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STONY CORALS AND REEFS OF DOMINICA

BY

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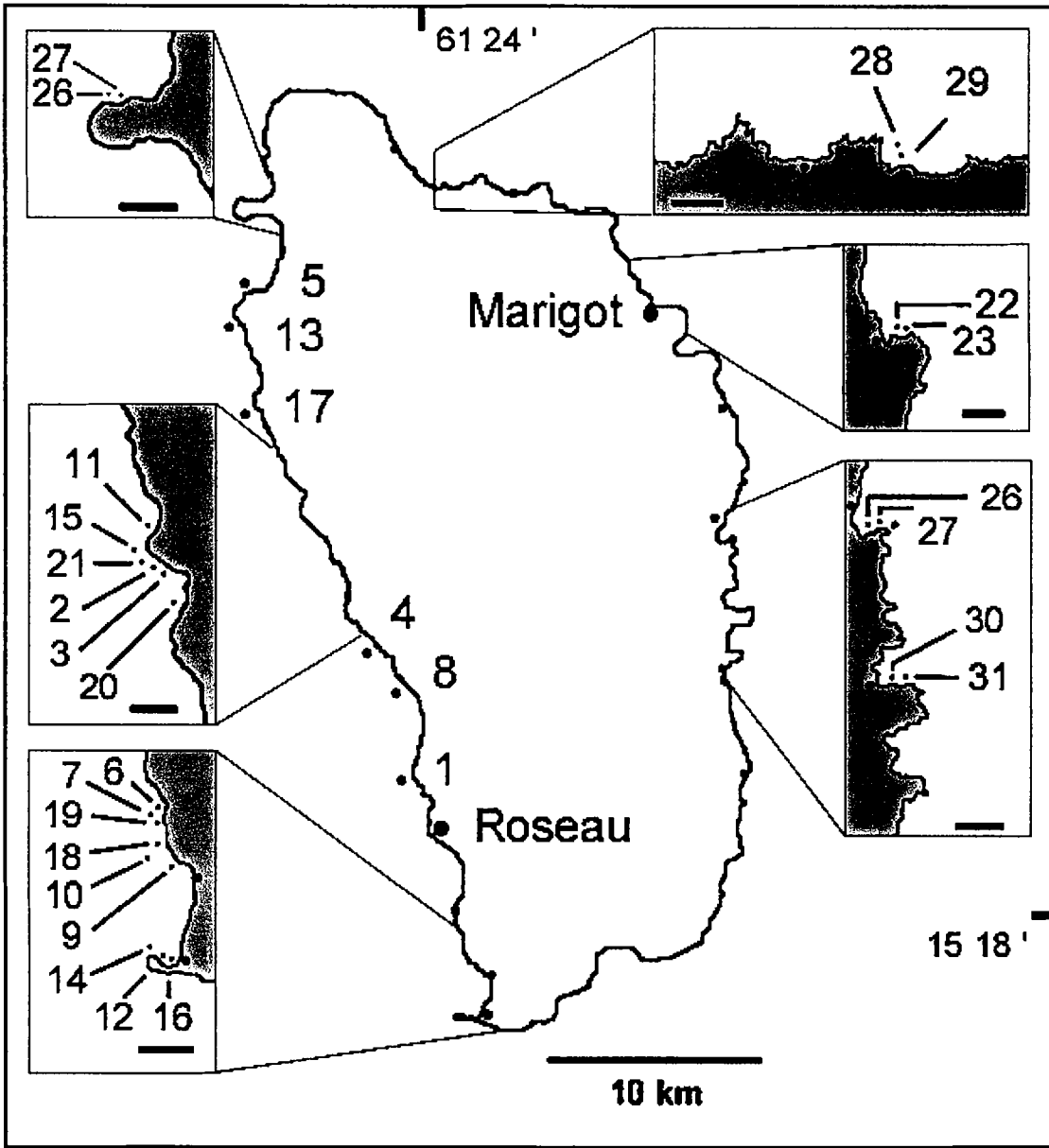


Figure 1. Commonwealth of Dominica, Lesser Antilles. Study sites. Scale bars in area boxes are 1 km.

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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 m² area examined, constituting 29.7 % of the total live coral recorded (166 m²). 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 scleractinian 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 km² 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 km² 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 m² of benthos from Dominica's eastern, northern, and western coasts.

METHODS

Data Collection

A 1 m² quadrat subdivided into 100 squares of 100 cm² 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 cm². In this study *Porites* sp. was included in the *P. astreoides* count.

Organisms ≥ 50 cm² were recorded and their benthic cover was estimated. Organisms and colonies smaller than 50 cm² were noted as present but not included in subsequent data analysis. Using a sample size of 20 m², 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 m² 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 $\geq 10\%$ 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 m² 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 m², 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: $\geq 10\%$ of total live coral cover surveyed (166.7 m²); common: 1% - 9.9% of total live coral cover; uncommon: $\leq 0.9\%$ of total coral cover; rare: not present within surveyed area. Only colonies with a size of 50 cm² or more were considered. The presence of species across sites is expressed as % site overlap.

	Species	Abundance	Site Overlap (%)
1	<i>Stephanocoenia intersepta</i> (Milne Edwards and Haime, 1848)	uncommon	73.3
2	<i>Madracis mirabilis</i> (Duchassaing and Michelotti, 1860)	abundant	53.3
3	<i>Madracis decactis</i> (Lyman, 1859)	common	46.7
4	<i>Madracis ormosa</i> (Wells, 1973)	rare	n/a
5	<i>Acropora palmata</i> (Lamarck, 1816)	uncommon	4.8
6	<i>Siderastrea siderea</i> (Ellis and Solander, 1786)	common	93.3
7	<i>Siderastrea radians</i> (Pallas, 1766)	uncommon	20.0
8	<i>Agaricia agaricites</i> forma <i>agaricites</i> (Linnaeus, 1758)	common	100.0
	<i>Agaricia agaricites</i> forma <i>purpurea</i> (Lesueur, 1821)	rare	n/a
9	<i>Agaricia fragilis</i> (Dana, 1884)	rare	n/a
10	<i>Agaricia humilis</i> (Verill, 1901)	rare	n/a
11	<i>Agaricia</i> spp. (mostly <i>A. lamarcki</i>)	common	33.3
12	<i>Leptoseris cucullata</i> (Ellis and Solander, 1786)	uncommon	33.3
13	<i>Meandrina meandrites</i> (Linnaeus, 1758)	abundant	86.6
14	<i>Dichocoenia stokesii</i> (Milne Edwards and Haime, 1848)	uncommon	46.7
15	<i>Dendrogyra cylindrus</i> (Ehrenberg, 1834)	uncommon	13.3
16	<i>Mussa angulosa</i> (Pallas, 1766)	uncommon	6.7
17	<i>Scolymia</i> sp.	rare	n/a
18	<i>Isophyllia sinuosa</i> (Ellis and Solander, 1786)	uncommon	26.7
19	<i>Isophyllastrea rigida</i> (Dana, 1848)	rare	n/a
20	<i>Mycetophyllia aliciae</i> (Wells, 1973)	uncommon	13.3
21	<i>Mycetophyllia ferox</i> (Wells, 1973)	rare	n/a
22	<i>Favia fragum</i> (Esper, 1797)	uncommon	26.7
23	<i>Colpophyllia natans</i> (Houttuyn, 1772)	common	80.0
24	<i>Diploria strigosa</i> (Dana, 1848)	common	80.0
25	<i>Diploria clivosa</i> (Ellis and Solander, 1786)	uncommon	46.7
26	<i>Diploria labyrinthiformis</i> (Linnaeus, 1767)	uncommon	20.0
27	<i>Montastraea annularis</i> (Ellis and Solander, 1786)	common	20.0
28	<i>Montastraea faveolata</i> (Ellis and Solander, 1786)	common	80.0
29	<i>Montastraea franksi</i> (Gregory 1895)	uncommon	6.7
30	<i>Montastrea cavernosa</i> (Linnaeus, 1767)	uncommon	66.7
31	<i>Eusmilia fastigiata</i> (Pallas, 1766)	uncommon	26.7
32	<i>Porites porites</i> (Pallas, 1760)	common	100.0
	<i>Porites porites</i> forma <i>divaricata</i>	rare	n/a
33	<i>Porites astreoides</i> (Lamarck, 1816)	abundant	100.0
34	<i>Porites</i> sp.	rare	n/a
35	<i>Porites colonensis</i> (Zlatarski, 1990)	uncommon	20.0
36	<i>Tubastrea coccinea</i> (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 cm² 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

