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CUBA'S MESOPHOTIC CORAL REEFS AND ASSOCIATED FISH COMMUNITIES

Arrecifes de coral mesofóticos de Cuba y comunidades de peces asociadas

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ABSTRACT

A joint Cuba-U.S. expedition was conducted May 14-June 12, 2017 to characterize for the first time the extent and health of mesophotic coral ecosystems (MCEs) along the entire coastline of Cuba. Remotely Operated Vehicle (ROV) dives at 36 sites confirmed the presence of MCE habitat along all coasts of Cuba. ROV dives covered 27 km, at depths of 25-188 m, and documented habitat and species with 103 hours of high-definition video and 21,146 digital images. A total of 477 taxa of benthic macrobiota and 178 fish taxa were identified, and 343 specimens of benthic invertebrates and algae were collected to verify taxonomy and assess population genetic structure. The primary geomorphological features were the Deep Island Slope (125->150 m), Deep Fore-Reef Escarpment (the 'Wall', 50-125 m), and Deep Fore-Reef Slope (30-50 m). Most vertical surfaces of the Wall were covered with dense sponges, algae, octocorals, and black corals. *Agaricia* was the most abundant scleractinian genus on the Wall at depths of 50-75 m, and was observed to 122 m. Of the 2,240 scleractinian colonies that were counted in this study, only 12 corals (0.53%, mainly *Agaricia* spp.) showed signs of bleaching, and one *Agaricia* had black band disease, comprising remarkably low disease prevalence. The most frequently recorded sponge genera were *Xestospongia, Aplysina,* and *Agelas*. At least 10 previously unknown sponge species were collected during the expedition. Sites outside of marine protected areas generally had lower fish abundances, a possible indicator of historical overfishing. Lionfish were observed at most sites but abundances were low compared to other Caribbean regions.

KEY WORDS: Cuba, mesophotic reef, geomorphology, biozonation, biodiversity.

RESUMEN
Entre el 14 de mayo y el 12 de junio de 2017 se llevó a cabo una expedición conjunta entre Cuba y EEUU. El objetivo fue mapear y caracterizar, por primera vez, la extensión y salud de los arrecifes de coral mesofóticos (MCE, por sus siglas en inglés) alrededor de las costas de Cuba. 43 inmersiones con un Vehículo Operado por Remoto (ROV, por sus siglas en inglés) en 36 sitios, confirmaron la presencia de arrecifes mesofóticos a lo largo de toda la línea costera cubana. Las inmersiones del ROV desde 25 a 188 m de profundidad abarcaron, en total, 27 km, y se documentaron hábitats y especies con 103 horas de videos de alta definición y 21,146 imágenes digitales. Un total de 477 taxa de macrobiota bentónica y 178 taxa de peces fueron identificados. Se recolectaron 343 especímenes de invertebrados bentónicos y algas para verificaciones taxonómicas y evaluación de estructura de poblaciones. Los zonas geomorfológicas más prominentes fueron: Pendiente profunda (125- >150 m), Escarpe profundo del arrecife frontal (la "pared", 50-125 m), y arrecife de franja profundo (30-50 m). La pared presentó la mayor diversidad y densidad de la macrobiota; todas las superficies verticales estuvieron cubiertas por diversidad de esponjas, algas, gorgonias y coral negro. Agaricia *fue el género más abundante de escleractíneos y dominó a profundidades entre 40-75 m. Solo 12 colonias de corales escleractíneos (principalmente Agaricia spp.) de 2,240 colonias (0,53%) registradas con el ROV mostraron signos de blanqueamiento, y una Agaricia presentó enfermedad de banda negra, evidenciando la muy baja prevalencia de enfermedades. Los géneros más frecuentes de Porifera fueron* Xestospongia*,* Aplysina*, y* Agelas*. Al menos una decena de especies de esponjas desconocidas para la ciencia fueron colectadas. Los sitios que se encontraban fuera de áreas marinas protegidas, generalmente poseían abundancia de peces baja, lo cual pudiera ser un posible indicador de sobrepesca histórica. Individuos de pez león fueron observados en la mayoría de los sitios pero con abundancias bajas en comparación con otras regiones del Caribe.*

PALABRAS CLAVES: Cuba, arrecife mesofótico, geomorfología, biozonación, biodiversidad

INTRODUCTION

Mesophotic coral reef ecosystems (MCEs) are light-dependent benthic communities that occur deeper than shallow reefs and typically range from depths of 30 m to the bottom of the photic zone, which may extend to >150 m in some regions (Lesser *et al*., 2009; Hinderstein *et al*., 2010; Baker *et al*., 2016). MCEs represent in part an extension of shallow-water coral reef ecosystems and support a diverse assemblage of habitat-building taxa, including corals, sponges and algae, and associated commercial and recreational fisheries. However, many of the MCE species are depth specialists not found on shallow reefs. Studies of MCEs worldwide are expanding our understanding of their distribution, health, biodiversity, and ecology (Hinderstein *et al*., 2010; Baker *et al*., 2016; Loya *et al*., 2016, 2018; Roman, 2018). Many MCEs worldwide appear to be thriving compared to shallow reefs. The deep reef refugia hypothesis suggests that MCEs may be less impacted from natural and anthropogenic impacts than shallow coral reefs, and may be more stable and resilient than shallow reefs (Bongaerts *et al*., 2010; Bridge and Guinotte, 2012). MCEs may also act as refugia for shallow reef species through the export of fish and coral larvae (Serrano *et al*., 2014; Vaz *et al*., 2016). However, it is now apparent that MCEs are also vulnerable to disturbances from all facets of perturbations including climate change, bottom trawling, invasive species, and pollution (Bak *et al*., 2005; Andradi-Brown *et al*., 2016; Appledoorn *et al*., 2016a). Smith and Holstein (2016) further state that the main premise of the deep reef refugia hypotheses is incorrect and that it now appears that increases in temperatures above the local mean warmest conditions can lead to thermal stress and bleaching. Also there is growing evidence that the hypothesis may only be applicable to depth generalists on MCEs, and their contribution to replenishment of shallow reefs may not be as consequential as once hoped (Schlesinger *et al.*, 2018).

MCEs have been studied extensively throughout the Western Atlantic regions of the Caribbean, Bahamas, and the Gulf of Mexico (Hinderstein et al., 2010; Baker et al., 2016; Loya *et al.*, 2016, 2018). Whereas considerable data have been reported regarding the distribution, ecology, and health of Cuba's shallow reefs (Alcolado *et al.*, 2001a; Alcolado *et al.*, 2001b; Alcolado *et al.*, 2003; Aguilar *et al.*, 2004; Aguilar Betancourt and González-Sansón, 2007 ; Alcolado and García, 2007; Martínez-Daranas *et al.*, 2008; Alcolado *et al.*, 2009; González-Díaz *et al.*, 2010; Perera Valderrama *et al.*, 2013; González-Díaz *et al.*, 2014; Alcolado *et al.*, 2015; González-Díaz *et al.*, 2015; Suárez *et al.*, 2015; Caballero Aragon *et al.*, 2016; Ferrer Rodríguez *et al.*, 2016; González-Díaz *et al.*, 2018; Roman, 2018), relatively little is known about the distribution, community structure and health of Cuba's deep mesophotic reefs. The book "The Ecology of the Marine Fishes of Cuba" (Claro *et al.*, 2001) provides a comprehensive description of physical attributes of coastal Cuba including geology, geomorphology, hydrology, and major habitats from intertidal depths out to the shelf break at approximately 30 m. The fish fauna of what Claro *et al.* (2001) termed as the slope and bathyal zone (100-600 m) was described from dives with Harbor Branch Oceanographic Institute's *Johnson-Sea-Link* submersible in 1997. In the 1970s, Vassil Zlatarski and Nereida Martinez Estalella were the pioneers of research on Cuba's mesophotic reefs. Zlatarski and Estalella's (1982) book "The Scleractinians of Cuba" (first published in Russian in 1980, 1982 in French, 2008 in Spanish) provides detailed reef profiles and coral species distributions from 44 sites around the island, some of which extend into the >40-70 m depth range; however, the eastern tip and northeast coast lack data. Scuba dives (some to depths of 70 m) for this study resulted in an extraordinary collection of corals (5,924 specimens) which are now archived in the National Aquarium of Cuba (in Havana). González Ferrer's (2004) book "Corales Petreos Jardines Sumergidos de Cuba" also provides invaluable data on the stony corals of Cuba as well as the history of Cuban reef research since the 16^{th} century. This book provides beautiful color plates for all the hard corals found in Cuba, as well as discussions of reef types, coral disease and bleaching. Kühlmann (1974, 1983) also provided data on the depth distribution of scleractinian corals from scuba dives to 70 m in Cuba.

In 2015, a Joint Statement was developed between the United States and the Republic of Cuba on Cooperation on Environmental Protection (November 24, 2015), and a Memorandum of Understanding (MOU) was signed by the U.S. National Oceanic and Atmospheric Administration (NOAA), the U.S. National Park Service and Cuba's National Center for Protected Areas. This MOU establishes a 'Sister-Sanctuary' relationship between Guanahacabibes National Park and Banco de San Antonio Marine Sanctuary in Cuba, and the Florida Keys National Marine Sanctuary (FKNMS) and Flower Garden Banks National Marine Sanctuary (FGBNMS) in the United States. It is recognized that these regions are all inextricably linked through ocean currents. In support of these agreements, a joint research expedition was conducted from May 14 to June 12, 2017 on the University of Miami's ship *F.G. Walton Smith* to survey the mesophotic reefs of Cuba. This project was jointly planned and in collaboration with organizations in Cuba and the U.S., including Centro de Investigaciones Marinas at University of Havana (CIM-UH), Centro Nacional de Áreas Protegidas (CNAP), Instituto de Ciencias del Mar (ICIMAR), Geocuba Estudios Marinos, Guanahacabibes National Park-Sistema Nacional de Areas Protegidas (PNG-SNAP), Acuario Nacional de Cuba (ANC); and for the U.S., two NOAA Cooperative Institutes: the Cooperative Institute for Ocean Exploration, Research, and Technology (CIOERT) at Harbor Branch Oceanographic Institute/ Florida Atlantic University (HBOI-FAU), and the Cooperative Institute for Marine and Atmospheric Studies (CIMAS) at the University of Miami.

The primary goal of this research expedition was to survey the extent of mesophotic reefs along the entire coastline of Cuba using a remotely operated vehicle (ROV). The objectives of the expedition were to: 1) characterize Cuba's MCE benthic habitats, benthic macroinvertebrate and algal communities, and fish populations (emphasis on commercially important grouper/snapper species, spawning grounds, and Lionfish); 2) understand the genetic connectivity of Cuba's MCEs with mesophotic and shallow reefs upstream and cross-stream (including the Sister-Sanctuaries in U.S. and throughout Cuba); 3) characterize the health of Cuba's MCEs; 4) conduct ROV collections of benthic species for taxonomy and molecular analyses; 5) collect CTD, ADCP (Acoustic Doppler Current Profiler) oceanographic data, and water column data for benthic carbonate chemistry including aragonite saturation state. Data collected during this expedition and on planned future cruises will be used to compare the health and connectivity of Cuba's MCEs to reef systems elsewhere in the Caribbean, Gulf of Mexico, and southeastern United States.

This paper provides a preliminary overview of the results of this expedition to date, including general descriptions of the oceanographic data around Cuba, MCE habitats, geomorphology, biozonation, and biodiversity of these reefs. Future taxonomic and genetic analyses of the specimens, along with quantitative analyses of the video and photographic data, will allow a more precise characterization of the diversity, zonation, health, and regional differences of the mesophotic communities of Cuba, as well as a better understanding of the connectivity of Cuban reefs with the Sister Sanctuaries in the U.S. and elsewhere in the Caribbean. These data will also be useful for decision making for new and existing marine protected areas (MPAs) into these deeper waters of Cuba. Cuba's strong marine policies and legislation has already resulted in 105 MPAs, covering nearly 25% of its insular shelf, yet overfishing, poaching, pollution and global warming are threats to these vulnerable ecosystems (Perera Valderrama *et al.*, 2018; Roman, 2018).

METHODS AND MATERIALS

Locations of proposed dive sites were compiled prior to the cruise, based on data from various sources: 1) recommendations from CIM-UH, CNAP, and ICIMAR; 2) NOAA and regional coastal charts; and, 3) site data from HBOI's *Johnson-Sea-Link* manned submersible 1997 expedition (Discovery

Channel "Forbidden Depths" documentary). Some sites were selected directly offshore of well-characterized shallow-water reef sites or within Marine Protected Areas (MPAs). Except for Banco de San Antonio, there are no high-resolution maps of the Cuba's deepwater shelf and slope. Specific sites were selected based on the above sources and plotted in ArcGIS 10.3 using coastal charts at depths of 30-150 m. In order to circumnavigate the island in the time available, transit between sites at night was generally from 50-150 km. Additional dives were made within the Guanahacabibes National Park which is of special interest. Two 3-4 hour dives were made each day with a *Mohawk* ROV. At each site a fathometer profile was made prior to the ROV dive to document the depth and location of the shelf-edge break and to select the exact target site for the ROV. Sketches of reef profiles were drawn to illustrate the various dive sites. The specific depths and slopes were drawn to scale from observations made during the ROV dives. The slope angles, inflections of the slopes at different depths, depths of zones, and depths of shelf-edge reef crest were made from the ROV dive notes.

Video was recorded throughout each ROV dive with an Insite Pacific Mini Zeus high-definition CMOS color zoom camera. Digital still images were taken with a Kongsberg Maritime OE14-408. Both cameras had 10-cm parallel lasers for scale (green- still; red- video). At each site a continuous video/photo transect commenced at a maximum depth of ~150 m and continued upslope to the upper mesophotic reef zone or about 30 m. The photo transects were used for habitat characterization and species identifications. When a second dive was made at the same dive site, it was usually for sample collections and fish video transects. Photo transects were conducted using the digital still camera oriented perpendicular to the substrate (~1-2 m off bottom), and images were haphazardly taken 2-3 per minute. In addition, at most sites, at least one horizontal transect was made along a constant depth contour wherever *Agaricia* spp. and *Montastraea cavernosa* corals first became common (usually between 50 and 70 m depths). These horizontal transects were typically along the face of the vertical rock wall or overhanging rock buttresses, so the camera was pointed straight forward, perpendicular toward the wall. Time and distance of the horizontal transects varied depending on currents and topography, but generally were about 15 minutes, and transited ~100 m, for a total of 30 images. Fish were identified throughout the dive using the video camera pointed forward and down ~20° to view from the horizon to close up. In addition, fish video transects of approximately 30 minutes were made at each site along the upper wall and deep fore-reef crest. Direction of transects were haphazard, but generally headed along slope, but also depended on the ship's maneuverability with the wind and current.

The *Mohawk* ROV was equipped with a collection skid, which consists of a small 5-function manipulator, five suction buckets, and a Plexiglas box. Specimens of corals, sponges, and algae were collected at most sites and will be used for museum specimens and taxonomic identification, genetic analysis, and coral health studies. Specimens were photographed in situ, and in the ship's lab, and then preserved in 95% ethanol, 5% formalin, or TRIzol. ROV sensors included: Seabird Fastcat 49, CO_2 and pH. Shipboard oceanographic data

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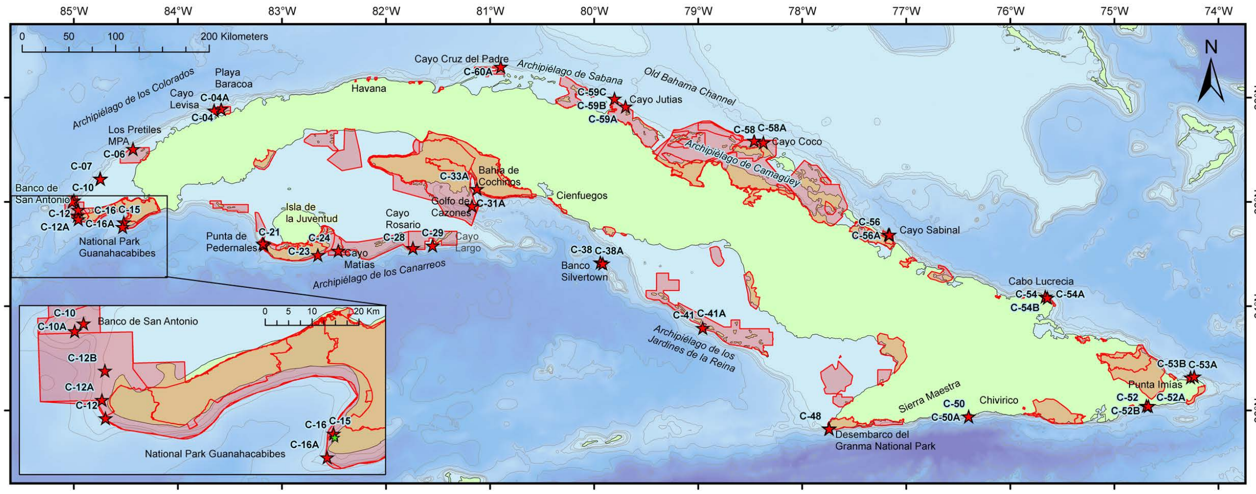

Fig. 1. Map of Cuba showing ROV dive sites (red stars) on mesophotic reef sites (30-150 m depths) during the *F.G. Walton Smith* cruise, May 14 to June 12, 2017. Pink polygons- marine protected areas (UNEP-WCMC, 2017).

continuously recorded surface water data including temperature, salinity, florescence, and dissolved oxygen, and ADCP data. A shipboard CTD and water sample rosette were cast daily to profile the dive sites.

Metadata and habitat dive notes were recorded during the dive into a Microsoft Access database which links to the ROV navigation data. Teams of U.S. and Cuban scientists specializing in coral, sponge, algae, and fish taxonomy recorded data in separate Access databases which were later compiled with the benthic habitat database. Duplicate sets of the video/photo data and specimens are curated in the U.S. at CIOERT (HBOI-FAU), and in Cuba at CIM-UH/ANC/ICIMAR/CNAP.

RESULTS

Thirty-six mesophotic reef sites around the coast of Cuba were surveyed during 43 ROV dives (Fig. 1, Table 1). Total ship

Table 1. ROV dive sites on Cuba's mesophotic reefs during the *F.G. Walton Smith* cruise, May 14 to June 12, 2017.

Station	Dive No.	Location	Latitude	Longitude	Depth Range (m)
C-04	1	Cuba, NW coast, Cayo Levisa MPA	22°53.483'N	83°34.969'W	25-188
C-04A	2,3	Cuba, NW coast, 2 nmi north of Cayo Arenas, Cayo Levisa MPA	22°52.638'N	83°39.103'W	49-172
C-06	4,5	Cuba, NW coast, Norte de Los Pretiles MPA	22°30.487'N	84°25.907'W	43-170
C-07	6,7	Cuba, NW coast, Archipiélago de Los Colorados, No MPA	22°13.405'N	84°44.837'W	45-178
C-10	8	Cuba, W coast, Banco de San Antonio MPA, east wall	22°00.901'N	84°59.947'W	25-183
C-10A	9	Cuba, W coast, Banco de San Antonio MPA, south wall	22°00.017'N	85°00.977'W	30-150
C-12	10	Cuba, W coast, Los Cayuelos, Guanahacabibes National Park	21°50.005'N	84°57.426'W	149
C-12A	11	Cuba, W coast, Faro Roncali, off lighthouse, Guanahacabibes National Park	21°52.111'N	84°57.824'W	45-156
C-12B	12	Cuba, W coast, Las Tumbas, Guanahacabibes National Park	21°55.477'N	84°57.494'W	38-148
C-15	13	Cuba, W coast, El Almirante, Punto de Buceo, Cabo Corrientes, Guanahacabibes National Park	21°48.224'N	84°31.137'W	25-145

C-16A	14	Cuba, W coast, Cabo Corrientes, Guanahacabibes National Park	21°45.512'N	84°31.874'W	28-150
C-21	15	Cuba, S coast, SW tip of Isla de la Juventud, Punta de Pedernales MPA	21°35.263'N	83°10.325'W	25-158
C-21A	16	Cuba, S coast, SW Isla de la Juventud, bay on west side of point, Punta Francés MPA	21°36.010'N	83°10.943'W	28-150
C-23	17	Cuba, S coast, SE Isla de la Juventud, Punta Brava MPA	21°29.419'N	82°39.228'W	37-150
C-24	18	Cuba, S coast, E of Isla de la Juventud, Archipiélago de Los Canarreos, Cayo Matías MPA	21°31.924'N	82°27.480'W	40-150
C-28	19	Cuba, S coast, Archipiélago de Los Canarreos, Cayo Rosario MPA	21°33.469'N	81°44.401'W	29-150
C-29	20	Cuba, S coast, Archipiélago de Los Canarreos, Cayo Largo del Sur MPA	21°34.854'N	81°33.130'W	26-157
C-31A	21	Cuba, S coast, Golfo de Cazones, Punta Brava, Sur Ciénaga de Zapata, no MPA	21°57.650'N	81°10.355'W	18-150
C-33A	22	Cuba, S coast, Bahía de Cochinos, east wall, Zapata National Park	22°07.444'N	81°07.518'W	30-150
C-38	23,24	Cuba, S coast, south of Cienfuegos, Banco Silvertown, west wall, proposed MPA	21°25.180'N	79°56.377'W	24-150
C-38A	25	Cuba, S coast, south of Cienfuegos, Banco Silvertown, south wall, proposed MPA	21°24.470'N	79°54.942'W	40-153
C-41	26	Cuba, S coast, Cayo Caballones, south slope, Jardines de La Reina MPA	20°47.495'N	78°57.323'W	30-150
C-48	27,28	Cuba, S coast, Cabo Cruz, Desembarco del Granma National Park	19°49.600'N	77°44.551'W	40-154
C-50	29,30	Cuba, S coast, Sierra Maestra, Chivirico Proposed MPA	19°56.551'N	76°23.937'W	27-155
C-52	31	Cuba, S coast, Sierra Purial, Punta Imías, no MPA	20°02.601'N	74°41.498'W	60-161
C-52A	32	Cuba, S coast, Sierra Purial, east tip of Punta Imías, 1 nmi east of ROV 31, no MPA	20°02.513'N	74°40.345'W	43-156
C-53A	33	Cuba, eastern tip of Cuba, NW Punta Maisí, Punta Silencio, no MPA	20°19.007'N	74°16.001'W	54-155
C-53B	34	Cuba, eastern tip of Cuba, NW Punta Maisí, Punta del Fraile, no MPA	20°19.482'N	74°13.940'W	50-142
C-54	35	Cuba, NE coast, Cabo Lucrecia, no MPA	21°05.508'N	75°39.821'W	45-151
C-54B	36	Cuba, NE coast, Cabo Lucrecia, proposed MPA	21°04.817'N	75°38.530'W	65-156
C-56	37,38	Cuba, NE coast, Archipiélago Sabana-Camagüey, Cayo Sabinal MPA	21°41.096'N	77°10.241'W	24-150
C-58	39	Cuba, NE coast, Archipiélago Sabana-Camagüey, Cayo Coco, proposed MPA	22°34.192'N	78°22.361'W	42-140
C-58A	40	Cuba, NE coast, Archipiélago Sabana-Camagüey, Cayo Coco, proposed MPA (just north of NW edge of MPA)	22°35.262'N	78°27.706'W	46-144
C-59A	41	Cuba, NE coast, Archipiélago Sabana-Camagüey, Cayo La Vela MPA	22°54.858'N	79°41.854'W	22-143
C-59C	42	Cuba, NE coast, Archipiélago Sabana-Camagüey, Cayo Jutía, ¼ nmi N of snorkel Station, no MPA	22°59.446'N	79°48.188'W	30-147
C-60A	43	Cuba, NE coast, Archipiélago Sabana-Camagüey, Cayo Cruz del Padre, inside and outside MPA	23°17.792'N	80°53.809'W	40-161

transit around the island covered ~2,778 km. Dives ranged from depths of 188 m to 25 m and resulted in a total dive time of 103 hours, covering approximately 27 km. A total of 21,146 digital still images documented habitat and species, and photo transect images (7,063) will be used for future analyses of percent cover and density of corals, sponges, and algae. The high-definition video will be used to document species composition and density of fish. A total of 343 specimens of benthic macro-invertebrates and macro-algae were collected with the ROV.

Oceanographic Data

The surface currents along the western half of Cuba, between Havana and Cienfuegos, were likely part of the Cuban Countercurrent, which flows counterclockwise against the Caribbean and Florida Currents (Fig. 2). Along the southeastern coast from Archipelago Jardines de la Reina to the eastern end, which abuts the northern steep slope of the Cayman Trench, currents were generally eastward. Surface currents were counterclockwise around the eastern end of Cuba. Surface currents along the northeastern Cuban coast, however, did not have a prevailing direction, and were likely influenced by the competition between the Florida Current and Antilles Current and by tidal fluctuations. Historical measurements by Atkinson *et al.* (1995) suggested that the residual currents in the Old Bahamas Channel were predominantly westward toward the Florida Straits. Temperatures recorded by the ROV showed surface temperatures ranging from 27.09-29.52°C for all dives (Table 2). In general, temperatures were greatest along the south coast (29.52°C). The coolest temperatures were found along the northeast coast (27.09°C). At mid-depth of the dives (50 m, in the deep mesophotic zone), temperatures ranged from 25.26-28.62°C. Minimum temperatures at the deeper depths (162-182 m) were 21.35- 25.93°C. A thermocline of 25-28°C was common around 80-100 m depths. Surface salinities ranged from 35.11-36.73 PSU and at 50 m depths were 35.14-36.77 PSU. Visibility based on ROV video was excellent at most sites (estimated 30- >50 m), except sites

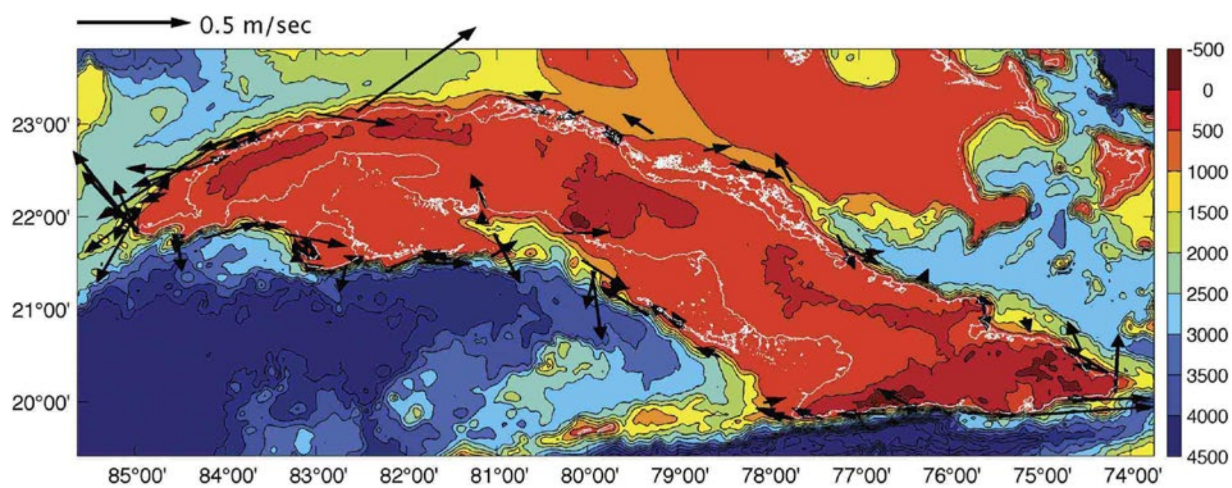

Fig. 2. Shelf-edge currents around Cuba from 6-hourly mean surface currents (arrows) measured with shipboard ADCP during the *F.G. Walton Smith* cruise, May 14 to June 12, 2017.

Table 2. Oceanographic data collected with a Seabird Fastcat 49 on the *Mohawk* ROV during the *F.G. Walton Smith* cruise, May 14 to June 12, 2017.

	Maximum Depth			Mid Depth (50 m)		Surface (1 m)	
	Depth (m) Max	Temp.(°C) Range	Salinity (PPT) Range	Temp. (°C) Range	Salinity (PPT) Range	Temp. (°C) Range	Salinity (PPT) Range
Northwest Coast	177.27	22.47-24.19	36.84-36.89	26.77-27.44	36.31-36.40	27.71-28.27	36.16-36.37
West Coast	182.13	22.53-25.93	36.65-36.90	27.50-28.25	36.29-36.37	28.17-28.58	36.28-36.31
Southwest Coast	162.29	22.69-24.15	35.59-36.89	27.68-28.46	35.14-36.41	28.53-29.52	35.11-36.41
Southeast Coast	162.06	22.53-24.41	36.80-36.93	25.99-28.62	36.11-36.67	28.42-29.48	36.04-36.35
Northeast Coast	162.01	21.35-25.56	36.72-37.41	25.26-27.88	36.39-36.77	27.09-28.54	35.64-36.73
Total	182.13	21.35-25.93	35.59-37.41	25.26-28.62	35.14-36.77	27.09-29.52	35.11-36.73

near stream runoff. Surface currents at the dives sites varied from 10 to 51 cm s^{-1} (0.2-1 kn), but occasionally were in excess of 100 cm s^{-1} during which the ROV could not be safely deployed and recovered.

Geomorphology

The ROV dives documented the deep mesophotic habitat surrounding Cuba. Many of the dive sites, especially on the eastern end of Cuba, had never been explored previously. All 43 dives confirmed the presence of MCE habitat. It appears from these dives that, just like the shallow reefs that fringe most of the Cuban coast, the deep reefs also parallel most of the shelf edge for nearly 2,800 km, and include deep fringing reefs that are close to shore (primarily along the northwest coast, southeast coast, and northeast coast), the barrier reefs along the various archipelagos (Los Colorados, Canarreos, Jardines de la Reina, and Sabana-Camagüey), and deep-water banks (Banco de San Antonio, and Banco Silvertown) (for terminology of reef types, see page 390, Zlatarski and Estalella, 1982; González Ferrer, 2004). Topographically, the most conspicuous features of most dive sites were the deep island slope (125- >150 m), deep fore-reef escarpment (vertical wall; 50-125 m), and deep fore-reef (30-50 m) (Fig. 3). The geology of the deep reef features are likely carbonate limestone, and none of the sites appeared to be granitic, even at the southeastern coast off the Sierra Maestra mountain range where we expected granitic rock slopes as the coastline drops from +1,974 m (mountain peak) to -7,686 m (Cayman Trough).

The following is a general description of the deep fore-reef and slope (Figs. 3, 4).

Deep Island Slope (125- >150 m)- At many sites, this zone was a steep (70°), relatively smooth rock pavement slope intersected with low relief, vertical sediment chutes (1-m deep, 1-3 m wide), although some sites had slopes varying between 45° and 90° at 150 m. The surface rock usually showed horizontal layering and had scallop-shaped erosional features (10-30 cm diameter). This zone had the lowest diversity and density of biota. Fathometer profiles showed slopes of 10-45° extending to depths of 500 m.

Deep Fore-Reef Escarpment (the 'Wall', 50-125 m)- This zone formed a near-vertical wall (80-90° slope) at most sites. The base of the wall was commonly between 100 and 125 m depths although at many sites the wall continued to >150 m (>200 m at Site C-29 off the NE coast). At some sites, the upper wall (45-80 m) was formed of large rock "buttresses" which overhung

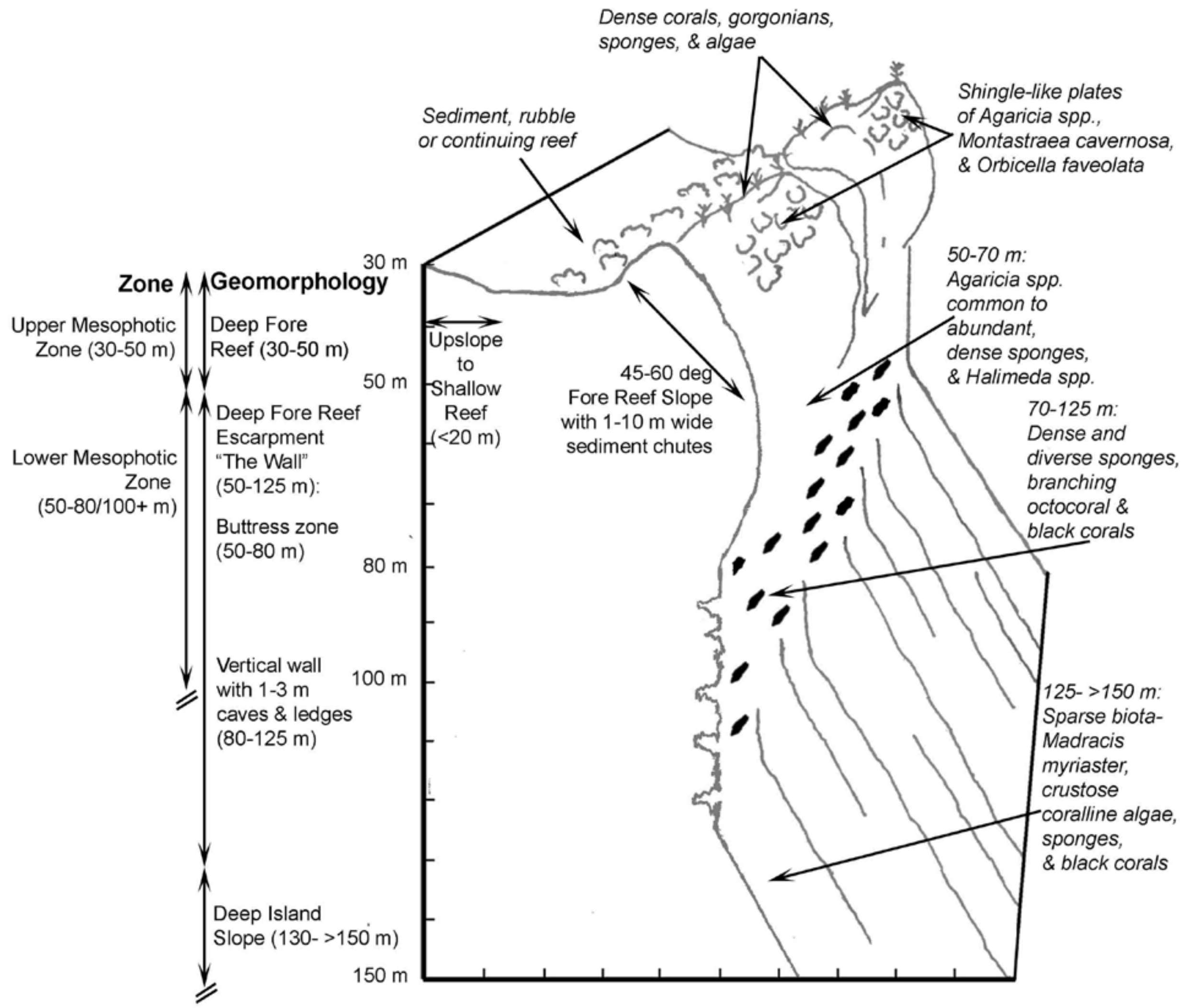

Fig. 3. Schematic of general geomorphological features and biozonation of Cuba's mesophotic reefs showing a well-developed fore reef zone and wall with buttresses.

the plane of the wall by 3-5 m. The buttresses were generally 10-20 m wide and were separated by sediment chutes which provided a conduit for the downslope transport of the shelf sediments (Hoskin *et al.*, 1986). Fewer macrobiota occurred in the chutes. Between depths of 60 and 125 m, the wall was highly eroded at many sites, with karst-like topography forming caves (1-3 m diameter) and ledges (1-2 m wide).

Deep Fore-Reef Crest and Slope (30-50 m)- Seaward of the shallower reef zones (3-25 m), a zone of shelf-edge reefs generally paralleled the shelf-edge break. At some sites the deep fore-reef crest formed a ridge or sill-like feature (3-5 m relief). Generally, this ridge was not continuous but a series of mounds (5-10 m diameter, 3-5 m high). The fore-reef slope of this zone was typically steep (45-60°) with rocky escarpments, and spurs and grooves. The fore-reef slope of this zone was often intersected with sediment chutes (1-10 m wide) which cut through the reef. At some sites these were actually fringing reefs close to the shore

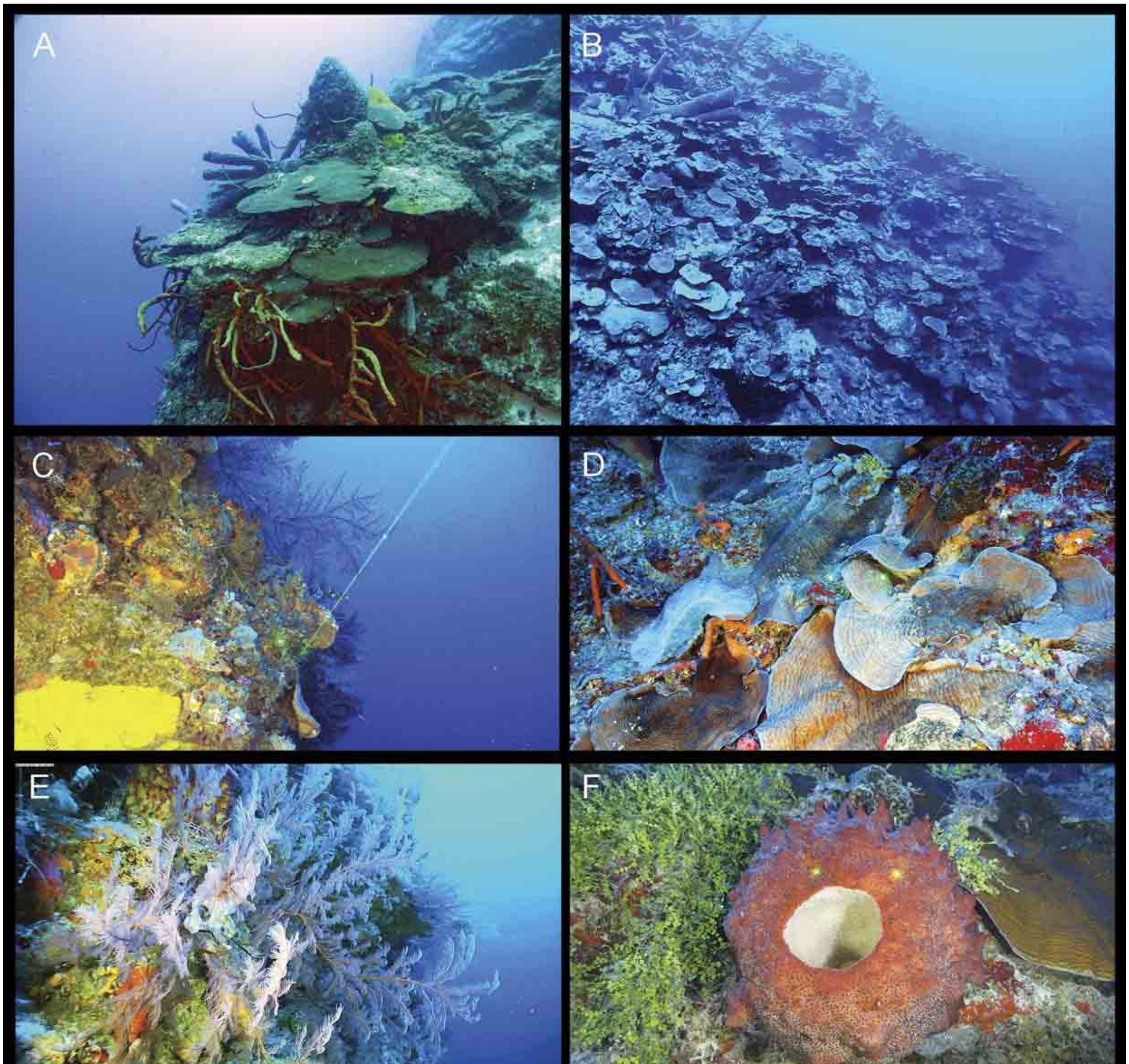

Fig. 4. Habitat and reef biota of Cuba's mesophotic reefs. Deep fore-reef slope: A) 1-m diameter plates of *Orbicella faveolata*, conical dead *Montastraea cavernosa*, tube sponges (*Aplysina archeri*), and rope sponges (*Agelas sceptrum*, *Aplysina cauliformis)*, Punta de Pedernales MPA, Site C-21, 33 m; B) dense shingle-like corals *O. faveolata*, *Agaricia* spp., *Montastraea cavernosa*, Bahía de Cochinos, Site C-33A, 30 m. Deep fore-reef escarpments (the 'wall'): C) rock buttress with dense array of sponges (yellow sponge- *Siphonodictyon coralliphagum*), black corals, branching octocorals, and stylaster corals, Guanahacabibes National Park, Site C-12B, 82 m (lasers 10 cm); D) plates of *Agaricia* spp., Guanahacabibes National Park, Site C-12B, 64 m (lasers 10 cm); E) black coral bushes *Plumapathes* sp. on vertical wall, Guanahacabibes National Park, Site C-12B, 79 m; F) large barrel sponge *Xestospongia* sp., green alga *Halimeda* sp., and scleractinian *Agaricia* sp., Cayo Largo del Sur MPA, Site C-29, 61 m.

(e.g., along the SE coast off Sierra Maestra, Bahia de Cochinos, and Guanahacabibes). Elsewhere the shelf-edge reefs occurred seaward of the Archipelagos (e.g., Los Colorados, Canarreos, Jardines de la Reina, Sabana-Camagüey) and may be considered barrier reefs (Zlatarski and Estalella, 1982; González Ferrer, 2004). Also the two deep-water banks that were surveyed (San Antonio and Silvertown) had similar topography along the shelf-edge break.

Biozonation

Mesophotic coral ecosystems (MCEs) are characterized by light-dependent corals and associated communities typically found at depths ranging from 30-40 m and extending to >150 m in tropical and subtropical regions (Baker *et al.*, 2016). Various researchers have divided what is now called the mesophotic zone into different subzones and depths (e.g., Goreau and Goreau, 1973; Lang, 1974; James and Ginsburg, 1979; Ginsburg *et al.*, 1991; Lesser *et al.*, 2009; Locker *et al.*, 2010; Sherman *et al.*, 2010; Clark *et al.*, 2014; Reed, 2016; Laverick et al., 2017). For this paper, we use the depth of 30 m as the upper extent of the upper mesophotic zone and have used the depth of 50 m as the transition between the upper and lower mesophotic zones where we generally saw a fairly distinct change in geomorphological zonation and species. Therefore, the upper mesophotic zone is generally in the deep fore-reef, and the lower mesophotic zone is basically on the wall and buttresses of the deep fore-reef escarpment. The definitive maximum depth of the mesophotic zone is problematic and varies from site to site based on light, sedimentation, and substrate (Baker *et al.*, 2016).

Deep Island Slope (125- >150 m)- Although the deep island slope often had photosynthetic species such as crustose coralline red algae (CCA) and encrusting green algae, there were no zooxanthellate corals. Ahermatypic corals such as *Madracis myriaster* were common along with various azooxanthellate, branching octocorals (*Ellisella elongata*, *Nicella goreaui, Swiftia exserta*), black corals (*Antipathes* sp., *Tanacetipathes* sp., *Stichopathes* sp.), and stylasterine corals. Sponges were common but not as diverse or dense as on the wall. Common sponge species include a bright yellow crustose sponge (Order Verongiida) forming abundant large patches (20-100 cm^2), thick-walled vase sponge (*Xestospongia* sp. Cu-01), several species of *Oceanapia* with elongated projections, and massive sponges from various taxa (Orders Haplosclerida, Suberitida, and Tetractinellida).

Deep Fore-Reef Escarpment (the 'Wall', 50-125 m)- This is the most impressive and recurring feature of most sites along the Cuban shelf edge. This zone had the greatest diversity and density of macrobiota of the deep reefs. Starting at 100-125 m, nearly all vertical surfaces were covered with sponges (e.g., *Agelas* spp., *Aplysina* spp., *Callyspongia* spp., *Ceratoporella nicholsoni*, *Clathria* spp., *Geodia* spp., *Leucetta* spp., *Oceanapia* spp., *Petrosia* spp., *Plakortis* spp., *Spirastrella* spp. and *Xestospongia* spp.); algae (CCA, *Halimeda* spp., Peyssonneliaceae (several species), *Lobophora* spp., and *Dictyota* spp.), branching octocorals (*Nicella* spp., *Ellisella* spp., *Swiftia exserta*), and black corals (bushy Antipatharia to 1-2 m, and dense fields of *Stichopathes* sp.). In general, the dominant scleractinian corals on the wall were *Agaricia* (*A. fragilis, A. grahamae, A.*

lamarcki, and possibly *A. undata*). These typically first occurred at the maximum depths of 80-122 m, and were often quite common to abundant between 50 and 70 m and on the upper slope of the buttresses. Therefore, the bottom of the mesophotic zone generally was around 80-120 m, but this was very variable by site. Corals were less common where there was less light, e.g., under the overhanging buttresses, on north facing walls, or where the deep fore-reef did not form a sill that blocks the flow of sediments downslope. For example, one reef at Faro Roncali, Guanahacabibes National Park (Site C-12A) had no ridge-like deep fore-reef to block sediment flow from the shelf, and as a result no scleractinian corals or CCA were observed on the wall. But, Site C-12B nearby had a distinct shelf-edge reef with 5-m relief which blocked sediment flow except in the area of the chutes, and also had dense populations of plate coral on the wall and upper slope.

Deep Fore-Reef (30-50 m)- This region forms the upper mesophotic zone where higher abundance and diversity of scleractinian species were characteristically found. *Agaricia* spp., *Montastraea cavernosa*, *Orbicella faveolata*, *Stephanocoenia intersepta* and *Porites astreoides* were dominant. Several sites, including Banco de San Antonio (Site C-10A), Guanahacabibes (C-12B), Bahía de Cochinos (C-33A), and Cayo Sabinal (C-54B), had dense shingles of plate corals (*O. faveolata* or *Agaricia* spp.) on the fore reef slope and crest (estimated 60-80% cover at Site C-33A). Common shallow reef sponges were abundant here as well, such as *Agelas* spp, *Aiolochoria* spp., *Aplysina* spp., *Amphimedon* spp., *Cinachyrella* spp., *Cliona* spp., *Ircinia* spp., *Niphates* spp., *Smenospongia* spp., *Spongia* spp., *Verongula* spp., and *Xestospongia* spp.

Biodiversity

A total of 477 taxa of benthic macrobiota and 178 fish taxa were identified from the ROV video/photo surveys and from the specimens collected (Appendices 1 and 2, respectively). These data will be quantified in the future for percent cover and for documenting densities of corals and fish. A total of 343 mesophotic benthic samples were collected during this expedition; preliminary analyses indicate that some are new species and records of depth or distribution.

Corals- A total of the 101 cnidarian taxa that were identified morphologically included 46 Scleractinia, 32 Alcyonacea (branching octocorals and Alcyoniina), and 15 Antipatharia. The deepest occurrences of identified zooxanthellate corals were *Agaricia* sp. (122 m), *Stephanocoenia intersepta* (104 m), and *M. cavernosa* (101 m) (Table 3). These were the most common scleractinians on the wall in the deeper mesophotic zone, whereas *O. faveolata* was more common in the upper mesophotic zone. The most common octocorals were in the genera *Ellisella*, *Nicella*, and *Antillogorgia* (syn. *Pseudopterogorgia*), and *Swiftia exserta*. The most common black corals included *Stichopathes* spp., *Tanacetipathes tanacetum*, *Tanacetiphates* sp., and Antipathidae. In addition, 123 scleractinian corals were collected, some of which will be used for genetic analysis.

Sponges- Cuban MCEs proved to be a very favorable habitat for marine sponges in both species richness and abundance. We identified 296 distinct taxa: 280 Demospongiae, 9 Homoscleromorpha, and 7 Calcarea, of which 115 (39%) were identified to species and 107 to genus (35%). The rest were only tentatively identified to families, orders, or classes, and are the subject of ongoing taxonomic research.

Table 3. Deepest observations of macrobiota during ROV dives at all Sites during the *F.G. Walton Smith* cruise, May 14 to June 12, 2017.

Taxa	Max. Depth (m)
Scleractinia	
Agaricia sp.	122
Stephanocoenia intersepta	104
Montastraea cavernosa	101
Helioseris cucullata	79
Agaricia grahamae	74
Orbicella faveolata	72
Octocorallia	
Swiftia exserta	188
Porifera	
Verongiida Cu-01 (yellow crust)	183
Xestospongia sp. Cu-01	168
Ceratoporella nicholsoni (sclerosponge)	159
Xestospongia muta	134
Leucetta sp. (Calcarea)	124
Chlorophyta	
Chlorophyta (thin green crust)	169
Halimeda sp.	127
Rhodophyta	
Crustose coralline (CCA)	169
Peyssonneliaceae	139
Ochrophyta	
Lobophora sp.	139
Dictyota sp.	100
Chordata	
Pterois volitans/miles (Lionfish)	188

The ten most frequently recorded species were the barrel sponge *Xestospongia muta*, *Xestospongia* sp. Cu-01, an encrusting unidentified bright yellow Verongiida sp. Cu-01, large tubular *Aplysina archeri*, several species of *Agelas* (*A. sceptrum, A. dilatata, and A. citrina*), and *Mycale laxissima*. Sponges colonized all depths and substrates surveyed. The deepest records were a bright yellow Verongiida sp. Cu-01 encrusting on rock (183 m deep), *Xestospongia* sp. Cu-01 (168 m), *Ceratoporella nicholsoni* (159 m), *X. muta* (134 m), and *Leucetta* sp. (124 m) (Table 3). Peak diversity started at depths of 100-125 m in which sponge morphologies (crusts, plates, tubes, spherical, vases, and branches) and multicolor patterns abounded. From the collections, there are at least 10 sponge species that are new to science within the genera of *Aplysina* and *Verongula* (Verongiida); *Amphimedon*, *Callyspongia,* and *Xestospongia* (Haplosclerida); *Clathria* (Poecilosclerida); *Cinachyrella* (Tetractinellida); *Aaptos* (Suberitida); *Erylus* (Tetractinellida) and *Plakortis* (Homosclerophorida).

Algae- A total of 63 taxa of macroalgae (29 Chlorophyta, 25 Rhodophyta, 9 Ochrophyta) and 1 Cyanobacteria (syn., Cyanophyta) have been identified to date. The most frequent taxa were crustose coralline algae (CCA), *Halimeda copiosa*, *Lobophora* spp., and *Dictyota* spp.. In general, the diversity and coverage of algae were very low on the deep island slope where only CCA and thin encrusting green algae occurred. Between 50 and 100 m, the algal diversity and cover increased, with *H. copiosa* and CCA dominating. In the upper mesophotic zone (30-50 m), the species richness and cover increased even more, with *Lobophora* spp. and other Dictyotales dominating. Some interesting records of maximum depth of algal occurance include an unidentified green crust (169 m), CCA (169 m), Peyssonneliaceae (139 m), *Lobophora* spp. (139 m), and *Halimeda* spp. (127 m) (Table 3). Cyanobacteria were observed at eight sites and abundant at one described below. Detrital leaves of the marine angiosperm *Thalassia testudinum* were also observed on the deep island slope at some sites showing the vertical connectivity between coastal-marine ecosystems.

Fish- A total of 178 species of fish were observed throughout the survey (Appendix 2). Between 60 and 150 m, fish diversity and abundances were low at all sites, whereas from 30-60 m the diversity increased, as well as the frequency and abundance of fish species. The deep island slope zone (125-150 m) was dominated by Blackcap Basslet (*Gramma melacara*), Cave Basslet (*Liopropoma mowbrayi*), Sunshinefish (*Chromis insolata*), Blackfin Snapper (*Lutjanus buccanella*), Squirrelfish (*Holocentrus adscensionis*) and Longspine Squirrelfish (*H. rufus*). The walls (lower mesophotic reef zone, 50-120 m) and upper deep fore-reef (30-50 m) were inhabited by species common on Cuban shallow reefs, including numerous species from the families Acanthuridae, Balistidae, Carangidae, Chaetodontidae, Haemulidae, Holocentridae, Labridae, Lutjanidae, Pomacanthidae, Pomacentridae, and Serranidae. Groups of jack (*Caranx latus, C. ruber* and *C. lugubris*) were frequently observed. Ten species of grouper (Serranidae) were identified throughout the sampling area including Coney (*Cephalopholis fulva*), Graysby (*Cephalopholis cruentata*), Nassau Grouper (*Epinephelus striatus*) and Red Hind (*E. guttatus*). Hundreds of Ocean Triggerfish (*Canthidermis sufflamen*) were observed at Banco de San Antonio MPA. Courtship and nest building behavior by the triggerfish were observed leading to the conclusion that this is a spawning aggregation site. A spawning aggregation of Dog Snapper (*Lutjanus jocu*) was also observed at a site in Archipelago de Camagüey between 60 and 70 m depths. This site is part of the Centro y Oeste de Cayo Coco Ecological Reserve (Perera-Valderrama *et al*., 2018). We propose this site should be made a no-take fishery reserve or, at least, a no-take during the spawning season(s) since other commercially important species might also spawn there. We observed Lionfish (*Pterois volitans/miles*) at most sites; the greatest depth was 188 m at Cabo Lucrecia (Site C-54B). The abundance of the invasive Lionfish was generally low, generally <10 observed during a four hour dive at most sites. An exception was at Cayo Coco (Site C-58) where they were relatively abundant with 38 counted on one dive. However, sampling by ROV video cameras could bias fish counts due to avoidance and therefore abundances of Lionfish could be greater than we observed.

Regional Comparisons of Cuba's MCEs

Sketches of reef profiles were drawn to illustrate various regions of Cuba (Figs. 5-8). These are not the specific coastal zones outlined in Areces (2002), but represent the reef profiles of six sites within each of the following general regions of Cuba: western, southern, eastern, and northern. Photographs taken with the ROV that represent each of these regions are provided in Appendix 3. Four general habitats were added to the sketches: rock pavement, mud/sediment, caves/ledges, and coral shingles. The zone of eroded rock forming caves or reentrants and ledges was found on the wall of the deep fore-reef escarpment at many of the sites. These features are karst-like topography likely formed during the low sea levels of the last glacial period. The coral shingles zone consisted mostly of *O. faveolata* and *Agaricia* spp. and was found at some sites on the deep fore-reef crest and slope (generally 30-40 m). Each profile also includes the maximum depth observed at that site for the primary plate corals: *M. cavernosa*, *Agaricia* spp., *O. faveolata,* and *S. intersepta* (abbr. in Figs. 5-8).

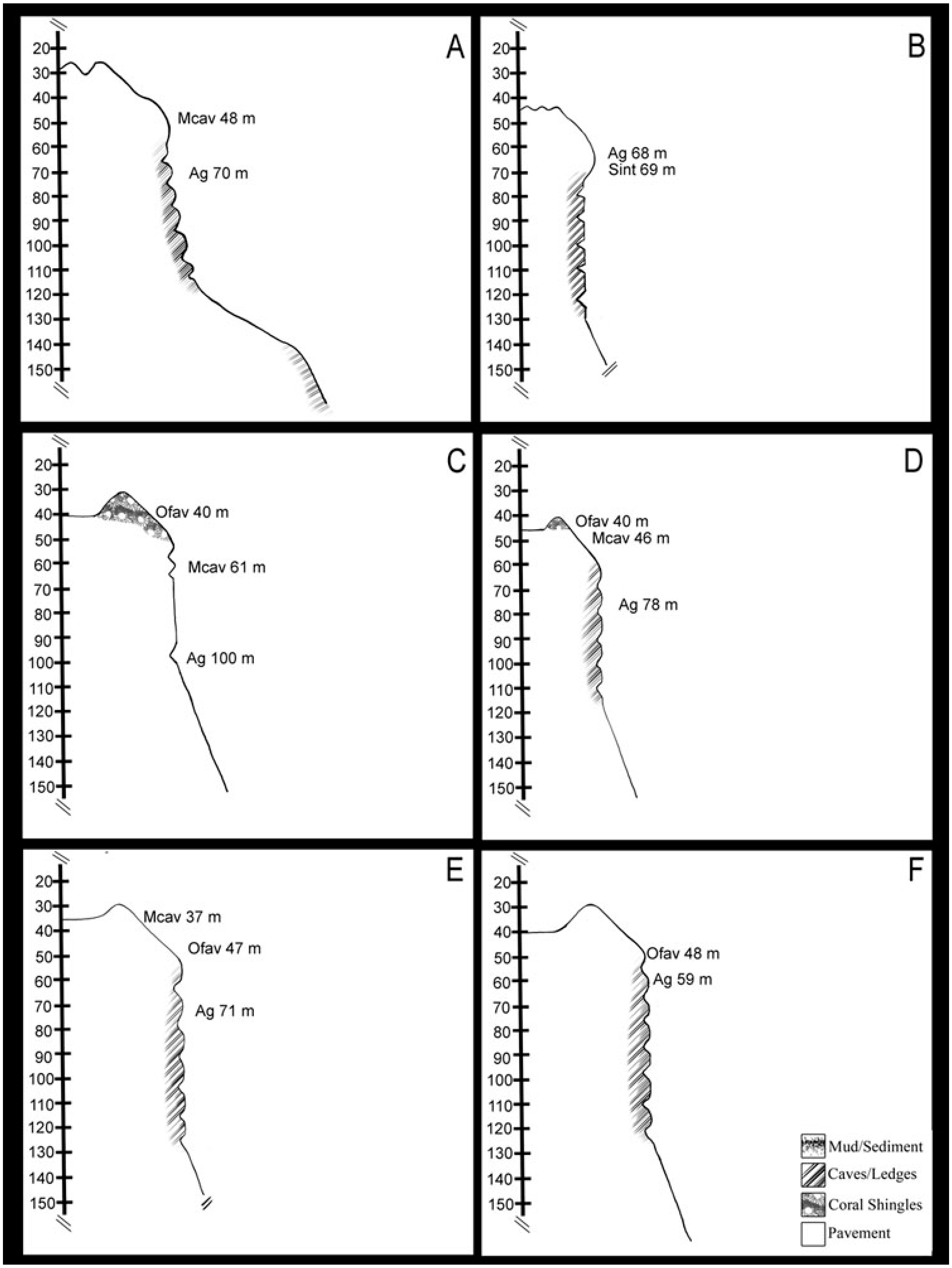

Fig. 5. Sketches of reef profiles selected to illustrate the various regions of Cuba's MCEs. (see Fig. 1). Western region (Archipelago de Los Colorados, Banco San Antonio, Guanahacabibes): A. Site C-04, B. Site C-07, C. Site C-10A, D. Site C-12B, E. Site C-15, F. Site C-16A. The specific depths and slopes were drawn to scale from observations made during the ROV dives.

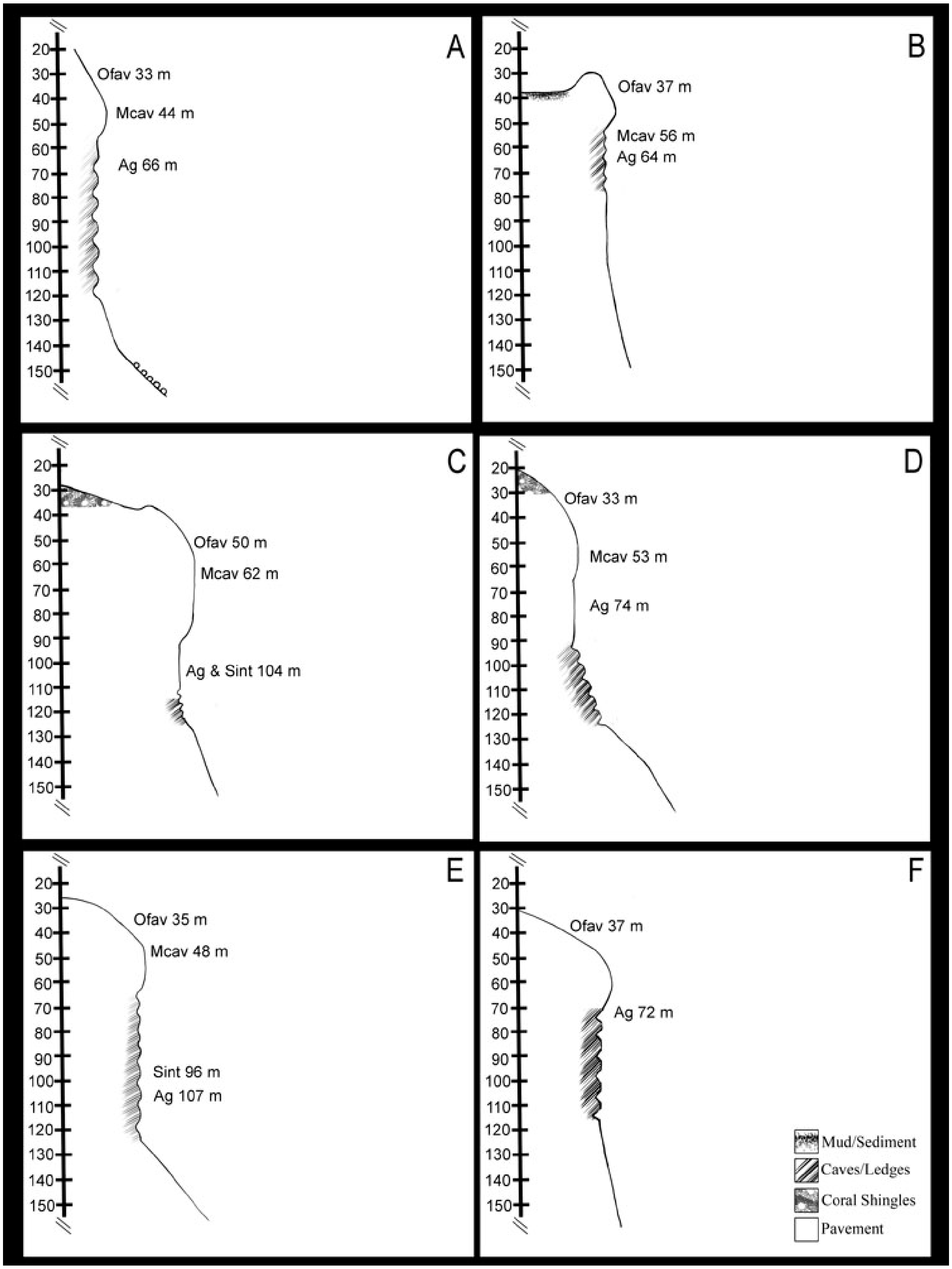

Fig. 6. Sketches of reef profiles selected to illustrate the various regions of Cuba's MCEs (see Fig. 1). Southern region (Isla de la Juventud, Archipelago de los Canarreos, Bahia de Cochinos, Banco Silvertown, Jardines de La Reina): A. Site C-21, B. Site C-23, C. Site C-28, D. Site C-33A, E. Site C-38, F. Site C-41. The specific depths and slopes were drawn to scale from observations made during the ROV dives

In the western region, the crest of the shelf-edge reefs was generally between 30 and 40 m (Fig. 5). This fore-reef zone generally consisted of a series of mounds (3-10 m relief) along the shelf-edge break that were intersected with sand chutes. Some had buttresses on the deep fore-reef slope and upper wall. Shingles of *O. faveolata* were found at Sites C-10A (Banco San Antonio) and C-12B (Las Tumbas, Guanahacabibes). The deep fore-reef escarpment generally was highly eroded with caves or reentrants and ledges at depths of about 60 to 110-130 m. *Agaricia* spp. generally was first observed around 70 m depth, but was as deep as 100 m at Banco San Antonio (Site C-10A). In addition, these shelf-edge reefs were all quite similar even though they comprise fringing reefs (Guanahacabibes), barrier reefs (Archipelago de Los Colorados), and bank reef (San Antonio).

The reefs of the southern region generally showed less pronounced mounds or ridges along the shelf-edge break (Fig. 6), and the shelf-edge break varied greatly among sites. For example, the fore-reef slope at SW Isla de Juventud (C-21) and Bahia de Cochinos (C-33A) continued up to at least 20 m depth where we had to cut off the transect for the safety of the ship. Site C-33A had the densest cover of *O. faveolata* coral shingles at any site, in depths of 20-30 m. Cayo Rosario (C-28) also had dense *O. faveolata* shingles on the deep fore-reef slope but these were mostly dead. *Agaricia* occurred in this region as deep as 107 m (Banco Silvertown, C-38). Also the zone of eroded topography varied greatly among the sites.

Shelf-edge reefs along the eastern region were highly variable (Fig. 7). The shelf-edge break of the deep fore-reef was as deep as 50-60 m at some sites, and several sites near the eastern tip of Cuba showed extensive erosion and lacked the vertical wall (Punta Imias, C-53; Punta Maisi, C-53A; Cabo Lucrecia, C-54B). Sherman *et al.* (2010) also found lower topographic relief and less pronounced escarpment on the southeastern region of Puerto Rico. They attribute this due to the fact that the eastern facing slopes are more exposed to trade-wind generated swells and tropical hurricanes that typically approach from the southeast. They also found that MCEs are patchier and more widely spaced on the southeast slopes.

The northern region of Archipelago de Sabana-Camagüey (Fig. 8) also showed variability ranging from eroded, low slope geomorphology (Sites C-58, C-58A) to the walls and buttresses (Sites C-56, C-59C, and C-60A) that were typically present at the western region. One site at Cayo Coco (C-58A) was mostly smooth rock pavement, with a relatively narrow region of highly eroded, rock ledge habitat at 70-90 m. Also the maximum depth of *Agaricia* tended to be shallower at several sites in this region perhaps due to the northern facing walls (45 m at C-58, 52 m at C-59C).

To date, only general comparisons of benthic macrobiota and fish distributions can be made for the various mesophotic regions of Cuba from these data. Quantitative analyses of the photo transects for macrobenthos cover and density as well as analyses of fish densities from the video transects are planned as part of our multinational research efforts and will allow for more detailed comparisons of any regional and depth differences in the future. Appendices 1 and 2 provide the species lists of macrobenthos (invertebrates and algae) and fish, respectively, by

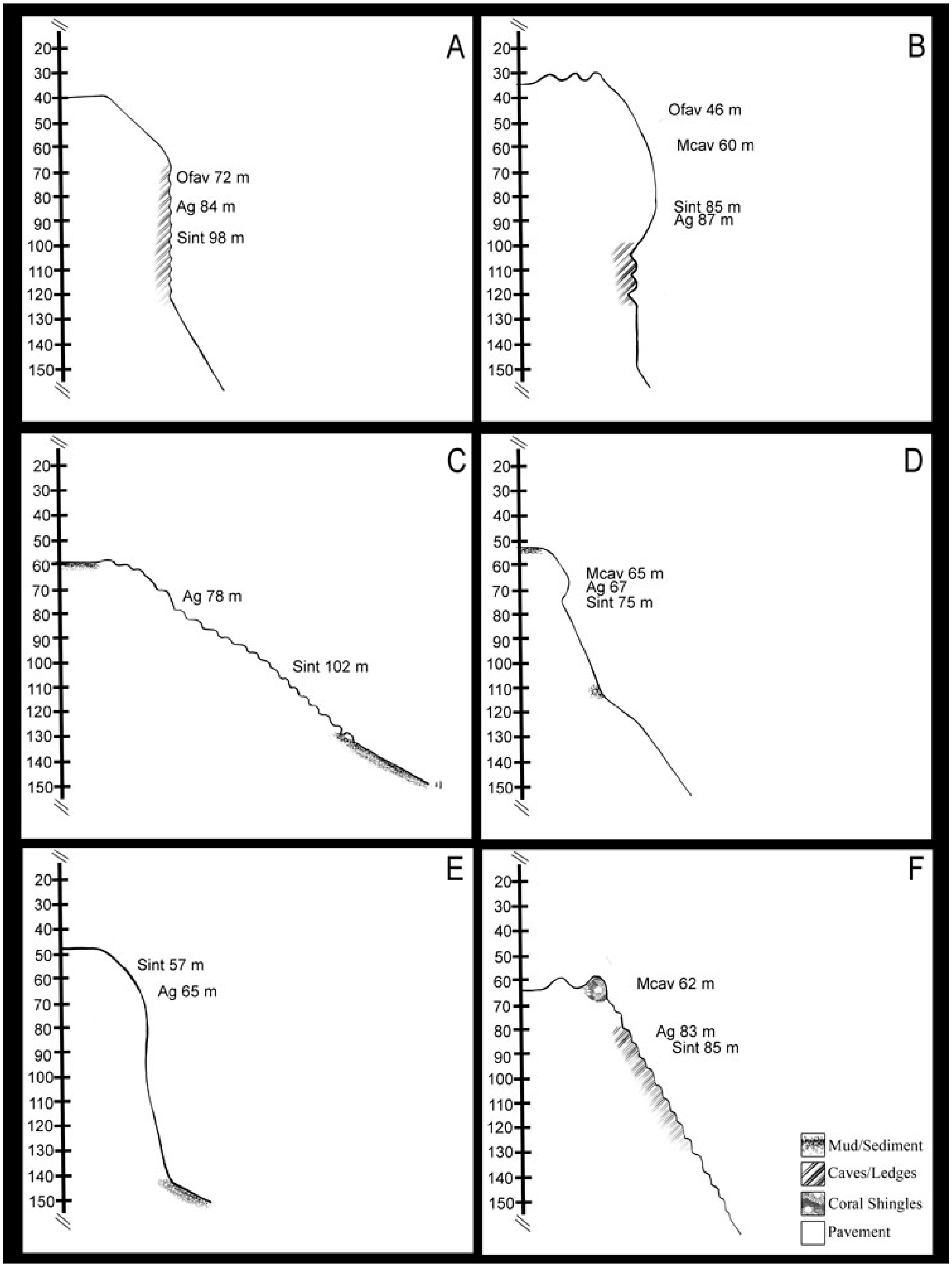

Fig. 7. Sketches of reef profiles selected to illustrate the various regions of Cuba's MCEs (see Fig. 1). Eastern region (Granma National Park, Chivirico MPA, Punta Imias, Punta Maisi, Cabo Lucrecia): A. Site C-48, B. Site C-50, C. Site C-52, D. Site C-53A, E. Site S-54, F. Site C-54B. The specific depths and slopes were drawn to scale from observations made during the ROV dives.

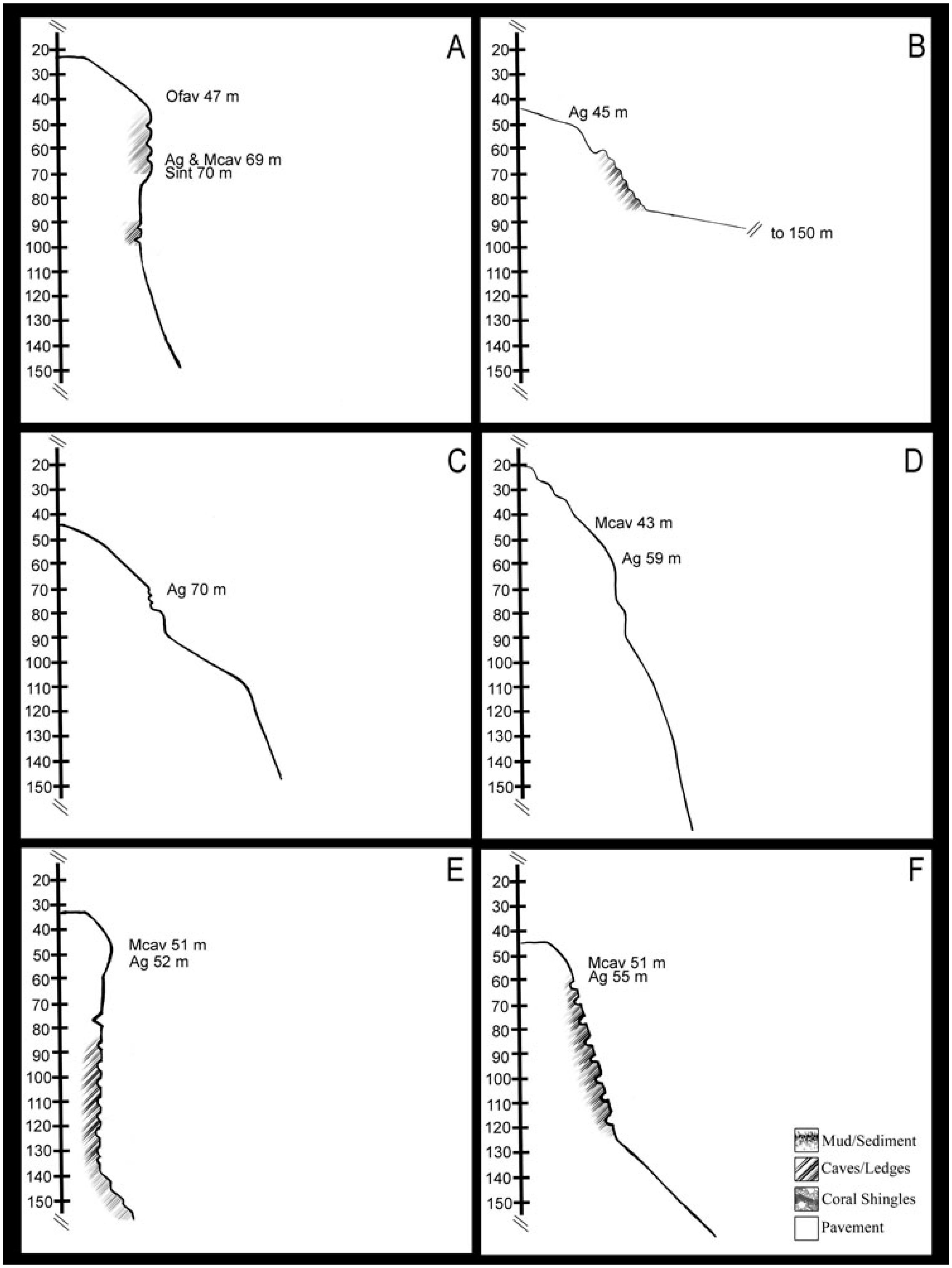

Fig. 8. Sketches of reef profiles selected to illustrate the various regions of Cuba's MCEs (see Fig. 1). Northern region (Archipelago de Sabana-Camagüey): A. Site C-56, B. Site C-58, C. Site C-58A, D. Site C-59A, E. Site C-59C, F. Site C-60A. The specific depths and slopes were drawn to scale from observations made during the ROV dives.

site and region based on the ROV annotations and sample collections. In general, there were some regional and site specific differences, but overall the MCE communities and species distributions were relatively similar around the island. For these comparisons we have divided the dive sites into 6 regions (see Fig. 1): Northwest coast- Archipelago de Los Colorados, Sites C-04 to C-07; West coast- Banco de San Antonio, Guanahacabibes, Sites C-10 to C-16A; Southwest coast- Isla de la Juventud, Archipelago de los Canarreos, Golfo de Cazones, Bahia de Cochinos, Sites C-21 to C-31A; Southeast coast- Banco Silvertown, Jardines de La Reina, Granma National Park, Chivirico MPA, Punta Imias, Sites C-38 to C-52A; Northeast Coast- Punta Imias [north side], Cabo Lucrecia, Archipelago de Sabana-Camagüey, Sites C-53 to C-60A). Based on the presence/absence species data of Appendix 1, both the northeastern and southeastern regions had the greatest number of macrobenthos taxa (259 taxa each). The west and southwest regions had 229 and 228 taxa, respectively, and the northwest had the least (205 taxa). However, the sites were not evenly distributed among these regions, so comparisons of species richness are only tentative. However, the number of taxa per site is more relevant, typically, each site had a similar amount of ROV time, basically one dive for the macrobenthic surveys. Sites C-48 (Granma) and C-50 (Chivirico) on the southeast coast had the most taxa (126 and 125 taxa, respectively), but C-52 (south Punta Imias), which is also on the southeast coast, had the least (57 taxa). Unlike most of the other sites in that region, Site C-52 was muddy from 160 to 130 m, and did not have the vertical rock wall and buttresses found at C-48 and C-50 (Fig. 7).

Corals- Cnidarian species richness of the mesophotic reefs based on the ROV annotations was greatest on Cuba's southeast coast, where a total of 146 taxa were observed. The sites with the greatest individual coral species richness (including Scleractinia, Octocorallia, and Antipatharia) were located on the southeast coast; 47 and 46 coral taxa having been recorded at Sites C-48 and C-50, respectively. The northwest coast had the fewest observed coral taxa (57 taxa), perhaps due in part to fewer stations within this region as compared to all other regions. The fewest coral taxa were observed at Site C-12A (11 taxa) at Guanahacabibes. This station was clearly an outlier in terms of observed coral species. Within octocorals, *Ellisella* sp. was observed at all sites while *Nicella* sp. was present in all sites except C-12A. Likewise, among the Scleractinia, *Agaricia* sp. were observed at all stations except C-12A. *M. cavernosa* was also commonly reported in the ROV annotations (32 of the 35 sites). Frequent Antipatharia taxa included *Stichopathes* sp. which was observed at all sites and *Tanacetipathes* sp. which occurred at 29 sites. Twenty taxa were only observed at single sites, the majority of which were either rare species (e.g., the scleractinians *Dendrogyra cylindrus* and *Madracis myriaster*). In terms of present/absence, few strong regional differences were observed among coral taxa, although the southeast coast showed the greatest species richness for scleractinian species and may represent a hotspot of reef-building species diversity. All other regions were generally similar in terms of observed coral taxa, with the exception of the northwest coast.

Sponges- Only two sponge species were present at all sites. The first, *Xestospongia* sp. Cu-01, may be a new species and resembles *X. muta*, but with thicker walls and is relatively shorter and chubby in appearance. The second, as yet unknown, is a thick bright yellow verongiid crust (Verongiida sp. Cu-01) that lacks any fiber skeleton. Three species were found at 33 sites (*Agelas sceptrum, Aiolochroia crassa,* and *X. muta*). The most species-rich sites for sponges were found at Site C-07 (Archipelago Colorados) on the northwest coast with 72 taxa and, on the south coast, C-28 (Archipielago Canarreos) with 68 taxa and C-50 (Chivirico) with 66 taxa. However, overall the most species-rich region for sponges was the northeastern region (153 taxa), followed by the southeastern region (148 taxa) and western region (142 taxa). The fewest taxa were found in the northwest region (113 taxa) and southwest (131 taxa). By station the fewest sponges were found at Site C-52 (33 taxa) and C-52A (37 taxa) at Punta Imias on the southeast coast, and C-58A (36 taxa) at Archipelago de Camagüey on the northeast coast. Surprisingly, 99 sponge taxa were found exclusively at single sites (33% of the 296 morphotypes) which might reflect high level of endemism or widespread but patchy distributions. The most diversified genera were: 1) *Agelas* with 16 identified species (6 of which occur at least in 15 sites) and 10 unidentified morphotypes, and 2) *Aplysina* with 10 identified species (6 taxa occur at more than 15 stations) and 7 unidentified morphotypes. The interpretation of the regional and local patterns of sponge diversity will require further analysis that will study factors such as habitat, current patterns, and biogeographic affinities.

Algae- Macroalgal taxa that were common to all regions of the Cuban mesophotic coral reefs included the coralline red algae (Subclass Corallinophycidae) and the family Peyssonneliaceae in the Rhodophyta; some green unidentified crustose forms, the genera *Halimeda* (particularly *H. copiosa, H. goreaui*, *H. tuna*), *Avrainvillea, Penicillus, Udotea* (particularly *U. cyathiformis*) in the Chlorophyta; and the genera *Dictyota* and *Lobophora* in the Ochrophyta. Site C-10 (Banco San Antonio, west coast) had the greatest number of taxa (24), whereas C-52 (southeast coast) which lacked the typical vertical wall had the least (4 taxa). The northeastern region had the highest number of macroalgal taxa identified so far (38 taxa), whereas the western regions had the least (24 taxa in the northwest region, and 25 in the southwest). These results could indicate better conditions for the development of macroalgae in the northeastern region of Cuba, and/or lower herbivory levels, but further work is still needed.

Fish- There were 178 fish taxa identified from the ROV annotations (Appendix 2), however only one, *Chromis insolata*, was present at all 36 sites. There were three species present at 33 sites; *Gramma melacara, Halichoeres garnoti*, and *Stegastes partitus*. An additional three species were found at 32 sites; *Holacanthus tricolor, Chromis cyanea* and the invasive Lionfish *Pterois volitans/miles*. Similar to sponges, the most species-rich site for fish was C-07 on the northwest coast, with 67 taxa observed. Site C-12B at Guanahacabibes had 63 taxa and C-48 on the southeast coast had 62 taxa. Regionally, the southeast coast was the richest with 112 fish taxa present; however, the site with the fewest taxa was on the southeast coast (Site C-52 with 17 taxa), which was also true for the sponges and algae, followed by Site C-52A (26 taxa) and C-04 on the northwest coast (27 taxa). Overall, the northwest coast had the lowest species richness with 91 taxa;

however, this region had the fewest number of sites. Thirty-nine taxa were found only at single sites while 13 were found at only two sites. The number of species found at single sites will likely decrease after detailed analyses of ROV videotapes are completed and fishes overlooked during real-time dive annotations are added to the database. Fish assemblages were not significantly different from one another inside and outside the MPAs based on the non-metric multidimensional scaling ordination (MDS) plot of the presence/absence transformed fish data from the ROV observations. With the exception of one dive, fish assemblages from all dives were 40% similar to one another, regardless if they were inside or outside the MPAs. Based on the SIMPER (Similarity Percentages), the species that had the most effect on fish assemblage differences inside and outside the MPAs were higher abundances of *Caranx lugubris, Haemulon plumierii,* Scaridea, and *Gramma loreto* inside the MPAs and higher abundances of *Holocentrus rufus* outside the MPAs. In the western area, sites that coincided with marine protected areas (Banco de San Antonio, Guanahacabibes National Park, and Cayo Rosario) had greater abundances of commercially important species, i.e., snapper (Lutjanidae), grouper (Serranidae), jack (Carangidae) and mackerel (Scombridae). The sites outside of these marine protected areas had a lower abundance of these species, which could be an indicator of historical overfishing.

DISCUSSION

Mesophotic Coral Habitats of Caribbean, Gulf of Mexico and Southeastern U.S.

MCE habitats are quite common throughout the Western Atlantic regions of the Caribbean, Gulf of Mexico, and southeastern U.S., and include deep island slopes, off-shore banks, and shelf-edge reefs. However, the MCE habitat and biota are quite variable within these regions. The general geomorphology and mesophotic zonation of the deep fore-reef slope and escarpment along the Cuban coast are strikingly similar to those described for the Bahamas (Porter, 1973; Reed, 1985; Ginsburg *et al.*, 1991; Lesser and Slattery, 2011); Jamaica (Goreau and Goreau, 1973; Goreau and Land, 1974; Lang, 1974; Land and Moore, 1977; Dustan and Lang, 2018), and the Belize barrier and atoll reefs (James and Ginsburg, 1979). The 'Wall' at Belize also forms spectacular vertical cliffs from depths of 65 to 120 m, with vertical fissures, ledges and caves, and in the 1970s, the upper brow of the wall (45-65 m) had coral growth consisting of large colonies of plate corals up to 50% cover. At Discovery Bay, Jamaica, the wall forms an escarpment from 55 to 114 m, also with caves and ledges, and in the 1970s-1980s was dominated by sponges, algae, and corals (its current condition is unknown, J. Lang, pers. comm.). At that time, the deep fore-reef slope (30-65 m) at Jamaica had similar dominant coral, sponge, and algal species as do the Cuban deep reefs. The corals were predominantly *Orbicella* in high abundance to 45 m at some sites, *Agaricia lamarcki* on upper slope, *A. undata, A. grahamae, Helioseris cuculata,* and *M. cavernosa* on the lower slope; and the algae were dominated by crustose coralline algae, *Halimeda copiosa, H. cryptica*, plus algal turfs and fleshy macroalgae (Goreau and Goreau, 1973; Lang, 1974; Dustan and Lang, 2018). Hermatypic corals (primarily *Agaricia* spp.) dominated the wall around 70 m. The deep island slope (> 120 m) in

Jamaica was also similar to the Cuban reefs, and had a similar heterotrophic community consisting of abundant sponges, including coralline sponges, the azooxanthellate scleractinians, alcyonaceans, fan and whip antipatharians, and stylasterine corals. In the Bahamas, Reed (1985) compared several locations including San Salvador Island that has a narrow shelf, and the windward and leeward sides of Grand and Little Bahama Banks. The wall of the deep fore-reef escarpment ranges from 45-143 m. The base generally ranges from 100-122 m. Some sites also have large buttresses occurring every 20-60 m along the top edge of the deep fore-reef slope, with sediment chutes incised between the promontories (Hoskin *et al.*, 1986). Notches, ledges and reentrants or caves are common between 75 and 107 m, similar to Cuba. At San Salvador Island, Bahamas, these reentrants likely connect to the brackish lakes on the island which show tidal influence. These karst-like features associated with deep fore reefs of Jamaica, Belize, Bahamas and Cuba, likely formed during Late Quaternary low stands of sea level which were at least -120 m below present level during the last glacial maximum (Fairbanks, 1989). The major topographic features are apparently controlled by underlying Plio-Pleistocene features that are mantled by 1-10 m of Holocene reef accretions (James and Ginsburg, 1979; Ginsburg *et al.*, 1991).

The Virgin Islands also support fairly extensive and diverse MCEs, predominately on steep walls around the islands and some areas of deep banks (Smith and Holstein, 2016). Extensive areas of the shelf that are potential MCE habitat (1,918 km^2) at depths of 25-65 m may exceed the area of the shallow reefs. MCE habitat around St. Croix is mostly on the steep island walls, which is typical of most Caribbean Islands and Bahamas, whereas St. Thomas and St. John have a broader shelf and deep banks. In the upper mesophotic zone (35 m), the dominant coral are *Orbicella* spp. and *Agaricia* spp. (Smith and Holstein, 2016). At deeper depths (65 m), the lettuce coral *Agaricia undata* dominates.

Off southwestern Puerto Rico, deep reefs occur at depths of 45-160 m; deep buttresses are common at depths of 45-65 m below the shallow barrier reef system (Appledoorn *et al.*, 2016b). A terrace occurs at 80-90 m, and a steep wall extends down to 160 m (Sherman *et al.*, 2010). This terrace feature which Sherman *et al.* (2010) suggests as being formed during the last deglaciation (14-15 ka) is not apparent at Cuba. *Agaricia* spp. and *Madracis* spp. corals dominate the MCE zone, and large colonies of *A. undata* are common. Seventeen species of scleractinian coral in the MCE zone (50-90 m).

Down current from Cuba are the mesophotic reefs of the northern Gulf of Mexico (GOM), including the Sister Sanctuaries (FGBNMS, FKNMS), and southeastern U.S. The geomorphology of these U.S. mesophotic reefs are quite different from those off Cuba. The shelf-edge reefs and banks in the northwestern GOM off Texas are built upon salt domes but also have a relatively steep mesophotic reef habitat which extends over a wide depth zone. FGBNMS is 180 km off shore Texas and is described as one of the most pristine coral ecosystems in U.S. waters (Hickerson et al., 2008). Although the top of the dome is a shallow water reef at depths of 18 m, the flanks extend into mesophotic depths down to 152 m (Clark *et al.* 2014). The mesophotic reefs at

FGBNMS have been surveyed with ROV by some of our team (JV, JR) using similar methods as in Cuba (Voss *et al.,* 2014). The mesophotic scleractinian coral communities on FGB and nearby banks outside the sanctuary have diverse hard coral populations (21 species) and are dominated by *O. franksi, M. cavernosa*, *S. intersepta*, and *Agaricia* spp. with *Pseudodiploria strigosa* and *Colpophyllia natans* also being relatively common. Also common at FGBNMS at mid-mesophotic depths (40-80 m) are algal nodules (rhodoliths) which we did not find at Cuba. The deep coral zone at FGBNMS from 85-150 m was primarily on the steep slopes of the banks, and dominated by azooxanthellate corals, antipatharian and gorgonian corals, bryozoa, and sponges. Many of these species are similar to Cuba on the lower mesophotic zone and deep island slope.

In the northeastern GOM, mesophotic-depth reefs are common all along the 70 m contour (60-90 m) from Alabama to the panhandle of Florida, and along the northwestern Florida shelf (Locker *et al*., 2010; Locker *et al*., 2016; see Reed, 2016 for map). However, for the most part, these lack zooxanthellate corals and are dominated by azooxanthellate corals such as *Madracis* sp. and *Oculina* sp., octocorals, black corals, sponges, and algae. In contrast to these reefs, Pulley Ridge, off the southwest Florida shelf, is one of the closest downstream mesophotic reefs to Cuba. It is a submerged intact barrier island that formed during the early Holocene marine transgression, and consists of the deepest photosynthetic coral reef in continental U.S. (Hine *et al*., 2008; Reed, 2016). The southern terminus of this geological feature is relatively flat limestone pavement and rubble at depths of 60-94 m, and supports a MCE of photosynthetic hard corals (17 species), macroalgae (95), sponges (92), and a large variety of tropical fishes (86) (Harter *et al*., 2017; Reed *et al*., 2017a; Reed *et al*., 2018). A total of 12 hard coral species were identified at Pulley Ridge. Plate coral species at Pulley Ridge include *Agaricia fragilis, A. lamarcki/grahamae, A. undata, H. cucullata, and M. cavernosa,* all of which are also common on the Cuban reefs. Unfortunately, Reed *et al.* (2018) found a shocking 93.6% loss of coral cover since 2004 within the Pulley Ridge Habitat Area of Particular Concern (PR HAPC). Recent taxonomic studies of sponges collected at Pulley Ridge (Reed *et al.* 2017a), show a rich sponge fauna with several new species; however, there seems to be important differences between Pulley ridge and Cuban mesophotic sponge fauna which must await for comparative biodiversity studies.

Just 60 km east of Pulley Ridge and 225 km west of Key West, Florida, at the terminus of the Florida Keys island chain, are the Tortugas Ecological Reserves (TER) which are part of the 'Sister Sanctuaries' within the FKNMS that have shallow mesophotic reef habitat. TER North protects coral reef banks known as Tortugas Bank (30-50 m depths). TER South includes Riley's Hump (30-50 m) which is an isolated offshore mound that has shallow MCE habitat (Weaver *et al*., 2006). Scleractinians include *M. cavernosa*, *O. annularis*, and *Siderastrea siderea*. Individual colonies of *M. cavernosa* are mostly small, ranging from 10-50 cm in diameter but some were observed to 2 m in height. At deeper mesophotic depths, the benthic community is dominated by rope sponges (*Aplysina cauliformis*) and calcareous algae including *Halimeda* spp. and *Penicillus* spp., similar to Cuba. The southern edge of the Hump is a sharp escarpment from 84-124 m called Miller's Ledge. The benthic assemblages of Miller's Ledge are not MCEs but are dominated by small sponges, bryozoans, small solitary corals, and the corkscrew sea whip, *Stichopathes* sp. This is more similar to what we found deeper in Cuba on the deep island slope of 120->150 m.

Further downstream are shallow shelf-edge reefs which extend along most of the Florida Keys and southeastern Florida but mostly only extend to 20-25 m depths. This region of Florida has very limited MCE habitat, primarily scattered patch reefs, ledges, or rubble habitat at depths of 30-100 m. However, the mesophotic depth zone (30-150 m) has not been adequately surveyed in this region. The earliest survey of its mesophotic reefs occurred in 1979 off Key Largo in the upper Florida Keys when Jameson (1981) documented deep coral reef habitat to 39 m and coral algal habitat to 55 m. In 2015, Reed *et al.* found some deep reefs (125 m) with ROV off Key West, Florida, but these lacked zooxanthellate hard corals and were dominated by the octocoral genera (*Diodogorgia*, *Thesea, Villogorgia,* and *Nidalia*) and sponges. However, it did provide essential fish habitat for several commercially important species including snowy grouper, tilefish and snapper. Based on the presence of paleo-shorelines elsewhere, we could expect to find ledges or hard bottom habitat especially along the 70 and 125 m contours off the Florida Keys and southeastern U.S. (Locker *et al.*, 2010). Some deep-water algal studies have also been conducted along the shelf off southeastern Florida (Hanisak and Blair, 1988; Leichter *et al.*, 2008) which could imply the presence of mesophotic habitat. This paleo-shoreline also forms the basis for the *Oculina* reefs that extend 250 km at depths of 60-90 m off eastern Florida, and then continues as shelf-edge rock ledges from north Florida to North Carolina. The deep *Oculina* coral reefs, however, are entirely formed by azooxanthellate *O. varicosa* (Avent *et al.*, 1977; Reed, 1980; Reed *et al.*, 2007; Harter et al., 2009). The shelf edge from Florida to North Carolina is primarily hard-bottom habitat that consists of extensive ledges and escarpments at mesophotic depths, and have dense populations of sponges, algae and octocorals, but limited Scleractinia, mostly *Oculina varicosa* and *Madracis* sp. (Harter *et al.*, 2015).

Depth Records

The maximum depth of zooxanthellate scleractinians in the world is considered to be 165 m in the Pacific, where the plate coral *Leptoseris hawaiiensis* occurs (Kahng and Maragos, 2006). In the Atlantic, the maximum depth is now 122 m for *Agaricia* sp. in Cuba. In the Atlantic Ocean and Caribbean, nine genera and at least 18 species of hermatypic scleractinia occur to depths exceeding 70 m (Reed, 1985). In the eastern GOM, the maximum depth range for 22 mesophotic scleractinian species is 31-60 m and 15 species have a maximum depth of 100 m (Jaap, 2015). Reed (1985) had found ten new depth records, including *Agaricia grahamae* (119 m)*, Helioseris* (syn. *Leptoseris*) *cucullata* (108 m), *Montastraea cavernosa* (113 m), and *Madracis* sp. (probably *M. decactis or M. pharensis* f. *luciphila*, 115 m), all on the deep fore-reef escarpments off San Salvador Island, Bahamas. In comparison, in Cuba (Table 3) we found *Agaricia* sp. to a maximum depth of 122 m, which is now a new depth record in the Tropical Western Atlantic, along with the depth record for

Stephanocoenia intersepta (104 m) which was previously 100 m (Reed, 1985). In the Caribbean, Kühlmann (1983) had reported *S. intersepta* (*S. michelini*, syn.) to depths of 95 m, and *Agaricia* spp. to 79 m. The deepest records for algae in the western Atlantic include *Halimeda copiosa* (130 m) and crustose coralline algae (268 m), also reported from San Salvador by Littler *et al.* (1985). In comparison, maximum depth of algal observations on our Cuba dives include an unidentified green crust (169 m), crustose coralline algae (169 m), Peyssonneliaceae (139 m), and *Halimeda* sp. (likely *H. copiosa*; 127 m).

Coral Disease/ Bleaching

Regarding coral health of Cuba's mesophotic reefs, of the 2,240 scleractinian colonies counted in this study, only 12 corals (0.53%, mainly *Agaricia* spp.) showed signs of bleaching. One *Agaricia* had black band disease, and one had an unidentified white syndrome disease (0.009%). In shallow water, the presence of black band, white band, and plague diseases have been recorded in Cuba (González Ferrer, 2004); white band was found in isolated colonies of *Acropora cervicornis*, and black band was found with relative frequency in isolated colonies (Alcolado *et al.*, 2000). In general, the Cuban mesophotic corals appeared quite healthy compared to many shallow Caribbean reef sites. In the past decade disease in shallow corals has increased as seawater temperatures increase (Andradi-Brown, 2016) and reports now show mesophotic coral communities are not immune to disease. In the Caribbean U.S. Virgin Islands, disease in mesophotic corals has been documented down to 100 m depths (Smith *et al.*, 2010). The type of disease in the Virgin Islands was placed in the category of 'White Syndromes" due to the characteristic white areas of recent tissue loss, similar to white plague disease (Weil and Hooten, 2008; Andradi-Brown, 2016). White syndromes disease was also reported on mesophotic reefs off southwestern Puerto Rico in *Agaricia undata, A. lamarcki, A. grahamae,* and *A. agaricites* (Appledoorn *et al.*, 2016b). Six percent of the coral community showed signs of the disease. Dustan and Lang (2018) have compiled detailed descriptions of mesophotic reefs on the fore-reef slope at Discovery Bay, Jamaica, comparing their conditions from the 1960s with the present. Extensive changes have occurred, especially since the 1980s due to the mass mortality of the herbivorous *Diadema* (to 40 m depths), coral disease, bleaching, loss of other herbivores (from overfishing), reduced water quality, and hurricanes. Although the pinnacles still retain their three-dimensional, "shingled" morphology to ~45 m, partial mortality had partitioned many of the original *Orbicella* colonies into smaller isolates by 2013. This appears somewhat similar to the upper mesophotic zone for some of the Cuban reefs where the slopes are covered with many smaller plate corals rather than the extensive sheets that may have been common in the 1960s-70s. Zlatarski and Estalella (1982) reported colonies of *Agaricia* (*f. unifaciata*, likely *A. lamarcki*) to diameters of 3.5 to 5.6 m on the Cuban reefs in the 1970s.

Few MCEs worldwide have long-term records monitoring changes of temperature over time or shorter-term events such as cold-water upwelling or internal waves sufficient to cause coral impacts. Long-term records at some sites do show bleaching events and there is evidence that some mesophotic corals may have lower bleaching thresholds than shallow colonies (Baker *et al.*, 2008, Andradi-Brown *et al.*, 2016). In the region of the Gulf of Mexico, a mass bleaching event at the FGBNMS in 2005 impacted 45% of the coral community (Precht *et al.*, 2006; Clark *et al.*, 2014). But the reefs showed resiliency and the bleaching had been reduced to 4% of the population within a year. Since the millennium, coral reefs in the northeastern Caribbean have had many bleaching events including two major bleaching events, in 2005 and 2010 (Smith and Holstein, 2016). In the U.S. Virgin Islands, mesophotic coral cover in some areas dropped from >25% cover (Aronson *et al.*, 1994) to currently less than 10% (García-Sais *et al.*, 2014) which has been attributed to both bleaching events and several large hurricanes (Smith and Holstein, 2016). Temperature records on Puerto Rico's mesophotic reefs show a seasonal range of 26-29.8°C (Appledoorn *et al.*, 2016a). Temperatures recorded by our ROV dives around Cuba in May-June showed a maximum surface temperature of 29.52°C along the south coast, whereas at 50 m depth, in the mesophotic zone, temperatures ranged from 25.26-28.62°C, and a thermocline of 25-28°C was common around 80-100 m depths. Although we do not have temperature records over the year, this upper temperature range would not be sufficient to cause bleaching typically for shallow corals, but the tolerance levels of mesophotic corals are less well understood. Since 1983, when the first bleaching event in Cuba was recorded, there have been 7 major events in Cuba (Jackson *et al.*, 2014). Recent surveys of Cuba's shallow reefs show a loss of reef-building species, such as *O. annularis* and *M. cavernosa* (Aguilar Betancourt and González-Sansón, 2007). Average coral cover on the fore reefs (2003-2009) was 13.4% (maximum of 27% at Bahia de Cochinos and Guajimico) but showed a decline of 1.75% / year which is slightly lower than estimated for the wider Caribbean (2.5-2.7% decline) (Alcolado *et al.*, 2009).

Direct Human Impacts

In general, most dive sites appeared relatively pristine with little signs of direct human impact. One site at Cayo Largo del Sur MPA (Site 29) showed evidence of nutrient pollution. Landward of the shelf-edge reef crest at Cayo Largo were extensive cyanobacterial mats on sediment, and the reef crest (35-40 m) had dense areas of 1-m conical mounds, which appeared to be old dead coral, probably *M. cavernosa*. Alcolado *et al.* (2001b) reported high nitrogen nutrients and dead coral at this site attributed from a tourist resort on nearby Cayo Largo where a sewage plant dumped partially treated waste water. On Cuba's shallow reefs, areas exposed to intense fishing and pollution, such as along the northwest coast and especially off Havana show reduced coral density and diversity (Duran et al., 2018). Increased nutrients have been linked to algal and cyanobacterial blooms elsewhere and on reefs in Florida and Belize (Lapointe, 2004; Lapointe *et al.*, 2004; Littler *et al.*, 2006). In addition, lost or discarded fishing gear were relatively uncommon; in total, fishing line or long line were found at eight sites and one lost net was observed. Most of these were found on the substrate on the upper mesophotic reefs but some were found at >100 m depths.

Invasive Species

Several invasive species have impacted Western Atlantic MCEs; in particular, various macroalgae such as *Codium* and *Caulerpa*, the gorgonian *Carijoa riisei*, and Lionfish *Pterois volitans* (Lapointe *et al.*, 2005; Andradi-Brown *et al.*, 2016). In the past decade Lionfish have become a major invasive on most MCE reefs in the Caribbean, Gulf of Mexico and southeastern U.S. (Schofield, 2010; Andradi-Brown *et al.* 2016). The first live Lionfish reported in northern Gulf of Mexico were documented at Pulley Ridge mesophotic reef west of the Florida Keys during submersible dives in 2010 where six fish were observed (Reed and Rogers, 2011). Since then, exponential increases in the abundance of Lionfish have been observed at Pulley Ridge mesophotic reef (Andradi-Brown *et al.*, 2016; Harter *et al.*, 2017). Thousands of Lionfish also have been recently documented at mesophotic depths in protected area reefs along the southeastern U.S. from Florida to North Carolina at depths of 50->100 m (Harter *et al.*, 2015). Recent genetic analyses indicate western Atlantic Lionfish most commonly cited as *Pterois volitans* are hybrids between *P. miles* and *P. lunulata/russelii* (Wilcox *et al.*, 2017); however, all of our identifications were based upon photographic data which precluded morphological or genetic analyses. On the Cuban mesophotic reefs, we observed Lionfish at most sites, but the abundance of Lionfish was generally low (<10 observed per site). Impacts of Lionfish on MCEs could result in declines of prey fish biomass and major shifts in the mesophotic benthic community. In studies of mesophotic reefs in the Bahamas, Lionfish predation on herbivorous fish has caused a shift in the benthic community to an increase of algae relative to corals (Lesser and Slattery, 2011). However, from ROV video surveys at Pulley Ridge, there has been no significant Lionfish effect on the fish assemblages (Harter *et al.*, 2017). The presence of Lionfish at greater depths makes it difficult to effectively control the species in shallow waters due to the contribution of larvae, juveniles and adults from deeper areas, where they are also difficult to catch. For this reason, there would be an intact reservoir of its populations in the mesophotic reefs which tentatively could populate shallow reefs.

CONCLUSIONS

This Joint Cuba-U.S. Expedition provides for the first time data on the extent and health of mesophotic coral reefs around the entire coast of Cuba, covering nearly 2,778 km. This research cruise is of special significance to understanding the distribution of the deep reefs and the basic oceanographic, biological and ecological processes that take place in MCEs around Cuba and at local and regional levels. Future analyses of the taxonomy and genetics of the specimens, along with quantitative analyses of the video and photo data, will allow a more precise characterization of the diversity and relative abundance of the mesophotic communities of Cuba, as well as a better understanding of the connectivity of Cuban reefs with the Sister Sanctuaries in the U.S. and elsewhere in the Caribbean. Also these data may lead to expanding or adding new Marine Protected Areas in Cuba or more fully protecting some existing MPAs. The full cruise report (Reed *et al.*, 2017b) provides a detailed characterization of each dive site which provides benchmark data for comparisons with future studies and the effects of climate change.

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APPENDICES

Appendix 1. Species list of benthic macrobiota (invertebrates and macroalgae) identified at Cuba's mesophotic reefs from ROV dives during the *F.G. Walton Smith* Cuba cruise, May 14 to June 12, 2017. Dive Sites (see Fig. 1) compiled by regions: Northwest coast- Archipelago de Los Colorados, Sites C-04 to C-07; West coast- Banco de San Antonio, Guanahacabibes, Sites C-10 to C-16A; Southwest coast- Isla de la Juventud, Archipelago de los Canarreos, Golfo de Cazones, Bahia de Cochinos, Sites C-21 to C-31A; Southeast coast- Banco Silvertown, Jardines de La Reina, Granma National Park, Chivirico MPA, Punta Imias, Sites C-38 to C-52A; Northeast Coast- Punta Imias (north side), Cabo Lucrecia, Archipelago de Sabana-Camagüey, Sites C-53 to C-60A.

	Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Algae																																			
Cyanobacteria				X	X							X				X		X												X		X		X	
Chlorophyta																																			
Anadyomene stellata (Wulfen) C. Agardh, 1823					X	X			X	X										X							X				X				
Avrainvillea sp.				X	X												X							X							X	X			
Caulerpa chemnitzia (Esper) J.V. Lamouroux, 1809					X	X																					X				X				
Chaetomorpha sp.							X																												
Chlorophyta- unid. spp.	X		X	X	X	X	X		X	X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cladophora sp.				X																X															
Cladophoropsis sp.			X			X																													
Dictyosphaeria cavernosa (Forsskål) Børgesen, 1932			X																																
Halimeda copiosa Goreau & E.A.Graham, 1967	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X
Halimeda discoidea Decaisne, 1842		X	X		X	X	X			X	X			X	X	X		X		X	X														
Halimeda goreaui W.R.Taylor, 1962			X	X	X			X		X	X	X		X			X	X	X			X	X									X			
Halimeda incrassata (J.Ellis) J.V.Lamouroux, 1816		X			X																														
Halimeda opuntia (Linnaeus) J. V. Lamouroux, 1816																			X																
Halimeda sp.	X	X	X	X	X	X	X	X			X	X	X	X					X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Halimeda tuna (J.Ellis & Solander) J.V.Lamouroux, 1816		X	X	X	X	X	X	X	X	X	X	X		X	X		X	X				X	X							X		X			
Microdictyon marinum (Bory) P.C.Silva, 1955																				X															

	Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Microdictyon sp.								X		X													X							X					X
Microdictyon umbilicatum (Velleg) Zanardini, 1862																									X		X					X		X	X
Penicillus dumetosus Børgesen, 1913					X	X																									X	X	X		
Penicillus pyriformis A.Gepp & E.S.Gepp, 1905									X																										
Penicillus sp.			X		X	X						X								X												X			
Rhipocephalus oblongus (Decaisne) Kützing, 1849						X		X			X	X																							
Rhipocephalus phoenix (J. Ellis & Solander) Kützing, 1843						X		X				X					X	X				X						X		X	X				
Udotea cyathiformis (J. Agardh) D. S. Littler & M. M. Littler, 1990				X	X					X	X							X					X									X			
Udotea dixonii D. S. Littler & M. M. Littler, 1990																															X	X			
Udotea sp.			X	X	X	X	X		X		X					X	X		X													X			
Valonia macrophysa Kützing, 1843																				X												X			
Valonia sp.							X																												
Valonia ventricosa J. Agardh, 1887																														X		X			
Ochrophyta																																			
Canistrocarpus cervicornis De Paula & De Clerck in De Clerck et al., 2006						X																													
Dictyota menstrualis (Hoyt) Schnetter, Hörning & Weber-Peukert, 1987																						X													
Dictyota pulchella Hörnig & Schnetter, 1988			X																X																
Dictyota sp.	X		X	X	X	X	X	X	X	X	X	X		X	X		X	X	X	X	X	X	X		X	X	X	X	X	X	X			X	X
Lobophora sp.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	
Phaeophyceae- unid. spp.	X		X		X								X																		X				
Sargassum hystrix J.Agardh, 1847														X	X		X		X	X								X		X					
Sargassum sp.						X									X						X			X											

	Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Stypopodium zonale (J. V. Lamouroux) Papenfuss , 1940													X		X										X		X								
Rhodophyta																																			
Amphiroa fragilissima (Linnaeus) J. V. Lamouroux, 1816			X		X					X																									
Amphiroa rigida J.V.Lamouroux, 1816					X																														
Amphiroa sp.												X																							
Botryocladia pyriformis (Børgesen) Kylin, 1931																											X								
Botryocladia sp.																																X			
Chrysymenia enteromorpha Harvey, 1853																																X			
Chrysymenia sp.																																X			
Corallinophycidae (crustose coralline algae)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cryptonemia sp.																																			X
Dasya sp.																														X					
Dichotomaria marginata (W. R. Taylor) M. J. Wynne, 2005																																		X	
Dichotomaria obtusata (J. Ellis & Solander) Lamarck, 1816																				X															
Gracilaria sp.						X																													
Hypoglossum involvens (Harvey) J. Agardh, 1898																																		X	
Jania adhaerens J. V. Lamouroux, 1812																																		X	
Jania capillacea Harvey, 1853			X																																
Jania pumila J.V.Lamouroux, 1816					X																														
Jania sp.														X																					
Laurencia sp.																				X															
Martensia pavonia (J.Agardh) J.Agardh, 1863	X																																		
Melanothamnus pseudovillum (Hollenb.) Díaz-Tapia & Maggs, 2017																																		X	

	Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Peyssonneliaceae	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X				X					X	X	X	X	X	X	X	X
Rhodophyta- unid. spp.					X	X									X					X										X					
Scinaia complanata (F.S.Collins) A.D.Cotton, 1907																											X								
Wrangelia sp.															X																				
Porifera																																			
Calcarea																																			
Calcarea sp. Cu-01					X			X														X													
Calcarea sp. Cu-02											X																	X							
Calcarea sp. Cu-03							X																												
Calcarea unid. sp.																														X		X			
Leucetta cf. floridana (Haeckel, 1872)																			X	X	X	X													
Leucetta floridana (Haeckel, 1872)									X							X				X	X	X													
Leucetta sp. Cu-01																			X			X													
Leucetta sp. Cu-02																X																			
Demospongiae																																			
Aaptos sp. Cu-01																								X							X		X	X	
Agelas cerebrum Assmann, van Soest & Köck, 2001	X		X		X	X					X			X	X	X			X	X		X												X	
Agelas cervicornis (Schmidt, 1870)	X		X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X		X		X		X	
Agelas cf. flabelliformis (Carter, 1883)																																X	X	X	
Agelas cf. tubulata Lehnert & van Soest, 1996																					X														
Agelas citrina Gotera & Alcolado, 1987		X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X		X		X	X
Agelas clathrodes (Schmidt, 1870)	X			X		X	X	X	X										X			X	X	X	X	X	X	X	X	X		X			
Agelas conifera (Schmidt, 1870)		X	X	X	X	X		X		X					X	X			X	X	X	X	X		X	X	X	X	X			X		X	X
Agelas dilatata Duchassaing & Michelotti, 1864	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Agelas dispar Duchassaing & Michelotti, 1864			X	X				X	X	X		X			X			X	X																
Agelas flabelliformis (Carter, 1883)			X				X		X	X					X			X	X		X	X	X	X		X	X			X					

	Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Agelas repens Lehnert & van Soest, 1998																			X			X													
Agelas sceptrum (Lamarck, 1815)		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Agelas schmidti Wilson, 1902																											X		X						
Agelas sp. Cu-01																										X									
Agelas sp. Cu-02																						X				X									
Agelas sp. Cu-03																										X		X							X
Agelas sp. Cu-04																							X												
Agelas sp. Cu-05																					X		X												
Agelas sp. Cu-06																	X													X		X			
Agelas sp. Cu-07																										X	X	X							
Agelas sp. Cu-08	X	X	X	X	X				X	X											X	X	X					X							
Agelas sp. Cu-09																										X									
Agelas sp. Cu-10								X																											
Agelas sventres Lehnert & van Soest, 1996			X			X																						X							X
Agelas tubulata Lehnert & van Soest, 1996	X	X	X					X										X					X										X	X	
Agelas wiedenmayeri Alcolado, 1984								X		X		X			X	X																			
Aiolochroia crassa (Hyatt, 1875)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X
Aiolochroia crassa var. dark blue (Hyatt, 1875)				X												X																			
Aiolochroia crassa var. gray (Hyatt, 1875)			X	X	X											X																			
Aiolochroia crassa var. purple (Hyatt, 1875)			X		X	X					X																								
Aiolochroia crassa var. purple-blue (Hyatt, 1875)				X	X								X		X		X																		
Aiolochroia sp. Cu-01															X				X	X	X		X			X							X		
Aiolochroia sp. Cu-02	X		X	X								X																							
Amphimedon cf. caribica (Pulitzer-Finali, 1986)																									X	X	X	X	X		X				X
Amphimedon compressa Duchassaing & Michelotti, 1864	X	X	X	X	X	X		X	X	X				X	X	X	X		X	X	X	X	X	X	X	X			X	X	X	X		X	X
Amphimedon sp. Cu-01	X				X				X			X					X	X				X						X					X		X
Amphimedon sp. Cu-02																	X	X			X	X												X	

	Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Amphimedon sp. Cu-03																		X																	
Amphimedon sp. Cu-04																						X													
Amphimedon sp. Cu-05																													X						
Amphimedon sp. Cu-06																						X													
Aplysina aff. lacunosa (Lamarck, 1814)		X																					X												
Aplysina archeri (Higgin, 1875)		X	X	X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
Aplysina bathyphila Maldonado & Young, 1998	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Aplysina cauliformis (Carter, 1882)		X	X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X		X	X				X	X	X	X	X	X	X
Aplysina cf. archeri (Higgin, 1875)						X																													
Aplysina cf. fulva (Pallas, 1766)																											X	X	X	X		X	X		X
Aplysina fistularis (Pallas, 1766)				X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X										
Aplysina fulva (Pallas, 1766)	X	X	X	X																		X													
Aplysina insularis (Duchassaing & Michelotti, 1864)																									X										
Aplysina lacunosa (Lamarck, 1814)		X				X											X	X				X	X	X	X	X	X								X
Aplysina sciophila Rützler, Piantoni, van Soest & Díaz, 2014				X	X			X	X	X			X							X	X	X	X	X	X	X	X		X				X		
Aplysina sp. Cu-01																											X			X	X	X			
Aplysina sp. Cu-02																									X										
Aplysina sp. Cu-03	X	X	X	X	X				X						X						X		X												
Aplysina sp. Cu-04			X		X	X	X	X		X		X	X		X	X	X	X		X	X	X	X	X		X		X		X			X	X	
Aplysina sp. Cu-05																																			X
Aplysina sp. Cu-06	X																																		
Asteropus sp. Cu-01								X	X	X																				X			X	X	
Auletta cf. tuberosa Alvarez, van Soest & Rützler, 1998		X	X		X		X	X																											
Auletta sp. Cu-01																													X						
Axinella cf. corrugata (George & Wilson, 1919)																																	X		
Axinella corrugata (George & Wilson, 1919)																				X			X				X		X	X	X				X
Axinellidae Cu-01					X	X	X													X					X								X		
Callyspongia armigera (Duchassaing & Michelotti, 1864)				X			X	X																										X	

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	Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Callyspongia cf. armigera (Duchassaing & Michelotti, 1864)																													X						
Callyspongia cf. fallax Duchassaing & Michelotti, 1864						X									X																				
Callyspongia cf. plicifera (Lamarck, 1814)																X					X														
Callyspongia fallax Duchassaing & Michelotti, 1864						X	X	X																											
Callyspongia pallida Hechtel, 1965																													X						
Callyspongia plicifera (Lamarck, 1814)		X		X		X	X								X	X	X			X	X	X	X			X			X	X	X		X	X	
Callyspongia sp. Cu-01																																			X
Callyspongia sp. Cu-02				X			X								X						X		X			X		X			X		X	X	
Callyspongia sp. Cu-03				X		X																													
Callyspongia sp. Cu-04										X																									
Callyspongia sp. Cu-05																X																			
Callyspongia sp. Cu-06																		X																	
Callyspongia vaginalis (Lamarck, 1814)										X								X	X			X					X						X		
Ceratoporella nicholsoni (Hickson, 1911)	X		X	X		X	X	X		X	X	X	X	X	X	X	X	X	X			X	X				X			X		X	X	X	
Chondrosia sp.											X																								
Cinachyrella cf. alloclada (Uliczka, 1929)																													X						
Cinachyrella kuekenthali (Uliczka, 1929)						X	X		X									X	X	X	X								X				X	X	
Cinachyrella sp. Cu-01						X																		X								X	X		
Cinachyrella sp. Cu-02																																	X	X	
Cinachyrella sp. Cu-03					X		X													X		X	X		X	X	X	X	X	X	X		X	X	X
Cinachyrella sp. Cu-04			X	X			X																												
Cinachyrella sp. Cu-05																																	X		X
Ciocalypta cf. porrecta (Topsent, 1928)							X	X	X						X							X													
Clathria echinata (Alcolado, 1984)	X		X																	X		X				X									
Clathria sp. Cu-01		X						X																											
Clathria sp. Cu-02																														X					
Clathria sp. Cu-03											X																	X							

	Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Clathria sp. Cu-04																															X				
Clathria venosa (Alcolado, 1984)	X							X								X	X			X			X												
Cliona caribbaea Carter, 1882		X													X									X											
Cliona delitrix Pang, 1973	X	X	X	X		X		X			X	X	X		X	X	X	X	X	X	X		X					X	X	X		X	X		
Cliona sp.				X														X																	
Corallistes sp.	X			X			X	X	X					X	X					X			X		X			X						X	
Cribrochalina vasculum (Lamarck, 1814)			X	X	X	X		X	X		X	X	X	X	X		X		X	X	X	X	X			X				X	X		X	X	
Demospongiae sp. Cu-01										X																							X		
Demospongiae sp. Cu-02									X								X						X												
Demospongiae sp. Cu-03																					X														
Demospongiae sp. Cu-04																											X	X	X						
Demospongiae sp. Cu-05																		X																	
Demospongiae sp. Cu-06																X		X			X		X												
Demospongiae sp. Cu-07														X																					
Demospongiae sp. Cu-08									X																					X					
Demospongiae sp. Cu-09																			X		X														
Demospongiae sp. Cu-10												X						X																	
Demospongiae sp. Cu-11													X	X	X		X	X		X	X	X			X	X		X							
Demospongiae sp. Cu-12																			X																
Demospongiae sp. Cu-13																						X	X												
Demospongiae sp. Cu-14											X	X	X	X	X	X		X	X		X	X													
Demospongiae sp. Cu-15																					X														
Demospongiae sp. Cu-16																												X	X						
Demospongiae sp. Cu-17															X																				
Demospongiae sp. Cu-18																							X												
Demospongiae sp. Cu-19																					X														
Demospongiae sp. Cu-20																						X						X		X					
Demospongiae sp. Cu-21															X			X																	
Demospongiae sp. Cu-22											X	X		X	X	X	X		X	X		X								X			X		
Demospongiae sp. Cu-23																						X												X	
Demospongiae sp. Cu-24																										X									
Demospongiae sp. Cu-25							X					X														X	X	X	X	X	X	X	X	X	
Demospongiae unid. sp.	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X

	Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Desmapsamma anchorata (Carter, 1882)			X																															X	
Desmapsamma sp.	X																																		
Dictyoceratida sp. Cu-01																						X													
Dictyoceratida unid. sp.					X																X									X	X				
Diplastrella megastellata Hechtel, 1965																																	X	X	
Diplastrella sp.																																	X	X	
Discodermia sp. Cu-01		X		X																	X		X												
Dragmacidon alvarezae Zea & Pulido, 2016				X					X		X				X																				
Dragmacidon cf. alvarezae Zea & Pulido, 2016		X		X		X	X	X		X									X																
Dragmacidon sp. Cu-01			X																																
Dysidea sp.																					X													X	
Ectyoplasia ferox (Duchassaing & Michelotti, 1864)						X					X								X		X		X										X		
Erylus cf. formosus Sollas, 1886														X																X					
Erylus new sp.	X																																		
Erylus sp. Cu-01								X																											
Geodia cf. cribata Rützler, Piantoni, van Soest & Díaz, 2014									X		X	X	X	X	X	X					X	X	X					X		X					
Geodia neptuni (Sollas, 1886)			X	X	X	X	X	X	X	X	X			X	X		X		X	X	X	X	X	X		X	X	X		X		X		X	X
Geodia sp. Cu-01																			X	X															
Geodia sp. Cu-02																	X	X		X															
Geodia sp. Cu-03	X	X	X	X	X	X	X	X		X					X			X							X					X					
Geodia sp. Cu-04								X																											
Geodia sp. Cu-05								X																											
Geodia sp. Cu-06																					X														
Haliclona sp. Cu-01												X																							
Halisarca caerulea Vacelet & Donadey, 1987					X							X											X												
Haplosclerida unid. sp.		X					X																												
Hymeniacidon caerulea Pulitzer-Finali, 1986			X								X																								
Igernella sp.				X														X						X				X				X			

	Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Iotrochota birotulata (Higgin, 1877)		X	X	X		X		X										X	X	X			X	X						X			X	X	X
Ircinia campana (Lamarck, 1814)	X			X							X							X																	X
Ircinia cf. strobilina (Lamarck, 1816)																														X					
Ircinia felix (Duchassaing & Michelotti, 1864)	X			X		X				X		X				X				X															
Ircinia sp. Cu-01																																			X
Ircinia sp. Cu-02																													X		X	X	X		
Ircinia sp. Cu-03		X														X		X		X										X					
Ircinia sp. Cu-04		X														X																			
Ircinia sp. Cu-05																												X							
Ircinia strobilina (Lamarck, 1816)	X		X	X		X	X	X	X	X	X	X			X			X	X		X	X	X				X		X		X	X		X	X
Leiodermatium sp.		X		X	X						X																								
Lissodendoryx colombiensis Zea & van Soest, 1986					X				X																										
Melophlus ruber Lehnert & van Soest, 1998																											X								
Microcionidae unid. sp.							X		X																										
Monanchora arbuscula (Duchassaing & Michelotti, 1864)								X																						X		X			
Mycale cf. laevis (Carter, 1882)												X																					X	X	X
Mycale laevis (Carter, 1882)	X		X			X		X		X					X	X	X																		
Mycale laxissima (Duchassaing & Michelotti, 1864)	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X	X			X				X						X	X	X
Myrmekioderma gyroderma (Alcolado, 1984)																									X										
Myrmekioderma sp. Cu-01																												X							
Myrmekioderma sp. Cu-02					X	X											X						X		X										
Neofibularia nolitangere (Duchassaing & Michelotti, 1864)					X	X													X	X															
Neopetrosia carbonaria (Lamarck, 1814)																															X				
Neopetrosia cf. dutchi Van Soest, Meesters & Becking, 2014							X										X																		
Neopetrosia subtriangularis (Duchassaing, 1850)																			X																
Niphates alba van Soest, 1980		X		X	X	X		X							X			X													X			X	

	Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Niphates arenata Rützler, Piantoni, van Soest & Díaz, 2014	X		X	X	X	X		X	X	X		X	X		X	X	X			X	X	X						X	X	X			X		X
Niphates cf. erecta Duchassaing & Michelotti, 1864																															X				
Niphates digitalis (Lamarck, 1814)		X	X			X	X	X	X	X	X		X	X		X	X	X	X	X		X			X	X						X		X	
Niphates erecta Duchassaing & Michelotti, 1864		X					X											X					X			X		X		X		X			X
Niphates sp. Cu-01			X	X	X	X		X		X																	X								
Niphates sp. Cu-02			X		X														X								X								
Niphatidae Cu-01				X																															
Oceanapia bartschi (de Laubenfels, 1934)		X																																	
Oceanapia peltata (Schmidt, 1870)				X																				X											
Oceanapia sp. Cu-01		X	X	X	X		X	X	X						X	X	X	X			X	X	X	X	X	X	X		X				X	X	X
Oceanapia sp. Cu-02				X	X	X	X							X	X	X	X	X	X	X	X		X												
Oceanapia sp. Cu-03	X		X																																
Oceanapia sp. Cu-04					X				X	X													X	X							X		X		
Oceanapia sp. Cu-05																										X		X	X				X		X
Oceanapia sp. Cu-06																							X												
Oceanapia sp. Cu-07																														X					
Petrosia weinbergi van Soest, 1980		X			X				X	X	X				X	X	X	X	X	X		X	X	X				X				X	X		
Petrosiidae Cu-01	X		X																																
Petrosiidae Cu-02								X																											
Petrosiidae Cu-03					X				X																										
Petrosiidae Cu-04																									X										
Petrosiidae Cu-05																			X																
Petrosiidae Cu-06													X		X	X		X		X	X				X		X					X	X		
Petrosiidae Cu-07							X																												
Petrosiidae Cu-08																			X																
Petrosiidae Cu-09																		X																	
Petrosiidae Cu-10																	X	X			X														
Petrosiidae Cu-11																		X																	
Petrosiidae Cu-12												X		X	X			X		X															

	Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Petrosiidae Cu-13		X																																	
Petrosiidae Cu-14																																			X
Petrosiidae Cu-15				X						X	X	X	X																						
Petrosiidae Cu-16															X																				
Petrosiidae Cu-17																X																			
Petrosiidae Cu-18											X									X															
Petrosiidae Cu-19							X																												
Petrosiidae Cu-20							X					X																							
Petrosiidae unid. sp.				X	X	X				X	X	X			X	X		X																	
Phakellia folium Schmidt, 1870																	X						X			X			X		X	X	X		X
Phorbas sp.				X																															
Polymastia sp. Cu-01		X	X		X	X					X		X				X								X			X	X				X	X	X
Polymastia sp. Cu-02					X																										X				
Polymastia sp. Cu-03																														X					
Polymastia sp. Cu-04				X									X												X			X							
Ptilocaulis walpersi (Duchassaing & Michelotti, 1864)	X	X		X			X			X					X			X	X	X		X	X			X			X		X			X	X
Scopalina ruetzleri (Wiedenmayer, 1977)			X	X	X	X		X																											
Siphonodictyon brevitubulatum Pang, 1973												X							X	X			X												
Siphonodictyon coralliphagum Rützler, 1971	X			X		X			X	X	X	X		X	X	X		X	X	X	X	X	X	X	X			X			X		X	X	
Siphonodictyon sp. Cu-01		X	X		X			X									X						X												
Smenospongia aurea (Hyatt, 1875)				X								X		X	X		X		X	X															
Smenospongia conulosa Pulitzer-Finali, 1986																				X				X											
Smenospongia echina (de Laubenfels, 1934)								X						X	X						X	X	X												
Smenospongia sp.											X		X																						
Spheciospongia vesparium (Lamarck, 1815)																	X																	X	
Spirastrella coccinea (Duchassaing & Michelotti, 1864)				X		X		X	X	X	X	X	X	X	X	X	X	X		X	X	X			X	X		X		X	X	X	X	X	
Spirastrella hartmani Boury-Esnault, Klautau, Bézac, Wulff & Solé-Cava, 1999		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X		X			X					X		X	X	X	

	Northwest Coast					West Coast					Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Spirastrella sp. Cu-01	X	X	X	X	X																														
Spirastrella sp. Cu-02																				X															
Spirastrellidae unid. sp.	X	X	X				X		X			X		X	X	X	X		X		X	X	X				X				X			X	
Spongia sp.																X																			
Spongia sp. Cu-01																												X							
Spongia sp. Cu-02																																			X
Stylissa caribica Lehnert & van Soest, 1998																																	X		
Stylissa sp.																								X		X			X				X		
Svenzea zeai (Alvarez, van Soest & Rützler, 1998)	X		X	X		X		X		X	X		X	X	X	X	X	X	X		X	X	X		X		X						X	X	X
Terpios belindae Rützler & Smith, 1993												X			X		X														X				
Terpios cf. belindae Rützler & Smith, 1993					X																														
Tetillidae unid. sp.																								X											
Tetractinellida																															X				X
Tetractinellida Cu-01	X		X		X			X							X																				
Tetractinellida Cu-02																			X																
Tetractinellida Cu-03																										X									
Tetractinellida Cu-04																													X						
Tetractinellida Cu-05																						X													
Tetractinellida Cu-06							X						X																						
Theonella atlantica van Soest & Stentoft, 1988				X													X																		
Topsentia sp.																							X		X	X	X		X						
Vansoestia caribensis Díaz, Thacker, Redmond, Pérez & Collins, 2015																		X																	
Verongiida Cu-01	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X		X	X	X	X
Verongiida Cu-02																				X															
Verongiida Cu-03											X																								
Verongiida Cu-04											X	X	X																						
Verongiida Cu-05			X				X	X	X	X	X	X	X	X	X	X	X	X			X	X						X	X	X	X		X		
Verongiida Cu-06				X			X				X																								
Verongiida Cu-07																					X														

	Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Verongiida Cu-08				X	X			X	X				X																						
Verongiida Cu-09																																	X		
Verongula cf. rigida (Esper, 1794)						X					X															X					X		X		
Verongula gigantea (Hyatt, 1875)		X	X	X		X		X			X			X	X			X	X	X	X								X		X	X			
Verongula reiswigi Alcolado, 1984						X			X			X		X	X		X	X	X	X	X					X			X						
Verongula rigida (Esper, 1794)									X			X	X	X	X	X	X	X	X	X	X	X				X	X	X	X				X		
Verongula sp. Cu-01								X												X							X		X				X		
Verongula sp. Cu-02							X																			X									
Xestospongia deweerdtae Lehnert & van Soest, 1999			X	X																			X	X			X								
Xestospongia muta (Schmidt, 1870)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X
Xestospongia purpurea Rützler, Piantoni, van Soest & Díaz, 2014					X									X			X			X			X		X	X	X								
Xestospongia sp. Cu-01	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Xestospongia sp. Cu-02		X																																	
Xestospongia sp. Cu-03							X		X																										
Homoscleromorpha																																			
Homosclerophorida unid. sp.	X	X														X																			
Oscarella sp. Cu-01															X								X												
Oscarella sp. Cu-02																					X												X		
Oscarellidae unid. sp.	X							X																											
Plakinastrella onkodes Uliczka, 1929																															X				
Plakinidae unid. sp.																				X											X				
Plakortis dariae Ereskovsky, Lavrov & Willenz, 2014			X														X																X		
Plakortis sp. Cu-01	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X		
Plakortis sp. Cu-02																															X				
Cnidaria																																			
Hydrozoa																																			
Hydroidolina	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X			X	X	X	X		X	X	X	X	X		X	X	X	X
Millepora alcicornis Linnaeus, 1758	X			X	X					X	X	X					X		X	X	X	X	X		X					X					
Stylasteridae	X		X	X	X	X	X	X	X	X		X		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	
Anthozoa- non coral																																			

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	Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Actiniaria	X	X									X		X	X																	X				
Condylactis gigantea (Weinland, 1860)															X		X												X						
Lebrunia neglecta Duchassaing & Michelotti, 1860																							X												
Palythoa grandis (Verrill, 1900)																													X						
Zoanthidae											X								X																
Alcyonacea - Alcyoniina																																			
Chironephthya caribaea (Deichmann, 1936)			X	X	X	X	X	X	X	X		X										X	X	X	X	X	X	X	X	X		X	X	X	X
Nidalia sp.																X																			
Alcyonacea - gorgonian																																			
Acanthogorgia sp.																	X																		
Bebryce sp.		X	X	X												X																			
Briareum sp.																				X															
Callogorgia gracilis (Milne Edwards & Haime, 1857)	X		X						X																										
Ellisella barbadensis (Duchassaing & Michelotti, 1864) syn. *elongata* (Pallas, 1766)	X																		X			X		X		X			X			X			X
Ellisella elongata (Pallas, 1766)			X												X										X										
Ellisella sp.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Eunicea sp.				X	X	X		X					X		X	X	X		X			X	X									X	X		
Gorgonia mariae Bayer, 1961						X																													
Gorgonia ventalina Linnaeus, 1758					X												X		X	X	X	X	X							X					
Gorgoniidae	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hypnogorgia sp.																						X	X							X					
Iciligorgia schrammi Duchassaing, 1870		X		X			X	X		X			X	X	X				X	X		X	X			X	X	X	X	X	X	X	X	X	X
Lignella richardi (Lamouroux, 1816)																																X			
Muricea sp.								X		X			X																	X					
Nicella goreaui Bayer, 1973							X									X	X								X										
Nicella sp.	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Paramuricea sp.				X																X		X		X		X			X				X		
Paramuriceidae																																	X		
Placogorgia sp.	X	X																																	

	Northwest Coast					West Coast					Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Plexaura sp.																			X						X						X				
Plexaurella sp.			X					X					X						X			X	X			X		X							
Plexauridae	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X		X					X		X	X	X	
Primnoidae										X					X				X	X															
Pseudoplexaura sp.								X											X																
Pseudopterogorgia (syn. *Antillogorgia*) *bipinnata* (Verrill, 1864)																						X													
Pseudopterogorgia sp.	X		X	X	X			X			X	X	X		X	X	X	X	X	X	X	X	X		X			X	X	X		X	X	X	X
Pterogorgia sp.					X																														
Swiftia exserta (Ellis & Solander, 1786)	X			X	X		X	X	X	X		X	X				X	X	X	X		X	X		X		X	X	X	X		X	X	X	X
Villogorgia sp.			X																																
Antipatharia																																			
Antipatharia unid. sp.				X																													X		
Antipathes atlantica Gray, 1857		X	X	X	X					X	X	X								X		X	X												
Antipathes furcata Gray, 1857	X		X																	X		X					X					X			
Antipathes sp.	X	X	X														X		X	X		X					X						X		X
Antipathidae				X		X	X	X		X		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Aphanipathes sp.									X												X	X													
Elatopathes abietina (Pourtalès, 1874)	X										X																				X				
Elatopathes sp.																			X	X															
Leiopathes sp.				X																															
Plumapathes pennacea (Pallas, 1766)				X	X			X		X										X	X														
Plumapathes sp.																									X							X	X		
Stichopathes lutkeni Brook, 1889	X												X																						
Stichopathes sp.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tanacetipathes sp.	X	X	X	X	X		X	X	X	X		X		X	X	X			X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tanacetipathes tanacetum (Pourtalès, 1880)												X											X			X	X		X	X	X	X	X	X	X
Scleractinia																																			
Acropora cervicornis (Lamarck, 1816)									X								X		X	X	X		X												
Agaricia agaricites (Linnaeus, 1758)			X	X	X	X		X	X	X	X	X						X	X	X	X	X	X			X	X	X							

	Northwest Coast						West Coast				Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Agaricia grahamae Wells, 1973																					X	X													
Agaricia lamarcki Milne Edwards & Haime, 1851		X												X						X	X	X	X		X										
Agaricia sp.	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Colpophyllia natans (Houttuyn, 1772)	X				X	X		X		X	X	X	X	X	X	X	X	X			X	X	X			X									
Dendrogyra cylindrus Ehrenberg, 1834						X																													
Dichocoenia stokesii Milne Edwards & Haime, 1848	X																																		
Diploria labyrinthiformis (Linnaeus, 1758)					X												X		X																
Eusmilia fastigiata (Pallas, 1766)					X	X		X		X									X	X		X	X							X					
Helioseris cucullata (Ellis & Solander, 1786)	X				X			X		X	X	X	X	X	X	X	X	X					X												
Isophyllia rigida (Dana, 1848)	X					X																													
Isophyllia sinuosa (Ellis & Solander, 1786)			X		X	X		X					X																						
Isophyllia sp.					X																														
Madracis asperula Milne Edwards & Haime, 1849																				X		X												X	
Madracis auretenra Locke, Weil & Coates, 2007			X																			X	X												
Madracis decactis (Lyman, 1859)						X									X								X												
Madracis formosa Wells, 1973																			X		X	X	X			X	X	X		X				X	X
Madracis myriaster (Milne Edwards & Haime, 1850)																							X												
Madracis sp.																				X			X	X	X	X	X			X		X	X	X	
Madrepora sp.																			X	X		X	X												
Meandrina meandrites (Linnaeus, 1758)	X	X		X	X	X		X		X	X	X	X	X	X		X	X		X	X	X	X		X			X		X					
Meandrina sp.																														X					
Montastraea cavernosa (Linnaeus, 1767)	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X	X	X
Mussa angulosa (Pallas, 1766)			X						X	X								X																	
Mycetophyllia aliciae Wells, 1973																					X														
Mycetophyllia lamarkiana Milne Edwards & Haime, 1848																			X		X														

	Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Mycetophyllia sp.		X				X		X	X	X	X	X	X	X			X	X	X	X	X	X	X												
Orbicella annularis (Ellis & Solander, 1786)						X				X			X				X			X															
Orbicella faveolata (Ellis & Solander, 1786)	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X			X					
Orbicella franksi (Gregory, 1895)				X	X	X			X								X	X				X													
Oxysmilia rotundifolia (Milne Edwards & Haime, 1848)	X																																		
Porites astreoides Lamarck, 1816	X		X		X	X		X	X	X		X		X	X	X	X	X	X	X	X	X	X					X	X	X					
Porites divaricata Le Sueur, 1820											X		X				X													X					
Porites furcata Lamarck, 1816			X																X	X	X		X												
Porites porites (Pallas, 1766)															X			X	X	X	X		X							X					
Porites sp.			X	X	X			X	X		X							X	X		X									X					
Pseudodiploria strigosa (Dana, 1846)					X	X				X									X	X		X													X
Scleractinia- unid colonial			X																		X							X				X			
Scleractinia- unid cup		X								X		X			X	X			X	X	X	X	X	X				X	X	X	X				
Scolymia cubensis (Milne Edwards & Haime, 1848)			X	X		X				X	X	X		X	X	X	X	X	X	X	X	X	X	X		X			X	X					
Scolymia lacera (Pallas, 1766)																									X										
Scolymia sp.			X	X		X		X		X	X						X	X																	
Siderastrea siderea (Ellis & Solander, 1768)				X	X	X			X	X	X	X	X	X	X		X		X	X	X	X	X							X					
Solenastrea bournoni Milne Edwards & Haime, 1849															X		X					X	X	X		X		X	X	X			X	X	
Stephanocoenia intersepta (Lamarck, 1836)	X	X	X	X	X	X			X	X	X	X	X	X	X	X		X			X	X	X	X					X	X	X		X		
Other																																			
Annelida																																			
Filograna sp.		X																																	
Polychaeta					X																														
Mollusca																																			
Entemnotrochus adansonianus (Crosse & P. Fischer, 1861)																											X			X					
Gastropoda			X																																
Strombus (syn. *Lobatus) gigas* Linnaeus, 1758																	X																		

	Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Scientific Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Bryozoa																																			
Bryozoa unid. sp.																						X		X			X	X				X			
Colatooecia serrulata (Smitt, 1 873)																												X							
Arthropoda																																			
Majidae	X																																		
Panulirus argus (Latreille, 1804)			X	X				X																											
Penaeidae		X																																	
Echinodermata																																			
Asteroidea																										X									
Comatulida	X	X					X																				X				X				
Crinoidea																						X													
Davidaster discoideus (Carpenter, 1888)																															X				
Ophiuroidea	X		X																		X				X		X		X						
Chordata - Invertebrate																																			
Ascidiacea	X	X				X														X	X						X			X					
Non-Fauna																																			
Human debris																																			
Human debris- fishing line	X																		X				X		X				X					X	
Human debris- long line	X																																		
Human debris- net		X																																	
Disease																																			
Black Band Disease	X																																		
Bleaching			X	X	X	X		X												X						X									
Dead Coral																X			X																
Disease- unid.																			X																

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Appendix 2. Species list of fish identified at Cuba's mesophotic reefs from ROV dives during the *F.G. Walton Smith* Cuba cruise, May 14 to June 12, 2017. Dive sites (see Fig. 1) compiled by regions (see Appendix 1 caption).

		Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Order/ Scientific Name	**Common Name**	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Chordata																																				
Actinopterygii																																				
Actinopterygii	Unid Fish		X	X	X	X	X	X	X	X				X	X	X	X	X		X	X				X	X	X	X	X	X	X	X	X	X	X	X
Actinopterygii- Larval	Larval Unid Fish																															X				
Anguilliformes																																				
Gymnothorax funebris Ranzani, 1839	Green Moray Eel								X																											
Gymnothorax sp.	Moray Eel																	X					X													
Aulopiformes																																				
Synodus sp.	Lizardfish												X			X																		X	X	
Synodus synodus (Linnaeus, 1758)	Red Lizardfish		X																															X		
Beryciformes																																				
Holocentrus adscensionis (Osbeck, 1765)	Squirrelfish		X	X	X	X									X								X		X	X			X		X		X		X	X
Holocentrus rufus (Walbaum, 1792)	Longspine Squirrelfish			X																X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Holocentrus sp.	Squirrelfish			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X												
Myripristis jacobus Cuvier, 1829	Blackbar Soldierfish				X																X								X			X			X	
Neoniphon marianus (Cuvier, 1829)	Longjaw Squirrelfish		X	X	X				X	X	X		X	X							X		X	X		X	X	X	X	X	X	X	X	X		
Plectrypops retrospinis (Guichenot, 1853)	Cardinal Soldierfish						X						X																							
Sargocentron vexillarium (Poey, 1860)	Dusky Squirrelfish			X			X																													
Lophiiformes																																				
Ogcocephalus nasutus (Cuvier, 1829)	Shortnose Batfish				X																															
Perciformes																																				
Abudefduf saxatilis (Linnaeus, 1758)	Sergeant Major																		X					X				X								
Acanthurus chirurgus (Bloch, 1787)	Doctorfish	X		X	X				X						X					X	X							X						X		

		Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Order/ Scientific Name	**Common Name**	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Acanthurus coeruleus Bloch & Schneider, 1801	Blue Tang	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X		
Acanthurus sp.	Surgeonfish																				X															
Anisotremus surinamensis (Bloch, 1791)	Black Margate									X		X																								
Anisotremus virginicus (Linnaeus, 1758)	Porkfish				X											X	X					X	X	X							X			X	X	
Apogon pseudomaculatus Longley, 1932	Twospot Cardinalfish			X																																
Apogon sp.	Cardinalfish		X	X																											X					
Apsilus dentatus Guichenot, 1853	Black Snapper		X																X																	
Bodianus pulchellus (Poey, 1860)	Spotfin Hogfish	X									X																X		X			X	X	X		
Bodianus rufus (Linnaeus, 1758)	Spanish Hogfish				X	X	X									X	X	X								X		X	X		X					
Calamus calamus (Valenciennes, 1830)	Saucereye Porgy																X																			
Calamus sp.	Porgy				X			X															X												X	
Carangidae	Jack																					X														
Carangoides bartholomaei (Cuvier, 1833)	Yellow Jack																				X															
Caranx lugubris Poey, 1860	Black Jack		X	X	X	X		X	X	X	X	X	X		X	X	X		X		X	X		X									X			
Caranx ruber (Bloch, 1793)	Bar Jack			X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X				X	X	X			X	X	
Caranx sp.	Jack					X																		X									X			X
Centropristis ocyurus (Jordan & Evermann, 1887)	Bank Sea Bass																											X								
Centropyge argi Woods & Kanazawa, 1951	Cherubfish		X																						X	X		X							X	
Cephalopholis cruentata (Lacepède, 1802)	Graysby		X	X	X	X	X	X	X	X	X	X	X		X				X		X			X		X		X	X		X	X	X	X	X	X
Cephalopholis fulva (Linnaeus, 1758)	Coney					X	X	X	X				X														X	X	X	X	X				X	
Chaetodon capistratus Linnaeus, 1758	Foureye Butterflyfish	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X			X	X	X
Chaetodon ocellatus Bloch, 1787	Spotfin Butterflyfish					X								X		X	X					X	X				X	X	X	X	X			X	X	
Chaetodon sedentarius Poey, 1860	Reef Butterflyfish	X		X					X			X												X	X		X	X		X			X	X		X

		Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Order/ Scientific Name	**Common Name**	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Chaetodon striatus Linnaeus, 1758	Banded Butterflyfish				X				X											X	X	X	X	X												
Chaetodontidae	Butterflyfish	X	X		X		X						X									X	X			X			X		X			X	X	X
Chloroscombrus chrysurus (Linnaeus, 1766)	Atlantic Bumper																																		X	
Chromis cyanea (Poey, 1860)	Blue Chromis	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X	X	X	X	X		X
Chromis enchrysura Jordan & Gilbert, 1882	Yellowtail Reeffish	X		X	X	X		X						X																						
Chromis insolata (Cuvier, 1830)	Sunshinefish	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chromis multilineata (Guichenot, 1853)	Brown Chromis									X	X			X							X															
Chromis scotti Emery, 1968	Purple Reeffish	X	X			X			X											X			X													
Clepticus parrae (Bloch & Schneider, 1801)	Creole Wrasse		X		X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X			X	X	X	X	X		X	
Coryphopterus glaucofraenum Gill, 1863	Bridled Goby								X																											
Coryphopterus personatus (Jordan & Thompson, 1905)	Masked/ Glass Goby			X	X		X		X	X	X	X			X				X		X										X					
Diplectrum formosum (Linnaeus, 1766)	Sand Perch																			X																
Elacatinus genie (Böhlke & Robins, 1968)	Cleaning Goby										X								X		X								X							
Elacatinus horsti (Metzelaar, 1922)	Yellowline Goby				X				X																											
Elacatinus louisae (Böhlke & Robins, 1968)	Spotlight Goby															X																				
Elacatinus sp.	Goby			X																																
Elagatis bipinnulata (Quoy & Gaimard, 1825)	Rainbow Runner								X	X																										
Epinephelus guttatus (Linnaeus, 1758)	Red Hind			X	X			X		X	X				X	X	X			X	X	X	X								X	X				
Epinephelus morio (Valenciennes, 1828)	Red Grouper			X	X			X		X					X	X																				
Epinephelus striatus (Bloch, 1792)	Nassau Grouper			X				X			X									X	X	X	X					X		X		X				
Equetus lanceolatus (Linnaeus, 1758)	Jacknife Fish																									X	X						X			

		Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Order/ Scientific Name	**Common Name**	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Equetus punctatus (Bloch & Schneider, 1801)	Spotted Drum											X																								
Gobiidae	Goby			X		X					X				X				X	X	X		X								X					
Gobiosoma sp.	Goby														X	X																				
Gramma loreto Poey, 1868	Fairy Basslet			X	X	X	X		X	X	X	X	X	X		X	X	X				X	X	X					X	X	X		X	X	X	X
Gramma melacara Böhlke & Randall, 1963	Blackcap Basslet	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	
Haemulon aurolineatum Cuvier, 1830	Tomtate				X							X					X						X			X				X						
Haemulon carbonarium Poey, 1860	Caesar Grunt			X					X	X																										
Haemulon flavolineatum (Desmarest, 1823)	French Grunt								X	X	X	X	X	X		X	X					X	X	X							X			X	X	
Haemulon melanurum (Linnaeus, 1758)	Cottonwick				X																										X					
Haemulon parra (Desmarest, 1823)	Sailors Choice				X																															
Haemulon plumierii (Lacepède, 1801)	White Grunt	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X					X	X	X	X	X	X	X	X
Haemulon sciurus (Shaw, 1803)	Bluestriped Grunt	X								X	X				X	X	X	X				X	X	X			X				X			X		X
Haemulon sp.	Grunt																					X											X			
Haemulon striatum (Linnaeus, 1758)	Striped Grunt								X																					X			X	X		X
Haemulon vittatum (Poey, 1860)	Boga			X					X													X														
Halichoeres bathyphilus (Beebe & Tee-Van, 1932)	Greenband Wrasse																															X				
Halichoeres bivittatus (Bloch, 1791)	Slippery Dick																				X															
Halichoeres garnoti (Valenciennes, 1839)	Yellowhead Wrasse		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Halichoeres maculipinna (Müller & Troschel, 1848)	Clown Wrasse																			X																
Halichoeres pictus (Poey, 1860)	Rainbow Wrasse						X																													
Holacanthus bermudensis Goode, 1876	Blue Angelfish			X	X	X	X	X	X	X	X			X	X		X			X	X	X														

		Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Order/ Scientific Name	Common Name	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Holacanthus ciliaris (Linnaeus, 1758)	Queen Angelfish			X	X	X		X	X	X		X	X									X	X				X	X			X		X	X		X
Holacanthus sp.	Angelfish			X	X	X			X							X						X												X	X	
Holacanthus tricolor (Bloch, 1795)	Rock Beauty	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
Hypoplectrus guttavarius (Poey, 1852)	Shy Hamlet						X												X																	
Hypoplectrus indigo (Poey, 1851)	Indigo Hamlet														X				X				X													
Hypoplectrus nigricans (Poey, 1852)	Black Hamlet	X	X	X	X			X															X	X					X					X		X
Hypoplectrus *puella* (Cuvier, 1828)	Barred Hamlet						X		X	X			X		X	X			X		X	X		X					X	X	X	X	X			X
Hypoplectrus sp.	Hamlet											X	X							X									X							
Hypoplectrus unicolor (Walbaum, 1792)	Butter Hamlet											X	X	X			X		X										X	X			X			
Kyphosus sp.	Chub					X	X		X		X					X		X																		
Labridae	Wrasse	X	X	X	X		X	X			X											X	X	X			X	X		X	X		X	X	X	X
Labrisomus filamentosus Springer, 1960	Quillfin Blenny																												X							
Lachnolaimus maximus (Walbaum, 1792)	Hogfish				X										X						X		X	X				X						X	X	X
Liopropoma mowbrayi Woods & Kanazawa, 1951	Cave Basslet			X	X	X	X		X				X	X	X	X	X	X	X			X	X	X		X	X						X	X	X	
Liopropoma rubre Poey, 1861	Peppermint Bass	X																																		
Liopropoma sp.	Basslet																							X												
Lucayablennius zingaro (Böhlke, 1957)	Arrow Blenny															X																				
Lutjanus analis (Cuvier, 1828)	Mutton Snapper				X			X												X																
Lutjanus apodus (Walbaum, 1792)	School-master				X				X	X	X	X	X	X	X	X	X	X					X	X			X		X	X	X			X		
Lutjanus buccanella (Cuvier, 1828)	Blackfin Snapper	X	X	X	X					X		X			X	X		X	X												X					X
Lutjanus campechanus (Poey, 1860)	Red Snapper																						X													
Lutjanus cyanopterus (Cuvier, 1828)	Cubera Snapper					X																														

Phylum/Class/Order/ Scientific Name	Common Name	Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
		C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Lutjanus griseus (Linnaeus, 1758)	Gray Snapper							X	X																											
Lutjanus jocu (Bloch & Schneider, 1801)	Dog Snapper				X	X						X		X				X									X				X	X	X			
Lutjanus mahogoni (Cuvier, 1828)	Mahogany Snapper	X			X						X	X		X	X	X						X		X												
Lutjanus sp.	Snapper	X			X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Lutjanus vivanus (Cuvier, 1828)	Silk Snapper														X																					
Malacanthus plumieri (Bloch, 1786)	Sand Tilefish																											X					X			
Microspathodon chrysurus (Cuvier, 1830)	Yellowtail Damselfish								X															X							X					
Mulloidichthys martinicus (Cuvier, 1829)	Yellow Goatfish				X				X	X						X	X				X			X					X	X				X		
Mycteroperca bonaci (Poey, 1860)	Black Grouper				X		X	X			X				X			X			X	X											X			
Mycteroperca interstitialis (Poey, 1860)	Yellowmouth Grouper																										X	X								
Mycteroperca phenax Jordan & Swain, 1884	Scamp				X	X	X		X		X						X															X				
Mycteroperca tigris (Valenciennes, 1833)	Tiger Grouper									X	X				X	X	X	X		X	X	X	X													
Mycteroperca venenosa (Linnaeus, 1758)	Yellowfin Grouper					X										X	X				X									X						
Ocyurus chrysurus (Bloch, 1791)	Yellowtail Snapper	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						X	X	X		X	X	X
Pagrus sp.	Porgy																				X															
Paranthias furcifer (Valenciennes, 1828)	Atlantic Creolefish																													X						
Pomacanthus arcuatus (Linnaeus, 1758)	Gray Angelfish			X	X		X	X	X	X		X	X	X	X	X	X			X	X		X	X			X		X		X	X	X	X	X	X
Pomacanthus paru (Bloch, 1787)	French Angelfish								X			X					X					X	X					X			X	X	X			
Pomacentrus sp.	Damselfish	X		X	X		X									X		X	X			X	X	X	X			X	X							
Pristigenys alta (Gill, 1862)	Short Bigeye																						X			X										
Prognathodes aculeatus (Poey, 1860)	Longsnout Butterflyfish			X	X			X	X		X				X				X	X	X		X	X			X	X	X	X	X	X	X	X	X	X

		Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Order/ Scientific Name	**Common Name**	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Prognathodes aya (Jordan, 1886)	Bank Butterflyfish							X				X					X																			
Prognathodes guyanensis (Durand, 1960)	French Butterflyfish														X																					
Pronotogrammus martinicensis (Guichenot, 1868)	Rough-tongue Bass										X					X																				
Pseudupeneus maculatus (Bloch, 1793)	Spotted Goatfish	X			X		X		X	X	X						X		X				X					X		X	X		X	X		
Ptereleotris calliura (Jordan & Gilbert, 1882)	Blue Dartfish																		X																	
Ptereleotris helenae (Randall, 1968)	Hovering Dartfish																															X				
Rypticus maculatus Holbrook, 1855	Whitespotted Soapfish																		X																	
Rypticus saponaceus (Bloch & Schneider, 1801)	Greater Soapfish																																		X	
Scaridae	Parrotfish	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X		X			X		X		X			X		X
Scarus coelestinus Valenciennes, 1840	Midnight Parrotfish															X																				
Scarus iseri (Bloch, 1789)	Striped Parrotfish		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X			X	X	X	X	X	X	X	X
Scarus taeniopterus Lesson, 1829	Princess Parrotfish		X	X	X				X												X	X								X	X		X	X	X	
Scarus vetula Bloch & Schneider, 1801	Queen Parrotfish																			X																
Scomberomorus regalis (Bloch, 1793)	Cero		X		X			X	X		X							X																		
Scomberomorus sp.	Mackeral																					X														
Seriola sp.	Amberjack			X																																
Serranidae	Grouper							X													X	X	X	X			X	X	X		X	X	X	X	X	X
Serranus annularis (Günther, 1880)	Orangeback Bass					X							X										X					X					X			X
Serranus notospilus Longley, 1935	Saddle Bass																					X														
Serranus phoebe Poey, 1851	Tattler						X																	X	X							X	X			X
Serranus sp.	Sea Bass																						X		X								X			
Serranus tabacarius (Cuvier, 1829)	Tobaccofish						X																			X	X	X								

		Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Order/ Scientific Name	**Common Name**	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Serranus tigrinus (Bloch, 1790)	Harlequin Bass					X		X												X	X										X	X	X		X	
Serranus tortugarum Longley, 1935	Chalk Bass		X	X															X				X													
Sparisoma atomarium (Poey, 1861)	Greenblotch Parrotfish																			X		X	X													
Sparisoma aurofrenatum (Valenciennes, 1840)	Redband Parrotfish							X	X					X	X				X	X	X	X	X	X	X				X	X	X			X		
Sparisoma rubripinne (Valenciennes, 1840)	Yellowtail Parrotfish		X																																	
Sparisoma viride (Bonnaterre, 1788)	Stoplight Parrotfish			X	X	X	X		X	X	X		X		X			X	X	X	X	X	X	X						X	X			X	X	
Sphyraena barracuda (Edwards, 1771)	Great Barracuda	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X			X		X	X	X	X	X	X	X	
Stegastes adustus (Troschel, 1865)	Dusky Damselfish		X	X																X			X										X			X
Stegastes diencaeus (Jordan & Rutter, 1897)	Longfin Damselfish																			X																
Stegastes leucostictus (Müller & Troschel, 1848)	Beaugregory											X				X			X		X	X	X	X				X			X					
Stegastes partitus (Poey, 1868)	Bicolor Damselfish	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X	X	X	X	X	X	X
Stegastes planifrons (Cuvier, 1830)	Threespot Damselfish																					X						X								
Thalassoma bifasciatum (Bloch, 1791)	Bluehead Wrasse			X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X				X			X	X				
Trachinotus blochii (Lacepède, 1801)	Permit											X	X																							
Trachinotus goodei Jordan & Evermann, 1896	Palometa															X																				
Scorpaeniformes																																				
Pterois volitans (Linnaeus, 1758)	Lionfish	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Syngnathiformes																																				
Aulostomus maculatus Valenciennes, 1841	Atlantic Trumpetfish																																		X	
Tetraodontiformes																																				
Acanthostracion polygonius Poey, 1876	Honeycomb Cowfish		X																																	

		Northwest Coast				West Coast						Southwest Coast								Southeast Coast							Northeast Coast									
Phylum/Class/Order/ Scientific Name	**Common Name**	C-04	C-04A	C-06	C-07	C-10	C-10A	C-12A	C-12B	C-15	C-16A	C-21	C-21A	C-23	C-24	C-28	C-29	C-31A	C-33A	C-38	C-38A	C-41	C-48	C-50	C-52	C-52A	C-53A	C-53B	C-54	C-54B	C-56	C-58	C-58A	C-59A	C-59C	C-60A
Aluterus scriptus (Osbeck, 1765)	Scrawled Filefish																				X															
Balistes vetula Linnaeus, 1758	Queen Triggerfish				X	X		X	X												X		X									X				
Balistidae	Triggerfish					X	X				X				X					X																
Cantherhines macrocerus (Hollard, 1853)	Whitespot-ted Filefish					X																														
Canthidermis sufflamen (Mitchill, 1815)	Ocean Triggerfish						X	X		X	X				X		X			X	X		X	X			X	X	X		X			X		X
Canthigaster rostrata (Bloch, 1786)	Sharpnose Puffer			X	X	X	X	X	X		X	X	X				X	X	X	X		X		X	X	X					X	X	X	X	X	X
Lactophrys triqueter (Linnaeus, 1758)	Smooth Trunkfish					X																	X													
Melichthys niger (Bloch, 1786)	Black Durgon					X	X	X		X	X									X	X			X							X			X		
Sphoeroides spengleri (Bloch, 1785)	Bandtail Puffer			X																	X															
Xanthichthys ringens Linnaeus, 1758)	Sargassum Triggerfish		X	X	X	X		X	X	X	X					X					X		X		X	X	X	X	X	X			X			
Elasmobranchii																																				
Carcharhiniformes																																				
Carcharhinidae	Shark					X																														
Carcharhinus leucas (Müller & Henle, 1839)	Bull Shark															X																				
Myliobatiformes																																				
Dasyatis americana Hildebrand & Schroeder, 1928	Southern Stingray			X										X																						
Orectolobiformes																																				
Ginglymostoma cirratum (Bonnaterre, 1788)	Nurse Shark			X	X				X																											
Reptilia																																				
Testudines																																				
Caretta caretta (Linnaeus, 1758)	Loggerhead Turtle							X	X																											
Eretmochelys imbricata (Linnaeus, 1766)	Hawksbill Sea Turtle								X																											

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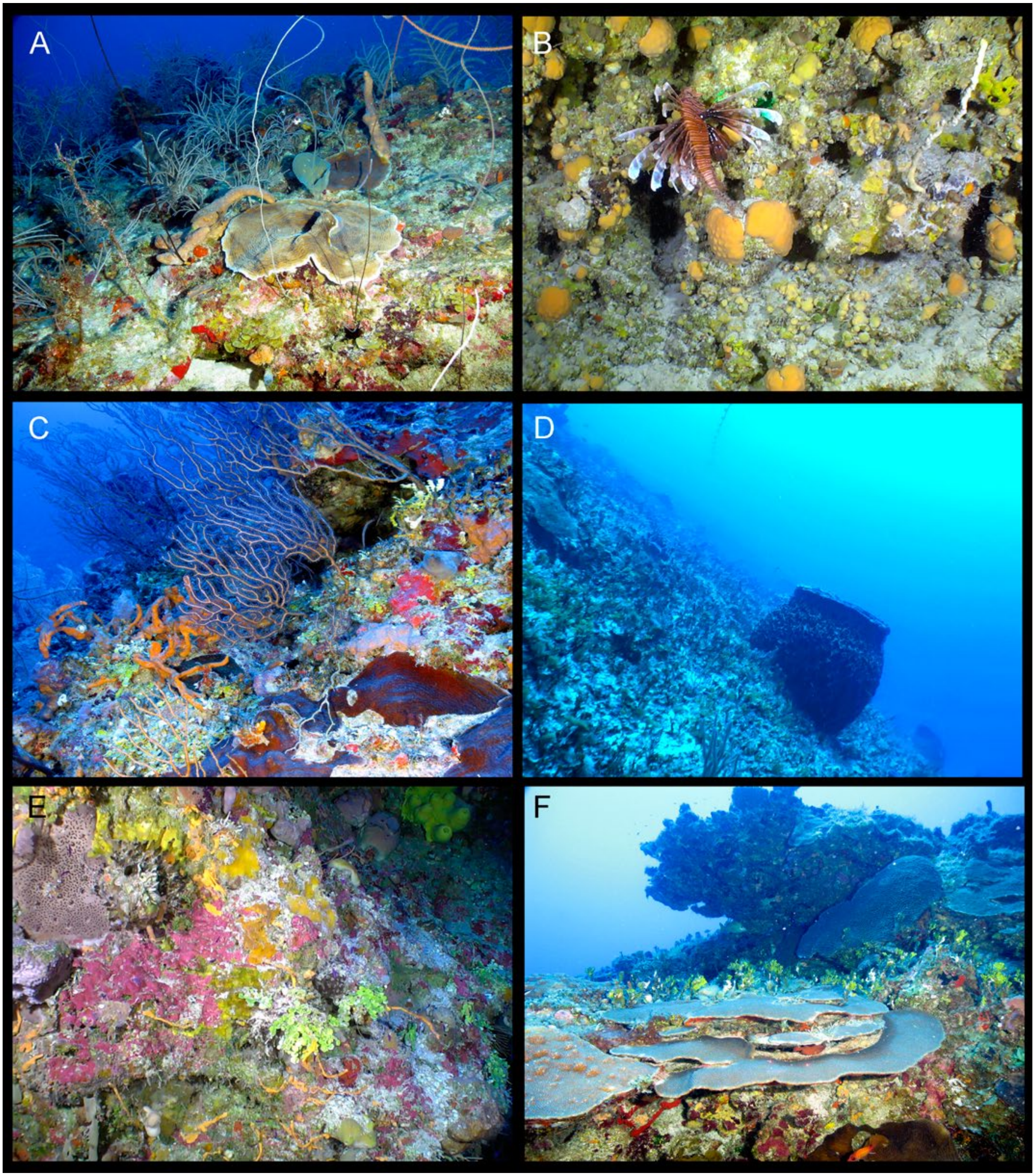
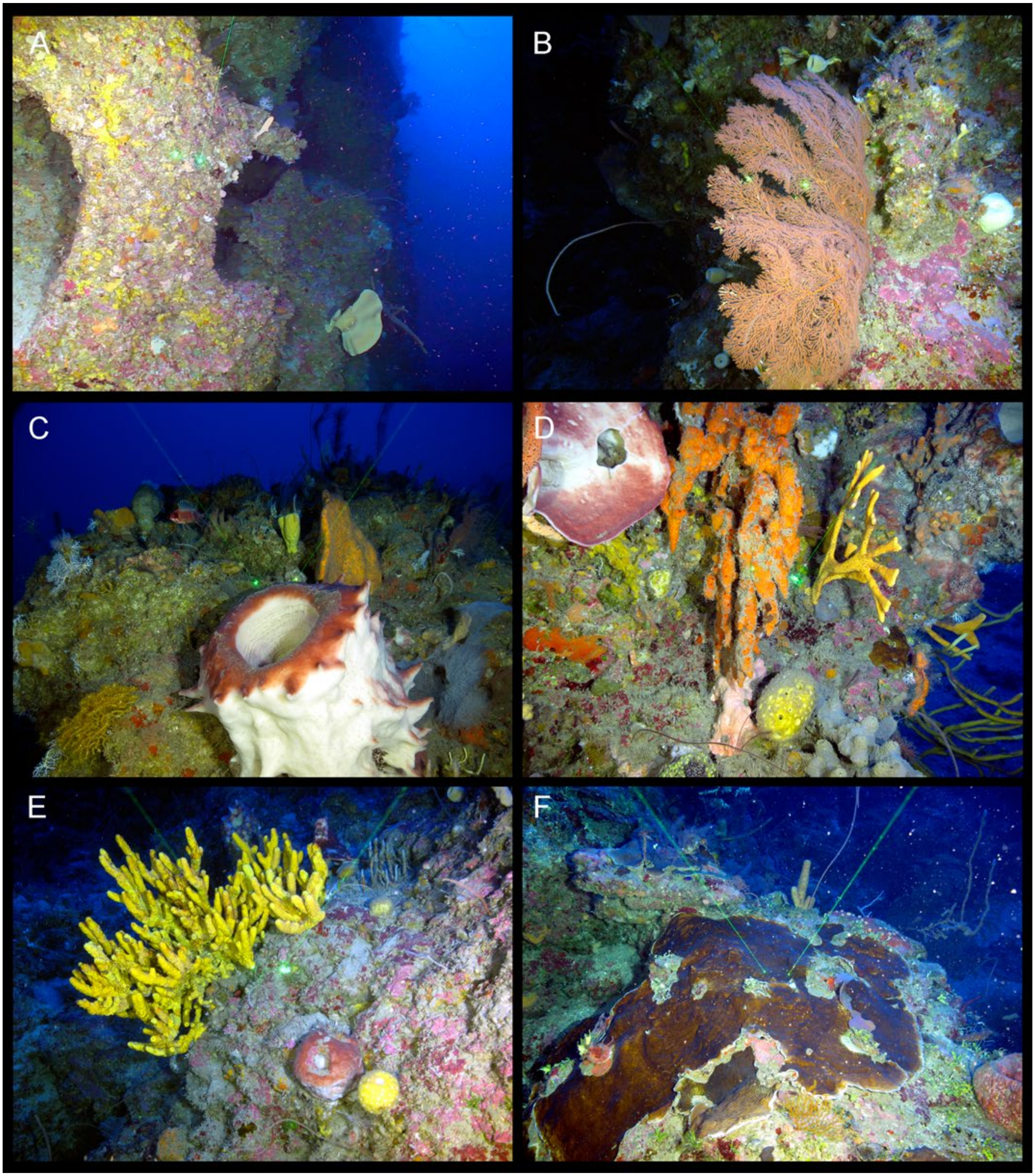
Appendix 3-1. Images from ROV dives to illustrate various regions of Cuba's MCEs.
Western region: A. Site C-04, 49 m, *Agaricia* spp., octocorals (*Antillogorgia* spp., *Ellisella* spp.), black coral- (*Stichopathes* sp.), sponges (tan finger- *Agelas sceptrum*, vase- N*iphates digitalis*); B. Site C-07, 112 m, Lionfish, sclerosponge (*Ceratoporella nicholsoni)*; C. Site C-12B, 66 m, *Agaricia* sp, octocoral (*Icilogorgia schrammi*), algae (*Halimeda* sp.), sponge (branching- *Agelas sceptrum,* encrusting tan- *Spirastrella hartmani*, encrusting red- *S. coccinea*); D. Site C-10, 35 m, large *Xestospongia muta*; E. Site C-10A, 104 m, algae (crustose coralline algae, *Halimeda copiosa*), sponges (spikey- *Oceanapia bartschi*, tan with zoanthids- Petrosida, thin rope- *Agelas repens,* encrusting yellow- Calcarea, tan sphere-*Geodia cribata,* yellow tubes- *Verongula rigida*); F. Site C-10A, 38 m, *Orbicella faveolata, Montastraea cavernosa*.



Appendix 3-2. Images from ROV dives to illustrate various regions of Cuba's MCEs.
Southern region: A. Site C-21, 32 m, *Orbicella faveolata*, sponges (orange lumpy-*Ectyoplasia ferox*, large sphere- unid. demosponge), algae (*Halimeda copiosa*), fish (Blackcap Basslet, *Gramma melacara*); B. Site C-24, 73 m, *Agaricia lamarcki*, sponges (purple tube- *Aplysina acheri*, plate- *Agelas dilatata*, sphere- *Geodia* sp.); C. Site C-29, 69 m, *Agaricia lamarcki*, sponge (tube- *Aplysina archeri*); D. Site C-38A, 108 m. sponges (elkhorn- *Agelas cervicornis*, tan fingers- *Agelas sceptrum*, black- *Asteropus* sp., purple lobate- *Aiolochroia crassa*, yellow encrusting- *Siphonodictyon coralliophagum*; E. Site C-41, 70 m, *Agaricia* sp., sponges (tan rope- *A. sceptrum,* red orange finger- *Amphimedon compressa*, orange rope- *Aplysina cauliformis, A. fulva*, orange branching- *Agelas cervicornis*, purple lobate- *A. crassa)*; F. Site C-41, 142 m, scalloped rock, deep island slope.

Appendix 3-3. Images from ROV dives to illustrate various regions of Cuba's MCEs.
Eastern region: A. Site C-48, depth 96 m, eroded wall, crustose coralline algae, sponges (fan- *Agelas*? sp., yellow encrusting- Verongiida sp.); B. Site C-50, 78 m, octocoral (*Nicella goreaui*); C. Site C-52, 105 m, sponges (vase- *Xestospongia* sp. Cu-01, fan- *Agelas clathrodes*), fish (Longspine Squirrelfish, *Holocentrus rufus*); D. Site C-52, 81 m, sponges (large orange- unid. demosponge, fan- *Cribrochalina vasculum*, yellow- *Agelas cervicornis*, sphere- *Cinachyrella* sp., tan lobate- *Smenospongia conulosa*); E. Site C-50, 92 m, sponges (yellow- undescribed Verongiida, tan vase- *Xestospongia* sp. 1, yellow sphere- *Cinachyrella* sp.); F. Site C-50, 70 m; large *Agaricia lamarcki* (lasers 10 cm), sponge (encrusting- *Spirastrella coccinea*).



Appendix 3-4. Images from ROV dives to illustrate various regions of Cuba's MCEs.
Northern region: A. Site C-56, 67 m, school of Silversides or Anchovies at mouth of cave; B. Site C-58, 44 m, algae (*Halimeda* spp., *Udotea* sp.); C. Site C-58A, 67 m, school of Dog Snapper (*Lutjanus jocu*); D. Site C-59A, 65 m, longline wrapped on wall; E. Site C-56, 88 m, overhang of buttress on wall; F. Site C-60A, 44 m, shelf-edge reef crest with dense octocorals and sponges.