THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

Influence of Water Physico-Chemical Parameters on the Distribution of the Communities of Macro invertebrates of Affon River in Bénin

Fadéby Modeste GOUISSI
Assistant Professor, Department of Management of Natural Resources (AGRN), University of Parakou (UP) BP 123 Parakou Bénin
Midogbo Pierre GNOHOSSOU
Associate Professor, Department of Management of Natural Resources (AGRN), University of Parakou (UP) BP 123 Parakou Bénin
Koudjodé Simon ABAHI
M.Sc. Student, Department of Management of Natural Resources (AGRN), University of Parakou (UP) BP 123 Parakou Bénin
Jeff Gildas Antoine OKOYA
M.Sc. Student, Water and Soil Engineering, University of Parakou (UP) BP 123 Parakou Bénin
Darius ADJE
M.Sc. Student, Laboratory of Ecology, University of Parakou (UP) BP 123 Parakou Bénin
Christelle Madina TCHAOU
M.Sc. Student, Health and Animal Production (LESPA), University of Parakou (UP) BP 123 Parakou Bénin
Zoulkanerou OROU PIAMI
M.Sc. Student, Faculty of Agronomy (FA), University of Parakou (UP) BP 123 Parakou Bénin

Abstract:
The objective of the study is to evaluate the influence of physico-chemical parameters on the distribution of macro invertebrates. Thus, for mapping biotic data, the 24 families collected and the matrix of physico-chemical parameters, a Canonical Correspondence Analysis (CAC) was performed. Physical analysis results indicate that the pH, depth, conductivity, TDS, and dissolved oxygen influence the distribution of macro invertebrates. In addition, a positive correlation was observed between the pollution-sensitive families: Perlodidae, Beraeidae, Potamanthidae and the pH, the dissolved oxygen, the conductivity then the TDS.

Keywords: *Physico-chemical parameters, distribution, macro invertebrates, Affon River*

1. Introduction

Macroinvertebrates are the most diverse and abundant organisms in aquatic systems and are a key element in the functioning of aquatic ecosystems (Gnohossou 2006, Moisan et al., 2013). The study of these benthic organisms is useful for assessing the overall health of aquatic ecosystems and providing a biological complement to the physico-chemical quality monitoring program for rivers (Moisan et al., 2013). Thus, the physic-chemical nature of river waters explains the presence or absence of certain aquatic species and affects their development (Tufféry 1980) and each organism is sensitive to abiotic factors of the living environment (Gaujous 1993). In addition, research on the links between macroinvertebrates and their environment are lacking at the river of Benin, particularly in northern Bénin; resulting in poor river management practices. However, in many rivers, water is severely polluted because of agriculture, urban and industrial discharges containing high concentrations of nutrients, organic matter (Pan et al., 2013). As a result, anthropogenic pollutants alter the composition of aquatic communities as a whole (Xu et al., 2014). Previous studies on macroinvertebrate assemblages have shown that macroinvertebrates are affected by altitude (Loayza-Muro et al., 2013), water temperature (Tenkiano 2017), conductivity (Stenert et al., 2008), the speed of flowing (Beauger 2008), dissolved oxygen (Kaller & Kelso 2007), substrates (Beauger 2008) and slope (Roy et al., 2003). Therefore, a better understanding of macroinvertebrate communities in relation to environments is of great interest for river management (Neff & Jackson 2011). Thus, the objective of this study is to study the links between environmental variables and the macroinvertebrate community of the Affon River.

2. Materials and Methods

2.1. Study Area

The Affon River located on the right bank and in the upper Ouémé classified forest in the Sudano-Guinean zone is one of the tributaries of the Ouémé River. It has a length of 152 km and a catchment area of 4320 km². The river is located in the Sudano-Guinean zone and is under the influence of the tropical climate characterized by the succession in the year of a single rainy season from April to October and a single dry season from November to March, marked by the preponderance of the harmattan.

After the exploration, the macroinvertebrates' collection was done in low water from upstream to downstream on the Affon River. Indeed, seven stations (Table 1) were selected for sampling according to five criteria: altitude, water sustainability, depth, speed of water flow and accessibility in all seasons (Abahi et al., 2018).

Stations	Code	Altitudes	Geographic Coordinates	
			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

Table 1: Characteristics of Sampling Stations

2.2. Data

The data used are the biotic data constituted from a presence-absence matrix of the 24 families collected and the abiotic data constituted by the measurement values of the 7 physico-chemical parameters of the stations.

2.3. Data statistic analysis

For mapping biotic data (24 taxa) and abiotic data (7 physicochemical parameters) obtained during the sampling, a Canonical Correspondence Analysis (CCA) was performed using the Past software (Hammer et al., 2001).

3. Results

A canonical correspondence analysis (CCA) was performed between physico-chemical parameters and macroinvertebrate densities (Figure 1).

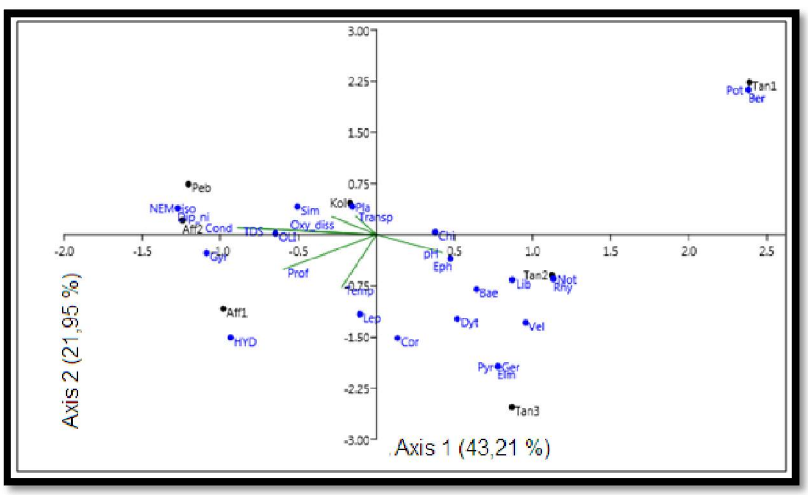

Figure 1: Canonical Correspondence Analysis of Macroinvertebrates and Physico-chemical Variables

<u>Legend</u>: 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 ; Temp = Temperature ; Transp = Transparence ; Prof = Depth ; Cond = Conductivity ; TDS = Total Dissolved Solids, oxy. diss = Dissolved Oxygen

The contained information in the variables is controlled at 65.16% by the system of axis 1 and 2. The first axis is negatively and strongly correlated with the conductivity and TDS while it is positively correlated with the pH.

As for the second axis, it is negatively and strongly correlated with the depth and temperature whereas it is positively correlated with the transparence and dissolved oxygen.
The first axis divides the stations into two large groups: The stations (Tanéka 1, Tanéka 2 and Tanéka 3) located upstream of the river Affon and the stations (Kolokondé, Pébouko, Afféou 1 and Afféou 2) located downstream of the river Affon.
Thus, the upstream stations are characterized by a high pH value whereas the downstream stations are related to the high values of conductivity, TDS and depth.

In addition, on the first axis, there is a positive association between upstream stations of the river with the majority of the pollution-sensitive families (Perlodidae, Beraeidae, Rhyacophilidae, Potamanthidae, Baetidae and Ephemerellidae) and a negative association between the downstream stations of the river and only two pollution-sensitive families (Isonychiidae and Leptophlebiidae).

Thus, the upstream stations of the river are less polluted than the downstream stations of the river.
In addition, on the second axis, the families: Perlodidae, Beraeidae, and Potamanthidae and the stations: Kolokondé and Pébouko are positively associated with conductivity, TDS and dissolved oxygen, while Tanéka 3, Afféou 1, Pyralidae, Hydracariens, Gerridae and Elmidae are negatively associated with depth and temperature.

4. Discussion

The distribution of macroinvertebrates depends on environmental variables. The canonical correspondence analysis confirmed this hypothesis and made it possible to distinguish two groups of stations. Indeed, Group 1, represented by the upstream stations, is strongly characterized by a low temperature, a high pH value and the majority of pollution-sensitive families, whereas Group 2 with downstream stations is characterized by higher temperature, depth, conductivity, TDS, and higher dissolved oxygen values.
Thus, the high conductivity recorded in this group is due to a higher mineralization in these stations, as a result of the accumulation of organic matter in these stations which are very close to houses and fields. Such results have already been recorded by (Imorou Toko et al., 2012) on the Bénin cotton basin.
In addition, the stations of the second group have aerobic conditions more favorable to the degradation of these organic matters, because the high values of conductivity are associated with the high values of dissolved oxygen. These results are comparable to those obtained by (Chouti et al., 2010) and by (Noumon et al., 2015).

5. Conclusion

This study reveals that physico-chemical parameters such as pH, depth, conductivity, TDS and dissolved oxygen best influence the distribution of macroinvertebrates. Thus, a positive correlation was established between Perlodidae, Beraeidae, Potamanthidae and pH, dissolved oxygen, conductivity and TDS.

6. Acknowledgements

We thank the people of our sampling stations for their participation in the study. Special thanks go to the team of the Laboratory of Hygiene, Sanitary, Ecotoxicology and Environmental health (HECOTES) and Laboratory of Ecology, Health and Animal Production (LESPA).

7. References

i. Abahi, K.S., Gnohossou, P., Akodogbo, H.H., Orou Piami,Z., Adje, D., Tchaou, C., Okoya, J. (2018). Structure et diversité des macroinvertébrés benthiques de la partie supérieure du fleuve Ouémé au Bénin. Afrique Science: *Revue Internationale des Sciences et Technologie*, 14(6), 259-270.
ii. Beauger, A. (2008). Bio-évaluation de la qualité de l'eau: établissement d'un protocole d'échantillonnage simplifié, basé sur la collecte des macroinvertébrés benthiques sur les seuils des rivières à charge de fond graveleuse (PhD Thesis). *Université Blaise Pascal-Clermont-Ferrand II; Université d'Auvergne-Clermont-Ferrand I.*
iii. Chouti, W., Mama, D., Alapini, F. (2010). Etude des variations spatio-temporelles de la pollution des eaux de la lagune de Porto-Novo (sud Bénin). *International Journal of Biological and Chemical Sciences*, 4(4), 1017-1029.
iv. Gaujous, D. (1993). La pollution dans les milieux aquatiques. Aide-mémoire. *Editions Technique et Documentation*, 212 p.
v. Gnohossou, P. (2006). 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/*
vi. Hammer, Ø., Harper, D.A.T., Ryan, P.D. (2001). Paleontological statistics software: package for education and data analysis. *Palaeontologia Electronica*, (4).
vii. Imorou, Toko I., Attakpa, E.Y., Gnohossou, P., Aboudou, E. F. (2012). Biodiversité et structure des macroinvertébrés benthiques du bassin cotonnier béninois. *Annales des Sciences Agronomiques*, 16(2), 165-182.
viii. Kaller, M.D., Kelso, W.E. (2007). Association of macroinvertebrate assemblages with dissolved oxygen concentration and wood surface area in selected subtropical streams of the southeastern USA. *Aquat. Ecol*, 41, 95–110.
ix. Loayza-Muro, R.A., Duivenvoorden, J. F., Kraak, M. H., Admiraal, W. (2013). Metal leaching, acidity and altitude confine benthic macroinvertebrate community composition in Andean streams. *Environ. Toxicol. Chem*, (33), 404–411.

x. Moisan, J., Pelletier, L., Gagnon, E., Piedboeuf, N., La Violette, N. (2013). Guide de surveillance biologique basée sur les macroinvertébrés benthiques d'eau douce du Québec (*2e éd.). Consulté à l'adresse www.mddefp.gouv.qc.ca*

xi. Neff, M.R., Jackson, D.A. (2011). Effects of broad-scale geological changes on patterns in macroinvertebrate assemblages. *Journal of the North American Benthological Society*, 30, 459–473.

xii. Noumon, C.J., Mama, D., Dedjiho, C.A., Agbossou, E., Ibouraima, S. (2015). Évaluation de la qualité physico-chimique et du risque d'eutrophisation de la retenue d'eau de Kogbétohouè (Sud-Bénin).*Journal of Applied Biosciences*, 85(1), 7848–7861.

xiii. Pan, B., Wang, Z., Yu, G., Xu, M., Zhao, N., Brierley, G. (2013). An exploratory analysis of benthic macroinvertebrates as indicators of the ecological status of the Upper Yellow and Yangtze Rivers. *Journal of Geographical Sciences*, 23(5), 871-882.

xiv. Roy, A., Rosemond, A., Paul, M., Leigh, D., Wallace, J. (2003). Stream macroinvertebrate response to catchment urbanisation (Georgia, USA). *Freshwater Biol*., 48, 329–346.

xv. Stenert, C., Bacca, R.C., Mostardeiro, C.C., Maltchik, L. (2008). Environmental predictors of macroinvertebrate communities in coastal wetlands of southern Brazil. Mar. *Freshwater Res*., *59*,540–548.

xvi. Tenkiano, N.S.D. (2017). 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).*

xvii. Tufféry, G. (1980). Incidences écologiques de la pollution des eaux courantes, révélateurs biologiques de la pollution. In : Pesson P. (ed.). La pollution des eaux continentales. Incidence sur les biocénoses aquatiques.*Gauthier-Villars*, 243-280.

xviii. Xu, M., Wang, Z., Duan, X., Pan, B. (2014). Effects of Pollution on Macroinvertebrates and Water Quality Bio-Assessment. *Hydrobiologia*, 729, 247-259.