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Spatial Variability in the Feeding Strategy of the Cichlid Fish *Hemichromis fasciatus* from Two Rivers in the Northwestern of Guinea Republic

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Abstract: ***Food composition and feeding strategy of the Cichlid fish Hemichromis fasciatus was studied in two rivers of Guinea Republic, in order to describe the spatial variability of the diet. Fish were collected during three surveys in October, November and December 2013. Out of 30 stomachs were analyzed and contribution of each food item was quantified using the frequency of occurrence (%Fo), percent by number (%N), contribution by weight (%W) and the main food index (MFI). The feeding intensity (FI) of the species in each ecosystem was also evaluated as the percentage of individuals with stomach content. The feeding strategy was determined using the Amundsen et al. (1996) method. Hemichromis fasciatus showed relatively high feeding intensity in the two rivers (FI = 80.95% in Kogon River and FI = 55.55% in Tinguilinta River). The species fed mostly on preys of animal origin (Fish, fish scales, shrimps, arachnids, Odonata, Hemiptera, larvae of Coleoptera, larvae of Trichoptera and insect parts) in both rivers. The food spectrum was wider in Kogon River than in Tinguilinta River (9 items versus 4). Fish preys were the main food. As feeding strategy, H. fasciatus was found as specialized feeder in the studied rivers.***

Keywords: *Hemichromis fasciatus*, feeding strategy, Kogon River, Tinguilinta River, Republic of Guinea

1. Introduction

In the Republic of Guinea, the development of mining has negative repercussions on the environment, especially aquatic ecosystems. This is the case of the Kogon and Tinguilinta Rivers, whose watersheds are subject to the exploitation of bauxite deposits. Aquatic communities in these rivers are therefore subject to pollution from this exploitation (Edia *et al.*, 2014). Among these communities, fish have of a great economic interest, especially for local populations. Therefore, sustainable management measures must be considered and these measures must be based on the biology and ecology of fish. (e.g. Kantoussan, 2007; Simon, 2011). In this context, was carried out a study on the diet of *Hemichromis fasciatus* as this species was reported (Edia *et al.*, 2014) to be among the most common in the Kogon and Tinguilinta Rivers and subject of a large subsistence fishery.

Studies on natural feeding of fish could provide useful informations on the trophic relationships in aquatic ecosystems, which could be used in formulating management strategy options in a multispecies fishery (e.g. Nagelkerken *et al.*, 2006; Abdel-Aziz & Gharib, 2007). Quantification of fish diets is also important in defining nutritional requirements of potential aquaculture species able to utilize food items available in culture environments (e. g. Mbabazi, 2004; Begum *et al.*, 2008).

Hemichromis fasciatus, also called the banded jewelfish and five-spot cichlid, is a fish species from the Cichlid family. It is distributed throughout West Africa and can also be found in the Nile Basin, Lake Chad, and the upper Zambezi. It can reach a length of 26.5 centimeters (Froese & Pauly, 2014). This species is overfished, and is used for consumption and in the aquarium trade. It is also used for tilapia control in pound. According to Azeroual *et al.* (2010), overfishing, loss of dry season refuges and rapids habitat due to development and dams represent threats to populations of this species.

The purpose of this study was to describe quantitatively the diet composition and feeding patterns of *H. fasciatus* across spatial gradient of Kogon and Tinguilinta Rivers.

2. Materials and Methods

2.1. Study Sites

The Kogon and Tinguilinta Rivers are located in the Northwestern of the Guinea Republic (12°16'-12°36'N and 06°12'-06°36'W) in West Africa (Figure 1). The study sites are located in a coastal region with a humid tropical climate. The annual average of rainfall can reach 2,675 mm. The vegetation is dense rain forest type. The Kogon River covers an area of 7,288 Km² with a length of 379 Km. Tinguilinta Rivercovers an area of 4,858 Km² with a length of 160 Km (Diallo *et al.*, 2009).

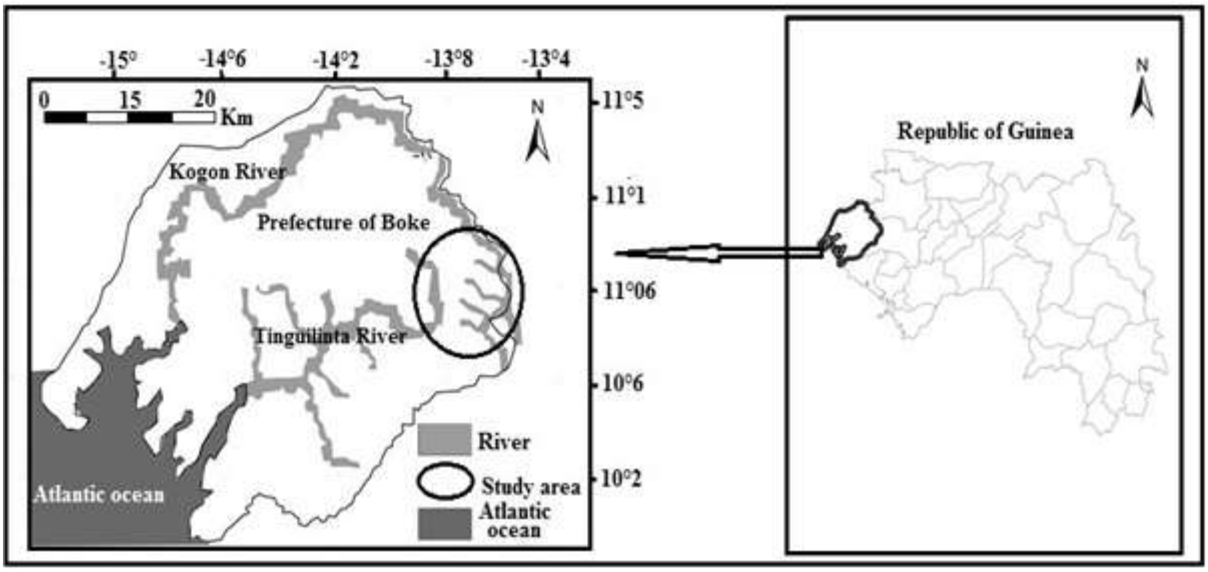

Figure 1: Map showing the studied rivers and the study area

2.2. Data collection

Samples were collected during 3 sampling surveys in October, November and December 2013. Fishes were collected using gill nets (10 mm to 40 mm stretch mesh). All specimens were identified following Paugy *et al*. (2003*a* and *b*), Sonnenberg & Busch (2009) and Froese & Pauly (2014).

Fish samples were transported on ice to the laboratory where they were dissected and the stomachs excised following standard procedures (e.g. Gomiero & Braga, 2004). For each specimen, we recorded site of capture, total length and standard length (to the nearest 1 mm), total weight and eviscerated weight (to the nearest 0.01 g), stomach weight (to the nearest 0.01 g). Stomachs with food were preserved in 10% formaldehyde for further analysis, while empty stomachs were recorded as empty and discarded. Preys found were identified to the lowest possible taxon.

2.3. Data analysis

Diet composition and feeding strategy of *Hemichromis fasciatus* were studied by analysis of stomachs contents. A total of 30 individuals of *H. fasciatus* had been analyzed for both rivers (21 and 9 specimens respectively from Kogon and Tinguilinta).

The feeding intensity (FI) was evaluated with the percentage of individuals having stomach content through the following formula (González *et al*., 2006):

$$FI = (n / N) \times 100$$

Where n was the number of individuals with stomach content and N was the total number of individuals sampled.

The importance of prey items was evaluated using numerical methods such as percent of frequency of occurrence (%Fo), percent of number (%N) and percent of weight (%W) reported by Hyslop (1980).

The results derived from these two methods were conjugated in order to determine the contribution of each prey category in fish diet. Hence, the MFI (Main Food Index) was determined using the combination of the three previously calculated indices (Zander, 1982):

$$MFI = ((N + Fo) \times W/2)^{1/2}$$

Then the MFI of the item i was expressed as a percentage of the total MFI. Then, according to the MFI values, preys were classified as: primary food (MFI > 75), main food (50 < MFI ≤ 75), secondary food (25 < MFI ≤ 50) and insignificant food (MFI ≤ 25).

The feeding strategy was assessed using the Costello (1990) method with modifications by Amundsen *et al*. (1996); where the Prey Specific Abundance (Pi) was plotted against Frequency of Occurrence (Fo) to generate a prey distribution plot defining the feeding strategy of the species (Figure 2).

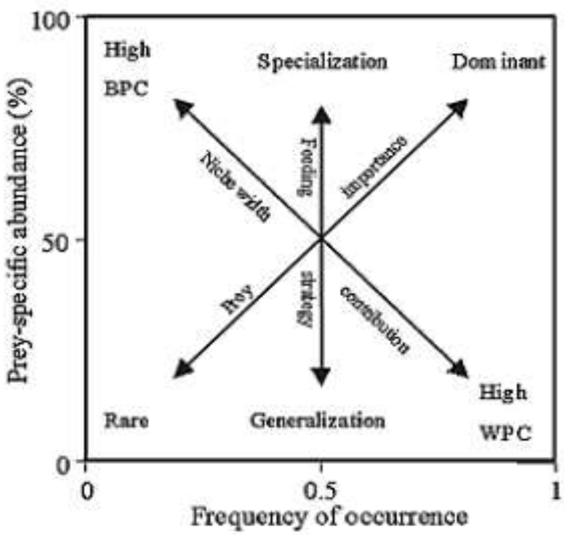

Figure 2: Modified Costello graph showing explanatory axes (Modified from Amundsen et al. (1996) and its interpretation to indicate feeding strategy; BPC: between-phenotype component; WPC: within-phenotype component.

3. Results

3.1. Feeding intensity of *Hemichromis fasciatus*

Fish size ranged from 42.44 to 133.33 mm SL (Average of 72.07 mm) for Kogon River. Concerning Tinguilinta, standard lengths ranged from 44.22 to 95.54 mm with an average of 68.99 mm.

In Kogon River, 21 specimens had been dissected and 17 had stomach content, indicating a feeding intensity of 80.95%. For Tinguilinta River, 5 individuals had stomach contents out of 9 analyzed. The feeding intensity in this river was of 55.55%.

3.2. Food composition of *Hemichromis fasciatus* diet in both rivers

The diet of *Hemichromis fasciatus* was composed of 10 items in Kogon and Tinguilinta Rivers (Table 1). The frequency of occurrence (%Fo) of fish as prey was the highest (45.45%), followed by fish scales (27.27%), shrimps (13.63%) and insect parts (13.63%). The others food items had %Fo less than 10%. Fish was also numerically the most dominant prey in *H. fasciatus* diet, accounting for 37.78%. Fish scales and shrimps represented 22.22% and 11.11% of total prey respectively. The diet composition by weight was predominated by fish with a contribution of 86.58% of stomach content weight. The overall remaining preys items weighted less than 5%. The MFI values indicated that fish preys were the main item (60.02%MFI) for *Hemichromis fasciatus*. The others items, with less than 25% MFI, represented insignificant food for *H. fasciatus*. But among these insignificant foods, shrimps (7.81% MFI) and fish scales (8.92% MFI) were more important.

3.3. Comparative analysis of feeding habits of *Hemichromis fasciatus* among rivers

In Kogon River, diet of *H. fasciatus* was composed of 9 items while it was composed of 4 items in Tinguilinta River. Three items were common to these two diets: insect parts, fish and fish scales. In Kogon River, *H. fasciatus* was found to feed mainly on fish which presented the highest values for frequency of occurrence, percentage of total prey, composition by weight and main food item (52.94%Fo, 44.44%N, 88.07%W and 65.48%MFI) (Table 3).

In Tinguilinta River, larvae of Coleoptera were numerically dominant, accounting for 44.44% of the number of prey. Insect parts composed 46.60% of the composition by weight of *H. fasciatus* diet. Concerning the MFI, larvae of Coleoptera (28.55%MFI) and insect parts (26.92%MFI) were recorded as secondary food of the diet (Table 2).

3.4. Feeding strategy of *Hemichromis fasciatus* in each river

Amundsen diagrammes (Figure 2) indicate that fish was the dominante prey in population of *H. fasciatus* from Kogon River, but some individuals practiced specialization in feeding on arachnids, shrimps and insects parts. Larvae of Trichoptera and Odonata were rare preys observed with some individuals. In Tinguilinta River, the feeding strategy adopted by *H. fasciatus* is a specialization in consuming either fish or insects or Coleoptera larvae.

Table 1: *Food composition of Hemichromis fasciatus in both Kogon and Tinguilinta Rivers in Guinea Republic;* %Fo: frequency of prey occurrence; %N: diet composition by number, %W: diet composition by weight, %MFI: percentage of the total Main Food Index

Prey items	%Fo	%N	%W	%MFI
Odonata	4.54	2.23	0.04	0.36
Hemiptera	4.54	2.22	0.34	1.07
Larvae of Coleoptera	4.54	8.89	0.58	1.97
Larvae of Trichoptera	4.54	4.44	0.26	1.08
Insect parts	13.63	6.67	1.38	3.74
Fish	45.45	37.78	86.58	60.02
Shrimps	13.63	11.11	4.94	7.81
Arachnids	4.54	2.22	0.45	1.22
Sand particles	4.54	2.22	2.46	2.88
Fish scales	27.27	22.22	2.97	8.92

Table 2: *Comparison of food composition of Hemichromis fasciatus from Kogon and Tinguilinta Rivers;* %Fo: frequency of prey occurrence; %N: diet composition by number, %W: diet composition by weight, %MFI: percentage of the total Main Food Index

	Kogon River				Tinguilinta River			
Prey items	%Fo	%N	%W	%MFI	%Fo	%N	%W	%MFI
Odonata	5.88	2.78	0.04	0.41	-	-	-	-
Hemiptera	5.88	2.78	0.04	0.41	-	-	-	-
Larvae of Coleoptera	-	-	-	-	20	44.44	25.33	28.55
Larvae of Trichoptera	5.88	5.56	0.28	1.24	-	-	-	-
Insect parts	11.76	5.56	0.32	1.63	20	11.11	46.6	26.92
Fish	52.94	44.44	88.07	65.48	20	11.11	23.84	19.25
Shrimps	17.64	13.88	5.05	8.92	-	-	-	-
Arachnids	5.88	2.78	0.47	1.41	-	-	-	-
Sand particles	5.88	2.78	2.53	3.3	-	-	-	-
Fish scales	23.52	19.44	3.20	8.29	40	33.34	4.23	12.43

4. Discussions

Hemichromis fasciatus showed relatively high feeding intensity in the two sampled rivers (FI > 50%). High feeding intensity of *Hemichromis fasciatus* was also reported by Blahoua *et al.* (2017) in the Ayamé Lake of Côte d'Ivoire (FI = 76.6%).

Examination of the gut contents of *Hemichromis fasciatus* revealed that the species feed mostly on preys of animal origin. Diet components encounter in the gut of *Hemichromis fasciatus* during the study period included fish, fish scales, shrimps, arachnids, odonata, hemiptera, larvae of coleoptera, larvae of trichoptera, insect parts and sand particles. Due to advanced digestion, species of fish preys identification could not be possible. The composition of this diet indicates a taxonomic diversity of insects relatively important with 4 Orders (odonata, hemiptera, coleoptera, and trichoptera). However, fish preys were the most dominant of diet components accounting for 60.02% of MFI.

River diet analysis indicated two very different trends. The food spectrum of *Hemichromis fasciatus* was wider in Kogon than in Tinguilinta (9 items versus 4). Fish preys were the main food in Kogon River while no preys were identified as main food in Tinguilinta River where two prey items were recorded as secondary food of the diet (Larvae of Coleoptera and insect parts). This difference in diet would be related to sample size and spatial variability of food resources in the rivers studied.

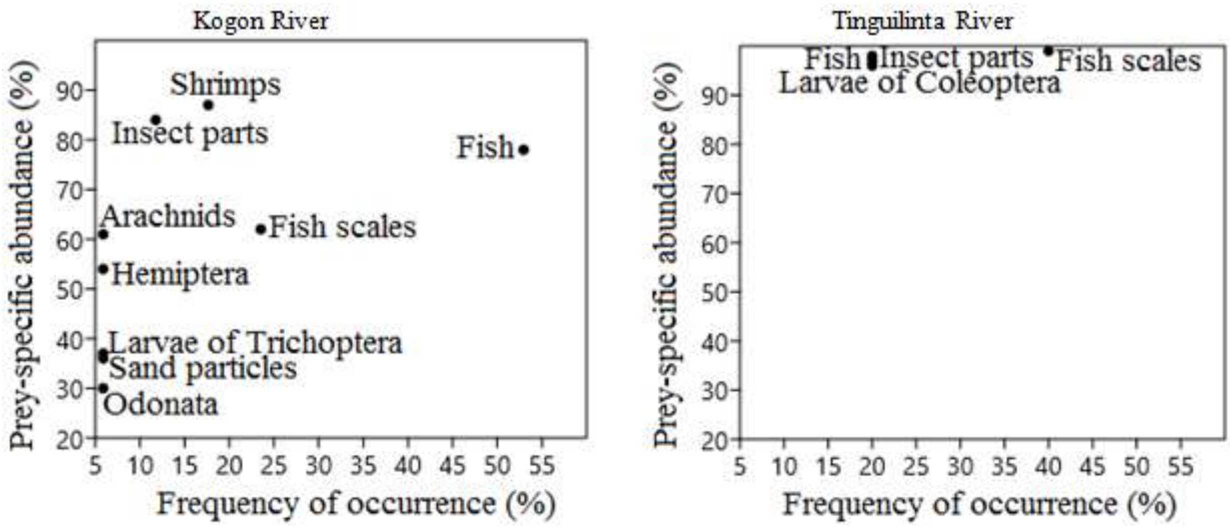

Figure 2: *Plots of the feeding strategies (Costello Diagrams) of Hemichromis fasciatus in Kogon and Tinguilinta Rivers according to* Amundsen et al. (1996) *method*

In Ayamé Lake, Blahoua *et al*. (2017) showed that diet of *H. fasciatus* was composed of 7 items divided into 4 categories: fish, insects, arachnids and macrophytes. Fish preys were the main food of *H. fasciatus* in this system while insects and macrophytes were the secondary items. In the Mankessim Reservoir of Ghana, *H. fasciatus* was found to feed more on benthos and fish fry which constituted greater than 30% of the total food consumed and occurred in not less than 80% of all the stomachs examined. In this ecosystem, algae and fish parts were also frequently found in the stomach of *H. fasciatus* (Atindana *et al*., 2016). As in the Kogon River, the diet of *H. fasciatus* from the Ayamé Lake and the Mankessim Reservoir was dominated by fish prey. However, the subsidiary items observed in diet composition of specimens from the two rivers studied were significantly different from those reported from Ayamé and Mankessim lakes where there was the presence of plant-derived items in the stomach contents of *H. fasciatus*. This finding may reflect an adaptation of the species diet according to the availability of prey. In fact, lacustrine systems are likely to produce a large plant biomass because of the accumulation of nitrate and phosphorus (e.g. Barroin, 2003; De Nardi, 2009).

Considering the prey consumed and the the specialization feeding strategy, *H. fasciatus* could be presented as carnivore in both studied rivers. However, the species had a piscivorous tendency in Kogon River. This observation differs from that reported by Blahoua *et al*. (2017) who noted that *H. fasciatus* had omnivorous diet with ichthyophagous tendency in Ayamé Lake. River is. As Kogon and Tinguilinta Rivers are located in the same watershed, the availability and nature of the prey could not vary significantly. Indeed, Lauzanne (1988) indicated that the feeding habit of African fish species is substantially identical over its entire area of distribution.

5. Conclusions

Spatial variability in the diet had been studied for the Cichlid fish *Hemichromis fasciatus* from Kogon and Tinguilinta Rivers located in the Northwestern of Guinea Republic. We reported that *Hemichromis fasciatus* exhibited high feeding intensity in the two rivers (FI = 80.95% in Kogon River and FI = 55.55% in Tinguilinta River). This species fed mostly on preys of animal origin (Fish, fish scales, shrimps, arachnids, Odonata, Hemiptera, larvae of Coleoptera, larvae of Trichoptera and insect parts) in both rivers. The food spectrum was wider in Kogon River than in Tinguilinta River (9 items versus 4). Fish preys were the main food. Analysis of the feeding strategy revealed that *H. fasciatus* had specialization strategy mainly on fish preys. Considering these findings in the two studied rivers, we concluded that *H. fasciatus* could be classified as carnivorous with a piscivorous tendency.

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