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Diversity and structure of the fish fauna of Rêverie Farm Water Reservoir at Anyama (Côte d'Ivoire)

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ABSTRACT

The Rêverie farm reservoir is an important eco-geographic area. It is inhabited by a variety of animals among them fishes that come to occupy its waters for reproduction and food needs. Reliable and basic information on these fishes is required for the sustainable management of this resource. The ichthyofauna was sampled monthly from July to December 2014. Experimental fisheries were conducted on the water body with various capture gears. A total of 820 fish samples was collected and belonging to 9 species, 6 genus and 5 families. The family Cichlidae (3 species with 1 hybrid) dominated qualitatively and quantitatively the population of this water reservoir. It was followed by the family Claroteidae (2 species). In terms of number and biomass and even in both seasons, the dominant species were *Coptodon zillii*, *Oreochromis niloticus*, *Chrysichthys nigrodigitatus* and hybrid (*Coptodon zillii x C. guineensis*). From a distribution point of view, the Shannon-Weaver (H '> 2) index and equitability (E > 0.5) values calculated reflect a good organization and stability of the ichthyological population. The results will serve as references for the fish fauna and also to guide decision for the Rêverie farm reservoir.

Keywords : Fish population, Diversity, Reservoir, Rêverie farm.

INTRODUCTION

Aquatic ecosystems play a crucial role in maintaining ecological processes in landscapes, including ecological processes, the biological function and integrity of aquatic and terrestrial environments and their interface (Mamonekene et al., 2006). A great biological diversity live there. The study of this biological diversity is important to understand the functioning of these environments, for example the survival of the different species, which depend on each other (Liquete et al., 2016). Aquatic vertebrates, particularly fish represent the main sources of animal protein available to many populations. In 2017, for example, on a global scale, the estimated average fish

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consumption per person was about 20.5 kg (FAO, 2018).

Several studies on water reservoirs fish populations of have been carried out in Africa (Kantoussan, 2007 ; Montchowui et al., 2008 ; Adeyemi et al., 2010 ; Ouedraogo et al., 2015).

In Côte d'Ivoire, among these aquatic ecosystems, water reservoirs are well represented. Initially, these water reservoirs built were used for agricultural, pastoral and hydroelectric purposes (Ouattara et al., 2006 ; Cecchi, 2007). However, nowadays, they represent a real fisheries potential (Adou et al., 2017). Indeed, Likes lakes, water reservoirs apart from playing the noble role of providing a relatively cheap source of animal protein, it can also provide employment opportunities along the capture fisheries value chain and to some extent reduce rural-urban drift (FAO, 2014). In addition, water reservoirs can provide support, protection and nursery to the early life cycle stages of almost all commercially and ecologically important freshwater fish (FAO, 2014). Despite their importance, these water reservoirs have been the subject of few studies (Da Costa, 2002). Since its creation, no study has been conducted in the Rêverie reservoir located in a farm at Anyama locality. Moreover, this reservoir would be a place of refuge for fish fleeing areas that are under strong anthropogenic pressure due to urbanization. Taking into account the role that this water body plays ecologically and the lack of essential data for conservation and sustainable management, it was needful to carry out the present study. Therefore, this study aimed at characterizing the ichthyological population of the Rêverie farm water reservoir in order to contribute to the conservation of these natural resources.

MATERIALS AND METHODS

Study area

The Rêverie farm water reservoir (5°32' - 5°33' North ; 4°01"- 4°03" West) is located at 7 km from Anyama precisely in the Yapokoi village (Figure 1). The vegetation that characterizes this farm is the primary forest, industrial crops represented by rubber cultivation, a palm grove and a reforestation area. The anthropic activities carried out within the farm are essentially agriculture, with food crops such as cassava, corn, pineapple and banana being cultivated. In the surrounding of this site is practiced a traditional type of sheep breeding. This area belongs to the equatorial climate characterized by two dry seasons and two rainy seasons (Brou et al., 2005).

Fish Sampling

Fishes were sampled by experimental methods between July and December 2014. Fishermen were used different mesh size of gill nets (8 to 90 mm), traps, bamboo traps and lines. Fishes caught were immediately identified to species level using the taxonomic keys of Paugy et al. (2003a, b), and standard length (mm) and body weight (g) were recorded for each specimen. The measurements were made using an ichthyometer and an electronic scale with a precision of 1 g, respectively.

Data analysis

The data were analyzed using numerical (%N) and weight abundances (%P), specific diversity index (H') of Shannon and Weaver (1963) and equitability (E) of Piélou (1984). The expressions are the following:

$$\mathbf{N = \frac{ni}{Nt} x100}$$

With: ni = Number of individuals of a taxonomic group (species, family or order), Nt = Total number of individuals.

$$\mathbf{P = \frac{p}{Pt} x100}$$

With: p = Weight of individuals in a taxonomic group (species, family or order), Pt = Total weight of individuals in a sample.

$$\mathbf{H' = -\sum_{s=1}^{s} Pi \log 2 Pi}$$

With :

$Pi = \frac{ni}{N}$

S = Number of species

N = Sum of the number of species

ni = Population size of each species

Pi = Relative abundance of species in the sample

$$\mathbf{E = \frac{H'}{\log 2\ S}}$$

Where :

H' = Shannon and Weaver diversity index

S = Specific richness

The Shannon and Weaver index of species diversity (H') measure the degree of organization of the stand and is between 0 and 5 (Ludwig and Reynolds, 1988). Equitability allows to assess the quality of this organization (Dajoz, 2000 ; Barbault, 2000). It varies between 0 and 1. These indices were carried out according to the PAST program.

Statistical analysis

Seasonal variations in individual fish species, Shannon (H') and Piélou (E) equitability indexes were compared using the Mann-Whitney U test. Differences of $p < 0.05$ were considered significant. All steps of this method were computed using STATISTICA 7.1 software.

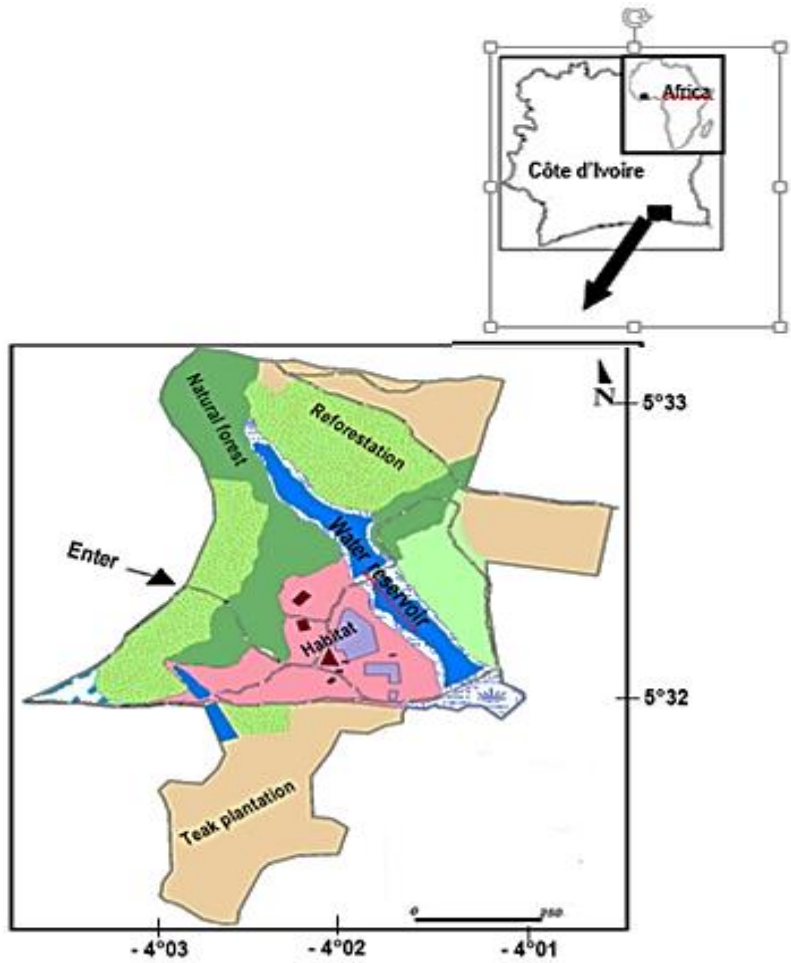

Figure 1 : Map of the Rêverie farm reservoir showing the sampled station.

RESULTS

Taxonomic composition of the fauna

Taxonomic identification of 820 fish samples caught revealed a total of 9 species belonging to 6 genus and 5 families (Table 1). Fish families identified were Cyprinidae, Claroteidae, Channidae, Cichlidae and Anabantidae. This fish population contained an introduced species (*Oreochromis niloticus*) and a hybrid (*Coptodon zillii* x *C. guineensis*). The best-represented families in the population were the Cichlidae with 4 species (*Oreochromis niloticus*, *Coptodon zillii*, *C. guineensis* and Hybrid), followed by the family Claroteidae with 2 species (*Chrysichthys nigrodigitatus* and *C. maurus*). Each of the other families are represented by one species. There were Channidae, Anabantidae and Cyprinidae, with respectively the species *Parachanna obscura*, *Ctenopoma petherici* and *Enteromius ablabes*.

Numerical and weight abundance

Concerning the numerical abundance of fish families (Figure 2), the Cichlidae predominate with 71.22% of the total number of fish species collected. It was followed by the Claroteidae (20%). In the catches of the Rêverie farm water reservoir, the most abundant species (Figure 3) were *Coptodon zillii* (31.95%), *Oreochromis niloticus* (28.54 %), *Chrysichthys nigrodigitatus* (11.95%), Hybrid (11.46 %) in order of importance. None of the remaining ones exceeded 10%.

In terms of weight abundance, Cichlidae (79.15%) and Claroteidae (13.67%) families dominate the fish population (Figure 4). None of the remaining ones exceeded 10% to the total biomass of the fish caught. At specific level, with a biomass of 37.65%, the most important taxon was *Oreochromis niloticus* (Figure 5). This species was followed by *Coptodon zillii* and Hybrid with 29.81% and 11.52% of the total biomass, respectively. Other species contribute less than 10% of the total fish biomass.

Seasonal composition species of the fish population

Figure 6 presents the seasonal composition species of the fish population. It indicates that 9 species were sampled during the rainy season, while 7 species were recorded during the dry season. In this last season, the species *Coptodon guineensis* and *Barbus ablabes* were not caught. The specific richness recorded during the two seasons did not show a significant difference (Mann-Whitney U test; $p > 0.05$). During the rainy season, the composition of the catches in terms of individuals was dominated by the families Cichlidae (72.77%) and Claroteidae (20.37%) (Figure 7). During the dry season, the same families of fish dominated the population. According to the biomass of each family, the Cichlidae dominated the fish population with a rate of 78.87% during the rainy season (Figure 8). This family was followed by the Claroteidae (14.62%). The same trend of results was observed during the dry season (Figures 9 and 10). The most dominant species were respectively *Coptodon zillii* (34.41%) and *Oreochromis niloticus* (27.39%) (Figure 11) during the rainy season. These species were followed by *Chrysichthys nigrodigitatus* (10.79%) and hybrid (10.27%). During the dry season, the same order was respected with a slight increase in the rate of *Oreochromis niloticus* (31.35%) (Figure 12). The best represented species with 36.16% and 32.13% of the weight percentage were *Oreochromis niloticus* and *Coptodon zillii* during the rainy season (Figure 13). This trend was also observed during the dry season (Figure 14). Statistical test showed no significant difference of biomass between two seasons (Mann-Whitney U test ; $p > 0.05$).

Shannon-Weaver species diversity and equitability indexes

Table 2 shows the values of the calculated Shannon-Weaver diversity and Equitability indexes of the Rêverie farm reservoir fish species. Analysis of the latter revealed that the specific diversity (H') and equitability (E) indexes recorded were relatively high with respective values of 2.47 bits/individual and 0.77. The Shannon diversity index values obtained was 2.49 for an equitability index of 0.79 during the rainy season, while these values were 2.36 and 0.72 respectively during the dry season. The Shannon specific diversity and equitability indexes values did not show significant variation during the seasons (Mann-Whitney test : $p > 0.05$).

Table 1 : List of fish species caught in the Rêverie farm reservoir

Families	Genus	Species
Cyprinidae	*Enteromius*	*Enteromius ablabes* (Bleeker, 1863)
Claroteidae	*Chrysichthys*	*Chrysichthys nigrodigitatus* (Lacépède, 1803)
		Chrysichthys maurus (Valenciennes, 1839)
Channidae	*Parachanna*	*Parachanna obscura* (Günther, 1861)
Cichlidae	*Oreochromis*	*Oreochromis niloticus* (Linnaeus, 1758)
	Coptodon	*Coptodon zillii* (Gervais, 1848)
		Hybrid (*Coptodon zillii* x *C. guineensis*) (Günther, 1862)
		Coptodon guineensis (Günther, 1862)
Anabantidae	*Ctenopoma*	*Ctenopoma petherici* (Günther, 1864)

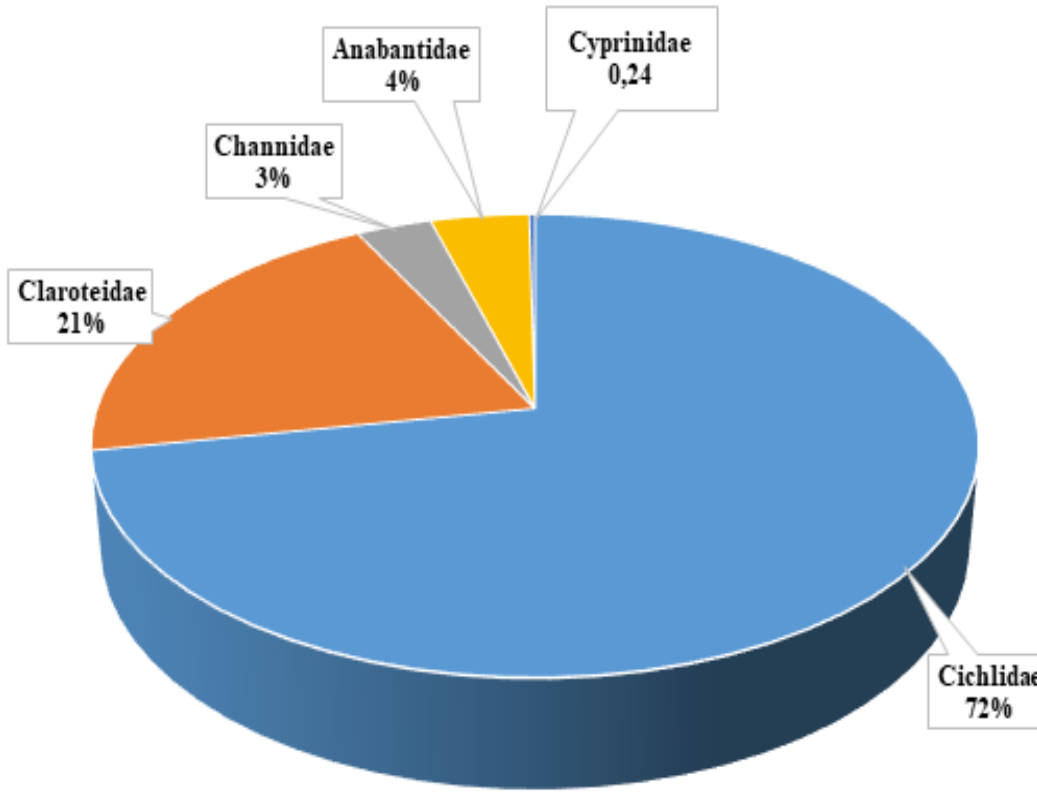

Figure 2: Numerical abundance of fish families caught in Rêverie farm reservoir.

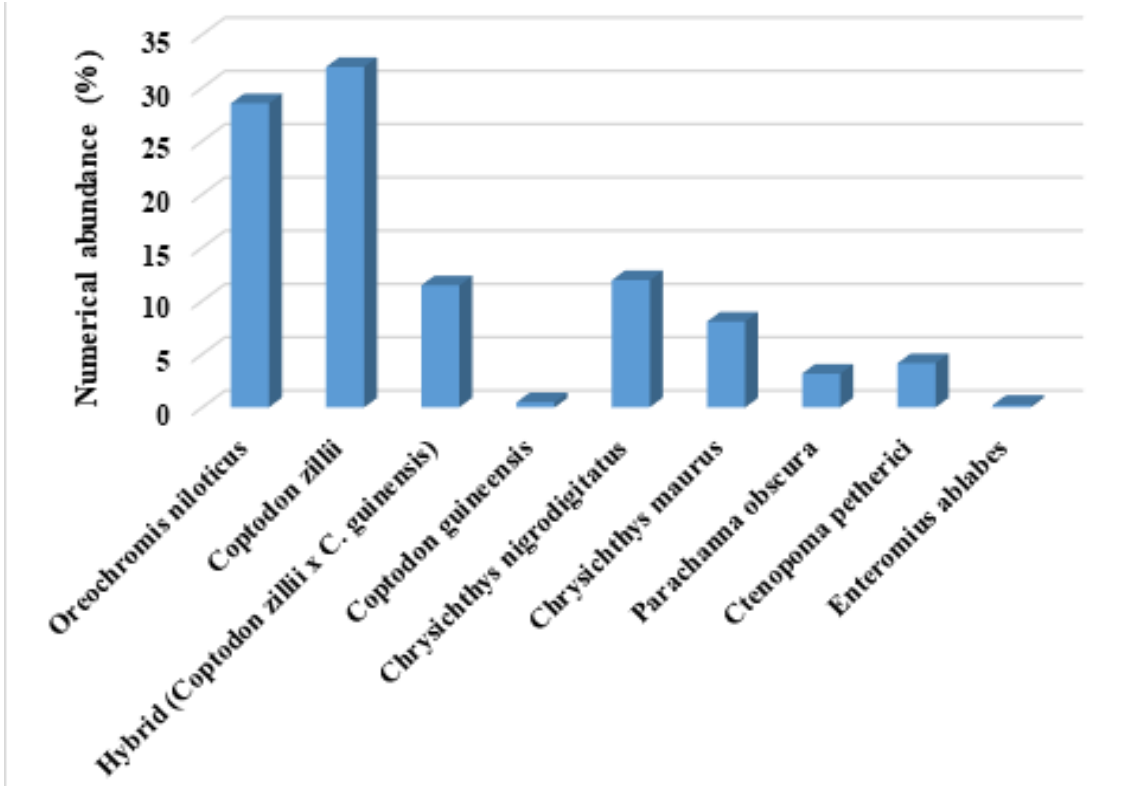

Figure 3: Numerical abundance of fish species caught in Rêverie farm reservoir.

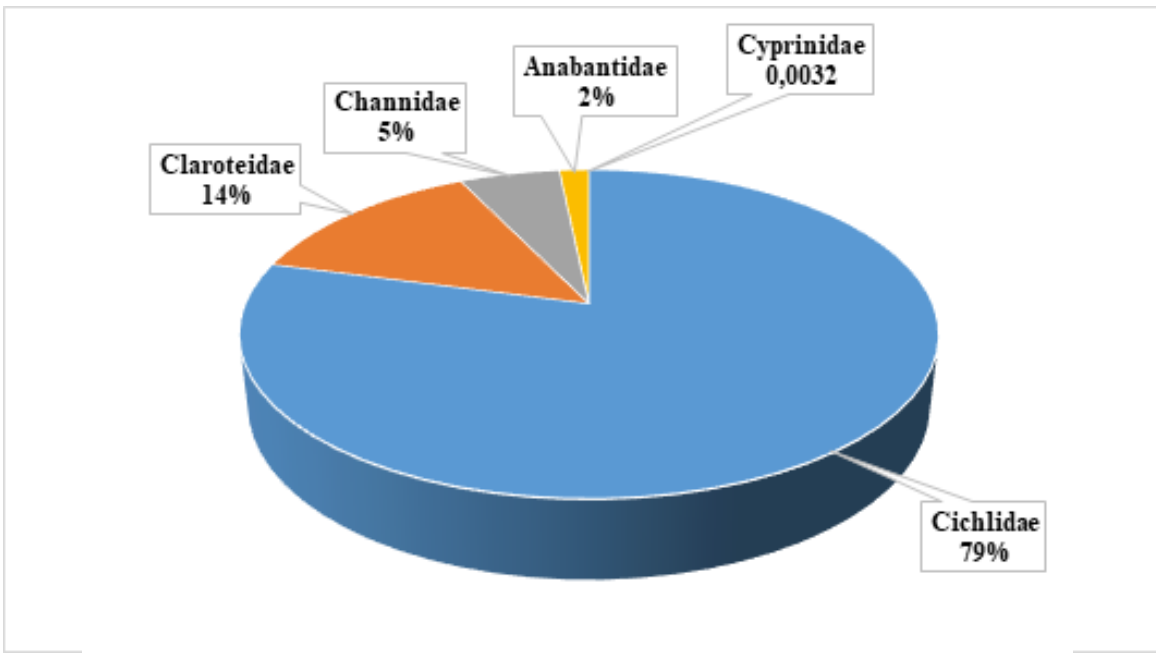

Figure 4: Weight abundance of fish families caught in Rêverie farm reservoir.

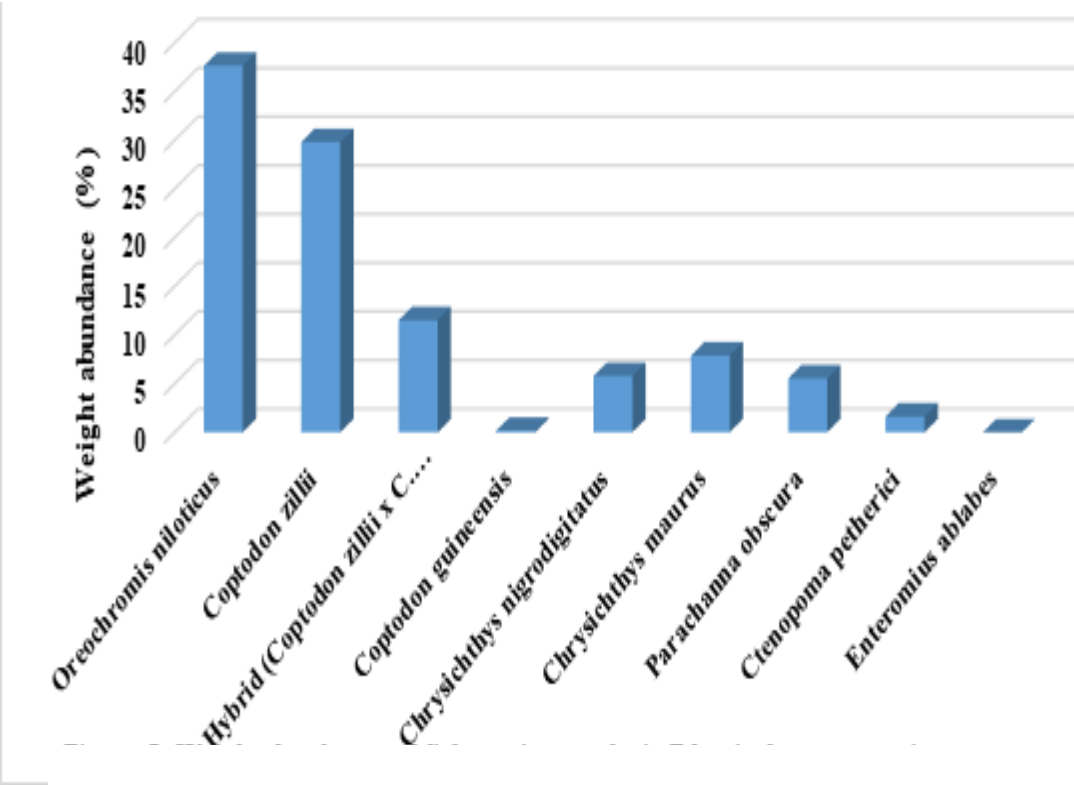

Figure 5: Weight abundance of fish species caught in Rêverie farm reservoir.

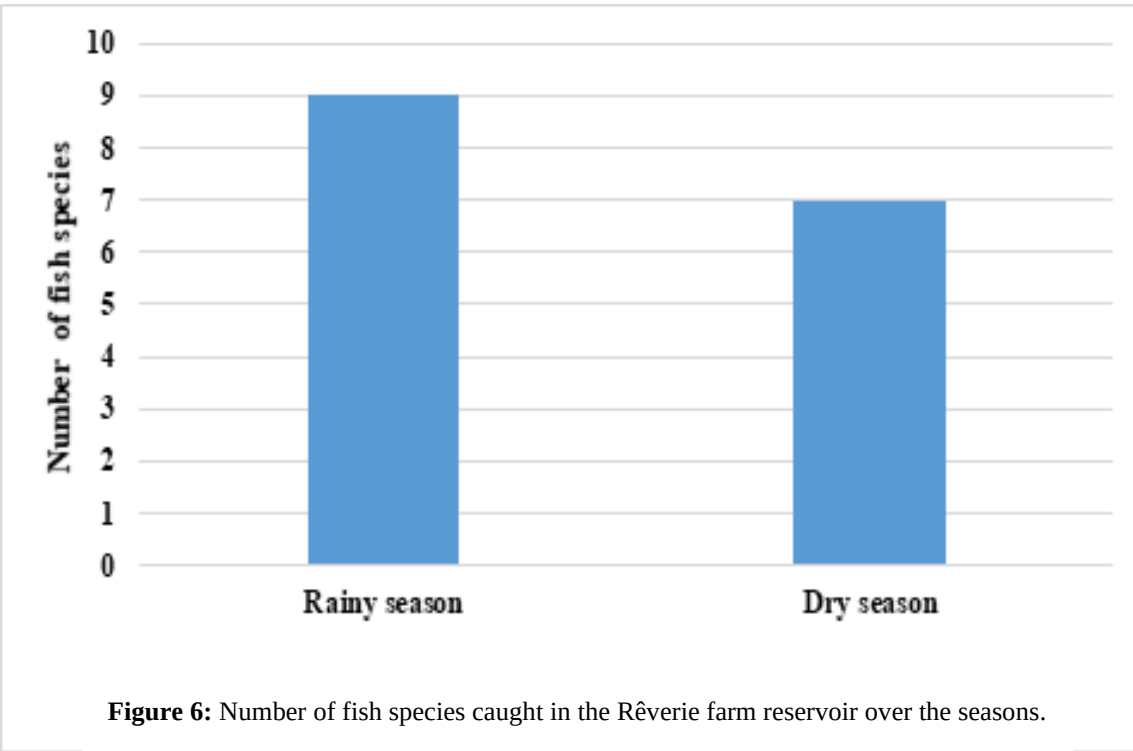

Figure 6: Number of fish species caught in the Rêverie farm reservoir over the seasons.

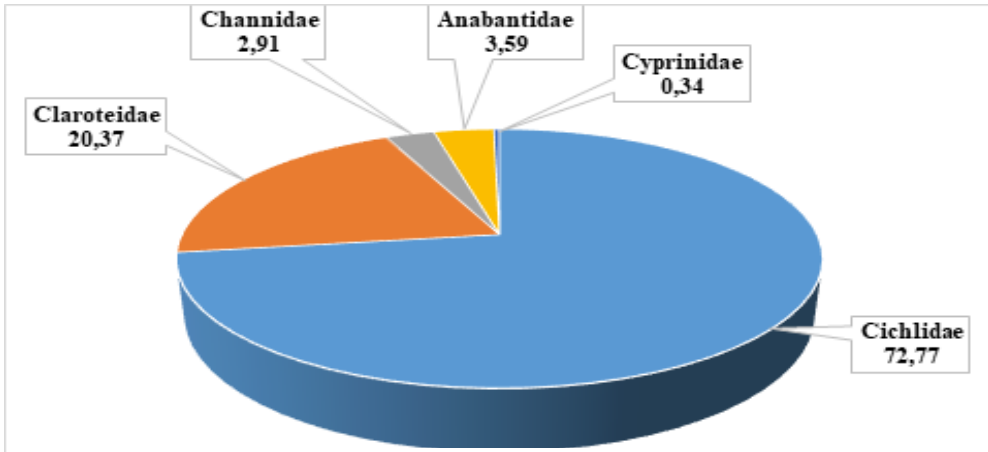

Figure 7: Numerical abundance of fish families caught in the Rêverie farm reservoir during the rainy season.

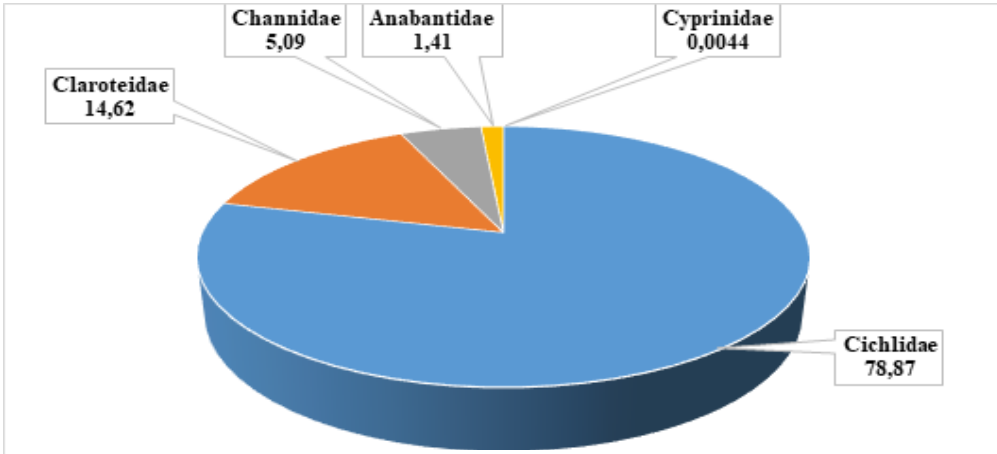

Figure 8: Weight abundance of fish families caught in the Rêverie farm reservoir during the rainy season.

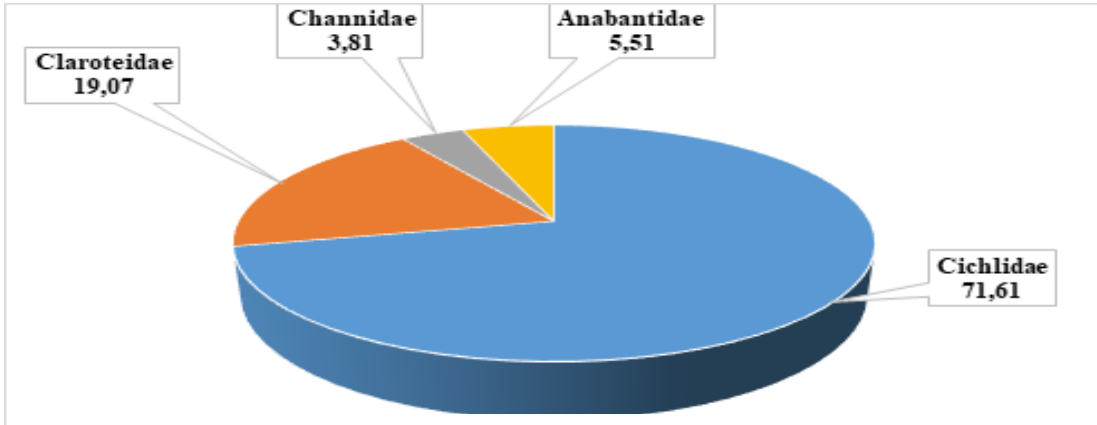

Figure 9: Numerical abundance of fish families caught in the Rêverie farm reservoir during the dry season.

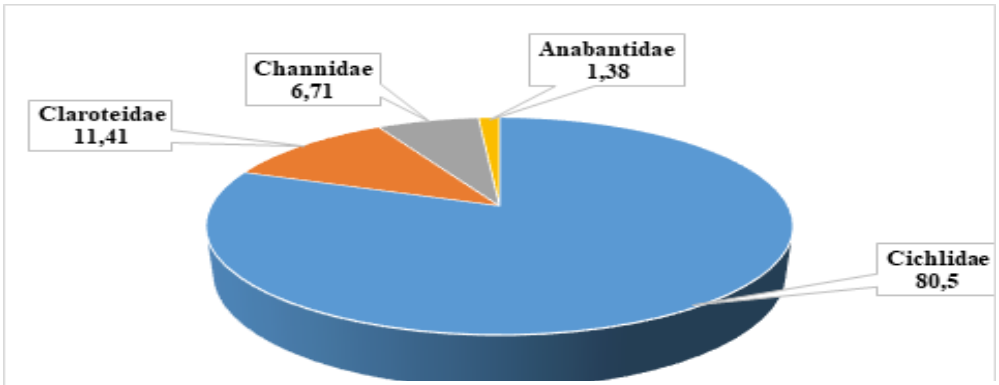

Figure 10: Weight abundance of fish families caught in Rêverie farm reservoir during the dry season.

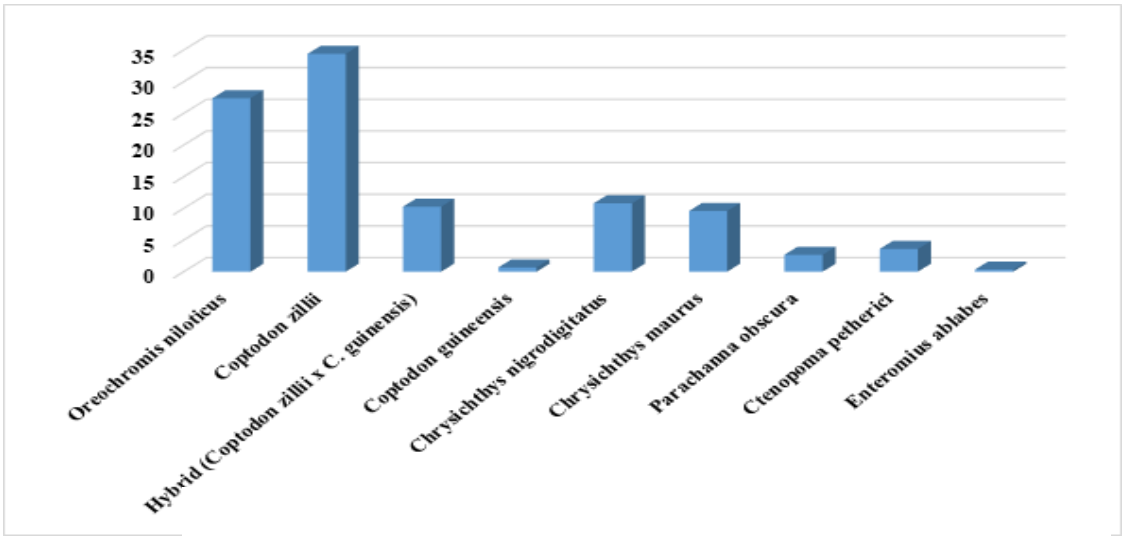

Figure 11: Numerical abundance of fish species caught in Rêverie farm reservoir during the rainy season.

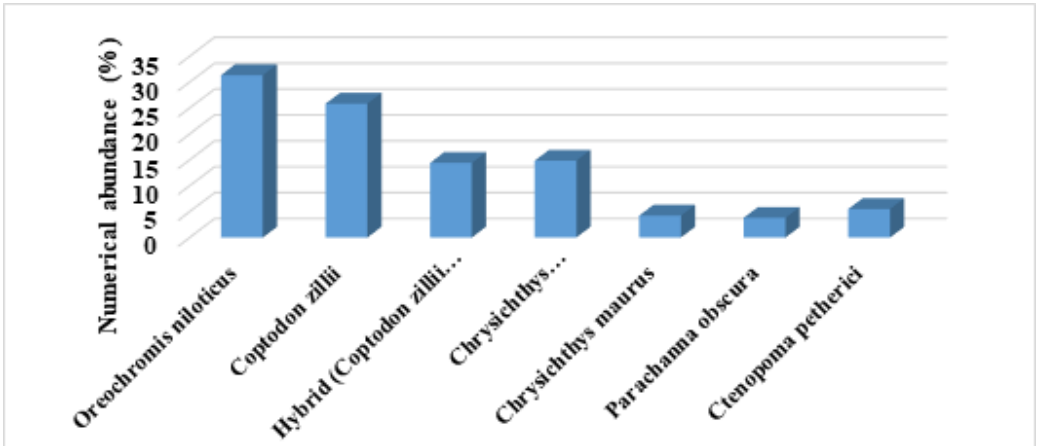

Figure 12: Numerical abundance of fish species caught in Rêverie farm reservoir during the dry season.

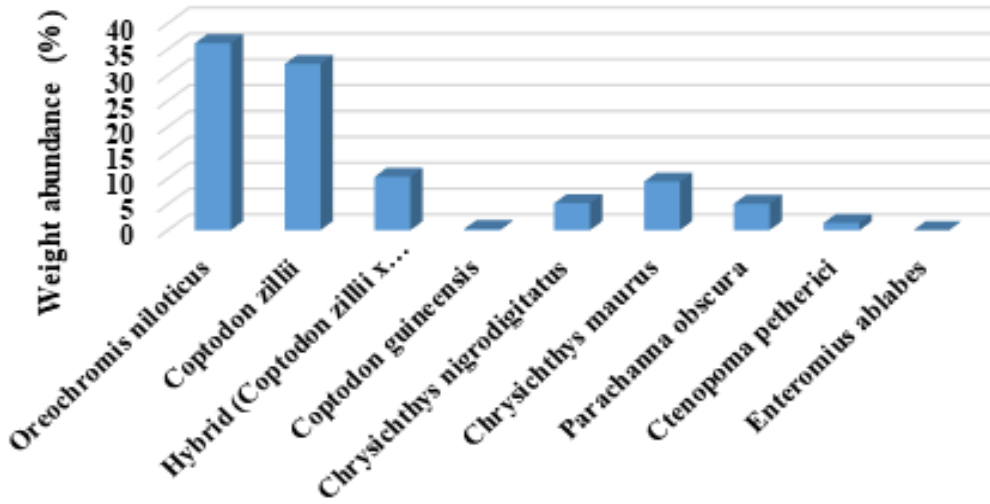

Figure 13: Weight abundance of fish species caught in Rêverie farm reservoir during the rainy season.

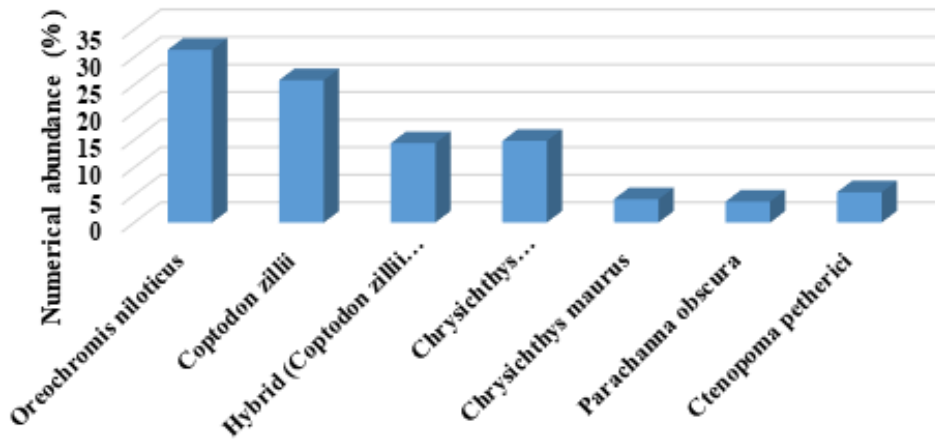

Figure 14: Weight abundance of fish species caught in Rêverie farm reservoir during the dry season.

Table 2 : Shannon and Pielou (1966) diversity index calculated for the fish fauna of the Rêverie farm resevoir

Indices	All season	Rainy season	Dry season
Specific diversity indice (H') of Shannon and Weaver	2.47	2.49	2.36
Equitability (E) of Piélou	0.77	0.79	0.72

DISCUSSION

Nine species were identified as habiting the Rêverie farm reservoir during the study. The comparison with the previous situation is difficult because there were no data on the fish fauna of this water reservoir in the literature. The results of the present study are consistent with the number of species in African hydroagricultural reservoirs. This is the case of an agglomeration body water, Kaby lake of Bongouanou of Côte d'Ivoire (n = 4) (West Africa) reported by Kouadio et al. (2018). However, the species richness of the hydro-agricultural reservoir of Faé (Côte d'Ivoire) in the forest zone reported by Da Costa et al. (2002) contained a higher number of species (n = 25) than that observed in the present study. The reduced number of species in the farm's water bodie could be due to the small size of this reservoir. It's well known that the number of species increases with stream size. Indeed, the increase in the size of the stream offers fish a diversity of habitats. These habitats would also provide suitable spawning areas for fish species (Montchowui et al., 2008). In addition, this could be partly as a result of the gear used (gill net) as suggested King (1995). According to this author the fishing gears may account for the type of fish species caught during the study period. In this study, the gillnet was the only fishing gear used during the sampling. This gear has the possibility of capturing a range of fish species, namely pelagic fishes which would justify the low number of species obtained.

The family Cichlidae dominates qualitatively and quantitatively the population of the Rêverie farm water reservoir. The dominance of Cichlid fishes agrees with what is obtained in many other lakes and reservoirs in Africa by numerous authors (Ita, 1993 ; Kantoussan, 2007 ; Montchowui et al., 2008 ; Komolafe and Arawomo 2008 ; Adeyemi et al., 2010 ; Ouédraogo et al., 2015 ; Kouassi et al., 2020). The preponderance of this family in terms of species diversity, number and weight could be attributed to the presence of high food resource such as plankton (Nwadiaro, 1989), their prolific breeding capabilities and their strong adaptation to lacustrine conditions of the Lake (Adeyemi et al., 2010). Another explanation is the fact that these species reproduce three to four times in the year compared to the species which reproduce once or twice as noted Bankole et al. (1994). Therefore, these fishes have high rate of juvenile and adult survival, or strong competitive abilities that allow them to dominate other species as suggested Van Dyke (2003).

At the specific level, the fish *Coptodon zillii* and *Oreochromis niloticus* are the most abundant of the catches in terms of numbers and biomass. The high proportion of *C. zillii* is explained by the fact that this fish is characterized by its faculties of adaptation, its high rate of reproduction and it is present in most of the rivers which irrigate certain water reservoirs (Ruwet et al., 1976). This would justify the presence of *C. zillii* in the Rêverie farm water reservoir. In this environment, the abundance of the species *Oreochromis niloticus* would be due to the fact that it finds there the favorable conditions for its reproduction and its growth. In addition, the high proportion of this species would be linked to the presence of floating cage fish farming on this water reservoir. Specimens of this species would have escaped from the cages to colonize the water body and increase their numbers.

The specific richness recorded did not show a significant difference during the two seasons. This specific composition of the catches reflects a good adaptation to the environmental conditions of the dominant species (Alhousseini, 2002) and these species could also have a large margin of tolerance to environmental factors (Yao, 2006). This study revealed that the family Cichlidae represented mostly by the species *Coptodon zillii* and

Oreochromis niloticus which dominate the fish population during the two seasons. Their high proportion could be explained by the effect of the reservoirs on the water body. Indeed, in a general way, the creation of reservoirs is followed by the colonization of these lakes by species of Cichlidae and some riverine species (Koné et al., 2003 a, b). According to these authors, in such environments the increase of the water level during the rainy season increases the immersed surfaces. The submergence of the surrounding vegetation leads to the nutrients for the fish. The species which exploit these resources and reproduce will be the most numerous.

According to Barbault (2000) and Dajoz (2000), good settlement organization results in an equitability equitability close to 1. Low equitability results from the predominance of a few species over all other. However, when there is not an overabundance of some organisms, the specific diversity is more important because spaces are freed up, thus favoring the proliferation of several other species. In this study, the Shannon diversity H' and equitability E indexes values obtained are respectively of 2.49 and 0.79 during the rainy season and 2.36 and 0.72 during the dry season. These values indicate a fairly good organization of the ichthyological population in the Rêverie farm water reservoir. Indeed, firstly, some species were caught ; hence a value of H' higher than 0. Secondly, some of these species such as *Oreochromis niloticus* and *Coptodon zillii* predominate over the others; resulting in a value of E lower than 1. This could be explained by the fact that this water reservoir is located in a private area which is far from anthropogenic activities which tend to degrade the environment

Conclusion

This investigation is a preliminary study of the ichthyological fauna of the Rêverie farm water reservoir. The specific richness of fish, although low (9 species) contributes to the animal biodiversity. The study also reveals that this farm water reservoir is a good environment for the growth and conservation of fish species. The improvement of fish biodiversity in pastoral hydraulic reservoirs must be based on a sustainable management approach of the ecosystem of these reservoirs including the implementation of environmentally friendly agricultural practices. Pastoral water reservoirs are a real asset for boosting livestock and agriculture in Côte d'Ivoire.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

YEA and KGB collected the data, analyze them and wrote the manuscript.

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REFERENCES

Adeyemi SO, Akombu PM, Adiukwu IA. 2010. Diversity and abundance of fish species in Gbedikere Lake, Bussa, Kogi State. *J. Res. Fores. Wil. Env.*, **2**(1): 1–6.

Adou YE, Blahoua KG, Bamba M, Yao SS, Kouamélan EP, N'Douba V. 2017. Premières données sur l'inventaire du peuplement ichtyologique d'un lac ouest Africain situé entre deux barrages hydroélectriques : lac d'Ayamé 2 (Côte d'Ivoire). *J. Appl. Biosci*., **110**: 10808-10818. DOI : http://dx.doi.org/10.4314/jab.v110i1.11.

Alhousseini S. 2002. Le poisson, une nouvelle ressource au barrage de Manantali. In *Gestion Intégrée des Ressources Naturelles en Zones Inondables Tropicales*, Orange D, Arfi R, Kuper M,

Morand P, Poncet Y (eds). Éditions IRD : Paris ; 501-513.

Barbault R. 2000. *Ecologie Générale : Structure et Fonctionnement de la Biosphère* (5ème édn). Dunod : Paris ; 326 p.

Cecchi P. 2007. Les petits barrages de Côte d'Ivoire. L'eau en partage. Institut de Recherche pour le Développement (IRD) Edition. Collection Latitude 23. 302 p.

Da Costa KS, Traoré K, De Morais LT. 1998. Effort de pêche et production exploitée dans les petites retenues du nord de la Côte d'Ivoire. *Bull. Fr. Pêche. Piscic*., **348** : 65-7.

Da Costa KS. 2002. Structure des peuplements et déterminisme de la diversité spécifique de l'ichtyofaune et pratique durable de la pêche dans quelques hydrosystèmes africains: Cas des bassins Agnébi, Bia et de 13 petits barrages du Nord de la Côte d'Ivoire. Thèse de Doctorat. Université d'Abobo-Adjamé, 213 p.

Dajoz R. 2000. *Précis d'Ecologie* (7ème édition). Dunod : Paris ; 615 p.

Eldin M. 1971. Le climat. In : Le milieu naturel en Côte d'Ivoire (Avenard JM, Eldin M, Girard G, Sircoulon J, Touchebeuf P, Guillaumet JL, Adjanohoun E, Perraud A, eds.). Mémoires ORSTOM, 50 : 77-108.

FAO. 2016. Situation mondiale des pêches et de l'aquaculture 2014. FAO, Rome, 200 p.

FAO. 2018. FAO publications catalogue. 2018.

Hugueny B. 1990. Richesse des peuplements de poissons dans le Niandan (Haut Niger, Afrique) en fonction de la taille de la rivière et de la diversité du milieu. In Les Poissons des Eaux Continentales Africaines : Diversité, Ecologie, Utilisation par l'Homme, Lévêque C, Paugy D (eds). IRD Edition; 237-249.

Ita EO. 1993. Inland Fishery Resources of Nigeria. CIFA Occasional paper No.20 Food and Agricultural Organization of the United Nations, Rome. 120pp.

Kantoussan J. 2007. Impacts de la pression de pêche sur l'organisation des peuplements de poissons : application aux retenues artificielles de Sélingué et de Manantali, Mali, Afrique de l'Ouest. Thèse de doctorat, Agrocampus Rennes, 195 p.

King M. 1995. *Fisheries Biology, Assessment and Management*. Fishing News Books: Oxford, UK.

Komolafe OO, Arawomo GAO. 2008. Preliminary observations on fish species in a newly impounded Osinmo Reservoir. *Turkish J. Fish. Aquat. Sci.*, **8**: 289-292.

Koné T, Teugels GG, N'Douba V, Gooré Bi G, Kouamélan EP. 2003 a. Premières données sur l'inventaire et la distribution de l'ichtyofaune d'un petit bassin côtier ouest-africain : Rivière Gô (Côte d'Ivoire). *Cybium*., **27** (2): 101-106.

Koné T, Teugels GG, N'Douba V, Kouamélan EP, Gooré Bi G. 2003 b. Fish assemblages in relation to environmental gradients along a small west African coastal basin, the San Pedro River, Ivory Coast. *Afr J Aquat Sci.*, **28** (2): 163-168.

Kouassi DK, Diaby M, Soro Y, N'Da K. 2020. Faune ichtyologique du lac de barrage Solomougou (Korhogo, Côte d'Ivoire). *Int. J. Biol. Chem. Sci*., **14**(7): 2528-2537.

Liquete C, Piroddi C, Macías D, Druon J-N, Zulian G. 2016. Ecosystem services sustainability in the Mediterranean Sea: assessment of status and trends using multiple modelling approaches. *Scientific Report*, **6**(34162): 1-14.

Ludwig JA, Reynolds JF. 1988. *Statistical Ecology: A Primer on Methods and Computing*. John Wiley & Sons: New York; 7 p.

Mamonekene V, Lavoué S, Pauwels OSG, Beh JHM, Mackayah JE, Tchignoumba L. 2006. Diversité des poissons de Rabi et

Gamba, province de l'Ogooé-Maritime, Gabon. *Bull. Biol. Soc. Wash*., **12**: 65-78.

Montchowui E, Chikou A, Kogbeto MJ, Lalèyè P, 2008. Biodiversité et structure des communautés de poissons du lac Hlan au Benin. *Int. J. Biol. Chem. Sci*., **2** (2): 196-206. DOI: 10.4314/ijbcs.v2i2.39733

Ouattara M, Gourène G, Touré V. 2006. Propositions de fermeture saisonnière de la pêche en vue d'une exploitation durable du poisson au lac d'Ayamé (Côte d'Ivoire). *Tropicultura*., **24**: 1-13.

Ouedraogo R, Soara AE, Oueda A, 2015. Description du peuplement piscicole du lac Sahélien de Higa, un site Ramsar du Burkina Faso, Afrique de l'Ouest. *J. Appl. Biosci* ., **95** : 8958-8965.

Paugy D, Lévêque C, Teugels GG (eds). 2003a. *Faune des Poissons d'Eaux Douces et Saumâtres de l'Afrique de l'Ouest* (Tome 1). IRD (Paris), MNHN (Paris), MRAC (Tervuren) ; 457 p.

Paugy D, Lévêque C, Teugels GG. 2003b. *Faune des Poissons d'Eaux Douces et Saumâtres de l'Afrique de l'Ouest* (Tome 2). IRD (Paris), MNHN (Paris), MRAC (Tervuren); 815 p.

Piélou EC. 1984. *The Interpretation of Ecological Data*. Wiley & Sons: New York; 7 p.

Ruwet JCJ, Voss L, Hanon J, Micha C. 1976. Biologie et élevage du tilapia. ln: Symposium on Aquaculture in Africa, FAO!CJFA. Tech. Pap., 4 (suppl. 1), 332-364.

Shannon EC, Weaver W. 1963. The mathematical theory of communication. University of Illinois Press; 117 p.

Van DYKEF. 2003. *Conservation Biology; Foundations, Concepts, Applications*. Springer : Netherlands.

Yao SS. 2006. Étude de la diversité biologique et de l'écologie alimentaire de l'ichtyofaune d'un hydrosystème Ouest africain : Cas du bassin de la Comoé (Côte d'Ivoire). Thèse de Doctorat, Université de Cocody-Abidjan (Côte d'Ivoire), 280 p.