Bathymetric Distribution of the Benthic Marine Flora in Chemuyil, Mexico

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Abstract. 34 species of benthic marine flora between 0.5 and 35 ms of depth were determined, species with the greatest dominance was: *Enteromorpha flexuosa, Halimeda incrassata, Coralline articulate, Lobophora variegata* and *Galaxaura oblongata, E. flexuosa* was the most common. The sampling methodology was based on 117 phototransects to different depths. The index of diversity and density increased with the depth. The most frequent species with relative abundance bigger than 10% were *E. flexuosa* and *H. incrassata*. In this work the importance of some ecological attributes in the bathymetric distribution for this group was analyzed. The depth with greater diversity was registered at 3 m. The analysis of assemblaje gives a high associations among stations, their diversity and specific richness, which evidence the importance of such factors as: depth, light availability, substratum, wave effect, sedimentation and environmental conditions, among others.

Key words: algae, macroflora, distribution, biodiversity, Yucatan.

Introduction

The vegetation is one of the main components of coralline reefs with multiple functions, one of the most significant is the stabilization of substratum, because it is the nutritional resource of a great number of herbivorous and a fixing device of vital elements such as nitrogen, which recycles and makes it available for other groups. Some genus, such as *Halimeda* and *Penicillus* deposit aragonite (as $CaCO_3$) forming sand and sediment, participate actively in the reef formation or in change processes.

In reef ecosystems, marine flora is represented by macro algae which are a group with high diversity. It is important to evaluate reef communities with emphasis in the structure of their populations, information necessary to formulate accurate hypotheses of the relation between the biotic and abiotic factors of these environments (Liddell and Ohlhorst 1991). Also, the present study analyzes the composition and space distribution of the macroalgae in the coralline reef of Chemuyil, Quintana Roo at different depths.

Material and Methods

Study Area. The reef of Chemuyil is a barrier located 115 km from Cancun in the coast of the State of Quintana Roo, Mexico. It is part of the northwest region of the Caribbean zoogeographic province (Fig. 1).

Sampling. The sampling took place by means of an annual cycle from 2006 to 2007, with 117 photographic transects of 20 m of length (Liddell and Ohlhorst 1991, Torruco 1995) and stations each meter, work was performed in 14 depths of the reef between 0.5 and 35 m. At the same time, a selective collection was made for its identification in the laboratory (Taylor 1960, Litter et al. 1989) and it was used as base of reference for the photo-interpretation.
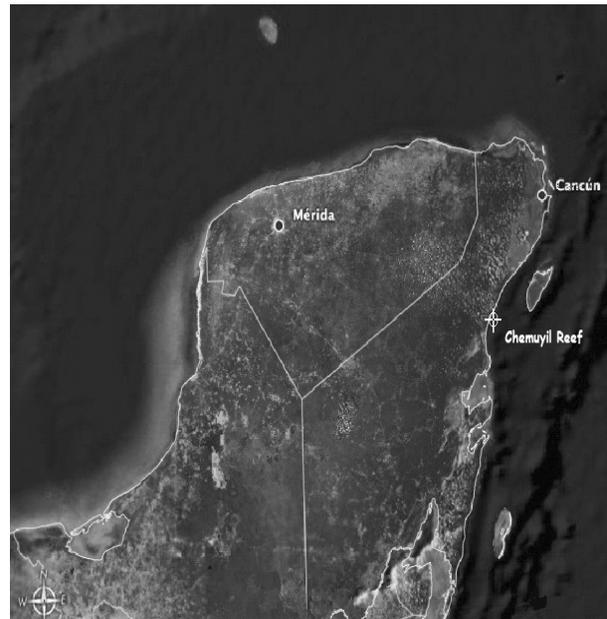

Figure1. Map showing the Chemuyil Reef, Quintana Roo, Mexico.

Analysis. The Dominance analysis was determined following Orlóci hierarchic criterion (Orlóci, 1978), the diversity was evaluated by means of the index of Shannon-Wienner (Magurran, 1988) and eveness with the equation of Pielou (1984). In the cluster analysis the index of similarity of Bray-Curtis was used with Lance and Williams criterion of flexible union with a β=0.25 (Orlóci, 1978). The discrimination of the species by depth was evaluated with the divisive analysis of arrangement using the content of information of order 2 (Ezcurra and Equihua, 1984).

Results

A total of 34 species of benthic marine flora between 0.5 and 35 m were determined. The ten more dominant species were: *Enteromorpha flexuosa* (16.54), *Halimeda incrassata* (15.55), *Lobophora variegata* (8.58), *Galaxaura oblongata* (8.45), *Dictyota divaricata* (6.31), *Amphiroa rigida* (4.86), *Halimeda opuntia* (4.32), *Caulerpa racemosa* (3.03), *Centroceras clavulatum* (2.77) and *Dictyota dichotoma* (2.45).

The highest specific richness was registered at 6 m of depth (S=12); followed by 3 m, 5 m and 35 m (S= 11), the lowest one appeared at 32 m (S= 4). Also, the most diverse depth corresponded to 6 m with H= 2.98 bits/ind and the lowest to 3 m with H= 1.23 bits/ind. In the eveness the pattern was the same, the highest at 6 m (E= 0.83) and the lowest at 3 m (E= 0.35, Fig. 2).

The similarity analysis registered three assemblajes at higher levels than 80 %. The first one at a 0.9 level links to 6 and 18 m depths, stations characterized by their high specific richness (S= 12 and 10 respectively) and diversity (H= 2.98 and 2.6 bits/ind). The second at a level of 0.85 associated mainly by the proximity of depth to the 13 and 14 m, with a variable specific richness (S= 6 and 10 respectively) and an intermediate diversity (H= 1.74 y 1.86 bits/ind).
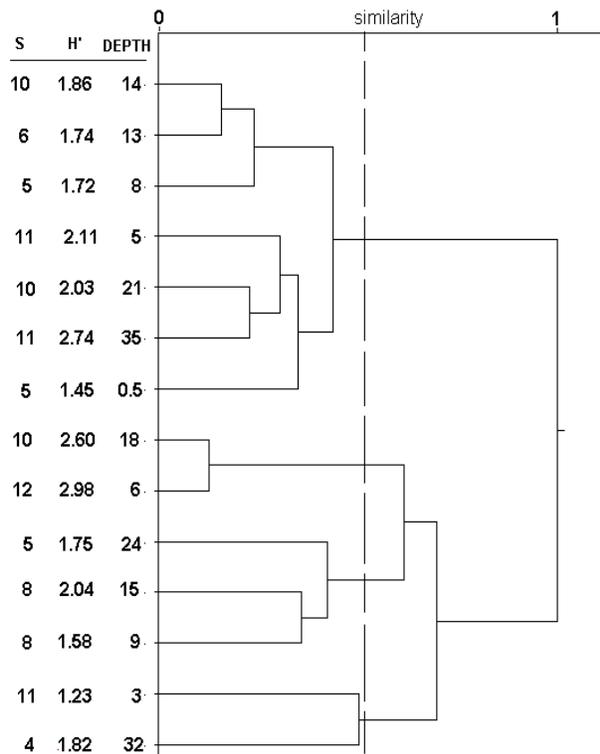

Figure 2. Cluster analysis of depth similarity, richness of species and diversity in Chemuyil Reef, Quintana Roo, Mexico.
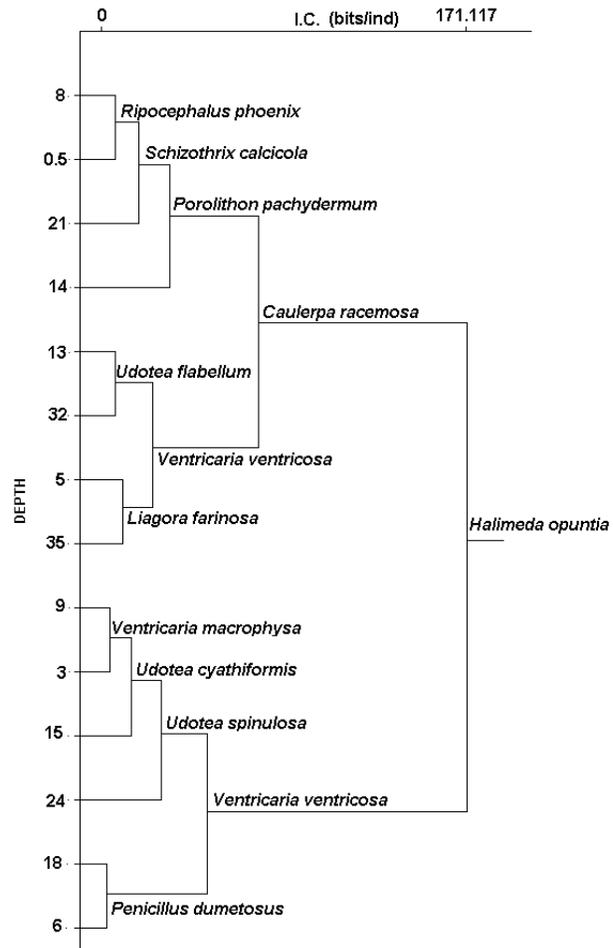

Figure 3. Cluster analysis of macroflora by discriminate the species in Chemuyil Reef.

The third at 0.80 level associated to high depths: 21 and 35 m, was characterized to register high specific richness (S= 10 and 11 respectively) and diversity (H= 2.03 and 2.74 bits/ind). These associations evidence high diversity and specific richness in the reef at high depths (Fig. 2).

The analyses of assemblage by depth to discriminate the species are shown in figure 3. The seven indicating species of the discrimination between the levels 0.07 to 0.87 are in sequential order: *Halimeda opuntia, Caulerpa racemosa, Ventricaria ventricosa, Porolithon pachydermum, Udotea spinulosa, U. cyathiformis* and *Schizothrix calcicola*. *Liagora farinosa* was the indicating species at 0.9 level and at greater levels than 0.93 the discriminating species were: *Ripocephalus phoenix, Udotea flabellum, Ventricaria macrophysa* and *Penicillus dumetosus*, this last species associated to the depths of 6 and 18 m, characterized by its high diversity and specific richness.

Discussion

The marine benthic macroflora of the barrier of Chemuyil was less diverse in comparison with other reefs areas of the region (Table 1). This result can be because the comparative one was made with protected natural zones, which provides a greater diversity and abundance. Other causes can be the sampling method used or a greater competitive pressure, due to the ample coralline development of the area.

Table 1. Comparison of the richness in the touristic corridor Cancun - Tulum. C= Chlorophyta, P= Phaeophyta, R= Rodophyta and S= Sorce.

Areas	C	P	R	S
Costa Occidental de I. Mujeres, P. Cancún y P. Nizuc	86	44	124	INE 1998a
Sian Ka'an	66	19	86	INE 1996
Sian Ka'an	15	46	35	Keeney 1999
Cozumel	75	55	166	INE 1998b
Chemuyil	17	7	10	This Work

Great part of the coast of Quintana Roo, is a combination between sandy and rocky beaches, specially the shallow reef areas, which originates an ample variety of habitats. The analysis registered an ample development of coral scleractinian in the platform, between their furrows and crests (63 % of the total area), reason why a competitive pressure with the macroflora is considered. The most conspicuous species were the calcareous forms of red algae, which reached 5 %, the total coverage of the group in the reef was of 24 %. Gutierrez-Carbonel et al. (1995) reports in the Reserve of the Biosphere of Sian Ka' an greater coverage (50 to 65%). The registered assemblies provide greater stability, the obtained pattern of high richness and diversity appeared to high depths and decreases towards intermediate depths. The indicating species of the state of health of the macroflora in Chemuyil were: *Enteromorpha flexuosa* and *Halimeda opuntia*.

Other authors (Cramer 2008, Gilner and Van Woesik 2008, Venera-Ponton et al. 2008), mention that the reefs of the Caribbean are being transformed into algae reefs; however the reef of Chemuyil registered a greater coralline development between the 30 and 40 ms of depth, although it is certain that the greater richness and diversity of macroflora appeared to high depths, the percentage of coverage was minor to the one of the coralline coverage, reason why this asseveration must be referred to shallow zones. Consequently, the richness of species and the obtained patterns of diversity probably exhibit low registries, they increase as depth increases, due to the high rate of sedimentation registered in the shallow zones, which originates a reduction in their biodiversity.

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