Progress in Aqua Farming and Marine Biology
ISSN: 2640-6764
Chembio Publishers
Right Choice for Researchers

Research Article

Volume 2; Issue 1

# Biodiversity of Coral Reef Communities in Marginal Environments along the North-Eastern Coast of Trinidad, Southern Caribbean

**Belford SG[1]*, Phillip DAT[2], Rutherford MG[2], Schmidt Roach S[2,3] and Duncan EJ[2]**

[1]Martin Methodist College, USA

[2]Department of Life Sciences, The University of the West Indies, St Augustine, Trinidad & Tobago, W.I.

[3]Institute for Marine and Antarctic Studies, University of Tasmania, Australia

***Corresponding author:** SG Belford, Martin Methodist College, 433 West Madison Street, Pulaski, Tennessee, 38478, USA, Tel: 1-931-424-4621; Email: sbelford@martinmethodist.edu

**Received Date:** April 15, 2019; **Published Date:** April 25, 2019

## Abstract

A survey of the biological diversity of coral and associated reef organisms was conducted for the Salybia and Grande L'Anse reefs along the north-eastern coast of Trinidad by reviewing the literature, museum collections, and conducting field surveys between the years 2005 through 2019. Surveys conducted used the line and point intercept and quadrat techniques to gather data. If unidentified and incompletely identified specimens are not included, this study found 257 species belonging to 134 families, 23 classes, and 11 phyla. Most species belonged to Mollusca (75 species), Chordata (57), Cnidaria (43) and Arthropoda (33). Despite their proximity to each other, only 42 species were common to both reefs. Of the other species, most (178) were found at Salybia Reef. Only members of Phylum Porifera showed a greater species richness at Grande L'Anse Reef than Salybia Reef, with five and two species, respectively. This is the first complete marine biodiversity survey for the most north-eastern part of Trinidad, which includes the only fringing coral reef in Trinidad. Coral reef monitoring is essentially important in this area, as there are current plans to build a port at Grande L'Anse Reef, thus potentially destroying a valuable area of the coral reef network observed along the north-eastern coast of Trinidad.

**Keywords:** Southern Caribbean; Grande L'Anse Reef; Salybia Reef; Benthic Communities; Marine Biodiversity; Marine Ecology

## Introduction

Caribbean coral reefs, like coral reefs across the globe, are among the world's most valuable and most threatened ecosystems, making them a major priority for conservation and management [1,2]. Globally, coral reefs are considered one of the most biologically diverse ecosystems in the world [3,4]. They cover only ~0.1% of the surface of the planet, yet hold an estimated 95, 000 described species, equivalent to 5% of the world's known diversity (1.9 million species), and about 35% of all described marine species [4,5]. It is likely that coral reefs may contain as many as 3 million (described and un-described) species [6]. Caribbean reefs are important as

**Citation:** Belford SG, et al. Biodiversity of Coral Reef Communities in Marginal Environments along the North-Eastern Coast of Trinidad, Southern Caribbean. Pro Aqua Farm Marine Biol 2019, 2(1): 180017.

Copyright © 2019 Belford SG, et al.

the storehouse of the bulk of the Atlantic Ocean's coral reef and associated biodiversity, which is estimated to contain about 30, 000 (known and un-known) coral reef-associated species [6].

Apart from being incubators of much of the world's marine biodiversity, coral reefs provide several critical ecosystem goods and services such as physical (*e.g*., shoreline protection), ecological (*e.g*., nutrient cycling, provision of fisheries resources), biogeochemical (*e.g*., acting as a carbon sink) and socio-cultural (*e.g*., recreation and tourism) benefits [7]. Despite their importance, coral reefs are among the most threatened of the world's ecosystems [8]. Threats to reefs range from over-exploitation and use of destructive resource exploitation methods, to pollution, disease outbreaks and climate change [2,9]. Wilkinson [10] estimated that as much as 20% of coral reefs across the globe had been destroyed, with very little chances of recovery, and further, that 24% of the reefs across the world were facing impending collapse. Caribbean reefs seem to be particularly vulnerable, as they have suffered disproportionally greater degradation, and are worse at recovering from disturbances than reefs elsewhere [11-13].

Under these circumstances, obtaining baseline information from biological surveys across the full range of variation of these reefs, and an understanding of the processes that help maintain coral reef diversity on individual reefs is critical for quantifying losses, and establishing restoration targets [14]. However, as Reaka-Kudla [6] observed, it is amazing how little we know about the taxonomic diversity of coral reef communities; and other information critical to the protection and maintenance of these ecosystems (*e.g*., abundance, ecological role, and reproductive biology and habitat affiliations of individual species). She indicated that one of the most basic information gaps that needed to be filled, as a priority, was simply what species occur on individual reefs, and argued that it was also important to know the distribution of species across reefs. These statements are valid for the Caribbean, where gaps in much of our knowledge exist for several reasons. Firstly, what we do know is based on selected, charismatic reefs, particularly those that meet a relatively narrow set of criteria-*e.g*., most coral reefs were studied in clear, tropical, coastal waters-with low-coral-diversity systems in marginal conditions largely ignored. Secondly, even the best-studied Caribbean reefs have not been thoroughly inventoried relative to species diversity, as the focus has usually been on a few taxonomic groups: *e.g*., corals, fishes, algae and sponges, with less attention paid to cryptic sessile fauna and non-disease-forming microbes [6]. This restricted focus may have arisen because many methods used in coral reef surveys have a limited focus suited to very specific research objectives (*e.g*., Atlantic and Gulf Rapid Reef Assessment (AGRRA), which was intended to provide information on coral reef accretion and degradation, focuses on reef builders and bioeroders). Additionally, there was the real problem of access to taxonomic expertise in the region [6]. Finally, data held by institutions across the region have not been collated and synthesised into a regional database, nor made easily accessible to researchers and/or resource managers [6]. As a result, we have only an incomplete idea of what biodiversity Caribbean coral reefs hold, what was lost, what was retained, and how this biodiversity is distributed across the region, and therefore we do not have adequate baseline descriptions of reef communities that can be useful for restoration [15].

The present study attempts to address one of the information gaps identified above, simply knowing what biodiversity exists in Caribbean coral systems is helpful with developing management or protection for these ecosystems. The focus will be little-known coral communities in the twin-island nation, Trinidad & Tobago (T&T), since it may be important to study previously neglected reefs, especially those in marginal conditions, as they may act as biodiversity reservoirs/refugia, or contain unique elements or combinations of biological diversity [16]. It is important to establish current baseline conditions (*e.g*., biological diversity, ecosystem health) for these ecosystems, and determine what, if any, contribution they can make to the fight to conserve Caribbean coral reef biodiversity. T&T was selected because: 1) the coral systems closest to, and able to survive the influence of the freshwater output from the Amazon and Orinoco rivers are located in Trinidad, so there are several marginal coral systems for a discussion on marginal conditions and reef marginality) in the country [14,17]; 2) T&T is located at the intersection of three western Atlantic biogeographic regions, the insular Caribbean, the continental Caribbean, and south-eastern continental South America, and may therefore have unique biota with elements of all three zones; 3) the most marginal of the reefs, those in Trinidad, have not been studied since T&T's reefs of worth are considered by many to be restricted to the more northerly of the two islands, Tobago, which therefore attracts almost all of the attention given to coral reef research in the country.

Trinidad, whose marine environment can be considered hostile to coral reef development due to the influence of highly-turbid, nutrient-rich, freshwater runoff from South America, has coral communities of varying sizes and stages of marginality, particularly along its northern coastline. These reach their highest level of organisation at Salybia Reef, which is considered to be a young fringing reef, located on the eastern extremity of the north coast

[18]. Though considered to be marginal, Trinidad's coral systems do provide important ecosystem goods and services, whose value, generally, have not been appreciated by resource managers. Grande L'Anse Reef, for instance, provides some measure of protection for housing and infrastructure along an otherwise eroding coastline (*e.g*., part of the coastal road slumped into the sea just over 10 years ago). Some, such as those at Macqueripe, Blanchisseuse and Toco Bay, provide sea moss, shell- and fin-fish, and recreation.

The objective of this paper is to challenge the widely-held view that marginal reefs are of little biological value by demonstrating that they can be remarkably species rich. We therefore compiled species lists of the macrobiota for two marginal coral systems on the north coast of Trinidad.

## Methodology

Salybia and Grande L'Anse reefs were chosen for the present study since both meet the same criteria set by Kleypas, et al. [19] for defining marginal coral systems, and both had been the subject of *ad hoc* biological collecting in the 20th and early 21st centuries. Descriptions of the biological diversity of these two coral systems were found in Kenny, et al. [18] and Ramsaroop [20]. Kenny, et al. [18] provided a qualitative description of the Salybia Reef that included brief, and somewhat cursory, mention of a number of taxa. Ramsaroop [20] described the octocorals of Trinidad, including those found on the Grande L'Anse Reef in Toco Bay. Later, Duncan & Lee Lum [21] published a checklist of the marine macroalgae of Trinidad & Tobago, citing several species from both Salybia and Grande L'Anse reefs.

### Site Descriptions

Salybia and Grande L'Anse reefs are located near the eastern extremity of the north coast of Trinidad (Figure 1), and are located at the eastern and western ends of an almost contiguous band of coral communities spanning several bays in this part of the island. Both reefs are shallow, turbid, high-energy systems, with *Porites* sp. as the main reef-building (hermatypic) coral. Maximum depths on the reef flats were less than 2 m. At Salybia, the shallow part of the reef (*i.e*., reef crest to back reef) ran approximately 1.3 km along shore, traversing Pequelle and Salybia bays, and extended about 200 m from shore to the outer edge of the reef crest. The shallow reef was bisected by the Salybia River, with noticeable differences on either side of the resulting stone bank and channel through the reef: there was a sandy lagoon with small *Porites* sp. outcrops, *Porites* sp. rubble and a seagrass bed to the west of the channel, whereas to the east, the lagoon was replaced by a broad *Porites* rubble zone, interspersed with small *Porites* colonies. Kenny, et al. [18] estimated that water depth in the lagoon ranged from 0.5-2m. There was obvious zonation progressing from the back reef to the reef crest; the latter was dominated by zoanthids, particularly *Palythoa caribaeorum.* Reef slope development was poor along the eastern and northern borders of the reef [18]. To the west, there were deeper waters dominated by octocorals.

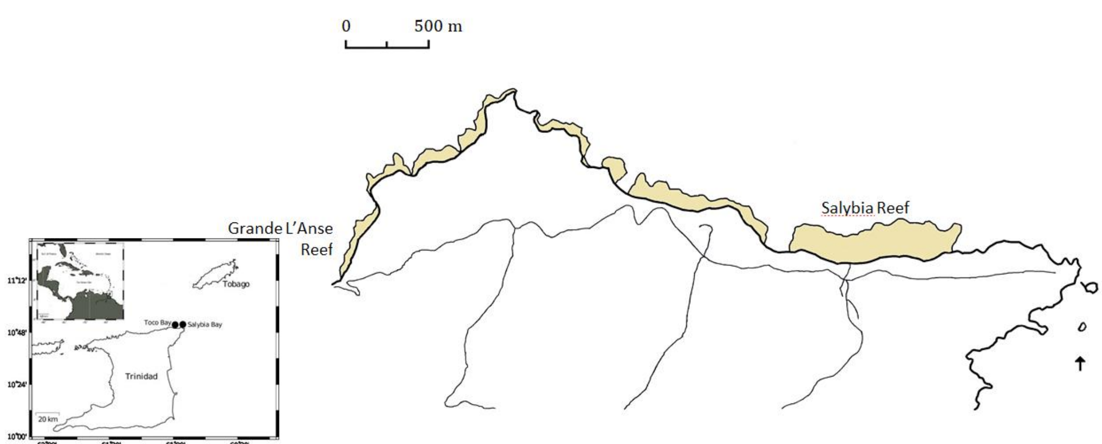


**Figure 1:** Location of the two coral communities examined by the present study. Grande L'Anse Reef is located across Baptiste Bay to the north and Toco Bay to the south, and Salybia Reef runs from Pequelle Bay to the east to Salybia Bay to the west. Shaded areas represent the extent of coral communities along the north coast of Trinidad. The insert is a map of the Caribbean showing the location of Trinidad & Tobago and a map of Trinidad and Tobago showing the location of the two main bays in which the coral communities are located. The inset is adapted from Belford & Phillip [14].

At Salybia Reef, surface salinities typically ranged from about 30-35 p.s.u. [18,20]. During the rainy season patches of low-salinity (5-15 p.s.u.) water were found near the outfalls of the three streams that emptied onto the reef [18]. Surface water temperatures ranged between 25 and 28°C, though in sunny conditions during lowest spring low tides extreme highs of 32°C and more recently 33°C have been measured [18,20]. There was a pronounced westerly current over the reef, which flowed at rates of 1.08–20 cm $s^{-1}$, except at the western end of reef crest where water flow was constricted near the shoreline, and current speeds in excess of 1 $ms^{-1}$ have been recorded [18]. Kenny, et al. [18] estimated the discharge rate of water from the lagoon to be 30, 000 $m^3hr^{-1}$.

Grande L'Anse Reef was a much smaller system to the west of Salybia Reef. The shallow part of the reef (*i.e.*, reef crest and back reef) ran approximately 0.8 km along shore, traversing Toco Bay, from Baptist Bay to the fishing jetty, and extended only about 50 m from shore to the outer edge of the reef crest. Though it was possible to distinguish zonation on this reef (Schmidt-Roach pers. obs.), there was minimal back reef, with no discernible lagoon or rubble zone. As with Salybia, the main hermatypic coral found on the reef flat was *Porites* spp., and the reef crest was dominated by soft corals, especially *Palythoa caribaeorum*. Reef slope development was also poor along the northern border of the reef, but to the west, there was deeper water dominated by octocorals.

Surface salinities on Grande L'Anse Reef ranged from 0.1-35.7 p.s.u. (Phillip & Belford unpubl. data). The very low salinities (0.1-12 p.s.u.) were obtained in distinct spots, almost midway between shore and the reef crest, during a very low spring low tide after a period of heavy rainfall. Such low salinities were obtained in areas of upwelling of fresh ground water; geologically, the northeastern peninsula is bisected by a swath of highly-fractured sandstone whose northern boundary ends into Toco Bay. Temperatures, which varied between 23.8 and 33.6 °C, were generally about 1 °C lower than those recorded at Salybia Reef. As with Salybia Bay, currents were generally westerly, flowing at speeds of 1.17–11.03 cm $s^{-1}$.

## Sampling

The species lists presented here focus only on the macrobiota, and are based on information compiled from surveys conducted by the authors in 2005 and 2008-2019; from reviews of museum collections; and from published and unpublished reports. The shallow depth, high turbidity and fierce waves made it difficult to conduct fieldwork on these reefs at most times of the day, and during most of the year. Fieldwork was therefore restricted to daytime low tides, especially during the period from about March to September, which was when spring tides resulted in more accommodating water conditions.

In the field, species diversity was determined using unstructured exploration of the reefs during which specimens were either collected, photo- or video-graphed *in situ*, and in structured surveys using line and point intercept, and quadrat survey methods. Line and point intercept and quadrat methods were used along transects run from shore to the reef crest at 50-m intervals. For the line and point method, the identity of the benthos under the transect at 1-m intervals was recorded. If it was difficult to identify the organism *in situ*, photographs were taken for later identification using taxonomic keys. Benthic invertebrates were sampled using 0.25 $m^2$ quadrats deployed along transects running parallel to shore. Using these, four 25 $cm^3$ of substrate were collected and taken back to the laboratory where the replicates were sorted separately, and specimens identified to the highest taxonomic level using available keys. Whenever possible, specimens were kept alive and returned to the reef after being identified.

Algae and plants were identified using field identification guides, whereas invertebrates were identified using a series of publications [22-33]. Fishes were identified using Humann & deLoach [34]. Additionally, specimens and registers in The University of the West Indies' Zoology Museum (UWIZM) and the National Herbarium (TRIN), both in the Department of Life Sciences, U.W.I., St. Augustine, and published and unpublished literature were reviewed for specimens and references to species occurring on these two reefs. Holdings of other collections were also accessed via the Global Biodiversity Information Facility [1]. Currently accepted taxonomic information for all species were as given in Boxshall, et al. [35].

## Results

The species list presents a total of 225 species (+32 unidentified), belonging to 167 genera (+7 unidentified), 133 families (+ 1 unidentified), 52 orders (+1 unidentified), 21 classes (+2 unidentified, one of which is due to unresolved taxonomic issues in the phylum), in 11 phyla, and three kingdoms (Chromista, represented by one phylum; Plantae, represented by three phyla; and

[1] http://www.gbif.org/ accessed as http://data.gbif.org/download/preparingDownload.htm?downloadFile=occurrence-search-13826338474793794280490869377111.zip, 23rd October 2013

Animalia, represented by seven phyla). The most speciose phyla were the Mollusca, followed by the Chordata, Cnidaria and Arthropoda. A far larger number of species was reported from Salybia Reef than from Grande L'Anse (Table 1). There were just under five times more species recorded only on Salybia Reef than on Grande L'Anse Reef, not including shared species. The number of species recorded at Grande L'Anse Reef was almost as many as the number shared with Salybia. Only one phylum, Porifera, showed a greater species richness at Grande L'Anse than Salybia, with four and one species, respectively.

The Chromista was represented four species of brown algae, or Phaeophyceae. In the plant kingdom, there was a single flowering plant *Thalassia testudinum*, and over 22 species of algae (representing at least 2 phyla (green and red algae), 5 classes, 9 orders, 16 families and 17 genera). If the algae were considered, altogether there were > 4 algae in Toco Bay and >20 species in Salybia. There were few species in common between the two reefs (*Caulerpa racemosa, C. sertularioides* and *Thalassia testudinum*). This may be an underestimate as some of the unidentified species may represent species shared between the two systems. One of the incompletely identified species *Gracilaria* sp. listed for Grande L'Anse Reef, for instance, may actually belong to one of the *Gracilaria* species listed for Salybia Reef (Table 2). In addition, the unidentified rhodophyte listed as a crystalline coralline alga (Table 2), is likely to comprise more than one species, at least one of which may be common to both reefs.

A greater diversity of Porifera was reported for Grande L'Anse Reef with only one species shared between the two reefs (Table 1). An examination of the actual species (Table 2) showed that those listed only for Grande L'Anse were typical of deeper, calmer waters, whereas reef-flat species were found at Salybia. This reflects the habitats from which sponge data were collected on the two reefs.

Cnidarians, particularly anthozoans, were relatively well represented on both reefs (Table 1). Though both reefs were described as overwhelmingly dominated by branching *Porites* spp., at least 10 other species of scleractinian corals were reported for Salybia, and three for Grande L'Anse (Table 2). Examination of the notes in table 2 showed that some of the species reported for Salybia (*Acropora prolifera*, *Montastrea cavernosa*, *Diploria clivosa* and *Oculina* sp.) have not been reported since the 1970s or late 1990s. Ahermatypic anthozoan diversity was dominated by the alcyonaceans, 12 (+5 unidentified) of 17 (+6 unidentified) species, particularly the gorgonians and plexaurids, most of which were reported for Grande L'Anse Reef (Table 2).

Molluscs were overwhelmingly dominated by the Gastropoda, which accounted for 57 (+2 unidentified) of the 75 species in the group (Table 1). Twenty two of these were archaeogastropods, the most speciose of the gastropod orders in the study (Table 2). Almost half of the species of gastropods reported for Grande L'Anse were also found in Salybia Reef. Though most were small, cryptic species, some (*e.g*., *Cittarium pica*, the West Indian topsnail, and *Lobatus raninus*, the hawkwing conch) were larger species of local commercial value (DAT Phillip pers. obs.). Others, such as the nudibranch, *Elysia crepistata*, were very visible at times due to their apparent seasonal population explosions (DAT Phillip & SG Belford pers. obs.). In addition, six species each of bivalves and polyplacophorans, and three (+1 unidentified) octopi were recorded.

| **Taxon: Class and Phylum (in bold)** | **Salybia only** | | | **Grande L'Anse only** | | | **Shared** | | | **Both sites combined** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Id. | Unid. | Total | Id. | Unid. | Total | Id. | Unid. | Total | Id. | Unid. | Total |
| Phaeophyceae | 4 | | 4 | | | | | | | 4 | | 4 |
| **Total Ochrophyta** | 4 | | **4** | | | | | | | 4 | | **4** |
| Chlorophyceae | 1 | | 1 | | | | | | | 1 | | 1 |
| Ulvophyceae | 4 | 1 | 5 | 3 | 1 | 4 | 2 | | 2 | 9 | 2 | 11 |
| **Total Chlorophyta** | 5 | 1 | **6** | 3 | 1 | **4** | 2 | | **2** | 10 | 2 | **12** |
| Florideophyceae | 11 | 1 | 12 | | 1 | 1 | | | | 11 | 2 | 13 |
| unidentified | | | | | | | | 1 | 1 | | 1 | 1 |
| **Total Rhodophyta** | 11 | 1 | **12** | | 1 | **1** | | 1 | **1** | 11 | 3 | **14** |
| unresolved | | | | | | | 1 | | 1 | 1 | | 1 |
| **Total Trachaeophyta** | | | | | | | 1 | | **1** | 1 | | **1** |
| Desmospongiae | 1 | | 1 | 4 | | 4 | 1 | | 1 | 6 | | 6 |
| **Total Porifera** | 1 | | **1** | 4 | | **4** | 1 | | **1** | 6 | | **6** |
| Hydrozoa | | | | | | | 1 | | 1 | 1 | | 1 |
| Scyphozoa | 1 | | 1 | | | | | | | 1 | | 1 |
| Anthozoa | 9 | 2 | 11 | 4 | 5 | 9 | 19 | 2 | 21 | 32 | 9 | 41 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Cnidaria** | 10 | 2 | **12** | 4 | 5 | **9** | 20 | 2 | **22** | 34 | 9 | **43** |
| Bivalvia | 5 | | 5 | 1 | | 1 | | | | 6 | | 6 |
| Cephalopoda | 3 | | 3 | | 1 | 1 | | | | 3 | 1 | 4 |
| Gastropoda | 38 | 2 | 40 | 11 | | 11 | 8 | | 8 | 57 | 2 | 59 |
| Polyplacophora | 6 | | 6 | | | | | | | 6 | | 6 |
| **Total Mollusca** | 54 | 2 | **54** | 12 | 1 | **13** | 8 | | **8** | 72 | 3 | **75** |
| Polychaeta | 1 | | 1 | | | | 1 | | 1 | 2 | | 2 |
| **Total Annelida** | 1 | | **1** | | | | 1 | | **1** | 2 | | **2** |
| Malacostraca | 27 | 1 | 28 | 1 | | 1 | | | | 28 | 1 | 29 |
| Maxillopoda | 4 | | 4 | | | | | | | 4 | | 4 |
| **Total Arthropoda** | 31 | 1 | **32** | 1 | | **1** | | | | 32 | 1 | **33** |
| Asteroidea | 1 | | 1 | | | | | | | 1 | | 1 |
| Crinoidea | | | | 1 | | 1 | | | | 1 | | 1 |
| Echinoidea | 1 | | 1 | | | | 1 | | 1 | 2 | | 2 |
| Holothuroidea | 4 | | 4 | | | | | | | 4 | | 4 |
| Ophiuroidea | 2 | | 2 | | | | | | | 2 | | 2 |
| **Total Echinodermata** | 8 | | **8** | 1 | | **1** | 1 | | **1** | 10 | | **10** |
| Actinopterygii | 35 | 13 | 48 | 4 | | 4 | 4 | 1 | 5 | 43 | 14 | 57 |
| **Total Chordata** | 35 | 13 | **48** | 4 | | **4** | 4 | 1 | **5** | 43 | 14 | **57** |
| Grand total | 158 | 20 | 178 | 29 | 8 | 37 | 38 | 4 | 42 | 225 | 32 | 257 |

Where: Id. = identified; Unid. = unidentified

**Table 1:** Number of species recorded by taxonomic group for Grande L'Anse and Salybia reefs. The data is presented by class, and summed by phylum. Unidentified species are those for which the genus and/or species has not been identified. Species recorded for both systems are listed separately to avoid double counting. It should be noted that it is unavoidable that some of the unidentified species taken from registers for overseas collections might be the same as species identified in the checklist, since we were not able to examine them.

Annelids were represented by two species, with one, *Hermodice carnunculata* the bearded fireworm, present on both reefs (Tables 1 and 2). Arthropods were dominated by the class Malacostraca (which accounted for 29 of 33 species), itself dominated by the Decapoda. The 29 malacostracan species were evenly distributed among the 18 families they represented, with only two families (Majidae with six species, and Xanthidae with four) with more than two species.

Though only 10 echinoderm species were recorded (Table 1), they represented five of the six classes in the phylum. The Holothuroidea was the most speciose class, with all four species found on Salybia Reef (Table 2). The only crinoid found in the study, *Tropiometra carinata*, was recorded for Grande L'Anse Reef only. Only one species, the rock-boring urchin *Echinometra lucunter*, was recorded for both reefs.

The Chordata was represented by six orders, all of which belonged to the class Actinopterygii (Table 2). At the level of order, the evenness aspect of diversity was low as all but six of the 43 (+14 unidentified) fishes belonged to the Perciformes. Though many typical reef fish families were present, most were represented by only one or two species. The most speciose families were the Pomacentridae and Haemulidae, with eight (+2 unidentified) and six (+1 unidentified) species, respectively.

The full species list is presented in Table 2.

| **Kingdom Chromista** | | | | |
|---|---|---|---|---|
| **Phylum**: Ochrophyta (Heterokontophyta) | | | | |
| **Class**: Phaeophyceae | | | | |
| **Order** | **Family** | **Species name and authority** | **Common name** | **Accession no. & notes** |
| Dictyotales | Dictyotaceae | *Dictyopteris delicatula* Lamouroux, 1809 | | Phillip & Belford unpubl.[a] |
| | | *Padina gymnospora* (Kützing) Sonder, 1871 | | TRIN27759 (1982)[a] |

| | | | | |
|---|---|---|---|---|
| | | *Padina pavonica* (Linnaeus) Thivy, 1960 | peacock's tail alga | TRIN27755 (1982)[a] |
| | | *Padina sanctae-crucis* Børgesen, 1914 | scroll alga | TRIN27632 (1982)[a] |
| **Kingdom Plantae** | | | | |
| **Phylum**: Chlorophyta | | | | |
| **Class**: Chlorophyceae | | | | |
| **Order** | **Family** | **Species name and authority** | **Common name** | **Accession no. & notes** |
| Ulvales | Cladophoraceae | *Cladophora catenata* (Linnaeus) Kützing, 1843 | | TRIN27760 (1982)[a] |
| **Class**: Ulvophyceae | | | | |
| **Order** | **Family** | **Species name and authority** | **Common name** | **Accession no. & notes** |
| Bryopsidales | Bryopsidaceae | *Bryopsis pennata* Lamouroux, 1809 | | TRIN27639 (1982)[a]; 2009[a] |
| | | *Bryopsis* sp. Lamouroux, 1809 | | Phillip & Belford unpubl.[b] |
| | Caulerpaceae | *Caulerpa mexicana* Sonder ex Kützing, 1849 | flat green feather alga | TRIN34984 (1975)[b] |
| | | *Caulerpa racemosa* (Forsskål) Agardh, 1873 | green grape alga | TRIN16767 (1960)[b]; Schmidt (2005)[b]; Phillip & Belford unpubl.[a,b] |
| | | *Caulerpa sertulariodes* (Gmelin) Howe, 1905 | green feather alga | TRIN27633 & TRIN27757 (1982)[a]; Schmidt (2005)[b]; Phillip & Belford unpubl.[a,b] |
| | Codiaceae | *Codium* sp. | dead man's fingers? | Phillip & Belford unpubl.[a] |
| Cladophorales | Cladophoraceae | *Chaetomorpha antennina* (Bory de Saint-Vincent) Kützing, 1847 | | TRIN16706 (1956)[b] |
| | | *Chaetomorpha gracilis* Kützing 1845 | | Phillip & Belford unpubl.[a] |
| | | *Cladophora coelothrix* Kützing, 1843 | | TRIN16716 (1956)[b] |
| Ulvales | Ulvaceae | *Ulva flexuosa* Wulfen, 1803 | sea lettuce | Phillip & Belford unpubl.[a] |
| | | *Ulva linza* Linnaeus, 1753 | green lettuce alga, sea lettuce | Belford unpubl.[a] |
| **Phylum**: Rhodophyta | | | | |
| **Class**: Florideophyceae | | | | |
| **Order** | **Family** | **Species name & authority** | **Common name** | **Accession no. & notes** |
| Ceramiales | Ceramiaceae | *Ceramium* sp. | | Phillip & Belford unpubl.[a] |
| | Corallinales | *Amphiroa rigida* Lamouroux, 1816 | Calcified- or Y-twig alga | TRIN27630 (1982)[a] |
| | Rhodomelaceae | *Acanthophora spicifera* (M. Vahl) Børgesen, 1910 | spiny sea weed | TRIN27634 (1982)[a] |
| | Spyridiaceae | *Spyridia clavata* Kützing, 1841 | | TRIN27623 (1982)[a] |
| | | *Spyridia filamentosa* (Wulfen) Harvey, 1833 | | Phillip & Belford unpubl.[a] |
| | Wrangeliaceae | *Pleonosporium flexuosum* (C.Agardh) Bornet ex De Toni, 1903 | | Phillip & Belford unpubl.[a] |
| Gigartinales | Crystocloniaceae | *Hypnea spinella* (Agardh) Kützing, 1847 | | TRIN27637 (1982)[a] |
| | Rhizophyllidaceae | *Ochtodes secundiramea* (Montagne) Howe, 1920 | | TRIN27635 (1982)[a] |
| Gracilariales | Gracilariaceae | *Gracilaria ornata* Areschoug, 1854 | | TRIN27763 & 27766 (1982)[a] |
| | | *Gracilaria papenfussii* Abbott, 1983 | | TRIN27636 & 27761 (1982)[a] |
| | | *Gracilaria* sp. | sea moss | Schmidt (2005)[b] |
| | | *Gracilaria venezuelensis* Taylor, | | TRIN27638, 27762 & 27764 |

| | | | | |
|---|---|---|---|---|
| | | 1942 | | (1982)[a] |
| Nemaliales | Galaxauraceae | *Tricleocarpa fragilis* (Linnaeus) Huisman & Townsend, 1993 | | TRIN27631 (1982)[a] |
| **Class**: Unidentified | | | | |
| **Order** | **Family** | **Species name and authority** | **Common name** | **Accession no. & notes** |
| unidentified | unidentified | unidentified | crustose coralline algae | Phillip & Belford unpubl.[a,b] |
| **Phylum**: Trachaeophyta | | | | |
| **Class** Under revision | | | | |
| **Order** | **Family** | **Species name & authority** | **Common name** | **Accession no. & notes** |
| Alismatales | Hydrocharitaceae | *Thalassia testudinum* Banks ex König, 1805 | turtle grass | Phillip & Belford unpubl.[a,b] |
| **Kingdom Animalia** | | | | |
| **Phylum**: Porifera | | | | |
| **Class**: Desmospongiae | | | | |
| **Order** | **Family** | **Species name and authority** | **Common name** | **Accession no. & notes** |
| Haplosclerida | Callyspongiidae | *Callyspongia* (*Cladochalina*) *plicifera* Lamark, 1814 | azure vase sponge | Schmidt (2005)[b] |
| | Phloeodictyidae | *Siphonodictyon coralliphagum* Rützler, 1971 | variable boring sponge | Schmidt (2005)[b] |
| | Niphatidae | *Amphimedon viridis* Duchassaing & Michelotti, 1864 | | Schmidt (2005)[b]; Phillip unpubl.[a] |
| Homoscleropho rida | Plakinidae | *Plakortis angulospiculatus* (Carter 1882) | viscous sponge | Phillip & Belford unpubl.[a] |
| Verongida | Aplysinidae | *Aiolochroia crassa* Hyatt, 1875 | | Schmidt (2005)[b] |
| | | *Aplysina fulva* (Pallas, 1766) | scattered pore rope sponge | Schmidt (2005)[b] |
| **Phylum**: Cnidaria | | | | |
| **Class**: Hydrozoa | | | | |
| **Order** | **Family** | **Species name and authority** | **Common name** | **Accession no. & notes** |
| Anthoathecata | Milleporidae | *Millepora alcicornis* Linnaeus 1758 | branching fire coral | UWIZM.2010.15.11, 2010.15.12, 2011.11.139[a]; Schmidt (2005)[b]; Phillip & Belford unpubl.[a,b] |
| **Class**: Scyphozoa | | | | |
| **Order** | **Family** | **Species name and authority** | **Common name** | **Accession no. & notes** |
| Rhizostomeae | Stomolophidae | *Stomolophus meleagris* Agassiz 1862 | cannonball jellyfish | UWIZM.2010.15.22[a] |
| **Class**: Anthozoa | | | | |
| **Order** | **Family** | **Species name & authority** | **Common name** | **Accession no. & notes** |
| Actiniaria | Actiniidae | unidentified sp. | anemone | 2010[a] |
| | Phymanthidae | *Phymanthus crucifer* (Lesueur 1817) | beaded anemone | UWIZM.2010.15.14 (2010)[a]; Schmidt (2005)[b]; Phillip & Belford unpubl.[a,b] |
| | Stichodactylidae | *Stichodactyla helianthus* (Ellis 1768) | sun anemome | UWIZM.2010.15.13 (2010)[a]; Phillip & Belford unpubl.[a,b] |
| Scleractinia | Acroporidae | *Acropora palmata* (Lamark 1816) | elkhorn coral | UWIZM.2011.11.166 (2009)[a]; encrustation on coral rubble |
| | | *Acropora prolifera* (Lamark 1816) | fused staghorn coral | Kenny *et al.* (1976)[a] |
| | Merulinidae | *Orbicella annularis* (Ellis & Solander) | Caribbean star coral | UWIZM.2011.11.158 (2009)[a]; Kenny *et al.* (1975)[a] |
| | Montastraeidae | *Montastraea cavernosa* Linnaeus 1767 | great star coral | UWIZM.2011.11.61[a] |
| | Mussidae | *Diploria clivosa* (Ellis & Solander | knobby brain coral | UWIZM.2011.11.5 (1971)[a] |

| | | | | |
|---|---|---|---|---|
| | | 1786) | | |
| | | *Diploria strigosa* (Dana 1846) | symmetrical brain coral | UWIZM.2011.11.163 (2009)[a]; Schmidt (2005)[b] |
| | | *Favia fragrum* (Esper 1795) | golfball coral | UWIZM.2011.11.64, 2011.11.152 (2009)[a]; Phillip & Belford unpubl.[a] |
| | Oculinidae | *Oculina* sp. | poss. diffusa | UWIZM.2011.11.145 (1998)[a] |
| | Poritidae | *Porites asteroides* Lamark 1816 | mustard hill coral | UWIZM.2011.11.11, 2011.11.12, 2011.24.13 (2008)[a]; Phillip & Belford unpubl.[a,b] |
| | | *Porites branneri* Rathburn 1887 | blue crust coral | Kenny (1988)[a] |
| | | *Porites divaricata* Le Sueur 1820 | thin finger coral | Phillip & Belford unpubl.[a] |
| | | *Porites furcata* Lamark 1816 | branched finger coral | Kenny (1988)[a,b] |
| | | *Porites porites* (Pallas 1766) | club-tip finger coral | Schmidt (2005)[b]; Phillip & Belford unpubl.[a,b]; UWIZM.2010.15.10, 2011.11.23, 2011.11.24, 2011.11.135 (2009–2010)[a] |
| | | *Porites* spp. | finger coral | UWIZM.2011.11.161, 2011.11.162, 2011.11.148 (2009)[a]; Phillip & Belford unpubl.[a,b] |
| | Siderastreidae | *Siderastrea radians* (Pallas 1766) | lesser starlet coral | UWIZM.2010.15.9, 2011.11.79, 2011.11.151, 2011.11.155, 2011.11.156 (2006–2010)[a]; Phillip & Belford unpubl.[a,b] |
| | | *Siderastrea siderea* (Ellis & Solander 1768) | massive starlet coral | Kenny (1988)[b] |
| | | *Siderastrea* sp. | | UWIZM.2011.11.165[a]; anon.[b] |
| Zoantharia | Sphenopidae | *Palythoa caribaeorum* (Duchassaing & Michelotti 1860) | white encursting zoanthid | UWIZM.2010.15.16 (2010)[a]; Phillip & Belford unpubl.[a,b] |
| | | *Palythoa mammillosa* | | Kenny (1988)[a] |
| | Zoanthidae | *Zoanthus pulchellus* (Duchassaing & Michelotti 1860) | mat zoanthid | UWIZM.2010.15.15 (2010)[a]; Phillip & Belford unpubl.[a,b] |
| | | *Zoanthus sociatus* Ellis 1768 | Button polyp | Kenny (1988)[a]; Belford unpubl.[a] |
| Alcyonacea | Ellisellidae | *Nicella* sp. | | Schmidt-Roach unpubl.[b] |
| | Gorgoniidae | *Gorgonia flabellum* Linnaeus 1758 | Venus sea fan | USNM.44163.21181[a]; Schmidt (2005)[b] |
| | | *Gorgonia ventalina* Linnaeus 1758 | Caribbean sea fan | UWIZM.2010.15.18, 2011.11.92, 2011.11.98 (2010)[a]; Kenny (1988)[a]; (Ramsaroop 1976)[b] |
| | | *Leptogorgia punicea* (Milne Edwards & Haime 1857) | sea whip | Ramsaroop (1976)[b] |
| | | *Pseudopterogorgia* sp. | sea plume | Schmidt (2005)[b] |
| | | *Pterogorgia citrina* (Esper 1792) | yellow sea whip | Ramsaroop (1976)[b] |
| | Plexauridae | *Eunicea* sp. | knobby sea rods | Schmidt (2005)[b] |
| | | *Eunicea tourneforti* Milne Edwards & Haime 1857 | gorgonian | UWIZM.2010.15.19 (2010)[a]; (Ramsaroop 1976)[b] |
| | | *Muricea elongata* Lamouroux 1821 | gorgonian | UWIZM.2010.15.20 (2010)[a]; (Ramsaroop 1976)[b] |
| | | *Muricea* sp. | spiny sea fan | Schmidt (2005)[b] |
| | | *Muriceopsis flavida* (Lamark 1815) | rough sea plume | UWIZM.2011.11.101 (2008)[a]; Ramsaroop (1976)[b]; Schmidt |

| | | | | |
|---|---|---|---|---|
| | | | | (2005)[b] |
| | | *Plexaura flexuosa* Lamouroux 1821 | bent sea rod | UWIZM.2011.11.96 (2009)[a]; Ramsaroop (1976)[b] |
| | | *Plexaurella dichotoma* (Esper 1791) | split pore sea rod | UWIZM.2010.15.21, 2011.11.146 (2009–2010)[a]; Ramsaroop (1976)[b] |
| | | *Plexaurella* sp. | | Schmidt-Roach unpubl.[b] |
| | Anthothelidae | *Diodogorgia nodulifera* (Hargitt & Rogers 1901) | | Ramsaroop (1976)[b] |
| | | *Erythropodium caribaeorum* (Duchassaing & Michelotti 1860) | encrusting gorgonian | UWIZM.2010.15.17 (2010)[a]; Schmidt (2005)[b] |
| | Briareidae | *Briareum asbestinum* (Pallas 1766) | corky sea finger | Phillip & Belford (unpubl.)[a,b]; Schmidt (2005)[b] |
| **Phylum** Mollusca | | | | |
| **Class** Bivalvia | | | | |
| **Order** | **Family** | **Species** | **Common name** | **Accession no. & notes** |
| Arcoida | Arcidae | *Arca imbricata* Bruguiere, 1789 | mossy ark | UWIZM.2011.14.732 (1968)[b] |
| | | *Arca zebra* (Swainson, 1833) | turkey wing | UWIZM.2010.15.42 (2010)[a] |
| | | *Barbatia candida* (Helbling, 1779) | white-beard ark | UWIZM.2011.1.348 (1955)[a] |
| | Noetiidae | *Arcopsis adamsi* (Dall, 1886) | Adams ark | UWIZM.2011.1.346 (1956)[a] |
| Veneroida | Lucinidae | *Codakia orbicularis* (Linnaeus, 1758) | tiger lucine | UWIZM.2011.1.384 (1955)[a] |
| | Semelidae | *Semele proficua* (Pulteney, 1799) | semele | UWIZM.2011.1.442 (1955)[a] |
| **Class**: Cephalopoda | | | | |
| **Order** | **Family** | **Species name & authority** | **Common name** | **Accession no. & notes** |
| Octopoda | Octopodidae | *Octopus briareus* Robson, 1929 | Caribbean reef octopus | UWIZM.2010.15.35 (2010)[a] |
| | | *Octopus filosus* Howell, 1867 | Caribbean 2-spot octopus | Phillip & Belford unpubl.[a] |
| | | *Octopus vulgaris* Cuvier, 1797 | common octopus | Belford unpubl.[a] |
| | | *Octopus* sp. | octopus | Phillip unpubl.[b] |
| **Class**: Gastropoda | | | | |
| **Order** | **Family** | **Species** | **Common name** | **Accession no. & notes** |
| Archaeogastropoda | Fissurellidae | *Diodora arcuata* (Sowerby II 1862) | arcuate keyhole limpet | UWIZM.2011.1.32 (1956)[a] |
| | | *Diodora cayenensis* (Lamarck, 1822) | Cayenne keyhole limpet | UWIZM.2011.14.526[a] |
| | | *Diodora listeri* (d'Orbigny, 1847) | keyhole limpet | UWIZM.2011.1.36, 2011.1.38 (1956–1976)[a] |
| | | *Fissurella barbadensis* (Gmelin, 1791) | Barbados keyhole limpet | UWIZM.2011.1.22 (1956)[a] |
| | | *Fissurella nimbosa* (Linnaeus, 1758) | keyhole limpet | UWIZM.2011.1.14 (1956)[a] |
| | | *Fissurella nodosa* (Born, 1778) | knobby keyhole limpet | UWIZM.2011.1.17 (1956)[a] |
| | | *Fissurella rosea* (Gmelin, 1791) | rosy keyhole limpet | UWIZM.2011.1.2 (1954)[a] |
| | | *Fissurella schrammii* Fischer 1857 | keyhole limpet | MCZ.124618[b] |
| | | *Hemitoma octoradiata* (Gmelin, 1791) | eight-rib emarginula | UWIZM.2011.1.70 (1956)[a] |
| | Lottiidae | *Lottia antillarum* G. B. Sowerby I, 1834 | southern limpet | UWIZM.2011.1.52 (1956)[a] |
| | Tegulidae | *Cittarium pica* (Linnaeus, 1758) | West Indian topsnail | UWIZM.2011.1.71[a]; UWIZM.2011.14.458 (1968)[b] |

| | | | | |
|---|---|---|---|---|
| | | *Tegula excavata* (Lamarck, 1822) | green-base tegula | UWIZM.2011.1.80, 2010.36.285 (1956, 1970)[a] |
| | | *Tegula lividomaculata* (C. B. Adams, 1845) | West Indian tegula | UWIZM.2011.1.73 (1955)[a] |
| | | *Tegula excavata* (Lamarck, 1822) | green-base tegula | UWIZM.2011.1.75, 2010.36.285 (1955–1970)[a,b] |
| | | *Tegula fasciata* (Born 1778) | silky tegula | MCZ.148523[b] |
| | | *Tegula lividomaculata* (C.B. Adams, 1845) | West Indian tegula | UWIZM.2010.36.374 (1970)[a] |
| | Turbinidae | *Lithopoma phoebium* (Roding, 1798) | longspine starsnail | UWIZM.2010.36.318 (1970)[a] |
| | | *Lithopoma brevispina* (Lamarck, 1822) | starsnail | UWIZM.2011.1.108 (1955)[a] |
| | | *Lithopoma phoebium* (Roding, 1798) | longspine starsnail | UWIZM.2011.1.531 (1956)[a] |
| | | *Lithopoma tectum* (Lightfoot, 1786) | West Indian star snail | Belford unpubl.[a] |
| | | *Lithopoma tuber* (Linnaeus, 1758) | green starsnail | UWIZM.2010.15.39, 2010.15.38, 2011.14.427 (2010)[a,b] |
| | | *Turbo castanea* Gmelin, 1791 | chestnut turban | UWIZM.2011.1.111 (1955)[a] |
| Archaeopulmonata | Ellobiidae | *Melampus coffea* (Linnaeus, 1758) | coffee melampus | UWIZM.2010.36.452 (2009)[b] |
| Caenogastropoda | Batillariidae | *Lampanella minima* (Gmelin, 1791) | West Indian false cerith | UWIZM.2011.1.172 (1956)[a] |
| | Cerithiidae | *Cerithium eburneum* Bruguière, 1792 | ivory cerith | UWIZM.2011.1.186 (1955)[a] |
| | | *Cerithium litteratum* (Born, 1778) | stocky cerith | Belford unpubl.[a] |
| | Epitoniidae | *Epitonium lamellosum* (Lamarck, 1822) | lamellose wentletrap | UWIZM.2011.1.145 (19556)[a] |
| | Planaxidae | *Angiola lineata* (da Costa, 1778) | dwarf Atlantic planaxis | UWIZM.2011.1.492 (1956)[a] |
| Cycloneritimorpha | Neritidae | *Nerita fulgurans* Gmelin, 1791 | Antillean nerite | UWIZM.2011.1.82, 2010.36.290, 2010.15.40 (1956–2010)[a,b] |
| | | *Nerita tessellata* (Gmelin, 1791) | checkered nerite | UWIZM.2010.36.265 (1963)[b] |
| Heterobranchia | Siphonariidae | *Siphonaria pectinata* (Linnaeus, 1758) | false limpet | UWIZM.2010.15.50 (2010)[a] |
| Littorinimorpha | Cassidae | *Cypraecassis testiculus* (Linnaeus 1758) | reticulated cowry helmet | MCZ.148648[b] |
| | Cypraeidae | *Luria cinerea* (Gmelin, 1791) | Atlantic gray cowrie | UWIZM.2011.1.227[a] |
| | | *Macrocypraea zebra* (Linnaeus, 1758) | measled cowrie | UWIZM.2011.1.226 (1955)[a] |
| | Hipponicidae | *Hipponix antiquatus* (Linnaeus, 1767) | white hoofsnail | UWIZM.2011.1.236, 2010.15.41, 2010.36.373, 2011.14.467 (1955–2010)[a,b] |
| | Littorinidae | *Echinolittorina ziczac* (Gmelin, 1791) | zebra periwinkle | UWIZM.2011.1.88, 2010.36.274, 2011.14.466 (1955–1968)[a,b] |
| | | *Littoraria flava* (King & Broderip, 1832) | periwinkle | UWIZM.2011.1.89 (1955)[a] |
| | Naticidae | *Naticarius canrena* (Linnaeus, 1758) | colorful moonsnail | UWIZM.2011.1.221 (1955)[a] |
| | | *Polinices uberinus* (d'Orbigny, 1842) | dwarf white moonsnail | UWIZM.2011.1.162 (1956)[a] |
| | Ranellidae | *Monoplex nicobaricus* (Röding, 1798) | goldmouth triton | UWIZM.2011.1.126[a] |

| | | | | |
|---|---|---|---|---|
| | Strombidae | *Lobatus gigas* (Linnaeus, 1758) | queen conch | 9.56 in UWIZM register (1970)[a] |
| | | *Lobatus raninus* (Gmelin, 1791) | hawkwing conch | UWIZM.2010.36.234 (1970)[a] |
| | Triviidae | *Niveria nix* (Schilder, 1922) | snowy trivia | UWIZM.2010.36.266 (1970)[b] |
| | Vermetidae | *Dendropoma irregulare* (d'Orbigny, 1841) | irregular worm shell | UWIZM.2010.36.514 (2009)[b] |
| Neogastropoda | Buccinidae | *Engina turbinella* (Kiener, 1836) | spotted lesser whelk | UWIZM.2010.15.44 (2010)[a] |
| | | *Gemophos auritulus* (Link, 1807) | gaudy cantharus | UWIZM.2010.15.43 (2010)[a] |
| | | *Pisania pusio* (Linnaeus 1758) | miniature trumpet triton | MCZ.75913[b] |
| | Columbellidae | *Mitrella ocellata* (Gmelin, 1791) | white-spot dovesnail | UWIZM.2011.1.212 (1956)[a] |
| | Conidae | *Conus ermineus* Born, 1778 | cone shell | UWIZM.2011.1.124[a] |
| | | *Conus mus* Hwass in Bruguière, 1792 | mouse cone | UWIZM.2010.36.233 (1970)[b] |
| | Fasciolariidae | *Leucozonia nassa* (Gmelin 1791) | chestnut nassa | MCZ.75917[b] |
| | Muricidae | *Plicopurpura patula* (Linnaeus, 1758) | widemouth rocksnail | UWIZM.2010.36.346, 2011.14.457 (1968–1970)[a,b] |
| | Nassaridae | *Nassarius* sp. | dog whelk | UWIZM.2010.15.45 (2010)[a] |
| | | *Nassarius albus* (Say, 1826) | white nassa | UWIZM.2011.1.168 (1956)[a] |
| | Volutidae | *Voluta musica* Linnaeus, 1757 | music volute | UWIZM.2010.15.33, 2012.29.15, 2010.36.304, 2011.14.459 (1968–2012)[a]; Belford unpubl.[b] |
| | Mitridae | *Mitra nodulosa* (Gmelin, 1791) | beaded mitre | UWIZM.2011.1.482 (1956)[a] |
| Nudibranchia | Chromodorididae | unidentified | seaslug | UWIZM.2010.36.582 (1988)[a] |
| Patellogastropoda | Acmaeidae | *Lottia antillarum* G. B. Sowerby I, 1834 | southern limpet | UWIZM.2010.36.371 (1970)[a] |
| Sacoglossa | Plakobranchidae | *Elysia crispata* Mörch, 1863 | lettuce seaslug | UWIZM.2010.15.32 (2010)[a] |
| | | **Class**: Polyplacophora | | |
| **Order** | **Family** | **Species** | **Common name** | **Accession no. & notes** |
| Chitonida | Callistoplacidae | *Calloplax janeirensis* (Gray, 1828) | ornate chiton | Baboolal *et al.* (1981)[a] |
| | Chitonidae | *Acanthopleura granulata* (Gmelin, 1791) | West Indian fuzzy chiton | Baboolal *et al.* (1981)[a] |
| | | *Chiton tuberculatus* Linnaeus, 1758 | West Indian green chiton | UWIZM.2010.36.528 (1957)[a] |
| | Ischnochitonidae | *Ischnochiton pectinatus* (Sowerby II, 1840) | chiton | Baboolal *et al.* (1981)[a] |
| | | *Ischnochiton striolatus* (Gray, 1828) | chiton | Baboolal *et al.* (1981)[a] |
| | | *Stenoplax purpurascens* (C. B. Adams, 1845) | Caribbean slender chiton | Baboolal *et al.* (1981)[a] |
| | | **Phylum** Annelida | | |
| | | **Class** Polychaeta | | |
| **Order** | **Family** | **Scientific Name** | **Common Name** | **Accession no. & notes** |
| Amphinomida | Amphinomidae | *Hermodice carunculata* (Pallas, 1766) | bearded fireworm | UWIZM.2012.29.14 (2012)[a]; Phillip & Belford unpubl.[a,b] |
| Phyllodocida | Nereididae | *Platynereis dumerilii* (Audoin and Milne Edwards 1834) | Dumeril's clam worm | UWIZM.2010.15.54 (2010)[a] |
| | | **Phylum** Arthropoda | | |
| | | **Class** Malacostraca | | |
| **Order** | **Family** | **Species** | **Common name** | **Accession no. & notes** |
| Decapoda | Aethridae | *Hepatus pudibundus* (Herbst, 1785) | box crab | Stonely (1970)[a] |
| | Carpiliidae | *Carpilius corallinus* (Herbst, 1783) | batwing coral crab | UWIZM.2010.15.25 (2010)[a] |
| | Diogenidae | *Calcinus tibicen* (Herbst, 1791) | orangeclaw hermit crab | UWIZM.2010.15.24 (2010)[a] |
| | | *Paguristes* sp. | Hermit crab | UWIZM.2013.22 (2011)[a] |

| | | | | |
|---|---|---|---|---|
| | Eriphiidae | *Eriphia gonagra* (Fabricius, 1781) | redfinger rubble crab | USNM.137739 (1970); UWIZM.2010.15.23 (2010)[a] |
| | Grapsidae | *Pachygrapsus transversus* (Gibbes, 1850) | mottled shore crab | USNM.139294 (1970)[a] |
| | Majidae | *Macrocoeloma trispinosum nodipes* (Desbonne, 1867) | decorator crab | UWIZM.2013.21.12 (1970)[a] |
| | | *Microphrys bicornutus (Latreille, 1825)* | decorator crab | UWIZM.2013.21.30 (1970)[a] |
| | | *Mithraculus coryphe* (Herbst, 1801) | nodose clinging crab | USNM.137756 (1970)[a] |
| | | *Mithraculus forceps* A. Milne Edwards, 1875 | red-ridged clinging crab | Stonely (1970)[a] |
| | | *Mithraculus sculptus* (Lamarck, 1818) | green clinging crab | UWIZM.2010.15.26, 2012.29.8 (2010, 2012)[a]; USNM.137758 (1970)[a] |
| | | *Mithrax verrucosus* H. Milne Edwards, 1832 | paved clinging crab | UWIZM.2013.21.10 (1971)[a] |
| | Menippidae | *Menippe nodifrons* Stimpson, 1859 | Cuban stone crab | Stonely (1970)[a] |
| | Palinuridae | *Panulirus argus* (Latreille, 1804) | Caribbean spiny lobster | UWIZM.2013.20 (2011)[a] |
| | Panopeidae | *Panopeus herbstii* H. Milne Edwards, 1834 | Atlantic mud crab | UWIZM.2010.15.31, 2012.29.7 (2010; 2012)[a] |
| | Parthenopidae | *Leiolambrus nitidus* Rathburn, 1901 | white elbow crab | 1940[b] |
| | Percnidae | *Percnon gibbesi* (H. Milne Edwards, 1853) | Sally lightfoot crab | USNM.139295 (1970)[a] |
| | Porcellanidae | *Petrolisthes armatus* (Gibbes, 1850) | green porcelain crab | Stonely (1970)[a] |
| | | *Petrolisthes galathinus* (Bosc, 1802) | porcelain crab | USNM.141359 (1970)[a] |
| | Portunidae | *Callinectes exasperatus* (Gerstaeker 1856) | rugose swimming crab | Stonely (1970)[a] |
| | | *Callinectes sapidus* Rathbun, 1896 | blue crab | UWIZM.2010.15.28 (2010)[a] |
| | Scyllaridae | *Parribacus antarcticus* (Lund, 1793) | slipper lobster | UWIZM.2010.15.27 (2010)[a] |
| | Xanthidae | *Cataleptodius floridanus* (Gibbes, 1850) | spoonfinger rubble crab | Stonely (1970)[a] |
| | | *Chlorodiella longimana* (H. Milne Edwards, 1834) | longhand rubble crab | Stonely (1970)[a] |
| | | *Cyclodius maculatus* (Stimpson, 1860) | xanthid crab | Stonely (1970)[a] |
| | | *Platypodiella spectabilis* (Herbst, 1794) | gaudy clown crab | USNM.139264 (1970)[a] |
| Isopoda | Tylidae | *Tylos wegeneri* Vandel, 1952 | waterlouse | UWIZM.2010.15.30 (2010)[a] |
| Stomatopoda | Gonodactylidae | *Neogonodactylus brendini* (Manning, 1969) | mantis shrimp | UWI.33 (1969)[a] |
| | Pseudosquillidae | *Pseudosquilla ciliata* (Fabricius, 1787) | mantis shrimp | UWIZM.2012.29.6 (2012)[a] |
| **Class**: Maxillopoda | | | | |
| **Order** | **Family** | **Species** | **Common name** | **Accession no. & notes** |
| Lepadiformes | Lepadidae | *Lepas pectinata* Spengler, 1793 | goose barnacle | UWIZM.2010.15.29 (2010)[a] |
| Sessilia | Chthamalidae | *Chthamalus bisinuatus* (Pilsbry, 1916) | barnacle | (2009)[a] |
| | Pyrgomatidae | *Ceratoconcha quarta* (Kolosváry, 1947) | barnacle | (1971)[a] |
| | Tetraclitidae | *Tetraclita stalactifera* (Lamarck, 1818) | ribbed barnacle | (1974)[a] |

| **Phylum** Echinodermata | | | | |
|---|---|---|---|---|
| **Class** Asteroidea | | | | |
| **Order** | **Family** | **Species** | **Common name** | **Accession no. & notes** |
| Valvatida | Ophidiasteridae | *Linckia guildingi* Gray, 1840 | common comet star | UWI.15 (echinoderm register, UWI Zoology Museum)[a] |
| **Class**: Crinoidea | | | | |
| **Order** | **Family** | **Species** | **Common name** | **Accession no. & notes** |
| Comatulidae | Tropiometridae | *Tropiometra carinata* (Lamarck, 1816) | elegant feather star | Schmidt-Roach unpubl.[b] |
| **Class:** Echinoidea | | | | |
| **Order** | **Family** | **Species** | **Common name** | **Accession no. & notes** |
| Arbacioida | Arbaciidae | *Arbacia punctulata* (Lamarck, 1816) | common arbacia urchin | UWIZM.2011.22.31 (2011)[a] |
| Camarodonta | Echinometridae | *Echinometra lucunter lucunter* (Linnaeus, 1758) | rock-boring urchin | UWIZM.2010.15.51, 2011.22.8, 2010.15.51 (1988–2011)[a]; Phillip & Belford unpubl.[a,b] |
| **Class**: Holothuroidea | | | | |
| **Order** | **Family** | **Species** | **Common name** | **Accession no. & notes** |
| Aspidochirotida | Holothuriidae | *Holothuria cubana* Ludwig, 1875 | Cuban sea cucumber | UWIZM.2012.29.3 (2012)[a] |
| | | *Holothuria grisea* Selenka, 1867 | Grey sea cucumber | UWIZM.2010.31.1, 2010.31.2, 2011.21.6, 2011.21.9, 2011.21.10, 2012.29.5 (2010–2012)[a] |
| | | *Holothuria surinamensis* Ludwig, 1875 | Surinam sea cucumber | UWIZM.2011.21.15, 2011.21.21, 2011.21.23, 2011.21.24, 2012.29.4 (1983–2012)[a] |
| | Stichopodidae | *Isostichopus badionotus* (Selenka, 1867) | three-rowed sea cucumber | UWIZM.2011.21.3, 2011.21.4, 2011.21.5, 2012.29.2 (2008–2012)[a] |
| **Class**: Ophiuroidea | | | | |
| **Order** | **Family** | ***Species*** | **Common name** | **Accession no. & notes** |
| Ophiurida | Ophiactidae | *Ophiactis savignyi* (Müller & Troschel, 1842) | six armed brittle star | UWIZM.2010.15.52 (2010)[a] |
| | Ophiodermatidae | *Ophioderma appressa* (Say, 1825) | banded-arm brittle star | (2012)[a] |
| **Phylum**: Chordata | | | | |
| **Class**: Actinopterygii | | | | |
| **Order** | **Family** | **Species** | **Common name** | **Accession no. & notes** |
| Anguilliformes | Muraenidae | *Echidna catenata* (Bloch 1795) | chain moray | UWIZM.2010.15.7 (2010)[a] |
| | | *Gymnothorax funebris* Ranzani 1839 | green moray | Phillip & Belford unpubl.[a] |
| Batrachoidiformes | Batrachoididae | *Opsanus* sp. | | TCWC 15715.05 (2012)[a] |
| Perciformes | Acanthuridae | *Acanthurus bahianus* Castelnau 1855 | ocean surgeonfish | Phillip & Belford unpubl.[a] |
| | | *Acanthurus chirurgus* (Bloch 1787) | doctorfish | TCWC15710.07, C15718.05 (2012)[a]; Phillip & Belford unpubl.[a] |
| | | *Acanthurus* sp. | | Phillip & Belford unpubl.[a] |
| | Blenniidae | *Ophioblennius macclurei* (Silvester 1915) | redlip blenny | Phillip & Belford unpubl.[a] |
| | | *Scartella cristata* (Linnaeus 1758) | molly miller | TCWC15710.09, 15715.01 |

| | | | | |
|---|---|---|---|---|
| | | | | (2012)[a] |
| | Carangidae | *Trachinotus goodei* Jordan & Evermann 1896 | palometa | Belford[a,b] |
| | | unidentified sp. | | TCWC15715.06 (2012)[a] |
| | Chaenopsidae | *Acanthemblemaria maria* Böhlke 1961 | secretary blenny | Phillip & Belford unpubl.[a] |
| | Chaetodontidae | *Chaetodon capistratus* Linnaeus 1758 | foureye butterfly fish | Phillip & Belford unpubl.[a] |
| | | *Chaetodon ocellatus* Bloch 1787 | spotfin butterflyfish | UWIZM.2010.15.5, 2010.15.6 (2010)[a] |
| | | *Chaetodon sedentarius* Poey 1860 | reef butterflyfish | Phillip & Belford unpubl.[a] |
| | | *Chaetodon striatus* Linnaeus 1758 | banded butterflyfish | Phillip & Belford unpubl.[a] |
| | Clinidae | unidentified sp. | | TCWC15710.03 (2012)[a] |
| | Gerreidae | *Eucinostomus melanopterus* (Bleeker 1863) | flagfin mojarra | Phillip & Belford unpubl.[a] |
| | Gobiidae | *Bathygobius soporator* (Valenciennes 1837) | frillfin goby | TCWC15718.07 (2012)[a] |
| | | *Bathygobius* sp. | | TCWC15710.05, 15710.08, 15715.04 (2012)[a] |
| | | unidentified sp. | | TCWC15710.01, 15710.04 (2012)[a] |
| | Haemulidae | *Anisotremus virginicus* (Linnaeus 1758) | porkfish | Phillip & Belford unpubl.[a,b] |
| | | *Haemulon aurolineatum* Cuvier 1830 | tomtate grunt | Belford unpubl.[b] |
| | | *Haemulon chrysargyreum* Günther 1859 | smallmouth grunt | Phillip & Belford unpubl.[a] |
| | | *Haemulon flavolineatum* (Desmarest 1823) | French grunt | Phillip & Belford unpubl.[a] |
| | | *Haemulon melanurum* (Linnaeus 1758) | cottonwick | Phillip & Belford unpubl.[a] |
| | | *Haemulon sciurus* (Shaw 1803) | bluestriped grunt | Belford unpubl.[b] |
| | | *Haemulon* sp. | | TCWC15718.09 (2012)[a] |
| | Labridae | *Halichoeres bivittatus* (Bloch 1791) | slippery dick | TCWC15718.03 (2012)[a], UWIZM.2010.15.8 (2010)[a]; Phillip & Belford unpubl.[a,b] |
| | | *Halichoeres radiatus* (Linnaeus 1758) | puddingwife | Phillip & Belford unpubl.[a] |
| | | *Halichoeres* sp. | | TCWC15715.1, 15715.09, 15718.06 (2012)[a] |
| | Labrisomidae | *Labrisomus bucciferus* Poey 1868 | puffcheek blenny | Phillip & Belford unpubl.[a] |
| | | *Labrisomus gobio* (Valenciennes 1836) | palehead blenny | Phillip & Belford unpubl.[a] |
| | | *Malacoctenus aurolineatus* Smith 1957 | goldline blenny | Phillip & Belford unpubl.[a] |
| | | *Paraclinus nigripinnis* (Steindachner 1867) | blackfin blenny | TCWC15715.02 (2012)[a] |
| | | unidentified sp. | | TCWC15710.02 (2012)[a] |
| | Lutjanidae | *Lutjanus griseus* (Linnaeus 1758) | grey snapper | Phillip & Belford unpubl.[a] |
| | | *Lutjanus synagris* (Linnaeus 1758) | lane snapper | TCWC15718.08 (2012)[a] |
| | Mullidae | *Pseudupeneus maculatus* (Bloch 1793) | spotted goatfish | Phillip & Belford unpubl.[a] |
| | Pomacanthidae | *Pomacanthus paru* (Bloch 1787) | French angelfish | Schmidt-Roach (unpubl.)[b] |

| | | | | |
|---|---|---|---|---|
| | | *Pomacanthus* sp. | queen or french | Phillip & Belford unpubl.[a] |
| | Pomacentridae | *Abudefduf saxatilis* (Linnaeus 1758) | sergeant major | Phillip & Belford unpubl.[b] |
| | | *Abudefduf* sp. | | TCWC15715.08 (2012)[a] |
| | | *Abudefduf taurus* (Müller & Troschel 1848) | night sergeant | Phillip & Belford unpubl.[a] |
| | | *Microspathodon chrysurus* (Cuvier 1830) | yellowtail damselfish | Phillip & Belford unpubl.[a] |
| | | *Stegastes adustus* (Troschel 1865) | dusky damselfish | TCWC15710.06, 15715.11, 15718.02 (2012)[a] |
| | | *Stegastes diencaeus* (Jordan & Rutter 1897) | longfin damselfish | Phillip & Belford unpubl.[a] |
| | | *Stegastes leucostictus* (Müller & Troschel 1848) | beaugregory | Phillip & Belford unpubl.[a] |
| | | *Stegastes planifrons* (Cuvier 1830) | threespot damselfish | Phillip & Belford unpubl.[a] |
| | | *Stegastes* sp. | damselfish | Phillip & Belford unpubl.[a,b] |
| | | *Stegastes variabilis* (Castelnau 1855) | cocoa damselfish | Phillip & Belford unpubl.[a] |
| | Scaridae | *Scarus iseri* (Bloch 1789) | striped parrotfish | Phillip & Belford unpubl.[a,b] |
| | | *Scarus taeniopterus* Lesson 1829 | princess parrotfish | Phillip & Belford unpubl.[a] |
| | | *Sparisoma* sp. | | TCWC15715.12 (2012)[a] |
| | | *Sparisoma viride* (Bonnaterre 1788) | stoplight parrotfish | TCWC15718.04 (2012)[a] |
| Ophidiiformes | Ophidiidae | *Brotula* sp. | | TCWC15715.07 (2012)[a] |
| Scorpaeniformes | Scorpaenidae | *Scorpaena plumieri* Bloch 1789 | spotted scorpionfish | TCWC15718.01 (2012)[a] |
| Tetraodontiformes | Tetraodontidae | *Sphoeroides testudineus* (Linnaeus 1758) | checkered pufferfish | TCWC15715.03, 15715.13 (2012)[a]; UWIZM.2010.15.5, 2010.15.6 (2010)[a] |

**Table 2:** Checklist of the macrobiota of Salybia and Grande L'Anse reefs. Phyla are arranged in phylogenetic order, but other taxonomic classes are arranged in alphabetical order.
[a]Salybia Reef
[b]Grande L'Anse Reef

## Discussion

The present study, with its somewhat cursory examination of two reefs, recorded a macrobiotic community of approximately 257 species in 134 families, 53 orders, 23 classes and 11 phyla. As this was apparently the first attempt to compile a broad, taxonomic-based species list for a marginal Caribbean coral reef, the discussion of results is at times general. Each taxon is discussed in turn, and where possible attempts were made to compare the findings of the present study with others on a taxon-by-taxon basis. Because Trinidad's environmental and biogeographic settings are unique, it was not obvious which reefs (*i.e*., insular *vs*. continental, and/or mainland continental *vs*. offshore continental islands, and/or northwestern *vs*. southwestern Atlantic) were most suitable for comparison.

Even though scleractinian coral diversity was low compared to other reefs in the Caribbean, the two coral systems did appear to contain considerable biodiversity. With few exceptions, the main coral-reef-associated taxa were represented. Missing phyla were microscopic or cryptic, sessile, encrusting organisms (*e.g*., members of the kingdom Bacteria, and phyla Bryozoa, Foraminifera and Tunicata), which can represent a substantial portion of coral reef biodiversity. Several studies have shown that the microhabitats used by the cryptobiota can be substantial-framework cavities, for instance, account for 30–70% of reef volume and reef-associated species diversity [26-38]. This microhabitat type, and the microbiota were not the focus of the present study, and therefore remain an important gap to be addressed.

The phyla that were the focus of the study were probably inadequately sampled, and therefore much of their species diversity not captured. The extent of the underrepresentation will not be homogenous as some taxa lend themselves more readily to the methods used in the surveys. Sponges for instance, which play an important role in sustaining coral reefs by retaining and recycling of nutrients and energy within coral reefs, *i.e.*, they are the base of a sponge-loop feeding cycle, tend to account for a significant proportion of reef species diversity in many Caribbean coral reefs [39,40]. The present study reported only six species, whereas Diaz [41,42], for instance, reported about 40 species from shallow reef habitats in the Bocas del Toro archipelago on the Caribbean coast of Panama. Our study is likely to be an underestimate of sponge diversity on the two reefs. No special attention was paid to cryptic sponges (*e.g*., boring sponges or those occupying cavities and crevices). Sponge diversity in these types of habitats can be substantial reported 220 species of sponges in sub-rubble communities in Bonaire and Curaçao [37]. Additionally, deeper water habitats were not explored at Salybia, and even though sponge diversity was better captured at Grande L'Anse Reef, sampling was incidental and limited by 1) the use of snorkelling and duck diving, rather than scuba, in > 3 m of water; 2) the narrow time window during which visibility was good enough for photo- and video-graphic methods; and 3) only a single sampling event was successfully conducted at Grande L'Anse Reef.

It was difficult to make definitive conclusions regarding the richness of the algal assemblage. The total of 25 (+5 unidentified) species from the present study compared favourably with a survey of the algae of T&T by Duncan & Lee Lum [21], which listed a total of 18 species from Salybia and Grande L'Anse reefs. However, when compared to single, within-country coral reefs in the region, 30 species indicated a depauperate flora. Phillips, et al. [43], for example, recorded 77 species for the Miskito bank in Nicaragua. On the other hand, the T&T marine flora did not appear depauperate compared to the rest of the region. In their study, Duncan & Lee Lum listed a total of 198 species of marine macroalgae for T&T, which compares favourably with Taylor's [44] list of 127 species of marine algae for the Lesser Antilles, and Earle's [45] ~120 species for the Atlantic coast of Panama. Additionally, Wysor & de Clerk (2003) collected 36 ochrophytes on the Caribbean coast of Panama, which is close to the total number of T&T species in this order. Perhaps these trends indicated that the reefs in the present study represented either species-poor or under-sampled locales within a national assemblage that was itself not depauperate. Incidentally, Duncan & Lee Lum's [21] list included 55 chlorophytes; 33 ochrophytes (phaeophytes); and 110 rhodophytes for the entire country. This national trend of relative importance of the three phyla, in terms of number of species (*i.e*., Rhodophyta > Chlorphyta > Ochrophyta), was upheld by the reefs in the present study (Table 1).

Cnidarian, particularly scleractinian, diversity was richer than expected based on recent visits to the reefs. Both reef flats were overwhelmingly dominated by branching species of *Porites*, with the occasional *Siderastrea radians*. In addition, *Porites astreoides* and *Favia fragrum*, were recorded on Salybia Reef crest, but they were rare. Other species of hard coral were included for Salybia Reef on the basis of the literature and coral skeletons in UWI's Zoology Museum (some collected as recently as 2009) (Table 2), and are likely to be very rare on the reef. Some species, such as *Acropora* sp. and *Montastrea cavernosa*., were more typical of the fore reef, an area not well explored due to poor visibility and strong water conditions. The present study reported 14 species of scleractinian corals, all of which are hermatypic. This compares favourably with Trinidad's total hermatypic coral diversity of 17 species [46]. Kenny's list for Salybia Reef was very similar to what is presented in table 2 (present study). The only species listed for Salybia that Kenny [46] did not include was *Oculina* sp. Also, he did not recognise the various branching forms of *Porites* as separate species as was done in the present study, but reported the morph at Salybia as furcata. In terms of similarity based on species composition, Trinidad's reefs (with 17 species) compared most closely with those of Venezuela (20 species; ~60% similarity), and are very distinct from those of the Dutch islands (Aruba, Bonaire and Curaçao – 43 species; ~40% similarity) or Brazil (15 species; ~20% similarity) [47]. Non-scleractinian species listed here that are important components of Caribbean reef flats are the zoanthids and *Millepora alcicornis*. *Millepora* spp. are important framework builders on parts of reefs throughout the world [48]. Other cnidarians belonged mainly to the order Alcyonacea, commonly referred to as gorgonians. Apart from *Erythropodium caribaeorum*, these are deeper water species found on the upper fore reef at both Salybia and Grande L'Anse.

The Mollusca and Arthropoda were the most dominant groups on the reef flat, both having taken advantage of the large volume of reef space accounted for by cryptic habitats, especially in the coral rubble. It is expected that the data presented here are underestimates of the species diversity of both groups since: 1) only a small fraction of the coral rubble has been sampled; and 2) other cryptic habitats, such as on the reef crest and fore reef, have not been explored. The literature was a very poor source of information for comparison with the present study. Zimmerman, et al. [49] found 64 species of molluscs in reef-flat environments in the Bahamas, which was close in species number to the 66 found in the present study. Gischler [50], in another study, found only six species of molluscs in coral rubble in Florida. These figures suggest that the Salybia Reef mollusc assemblage was indeed species-rich. Similarly, there was very little published information on the species diversity of coral reef decapods, especially those associated with shallow backreef environments, but what is there provided mixed indications regarding the diversity of this assemblage in our study. Werding, et al. [51] reported 28 species of porcelllanid crabs from Venezuela, and 19 for tropical Brazil, whereas there were only two in present study. This indicated that either our study grossly undersampled that assemblage, or that decapod communities were very impoverished. Interestingly perhaps, the two species reported for Salybia Reef were highlighted by Werding, et al. [51] as the two most widely distributed species in the region, and described as possibly representing species complexes. In contrast, Giraldes, et al. found 34 species of decapods in a study conducted in shallow, subtidal coral reef habitats in Brazil. This compares well the 25 species reported in the present study. Taken together, it appeared that the coral rubble microhabitats on Salybia Reef represented important reef *refugia* that accommodated a substantial proportion of the reef's biodiversity.

In his recent review of echinoderms in the Greater Caribbean, Alvarado [52] listed 433 species, or 6.5% of the global species diversity of the phylum. When compared to the rest of the region, Trinidad & Tobago, with 55 species, has a depauperate echinoderm assemblage, the third poorest of the region. There is at least one error in his data, as Trinidad & Tobago, contrary to his reporting, has more than one species of echinoid; we list two species in the present study, and UWI's Zoology Museum has specimens of 11 T&T species in its holdings. Even so, species diversity in all classes in the phylum was low on the two reefs when compared to T&T and the region.

The fish data from the present study indicated a depauperate assemblage when compared to other reefs in several parts of the Atlantic Ocean (Table 3). In terms of total species richness, Salybia and Grande L'Anse reefs, combined, were closest to most the reefs of the central Atlantic islands, which had the lowest species richness of all reefs presented. In other words, the data indicates that the fish assemblage of Salybia and Grande L'Anse reefs is species poor. Turbid-water reefs are known to show more depauperate faunas than their clear-water counterparts. Bejarano & Appeldoorn [53], for instance, recorded higher species richness in clear-water sites than in turbid ones (16 vs. 7, respectively) for reefs studied along a 20 km stretch along the south coast of Puerto Rico. In fact, their analyses showed that seawater turbidity had the greatest power in accounting for variation in fish species richness, surpassing even rugosity and coral cover.

Another possible contributing factor to the low species richness recorded in the present study might be sampling biases. For instance, fish surveys were conducted only during the spring low tides on both reefs. Also, at Salybia, efforts were restricted to the reef flat, whereas at Grande L'Anse records were primarily for the deeper reef area to the west. Whereas the Salybia fish fauna was surveyed on several occasions, the records of the fish fauna at Grande L'Anse was based primarily on incidental observations made during a single snorkelling survey to determine the zonation of cnidarians on the reef. It is well known that spatial and temporal partitioning of the use of the reef is one strategy utilised by fishes [54,55]; thus any sampling strategy that is limited where either of these factors is concerned, may provide biased results (*e.g.*, only individuals active during the daytime low and early rising tides would have been sighted, which implies that fish species that remain in *refugia* during this time of day may have been missed).

| Fish families | Western north Atlantic islands | | South American shelf | | | Brazilian offshore islands | | | Central Atlantic | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | NE T'dad | Brazil | | | | | | | |
| | Bermuda | Cayman Islands | present study* | Para´ıba | Três Ilhas Archipaelago | Atol das Rocas | Fernando de Noronha | Trindade Island | St Paul's Rocks | Ascension Island | St Helena Island |
| Acanthuridae | 3 | 3 | 2(1) | 3 | 3 | 3 | 3 | 2 | | 2 | 1 |
| Apogonidae | 12 | 13 | | 5 | 6 | 2 | 1 | 1 | 1 | 1 | 2 |
| Balistidae | 6 | 4 | | 3 | 3 | 2 | 3 | 4 | 2 | 3 | 2 |
| Blenniidae | 5 | 5 | 2 | 5 | 5 | 4 | 3 | 3 | 2 | 3 | 3 |
| Bothidae | 4 | 3 | | 1 | 1 | 2 | 1 | 1 | | 3 | 2 |
| Chaenopsidae | 1 | 13 | 1 | 2 | 1 | | | | | | |
| Chaetodontidae | 5 | 5 | 4 | 2 | 3 | 1 | 2 | 2 | 2 | 2 | 2 |
| Diodontidae | 3 | 2 | | 3 | 3 | 1 | 2 | 2 | 1 | 3 | 2 |
| Gobiesocidae | 1 | 6 | | 3 | 3 | 1 | | 1 | | | |
| Gobiidae | 15 | 37 | 1(2) | 16 | 9 | 6 | 6 | 4 | 1 | 2 | 2 |
| Grammatidae | 1 | 3 | | 1 | 1 | | 1 | | | | |
| Haemulidae | 7 | 10 | 6(1) | 9 | 8 | 3 | 4 | 1 | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Holocentridae | 8 | 9 | | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| Labridae | 16 | 12 | 2(1) | 11 | 10 | 5 | 6 | 7 | 4 | 4 | 4 |
| Labrisomidae | 3 | 20 | 4(1) | 9 | 9 | 4 | 3 | 2 | 2 | | |
| Lutjanidae | 11 | 13 | 2 | 7 | 5 | 1 | 2 | 1 | 1 | 1 | |
| Monacanthidae | 8 | 5 | | 4 | 7 | 1 | 2 | 3 | 2 | 1 | 2 |
| Mullidae | 2 | 2 | 1 | 2 | 3 | 2 | 2 | 2 | | 1 | 1 |
| Muraenidae | 14 | 10 | 2 | 8 | 6 | 9 | 8 | 5 | 8 | 10 | 6 |
| Opistognathidae | | 1 | | 2 | 2 | | | 1 | | | |
| Ostraciidae | 4 | 5 | | 3 | 2 | 3 | 2 | 1 | | 1 | 1 |
| Pomacanthidae | 3 | 5 | 1(1) | 4 | 5 | 2 | 3 | 2 | 2 | 2 | |
| Pomacentridae | 10 | 12 | 7(2) | 7 | 8 | 4 | 4 | 5 | 4 | 3 | 4 |
| Priacanthidae | 4 | 2 | | 1 | 2 | 1 | 1 | 1 | | 1 | 3 |
| Scaridae | 13 | 11 | 3(1) | 7 | 9 | 3 | 3 | 3 | 4 | 1 | 1 |
| Scorpaenidae | 5 | 6 | 1 | 2 | 4 | | | 1 | 1 | 3 | 4 |
| Serranidae | 33 | 21 | | 12 | 24 | 5 | 6 | 10 | 3 | 5 | 5 |
| Sparidae | 4 | 2 | | 3 | 8 | | | 1 | | 1 | 1 |
| Syngnathidae | 8 | 6 | | 1 | 2 | 1 | 1 | | | | 1 |
| Tetraodontidae | 3 | 2 | 1 | 1 | 3 | | 2 | | | 1 | 2 |
| Tripterygiidae | | 4 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Other families† | 25 | 18 | 5(2) | 13 | 19 | 4 | 8 | 4 | 3 | 9 | 13 |

†Antennariidae, Aulostomidae, Batrachoididae, Carangidae, Cirrhitidae, Congridae, Ephippidae, Fistulariidae, Gerreidae, Kyphosidae, Ophidiidae, Pempheridae and Synodontidae

*numbers indicate identified species; number in brackets represent additional (incompletely identified) species.

**Table 3:** Number of species per family in the present study and other reefs in selected territories in the Atlantic Ocean. Adapted from Floeter & Gasparini [56].

## Conclusion and Recommendations

While it is undoubted that these two systems are depauperate, it is difficult to conclude with any certainty to what extent the results presented are representative of the true species richness; on the one hand, the literature gives conflicting implications, and on the other, the species list presented here may be far from complete, as many taxa and microhabitats were not adequately surveyed. It does appear that some taxa were more heavily studied than others; *e.g.*, there were focussed surveys for crabs, octocorals [20], algae [21] and fishes. While there were some general surveys [18], these often covered only epibenthic organisms; thus, there were under-sampled habitats including cryptic habitats (*e.g.*, sponge internal cavities, and framework cavities, both natural and artificial) and deeper-water habitats (especially at Salybia). Though coral rubble was sampled on the Salybia back reef, the total volume sampled was about 1000 cm3, only one-third of the 3000 cm3 minimum recommended by Meesters, et al. [37]. Symbionts, which can comprise a substantial proportion of coral reef biodiversity, were largely ignored in the surveys that contributed to the species list. If the results of Villamizar's & Laughlin's [57] survey of a single species of sponge, which hosted as many as 139 species, including fishes, crustaceans, ophiuroids and molluscs, is any indication, then it may be safe to conclude that at least some groups were underestimated in the present survey.

The survey also implied that Salybia Reef was more species-rich than Grande L'Anse; however, this may not be reflective of real patterns of diversity, but rather patterns in sampling effort and taxonomic interest since greater effort was expended at Salybia than Grande L'Anse. The only exception was the sampling of deeper reef habitats at Grande L'Anse but not at Salybia. On the other hand Grande L'Anse Reef is found in more turbid waters, and has somewhat lower rugosity (DAT Phillip, pers. obs), conditions which Bejarano & Appeldoorn [53] reported to have negative effects on fish diversity.

Depauperate or not, the species found on these two reefs are typical of Caribbean coral reef systems, since the main coral reef associated taxa were represented. We recommend that instead of making assumptions regarding marginal coral systems, that a programme of biological surveys be implemented to gain an understanding of what is actually out there. In the next phase, we need to deepen our studies of these reefs to determine their trajectories-*e.g.*, are they healthy/unhealthy, improving/declining/stable and to develop an understanding of the processes underlying these trends. We agree with Hughes, et al. [58,59], that conventional monitoring is insufficient, and that monitoring should be adapted to include processes responsible for the maintenance of healthy coral ecosystems [60-66].

## Acknowledgements

Firstly, the authors thank the students of UWI's Department of Life Science's undergraduate field course (2009-2012) for assistance with field collecting. We express our gratitude to M.C. Díaz (sponges), C. Messing (crinoids) and J. Gobin (polychaetes), who assisted with identification of specimens, and J.B. Alemu I for insightful comments on the draft manuscript. This research was partially funded by DATP and the American Museum of Natural History, Lerner Gray Fund for Marine Research grant. The Department of Life Sciences of UWI provided field support and allowed access to its biological collections. Undergraduate student researchers from Martin Methodist College.

## References

1. Bellwood DR, Hughes TP, Folke C, Nyström M (2004) Confronting the coral reef crisis. Nature 429: 827-833.
2. Mumby PJ, Steneck RS (2008) Coral reef management and conservation in light of rapidly evolving ecological paradigms. Trends in Ecology & Evolution 23(10): 555-563.
3. Talbot FH (1994) Coral reef protected areas: what are they worth? In: Brunkhorst DJ, (Eds.), Marine Protected Areas and Biosphere Reserves: 'Towards a New Paradigm'. Australian Nature Conservation Agency, Canberra, Australia, pp: 40-44.
4. Reaka-Kudla ML (1997) The global biodiversity of coral reefs: a comparison with rain forests. In: Reaka-Kudla ML, Wilson DE, Wilson EO, (Eds.), Biodiversity II: understanding and protecting our biological resources. Joseph Henry Press, Washington, D.C, pp: 83-108.
5. Reaka-Kudla ML (2001) Known and unknown biodiversity, risk of extinction, and conservation strategy in the sea. In: Bendell-Young L, Gallaugher P, (Eds.), Waters in Peril, Kluwer Academic Publishers, USA, pp: 19-33.
6. Reaka-Kudla ML (2005) Biodiversity of Caribbean coral reefs. In: Miloslavich P & Klein E, (Eds.), Caribbean Marine Biodiversity: The Known and the Unknown. Lancaster, Pennsylvania: DES tech Publications, pp: 259-276.
7. Mogerg F, Folke C (1999) Ecological goods and services of coral reef ecosystems. Ecological Economics 29(2): 215-233.
8. Halpern BS, Walbridge S, Selkoe KA, Kappel CV, Micheli F, et al. (2008) A global map of human impact on marine ecosystems. Science 319(5865): 948-952.
9. Glynn PW, Joshua SF, Andrew B, Stuart B, Julia C, et al. (2018) State of corals and coral reefs of the Galápagos Islands (Ecuador): Past, present and future. Marine Pollution Bulletin 133: 717-733.
10. Wilkinson C (2004) Status of Coral Reefs of the World. Austr Inst Mar Sci, Townsville, Australia.
11. Connell JH (1997) Disturbance and recovery of coral assemblages. Coral Reefs 16: S101-S113.
12. Hughes TP, Tanner JE (2000) Recruitment failure, life histories, and long-term decline of Caribbean corals. Ecology 81(8): 2250-2263.
13. Pandolfi JM, Bradbury RH, Sala, E, Hughes TP, Bjorndal KA, et al. (2003) Global trajectories of long-term decline of coral reef ecosystems. Science 301(5635): 955-958.
14. Belford S, Phillip D (2011) Rapid assessment of a coral reef community in a marginal habitat in the southern Caribbean: a simple way to know what's out there. Asian Journal of Biological Sciences 4(7): 520-531.
15. Sandin SA, Smith JE, Martini EE, Dinsdale EA, Donner SD, et al. (2008) Baselines and Degradation of coral reefs in the northern Line Islands. PLoS ONE 3(2): e1548.
16. Gray JS (1997) Marine biodiversity: patterns, threats and conservation needs. Biodiversity and Conservation 6(1): 153-176.
17. Perry CT, Larcombe P (2003) Marginal and non-reef-building environments. Coral Reefs 22(4): 427-432.
18. Kenny JS, Field CA, Ramsaroop D, Allick S, Alkins ME (1975) A Guide to the Shallow-water Corals of Trinidad. Department of Biological Sciences, The University of the West Indies, St Augustine.
19. Kleypas JA, McManus JW, Meñez Lambert AB (1999) Environmental limits to coral reef development:

where do we draw the line? American Zoologist 39(1): 146-159.

20. Ramsaroop D (1976) Studies on the Octocorallia of Trinidad. PhD Thesis, UWI, St. Augustine, Trinidad and Tobago.

21. Duncan EJ, Lee Lum LM (2006) A checklist of the marine macroalgae of the Republic of Trinidad and Tobago. Caribbean Marine Studies 7: 196.

22. Littler DS, Littler MM (2000) Caribbean Reef Plants: an Identification Guide to the Reef Plants of the Caribbean, Bahamas, Florida and Gulf of Mexico. Offshore Graphics Inc., USA.

23. Humann P, DeLoach N (2002a) Reef Coral Identification: Florida, Caribbean, Bahamas, enlarged. New World Pulications Inc., Florida.

24. Humann P, DeLoach N (2002b) Reef Creature Identification: Florida, Caribbean, Bahamas enlarged. New World Pulications Inc., Florida.

25. Warmke GL, Abbott RT (1962) Caribbean Seashells. Livingston Publishing Company, Narberth, Pennsylvania.

26. Stonley JM (1971) A Monograph of the Crabs of Trinidad. M.Phil. Thesis. The University of the West Indies, St. Augustine.

27. Southward AJ (1975) Intertidal and shallow water cirripedia of the Caribbean. Studies on the Fauna of Curaçao and other Caribbean Islands 46(150): 1-53.

28. Baboolal S, Johnatty S, Ali Z (1981) Studies on the Trinidad chitons. Living World Journal, pp: 39-45.

29. Uebelacker JM, Johnson PG (1984) Taxonomic Guide to the Polychaetes of the Northern Gulf of Mexico. Final report to the Minerals Management Service, contract 14-12-001-29091. Barry A Vittor and Associates Inc.

30. Kaplan EH (1988) Southeastern and Caribbean Seashores. Houghton Mifflin Company, Boston and New York.

31. Abbott RT, Morris PA (1995) Shells of the Atlantic and Gulf Coasts and the West Indies. Houghton Mifflin Company, Boston and New York.

32. Hendler G, Miller JE, Pawson DL, Kier PM (1995) Sea Stars, Sea Urchins, and Allies. Echinoderms of Florida and the Caribbean. Smithsonian Institution Press, Washington and London.

33. Zea S, Henkel TP, Pawlik JR (2009) The Sponge Guide: a picture guide to Caribbean sponges.

34. Humann P, DeLoach N (2002) Reef Fish Identification: Florida, Caribbean, Bahamas, enlarged. 3rd (Edn.), New World Pulications Inc, Florida.

35. Boxshall G, Mees J, Costello MJ, Hernandez F, Vandepitte L, et al. (2013) World Register of Marine Species.

36. Ginsburg RN (1983) Geological and biological roles of cavities in coral reefs. In: Barnes DJ (Ed.), Perspectives on Coral Reefs. AIMS, Townsville, Australia.

37. Meesters E, Knijn R, Willemsen P, Pennartz R, Roebers G, et al. (1991) Subrubble communities of Curaçao and Bonaire coral reefs. Coral Reefs 10(4): 189-197.

38. Scheffers SR, Van Soest RWM, Nieuwland G, Bak RPM (2010) Coral reef framework cavities: is functional similarity reflected in composition of the cryptic macrofaunal community. Atoll Research Bulletin 583: 1-24.

39. De Goeij JM, van Oevelen D, Vermeij MJA, Osinga R, Middelburg JJ, et al. (2013) Surviving in a marine desert: the sponge loop retains resources within coral reefs. Science 342: 108-110.

40. Díaz CM, Rützler K (2001) Sponges: an essential component of Caribbean coral reefs. Bulletin of Marine Science 69(2): 535-546.

41. Díaz MC (2005) Common sponges from shallow marine habitats from Bocas del Toro region, Panama. Caribbean Journal of Science 41(3): 465-475.

42. Díaz S, Fargione J, Chapin FS, Tilman D (2006) Biodiversity loss threatens human well-being. PLoS Biology 4(8): 1300-1305.

43. Phillips RC, Vadas RL, Ogden N (1982) The seagrasses and marine algae of the Miskito bank, Nicaragua. Growth Regulators in Aquatic Plants 13: 187-195.

44. Taylor WR (1962) Marine algae from the tropical Atlantic Ocean. V. Algae from the Lesser Antilles. Contributions from the National Herbarium 36: 43-62.

45. Earle SA (1972) A review of the marine plants of Panama. Bulletin of the Biological Society of Washington 2: 69-88.

46. Kenny JS (1988) Hermatypic scleractinian corals of Trinidad. Studies of the fauna of Curaçao and other Caribbean islands 123: 83-100.

47. Chiappone M, Sullivan KM, Lott C (1996) Hermatypic scleractinian corals of the southeastern Bahamas: a comparison to western Atlantic reef systems. Caribbean Journal of Science 32(1): 1-13.

48. Lewis JB (1989) The ecology of Millepora Coral Reefs 8(3): 99-107.

49. Zimmerman RA, Cummins H, Boardman MR, Deehr RA (2001) Living molluscan community distribution and species composition as it relates to seagrass density in a tropical carbonate lagoon, Graham's Harbour, San Salvador, Bahamas. In: Greenstein BJ, Carney CK, (Eds.), Proceedings of the 10th Symposium on the Geology of the Bahamas and Other Carbonate Regions, Gerace Research Center, San Salvador, Bahamas, pp: 175-186.

50. Geischler E (1997) Cavity dwellers (coelobites) beneath coral rubble in the Florida reef tract. Bulletin of Marine Science 61(2): 467-484.

51. Werding B, Hiller A, Lemaitre R (2003) Geographic and distributional patterns of western Atlantic Porcellanidae (Crustacea: Decapoda: Anomura), with an updated list of species. In: Lemaitre R, Tudge CC, (Eds.), Biology of the Anomura. Proceedings of a symposium at the Fifth International Crustacean Congress, Melbourne, Memoirs of Museum Victoria, Australia 60(1): 79-85.

52. Alvarado JJ (2011) Echinoderm diversity in the Caribbean Sea. Marine Biodiversity 41(2): 261-285.

53. Bejarano I, Appledoorn RS (2013) Seawater turbidity and fish communities on coral reefs of Puerto Rico. Marine Ecology Progress Series 474: 217-226.

54. Colton DE, Alevizon WS (1981) Diurnal variability in a fish assemblage of a Bahamian reef. Environmental Biology of Fishes 6(3,4): 341-345.

55. Clark R, Monaco ME, Appledoorn RS, Roque B (2005) Fish habitat utilization in a Puerto Rico coral reef ecosystem. Proceedings of the 56th Gulf and Caribbean Fisheries Institute 56: 467-485.

56. Floeter SR, Gasparini JL (2000) The southwestern Atlantic reef fish fauna: composition and zoogeographic patterns. Journal of Fish Biology 56(5): 1099-1114.

57. Villamizar E, Laughlin RA (1991) Fauna associated with the sponges Aplysina archeri and Aplysina lacunosa in a coral reef of the Archipielago de Los Roques, National Park, Venezuela. In: Reitner J, Keupp H, (Eds.), Fossil and recent sponges, Springer-Verlag, Berlin, pp: 522-542.

58. Hughes TP, Graham NAJ, Jackson JBC, Mumby PJ, Steneck RS (2010) Rising to the challenge of sustaining coral reef resilience. Trends in Ecology and Evolution 25(11): 633-642.

59. Hughes TP, Baird AH, Bellwood DR, Card M, Connolly SR, et al. (2003) Climate change human impacts and the resilience of coral reefs. Science 301(5635): 929-933.

60. Antonius A (1980) Occurrence and distribution of stony corals in the Gulf of Cariaco, Venezuela. Int Rev Ges Hydrobiol 65(3): 321-338.

61. Baillie JEM, Hilton Taylor C, Stuart SN (2004) IUCN Red List of Threatened Species-a Global Species Assessment. IUCN, Gland, Switzerland.

62. Chapin FS, Zavaleta ES, Eviner VT, Naylor RL, Vitousek PM, et al. (2000) Consequences of changing biodiversity. Nature 405: 234-242.

63. Collin RM, Díaz C, Norenburg J, Rocha RM, Sánchez JA (2005) Photographic identification guide to some common marine invertebrates of Bocas Del Toro, Panama. Caribbean Journal of Science 41(3): 638-707.

64. Maragos JE, Crosby MP, McManus JW (1996) Coral reefs and biodiversity: a critical and threatened relationship. Oceanography 9(1): 83-99.

65. Mikkelsen PM Cracraft J (2001) Marine biodiversity and the need for systematic inventories. Bulletin of Marine Science 69(2): 525-534.

66. Rapport DJ, Regier HA, Hutchinson TC (1985) Ecosystem behavior under stress. American Naturalist 125(5): 617-640.

67. Snyder AM (2003) Catalogue of the Marine Gastropod Family Fasciolariidae. Special Publication 21 of the Academy of Natural Sciences of Philadelphia 21(21): 1-431.

68. Verrill AE (1901) Comparisons of the Bermudian, West Indian and Brazilian coral fauna. Transactions of the Connecticut Academy of Arts and Science 11(3): 169-206.