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DISTRIBUTION OF BENTHIC MACROINVERTEBRATE COMMUNITIES IN RELATION TO ENVIRONMENTAL FACTORS IN THE EBRIÉ LAGOON (IVORY COAST, WEST AFRICA)

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BENTHIC MACROINVERTEBRATES
COMMUNITY STRUCTURE
EBRIÉ LAGOON
IVORY COAST

ABSTRACT. – This paper aims to reveal the organisation and environmental variables affecting the spatial distribution of benthic macroinvertebrates in the Ebrié lagoon (Ivory Coast, West Africa). The organisation of benthic macroinvertebrates was recorded at 13 stations across the whole lagoon. The study was based on seasonal sampling over a one year period. A total of 2571 individuals representing 66 taxa belonging to 30 families and 10 orders were collected. Among these taxa 21 were molluscs, 19 were crustaceans, 10 were insects, polychaetes were represented by 14 taxa, one unidentified taxon and oligochaetes. The most diversified groups (molluscs and crustaceans) represented 60.59 % of the taxonomic richness. Benthic macroinvertebrates community composition was different not only between stations but also presented interseasonal variations. Four distinct benthic assemblages were identified between which diversity indices and abundances were significantly different. Dissolved oxygen, mud and coarse sand were the environmental variables most influential in structuring benthic macroinvertebrates communities in the Ebrié lagoon.

INTRODUCTION

Lagoons are considered to be among the most productive aquatic ecosystems due to high levels of primary production, intense reserve of organic matter and habitat diversity, thereby attracting numerous aquatic species for taking refuge and/or as breeding ground (Baran 2000, Glaser 2003, Glaser & da Silva Oliveira 2004). Species production in lagoons is generally 10-15 times higher than levels observed elsewhere within the continental shelves (Duarte 1995). Due to their position between land and sea, lagoons generally have large temporal and spatial variations in hydrochemical characteristics and biological diversity (Suzuki *et al*. 2002). The functioning of these ecosystems is closely linked to freshwater and seawater inputs. Nowadays, many lagoons receive special attention because they are subject to intense anthropic action. In the Ebrié lagoon, one of the largest lagoons in West Africa and among the most polluted in the world (Kouassi *et al*. 1995, Diaz & Rosenberg 2008, Koné *et al*. 2009), anthropic impacts consist in natural resources over-exploitation, particularly through fisheries, mangrove firewood usage, chemical release and thermal pollution due to the presence of industries, sand extraction and banking up for the building construction (Ecoutin *et al*. 1994, Sankaré *et al*. 1999, Kouassi *et al*. 2005). The consequence of these actions is the loss of biodiversity in general and particularly benthic macroinvertebrates (Agostinho *et al*. 2005).

Benthic macroinvertebrates are a critical component of lagoons. They are essential members of detrital foodwebs by processing organic matter and serving as food for fishes and birds (Stoner & Acevedo 1990, Barbour *et al*. 1999). They are also ideal for use in bio-assessment due to their ubiquity in aquatic systems (Barbour *et al*. 1999). Their monitoring offers three main interesting attributes: they are relatively sedentary and long-lived, they occupy an important intermediate trophic position and they respond differently to varying environmental condition (Borja *et al*. 2000). The major environmental events and processes affecting the local biota can be understood by examining shifts in benthic communities' structure overtime (Simboura *et al*. 1995). In the Ebrié lagoon, previous studies of benthic macroinvertebrates (Zabi 1982, Sankaré & Etien 1991, Le Loeuff & Zabi 1993) are out-dated and need to be actualized. The objective of the present study was to describe the variability of benthic macroinvertebrate community structure and to identify the abiotic variables driving the structure and the functioning of the communities.

METHODS

Study area: The Ebrié lagoon (Fig. 1) is located between 3°47' and 5°29' W and 5°02' and 5°42' N. It is the largest lagoon (566 km^2) of Ivory Coast stretching for 130 km east to west with a maximum width of 7 km (Albaret 1994, Durand & Guiral

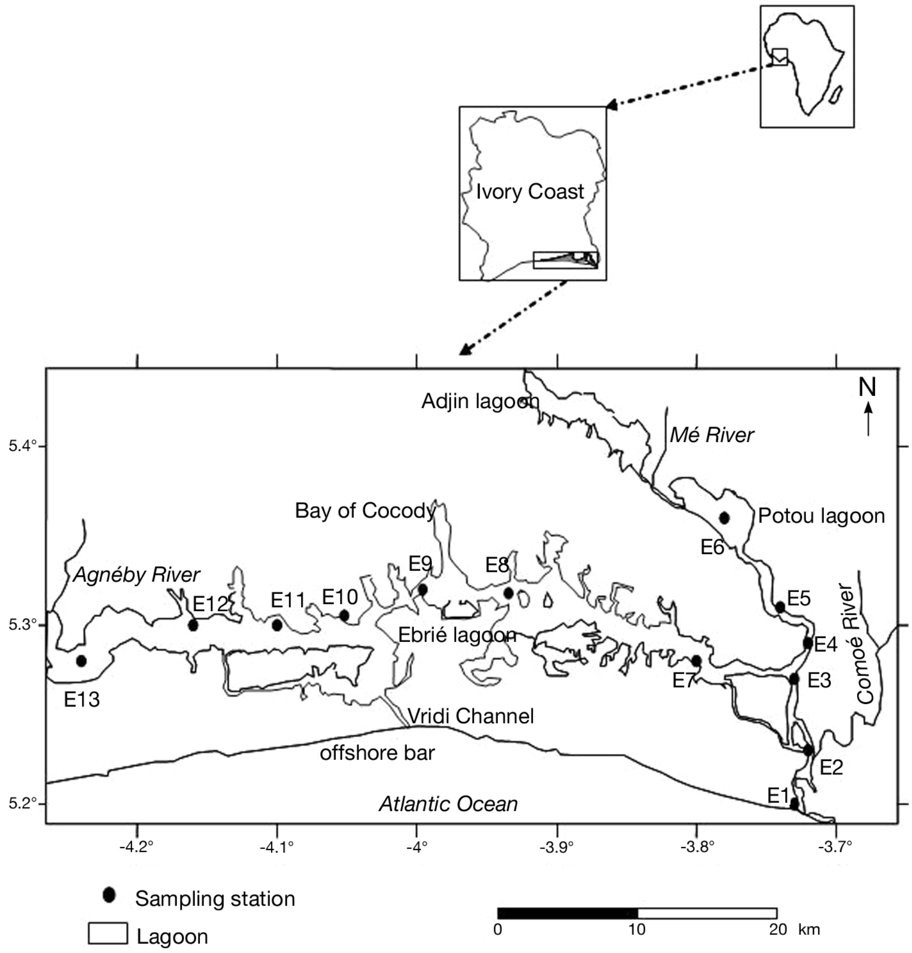

Fig. 1. – Map of the Ebrié lagoon showing the benthic macroinvertebrate collection sites.

1994). The Ebrié lagoon is composed of small lagoons such as Aghien and Potou located at the eastern extremity. Its average depth is of 4.8 m although some pits of 20 m depth close to Abidjan can be observed where human sand extraction occurred. The total volume of the lagoon is therefore estimated to about 2.7 km ^{3}. The lagoon's water is flushed by seawater through the tidal action and freshwater *via* three permanent rivers; Comoé and Mé in its eastern part and Agnéby in the western one. The lagoon is connected to the sea through the Vridi canal in its central part near Abidjan.

The surrounding vegetation is dominated by a mangrove forest (*Rhizophora racemosa*, *Avicennia germinans*, *Conocarpus erectus*), alternating with palm tree (*Elaeis guineensis*) and coconut (*Cocos nucifera*) cultures. Two main sedimentary habitats can be identified within the lagoon (Sankaré *et al*. 1999). The first, which is the sandy bottom in the central part, is primarily of oceanic origin. Its presence is related to wave action and tidal currents. The second, which is muddy with high organic content and shell fragments, is found in the eastern and the western parts of the lagoon.

The climate in the study area is equatorial-like with an annual rainfall ranging between 1500 and 1800 mm. It is characterized by two rainy seasons and two dry seasons (Durand & Skubich 1982). The Long Rainy Season (LRS) extends from April to July, the Short Dry Season (SDS) from August to September, the Short Rainy Season (SRS) from October to early December and the Long Dry Season (LDS) from December to March.

Sampling: The sampling stations were selected by using criteria such as accessibility, water depth, and sediment characteristics and in order to reflect the lagoon's different sedimentary and watershed habitats. Thus, thirteen (13) stations (E1 to E13) were selected (Fig. 1): ten (10) stations were positioned along the longitudinal axis of the lagoon, from the Comoé River to the Agnéby River mouths, respectively (E1 to E3 and E7 to E13); three (3) stations were located in the sector of Potou (E4 to E6). The sampling stations were investigated seasonally during four cruises (June 2006, September 2006, November 2006 and March 2007). Samples were collected using a 0.05 m^2 Van Veen grab. At each station, six samples were collected for benthic macroinvertebrates analyses. Each sample was sieved *in situ* through a 1 mm mesh. The organisms retained by the sieve were fixed in formaldehyde 10 % solution. At the laboratory, macroinvertebrates were sorted, identified to the lowest possible taxonomic level and counted.

Each faunal sampling was coupled with *in situ* measurements of abiotic variables including water salinity, temperature, dissolved oxygen, transparency and depth. Salinity and temperature data were measured by using a portable conductivity meter (WTW Cond-340) with a precision of ± 0.1 and 0.1°C, respectively. Dissolved oxygen data were obtained by using a portable oxymeter (WTW OXI-340) while a Secchi disc was used for water transparency measures. At each station, sediment samples were also collected for granulometry analyses (AFNOR, 1996) using three sediment grain-size classes: mud (size < 63 µm), very fine sand (125 µm > size > 63 µm) and fine and coarse sand (size > 125 µm).

Data analysis: The assemblage's structure was studied through the species richness (S), the Shannon-Wiener diversity index (H') and the Pielou evenness index (E). Benthic macroinvertebrate assemblages were identified by an Ascending Hierarchical Classification (AHC, Weighted mean distances as a criterion of aggregation, Chi-square distance) method based on the abundance matrix. Data on abundances were square-root transformed to avoid over-domination of the analysis by the very abundant taxa and to allow taxa of intermediate and rarer abundances to contribute to the analysis. Dominance was calculated as $Dm = (n_i/N) \times 100$, where Dm is the mean dominant index for taxa i; n_i, the number of the individuals belonging to taxa i; N, the total number of individuals belonging to all the taxa. Significant differences in species richness, diversity indices and abundances were performed using a Kruskal-Wallis test followed by Rank multiple comparison tests. The analyses were carried out using the STATISTICA 7.1 software computer.

In order to determine the possible factors influencing the benthic macroinvertebrate assemblages, a Redundancy analysis (RDA; ter Braak 1986) was performed taking into account the abundance of the dominant taxa as biotic variable and the abiotic factors. Taxa with an occurrence rate smaller than 5 % were excluded from analysis (Bachelet *et al.* 1996). RDA was conducted using the CANOCO software. The results of this analysis are presented as ordination diagrams containing continuous explanatory variables plotted as vectors with points for sites and taxa.

RESULTS

Physical and chemical variables

Figure 2 shows the temporal trends of physical and chemical variables measured during the study. Temperature (Fig. 2a) ranged between 26.3°C (station E10, SDS)

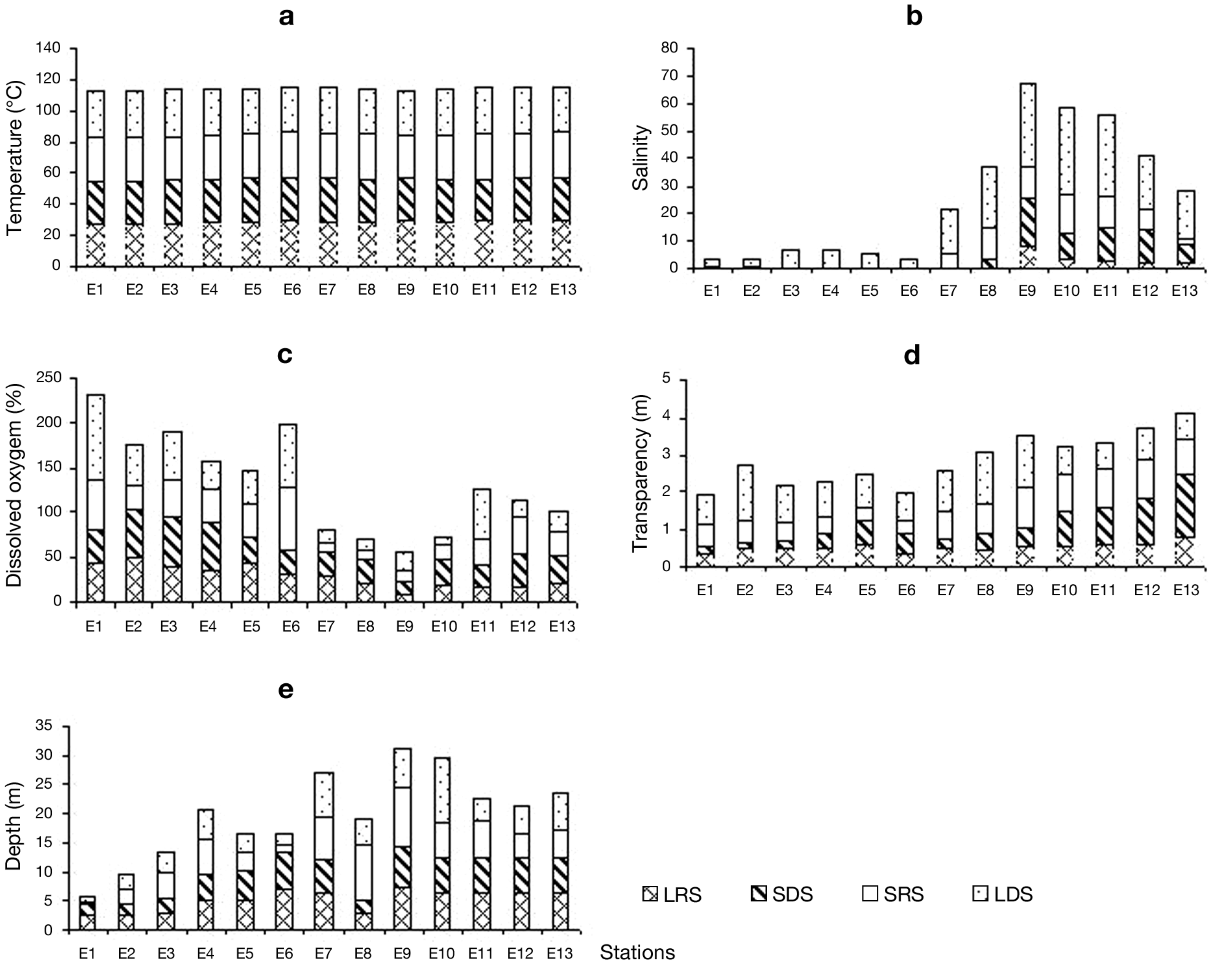

Fig. 2. – Spatial and temporal trends of temperature (a), salinity (b), dissolved oxygen (c), transparency (d) and water depth (e) of bottom water in Ebrié lagoon. LRS = Long Rainy Season, SDS = Short Dry Season, SRS = Short Rainy Season, LDS = Long Dry Season.

Table I. – List of benthic macroinvertebrates found at the thirteen stations in Ebrié lagoon; symbol + means the presence of the taxon at the station.

					Stations												
Class	Order	Family	Taxon	Acronym	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
Mollusca	Mésogastropoda	Neritidae	*Neritina afra* (Morelet, 1848)	Nafr							+						+
			Neritina cristata (Morelet, 1874)	Ncri							+						+
			Neritina glabrata (Sowerby, 1849)	Ngla	+		+	+			+	+				+	+
			Neritina kuramoensis (Yoloye & Adegoke, 1977)	Nkur							+			+			
			Neritina oweniana (Rafinesque, 1815)	Nowe									+				
		Thiaridae	*Melanoides tuberculata (Müller, 1774)*	Mtub							+						
			Pachymelania aurita (Dartevelle, 1956)	Paur	+		+		+			+		+			+
			Pachymelania byronensis (Wood, 1828)	Pbyr			+		+								
			Pachymelania fusca (Gmelin, 1791)	Pfus	+		+	+	+	+	+	+					
			Pachymelania fusca quadriseriata (Gray, 1831)	Pfuq								+					
			Potadoma freethii (Gray, 1834)	Pfre										+			
		Potamididae	*Tympanotomus fuscatus* (Linnaeus, 1758)	Tfus	+				+		+	+				+	+
			Tympanotomus fuscatus radula (Linnaeus, 1758)	Tfur							+	+			+		
	Eulamellibranchia	Arcidae	*Anadara senilis* (Linnaeus, 1758)	Asen									+	+			
		Corbulidae	*Corbula trigona* (Hinds, 1843)	Ctri	+	+	+	+	+	+	+		+		+	+	+
		Donacidae	*Iphigenia delesserti* (Bernardi, 1860)	Idel										+			
			Iphigenia laevigata (Gmelin, 1791)	Ilae										+			
		Mytlidae	*Mytilopsis africana* (van Beneden,1831)	Mafr									+				
		Ostreidae	*Crassostrea gasar* (Dautzenberg, 1891)	Cgas								+	+		+	+	
		Solecurtidae	*Tagelus angulatus* (Sowerby, 1874)	Tang									+		+		
		Tellinidae	*Tellina ampullacea* (Linnaeus, 1767)	Tamp									+		+		
Crustacea	Amphipoda	Corophiidae	*Corophium acherusicum* (Costa, 1857)	Cach								+	+				
			Corophium curvispinum (Sars,1895)	Ccur							+	+					
			Corophium orientale (Schellenberg, 1928)	Cori								+					
			Corophium sp.	Cosp									+			+	+
		Gammaridae	*Echinogammarus* sp.	Ecsp		+						+					
			Gammarus chevreuxi (Sexton, 1913)	Gche						+		+					
			Gammarus pulex (Linnaeus, 1758)	Gpul								+	+				
			Gammarus roeseli (Gervais, 1835)	Groe	+	+				+		+	+			+	+
			Gammarus sp.	Gasp					+	+		+	+				
	Isopoda	Cirolanidae	*Excirolana latipes* (Barnard, 1914)	Elat			+				+	+	+				
		Ligiidae	*Ligia exotica* (Roux, 1828)	Lexo								+					
		Sphaeromatidae	*Sphaeroma terebrans* (Bate, 1866)	Ster						+							
	Decapoda	Alpheidae	*Potamalpheops monodi* (Sollaud, 1932)	Pmon						+							

Table I. – Continued.

Class	Order	Family	Taxon	Acronym	Stations E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
		Diogenidae	*Clibernhardius africanus* (Burgis et Symoens, 1987)	Cafr								+	+	+	+		+
			Clibernhardius cooki (Rathbun, 1900)	Ccoo				+				+	+	+	+	+	+
		Gecarcinidae	*Cardiosoma armatum* (Herklots, 1851)	Carm								+					
		Palaemonidae	*Nematopalaemon hastatus* (Aurivillius, 1898)	Nhas						+		+					
		Penaeidae	*Penaeus notialis* (Perez-Farfante, 1969)	Pnot								+					
		Portunidae	*Callinectes* sp.	Casp								+					
Insecta	Diptera	Chironomidae	*Ablabesmya dusoleili* (Goetghebuer, 1935)	Adus						+							
			Clinotanypus claripennis (Kieffer, 1918)	Ccla						+							
			Chironomus imicola (Kieffer, 1913)	Cimi						+							
			Nilodorum brevipalpis (Kiefer, 1918)	Nbre						+							
			Nilodorum rugosum (Freeman, 1957)	Nrug						+							
			Polypedilum deletum (Goetghebuer, 1936)	Pdel						+							
			Polypedilum fuscipenne (Meigen, 1818)	Pfus			+			+							
			Stictochironomus caffrarius (Kieffer, 1921)	Scaf			+			+							
			Stenochironomus sp.	Stsp	+												
	Odonata	Calopterygidae	*Phaon iridipennis* (Burmeister, 1839)	Piri						+							
Oligochaeta				Oligo	+	+	+	+	+	+		+	+	+	+		+
Polychaeta	Capitelliformia	Capitellidae	*Capitella capitata* (Fabricius, 1780)	Ccap									+		+		
			Notomastus latericeus (Sars, 1850)	Nlat					+		+	+	+				
	Nereidiformia	Amphimonidae	*Hermodice carunculata* (Pallas, 1766)	Hcar								+	+	+			
		Eunicidae	*Marphisa sanguinea* (Montagu,1815)	Msan							+	+	+				
		Glyceridae	*Glycera convoluta* (Keferstein, 1862)	Gcon			+					+	+				
			Glycera gigantea (Quatrefages, 1866)	Ggig									+				
		Nephtidae	*Nephtys caeca* (Fabricius, 1780)	Ncae									+			+	
			Nephtys inermis (Ehlers, 1887)	Nine			+			+		+	+				+
			Nephtys polybranchia (Fauvel, 1932)	Npol							+		+	+		+	+
		Nereidae	*Hediste diversicolor* (Müller, 1776)	Ndiv	+	+	+	+	+	+	+		+	+			
			Nereis indica (Kinberg, 1866)	Nind		+			+	+	+	+	+				+
			Perinereis cultrifera (Grube, 1840)	Pcul				+		+	+	+	+	+	+		
	Sabelliformia	Sabellidae	*Euchone rosea rosea* (Langerhans, 1884)	Eros									+				
			Sabella pavonina (Savigny, 1820)	Spav								+	+				
Unspecified				Unsp									+				
Total			**66**		**9**	**6**	**12**	**7**	**10**	**22**	**17**	**32**	**31**	**13**	**10**	**9**	**14**

and 30.2°C (Station E1, LDS). The salinity values within the seasons LRS, SDS and SRS were similar in stations E1 to E6 (Fig. 2b). Highest values were obtained at stations near the Vridi Canal with a peak of 32 at E10 in long dry season (LDS). Dissolved oxygen saturation (Fig. 2c) was lowest at the stations in the centre of the lagoon fluctuating between 8 % (station E9; LRS) and 93 % (station E1, LDS). In contrast to dissolved oxygen, the highest values of transparency (Fig. 2d) where obtained at stations of the centre and the west excepting station E2 in long dry season (LDS). These values varied between 0.15 m (station E2, SDS) and 1.7 m (station E13, SDS). Water depth varied from 0.6 m (stations, SRS) to 11.2 m (station E10, LDS).

Macroinvertebrate assemblages

A total of 2,571 individuals representing 66 taxa belonging to 30 families and 10 orders of benthic macroinvertebrates were collected during this study (Table I). Among these taxa, 21 were molluscs, 19 were crustaceans, 10 were insects, and polychaetes were represented by 14 taxa. Molluscs, crustaceans and polychaetes were the most diversified groups. They represented 81 % of the taxonomic richness.

Stations E6, E8 and E9 containing more than 20 taxa each were the most diversified. Molluscs were less present at station E2 (1 species) and relatively diversified at station E7 (S = 9). As to crustaceans, they were well represented in station E8 (16 taxa) and relatively well in stations E6 (6 taxa) and E9 (8 taxa). On the other hand, they were less noticeable in stations E2 and E4 (1 taxon). Insects were present only at three stations: E1 (1 taxon), E3 (2 taxa), E6 (9 taxa). Polychaetes were not much present at station E1 (1 species). However, they were well represented at stations E8 and E9 with respectively 8 and 14 species.

The dominance of molluscs also appeared at a high level with 71 % of the total abundance. They were followed by crustaceans and oligochaetes representing respectively 16 % and 9 % of the total number of organisms.

Spatial and seasonal patterns

Figure 3 illustrates the spatial variation of diversity index, evenness index and species richness of benthic macroinvertebrates in the Ebrié lagoon during the four seasons. Diversity index and species richness increased from the east (stations E1 to E6) to the centre (station E7, E8 and E9) with the highest values (2.99 and 24 respectively) at station E9 during the long dry season (LDS). From the centre to the west (stations E10 to E13), these parameters decreased with lowest values obtained at stations E10 and E12 in SRS. Concerning the evenness, stations E4, E5 and E6 presented low values during all seasons with a minimum (0.21; station E5) in SDS. Stations in the central and western part of the lagoon recorded the highest values of this parameter.

Cluster identification

The cluster analysis (Fig. 4) indicated the existence of four groups of stations. The first and the second groups (I

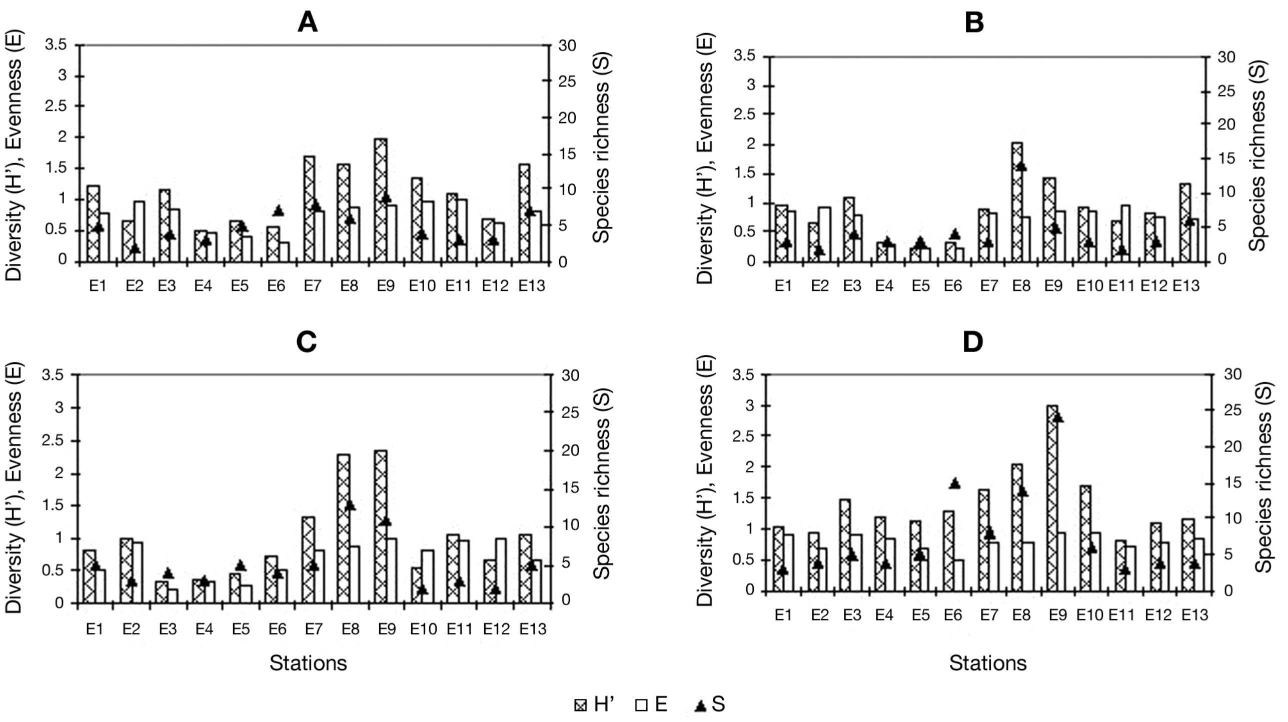

Fig. 3. – Community indices the 13 sites for the four sampling campaigns. H' = Shannon diversity index, E = Pielou evenness, S = Species richness, A = Long Rainy Season, B = Short Rainy Season, C = Short Rainy Season, D = Long Dry Season.

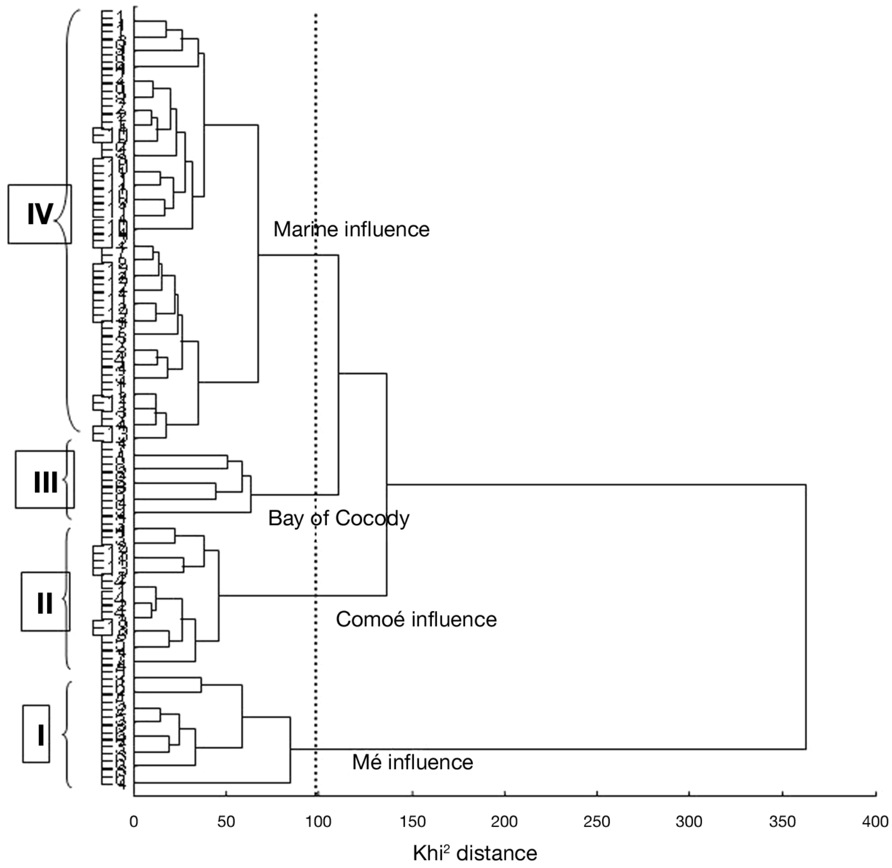

Fig. 4. – Cluster analysis of benthic macroinvertebrates showing similarities between the sampling stations in Ebrié lagoon. I to IV = Clusters; E1 to E13 = stations; in index: 1 = LRS (Long Rainy Season), 2 = SDS (Short Dry Season), 3 = SRS (Short Rainy Season), 4 = LDS (Long Dry Season).

and II) were influenced by freshwater. Group I included essentially samples from stations E5 and E6 located in the east, near the entrance of the Mé River in the lagoon. In the second group (II), samples of stations E3 and E4 also in the east were influenced by the Comoé River and samples of station E13 in the west were influenced by the Agnéby River. Only samples from stations E8 and E9, located near the bay of Cocody, constituted the third group (III). Samples in the fourth group were dominated by those collected in the central part of the lagoon at the vicinity of the Vridi Canal (E10, E11 and E12). These stations were influenced by seawater. Overall, the species richness, diversity indices and abundances were significantly different between the groups (Kruskal-Wallis test, $p < 0.05$). Species richness and Shannon diversity were significantly higher in group III (zone near the bay of Cocody) compared to the others (Rank Multiple Comparison test, $p < 0.05$) (Fig. 5). Relative to the abundance, the highest values were obtained in group I (zone influenced by the Mé River).

Relationships with the abiotic variables

In order to have a closer approach of the species distribution according to the environmental variables, the characteristic taxa of the lagoon were determined on the basis of their dominance during the study. The Monte Carlo permutation tests (n = 1000 permutations) indicated that the results of the redundancy analysis performed were significant ($p < 0.05$). In addition, a total of 57.6 % and 16 % of the variance were explained by the first and second axis respectively, which justifies their choice for the interpretation of the analysis. Among the environmental variables, oxygen, mud and coarse sand were the most important variables explaining the macroinvertebrate distribution, while fine sand appeared to be the least important factor affecting the distribution (Fig. 6). Four groups of samples and taxa can be distinguished in the graph: (I) samples of stations E5 and E6 located in the eastern part, influenced by freshwater discharge (Mé River) and characterized by mud in which *Gammarus roeseli, Pachymelania fusca, Tympanotomus fuscatus,* and *Corbula trigona* were the most important taxa; (II) samples of stations E1 to E4 and E7 influenced by Comoé River with sediment characterized by coarse sand in which the dominant taxa were *Echinogammarus* sp., *Pachymelania aurita*, *Glycera convoluta*, *Excirolana latipes*, *Notomastus latericeus, Neritina glabrata* and Oligochaeta; (III) samples of high temperature values located near the bay of Cocody (stations E8, E9) essentially composed of *Hermodice carunculata*, *Perinereis cultrifera*, *Gammarus pulex*, *Ligia exotica*, and *Nephtys inermis*; (IV) stations close to the Vridi Canal (E10 to E13) with high values of salinity and transparency, characterized by *Clibernhardius africanus*, *C. cooki*, *Tympanotomus fuscatus radula,*

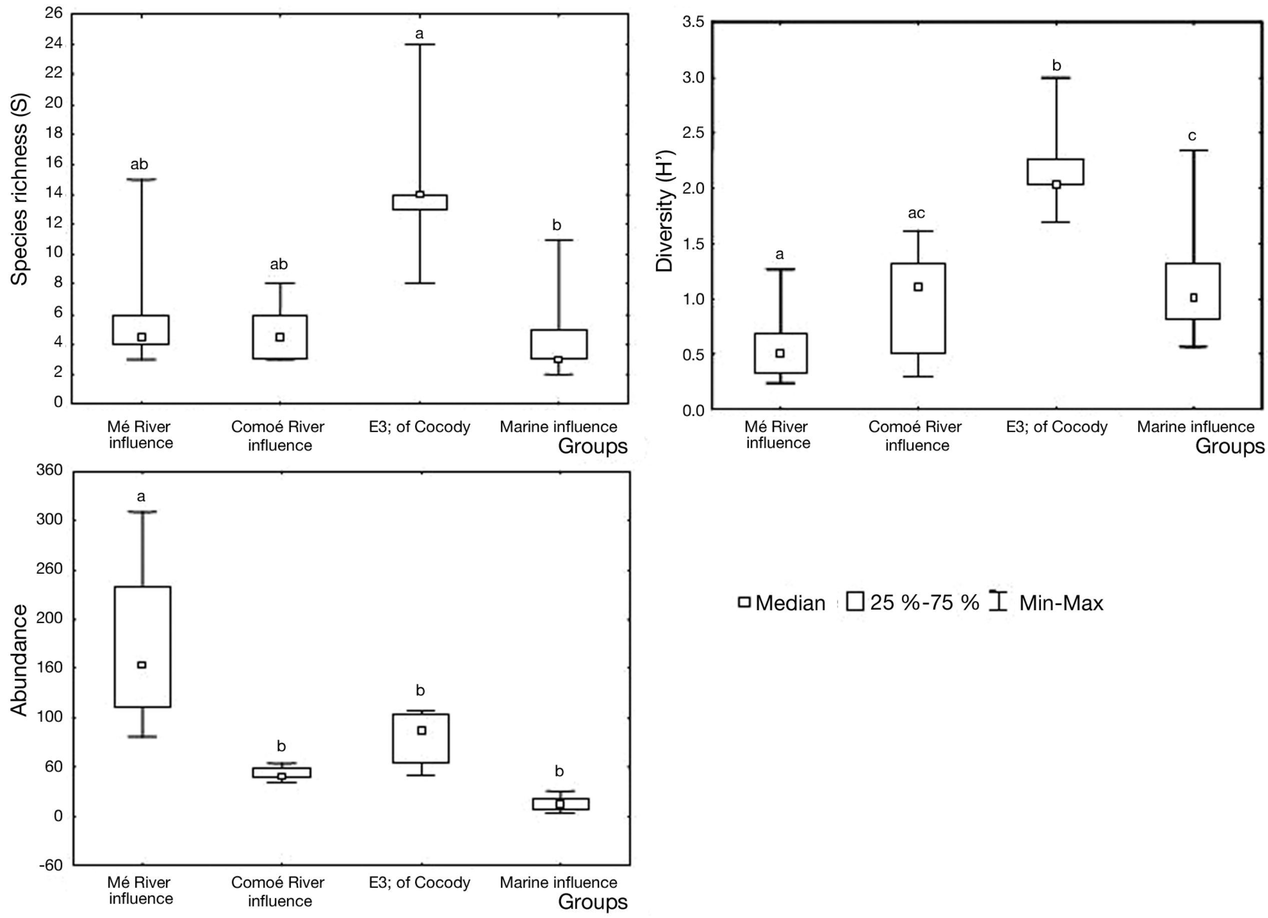

Fig. 5. – Box-plots showing differences in species richness, diversity indices and abundances between the clusters. The box corresponds to 50 % of the values, the point in the box to the median and vertical bars to the minimum/maximum values. The various alphabetical letters on the box-plots indicate a significant difference ($p < 0.05$; multiple comparison test) between clusters; there is no significant difference between the box having an alphabetical letter in common ($p > 0.05$).

Crassostrea gasar, Anadara senili, Nephtys polybranchia, Marphisa sanguinea and *Corophium* sp.

DISCUSSION

In the Ebrié lagoon, the present study showed high spatial and seasonal variations of environmental variables such as salinity, dissolved oxygen and transparency. The study sites in the eastern part of the lagoon exhibited the lowest values of salinity and transparency due to the influence of Comoé and Mé Rivers. According to Durand & Chantraine (1982), the mixture of these coastal rivers and the lagoon water involves a decrease of salinity. In addition, the brown water of these rivers enriched the lagoon water in organic matter and thus reduced the transparency. In contrast, the sites of the center lagoon located near the Vridi Canal revealed highest values of salinity and transparency. This could be explained by the seawater entering the lagoon. Concerning dissolved oxygen, its lowest values were obtained at the stations located in the central part of the lagoon because of great depth and the presence of the bay of Cocody. At these sites, most of the wastes of Abidjan city are dumped into the lagoon (Kouassi *et al.* 1995). Otherwise, abiotic variables; and especially salinity, showed high values during the long dry season (LDS). According to Munari *et al.* (2003), this could be caused by the combined effects of high evaporation and the reduction of freshwater inflow in the lagoon during this season.

The taxonomic composition of benthic macroinvertebrates of the Ebrié lagoon is characterized by Gastropoda, bivalves, Amphipoda, Isopoda and polychaetes. This taxonomic list is common to the traditional ones obtained in the lagoonal environment as suggested by Bazaïri *et al.* (2003) in the Merja Zerga lagoon (Morocco), Kouadio *et al.* (2008) in the Aby lagoon (Ivory Coast) and Lamptey & Armah (2008) in the Keta lagoon (Ghana). In comparison to the species richness of these lagoons, the Ebrié lagoon appears to be rich in benthic macroinvertebrates probably because of its large surface area and the heterogeneity of habitats as suggested by Sankaré *et al.* (1999). According to Palmer *et al.* (2000), a high degree of habitat heterogeneity favours biotic diversity, especially for inverte-

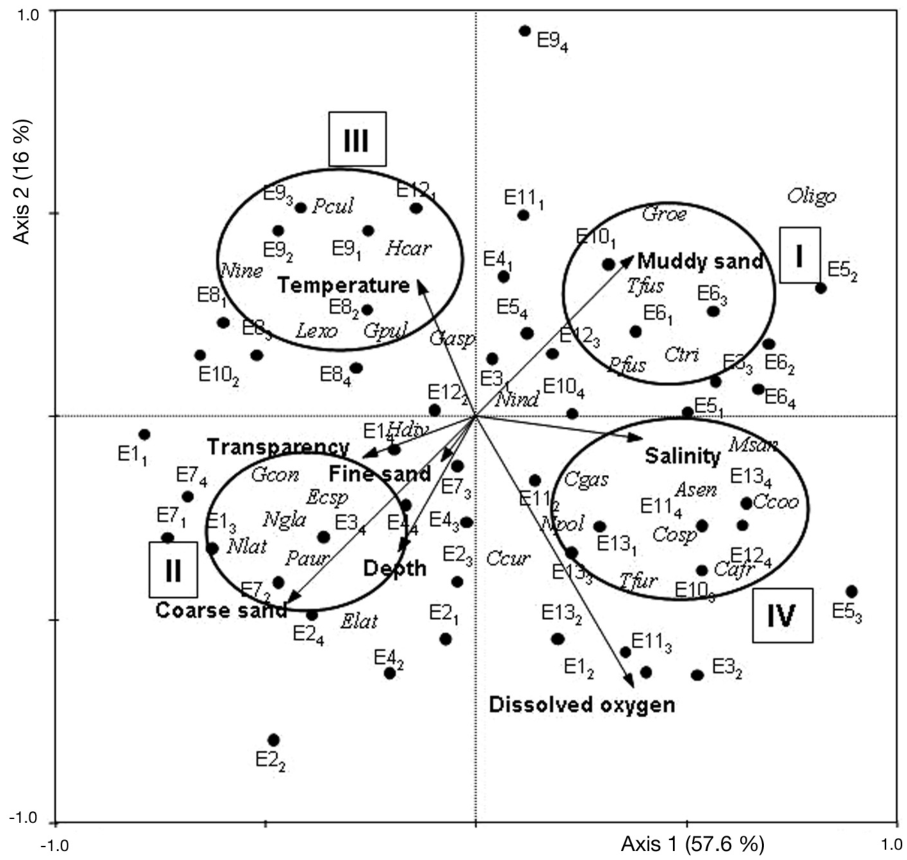

Fig. 6. – Redundancy analysis showing the 28 dominant taxa and the stations with respect to the abiotic variables, relative to axis I and II; dashed circles (I to IV) represent the groups identified by hierarchical classification; E1 to E13 = stations; in index: 1 = LRS (Long Rainy Season), 2 = SDS (Short Dry Season), 3 = SRS (Short Rainy Season), 4 = LDS (Long Dry Season).

brates. In addition, the connection of the Ebrié lagoon to the sea and its exchanges with fresh waters from Comoé, Mé and Agnéby allowed it to contain diverse organisms from freshwater, brackish and marine habitats (Le Loeuff & Zabi 1993).

The spatial distribution of these macroinvertebrates showed differences in taxa composition and community structures according to the sites of the lagoon. The central part of the lagoon is characterized by more diversified settlement of macroinvertebrates due to the influence of seawater through the Vridi Canal and the high level of dissolved oxygen. According to Menif & Ben Hassine (2003), the influence of the sea results in high species richness following the intrusion of marine species such as polychaetes and crabs in the lagoon. In contrary to the central part, the east and the west sites of the lagoon revealed low species richness and diversity indices values. That could be caused by the influence of Comoé and Mé Rivers in the east. Indeed, the high concentrations of nutrient obtained by Kouamé *et al*. (2009) in these rivers suggested organic pollution from sources such as domestic sewage, industrial wastes and fertilizer run-off. According to Marzano *et al*. (2003), macrobenthic communities often suffer abrupt changes in number of species and individuals as a response to abiotic stress.

The seasonal distribution of benthic communities in the Ebrié lagoon showed differences between long rainy season and long dry season. Seasonal variability in the abundances of benthic organisms could be attributed to temporal variability in environmental conditions that may affect recruitment, survival and reproduction as shown by Posey *et al*. (1998). In addition, benthic macroinvertebrate assemblages increased in number of species at most of stations in the long dry season. During this season, the increase of salinity could favour the intrusion of marine species such as polychaetes (Le Loeuf & Zabi 1993). On the other hand, low values of species richness during the long rainy season could be explained by the high concentration of suspended sediments due to the quantitative provision of fresh water. According to Lloyd *et al*. (1987), the increase of turbidity due to the suspended sediments could reduce the productivity in the lagoon by decreasing the penetration of light, inhibiting photosynthesis and stressing physically the benthic communities.

The classification and ordination techniques used to perform a characterisation of the lagoon based on the benthic macroinvertebrate distribution according to abiotic variables revealed that dissolved oxygen, mud and coarse sand were the most important variables explaining the macroinvertebrate distribution in the Ebrié lagoon. Fine sand appeared to be the least important factor affecting the distribution. This result agrees with studies of Sousa *et al*. (2006) and Fujii (2007) which showed that salinity and sediment characteristics affect the distribution of macrobenthic animals. In addition, according to Erman & Erman (1984), Hagberg & Tunberg (2000) and Mistri *et al*. (2000), there is a correlation between the structure of benthic macroinvertebrate communities and the average grain size of the particles present in the substrate. On the other hand, the weak influence of fine sand could be explained by the fact that this substrate is less regularly encountered in the stations of the Ebrié lagoon.

This study on the distribution of benthic macroinvertebrate communities in the Ebrié lagoon has contributed to identify 66 taxa dominated by molluscs and crustaceans. Compared to the taxonomic list of similar other ecosystems, benthic macroinvertebrates in the Ebrié lagoon seem to be diversified and abundant. However, the increase of anthropic disturbances on this lagoon could affect the benthic fauna which supplies food for exploited species such as fishes in the long term. Therefore, some investigations to access the ecology of these organisms appear necessary for a conservation program.

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