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Community of macroinvertebrates of the Affon River water in Bénin

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Abstract

The present study aims at making an inventory of the Affon River's macroinvertebrates. By means of a Suber net, they were sampled in low water in seven different stations along the river. We had thus possessed in the calculations of their occurrence frequency, the Simpson Index, the Shannon Biodiversity Index and the equitability of Piélou. Of the 1250 species of macroinvertebrates summed and divided into 3 classes, 11 orders and 24 families were inventoried. From there, the insects with 68.56% of the species' richness were the most diversified because we found that 54.17% of the groups captured are rare species. It is thus noted that low diversity and fairness values strongly noticed in the majority of the experiment stations show the river's bad quality under the influence of used domestic water discharged, as well as agricultural effluents. So it is important to note that this situation has resulted in the disappearance of several species of Macroinvertebrates especially those pollution-sensitive but looking at the high rate of the diversity of the pollution-sensitive macroinvertabrates in Teneka 1 station, it shows that the water therein is of a very good quality. Thus, further studies need to be undertaken to study the ecological status of the river using biotic indices in order to make adequate decisions for its sustainable management and avoid its irreversible degradation.

Keywords: macroinvertebrates, pollution, water quality, affon river, bénin

1. Introduction

The comparison of measurements series of water physico-chemical parameters to the standards of the approved quality has often been made in evaluating a water quality. According to Hepp *et al.*, [1] they stated that this method based on the measurement of physical and chemical parameters is less effective in the detection of pollution. Hence, they are being abandonned and exchanged by biological criteria called bio-indicators. In accordance to that, Benetti and Garrido [2] demonstrated that macroinvertebrate are nowadays very useful and widely used as a bio-indicator in determining the ecological status of aquatic environments. In the same vein, Camargo *et al.* [3] pointed out that their use as a good indicator of the ecological conditions of aquatic ecosystems is due to: their presence, their abundance in all types of waterways, their sedentary longevity and the diversity of their responses to disturbances of those ecosystems. Their fundamental role in the food web is shown by Gnohossou [4] as well as their role in the decomposition of organic materials in rivers according to Tenkiano [5].

More over, the macroinvertebrate community is often used as an indicator of the effects of human activity on aquatic ecosystem and it is thus important to note that its study is of paramount importance because it provides a wealth of information on the quality of water and habitat according to Woodcock and Huryn [6]. Sanogo *et al.* [7] furthermore emphasized that the various macroinvertebrates spread over the different strata of water are characterized by their differential pollution-sensitivity, which is essential in bioindication of hydrosystems.Towards the north of Benin, these benthic macroinvertebrates of the Affon river located in the Upper Ouémé basin are still unknown and not studied despite the research carried out in some nearby rivers such as: the upper part of the Ouémé River by Abahi *et al.* [8], the Alibori River by Agblonon Houelome *et al.* [9], the same by Imorou Toko *et al.* [10], and the Sota River by Orou Piami [11]. To fill this gap, we carried out our research on the Affon River which is a relatively anthropized watercourse located in the Donga Region in order to provide a first database of macroinvertebrates of this region.

2. Materials and methods

2.1 Study area

The Affon River located on the right bank and in the classified forest of the Upper Ouémé in the Sudano-Guinean zone is one of the tributaries of the Ouémé River. 152 km long with a catchment area of 4320 km², it is influenced by the tropical climate characterized by the succession of a single rainy season in the year between April and October and a single dry season from November to March which is often marked by the preponderance of the harmattan.

After the survey, macroinvertebrates were collected in low water, upstream and downstream on the Affon River. Indeed, seven different stations were chosen to serve as a sample according to five main criteria namely: the altitude, the water permanence, the depth, the speed of water flow and the accessibility in all seasons used by Abahi *et al.* [8]

research in this field (Table 1).

Table 1: Characteristics of sampling stations

Stations	Code	Altitudes	Geographiccoordinates	
			Longitude	Latitude
Taneka 1	Tan1	486 m	9°51’21N	01°32’34E
Taneka 2	Tan2	440 m	9°52’39N	01°31’00E
Taneka 2	Tan3	400 m	9°52’47N	01°30‘88E
Kolokondé	Kol	376 m	9°53’88 N	01°47’47 E
Kpébouko	Kpe	360 m	9°57’53 N	1°51’42 E
Afféou 1	Aff1	351 m	9°56’55 N	1°50’51 E
Afféou 2	Aff2	334 m	9°56’57 N	1°50’53 E

2.2 Data collection
With a surber net surging on a source area of 1/20 m² and a 500 -µm mesh used by Archaimbault and Dumont [12] during their research, the macroinvertebrates were sampled in the dry season at the seven stations selected. At each station, twelve samples were taken, eight of which were dominant habitats and four of which were marginal habitats as done by Archaimbault [13]. On a few centimeters by hand we scratched the substrates which allows to collect the organisms in the net because the surber has already been laid on the substrates but with the opening of the net against the stream of water [14]. The organisms thus captured were then fixed at 10% formalin in some well labeled plastic bowls which were carried to the laboratory.

2.3 Macoinvertebrates Identification
In the laboratory, these captured macroinvertebrates were rinsed in order to rid them of the formalin and then they were sorted station by station under a binocular dissecting microscope. After the sorting, we grouped them according to their class up to their family apart from oligochaetes, nemathelminths, hydracarians, hydrozoans, sponges, bryozoans and nemers that are kept aside such as Archaimbault [13] and Abahi *et al*. [8] have done. The taxonomic determination was made using the following keys: "benthic macroinvertebrates of the streams of "la Nouvelle-Calédonie" by Mary [15], "identification guide of the main benthic macroinvertebrates of freshwater from Quebec written by Moisan [16], "Freshwater invertebrates: Systematics, biology, ecology" by Tachet *et al*. [17] and "Aquatic entomology" by McCafferty [18] after which macroinvertebrates were enumerated and then stored in pillboxes containing 70% alcohol.

2.4 Data interpretation
The fauna data identified allowed us to calculate the following metrics and indices:

Taxonomic richness (S) = number of taxa present in each station

Abundance (N) = number of individuals from a taxonomic group in each station

Relative abundance (Nr) = ratio as a percentage of the number of taxon individuals in a station to the total number of individuals of all species of all stations.

Frequency of family observation (FO) = (F_i × 100)/F_t. An such, F_i = number of stations containing the family and F_t = total number of stations studied. Three families were thus distinguished as Abahi *et al*. [8] has previously demonstrated. We have the very frequent families (F≥50%), the frequent families (25%≤F≤50%) and the rare families (F≥25%).

Shannon index (H) = -£pi.log2pi, with **pi** meaning the relative abundance of the i species in the sample. The Shannon index is expressed in bits.

Piélou index (E) = H'/log2S with **S** standing for the total number of individuals.

Simpson index (D) = $1-£_{i=1}^{s}(pi)^2$ with **S** standing for the total number of individuals and **pi=** meaning the relative abundance .

2.5 Statistics analysis of data
Parametric and non-parametric tests (test t student and test of Kruskal-Wallis) were used to evaluate the variability of the taxonomic richness of the abundances and diversity indices at the 5% threshold with the R3.4.2 software [19]. Moreover, the factorial correspondence analysis (FCA) was used for grouping the stations according to the similarity association of macroinvertebrates families.

3. Results
3.1 Taxonomic richness of the harvested benthic macrofauna
At the end of the harvest, we recorded a total number of:

- 24 families, 11 orders and 3 classes of macroinvertebrates (Table 2).

Table 2: List of macroinvertebrates collected in the study area

Classes/orders	Families	Tan1	Tan2	Tan3	Kol	Peb	Aff1	Aff2	Nr (%)	FO (%)
Insects										
Plecoptera	Perlodidae		*						0,08	14,29
Trichoptera	Beraeidae		*						0,08	14,29
Trichoptera	Rhyacophilidae			*					0,24	14,29
Ephemeroptera	Baetidae	*		*	*			*	1,04	42,86
	Ephemerellidae	*	*	*	*	*	*		1,68	85,71
	Isonychiidae							*	0,24	14,29
	Leptophlebiidae			*			*		0,40	28,57
	Potamanthidae		*						0,96	14,29
Heteroptera	Corixidae	*		*	*		*		1,52	57,14
	Gerridae	*							0,40	14,29
	Notonectidae			*					0,08	14,29
	Veliidae	*		*					0,16	28,57
Coleoptera	Dytiscidae	*	*				*		0,56	28,57

	Elmidae	*							0,08	14,29
	Gyrinidae					*	*		0,16	28,57
Diptera	Chironomidae	*	*	*	*	*	*	*	48,08	100
	Simuliidae	*			*	*	*		9,52	57,14
	Not identified							*	0,24	14,29
Odonata	Libellulidae				*	*		*	2,80	57,14
	Platycnemididae				*				0,16	14,29
Lepidoptera	Pyralidae	*							0,08	14,29
Worms										
Oligochaeta	Oligochaeta	*		*	*	*	*	*	30,96	85,71
Nemathelmintes	Nemathelmintes							*	0,08	14,29
Arachnid										
Hydracarians	Hydracarians						*		0,40	14,29
Taxonomic richness per station		12	7	10	7	5	10	6		
Total abundance per station		88	70	231	493	116	129	123		

Legend: *=Presence of the species; FO = Frequency of occurrence (en %); Tan= Tanéka; Kol=Kolokondé; Kpe=Kpébouko ; Affe=Afféou

- 8 orders and 21 families of insects that accounted for 68.56% of the total wealth.
- 2 orders of worms representing 31.04% of the total wealth.
- 1 order of arachnids which constituted only 0.40% of the total wealth (Figure 1).

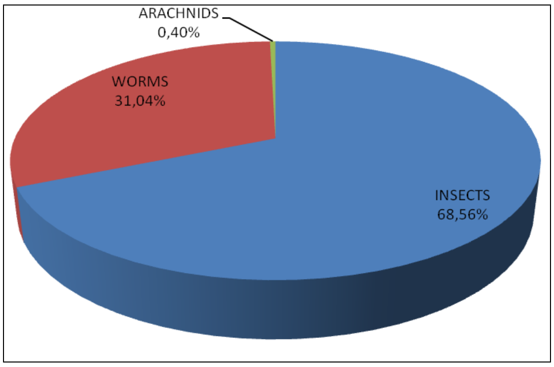


Fig 1: Taxonomic richness of the harvested benthic macrofauna

As for the orders, the Diptera composed of 57, 84% of the total number were the most abundant. Then the Oligochaeta and Ephemeroptera followed respectively with 30, 96% and 4, 32% of the total number of individuals harvested (Figure 2).

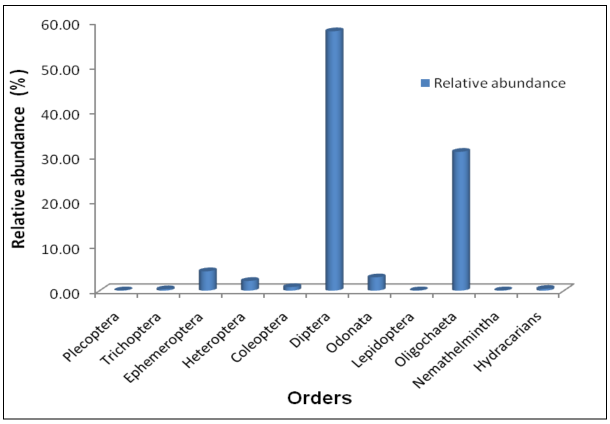


Fig 2: Abundance of the orders of haverstedmacroinvertebrates

Concerning the families, the Chironomidae was the most dominant family with 48.8% of the total richness (Table 3).

Table 3: Spatial variation of ecological indexes

Stations	Shannon index (H')	Piélouindex (E)	Simpson index (D)
Taneka1	1,85	0,75	0,75
Taneka2	1,00	0,51	0,48
Taneka3	0,98	0,43	0,41
Kolokonde	1,04	0,54	0,59
Pebouko	1,16	0,72	0,64
Affeou1	1,44	0,37	0,62
Affeou2	0,86	0,55	0,46
Probabilities	0,00009	0,00004	0,00001

Followed by the Oligochete (30,96%), the Simuliidae (9,52%) and the Libellulidae (2,80%), others remaining families are less represented and they are composed of only 8,64.

3.2 Harvested macroinvertebrate taxa's occurrence frequency

The frequency of occurrence of families was calculated from the presence-absence matrix of macroinvertebrates. Thus, 6 families including Corixidae, Simulidae, Dragonfly, Ephemerellidae, Oligochaetes and Chironomidae were found to be the most frequent (25%). Likewise, 5 other families were discovered, being the frequent (20.83%). There are: Leptophlebiidae, Veliidae, Dytisxidae, Gyrinidae and Baetidae. Finally, 13 other families were detected as rare (54.17%).

3.3 Spatial variation of taxonomic richness and abundance

In this section, we focused on the taxonomic richness and abundance spatial variation. Thus, a total number of 1250 benthic macroinvertebrate individuals were inventoried during the study and we found that there is an overall growth from the source (Tanéka) till Kolokondé before a decay is noticed. This explains the higher yield of 493 individuals at Kolokondé station and the low one recorded at the station of Tenéka 2 (Figure 3).

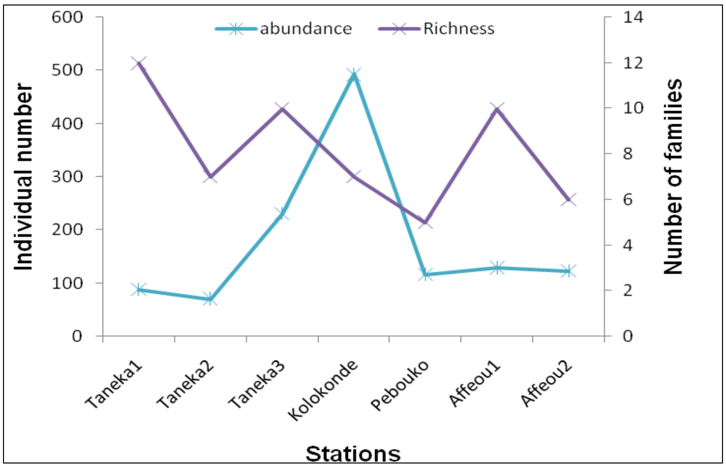


Fig 3: Variation of richness and Taxonomic Abundance of Affon River Macroinvertebrates

3.4 Spatial variation of economic indices of macroinvertebrates

Taking a look at Table 3, we can see a clear detail on the study of spatial variations of the Simpson index, the Shannon biodiversity index and Piélou equitability index. For example at Afféou station 2, the Shannon index varied by 0.86 bit while at Téneka station 1, it is 1.85 bit. Concerning Piélou index, we also noted values fluctuating by 0.37 and 0.75 respectively at Affeou station 1 and Tenéka 1. Speaking of Simpson index, it varied by 0.41 at Teneka Station 3 and 0.75 at Teneka Station 1. Those indexes showed significant variations between stations.

3.5 Biotypology of stations

The hierarchical classifications made from a presence-absence matrix of 24 families of macroinvertebrates revealed that the information contained in the variables are controlled at 53.67% by the dimension 1 and 2 system. It actually helped us to group the stations in three different groups which are: (i) the Afféou 1 station group, (ii) the Teneka 1 station group, (iii) the Teneka 2, teneka 3, kolokondé, Afféou 2 and Pébouko stations group (Figure 4).

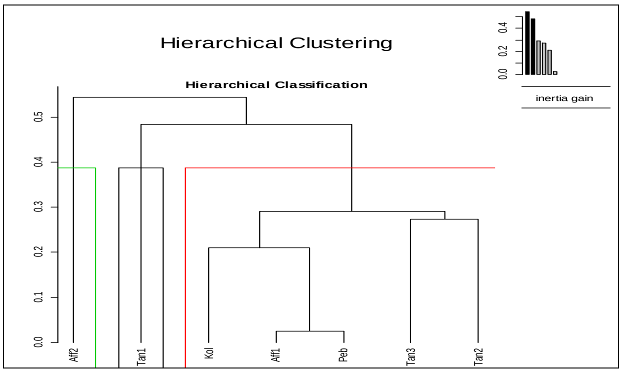
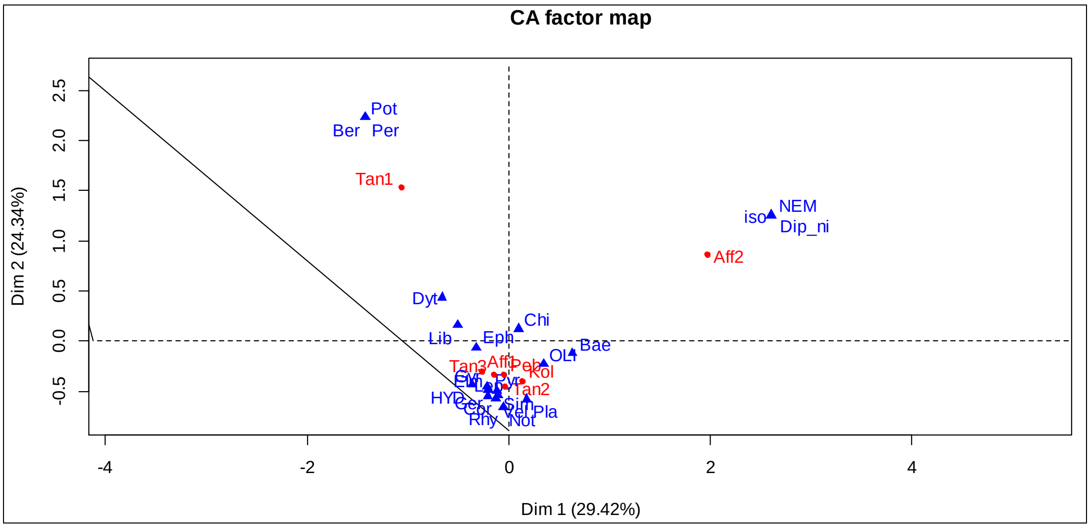


Fig 4: Dendrogram of the stations according to the similarity of association of the macroinvertebrate families

The results of the factorial correspondence analysis has revealed to us the relationship between the different stations and the families of macroinvertebrates. From the above, we can see the following associations (Figure 5):



Legend: Aff= Afféou ; Tan= Taneka ; Kol= Kolokondé ;Peb=Pébouko; Perlidae= Per ; Rhyacophilidae =Rh ; Caenidae= Ca ; Baetidae= Ba ; Potamanthidae= Po ; Notonectidae= No ;Elmidae= Elm ; Dytiscidae= Dyt ;Chironomidae= Chir ; Culicidae= Cul ; Libelludiae= Lib ; Pyralidae= Pyr ; Nematodes=Nem ; Hydracarians= HYD.

Fig 5: Factorial map of stations showing the distribution of macroinvertebrate families

Group I: Characteristic taxa: Nemathelminths, Diptera non identified and isonychiidae.

Group II: Characteristic taxa: Potamanthidae, Beraeidae and Perlodidae

Group III: Characteristic taxa: Rhyacophilidae, Baetidae, Ephemerellidae, Leptophlebiidae, Corixidae, Gerridae, Notonectidae, Veliidae, Dytisxidae, Elmidae, Gyrinidae, Chironomidae, Simuliidae, Libellulidae, Platycnemididae, Pyralidae, Oligochaetae and Hydracarians.

4. Discussion

The study of the Affon River's macroinvertebrates has identified 24 families, 11 orders and 3 classes. The taxonomic richness recorded is lower than that obtained in the Comoé River (49 families) Ivory Coast by Kra *et al*., [20] and in the Alibori River (41 families) Benin Republic by Agblonon Houelome *et al*., [9] but identical to that of the upper stream of the Ouémé river (24 families) obtained by Abahi *et al*. [8]. Thus, we can say that the difference observed in our study compared to that of Kra *et al*., [20] and that of Agblonon Houelome *et al*., [9] would be due to the sampling period and to the Surber net used because we used a surber net surging on a source area of 1/20 m² and a 500 - µm mesh contrary to Kra *et al*., [20] and Agblonon Houelome *et al*., [9] who used the troubleau net and the 25 cm dump of type Eckman.

The captured benthic fauna is strongly represented by insects. This diversity of the harvested macro fauna is marked by the Diptera predominance dominated mainly by the Chironomidae family. Previous studies on macroinvertebrates in the northern Benin have shown that the class of insects and the Chironomidae family are the most important taxa. Similar results were recorded by Alhou *et al*. [21] on the River Niger and Diomandé *et al*. [22] on the River Agnéby in Ivory Coast. The proliferation of Chironomidae observed explains the abundance of organic matter accumulated in the river. In that respect, Adandedjan *et al*. [23] in their research have shown that when the organic load becomes important, the pollution-sensitive species disappear to give place to the pollution-tolerant one like the Chironomidae. The Benthic standing structure also shows that the stream hosts a poorly diversified and unbalanced stand compared to the streams studied by Foto *et al*. [24] and by Camara *et al*. [25]. The values of the indices are higher at the Taneka 1 station than the one obtained at the other stations. This allows us to affirm that the upstream macroinvertebrate community is diversified and organized. Thus, the upstream of Taneka 1 presents the best conditions for the development of macroinvertebrate communities that could be due to the fact that this station undergoes less anthropic disturbance. These observations are similar to that of Camara *et al*. [25] and Dalu *et al.* [26] The assembly of the Teneka 1 station with Potamanthidae, Beraeidae And Perlodidae which are pollution-sensitive families could be attributed to the best conditions for the development of the macroinvertebrate communities that this station possesses. All observations attest to the good quality of station 1 compared to others.

5. Conclusion

In short, the Affon Rive's macroinvertebrates survey made it possible to have an idea of the diversity of macroinvertebrates and the pressure to which the environment is subjected by the numerous anthropogenic activities. This study deserves thus to be more studied in order to evaluate the ecological quality of this river with biotic indices specific to the country standard. This will help to make adequate decisions for a sustainable management of this river.

6. Acknowledgements

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7. Conflict of Interest

The authors declare no conflict of interest in the present study.

8. References

1. Hepp LU, Milesi SV, Biasi C, Restello RM 2010. Effects of agricultural and urban impacts on macroinvertebrates assemblages in streams (Rio Grande do Sul, Brazil). Zoologia (Curitiba). 2010; 27(1):106–113.
2. Benetti CJ, Garrido J. The influence of water quality and stream habitat on water beetle assemblages in two rivers in northwest Spain. Vie et milieu. 2010; 60(1):53–63.
3. Camargo JA, Alonso A, De La Puente M. Multimetric assessment of nutrient enrichment in impounded rivers based on benthic macroinvertebrates. Environmental Monitoring and Assessment. 2004; 96(1):233–249.
4. Gnohossou P. La faune benthique d'une lagune ouest Africaine (le lac Nokoue au Bénin), diversite, abondance, variations temporelles et spatiales, place dans la chaine trophique (Institut National Polytechnique de Toulouse). Consulté à l'adresse http://ethesis.inp-toulouse.fr/archive/00000481/ 2006.
5. Tenkiano NSD. Macroinvertébrés benthiques et hyphomycètes aquatiques : diver- sité et implication dans le fonctionnement écosystémique des cours d'eau de Guinée. Biodiversité et Ecologie. Universite Toulouse 3 Paul Sabatier (UT3 Paul Sabatier), 2017.
6. Woodcock TS, Huryn AD. The response of macroinvertebrate production to a pollution gradient in a headwater stream. Freshwater Biology. 2007; 52:177-196.
7. Sanogo S, Kabré TJA, Cecchi P. Inventaire et distribution spatio-temporelle des macroinvertébrés bio-indicateurs de trois plans d'eau du bassin de la Volta au Burkina Faso. International Journal of Biological and Chemical Sciences. 2014; 8(3):1005-1029.
8. Abahi KS, Gnohossou P, Akodogbo HH, Orou Piami Z, Adje D, *et al*. Structure et diversité des macroinvertébrés benthiques de la partie supérieure du fleuve Ouémé au Bénin. Afrique Science: Revue Internationale des Sciences et Technologie. 2018; 14(6):259-270.
9. Agblonon Houelome TMA, Adandedjan D, Chikou A, Imorou Toko I, Koudenoukpo CZ, Youssao I, Laleye P. Inventaire et caractéristiques faunistiques des macroinvertébrés de la rivière Alibori dans le bassin

cotonnier du Bénin. International Journal of Innovation and Applied Studies. 2017; 21(3):433-448.
10. Imorou Toko I, Attakpa EY, Gnohossou P, Aboudou EF. Biodiversité et structure des macroinvertébrés benthiques du bassin cotonnier béninois. Annales des Sciences Agronomiques. 2012; 16(2):165-182.
11. Orou Piami Z. Diversité et distribution spatiale des macroinvertébrés benthiques de la rivière Sota au Bénin. Mémoire pour l'obtention du Diplôme de Master Recherche de l'Ecole Doctorale des Sciences Agronomiques et de l'eau de l'Université de Parakou, Bénin, 2018.
12. Archaimbault V, Dumont B. L'indice biologique global normalisé (IBGN): principes et évolution dans le cadre de la directive cadre européenne sur l'eau. Sciences Eaux Territoires: la revue du IRSTEA. 2010; 1:39-39.
13. Archaimbault V. L'indice Biologique Global Normalisé français (IBGN, Norme AFNOR NF T90 –350, 2004) : ses principes et son évolution dans le cadre de la Directive Cadre Européenne sur l'Eau, 2004.
14. Agence de l'eau. Indice Biologique Global Normalisé (I.B.G.N NF - T 90 - 350): Guide technique, 1992.
15. Mary N. Les macroinvertébrés benthiques des cours d'eau de la Nouvelle-Calédonie. Guide d'identification. Version révisée 2017 (DAVAR Nouvelle-Calédonie). Consulté à l'adresse www.oeil.nc, 2017.
16. Moisan J. Guide d'identification des principaux macroinvertébrés benthiques d'eau douce du Québec, 2010: surveillance volontaire des cours d'eau peu profonds. Consulté à l'adresse www.mddep.gouv.qc.ca, 2000
17. Tachet H, Richoux P, Bournaud M, Usseglio-Polatera P. Invertébrés d'eau douce : systématique, biologie, écologie. CNRS Editions, 2000.
18. McCafferty PW. Aquatic entomology. The fisherman's and ecologists'Illustrated. Guide to Insects and their relatives. London, 1981.
19. R Core Team. R: A Language and Environment for Statistical Computing. Vienna, Austria: R Foundation for Statistical Computing, 2018.
20. Kra MK, Camara IA, Edia EO, Konan MK, Diomande D, Ouattara A. Qualitative analysis of aquatic macroinvertebrates in lower comoe river (Côte d'Ivoire). International Journal of Fisheries and Aquatic Studies. 2018; 6(2):472-481.
21. Alhou B, Micha J-C, Dodo A, Awaiss A. Etude de la qualité physico-chimique et biologique des eaux du fleuve Niger à Niamey. International Journal of Biological and Chemical Sciences. 2009; 3(2):240-254.
22. Diomandé D, Bony YK, Edia EO, Konan KF, Gourene G. Diversité des Macroinvertébrés Benthiques de la Rivière Agnéby (Côte d'Ivoire; Afrique de l'Ouest). European Journal of Scientific Research. 2009; 35(3):368-377.
23. Adandedjan D, Lalèyè P, Gourene G. Macroinvertebrates communities of a coastal lagoon in southern Benin, West Africa. International Journal of Biological and Chemical Sciences. 2012; 6(3):1233–1252.
24. Foto MS, Zebaze TSH, Nyamsi TNL, Ajeagah GA, Njiné T. Evolution Spatiale de la Diversité des Peuplements de Macroinvertébrés Benthiques dans un cours d'eau Anthropisé en Milieu Tropical (Cameroun). European Journal of Scientific Research. 2011; 55(2):291-300.
25. Camara AI, Diomande D, Gourène G. Impact des eaux usées et de ruissellement sur la biodiversité des macroinvertébrés de la rivière banco (parc national du banco ; côte d'ivoire). Revue CAMES: Science de la vie, de la terre et agronomie. 2014; 2(1):58-68.
26. Dalu T, Clegg B, Nhiwatiwa T. Macroinvertebrate communities associated with littoral zone habitats and the influence of environmental factors in Malilangwe Reservoir, Zimbabwe. Knowledge and Management of Aquatic Ecosystems. 2012; 406:06.