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Community Structure and Intertidal Zonation of the Macroinfauna on the Atlantic Coast of Uruguay

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ABSTRACT

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Five sandy beaches, covering a complete range of dissipative-reflective categories, were studied at the Atlantic coast of Uruguay. The objective of this study was to analyze the species richness, abundance and zonation of the intertidal macroinfauna in relation to beach textural characteristics. The most distinctive features of the macroinfauna studied were: (a) maximum species richness (17), densities and biomass occurred at a long dissipative beach (Barra del Chuy) of fine sands and a flat slope, while the lowest values of community parameters occurred at a truly reflective beach (Manantiales), with coarse sands and a steep slope; (b) polychaete worms were mostly collected from the long dissipative beach; (c) cirolanid isopods showed a distinct pattern of distribution, with *Excirolana braziliensis* as the dominant cirolanid in coarse sands and *Excirolana armata* in fine sands; and (d) faunistical zones were not easy to distinguish: they were recognized at Arachania and Punta del Diablo (two belts), and Barra del Chuy (three belts).

ADDITIONAL INDEX WORDS: *Community structure, intertidal zonation, sand beach, Uruguay coast, macroinfauna.*

INTRODUCTION

Substrate characteristics (*i.e.* grain size, sorting), which generally result from wave conditions and the geological history of an area, have been widely documented as one of the major factors influencing distribution and abundance of sandy beach macroinfauna (see review by McLachlan, 1983). Generally, in a gradient of grain size and wave exposure, crustaceans dominate towards coarser and more exposed areas, while the proportion of polychaetes and bivalves increase towards the other side of that gradient (*e.g.* Seed and Lowry, 1973; Croker *et al.,* 1975; Eleftheriou and Nicholson, 1975; McLachlan *et al.,* 1981; Dexter, 1984).

Until recently, very little was known about animal-substrate relationship and macroinfaunal community structure of sandy beaches of Uruguay; earlier studies were mainly descriptives like those of Scarabino *et al.* (1974) and Escofet *et al.* (1979). Reflective and dissipative beaches (*sensu* Short, 1979, 1983; Short and Wright, 1983) alternate along nearly 200 km of Atlantic coast providing a wide between-site variability in textural characteristics, a situation which in turn suggests a macroinfaunal variability. Thus, the objective of this study was to analyze the zonation and community structure of the macroinfauna along this coast by comparing five beaches with different physical characteristics.

MATERIAL AND METHODS

Five sandy beaches on the Atlantic coast of Uruguay, at Manantiales, Solari, Arachania, Punta del Diablo and Barra del Chuy (Figure 1) were sampled during October 1982. The beaches were selected to represent a wide variability in grain size characteristics. Triplicate 0.11 m^2 sediments samples were collected at 5 m intervals on transects normal to the shoreline and spaced 3 m apart. Each transect was extended between the lower limit of the swash zone, determined by the minimum tide advance during the sampling time, and the beach face (defined by foredunes, cliff or drift lines). Depending on the width of each site, those beach levels varied between five and twelve stations. The sediment samples were sieved through a 1 mm screen and macroinfauna fixed in 5% formalin for later analyses. These analyses included species identification, counting and dry weight determinations.

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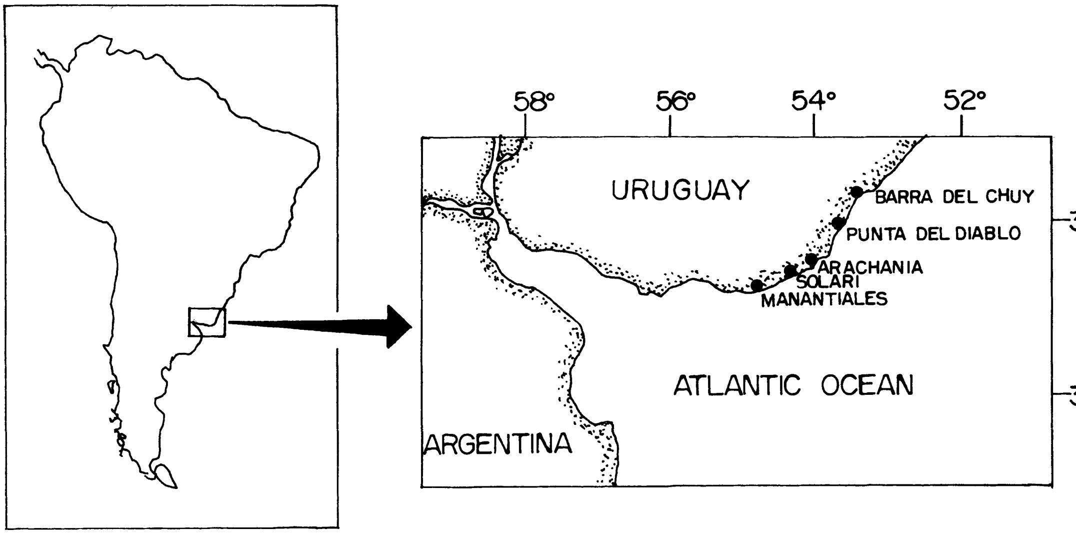

Figure 1. Map of the Atlantic coast of Uruguay showing the location of the beaches analyzed in this study.

The beach face slope of each site was measured by the coefficient a/l × 100, where a is the difference in height between the highest and lowest station (lower water line) and l is the distance between these two points. One sediment sample (20 cm deep) for grain size analyses was collected at each station. These samples were passed through a series of sieves of −1.0, 0.0, 1.0, 2.0, 3.0 and 4.0 phi (phi = $-\log_2$ mm); a mechanical shaker was used for 15 minutes on each sample. Graphic mean and standard deviation were determined by FOLK's method (1980). Results were expressed in phi units and mm.

The rating system proposed by MCLACHLAN (1980a) was used to categorize the five sandy beaches in relation to exposure. MCLACHLAN's rating system of exposure takes into account observations of wave action, surf zone width, percentage of fine sand, median particle diameter, slope, depth of reduced layers and the presence of stable burrows. On a 20 point scale of exposure, beaches scoring 5 to 10 are considered sheltered, 11 to 15 exposed, and higher than 15 define very exposed beaches.

Density values per 0.11 m^2 were calculated and used to draw kite diagrams and describe zonation patterns. To analyze the zonation of species as well as abundance variability amongst sites, macroinfaunal samples were subjected to classification and ordination procedures as follows:

(1) The taxonomic similarity between paired samples within and between beaches was calculated with the quantitative Bray-Curtis coefficient (FIELD *et al.*, 1982), and dendrograms were obtained after the Pair Group Method (SOKAL and SNEATH, 1973). In order to analyze clustering, the original abundances were root-root transformed (FIELD *et al.*, 1982; RAFFAELLI *et al.*, 1991).

(2) Ordination techniques were carried out by means of: (a) Principal Component Analysis (PCA), performed on substrate composition data (standarized correlation matrix), to search for patterns of substratum heterogeneity and to interpret macroinfaunal variability in terms of grain size (GREEN, 1979). (b) Nonmetric Multidimensional Scaling (MDS), based on root-root transformed abundances, was applied in order to characterize the among-sites variability of the macroinfauna (MCLACHLAN, 1990; RAFFAELLI *et al.*, 1991).

RESULTS

The Beaches

The geographic location and several physical characteristics of the beaches studied are given in Table 1. Length and width showed a high between-site variability; Barra del Chuy being the longest and widest beach (22 km in length and 60 m in width). In general, the steepest beaches

Table 1. *Physical and biological characteristics of Uruguay sandy beaches.*

Beach Features	Manantiales	Solari	Arachania	Punta Diablo	Barra Chuy
Latitude	34°58'S	34°40'S	34°36'S	34°07'S	33°45'S
Longitude	54°48'W	54°12'W	54°06'S	53°44'W	53°27'W
Length (km)	2.50	12.00	3.50	2.50	22.00
Width (m)	20.00	30.00	35.00	25.00	60.00
Textural group*	coarse	fine	medium	fine	fine
Beach face slope (%)	11.00	5.16	7.56	3.00	3.17
Grain size** Φ	0.31	2.46	1.00	2.32	2.31
μm	807	182	500	200	202
Sorting Φ	0.73	0.46	1.11	0.63	0.59
μm	603	727	463	646	664
Exposure***	very exposed	exposed	very exposed	sheltered	exposed
Morphodyn. type	reflective	dissipative	intermediate		dissipative
Number of species	4	2	5	4	17
Density: Ind·m^{-2}**	26 ± 2	249 ± 98	65 ± 16	202 ± 81	536 ± 137
Dry biomass (g·m^{-2})**	0.18 ± 0.03	1.16 ± 0.48	11.59 ± 6.26	4.00 ± 1.77	20.32 ± 8.24

* Type of sand after Folk (1980); ** overall mean based on the mean values calculated for the individual stations at each size; *** after McLachlan (1980a)

(Manantiales and Arachania) had the coarsest sediments and vice versa (Table 1). Grain size increased seaward, except at Barra del Chuy which presented the coarsest grains at both, the high and low beach levels (Figure 2). Sediments of Manantiales were represented by coarse sands (0.1–0.5 phi) all over the transect studied. The same holds true for the mid and low beach levels of Arachania (station 4–8), while those of the high beach levels (station 1–3) were made up of medium sands (1.2–1.7 phi). On the other hand, the sediments of Solari, Punta del Diablo and Barra del Chuy were fine sands (2.1–2.6 phi). Stations with the coarsest grains had the highest sorting values, and *vice versa* (Figure 2).

The rating system proposed by McLachlan (1980a) defined the beaches of Manantiales and Arachania as very exposed (score = 16); Solari (10) and Barra del Chuy (13) were defined as exposed, whereas Punta del Diablo, partly protected by rocky sharps, is relatively sheltered (9) from wave action (Table 1).

The Macroinfauna

The highest values of overall mean density and biomass were found at Barra del Chuy beach, which also had the highest number of species. The lowest mean densities were observed from Manantiales and Arachania, being also the former the site with the lowest biomass (Table 1).

Mean grain size and slope values were significantly correlated ($r = -0.94$; $p < 0.02$) with macroinfaunal densities (Figure 3). In both cases, a monotonically decreasing exponential function of the form

$$\text{DENSITY} = ae^{-bX}$$

was successfully fitted, X being either slope or mean grain size.

Table 2 shows mean densities and abundances calculated for all species at each beach. The cirolanid isopods *Excirolana braziliensis* and *Excirolana armata* numerically dominated all the sites, except Barra del Chuy. *Excirolana braziliensis* reached densities up to 44 ind m^{-2} (Arachania), while the highest value for *Excirolana armata* was 264 ind m^{-2} (Solari); both cirolanids had a percentage representation higher than 60%. Barra del Chuy was numerically dominated by *Euzonus furciferus,* a polychaete with a mean density of 567 ind m^{-2} and 44% of the whole macroinfauna. In terms of dry biomass, cirolanid isopods dominated at Manantiales (0.13 g m^{-2}) and Solari (0.90 g m^{-2}), while bivalves (*Donax hanleyanus* and *Mesodesma mactroides*) made up the bulk of the biomass at the other beaches. *Donax hanleyanus* dominated at Arachania (mean = 9.8 g m^{-2}), while *Mesodesma mactroides* was the major contributor to biomass at Punta del Diablo (mean = 1.8 g m^{-2}) and Barra del Chuy (mean = 8.6 g m^{-2}).

The zonation of the species showed that high beach levels were mainly occupied by the talitrid amphipod *Orchestoidea brasiliensis* and the cirolanid isopods *Excirolana braziliensis* and *Excirolana armata* (Figure 4). *Orchestoidea brasiliensis* and *Excirolana braziliensis* made up the

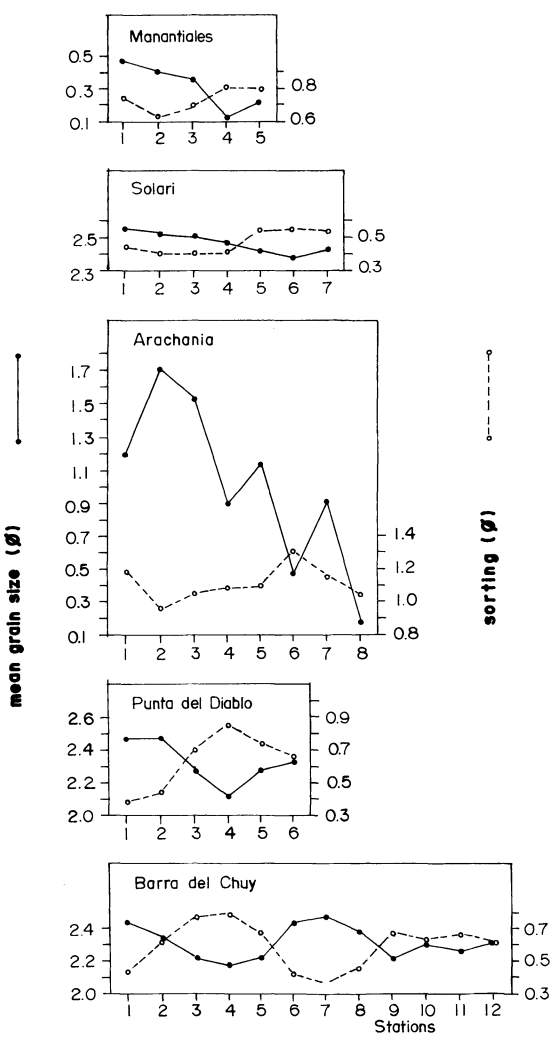

Figure 2. Mean grain size and sorting of the intertidal sediments sampled at the beaches studied.

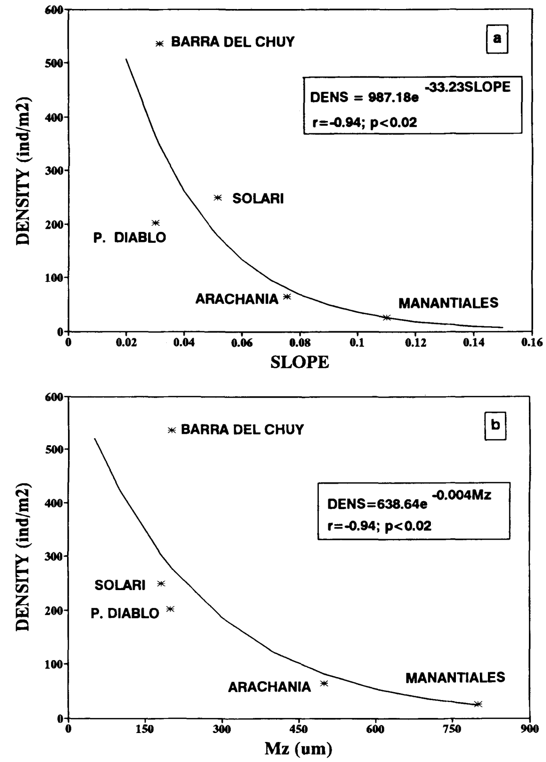

Figure 3. Scatter diagrams and relationship between overall mean densities and (a) slope and (b) mean grain size (Mz).

main component of the mid beach levels at Manantiales and Arachania, the beaches with the coarsest grains. On the other hand, the mid beach levels of Solari and Punta del Diablo were numerically dominated by *Excirolana armata*. This species and the polychaete *Euzonus furciferus* were the dominant organisms at similar beach levels of Barra del Chuy. The low levels of this beach had the highest species richness of all the similar beach levels, and included the amphipods *Bathyporeiapus ruffoi, Stephensenia haematopus* and *Metarpinia* sp., the isopod *Macrochiridotea giambiagiae,* the bivalves *Donax hanleyanus* and *Mesodesma mactroides,* the anomuran crab *Emerita brasiliensis,* the polychaetes *Spio gaucha* and *Sigalion cirriferum,* and the gastropods *Olivancillaria vesica auricularia* and *Buccinanops duartei* (Figure 4).

Multivariate Analysis

The first two components obtained from PCA based on percentage substrate size fractions for all sampling stations, accounted for 75% of the variation. The first component explained 59% of the variance and showed a dominant trend from fine to medium-coarse sands. Three main groups were delineated: (1) group G1, including stations with finer sands of Barra del Chuy, Solari and Punta del Diablo; (2) coarse grain stations of Manantiales and higher-mid levels of Arachania defined group G2; and (3) group G3, mainly represented by stations 6, 7 and 8 of Arachania (lower level), which presented the coarsest grain sizes.

The classification analyses discriminated by

Table 2. *Species, taxonomic composition, dry biomass and density of the fauna on five Uruguay beaches.*

Species (and taxon)		Manantiales		Solari		Arachania		Punta Diablo		Barra Chuy	
		B	D	B	D	B	D	B	D	B	D
Orch. brasiliensis	(A)	50	7			80	15			20	17
Excirolana armata	(I)			901	264			1,636	216	580	169
Exc. braziliensis	(I)	134	18			410	44	14	6	23	13
Bathyporeiapus ruffoi	(A)									14	41
Phoxoceph. zimmeri	(A)	0.3	3							22	100
Macrochiridotea giam.	(I)									6	11
Euzonus furciferus	(P)									1,548	567
Donax hanleyanus	(B)					9,780	24			3,052	32
Hemipodus olivieri	(P)					91	10			68	12
Metarpinia sp.	(I)	1	7							16	70
Mesodesma mactroides	(B)							1,768	6	8,589	34
Stephensenia haemat.	(A)									0.2	10
Emerita brasiliensis	(An)			262	87	1,129	19			1,508	22
Spio gaucha	(P)									1	20
Buccinanops duartei	(G)									4,433	40
Olivancillaria v.a.	(G)							586	7	411	17
Sigalion cirriferum	(P)									28	20

B = dry biomass ($mg \cdot m^{-2}$), D = density ($ind \cdot m^{-2}$). Under taxon A = Amphipoda, I = Isopoda, P = Polychaeta, B = Bivalvia, G = Gastropoda, An = Anomura

beach (Figure 5) showed that four of the five stations sampled at Manantiales (in station 5 no macrofauna was found) had a high value of taxonomic similarity (> 60%); *i.e.* no major groups were detected. At Solari, stations 1 to 6 formed a compact group (with *Excirolana armata* as the single species), while the lowest intertidal level (station 7) remained apart. Stations sampled at Arachania were clearly classified in two groups; one with *Orchestoidea brasiliensis* and *Excirolana braziliensis* (stations 1 to 5), and another one with *Donax hanleyanus, Emerita brasiliensis* and *Hemipodus olivieri* as characteristic species (stations 6 to 8). At Punta del Diablo, two groups of stations were also identified: the co-occurrence of cirolanid isopods *Excirolana braziliensis* and *Excirolana armata* defined the first group (stations 1 to 3), while stations 4 to 6 showed a high value of taxonomic similarity (> 75%) due to the presence of the bivalve *Mesodesma mactroides* and its major predator, the gastropod *Olivancillaria vesica auricularia.* Finally, the dendrogram obtained for Barra del Chuy showed that the intertidal levels of this beach can be classified in three groups which are linked at very low values of taxonomic similarity with station 1 (Figure 5).

Examination of the cluster analysis by pooling the sampling stations for all beaches (similarity level greater than 40%), and ordination plot by means of MDS, suggested the same affinities and association of stations with similar physical characteristics (*e.g.* grain size). Thus, only the MDS plot is shown (Figure 6). Four groups were recognized: (1) group G1, clustering the majority of stations of Barra del Chuy, except those of higher beach levels; (2) group G2, comprising all stations with finer sands and flatter slopes (*i.e.* Solari and Punta del Diablo) and the common occurrence of the cirolanid isopod *Excirolana armata*; (3) group G3, corresponding to Manantiales and high-mid levels of Arachania. These stations with coarse grain had in common the numeric dominance of the cirolanid isopod *Excirolana braziliensis* and the amphipod *Orchestoidea brasiliensis.* Finally, group G4 clumped stations pertaining to lower beach levels of Arachania, (*i.e.*, group G3 in the PCA), with the presence of the tidal migrators *Donax hanleyanus* and *Emerita brasiliensis.* Stations 2 and 3 of Barra del Chuy, with a mixed macroinfauna of coarser (*e.g. Orchestoidea brasiliensis, Excirolana braziliensis*) and finer (*e.g. Excirolana armata*) sands, and station 7 of Solari, with the unique presence of *Emerita brasiliensis,* departed from groups G2 and G3 respectively.

DISCUSSION

Community Structure and Ecology of Uruguayan Beaches

The five sandy beaches analyzed in this study covered a wide range of beaches with differences in their morphodynamic type and exposure. Even though morphodynamic type was not accurately

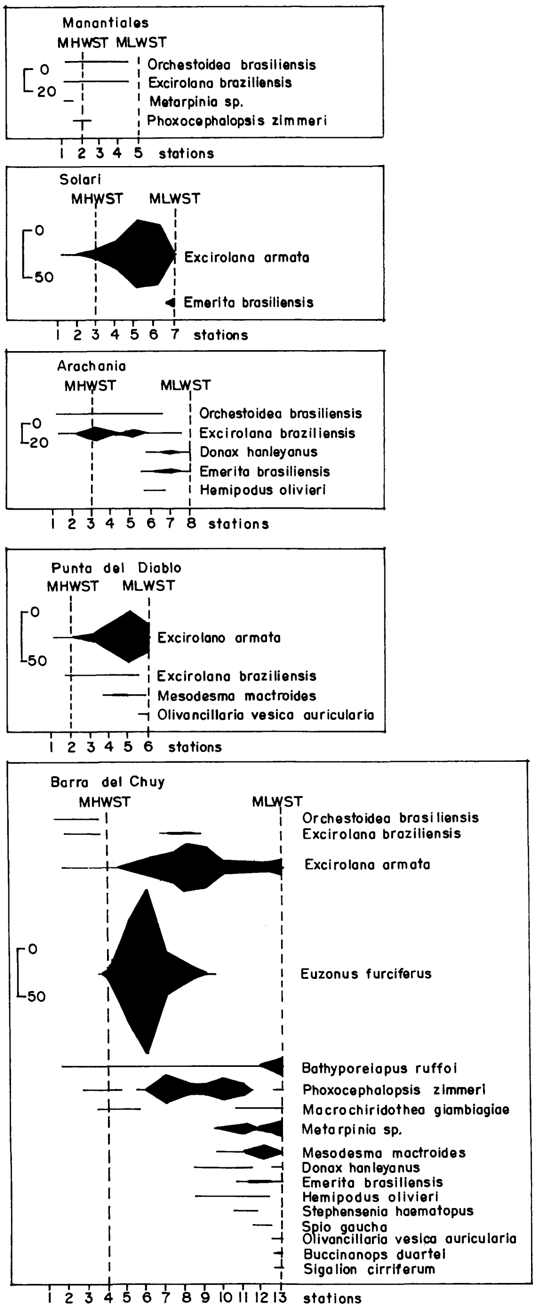

Figure 4. Intertidal distribution of the macroinfauna at five Uruguay sandy beaches.

quantified by means of Dean's parameter (SHORT and WRIGHT, 1983; MCLACHLAN, 1990), it is clear that coarser grains, a steep slope and a narrow surf zone width found at Manantiales chiefly defined its reflective character, while the finer sands and flatter slopes demarcated the dissipative character of Solari and Barra del Chuy. Arachania, with intermediate values in grain sizes and slopes, may be categorized as an intermediate type of beach but closer to the reflective category.

The results of this study agree with others in which grain size and slope are assumed to be among the dominant factors controlling sandy beach community structure (*e.g.* COLMAN and SEGROVE, 1955; JONES, 1970; CROKER, 1977; DEXTER, 1979; MCLACHLAN *et al.*, 1981; JARAMILLO, 1987). The most obvious difference between the macroinfauna was the marked contrast in abundance of the species collected in the reflective and intermediate beaches of Manantiales and Arachania, respectively as compared with the other beaches. The paucity of macroinfauna at those sites agrees with the findings of GAULD and BUCHANAN (1956), DYE *et al.* (1981) and MCLACHLAN (1985), who reported that reflective beaches of Ghana, South Africa and Australia were characterized by an impoverished macroinfauna. As shown by several authors (*e.g.* MCLACHLAN *et al.*, 1981; DEXTER, 1983), species richness and macroinfaunal abundance were negatively correlated with particle size. But grain size characteristics can not explain the low diversity of Solari, a dissipative beach with sands similar in size to that of Punta del Diablo and Barra del Chuy, which had a higher species richness. The sands of Solari differed from that of the other beaches by its higher water content, due to the fact that an effluent of Laguna de Rocha flows through this beach. Thus, the higher water content (and hence, a different sediment fabric) affects the macroinfaunal community of this beach.

Another important difference along the Atlantic beaches of Uruguay was related to the abundance of cirolanid isopods. While *Excirolana braziliensis* characterized the upper and middle intertidal of coarsest beaches (Manantiales and Arachania), *Excirolana armata* dominated the fine sands of Solari, Punta del Diablo and Barra del Chuy. This pattern suggests preferences or adaptative abilities to different environmental characteristics such as wave exposure and grain size (DE ALAVA, 1989; DEFEO *et al.*, 1989), as observed for some closely related sandy beach peracarids (JONES, 1970). The distributional pattern shown by *Excirolana* spp. on the beaches studied here, represents a common example of closely related species partitioning available space as a way of reducing or avoiding potential competition (JONES,

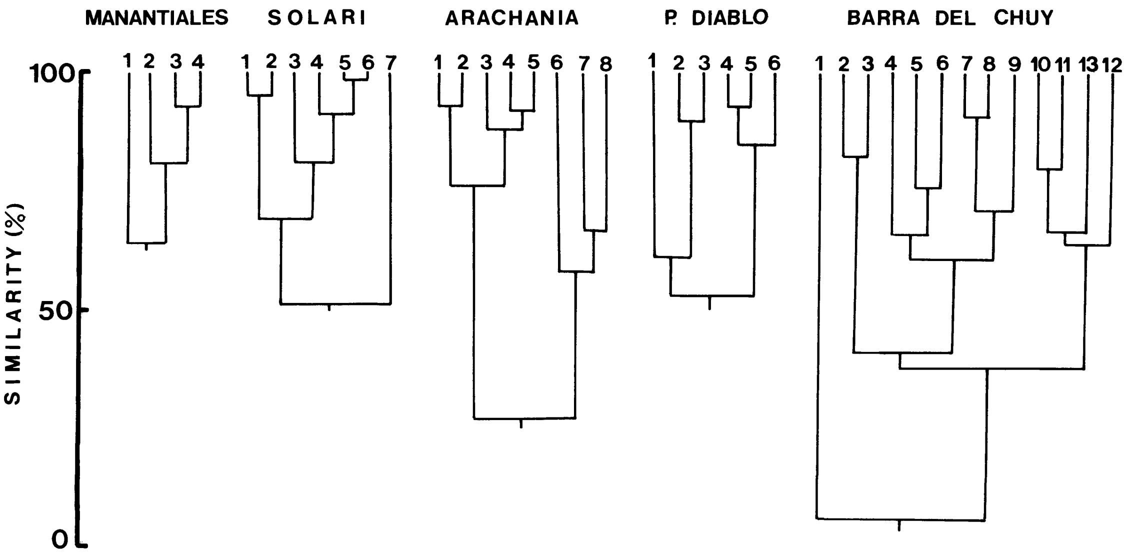

Figure 5. Cluster analysis of Uruguay fauna discriminated by beach. Stations are numbered as in Figure 4.

1979; CROKER, 1967; CROKER and HATFIELD, 1980; DEFEO *et al.*, 1989).

Abundance and diversity of polychaetes were other differences found along Uruguayan beaches. As reported by several authors (*e.g.* MCINTYRE, 1970; SEED and LOWEY, 1973; CROKER, 1977; DEXTER, 1983; MCLACHLAN, 1983), the abundance of sandy beach polychaetes increases along a gradient of decreasing wave exposure. In contrast, in our study most of the polychaetes were collected at the dissipative beach of Barra del Chuy, being the opheliid *Euzonus furciferus* the macroinfaunal species which reached the highest abundance, whereas no polychaetes were collected on Punta del Diablo, a relatively sheltered beach with similar beach slope and grain sizes to Barra del Chuy.

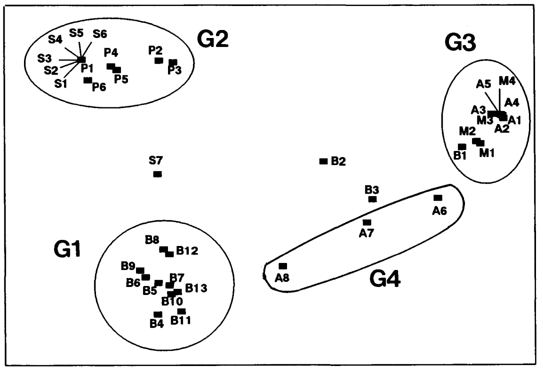

Figure 6. Ordination of stations using Multi-dimensional Scaling. Groups identified in the dendrogram are encircled here.

The above mentioned facts suggest that factors other than those related to wave energy could explain the observed differences in abundance and species richness among the dissipative beaches studied. Such differences may be related to the amount of food supply, usually provided by surf phytoplankton (MCLACHLAN, 1980b; MCLACHLAN and LEWIN, 1981; GIANUCA, 1983; LEWIN and SCHAEFER, 1983). High productivity and dense blooms of surf diatoms (particularly *Asterionella glacialis*) have been frequently registered at Barra del Chuy (BAYSSE *et al.*, 1989; DEFEO and SCARABINO, 1990). This situation does not occur at Solari and Punta del Diablo, with lower wave energy and surf diatom productivity. Such differences in food availability may also explain the higher biomass of filter feeders such as *Mesodesma mactroides, Donax hanleyanus* and *Emerita brasiliensis* at Barra del Chuy, as reported for similar beach/surf zone ecosysytems around the world (MCLACHLAN, 1983, 1990).

Zonation

Several zonation schemes have been proposed for sandy beach habitats. While DAHL (1952), PICHON (1967) and TREVALLION *et al.* (1970) based their schemes on biological factors (*i.e.* the intertidal distribution of the macroinfauna), SALVAT (1964) used physical characteristics; *i.e.* the water content of the sediments (see detailed discussion of these schemes in McLACHLAN, 1990 and RAFFAELLI *et al.*, 1991). Recently, classification and ordination techniques have been used to examine the number of such faunistical zones: four zones have been identified in sandy beaches of South Africa (BALLY, 1983; WENDT and McLACHLAN, 1985), Namibia (DONN and COCKCROFT, 1989) and United States (McLACHLAN, 1990), while in northern Chile just three zones were determined (CLARKE and PEÑA, 1988). However, the recent paper of RAFFAELLI *et al.* (1991) highlighted the difficulties in establishing major biological zones, and suggested that the only zonation scheme universally applicable might be the one's of BROWN and McLACHLAN (1990), which recognizes a high-shore assemblage of air-breathers and a low zone of water-breathers.

The kite diagrams representing the intertidal distribution of the macroinfauna and the multivariate analysis carried out, showed that a general pattern of zonation can not be presented for the Atlantic beaches of Uruguay; *i.e.*, the number of faunistical belts varied between one (Manantiales) and three (Barra del Chuy). However, it was possible to distinguish species which characterize different tidal levels. Thus, *Orchestoidea brasiliensis* and *Excirolana braziliensis* can be considered as typical species of the subterrestrial fringe of DAHL (1952) or drying zone of SALVAT (1964). Both peracarids also characterize the high beach levels of the midlittoral zone (retention zone, *sensu* SALVAT, 1964) in which *Excirolana armata* and *Euzonus furciferus* also occured. Mid and low levels of the midlittoral zone may be characterized by cirolanid isopods and polychaetes, while the sublittoral fringe or saturation zone is chiefly characterized by *Emerita brasiliensis, Mesodesma mactroides* and *Donax hanleyanus.* It should be emphasized, however, that seasonal migration of some species such as *Mesodesma mactroides* (DEFEO *et al.*, 1986) and *Excirolana armata* (DE ALAVA and DEFEO, 1991) might obscure the observed zonation schemes.

In summary, three main conclusions can be drawn:

(1) The sandy beach macroinfauna of the Atlantic coast of Uruguay increased in number of species and abundances from reflective to dissipative beaches. A quantitative relationship between biological (*i.e.* total densities) and physical (slope, grain size) variables was observed: total abundance of macroinfauna was negative and exponentially correlated with grain size and slope. Multivariate analysis also showed the significance of particle size in structuring sandy beach communities.

(2) It was possible to recognize typical organisms that inhabit beaches with different grain size, such as *Excirolana armata* in finer sands and flatter slopes, and *Excirolana braziliensis* in coarser sands and steep slopes.

(3) Even though macroinfauna increased from higher to lower beach levels and, in some beaches, discrete assemblages coincided with Salvat's and Dahl's zones, zonation patterns were not easily distinguished.

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□ RÉSUMÉ □

On a étudié cinq plages de la côte atlantique uruguayenne qui se classent entre les types à dissipation et à réflexion. On a pu ainsi analyser en relation avec les caractères texturaux, la richesse des espèces, l'abondance et la zonation de la macroendofaune. Les principales caractéristiques de la macroendofaune sont: (a) l'abondance maximale en espèces (17), densités et biomasse se produit sur une longue plage de sable fin et plate, à dissipation (Barra del Chuy). Les plus faibles valeurs des paramètres se produisent sur une vraie plage à dissipation, au sable grossier et en pente raide (Manantiales). (b) Les vers polychètes se récoltent le plus fréquemment sur les plages à dissipation. (c) Les isopodes cirolanides ont une distribution bien distincte, *Excirolana braziliensis* domine dans les sables grossiers, *Excirolana armata* dans les sables fins. (d) La zonation faunistique n'est pas facile à faire. On a pu la reconnaître à Archania, à Punta del Diablo (deux ceintures), et à Barra del Chuy (trois ceintures).—*Catherine Bousquet-Bressolier, Géomorphologie E.P.H.E., Montrouge, France.*

□ RESUMEN □

En la costa Atlántica del Uruguay se han estudiado cinco playas arenosas, que cubre el rango completo desde playas disipativas a reflectivas. El objetivo de este estudio fue analizar la abundancia de las especies, la abundancia y la zonación de la macrofauna intermareal en relación a las características texturales de la playa. Las características principales de la macrofauna estudiada eran: (a) máxima abundancia de las especies (17), densidades y biomasas a lo largo de una playa disipativa (Barra del Chuy) compuesta de arena fina y poca pendiente, mientras que los valores más bajos de los parámetros de la comunidad se presentaron en una verdadera playa reflectiva (Manantiales), con arenas gruesas y una fuerte pendiente; (b) los poliquetos fueron recogidos sobre una larga playa disipativa; (c) los isopodos cirolanidos presentaban un esquema de distribución diferente, con *Excirolana braziliensis* con cirolanidos dominantes en las arenas gruesas y *Excirolana armata* en las arenas finas; (d) no fue sencillo distinguir las zonas faunísticas: ellas eran reconocidas en Arachania y Punta del Diablo (dos fajas), y en la Barra del Chuy (tres fajas).—*Néstor W. Lanfredi, CIC-UNLP, La Plata, Argentina.*

□ ZUSAMMENFASSUNG □

An der Atlantikküste von Uruguay wurden fünf Strände untersucht, welche das gesamte Energiespektrum von vollständig reflektierten Wellen bis vollständigem Wellenenergieverlust umfassen. Das Ziel dieser Studie war die Analyse von Artenvielzahl, Reichhaltigkeit und Zonierung der Makrofauna im Gezeitenbereich in ihrer Beziehung zum Aufbau und dem Gefüge des Strandes. Die untersuchte Makrofauna zeichnet sich durch folgende besondere Charakteristika aus: A) Maximales Artenreichtum (17), Dichte und Biomasse traten an einem langen Strand auf, der Wellenenergieverlust aufwies (Barra del Chuy). Der Strand setzte sich aus Feinsand zusammen und besaß eine geringe Neigung. Die niedrigsten Werte für sog. Tiergesellschaftsparameter fanden sich aber an einem rein reflektierenden Strand (Manantiales), welcher sich durch Grobsand und eine starke Neigung auszeichnete. B) Polychätenwürmer wurden hauptsächlich an dem langen Strand mit Wellenenergieverlust gesammelt. C) Die Vertreter der Isopodengattung Cirolana zeigten ein bestimmtes Verbreitungsmuster, in dem *Excirolana braziliensis* als die dominante Art im Grobsand vorherrschte und *Excirolana armata* im Feinsand. D) Es war nicht so einfach, zwischen faunistischen Zonen zu unterscheiden, aber bei Arachania und Punta del Diablo waren es zwei und bei Barra del Chuy drei Gürtel zwischen denen unterschieden werden konnte.—*Ulrich Radtke, Geographisches Institut, Universität Düsseldorf, Germany.*