

Composition, Distribution and Abundance of Macroinvertebrates in Aghien lagoon (Ivory Coast; West Africa)

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ABSTRACT: Macroinvertebrates communities of Aghien lagoon were sampled monthly between June 2014 and May 2015 using the kick sampling technique and Van Veen Grab methods. The distribution of organic matter and current velocity were accounted for the variations of species composition, taxonomic richness and total abundance. Insects class was the most dominant and represented. Diptera was more dominant in all stations of Aghien lagoon with chironomid family. High human activities around lagoon which released waste into the River accounted for the poor species richness.

KEYWORDS: Composition, Distribution, Macroinvertebrates, Aghien lagoon, Ivory Coast

I. INTRODUCTION

The composition and structure of macroinvertebrates communities has been subject of much research in river system. It's include the quick assessment of biological resources for the conservation purpose and the detection of pollution through differences between predicted and actual faunal assemblages [1, 2]. Researchers established a pattern of relationship between aquatic fauna, depth, substrate type and organic contents of sediment. Other studies using macroinvertebrate as bio-indicator of anthropogenic impact on aquatic ecosystem have shown general decrease in benthic population and reduction in species diversity and richness [3] and they possess higher ability to tolerate pollution-induced environmental stress than plankton [4]. They are useful bio-indicators providing a more accurate understanding of changing aquatic conditions than chemical and microbiological data, which only gives short term fluctuations [5]. Studies on African lentic waters are few in literature and until recently has not received much attention in Ivory Coast. The structure and composition of benthic fauna of Aghien lagoon is poorly known. This study aimed to show the composition and structure of macroinvertebrates in this lagoon

II. MATERIALS AND METHODS

A. Study site

Located between latitudes 5°22'N and 5°26'N and longitudes 3°49'W and 3°55'W. Aghien lagoon covers a catchment area of 340 km² and covers 19 km². The most important tributaries of Aghien lagoon are Bete, Mé and Djibi rivers [6,7];. The Aghien lagoon up to 11 meters deep. In this freshwater lagoon, the water is all year almost exclusively of continental origin [8].

B. Sampling procedure

The stations selected for this study are located along the main axis of the lagoon with two transects perpendicular to the longitudinal transect (Fig.1). The first transect is located opposite the of Akandjé town in order to determine if the water quality varies according to the distance to shore. The second transect is positioned in the area west of the lagoon

to investigate the possible influence of Mé river on biological communities of lagoon. Stations were selected nearest DjibiBete and Mé rivers to assess the rate of exchange in different backgrounds.



Fig.1: Sampling locations map

Macroinvertebrates sampling was carried out for twelve (12) months at monthly intervals between June 2014 and May 2015. Benthic fauna were sampled in each of the eleven (11) stations defined on Aghien lagoon following a longitudinal rampe with a kick net (250 microns mesh size) following SASS method (South African Scoring System) (Dickens and Graham, 2002). The samples were collected for 2 to 3 minutes by submerging the kick net and dragging it into the water column. The net has also been banged against the bottom substrate to dislodge and collect sediment organisms. The collect was also done using a Van Veen grab. At each site, three (03) sediment samples corresponding to a total area of 0.15 m² were taken at several depths. At the exit of water, the contents net was washed on a sieve of 0.5 mm. All samples were fixed in 70% alcohol. In the laboratory, all samples were sorted using a binocular microscope, counted and identified at the lowest taxonomic level by combining the appropriate key [9, 10].

C. Data analysis

Biological indices such as Taxa richness (S); Shannon index (H) and Equitability (J) were used in the calculation of taxa richness, diversity and evenness.

- **Taxa richness (S)**: is a measure of species richness [16].

- **Shannon index diversity (H)** $H = - \sum p_i \cdot \log_2 p_i$ where p_i represents the relative abundance of species i in the sample ($p_i = n_i / N$).

- **Equitability or evenness J index** ($H'_{max} = \log_2 S$). $J = H' / \log_2 S$. Where; H was the Shannon and weavers index S was the number of species in samples.

III. RESULTS

A. Macroinvertebrates composition

The list of taxa inventoried in Aghien lagoon is presented in Table I. Of the total eleven sampling stations 8589 individuals from 93 taxa belonging to 65 families and seventeen orders have been identified. Macroinvertebrates collected from four zoological groups namely insects, mollusks, crustaceans and worms.

Insects are the best represented with 81.8% of the total number of organisms collected during the twelve campaigns, followed by molluscs with 14.9% and crustaceans and worms with respectively 2.1% and 1.2% of the total (Fig. 2).

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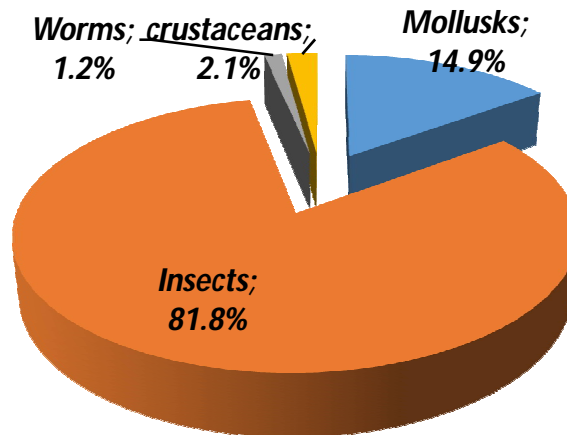


Fig. 2: The relative proportions of the major macroinvertebrate groups harvested in Aghien lagoon

All the stations, insects are represented by 8 orders including Diptera are the most diversified with 4712 individuals from 16 taxa distributed in 11 families which Chironomid are most dominant with 4507 individuals. The Following group are Hemiptera and Coleoptera with 13 taxa and 797 individuals respectively 10 families (dominated by Belostomatidae and Mesoveliidae) and 168 individuals from nine families (dominated by Hydrophilidae and Hydraenidae). Odonata are represented by 10 taxa of 977 individuals belonging to five families dominated by Coenagrionidae while Ephemeroptera are divided in 4 families (dominated by Leptophlebiidae) with 7 taxa and 316 individuals. Trichoptera belonging to 6 families with 36 individuals collected, and Lepidoptera and Plecoptera are poorly represented respectively 2 taxa of 2 different families (Crambidae and Pyralidae) of 11 individuals and families (Perlidae) 8 individuals.

Mollusks are represented by 16 taxa belonging to 10 families and 4 orders. Basommatophora order has the highest with 630 individuals collected from 6 taxa belonging to 4 families, then Caenogastropoda are most diverse with 8 taxa represented by 571 individuals in 4 families. Archeogastropoda and Veneroidea orders had each one taxon with 52 and 29 individuals. In this group, the Thiaridae had 5 taxa and Planorbidae had 3 taxa. The families of Sphaeriidae; Neritidae; Lymnaeidae; Physidae; Viviparidae; Bithyniidae; Ampullariidae and Hydrobiidae have each single taxon.

Crustaceans of the order Decapoda are represented by two taxa of Atyidae family or 158 individuals Atyoidaserrata and 1 individual Macrobrachium vollenhovenii of Palaemonidae family, and the amphipods order is represented by 13 individuals in Talitridae family. Worms Oligochaeta are represented by 93 individuals and Rhynchobdellida order had 2 taxa; 2 *Helobdella* sp. of Glossiphonidae family and 7 *Barbronia* sp. of Salifidae family. The trombidiforma are represented by eight individuals *Hydracarina* sp. of Hydrachnidiaefamily..

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Table I: recap of aquatic macroinvertebrates found in Aghien lagoon

CLAS S	ORDER	FAMILIES	TAXONS	STATIONS											Tot al
				P0 1	P0 2	P0 3	P0 4	P0 5	P0 6	P0 7	P0 8	P0 9	P1 0	P1 1	
	Trombidifor ma	Hydrachnidi ae	<i>Hydracarina</i> sp.	0	2	0	0	0	0	0	0	0	0	6	8
Worms	Oligochetha	Oligochèthes	-	3	31	13	3	1	3	3	1	32	1	2	93
	Rhynchobde llida	Glossiphoni dae	<i>Helobdella</i> sp.	0	0	0	0	0	0	0	1	0	0	1	2
		Salifidae	<i>Barbronia</i> sp.		1	2	0	1	0	0	0	2	0	0	1
Crustac ean	Amphipoda	Talitridae	-	1	0	0	0	0	8	0	1	0	0	3	13
	Decapoa	Atyidae	<i>Atyoidaserrata</i>	39	2	0	4	0	41	0	40	0	10	22	158
		Palaemonida e	<i>Macrobrachiumvoll enhovenii</i>		0	0	0	0	0	0	0	0	1	0	1
Mollus ca	Veneroïda	Sphaeriidae	<i>Musculium</i> sp	0	0	1	0	0	0	17	2	0	4	5	29
	Archeogastr opoda	Neritidae	<i>Septariaborbonica</i>	0	4	0	1	0	0	0	23	0	11	13	52
	Basommat ophora	Lymnaeidae	<i>lymnaeanatalensis</i>	25	19	0	31	0	6	0	8	0	13	1	103
			Physidae	<i>Aplexamarmorata</i>	2	15	0	35	0	23	0	0	77	4	125
		Planorbidae	<i>Bulinusguernei</i>	0	0	0	0	0	0	0	3	0	0	0	3
			<i>Bulinustruncatus</i>	0	0	0	0	0	1	0	1	0	0	0	2
			<i>Indoplanorbisexustu s</i>	38	62	0	22	0	20	0	10	0	19 3	33	378
	Viviparidae	<i>Bellamyacapillata</i>	0	16	0	0	0	0	0	0	0	0	3	19	
	Caenogastro poda	Ampullariid ae	<i>Lanistes varicus</i>	1	16	0	12	0	4	0	0	0	2	3	38
		Bithyniidae	<i>Bithyniatentaculata</i>	0	0	0	15	0	0	0	3	0	0	1	19
		Hydrobiidae	<i>hydrobiagabonensis</i>	12	10	0	32	0	2	0	0	0	1	1	58
		Thiaridae	<i>Bridouxia</i> giraudis	0	0	0	0	0	0	0	2	0	0	1	3
			<i>Melanoïdestubercul ata</i>	3	34	3	24	0	4	2	6	5	31	5	117
			<i>Pachymelania</i> byron ensis	0	0	0	0	0	2	9	23	3	23	4	64
			<i>Pachymelania</i> fusca	0	7	0	0	0	0	5	59	3	3	14	91
<i>Potadomaliricincta</i>		6	0	4	0	0	2	3	68	8	29	61	181		
Insecta	Coleoptera	Dytiscidae	<i>Bidesussp</i>	0	0	0	3	0	2	0	4	0	3	2	14
			<i>Laccophilussp</i>	0	0	0	0	0	0	0	2	0	1	0	3
		Elmidae	-	0	0	0	1	0	0	0	0	0	0	0	1
		Gyrinidae	<i>Orectogyrussp.</i>	2	0	0	0	0	0	0	0	0	4	0	6
		Haliplidae	<i>Haliplussp.</i>	0	1	0	0	0	0	0	0	0	0	0	1
		Hydraenidae	-	10	2	0	8	0	0	0	3	0	4	7	34
			<i>Coelostomasp.</i>	27	7	0	2	0	0	0	2	0	0	9	47
		Hydrophilid ae	<i>Enochrussp</i>	1	11	0	7	0	1	0	1	0	1	1	23
			<i>hydrobiinae</i>	1	0	0	0	0	2	0	2	0	1	2	8
			<i>laccobiussp.</i>	2	2	0	1	0	0	0	0	0	1	0	6
		Psephenidae	<i>Afroebriasp.</i>	4	0	0	0	0	5	0	0	0	0	0	9

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	Spercheidae	-	1	0	0	0	0	0	0	1	0	2	1	5
	Sphaeriusidae	<i>Microsporussp.</i>	0	2	0	2	0	4	0	2	0	0	1	11
Diptera	Blephariceridae	-	0	0	0	0	0	0	1	0	3	0	0	4
	Ceratopogonidae	<i>Atrichopogonsp.</i>	1	0	1	0	0	0	0	0	0	0	1	3
		<i>Ceratopogonsp.</i>	0	2	0	0	0	0	0	0	8	7	0	17
		<i>Dasyheleasp.</i>	1	0	1	0	0	0	0	0	0	0	0	2
		<i>Forcipomyiasp.</i>	2	0	0	2	0	0	0	3	0	0	1	8
	Chaoboridae	<i>Chaoborussp.</i>	1	0	0	0	0	0	1	0	0	0	0	2
	Chironomidae	<i>Chironominae</i>	34 5	44 9	8	37 3	44	15 2	15	11 95	11 2	10 37	31 3	4 043
		<i>Orthoclaadiinae</i>	73	51	4	13	15	9	9	10 6	46	89	2	427
		<i>Tanypodinae</i>	2	4	1	0	13	0	2	3	5	3	4	37
	Simuliidae	<i>Simuliumsp.</i>	0	0	0	0	0	0	0	0	0	1	0	1
	Culicidae	<i>Culex sp.</i>	0	0	8	0	3	0	0	0	0	66	8	85
	Empididae	-	9	1	0	2	0	0	0	1	0	0	1	14
	Muscidae	<i>Muscasp.</i>	0	0	0	0	0	0	0	0	0	2	0	2
	Psychodidae	-	5	0	4	3	11	0	2	0	25	8	7	65
Stratiomyidae	-	0	0	0	0	0	0	0	1	0	0	0	1	
Syrphidae	<i>Eristalissp.</i>	0	0	0	0	0	1	0	0	0	0	0	1	
Ephemeroptera	Baetidae	<i>Centroptilumsp.</i>	27	18	0	14	0	7	0	4	0	6	7	83
		<i>Cloeonsp.</i>	0	1	0	0	0	0	0	0	0	0	3	4
	Heptageniidae	<i>Afronurussp.</i>	0	0	0	0	0	0	0	0	0	1	0	1
	Polymitarcyidae	<i>Ephoronsp.</i>	1	0	0	0	0	0	0	0	0	0	0	1
	Leptophlebiidae	<i>Adenophlebiodesp.</i>	0	11 3	0	0	0	0	0	0	0	5	0	118
		<i>Choroaterpessp.</i>	0	0	0	0	0	0	0	2	0	0	0	2
<i>Adenophlebiasp.</i>		42	19	0	16	0	5	0	5	0	4	16	107	
Hemiptera	Belostomatidae	<i>Diplonychussp.</i>	46	84	0	0	0	5	0	64	0	20	74	293
	Corixidae	<i>Micronecta sp</i>	31	24	0	2	0	0	30	0	10	20	117	
	Gerridae	<i>Limmogonussp.</i>	6	4	0	1	0	2	0	2	0	1	3	19
	Hydrometridae	<i>Hydrometrasp.</i>	1	5	0	0	0	3	0	1	0	0	2	12
	Leptopodidae	<i>Valleriolasp.</i>	0	0	0	0	0	0	0	0	8	1	9	
	Mesoveliidae	<i>Mesoveliasp.</i>	29	34	0	11	0	1	0	9	0	15	56	155
	Naucoridae	<i>Laccocoris sp.</i>	3	2	0	0	0	0	0	1	0	0	1	7
		<i>Macrocossisp.</i>	2	0	0	9	0	0	0	3	0	2	0	16
<i>Naucoris sp.</i>		41	3	0	0	0	0	0	4	0	8	9	65	

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	Notonectidae	<i>Anisopssp.</i>	0	0	0	0	0	1	0	0	0	0	0	1
	Nepidae	<i>Ranatrasp.</i>	19	9	0	1	0	0	0	2	0	9	5	45
	Veliidae	<i>Microveliasp.</i>	10	2	0	8	0	4	0	19	0	5	9	57
		<i>Rhagoveliasp.</i>	0	0	0	0	0	0	0	1	0	0	0	1
Lepidoptera	Crambidae	<i>Eoophilasp.</i>	0	2	0	0	0	0	0	0	0	0	0	2
	Pyralidae	-	3	0	0	2	0	2	0	0	0	2	0	9
Odonata	Aeshnidae	<i>Aeshnasp.</i>	0	0	0	0	0	0	0	0	0	0	1	1
	Coenagrionidae	<i>Coenagriocnemissp.</i>	15	85	0	12	0	30	0	53	0	31	37	520
		<i>Pseudagrionsp.</i>	45	54	0	59	0	68	0	39	0	19	48	332
	Isostictidae	-	0	0	0	0	0	5	0	0	0	0	0	5
	Libellulidae	<i>Crocothemissp.</i>	0	9	0	2	0	2	0	2	0	0	0	15
		<i>Diplacodessp.</i>	1	0	0	0	0	0	0	0	0	0	1	2
		<i>Orthetrumsp.</i>	0	1	0	1	0	0	0	0	0	0	0	2
		<i>Pantalaflavescens</i> <i>zygonixsp.</i>	3	0	0	0	0	0	0	0	0	0	0	3
	Corduliidae	<i>Hemicorduliasp.</i>	0	0	0	0	0	0	0	1	0	0	0	1
Plecoptera	Perlidae	<i>Neoperlaspio</i>	1	0	0	0	0	0	2	0	1	4	8	
Trichoptera	Hydrophilidae	-	0	0	0	3	0	0	0	0	0	0	0	3
	Hydropsychidae	<i>Hydropsychesp.</i>	0	0	0	0	0	0	0	0	0	0	4	4
	hydroptilidae	<i>Afritrichiasp</i>	1	0	0	0	0	0	0	1	0	0	0	2
		<i>hydroptilasp</i>	3	0	0	1	0	0	0	2	0	2	7	15
	Leptoceridae	<i>Leptocerussp.</i>	0	3	0	2	0	0	0	2	0	0	0	7
		<i>Oecetissp</i>	0	0	0	0	0	0	0	0	0	0	1	1
	Polycentropodidae	<i>Dipseudopsissp.</i>	3	0	0	0	0	0	0	0	0	0	0	3
Philopotamidae	<i>Chimarabettinae</i>	0	1	0	0	0	0	0	0	0	0	0	1	
Total général			11	12	48	85	87	43	69	18	25	17	86	8
			29	38		9		7		40	0	84	9	589

B. Macroinvertebratesdistribution

Table II shows the diversity index obtained for different sampling stations. The station P11 has the highest taxonomic richness (57 taxa) followed by stations P08 with 54 taxa and P01 (51 taxa) and P10 (49 taxa). The station P05 has the lowest taxonomic richness with 6 collected taxa. Also, the highest specific abundances were obtained with stations P08 (1840 ind) and P10 (1784 ind). The lowest densities observed in stations P05 (87 ind), P07 (69 ind) and P03 (48 ind). The higher Shannon indices were obtained at stations P01 (2,714) and P11 (2,704) while the lowest were observed in P05 (1,361) and P08 (1,690). As regards the equitability, the higher values are observed in P03 (0.86) and P07 (0.84) while the P08 stations (0.42) and (0.47) had the lowest scores.

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Table II : Recap of calculated diversity index

Index	STATIONS										
	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11
Taxonomic richness_S	51	45	11	40	6	34	12	54	11	49	57
Individuals	1129	1238	48	859	87	437	69	1840	250	1784	869
Shannon_H	2.71	2.59	2.07	2.26	1.36	2.43	2.10	1.69	1.70	1.86	2.70
Equitability_J	0.69	0.69	0.8	0.61	0.75	0.69	0.84	0.42	0.70	0.47	0.66

III. DISCUSSION

The results shows that Aghien lagoon has a wide variety of macroinvertebrates dominated by insects (with 81,8%). However, the station (P05, P07 and P03) situated in open water has the lowest taxonomic richness harvested with 6 taxa and had poor individual densities (ind 48 to 87 ind). Also, the highest species abundance were obtained at stations to the banks of lagoon (P08, P10, P02, P01, P11, P04, P06 and P09) and are also characterized by high densities (250-1840 ind). Furthermore, the relative abundance of Chironomidae recognized tolerant to a wide range of disturbances and in particular the sedimentary type of pollution is very high in all the stations of the Aghien lagoon. Also, the spatial variations of Ephemeroptera Plecoptera, Trichoptera and Coleoptera (EPTC) show very low values in all stations (0 to 14.5%), reflecting the low representation or absence of pollution-sensitive taxa. Which would be a relatively poor water quality of the area surveyed [10]. Some macroinvertebrates taxa identified in this study are: *Lanistes varicus*, *Melanoides tuberculata*, *Atyoida serrata*, *Abedus lutarium*, *pseudagrion* sp., *Macrobrachium vollenhovenii*, *Musculium* sp., *Indoplanorbis exustus*, *Bithynia tentaculata*, *Pachymelania byronensis*, *P. fusca*, *Aeshna* sp., *Crocothemis*, *Diplacodes* sp., *Orthetrum* sp., *Hemicordulia* sp. and *Pantala flavescens* are described by the IUCN as least concern, the species is near threatened *Potadomaliricincta* while other taxa present no special conservation status. However, we had the presence of *Microvelia* kind that is uncommon. As we note the presence in Hemiptera order two taxa hosts and / or potential vector of Buruli ulcer, the Belostomatidae *Diplonychus* sp. and Corixidae *Micronecta* sp. and larvae of the order Diptera. The Shannon Index has low species diversity in the stations. The lowest diversities are at stations P05, P08, P09 and P10. The value of the Fairness indicate that stations P03, P05, P07 and P09 in deep waters have a more balanced stand than those at the banks.

IV. CONCLUSION

Macroinvertebrates identified in this study indicate that the taxa balanced settlement but show a strong sedimentary pollution at all stations on the selected Aghien lagoon. Diptera order is best represented in all stations including the family of midges which has the highest relative abundance. The stations on the lagoon banks are more diversified than in the open water stations. However, it is noted a potential risk to public health by the presence of vectors of Buruli ulcer and certain neglected tropical diseases. Our study highlights the need for further study to establish a general health risk map in Aghien lagoon.

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