²*Original Research Article*

Feeding habits of the African carp *Labeobarbus batesii* (Pisces: Cyprinidae) from the Mbô Floodplain Rivers

Abstract

Aims: The African cyprinids were not yet used in aquaculture. For domestication and preservation of the African carp *Labeobarbus batesii*, aspects of feeding habits in term of its aquaculture potential proves necessary.

Place and Duration of Study: Laboratory of Applied Ichthyology and Hydrobiology, Department of Animal Productions, Faculty of Agronomy and Agricultural Sciences, University of Dschang, Cameroon, from May 2008 to October 2009.

Methodology: 318 fish samples (17 cm to 93.70 cm, means 25.47±4.47 cm of total length; 40 g to 6000 g, means 187.41±125.69 g for total weight) were collected monthly from artisanal fishermen in the Mbö Floodplain Rivers (MF). After fish's dissection, guts were immediately removed and dissected, empty and replete guts were counted. Food items were identified to lowest possible taxon. They were counted under a stereoscopic binocular microscope in petri dishes. The microscopic food organisms were examined under a light microscope and the identified organisms were counted using Thoma lam. Three indices were used for gut contents analysis: Gut vacuity index, Frequency of occurrence and Percentage of abundance. Descriptive statistics,analisis of variance (ANOVA) and the generalized linear model at P = 0.05 and P = 0.001 probability level were used.

Results: Gut vacuity index was very low (11.95 %**),** and varied between seasons, zones, sexes and maturity state. Seven taxonomic groups were observed in *L. batesii* guts: plant foods (macrophyta and algae) are predominant both in frequency and abundance in the diet than animal foods (insects, *Crustaceans*, *Nematoda*, *Protozoa* and other invertebrates).

Conclusion: *Labeobarbus batesii* consumes many varieties of animal and plant organisms. This species is benthopelagic, detritivorous and omnivorous with a preference for plant material.

Keywords: African Carp, *Labeobarbus batesii*, trophic activity, diet, Floodplain, domestication, Cameroon

1. Introduction

It is now accepted that the development of fish farming currently compensates for the stagnation of fishery catches while the market demand continues to increase [1]. The development of fish farming relies on an active diversification of farmed fish species. A diversification based on the farming of native species could reduce the environmental impact of fish culture and could better fit to needs of local markets. Such development could also favour a more integrated local economy. It is in this context that new species in many areas of the world were domesticated especially in Amazonia [2] and in the Mekong River Bassin [3]. Moreover, these context world environmental conditions are changing quickly with the depletion of wild fish stocks, the introduction of exotic species and the production of hybrids for aquaculture. Domestication is thus becoming a means of protecting biodiversity. The diversity of fish fauna in Africa is one most extensive of the planet with approximately 3200 species listed [4]. In spite of this great ichthyological diversity, the fish culture production of alien species is higher than that of autochthonous ones. In Cameroon, as in many countries in Africa, no native species are used in fish farming. The three farmed fish species currently used (C*larias gariepinus*, *Oreochromis niloticus* and *Cyprinus carpio*) are introduced or naturalised. In the process of domestication, for a given species, the availability of fish seeds is the main constraint, followed by hardiness and markets value [3]. According to Cacot and

Lazard [3] the feeding regime is a minor factor but it will most probably soon become crucial due to the scarcity and the high price of animal protein, essential component of fish feed. Fontaine et al. [1] reported that species tested for domestication over the last decades were generally chosen because of their maximum size, which assumed good growth in livestock and / or their acceptance in the local market, or have an omnivorous diet or detrivorous, promoting coverage needs food using less expensive and more readily available inputs. This work on the African carp *Labeobarbus batesii* fits into this objective. Indeed, Mbô Floodplain is an important scientific and socioeconomic centre in Cameroon, where the fishery improves the incomes and the consumption rates of animal protein of the local people [5]. Apart from studies on the growth and reproductive strategy in the Mbô Floodplain [6, 7, 8], nothing is known about the diet and feeding ecology of this species, even though it is economically important. Yet the knowledge of the systematic, of the bio-ecology and notably of the trophic relations within an ecosystem is necessary for a lasting exploitation of its resources [9]. This paper therefore provides information on gut vacuity index and food preferences of *L. batesii* in the Mbô Floodplain Rivers of Cameroon.

2. Materials and methods

2.1. Study area

The study was carried out from May 2008 to October 2009 in the Mbô Floodplain (MF) (NL 5°1’, LE 9°50’) in Cameroon, an area of 390 km^2 with an altitude of about 700 m. It is located between the littoral and west regions of Cameroon. The soil is volcanic, sandy and favourable to agriculture all year round. MF has a hot and humid climate characterised by two seasons; the dry season starts in mid-November and ends in mid-March. The temperature ranges from 17°C to 30°C and the relative humidity varies from 49% to 98% in dry and rainy seasons, respectively. The average rain fall is about 1860 mm. The MF Rivers descend from the Bambouto Mountains (Menoua River), which is part of the Manengouba Massif (Nkam and

Black Water Rivers). Several streams, such as Metschie and Mfouri, descend from the Bana Massif. All are drained by the Wouri River, which flows into the Atlantic Ocean [6, 7, 8].

2.2. Fishes sampling

Monthly samples, totaling 318 samples of *Labeobarbus batesii* (17 cm to 93.70 cm, means 25.47±4.47 cm of total length and 40 g to 6000 g, means 187.41±125.69 g for total weight), were obtained from artisanal fishermen from May 2008 to October 2009. Ten sampling sites were identified and were gathered into two zones (confluence and inter-confluence). Fishes were collected by means of traditional fishing gear (bow nets, hooks, and gill nets). Collected fish were counted, rinsed and anesthetized in the solution of tricaine methanesulfonate (MS 222), prepared by dissolving 4 g of MS 222 in 5 L tap water, and then preserved in 10% formalin. The samples were transported to the laboratory for analysis. Fishes were identified according to the criteria of Stiassny et al. [10]. The sex of fish was determined by macroscopic examination of the gonads after dissection. Fishes with undifferentiated sex were considered as immature. Guts were removed immediately after dissection and were stored individually in formaldehyde solution (5 %) until the contents were analysed.

After the dissection of guts, empty guts were counted. The volume of the contents of each gut was measured nearest 0. 01 g. Gut analysis was later carried out. Food items were identified to lowest possible taxon using Needham and Needham [11] and Durand and Lévêque [12] keys. They were counted under a stereoscopic binocular microscope (magnification X 4) in petri dishes. To examine the microscopic food organisms, a light microscope (magnification X 40) was used and the identified organisms were counted using Thoma lam. The number of microscopic food organisms was rationed to total gut volume.

Three indices were used for gut contents analysis:

- Gut vacuity index: $VI = eG/TaG * 100$ (where eG = Empty guts, TaG = total guts examined and VI = vacuity index)

- Frequency of occurrence (FO): FO = N'/N *100 (where N'= number of replete guts which contained one category food item, N = total number of replete guts examined) [13].

- Percentage of abundance (%A): % A = A'/A*100 (A' = Total number of one category food item, A = Total number of foods items in all replete guts analyzed)

2.3. Statiscal analysis

Data collected were collated and analyzed using descriptive statistics (mean and percentage). Statistical comparison of data between zones, seasons, sexes and maturity state was carried out using analysis of variance (ANOVA) and line graphs using Excel statistical package 2007. Multiple linear regressions according to the generalized linear model (GLM) were used for food preferences data; through software R2.12.1 at P = .05 and P = .001 probability level.

3. Results and Discussion

3.1. Gut vacuity index

In general, gut vacuity index of *Labeobarbus batesii* (Table 1) was very low (< 17 %). It was significantly (P = .05) higher in the inter-confluence than in the confluence, in mature than immature fishes. Concerning season and sex, gut vacuity index was significantly (P = .05) higher in the rainy season and in females than in the dry season and in males respectively.

The lower vacuity index registered means that *L. batesii* has an intense feeding activity. However, this activity is higher in the confluence than in the inter-confluence and higher in the dry season than in the wet season. These differences can be explained by capture techniques used by fishermen. Indeed, in the inter-confluence, and in the rainy season fishermen use more traps and baited longlines to catch fish. These machines are fish traps in which fish can stay several days and thus are caught hungry and then, the vacuity index should be higher. On contrary fishermen in the confluence and in the dry season used the hawk or angling which are a sort of stalking or harpoon where the prey is caught by surprise, sometimes spirited feed and therefore his gut is full. Then the vacuity index should be lower.

Similarly, the vacuity index is higher in males and immature than in females and mature fishes. These differences observed between the sexes can be explained by the fact that during the breeding season, the female intended to lay stops feeding. According to West [14], the nutritional status of the population, especially during the period of vitellogenesis is the important biological factor to affect this process. Instead, the male who was in charge of the preparations for lying spend a lot of energy, must compensate by eating more. Regarding immature, their intense feeding activity compared to mature can be attributed to the maintenance and protection of offspring early stage by parents. In other hands, the mature would be much more active at this time.

Table 1: Gut vacuity index depending on the area and season of capture, sex and state of maturity in *Labeobarbus batesii* in Mbô Floodplain Rivers

Factor of variation	eG	T aG	VI (%)
Zone			
Inter-confluence			
♂	7	71	9.86^{b}
♀	20	121	16.53^{a}
Total	27	199	13.57^{a}
Confluence			
♂	3	51	5.88^{b}
♀	7	62	11.29^{a}
Total	11	119	9.24^{b}
Season			
Dry			
♂	2	39	5.13^{b}
♀	5	38	13.16^{a}
Total	8	83	9.64^{b}
Wet			
♂	8	89	8.99^{b}
♀	22	139	15.83^{a}
Total	30	235	12.76^{a}
Sex			
♂	10	129	7.75^{b}
♀	27	176	15.34^{a}
Maturity state			
Mature	37	305	12.13^{a}
Immature	1	13	7.69^{b}
Total	38	318	**11.95**

eG = empty guts,, TaG = total number of guts analysed, VI = vacuity index.

(a,b) : For each factor of variation, number with same superscript were not significantly different ($P > 0.001$)

Gut contents

The guts contents analysis of *L. batesii* shows that this species consumes a wide variety of foods (Table 2). These foods are composed of detritus and seven other food categories found in all levels of the water column. This means that fish foraging at all levels of water: *L. batesii* is a predator that catches insects on the surface of water, so it is a carnivorous. It forages on the riverbed because in his gut, we found worms, insect larvae, mollusks and detritus: It is a benthophagous as a common carp [15]. It also consumes zooplankton (*Copepoda*, *Cladocerans* and *Rotifera*) as bighead carp: it is a zooplanktivorous. His gut also contains floating plants emerged and / or submerged, dry and / or fresh: it is a macrophytophagous. This diet is an ecological advantage because in captivity, this species could be used in the control of aquatic vegetation, i.e. to fight against a large number of macrophyta as grass carp *Ctenopharyngodon idella* [16]. It feeds on filamentous algae and microalgae as Cyprinidae *Catla catla* [17] and the silver carp: it is therefore a phytoplanktivorous [18]. This diversity in the diet of *L. batesii* can be explained by several morphological adaptations of the body and digestive tract to his diet [19, 20, 10]. This large food spectrum reveals flexibility and an ecological advantage that allow it to move from one food category to another depending on the fluctuation in abundance. Ikpi and Okey [21] reported the same observation for *Labeo coubie* in Nigeria. These results confirm the work of Brummett (personal observations), which stipulate that the fish of the genus *Labeobarbus* are benthopelagic. In captivity, *L. batesii* could thus be raised in a polyculture system with other species that feed in less trophic level.

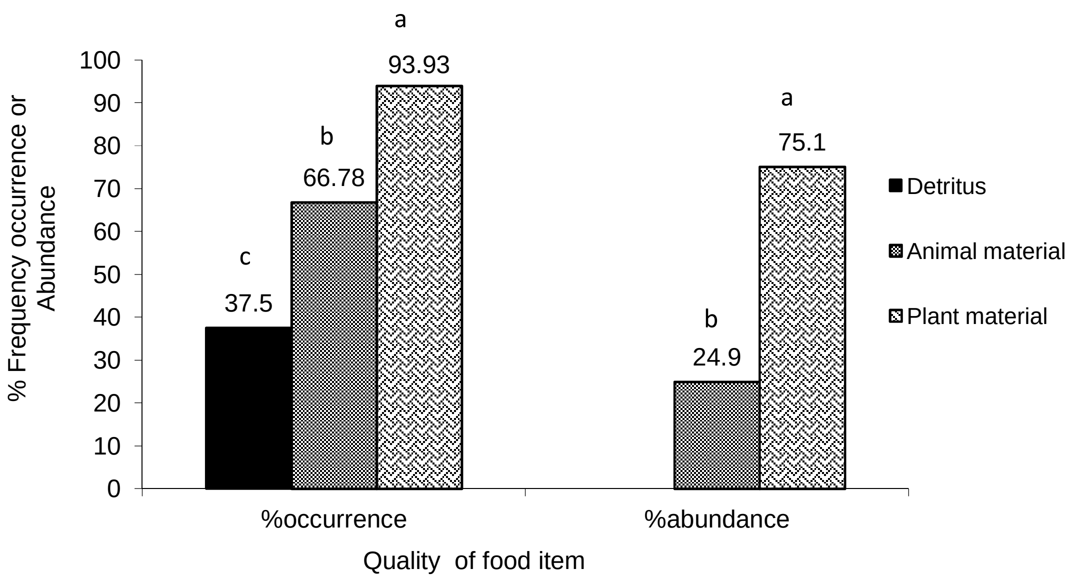
Table 2: Distribution by food categories and types or genera found in guts contents of *Labeobarbus batesii* in Mbô Floodplain Rivers

Food category	Types or genera
****Detritus and undigestibles debris***	Plants and animals, sand, earth, polyester wire…
****Plant food item***	
Macrophyta	Arachidna, Mitragyra, Anthocleista, Zea, Alchrnea, Theobroma, Penisetum, Gnetum, Prunus, Voacanga, Coffea, Colocasia, Cucumis
Algae	
Chlorophyta	Botryococcus, Dictyosphaerium, Coelastrum, Crucigenia, Scenedesmus, Protococcus, Sorastrum, Chaetophora, Draparnaldia, Oedogonium, Kirchneriella, Cladophora, Characium, Hydrodictyon, Microspora
Cyanophyta	Nostoc, Anaebana, Oxillatoria, Spiriluna, Polycystis, Aphanizomenon, Phormidium
Zygonemataceae	Spirogyra, Zygnema, Mesataenium, gonatozygon,
Bacillariophyceae	Synedra, navicula, Nitzschia, Meridion
Desmidiaceae	Closterium, Pleurotaenium, Staurastrum, Genicularia,
****Animal food item***	
Insects	
Diptera (larves)	Chironomus, Pedicia, Helius
Coleoptera (larva and adults)	
Odonata (nymphs)	Zygoptères et Anisoptères
Plecoptera (larva and nymphs)	Gyrinidae, Dryopidae
Tricoptera (larva)	Leptocella, Brachycentrus, Triaenodes, Ptilostomis
Ephemeroptera (larva and nymphs)	Siplonurus, Cynigma
Crustaceans	
Copepoda	Eggs and adults
Cladocera	Adults
Rotifera	Adults
Other Crustaceans	Syncaris, Gamarus, Palaemonetes, Neomysis, Corophium
Protozoa	Uroglena, Harmanella, Vorticella, Oxytricha, Halteria,, Oikomonas, Naegleria, Chilodonella, Monas, Gastérotrih, Loxodes, Stendor, Acantocyst, Paranema, Spirostomium, Symera, Actinosphaerium
Nematoda worms (Adults)	Oxyuridae, Kathlanidae
Other invertebrates	Molluscs, Oligochaeta, Jellyfish, Placobdella, Spider crab

3.2. **Food preferences**

The frequency occurrence and the percentage abundance by organic matter presented by Figure 1, shows that plant matter were significantly frequent and abundant ($P < .001$) compared to animal food and litter.

These results show that this species is omnivorous tendency to herbivorous and detritivorous. It could well be rearing in polyculture with African cat-fishes and *Oreochromis niloticus*, which according to Yalcin et al. [13] have accidentally preferences for macrophyta and algae. Furthermore, plant proteins being increasingly used in aquaculture, one might think *L. batesii* would likely be domesticated because it can better use these flours [22, 2].



(a,b,c): histograms with same superscript were not significantly different (P > 0.001for occurrence and abundance)

Figure 1: Food preferences depending on organic material

Conclusion

According to this study, it appears that *L. batesii* consumes many variety of animal organisms (larvae and nymphs of insects, crustaceans, protozoa, other invertebrates) and plant organisms (macrophyta and algae), as well as of rubbishes. This broad food spectrum is an indicator of its flexibility and its ability to adapt to changes in food availability. *L. batesii* is benthopelagic, omnivorous with a preference for plant material and detritivorous. This species can thus exploit different trophic niches of water. In captivity, it could be breeding in polyculture, in associated with other fish species which more specialized diet. Furthermore, the preferences for plant foods could be an ecological interest in the control of aquatic vegetation.

Competing Interests

Authors declared that no competing interests exist,

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