Revista de la Sociedad Geológica de España 23 (3-4)

SHORT-TERM VARIABILITY IN SEDIMENTARY AND COMPOSITIONAL PROPERTIES OF TWO BEACHES IN TENERIFE (CANARY ISLANDS, NE ATLANTIC OCEAN)

Rodrigo Riera [(1*)], Jorge Núñez [(2)] and María del Carmen Brito [(2)]

[(1)] *Centro de Investigaciones Medioambientales del Atlántico (CIMA SL), Arzobispo Elías Yanes, 44, 38206 La Laguna, Tenerife, Canary Islands, Spain. rodrigo@cimacanarias.com*

[(2)] *Benthos Lab, Department of Animal Biology, Faculty of Biology, University of La Laguna, 38206 La Laguna, Tenerife, Canary Islands, Spain. janunez@ull.es*

Abstract: The beaches of Los Abrigos del Porís (SE Tenerife) and Los Cristianos (SW Tenerife) were sampled monthly throughout a year (May 2000-April 2001) in two sampling stations (intertidal and shallow subtidal). Sedimentary variables (grain size, organic matter, carbonates and total nitrogen) have been analyzed monthly during the study period. Rather low values of total nitrogen (< 0.015%) were found in the two localities and the content of carbonates varied largely between the two sampling locations, showing low percentages in Los Abrigos del Porís (< 7%) and high cocentrations in Los Cristianos (> 15%) because of their different geologic origin (volcanic *vs* organogenic). The organic matter content was characterised by low-to-intermediate values in both localities. Sediments were dominated by medium sands in the intertidal sampling station of Los Abrigos del Porís and the remaining sampling stations were dominated by fine sands. Multivariate analyses showed differences between the intertidal of Los Abrigos del Porís and the rest of sampling stations.

Key words: Beach sediment, intertidal, subtidal, Tenerife, Canary Islands, Atlantic Ocean.

Resumen: Se muestrearon mensualmente dos localidades de la isla de Tenerife, las playas de Los Abrigos del Porís (NE Tenerife) y Los Cristianos (NO Tenerife) a lo largo de un año (Mayo 2000-Abril 2001) tanto en el nivel intermareal como submareal somero. Las variables sedimentarias analizadas fueron (granulometría, materia orgánica, carbonatos y nitrógeno total). Los porcentajes de nitrógeno total fueron muy bajos en todos los puntos de muestreo (< 0.015%). El contenido en carbonatos varió según la localidad, con valores bajos en Los Abrigos del Porís (< 7%) y altos en Los Cristianos (> 15%), debido a su diferente origen geológico (volcánico *vs* organógeno). El porcentaje de materia orgánica obtuvo valores bajos e intermedios en ambas localidades. Los sedimentos estuvieron dominados por las arenas medias en el intermareal de Los Abrigos del Porís y por arenas finas en el resto de puntos analizados. Los análisis multivariante muestran diferencias entre el intermareal de Los Abrigos del Porís y el resto de los puntos de muestreo.

Palabras clave: Sedimento, intermareal, submareal, Tenerife, Islas Canarias, Océano Atlántico.

Riera, R., Nuñez, J. and Brito, M.C. (2010): Short-term variability in sedimentary and compositional properties of two beaches in Tenerife (Canary Islands). *Revista de la Sociedad Geológica de España*, 23 (3-4): 81-88

The interactions between organisms and sediments where they inhabit can discern distribution patterns, dynamics and autoecology of the different infaunal species and assemblages (Junoy, 1988). The grain size of sediment is one of the key factors in describing infauna habitats, determining spatial and structural conditions of faunal assemblages. Moreover, grain size influence indirectly both physical and chemical conditions of the sedimentary bed as a biotope (Giere, 1993). Other abiotic parameters, such as, organic matter, carbonates and nitrogen can be of great importance in the spatial distribution of the pore-living fauna.

The deposition of organic matter is one of the main sources of food for infauna assemblages (Gee and Warwick, 1985). The origin of the organic matter in oceanic waters is from fitoplancton, decaying organisms and faecal pellets of zooplancton (Anger, 1984), so as the own individuals of zoobenthic species can segregate organic mucus named EPS (Extracellular Polymeric Secretion) in the pores to stabilyze de sand grains (De Winder *et al.*, 1999). Carbonates content define the sediment origin, as well as, the community structure (Parapar, 1991). Nitrogen concentration in sediments is one of the most important organic indicators froming usually part of the terrigenous component coming from rivers and lakes or from urban-wasted pipelines (Guerra-García, 2001).

Intertidal beaches of the Canarian archipelago can be divided into two groups depending on their origin: volcanic and organogenic. (i) Volcanic beaches are characterized by black sediments, mainly medium sands with low content of silt/clay and carbonates (< 10%) (ii) Organogenic beaches are composed by fine sand characterized by the presence of remaining of biotic structures (e.g. shells) and thus showing a high content of carbonates. These beaches are typical of the south coast of the Canary Islands, mainly Fuerteventura, Gran Canaria and Tenerife. However, most of the beaches in Tenerife are artificial and formed by sands collected by dredging in subtidal seabeds (frequently muddy sand bottoms).

The sediment structure of these beaches can be drastically altered by meteorological events, with special relevance to ravine discharges during rainfalls (runoffs). These runoffs produce the accumulation of big amounts of terrigenous material (silt/clay), with drastic changes in sedimentary composition of the sediment. Moreover, seasonality of sediment properties have been object of little attention in the Canarian archipelago, with scarce data on main sedimentary variables (grain size and organic matter content, among others) in intertidal sandy zones. These data should be crucial in order to understand sedimentary dynamics of these environments and thus, could be used as a database to measure environmental perturbations (natural or anthropogenic) in intertidal sandy habitats.

A high instability of oceanographic conditions is characteristic of both studied areas in South Tenerife (Puertos del Estado, Dirección General de Costas, http://www.puertos.es). Tidal regime is semidiurnal and microtidal with minimum values of 70 cm in extreme neap tides and maximums of 2 m during extreme spring tides. The mean tidal level ranged from -16 cm (August) to -55 cm (January). The main part of time the waves came from the NE to the Canary Islands induced by the «Alisio» winds, so both beaches are protected from the main storms. Nevertheless, the mean annual significant wave height is 1.2 m, proper of oceanic beaches where the wave dissipation on a continental shelf is not present.

The aim of the present study was to compare the monthly variations of sediment variables (grain size, organic matter, total nitrogen and carbonates) in the intertidal and shallow subtidal (3 m deep) of Los Abrigos del Porís Bay (SE Tenerife) and Los Cristianos Bay (SW Tenerife) throughout a study year (May 2000 to April 2001).

Material and methods

Samples were collected in two beaches on the south coast of Tenerife (Canary Islands, NE Atlantic Ocean). In each locality intertidal and subtidal samples were taken. The studied stations were: Los Abrigos del Porís

		S_0	Selection	Dominant sedimentary type
AI	May-00	0.83	Very good	Medium sand
	June-00	0.84	Very good	Medium sand
	July-00	0.98	Very good	Medium sand
	August-00	0.87	Very good	Medium sand
	September-00	0.85	Very good	Medium sand
	October-00	0.93	Very good	Medium sand
	November-00	0.88	Very good	Medium sand
	December-00	0.96	Very good	Medium sand
	January-01	0.97	Very good	Medium sand
	February-01	1.04	Very good	Medium sand
	March-01	0.79	Very good	Medium sand
	April-01	0.85	Very good	Medium sand
AS	May-00	0.86	Very good	Medium sands
	June-00	0.75	Very good	Medium sands
	July-00	0.78	Very good	Medium sands
	August-00	0.79	Very good	Fine sands
	September-00	0.69	Very good	Fine sands
	October-00	0.73	Very good	Fine sands
	November-00	0.73	Very good	Fine sands
	December-00	0.75	Very good	Medium sands
	January-01	0.72	Very good	Fine sands
	February-01	0.73	Very good	Fine sands
	March-01	0.75	Very good	Medium sands
	April-01	0.71	Very good	Fine sands
CI	May-00	0.63	Very good	Fine sands
	June-00	0.79	Very good	Medium sands
	July-00	0.66	Very good	Fine sands
	August-00	0.56	Very good	Fine sands
	September-00	0.57	Very good	Fine sands
	October-00	0.57	Very good	Fine sands
	November-00	0.68	Very good	Fine sands
	December-00	0.70	Very good	Fine sands
	January-01	0.76	Very good	Fine sands
	February-01	0.58	Very good	Fine sands
	March-01	0.57	Very good	Fine sands
	April-01	0.68	Very good	Fine sands
CS	May-00	0.60	Very good	Fine sands
	June-00	0.57	Very good	Fine sands
	July-00	0.57	Very good	Fine sands
	August-00	0.69	Very good	Fine sands
	September-00	0.60	Very good	Fine sands
	October-00	0.56	Very good	Fine sands
	November-00	0.54	Very good	Fine sands
	December-00	0.58	Very good	Fine sands
	January-01	0.57	Very good	Fine sands
	February-01	0.73	Very good	Fine sands
	March-01	0.59	Very good	Fine sands
	April-01	0.56	Very good	Fine sands

Table I.- Coefficient of selection (S_0), and dominant sedimentary type of the four sampling stations. (AI, Abrigos del Porís intertidal; AS, Abrigos del Porís subtidal; CI, Cristianos intertidal; CS, Cristianos subtidal).

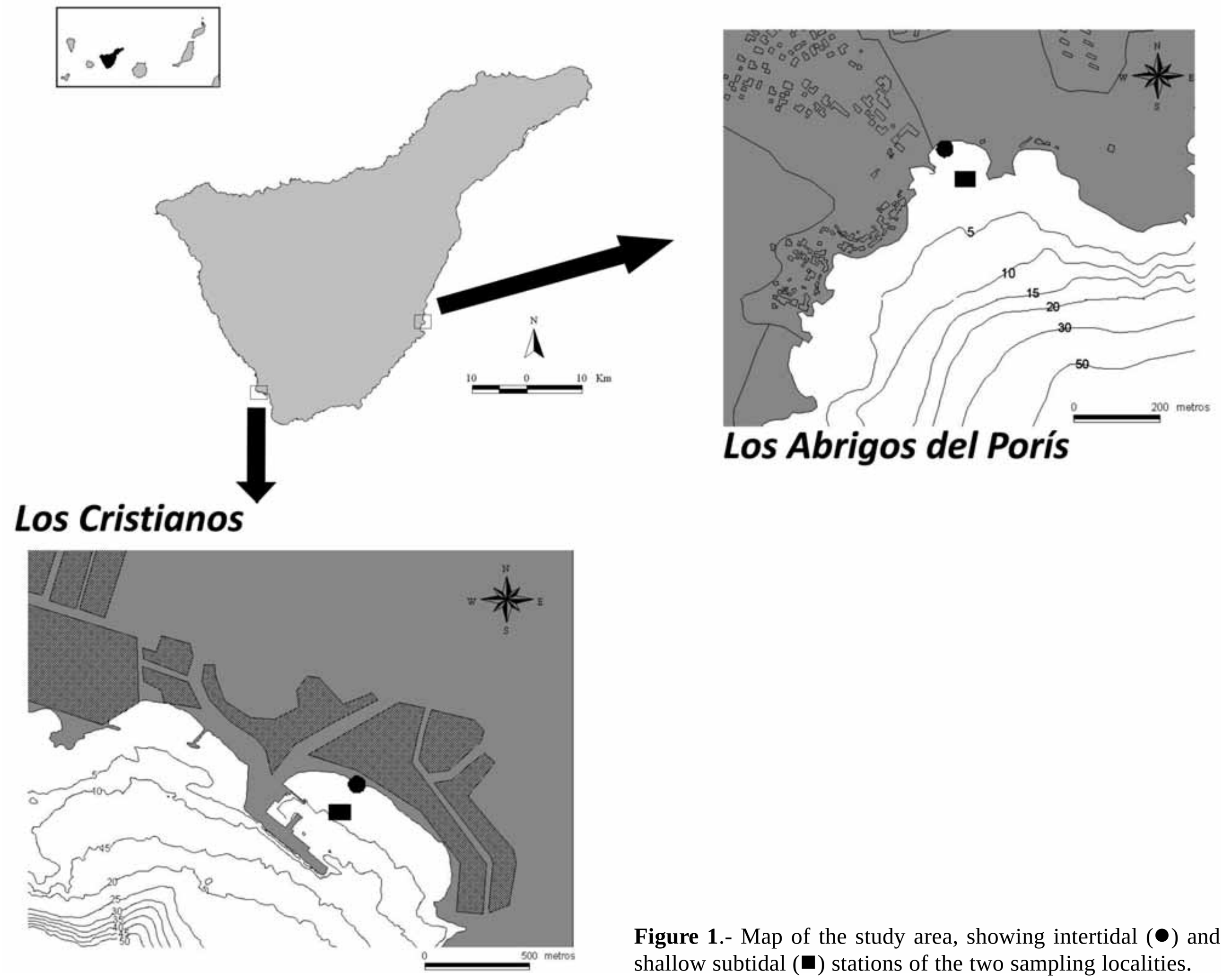

Figure 1.- Map of the study area, showing intertidal (●) and shallow subtidal (■) stations of the two sampling localities.

(intertidal: 28º08´34.26´´N/16º20´82.53´´W and shallow subtidal -3 m deep-: 28º08´30.20"N / 16º26´10.91"W) and Los Cristianos (intertidal: 28º02´58.34"N / 16º42´54.73"W and shallow subtidal -3 m deep-: 28º02´58.83"N / 16º42´54.70"W) (Fig. 1). Both sites are characterized by a low slope (< 5º) and located in sheltered bays, protected to the dominant «Alisio» winds and their induced waves. Tides can reach up to 2 m of amplitude in both study areas. In both cases sand is deposited on a rocky platform. The sediment thickness of the intertidal beach showed slight differences between both stations, being higher in Los Cristianos (0.6-0.7 m) compared to Los Abrigos del Porís (0.4-0.5 m).

One sample was collected monthly in each sampling station (intertidal and subtidal) from May 2000 to April 2001. Intertidal samples were collected during reciding tides, at the low tide level.

Analysis of sedimentary factors

To assess grain size distribution, 100 g of sediment from each monthly sample was oven dried at 105ºC, passed through a logarithmic graded series of sieves (2 mm, 1 mm, 0.5 mm, 0.25 mm, 0.125 mm and 0.063 mm), and then weighed (Buchanan, 1984). The percentages of granulometric fractions were represented for each sample by means of cumulative curves; from then, the median (Q_{50}), the first (Q_{25}) and the third quartil (Q_{75}) were determined, and from the two latter the grain coefficient of selection (S_0) was calculated as well (Buchanan, 1984). Low values of S_0 characterize well selected sediment, where a sedimentary fraction is dominant. High values of S_0 are typical of sediments dominated by several granulometric fractions.

The Walkley and Black (1934) method was used to determine the organic matter content in the sediment. The concentration of total nitrogen (organic and inorganic) in the sediment was determined by the Kjeldahl method. The methology of Demolon and Leroux (1952) and Allison and Moodie (1965) was developed to determine the carbonates content of the studied samples.

Affinities among sampling stations based on the values of measured abiotic variables were established using the Cluster analysis. Data were arc-sen transformed and the Bray-Curtis similarity index was used. The ANOSIM routine (Clarke, 1993) was used to analyze differences between the two studied localities (Los Abrigos del Porís *vs* Los Cristianos) and tidal levels (intertidal *vs* shallow subtidal). A PCA (Principal Component Analysis) was carried out for analyzed sedimentary variables to visualize the multivariate relations between sampling stations. The scores of the axis were retained for analysis interpretation. Multivariate analyses were carried out using the PRIMER 5.2. package

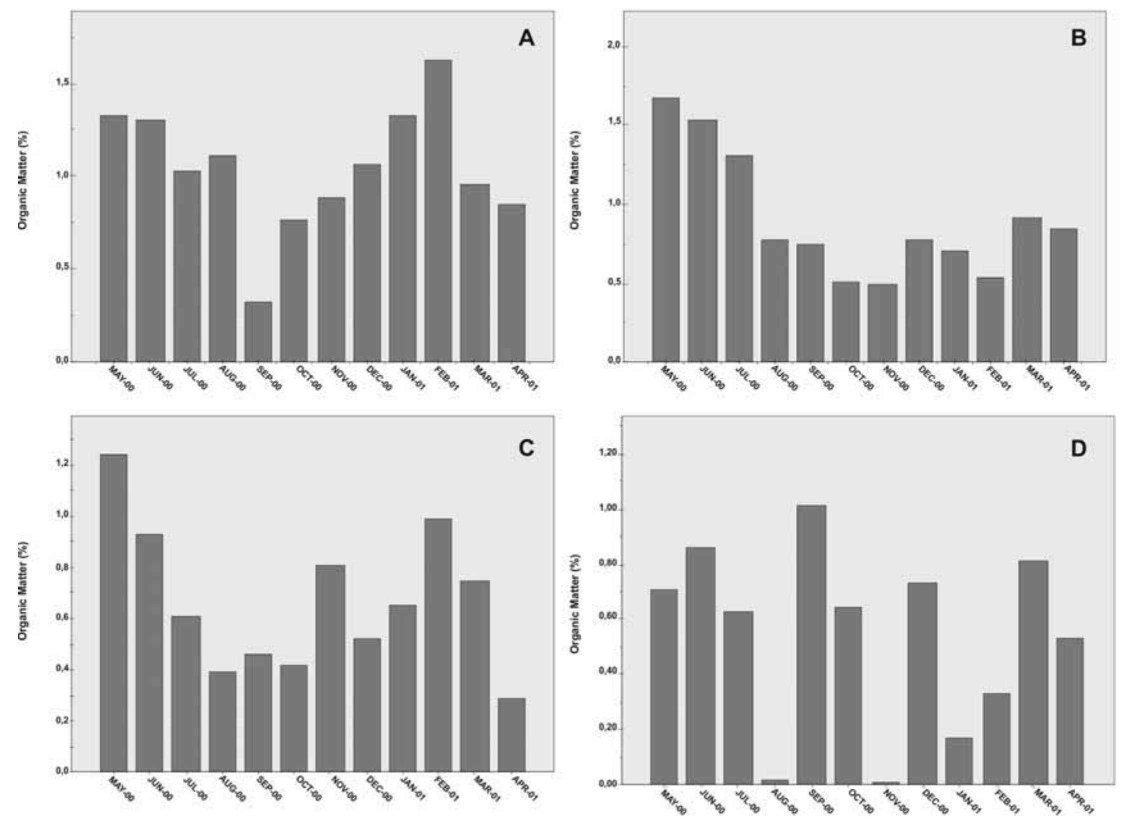

Figure 2.- Percentage of organic matter of the four sampling stations throughout the study period (May 2000-April 2001). A. Los Abrigos del Porís intertidal. B. Los Abrigos del Porís subtidal. C. Los Cristianos intertidal. D. Los Cristianos subtidal.

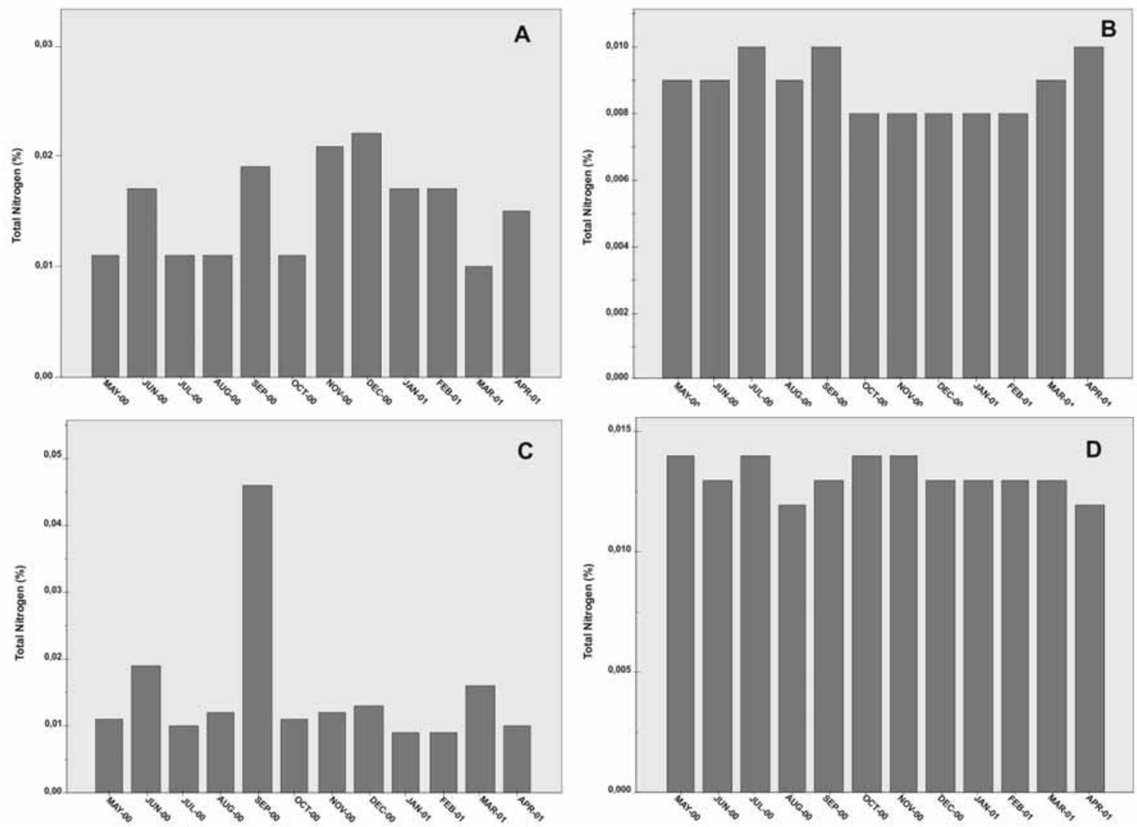

Figure 3.- Percentage of Total Nitrogen of the four sampling stations throughout the study period (May 2000-April 2001). A. Los Abrigos del Porís intertidal. B. Los Abrigos del Porís subtidal. C. Los Cristianos intertidal. D. Los Cristianos subtidal.

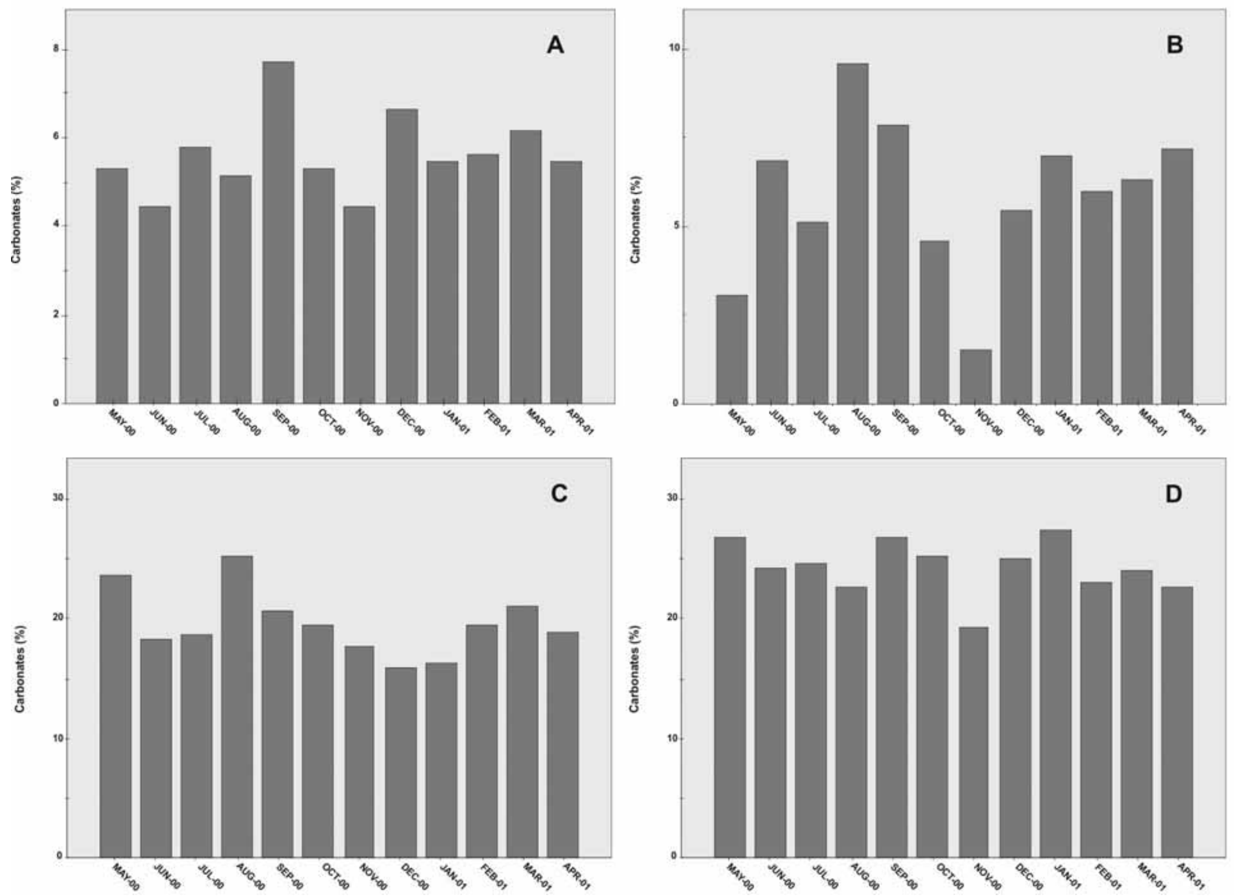

Figure 4.- Percentage of Carbonates of the four sampling stations throughout the study period (May 2000-April 2001). A. Los Abrigos del Porís intertidal. B. Los Abrigos del Porís subtidal. C. Los Cristianos intertidal. D. Los Cristianos subtidal.

(Plymouth Routines In Multivariate Ecological Analysis) (Clarke and Gorley, 2001).

Results

Los Abrigos del Porís intertidal area (AI)

The station was characterized by sediments with a very good selection, varying S_0 between 0.79 in March 2001 and 1.04 in February 2001 (Table I). The most abundant sedimentary fraction was medium sand, with a mean percentage of 60.75%, followed by coarse sand with a mean of 17.89%. Very fine sand and mud (silt+clay) were very scarce during the study period, with a mean of 0.85% and 0.07%, respectively (Table II).

The organic matter content showed a mean value of 1.05% throughout the study period, with a maximum concentration in February 2001 (1.62%) and a minimum value in September 2000 (0.62%) (Fig. 2A). These percentages could be considered as intermediate values of intertidal seabeds of the Canarian archipelago (Riera, *pers. obs*.).

The concentration of total nitrogen in the sediment was scarce, with a mean content of 0.015%. The percentages of total nitrogen ranged from 0.010% (March 2001) and 0.022 (December 2000) (Fig. 3A). These results are characteristic of areas with sediments non-eutrophicated from terrestrial inputs.

The percentage of carbonates was low (< 15%), characteristic of volcanic sands with scarce organogenic grains. The mean concentration of carbonates was 5.63%, with a maximum content in September 2000 (7.69%) and a minimum one in June 2000 and November 2000 (4.44%) (Fig. 4A).

Los Abrigos del Porís subtidal area (AS)

Sediments were very well selected during the study period, varying from 0.69 (September 2000) to 0.86 (May 2000) (Table I). The most abundant sedimentary class was medium sand, with a mean content of 48.70% along the study period, followed by fine sands with 38.74%. Very fine sands and gravels were scarce, with mean values of 2.28% and 0.18%, respectively (Table II).

The organic matter content has a mean value of 0.90%. The maximum concentration was registered in May 2000 (1.68%) and the minimum in November 2000 (0.50%) (Fig. 2B).

The total Nitrogen concentration was characterized by rather low values, with a mean of 0.009%. The content of this parameter ranged from 0.008% (October 2000, November 2000, December 2000, January 2001 and February 2001) and 0.010% (June 2000, September 2000 and April 2001) (Fig. 3B).

The percentage of carbonates were also characterized by low values (< 15%), with an average of 5.88% along the study period. The maximum concentration was obtained in August 2000 (9.57%) and the minimum one in November 2000 (1.54%) (Fig. 4B).

		Gravels	VCS	CS	MS	FS	VFS	Mud
AI	May-00	0.14	0.59	6.79	80.86	11.43	0.16	0.03
	June-00	0.91	2.53	15.58	64.53	16.12	0.28	0.04
	July-00	3.46	6.54	27.11	50.87	11.48	0.46	0.08
	August-00	2.76	2.87	19.85	58.84	14.93	0.70	0.06
	September-00	1.16	2.89	17.03	61.85	16.4	0.59	0.08
	October-00	7.57	3.52	18.44	52.98	16.57	0.86	0.05
	November-00	1.68	2.18	22.76	59.21	10.52	3.20	0.46
	December-00	5.86	9.03	16.42	53.42	14.97	0.31	0
	January-01	0.46	4.2	28.85	62.16	4.32	0.01	0
	February-01	12.44	6.58	18.33	48.69	10.92	2.99	0.04
	March-01	2.13	2.08	10.02	61.09	24.08	0.54	0.06
	April-01	0.38	1.41	13.51	74.54	10.03	0.13	0
AS	May-00	9.82	6.98	7.71	58.5	16.57	0.39	0.03
	June-00	5.42	2.44	3.62	52.04	32.36	3.88	0.25
	July-00	5.64	1.72	5.29	57.41	25.84	3.81	0.29
	August-00	12.24	4.87	5.49	31.7	41.91	3.46	0.32
	September-00	2.56	1.18	1.17	35.61	55.89	3.21	0.38
	October-00	0.46	0.92	1.61	54.21	40.76	1.94	0.11
	November-00	2.28	1.35	2.11	50.61	41.89	1.63	0.13
	December-00	0.48	1.09	2.58	64.38	30.32	1.07	0.07
	January-01	1.56	0.65	1.06	50.82	44.5	1.33	0.09
	February-01	1.56	1.55	2.48	52.04	40.32	1.88	0.17
	March-01	7.83	3.72	3.4	42.63	40.41	1.87	0.14
	April-01	5.72	1.58	1.25	34.44	54.08	2.75	0.17
CI	May-00	0.20	1.25	3.62	25.75	62.74	5.94	0.49
	June-00	0.63	1.56	6.95	66.45	23.76	0.55	0.10
	July-00	1.83	2.42	2.85	27.13	62.83	2.73	0.21
	August-00	0.89	0.29	0.37	13.22	81.32	3.69	0.22
	September-00	0.06	0.36	0.90	18.36	74.17	5.91	0.23
	October-00	0.99	0.77	1.35	17.67	72.35	6.45	0.41
	November-00	6.11	3.22	4.51	20.41	58.92	6.21	0.63
	December-00	6.78	4.42	4.66	18.94	55.69	8.91	0.60
	January-01	5.87	9.24	5.21	27.51	47.66	4.12	0.39
	February-01	3.25	1.46	1.75	18.93	68.7	5.50	0.41
	March-01	0.04	0.17	0.42	19.11	76.82	3.28	0.16
	April-01	5.98	2.05	2.76	24.96	57.94	6.12	0.20
CS	May-00	0.39	0.82	3.14	34.32	59.61	1.49	0.22
	June-00	0.04	0.46	1.61	20.44	73.22	3.83	0.4
	July-00	0.27	0.69	0.95	19.18	75.85	2.86	0.2
	August-00	6.19	4.59	4.14	20.27	56.26	8.01	0.53
	September-00	0.03	0.25	0.64	26.59	67.67	4.57	0.25
	October-00	0.15	0.13	0.17	9.61	82.86	6.78	0.31
	November-00	1.93	0.68	0.77	7.67	78.31	9.87	0.78
	December-00	0.05	0.33	0.81	24.92	68.8	4.78	0.31
	January-01	0.13	0.64	0.8	22.47	71.2	4.53	0.24
	February-01	8.59	4.49	5.86	19.55	55.79	5.35	0.36
	March-01	0.13	0.79	2.18	22.76	69.99	3.9	0.24
	April-01	0.03	0.61	0.63	17.87	76.45	4.17	0.25

Table II.- Percentage of sedimentary fractions of the four sampling stations (AI, Abrigos del Porís intertidal; AS, Abrigos del Porís subtidal; CI, Cristianos intertidal; CS, Cristianos subtidal) throughout the study period (May 2000-April 2001). VCS, Very coarse sands; CS, Coarse sands; MS, Medium sands; FS, Fine sands; VFS, Very fine sands.

Los Cristianos intertidal area (CI)

The intertidal station of Los Cristianos was characterized by sediments with a very good selection during the study period (May 2000 to April 2001). Values of S_0 ranged from 0.56 (August) to 0.79 (June) (Table I).

Fine sands and medium sands were the most abundant sedimentary fractions, being dominant the fine sands among all months with the exception of June where medium sands were the most abundant class. Very coarse sands (2.27%) and mud (0.34%) were the least abundant sedimentary fractions in the sampling station (Table II).

The organic matter content obtained shown a mean value of 0.67% along the study period, with a

	Axis 1	Axis 2
Organic matter	0.295	0.026
Nitrogen	-0.022	-0.145
Carbonates	**-0.379**	-0.057
Gravels	0.123	**0.651**
Very coarse sands	0.220	**0.557**
Coarse sands	0.339	0.103
Medium sands	**0.405**	-0.190
Fine sandss	**-0.427**	-0.054
Very fine sands	**-0.371**	0.300
Silt/clay	-0.328	0.319
% explained variability	**PC1 = 50.80%**	**PC2 = 18.10%**

Table III.- Percentages of explained variability (PCA) by sedimentary variables of the sampling stations.

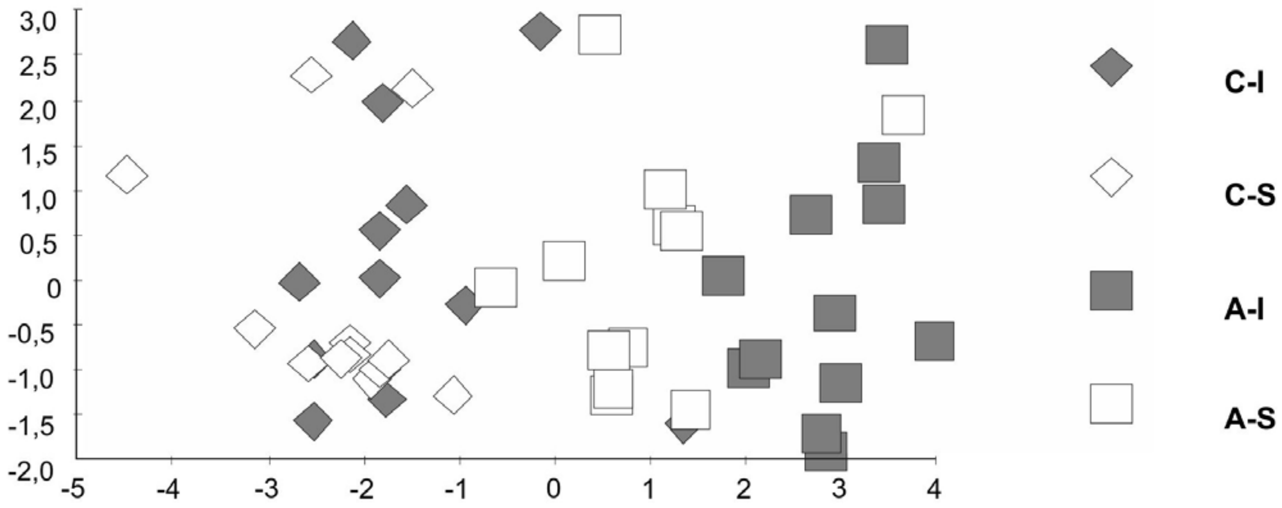

Figure 5.- PCA bidimensional ordination of the sampling stations throughout the study period (May 2000-April 2001). A-I, Intertidal Los Abrigos del Porís; A-S, Subtidal Los Abrigos del Porís; C-I, Intertidal Cristianos; C-S, Subtidal Cristianos.

maximum concentration in May (1.24%) and a minimum value in April (0.29%) (Fig. 2C).

Total nitrogen showed rather low values in the studied sampling station, with the exception of September. The mean concentration of this parameter was 0.015% throughout the study period, with a maximum content in September (0.046%) and a minimum in February (0.009%) (Fig. 3C).

The content of carbonates is high, typical of organogenic sediments. The mean annual concentration was 19.60% throughout the study period. The maximum concentration of carbonates was found in May (23.59%) and the minimum in December (15.89%) (Fig. 4C).

Los Cristianos subtidal area (CS)

The subtidal station of Los Cristianos was characterized by having sediments with a very good selection throughout the study period (May 2000 to April 2001). The values of S_0 ranged from 0.54 (November) to 0.73 (February) (Table I). Fine sands and medium sands were the dominant sedimentary classes during the sampling period (Table II).

The organic matter content in the sediment was characterized by low values, with a mean concentration of 0.54%. The highest percentage was recorded in September (1.01%) and the minimum in August (0.02%) (Fig. 2D).

The total nitrogen content was scarce throughout the study period (May 2000-April 2001) with a mean value of 0.013%. The maximum concentration was obtained in May, July, October and November (0.014%) and the lowest in August and April (0.012%) (Fig. 3D).

The percentage of carbonates was high along the whole study period, with a mean concentration of 24.31%. The maximum content was found in January (27.35%) and the minimum value in November (19.31%) (Fig. 4D).

Multivariate analyses

The first two axes from the PCA explained ca. 69% (PC1: 50.80%; PC2: 18.10%) of the total variation in sedimentary variables of the sampling stations (Table III, Fig. 5). In the first axis, the most important sedimentary variables to explain sample variability were: fine sands (-0.427), medium sands (0.405), carbonates content (-0.379) and very fine sands (-0.371). In the second axis, the most important variables were: gravels (0.651) and very coarse sands (0.557) (Table III). A clear separation can be discerned between samples dominated by medium sands (right) and by fine sands (left). The two tidal areas of Los Abrigos del Porís (intertidal and shallow subtidal) are clearly separated each other, whilst samples from Los Cristianos are together. Thus, Los Cristianos beach showed a higher sedimentary homogeneity compared to Los Abrigos del Porís, because of it is a closer bay and less exposed to dominant coastal waves and currents.

Differences in analyzed sedimentary variables (grain size, organic matter, carbonates and nitrogen) were significant among the four sampling stations (Los Abrigos del Porís intertidal and shallow subtidal; Los Cristianos intertidal and shallow subtidal) throughout the study period (Two-way nested ANOSIM, «Station (Month)», R = 0.074, p = <0.01). Post-hoc pairwise analyses showed differences betwell all sampling stations, with the exception of the two sampling sites in los Cristianos bay (intertidal *vs* shallow subtidal) (One-way ANOSIM, p = 0.066, p = 0.102) (Table IV). These results confirmed the differences in sedimentary variables between localities (Los Abrigos del Porís *vs*

Stations	R	Possible permutations	Used permutations	p
C-I, C-S	0.066	1.352.078	20.000	10.2%
C-I, A-I	0.940	1.352.078	20.000	**0.0%**
C-I, A-S	0.632	1.352.078	20.000	**0.0%**
C-S, A-I	1	1.352.078	20.000	**0.0%**
C-S, A-S	0.858	1.352.078	20.000	**0.0%**
A-I, A-S	0.757	1.352.078	20.000	**0.0%**

Table IV.- Analysis of similarity (ANOSIM) among sampling stations. A-I, Abrigos intertidal; A-S, Abrigos subtidal; C-I, Cristianos intertidal; C-S, Cristianos subtidal.

Los Cristianos), specially in the dominance of grain size fractions (fine sands in Los Cristianos and medium sands in Los Abrigos del Porís), as well as, in carbonates content (high in Los Cristianos and low in Los Abrigos del Porís).

Discussion

The beach of Los Abrigos del Porís is characterized by volcanic sands and thus, low content of carbonates. The concentration of organic matter in intertidal and subtidal sediments is intermediate and nitrogen content is scarce, indicating the absence of eutrophication in the sampling area. The dominant sedimentary class is medium sand in the two studied stations, being also well represented the fine sand in both sampling areas and coarse sands in the intertidal zone. The beach of Los Cristianos Bay is characterized to be a very stable environment, with scarce seasonality of abiotic variables along the year. The two sampling stations were dominated overwhelmingly by the sedimentary fraction of fine sands all over the study year. The organic matter content in the sediment was represented by intermediate values, with no eutrophication perturbations from the land. The same situation happened with rather low values of total nitrogen, which implies the absence of environmental perturbations from terrestrial run-offs. The concentration of carbonates is characteristic of organogenic sediments, with percentages quite higher than volcanic beaches.

To our knowledge, this is the first contribution about sedimentary variables in beaches from the Canary Islands. The present study can be used as baseline data for future environmental assessment studies, as well as, to compare before-after conditions following a natural (e.g. run-offs, rough seas, etc.) of man-induced perturbation (e.g. oil spills, beach nourishment, artificial beaches, etc…).

Nevertheless, the results of the present study must be taken with care, because of its periodicity (only one year from May 2000 to April 2001) and the number of replicates (only one) in the intertidal and shallow subtidal areas of the studied beach. From this point of view a wider analysis would be done to understand the interannual variations.

In addition, a more detailed sedimentological study would be convenient in order to characterize the studied beaches, and complementary works (currents, wave movements, tides, wind dynamics or littoral drift) are crucial to understand sedimentary dynamics in the studied area.

Acknowledgements

We are indebted to Dr. Francisco Díaz (Dept. of Edafology, University of La Laguna) for helping with carbonates procedures. Thanks also to Pedro Riverol (IPNA, CSIC) for his technical assistance in the determination of Kjeldahl Nitrogen and organic matter in sediment samples.

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Manuscrito recibido el 23 de diciembre de 2010
Aceptado el manuscrito revisado el 25 de mayo de 2011