992). The contents were analyzed instantly but where impossible, they were preserved in 4% formaldehyde. Frequency of Occurrence (O), Numerical (N) and Gravimetric (G) methods were employed in the analysis. Dietary importance of all prey items were determined using the index of relative importance calculated with the formula (% N + %G) x % F as described by Barry *et al*., (1996).

Fecundity: A total of 56 gravid fish ranging from sizes (17-33cm) of length and weight (79.65 – 233.20g). The ripe eggs were removed from the gravid fish weighed and preserved in modified Gilson fluid (Nitric Acid 17ml, Acetic Acid 4ml, Mercuric Chloride 20g, Ethanol 95% and Distilled water 900ml) according to Ekanem (2000). The preserved ovaries were washed several times to get rid of the preservative. Eggs were then separated from the ovaries and placed on filter papers to remove excess water before being weighed using chemical balance. Fecundity was estimated by counting the number of matured ova from known weight of subsamples collected from the ovaries and calculated by multiplying the total weight of eggs by the number of eggs per gram weight (Abayomi and Arawomo 1996). Relative fecundity (RF) was obtained as the number of eggs per unit length (cm) or per unit weight (g). The relationship between fecundity, fish weight and length were determined by linear regression technique. The best predictive equation was computed as a logarithm transformation of the equation.

$F = a X^b = \text{Log } F = \text{Log } a + b \text{ Log } X$

Where: F = Fecundity; X = Length / Weight; a = Regression constant; b = Regression coefficient.

Measurement of length and weight recorded for each fish were used for calculating Fulton's condition factor K. This was calculated using the formula $K = 100\ W \times L^{-3}$, where W is the weight and L is the length of fish, and the number 10^3 is introduced to bring the value to unity. The sex ratio of the fish was studied using Chi square test (X^2) following the equation of Suresh *et al*., (2006), assuming the ratio of female to male in the population to be 1:1. Gonadosomatic index (GSI) was estimated following Allison *et al*., (2008). The spawning and breeding periodicity were determined from the inverse trend of GSI and condition factor (K).

RESULTS AND DISCUSSION

Stomach content: From the 328 stomach analyzed, 141 (43%) had empty stomach and 187 (57%) contained various food items (Table 1). The food items showed that variety of the prey items comprised organisms of plant and animal materials as well as detritus. A total of 20 prey categories were observed in the stomach of *L. coubie*. The dominant food items were rotifers, Keretella and Testudinella, which occurred in about 88.77%, 68.25% and 60.99% stomach respectively. The most frequently utilized food types were the crustaceans with about 7 species identified. Detritus contributed the most occurred dietary (94.16%) item and weighed (12.63%), while the worm (Branchiura) and crustacean (Diaptomus) had the least occurrences of 1.06% and 2.14% respectively. The mean numbers of different prey per stomach were 2 preys and ranged between 4 – 176 species and weight of prey per stomach was 0.27g and ranged between 0.87 – 6.38g. The index of relative importance (IRI) values for insect larvae (470.82), Keretella (562.80) and Detritus (1239.76), which were higher than those of other prey items. Insect larvae (21.41%) and Daphnia (22.70%) constitute the dominant prey items numerically while detritus (12.63%), gravimetrically were more than other food items in the stomach of *L. coubie*.

Reproductive Biology: The mean monthly values of the different parameters calculated for the species are presented in Table 2. The sex ratio of the fish showed highly significant monthly variations from the expected male: female ratio. The pooled observations for the overall sex ratio also varied significantly from the expected ratio P>0.001 (Table 3). A total of 123 males and 205 females were observed giving rise to a ratio of 1: 1.67 which ranged from 1: 0.67- 1:2.89. Within the months, males were dominant only in September (1:0.67) and November (1:0.83).

Table:1. Diet composition and relative importance index of major food items in the stomach of *L. coubie* in Cross River, Nigeria.

Prey categories	Occurrence Method		Numerical Method		Gravimetric Method		IRI
	No	%	No	%	Weight (g)	%	
Crustecean							
Gamerus	8	4.28	18	4.64	0.90	1.78	27.48
Anisogamus	6	3.21	15	3.87	1.21	2.40	20.13
Streptocephalus	12	6.42	18	4.64	1.20	2.40	45.20
Diatomus	4	2.14	21	5.42	1.32	2.61	17.18
Cyclops	5	2.66	32	8.26	1.52	3.03	30.03
Diaphnia	45	24.08	88	22.70	1.60	3.17	587.25
Neuplius	6	3.21	29	7.48	1.31	2.61	32.39
Rotifers							
Keretella	166	88.77	*		3.23	6.34	562.80
Philodina	97	83.42			2.17	4.30	223.17
Testudinella	114	51.90			2.33	4.61	281.16
Polyarthera	107	57.25			2.72	5.39	308.58
Insects							
Chironomus	13	6.96	20	5.16	2.33	4.61	68.10
Chaoborus	17	9.10	19	4.90	2.24	4.44	84.99
Dystiscud	5	2.66	12	3.10	2.46	4.87	21.21
Coleopteran larvae	10	5.35	11	2.84	1.82	3.60	34.45
Unidentified insect larvae	31	16.59	83	21.41	3.43	6.79	470.82
Worms							
Tubifex	7	3.75	13	3.35	1.12	2.23	20.93
Brachiura	3	1.06	9	2.32	0.87	1.72	4.28
Plants							
Plant parts	101	54.04	*		4.29	8.49	458.80
Detritus	176	94.16	*		6.38	12.63	1239.76
Unidentified substances	132	70.63	*		5.81	11.50	812.13

* = Did not occur in discrete unit, RI = Relative importance index

Fecundity: Out of the 205 females sampled only 58 (28.29%) had matured gonads with ripe eggs (gravid) for fecundity estimation. Absolute fecundity varied with individual fish from 679 of Length 15.30cm to 15073 eggs of Length 36.40cm. The monthly relative fecundity per gram body weight and unit length ranged from (16 – 286eggs/g) and (40 – 793 eggs/cm) respectively (Table 2). The monthly mean fecundity calculated as mean of fecundities of monthly samples is shown in (Fig 1). Fecundity was highest in the months of May – August.

Table 3: Monthly variation in sex ratio (male: female) of *L.coubie*

Months	Total sample	Male	female	Sex ratio M : F	Chi-square
Oct	13	5	8	1:1.6	0.82
Nov	11	6	5	1:0.83	0.03
Dec	32	10	20	1:2.0	2.24
Jan	35	12	23	1:1.92	1.27
Feb	44	18	24	1:1.32	1.01
Mar	27	10	17	1:1.7	0.95
Apr	27	12	15	1:1.25	0.26
May	40	17	23	1:1.35	1.05
Jun	35	9	26	1:2.89	3.05
Jul	20	7	13	1:1.86	1.34
Aug	34	7	27	1:2.45	2.54
Sep	10	6	4	1:0.67	0.08
Total	328	123	205	1: 1.67	14.64*

Significant at * = 0.05

Table 2: The mean monthly values of different parameters of *L. coubie*

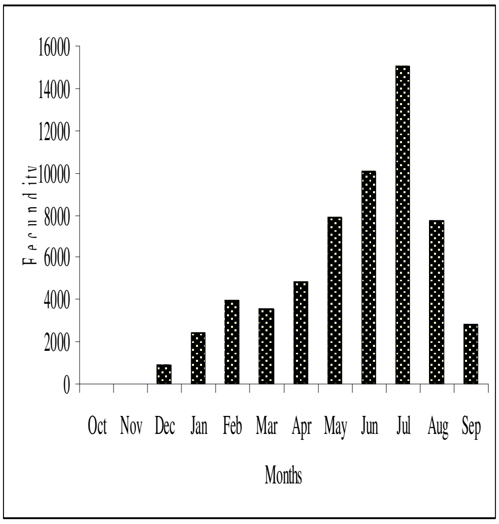

Fig. I. Mean monthly variation in fecundity of *L. coubie*

The length weight equation model established for both sexes of *L. coubie* is shown in Table 4. The regression model of the relationship of fecundity with length and weight of the fish was Log F= 2.33 log L – 8.467 and Log F= 10.65 Log W + 51.93. The condition factor (K) of this population varied from 0.31 to 2.7. The length - weight equation model established for both sexes of *L. coubie* is given in Table 4. The regression model fitted for length and weight yielded significant results for females (Log W= 5.127 Log L + 0.815, R^2 = 0.94) and males (Log W= 5.937 Log L – 11.131, R^2 = 0.88). There was a progressive increase in gonadosomatic index (GSI) and ripe ova between December to September with peaks in May (11.84%) and August (23.36%). The frequency of matured eggs began to fall from September with complete absence in October and November, indicating that the spawning season was over. The condition factor K of male and female is shown in fig 2.

Table 4: Regression model for different variables of *L. coubie*

Variable	Model	Range	V	R
L/weight (F)	Log W = 5.13 Log L + 0.82	13.40 – 39.30cm, 64.40- 264g	205	0.96
L/weight (M)	Log W =5.58 Log L -11.13	12.60-35.60cm, 53.50- 139.50g	128	0.94
L/weight (Gravid)	Log W = 5.94 Log L -6.27	17.30- 39.30cm, 89.20- 264g	58	0.88
Length-fecund	Log F = 244.01 Log L + 689.93	17.30- 39.30cm	58	0.20
Wt/Fecund	Log F = 30.53 Log W + 197.20	89.20- 264.00g	58	0.13
GSI/ Fecund	Log F= 1866Log GSI+ 1844.57	17.30- 39.30cm, 89.20- 264g	58	0.20
K/ Fecund	Log F= 456.2 Log K + 938.54	17.30- 39.30cm, 89.20- 264g	58	0.28

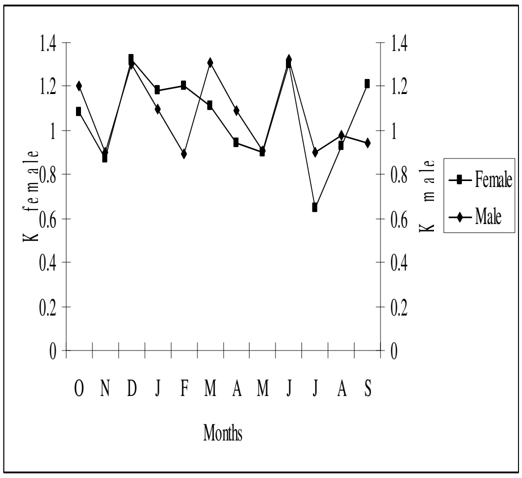

Fig. 2: The monthly variation of condition factor of male and female *L. coubie*

About 43.50% *L. coubie* stomachs were found to be empty. The percentage was similar to those recorded by Ayotunde *et al*., (2007); Ugwumba and Adebisi, (1992) on the food and feeding habits of *L. coubie* and juveniles of culturable freshwater fishes respectively. Suresh *et al*., (2006) recorded about 81.8% empty guts which is higher than that obtained in this study but lower values were also recorded for S. membranaceus and *Brycinus nurse* (Owolabi, 2008; Saliu, 2002). A higher percentage of empty stomachs may reflect short period of feeding followed by period of rapid digestion. The relatively higher incidence (> 50%) stomach with various food items according to Ekpo (1993) is indicative of abundance of food supply in the habitat. Variety of food items present in the diet of *L. coubie* showed that it can explore all the major biotopes for food. Insect larvae and detritus were reported to be significant in the food of river fish including *Heterotis niloticus* (Fagbenro *et al*., 2000). The qualitative analysis showed that prey items ranged from detritus, plants and animals sources, indicating that *L. coubie* is an omnivorous or euryphagous feeder. Euryphagy is an important characteristic of culturable fish species meaning that *L. coubie* have brighter prospects for culture in ponds where production of planktons can be significantly influenced by fertilizer application.

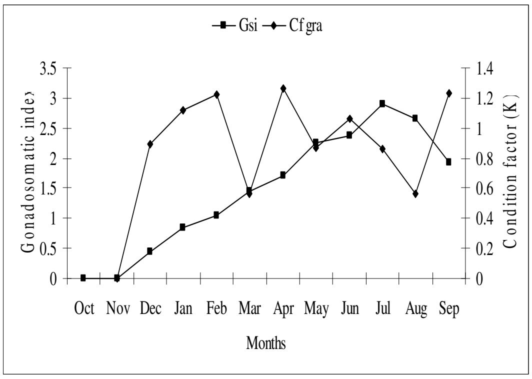

Fig. 3: The monthly variation of gonadosomatic index (GSI) and condition factor of female *L. coubie*

The overall sex ratio of 1:1.67 in favour of females with few exception of monthly males dominance in this study agrees with works of Olatunde (1999) for *Synodontis schall* Allison *et al*., (1999) for *Cynoglosus* species and Suresh *et al*., (2006) for *Macrognathus pancalus*. Sex ratio divergence might also be explained by partial segregation of ripe forms either through preference school formation, hence rendering one sex more vulnerable to capture (Allison *et al*., 1999). Although the preponderance of males have been recorded for some other fish species such as *Sierranthrissa leone* (Otobo, 1995) and *Parailia pellucida* (Allison *et al*., 2008).

The proportion of gravid females *L. coubie* (58 out of 205) recorded in this study was higher than those of *Chrysichthys nigrodigitatus* (53 out of 502) of Cross River and *Parailia pellucida* (49 out of 709) of Nun River observed by Ekanem (2000) and Allison *et al*., (2008) respectively. The absolute fecundity range of (679 - 15073 eggs) was considered low when compared to that observed on *Chrysichthys nigroditatus* (3046 – 28086 eggs) by Ekanem (2000). Although this is higher than those reported in *P. pellucida* (511-1810 eggs) by Allison *et al*., (2008) and in *Brycinus longipinus* (268-1113) by Ikomi and Sikoki (2003). This disparity might be due to the differences in size, species, location and food availability (Inyang and Ezenwaji, 2004). The increased fecundity with increased fish size observed in *L. coubie* with wide variations among fish of the same length is in agreement with Olatunde (1999), Fagade (1983), Inyang and Ezenwaji (2004). The low positive relationship between fecundity- length (R^2 = 0.184) and fecundity- weight (R^2 = 0.101) is similar to those recorded for *P. parailia* (R^2 = 0.028) and *Pellonula leonensis* (R^2 = 0.137) by Allison *et al*., (2008), Ezenwaji and Offiah (2005) respectively. The wide food range observed, abundance in favour of female and high fecundity accounts for its suitability for culture in freshwater ponds.

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