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Benthic communities associated to *Thalassia testudinum* (Hydrocharitaceae) at three localities of Morrocoy National Park, Venezuela

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Abstract: The benthic community associated with the turtlegrass *Thalassia testudinum* beds was analized at three localities of Morrocoy National Park, Venezuela. The localities were selected according to their exposure to the open sea : A (protected), B (intermediate) and C (exposed). At each locality. a 20 x 20 m area was randomly chosen, delimited and divided into 400 1x1 m quadrats. Inside each, ten randomly selected quadrats/month were sampled during 13 consecutive months. At each site all macroinvertebrates and several physical variables were recorded, as well as leaf and rhizome biomass of *T. testudinum*. All parameters had a step- wise gradient from A through C: organic matter, carbon nitrogen, oxygen, salinity and temperature gradient was: A>B>C. Percentages of sand, silt and clay showed an inverse gradient; A<B<C. The diversity, evenness and dominance had a different pattern: B>C>A. The collected fauna was composed of Coelenterata (Anthozoa), Polychaeta, Sipuncula, Mollusca, Crustacea and Echinoderms. The relative abundance of molluscs increased according to *Thalassia* rhizome biomass: A< B < C, where C had the highest values (1496 g dw/m2). Environmental stress could also influence the distribution of some molluscs species like *Chione cancellata*: in fact, it showed a significant negative correlation with organic matter and carbon (r= - 0.56 p< .01). Principal Component Analysis: for abiotic parameters the first three components account for PC1 (clay-sand): 79.1 %. PC2 (C:N ratio): 91.5 % and PC3 (salinity): 95.8 %. For biotic parameters (species) the first three components account for PC1 (*Potamilla* sp.): 96.4 %. PC2 (*Lytechinus variegatus*)(Lamarck): 98.5 % and PC3 *Condylactis gigantea* (Weinland, 1860) - *Loimia* sp.: 99 %. The changes in the faunal composition, distributional patterns and community structure were evident among the studied places. The abundance of benthic organisms associated to *T. testudinum* depends on local variation of biotic and abiotic features. This interaction influences the community structure as local characteristics in a differential way.

Key words: Seagrass beds, *Thalassia*, benthic community, community structure.

According to Phillips and Meñez (1988), the seagrass ecosystem consists of three basic components: composition of associated flora and fauna, distribution of organisms in space and time, and relationships between community and the abiotic parameters . The associated biota can be subdivided into four units: epiphytic, epibenthic, infaunal and nektonic organisms (Kikuchi and Pèrés 1977). The molluscs are common components of epibenthic, infaunal and the epiphytic organisms. This biota and its interaction with biotic and abiotic factors is important to the seagrass ecosystem because of its relative abundance and distribution in the community.

The invertebrate fauna associated to the turtlegrass *Thalassia testudinum* (Banks ex König, 1805) is diverse and rich, with dramatic changes in the faunal composition, density and community structure, even in neighboring localities (Zieman 1982). The observed faunal distribution is a result of the influence of the interaction of biotic and abiotic factors (Bitter 1988, Miron and Desrosiers 1990).

According to some authors, attention has been focused on the evaluation of the influence of the *T. testudiunm* aspects above mentioned (Kikuchi and Pèrés 1977, Heck and Wetstone 1977, Heck and Orth 1980, Peterson and Black 1986, Bitter 1988). Seagrass plant architecture plays a significant role in establishing the abundance of species associated to seagrass habitat (Orth *et al.* 1984). Features of the seagrass ecosystem can influence in many ways the trophic web and associated flora and fauna (Thayer *et al.* 1988). The aim of this work was to study the invertebrate community associated to *Thalassia testudinum* beds, and to establish their relationships with the environmental and biological parameters, as a function of their abundance and distribution at the sampled sites.

MATERIALS AND METHODS

Study site: three localities of the Morrocoy National Park Venezuela (10° 52'N - 68° 16'W) were selected according to their vicinity to the open sea and bed features (Fig. 1): site A is protected by mangove forests, having a depth between 30±10 cm, and lies at 8.3 km from the open sea; substrate is covered by patches of the algae *Halimeda opuntia* (Linné) and *T. testudinum.* Site B is located in an intermediate area between A and C, with a depth ranging between 70 and 90 cm, and lies at 6.7 km from open sea. Site C is exposed to waves and current, 150 ±10 cm depth and 5.6 km from open sea; substrate is covered by pathes of *T. testudinum*, the algae *Halimeda opuntia* and *Caulerpa racemosa* (Forsskal).

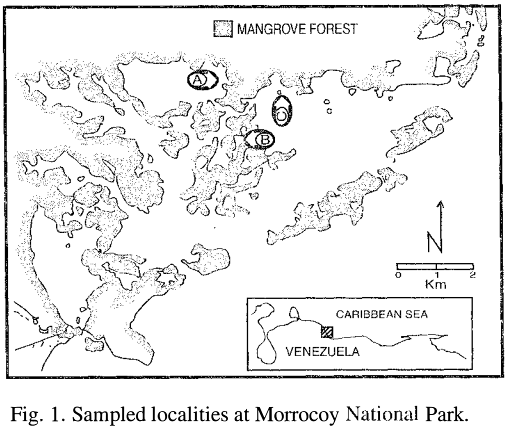

Fig. 1. Sampled localities at Morrocoy National Park.

Sampling design: at each site, an area of 20 x 20 m was randomly chosen and marked. Each selected plot was subdivided into 1 x 1 m quadrats, according to Weinberg (1981). From each plot, 10 different quadrats were monthly chosen using a simple random sampling design (using a random digits table).

Biotic and abiotic parameters: macroinvertebrates were observed and registered by means of light scuba equipment; the taxonomic identification was stablished according to Abbott (1974) (for molluscs), Tommasi (1966) and Deichmann (1963)(for echinoderms), Salazar *et al.* (1988)(for polychaetes), Agudo (1987)(for anthozoans).

Monthly data measurements included disolved oxygen (by oxygenometer), salinity (by refractometer), water temperature (using telethermometer). Samples of sediment (five monthly samples) were collected using a metallic core (20 cm heigh and 4.5 cm in diameter). Organic matter content (using easily oxidizable carbon fraction method), organic carbon (Jackson 1982), organic nitrogen Micro-Kjeldahl method), sand, silt and clay content (texture by Hydrometer method-Bouyouco) were determined. Quaterly determinations (by triplicate) of biomass (dry weight/m^2) of *T. testudinum* leaves and rhizomes were made and biomass (idem) of the algae *H. opuntia* were also determined. Samples of leaves and rhizomes were collected using a metallic core (9971.42 cm^3 vol and a basal area of 0,042 m^2.). Most of the sediment trapped in the core was removed by washing the sample through a 0.8 mm mesh net. Samples of leaves for determining biomass (dry weight/m^2) were cleansed from epiphytes and residual sediment by washing them with running freshwater.

Ecological anaysis: Data gathered were used to estimate abundance, frequency of occurrence, dispersion and the distributional patterns of the observed species. Species presenting more than two specimen per sampling were used for estimating the Morisita Index(Morisita 1959). Estimations were also made for diversity measured as N1 (exp H')(H': Shannon-Weaver Index), evenness (J') and dominance (1- J')(Hill 1973, Birch 1981).

Statistical analysis: an independence G test (RxC)(Sokal and Rohlf 1969) was used to evaluate the frequency of taxonomic groups. The interaction of biotic and abiotic parameters was evaluated by means of multiple regression analysis (Sokal and Rohlf 1969). Principal Components Analysis (Hill, 1973) was used to determine the variables that influence on community structue. Freeman (F) two way Anova and Kruskal-Wallis (H) test (Siegel 1956) was carried out on variations in abiotic and biotic parameters.

RESULTS

Percentages of organic matter in the sediment showed a step wise gradient: A > B > C (Table 1). A Freeman two-way Anova showed that the determined variation first depended on locality (Freeman = 8.68 $p < .05$) and secondly on monthly-dependent site interaction (Freeman = 6.03 $p < .01$). Percentages of carbon showed the same pattern as described for organic matter. Nitrogen values showed high variation with wide confidence limits, not shown in table; in general, it was determined a gradient as follow: A > B > C (Table 1).

TABLE 1

Measured (mean ± sd) parameters at the three studied localities

		A	B	C
Organic matter	(%)	9.68 ± 1.19	6.91 ± 2.09	4.71 ± 1.45
Carbon(organic)	(%)	5.60 ± 0.69	3.99 ± 1.21	2.76 ± 0.85
Nitrogen	(%)	0.45 ± 0.58	0.38 ± 0.95	0.25 ± 0.36
Oxygen	(mg/l)	5.83 ± 0.97	5.53 ± 0.45	5.36 ± 0.40
Salinity	(‰)	34.20 ± 1.24	33.90 ± 1.45	33.70 ± 1.34
Water temp.	(C)	31.50 ± 1.16	29.40 ± 1.23	29.20 ± 1.03
Sand	(%)	67.93 ± 7.82	75.50 ± 7.74	80.50 ± 4.04
Silt	(%)	14.10 ± 1.44	14.20 ± 8.98	12.00 ± 1.87
Clay	(%)	18.07 ± 8.13	10.50 ± 2.39	7.50 ± 2.25
Sustrate type		(1)(2)(4)	(1)	(1)(2)(5)
Algae		(10)	(2)(11)	(2)(3)
Colonial invertebrates		—	(6)(7)(8)(9)	(6)(7)
Patch environment		(12)	(13)(14)	(15)
Diversity (N1)		1.96 ± 0.52	5.72 ± 1.46	3.85 ± 0.69
Evenness (J')		0.12 ± 0.08	0.29 ± 0.09	0.21 ± 0.07
Dominance (1-J')		0.88 ± 0.08	0.71 ± 0.09	0.79 ± 0.07

(1) *Thalassia testudinum*
(2) *Halimeda opuntia*
(3) *Caulerpa racemosa*
(4) Small bare space
(5) Wide bare space
(6) *Haliclona viridis*
(7) *Tedania ignis*
(8) *Spongia* sp. (Spongiidae)
(9) *Millepora alcicornis*
(10) Brown algae epiphytes
(11) Scarse epiphytes
(12) *H. opuntia* patches
(13) Colonial invertebrates
(14) Wide cover of *Thalassia*
(15) *Thalassia-Caulerpa-Halimeda*

N1 = exp(H') H' : Shannon-Weaver Index
J' = Ln N1/ No No : Number of total species

Dissolved oxygen values showed a minimum in April-May according to rainy season. A Freeman two-way Anova showed that oxygen values first depended on the sampling month (Freeman = 4.45 $p< .05$), and secondly on the monthly-dependent site interaction (Freeman = 20 $p< .05$).

Salinity values showed a minimum in the same period as values of the oxygen values. The oscillations values at site C were attenuated (step wise way) comparing with A and B sites (lower deep).

Water temperature values between localities were very close but they were statistically different (Kruskal-Wallis = 31.8 $p < .01$). In average, locality A (extreme shallowness at low tide) showed the highest temperature than B and C sites (2±1.2°C higher).

Sediment texture showed differences among localities based on sand, silt and clay percentages. In fact, there was a gradient of sand as follow: $A < B < C$; the percentage of sand was the highest at site C (84.5 %). Silt and clay percentages showed gradient as well, but in a reverse way: $A > B > C$. The highest values were determined at site A (Table 1).

Thalassia testudinum was the dominat plant in the three localities with patches of *H. opuntia* (site A), unknown macroalgae (site B) and *H. opuntia* and *C. racemosa* (site C).

The turtlegrass biomass increased significantly along a gradient from A to C ($A<B<C$)(Kruskal-Wallis = 156 $p< .05$) (Table 2). Percentage of leave biomass decreased and percentage of rhizomes biomass increased from A to C. The biomass of *Halimeda opuntia* had a similar gradient as *T. testudinum* leaves : 1125.3 876, 401.2 306 and 370.4 93 (A, B and C sites respectively).

The Principal Component Analysis revealed that for abiotic variables, the first three component account for PC1 (clay-sand): 79.11 %, PC2 (C:N ratio): 91.52 % and PC3 (salinity): 95.81 % of the total observed variance. For biological variables (species) the three first component account for PC1 (*Potamilla sp.*) (Polychaeta: Sabellidae): 96.39 %, PC2 *Lytechinus variegatus* (Lamarck): 98.49 % and PC3 *Condylactis gigantea* (Weinland,1860) - *Loimia* sp. (Polychaeta: Terebellidae): 99 %.

The associated fauna collected was composed of the following taxa: Polychaeta (53.5%), Echinodermata (34.7%), Coelenterata (Anthozoa) (7.7%), Mollusca (3%), Sipuncula (0.6%) and Crustacea (0.5%) Coelenterata was represented by the anemones *Condylactis gigantea* and *Bartholomea annulata* (Lesueur, 1817). Polychaeta was dominated by the tube-builders *Potamilla* sp. and *Loimia* sp. Sipuncula by *Sipunculus* sp. Crustacea by the seacrab *Mythrax forceps* (Milne Edwards, 1875). Molluscs were represented by 13 species, seven and six gastropods and bivalves respectively. Echinoderms were represented by the *Thalassia* grazer *Lytechinus variegatus*, the sea star

TABLE 2

Biomass (mean ± sd) of Thalassia testudinum *at three studied localities*

	A	B	C
Leave biomass *	430.1 ± 295	532.8 ± 186	609.7 ± 253
%	40.4 ± 4.3	32.0 ± 3.7	36.3 ± 3.9
Rhizome biomass *	634.9 ± 520	1131.7 ± 421	1496.4 ± 599
%	59.6 ± 4.3	67.9 ± 3.7	73.7 ± 3.9
Total biomass	1065.0 ± 570.11	1665.0 ± 398.82	2106.0 ± 396.86
volume cm^3	310.0 ± 133.5	457.0 ± 69.35	509.0 ± 53.33
Leave density **	1327 ± 481	1749 ± 178	1743 ± 461
Ratio Lb:Rb	1:1.5	1.2	1:3

* g dw/m^2 (means of all months) ** Number of blades/m^2

Oreaster reticulatus (Linné, 1758) and the deposit-feeders *Holothuria mexicana* (Ludwig, 1875) and *Isostichopus badionotus* (Selenka, 1867).

At site A, 98 % of dominance was given by five species (Table 3), in particular the tube-building polychaete *Potamilla* sp. that comprised more than 80 % of all individuals. The remaining 2 % was constituted by 12 species, including two gastropods (Table 5); these two species were always found on *T. testudinum* leaves. At site B the five most abundant species had 90 % of dominance; the remaining 10 % were comprised by 18 species, including eight species of molluscs (1.79 %). The genus *Modulus* and *Cerithium* were found living on *Thalassia* leaves. The remaining species of molluscs were found in sediment. Five species at locality C comprised 89 % of dominance; the remaining 11 % included 17 species, eight of them represented by molluscs. *Glossodoris bayeri* was found moving among the *T. testudinum* leaves and *C. racemosa*. The analysis at level of frequency indicates that variation depends on each sampling locality (G= 4.284 p < .05) (Table 5).

Rank of molluscs (% dominance) was low, being 4th (1.75) in A, and 6th (1.79) and 5th (6.95) in B and C respectively. A multiple linear regression revealed a significant negative correlation between the presence of the bivalve *Chione cancellata* and the percentajes of organic matter, carbon and C:N ratio (r=-0.56,- 0.56 and - 0.63 respectively) (p< .01).

TABLE 3

Community structure and rank of the five most abundant species at the studied localities

	A			B	
	% Dom.	Abund		%Dom.	Abund.
(P) *Potamilla* sp.	82.1	21.49	(E) *Lytechinus variegatus*	32.22	3.76
(E) *Lytechinus variegatus*	10.1	3.50	(E) *Holothuria mexicana*	18.93	3.85
(E) *Oreaster reticulatus*	2.6	2.56	(C) *Condylactis gigantea*	16.44	2.24
(P) *Loimia* sp.	2.0	1.41	(P) *Loimia* sp.	15.13	2.48
(M) *Modulus modulus*	1.7	2.80	(E) *Isostichopus badionotus*	7.53	2.45

	C	
(E) *Lytechinus variegatus*	59.29	4.74
(C) *Condylactis gigantea*	11.61	1.97
(C) *Bartholomea annulata*	6.52	1.70
(E) *Holothuria mexicana*	5.89	1.35
(P) *Loimia* sp.	5.63	1.80

(P) : Polychaeta Dom: Dominance
(M): Mollusca Abund: Abundance
(C) : Cnidiaria
(E) : Echinodermata

TABLE 4

Distributional pattern (I) of the five most abundant species at studied localities

A	Iδ	B	Iδ	C	Iδ
Potamilla sp.	1.96	*Lytechinus variegatus*	1.51	*Lytechinus variegatus*	1.16
Lytechinus variegatus	1.83	*Holothuria mexicana*	1.30	*Condylactis gigantea*	0.95
Oreaster reticulatus	0.67	*Condylactis gigantea*	0.95	*Bartholomea annulata*	1.03
Loimia sp	0.46	*Loimia* sp.	1.65	*Holothuria mexicana*	1.62
Modulus modulus	1.16	*Isostichopus badionotus*	1.16	*Loimia* sp.	2.23

Iδ : Morisita dispertion Index

TABLE 5

Species of molluscs associated to Thalassia testudinum *at the three studied localities, ranked by relative abundance*

Species		LOC.	N	ABUND.	% FREQ
Modulus modulus	(Linné, 1758)	A	56	2.80	14.20
Cerithium lutosum	Menke,1828	A	3	1.00	2.13
Arcopsis adamsi	(Dall,1886)	B	15	15.00	0.68
Codackia orbicularis	(Linné, 1758)	B	3	3.00	0.68
Chione cancellata	(Linné,1767)	B	3	1.00	1.36
Cerithium lutosum	Menke, 1828	B	2	1.00	1.36
Tellina fausta	Pulteney, 1799	B	1	1.00	0.68
Lucapina philippiana	(Finlay, 1930)	B	1	1.00	0.68
Pecten ziczac	(Linné, 1758)	B	1	1.00	0.68
Nitidella sp.	Swainson, 1840	B	1	1.00	0.68
Modulus modulus	(Linné, 1758)	C	52	2.36	15.00
Chione cancellata	(Linné, 1767)	C	18	1.80	6.11
Glossodoris bayeri	Marcus & Marcus, 1967	C	5	1.00	3.82
Codakia orbicularis	(Linné, 1758)	C	1	1.00	0.76
Chione paphia	(Linné, 1767)	C	1	1.00	0.76
Turbo castanea	Gmelin, 1791	C	1	1.00	0.76
Nitidella sp.	Swainson, 1840	C	1	1.00	0.76
Calliostoma sp.	Swainson, 1840	C	1	1.00	0.76

Abundance: N/C — N: number of total specimens observed in all study period
C: number of total occupied quadrats
Frequency: C/T — T: number of total sampled quadrats

TABLE 6

Species of invertebrates identified in the studied sites

Species	Phylum
Potamilla sp.	Polychaeta
Loimia sp.	"
Isostichopus badionotus	Echinodermata
Holothuria mexicana	"
Oreaster reticulatus	"
Lytechinus variegatus	"
Condylactis gigantea	Coelenterata
Bartholomea annulata	"
Mythrax forceps	Crustacea
Sipunculus sp.	Sipuncula
Modulus modulus	Mollusca
Cerithium lutosum	"
Arcopsis adamsi	"
Codackia orbicularis	"
Codackia orbiculata	"
Chione cancellata	"
Tellina fausta	"
Lucapina philippiana	"
Pecten ziczac	"
Nitidella sp.	"
Glossodoris bayeri	"
Chione paphia	"
Turbo castanea	"
Calliostoma pulchrum	"
Calliostoma sp.	"

In all the localities most of the five frecuently observed species of macroinvertebrates, showed an agregated distributional pattern (Table 4), in particular the polychaete *Potamilla* sp. (I = 28.08 at site C) and *C. cancellata* (I = 6.63 at site C).

DISCUSSION

Analysing the communities at the studied sities, echinoderms were ranked as the one of the two major groups, the other one were the polychaetes. This coincides with that reported by Jackson (1972) in relation to echinoderms as dominant members of epifauna associated to *T. testudinum.* On the other hand, comparing the results with the same author and Galindo (1997), it has been observed a difference in relation to molluscs as the most abundant macroinvertebrates.

The changes in the distribution of species and the structure of the community were evident among the studied sites because of the abundance of the five most abundant species of macroinvertebrates fluctuated significantly between localities. According to Jackson (1972), salinity and temperature are decisive factors in the distribution of the Caribbean shallow water bivalve. Zieman (1982) also points out that the temperatures between 30 and 34 °C, exclude from community the 50% of the invertebrates and fish. It was determined through the analysis of main components that temperature and salinity were among the parameters that explained the greater observed variance, according with the authors mentioned before.

The highest dominance percentage of molluscs at site C was apparently due to a) high rhizome biomass and its volume in this area; b) a differential recruitment which is reflected on Morisita Dispersion Index of many species, for example *C. cancellata.* High biomass probably reduces the efficiency of molluscs predators as reported by Peterson (1982) for *C. cancellata* and *Mercenaria mercenaria* in relation to their predator *Busycon* sp., by decreasing the penetrability of surface sediment (Eckman 1987), so that the mortality due to predation is disminished (Peterson et al. 1984). This fact is supported by the highest percentages of sand and rhizome at site C, showing this site as a stabilized bottom (Wanless 1981). This percentage suggests the importance of an organ of anchorage in a place with a strong influence of marine current as reported for site C (Jackson 1972, 1973).

The value of diversity in locality B can be explained because the dominance of the hierarchically most abundant species is not excessivelly high, which is reflected by the values of dominance and evenness. In this, the contribution of the molluscs to the diversity is important, even though their abundances were low. Our data coincide with those of Jackson (1972, 1973) in that the environmental variations were not severe in this locality, as it was in site A; due to this, biological factors, like predation, would be more important than physical factors. This could explain the presence of great amount of empty shells of juvenile bivalves of *C. orbicularis* and *C. cancellata.* According to the same author, the bivalve *Arcopsis adamsi* is able to tolerate temperatures of 41°C. In our data this species was registered in site B, where the environmental variations are not that severe as in A (extreme shallowness and highest water temperature), at this site, the specimens of the two registered gastropod were always found on *T. testudinum* leaves; such factor coincide with that reported by Jackson (1972) in relation to temperature resistance over 41 °C for three epifaunic gastropod, among them it is found the genus *Cerithium.* and the bivalve *A. adamsi* just mentioned, even though it was not found in sediment at site A. Another important aspect is given by a negative correlation (statistically significative) between *C. cancellata* and the percentage of organic matter, evidenced by the absence of this species at site A with respect to other localities. According to Jackson (1973), *C. cancellata* is not able to tolerate silt and clay because of ctenidia obstruction, and reported two exceptions to this: the bivalves of the families Lucinidae and Tellinidae, represented in localities B and C by *Codakia orbicularis.* Other factors that influence the associated fauna were given by the leaf biomass of *H. opuntia* and the amount of nitrogen present in the sediment, which positively affect the abundance of *Potamilla* sp. (Bitter 1993). Water temperature is also importat, since in low tide the foliage of *T. testudinum* remains exposed to the sun, which produces a thermal and light stress, and the reposition of the damaged foliage biomass.

The molluscs changed in rank position, due to that, even in site A were found two species, whereas in sites B and C were counted eight species. The contribution of these species to community structure is low, because of low abundance, taking into consideration the whole community.

In conclussion, the distribution and space-seasonal variations of epifaunal species, according to Miron and Desroniers (1990), depend on the interaction among particular environmental factors and interacting biotic factors as well (Commito and Boncavage 1989). The interaction of these factors influences the community structure as local characteristics in a different way.

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RESUMEN

Se analizó la comunidad bentónica asociada a *Thalassia testudinum* y su relación con algunos parámetros bióticos y abióticos, en tres localidades del Parque Nacional Morrocoy, Falcón-Venezuela; éstas fueron seleccionadas de acuerdo al grado de exposición al mar abierto: A(protegída), B (intermedia) y C (expuesta). En cada localidad se demarcó un área de 20 x 20m, se muestrearon aleatoriamente 10cuadrantes/mes, (130 cuadrantes-/localidad). Se efectuaron registros de oxígeno disuelto, salinidad, temperatura, porcentajes de materia orgánica, carbono y nitrógeno, textura del sedimento, biomasa foliar y de rizoma de *T. testudinum*. Todos los parámetros analizados presentaron un gradiente escalonado. Materia Orgánica, Carbono y Nitrógeno, Oxígeno disuelto, Salinidad y Temperatura presentaron el gradiente: A>B>C. Los porcentages de Arena, Limo y Arcilla presentaron un gradiente inverso. El patrón en la Diversidad, Equidad y Dominancia fue: B>C>A. La fauna colectada estuvo compuesta por los grupos: Coelenterata (Anthozoa), Polichaeta, Sipuncula, Molusca, Crustacea y Echinodermata. Se identificaron 15 especies de moluscos (gastrópodos y bivalvos), (3 % de los invertebrados colectados). La abundancia relativa y dominancia de los moluscos se incrementó en aquellos sitios donde hay un aumento en la biomasa de rizoma de *T. testudinum* (porcentaje de dominancia A<B<C). La presencia de estas especies podría relacionarse con un fondo estabilizado de hierbas marinas. Se encontró además, relación entre la tensión ambiental y la distribución de algunas especies de moluscos como *Chione cancellata*, la cual mostró una correlación negativa con el contenido de materia orgánica y carbón ($r= - 0.56$ $p< .01$). Mediante el Análisis de Componentes Principales se determinó para los parámetros abióticos: 1^{er} componente (arcilla-arena): 79.1%, 2° componente (proporción C:N): 91.5% y 3° componente(salinidad): 95.8%. Para los parámetros bióticos (especies): 1°(*Potamilla* sp.): 96.4%, 2°(*Lytechinus variegatus*)(Lamarck): 98.5% y 3° *Condylactis gigantea* (Weinland, 1860)-*Loimia* sp.: 99%. Los cambios en la composición faunística, patrones de distribución y en la estructura comunitaria se hicieron evidentes entre los sitios estudiados.

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