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Diversity and Spatiotemporal distribution of the Ichtyofauna of an Urban Natural Environment: Mfilou River, Brazzaville - Congo

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Abstract

Mfilou River is a waterway located in south districts of Brazzaville, this river constitutes a site of economic and scientific interests, because of many activities which take place there (fishing, maraichage, breeding and military activities). The inventory of ichthyofauna of three stations, from the period of March 2008 to May 2009, reveals the presence of 38 species regrouped in 24 genera, 11 families and 7 orders. The specific richness varies from 18 to 36 species. The Shannon index oscillates between 2,24 and 3,05 with a raised value in station 1 (confluence with Djoue River). This tendency shows the influence of Djoue river in the diversification and the distribution of species along the river. The equitability varies between 0,78 and 0,87, these values indicate an homogeneous repartition. Station 2 (less anthropized) presents some seasonal particularities marked in dry season by abundance of species which are occasional or accidental in other stations. Station 1 presents a greater specific richness and specific diversity in spite of important human activity and the bad water quality. Species are more diversified in rainy season. Fishes population of Mfilou River is balanced and distributed in a homogeneous way on the whole stream. It is also interesting to notice that some species of fishes captured occasionally in Mfilou River may come from Djoue River. These big spatiotemporal variabilities of fishes communities and the significant similarities observed between the sampling stations of Mfilou River during different seasons remain to re-specify.

Keywords: Mfilou River, ichtyofauna, spatiotemporal distribution, shannon index, equitability

Introduction

Aquatic ecosystems constitute particular and diversified biotopes, where relations between water characteristics and organisms which live in are very close[1]. In tropical area, these ecosystems are poorly understood and still few known in fish assessment. The conservation of Icthyo faunal biodiversity is one of the major environmental challenges[2]. Fishes are one of the best indicators of quality of any aquatic ecosystem and occupy a remarkable position from socioeconomic point of view. The fishes are very rich source of protein as well as vitamins and other minerals[3]. Currently, many studies of spatial and temporal distribution of freshwater fishes are making. They are useful to examine different factors that influence the structure of the fish community. Anthropogenic activities such as modification of the environment, culture, harvesting and effects of modernization have resulted in habitat loss, degradation, and fragmentation[4].

Documentation of biodiversity has become very important aspect of science now a day due to various environmental influences. Fish diversity of any regime has great significance in assessment of that zone reference to environment and pollution, as well as contributes to the necessary information for fisheries. Documentation of biodiversity has become very much important aspect to understand different ecosystem and influences on them[5].

The database on fish fauna of right bank of Congo Basin are essentially on the systematic. The investigation of biology and ecology of species which have economical and ecological importance are very scarce. This report led to us to centre the main part of our researches on: i. The specific richness of fishes of Mfilou River, an aquatic ecosystem located in urban anthropized area; ii. The spatiotemporal distribution of the various fish species along Mfilou River.

Material and Methods

The Mfilou river, is among the most important streams of Brazzaville with Tsieme River, Mfoa River, Mikalou River, Madukutsekele River, Djiri River and Djoue River (figure-1). It sprays two districts of the South Brazzaville (Mfilou and Makelekele) and drains waters of Ngamboulou River before throwing into Djoue River, tributary of the right bank of Congo River[6]. Mfilou River flows from north to south between 315 and 278 m, 4°26 and 4°30 South latitude, 15°24 and 15°22 East longitude, covering an area of 20 km^2 , flows of 580 mm of water, with a deficit of 850 mm per year and a specific rate of 18 $l/s/km^2$ is a runoff coefficient of 41%[7]. It is characterized by an important herbaceous plant place setting to *Cyperus papyrus* and *Echinochloa stagnina* and by slightly basic waters. The sampling of the ichtyofauna was realized in three stations from March 2008 to February 2009.

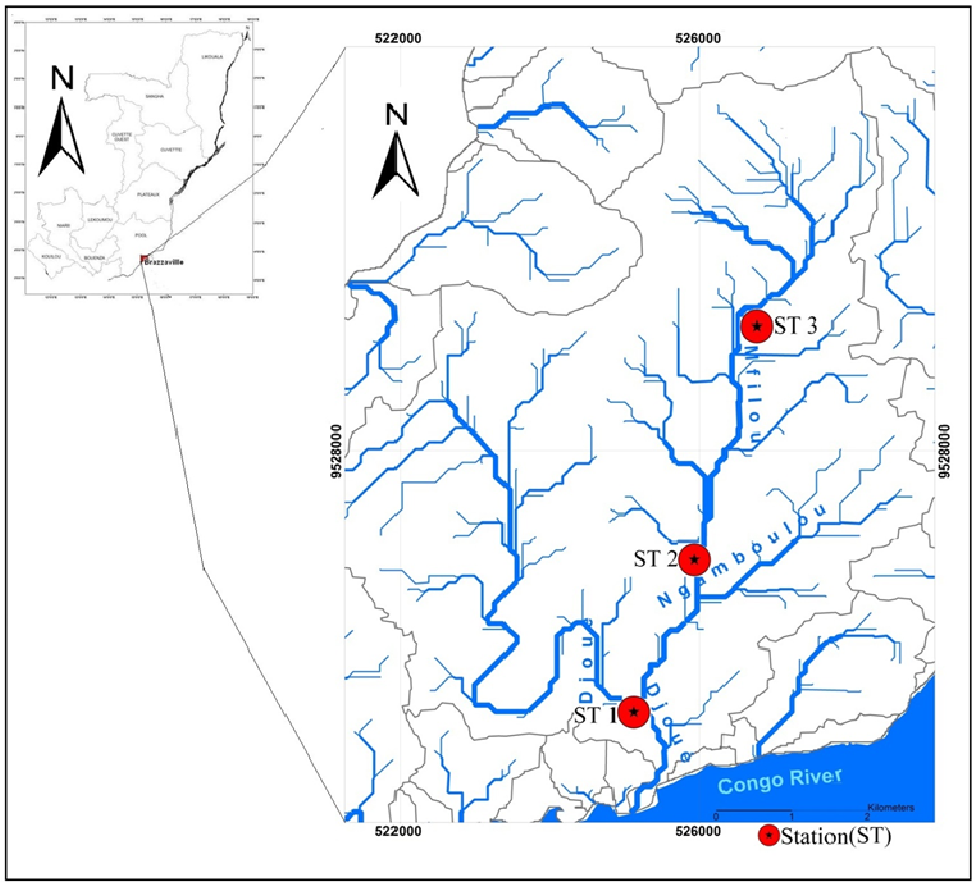

Figure-1
Localization of the sampling area

Sampling of fish fauna was conducted for two years (March 2008-February 2010), in three characterized by the type of vegetation and distributed source at the confluence with the Djoue River stations. Samples are collected using hawks nets 9 m drop with a mesh of 10 and 15. The fish are sorted and fixed in 10% formalin for later identification from different keys available[8-15]. The specific diversity is determined using Shannon biodiversity index (H)[16] and Pielou index or equitability (E)[17]. The similarity index of Jaccard (J) was used to estimate the similarity of the ichtyofauna between stations[18,]. A hierarchical classification is used on dendrogram according to the Ward method with Statistica to discriminate stations.

Results and Discussion

Ichtyofauna composition: 1000 specimens of fishes captured during twenty oven months of inventory belong to 38 species , 24 genera, 11 families and 7 orders. The proportional repartition of different orders, on the basis of the number of present species (figure- 2) shows that the order of Perciformes is the most rich with 34 %, followed by Cypriniformes (22 %) and Characiformes (16 %). Osteoglossiformes and Siluriformes represent respectively 11 %, Lepidosireniformes and Clupeiformes are the least represented orders with 3 %. Siluriformes are the most representative order of Congo River with 23.5 %[19] Results are different in Mfilou River, Perciformes is the most important order. The difference so obtained would be attributable to the water quality of Mfilou River, which is in a very anthropised area.

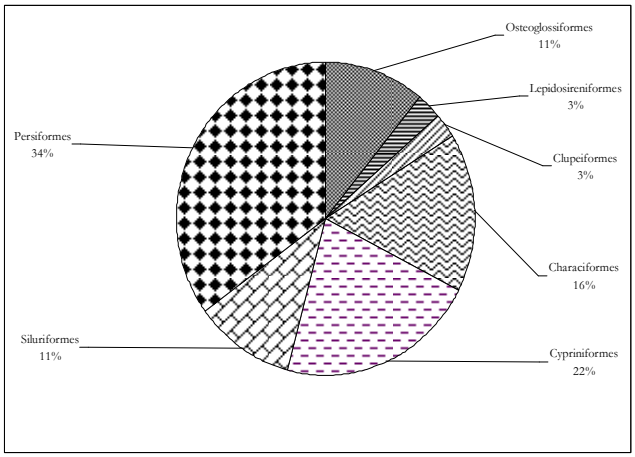

Figure-2
Specific richness of orders

The species of fishes listed, grouped in families suggest that Cichlidae (33 %), Cyprinidae (20 %) and Alestidae (16 %) constitutes the most representative families. Other families have percentages included between 8 % and 3 %. (figure-3). In Congo River, the most diversified family is Cyprinidae. Mfilou River is very small than Congo River that explain the difference of familial profile of the two rivers[20].

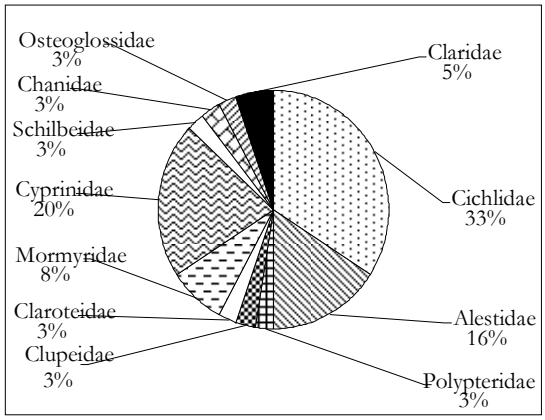

Figure-3
Specific richness of families

The abundance of Cichlidae in stations could justify itself by the absence very marked with the predators in certain zones which are not accessible; it would increase the probability of survival of these resistant and tolerant species of the big environmental variations. It is necessary to indicate the existence of several artificial ponds along the river which could, in floods period, let escape their fishes in the river knowing that the species of Cichlidae are the most used in fish farming. The inaccessible housing environments are of this fact colonized by these as underlines it[21].

Besides, the Cichlidae (33%) were divided into two groups of individuals: Cichlidae Haplochrominii and Cichlidae not Haplochrominii. Cichlidae not Haplochrominii represents 55 % and the Haplochrominii 45 %. Cichlidae Haplochrominii appears well represented in collection. The figure- 4 shows the proportional distribution of various species according to their constancy in the stream. The regularity of capture of the species and the calculation of constancy index of species, showed that 63 % of Mfilou River species can be qualified as accessories because captured sporadically. The species captured accidentally represent 24 % and the constantly captured species correspond to 13%.

The species below are constantly captured: *Tilapia tholloni*, *Sarotherodon boulengeri, Hemichromis elongatus, Ctenochromis polli* and *Clypeobarbus pleuropholis*. We can notice that Cichlidae remains the most present in Mfilou River.

Variation of specific richness: The observations of various inventories were grouped by stations as well as it appears on the table 2. These results allowed a global comparison of species number observed in the three stations (figure 5). The station 1 is best represented with 36 species. It is followed by the station 2 with 26 species and the station 3 which has 17 species. We can note the importance of Cichlidae and Alestidae in stations 1 and 3. Other families of fishes remain weakly represented in all stations (figure- 5). The distribution of fishes communities within stations gives a maximum of 36 species to the station 1. The minimum of species is captured in the station 3 (17 species); the station 2 has 24 species. We notice a decrease of specific richness in stations which are farther off the Djoue River confluence. The station 1 which communicates directly with the Djoue River, has the biggest specific richness. The station 1 which is the confluente station in the Djoue River could be a spawning area for fishes of Djoue River[22,23]. The stations 2 and 3 are particular because Mormyridae species which are demanding in oxygen were captured. The presence of hydrophytes in these stations, purifies partially its waters, which could justify the presence these species.

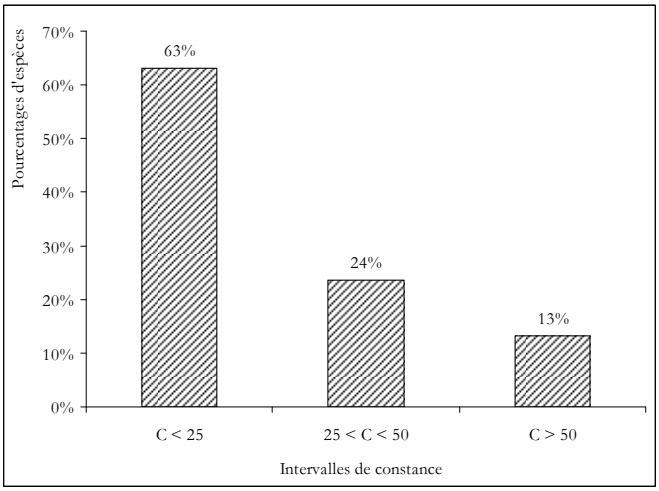

Figure-4
Repartition of constancy

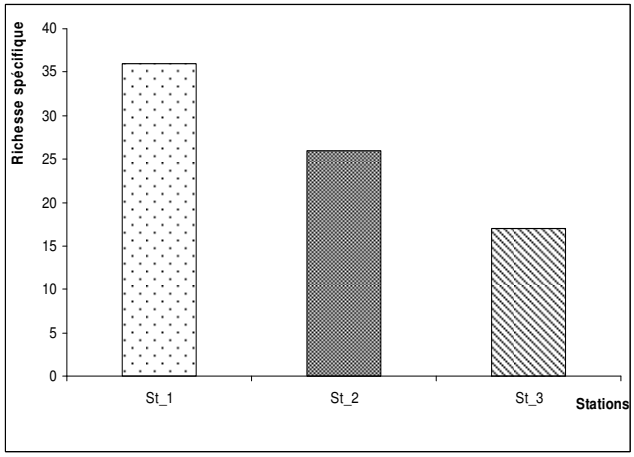

Figure-5
Specific richness in stations

Table-1
Fish fauna composition of Mfilou River

Ordre	Famille	Espèce
Osteoglossiformes	Osteoglossidae	*Heterotis niloticus*
	Mormyridae	*Cyphomyrus psittacus*
		Marcusenius macrolepidotus angolense *angolensis* Boulenger1905 (Boulenger, 1897)
		Gnathonemus cf petesii
Lepidosireniformes	Polypteridae	*Polypterus weeksi*
Clupeiformes	Clupeidae	*Pellonula vorax*
Characiformes	Alestidae	*Brycinus imberi*
		Brycinus comptus
		Bryconaethiops microstoma
		Bryconaethiops macrops
		Micralestes stormsi
		Micralestes acutidens
Cypriniformes	Cyprinidae	*Clypeobarbus holotaenia*
		Clypeobarbus pleuropholis
		Labeo vittiger
		Labeo lineatus
		Leptocypris weeksi
		Raïamas christyi
		Raïamas buchholzi
		Raïamas sp
Siluriformes	Claroteidae	*Parauchenoglanis punctatus*
	Schilbeidae	*Schilbe marmoratus*
	Claridae	*Clarias gariepinus*
		Clarias sp
Perciformes	Channidae	*Parachanna insignis*
	Cichlidae	*Ctenochromis sp*
		Ctenochromis polli
		Hemichromis bimaculatus
		Hemichromis elongatus
		Hemichromis stellifer
		Hemichromis sp
		Oreochromis niloticus
		Tilapia tholloni
		Tilapia zilli
		Tilapia camerunensis
		Sarotherodon boulengeri
		Tylochromis lateralis
7 ordres	**11 familles**	***38 espèces***

Table-2
Distribution des espèces de poissons par station

Species		St_1	St_2	St_3
1	*Heterotis niloticus*	+	+	-
2	*Polypterus weeksi*	+	-	-
3	*Cyphomyrus psittacus*	+	+	-
4	*Marcusenius m. angolensis*	-	+	+
5	*Gnathonemus cf petesii*	+	+	-
6	*Pellonula vorax* Güther	+	+	+
7	*Brycinus imberi*	+	-	-
8	*Brycinus comptus*	+	-	-
9	*Bryconaethiops microstoma*	+	-	-
10	*Bryconaethiops macrops*	+	-	-
11	*Micralestes stormsi*	+	+	-
12	*Micralestes acutidens*	+	-	-
13	*Barbus holotaenia*	+	+	+
14	*Clypeobarbus pleuropholis*	+	+	+
15	*Labeo vitiger*	+	+	-
16	*Labeo lineatus*	+	-	-
17	*Leptocypris sp*	+	+	-
18	*Raïamas christyi*	+	+	+
19	*Raïamas buchholzi*	+	+	-
20	*Raïamas sp*	-	+	-
21	*Parauchenoglanis punctatus*	+	-	-
22	*Schilbe marmoratus*	+	+	-
23	*Schilbe sp*	+	-	-
24	*Clarias gariepinus*	+	+	+
25	*Clarias sp*	+	+	+
26	*Parachanna insignis*	+	-	-
27	*Ctenocromis polli*	+	+	+
28	*Ctenochromis sp*	+	+	+
29	*Hemichromis bimaculatus*	+	+	+
30	*Hemichromis elongatus*	+	+	+
31	*Hemichromis stellifer*	+	+	+
32	*Hemichromis sp*	+	-	-
33	*Oreochromis niloticus*	+	+	+
34	*Tilapia tholloni*	+	+	+
35	*Tilapia sp*	+	+	+
36	*Sarotherodon cf boulengeri*	+	+	+
37	*Tilapia camerunensis*	+	+	+
38	*Tylochromis cf lateralis*	+	-	-
Total	**38**	**36**	**24**	**17**

+ = Present species ; - = Absent species

Similarities and differences observed within populations of various stations can be understandable by the presence of the bridge on the railroad, which constitutes a barrier which stops fishes moving of the lower course towards the upper course. Another limiting factor for the movements of fishes of these stations is the estrangement of stations in the Mfilou-Djoue confluence.

The calculation of diversity index by station , allowed us to notice that, the fish population of Mfilou River of the upper course (stations 3 and 2) are characterized by a relatively low specific abundance and specific diversity with regard to those determined in station 1 located in the lower course (figure 6). The Shannon index values corresponding to captures realized in stations 1, 2 and 3 are respectively 4.12; 3.59 and 3.49 (figure-6).

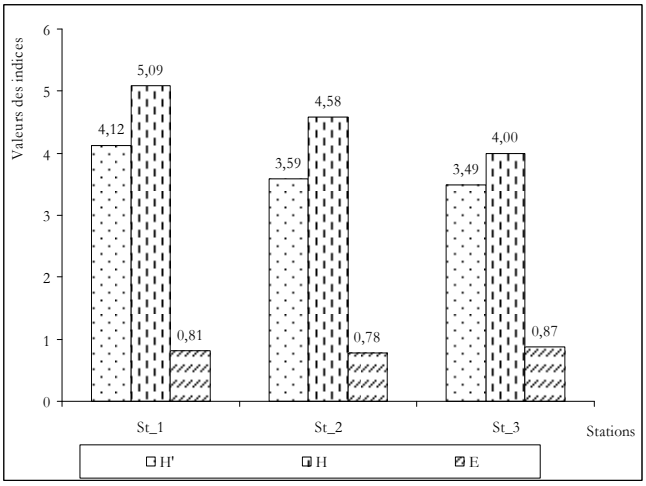

Figure-6
Diversity index in stations

Equitability varies between 0.78 and 0.87. The lowest equitability is observed at station 2 and the strongest at station 3. The values of equitability so obtained indicate a well-balanced populating, thus a homogeneous distribution. The similarities between stations, determined by the similarity index of Jaccard, allowed to notice that the station 1(36) species, has 24 similar species with the station 2, 26 species that is $S_{(1)-(2)}$= 24 or J = 67 %. It's the same in stations 2 and 3 which have in common 17 species, that is to say a similarity J = 68 %. Finally, stations 1 and 3 have in common 16 species and a similarity of 47 % (J lower than 50 %). Some species were captured only in the station 1 where they represent 33 % of species number of the station. As regards the station 2, 8 % of species of this station are specific there. Station 3 has 6 % of species not captured in others stations (figure- 7).

Some differences are observed between the data stemming from various sampled stations. A comparison of these data allows to obtain the results illustrating a hierarchical classification including the specific richness of three stations (figure- 8).

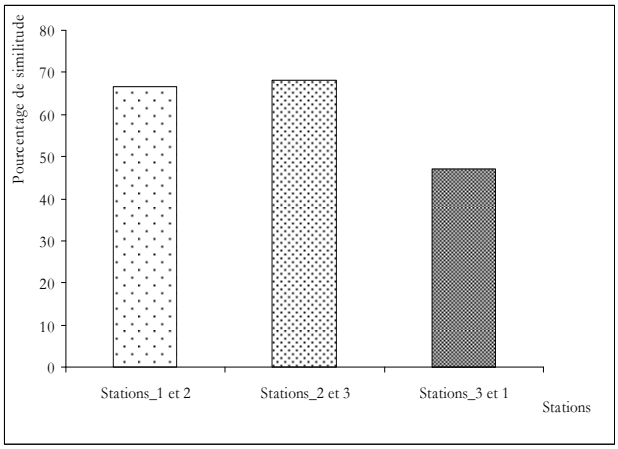

Figure-7
Similarity within stations

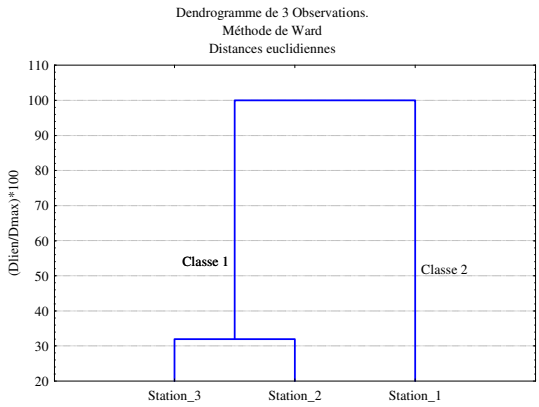

Figure-8
Dendrogram of ichtyofauna in stations

The station 1 presents a profile comparable to that of all river, with an ascendancy of secondary species (58 %). The accidental species represent 28 % of the total and the constant species represent 14 % (figure- 9).

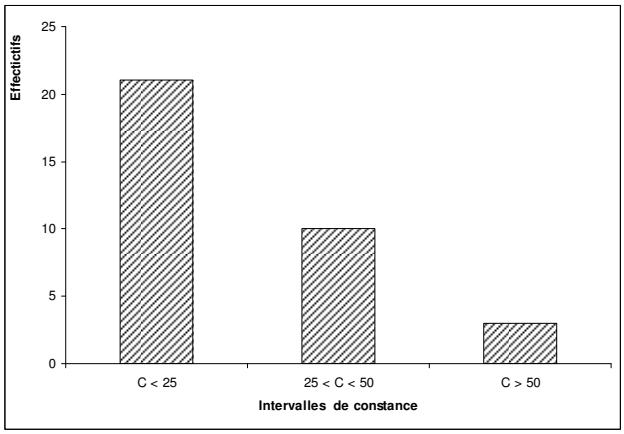

Figure-9
Constancy of species in station 1

The fish population of the station 1 is dominated by *Ctenochromis polli*, *Clarias sp* and *Brycinus imberi*. The station 2, presents certainly a dominance of the accidental species but the general tendency is slightly different as far as the constant species are relatively more numerous (figure- 10). *Marcusenius macrolepidotus angolensis*, *Clypeobarbus pleuropholis*, *Ctenochromis polli*, *Hemichromis elongatus*, *Tilapia tholloni* and *Tilapia sp* are present in a constant way within this station as in all river.

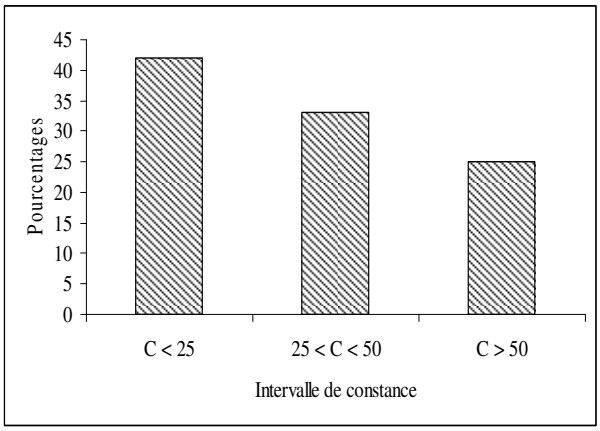

Figure-10
Constancy of species in station 2

The station 3 postpones stations 1 and 2, because it abounds more secondary species than accidental species (figure- 11). The accidental species represent 35 %, the secondary species 47 % and the constant species 18 %. *Clypeobarbus pleuropholis, Raïamas christyi, Clarias gariepinnis, Ctenochromis polli, Hemichromis bimaculatus* and *Hemichromis elongatus* are the constant species in the station.

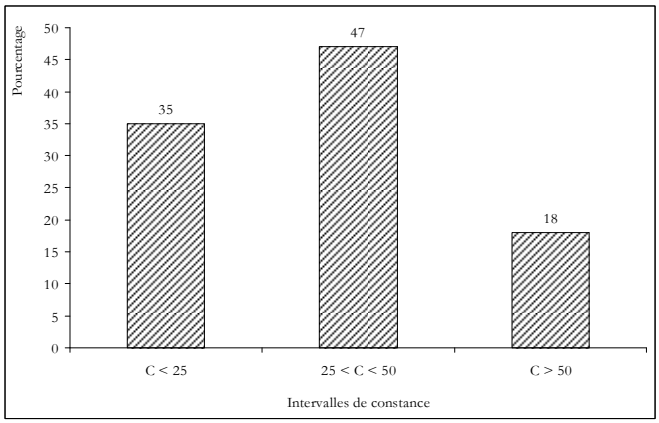

Figure-11
Constancy of species in station 3

Monthly variation of specific richness: The monthly evaluation of species richness for all stream shows that catches of January, February, March, August, June, May, November and December are the most abundant, in April, July and September against the number of species caught is low (figure 12).

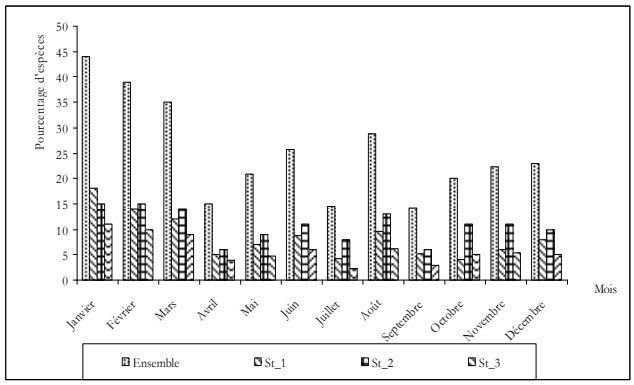

Figure-12
Monthly representation of specific richness

A count of species per station establishes a direct relationship with the monthly collection (figure-13). Similar changes in the number of species were observed in all stations. December, January, February and March, have high species richness. A decline in species richness was observed in April and May, another increase is observed in August.

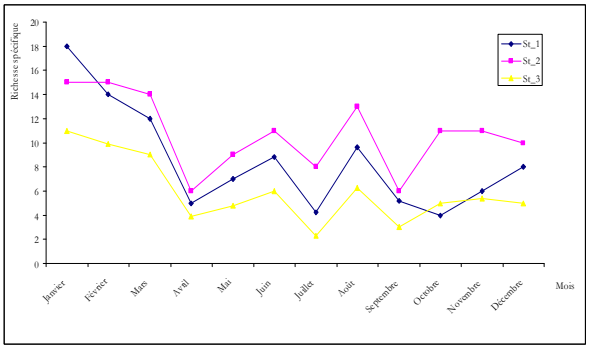

Figure-13
Mensual specific abundancy

A comparison of the monthly distribution of species in different stations shows that: overall, station 2 gives more cash each month, except for January when the station gives one more species than station 2 and that of October 'station where one has fewer species than the station 3. On the other hand, species richness at station 1 is higher in January while the station dominates the three months from August to April. This uneven species distribution according to the station is a more important part in station 1 and the species richness is greater in stations 2 and 3. Haut du formulaire.

The strongest species richness is recorded during the dry season in both stations of the lower course. However, the station of the lower course (station 1) has a stronger species richness in the rainy season. At this level also, these changes can be attributed to precocial migrations and survival migrations[24]. These results could be explained by the bad distribution of the populations of the upper course of the river, because of pollution and toxic effects from diverse organic and metallic micropollutants bringed by urban discharges.

Seasonal variation of diversity index: The evolution of Shannon index and equitability, observed seasonaly in every station is presented in figures 14 and 15. During dry season, station 2 is the most diversified followed by station 1 and station 3 which is the least diversified in dry season. The species so identified are distributed in a homogeneous way on all stations and equitability values indicate a well-balanced population (figure- 15). During rainy season, Shannon index and equitability give different values from a station to the other one. The highest values of Shannon index and equitability were noted in stations 1 and 3. However, low value of Shannon index and equitability are recorded at the station 2.

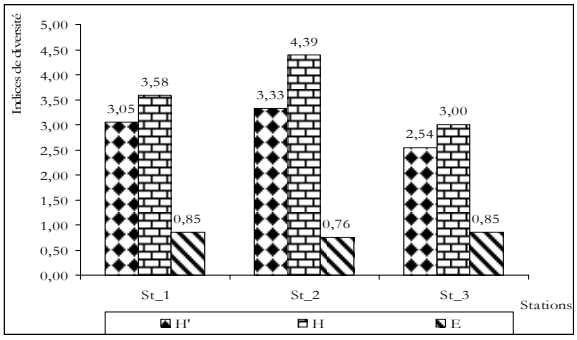

Figure-14
Diversiy index in dry season

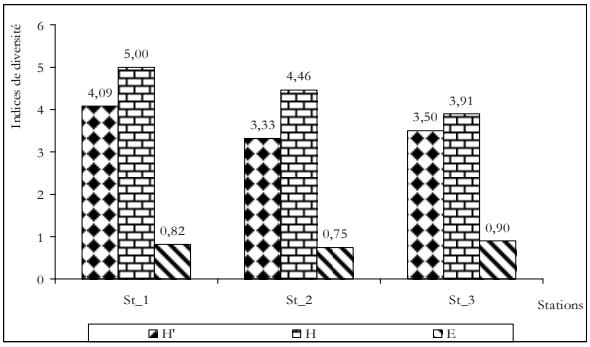

Figure-15
Diversity index in rainy season

In stations 1 and 2, namely a specific richness raised in dry season with greater diversity index; the rainy season adorned to be the most diversified for the station 3 (figure- 16).

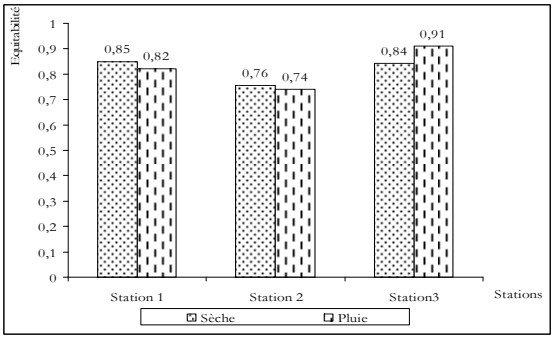

Figure-16
Seasonnal variation of equitability

The station 2 seems particular because during both seasons, equitability values are 0.70. Homogeneity of populations is remarkable during both seasons, in the three stations.

Seasonal variation of constancy index: During both sampling seasons, 26 species are present in all stations, 12 species are present essentially in the station 1, species was essentially found in the station 2 (*Raïamas sp*). This species The constancy index of these species by station is shown in figure- 17. The station 2 is the richest (10 species on average in year), followed by the station 1 which is closer to Djoue River (8 species on average in year). The station 3 is the poorest, with 6 species on average in dry season and in rainy season. Most of species are met in all river only during the dry season (figure- 17, figure- 18 and figure- 19). Rare species were met only during a very short period of the year (June and July) and only in the station close relations of the Djoue River.

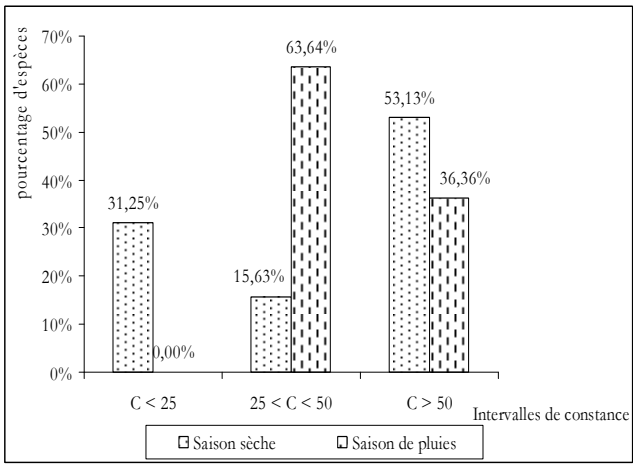

Figure-17
Seasonal variation of constancy in station 1

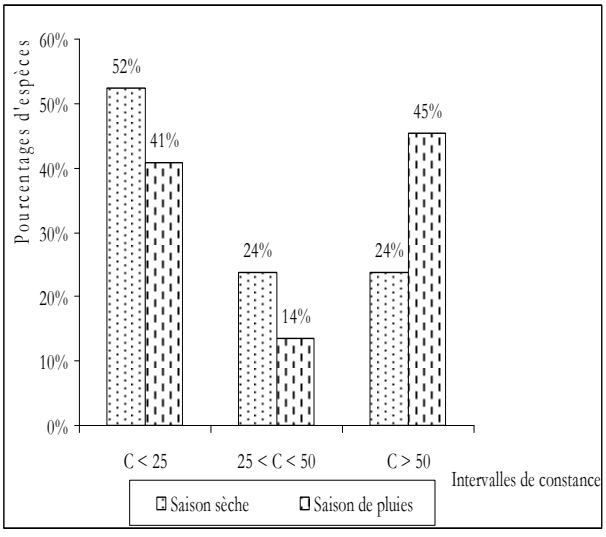

Figure-18
Seasonal variation of constancy in station 2

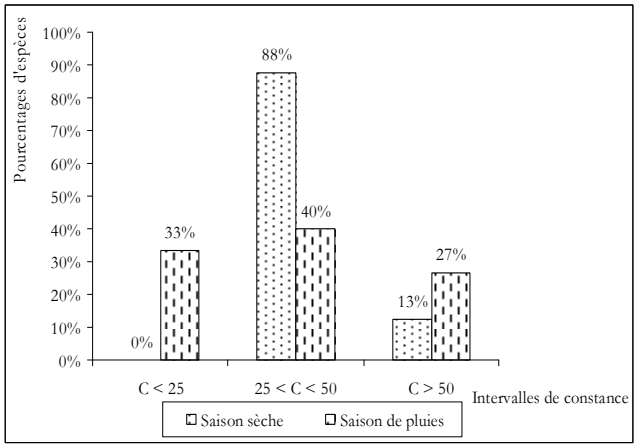

Figure-19
Seasonal variation of constancy in station 2

Among 38 identified species, 26 were almost observed all year along the river. Twelve contain only a small number of specimens and are present in the station 1 only in rainy season. The most low abundances were observed during rainy season and the strongest during dry season. However, the seasonal evolution of the abundances differs from a station in the other one. (figure-19). The scale 2 of variation of specific richness (variation following the seasonal gradient) is respected.

Conclusion

Results obtained in this study show the impact of human activities on presence of species like *Ctenochromis polli* and *Clypeobarbus pleuropholis*, which seem sensitive to the enrichment in organic matter of the water, strikingly noticed in certain stations. Our investigations limit itself now to study species distribution along the stream. The extension of these studies in the others streams of Congo River watershed will increase the knowledge of the fish potential of this badly known basin and the evaluation of incidence of physical, chemical and biological changes of this environment on fishes populations.

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