Diversity and Distribution of Aquatic Macroinvertebrates in Faé Dam Lake (South-West of Côte d'Ivoire)

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Abstract: ***An ecological study was done on Faé Lake. Its main objective was to inventory aquatic macroinvertebrates and to identify abiotic parameters that structure these stands. For this purpose, six sites were sampled during eight campaigns from November 2017 to October 2018. Aquatic macroinvertebrates were collected using a hand net and a Van Veen grab. Environmental variables were recorded also. Water was collected from each sampling site for nutrient (phosphorus, ammonium and nitrate) analysis in laboratory. In total 123 taxa have been inventoried and subdivided into 6 classes (Insecta, Gasteropoda, Acheata, Bivalvia, Malacostraca and Arachnida), 16 orders and 54 families. The most diversified class was Insecta with 85.37% of the taxa inventoried. Among the insects found, most diverse order was Odonata (22 taxa, 5 families) followed Coleoptera (21 taxa, 8 families) Hemiptera (18 taxa, 9 families) and Diptera (16 taxa, 6 families). Although higher values of rarefied richness, Shannon index and evenness were obtained in the site S6, significant differences between the six sites were not observed. Focused Principal Component Analysis revealed that main taxa abundances was influenced by environmental variables such as nitrate, turbidity, conductivity and temperature. According to the results obtained, Faé Lake is still less disturbed.***

Keywords: Faé Lake, Aquatic macroinvertebrates, diversity, distribution, Côte d'Ivoire

1. Introduction

The hydroelectric dams, whose essential role is the production of electricity, contribute not only to the water supply of the population, but also support agricultural activities and fishing. The artificial reservoirs generated by these hydropower dams provide many valuable economic services to the bordering populations mainly though their halieutic resources. However, the availability of halieutic resources of these aquatic systems is threatened because of stocks overexploitation and pollution (Camargo *et al*., 2005 ; Conley *et al*., 2009).

Faé is the smallest dam lake with an agro-hydroelectric vocation of Côte d'Ivoire.Built on the main course of the San Pedro River, this lake is a focal point for freshwater fishing activities in South-West region of Côte d'Ivoire (Da Costa *et al*., 2007).

Yet it suffers a growing anthropogenic action, determined by demographic and socio-economic development, as well as by urban and road development. These activities, according to Kazi*et al.* (2009), cause water pollution, which disrupts living conditions and aquatic balances thus compromising their multiple uses. These disturbances are very often felt in biological communities (Moisan& Pelletier, 2008). Therefore, the monitoring of the integrity of these ecosystems has relied heavily today on measures relating to the biological communities in place, and mainly macroinvertebrates (Haouchine, 2011; Sanogo*et al*., 2014). These organisms, variously spread over the different strata of water, are characterized by their differential polluo-sensitivity; character used in bioindication of aquatic ecosystems (Sanogo*et al*., 2014).

The use of aquatic macroinvertebrates as bioindicators is also explained by their great taxonomic diversity, their relative stability over time with sufficiently sedentary populations to establish a good correspondence with the environmental conditions (Moisan and Pelletier, 2008; Diomandé*et al.*, 2009; Foto*et al.*, 2011).

In Côte d'Ivoire, studies on macroinvertebrates are numerous and diverse, including the work of (e.g. Diomandé*et al*., 2013 ; Camara*et al*., 2012 ; Edia*et al.*, 2013;Kouamé*et al*., 2011 ; Kra*et al*,. 2018 ; Tapé*et al.*, 2018). However, studies on the aquatic macroinvertebrates of the Faé Lake are inextant. The present study aimed to provide a first database on the aquatic macrofauna of the Faé Lake. The objective was to evaluate the diversity of this fauna and to identify the abiotic parameters that structure these stands.

2. Material and Methods

2.1 Study area and sampling sites

This work focused on the Fae reservoir located between 4° 58' and 5 ° 02' N, and 6 ° 38' and 6° 42' W(Fig.1). This body of water is characterized by a very deep central part of 8 to 15 m depth. There are several islands and bays with shallow floodplains occupied by herbaceous vegetation and ferns.This dam lake has a littoral zone with steep banks or low slopes with a water depth of 0.2 to several meters.The discharge threshold is 20.8 m with a dike top equal to 24 m (Da Costa, 2008). The upstream part of the lake is subject to the influence of San Pedro River. The more stable central part, with a left lateral appendage is characterized by numerous bays and the lacustrine pocket contiguous to the dike. This part is also characterized by strong water currents, due to the curvilinear appearance of the dike of the dam.

These currents are accentuated during periods of flood or turbine operation of the dam power station (Da Costa, 2008). The climatic regime is of the equatorial type of transition with two rainy seasons and two dry seasons. The annual rainfall over the period from 1995 to 2010 is between 1200 and 1900 mm with an average of 1490 mm. The average temperatures recorded oscillate between 25 and 30° C. The evapotranspiration evaluated over this period is equal to 1206 mm (De Lasme*et al.,* 2012).

Six sampling sites were selected in FaéLake (S1 to S6) (Fig. 1). These sites were sampled during eight sampling campaigns from November 2017 to October 2018. Table 1 summarizes the characteristics of these sampling sites.

2.2 Data collection

Samples were collected each 45 days during eight campaigns at each sampling site. Macroinvertebrates were sampled using a hand net (250 µm mesh, 50 cm length) and a Van Veen grab of 0.05 m^2 internal area.

The samples were sieved in the field through a 1mm mesh, and the material retained on the mesh was immediately fixed in 70% alcohol. In the laboratory, the samples were washed using 1 mm sieves, sorted and identified under a binocular magnifying glass (Olympus SZ 40). Macroinvertebrates were counted and identified to the lowest taxonomic level by means of the keys in Dejoux*et al*. (1981), Day *et al.* (2001, 2003), De Moor *et al*. (2003a, 2003b), Stals and De Moor (2007) for Insecta, Tachet*et al*. (2010) for other Insecta, Acheata and Oligocheata, Brown (1994) for Gasteropoda.
At each sampling period, before macroinvertebrates sampling, temperature, pH, conductivity and dissolved oxygen were determined directly at the same sampling site with a portable multi-parameter (HANNA), turbidity was measured using a turbidimeter, water transparency was determined with a Secchi disc. Water was also collected with bottle of 1L at each sampling site for nutrients (phosphorus, ammonium and nitrate) analysis in the laboratory using Rodier methods (Rodier*et al*., 2009).

2.3 Data analysis

Macroinvertebrate structure was described through taxonomic composition, abundance of individuals, Shannon-Weiner index, Pielou's Evenness index, and rarefied richness. Taxa richness was rarefied to eliminate any bias related to differences in abundances between samples (Heck *et al*., 1975;Edia*et al*., 2016). Calculations were performed using the lowest abundance found in all sites as the target number of individuals (Oksanen*et al*., 2013).

Aquatic macroinvertebrate abundance was obtained by counting all individuals per taxon and expressing the results as numbers per sample.

Before performing the comparison test, the normality of data was checked by Shapiro test. Variations in biotic index were determined using the Kruskal-Wallis test. A significance level of p <0.05 was considered.

A Focused Principal Component Analysis (FPCA)(Falissard, 1999) was carried to expresses the main relations between species and environmental variables. Taxa occurring in more than 5% of the samples were retained. This has been done to minimize the influence of rare taxa. Nine environmental parameters were returned for the analysis. The analyses were computed with the package *psy* (Legendre &Vaudor, 1991) for the R 3.6.1 freeware (R Core Team, 2019).

3. Results

3.1 Environment variables

The table 2 shows the variations of environmental variables measured in the six studied sites. Temperature ranged from 25.6°C (S3) to 31.6°C (S1). Conductivity varied between 40.7 µS/cm (S3) and 79.5 µS/cm (S1). The lowest value of the turbidity (3.6) was recorded in site S3 and the highest value (63.7) in site S6. The dissolved oxygen was situated between 1.23 mg/L (S6) and 6.12 mg/L (S4). The water transparency values varied from 24 cm (S1) to 80 cm (S4). Concerning the pH, it varied from 6.04 to 9.91 (S2). Nitrate concentrations ranged from 0.144 mg/L (S1) to 2.594 mg/L (S3). Regarding the Phosphorus and ammonium, their values were low, varied from 0.031 mg/L (S1) to 0.342 mg/L (S4) and from 0.004 mg/L (S6) to 0.172 mg/L (S2) respectively. Analysis showed no significant differences of these parameters between sites (Kruskal-Wallis, p > 0.05).

3.2 Taxonomic richness and composition

The composition of the macroinvertebrate assemblages is shown in table 3. A total of 123 different taxa belonging to six Classes (Insecta, Gasteropoda, Acheata, Bivalvia, Malacostraca and Arachnida), 16 orders and 54 families comprising 10 982 individuals were collected. One taxa (Arachnida) was identified to Class level, two (Culicidae;Polymitarcyidae) to family, 97 to genus and 24 to species level. Taxonomic richness was dominated by insects (85.37%): Coleoptera (20%), Diptera (15.24%), Hemiptera (17.14%), Trichoptera (12.38%), Ephemeroptera (12.38%), Lepidoptera and Plecoptera (0.95%) and Odonata (20.95%).
Among the 123 taxa identified in the FaéLake, only five are present in all the sites. These are:*Melanoidestuberculata* (Mesogastropoda) and four Diptera belonging to the family of the Chironomidae (*Chironomus*sp.,*Cryptochironomus* sp., *Nilodorum* sp., *Polypedilum* sp.)

22 taxa were solely absent to the site S2. S4 and S5 had each seven taxa that were specific to them. Thirteen (13) of the 72 taxa identified in site S1 were specific to this site. Only one taxon was typical of the site S2. As for the sites S3 and S6, they had respectively ten and three taxa specific.

The spatial variations of the relative abundance of the main orders of aquatic macroinvertebrates in the different sites are illustrated by figure 2. The main orders are those that appear in at least five sites. These orders were:Diptera, Hemiptera, Odonata, Trichoptera, Coleoptera, Mesogastropoda, Ephemeroptera and the Basomatophora.

The Odonata dominated the population in the site S1 when the Mesogastropoda display a numeric importance at S2. In the site S3, the population was dominated by the Trichoptera while in the sites S4 and S6, the Diptera were majority. The Hemiptera were the most numerous to the site S5.

Concerning the variation of the relative abundance of the different classes, the Insecta were numerically the most numerous with 71.43% of the individuals collected. They dominated the population in all site, except S2 where the Gasteropoda were the most numerous. Malacostraca registered the lowest abundance and were only present in S5 and S6(Fig 3).

Yet, difference in rarefied richness (Fig. 4A) and abundances (Fig 2 and 3) calculated for each sites was not significant (Kruskal-Wallis test, p>0.05).

The Shannon-Weiner Diversity Index (H') (Fig. 4B) and Pielou's Evenness Index (E) (Fig. 4C) were calculated for each sample to determine macroinvertebrate structure in the six sites. The lowest values of Shannon's index (0.08) and equitability (0.12) were obtained at site S2. As for the highest values (2.81 for Shannon and 0.91 for equitability), they were recorded at site S6. Concerning the rarefied richness (Fig. 4A), it varied from 1.03 to 1.93 with the lowest in site S2. The highest values of rarefied richness correspond to site S6.The Kruskal-wallistest showed no significant difference for these three parameters between sites.

3.3 Taxa relationships with environmental variables

Relationships between environmental parameters and main macroinvertebrate taxa have been established from Focused Principal Component Analysis (FPCA) (Fig. 5). This analysis shown that the abundance of taxa *Caenis* sp., *Nilodorum* sp., and *Pseudagrion* sp., were significantly and positively correlated with temperature and conductivity but correlated significantly and negatively with turbidity.There was a positive and significant correlation between *Orectogyrus* sp. abundance and nitrate concentration. Conductivity influenced positively and significantly *Microvelia* sp. abundance. As for the abundance of *Chironomus* sp., it increased significantly with low values of turbidity.

4. Discussion

The analysis of environmental variables measured at different sampling sites of Faé Lake shown no significant variation between sites. This could be explained by the relatively small size of the lake which would favor a constant communication between the waters of the various sampling sites considered; resulting in a certain homogeneity of the water of the reservoir.This exchange would itself be due to the large circulation of water bodies that play a fundamental role in the transport and redistribution of nutrients in lakes (Salencon & Calmels, 1994).

However, the temperature range recorded in Fae Lake is between 25.6 ° C and 31.6 ° C. These relatively high temperatures are typical of tropical environments. Indeed, according to Lemoalle (1999), in tropical Africa, average water temperatures in aquatic environments are high and most often above 20 ° C.

With regard to dissolved oxygen, the range is between 1.23 and 6.12 mg / L. This range is lower than that obtained in Kodjoboué Lake (0.10 and11.3 mg/L) by Kra*et al.*, (2018). The range of variation in temperature and dissolved oxygen may be related to the lack of vegetation cover on the lake. The water transparency varies between 24 and 80 cm at Faé Lake. Its values are lower than those observed (73 and 112 cm) at Lake Ayamé by Diétoa (2002). As for turbidity, it oscillates between 3.6 and 63.7 NTU. These values are higher than those obtained (9.04 - 25 NTU) by Diomandé*et al.*, 2013 in Lake Taabo.

Low values of nitrate (0.144 à 2.594 mg/L), phosphorus (0.031 mg/L à 0.342 mg/L) and ammonium (0.004 - 0.172 mg/L) were recorded. These low nutrient values are due to the fact thatthe upstream lake is occupied by the Grah classified forest and rubber plantations, thus limiting the action of humans. According to Meybeck (1989) nutrient concentrations in surface waters that are free of human activities are less than 1 mg/L.

A total of 123 aquatic macroinvertebrate taxa belonging to 54 families, 16 orders and 06 classes were harvested. The taxonomic richness of Faé Lake was higher than those obtained in other lakes in Côte d'Ivoire (Kouamé*et al.*, 2010;Kouamé*et al.*, 2011;Diomandé*et al.*, 2013;Kra*et al.*, 2019). These authors recorded respectively 68, 43, 29 and 74 taxa. This strong taxonomic richness would be due to variability of habitats favoured by the presence of several islands in this lake.

Macroinvertebrate community of Faé Lake is composed mainly of insects with 85.37% inventoried taxa.They also dominate the global abundance at over 70%.This dominance of insects was also reported by Diomandé&Gourène (2005) in Ayamé Lake. According to Gagnon &Pedneau (2006), the most diverse taxonomicgroup among aquatic macroinvertebrates are insects. They colonize all the aquatic environments owing to their dispersal capacity with strong preference for freshwaters (Tachet*et al.*, 2003).

The Shannon-Weiner index (H') and Pielou's Evenness index values (E) were relatively high at all sites except S2 where low values (H': 0.08-0.65 and E: 0.17-0.86) were recorded.At this site (S2), only Diptera (Chironomidae) and Mesogastropoda (Thiaridae) were present.This low diversity is believed to be due to the depth of the sampling area (more than 3m), and the absence of aquatic vegetation. In fact, the aquatic vegetation would house a diverse macrofauna (Kouamé*et al.*,2010;Kornijow*et al.*,2010; Habib &Yousuf, 2014). Also, according to Salmoiraghi*et al.* (2001), the diversity and abundance of macroinvertebrates in lakes would decrease from the littoral to deep areas.

For the other sites H' varies between 1.16 and 2.81 and E between 0.44 and 0.908. These results show that Fae Lake macroinvertebrates are diversified and well organized. Most sites have good ecological status. These results are similar to those of Kra*et al.* (2018), which obtained H' values ranging from 0.84 to 2.40 and E from 0.43 to 0.98 in Lake

Kodjoboué. The site S6, with its maximum values of diversity index (H: 2.81) and equitability (E: 0.908), appears as the most diversified site, the most stable and the best organized.

Focused Principal Component Analysis (FPCA) related the influence of environmental parameters on principal taxa.

This analysis shows that taxa *Caenis*sp. (Ephemeroptera) proliferates in areas where conductivity and temperature are relatively high, with low turbidity values. These characteristics indicate a relatively good ecological quality water. These observations were made by Mandaville, (2002);Voshell, (2002);Arimoro*et al.* (2007) and Galbrand*et al.* (2007), which classify Ephemeroptera as taxa particularly sensitive to pollution and typically abundant in aquatic environments with good water quality.

The abundance of *Nilodorum*sp.is positively correlated with conductivity and temperature but negatively correlated with turbidity. As for *Chironomus*sp., it proliferates in low turbidity environments. These two Diptera of the Chironomidae family are recognized as being resistant to pollution and can live in polluted or unpolluted areas (Arimoro*et al.*, 2007). This would explain their presence at all sampling sites.

Concerning *Pseudagrion* sp. (Odonata), its abundance would be positively and significantly related to temperature and conductivity. These conditions are favourable to the proliferation of Chironomidae. Thus, the abundance of Odonata would be the consequence of the large number of Chironomidae on which these predatory insects feed.

The influence of physico-chemical water parameters on the abundance, composition and organization of aquatic macroinvertebrate communities has also been shown by several authors (Bony, 2007 and Bond &Downes, 2003).

5. Conclusion

The present study conducted that aquatic macroinvertebrates of the Faé Lake are rich and diversifiedwith, 6 classes, 16 orders, 54 families and 123 Taxa. The most diversified class was Insecta with 85.37% of the taxa inventoried. Among the insects found, most diverse order was Odonata (22 taxa, 5 families) followed Coleoptera (21 taxa, 8 families) Hemiptera (18 taxa, 9 families) and Diptera (16 taxa, 6 families). The main taxa abundances is influenced by environmental variables such as nitrate, turbidity, conductivity and temperature. The different indices studied, show that overall, this lake is less disturbed. It is therefore necessary to protect the Faé Lake in order to conserve itsbiodiversity.

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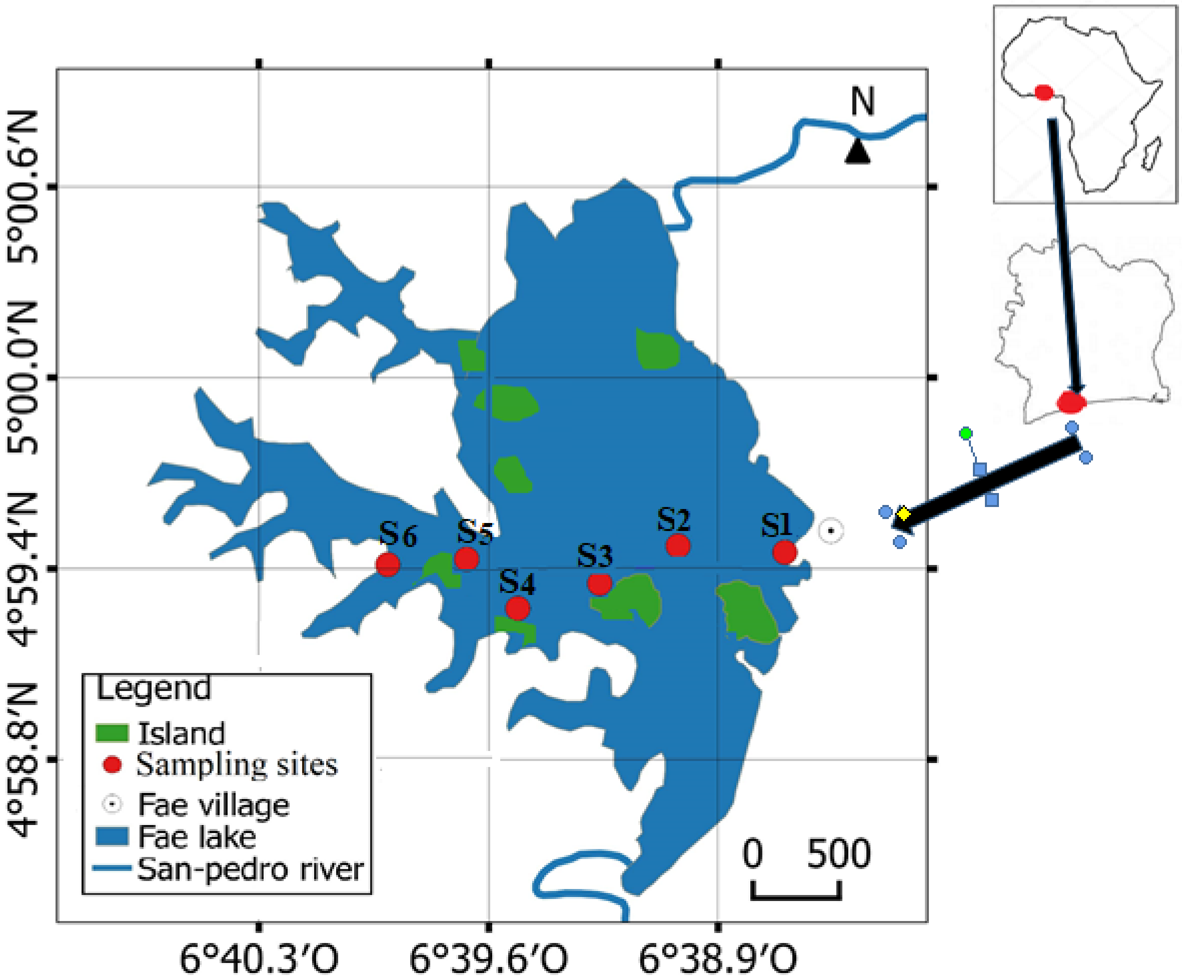

Figure 1: Location of the study area showing the six sampling sites of Faé Lake (South-West of Côte d'Ivoire)

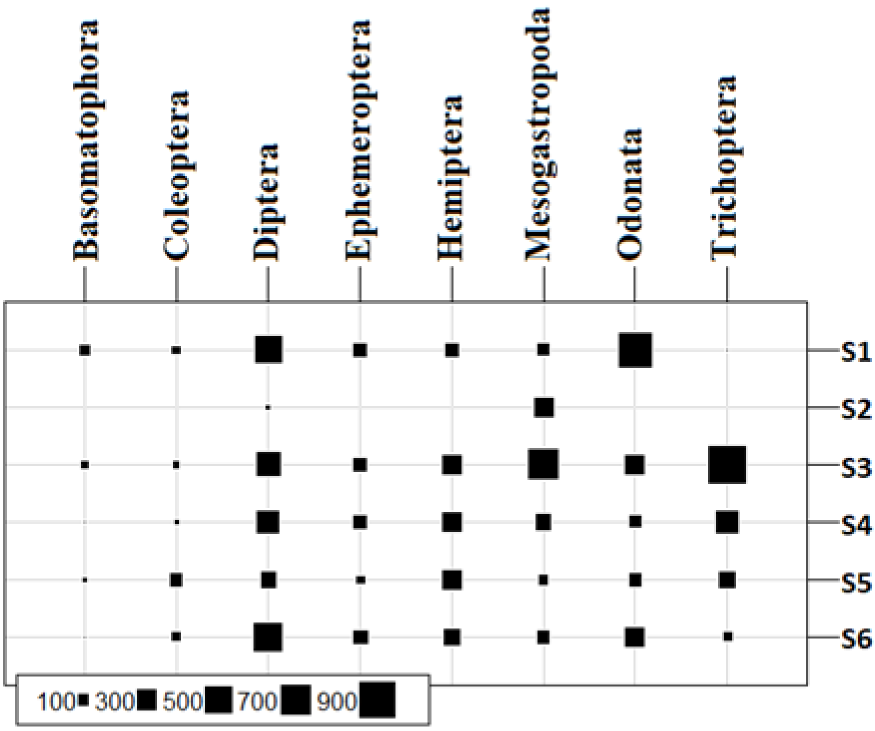

Figure 2: Relative abundance of different orders of aquatic macroinvertebrates in Faé Lake during the study period

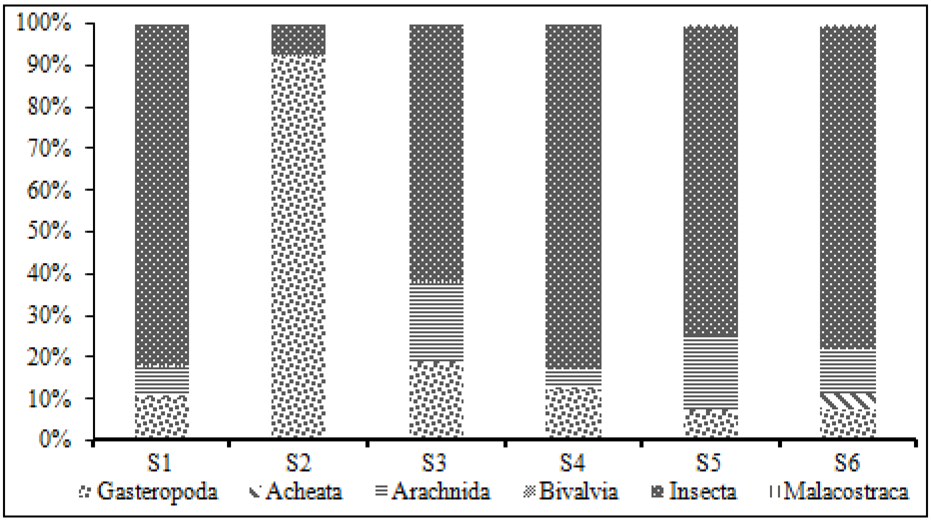

Figure 3: Relative abundance of different classes of aquatic macroinvertebrates in Faé Lake during the study period

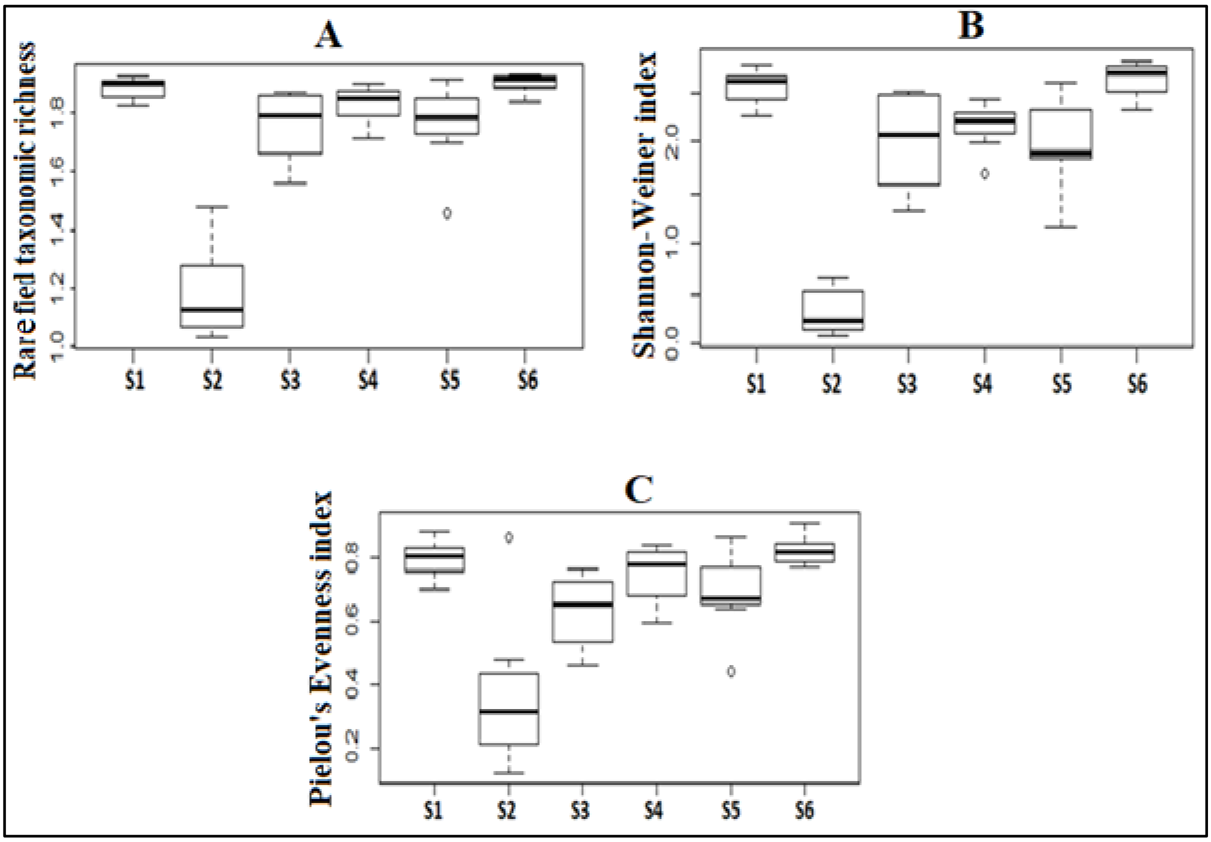

Figure 4: Box-plots showing variation of Rarefied taxonomic richness (A), Shannon-Weiner index (B), and Pielou's Evenness index (C) of Faé Lake.

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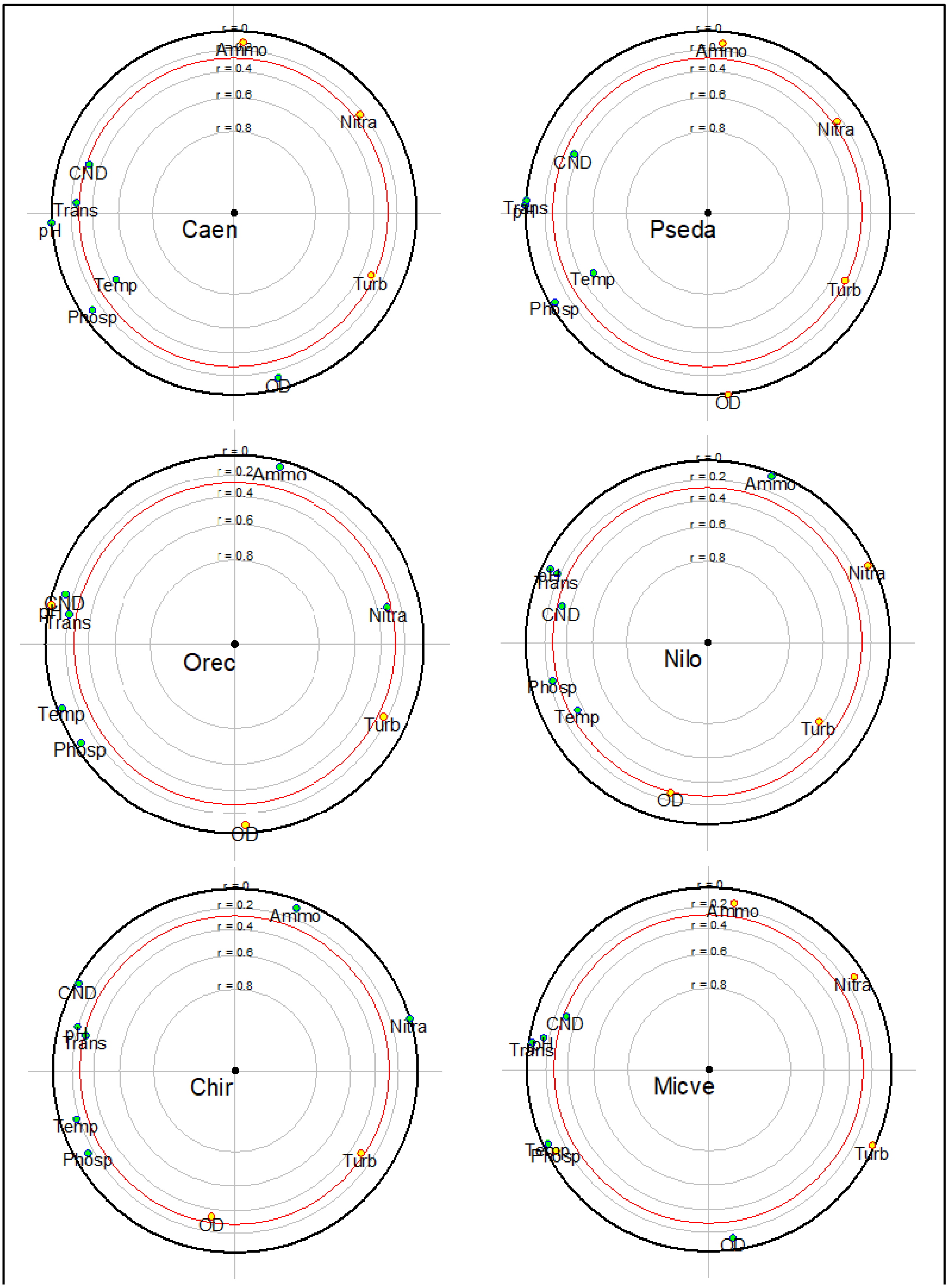

Figure 5: Focused Principal Component Analysis (FPCA) showing the relationships between environmental variables and biological variables. Codes : Caen = *Caenis* sp. ; Chir = *Chironomus* sp. ; Micve = *Micrvelia* sp. ; Nilo = *Nilodorum* sp. ; Orec = *Orectogyrus* sp. ; Pseda = *Pseudagrion* sp. ; Ammo = Ammonium ; CND = conductivity ; Nitra = Nitrate ; OD = Dissolved Oxygen ; Phos = Phosphorus ; T= Temperature ; Turb = Turbidity ; Trans = Transparency

Table 1: Characteristics of the six study sampling sites in Faé Lake (South-West of Côte d'Ivoire)

Sites	Coordinates		Cover (%)	Canopy (%)	slope (%)	Land use
S1	N 04°59'27.2''	W 006°38'40.2''	20	20	20	Faé village
S2	N 04°59'26.3''	W 006°39'00.8''	0	0	-	-
S3	N 04°59'21.8''	W 006°39'11.4''	20	70	20	Cocoa plantation
S4	N 04°59'10.9''	W 006°39'33.4''	5	30	45	Cocoa plantations
S5	N 04°59'21.5''	W 006°39'40.7''	5	50	90	Rubber plantation
S6	N 04°59'24.5''	W 006°39'55.0''	5	100	5	Grahdrill classified

Table 2: Environmental variables measured at six sampling sites of Faé Lake (South-West of Côte d'Ivoire). T= temperature; Cond= conductivity; Turb= turbidity; Trans= transparency ; OD= dissolved oxygen ; NO^{3-} = nitrate ; PO_4^{3-} = phosphorus ; NH_4^+= ammonium

Sites		T (°C)	Cond (µS/cm)	Turb (NTU)	pH	Trans (cm)	OD (mg/L)	NO^{3-} (mg/L)	PO_4^{3-} (mg/L)	NH_4^+ (mg/L)
S1	Min	26.3	48.3	8.3	6.19	27	3	0.144	0.031	0.024
	Med	27.5	68.7	33.7	7.23	40.2	3.75	0.456	0.101	0.059
	Max	31.6	79.5	63.6	8.71	60	5.58	1.331	0.192	0.109
S2	Min	25.7	47.2	7.8	6.04	30	2.8	0.29	0.043	0.026
	Med	27.9	67.7	33.1	7.33	34.5	3.38	0.774	0.112	0.074
	Max	31.6	79.3	63.7	9.91	63	5.13	1.789	0.249	0.172
S3	Min	25.6	40.7	3.6	7.1	29	1.4	0.417	0.061	0.018
	Med	26.9	61	32.75	7.59	41	4.74	0.734	0.136	0.084
	Max	29.6	75	38.2	8.4	63	6.1	2.594	0.282	0.146
S4	Min	25.5	48.2	4.7	6.75	30	3.7	0.26	0.05	0.042
	Med	27.25	65.9	30.75	7.53	49	5.07	0.513	0.159	0.072
	Max	30.1	77.8	47.1	8.06	80	6.12	2.16	0.342	0.103
S5	Min	25.7	48	5.7	6.67	32	3.74	0.309	0.055	0.041
	Med	27.6	67.1	26	7.64	51	4.6	0.678	0.16	0.098
	Max	30.3	78.7	46	8.17	76	5.67	2.291	0.202	0.125
S6	Min	25.6	47.8	6.09	6.81	31	1.23	0.221	0.068	0.004
	Med	27.5	68.6	19.9	7.58	58	3.8	0.383	0.093	0.067
	Max	30.9	77.7	47.3	8.77	79	4.91	0.858	0.203	0.168

Table 3: List of the macroinvertebrates taxa found in the six sites of Faé Lake (South-West of Côte d'Ivoire). *** Very frequent (FO > 50%); ** frequent (25 < OF ≤ 50); * rare (OF ≤ 25)

CLASS	ORDER	FAMILY	TAXON	S1	S2	S3	S4	S5	S6
Acheata	Pharyngobdeliformes	Erpobdellidae	*Dina* sp.	***		**		**	***
	Rhynchobdeliformes	Glossiphinidae	*Glossiphonia*sp.	*			**	**	
			*Helobdelia*sp.						***
Gasteropoda	Basomatophora	Planorbidae	*Biomphalariapfeifferi*	***		***		***	*
			Bulinusforskalii	***				*	
			Bulinusglobosus	**					
			Bulinustroncatus	*					*
			Indoplanorbisexustus	*		***	*	**	**
		Lymnaeidae	*Lymnaeanatalensis*	***		**	*	*	*
		Physidae	*Physamarmorata*			*			*
	Mesogastropoda	Ampullariidae	*Lanitesvaricus*	***				*	
			Pila africana			*		*	
		Bythinidae	*Gabbiellaafricana*					*	***
		Thiaridae	*Melanoidestuberculata*	***	***	***	***	***	***
Bivalvia	Eulamellibranches	Margaritiferidae	*Margaritifera*sp.		*				
	Myoida	Corbulidae	*Corbulatrigona*	*		*			
Malacostraca	Decapoda	Palaemonidae	*Macrobrachium*sp.					*	*
Insecta	Ephemeroptera	Baetidae	*Acentrella*sp.					*	
			*baetis*sp.	***		***	***	***	***
			*Cloeon*sp.	*		*			
			*Procloeon*sp.			*	*		*
			*Pseudocloeon*sp.				*		
		Caenidae	*Brachycercus*sp.					*	
			*Caenis*sp.	***		***	***	**	***
		Leptophlebiidae	*Adenophlebiodes*sp.	*		*			
			*Choroterpes*sp.			*	**		
			*Thraulus*sp.	*					
		Polymitarcyidae	Ind					*	
			*Povilla*sp.	**		**	**	**	***
		Tricorythidae	*Machadorytus palanquin*			*		*	

	Plecoptera	Perlidae	_Perla_ sp.			**			
	Odonata	Caloptérygidae	_Phaon_sp.	***		**	**	*	**
		Coenagrionidae	_Ceriagrion_sp.	***		**	*	*	***
			Chlorolestesfasciatus					*	
			Coperavittata				*	*	**
			Enallagmaglaucum	**					*
			_Pseudagrion_sp.	***		***	***	***	***
		Macromiidae	_Phyllomacromia_sp.	***		***	**	***	***
		Gomphidae	_Gomphidia_sp.	*		*	*		*
			_Ictinogomphus_sp.	*			*		**
			_Neurogomphus_sp.				*		
			_Paragomphus_sp.				*		
		Libellulidae	_Brachythemislacustris_	***		*			
			_bradinopyga_sp.			*		*	*
			_Chalcostophia_sp.	*					
			_Crocothemis_sp.	*					
			_Diplacodes_sp.					*	
			_Orthetrum_sp.				*		
			Parazyxommaflavicans	*		*		*	*
			_Sympetrum_sp.	*					
			_Trithemis_sp.	*			*		
			_Zygonyx_sp.	*					
			Zyxommapetiolatum	*		*			
	Hemiptera	Belostomatidae	_Diplonychus_sp.	***		**		***	***
			_Limnogeton_sp.	*					
		Corixidae	_Micronecta_sp.						***
		Gerridae	_Eurymetra_sp.	**		***	***	***	***
			Gerris sp.				*		
			Limnogonuschopardi	*		*	*	**	
			_Neogerris_sp.	*					
			_Rhagodotarsus_sp.				**		*
		Mesoveliidae	_Mesovelia_sp.	***		**	**	**	**
		Naucoridae	_Macrocoris_sp.			*			
			_Naucoris_sp.			*			
		Nepidae	_Laccotrephes_sp.	*					**
			_Ranatra_sp.	***		*	**	*	*
		Notonectidae	_Anisops_sp.	**		***	***	***	***
			_Enithares_sp.	*					
		Pleidae	_Plea_sp.			*	*		
		Veliidae	_Microvelia_sp.	***		***	***	***	***
			_Rhagovelia_sp.					**	*
	Lepidoptera	Pyralidae	_Elophila_sp.	**		**		*	
	Coleoptera	Chrysomelidae	_Donaciastagoeckei_	*		**	*		
		Curculionidae	_Bagous_ sp.	*					
			_neochetina_sp.			*			
			Pseudobagouslongulus	*		**	**	*	
		Dytiscidae	_Hybius_sp.					*	
			_Hydaticus_sp.			**			
			_Hydrocantus_sp.	*		*			
			_Hydrovatus_sp.	*			*		
			_Laccophilus_sp.	*		*		**	**
		Elmidae	_leptelmis_sp.			*			
			_Limnus_sp.			**		**	
		Gyrinidae	_Aulonogyrus_sp.					*	
			_Dineutus_sp.				*	*	***
			_Orectogyrus_sp.					**	***
		Hydraenidae	_Discozantaena_sp.	**			*	*	
		Hydrophilidae	_Amphios_sp.			*	*		
			_Berosus_sp.	*				*	
			_Enochrus_sp.	***		***	**	**	**
			_Hydrobius_sp.	*		**			
			_Hydrocharra_sp.			*			
		Spercheidae	_Spercheus_sp.	**		*	**	*	***
	Trichoptera	Ecnomidae	_Ecnomus_sp.			*		*	
		Goeridae	_Silo_ sp.	**		***	***	***	***
		Hydropsychidae	_Cheumatopsyche_sp.				**		*
			_Macronema_sp.	*					

		Hydroptilidae	*Hydroptila*sp.				**		
			*Ugandatrichia*sp.			*			
		Leptoceridae	*leptocerina*sp.				*		
			*Oecetis*sp.	*				*	*
			*Parasetodes*sp.			***	**	**	*
			*Setodes*sp.			**	*	*	*
		Philopotamidae	*Chimarrapetri*			***	**	*	***
			*Phylopotamus*sp.			*			
		polycentropodidae	*Dipseudopsiscopensis*			**	*	*	**
	Diptera	Ceratopogonidae	*Bezzia*sp.	**		**	**	*	*
			Culicoides	***		*	*	*	*
		Chaoboridae	*Chaoborus*sp.						**
		Chirinomidae	*Ablabesmyia*sp.	*		***	*	*	**
			*Chironomus*sp.	***	*	***	**	***	***
			*Clinotanypus*sp.	*	*				
			*Cricotopus*sp.	***		***	**	**	
			Cryptochironomussp.	***	**	***	***	***	***
			*Nilodorum*sp.	***	**	***	***	**	***
			*Polypedilum*sp.	***	***	***	***	***	***
			*Procladius*sp.			*			*
			*Steriochironomus*sp.			*			
			*Stictochironomus*sp.	***		***	**	*	***
		Culicidae	Ind	*		**	*		*
		Limoniidae	*Dicranota*sp.	*					
		Thaumaleidae	*Thaumalea*sp.	*					
Arachnida	ind	Ind	Ind	***		***	***	***	***
Taxonomicrichness				**72**	**7**	**71**	**57**	**64**	**58**

*** Very frequent (FO > 50%) ; ** frequent (25 < OF ≤ 50) ; * rare (OF ≤ 25).