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Coral community structure at Isla Lobos reef, Gulf of Mexico

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Abstract. Isla Lobos is the northernmost reef on southwestern margin of the Gulf of Mexico and like the others reefs in the area, these are frequently influenced by the action of natural (each winter cold fronts decrease seawater temperature and increase surf and turbidity) and anthropogenic stressors (chemical pollutants, unrestricted recreational diving, ship groundings, sewage effluents etc). It's well known that some of these factors influence the coral community structure, so the aim of this work was to contribute with information about this coral reef and assess its condition. For this purpose, structural patterns on windward and leeward fore-reefs were compared, at shallow (5-10m) - and deep (10-15) depths. At five sites of the reef, we use in 40 transects lines (50m each) underwater digital photography and employing Coral Point Count with Excel extensions (CPCe) we estimate coral abundance, species richness, Shannon- Weaver diversity and Pielou evenness index. Patterns in coral community structure were found by multivariate statistical analysis. Results shows that the reef is dominated by fleshy algae mostly and that stony coral common species are *Colpophyllia natans, Montastraea cavernosa, Siderastrea siderea, Diploria strigosa, Porites astreoides* and *Montastraea annularis.* Leeward has more species, more coral abundance, diversity than windward; significant differences ($H_{(1,40)}$=8.83, P=0.003) between these two zones might be the reflex of several factors such as light intensity, depth, wave exposure and disturbance regimes.

Key words: Scleractinians, Diversity, CPCe, Marginal environment

Introduction

The southwestern Gulf of México coral reefs are composed by two major reef systems: Antón Lizardo-Veracruz, and Lobos-Tuxpan reefs. These platform-type reefs are frequently influenced by riverine waters that drain large amounts of suspended sediments in to the reefs. These waters are also heavily contaminated with a wide array of pollutants (Horta-Puga, 2006). Climatological events also have impact on these coral reefs; during rainy season sediment plumes over the reefs reduce visibility to a few decimeters at shallow waters, at winter, cold fronts decrease seawater temperature and increase surf and turbidity (Horta-Puga, 2003). The combined effects of both natural and anthropogenic disturbances limit and reduce the development of stony coral communities (Tunnell 1988; Jordan Dalhgren 2002, Jones *et al*., 2008).

The six coral reefs of the Lobos-Tuxpan Reef System (LTRS) are located near Cabo Rojo and the city of Tuxpan (Fig.1); these reefs grow under conditions of chronic environmental stress, these features making one of the few ecosystems of its kind in Mexico and the world, seen as ecosystems of complex and exceptional scientific interest for its development in atypical environments (Horta-Puga, 2003, Tunnell, 1988).

It has been suggested that increased environmental stress during the last decades have significantly affected the reefs of the area (Horta-Puga, 2003), for this reason, the objective of this study was to describe the structure of coral reef community of Isla Lobos in order to provide information about the current condition of the reef, as a basis for its management and conservation.

Material and Methods

Non destructive sampling was used to describe Isla Lobos coral community composition and structure. Surveys were conducted by SCUBA divers during august 2010, quantitative data was obtained by photographic transects (50m) at two depth levels: 1) shallow (1-5m) y 2) deep (10-15m) both in the windward and the leeward reef. We analyzed information from 40 phototransects (n = 600 photos) for five sampling sites, underwater photographs were processed using Coral Point Count program w/Excel V3.4. Each photograph was superimposed on a matrix of 36 points distributed randomly; there, scleractinians, milleporines and type of substrate under each point were identified. The abundance of corals and ecological indices (richness, Shannon-Wiener diversity, and Pielou´s equitability at each sampling site were determined for further comparisons between areas and depths.

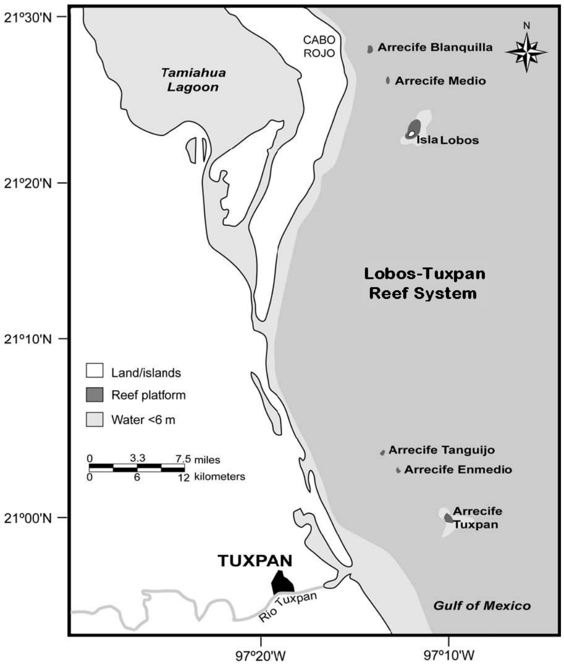


Figure 1: Reefs of the Lobos-Tuxpan Reef System (LTRS), in the southwestern Gulf of Mexico, near Cabo Rojo, Mexico. Modified from Tunnell (2006).

Coral community analysis
Possible patterns in coral community data were investigated using multivariate statistical analyses (Primer 6.0, Clarke and Warwick 2001; Statistica 6.0 (Statsoft)). Coral community data on coral densities was square root transformed, prior to the multivariate analysis and pooled into the five sites: North Windward (NW), South Windward (SW), North Leeward (NL), Centre Leeward (CL) and South Leeward (SL). Multidimensional scaling plots (MDS) (Clarke and Warwick 2001) were created using a Bray-Curtis Similarity matrix. SIMPER (similarity percentage breakdown; Clarke and Warwick 2001) analysis was used to determine which stony coral species was responsible for driving the differences among sites.

Results
From 40 transects analyzed, we found that the reef is made up mainly of algae (44.7%), being filamentous algae the most abundant, followed by hexacorals (27.7%), non-living substrate (15.1%) and sponges (11.8%). The coral community is represented by 9 families, 12 genera and 20 species: 18 species are scleractinians (Class: Anthozoa, Order: Scleractinia), one Hydrozoan (Class Hydrozoa, *Millepora alcicornis*) y one octocoral (Class: Anthozoa, *E. caribaeorum*). Dominant species for all the reef were: *Colpophyllia natans* (31.32%), *Montastraea cavernosa* (25.60%), *Siderastrea siderea* (18.50%), *Diploria strigosa* (7.71%), *Porites astreoides* (5.11%), and *Stephanocoenia intersepta* (3.55%).

The leeward reef displays more species diversity (16 species), higher abundance (Table 1) and a higher Shannon-Wiener diversity (2.4bits/ind). The lowest richness and diversity values were found at the deeper windward reef levels in the North (7 species, H` = 1.67 bits/ind) and in the South sampling sites (5 species, H´ = 1.82 bits/ind; Table 2).

	% Abundance ± SD					
Species	**Windward**			**Leeward**		
Agaricia agaricites	0.00	±	0.00	0.81	±	2.04
Agaricia fragilis	0.00	±	0.00	0.58	±	1.52
Colpophyllia natans	4.95	±	5.43	38.25	±	52.91
Diploria clivosa	1.71	±	1.69	0.63	±	1.90
Diploria sp	1.71	±	1.08	0.00	±	0.00
Diploria strigosa	12.29	±	12.68	6.50	±	15.91
Madracis decactis	0.85	±	1.29	0.76	±	3.10
Millepora alcicornis	4.61	±	5.57	1.21	±	5.68
Montastraea annularis	0.00	±	0.00	2.02	±	7.20
Montastraea cavernosa	52.39	±	34.07	18.57	±	46.06
Mycetophyllia ferox	0.00	±	0.00	0.04	±	0.26
Mycetophyllia lamarckiana	0.00	±	0.00	0.18	±	1.03
Porites astreoides	3.58	±	2.41	5.52	±	11.73
Porites colonensis	0.00	±	0.00	0.09	±	0.60
Porites porites	0.00	±	0.00	0.81	±	3.19
Scolymia cubensis	0.00	±	0.00	0.13	±	0.77
Siderastrea radians	0.00	±	0.00	0.76	±	3.35
Siderastrea siderea	17.92	±	12.39	18.65	±	33.73
Stephanocoenia intersepta	0.00	±	0.00	4.48	±	11.67

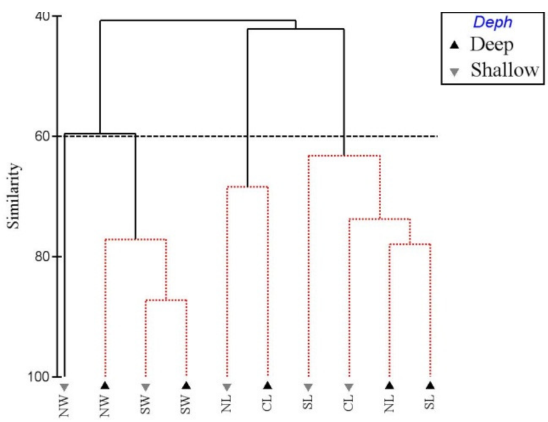
Table 1: Percent total abundance stony live corals (scleractinians and hydrozoans), standart deviation (SD) at windward and leeward of Isla Lobos reef.

Site	NWD	NWS	SWS	SWD	NLS	NLD	CLS	CLD	SLS	SLD
S	7	9	8	5	9	11	16	11	12	9
H'(log2)	1.67	2.39	2.03	1.82	2.10	2.27	2.37	2.83	2.24	2.17
J'	0.60	0.75	0.68	0.78	0.66	0.65	0.59	0.82	0.62	0.69

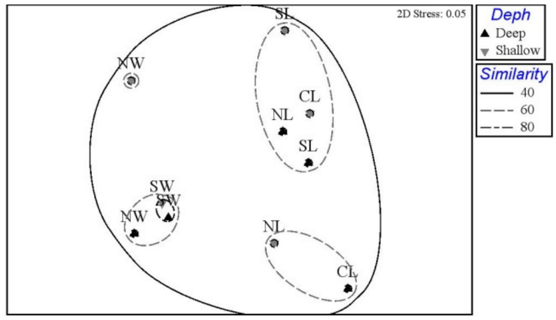
Table 2: Diversity index summary for sites at depths: NWD (North Windward Deep), NWS (North Windward) Shallow, SWS (South Windward Shallow), SWD (South Windward Deep), NL S (North Leeward Shallow), NLD (North Leeward Deep), CLS (Centre Leeward Shallow), CLD (Centre Leeward deep), SLS (South Leeward Shallow) y SLD (South Leeward deep). Richness (S), Shannon-Wiener index (H´) and Pielou evenness index (J´).

Likewise, differences in abundances of coral species between zones were significant ($H_{(1,40)}$=8.83, P<0.05); however, when different depth strata were compared, no statistical differences were found.

A 40% similarity in the species composition of the coral community was found at all sampling sites; the Bray-Curtis analysis indicates the organization of two main zones, windward and leeward (Fig. 2). The SIMPER analysis indicates that the similarity of the whole group at the windward side was 74.44%, while on the the lee reef it was 60.64%. The MDS method indicates that the north windward reef is not very similar respecting to other sites, the percentage of dissimilarity between it and its nearest group (SW) was 29.78% where discriminating species are *S. siderea* (19.82%), *M. alcicornis* (14.36%), *Diploria spp* (13.63%), and *P. astreoides* (12.25%).



A.



B.

Figure 2: Bray-Curtis similarity (complete linkage) (A). and multidimensional scaling plots (MDS) (B) analysis for stony corals (scleractinians and hydrozoan, *Millepora alcicornis*). NW (North Windward), SW (South Windward), NL (North Leeward), CL (Centre Leeward) and SL (South Leeward) at shallow (▲) and deep ̃(▼) depths.

Discussion

The abundance and diversity of the coral community of Isla Lobos is limited by the action of physical factors of their microenvironments, such as wave exposure, light availability, sediment discharges, seasonal changes in temperature and salinity (Horta-Puga 2006). Although during this study was not a direct correlation with these factors, several authors have attributed the low coral cover and diversity to the combination of them (Tunnell, 1988, Jordan-Dahlgren & Rodriguez-Martinez, 2003; Horta-Puga, 2006, Tunnell & Chavez, 2007). Likewise, although it is commonly accepted that coral reefs that develop under marginal environmental conditions and possibly low coverage have few interactions between species (Connell, 1973; Jordan-Dalhgren, 1992), the low coral cover in recent decades has attributed to increased human activities in the vicinity of these, especially those reefs near large cities (Jones et al., 2008). Another noticeable trend has been that with the decline of coral cover has increased the coverage of filamentous and crustose algae, which develop opportunistically and in many cases the absence of biological control agents have allowed to increase in number, creating what some have called " change of phase", where coral reefs formerly dominated by scleractinian corals, become dominated by macroalgae (McCook et al., 2001).

In the Veracruz Reef System (VRS), a recent study showed that 80.9% is covered by non-living substrate, where likewise as Lobos island, filamentous algae (44%) and calcareous algae (18.3%) have a higher coverage, indicating that the environment in which they develop have low rates of herbivory and low bioavailability of nutrients (Horta-Puga-Musi & Tello, 2009).

Species richness, total species number found in this study was lower as compared to studies made in the VRS where 26 species of hermatypic corals (25 scleractinian and 1 milleporine) have been recorded, but species richness is similar to that found at the Tropical Western Atlantic (TWA), with 21 species. Likewise, the dominant species for the Lobos Island reef, are the same as those at VRS reefs in similar proportions: *S. radians* (24.1%), *C. natans* (13.0%), *M. cavernosa* (10.5%), *S. siderea* (10.2%) and *D. strigosa* (3.1%) (Jones *et al*., 2008, Horta-Puga-Musi & Tello, 2009). The most abundant species found in this study and the VRS are euryoic and is said to have the ability to withstand adverse environmental tolerance limits; likewise, is remarkable to find out the dominant presence of species typical of environments with high terrigenous sedimentation such as *C. natans, M. cavernosa*, and *S. siderea* (Horta-Puga-Musi & Tello, 2009).

Although it has been suggested that the reefs in the area are growing in suboptimal conditions, hermatypic corals grow as well as in the rest of the Southern Gulf of Mexico and even at the TWA (Carricart-Ganivet et al., 1993; Horta -Puga-Musi & Tello, 2009).

In the case of reef areas and supporting the results obtained by Horta-Puga & Tello-Musi (2009), in this study it was found that the leeward reef displays higher coral densities, higher species richness, and higher diversity, despite other authors have reported the opposite (Jones et al., 2008); significant differences between these two zones might be the reflex of several factors such as light intensity, depth, wave exposure and disturbance regimes.

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