ON THE IMPORTANCE OF SPATIAL SCALES ON CORAL'S ALPHA AND BETA DIVERSITY: A CASE STUDY FROM VENEZUELAN CORAL REEFS

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PROBLEM | OBJECTIVES

Ecological processes act at different temporal and spatial scale generating diferent distribution patterns. That is why the problem of scales has kept the interest of experimental ecologists for decades.

In recent years, beta diversity has been recognized as distinctive property that actually makes communities differ from one another. However, the use of beta diversity is surprisingly rare in coral reef studies. The Venezuelan coast is an excellent example: spatial variation across different spatial scales remains poorly understood and alpha diversity has dominated the literature for decades despite reefs occur along strong environmental gradients.

This is the first study in Venezuela to measure spatial variation of coral communities across hierarchical spatial scales and to estimate and decompose beta diversity (i.e., species turnover and nestedness) across these scales.

EXPERIMENTAL DESIGN

Regions

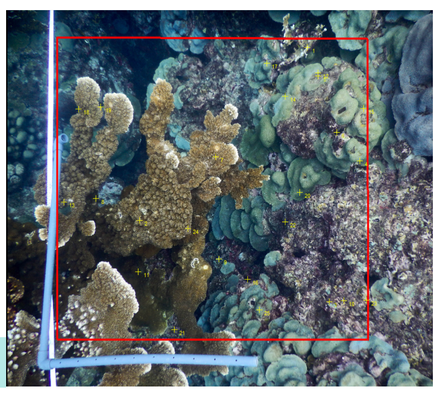
West | Center | East

Loc 1 | Loc 2 | ...

Site 1 | Site 2 | ...

T1 | T2 | T3 | T4

Q1 | Q2 | ...



West | Morrocoy | Cayo Norte | T1 | Q6

MATERIALS AND METHODS

FIELD WORK

Four 30 m long TRANSECTS on each site
(Parallel to the coast | 8-10m deep)

15 PHOTOS
Every other meter

PHOTOQUADRATS
Analysis area: 7.200 cm2
25 random points
PhotoQuad Software

LABORATORY WORK

DATA ANALYSIS
- Permanova
- Test for homogeneity of multivariate dispersions (PermDisp)
- Canonical analysis of principal coordinates (CAP)

R Software
PRIMER 6 - Permanova+

RESULTS

SPATIAL VARIABILITY

PERMANOVA

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms	%CV
Re	2	5,65E+05	2,82E+05	2,7263	0,058	998	13,7847
Lo(Re)	4	3,98E+05	99385	1,9731	0,025	998	11,0409
Si(Lo(Re))	29	1,46E+06	50352	9,984	0,001	999	23,1426
Tr(Si(Lo(Re)))	107	5,40E+05	5044,7	2,1136	0,001	995	11,1647
Res	1991	4,75E+06	2386,8				40,8671
Total	2133	7,75E+06					100

Table 1. Four-way Permutation-based analysis of variance (Permanova) based on Bray-Curtis Similarity to test differences in coral community structure.
Factors: (1) Region (fixed with two levels: west, center and east), (2) Locality (Random with 2-3 levels nested within factor 1), (3) Site (random with 3-7 levels nested within factor 1 and 2) and (4) Transect (random with 3-4 levels nested within factor 1, 2 and 3)

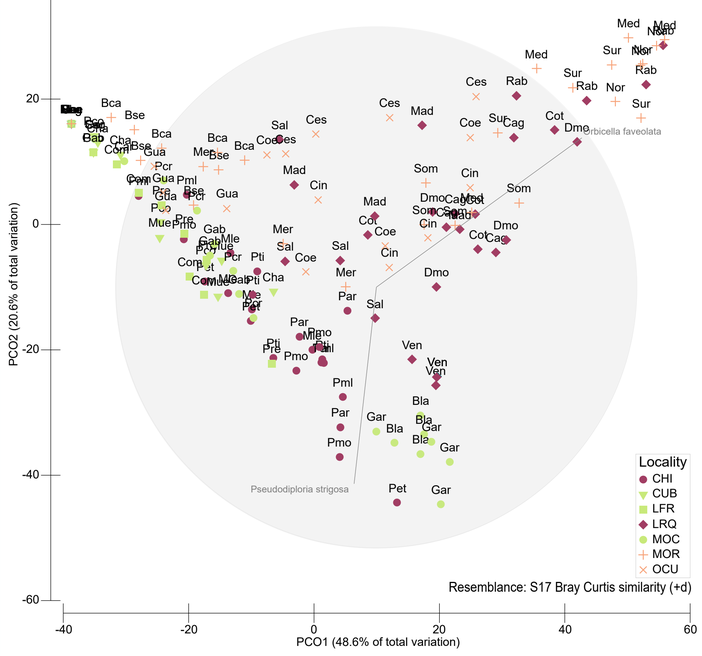


Figure 1. Principal coordinates ordination plot (PCO) showing the structure of coral community of sites within localities. The vectors represent de Pearson correlation (Corr > 0.7) with cover of the most important species.

LONGITUDE AND LATITUDE AS PREDICTORS OF THE CORAL COMMUNITY

Canonical analysis of principal coordinates (CAP) generated from Bray Curtis similarity of the coral abundance matrix using latitude and longitude as predictor variables.

There is a high correlation between the coverage of corals with respect to longitude and latitude at which the site factor is located (longitude Ccor = 0.79, SqrCcor = 0.62, P = 0.005 and latitude Ccor = 0.73, SqrCcor = 0.53, P = 0.016)

PERMDISP

		Df	Sum Sq	Mean Sq	F	N.Perm	Pr(>F)
Transect	Groups	131	28,316	0,216151	8,5169	999	0,001
	Residuals	1068	27,105	0,025379			
Site	Groups	35	1,34538	0,038439	4,4145	999	0,001
	Residuals	97	0,84464	0,008708			
Locality	Groups	6	0,025435	0,0042391	0,5415	999	0,773
	Residuals	29	0,227016	0,0078281			
Region	Groups	2	0,015215	0,0076077	1,1282	999	0,552
	Residuals	4	0,026972	0,0067431			

Table 2. Test of homogeneity of dispersions (PermDisp) to compare the distances from each factor to centroids as a test for similarity in beta diversity among factors.

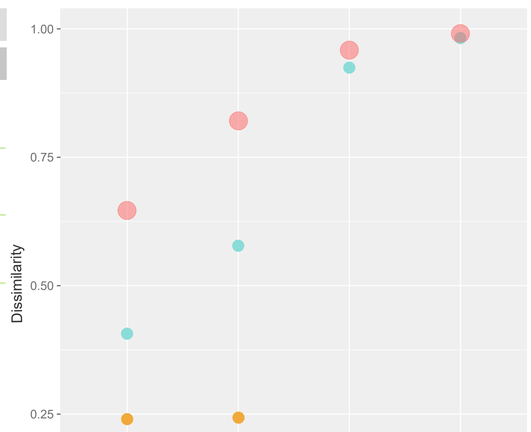


Figure 2. Total dissimilarity as Jaccard index and their respective turnover and nestedness components for each spatial scale.

BETA-DIVERSITY

COMPONENTS OF BETA DIVERSITY ACCORDING TO BASELGA (2010)

NESTEDNESS of species assemblages occurs when the biotas of sites with smaller numbers of species are subsets of the biotas at richer sites.
Process of species loss

SPATIAL TURNOVER of species assemblages implies the replacement of some species by others.
Process of species replacement

Baselga, Andrés. "Partitioning the turnover and nestedness components of beta diversity." Global Ecology and Biogeography 19.1 (2010): 134-143.

KEY MESSAGES

Coral communities in Venezuela are extremely variable at each spatial scales. This might be interpreted as an evidence suggesting that both small scales (e.g. competition for substrate and other biological interactions, differences in microhabitats, etc.) and large scale (e.g. strong environmental gradients, patterns of circulation, etc.) processes might be responsible for shaping the structure of these coral communities.

Latitude and longitude are good predictors of the structure of the coral community, which confirm that the larger spatial scales are relevant and must be taken into account when making predictions about ecological patterns.

Patterns of beta diversity supports that both small and large scale processes shape coral communities in Venezuela. We found that at smaller spatial scales, species turnover prevails (i.e., species replace from one transect or site to another), whereas at larger spatial scales species nestedness becomes more important (i.e., species are subsets of species pools).

Our results are unvaluable to pinpoint the pontential role of key ecological processes and anthropogenic disturbances wich may shape coral communities in Venezuela. Hence the importance of this study for future conservation plans.

This study not only contributes to understand multi-scale variation of coral communities, it is the first to measure beta diversity and to decompose its components in Venezuela.

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