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Influence of Physico-Chemical Parameters on The Diversity of Benthic Macroinvertebrates in The Rivers of the Odienne Department in Northwest Côte D'Ivoire

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Abstract: The aim of this study was to determine the relationships between the distribution of macroinvertebrates and the physico-chemical parameters that influence their distribution in four rivers (Tièkorodougou, Massadougou, Koungbeni and Zébenin) located in the north-west of Côte d'Ivoire. Macroinvertebrate sampling was carried out in the four rivers using a Van Veen bucket and a haul net over an area of 1 m² (2 m *0.5 m). The structure of the benthic communities was then studied using the Shannon-Weather diversity and Piélou equitability indices. Finally, a Canonical Correspondence Analysis (CCA) was carried out to highlight the relationships between the distribution of macroinvertebrate communities and physicochemical parameters. The results showed that a total of 117 macroinvertebrate individuals, divided into 03 Classes, 07 Orders and 13 families, were identified in these different rivers. The structure of this macrofauna indicates that it is made up of 73% arthropods, 15% molluscs and 12% worms. The insect class was the best represented, with several orders including Hemiptera, Coleoptera, Diptera and Odonata. The order Hemiptera is the most dominant. Jaccard's similarity index showed that the Tièkorodougou river is 90% similar to the Zébenin river. Analysis of diversity revealed that the macroinvertebrate communities of the Massadougou and Koungbeni rivers are not very diverse or balanced. The distribution of macroinvertebrates was strongly influenced by temperature, conductivity, nitrite, dissolved oxygen, transparency, nitrate and total phosphorus. These results lay the foundations for any action to biomonitor the ecological quality of the water in these rivers.

1. Introduction

Global water use has increased sixfold over the past 100 years and continues to rise progressively by around 1% per year (OMS, 2015). Preserving this resource and managing it rationally and efficiently is currently a global priority in terms of both quantity and quality (Goaziou, 2014). However, the distribution of this resource across the globe is highly heterogeneous. According to UNEP, 2010, Africa is one of the driest continents in the world, with only 9% of freshwater resources. Côte d'Ivoire has a dense hydrographic network with four main rivers: the Comoé, Bandama, Sassandra and Cavally. In addition to these major rivers, there are several others. These rivers include others in the north of Côte d'Ivoire, more specifically in the department of Odienne. In fact, these aquatic ecosystems are of great importance because they are a vulnerable resource due to the growing anthropogenic pressures exerted on them (AGROPOLIS, 2007; Sanogo & Kabre, 2014; Sanogo *et al*., 2014). Most of the liquid, solid and gaseous waste produced by human activities, such as agricultural intensification, rampant urbanization and the development of industries, ends up in these aquatic ecosystems and constitutes the final receptacle **(**Colas *et al*., 2014; Bouknana *et al.,* 2021; Errich *et al.,* 2021; Akartasse *et al.,* 2022; Salahat *et al.,* 2023). Hence the need to assess the diversity of benthic macroinvertebrates, which are good bioindicators for determining the ecological health of these rivers **(**Diomandé, 2014**)**. These organisms are, by definition, invertebrates, visible to the naked eye, that live on the bottom of a watercourse or only move a short distance from it for most of their lives **(**Moisan & Pelletier, 2011**)**. This group includes insects, molluscs, crustaceans, Annelids and Trombidiformes. They are highly diversified and form a very important part of the fauna of freshwater ecosystems. This group includes insects, molluscs, crustaceans, Annelids and Trombidiformes. They are highly diversified and form a very important part of the fauna of freshwater ecosystems. In addition, they are made up of sedentary organisms with varying degrees of sensitivity to different environmental stresses **(**Tachet *et al*., 2006**)**. They are mainly aquatic insects, present in the water in different forms depending on their life cycle: larva, nymph, adult. Unfortunately, there is no data on the biodiversity of benthic macroinvertebrates in four (04) rivers located in the department of Odienne, specifically in the villages of Tièkorodougou, Massadougou, Koungbeni and Zébenin. The aim of this study is to characterize the structure and diversity of benthic macroinvertebrates in these rivers and to identify the parameters that influence their distribution. This study will add to our knowledge of the fauna of benthic macroinvertebrates in Côte d'Ivoire.

2. Methodology

2.1 Sampling sites

Four sampling stations were selected in four different rivers for this study (**Figure 1**). They were chosen on the basis of the durability of the water, accessibility in all seasons and the speed of the water current. These rivers are located in the north-west of Côte d'Ivoire, more precisely in the department of Odienne. The various rivers studied are drained by the Sassandra and its tributaries the Tiemba and Boa.

Station S1 : Station S1 is located approximately 120 metres from the village of Tièkorodougou. The station is surrounded by vegetation and an access track.

Station S2 : This station is about 760 metres from the village of Massadougou. There is vegetation on the various banks.

Station S3 : This point is about 180 metres from the village of Kougbeni. There is vegetation near the site.

Station S4 : This sampling point is located approximately 4.16 km from the village of Zébenin. Not far from the site was a cotton plantation and ox droppings.

Table 1 shows the different characteristics of the sampling stations.

2.2 Analysis of physico-chemical parameters in rivers

Physicochemical parameters were measured both in the field and in the laboratory. Temperature, dissolved oxygen content, pH and electrical conductivity were measured in situ using an AZOTA multimeter. Transparency and depth were measured by fully immersing the Secchi disc at a lower level than the bottom, using a rope. Water samples were also taken from the various stations on the rivers in question in 500 ml polyethylene bottles. They were transported to the ENVAL laboratory in coolers containing ice packs, where they were kept refrigerated at 5°C before being analysed. These water samples were used to determine nitrite (NO^{2-}) and nitrate (NO^{3-}) ions and total phosphorus according to the standard protocols of the Association Française de Normalisation **(**AFNOR, 1992**)**.

Table 1: Summary table of sampling point characteristics

Code	**S1**	**S2**	**S3**	**S4**
Ecosystem types	Tièkorodougou River	Massadougou River	Kougbeni River	Zebenin River
Villages	Tièkorodougou	Massadougou	Kougbeni	Zebenin
Latitude (m)	690416.19 E	679301.00 E	676869.76 E	680048.60 E
Longitude (m)	998914.83 N	1005969.00 N	1011468.45 N	1028861.45 N
Appearance of the water	Disorder	Disorder	Disorder	Claire
Substrate	Clay	Sandy	Sandy	Sandy
Flow speed	Fast flow	Fast flow	Slow flow	Slow flow
Depth (cm)	30	20	35	18
Sand (%)	20	70	50	70
Gravel (%)	5	20	40	25
Clay and silt (%)	75	10	10	5

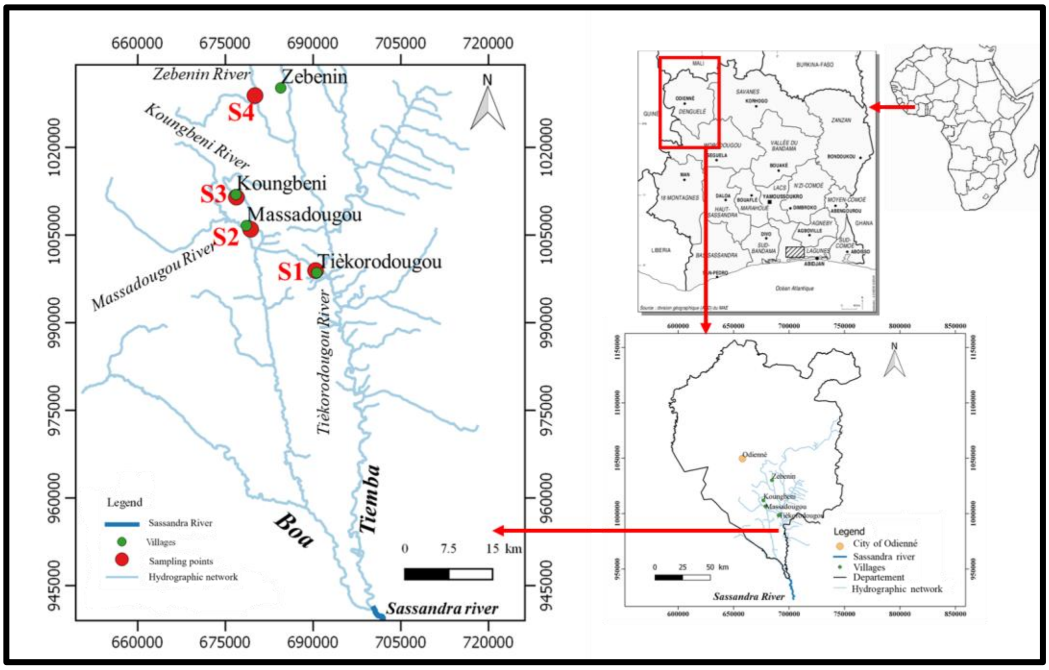


Figure 1: Presentation of the study area

2.3 Sampling of macroinvertebrates in rivers

Benthic macroinvertebrates were sampled using a stainless steel Van Veen bucket for sediment organisms and a dip net for submerged macroinvertebrates. For the benthos, at each site, three sediment samples corresponding to a total surface area of 0.15 m2 were taken at different depths. For submerged organisms, a haze net (250 µm mesh) was used using the SASS (South African Scoring System) method **(**Dickens & Graham, 2002**)**. Samples were collected for 3 minutes by submerging the net and dragging it through the water column over an area of 1 m² (2 m *0.5 m). The net was also knocked against the substrate to dislodge and collect the organisms from the sediment. The collected organisms were fixed in 70% ethanol in labelled jars and transported to the laboratory.

2.4 Triage, Observation and Analysis of samples

In the laboratory, each sediment sample, previously preserved in alcohol, was rinsed with tap water. The samples were then sieved and the individuals collected sorted using a binocular magnifying glass to separate the fauna from the debris and sediment particles. The organisms collected were counted, photographed and identified to the lowest possible taxonomic level using the appropriate determination keys (Dejoux *et al*., 1981; Brown, 2005) and preserved in 70% ethanol.

2.5 Data Analysis

-**Taxonomic richness**: corresponds to the total number of species encountered at each sampling site (Ramade, 2003).

-**Abundance of taxonomic groups**: this represents the quotient of the number of individuals of a taxon i present by the total number of individuals on a sampling site at a given period (Ramade, 2003).

The expression for relative abundance is as follow :

$$Pi = ni/N$$

where Pi is the relative abundance of species i, ni is the number of individuals of species i and N is the total number of individuals.

-**Jaccard index**: This index has been used to assess the similarity of macroinvertebrates between two sampling sites (Plafkin *et al*., 1989). It is calculated as follows:

$$J = \frac{S_{a-b}}{S_a + S_b - S_{a-b}} X\ 100$$

where Sa is the total number of species at site a, Sb the total number of species at site b and Sa-b the number of species common to a and b.

J ≥ 50% : High similarity; J< 50%: Low similarity

-**Shannon-Weaver diversity index**: based on the number of species and the regularity of their distribution frequency. $H' = - \Sigma\ p\ i \log 2\ pi$ where pi represents the relative abundance of species i in the sample ($p\ i = n\ i /N$). H' fluctuates between 0 and log S.

A high Shannon index corresponds to favourable environmental conditions allowing many species to establish themselves. Generally, the value of H' is between 0.5 (very low diversity) and 4.5 or 5 (most diverse communities).

-**Piélou equitability**: Equitability has been used to study the regularity of species distribution and to compare the diversity of two stands with different numbers of species (Dajoz, 2000).

$$J = H\ log2\ (S)$$

Where H is the Shannon diversity index for a sample and S is its species richness. Equitability varies from 0 to 1.

2.6 Statistical Analysis of data

The Shapiro-Wilk normality test was used to test the normality of the various data. In this test, the p-value was used to analyse the results. The Kruskal-Wallis test was used to compare the various parameters measured at different sampling stations.

Canonical correspondence analysis (CCA) was performed using Past software version 3.14 **(**Zinsou *et al.*, 2017**)** to map biotic data to abiotic data obtained during sampling.

Ascending hierarchical clustering (HAC) was carried out using Past version 3.14 software to group stations according to the abundance of macroinvertebrates collected.

All the static analyses were carried out using Past version 3.14 software.

3. Results and Discussion

3.1 Physical and chemical quality of river water

Mean temperature values ranged from 27.8°C to 29.9°C. The lowest temperature was obtained in the Zébenin river (S4) while the highest value was recorded in the Massadougou river (S2) (**Figure 2a**). Water transparency fluctuated between 13 cm (Koungbeni river (S3) and 20 cm (Massadougou (S2) (**Figure 2b**). Dissolved oxygen levels varied between 4.1 mg/l and 5.7 mg/l. The maximum value was observed in the Koungbeni river (S3) while the maximum value was obtained in the Tièkorodougou river (S1). The pH ranged between 7.16 and 7.21 (**Figure 2c**). It was highest in the Zébenin river (S4) and lowest in the Tièkorodougou river (S1) (**Figure 2d**).

At the river stations, the physico-chemical parameters measured are water temperature, hydrogen potential (pH), conductivity, dissolved oxygen, water transparency, total phosphorus, nitrate and nitrite. The average temperature of the rivers varied between 27.8°C (S4) and 29.9°C (S2). This variation is similar to that of the ambient temperature and could be explained by the fact that the vegetation in the department of Odienné is a wooded savannah favouring greater exposure of the water to incident solar radiation. This result is similar to those of Iltis & Lévèque (1982), who found that river temperatures in Côte d'Ivoire rarely fall below 25°C. The range of variation (27.8°C-29.9°C) obtained is close to those recorded in the rivers of Côte d'Ivoire, namely the Boulo 2 (24.5°C-29.2°C) (Simmou, 2023).

The average pH of river water ranges from 7.16 (S4) to 7.21 (S1). River water is basic, which can be attributed to the nature of the substrate. The pH of the water depends on the layers of soil crossed during percolation (Nola *et al.,*1999). This range of pH variation is within the tolerable limit (5 to 9) for most aquatic species (Montcho *et al*., 2011). These pH characteristics are similar to those obtained by Tchakonté, (2016) in streams in Yaoundé, Cameroon. Dissolved oxygen levels fluctuate between 4.1 mg/l and 5.7 mg/l. These dissolved oxygen values indicate fairly good oxygenation of the river water. Water transparency fluctuates between 13 cm (Koungbeni river (S3) and 20 cm (Massadougou (S2). This low transparency could be explained by human activities such as the use of fertilisers and pesticides, laundry, and animal grazing, which all contribute to increasing water turbidity **(**Houelome *et al*., 2016**)**.

Conductivity varied between 105 µS/cm and 346 µS/cm. It was highest in the Massadougou river (S2) and lowest in the Tièkorodougou river (S1) (**Figure 3e**). The Tièkorodougou (S1) and Koungbeni (S3) rivers were characterised by low concentrations of total phosphorus (0.04 mg/l), whereas the Massadougou river had a high level (0.25 mg/l) of this parameter (**Figure 3f**). Nitrate levels vary from 1.24 mg/l (station S3) to 3.81 mg/l (station S1) (**Figure 3g**).

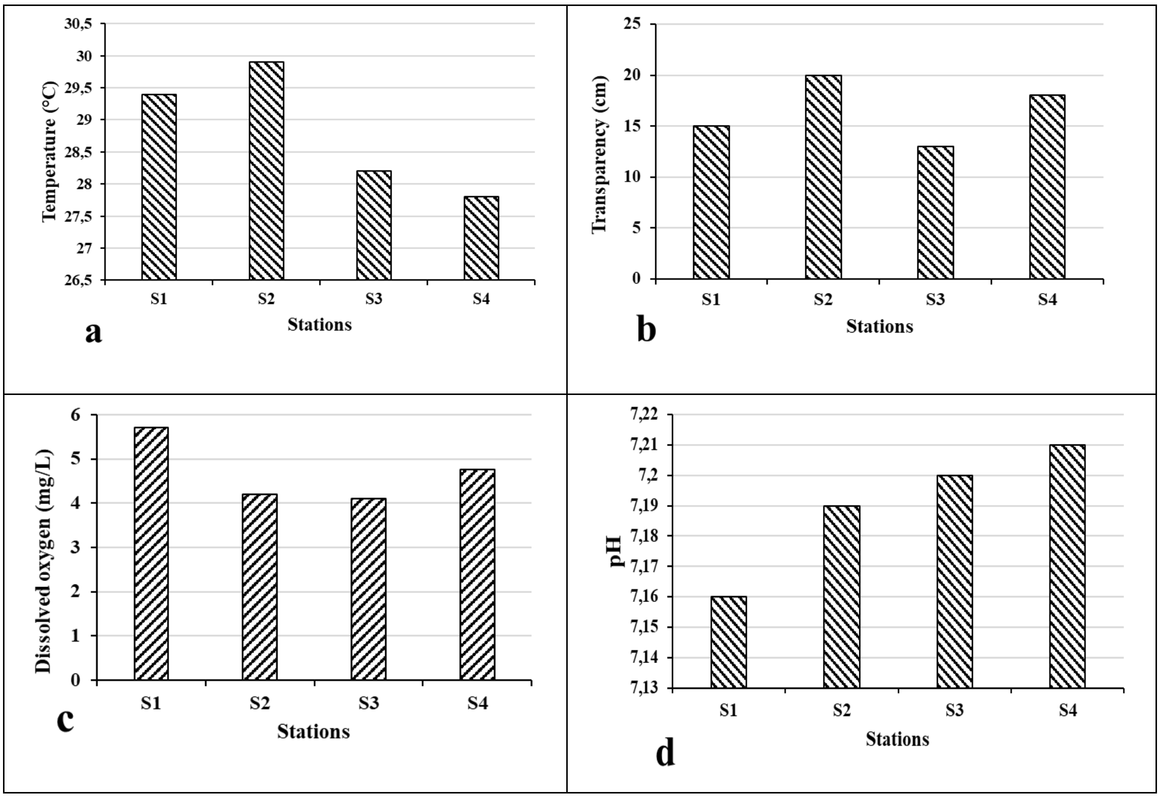


Figure 1 : Distribution of physico-chemical parameters (conductivity (e), total phosphorus (f), nitrate (g) and nitrite (h) at stations S1, S2, S3 and S4 on the Tièkorodougou, Massadougou, Koungbeneni and Zébenin

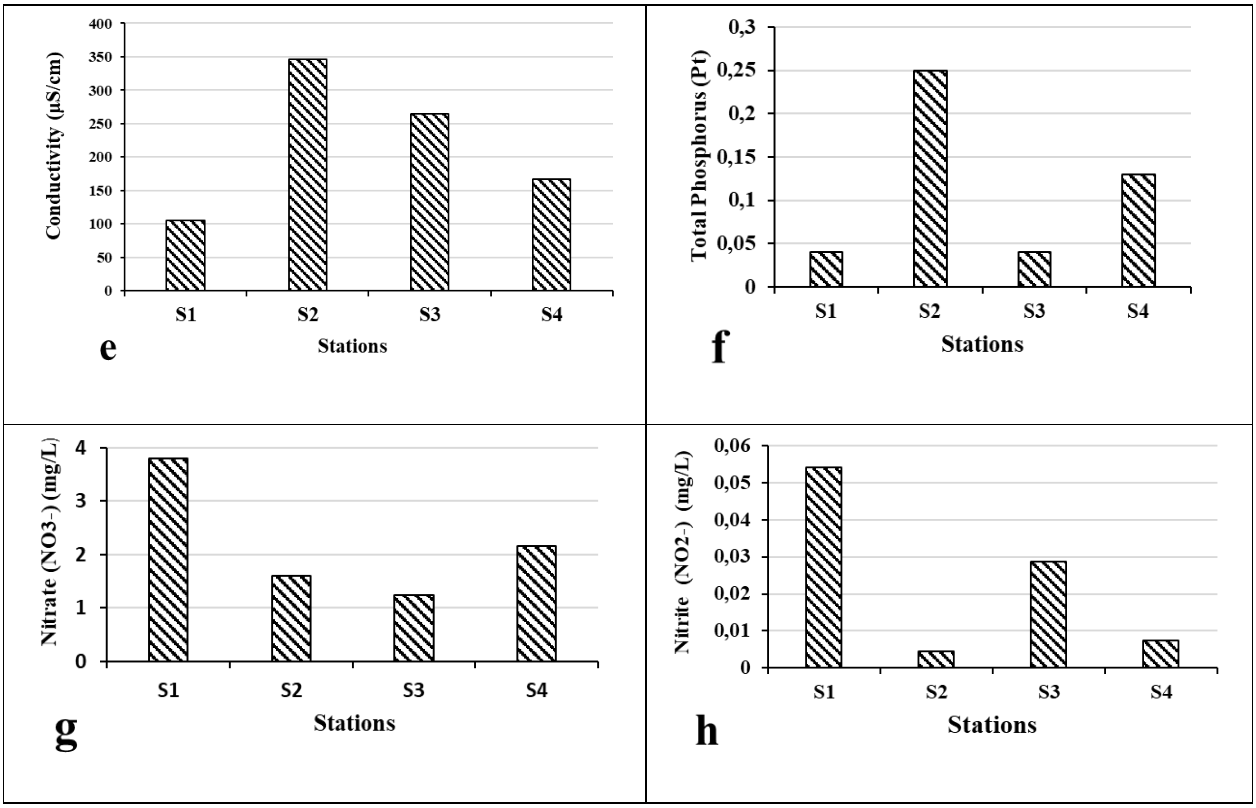


Figure 2 : Distribution of physico-chemical parameters (conductivity (e), total phosphorus (f), nitrate (g) and nitrite (h) at stations S1, S2, S3 and S4 on the Tièkorodougou, Massadougou, Koungbeneni and Zébenin

Nitrate concentration varies from 0.0044 mg/l in the Massadougou River (S2) to 0.0542 mg/l in the Tièkorodougou River (S1) (**Figure 3h**). These findings reveal that the nitrate level are acceptable and not higher at AFNOR norms (Benkaddour *et al*., 2020). In general, the physico-chemical water quality parameters subjected to the Kruskal-Wallis test revealed no significant difference between the stations ($p > 0.05$). The average electrical conductivity varies between 105 µS/cm (S2) and 346 µS/cm (S1). Conductivity, which is related to dissolved salts, indicates fairly significant mineralisation of river water. The values obtained are almost similar to those obtained by Kaboré *et al*. (2022) in areas disturbed by human activities in Burkina Faso.

3.2 Composition of benthic fauna in different rivers

Table 2 shows the general list and spatial distribution of benthic macroinvertebrate taxa encountered in the Tièkorodougou (S1), Massadougou (S2), Koungbeni (S3) and Zébenin (S4) rivers. At all the sampling stations, 14 taxa belonging to 13 families and 07 orders were recorded. The macroinvertebrates collected come from 03 phyla: Molluscs, Annelids and Arthropods. These species are grouped into 03 classes : Insects, Gastropods and Clitellates. The Insect class is the most represented with 10 taxa. Next come the Gastropods with 03 taxa. Clitellates are represented by one taxon. Insects are represented by the orders Coleoptera (02 families), Diptera (01 family), Hemiptera (04 families) and Odonata (02 families). Gastropods are represented by the order Caenogasteropoda with 02 families (Planorbidae and Tomichiidae) and the order Basommatophores with the family Physidae. In terms of abundance, a total of 117 macroinvertebrate individuals were collected in all the rivers. The macroinvertebrate communities at the study stations were dominated by the insect class, with 85 individuals collected. The order Hemiptera is the most diversified in the study stations with 37 individuals and 05 taxa, namely *Appasus* sp., *Diplonychus* sp., *Ranatra* sp., *Anisops* sp. and *Microvelia* sp. This result highlights the preponderance of insects in the rivers.

Table 2 : Composition of benthic fauna in rivers

Branch	Classes	Orders	Families	*Species*	*Code*	S1	S2	S3	S4
Mollusc	**Gastropods**	**Basommatophora**	Physidae	*Aplexa waterloti*	*Apl*	-	+	-	-
		Caenogastropods	Planorbidae	*Afrogyrus rodrignezensis*	*Afr*	+	-	-	+
			Tomichiidae	*Tomichia sp.*	*Tom*	+	-	-	+
Arthropods	**Insects**	**Coleoptera**	Dytiscidae	*Laccophilus luctuosus*	*Lac*	+	-	-	+
			Gyrinidae	*Dineutus* sp.	*Din*	+	-	+	+
		Diptera	Chironomidae	*Polypedilum fuscipenne*	*Pol*	-	+	-	-
		Hemiptera	Belostomatidae	*Appasus* sp.	*App*	+	-	-	+
				Diplonychus sp.	*Dip*	-	-	+	-
			Nepidae	*Ranatra* sp.	*Ran*	-	+	-	-
			Notonectidae	*Anisops* sp.	*Ani*	+	-	-	-
			Veliidae	*Microvelia* sp.	*Mic*	+	-	+	+
		Odonata	Coenagrionidae	*Coenagriocnemis reuniense*	*Coe*	+	-	+	+
			Libellulidae	*Zygomix torridus*	*Zyg*	+	+	-	+
Annelids	**Clitellata**	**Haplotaxida**	Tubificidae	*Tubifex* sp.	*Tub*	+	-	-	+

(+) : *Presence*, (-) : *Absence*

The taxonomic inventory yielded three (03) classes of macro invertebrates, with insects dominating. Insects accounted for 72.65% of the orders and families identified. This was noted in a river by Sanogo

(2010) who found a strong presence of Insects representing 90.70%. Heteroptera and Coleoptera were dominant (32% and 25% of families respectively) in the insect community in this study. The results of this study are in agreement with those of Yapo *et al.* (2012), who when sampling macroinvertebrates in fish ponds in Côte d'Ivoire, found that Heteroptera and Coleoptera qualitatively dominated the entire Insect community: and those of Nyamsi *et al.* (2014) whose studies in streams in south-central Cameroon found that Heteroptera (20.27%) and Coleoptera (19.71%) also qualitatively dominated the Insect class. The numerical and taxonomic importance of the insect class followed by that of the gastropod class was observed in this study. According to **(**Tachet *et al*., 2010**)**, the predominance of Insects in terms of taxonomic richness and abundance observed in rivers is due to the diversity of species that this class contains and also to their larvae, most of which are exclusively aquatic. Our results are in line with those of **(**Kabré *et al*., 2002**)** **(**Alhou *et al*., 2014**)**.

3.3 Composition of benthic fauna in different rivers

The aquatic fauna of the various rivers is dominated by Arthropods with 85 individuals (i.e. 72.65% of the total abundance). They were followed by Molluscs with 18 individuals, i.e. 15.38% of the total abundance, and Annelids with 14 individuals, i.e. 11.97% of the total abundance. Among the classes, Insects are the most dominant, with a relative abundance of 73%, followed by Gastropods (15%). The Clitellata class represents 12% of the total number of macroinvertebrates. Among the Orders, Hemiptera are the most represented with 37 individuals, or 32% of total abundance, followed by Coleoptera (29 individuals, or 25% of abundance) and Caenogasteropoda (17 individuals, or 14% of abundance), Odonata (15 individuals or 13% of abundance), Haplotaxida (14 individuals or 12% of abundance), Diptera (04 individuals or 3% of abundance) and Basommatophora (01 individual or 1% of abundance). Among the families, Belostomatidae dominated with 24 individuals or 20.51%, followed by Dytiscidae (17 individuals or 14.54%) and Tubificidae (14 individuals or 11.97%) (**Figure 4**).

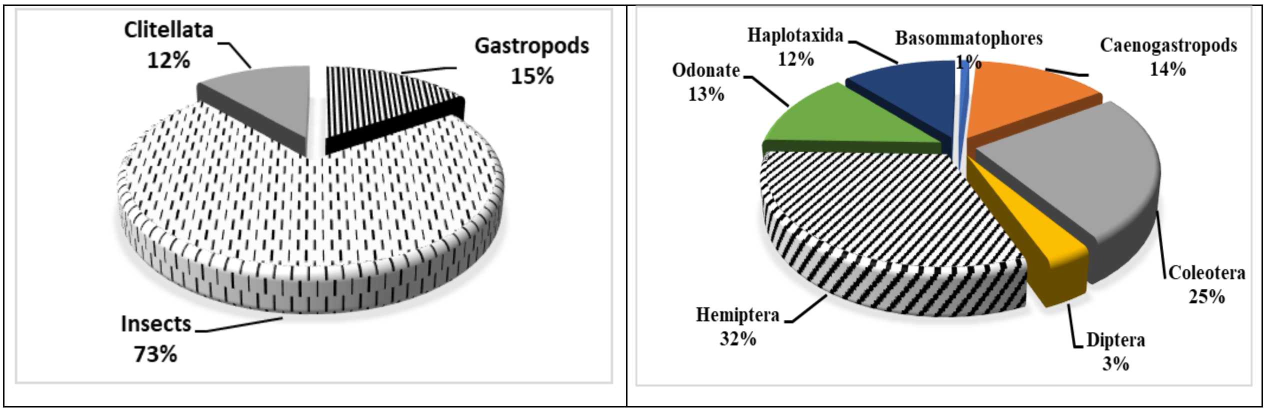


Figure 3 : Relative abundance of macroinvertebrates in different rivers

3.4 Proportions of orders of benthic macoinvertebrates in rivers

Figure 5 shows the spatial variations in the nine orders of macroinvertebrates identified at the various river stations. The order Hemiptera is more than 35% represented in the Tièkorodougou (S1) and Koungbeni (S3) rivers. As for the Coleoptera order, it is more than 25% dominant in the Zebenin river (Station S4). The Diptera order is more than 50% dominant in the Massadougou river (S2). Odonates account for 10% in the Tièkorodougou (S1) and Zebenin (S4) rivers respectively.

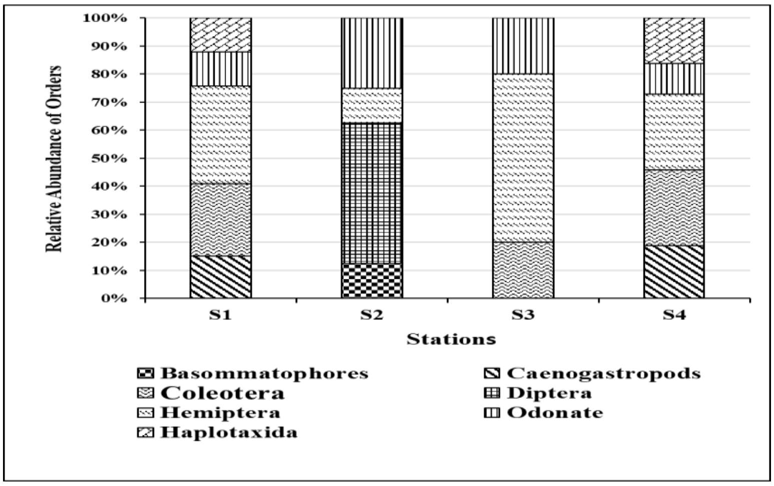


Figure 5: Proportions of macroinvertebrate orders in rivers

3.5 Spatial distribution of taxonomic richness and number of individuals

Maximum abundance (66 individuals) was recorded at station S1, while minimum abundance was observed at station S3 (05 individuals). Station S1 recorded the highest taxon richness with 10 taxa, while the lowest taxon richness was recorded at stations S2 and S3 with 4 taxa (**Figure 6**).

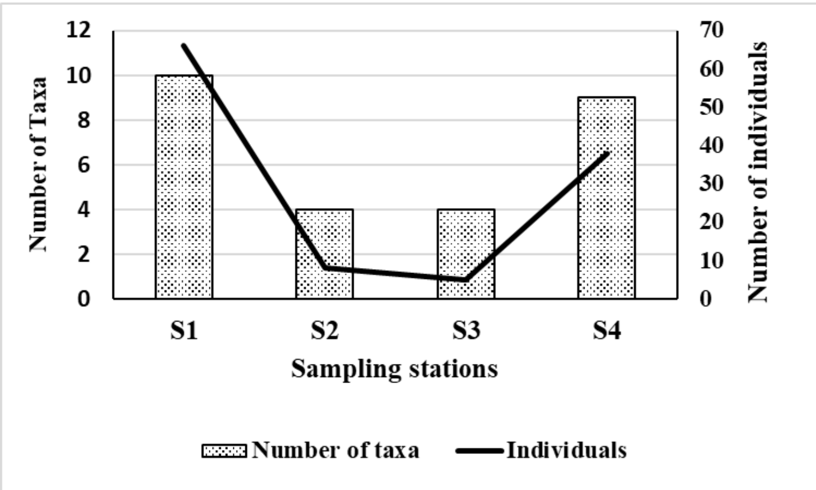


Figure 6: Spatial trends in abundance and species richness of macroinvertebrates in different rivers

3.6 Similarity between different rivers

Jaccard similarity indices (J) were calculated in order to compare all the stations studied in pairs (**Table 3**). For all the stations, the similarity index values ranged from 0% to 90%. This result shows that the Tièkorodougou river (S1) is 90% similar to the Zébenin river (S4).

Table 3 : Jaccard's taxonomic similarity indices expressed as a percentage

Stations	S1	S2	S3	S4
S1	100%			
S2	7%	100%		
S3	27%	0%	100%	
S4	**90%**	8%	30%	100%

3.7 Spatial distribution of the Shannon Index (H) and Equitability Index (E)

Figure 7 shows the spatial evolution of the Shannon diversity and Piélou equitability indices. It shows that the highest value of the Shannon diversity index (2.17bits) is observed at the Tièkorodougou river (station S1), while the lowest value of this index (1.21bits) is recorded at the Massadougou river (station S2).

The Piélou equitability index shows a different trend to that of the Shannon index. Indeed, the highest value of equitability (0.96) is observed in the Koungbeni river (station S3), while the lowest value of the index (0.88) is recorded in the Massadougou river (station S2). Analysis of the indices using the Kruskal-Wallis test revealed no significant difference between stations ($p > 0.05$).

The value of the Shannon index (<2) indicates low macroinvertebrate diversity. In contrast, the Pielou Equitability Index shows average regularity in the distribution of taxa. This low diversity could be explained by the average ecological quality of these rivers. Macroinvertebrate diversity depends on the ecological quality of the environment. An environment of very good ecological quality is likely to harbour macroinvertebrate taxa that are sensitive to pollution, which increases diversity **(**Kaboré *et al*., 2022**)**.

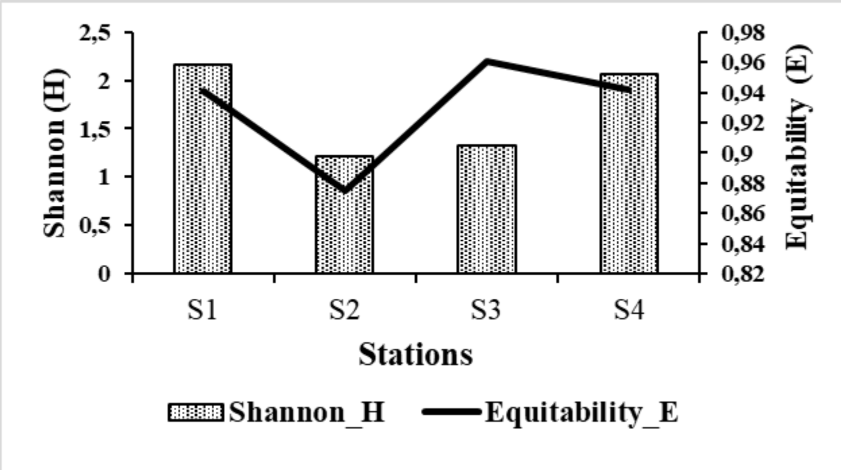


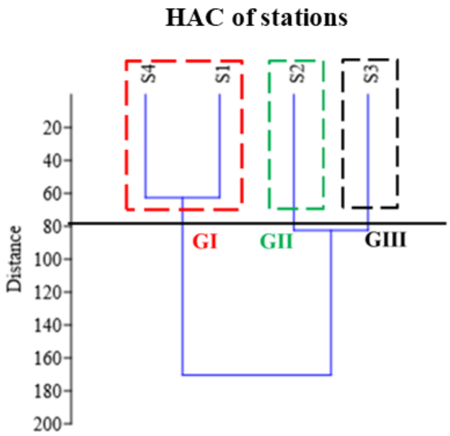
Figure 7: Distribution of Shannon Diversity (H) and Equitability (E) indices at the various river stations

3.7 Relationship Between macroinvertabrates and Physico-Chimical parameters in different river

The following graph shows the result of the CCA between the physico-chemical parameters and the abundance of benthic macroinvertebrates in the rivers studied (**Figure 8**). The information contained in the variables is 97.8% controlled by the axes 1 and 2 system. The first axis is negatively and strongly correlated with nitrite concentration, while the second axis is negatively and strongly correlated with dissolved oxygen and nitrate. Conductivity, total phosphorus, temperature and transparency are positively and strongly correlated with axis 1. Nitrite, Nitrate, Dissolved Oxygen, Conductivity, Total Phosphorus, Temperature and Transparency therefore influence the distribution of macroinvertebrates. Projection of the taxa on the vector axes of the environmental parameters (**Figure 8**), shows that on axis 2, there is a strong negative correlation between *Tubifex* sp. *Anisops* sp., *Appasus* sp., *Laccophilus Luctuosus*, *Tomichia* sp., *Afrogyrus rodrignezensis* and nitrate and dissolved oxygen at stations S1 (Tièkorodougou River) and S4 (Zebenin River) of group I. On the same axis, a weak positive correlation was observed between Diplonychus sp., *Coenagriocnemis reuniense* and pH at station 3 (Koungbeni River), which forms Group III. On axis 1, there was a negative association between

Microvelia sp., *Dineutus* sp. and Nitrite levels. On this same axis, there is a positive association between *Ranatra* sp., *Polypedilum fuscipenne*, *Zygomix torridus*, Aplexa waterloti and Temperature, conductivity, total phosphorus and transparency with station 2 (Massadougou River), which corresponds to group II.

The correlation between physico-chemistry and benthic macroinvertebrates in the various rivers showed that temperature, pH, conductivity, dissolved oxygen, nitrite, nitrate, total phosphorus and transparency are the physico-chemical parameters that significantly influence the abundance of benthic macroinvertebrates. The canonical analysis showed that these physico-chemical parameters explain 97.8% of the variability in benthic macroinvertebrates in the different rivers. The remaining 2.2% of the variability could be explained by the influence of environmental variables other than the physicochemical ones studied.



Eigenvalues

Parameters	Axis 1	Axis 2
Temp	0,75	-0,25
Transp	0,83	-0,60
DisolvOxy	-0,31	-0,68
pH	-0,06	0,32
Cond	0,68	0,49
Pt	0,93	-0,30
NO2-	-0,54	0,02
NO3-	-0,23	-0,68

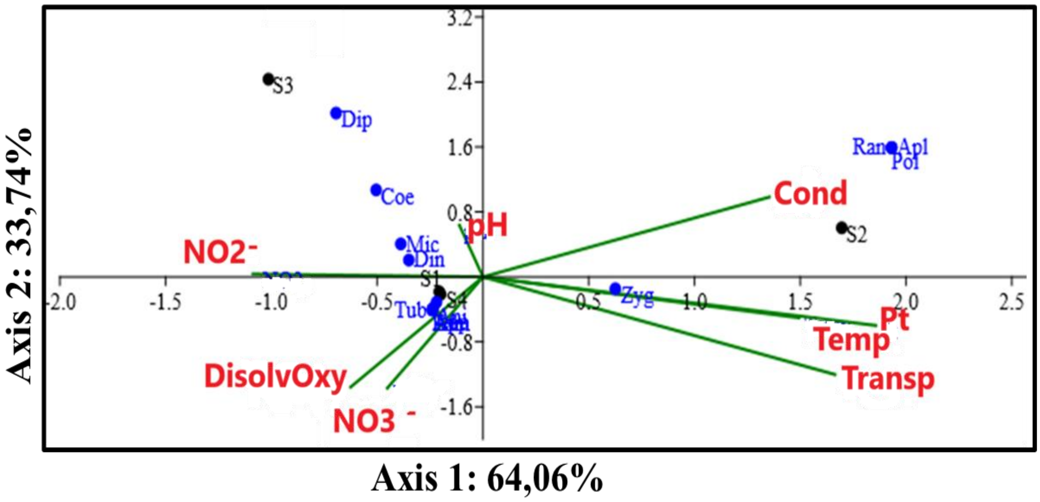


Figure 8 : Canonical Correspondence Analysis of benthic macroinvertebrates and physico-chemical variables for stations corresponding to rivers

Legend: *Apl* : *Aplexa Waterloti*, *Afr* : *Afrogyrus rodrignezensis, Tom : Tomichia* sp., *Lac : Laccophilus luctuosus Din : Dineutus* sp., *Pol : Polypedilum fuscipenne, App : Appasus* sp, *Dip : Diplonychus* sp., *Ran : Ranatra* sp., *Ani : Anisops* sp., *Mic : Microvelia* sp., *Coe : Coenagriocnemis reuniense, Zyg : Zygomix torridus, Tub : Tubifex* sp.

Temp : Temperature, **Cond** : Conductivity, **NO2⁻** : Nitrite, **NO3⁻** : Nitrate, **Pt** : Total phosphorus, **DissolvOxy**: Dissolved oxygen, **Transp**: Transparency and **pH.**

Conclusion

This work made it possible to characterise the benthic macrofauna of the Tièkorodougou, Massadougou, Koungbeni and Zebenin rivers. It also enabled a physico-chemical characterisation of these different rivers. Generally speaking, the water in the various rivers studied is basic, has high conductivity, is moderately oxygenated and has low concentrations of nitrogen and phosphorus. This study enabled 117 macroinvertebrate individuals to be inventoried, corresponding to 3 faunal groups (Annelids, Molluscs, Arthropods), 03 Classes, 07 Orders and 13 families. Among these different classes, insects were the most abundant and diverse taxonomic group. The similarity index showed that the Tièkorodougou River (S1) is 90% similar to the Zébenin River (S4) in terms of the macroinvertebrate species encountered. Analysis of the structure of the benthic fauna reveals a poorly diversified and poorly organised population in the Massadougou (S2) and Koungbeni (S3) rivers. Canonical correspondence analysis showed that temperature, conductivity, nitrite, dissolved oxygen, transparency, total phosphorus and nitrate are the parameters that most influence macroinvertebrate distribution. These results provide a basis for any action to biomonitor the ecological quality of the water in these rivers in relation to the various human activities taking place in the catchment area.

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