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Dominant Macroalgae in Bahía de Cochinos, Matanzas, Cuba

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Abstract

Spatial-temporal variations of macroalgae were analyzed in a study conducted in Cueva de Los Peces (CP) and Punta Perdiz (PP), two dive sites located on the eastern coast of Bahía de Cochinos. The most conspicuous species found from 3 to 20 m depths were present in the biotopes of ridges and shallow and deep terraces. Sampling was carried out in September 2014, and March and October 2016 by autonomous diving and direct methods. Qualitative visual censuses and quantitative analyzes were used to estimate the coverage (%) of the genera according to the AGRRA methodology with the use of the 10 m linear transect and quadrats as the sampling unit. The first list of macroalgae for the area is offered that includes 49 taxa of which 10 were Rhodophyta, 10 Ochrophyta (Phaeophyceae), and 29 Chlorophyta. The dominant genera during the study period were *Halimeda*, *Dictyota*, *Lobophora*, and *Udotea*. Spatial differences were found regarding the specific composition. Temporal variations were evidenced in terms of the relative abundance of the genera present, which reveals temporal changes in the qualitative structure, where some species replace others. The information obtained is pioneering and can serve as a comparative baseline for future monitoring of the area.

Keywords

Cuba, Macroalgae, Spatial-Temporal Variations, Species List

1. Introduction

The eastern coast of Bahía de Cochinos, classified as a National Park, is located south of the province of Matanzas. This area is widely used as a recreational diving area, underwater video and photography, collection of species for aquaria, and teaching activities [1]. All this is possible because of the high aesthetic value of the coastal reef of the place; also, because it is an area protected from the waves, it allows diving at any time of the year [2].

Between 2002 and 2003, the National Aquarium of Cuba (ANC) carried out an evaluation of the main reef communities on the eastern coast of the Bahía de Cochinos [2]. From this study period, the results on stony coral communities [3], octocoral [4], fish [5] [6], and sponges [7] have already been published. However, this area constitutes a knowledge gap concerning the diversity of marine macroalgae [8], and there is no study in space and time analyzing, specifically, the possible variations in the algal associations thereof.

The present work aims to provide information on the diversity of marine macroalgae in the area, mainly those associated with coral reefs that have not been previously studied. This study also aims to evaluate the variations in space and time of the same. Our results represent an important baseline for evaluating changes in benthic macroalgal assemblages due to increased local and global stressors and will serve as a reference for future research projects.

2. Materials and Methods

2.1. Study Area

The eastern coast of the Bahía de Cochinos presents a continuous coastal reef that extends approximately 15.53 miles along the coast homogeneously (from 22˚15'N, 81˚10'W to the 22˚05'N, 81˚05'W). The reef begins a few meters from the shore (9 to 16 m), between 3 and 9 m deep, the depth gradually increasing to about 32 - 49 m (about 656 m from the coast). From this point the slope falls sharply, forming an almost vertical wall that descends to about 262 m of depth.

This bay has no major polluting sources. There is only the mouth of the Sopllillar Canal that comes from the Hanábana River. Fertilizers are discharged into this waterway from the surrounding rice crops, although the exact quantities of these discharges are not known. It is not considered a highly polluted area, compared to the bay of Cienfuegos, also located in the southern platform of the country [9]. The extra supply of fresh water to the bay is considerable because of its proximity to the Ciénaga de Zapata, the main reservoir of surface water in the region [10], which is also increased by the existence of numerous underground rivers [5].

The study area, located on the west coast of the Bahía de Cochinos to the south of the province of Matanzas, corresponds to the one cited by [5], with the stations corresponding to two sites: Cueva de Los Peces (**CP**) and Punta Perdiz (**PP**) (**Figure 1**). In both sites, there are three biotopes [coral hillock, shallow and deep terrace]. The one with coral hillocks whose depth ranges between nine and 19 m, and consists of a plain of sand with scattered hillocks. Also, the shallow terrace consists of a rocky bottom with many coral colonies and a depth of 26 to 32 m, and the deep one, with 49 m and has an extensive coral cover, a slope greater than the shallow and infinity of caves of different sizes.

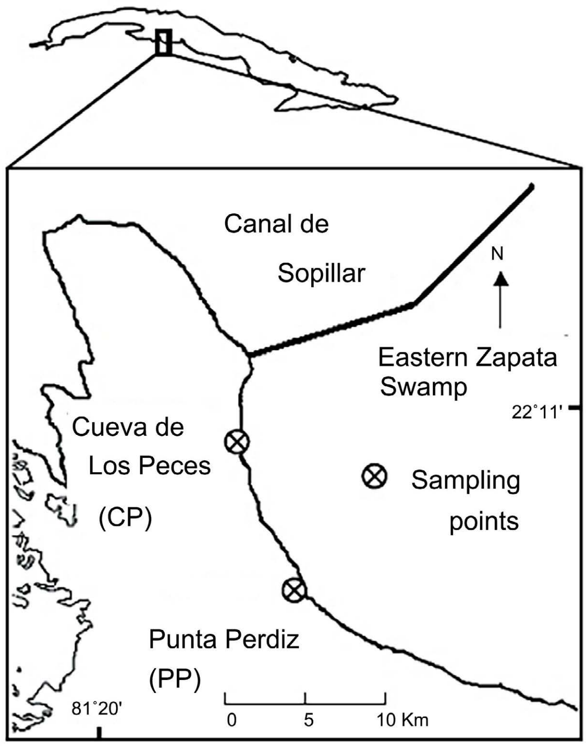

Figure 1. Sampling points on the east coast of Bahía de Cochinos. **CP**, Cueva de Los Peces; **PP**, Punta Perdiz.

2.2. Methodology

Quantitative analyses were performed at a 32-foot depth on the shallow terrace in September 2014, March, and October 2016. For the estimation of the sample size, a pilot study was carried out to establish the number of sampling units to be used.

Four 32-foot-long transects were placed equidistant from each other according to the reef layout and bottom configuration. In each transect, 10 quadrats of 9.8 × 9.8 inches were placed directly below the cord and perpendicular to the coastline [11] [12].

Within each quadrat, the percentage of algal cover was estimated, identifying them to the lowest possible level. For the census of the present species, the most conspicuous macroalgal specimens were collected through autonomous diving and deposited in labeled bags. All the collected material was identified in the laboratory. All samples were preserved in 70% alcohol and deposited in the Marine Collections Department of the National Aquarium of Cuba (**HANC**).

The collections were made in the biotopes of coral hillocks, sandy bottoms, and the shallow and deep terraces (**Figure 2**), and the depths in each of the biotopes varied from 9 m in the hillocks to 65 m in the deep terraces.

Specialized identification guides were followed: [13] [14] and [15] for the species determination. Scientific names were reviewed and updated by the [16] checklist and AlgaeBase [17].

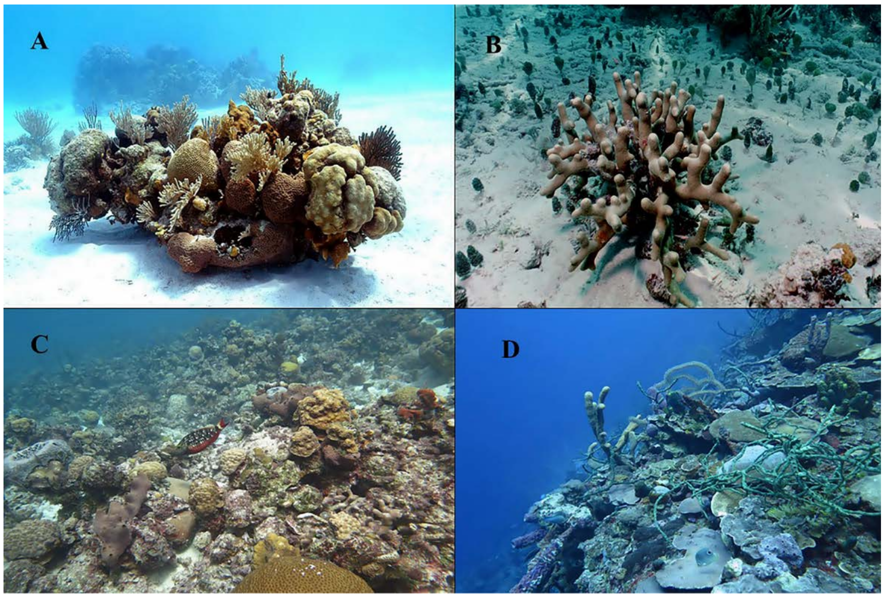

Figure 2. Biotopes where macroalgae were collected. (A), Coral hillock; (B), Sandy bottom with isolated corals and rocks; (C), Shallow terrace; (D), Deep terrace.

2.3. Data Analysis

Species identified *in situ* were grouped into genera for statistical analysis. Within each quadrat, the percentage of coverage of each genus was estimated. Using this data for the genera that contributed up to 95% of the coverage [18]. Permutational analyses of variance (PERMANOVA, [19], with a factor (months), were used to verify differences between CP and PP coverage. The Bray-Curtis index was used as a measure of similarity for the multivariate data matrix [19]. All statistical analyses were made from 9999 permutations to detect significant differences with a significance level of 0.05 according to [20]. The test of paired comparisons (Pair-Wise tests) carried out by the PERMANOVA was used for the multiple retrospective comparisons of the means.

The method proposed by [21] is used to determine the relative abundance values. To explore possible similarities between the sampling dates and the stations, a similarity matrix with the Bray-Curtis index was made with the data (not transformed) of relative macroalgal abundance.

With this matrix, a non-Metric Multidimensional Scaling (nMDS) ordering analysis was used. Similarity analysis of the contribution of taxa (SIMPER) was also performed to detect which groups; in this case, defined as genera will mark the differences between sampling stations.

The primary processing of the coverage data was done in a Microsoft Excel 2013 spreadsheet. The graphs, charts, and statistical calculations were obtained with the help of the programs STATISTICA 7.0 [22] and PRIMER 1.0.6 [23] and its version PERMANOVA 6.1.15 [19].

3. Results

A total of 49 taxa were collected, grouped into 11 orders, 17 families, and 27 genera, and distributed 10 in Rhodophyta, 10 Ochrophyta (Phaeophyceae), and 29 Chlorophyta. They are taxonomically organized in **Appendix I**.

The nMDS graph of the relative abundance of macroalgal genera showed spatial ordering more clearly than the temporal. Punta Perdiz (PP) was characterized by its greater abundance of *Lobophora*, *Dictyota* and *Halimeda*, while Cueva de Los Peces showed a greater predominance of *Halimeda* and *Udotea* (**Figure 3** and **Figure 4**). For the check of the summed values of relative abundance in the sampling units and their contribution percentage refer to **Appendix II**.

Species composition and relative abundance by season were determined. **Table 1** presents the mean values by sample units for the genera that constituted 95% of the total of individuals in each of the times of the year, ordered in a decreasing way according to their abundance. The most abundant genera in space and time were: *Halimeda*, *Dictyota*, *Lobophora* and *Udotea*.

Table 1. Summary of macroalgal relative abundance values (%) in descending order (95% of the total identified species grouped by genera are presented). Cueva de Los Peces (**CP**), Punta Perdiz (**PP**).

Data		**SEP 14**		**MAR 16**		**OCT 16**	
Genera	**Acronym**	**CP**	**PP**	**CP**	**PP**	**CP**	**PP**
Halimeda	HAL	18.9	22.5	30.4	26.9	31.1	23
Dictyota	DICT	14.2	24	14	26.4	14.3	22.2
Lobophora	LOB	7.18	20.9	20.8	37.3	11.2	25.7
Udotea	UDO	19.1	4.68	20.9	2.61	12.7	5.8
Penicillus	PEN	5.29	5.85	4.95	0.1	0	0
Rhipocephalus	RHI	0	0.92	1.03	0.64	0.27	0
Amphiroa	AMP	0.38	3.69	0	0	0	0
Jania	JAN	0	0	4.13	5.67	0	14.7
Bryopsis	BRY	4.15	0	0	0	5.93	0
Microdictyon	MIC	1.13	1.54	0	0	0	0
Peyssonnelia	PEY	0.76	0	2.58	0	0	0
Valonia	VAL	0	0	0	0	7.81	0.19
Filamentous	FIL	12.1	8	0	0	16.7	0
Padina	PAD	0	1.11	0	0	0	0
Codium	COD	0	0	0	0	0	1.52
Sargassum	SAR	0	0	0	0.25	0	0
Others		16.8	6.83	1.03	0	0	6.94
Total coverage		42.71	58.04	27.69	36.85	48.84	65.90

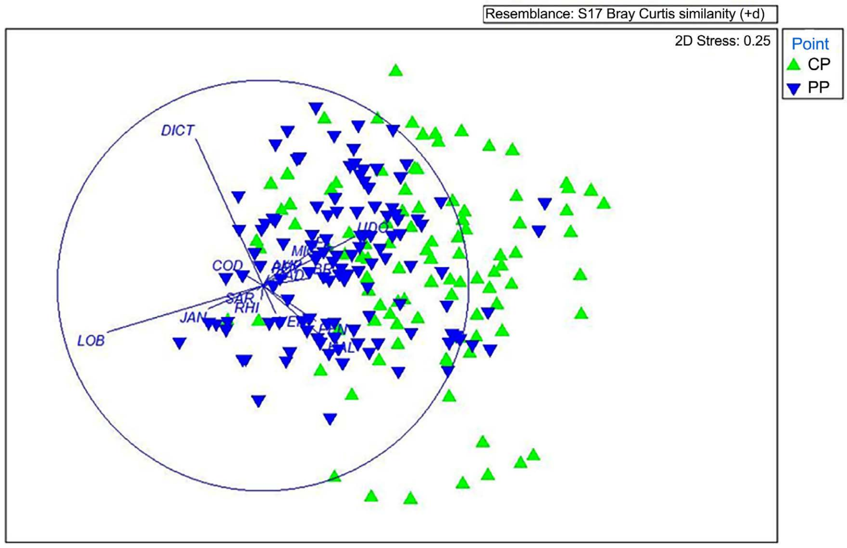

Figure 3. Non-Metric Multidimensional Scaling (nMDS) between collection stations according to the Bray Curtis Similarity index used the relative abundance values of macroalgal genera as magnitude of importance. **CP**, Cueva de Los Peces; **PP**, Punta Perdiz. Gender acronyms are summarized in Table 1.

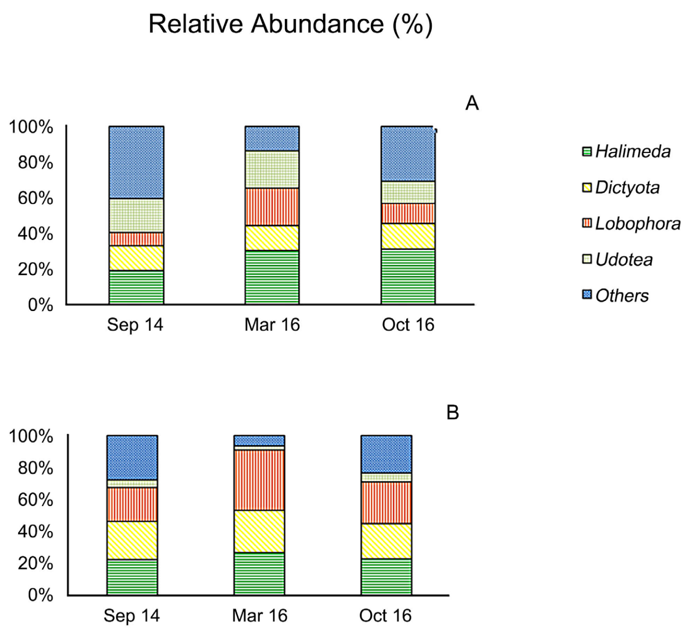

Figure 4. Relative abundance of macroalgae based on the four genera that contributed most to the coverage. (A), Cueva de Los Peces; (B), Punta Perdiz.

Figure 5 shows graphically which are the groups of species included in the variable others (see details in Figure 4), and that complete the information provided by the four dominant genera: *Halimeda*, *Dictyota*, *Lobophora*, and *Udotea*. The highest coverage values for dominant genera were observed in October 2016 and the lowest in September 2016. The highest coverage of *Halimeda* was observed in March 2016 for Punta Perdiz. For its part, Cueva de Los Peces, the months of March and October were the most abundant for this genus.

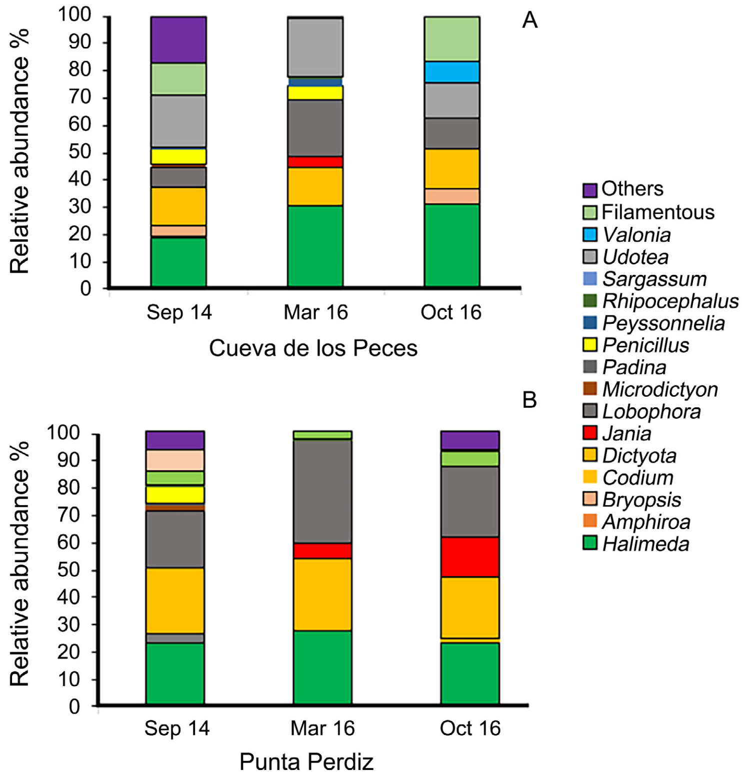

Figure 5. Results of the temporary monitoring of the relative abundance of macroalgae. (A), Cueva de Los Peces (**CP**), (B), Punta Perdiz (**PP**). **Table 1** reflects in descending order the contribution of each genus.

Although the dominance of *Halimeda*, *Dictyota*, *Lobophora*, and *Udotea* is unequivocal throughout the three months sampled, the lowest coverage values for these were found in September 2014 for both sampling sites, where there was greater coverage of other genera (**Figure 5(A)**, **Figure 5(B)**).

Udotea was another genus that was observed with moderate abundance. Its highest coverage was observed in March 2016 for Cueva de Los Peces and the lowest in October 2016. However, in Punta Perdiz the highest coverage of this genus was observed in October 2016 and the lowest in March 2016.

The genera *Lobophora* and *Dictyota* were noted for their high relative abundance values (**Table 1**, **Figure 4** and **Figure 5**). The highest coverage of *Lobophora* was observed in March 2016 for both stations and the lowest in September 2014. For *Dictyota* there was greater coverage in March 2016 in **PP**, and October 2016 in **CP**, in contrast, the lowest values for this genre were found in October 2016 for Punta Perdiz and March 2016 for Cueva de Los Peces.

These results were supported by the values obtained in the analysis of variance of relative abundance, where significant differences were found between the sites (**Table 2**).

Routine SIMPER analysis shows the genres that contributed most to the seasonal differences in relative abundance between sampling dates (**Table 3**, **Table 4**).

Table 2. Result of the analysis of variance for each variable. Cueva de Los Peces (**CP**), Punta Perdiz (**PP**). Significant differences are indicated in red.

PERMANOVA Sites							
						Unique	
Source	**df**	**SS**	**MS**	**Pseudo-F**	**P(perm)**	**perms**	
Sites	1	39,153	39,153	15.986	**0.0001**	9951	
Res	225	5.51E+05	2449.2				
Total	226	5.90E+05					
PERMANOVA Months							
						Unique	
Source	**df**	**SS**	**MS**	**Pseudo-F**	**P(perm)**	**perms**	**P(MC)**
Monts	2	30,114	15,057	60,215	**0.0001**	9932	0.0001
Res	224	5.60E+09	2500.5				
Total	226	5.90E+09					
PERMANOVA Sites x Months							
						Unique	
Source	**df**	**SS**	**MS**	**Pseudo-F**	**P(perm)**	**perms**	
Sites	1	39,153	39,153	17,202	**0.0001**	9941	
Months	2	28,993	14,497	6.3692	**0.0001**	9922	
Sites x Months	2	19,081	9540.6	4.1918	**0.0001**	9931	
Res	221	5.03E+05	2276				
Total	226	5.90E+05					

Relative Abundance of Macroalgae					
CP			**PP**		
Pseudo-F	P(perm)	perms	Pseudo-F	P(perm)	perms
4.7813	0.0001	9927	4.581	0.0001	9937

Table 3. Contribution of macroalgae genres that provided up to 20% similarity in each site and month of the study area (from the SIMPER routine) and the average similarity within each.

Site	**Genera**	**Average similarity**
CP	*Halimeda*, *Udotea*	26.02
PP	*Halimeda*, *Lobophora*, *Dictyota*	29.07
Months		
Sep 2014	*Halimeda*, *Dictyota*	22.79
Mar 2016	*Halimeda*, *Lobophora*, *Dictyota*	24.25
Oct 2016	*Halimeda*, *Lobophora*, *Dictyota*	44.72

Table 4. Decomposition of the mean Dissimilarity and the contribution of each genus of macroalgae in descending order (%), obtained from the SIMPER routine, in comparisons between site pairs and months in the study area with the scores given by the presence of macroalgae. Only those that contributed at least 50% of the accumulated average dissimilarity (DM) are presented. In bold are the highest values.

Genera	Average score Site 1	Average score Site 2	Contribution to mean Dissimilarity	Accumulated
	CP	PP	Average Dissimilarity = 74.18	
LOB	4.86	**14.42**	22.32	22.32
HAL	10.8	**12.33**	20.99	43.31
DICT	5.66	**12.29**	20.17	63.47
UDO	**6.64**	2.29	11.99	75.46
FIL	**4.52**	1.06	7.37	82.83
JAN	0.38	**4.08**	6.47	89.3
PEN	**1.13**	0.79	3.21	92.51
	SEP 14	MAR 16	Average Dissimilarity = 77.93	
HAL	**10.42**	9.34	21.97	21.97
LOB	7.37	**10.66**	21.87	43.83
DICT	**9.8**	7.47	20.82	64.66
UDO	**5.58**	2.84	12.74	77.39
FIL	**4.92**	0	7.39	84.78
PEN	**2.8**	0.56	5.79	90.57
	SEP 14	OCT 16	Average Dissimilarity = 69.90	
HAL	10.42	**15.17**	19.35	19.35
LOB	7.37	**11.35**	18.57	37.92
DICT	9.8	**10.91**	18.31	56.23
UDO	**5.58**	4.97	11.99	68.21
FIL	**4.92**	3.97	10.5	78.71
JAN	0	**4.96**	6.97	85.68
PEN	**2.8**	0	3.94	89.62
BRY	0.93	**1.41**	3.21	92.83
	MAR 16	OCT 16	Average Dissimilarity = 69.48	
HAL	9.34	**15.17**	22.94	22.94
LOB	10.66	**11.35**	21.99	44.92
DICT	7.47	**10.91**	19.87	64.79
UDO	2.84	**4.97**	10.37	75.16
JAN	1.72	**4.96**	9.13	84.28
FIL	0	**3.97**	6.97	91.25

4. Discussion

The macroalgae collected in this study are among the most conspicuous among those present on the Cuban platform [24]. Despite having been sampled for a short time, a list of species for the eastern coast of Bahía de Cochinos is achieved for the first time, as well as new records provided by [25], which demonstrates the potential of the area as a source of biodiversity. It is to be expected that from repetitive collections over time, more species can be found, due to the temporal variability presented by these organisms.

The collections were mostly on a rocky bottom with a thin layer of sediments, in hillocks and the sand. They were found dominating the typical reef species and found in other areas of the Cuban and Caribbean shelf in general [8] [26] [27] [28]. The families Halimedaceae and Udoteaceae within the Chlorophyta were the most common, which is consistent with studies conducted in the South-Central region of Cuba [29] [30].

The multidimensional scaling reflects a slight difference between the two macroalgae communities within the studied area. However, there is a similarity between the genera (especially the dominant ones: *Halimeda*, *Lobophora*, *Dictyota* and *Udotea*) within these seasons, which is reinforced by a stress value of 0.25 (**Figure 3**). Possibly this is due to the spatial proximity of both sites contributing to an exchange of spores or gametes. However, differences in the specific composition are evident, possibly due to natural factors such as water movement. The station Punta Perdiz (PP) is the closest to the open sea and therefore with a greater influence on marine circulation. This reaffirms that the spatial component is more remarkable and determinant than the temporal one according to the results of [31] for sites with different degrees of tidal influence or mechanical damage, or different types of substrates [32].

The temporal variations were evidenced in terms of the relative abundance of the species present, but not in terms of diversity, which evidences seasonal changes in the qualitative structure, where some species replace others in the community. Among the months, March presents the lowest values of abundance, a result that coincides with the observations of other authors [33]. According to the results of [24] in that month, there are changes in the structure of algal communities. In addition, in the months of September-October there is a decrease in macroalgal species, as there are transition periods between peaks of abundance. So having found a greater coverage in these months could be due to a greater sampling effort [34].

The algae of the genera *Halimeda* and *Udotea* that correspond to the calcareous morphotype were the dominant algal morphotype. This group is composed of species with slow growth and abundant calcium carbonate, typical of areas with low levels of nutrients and with optimal conditions for coral development. At Punta Perdiz (PP), these presented significant differences, unlike their counterpart of the site Cueva de Los Peces (CP), with less tidal influence. This is consistent with the results of [35] [36], who argue that these are dominant over other macroalgal groups in low-nutrient conditions and higher ocean churning [37]. Yet, despite this research, basic aspects of the ecology of most *Halimeda* and

Udotea species remain poorly understood, often because opportunities for conducting long-term field research have been limited [38]. Similarly [35] they argue that this morphofunctional group is one of the historically dominant in reefs with normal conditions.

In the months of September to October the highest coverage values were recorded for *Halimeda* which coincides with the rainy season. Meanwhile, the lowest coverage values for *Halimeda* were found from November to April. These results coincide with those obtained by [36] who argued that chlorophylls are more predominant in this period.

Lobophora was another genus that was abundant in the rainy season and had its lowest values in the dry season. Both this genus and *Dictyota*, also dominant, belong to the least grazed algal groups because they avoid herbivory through morphological or physiological adaptations [39]. *Dictyota* also prevails in places where the waves are more intense [33].

The highest coverage of *Dictyota*, by contrast, was observed in the dry season and the lowest in rain. However, [40] found for the Canasí reef that this genus contributed the most to the percentage of coverage in almost every month. Other authors such as [33] argue that dominance of *Dictyota* throughout the year and variations in its abundance due to increased nutrients have been found in other reefs in Cuba and the Caribbean. In addition, this genus is considered an annual and without seasonal variations, although with generations in succession throughout the Caribbean region [41].

Coral reefs have changed radically in recent decades [42]. In the Caribbean now the average is 13% coral cover and 40% macroalgae cover [43]. Unlike other regions of the Caribbean where the main contributors of biomass are brown algae e.g., *Dictyota* and *Lobophora* [44] [45] at both sites, it is established that the largest contribution is in calcareous algae such as *Halimeda* and *Udotea*, which corresponds to the results of [46]. Studies on the influence of herbivorous fish on species control showed that many species prefer tiny algae over more robust species [47].

5. Conclusions

As stated in the evaluations carried out (coverage by genus). This work also produced significant new scientific knowledge on key genera in reef ecosystems, and towards the development of standardized biodiversity monitoring protocols for various genera of macroalgae.

In addition to presenting a list of species, other contributions of our results are to offer a rapid evaluation without requiring a lengthy study needed for the identification of species, and secondly, to present the genera that, due to their coverage, better explain the structure of the community.

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Roles by Authors

YA & PGS conceived and designed the experiments, analyzed the data, prepared figures, and reviewed all manuscript drafts. HCA & PC project coordination and logistics. JDL prepared figures and worked on conceptualization and analysis. RC contributed to data analysis, and reviewed all drafts for this manuscript. All authors have read and agreed to the version of the manuscript submitted.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix I. Checklist of Species Found in the Study Area

Phylum OCHROPHYTA

Class Phaeophyceae

Order Dictyotales

Family Dictyotaceae

Dictyota bartayresiana J. V. Lamouroux

D. caribaea Hörnig & Schnetter

D. ciliolata Sonder ex Kützing

D. mertensii (Martius) Kützing

D. pinnatifida Kützing

D. pulchella Hörnig & Schnetter

Lobophora cf. ***variegata*** (J. V. Lamouroux) Womersley ex E. C. Oliveira

Padina boergesenii Allender & Kraft

Stypopodium zonale (J. V. Lamouroux) Papenfuss

Order Fucales

Family Sargassaceae

Sargassum hystrix J. Agardh

Phylum RHODOPHYTA

Subphylum Eurhodophytina

Class Floridophycidae

Subclass Corallinophycidae

Order Corallinales

Family Corallinaceae

Subfamily Corallinoideae

Jania adhaerens J. V. Lamouroux

Subfamily Lithophyloideae

Amphiroa fragilissima (Linnaeus) J. V. Lamouroux

A. rigida J.V. Lamouroux

A. tribulus (J. Ellis & Solander) J. V. Lamouroux

Subclass Nemaliophyceae

Order Nemaliales

Family Galaxauraceae

Dichotomaria obtusata (J. Ellis & Solander) Lamarck

Galaxaura sp

Subclass Rhodymeniophycidae

Order Ceramiales

Family Delesseriaceae

Dasya ramossissima Harvey

Family Wrangeliaceae

Wrangelia bicuspidata Børgesen

Order Peyssonneliales

Family Peyssonneliaceae

Peyssonnelia sp.

Order Rhodymeniales
Family Champiaceae
Champia salicornioides Harvey
Phylum CHLOROPHYTA
Class Ulvophyceae
Order Bryopsidales
Family Bryopsidaceae
Bryopsis hypnoides J. V. Lamouroux
B. pennata J. V. Lamouroux
Family Caulerpaceae
Caulerpa racemosa (Forsskål) J. Agardh
Family Codiaceae
Codium decorticatum (Woodward) M. Howe
Family Dichotomosiphonaceae
Avrainvillea asarifolia Børgesen
Avrainvillea nigricans f. ***parva*** D. Littler & Littler
Family Halimedaceae
Halimeda copiosa Goreau & E. A. Graham
Halimeda discoidea Decaisne
Halimeda gracilis Harvey ex J. Agardh
Halimeda goreaui W. R. Taylor
Halimeda monile (J. Ellis & Solander) J. V. Lamouroux
Halimeda opuntia (Linnaeus) J. V. Lamouroux
Halimeda tuna (J. Ellis & Solander) J. V. Lamouroux
Family Udoteaceae
Penicillus pyriformis A. Gepp & E. Gepp
Penicillus pyriformis f. ***explanatus*** Børgesen
Rhipidosiphon floridensis D. Littler & Littler
Rhipocephalus phoenix f. ***longifolius*** A. Gepp & E. Gepp
Udotea cyathiformis Decaisne
Udotea cyathiformis f. ***infundibulum*** (J. Agardh) D. S. Littler & Littler
Udotea cyathiformis f. ***sublittoralis*** (W. R. Taylor) D. S. Littler & Littler
Udotea cyathiformis var. ***flabellifolia*** D. S. Littler & Littler
Udotea norrisii D. S. Littler & Littler
Udotea unistratea D. S. Littler & Littler
Orden Cladophorales
Family Anadyomenaceae
Anadyomene stellata (Wulfen) C. Agardh
Microdictyon sp.
Family Cladophoraceae
Cladophora prolifera (Roth) Kützing
Family Valoniaceae
Valonia macrophysa Kützing

Valonia ventricosa J. Agardh

Orden Ulvales

Family Ulvaceae

Ulva lactuca Linnaeus

Appendix II. Total Values of Relative Abundance and Their Contribution in Percentage

Sites	Cueva de Los Peces						Punta Perdiz					
Months	Sep 14	%	Mar 16	%	Oct 16	%	Sep 14	%	Mar 16	%	Oct 16	%
Dictyota	188	14.20	136	14.04	265	14.28	390	24	536	26.44	586	22.23
Lobophora	95	7.18	202	20.85	208	11.21	340	20.92	757	37.35	677	25.68
Padina	0	0	0	0	0	0	18	1.11	0	0	0	0
Sargassum	0	0	0	0	0	0	0	0	5	0.25	0	0
Amphiroa	5	0.38	0	0	0	0	60	3.69	0	0	0	0
Jania	0	0	40	4.13	0	0	0	0	115	5.67	387	14.68
Galaxaura	0	0	0	0	0	0	0	0	0	0	3	0.11
Peyssonnelia	10	0.76	25	2.58	0	0	0	0	0	0	0	0
Halimeda	250	18.88	295	30.44	578	31.14	365	22.46	546	26.94	605	22.95
Bryopsis	55	4.15	0	0	110	5.93	0	0	0	0	0	0
Codium	0	0	0	0	0	0	0	0	0	0	40	1.52
Caulerpa	210	15.86	10	1.03	0	0	70	4.31	0	0	125	4.74
Microdictyon	15	1.13	0	0	0	0	25	1.54	0	0	0	0
Penicillus	70	5.29	48	4.95	0	0	95	5.85	2	0.10	0	0
Rhipocephalus	0	0	10	1.03	5	0.27	15	0.92	13	0.64	0	0
Udotea	253	19.11	203	20.95	235	12.66	76	4.68	53	2.61	153	5.80
Ulva	13	0.98	0	0	0	0	41	2.52	0	0	55	2.09
Valonia	0	0	0	0	145	7.81	0	0	0	0	5	0.19
Filamentous	160	12.08	0	0	310	16.70	130	8	0	0	0	0