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Macrobenthofauna of Lagoons in Guadeloupean Mangroves (Lesser Antilles): Role and Expressions of the Confinement

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ABSTRACT

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The distribution of abiotic parameters is compared to the qualitative and quantitative distribution of the macrobenthofauna in a couple of mangrove lagoons under tropical climate. From several mathematical treatments of collected data it appears that the two lagoons are very different as far as abiotic parameters are concerned. They meanwhile display a similar macrofaunal organization. Furthermore none of the studied abiotic parameters is able to account by itself for this common biological zonation of both lagoons which seems to be better understood in terms of restriction with respect to the open sea, *i.e.* in terms of confinement. Two kinds of Pelecypods species may be separated. The first one is composed of species that live in the lagoonal areas and in apparently open marine conditions whereas the second one is composed of species that only live in the most restricted parts of both lagoons. Besides, a detailed study of living *Lucina pectinata* and empty shells displays the recent evolution of both lagoons towards less restricted conditions.

It finally appears that the ecological structure and functioning of such tropical lagoons is very similar to those of mediterranean coastal paralic basins. This tends to confirm the existence of a common biological organization of most of paralic basins.

ADDITIONAL INDEX WORDS: *Lagoon, tropical, macrobenthofauna, Pelecypods, confinement, Lesser Antilles.*

INTRODUCTION

Several multidisciplinary studies of lagoons around the Mediterranean (GUELORGET *et al.*, 1983, 1986, 1987; NICOLAIDOU *et al.*, 1988) and in neighbouring areas (IBRAHIM *et al.*, 1985) indicate that their common qualitative and quantitative biological zonation is not controlled by abiotic parameters, *e.g.* salinity, but mainly by hydrological factors which command the degree of restriction (or degree of confinement) of the environment with respect to the open sea (GUELORGET and PERTHUISOT, 1983).

In order to know whether these conclusions could be generalized elsewhere, it was worth studying lagoons or other restricted "paralic" basins under different climates and/or in different biogeographical provinces. The present paper deals with one of these investigations in the Caribbean area.

GEOGRAPHICAL SITUATION AND CLIMATE

Both studied lagoons (Figures 1 and 2), Manche à Eau and Belle Plaine, are situated in the mangrove paralic complex that runs alongside the Grand Cul-de-Sac Marin, on both sides of the Rivière Salée which is a channel separating Grande Terre from Basse Terre (GUILCHER and MAREC, 1978). Due to the low latitude, the climate of the island is characterized by rather constant temperature (month averages varying between 25 and 28°C) and length of day. On the contrary, the rainfall varies widely. The dry season extends from January to March or June with monthly rainfalls

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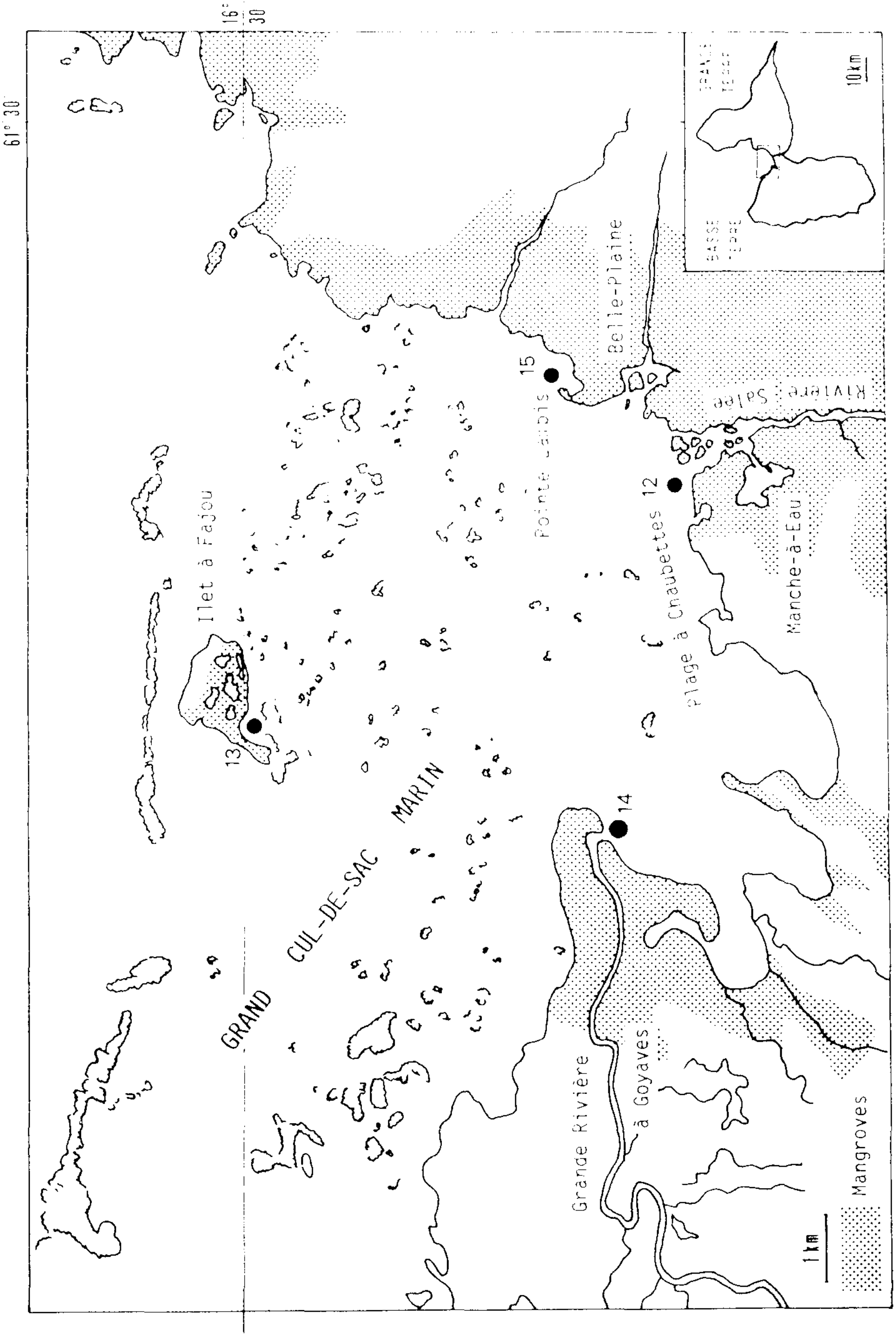

Figure 1. Map of the Grand Cul-de-Sac Marin and location of extralagoonal stations (12 to 15).

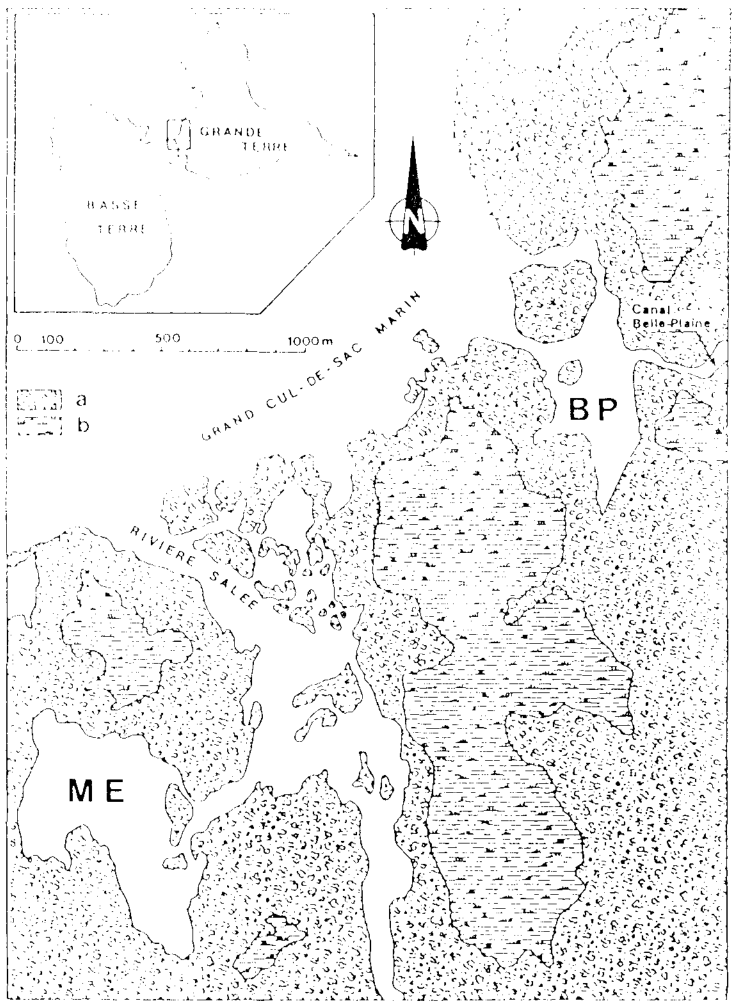

Figure 2. Environments of the studied lagoons. (a) mangroves; (b) marshes; (BP) Belle Plaine lagoon; (ME) Manche à Eau lagoon.

less than 100 mm. During the humid season which follows onto the end of the year, the monthly rainfall may reach more than 350 mm (Figure 3).

THE LAGOONS

Manche à Eau lagoon extends over 0.26 km^2. It receives fresh water inputs from the peripheral diffuse runoff. Marine water supplies are brought into the lagoon by a channel coming from the Rivière Salée and is linked with the basin through a couple of inlets situated on its eastern side (Figure 4). The basin is generally shallow in its central part but both the western and southern bays are slightly deeper and reach 3 m depth. Samples have been collected at 6 stations located in the main biotopes: (1) the zones under continental influence (stations 3 and 4); (3) the peripheral areas (station 2 at the edge of the mangrove); (4) the deepest zones (station 5 in the western bay).

Belle Plaine lagoon extends over 0.18 km^2 (Figure 4). Due to a couple of deep passes on its western side, it is more widely open to the Grand Cul-de-Sac Marin than Manche à Eau lagoon. Meanwhile, on its opposite side, the Belle Plaine channel brings to the basin large

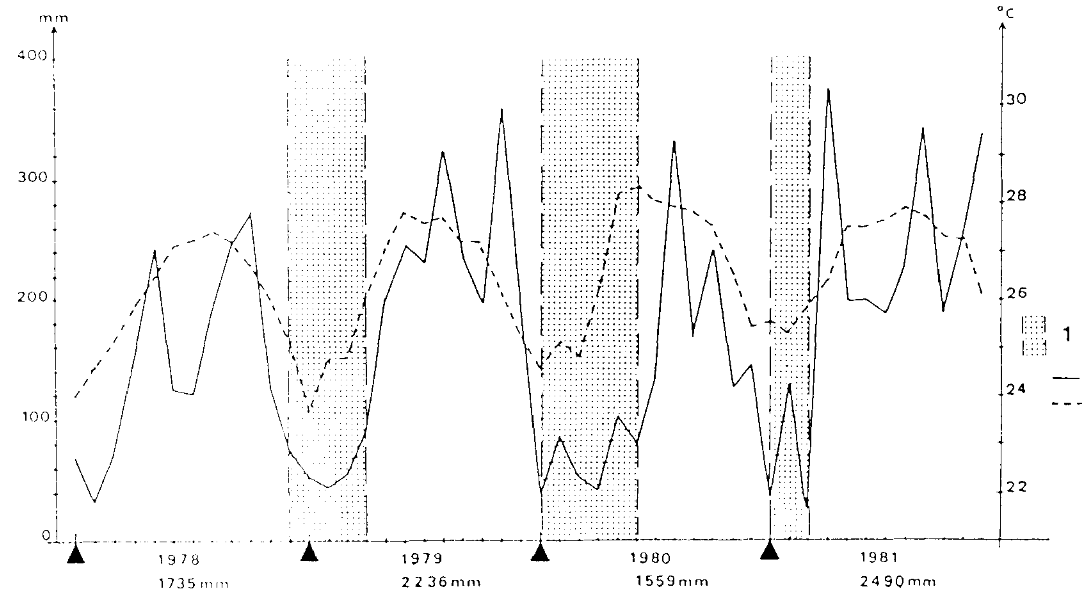

Figure 3. Seasonal variations of rainfall (2) and air temperature (3), monthly averages from 1978 to 1981. (From the meteorological station of Raizet). After Louis (1983).

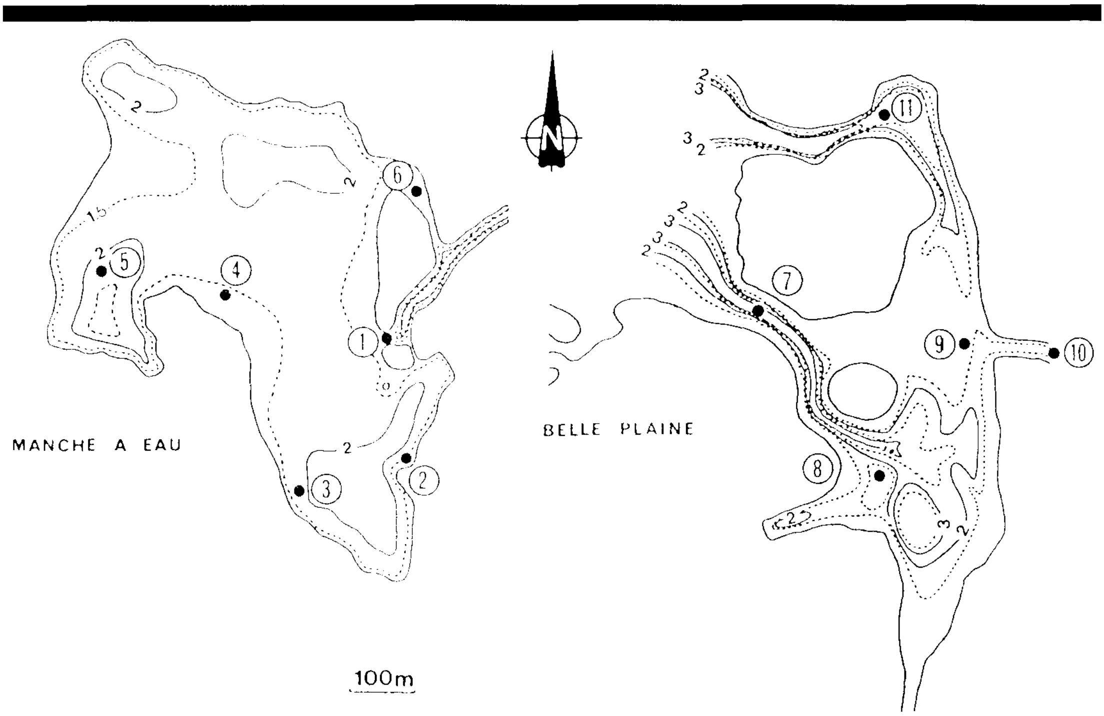

Figure 4. Bathymetric sketch maps of studied lagoons (depths in meters) and location of sampling stations.

Table 1. *Abiotic parameters measured at the lagoonal stations (S: surface; B: bottom). Averages of monthly sampling from November 1980 to January 1981.*

Manche—A—Eau											
		T° (°C)		0_2mg/l		S ‰		pH		Veg. debris	Granul.
Stations	Depth (m)	S	F	S	F	S	F	S	F	g/m²	(% < 50µ)
1	1,50	27,2	27,7	4,0	2,8	32,4	34,0	7,7	7,7	5	50
2	0,80	27,8	27,7	3,5	1,5	34,2	33,3	7,5	7,6	4000	100
3	1,80	27,6	28,2	4,2	1,3	34,2	33,9	7,7	7,6	25	96
4	1,50	27,7	28,2	4,3	1,7	31,6	33,1	7,8	7,7	50	74
5	2,30	27,8	28,1	4,4	0,4	32,7	33,3	7,8	7,5	250	99
6	1,60	27,6	27,6	3,9	2,5	33,1	33,5	7,7	7,7	5	46
moyenne	—	27,6	27,9	—		33,0	33,5	7,7	7,6	—	—

Belle Plaine											
		T° (°C)		0_2mg/l		S ‰		pH		Veg. debris	Granul.
Stations	Depth (m)	S	F	S	F	S	F	S	F	g/m²	(% < 50µ)
7	3,30	27,2	28,2	4,3	4,3	30,6	35,1	7,8	7,8	300	69
8	1,20	27,5	28,9	4,0	4,0	33,3	37,1	7,8	7,8	5	36
9	0,60	28,9	29,3	3,5	1,5	30,9	35,4	7,3	7,6	400	40
10	1,30	25,2	28,7	1,7	2,0	8,4	36,7	7,2	7,7	1500	—
11	2,80	27,6	28,3	4,0	4,0	32,0	35,9	7,6	7,9	50	64
moyenne	—	27,3	28,7	—		27,0	36,0	7,5	7,8	—	—

ure 5). In the present case, both axes "explain" 75% of the variance.

From the plotting of all lagoonal stations on the Principal Plane (Figure 6), it first appears that they are gathered in two groups corresponding to each lagoon. This means that the bottom waters are globally very different from one lagoon to the other: Belle Plaine lagoon contains warmer, saltier, more oxygenated and more alcaline bottom waters than the Manche à Eau. This is obviously mainly due to a different balance between marine and fresh water supplies to each basin. Meanwhile, each property is elongated following the second bisecting line which, according to Figure 5, shows the maximum variance of depth and vegetal debris content in sediments. Hence, while the two lagoons are globally rather different notably as far as salinity, temperature, pH and dissolved oxygen content are concerned, both offer a similar pattern as a function of the increasing degree of restriction (or confinement) from their entrances (Station 1 and 6 in Manche à Eau; stations 7 and 11 in Belle Plaine) towards their most continental reaches (Station 2 in the Manche à Eau; stations 9 and 10 in Belle Plaine). This gradient may be primarily described in terms of decreasing depth and increasing vegetal debris content in sediment (which depicts the continental influence) and secondarily in terms of decreasing pH and water oxygenation.

The average biomasses and densities of the main zoological groups (Polychaetes, Gastropods, Pelecypods, Crustaceans and Echinoderms) calculated for the investigation period are given in Table 2 and visually presented in Figure 7. It may seem simplistic to study the main zoological groups rather than the species. First, in each group the ecological behaviour of the different species notably their relationships with the bottom and sediment are rather similar. For example Crustaceans are able to migrate if the environmental conditions become unfavourable whereas Pelecypods can hardly migrate and have to adapt to changing conditions so that their populations better integrate the variations of the medium. Second, the specific determinations notably for Polychaetes and Crustaceans are in some cases hazardous because the fauna of French Antilles is to date still not well known. Meanwhile, Pelecypods are hereafter studied in detail.

The calculation of biological similarities of the stations is operated following the Steinhauss index (LEGENDRE and LEGENDRE, 1979) taking into account the densities of the zoological groups. The association matrix obtained from the calculation of similarities was used as input to a multidimensional scaling

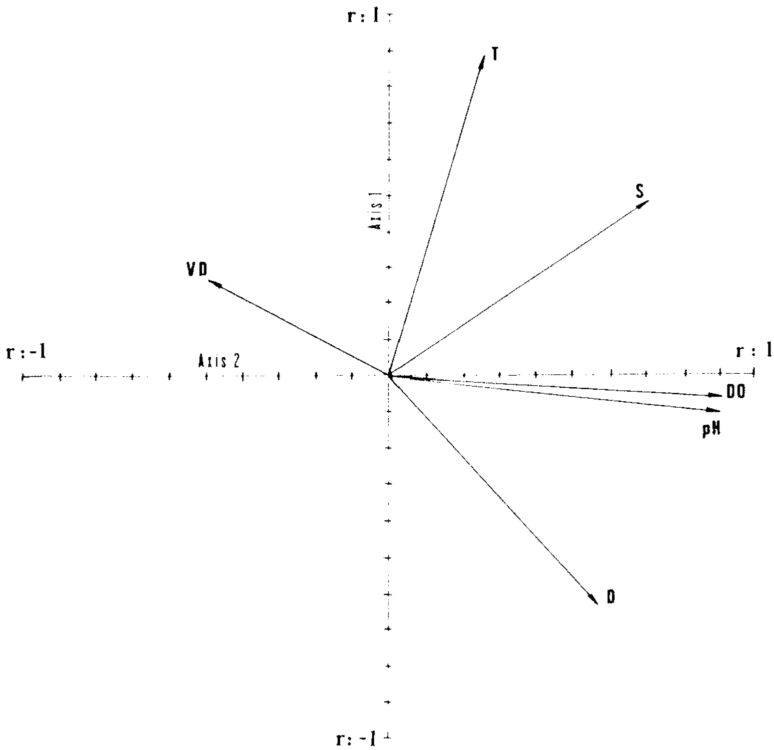

Figure 5. Measured abiotic parameters. Correlations between variables and Principal Axes. (T) temperature; (S) salinity; (DO) dissolved oxygen content of bottom waters; (D) depth; (VD) vegetal debris content of sediments.

program. The resulting graphical plotting of stations is depicted by using a clustering method which allows one to put together stations above a given level of similarity (Figure 8). From this graphic representation, it is possible to separate two groups of stations and two isolated stations.

Group 1 comprises stations 1, 6, 7, 8 and 11. Here the benthic populations are the most abundant. All zoological groups are present including Echinoderms.

Group 2 comprises stations 2, 4, 9, 10. The populations are less abundant. The Echinoderms are lacking.

At station 3 all groups are present except the Echinoderms but densities are very low.

Station 5 is practically azoic with only a few Polychaetes.

The difference between the two lagoons, demonstrated in terms of abiotic parameters, disappears when benthic populations are considered. On the contrary, a common biological zonation clearly appears following the confinement gradients. As a matter of fact, group 1 is composed of stations situated in the neighbourhood of the entrances under dominant marine influence. Group 2 is composed of lagoonal stations which receive fresh water supplies, station 10 being the most under influence of the mangrove drainage. Lastly, stations 3 and 5 are situated in peripheral hydrologically isolated bays.

POPULATIONS OF PELECYPODS

Among the benthic organisms Pelecypods are of a great interest because of their ecological significance and economic importance. They have been studied by analyzing the linear correlations between abundance of species (Logarithms of average densities) and the abiotic parameters (Table 1). The correlation analysis has been carried out separately for each lagoon. The results are given in Table 3. When inter-

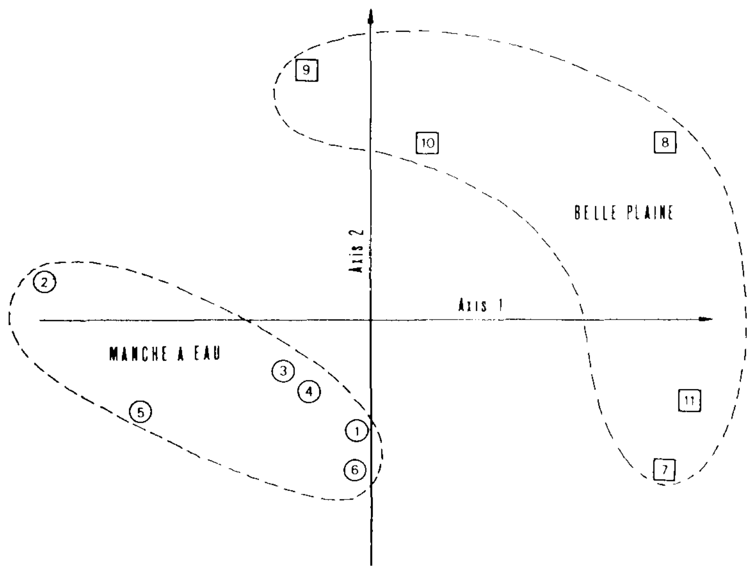

Figure 6. Principal Components Analysis of abiotic data. Multidimensional plotting of sampling stations on the Principal Plane.

Table 2. *Average densities and biomasses of benthic macrofauna in Belle Plaine and Mache à Eau lagoons.*

	1		2		3		4	
Stations	*Density*	*Biomass*	*Density*	*Biomass*	*Density*	*Biomass*	*Density*	*Biomass*
Echinoderms	369	3165	—	—	—	—	—	—
Pelecypods	740	2099	80	238	12.5	7935	213	11 546
Gastropods	215	602	—	—	2.5	1	—	—
Crustaceans	203	115	—	—	2.5	0.25	10	8
Polychaetes	7525	9800	375	100	30	5	668	213
Total	*9052*	*15781*	*455*	*338*	*47.5*	*7941*	*891*	*11 767*
Stations			6		7		8	
Echinoderms	—	—	48	302	6	56	30	280
Pelecypods	—	—	315	449	30	86	110	509
Gastropods	—	—	68	122	13	2	280	406
Crustaceans	—	—	118	538	44	419	555	1090
Polychaetes	4	1	2108	3149	113	75	1875	507
Total	*4*	*1*	*2657*	*4560*	*206*	*638*	*2850*	*2792*
Stations	9		10		11			
Echinoderms	—	—	—	—	5	47		
Pelecypods	19	14	6	8	33	39		
Gastropods	—	—	—	—	24	4		
Crustaceans	14	459	—	—	31	265		
Polychaetes	538	108	393	37	413	447		
Total	*571*	*581*	*399*	*45*	*506*	*802*		

preting such results one must keep in mind the significance of linear correlations coefficients. For instance a high value (r close to +1 or −1) means a numerical relation between the two considered variables but does not imply a direct causal relationship. On the other hand, a low correlation coefficient is not necessarily incompatible with a causal non-linear relationship between the various parameters.

In Manche à Eau lagoon, the Pelecypod abunamounts of continental fresh water as it drains the mangrove along more than 3 km. The bottom of the basin is marked by two deep channels coming from the Grand Cul-de-Sac Marin through both passes. A mud fan extends northwestward from the mouth of Belle Plaine channel. The southern part of the basin is barred by several shallows. The sampling stations were selected by considering these bathymetric features: (1) stations 7 and 11 in the deep channels; (2) station 8 on a shoal under marine influence; (3) stations 9 and 10 in the most restricted parts of the basin, at the mouth of Belle Plaine channel and in the channel itself.

Several studies (CARVACHO, 1977; LASSERRE and TOFFART, 1977; ASSOR and JULIUS, 1978; BOURGEOIS-LEBEL, 1980; PORTECOP, 1980, 1982; TOFFART, 1980; DELESALLE, 1981; GAUJOUS, 1981; ROJAS-BELTRAN, 1981; LOUIS and GUYARD, 1982; LOUIS, 1983) have already delt with these lagoons in conjunction with the French Government's "Mangroves and coastal zones" program.

SAMPLING AND MEASURES

The sediments and the benthic macrofauna samples were collected with a core driller at the deepest stations where sediments are usually rather compact and by mean of an Eckmann dredger at the shallow stations where sediments are lighter. Whatever the sampling method, the sampled area was 0.1 or 0.2 m^2. The tools could hardly reach more than 30 cm depth which, however, is enough to collect representative sample of the endobenthic fauna. The only difference between the two methods is the shape of the sampler so that comparison between shallow and deep stations is possible.

After sieving on a 1 mm^2 mesh, samples of benthic macrofauna were fixed with formalin (10%), stained with Rose Bengal on the field. In the laboratory, the animals were separated from detritus by hand and sorted. Counts of individuals for each species or group densities are expressed in numbers of individuals per m^2.

Afterwards, animals with calcareous parts were decalcified and sediment eaters were relieved of their stomach content. All individuals of each spaces were then dried in an oven at 105°C for 48 hours. Biomasses are expressed in grams of dried organic matter after decalcification per m^2.

Samples have been collected monthly at each station from November 1980 to February 1981 astride the turning from the wet season to the dry season so that data may be considered as representing the average features of both lagoons.

Just before collecting samples, several abiotic parameters were measured in the field in surficial and bottom waters: salinity, pH, temperature and dissolved oxygen content. Two sedimentological parameters were additionally measured in the laboratory: (1) the percentage of mud (particles less than 50μm size) in sampled sediment; (2) the quantity of vegetal debris (mainly from *Rhizophora*) that were sorted out by hand from the retained detritus of sieved sediments. They were then dried in an oven at 105°C and weighed. Results are expressed in grams per m^2 of dry matter.

MATHEMATICAL TREATMENTS AND INTERPRETATIONS

All data on abiotic parameters (averages for the four month period of investigation) are given in Table 1. The intercomparison of stations is based on six variables which are: depth, quantity of vegetal debris in the sediment and temperature, salinity, pH, and dissolved oxygen content of bottom waters. Indeed, the benthofauna is not really dependent upon surficial water. Besides, the lagoonal water bodies are stratified in several places as shown by wide variations of hydrological parameters in the water column. The bottom waters are even hydrologically isolated in some deep areas. The data were treated by Principal Components Analysis (PCA) which enables one to present the abiotic parameters in scatter diagrams with maximum information content. For instance, an observation of k parameters simultaneously considered for one station is theoretically represented by one point in a k dimensionalities hypervolume. All ordinations allow one to present this point in less than k axes. PCA is an axes change in such a way that the maximum of variance is shown on the first axis; then the second axis is chosen to show the maximum of the remaining variance. These two axes define the Principal Plane on which each station is represented by a point and each variable by a vector the component scores of which are the correlation coefficients (r) with both axes (Fig-

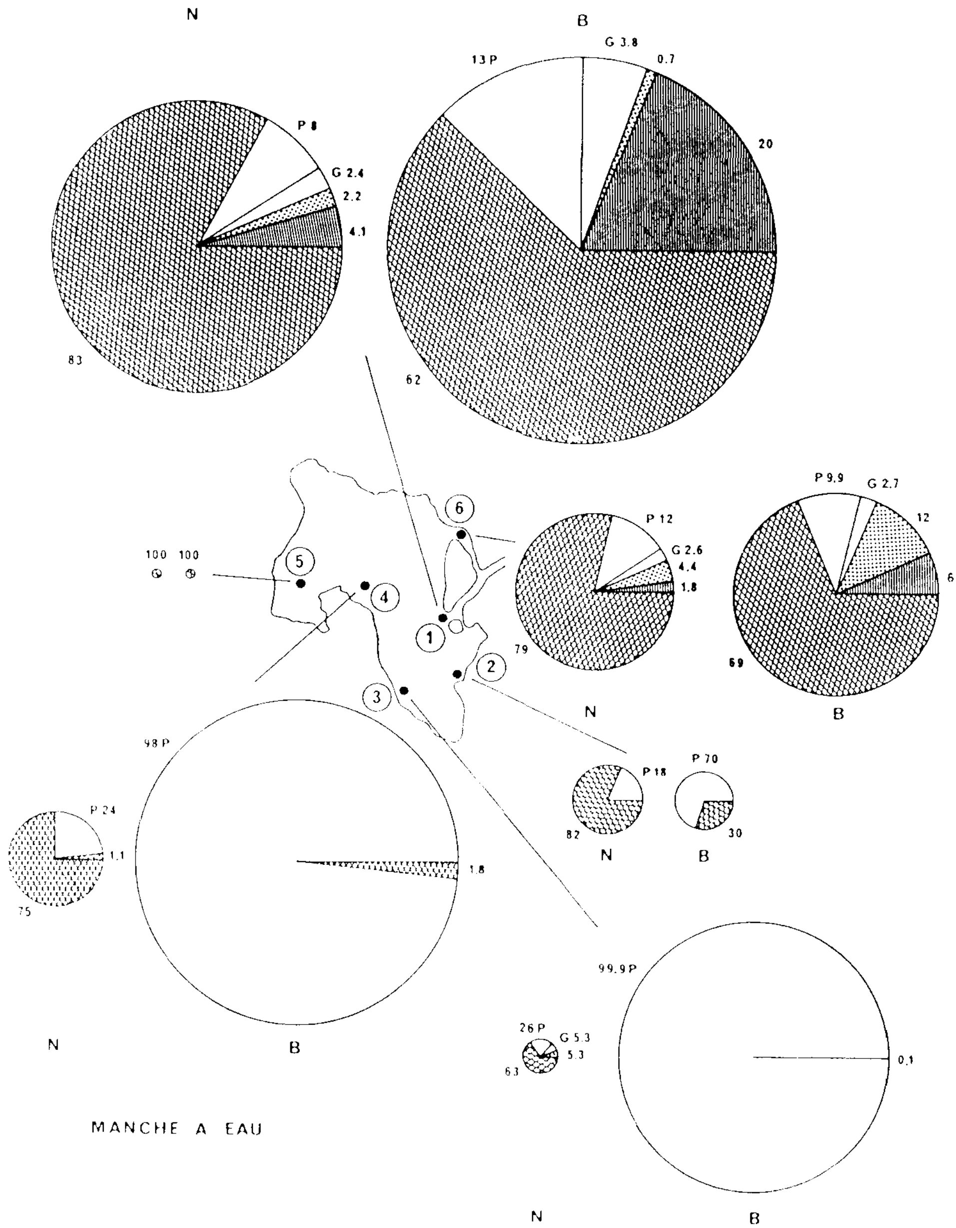

Figure 7. Densities (N) and biomasses (B) of the main macrobenthofaunal groups. (1) Pelecypods; (2) Gastropods; (3) Polychaetes; (4) Crustaceans; (5) Echinoderms.

dance is highly correlated with the dissolved oxygen content of bottom water and well correlated with pH and temperature as these parameters are more or less linked to the phytoplanktonic activity of the environment. In Belle Plaine the best (negative) correlation appears between the Pelecypod abundance and the vegetal debris content of sediments. Thus, none of the chosen parameters may separately account for the distribution and abundance of Pelecypods in both lagoons. The same restriction (or confinement) gradient controls the dis-

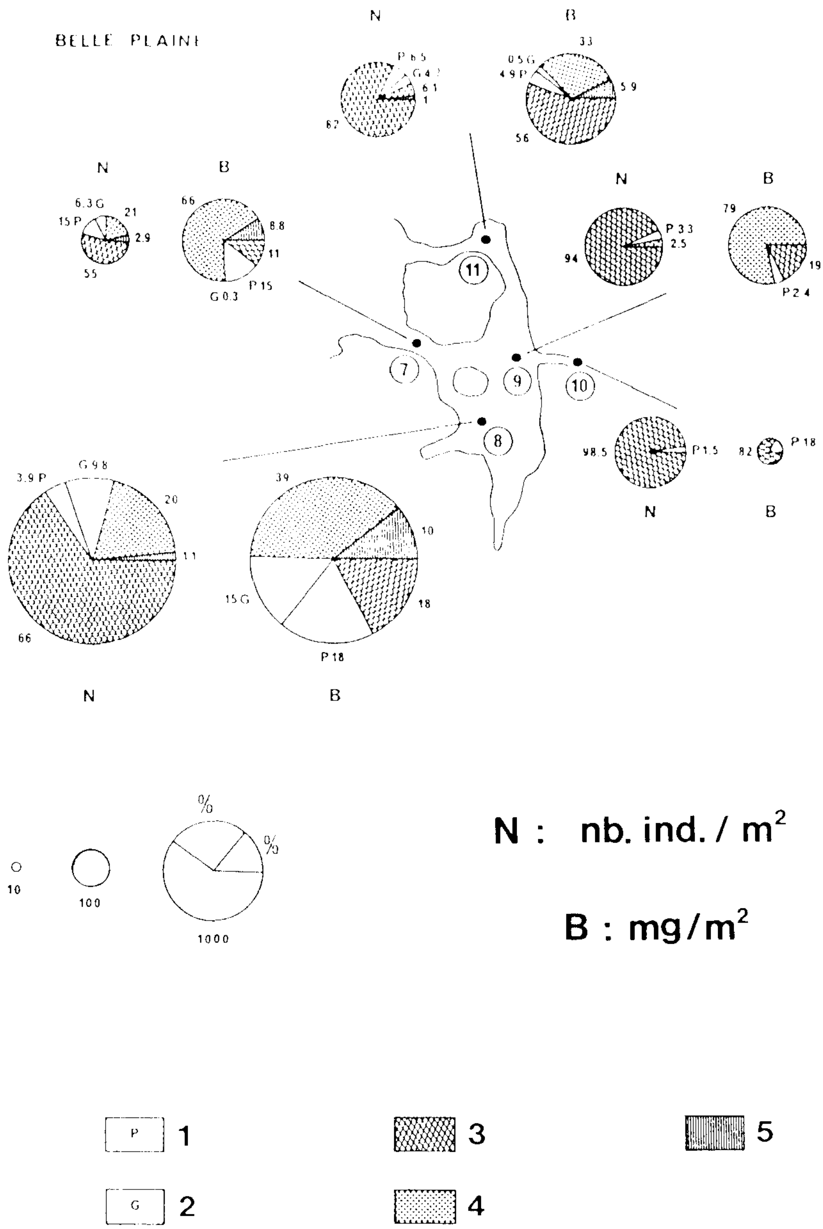

Figure 7. (cont.)

tribution of the whole benthic macrofauna among which Pelecypods. Because of the general physiographic pattern of each lagoon, the confinement is better expressed by the quantity of vegetal debris in sediments in Belle Plaine which is widely connected to the open sea and contains well oxygenated waters whereas it is better expressed by the oxygen depletion of bottom waters in the more restricted Manche à Eau lagoon.

The distribution and density of the main Pelecypods species are given in Table 4. In addi-

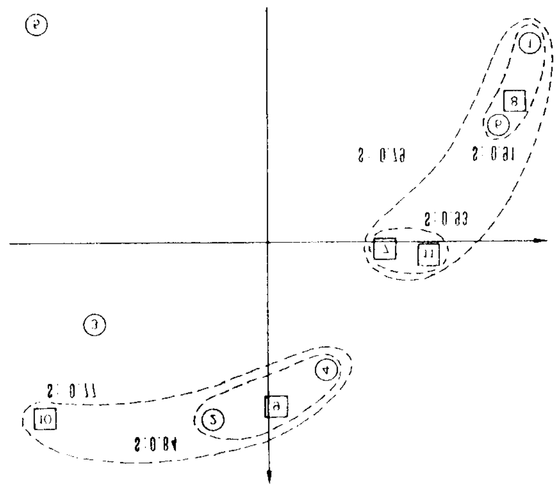

Figure 8. Multidimensional plotting of stations after Similarity Analysis of macrobenthofaunal populations. (S) similarity sill.

Table 3. *Correlation matrixes between Pelecypods densities (log (number of individuals per m^2)), specific richness (number of species) and abiotic parameters (averages) in Belle Plaine and Manche à Eau lagoons.*

Manche A Eau								
T_1								
O_2	$0,80^A$	1						
S_1	-0,22	0,41	1					
pH	0,41	$0,77^A$	0,14	1				
Veg. debris	0,04	0,12	0,42	0,41	1			
Depth	0,34	0,49	0,19	0,25	$0,75^A$	1		
log (n indiv.)	0,72	$0,96^D$	0,18	$0,80^A$	0,01	-0,62	1	
n species	$-0,85^B$	$0,93^D$	0,54	0,60	0,26	0,26	$0,83^B$	1
	T_1	O_2	S_1	pH	Veg. debris	Depth	Log (n indiv.)	In species

degree of freedom: 4

Belle Plaine								
T_1	1							
O_2	-0,75	1						
S_1	0,23	0,01	1					
pH	$0,81^{A1}$	$0,93^B$	0,15	1				
Veg. debris	0,11	0,61	0,22	0,48	1^C			
Depth	$-0,96^D$	0,78	0,45	0,76	0,29	1		
log (n indiv.)	-0,05	0,66	0,01	0,49	$-0,95^C$	0,20	1	
n species	0,44	0,19	0,71	0,11	0,39	0,47	0,62	1
	T_1	O_2	S_1	pH	Veg. debris	Depth	log (n indiv.)	n species

degree of freedom: 3

Probability of error (p) : (A) : $0,05 < p < 0,10$
(B) : $0,02 < p < 0,05$
(C) : $0,01 < p < 0,22$
(D) : $p < 0,01$

tion and for comparison four mangrove extra-lagoonal stations situated in the Grand Cul-de-Sac Marin have been studied. These are (Figure 1): station 12 near the mouth of the Rivière Salée among an inter-islands mangrove; station 13 in a reefal on the southern coast of the

Table 4. *Densities of Pelecypods species at lagoonal and extra-lagoonal stations.*

Stations	Manche A Eau					Belle Plaine						Grand Cul De Sac Marin			
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
a Lucina pectinata	22,5	26,5	12,5	40,0		7.5		12,5			5,0			55	
b Codakia orbicularis	12,5														
c Codakia orbiculata	12.5					2,5									30
d Trachycardium muricatum	40,0					2,5		2,5				40			
e Chione cancellata	232,5					22,5		10,0				150	5		
f Anomalocardia brasiliana	40,0	5,0		40,0		65,0		5,0	6,25	2,5					
g Pitar albidus	20,0							5,0							
h Tellina alternata	15,0					12,5	25,0	22,5			25,0				
i Tellina fausta	10,0							15,0				20			
j Macoma constricta	107,5	40,0	5,0	12,5		52,5		20.0	2,5	2.5					
k Tellina lineata	20,0											40	5		
l Tagellus divisus	155,0			87,5		132,5	5,0	7,5	8,75	1,25					
m Corbula caribae	5,0					2,5		5,0							
n Corbula contracta	27,5							2,5	1,25		5,0			5	

Ilot à Fajou; station 14 in an estuarian mangrove at the mouth of the Grande Rivière à Goyaves; station 15 in a sea-front mangrove at the Pointe Lambis. The lagoons data have been treated by Similarity Analysis in the same way as described above comparing the Pelecypods species as a function of their distribution in the lagoonal stations. The results of multidimensional plotting are given in Figure 9.

Two main groups appear. Group A is composed of narrowly distributed species which occur at no more than 4 stations. These are: *Codakia orbicularis, C. orbiculata, Trachycardium muricatum, Pitar albidus, Tellina fausta, T. lineata, Corbula caribae* and *C. contracta*. Among this group, *Corbula contracta* conspicuously occurs in organic matter accumulating areas (Station 9 in Belle Plaine, station 14). This particular facies is closely related to the *Corbula gibba* facies of Mediterranean lagoons where it occurs in deep areas where organic matter also accumulates (BURELLI *et al.*, 1979; FRISONI *et al.*, 1983; IBRAHIM *et al.*, 1985; GUELORGET *et al.*, 1989). Group B is composed of widely distributed species (6 stations or more): *Lucina pectinata, Anomalocardia brasiliana, Macoma constricta, Tagellus divisus*. In addition two species display a particular

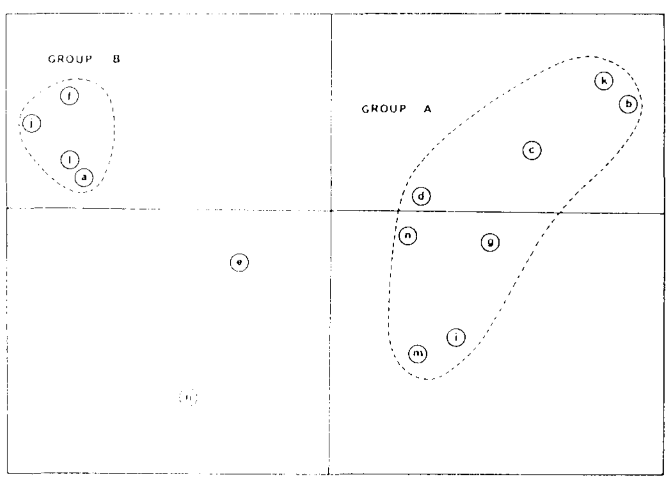

Figure 9. Multidimensional plotting of Pelecypods species after their repartition similarities (see Table 4).

distribution. *Tellina alternata* is the only abundant species at stations 7 and 11 in Belle Plaine. *Choine cancellata* is very abundant at the only station 1 in the Manche à Eau but may reach high densities in sandy shallow coastal areas (Station 12). It is called "chaubette" and locally harvested and consumed.

The species of group B are widely distributed inside the lagoonal areas. For instance, they are the only species living in the most restricted areas of the Manche à Eau lagoon (stations 2, 3, 4) but they never occur in extra-lagoonal environments. These species being bound to restricted environments may be dubbed "paralic" species (GUELORGET and PERTHUISOT, 1983) in opposition to "thalassic" species which only live in open marine conditions. Among paralic species, *Lucina pectinata* which is called "palourde" (clam) in Guadeloupe, is the only species encountered at the adult stage. Group A (close to which are *Chione cancellata* and *Tellina alternata*) is composed of species which preferentially live in lagoonal areas under prominent marine influence (stations 1, 6, 7, 8, 11) but may occur in apparently open marine conditions (stations 12, 13, 15). They may be dubbed "ambivalent" species (espèces "mixtes" after GUELORGET and PERTHUISOT, 1983). Among this group *Codakia orbicularis* and *C. orbiculata* which also are called "palourde" may be found at the adult stage in open marine environments. It finally appears that most of the recorded Pelecypods are ambivalent species living in slightly restricted lagoonal areas or in open marine conditions whereas only a few paralic species stay in the most restricted parts of lagoons. It is worth noting that most of these species are represented by small size or juvenile individuals similarly to Mediterranean lagoons. *Lucina pectinata* is the only one that reaches a valuable size for economical exploitation.

In addition to monthly samplings at all stations, the distribution of *Lucina pectinata* has been studied by complementary samples in both lagoons (Figure 10). Three types of samples occur: (1) samples containing living individuals and empty shells; (2) samples with only empty shells; (3) samples without any trace of this clam. In Belle Plaine lagoon the living clams occupy the close vicinity of the Belle Plaine channel mouth and in the channel itself which are the most restricted parts of the lagoon. Empty (fossil) shells occur in a larger area in the lagoon. Elsewhere there is no trace of living individuals nor any remains of fossil shells. In the Manche à Eau lagoon the living clams occur only on the western part of the basin. Elsewhere sediments contain only empty shells. This distribution confirms that the Manche à Eau lagoon is globally more confined than Belle Plaine lagoon since the paralic species *L. pectinata* is more widespread in the former. Besides, both lagoons were at the time of the study undergoing a stage of deconfinement or "marinization" since the living clam area was shrinking in each of them. This evolution is probably due to the regression of mangroves as a result of human interference.

CONCLUSIONS

The present study tends to confirm that the biological organization of mangrove tropical lagoons is similar to that of Mediterranean lagoons. Notably, as far as the main taxonomic groups are concerned the benthic macrofauna zonation is qualitatively and quantitatively similar. In both cases the zonal biological organization appears to be mainly controlled by the confinement or degree of restriction with respect to the open sea which is somehow inversely proportional to the flux of marine originated elements in a given point (GUELORGET and PERTHUISOT, 1983). This concept is not far from the "embayment degree" concept which has been proposed for coastal ecosystems in Japan (MIYADI *et al.*, 1944; HORIKOSHI, 1988). Here the question arises in which manner the restriction acts on living populations. First, it must be emphasized that species adapted to restricted environments are also adapted to the *variations* of abiotic parameters. As an hypothesis, GUELORGET and PERTHUISOT (1983) suggest that seawater could carry substances such as vitamins and/or oligoelements that are trapped or destroyed by living beings. In restricted environments, the depletion of water with these substances could select adapted species. Whatever the reality of such an hypothesis, most (if not all) of paralic ecosystems seem to have a common organization and functioning as far as benthic macrofauna is concerned but this could be extended to other biological compartments (GUELORGET and PERTHUISOT, 1983; FRISONI, 1984).

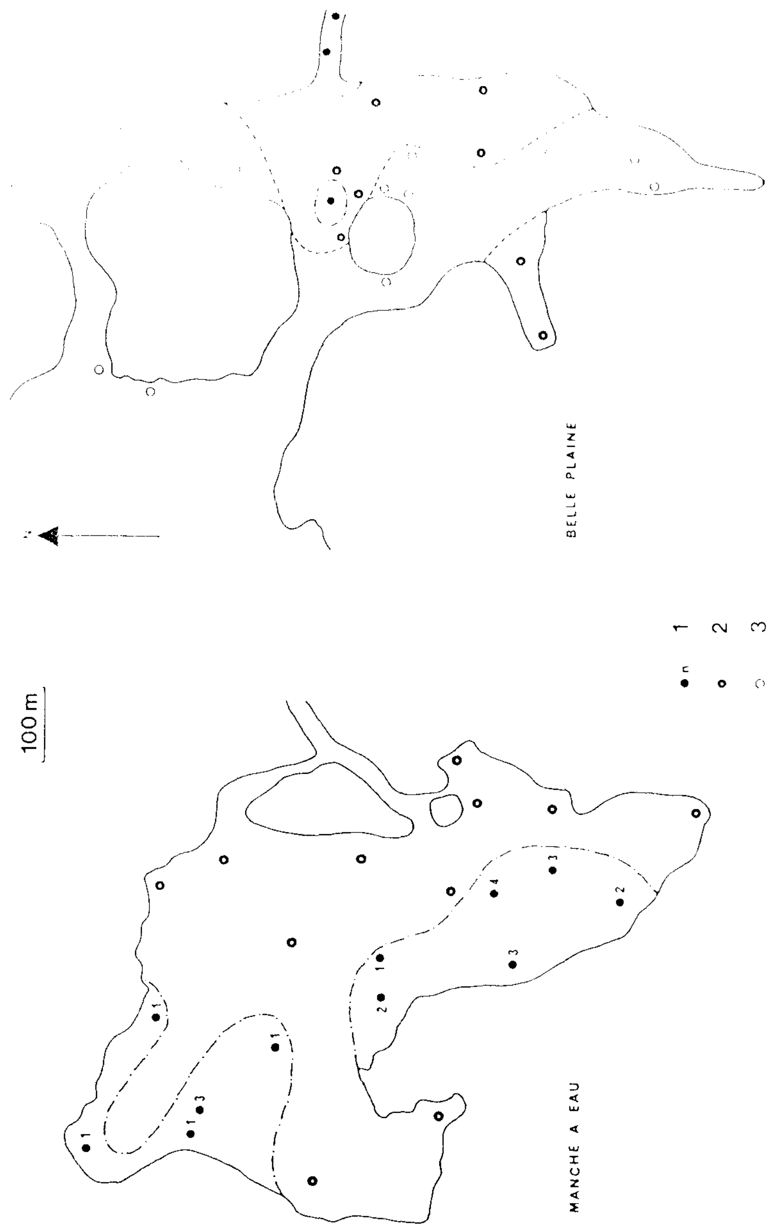

Figure 10. Distribution of the clam *Lucina pectinata*. (1) Presence of living individuals (n) number of individuals per 0,1 m^2); (2) presence of empty shells only; (3) absence of clams, dead or alive.

There is generally no physical, chemical or sedimentological parameter which is able to measure the degree of restriction either in a given area or for the whole paralic realm. The best indicators of the restriction gradients remain biologic ones, notably the benthic macrofauna which integrates the short term variations of the environment.

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□ RESUMEN □

Se compara la distribución de parámetros abióticos con la distribución cualitativa y cuantitativa de la fauna macrobentónica en un par de albuferas de mangrove bajo clima tropical. Mediante varios tratamientos matemáticos de los datos recogidos se obtiene que las dos albuferas son muy diferentes en lo concerniente a los parámetros abióticos. Entretanto, presentan una organización similar de la macrofauna. Además, ninguno de los parámetros abióticos estudiados es capaz por si mismo de relacionarse con la zonación biológica de ambas lagunas que parece se entiende mejor en términos de la restricción con respecto al mar abierto, es decir, en términos de confinamiento. Se pueden separar dos tipos de especies de Pelecipodos. El primero está compuesto por las especies que viven en las áreas lagunares y en condiciones aparentes de mar abierta, mientras que el segundo está compuesto por las especies que sólo viven en las partes más restringidas de ambas albuferas. Por otro lado, un estudio detallado de la Lucina pecniata vivas y de las conchas vacias muestra la evolución reciente de ambas albuferas hacia condiciones menos restringidas. Finalmente, se obiene que la estructura ecológica y el funcionamiento de estas albuferas tropicales es muy similar a los de las costas mediterráneas. Esto tiende a confirmar la existencia de una organización biológica común en la mayoria de las albuferas.—*Department of Water Sciences, University of Cantabria, Santander, Spain.*

RÉSUMÉ

Compare la distribution des paramètres abiotiques aux distributions qualitatives et quantitative de la macrofaune de deux lagunes à mangrove en climat tropical. Il apparait d'après plusiers traitement des données recueillies que ces deux lagunes diffèrent par les paramètres abiotiques, mais présententent une organisation semblable de la macrofaune. De plus, aucun des paramètres abiotiques ne rend compte à lui seul de la zonation biologique des deux lagunes que l'on peut mieux comprendre en termes d'une progression vers le confinement depuis la mer ouverte. La première lagune est composée d'espèces lagunaires et aussi de mer apparemment ouverte; la seconde est composée d'espèces qui ne vivent que dans des parties restreintes des deux lagunes. La répartition de *Lucina pectinana* vivant et de ses coquilles vides montre l'évolution des deux lagunes vers le confinement. Il apparaît donc que la structure écologique et le fonctionnement de telles lagunes tropicales ressemblent à ceux des bassins paraliques de la côte méditerranéenne. Ceci tend à confirmer l'existence d'une organisation biologique commune à la plupart des bassins paraliques.—*Catherine Bressolier (Géomorphologie EPHE, Montrouge, France).*

ZUSAMMENFASSUNG

Die Verteilung abiotischer Parameter wird verglichen mit der qualitativen und quantitativen Verteilung des Macrobenthos in einigen tropischen Mangrovelagunen. Durch eine besondere mathematische Behandlung der Daten läßt sich zeigen, daß zwei Lagunen in ihren abiotischen Parametern große Unterschiede aufwiesen. Mittlerweile zeigen sie aber eine ähnliche macrofaunische Gliederung. Keiner der untersuchten abiotischen Parameter kann die biologische Zonierung beider Lagunen erklären. Diese läßt sich besser verstehen durch den Grad der Abtrennung der Lagune vom Meer. Zwei Muschelarten (Pelecypoden) kommt eine besondere Bedeutung zu. Die eine Art ist einer Gruppe zuzuordnen, die sowohl in Lagunen als auch im Meer lebt. Die andere Art ist Spezies zuzuordnen, die nur in sehr abgelegenen Lagunenteilen leben. Spezielle Untersuchungen weisen darauf hin, daß in beiden Lagunen der Einfluß des Meeres zunimmt. Die ökologische Struktur und Funktionsweise der untersuchten tropischen Lagunen ähnelt der maritimer küstennaher Becken im Mittelmeerraum. Daraus könnte die Existenz einer allgemeinen biologischen Gliederung der meisten derartiger Becken abgeleitet werden.—*Reinhard Dieckmann, WSA Bremerhaven, FRG.*