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FISH DIVERSITY AND STRUCTURE IN THE BANCO STREAM (BANCO NATIONAL PARK, IVORY COAST)

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FISH
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ABSTRACT. – The fish fauna in the Banco Stream has been investigated to update the inventory of the fish species in this stream in order to establish a basis for the conservation of these fish communities and their habitat. Seven sites were sampled from November 2008 to March 2009 using gill and hand nets, and environmental conditions were determined. A total of 141 fish have been collected and classified into 14 species, 11 families and 5 orders. The order Perciformes with 7 species belonging to 5 families was the most diversified, followed by Cyprinodontiformes (3 species) and Siluriformes (2 species). The dominant families were Cichlidae and Aplocheilidae. This study has reported 3 species discovered for the first time in the Banco Stream. The diversity of Shannon-Weaver (1.20-2.70 bits/ind.) and the evenness (0.76-0.99) indices indicated that the habitat was slightly disturbed and the species distribution was regular. A zonation was observed in fish assemblages from the Banco Stream; species belonging to piscivorous or aquatic invertivorous guilds were predominant downstream and those with an opportunistic omnivorous diet more abundant in upper zones. The distribution of these species was more influenced by some environmental conditions.

INTRODUCTION

The Banco National Park is a tropical rain forest with primary relicts of evergreen forest (Hall & Swaine 1981, Parren & De Graaf 1995). It is located in the southern of Ivory Coast within the economic capital, Abidjan (Assémian *et al*. 2006, Lauginie 2007). This park plays an important role in the conservation of the forest ecosystem and the biodiversity, protection of the groundwater, and climatic micro regulation for Abidjan (Lauginie 2007).

This protected area contains a small water body (the Banco Stream), the basin of which being entirely included in the park. The Banco Stream plays an important role in aquatic fauna conservation, the fish particularly. This stream is subjected to anthropogenic disturbance due to sewage draining by canals coming from the neighboring cities of Banco National Park (Camara *et al*. 2009, 2012). These intense human intervention causes habitat loss and degradation and as a consequence, many fish species have become highly endangered, especially in shallow rivers. There is a need to better identify and assess the conservation value of this area in relation to biogeographical diversity of fish population and the habitat characteristics of fish communities (Jang *et al*. 2003, Sutin *et al*. 2007). Despite the conservation role of Banco National Park, only one study on freshwater fish fauna in the Banco Stream (Daget & Iltis 1965) has been carried out to date. The study of Daget & Iltis (1965) was included in general investigation of freshwater and brackishwater fish from the Ivory Coast. In this study, the authors reported 12 native fish species (*Papyrocranus afer* (Günther, 1868), *Brycinus longipinnis* (Günther, 1864), *Epiplatys chaperi* (Sauvage, 1882), *Nimbapanchax petersi* (Sauvage, 1882), *Poropanchax rancureli* (Daget, 1965), *Afronandus sheljuzhkoi* (Meinken, 1954), *Hemichromis bimaculatus* Gill, 1862, *Hemichromis fasciatus* Peters, 1857, *Chromidotilapia guntheri* (Sauvage, 1882), *Ctenopoma kingsleyae* Günther, 1896, *Parachanna obscura* (Günther, 1861), *Eleotris vittata* Duméril, 1861) and one non-native species (close to *Coptodon zillii* (Gervais, 1848)) imported from the Democratic Republic of Congo. Accordingly, the species diversity of fishes in the Banco National Park is poorly known. Approximately 50 years after the first studies, it is necessary to update data on fish to know the present ichthyofaunal diversity of the Banco Stream. Today, fish diversity and the associated habitat management is a great challenge (Dudgeon *et al*. 2006).

The present study aimed at examining fish diversity, abundance and structure in the Banco Stream at Banco National Park. In this study, different indices are used to describe the diversity and population structure. Measuring species richness is an essential objective for many community ecologists and conservation biologists (Gotelli & Colwell 2011). The number of species, Shannon diversity and equitability in a local assemblage are intuitive and natural indices to understand community structure (Blake & Loiselle 2000). The findings from the study will also benefit the planning, management and conservation of natural resources at national and international levels.

MATERIAL AND METHODS

Study area and sampling sites: The Banco National Park (BNP), situated between 5°21' and 5°25' N latitude, and 4°01' and 4°05' W longitude, is a rain forest remnant of 3000 ha located in the middle of Abidjan (Daget & Iltis 1965, Assémian *et al*. 2006). Its basin drains an area of approximately 38.48 km^2. This stream crosses the entire park over 10.70 km of length with a depth average less than 1 m and flows into the Ebrié lagoon. According to Cougny *et al*. (1995), the mean annual flow of this stream is 1.35 m^3/s. The mean annual precipitation ranges from 1600 to 2500 mm and the mean annual temperature in this park is 26.4 °C (Assémian *et al*. 2006, Kouamé *et al*. 2008a). A long dry season extends from December to March and is followed by the period with highest precipitation (long rainy season) from March to July. The minor rainy and dry seasons last from July to August and from October to November, respectively.

Sampling was conducted from November 2008 to March 2009 in seven stations (Fig. 1). Five sites (ST_1, ST_2, ST_3, ST_5 and ST_7) were situated on the main stream channel, while the other two (ST_4 and ST_6) were permanent pools close to the banks. Stations ST_1 and ST_2 were located in the upstream and were commonly characterized by clean water, and the presence of fragmented leaves, woody debris, riparian vegetation (*Turraenthus africanus*, *Petersianthus macrocarpus*, *Dacryodes klaineana* and *Thaumatococcus daniellii*), with a sandy-silty substratum (Camara *et al*. 2009). In the midstream station (S_3), the water was turbid, smelly, and contained a lot of suspended matter due to arrival of waste water from Abobo city and the civil prison of Abidjan. *Musanga cecropioides* and *Xanthosoma* sp. were the marginal vegetation found at this station. Downstream, the station ST_5 was characterized by rocky and sandy bottom, and turbid water with marginal grassy vegetation comprising mainly *Cyclosorus striatus* and *Nephrolepis biserrata*. The station ST_7, close to the mouth of the Banco Stream, was characterized by the presence of fragmented leaves and woody debris with a clay bottom and high vegetation coverage. In the permanent pools, water was clear (ST_4) to dark (ST_6). These sites were defined by an abundance of roots and large quantities of plant detritus with a sandy to silty bed and high vegetation coverage. The station ST_6 was covered by Indian bamboo trees (*Bambusa* sp.).

At each station, water temperature, pH, conductivity and dissolved oxygen were measured with a multi-parameter WTW 340i/SET. The turbidity was determined using a turbidity meter AQUALYTIC PC_H 37164. For the nitrate, samples of water were collected and analyzed in the laboratory using the standard method AFNOR T90-023. Substrate types and the area of the stream channel covered by overhead vegetation were recorded with the Basinwide Visual Estimation Technique (BVET) developed by Hankin & Gordon (1988). The technique entails a visit to every reach within the study area to record visual observations of habitat characteristics (Hankin & Gordon 1988, Dolloff *et al*. 1992, Gordon *et al*. 1994). Current velocity (m·s^{-1}) was measured in mid-channel on five occasions by timing a floating object (polystyrene cube) over a 5-meter stretch of the river. The value of current velocity was the average of the five trials (Camara *et al*. 2009, 2012). The average values of physico-chemical variables water of the Banco stream are summarized in table I.

Fish sampling: Fishes were collected at each of the seven selected sites in four surveys (two during the rainy season and two during the dry season) using monofilament gill nets with different mesh sizes (10, 14, 20, 25, 30, 35 mm) and landing nets. Gill nets were placed early in the morning at suitable depth (≥ 0.5 m) and removed 24 hours later. A long-handled net (25 cm

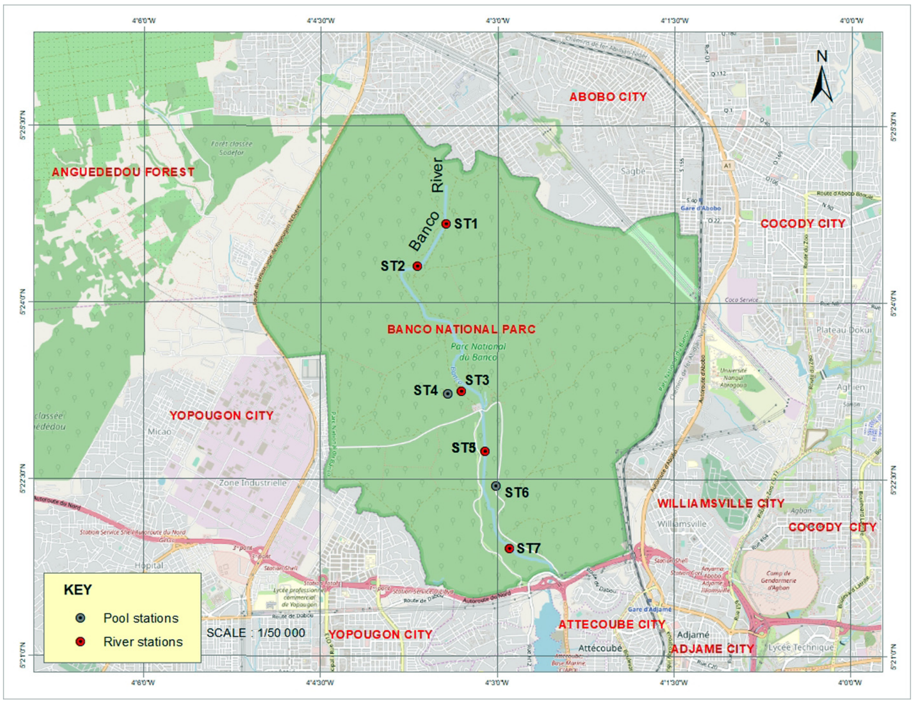

Fig. 1. – Localization of the sampling sites.

Table I. – Average values of the physico-chemical factors in the Banco Stream (DS = dry season; RS = rainy season).

Sites	Temperature (°C)		pH		Conductivity (µS.s⁻¹)		Turbidity (NTU)		Dissolved Oxygen (mg.L⁻¹)		Nitrogen (mg.L⁻¹)		Velocity (m.s⁻¹)	
	DS	RS	DS	RS	DS	RS	DS	RS	DS	RS	DS	RS	DS	RS
ST_1	26.25 ± 0.64	25.60 ± 0.32	5.53 ± 0.44	4.88 ± 0.96	21.00 ± 1.77	22.50 ± 1.41	13.10 ± 1.06	13.40 ± 0.18	4.75 ± 0.81	4.55 ± 0.33	0.37 ± 0.32	0.31 ± 0.26	0.23 ± 0.18	0.20 ± 0.14
ST_2	25.75 ± 1.06	26.00 ± 0.00	5.58 ± 0.23	5.13 ± 0.57	29.50 ± 9.19	22.50 ± 0.71	8.05 ± 1.34	11.60 ± 1.83	5.30 ± 0.11	4.74 ± 0.21	0.53 ± 0.30	0.53 ± 0.08	0.30 ± 0.20	0.22 ± 0.12
ST_3	25.85 ± 0.14	26.35 ± 0.21	5.57 ± 0.23	5.59 ± 0.05	51.00 ± 28.28	32.50 ± 1.06	37.35 ± 20.78	43.10 ± 0.71	4.14 ± 0.11	4.30 ± 0.08	0.31 ± 0.21	0.44 ± 0.03	0.54 ± 0.35	0.38 ± 0.26
ST_4	26.35 ± 0.07	25.85 ± 0.28	5.58 ± 0.25	5.56 ± 0.60	33.50 ± 14.14	35.50 ± 22.63	28.55 ± 2.30	31.50 ± 0.71	5.25 ± 0.82	4.70 ± 0.72	0.37 ± 0.11	0.64 ± 0.01	0.00 ±	0.00 ± 0.00
ST_5	25.90 ± 1.06	25.95 ± 0.35	5.14 ± 0.66	5.65 ± 0.16	37.00 ± 2.12	36.00 ± 2.12	20.70 ± 10.6	84.25 ± 12.02	1.75 ± 0.49	2.71 ± 0.21	0.17 ± 0.06	0.26 ± 0.18	0.38 ± 0.23	0.30 ± 0.15
ST_6	26.35 ± 0.42	26.30 ± 0.35	5.38 ± 0.13	5.72 ± 0.32	58.00 ± 1.41	65.00 ± 5.66	53.70 ± 6.08	24.60 ± 1.41	1.98 ± 1.48	3.29 ± 0.70	0.12 ± 0.05	0.10 ± 0.02	0.00 ± 0.00	0.00 ± 0.00
ST_7	25.85 ± 1.20	25.75 ± 0.35	5.15 ± 0.58	5.30 ± 0.44	42.50 ± 9.19	33.00 ± 3.54	26.65 ± 15.90	21.35 ± 0.57	2.51 ± 1.10	3.51 ± 0.57	1.21 ± 0.20	0.89 ± 0.10	0.04 ± 0.00	0.02 ± 0.00

diameter, 2 mm mesh) were used at low depth (< 0.5 m) by submerging the net and sweeping it through the water column. In sites ST2, ST3, ST4 and ST6, only the handled net was used due to the low depth of these sites.

Sampled fishes were counted and identified according to the keys prescribed by Paugy *et al*. (2003a, b). After identification, each fish was measured (standard and total lengths: precision 0.05 mm) and weighed (precision 0.01 g).

Data analysis: Diversity of fish was analyzed using species richness (SR_S), defined as the number of species caught at a sampling station on each sampling date (Oliveira *et al*. 2004). After checking normality condition with the Shapiro test (Shapiro *et al*. 1968), significant differences in species richness between sites were performed using Kruskal-Wallis test. This test is used to compare a parameter between more than two independent samples when the data do not meet the normal distribution condition (Sokal & Rohlf 1995).

In addition, the theoretical number of species from the basin (SR_B) was evaluated using the three following empirical models:

1 – $SR_B = 5 \times S^{0.5}$ (Daget & Iltis 1965);

2 – $\mathrm{Ln}(SR_B) = 0.245\mathrm{Ln}\,(Q) + 0.135\mathrm{Ln}\,(S) + 1.504$ (Hugueny & Lévêque 1999);

3 – $SR_B = SR_{obs} + \mathrm{r}(\mathrm{n} - 1)/\mathrm{n}$ (Schucany *et al*. 1971);

where S is the basin surface, Q is the flow, SR_{obs} is the number of species number, r is the number of species found in only one sample, and n is the number of samples taken.

The two first models were related to the basin surface while the third depended on the sampling effort.

The species accumulation curve was plot according to Ugland *et al*. (2003), Colwell *et al*. (2004) and Kindt *et al*. (2006).

The taxonomic similarity between stations was evaluated by Sorensen's similarity index (C). This index, used to compare the species composition between habitats, was evaluated using the equation C = 2j / (a+b) in which a is the number of species found in station 1, b is the number of species in station 2 and j is the number of species common to both stations (Dajoz 1982, Nathan *et al*. 2003, Zhou *et al*. 2008). Dendrograms were constructed to understand the similarity of fish assemblage structure between the sampling sites using Sorensen's similarity index. In the present study, the minimum variance clustering method or Ward's method was used as a linkage criterion and the Tchebychev distance (Sutherland 1975) was used as metric distance.

The structure of fish assemblages was analyzed using Pielou Evenness (E). The Evenness in the distribution of individuals among species was determined using the equation $E = H'/Log_2SR$ (H' is the Shannon-Weaver index estimated using the formula $H' = \Sigma P_i(Log_2P_i)$ where P_i is the proportion of individuals in the community belonging to the i^{th} taxon). The Evenness index was determined at sampling site level.

Species abundance in relation to environmental variables was analyzed using the ReDundancy Analysis (RDA). In this analysis, samples from each site were grouped by season. The RDA method was used to detect patterns of species assemblages related to environmental variables (TerBraak & Verdonschot

1995). Environmental variables and fish data were log10(x + 1) transformed prior to analysis. Monte Carlo permutations (500) were done so as to identify a subset of measured environmental variables which exerted significant and independent influences on fish distribution at $P < 0.05$. RDA was performed using CANOCO 4.5 (terBraak & Smilauer 2002) whereas STATISTICA 7.1 computer package (StatSoft 2006) was used for Kruskal-Wallis analysis.

RESULTS

Taxonomic composition and spatial distribution of fish species

A total of 141 individuals belonging to 14 species, 13 genera, 11 families and 5 orders were recorded in the Banco Stream (Table II). The most diversified order was Perciformes with 7 species (50 %), followed by Cyprinodontiformes with 3 species (21.43 %) and Siluriformes with 2 species (14.28 %). Characiformes and Osteoglossiformes were each represented by one species. The family of Cichlidae the most diversified accounting for 21.43 % (3 species: *Chromidotilapia guntheri*, *Hemichromis bimaculatus* and *H. fasciatus*) of the total number of fish species identified. It was followed by Nothobranchiidae (14.28 %) represented by 2 species (*Nimbapanchax petersi* and *Epiplatys chaperi*). Each of the nine other families (Clariidae, Amphiliidae, Channidae, Eleotridae, Nandidae, Anabantidae, Hepsetidae, Mormyridae and Poeciliidae) occurred with one species. The highest values of specific richness were observed at stations ST_7 (7 species), ST_1 (6) and ST_5 (5). The lowest values of this index (3) were registered at stations ST_4 and ST_2. At the station ST_3, none fish specimen was caught. The theoretical species richness obtained for empirical models 1, 2 and 3 was 12, 8 and 21, respectively.

The Sorensen's similarity index ranged from 0 to 0.66. The dendrogram based on this index revealed that fish community of Banco stream was clustered into two assemblages (Fig. 2). The site ST7 (I), with four specific species (*Parachanna obscura*, *Hemichromis bimaculatus*, *Ctenopoma kingsleyae* and *Hepsetus odoe*), was most distant from the other sites. The second assemblage (II) was subdivided into two groups. The group II_1 was constituted of sites ST4, ST5 and ST6 in which ST5 and ST6 had more similar fish faunal assemblage. Both of these sites had in common three species of fish (*Eleotris vittata, Nimbapanchax petersi* and *Epiplatys chaperi*). The group II_2 included the sites ST1, ST2 that presented a similar fish composition. They also shared three species of fish (*Afronandus sheljuzhkoi, Paramormyrops kingsleyae* and *Epiplatys chaperi*).

The species accumulation curves in stream were presented on Fig. 3. The accumulative curve was asymptotic

Table II. – List of sampled fish species in the Banco Stream (* = presence)

Orders	Families	Species	Stations						
			ST1	ST2	ST3	ST4	ST5	ST6	ST7
Siluriformes	Clariidae	*Clarias buettikoferi* Steindachner, 1894						*	
	Amphiliidae	*Amphilius atesuensis* Boulenger, 1904	*						
Perciformes	Channidae	*Parachanna obscura* (Günther, 1861)							*
	Eleotridae	*Eleotris vittata* Duméril, 1861					*	*	
	Cichlidae	*Chromidotilapia guntheri* (Sauvage, 1882)	*				*		*
		Hemichromis bimaculatus Gill, 1862							*
		Hemichromis fasciatus Peters, 1857	*						*
	Nandidae	*Afronandus sheljuzhkoi* (Meinken, 1954)	*	*			*		*
	Anabantidae	*Ctenopoma kingsleyae* Günther, 1896							*
Characiformes	Hepsetidae	*Hepsetus odoe* (Bloch, 1794)							*
Osteoglossiformes	Mormyridae	*Paramormyrops kingsleyae* (Günther, 1896)	*	*					
Cyprinodontiformes	Nothobranchiidae	*Nimbapanchax petersi* (Sauvage, 1882)				*	*	*	
		Epiplatys chaperi (Sauvage, 1882)	*	*		*	*	*	
	Poeciliidae	*Poropanchax rancureli* (Daget, 1965)				*			
		Species richness	6	3	0	3	5	4	7
		Pielou Evenness (E)	0.78	0.76	–	0.78	0.77	0.99	0.96
Empirical models of species richness assessment		Daget & Iltis (1965)				12			
		Hugueny & Lévêque (1999)				8			
		Schucany *et al*. (1971)				21			

from the third campaign, suggesting that the number of sampled species is the true basin species richness.

Abundance of fish species

A total of 141 fish were caught in all stations during four sampling campaigns. In general, fish abundance was low in the Banco stream. The Nothobranchiidae *Epiplatys chaperi* with 48 specimens (34.04 %) were more encountered in the Banco Stream (Fig. 4A). It is followed by the Cichlidae *Chromidotilapia guntheri* with 35 individuals (24.82 %). *Afronandus sheljuzhkoi* (16 individuals) and *Hemichromis fasciatus* (15 individuals) displayed more or less important abundances with 11.35 % and 10.64 %, respectively. A small number of specimens (1-7) was recorded for the other species representing 0.7 % to 4.96 %. At the station ST1, *C. guntheri*

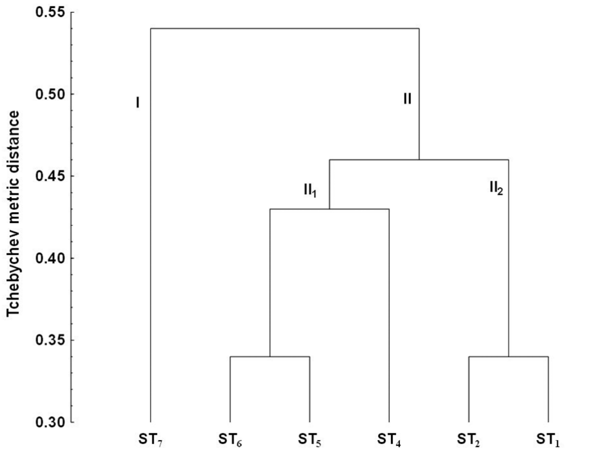

Fig. 2. – Cluster analysis of species diversity per sampling sites (ST1-ST7).

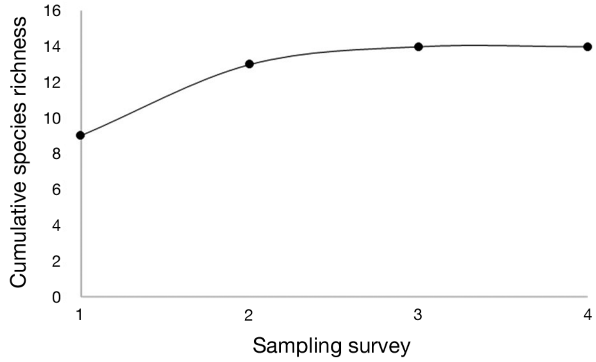

Fig. 3. – Fish species accumulation curves for the Banco Stream.

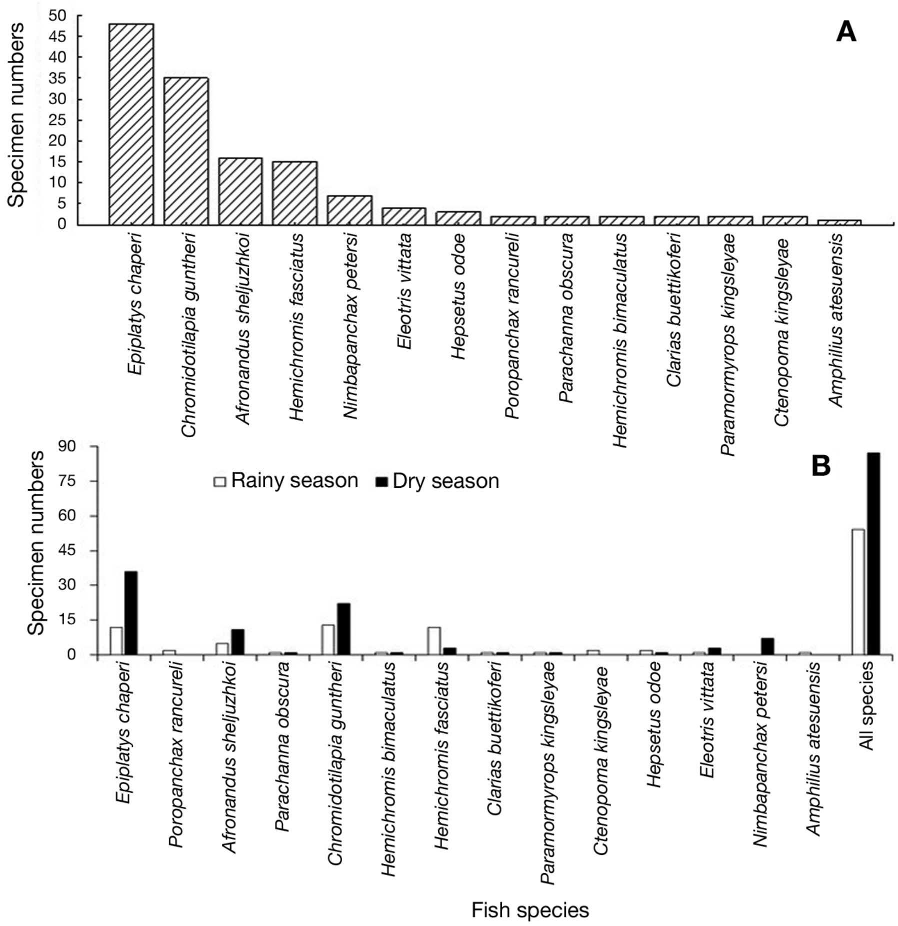

Fig. 4. – Abundance of fish species caught in the Banco Stream during the study period (**A**) and by season (**B**)

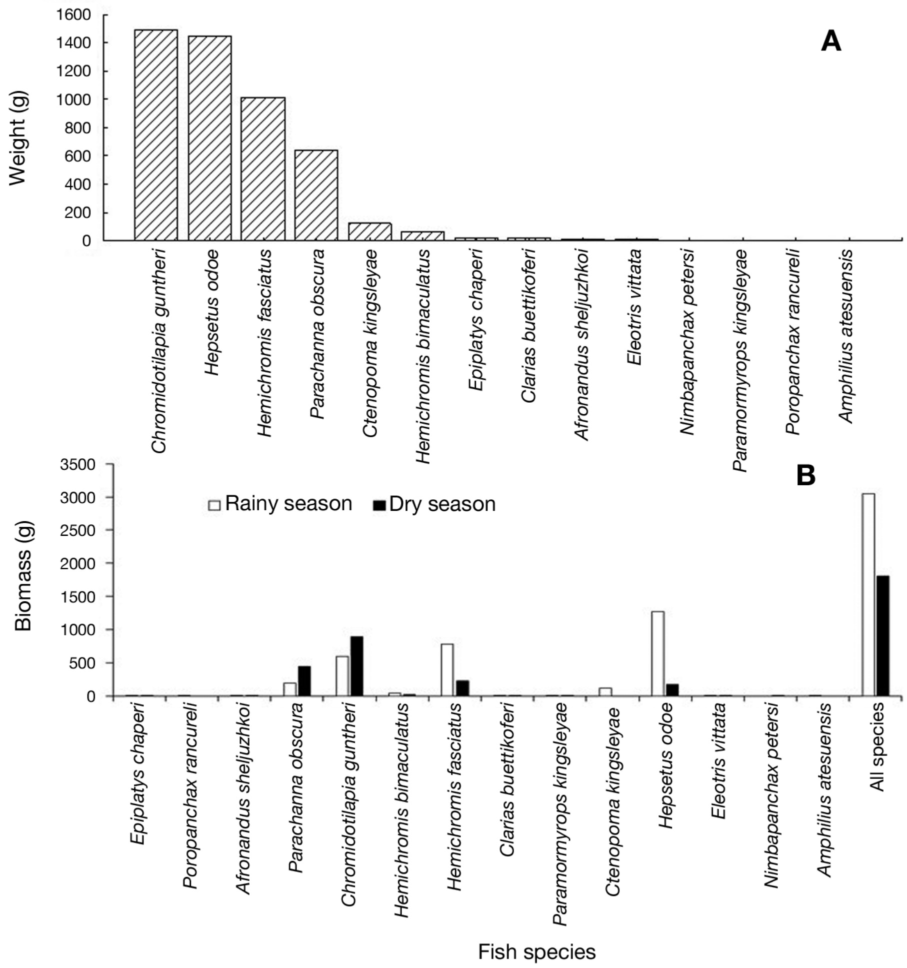

Fig 5. – Biomass of fish species caught in the Banco Stream during the study period (**A**) and by season (**B**).

was the most abundant, with 41.56 % of fishes at this site. It was followed by *E. chaperi sheljuzhkoi* (24.66 %) and *H. fasciatus* (18.2 %). In the stations ST2, ST4 and ST5, *E. chaperi sheljuzhkoi* was the most abundant with 64.28, 72.7 and 52.9 %, respectively. No species dominated fish population in the other stations (1 to 4 individuals).

Despite this relative dominance of these species at some sites, the evenness index varied slightly and was comprised between 0.76 at site ST_2 and 0.99 at site ST_6. This index indicated that there were no dominant species at different stations and the distribution of species was regular.

The seasonal variation of abundance has been analyzed by considering the entire basin. Of the 141 fish caught, 87 were sampled during the dry season and 54 in the rainy season (Fig. 4B). The most abundant species encountered in the dry season were *Epiplatys chaperi, Afronandus sheljuzhkoi, Chromidotilapia guntheri, Eleotris vittata* and *Nimbapanchax petersi*. On the other hand, the greatest individual number of *Poropanchax rancureli, Hemichromis fasciatus* and *Ctenopoma kingsleyae* has been obtained during the rainy season. For the other species, as many individuals are captured in the dry season as in the rainy season.

Biomass of fish species

During this study, a total biomass of 4,855.76 g of fish was obtained. The highest biomass was recorded in *C. guntheri* with 1,494.22 g (30.77 %), followed by *Hepsetus odoe* (1,446.50 g; 29.78 %) and *H. fasciatus* (1,014.03 g; 20.88 %). The species *Parachanna obscura* (642.36 g) represented 13.22 % of the total biomass while *E. chaperi sheljuzhkoi* with a total mass of 22.66 g represented 0.46 % of this biomass (Fig. 5A). Like the abundance, the seasonal variation of biomass was analyzed by considering the basin. In contrary to numerical abundance, the highest biomass is recorded during the rainy season (Fig. 5B). In the species *Hemichromis fasciatus*, *Hepsetus odoe* and *Ctenopoma kingsleyae,* the highest biomass was obtained in rainy season while the opposite was observed in *Parachanna obscura* and *Chromidotilapia guntheri*.

Environmental factors accounting for the distribution of the species

The results of RDA showed that the first two factorial axes represented 71.2 % (45.5 % for axis1 and 25.7 % for axis2) of the total variance explained by overall variables

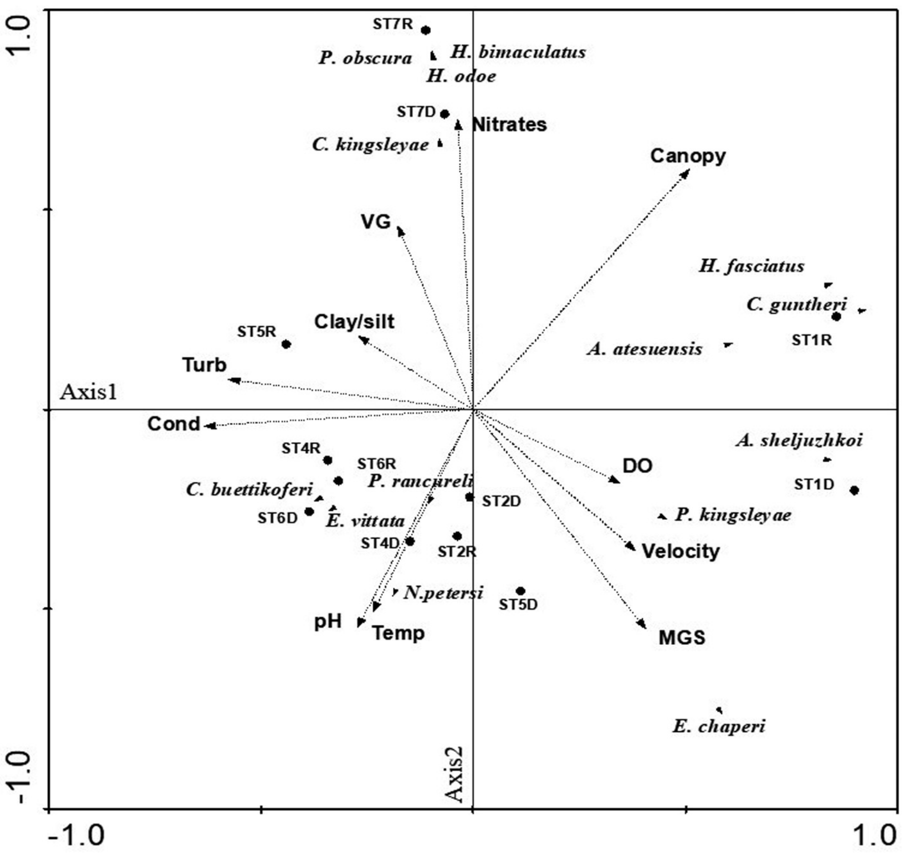

Fig. 6. – Ordination in RDA of the fish species and the abiotic factors in the stations on the first two canonical axes. ST1 to ST7; stations of sampling, 1: rainy season, 2: dry season

(Fig. 6). On the axis 1, the species *A. sheljuzhkoi* and *P. kingsleyae* were more abundant during the two seasons in ST1 characterized by the higher values of oxygen level and lower values of turbidity and conductivity. On the other hand, on axis 2, the highest values of pH and temperature seemed to be decisive in the distribution of *N. petersi*. The species *H. bimaculatus*, *H. odoe* and *P. obscura* were most abundant at station ST7 where the water was relatively rich in nitrates. The distribution of the other species was less influenced by environmental factors. The season seemed to have no influence on the fish assemblage in the Banco Stream.

DISCUSSION

A total of 14 fish species was identified in this study on the Banco Stream. The results were almost in conformity with those of Daget & Iltis (1965) who recorded 12 species from the same stream. In addition, the species accumulation curve taking into account all sampling sites was asymptotic, suggesting that the sampling effort in this study was sufficient to attain the maximum specific richness. These results showed that the sampling in this study was effective, as implemented by Degerman *et al.* (1988), Degiorgi (1994), Neumann *et al.* (1995) and Lévêque & Paugy (1999). The theoretical number of species of this basin determined using the models proposed by Daget & Iltis (1965), and Hugueny & Lévêque (1999) was 12 and 8, respectively. The species richness of the Banco Stream observed in the present study, was at least 1.2 times greater than that predicted by the empirical models of Daget & Iltis (1965) and Hugueny & Lévêque (1999). In contrast, the theoretical number of species from the model of Schucany *et al.* (1971) was higher than that registered in the present study. This result suggested that the most efficient empirical methods to evaluate the fish specific richness in the Banco Stream were those related to the basin surface. Among the 14 species recorded in this investigation, 3 of them (*Amphilius atesuensis*, *Clarias buettikoferi* and *Hepsetus odoe*) were reported for the first time in this area, while 3 others (*Brycinus longipinnis, Papyrocranus afer*) previously found by Daget & Iltis (1965) and *Coptodon guineensis*, an introduced species in this area were not recorded during our sampling. The absence of these species did not justify their extinction in this area but were probably due to the sampling methods used, the type of sampled habitats and the sampling periods. It was also possible that these species were withdrawn in particular habitats not prospected during this study as suggested by Lalèyè *et al.* (2004). During its life and according to its daily activity, the same fish species could occupy several types of habitats successively (Lévêque, 1995). The number of new recorded species (3) in our study indicated that the list of fish species was not probably exhaustive in the previous study of Daget & Iltis (1965). Finally, according to all the studies carried out, 17 species of fish have been found in the Banco Stream.

The presence of all fish species encountered in this investigation was indicated by previous studies in coastal rivers of The Ivory Coast (e.g. Teugels *et al*. 1988, Gourène *et al*.1999, Da Costa *et al*. 2000, Koné *et al*. 2003 a, b, Kouadio *et al*. 2006, Kouamé *et al*. 2008b, Kamelan *et al*. 2013, Konan *et al*. 2013, Nzi *et al*. 2015). However, three species (*Afronandus sheljuzhkoi*, *Nimbapanchax petersi* and *Epiplatys chaperi*) had a restricted distribution; they were known only from The Ivory Coast and southwestern Ghana. Two of them (*N. petersi* and *E. chaperi sheljuzhkoi*) have been listed in the IUCN (International Union for Conservation of Nature) red list of Threatened Species. *E. chaperi sheljuzhkoi* is classified Near Threatened (Lalèyè 2010) and *N. petersi* is Vulnerable (Entsua-Mensah & Lalèyè 2010). The incorporation of the entire Banco Stream basin within a protected area could be an interesting site for conservation of these fish species.

The Shannon-Weaver diversity and evenness indexes varied from 1.20 to 2.70 and from 0.76 to 0.99, respectively. The diversity Shannon-Weaver index of fish communities in the Banco Stream could be categorized as moderate level, suggesting that the habitat is slightly disturbed. Concerning the evenness index, the high values indicated that there were no dominant species in this stream and the distribution of the species was regular (Amanieu & Lasserre 1982, Dajoz 2000). Similar values of H' (1.1 to 3.7 bits/ind.) were registered by Konan (2008) in four rivers of south-eastern of The Ivory Coast (Soumié, Eholié, Ehania and Noé). On the other hand, the same author observed the evenness values (0.3 to 0.7) less than those obtained within the Banco Stream.

The cluster analysis revealed two fish assemblages in the Banco Stream, the station ST7 (group I) the most in downstream and the others (group II). The group II clustered the sites of upstream (II_2) and middle stream (II_1) suggesting that the two zones had more similar fish faunal assemblages. A zonation was observed in fish assemblages in the Banco Stream as reported by Tito de Morais & Lauzanne (1994) in the Sinnamary River (French Guiana), Hoeinghaus *et al*. (2004) in the Portuguesa River (Venezuela) and Tejerina-Garro and de Mérona (2010) on the Comté River. Downstream (ST7) fish species mainly belonging to piscivorous or aquatic invertivorous guilds (*Hepsetus akodoe, Parachanna obscura, Hemichromis bimaculatus, H. fasciatus*…) were predominant, whereas in upper zone the fish assemblage was characterized by species or families with an opportunistic omnivorous diet. These observations were in agreement with those of Tejerina-Garro & de Mérona (2010) on the Comté River (French Guiana). In the station ST3 situated in middle stream, none fish species was encountered. The absence of the fish was related to regular point sources of pollution discharge due to the arrival of non-treated domestic sewage bringing water quality deterioration (Camara *et al*. 2009).

The results of RDA showed that some environmental factors influenced fish assemblage in the Banco Stream. These results are consistent with those of Lévêque (1999), who reported that in a river, the distribution of fish species inhabitats is not random, but related to their biological and ecological requirements. According to Pourriot & Meybeck (1995), hydrological characteristics and morphology of the hydrosystems can be considered as factors structuring biological communities they harbor. Dissolved oxygen, turbidity, conductivity, pH, temperature, nitrates, mixture gravel sand and current velocity were the most important factors that influenced the fish assemblage structure in the Banco Stream. These observations were also made by Da Costa *et al*. (2000), Koné *et al*. (2003b) and Nzi *et al*. (2015) studying ichthyofauna diversity and ecological status of a coastal River Nero, and characterization of fish communities of two West African coastal rivers (The Ivory Coast). In addition, these findings were in agreement with the results of Khairul Adha *et al*. (2009) in Batang Kerang Floodplain (Malaysia) and Johnson *et al*. (2012) in the Ken River (India). The season influence on fish assemblage was lower in the Banco Stream. This result could be due to the low seasonal variation of environmental variables (Table I) and the hydrological regime of the Banco Stream. Furthermore, Lauginie (2007) reported that, although the regime of this stream is influenced by that of rain interrupted by two dry seasons, this stream never knows pronounced low water.

In conclusion, the results of the present work showed that among the 14 species encountered, three (*Amphilius atesuensis*, *Clarias buettikoferi* and *Hepsetus akodoe*) were reported for the first time in this area. The pattern of longitudinal distribution of the fish community of the Banco Stream presents a transition between two stretches, one formed by the upper and middle zones, which were found to be similar as regards fish composition and diversity (mainly opportunistic omnivorous), and the other one by the lower stretch, in which fish species mainly belong to piscivorous or aquatic invertivorous guilds. Some environmental factors influenced fish assemblage in the Banco Stream. This stream basin entirely included in a protected area constituted an interesting site for conservation and preservation of the threatened fish species (*Afronandus sheljuzhkoi, Nimbapanchax petersi* and *Epiplatys chaperi*). An increase in the number of stations and the fishing effort would be necessary to know the true number of fish species in this stream.

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