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STONY CORALS AND REEFS OF DOMINICA

BY

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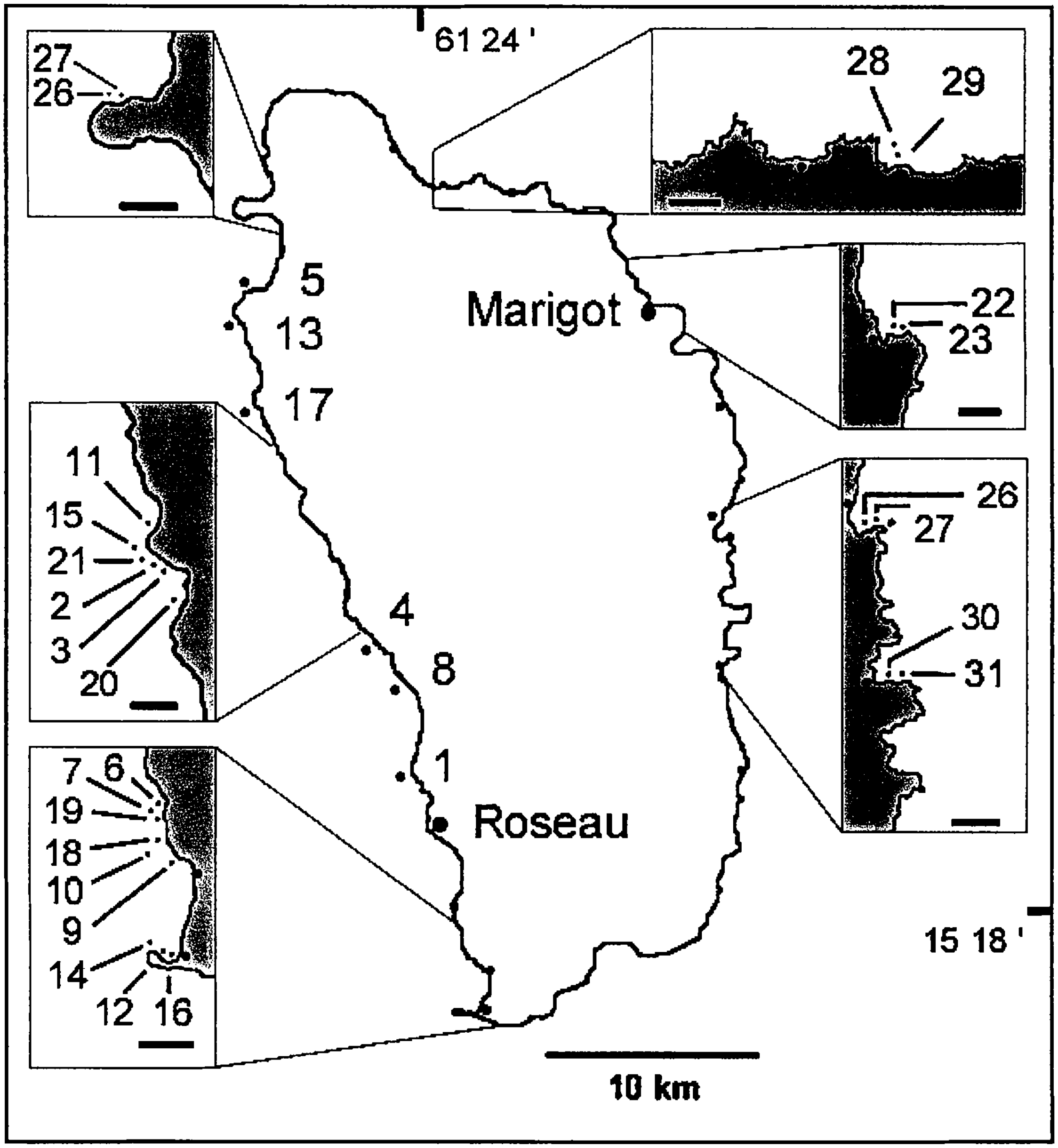

Figure 1. Commonwealth of Dominica, Lesser Antilles. Study sites. Scale bars in area boxes are 1 km.

STONY CORALS AND REEFS OF DOMINICA, LESSER ANTILLES

BY

SASCHA C.C. STEINER[1]

ABSTRACT

Thirty-six scleractinian coral species were identified *in situ* during the first comprehensive quantitative survey of reefs around the Commonwealth of Dominica. *Porites astreoides* dominated most assemblages within the 1,146 m^2 area examined, constituting 29.7 % of the total live coral recorded (166 m^2). The abundance of constructional, yet non-reef-building, species along the west coast may be one of the reasons for the paucity of reef accretion. Coral reefs in the strictest sense are found along the narrow shelf of the west coast where they are sheltered from turbulence by depth and coves. *Madracis mirabilis* was among the main reef builders, forming mono-, as well as bi-specific banks with *Porites porites*. East-coast reefs were characterized by patch and fringing reefs whose main scleractinan component were built by *A. palmata* frameworks. However, these reefs had a comparatively low live cover (9.25%). East-coast reefs (windward) were also significantly less diverse (ANOVA, F=9.1, P=0.01) than west-coast reefs (leeward), among which shallow sites (1-5 m) were significantly less diverse (ANOVA, F=16.2, P=0.01) than deeper sites (6-18 m).

A negative correlation was detected between the live cover of Scleractinia and other sessile invertebrate groups, mostly sponges, hydrocorals and zooanthids. No correlation between the presence of Scleractinia and algae was found. Given Dominica's young and narrow shelf, the assemblage types are harbored within a relatively small area suitable for reef development and lie in close proximity to the shoreline where coastal developments are the source of many disturbances. Coral reefs of Dominica can be considered as marginal systems yet a historically important artisanal fishing resource. Although it is doubtful that these reefal habitats have remained unaffected by human activities, new user groups are targeting Dominica's marine resources and thus the justification for conservation measures is suggested.

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INTRODUCTION

Dominica lies within the western and geologically younger arc of the Lesser Antillean volcanic islands, which include Saba, St. Eustasius, St. Kitts, Redonda, Montserrat, western portions of Guadeloupe, northern Martinique, central St. Lucia, and St. Vincent (see Martin-Kay, 1971). With an area of 750 km^2 and several mountain peaks above 1,000 meters, Dominica is among the least eroded islands of the region and characterized by a narrow shelf. Approximately 150 km^2 of shelf lie in waters shallower than 50 m. This is the extent of potentially suitable habitats for zooxanthellate Scleractinia, based on depth alone. However, given the island's many rivers and fluvial sediment outfalls, the area with stable substrates suitable for reef development is far smaller.

Until recently, reefs of Dominica have only been explored marginally by biologists. In the 1960s the Bredin-Archbold-Smithsonian expeditions to the island included studies on boring sponges (Rützler, 1971), archiannelids (Kristeuer, 1967), balanomorph barnacles (Ross, 1968), decapods (Raymond, 1970), and echinoids (Porter, 1966). Since then, only a few reports on the marine benthos have been produced (see Smith *et al.,* 1997), primarily consisting of non-peer-reviewed documents (Evans, 1997; Goodwin, 1985; Summers, 1985) focusing on a single area, the Soufriere Bay located in the south of the island.

Comprehensive surveys of Dominican reefal communities began in 1999 with surveys along the narrow shelf (50-300 m) of the west coast (leeward). Preliminary results showed coral assemblages with a mean live cover of 15% and a paucity of reef accretion (Steiner and Borger, 2000). In contrast, the northern and eastern (windward) shelf is wider (200–1200m) providing more potential coral habitat than the west coast. Given the trade-wind-driven surface currents, east- and north-coast coral populations may play an important role in reseeding leeward communities which are currently under the heaviest fishing pressure. Prior to this study, the exploration of coral communities along the Atlantic coast, notorious for its treacherous waters, had not taken place.

The assessment of Dominica's coral environments is in its infancy, yet the future holds renewed and increased disturbance levels, posing a variety of threats to this narrow band of coastal marine resources which have traditionally been areas of artisanal reef fisheries (line fishing, traps, seine nets). With the decline of the island's agro industries, following a series of boom and bust cycles over the past two centuries, Dominicans are migrating towards the increasingly crowded coastal settlements (Honychurch, 1995). Rain forests have reclaimed abandoned agricultural lands (Honychurch, 1995; pers com A. James, Forestry Division) and sediment runoff enhanced by deforestation is expected to decrease. The imminent sources of disturbance on an already marginal reef system include increased reef-fishing pressure, construction, and sewage fallouts. Furthermore, the marine environment has recently been targeted by the tourism industry to complement better established land-based tourism.

In light of this situation, and the fact that Dominica still represents a gap in our "upstream" (surface currents) Caribbean coral data base, this ongoing survey of live coral cover has the following objectives: (a) to establish the occurrence and geographic distribution of zooxanthellate constructional (*sensu* Schuhmacher and Zibrowius, 1985) scleractinian corals; (b) to ascertain site-specific scleractinian assemblage structure based on live cover of individual coral species, as well as the live benthic cover of other sessile invertebrates and algae; and (c) to provide a comprehensive reference point for future investigations and conservation measures. These objectives were addressed based on the first 31 detailed quantitative and qualitative site surveys, encompassing 1,146 m^2 of benthos from Dominica's eastern, northern, and western coasts.

METHODS

Data Collection

A 1 m^2 quadrat subdivided into 100 squares of 100 cm^2 was used to estimate the percent live cover of individual scleractinian species, non-scleractinian sessile invertebrates (sponges, soft corals, and hydrocorals) and algae *in situ* at 31 sites (Fig. 1*)*. Actinians, zoanthids, and sabellid polychaetes that formed patches were also included in the measurements. Encrusting calcareous algae such as *Porolithon* were not included in this survey. Coral species identification was based on Cairns (1982), Wells (1973), Humann (1994), Smith (1971) and Weil and Knowlton (1994). Counts of *Meandrina meandrites* may include *M. memorialis*. A few colonies of an unidentified *Porites sp.* were observed at sites 26, 27 (east), 28, and 29 (north). Similar to the general colony habitus of *P. astreoides*, this coral displays a whitish coloration with a pale blue tint. Tentacles of brown-to-reddish shades appear in stark contrast. All colonies observed formed more or less hemispheric mounds of up to 100 cm^2. In this study *Porites sp.* was included in the *P. astreoides* count.

Organisms ≥ 50 cm^2 were recorded and their benthic cover was estimated. Organisms and colonies smaller than 50 cm^2 were noted as present but not included in subsequent data analysis. Using a sample size of 20 m^2, the quadrat was placed at 1 m intervals along a transect line temporarily installed perpendicular to the shelf slope. The starting points were selected in a strategic manner so that sand patches larger than 3 m in diameter could be avoided. A total of 1,146 m^2 of live benthic cover across 31 sites (Fig.1) were thus quantitatively assessed. The field data were collected in May 1999, March-May 2000, June-Oct 2001, and May-Aug 2002. Sites deeper than 3 m were surveyed using scuba.

Data Analysis

The abundance of scleractinian species was categorized based on the percent live cover in order to create a semi-quantitative species reference list. Individual species making up ≥10% of the total live coral cover were considered abundant and those with 1-9.9% cover were regarded as common. Species that contributed less than 1% of the total coral cover were regarded as uncommon while those identified at the study sites, but not within the surveyed area, were considered to be rare (Table 1). Species identified outside of study sites also were recorded but their abundance was not weighed. The presence of individual species across all sites was expressed as percent site overlap. Scleractinian diversity (H') and evenness (J'), based on live cover at each site, were calculated using the Shannon and Wiener (1948) diversity and Pielou (1966) evenness indices respectively.

Similarity among sites, based on species-specific live cover at each site, was discerned with the Bray Curtis similarity cluster analysis. Non-metric multidimensional scaling was used to depict differences in the cover of Scleractinia, non-scleractinian invertebrates, and algae among all sites. All calculations were performed in Primer v5 (Clarke and Gorley, 2001). Coral-cover data were square-root transformed to reduce the masking patterns of rare species by common and to thus better depict the role of rare species in the differentiation of site-specific species assemblages.

RESULTS

Species Occurrence and Benthic Cover

Thirty-six species of stony corals were identified *in situ* (Table 1). Thirty of these species occurred within the 1,146 m^2 surveyed, and the others were identified outside the sample area. *Porites astreoides, Porites porites* and *Agaricia agaricites* occurred at all sites.

A total of 14.6% of the sample area, or 166.8 m^2, was covered by live coral tissue. The most abundant species in terms of live cover was *Porites astreoides* (Fig. 2) constituting 4.3% of the surveyed area or 29.7% of the total live cover recorded. *Porites astreoides, Madracis mirabilis, P. porites, A. agaricites*, and *Meandrina meandrites* made up 66% of the live coral cover. The remaining 54% was composed of 26 other coral species.

Live coral cover ranged from 2.25% to 31.88% (Table 2) with a mean cover of 9.25% for east-coast assemblages which differed significantly from the west coast assemblage with a mean cover of 16.68% (ANOVA, F=7.97, P=0.01). The overall mean coral cover was 14.77%. The mean evenness (J') of distribution of species-specific live cover (Fig. 3) was 0.78 (SD = 0.21). Excluding species that occurred at less than 20% of the sites resulted in a mean evenness (J') of distribution of 0.8 (SD =0.1).

Geographic differences in species occurrence were noted for *Acropora ormosa* which was one of the dominant corals on east-coast reefs but virtually absent along the west coast. Subtle differences in species occurrence were observed in *Isophyllia sinuosa* commonly found in northwestern and eastern reefs, yet rare in southwestern reefs. Alternatively, *Eusmilia fastigiata* was commonly found in southwestern reefs but was rare in other regions of Dominica. Other species displayed a more patchy occurrence. For example, *Dichocoenia stokesii* was commonly seen in northwestern and southwestern reefs but was less common in central-western regions of Dominica.

Table 1. Scleractinian abundance and site overlap. Abundant: ≥10 % of total live coral cover surveyed (166.7 m^2); common: 1 % - 9.9% of total live coral cover; uncommon: ≤ 0.9% of total coral cover; rare: not present within surveyed area. Only colonies with a size of 50 cm ^{2} or more were considered. The presence of species across sites is expressed as % site overlap.

	Species	Abundance	Site Overlap (%)
1	*Stephanocoenia intersepta* (Milne Edwards and Haime, 1848)	uncommon	73.3
2	*Madracis mirabilis* (Duchassaing and Michelotti, 1860)	abundant	53.3
3	*Madracis decactis* (Lyman, 1859)	common	46.7
4	*Madracis ormosa* (Wells , 1973)	rare	n/a
5	*Acropora palmata* (Lamarck, 1816)	uncommon	4.8
6	*Siderastrea siderea* (Ellis and Solander, 1786)	common	93.3
7	*Siderastrea radians* (Pallas, 1766)	uncommon	20.0
8	*Agaricia agaricites* forma *agaricites* (Linnaeus, 1758)	common	100.0
	Agaricia agarcites forma *purpurea* (Lesueur, 1821)	rare	n/a
9	*Agaricia fragilis* (Dana, 1884)	rare	n/a
10	*Agaricia humilis* (Verill, 1901)	rare	n/a
11	*Agaricia* spp. (mostly *A. lamarcki*)	common	33.3
12	*Leptoseris cucullata* (Ellis and Solander, 1786)	uncommon	33.3
13	*Meandrina meandrites* (Linnaeus, 1758)	abundant	86.6
14	*Dichocoenia stokesii* (Milne Edwards and Haime, 1848)	uncommon	46.7
15	*Dendrogyra cylindrus* (Ehrenberg, 1834)	uncommon	13.3
16	*Mussa angulosa* (Pallas, 1766)	uncommon	6.7
17	*Scolymia* sp.	rare	n/a
18	*Isophyllia sinuosa* (Ellis and Solander, 1786)	uncommon	26.7
19	*Isophyllastrea rigida* (Dana, 1848)	rare	n/a
20	*Mycetopyllia aliciae* (Wells, 1973)	uncommon	13.3
21	*Mycetophyllia ferox* (Wells, 1973)	rare	n/a
22	*Favia fragum* (Esper, 1797)	uncommon	26.7
23	*Colpophyllia natans* (Houttuyn, 1772)	common	80.0
24	*Diploria strigosa* (Dana, 1848)	common	80.0
25	*Diploria clivosa* (Ellis and Solander, 1786)	uncommon	46.7
26	*Diploria labyrinthiformis* (Linnaeus, 1767)	uncommon	20.0
27	*Montastraea annularis* (Ellis and Solander, 1786)	common	20.0
28	*Montastraea faveolata* (Ellis and Solander, 1786)	common	80.0
29	*Montastraea franksi* (Gregory 1895)	uncommon	6.7
30	*Montastrea cavernosa* (Linnaeus, 1767)	uncommon	66.7
31	*Eusmilia fastigiata* (Pallas, 1766)	uncommon	26.7
32	*Porites porites* (Pallas, 1760)	common	100.0
	Porites porites forma *divaricata*	rare	n/a
33	*Porites astreoides* (Lamarck, 1816)	abundant	100.0
34	*Porites* sp.	rare	n/a
35	*Porites colonensis* (Zlatarski, 1990)	uncommon	20.0
36	*Tubastrea coccinea* (Lessuer, 1829)	rare	n/a

Table 2: Dominican coral assemblages by geographic region. Assemblage types [WSN: windward, shallow (1-5m) and near-shore (within 100m); LSN: leeward, shallow and near-shore; LDN: leeward, deep (6-18 m) and near shore; LDO: leeward, deep and off-shore (beyond 100m)] in relation to area surveyed, live coral cover (%), species richness (n), species diversity and evenness expressed as H' and J' respectively. Values (n) include species present at the site in sizes less than 50 cm^2 which were not included in the calculation of H', but taken into account for the calculation of H' max.

Location	Type	Area	% Live Cover	n	H'	H'max	J'
North Coast							
Hodges Bay S (Site 28)	WSN	40m^2	14.39	9	1.23	1.20	1.03
Hodges Bay N (Site 29)	WSN	40m^2	9.98	7	1.21	1.95	0.62
East-Coast Northern Region							
Marigot Middle Bay W (Site 22)	WSN	40m^2	14.64	6 (7)	1.24	1.95	0.64
Marigot Middle Bay E (Site 23)	WSN	40m^2	11.93	8	1.14	2.08	0.55
East-Coast Central Region							
Castle Bruce SW (Site 26)	WSN	40m^2	3.98	5	1.31	1.61	0.80
Castle Bruce SE (Site 27)	WSN	40m^2	5.76	6	1.53	1.79	0.85
Saint Sauve W (Site 30)	WSN	40m^2	8.96	8	1.45	2.08	0.67
Saint Sauve E (Site 31)	WSN	40m^2	4.36	7	0.93	1.95	0.48
West-Coast Northern Region							
Tabby Bay S, (Site 5)	LSN	40m^2	7.58	13	1.71	2.56	0.67
Point Ronde S (Site 13)	LSN	40m^2	11.08	12	1.92	2.48	0.77
Coubari Bay (Site 17)	LSN	40m^2	6.75	15(18)	1.77	2.89	0.61
Cabrits NE (Site 24)	LDN	40m^2	17.13	14	1.85	2.64	0.70
Cabrits NW (Site 25)	LDN	40m^2	12.66	15	2.09	2.71	0.71
West-Coast Central Region							
Woodbridge Bay North (Site 1)	LSN	40m^2	21.01	14 (15)	1.26	2.71	0.46
Salisbury Bay North C (Site 2)	LSN	40m^2	21.55	13	1.33	2.56	0.52
Salisbury Bay North W (Site 3)	LSN	20m^2	21.28	13	1.40	2.56	0.55
Tarou Point (Site 4)	LSN	40 m^2	12.14	15	2.00	2.75	0.73
Les Point (Site 8)	LSN	36 m^2	2.25	6(7)	1.49	1.95	0.76
Floral Gardens NW (Site 11)	LSP	40 m^2	16.69	17(18)	2.10	2.89	0.73
Rena's (Site 15)	LDN	40 m^2	18.58	17(18)	1.93	2.89	0.67
Mero Mirabilis (Site 20)	LDO	30 m^2	29.95	6	0.48	1.79	0.44
Nose Reef (Site 21)	LDO	40 m^2	15.19	14(15)	2.07	2.75	0.75
West Coast Southern Region							
Champagne E (Site 6)	LSN	40m^2	17.79	12(14)	1.40	2.64	0.53
Champagne S (Site 19)	LSN	20m^2	19.68	9	1.15	2.20	0.52
Champagne W (Site 7)	LDN	20m^2	13.58	15(16)	2.13	2.77	0.77
Soufrière N (Site 9)	LDO	20m^2	11.63	11(12)	1.87	2.48	0.75
Pinnacles (Site 10)	LDO	40m^2	21.79	15(16)	1.85	2.77	0.67
Scotts Head N C (Site 12)	LSN	40m^2	31.88	10	1.51	2.30	0.66
Scotts Head NW (Site 14)	LDN	40m^2	12.83	10(11)	1.80	2.40	0.75
Scotts Head NE (Site 16)	LDN	40m^2	17.36	14(15)	1.96	2.75	0.71
Coral Gardens (Site 18)	LDO	40m^2	23.34	14(16)	1.86	2.77	0.67

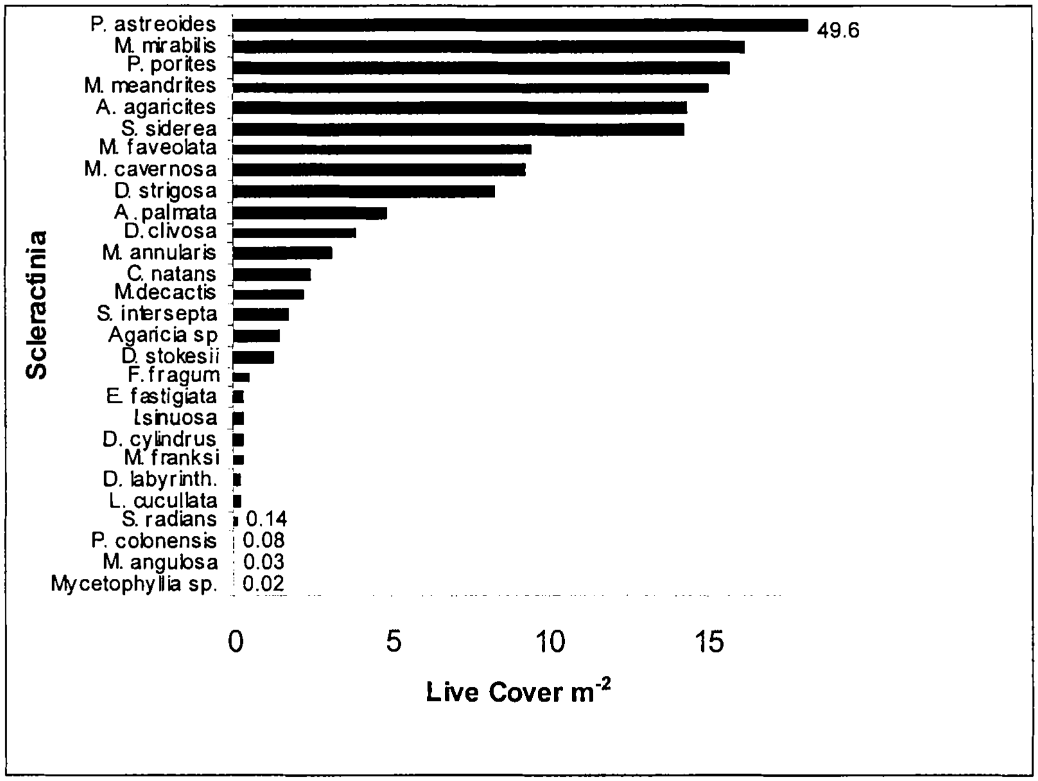

Figure 2: Total live cover (m^2) of individual Scleractinia.

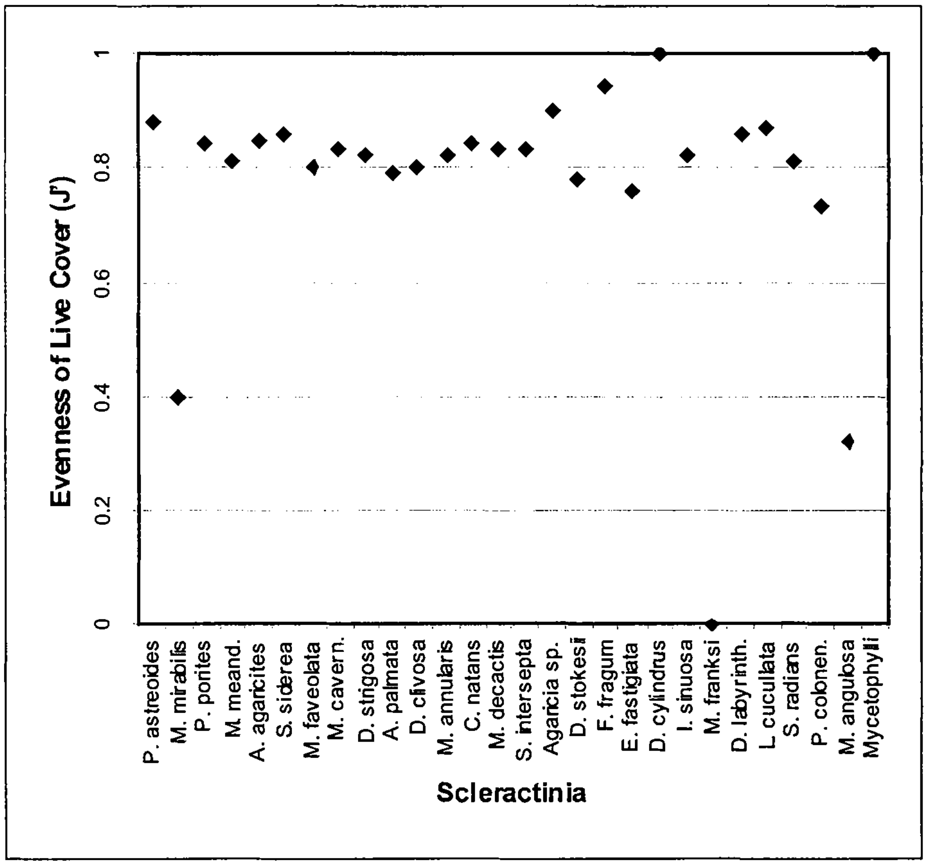

Figure 3: Evenness (J') of live cover distribution of individual Scleractinia.

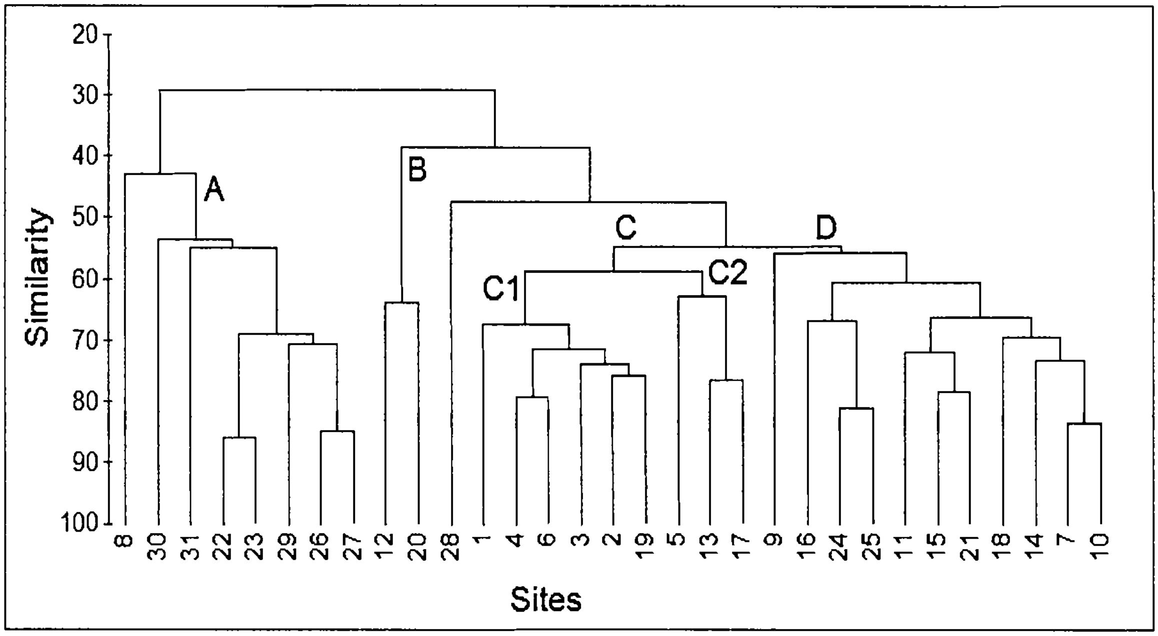

Figure 4: Bray-Curtis similarity among sites based on species-specific scleractinian cover.

Species Diversity

Species diversity expressed as H' ranged from 0.48 to 2.13 (Table 2). A significant difference (ANOVA, F=9.1, P=0.01) was noted between the diversity of east-coast assemblages (mean = 1.26) and those of the west coast (mean = 1.69). Among the west-coast assemblages, deeper sites (group D, 6-18m, Fig. 4) with a mean H' of 1.96 were more diverse than shallow sites (group C, 1-5m, Fig. 4) with a mean H' of 1.55 (ANOVA, F=16.2, P=0.01). Overall, comparatively high diversity values (H'>1.5) occurred at sites sheltered by depth or topographic features like coves.

Similarities Among Assemblages

Based on the comparison of species-specific live cover, east- and west-coast coral assemblages could be differentiated (Fig. 4). East-coast sites (Group A, Fig. 4) were characterized by comparatively low species richness and live cover and the presence of *A. ormosa* as one of the dominant corals. These sites also included *A. ormosa* frameworks, some of which have formed patch and fringing reefs. In contrast, the west-coast assemblages were characterized by higher coral cover, species richness, and diversity (see above).

Among the west-coast sites, two main groups (Groups C and D, Fig. 4) could be differentiated. Within Group C, subgroup C1 constitutes the assemblages in the southern and central regions of Dominica's west coast, while subgroup C2 constitutes those of the northern west coast. Group D contained assemblages that show signs of reef accretion, such as massive structures of carbonate buildup, which are absent at all but two other west-coast sites. The two exceptions were sites 12 and 20 (Group B, Fig. 4). Site 12 is dominated by large banks of bi-specific assemblages of *P. astreoides* and *M. mirabilis.*

Site 20 harbors mono-specific assemblages of *M. mirabilis.* Both of these sites are characterized by massive banks greater than 500 m^2 and have up to 3-5 meters of vertical (carbonate) accretion.

Two sites that did not fit the east-west differentiation were 8 and 28 (Fig. 4). Site 8 had comparatively few coral species with low benthic cover and was dominated by hydrocorals and sponges. Site 28, although a west-coast site harboring *A. ormosa*, was characterized by comparatively large amounts of *Siderastrea ormosa* and *Montastraea faveolata*, more typical for sheltered west-coast assemblages.

Scleractinia, Non-Scleractinian Sessile Invertebrates and Algae

Non-scleractinian sessile invertebrates were dominated by sponges and encrusting cnidarians such as the hydrocoral *Millepora* spp and the zooanthid *Playthoa caribeorum.* With the exception of *Sargassum* sp., fleshy macroalgae dominated the algal component at sheltered sites while filamentous turf algae dominated turbulent sites. A negative correlation was evident when comparing total coral cover to that of non-scelaractinian invertebrates (r = -0.47, P = 0.05). Similar comparisons to macroalgae rendered no significant correlation. Nevertheless, using MDS techniques, differences in the site-specific abundance presence of the three organism groups could be visualized (Figs. 5, 6, 7 and 8).

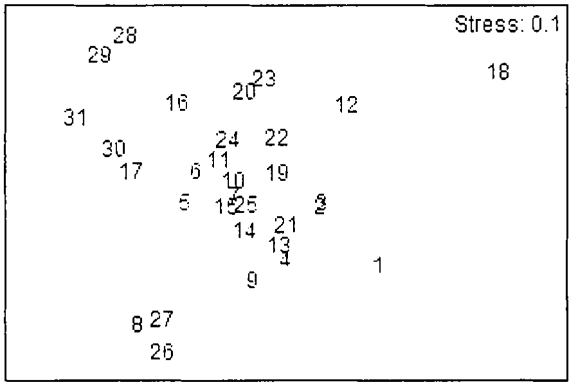

Figure 5: MDS Distribution

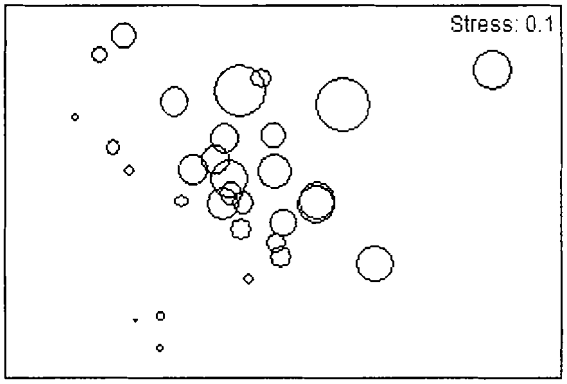

Figure 6: MDS Distribution of scleractinian cover

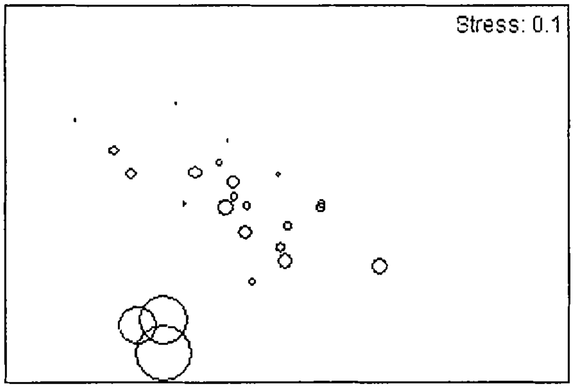

Figure 7: MDS Distribution on non-scleractinian sessile invertebrate cover.

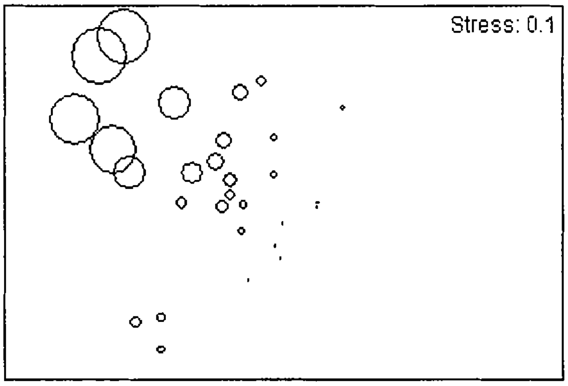

Figure 8: MDS Distribution of macroalgal cover.

DISCUSSION

Species Richness

Thirty-six species of Scleractinia were identified in this study. This represents the first comprehensive list and, so far, largest number reported for Dominica (compare to Summers, 1985). The species listed in this study include various formae and ecomorphs, which are considered to be separate species by some researchers. Hence, the species count for Dominica depends on the species differentiation applied. All but two species identified have a fairly broad geographic range of distribution across the wider Caribbean. *Tubastrea coccinea*, however, is known to have a random and isolated distribution (Cairns, 2000; Fenner, 2001). In Dominica, *T. coccinea* has been identified in only two locations near site 19 (Fig. 1). *Porites sp.* was found at several shallow and very turbulent sites on the east and north coasts. Corals fitting the general description of *Porites sp.* from Dominica were also observed in Los Roques (Venezuela), The Netherland Antilles, and Jamaica (E. Weil, pers. com.) Additional surveys may lead to the identification of further species such as *A. cervicornis* which has so far only been found in the form of skeletal remains.

Coral Assemblages

Dominica's zooxanthellate scleractinian assemblages are dominated by "constructional" species (*sensu* Schumacher and Zibrowius, 1985), such as *P. astreoides* and *M. meandrites*, rather than hermatypic species like *M. faveolata* (Fig. 2). This may account for the overall paucity of reef accretion observed in Dominica. In most reefal settings of the west coast, corals grow on volcanic rock. Carbonate frameworks are rare as are coral reefs in the strictest sense. Where reef accretion is evident, assemblages are sheltered from turbulence by depth or coves. These sites could be considered to have "intermediate disturbance levels" (*sensu* Connell,1978) with regard to turbulence.

Interestingly, one of the main reef-builders on the west coast is *M. mirabilis* (Fig. 2 and Group B, Fig. 4) which forms mono-specific as well as bi-specific assemblages with *P. porites* (Steiner and Borger, 2000). It appears that the delicate, branching colony morphology of *M. mirabilis* enhances the fallout of sediment. Analogous to the "race" between sedimentation and growth rates in sea-grass beds that lead to the formation of rhizome layers (Ott, 1988), sediments accumulate between the branches of *M. mirabilis* assemblages thus solidifying the bioherm and leading to the formation of large banks. Similar aggregations were reported for the Indo-Pacific and eastern Pacific (Cortés, 1997), the western Arabian Sea (Glynn, 1993) and the Gulf of Aden (Kemp and Benzoni, 1999). For the west coast as a whole, *M. mirabilis* is among the most successful reef-building corals (see also Fig. 4, Group B) and its role as part of Dominica's reefal communities deserves further attention.

In contrast to the west coast, *A. palmata* is the main hermatypic scleractinian component of east-coast fringing reefs. However, these reefs are marked by low live cover (Table 2), possibly associated with the wide-spread decline of *A. palmata* which was also reported for the eastern Caribbean island of Barbados (Lewis, 1984). So while the east coast does harbor "true coral reefs", they are mostly dead.

Differences between the leeward (west, Groups B, C, and D, Fig. 4) and windward (east, Group A, Fig. 4) coral assemblages were also evident with regards to species richness, diversity and live cover (Fig. 4). The west coast harbors the more diverse assemblages with a higher live cover (Table 2). However, the surveys carried out along the east coast to date do not include sites deeper than 6m. It is therefore unknown whether the lower diversity and live cover seen in east-coast shallow reefs is an indication of the type of assemblages to be expected in deeper waters. In comparison to the west coast where deeper reefs (6-8 m) were more diverse and marked by a higher percent live cover (Table 2), deeper reefs of the east coast may also have greater diversity and live cover.

The question remains, why are there only few signs of reef accretion on the leeward side where larger number of species provide larger live benthic cover compared to east-coast reefs? One explanation is related to Dominica's young volcanic topography. The western shelf of the island is narrow (50-500 meters) and steep, providing no energy-dissipating features. Storms thus impact coastal environments with full force. It is likely that entire coral colonies or fragments are either washed onto shore during storm events, as happened during Hurricane Lenny in November 1999 (pers. obs.), buried in the sandy shelf, or transported into aphotic depths. Thus, the survival of coral fragments would be minimal and the frequency and intensity of storm-related disturbances would be among the controlling forces of reef accretion. In addition, the close proximity of fluvial sediment fallouts have certainly also influenced reef development (Scleractinia, non-scleractinian invertebrates and macroalgae), especially during the 19th century when agriculture–related deforestation was at its peak.

The comparison of scleractinian cover and that of other heterotrophic and autotrophic benthic groups may render valuable perspectives on the status of coral assemblages and reefs. Although not the main focus of this study, the non-scleractinian data serve as reference points for the detection of potential future phase shifts as described for Jamaica (Hughes 1994) and Panama (Lessios, 1995), and are evaluation factors in the density of algae and vagile reef consumers. In Dominica, the 18% increase of *Diadema antillarum* from 2001 to 2002 coincided with a 15% decrease of turf and macroalgae combined (Steiner and Williams, in prep). Should this trend continue an increase in coral cover may follow although increased echinoid grazing pressure may reduce coral recruitment rate.

CONCLUSIONS

The data presented here underline the fact that Dominica's reefal environments are diverse in terms of species richness but not in terms of live cover and physical structure (reef accretion). Having a relatively small total surface area, these marginal systems are "clinging" to the narrow shelf and lie in close proximity to Dominica's urban developments. There is no question that conservation measures are valid and necessary should this natural resource be protected. Furthermore, a patchy array of coral ssemblage types constitutes the reef resources of Dominica. The patchiness is evident in the scattered presence of stable substrates adequate for coral growth due to the extensive sandy areas produced by fluvial sediment outputs. It is also evident in the benthic cover and geographic distribution of individual species. Not all species that have an overall high percent of coral cover are present in a high number of locations (Table 1). Consequently, individual types of coral communities cover an even smaller surface area than the already limited scleractinian cover of the island. These features of Dominica's coral assemblages are key reference points in evaluating the adequacy of indiscriminate or "across-the-board" conservation measures such as site-use allocation.

Given the relatively small area suitable as coral-reef habitat and a coral cover that is influenced by the shelf morphology with its absence of energy-dissipating features, these coral communities represent a limited and fragile natural resource. Considering the effects of (a) hurricanes on narrow-shelved islands which have been poorly recorded in Dominica but were well-documented in the neighboring islands of Guadeloupe and Martinique (Bouchon and Laborel, 1986; Bouchon *et al.*, 1991), (b) deforestation between the late 18th and early 20th century (Honychurch, 1995), as well as (c) overfishing on reefs throughout the 20th century (pers. com. H. Guiste; IRF/CCA, 1991), it is probable that such a system has been negatively affected by human activities and that it will not remain in its current condition. Statements such as "the low population level and lack of extensive coastal development has meant that reef communities have not been severely impacted by human activities" (Smith *et al.,* 1997) are not convincing and relay a false sense of security. On a small island like Dominica, the overall population may be low (~ 71,00 in 2001), yet approximately 90% of the population is living along the shores (Commonwealth of Dominica, census 2001) and is using the marine resources on a daily basis in extractive and intrusive ways. Thus, human impacts originating from past and current resource uses are to be expected (see Jackson, 1997). It is, and will be, challenging to conserve these reefal resources in light of their marginal scale and the array of natural and anthropogenic disturbances that are, and have been, affecting Dominica's marine environments.

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