BIOMETRIC RELATIONSHIP, FOOD AND FEEDING HABIT OF *Heterotis niloticus* (Cuvier, 1829) AND *Labeo coubie* (Ruppell, 1832) FROM LOWER RIVER BENEU

Shola Gabriel Solomon, Victor Tosin Okomoda, Sylvia Achodo

Department of Fisheries and Aquaculture, University of Agriculture, Makurdi, Nigeria

Received: 03.12.2015
Accepted: 26.08.2016
Published online: 25.12.2016

Abstract:

This study investigated the length-weight relationship as well as feeding habit of two important commercial fish species from lower River Benue namely *Heterotis niloticus* and *Labeo coubie*. Fish samples were collected between November 2014 and January 2015 every fortnight for the recording of relevant data (length, weight and stomach content). The result obtained reveals significantly higher biometric parameters in *H. niloticus* compared to *L. coubie*. Many biometric parameters measured correlated significantly with the gut characteristics. The length-weight relationship revealed negative allometric growth for both species. However, sampled fishes were in good condition at the time of the study. Food item isolated in both species revealed an omnivorous feeding habit, hence these fish species may be considered as potential candidates for aquaculture.

Keywords: African bonytongue, African carp, River Benue, Length-weight relationship, Feeding habit
Introduction

The African bonytongue *Heterotis niloticus* is a large fish that is native and widely spread in many parts of Africa (Moreau, 1982, Micha, 1973). Its hardiness and high growth rate make it a possible candidate for aquaculture in Africa (Welcomme, 1988). It is currently estimated that 60% of the breeding and nursery habitat for this species has been lost due to environmental degradation caused by oil spillages, pollution, and destruction of mangrove swamps, (Bake and Sadiku 2005). Although it is currently listed by IUCN Red List Status, as least concern (LC) (IUCN 2012), it is important to make a conscious effort to conserve this fish species to prevent further depletion of stock. African carp *Labeo* is also another major fish genus found in many rivers of African countries such as Nigeria, Senegal, Gambia, Ivory Coast, Liberia, Zaire, and Gabon (Ayotunde et al; 2007). Four species of this genus (*Labeo*) are largely found in rivers, and they include *Labeo senegalensis, Labeo pseudo-coubie, Labeo rhohtia, and Labeo coubie* (Idodo-umeh, 2005, Ayotunde et al., 2007). They are highly valued fish food in African countries and usually known for being rich in protein along with their sweet tastes (Rahman, 1989, Ayotunde et al., 2007). They can grow up to very large sizes and are likely future aquaculture candidate if its biology is well understood.

Research on the exploitation of *H. niloticus* for aquaculture is ongoing in many African countries, notably among these are the works of Yao et al. (2003), Nguenga and Brummett (2003), Olayan and Zwilling, (1963) and Akegbejo-Samsons et al., (2003). Despite these efforts, the realization of the full aquaculture potentials of this fish is still far in sight. The major setback preventing successful mass propagation of this fish in captivity include problems of artificial reproduction and larval rearing (weaning) (Froese and Pauly, 2012). To our knowledge, no reported accounts exist on the exploitation of *L. coubie* for aquaculture. It is important to note that realizing the full potential of fish for aquaculture purposes would require a good understanding of the biology of the fish. Studies on fish biology are an indispensible aspect of sustainable management and conservation of fish biodiversity (Solomon et al., 2012). Okoaf et al. (2012) also stated that insufficient knowledge of the biology of commercially exploited fishes is the main reason for continuous failure experienced in the attempts to culture them in captivity. The continuous decline in fish catches due to lack of monitoring and poor regulation (Adyemo, 2004, Solomon et al., 2012) makes it imperative to focus research on the biology of fishes in an attempt to provide information that will make domestication a success. This study was designed with the aim of investigating the length-weight relationship, condition factor, as well as food and feeding habit of two importantly exploited fish of River Benue (*H. niloticus and L. coubie*). This is to provide information necessary to understand the welfare and husbandry requirements in the wild so as to adopt same in captivity for a successful domestication program.

Materials and Methods

The study was conducted in Makurdi the Benue State capital (in Nigeria) located at Longitude 7°43′N and Latitude 8°32′E (Fig1). The town is divided into the North and the South Bank by the River Benue from which fish samples were collected. The river contains several species of fish which are of economic importance to the people of the State. This study, however, focused on two species namely *H. niloticus and L. coubie*. The fish samples for this study were obtained from fishermen at three major landing sites of lower River Benue in Makurdi. The fishing gears used by fishers in catching the fish includes; traps, seine nets, cast net, gill nets, clap nets, hook, and line while crafts were canoe and calabash. *H. niloticus* and *L. coubie* were randomly sampled at each site every fortnight over a period of three months (November 2014 – January 2015). Sampling time was between 6:00 am to 8:00 am, a time when fishermen would be returning to landing site after fishing through the night. Collected samples were fixed in an ice chest and moved to the Department of Fisheries and Aquaculture University of Agriculture Makurdi where data collection of biometric parameters and observation of the stomach content were carried out.

A total of 150 fish specimens each of *H. niloticus* and *L. coubie* was obtained from fishermen. Total and standard lengths of each fish species were measured in centimeters (cm) using a meter rule while the weight was taken in grams (g) using an electronic weighing balance.
Figure 1. Map of Makurdi showing location of the study areas of sample collection (Source google maps 2016)

The length-weight relationship was calculated using the equation by Van Snik et al., (1997) as stated below;

\[ \log W = \log a + b \log L \]

The condition factor (K) was calculated according to the equation by Pauly (1983) below:

\[ (K) = \frac{100W}{L^3} \]

The ventral part of the fish was dissected, and the stomach immediately preserved in sterile bottles containing 5% formalin. Individual stomach fullness was determined, and the content emptied into separate Petri-dishes. While some stomach contents were identified macroscopically, others were identified microscopically using a light microscope. The component food items were identified using identification guide (Barnes 1980, Kaestner 1970) provided in the laboratory of the Department of Fisheries and Aquaculture University of Agriculture Makurdi. The food items encountered were analyzed using frequency of occurrence method (Hynes, 1950) as stated in the formulae below.

Frequency of occurrence = \[ \frac{\text{Total number of stomachs with the particular food item}}{\text{Total number of stomachs with food}} \times 100 \]

The gut length and its equivalent weight were also recorded as appropriate.

Statistical Analysis

Data analysis was carried out using Minitab 14 software. Biological parameters were subjected to student t-test to determine if significant differences exist between the two species. Analysis of variance was used to determine monthly differences in parameters measured. When significant differences were observed, means were separated by Fisher’s least significant difference. Correlation between various biometric and gut parameters was also done to determine the relationship between these parameters.

Results and Discussion

Table 1 shows some biometric parameters of _H. nilotocus_ and _L. coubie_ from lower River Benue. The result obtained reveal _H. nilotocus_ to be significantly higher in standard length (31.57), total length (34.46), body weight (399.5) and condition factor (0.96) compared to _L. coubie_ (23.98; 29.03; 216.7 and 0.84 respectively). However, gut length and weight were higher in _L. coubie_ (251.3 and 10.34 respectively) compared to _H. nilotocus_ (37.92 and 12.79 respectively). Statistically, stomach fullness was same among both species.

Monthly variations in morphometric parameters of _H. nilotocus_ and _L. coubie_ are shown in Table 2. The result obtained shows that samples of _H. nilotocus_ collected in November were higher in body weight (455.4), condition factor (1.05), gut length (39.19), gut weight (14.05) and stomach
fullness (0.49) compared to other months. However, no significant difference was observed for standard length and total length across the months of the experiment. In *L. coubie*, however, samples collected in November were significantly higher in standard length (24.76), total length (29.38), gut length (314.9) and stomach fullness (0.49) compared to other months. The highest body weight and gut weight for this species during the study were observed in December (223.4 and 13.15 respectively).

Correlation of morphometric parameters of *H. niloticus* and *L. coubie* as shows in Table 3 reveals high positive and negative correlation between several parameters. Length-weight relationship of *H. niloticus* and *L. coubie* are shown in Figures 1 and 2. The result indicates that both species have negative allometric growth pattern. However, $R^2$ value of *H. niloticus* was higher (0.71) compared to *L. coubie* (0.52).

Food and feeding habit of *H. niloticus* and *L. coubie* using the frequency of occurrence method is represented in Fig 3. The result shows the presence of mud (26.25%), digested food (13.75%), detritus (15%), insect larvae (18.75%), algae (26.25%), plant part (15%) and some unidentified food items (6.25) as the dietary composition of *L. coubie*. However, the gut of *H. niloticus* consisted of detritus (6.25%), insect larvae (20.00%), algae (18.75%) plant part (22.5%) sand (35.0%), copepods (17.5%) and unidentified items (1.25).

| Parameters | *H. niloticus* | *L. coubie* | P-Value |
|------------|----------------|-------------|---------|
| Standard length | 31.57 ± 0.59<sup>a</sup> | 23.98 ± 0.61<sup>b</sup> | 0.001 |
| Total length | 34.46 ± 0.61<sup>a</sup> | 29.03 ± 0.68<sup>b</sup> | 0.011 |
| Body weight | 399.5 ± 22.9<sup>a</sup> | 216.7 ± 18.6<sup>b</sup> | 0.012 |
| K | 0.96 ± 0.04<sup>a</sup> | 0.84 ± 0.05<sup>b</sup> | 0.035 |
| Gut length | 37.92 ± 0.75<sup>a</sup> | 251.3 ± 13.10<sup>a</sup> | 0.035 |
| Gut weight | 12.79 ± 0.41<sup>b</sup> | 10.34 ± 0.88<sup>a</sup> | 0.035 |
| Stomach fullness | 0.43 ± 0.04 | 0.44 ± 0.04 | 0.135 |

Mean in the same column with different superscripts differ significantly (P<0.05)

| Parameters | November | December | January | P-Value |
|------------|----------|----------|---------|---------|
| Standard length | 31.52 ± 1.12 | 31.47 ± 0.35 | 31.72 ± 1.39 | 0.098 |
| Total length | 34.77 ± 1.01 | 34.16 ± 0.43 | 34.45 ± 1.48 | 0.121 |
| Body weight | 455.4 ± 46.3<sup>a</sup> | 345.1 ± 12.6<sup>a</sup> | 398.1 ± 47.3<sup>b</sup> | 0.012 |
| K | 1.05 ± 0.08<sup>a</sup> | 0.86 ± 0.02<sup>c</sup> | 0.96 ± 0.09<sup>b</sup> | 0.05 |
| Gut length | 39.19 ± 0.99<sup>a</sup> | 37.43 ± 0.79<sup>b</sup> | 37.13 ± 1.86<sup>b</sup> | 0.05 |
| Gut weight | 14.05 ± 0.82<sup>a</sup> | 12.57 ± 0.34<sup>b</sup> | 11.78 ± 0.80<sup>c</sup> | 0.035 |
| Stomach fullness | 0.49 ± 0.07<sup>a</sup> | 0.40 ± 0.06<sup>b</sup> | 0.39 ± 0.06<sup>b</sup> | 0.002 |

Mean in the same column with different superscripts differ significantly (P<0.05)
Table 3. Correlation matrix of the morphometric parameters of *H. niloticus* and *L. coubie*

| Correlations | *H. niloticus* | *L. coubie* | Correlations | *H. niloticus* | *L. coubie* |
|--------------|---------------|-------------|--------------|---------------|-------------|
| TL/SL        | 0.93***       | 0.88**      | K/BW         | 0.45**        | 0.12        |
| BW/SL        | 0.76**        | 0.83**      | GL/ BW       | 0.34**        | 0.53**      |
| K/SF         | -0.06         | -0.17       | GW/ BW       | 0.57**        | 0.79**      |
| GL/SL        | 0.54**        | 0.67**      | SF/ BW       | 0.34**        | 0.51**      |
| GW/SL        | 0.66**        | 0.73**      | GL/ K        | -0.18         | -0.29**     |
| SF/SL        | 0.49**        | 0.41**      | GW/ K        | -0.05         | -0.14       |
| BW/TL        | 0.72**        | 0.85**      | SF/ K        | -0.09         | 0.12        |
| K/TL         | -0.17         | -0.37**     | GW/ GL       | 0.39**        | 0.69**      |
| GL/TL        | 0.54**        | 0.68**      | SF/ GL       | 0.37**        | 0.29**      |
| GW/TL        | 0.67**        | 0.81**      | SF/ GW       | 0.58**        | 0.35**      |
| SF/TL        | 0.49**        | 0.43**      |              |               |             |

(**=P<0.01)

Where TL= Total length, SL= Standard length, BW= body weight, K= condition factor, GL= gut length, SF= Stomach fullness, GW= gut weight.
**Fig. 3:** Length-weight relationship of *Heterotis niloticus* from lower river Benue

\[ y = 2.7643x - 1.6899 \]

\[ R^2 = 0.7076 \]

**Figure 4:** Feeding habit of *L. coubie* and *H. niloticus* from lower River Benue
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 (Ekwu 2006 and Arendt et al. 2001). It is also important in the creation of trophic models as a tool for understanding complex ecosystems (Lopez and Arcila 2002). Numerous studies have shown that natural food tends to vary quantitatively and qualitatively within a year (Ekpo 1993, Ugwuba and Adebisi 1992), hence the need to continually study this concept over a period. From the shape of the mouth and the gills arrangement of *H. niloticus*, it could be concluded that filter-feeding habit is aided by the possession of a fine gill raker (Bake and Sadiku 2002). Hence, it is capable of filtering planktons and other food substances in the water. Although this species has earlier been described as more of plankton feeder (Reed et al. 1967 and Bake and Sadiku 2002), this study has shown that it is an omnivore. Larger (1977) had also earlier describe it has more of an omnivore. While Edoghotu et al. (2014) based on their observation which isolated macrophytes, plankton, insects and worms in the gut of the fish also concluded it is omnivorous in feeding habit. Insect larvae and detritus have been previously reported to be significant in the food of *H. niloticus* by Fagbenro et al., (2000). However, the observed food types in this study for *H. niloticus* suggest that aside filter feeding, the fish probably grazed on other benthic community species by scraping, nimble or nipping plants off their substrate. Hence, the presence of the muddy substance, detritus, and sand in the food composition isolated in this study. However, the variety of food items present in the diet of *L. coubie* showed that it explores all the major biotopes for food, hence indicating *L. coubie* to be an omnivorous or euryphagous feeder. Euryphagy is an important characteristic of culturable fish species. This means that *L. coubie* have brighter prospects for culture in ponds where production of planktons can be significantly influenced by fertilizer application. This result is similar to the findings of Idodo-Umeh (2003) who reported that the diet of *L. coubie* was mainly epipelagic algae and mud. Lagler (1977) had earlier described the stomach of an omnivore as a food grinder which requires a long gut length. The gut length and weight recorded in this study (mean of 251.3cm) suggests a long gut transit time for the food of this fish which is typical of omnivores.

Variation in condition factor (K) reflects information about the physiological state of the fish in relation to changes in its environment (King 1996). *H. niloticus* were observed to be in the best condition in November with the mean condition factor of about 1.00. This is an indication that the environmental conditions of the water body are at optimum level, giving the fish the best condition of growth and development than the other month of the study. However, the mean value of condition factor observed in *H. niloticus* was higher than those observed for *L. coubie*. This may be due to their feeding on a broad range of material compared to the *L. coubie* as observed in their feeding habit. Results of the length–weight relationship indicated that specimens of *H. niloticus* and *L. coubie* exhibited negative allometric growth in the study. Hence, both populations can, therefore, be considered as having homogenous groups with body weights varying differently from the cube of total length. The negative allometric exhibited by the species may be as a result of the hydrological, ecological and human factors. Many authors have reported both isometric and allometric growth for different fish species from various water bodies. Allometric growth patterns for *Tilapia* species from Umuoseriche Lake have been reported by King (1991). Also, isometric growth for *Pseudotolithus elongatus* from Qualboe estuary was reported by King (1996). Isometric growth pattern for *E. fimbriata* had also been reported from Cross River estuary in Nigeria by Pervin and Mortuza (2008). The b value for *L. coubie* (2.599) is the same with the report of Ikpi et al. (2012) on the same specie. This study is also in accordance with the study by Offem (2006) on *L. mrigala* (2.657) in Kaptai Lake, Bangladesh. It is however, different from the isometric value (3.08 ) recorded for *L. coubie* in the tributaries of the Volta River, Ghana (King 1996). The differences observed in this study, and those of cited authors are based on the difference in the study area, species and spectrum of food available in the environment at the times these studies were conducted.

**Conclusions**

This study has shown that both *L. coubie* and *H. niloticus* are omnivorous feeders and are in good condition in the lower river Benue during the time of the study. Based on the assertions of this study it is recommended that other aspect of the biology of these important species be the focus of future research. In addition, wild fingerlings of
these species can be collected for nutrition trials based on their observed feeding habit reported in this study.

References

Adeyemo, O.K. (2004): Consequences of Pollution and Degradation of Nigerian Aquatic Environment on Fisheries Resources. The Environmentalist, 23(4), 297-306

Akegbejo-Samsons, F.O., George A. & Agbon A. O. (2003). Growth, reproduction and aquaculture potential of the African bonytonque fish (H niloticus) in ponds and reservoirs in coastal south-west states of Nigéria. In: International Conference of the Panafrienc Fish and Fisheries Association, Cotonou, Benin, 10-14 November 2003.

Arendt M.D., Olney, J.E. & Lucy J. A. (2001). Stomach content analysis of cobia, Rachycentron canadum, from lower Chesapeake Bay. Fishery Bulletin, 99, 665-670.

Ayotunde, E.O., Ochang, S.N. & Okey, I.B. (2007). Parasitological examinations and food composition in the gut of feral African carp, Labeo coubie in the Cross River, Southeastern, Nigeria. African Journal of Biotechnology, 6(5), 625-630.

Bake, G.G. & Sadiku S.O.E. (2002). Food and Feeding habits of Heterotis niloticus from river Kaduna flood plain. Proceeding of the Annual conference of the fisheries society of Nigeria (FISON) p. 511-514.

Bake G.G. & Sadiku S.O.E. (2005). 19th Annual Conference of the Fisheries Society of Nigeria (FISON), 29 November - 03 December 2004, Ilorin, Nigeria (Food and feeding habits of Heterotis niloticus from River Kaduna floodplain).

Barnes, R.D. (1980). Invertebrate Zoology. Saunders college. 1089pp. (Good background in invertebrate biology: good descriptions of broad taxa. For updated version see Rupert et al., (2004).

Edoghotu, A.J. & Hart, I.A. (2014). Feeding Habit of Heterotis niloticus of Kugbo Creek in Niger Delta, Nigeria. Journal of Environmental Science, Toxicology and Food Technology, 8(10), 26-29.

Ekpo, A.O. (1993). Growth, feeding and reproductive biology of Hydrocynus forskali, Alestes macrolepidotus and Channa obscura in Asejire Reservoir, PhD Thesis, University of Ibadan, Ibadan, pp. 209.

Ekwu, A.O., (2006). Impact of oil spill on the fecundity and gonadosomatic index of ichthyofauna species in the Cross River Coastal Waters. Pollution Research, 25(2), 213-216.

Fagbenro, O.A., Adedire, C.O. & Ayotunde, E.O. (2000). Haematological profile, food composition and digestive enzyme assay in the gut of the African bony-tongue fish, Heterotis (Clupisudis) niloticus (Curvie 1989) (Osteoglossidae). Tropical Zoology, 13, 1-9.

Froese, R. & Pauly D. (2012). FishBase. FishBase. http://www.fishbase.org

Hynes, H.B.N. (1950): Food of fresh water stickle backs with a review of methods used in studies of food fish. Journal of Animal Ecology, 19, 36-58.

Idodo-Umeh, G. (2003). Fresh water fishes of Nigeria. Taxonomy, ecological notes, diets and utilization. Idodo-Umeh Publishers Limited, Nigeria, 232.

Idodo-Umeh, G. (2005). The feeding ecology of Mochokid species in River Ase, Niger Delta, Nigeria. Tropical Freshwater Biology, 14(1), 71-93.

Ikpi, G.U., Jenyo, A. & Offem B.O. (2012) Catch Rate, Distribution, Trophic and Reproductive Biology of the African Carp Labeo coubie in the Agbokim Waterfalls, Nigeria Fisheries and Aquaculture Journal, 2012, FAJ-38

IUCN (2012). IUCN Red list of threatened Species. Retrieved on 20th February 2014.

Kaestner, A. (1970). Invertebrate Zoology, The Crustacea V. 3. Published by John Wiley & Sons Inc., 523pp. ISBN 9780471454175.

King, R.P. (1991). The biology of Tilapia mariae Bovlenger 1899 (Perciformes: Cichlidae) in a Nigerian Rainforest Stream. PhD Thesis, Department of Zoology, University of Port Harcourt, Nigeria, 36-182.

King, R.P. (1996). Biodiversity of fresh water fishes of the Cross River in the Rain forest Belt of Cameroon-Nigeria. Proceedings of...
Workshop on the Rain Forest of South Eastern Nigeria and South Western Cameroon, Held at Obudu Cattle Ranch and Resort, Obanliku Local Government Area, Cross River State, Nigeria, 20–24th Oct. 1996, 184-197.

Largler, K.F., Bardach, J.E., Miller, R.R. & Passino D.R.M. (1977). Ichthiology, 2nd edition. John Wiley and Sons, New York, USA. ISBN 978-0-471-51166-3

Lopez-Peralta, R.H. & Arcila, T. (2002). Diet composition of fish species from Southern Continent Shelf of Colombia. NAGA World Fish Center Quarterly, 25, 23-29.

Micha, J.C. (1973). Etude des populations piscicoles de l'Ubangui et tentatives de sélection et d'adaptation de quelques espèces à l'étang de pisciculture (Study on fish populations in Ubangui and tentative selection and adaptation of some species to pond aquaculture). Nogent-sur-Marne, France: Centre Technique Forestier Tropical (CTFT), pp.147.

Moreau, J. (1982). Exposé synoptique des données biologiques sur Heterotis niloticus (Cuvier, 1829). Food and Agriculture Organization Synopsis des Pêches, 131:1-45.

Nguenga, D. & Brummett, R. (2003). Introduction du "Kanga" Heterotis niloticus (Cuvier, 1829) dans le fleuve Nyong (Cameroon): Echec ou réussite?. In: International Conference of the Panafrican Fish and Fisheries Association, Cotonou, Benin, 10-14 November 2003.

Offem, B.O. (2006). Water quality and fish abundance in inland wetlands of Cross River, Nigeria. PhD Thesis, University of Agriculture, Abeokuta, Nigeria. pp. 192.

Okafor, A.I., Egonwman, R.I. & Chukwu, L.O. (2012). Behavioural Ecology of the African Lungfish, Protopterus annectens (Owen, 1839) of Anambra River, Nigeria. International Journal of Environmental Biology, 2(4), 208-214.

Olanyan, C.I.O. & Zwilling, K.K. (1963). The suitability of Heterotis niloticus (Ehrenberg) as a fish for cultivation with a note on their spawning behaviour. Bulletin de l'Institut Français d'Afrique Noire (A Sci. Nat.), 25(2), 513-25.

Pauly, D. (1983): Some simple methods for the assessment of tropical fish stocks. FAO Fisheries Technical Paper, (234), FAO Rome, Italy.

Pervin, M.R., & Mortuza, M.G. (2008). Length-weight relationship and condition factor of fresh water fish, L. boga (Hamilton) (Cypriniformes: Cyprinidae). University Journal of Zoology (Rajshahi University), 27, 97-98.

Rahman, A.K. (1989). Freshwater Fishes of Bangladesh. Zoological society of Bangladesh 4, 177-180

Reed, W., Burchard, J., Jennes J. & Yaro, I. (1967). Fish and Fisheries of Northern Nigeria. MAO. 226pp

Solomon, S.G., Okomoda, V.T. & Aladi S.L. (2012), Fish fauna in lower River Niger at Idah in Kogi State. Journal of Agricultural and Veterinary Sciences, 4, 34-37

Ugwumba, A.A. & Adebisi, A.A. (1992). The food and feeding ecology of Sarotherodon melanotheron (Ruppell) in a small freshwater reservoir in Ibadan, Nigeria. Archiv für Hydrobiologie 124, 367-382.

Welcomme R.L. (1988). International introductions of inland aquatic species. FAO Fisheries Technical Paper, No. 294:x + 318 pp.

Yao, K., Yapo, A., N'da, K. & Aoussi, S. (2003). [English title not available]. (Effet de la densité d'élevage sur la croissance et la survie de Heterotis niloticus (Osteoglossidae) en captivité étroite.) In: International Conférence of the Panafrican Fish and Fisheries Association, Cotonou, Benin, 10-14 November 2003.