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Entomofaunal diversity and involvement in the diagnosis of water quality in Afridougou's Drébot Lake used for drinking water supply in Gagnoa (Centre-West, Côte d'Ivoire)

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Abstract

The population of Gagnoa is growing, leading to the expansion of human activities such as agriculture, urbanisation and leisure activities around Drébot Lake, which is used to supply drinking water. These anthropogenic pressures are characterised by the discharge of toxic substances into this lake and the degradation of its ecological quality, which is still poorly understood. This study was carried out to provide the first data on the entomofauna and the ecological status of the water in Gagnoa's Drébot Lake. Sampling took place in February 2023 at 22 stations. Aquatic insects were collected using a turbid net (2.5 m^2 of surface area sampled) and a Van Veen bucket (0.3 m^2 of sediment per sample). Physico-chemical parameters were measured using a multiparameter. Spatial variations in physico-chemistry indicate that only transparency and depth varied significantly between sampling stations on Drébot Lake. The inventory revealed 317 insect individuals divided into 31 taxa, 19 families and 4 orders. The order Diptera (9 taxa) is the most diverse and the most abundant (141 individuals).Species richness is higher on the banks (28 taxa) than in open water (2 taxa).Predatory organisms dominate the trophic structure of the lake's insect population.The insect population was not very diversified, but balanced. Assessment of water quality using the Chironomidae index indicated that most of the sites surveyed have good quality water.

Keywords: Entomofauna diversity; State of integrity; Water quality; Drébot Lake; Gagnoa

1. Introduction

Drébot Lake, located in the Afridougou district to the north of the Gagnoa city, is suffering from the impact of anthropogenic activities carried out in its catchment area [1]. This situation is due to population growth and rampant urbanisation, which have led to the development of housing, hotels, agri-food industries, livestock farming and various agricultural crops (market gardening and food crops) [2]. In addition, the lack of wastewater treatment and sewerage systems in the area means that domestic effluent is discharged directly into the lake [3]. However, the lake environment plays an important role in the town of Gagnoa. It provides a number of ecosystem services, including water purification, recreation, tourism and the supply of running drinking water to a third of the town [1]. Given the importance of this lake to the city, it is necessary to assess the ecological quality of the water in order to ensure its preservation. However, there is little data on the lake's aquatic entomofauna. What's more, the ecological quality of the water in Gagnoa's Drébot Lake is still poorly understood. The general aim of this study is therefore to provide the first data on the entomofauna and the ecological status of the water in Drébot Lake in Gagnoa.

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2. Material and Methods

2.1. Study area

Gagnoa is located in west-central Côte d'Ivoire, between latitudes 6°05'30'' and 6°09'30'' north and between longitudes 5°05'30'' and 5°05'50'' west. Gagnoa, the capital of the Gôh region, is 275 km from the economic capital Abidjan [4]. The town of Gagnoa covers an area of 4,428 km^2 and has 18 districts with a population of 277,044 [1].

The climate in the Gagnoa is equatorial, with two seasons [4]. The site is a plateau with low hills bordered by low-lying areas through which flow the Gnousso and Drébot streams and the main Guéri river (a tributary of the Sassandra river) [1]. The town's wetlands are drained by the tributaries of the Guéri River, namely the Drébot, Gnousso and Kouablo streams, which flow right through the town. Drébot Lake was created when a dam was built across the Drébot stream [1] (Fig 1).

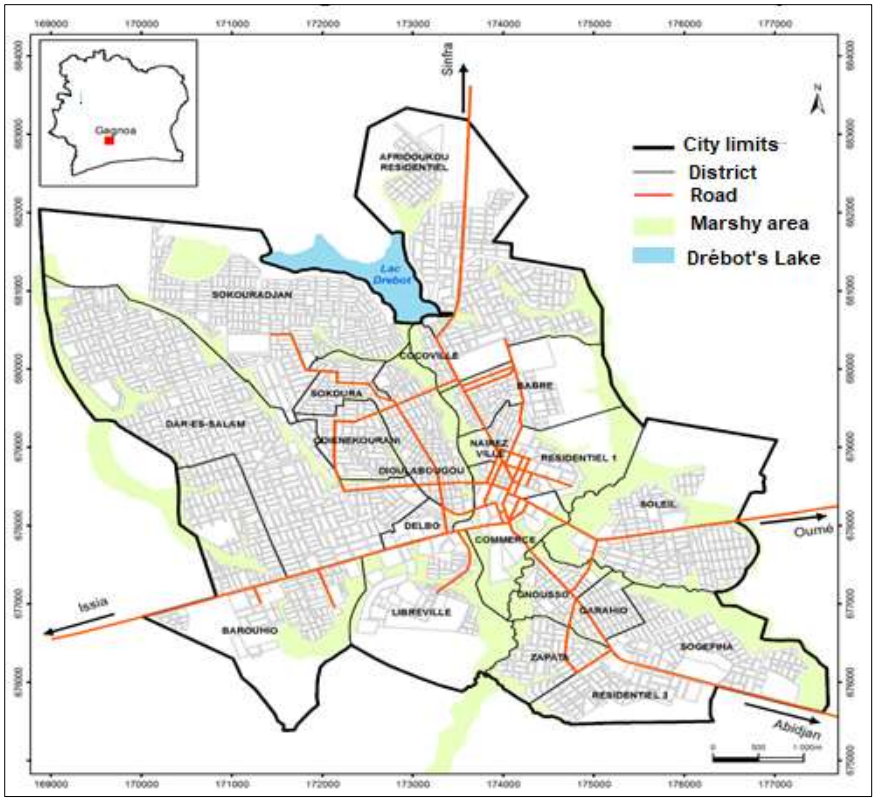

Figure 1 Location map of Drébot Lake of Afridougou modified [1]

2.2. Sampling procedure

The study took place at 22 sampling sites. These were defined so as to cover the entire lake (banks and open water). They were also chosen on the basis of their accessibility and proximity to human activities and sources of pollution. As a result, 22 stations numbered P1 to P22 were selected, including 16 on the banks and 6 in open water (Fig 2). The coordinates of these stations and their locations are shown in Table 1.

Samples were collected for 4 minutes using a net over an area of 2.5 m^2 (5 x 0.5 m) [5], for pelagic macroinvertebrates and (6) six strokes of a Van Veen bucket for benthic macroinvertebrates, i.e. an area of 0.3 m^2 (6 x 0.05 m^2). In situ, the samples were preserved in labelled 1-litre jars containing 70% alcohol. In the laboratory, the insects were sorted and separated from all the macroinvertebrates under a binocular magnifying glass at 40 x magnification, then identified using the keys and works of [6] and [7].

Table 1 Coordinates of sampling sites in Drébot Lake

N° Stations	Geographical coordinates	Situation
P1	X=6.161226 , Y=-5.952921	Near the shore
P2	X=6.158688 , Y= -5.952531	Near the shore
P3	X=6.156313 ; Y= -5.951760	Near the shore
P4	X=6.153858 ; Y= -5.951231	Near the shore
P5	X=6.152308 , Y= -5.949621	Near the shore
P6	X=6.151680 ; Y=-5.951017	Near the shore
P7	X=6.151058 ; Y= -5.953653	Near the shore
P8	X=6.152983 ; Y= -5.954375	Near the shore
P9	X=6.155556 ; Y= -5.956130	Near the shore
P10	X=6.157104 ; Y= -5.959369	Near the shore
P11	X=6.157628 ; Y=-5.962111	Near the shore
P12	X=6.159069 ; Y=-5.962190	Near the shore
P13	X=6.159599 ; Y=-5.960561	Near the shore
P14	X=6.158068 ; Y=-5.957011	Near the shore
P15	X=6.159631 ; Y=-5.954108	Near the shore
P16	X=6.152663 ; Y=-5.952238	Full water
P17	X=6.154671 ; Y=-5.953688	Full water
P18	X=6.157168 ; Y=-5.954269	Full water
P19	X=6.157663 ; Y=-5.958225	Full water
P20	X=6.158591 ; Y=-5.961280	Full water
P21	X=6.158859 ; Y=-5.953309	Full water
P22	X=6.150877 ; Y=-5.952042	Near the shore

Figure 2 Location of the sampling stations defined on Drébot Lake of Afridougou

2.3. Data analysis

- Relative abundance was used to identify the main insect species in Drébot Lake, representing at least 4% of the total number of insects collected at one of the sampling sites [8].
- -The analysis of stand diversity was based on Shannon's diversity index (H') to quantify the diversity of stands and Piélou's equitability index (J) to assess their degree of equilibrium: H' = - Σpi*log2pi. Where: pi represents the relative abundance of species i in the sample (pi = ni/N). J = H'/ log2 S. with S was the number of species in samples [9].
- The Self Organizing Maps (SOM) algorithm was used to order insects according to environmental variables and assemblages of aquatic insect taxa [8].
- Hierarchical Classification Analysis (HCA) using the Ward method and Euclidean distance was used to classify the cells of the self-organising map into three groups.
- -Water quality at the Drébot Lake sampling stations was determined using the Chironomidae index (CI), which represents the quotient of Chironomidae abundance over the total abundance of insects present at a station [10]. [11] proposes the following classification based on CI values:
- % CI > 75%: Highly polluted water (HP);
- 20% < % CI ≤ 75%: moderately polluted water (MP);
- 5% < % CI < 20%: slightly polluted water (SP) ;
- % CI < 5%: good quality water (GQ).

The Kruskal-Wallis test was used to test the variability of the parameters between different groups of stations. The Mann-Whitney test was then used to identify differences between groups taken in pairs. The "asymptotic significance" value indicates that there are no significant differences between the variables when it is greater than 0.05, and conversely when it is less than 0.05.

In addition, the G proportion test was used to compare the proportions of stations according to the different spatial distributions of insects.

The data collected were processed using Matlab version 6.1 and Xlstat version 2018.

3. Result

3.1. Taxonomic composition

The taxonomic compositions of the aquatic insects inventoried at the various sampling stations in Gagnoa's Drébot Lake are presented in Table V. At all the stations, 31 taxa divided into 19 families and 4 orders were collected. Among the orders recorded, the orders Diptera and Odonata were the best represented, with 09 taxa each, i.e. 29% of the taxonomic richness. These orders are followed by the Coleoptera, with 08 taxa, or 26% of insect taxa. The order Hemiptera is the least diverse, with 05 taxa, or 16% of taxa.

The distribution of taxonomic richness shows that stations P7 and P8 near the lake shore are the most diverse, with 7 taxa each. They are followed by station P6, which recorded 06 taxa. However, stations P2, P3, P9, P10 and P13 close to the shore and stations P16 and P21 in open water were less diverse, with 01 species each (Table 2).

The distribution of taxonomic richness according to habitat indicates that 02 taxa are found only in open water, compared with 28 taxa on the banks (Table 2).

In terms of occurrences of insect taxa, *Enochrus* sp. (Coleoptera), *Chironomus* sp. (Diptera), *Microvelia* sp. (Hemiptera) and *Zygonyx torridus* (Odonata) are the most common in Drébot Lake, with occurrences of 23% each. These taxa are followed by the Coleoptera *Anacaena* sp. and *Amphiops* sp., with occurrences of 18% and 14% respectively.

Table 2 Taxonomic composition of insects at different stations in the Drébot Lake of Afridougou

					Near the shore sites															Full water sites					
Order	**Families**	**Taxa**	**Sigle**	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**	**P12**	**P13**	**P14**	**P15**	**P22**	**P16**	**P17**	**P18**	**P19**	**P20**	**P21**
Coléoptères	Dryopidae	*Strina promontorii*	Spr	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
	Dytiscidae	*Bidessus* sp.	Bid	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Dytiscus marginalis	Dma	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
		Methles cribatellus	Mcr	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Gyrinidae	*Dineutus* sp.	Din	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
	Hydrophilidae	*Amphiops* sp.	Amp	+	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Anacaena sp.	Ana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	-
		Enochrus sp.	Eno	-	-	-	-	+	-	-	+	-	-	+	+	-	-	+	-	-	-	-	-	-	-
Diptères	Chironomidae	*Chironomus* sp.	Chi	-	+	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	+	-
		Nilodorum brevibucca	Nbr	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Polypedilum abyssiniae	Pab	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Polypedilum fuscipenne	Pfu	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Polypedilum laterale	Pla	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Polypedilum longicrus	Pol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+
	Empididae	*Empis* sp.	Emp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
	Psychodidae	*Clogmia* sp.	Clo	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Tipulidae	*Conosia ivrorata*	Civ	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hémiptè	Belostomatidae	*Belostoma elegans*	Bel	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Mesoveliidae	*Mesovelia vittigera*	Mvi	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	Naucoridae	*Laccocoris* sp.	Lac	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Notonectidae	*Anisops* sp.	Ani	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
	Veliidae	*Microvelia* sp.	Mic	-	-	-	-	-	+	+	+	-	-	-	-	+	-	+	-	-	-	-	-	-	-
Odonates	Aeshnidae	*Anax impevator mauricianus*	Aim	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
	Coenagrionidae	*Coenagriocnemis reuniense*	Cre	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Pseudagrion sp.	Pse	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Corduliidae	*Phyllomacromia bifasciata*	Pbi	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Gomphidae	*Neurogomphus* sp.	Neu	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Libellulidae	*Trithemis dorsalis*	Tdo	-	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
		Trithemis werneri	Twe	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Zygonyx torridus	Zto	-	-	-	-	-	-	-	+	+	-	-	-	-	+	-	-	+	-	-	+	-	-
	Macromiidae	*Phyllomacromia Picta*	Ppi	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total = 4	19	31		2	1	1	4	4	6	7	7	1	1	3	2	1	2	2	3	1	2	2	2	2	1
				28 taxons																02 taxons					

3.2. Determinism of taxonomic richness

3.2.1. Ordination of samples according to taxa

Self-Organizing Map learning based on the presence/absence matrix of insect taxa collected in Drébot Lake was used to classify the 31 samples from the various stations. The classification was based on the distribution and probability of occurrence of the taxa. The 24 cell map (8 rows x 3 columns) was chosen because this size recorded the smallest quantification and topographical errors on this map (Table 3).

Table 3 Different Kohonen map sizes and corresponding quantification and topographic errors.

Map size	Quantification error	Topographical error
12*2	0.735	0
8*3	0.734	0.000
6*4	0.749	0.000

The size chosen is in bold

The cells in the self-organising map were classified into three groups (GI, GII and GIII) using Hierarchical Classification Analysis with the Ward method and Euclidean distance. The groups are illustrated by different figures on the Kohonen map (Fig 3 and 4). Group I represented 59.09% of all the samples and included samples from stations P1, P2, P3, P9, P10, P13, P14, P16, P17, P18, P19, P20 and P21. This dominance is significant (G test: $p < 0.05$). Group II (31.82%) is significantly characterised by samples from stations P5, P6, P8, P11, P12, P15 and P22 (G test: $p < 0.05$). Group III (9.09%) includes samples from stations P4 and P7.

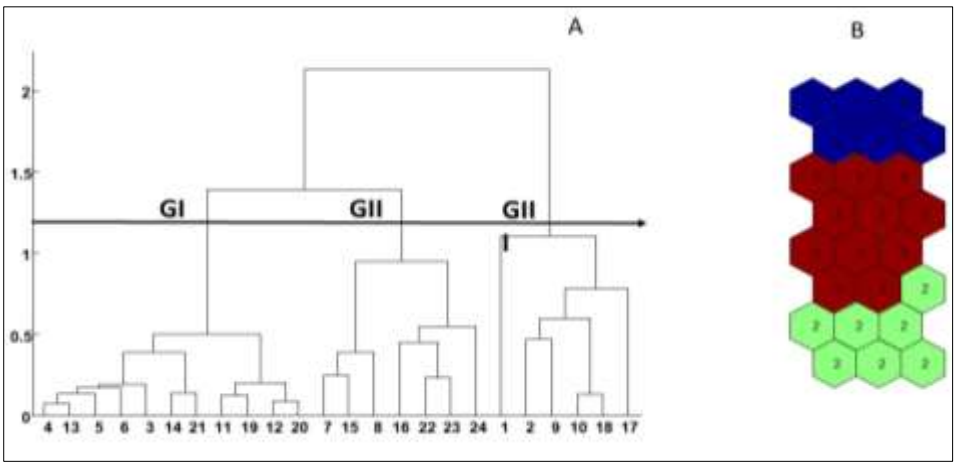

Figure 3 Ascending hierarchical classification of SOM cells based on insect taxa collected in Drébot Lake.

A = Hierarchical Ascending Classification of the cells in the Kohonen map using the Ward method and the Euclidean distance as the assembly distance (the numbers [1 to 24] correspond to the cell numbers in the Kohonen map); B = Kohonen map with the cells numbered 1, 2 and 3. The Arabic numbers [1, 2 and 3] represent the selected groups.

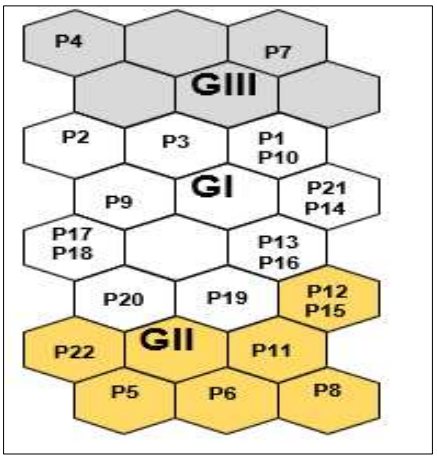

Figure 4 Distribution of samples in the SOM based on presence/absence data for insect taxa

The Roman numerals (I, II and III) represent the groups defined by the ACH.

The distribution of each of the aquatic insect taxa in each group defined by the SOM is illustrated in Figure 5. The distribution is based on an analysis of the contribution of each taxon in each group. The grouping of taxa belonging to the same SOM group is shown in Figure 6. Group I, which is less diverse, contains 3 taxa. Group II contains 16 taxa and is more diverse. Group III has 12 taxa. The number of taxa recorded in the different groups differed significantly from one group to another (Kruskal-Wallis test, $p < 0.05$). Groups II and III are the richest in taxa compared with Group I (Mann-Whitney test, $p < 0.05$).

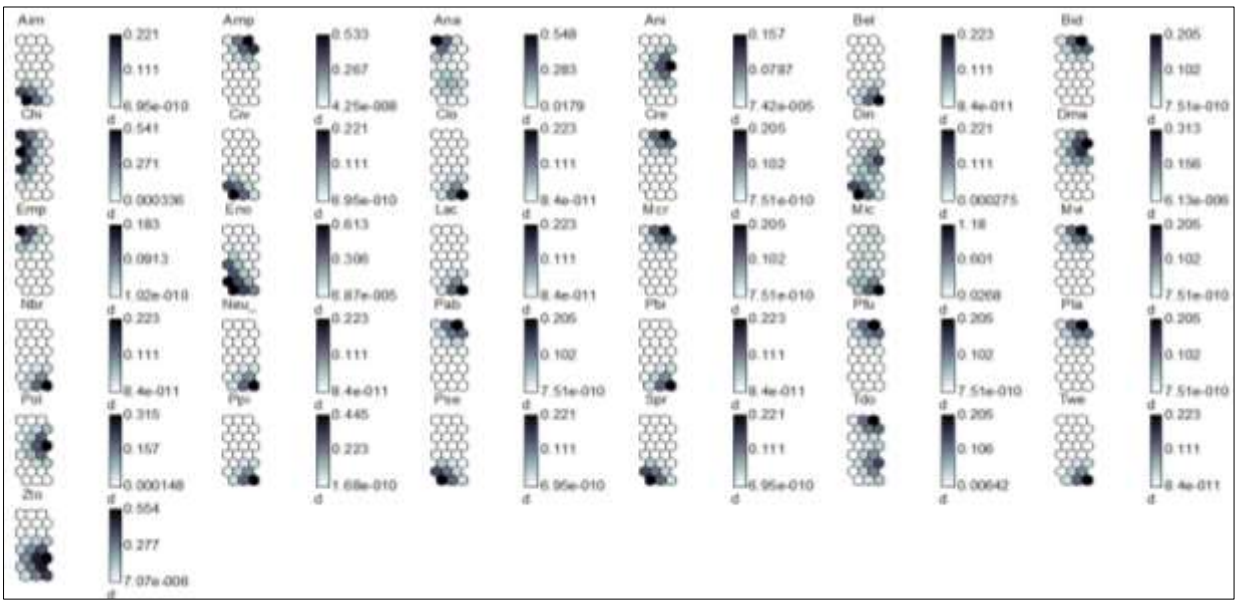

Figure 5 Distribution profile of insect taxa collected in Drébot Lake on the Kohonen map based on insect taxon presence/absence data.

Dark colour = high probability of presence; light colour = low probability of presence; d = scale.

Group I 	Representative taxa *Anisops* sp, *Chironomus* sp, *Polypedilum longicrus*
Group II 	Representative taxa *Anax impevator mauricianus*, *Belostoma elegans, Dineutus* sp., *Trithemis werneri, Conosia ivrorata, Laccocoris* sp. *Enochrus sp., Clogmia* sp., *Phyllomacromia Picta, Pseudagrion* sp., *Strina promontorii, Neurogomphus* sp., *Phyllomacromia bifasciata, Nilodorum brevibucca, Microvelia* sp, *Zygomix torridus.*
Group III 	Representative taxa *Bidessus* sp., *Dytiscus marginalis, Trithemis dorsalis,, Empis* sp., *Coenagriocnemis reuniense, Polypedilum fuscipenne, Mesovelia vittigera, Amphiops* sp., *Methles cribatellus, Anacaena* sp, *Polypedilum abyssiniae Polypedilum laterale*

Figure 6 Distribution of insect taxa collected in Drébot Lake in each group defined by the SOM.

Dark colour = high frequency; light colour = low frequency or absence. GI to GIII: Groups defined by the SOM.

3.3. Relationship between physico-chemical parameters and the distribution of aquatic insect taxa

Figure 7 shows the Relationship between physico-chemical parameters and the distribution of aquatic insect taxa collected at the Drébot Lake sampling stations defined by the SOM. Temperature, depth, hydrogen potential (pH) and conductivity influence the distribution of group II taxa. Group I taxa are influenced by the dissolved solids content (TDS). Group III taxa are influenced by hydrogen potential (pH) and temperature.

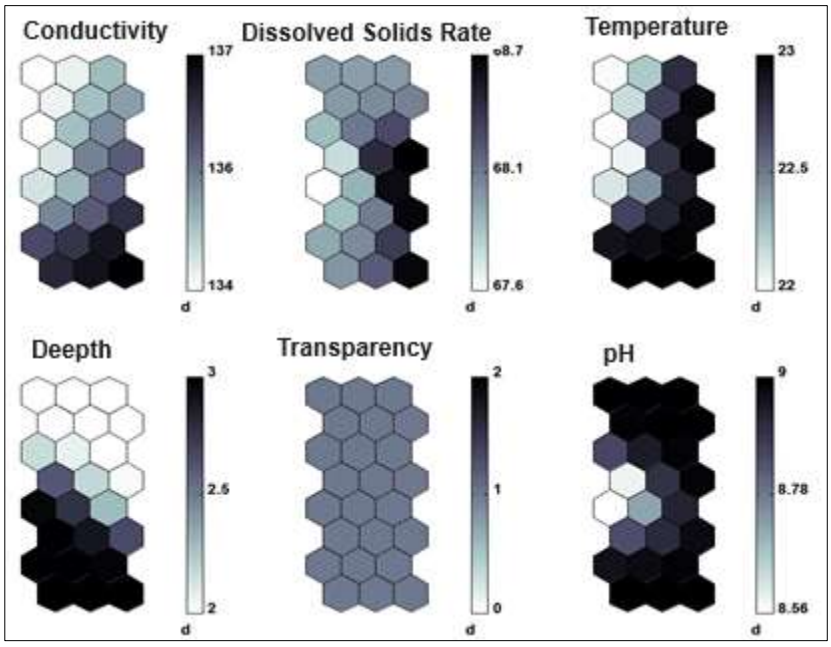

Figure 7 Relationship between physico-chemical parameters and the distribution of aquatic insect taxa collected at SOM sampling stations in Drébot Lake.

3.4. Trophic structure of insect populations in Lake Drédot

The trophic structure of insect populations in Drébot Lake is shown in fig 8. Three trophic groups were identified at all the stations. Predators, with 14 taxa (i.e. 45% of taxa) dominate the population. They are followed by Detritus feeders (9 taxa) and Herbivores (8 taxa). The latter represent 29% and 26% of insect diversity respectively.

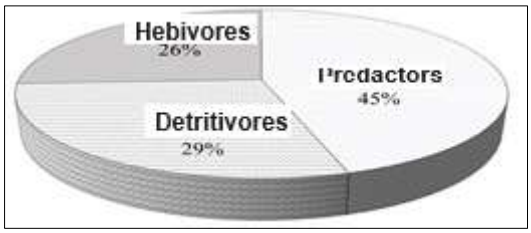

Figure 8 Specific proportions of the three trophic groups of insects collected on Lake of Afridougou

3.5. Spatial variations in relative abundance of orders

Figure 9 shows the spatial variations in the relative abundance of the orders of aquatic insects in Drébot Lake. Coleoptera dominate numerically at stations P1 and P10 on the banks, where they represent 100% of the orders inventoried. This order is also abundant at stations P5, P11 and P15 on the banks and at stations P18 and P19 in open water, with relative abundances of 50%, respectively. Odonates are 100% abundant at station P9 near the shore and at stations P14 and P16 in open water. They were also abundant at stations P4 (80%) and P6 (62.5%) on the banks and in open water at station P19 (50%). Hemipterans make up 100% of the population at station P13 on the bank. They are also abundant at stations P7 (36.36%), P8 (63.15%), P15 (50%) and P22 (60%) on the banks. Diptera were 100% abundant at stations P2 and P3 on the banks and at station P21 in open water. They are also abundant at station P12 (60%) on the bank and represent 66.66%, 50% and 66.66% respectively of the populations at stations P17, P18 and P20 in open water.

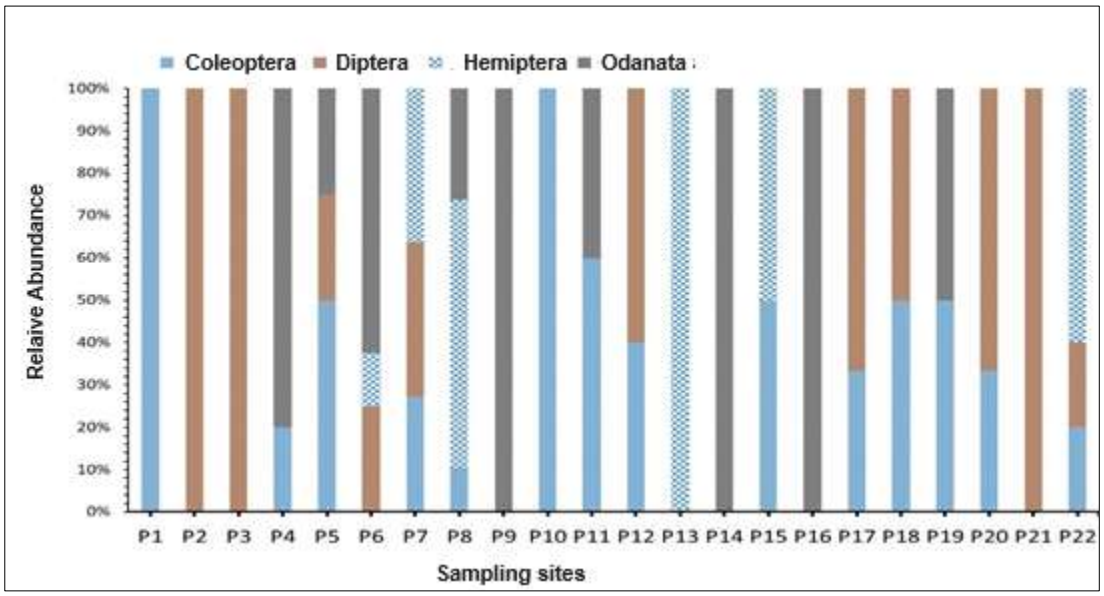

Figure 9 Spatial variations in the relative abundance of insect orders collected in Drébot Lake

3.6. Ecological quality of the water in lake drébot lake

Table 4 shows the water quality classes at the sampling stations in Drébot Lake, based on the Chironomidae index. Overall, eleven of the 22 stations in the lake (P1, P4, P5, P7, P8, P9, P10, P11, P13, P14, P15 and P16 near the shore and stations P18 and P19 in open water) showed good water quality (BQ). In addition, the water at stations P6 and P22 on the banks was only slightly polluted (FP). In addition, stations P7 and P12 on the banks and stations P17 and P20 in open water had moderately polluted water. On the other hand, the water is very polluted at stations P2 and P3 on the banks and at station P21 in open water.

The spatial variations in the Shannon (H') and equitability (E) indices of the insect populations collected in Afridougou's Drébot Lake are presented in Table 4. The Shannon value varies from 0.62 Bit (station P1) to 1.98 Bit (station P7). Furthermore, with the exception of stations P2, P3, P9, P10, P13, P16 and P21 with unbalanced insect populations, the insect population at all the other stations is stable and balanced, for equitability index values ranging from 0.73 to 1.

Table 4 Biological quality of the water in Drédot Lake

Sampling sites	Taxa_S	Individuals	Shannon Index_H	Equitability index_J	Chironomidae abundance	Chironomidae Index	Water Quality
P1	2	8	0.5623	0.8113	0	0	BQ
P2	1	66	0	0	66	100	TP
P3	1	46	0	0	46	100	TP
P4	4	20	0.9404	0.6784	0	0	BQ
P5	4	8	1.386	1	0	0	BQ
P6	6	16	1.667	0.9306	2	13	FP
P7	7	22	1.846	0.9488	8	36	MP
P8	7	38	1.584	0.8141	0	0	BQ
P9	1	2	0	0	0	0	BQ
P10	1	10	0	0	0	0	BQ
P11	3	10	1.055	0.9602	0	0	BQ
P12	2	10	0.673	0.971	6	60	MP
P13	1	10	0	0	0	0	BQ
P14	2	8	0.6931	1	0	0	BQ
P15	2	4	0.6931	1	0	0	BQ
P16	1	16	0	0	0	0	BQ
P17	2	3	0.6365	0.9183	2	67	MP
P18	2	4	0.6931	1	0	0	BQ
P19	2	2	0.6931	1	0	0	BQ
P20	2	3	0.6365	0.9183	2	66,67	MP
P21	1	1	0	0	1	100	TP
P22	3	10	0.9503	0.865	2	20	FP

4. Discussion

Analysis of the physico-chemical parameters of the water in Drébot Lake at Gagnoa showed that, with the exception of transparency and depth, the other parameters measured did not vary significantly from one station to another. However, the significant variations in depth and transparency are linked to the different habitats of the lake. Stations close to the shore are shallower and less transparent than those in open water. In addition, the low transparency of the water at the stations close to the shore can be explained by the fact that the banks are the entry points for domestic and agricultural effluent from the human activities carried out in the catchment area. This observation is corroborated by [12], who believes that the input of xenobiotic substances from the catchment contributes to the enrichment of the water in nutritive elements.

The inventory of insects in Drébot Lake identified 31 taxa from 19 families and 4 orders. This composition is lower than that of [13] who collected 34 insect taxa on Lake Taabo. In fact, Kouamé [13] carried out seasonal sampling at 05 stations, unlike this study, which took place once during the dry season at 22 stations.

In Drébot Lake, Diptera are the most diverse (29% of taxa). On the other hand, in lakes Kossou and Taabo, Hemiptera are the most diverse, with 35.71% and 50% of taxa respectively. In terms of abundance, on all three lakes (Kossou, Taabo and Afridougou), Diptera are the most abundant, with 61%, 45.65% and 44.47% of individuals respectively. This

abundance of Diptera, reputed to be pollutant-resistant in this lake, can be explained by their ability to adapt to different environmental conditions [14].

The preponderance of Diptera would also be due to the high presence of organic matter at certain stations. These observations corroborate those of [15] in the Okpara river in Benin. These authors report that the presence of Chironomidae is characteristic of environments polluted by organic matter. This observation is also related to the absence of taxa belonging to the Ephemeroptera, Plecoptera and Trichoptera complex, which are polluo-sensitive orders, at certain sampling stations in Drébot Lake [16]. The Shannon diversity and equitability index values of the aquatic insect population in Drébot Lake indicate a low diversity of the population with Shannon values between 0 and 1.98 bit and a stable and balanced population with equitability values greater than 0.5. The balance and stability of the aquatic insect population in this lake would appear to be related to the availability of food resources and habitats suitable for their survival [16].

In addition, assessment of the quality of the water in this lake using the Chironomidae biotic index shows that almost all the stations have good quality water, with the exception of stations P2 and P3 (located on the banks) and P21 in open water, which have very polluted water. This result may be due, in part, to the low preponderance of Chironomidae at all the sites surveyed.

5. Conclusion

The work carried out in February 2023 on Drébot Lake in Afridougou Gagnoa provided the first data on the entomofauna and enabled the ecological quality of the lake's waters to be assessed. Analysis of the physico-chemistry of the water showed that the pH, TDS, conductivity and temperature are uniform throughout the lake. However, transparency and depth differed between the stations surveyed. A total of 31 taxa in 19 families and 4 orders were collected. The order Diptera was the most diverse and the most abundant. A high diversity of insects was recorded at sites close to the shore (28 taxa) compared with 2 taxa in open water.

In addition, the Chironomidae index indicates that water of good biological quality has been recorded at most of the sites surveyed, and that water pollution is therefore low. In order to preserve the biotic integrity of this lake, a biomonitoring programme should be set up, based on monitoring and evaluation of the insect population.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Kouadio A.M. & Mondesir T.K. Access to drinking water and waterborne diseases among immigrants in the city of Gagnoa (West Central of Côte d'Ivoire). *Revue Espace, Territoires, Sociétés et Santé.* [Online] 2019, online 30 June 2019, accessed 2023-09-25 07:02:35, URL: https://www.retssa-ci.com/index.php?page=detail&k=51

[2] Fofana A. Diversity of the benthic entomofauna and diagnosis of the state of integrity of the Afridougou urban lake used for drinking water supply in Gagnoa (Centre-west, Côte d'Ivoire). Master's thesis, Jean Lorougnon Guédé University, Daloa, Côte d'Ivoire. 2023 ; 50 p.

[3] Sadat A.W., N'goran E.B.Z., Sorho S. & Parinet B. The value of multidimensional analysis for assessing the physicochemical quality of water in a tropical lake system: the case of the Yamoussoukro lakes (Côte d'Ivoire). *Journal of Applied Biosciences,* 2011 ; 38 : 2573-2585.

[4] Zouré M. Climate change and water availability in the Davo river catchment area for the drinking water supply of the town of Gueyo, Ivory Coast. Master's thesis in Applied Physics and Chemistry. Jean Lorougnon Guédé University, Daloa (Côte d'Ivoire), 2021 ; 56 p.

[5] Mary N. Methodological guide for determining the New Caledonia Biotic Index: sampling of benthic fauna. Department of Veterinary, Food and Rural Affairs, Water Resources Observatory, New Caledonia (France), 2002 ; 25 p.

[6] Déjoux C., Elouard J. M., Forge P. & Malsin J. Iconographic catalogue of aquatic insects of Côte d'lvoire. ORSTOM report, Bouaké (Côte d'Ivoire), 1981 ; 172 p.

[7] Tachet H., Richoux P., Bourneau M. & Usseglio-Polatera P. Freshwater invertebrates: systematics, biology, ecology. CNRS, Paris (France), 2003 ; 587 p.

[8] Allouko J.R., Kressou A., Djéné K.R. & Bony K.Y. Influence of physico-chemical parameters on the distribution of aquatic molluscs in Daloa's rice and fish ponds (Central West, Ivory Coast)., *International Journal of Innovation and Applied Studies,* 2022 ; 35(4) : 513-522.

[9] Allouko J.R., Djiriéoulou K.C., Koné K., Kressou A. & Kotchi Y.B. Macroinvertebrate diversity and assessment of water quality in the area under the influence of mining activities in the Yaouré basin (Kossou, central of Côte d'Ivoire). *Journal of Entomology and Zoology Studies*; 2023 ; 11(3) : 132-137. DOI: https://doi.org/10.22271/j.ento.2023.v11.i3b.9205.

[10] Rosa B.J.F.V., Rodrigues L.F.T., Da Gama A.R. & De Oliveira G.S. Chironomidae and Oligochaeta for water quality evaluation in an urban river in southeastern Brazil. Environmental Monitoring and Assessment, 2014 ; 186 : 7771-7779.

[11] Mary N. Physicochemical and biological characterisation of New Caledonian rivers, proposal for a biotic index based on the study of benthic macroinvertebrates. Doctoral thesis in Ecology. French Pacific University, New Caledonia (France), 1999 ; 181 p.

[12] Evrard M. Use of Chironomidae (Diptera) Surface-Floating Pupal Exuviae as a Rapid Bioassessment Protocol for Water Bodies. Doctoral thesis in Applied Ecology. Université Notre Dame de la Paix, Namur (Belgium), 1996 ; 204 p.

[13] Kouamé K.M. Diversity, structure and functional response of macroinvertebrates to the invasion of Lake Taabo (Ivory Coast) by the water hyacinth, Eichhornia crassipes (Mart) Solms-Laubach, 1883. Doctoral thesis in Ecology and Management of Aquatic Ecosystems. Nangui Abrogoua University, Abidjan (Côte d'Ivoire), 2014 ; 201 p.

[14] Diomandé O., Bony K.Y., Edia O.E., Konan F.K. & Gourène G. Diversity of the Macroinvertebrates Benthiques de la Rivière Agnéby (Ivory Coast; Western Africa). *European Jounal of Scientific Research*, 2009 ; 35(3) : 368-377.

[15] Abahi K.S., Gouissi F.M, Akodogbo HH, Lassissi F., Gnohossou PM. mpacts of anthropogenic activities on the macroinvertebrate community of the Okpara river in Benin. *Revue Africaine d'Environnement et d'Agriculture*. 2021 ; 4(4) :51-59.

[16] Koumba M., Mipounga H.K., Koumba A.A., Koumba C.R.Z., Mboye B.R., Liwouwou J.F., Mbega J.D. & Mavoungou J.F. Family diversity of macroinvertebrates and watercourse quality in Moukalaba Doudou National Park (Sud-ouest du Gabon). *Faunistic Entomology*, 2017 ; 70(13) : 107-120.