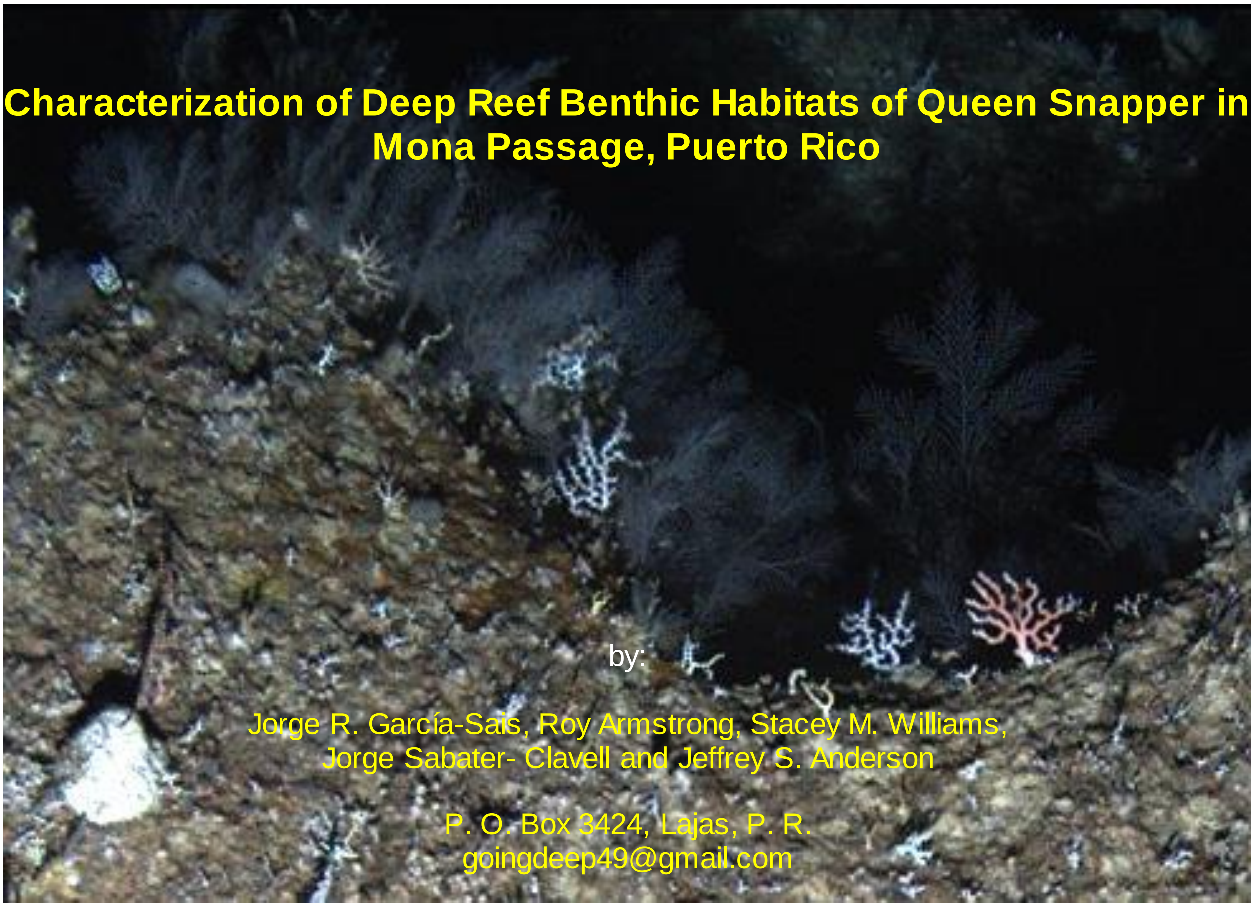
FINAL REPORT



Characterization of Deep Reef Benthic Habitats of Queen Snapper in Mona Passage, Puerto Rico

by:

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Submitted to:
Caribbean Fishery Management Council
San Juan, Puerto Rico

June, 2015

Executive Summary

This study is a groundbreaking initiative from the Caribbean Fishery Management Council to provide a baseline characterization of the benthic habitats of deep sea snappers and groupers that represent the most important finfish assemblage of the Puerto Rican fishery, with particular attention to the queen snapper (*Etelis oculatus*) habitat. This latter species represents about 10% of the total finfish landings of Puerto Rico, and more than 90 % of its fishery is targeted from reef habitats in Mona Passage within the 250 – 400 m depth range. West coast bonafide deep sea snapper and grouper fishermen collaborated with the CFMC in this research initiative by providing coordinates of prime queen snapper fishing grounds and identifying areas of particular interest, where frequent entanglements of fishing gear with deep water corals occurred.

A total of six stations in Mona Passage and one off the insular slope south of La Parguera were surveyed using a SeaBed Autonomous Underwater Vehicle (AUV) fitted with a downward looking camera, light strobes, transponder, ADCP and CTD to obtain water column salinity and temperature (ST) profiles and digital georeferenced photographic transects of benthic habitats maintaining a constant distance (3.0 m) from the seafloor. Estimates of percent cover by substrate categories and densities of reef biota were produced from analyses of photo images using Coral Point Count with Excel Extensions (CPCe) software and/or whole counts of organisms per photo frame. A total of 1,006 non-overlapping photo images of the seven (7) transects were analyzed.

The density and relative composition of sessile-benthic biota colonizing deep-reef habitats in Mona Passage and La Parguera varied markedly. Availability of hard bottom, depth, slope and distance from shore are proposed as factors potentially regulating sessile-benthic community structure. The benthic community at Station QS – 1, surveyed northeast of Bajo de Sico at mesophotic depths within the 78 – 108 m range was markedly different from all other stations. Biotic cover at QS – 1 was 80.5 %, more than twice as high as any other station surveyed. Benthic algae were the main biological component colonizing the seafloor, whereas aphotic reef stations were devoid of benthic algae. Also, the numerically dominant scleractinian corals in terms of reef substrate cover and density of colonies at QS – 1 were hermatypic taxa, whereas corals from aphotic stations were all ahermatypic (aposymbiotic). Thus, the prevalence of benthic algae and photosynthetic endosymbionts in corals at QS – 1 evidences that light penetration was a factor regulating major differences of community structure relative to other deeper, colder, aphotic stations included in this study. Boulder Star Coral, *Orbicella franksi* was photographed growing at a depth of 78 m (257 feet) in QS – 1, which may be the maximum depth distribution record for the species (at least within the Puertorrican EEZ).

Densities of aposymbiotic corals were much higher at station QS – 5 (Bajo Placeres West) than at any other station in the study. The combined substrate cover by scleractinian, antipatharian, hydrocorals and soft corals was 15.5 % over the total transect area (64% sand), with 43.0% cover on suitable substrate, hard bottom. Such level of reef substrate cover by live ahermatypic corals is higher than that of hermatypic (symbiotic) assemblages from most shallow-reef coral reef systems in the Natural Reserves of Puerto Rico. The high percent of substrate cover by live corals of different species and growth shapes contributed significantly to the reef topographic relief and benthic habitat complexity, along with its implications for enhanced benthic productivity, microhabitat availability and ecosystem biodiversity, which is consistent with the classification of this benthic habitat as an ahermatypic coral reef system. QS – 5 was the only "high relief" station (accidentally) surveyed by the AUV in this study, but from the limited bathymetric data available, this type of irregular, high topography seafloor features appear to be common throughout the Antillean Ridge, suggesting that ahermatypic coral reefs may have a widespread distribution and contribute significantly to the biodiversity and fisheries production of Mona Passage.

Marked gradients of substrate colonization and community structure were evidenced from stations QS – 5, QS-Alt 3 and QS-Alt 4, spaced along an offshore - onshore gradient from Mona Passage to the west coast shelf-edge. Reef substrate cover by ahermatypic scleractinian and antipatharian corals, as well as the total density of sessile-benthic colonies increased offshore towards Mona Passage. Soft corals (gorgonians), particularly sea whips (*Ellisella sp*) were more abundant at stations QS Alt – 3 and also presented a relatively high density at QS - 6, both stations had a relatively low topographic relief and high sediment cover. Amongst motile megabenthic invertebrates, echinoderms were by far the most abundant at all aphotic stations. These were mostly observed over unconsolidated substrate, particularly sandy substrates and thus, their density appeared to be influenced by the relative prevalence of sand at the sites surveyed.

A total of 29 fish individuals, possibly five or six species were observed within transect areas. Most (22 out of 29) were observed aggregated in schools over hard bottom at QS – 2 (Isla Desecheo), but none could be positively identified. The down-looking camera system of the AUV was not designed to provide quantitative estimates, nor to optimize detection of pelagic taxa. Therefore, the fish photographic records obtained from the AUV should be considered mostly incidental and/or descriptive of demersal, if not epibenthic species, such as what appear to be an Antillean Catfish (*Gadus antillensis*), the Bluestriped Lizardfish, *Synodus saurus* and the Elongated Whiff flounder (*Citharichthys dinoceros*). Relationships between benthic community structure and the fish taxonomic composition and abundance will require additional survey components that may include a combination of direct (fishing) and indirect (photographic/acoustic) approaches.

One of the main findings of this baseline study is the dense biological colonization of the hard ground substrate by ahermatypic corals and other taxa, consistent with the classifications of these benthic habitats as coral reefs, appear to be concentrated in areas of marked substrate discontinuities and high topographic relief, but these were mostly avoided because of the AUV limitations for surveying irregular, high relief areas. Thus, alternative approaches must be considered for exploration of these benthic habitats that may represent some of the most extensive, yet unexplored coral reef resources of Puerto Rico and perhaps of fundamental relevance for the deep sea snapper and grouper fishery.

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Introduction

With a combined (commercial and recreational) average of approximately 600,000 pounds per year (1999-2005), deep-water snappers (Species units 1 & 2) comprise the largest and most important catch of the Puertorrican finfish fishery (CFMC, 2010). Artisanal commercial and recreational fishermen target specific species, or group of species at depths from 160 to 400 m. Ontogenetic depth preferences by several species of deep-water snappers have been reported (Colin, 1974; Rosario et al, 2006). Within this depth range, benthic habitats are distributed down the insular slope, on the reef tops and slopes of oceanic seamounts, and throughout the poorly known platform of the Puerto Rico fault zone, a submerged section of the Antillean Ridge that extends across the entire Mona Passage, connecting Puerto Rico with La Hispaniola (Garcia-Sais et al., 2005). The submerged reefs of Mona Passage are of particular interest because they are the main habitats of the queen snapper (*Etelis oculatus*), a species of prime commercial value that represents about 10% of the entire finfish annual catch (CFMC, 2010).

Fishing for adult queen snapper and grouper species (e.g. misty and yellowedge groupers, *Epinephelus mystacinus, E. flavolimbatus*) at depths between 250 – 400 m, fishermen have identified zones of "high biological diversity" where increased numbers of fish species are caught and frequent entanglements of their fishing gear with corals and sponges occur. According to Cairns (1979), the greatest number of ahermatypic coral species in the Caribbean are from the 200 - 500 m depth range, suggesting that fishing grounds of queen snapper and other deep snappers and groupers from Mona Passage may include deep coral reef habitats. Since the location of these deep reef habitats in Mona Passage lie within the U. S. Caribbean EEZ, the CFMC launched this research initiative to obtain critically relevant information leading to their protection and management.

The U. S. Caribbean EEZ has not been extensively surveyed for deep-sea corals (Luntz and Ginsburg, 2007). Inferences of deep reef habitats and associated communities of Puerto Rico and the U. S. Virgin Islands were produced more than 100 years ago (Garcia-Sais et al., 2005), during the early ocean exploration surveys that included the HMS Challenger of 1873 (only two stations), dredging surveys by "Blake" during 1878-79 (mostly USVI), U. S. Fish Commission "Fish Hawk" in 1899 (mostly neritic), and the Johnson-Smithsonian Expedition of 1933 (only very deep in the PR Trench). Deep-sea coral banks have not been reported, but at least 33 species of azooxanthellate (ahermatypic) deep-sea corals, including the deep-water reef builder

Lophelia pertusa, have been reported from deep reef habitats of the U. S. Caribbean EEZ (Garcia-Sais, 2005).

Most of the research attention on deep-sea communities of Puerto Rico and the USVI has been focused toward fishery resources. Assessment surveys of the deep sea snapper and grouper fisheries potential were performed during the late 70's and throughout the 1980's by the National Marine Fishery Service (NMFS) in collaboration with the local governments of Puerto Rico, USVI, and the CFMC. These surveys consisted of at least 11 cruises of the R/V Oregon II, R/V Delaware II and the Seward Johnson-Sea Link II submersible survey of the insular slope of PR and the USVI in 1985. Despite the generalized conclusion from these surveys that deep-sea fish stocks were depauperate, deep sea snapper and grouper fisheries still represent the main fisheries resource in terms of catch and value in the US Caribbean EEZ (Garcia-Sais et al., 2005). While insular slope habitats have received most of the limited scientific attention toward deep reef systems in Puerto Rico, deep reef promontories of Mona Passage had not been explored until very recently (April 2015), when the NOAA Ship Okeanos Explorer scheduled a mission to explore and document the biological diversity and geological/geophysical features of the Puertorrican trench and seamounts in the west and south coasts (NOAA 2015).

This initiative by the CFMC is an exploratory survey of deep reefs in Mona Passage that represent essential habitats of deep-water snappers and groupers. Research is directed towards the mapping, geophysical and biological characterization of benthic habitats. Such information is relevant for management and protection of these fishery resources by the CFMC.

The main objectives of this study were to:

1) Explore and photographically document seafloor features that serve as habitat of deep reef snapper and grouper species in Mona Passage
2) Produce an inventory, to the lowest possible taxonomic classification of the sessile-benthic, motile megabenthic invertebrate and fish species associated with these deep reef habitats
3) Provide quantitative estimates of substrate cover by sessile-benthic categories and densities of colonizing biota of the benthic habitats, and examine the variations of benthic community structure between the deep reef habitats surveyed
4) Provide physical oceanographic data of temperature and salinity profiles that characterize the deep snapper/grouper habitats.

Research Background

A series of exploratory cruises have sampled the submerged ridges, seamounts and insular slope habitats of PR and the USVI, producing highly valuable collections from which the taxonomic record of our deep reef communities has been constructed. This includes the pioneer expedition of the H. M. S. Challenger, which sampled the north coast of St. Thomas (USVI) at 390 fathoms (709 m) in 1873. Other major expeditions include the U. S. Coast Survey Steamer "Blake", which sampled insular slope stations of the Lesser Antilles during 1878-79; the expedition by the U. S. Fish Commission "Fish Hawk", which sampled 17 stations below 20 fathoms (36 m) off San Juan, Mayaguez, Aguadilla, Vieques and St. Thomas in 1899; and the Johnson-Smithsonian expedition to the Puertorrican Deep, which sampled 109 stations in the north coast of Puerto Rico, the Puerto Rico Trench, Desecheo and Mona Islands, and the USVI during 1933 (Garcia-Sais et al., 2005). More recently, the NOAA Ship Okeanos Explorer launched a mission to investigate and document the biological diversity and geological/geophysical features of the Puertorrican trench and seamounts in the west and south coasts during April 2015 (NOAA 2015). While most of the Okeanos ROV dives were launched to depths much greater than the depth range overlapping the benthic habitats of the commercially exploited deep snapper/grouper complex, one station within the depth range of the queen snapper (*Etelis oculatus*) was occupied in Mona passage as a request from the CFMC. Data from this station is being analyzed at present.

Extensive deep-sea samplings of the southwestern Atlantic were performed during the 1956 – 60 by the exploratory fishing vessels R/V Oregon, R/V Silver Bay, R/V Combat, and R/V Pelican (Bullis and Thompson, 1965; Manning, 1969). Likewise, the Florida Straits, Gulf of Mexico, West Central and Southern Caribbean, Bahamas, and the Lesser Antilles were intensively sampled during the 1960's - 1970's by the R/V Gerda, R/V Pillsbury, Columbus-Iselin, and R/V Oregon (Gore, 1974; Cairns, 1976; Cooper, 1977; Meyer et al. 1978). Interestingly, only very few stations in waters of the Hispaniola, Puerto Rico and the U S Virgin Islands were occupied by these sampling expeditions (R/V Oregon stations 644, 646, 6715; R/V Pillsbury stations P1386, P1397, P1401, P1402 see Cooper, 1977). During the 1970's through the 1980's, the CFMC, with funding from the NMFS explored the deep-sea fisheries potential of the insular slope of PR and the USVI. The fisheries effort included a series of at least 11 cruises of the R/V Oregon and R/V Delaware, with particular attention to the north coast of PR and the USVI (Nelson et al., 1984).

The taxonomic inference from all of these exploratory samplings is that the Caribbean Sea is a species rich region of deep reef biota that functions as a source of fish and invertebrate larvae to the Western North Atlantic (including the Gulf of Mexico) through an effective connectivity via inter-island passages (Rass, 1971; Cairns, 1979; Dawson, 2002). Aside from the relevance of deep reef systems for the general biodiversity of the region, commercial and recreational fisheries that include demersal (snapper/grouper) and pelagic species (billfish, tunas, mackerels) are associated with deep reef habitats of the insular slope and submerged seamounts of PR and the USVI (Nelson et al., 1984).

In the only submersible survey of deep reef habitats of Puerto Rico, the Seward Johnson-Sea Link II (JSL II) provided an unprecedented and exceptional insight of our insular slope (13 sites) and oceanic seamount (2 sites) communities, including taxonomic accounts and density estimates of commercially valuable fish species. The purpose of the survey was to provide information on deep water habitats between 300 and 1,500 feet (ca. 100 – 500 m), and to document faunal assemblages and habitat associations of commercially important fish species around Puerto Rico and the USVI, as well as to provide an assessment of the fisheries potential of deep water resources (Nelson and Appeldoorn, 1985). The insular slope habitat was almost exclusively explored by the JSL II. Vertical submersible transects were performed from the lower slopes and rock walls to the shelf-break. The typical habitat at the deep end of the insular slope consisted of unconsolidated sand-silt and mud (e.g. SS, MS, MSS). Rock-sand, (RS), rock-rubble (RR), lower wall (LW), rock-wall (RW) and rock-rubble-sand (RRS) were found higher along the slope. An assemblage of demersal species associated with soft bottom and reef slope habitats was observed, along with a benthopelagic assemblage distributed throughout the water column associated with the slope (see review by Garcia-Sais, 2005).

The first quantitative assessment of reef substrate cover by benthic communities from deep hermatypic reefs of the upper insular slope of PR was produced by Singh et al. (2004) using the SeaBED Autonomous Underwater Vehicle (AUV) off the La Parguera shelf-edge. The SeaBED AUV is a modern imaging platform designed for high resolution optical and acoustic sensing (Singh et al., 2004). The main purpose of the deployment was to perform engineering tests of the vehicle and to build initial photo-mosaics of shallow-water reef sites. However, one deep transect along the insular slope south of La Parguera starting at 20 m over the shelf-edge to 125 m depth was included in the scope of work. The UPRM Department of Marine Sciences 14 m R/V Sultana was used as the support vessel. Scleractinian corals were the dominant sessile-benthic invertebrate at depths down to 30 m, with maximum reef substrate cover (25 %) at the 24 – 30 m depth interval. Below 30 m sponges were the dominant sessile-benthic invertebrate with a substrate cover of less than 10%. Benthic algae, sand and other abiotic substrates prevailed down the insular slope of La Parguera to a maximum depth of 125 m. Black corals (*Antipathes sp.* and *Cirrhipathes sp*.) were reported from the deepest section of the transect (90-100 m).

As part of the NMFS-CFMC initiative toward the mapping and characterization of mesophotic reef systems in the U.S. Caribbean EEZ, the marine reserve at Isla Desecheo, the seasonally closed reefs at Bajo de Sico and Abrir La Sierra in Mona Passage, and the Hind Bank Marine Conservation District of St. Thomas, USVI have been recently studied (Garcia-Sais, 2005; Garcia-Sais et al, 2005, 2007, 2009; Nemeth et al, 2008, Smith et al. 2010). These characterizations were limited to a maximum depth of 50 m. Statistically significant differences of sessile-benthic and fish community structure were found between euphotic and mesophotic habitats at Isla Desecheo (Garcia-Sais, 2010). The percent of live coral cover and the relative composition of coral species, sponges and benthic algae exhibited marked variations with depth and/or benthic habitat (Garcia-Sais, et al. 2005, Garcia-Sais, 2010). Similar findings were reported for Bajo de Sico and Abrir La Sierra (Garcia-Sais et al., 2007, 2009), where important shifts of sessile-benthic and fish community structure appear to be associated not only with depth, but also with habitat type, slope and rugosity. The recently studied mesophotic reefs share the presence of large demersal fishes in abundances never previously reported for shallow reefs in Puerto Rico. In general, fish assemblages exhibit marked differences of relative abundance associated with habitat type and/or depths, high taxonomic connectivity between habitats across depth gradients, and presence of what appears to be a small group of indicator fish species of mesophotic reefs (Garcia-Sais et al., 2007, 2009; Garcia-Sais, 2010).

Taxonomic characterizations of fish communities from deep reef habitats in Puerto Rico and the U. S. Virgin Islands started during the late 19th century and are probably still incomplete due to the extreme sampling difficulties imposed by depth, visibility, and the high rugosity and abrupt insular slope around these islands. Although geographically separated from the Western Atlantic by chains of islands and submarine ridges, the Caribbean Sea is physically connected to the Atlantic Ocean by island passages up to 1,600 m deep. Such deep water pathways allow for an effective Caribbean - Atlantic connectivity of adult and larval deep sea fishes.

A total of 160 fish species associated with deep reef habitats of the Caribbean basin, including collections from the insular slope of Puerto Rico and other islands were initially reported by Rass (1971). Nine groups of deep-sea fishes representing 31 families comprised 80 % of the total number of species collected during early sampling expeditions to the Caribbean Sea. Stomiatoidea (Dragon fishes- 56 spp), Myctophoidea (Lanternfishes-15 spp), and Gonostomoidea (Bristlemouths-15 spp) were the fish groups with the highest numbers of species collected. Rass (1971) proposed that the Caribbean region is the center of origin of Melanostomiatidae in the Atlantic Ocean. The taxonomic record of fishes from Puerto Rico and the U. S. Virgin Islands collected from depths of at least 30 m has been recently updated to 872 species, included in 173 families and 35 orders (Grana, 2005a). Serranidae (groupers and sea basses) with 53 species, Stomidae, with 51 species, and Myctophidae, with 49 species are the most specious families. Most perciform fishes are associated with upper slope habitats. Dragonfishes and barracudinas (Paralepididae) exhibited distributions mostly associated with deep slope habitats. The deepest record (8,370 m) is for *Abyssobrutula galatheae* (Ophididae). Another four cuskeels are reported from depths below 3,000 m (Garcia-Sais, 2005).

Exploratory fishing surveys of commercially valuable fishes associated with deep reefs of the insular slope were launched during the 1970's and 1980's (Juhl, 1972; Nelson et al., 1984). The initial survey, coordinated by the Fisheries Development Program of the Commonwealth of Puerto Rico (Juhl, 1972) examined the efficiency of several types of fishing gear, such as fish traps, snapper reels, trolling lines and bottom gill nets for the collection of deep water fishes. A total of 40 fish species were reported, including some species from insular shelf habitats. The National Marine Fishery Service (NMFS) Southeast Fisheries Center conducted annual bottom long line fishing surveys around Puerto Rico and the USVI from 1980 -1984. Fishing effort was concentrated in the 90 - 450 m (300 -1,500 feet) depth range of the insular slope. The primary purpose of these surveys was to evaluate the abundance and spatial distribution of commercial fish resources, with particular interest on deep-water snappers and groupers (Nelson et al., 1984).

Exploratory fishing cruises sailed aboard the NOAA ships Oregon II and Delaware II and targeted the north and west insular slopes of PR and the north and south coast of the USVI. The commercially valuable fish assemblage identified by these surveys included 12 species of snappers (Lutjanidae) and seven species of groupers (Serranidae). The red hind (*Epinephelus guttatus*), yellow-edge grouper (*E. flavolimbatus*), and mutton snapper (*Lutjanus analis*) yielded the highest CPUE at upper slope depths between 90 – 180 m. Misty grouper (*E. mystacinus*), queen snapper (*Etelis oculatus*), and silk snapper (*Lutjanus vivanus*) dominated the mid-slope habitat between 181 – 270 m.

The catch at the deeper end of the slope, between 271 – 454 m was dominated by misty and yellow-edge groupers, and the queen and wenchman snappers (*Pristipomoides macrophthalmus*) (Nelson et al. 1984). Although not considered of commercial value, unidentified "sharks" and "others" comprised the largest catch at all depths from the NMFS-NOAA surveys. The swordfish, *Xyphias gladius* has been captured by recreational fishermen at the deeper end of the insular slope, close to the bottom (Garcia-Sais, 2005).

From the material provided by the 19th century expeditions, Cairns (1979) prepared the first regional review of the taxonomic composition and geographic distribution of the deep water ahermatypic (azooxanthellate) scleractinian corals of the Caribbean Sea and adjacent waters. A total of 88 species were initially reported by Cairns (1979), including 18 deep-water coral species collected from Puertorrican waters. In a subsequent taxonomic revision of the ahermatypic corals of the Caribbean (Dawson, 2002) updated the list to a total of 129 species, including a total of 85 for PR and the West Indies. The greatest number of ahermatypic coral species in the Caribbean and adjacent waters are from a depth range of 200 - 500 m (Cairns, 1979). Although there are "thicket-like" banks of some of the branching ahermatypes, the isolated "shrub-like" growth forms are the most frequently encountered in the deep waters of the Atlantic Ocean (Squires, 1959). Biogeographic patterns of ahermatypic corals in the Caribbean show a definitive trend toward increase in endemism when the faunas are ordered from greater to lesser depths, supporting the theory that the deep Atlantic Ocean is an effective barrier for the dispersal of shallow water coral species. According to Cairns (1979), the Caribbean, and specifically the Antilles is the center of diversity of scleractinian corals in the tropical western Atlantic.

From this previous research background it is evident that the limited information available on deep reef systems of Puerto Rico and the Caribbean EEZ in general, has been concentrated on the insular slope. The submerged ridge of Mona Passage is intensively fished for migratory pelagic species and has been fished for deep-water snappers and groupers for more than 30 years. At present, there is still not an adequate characterization of the benthic habitats that sustain these important populations.

Methods

According to bonafide fishermen of the west coast of Puerto Rico, the preferred habitat of the adult queen snapper is near or close to the base of reef outcrops that rise from the Antillean Ridge, at depths between 250 – 400 m, off the insular shelf of Rincon and Cabo Rojo. West coast fishermen provided the CFMC with five (5) geographic locations in Mona Passage where fishing activities for deep water snappers and groupers were taking place, including one relatively shallow station at Bajo de Sico (< 250 m) where they reported frequent entanglements with corals. One of these stations, located north of Mona Island was beyond the range of our capabilities and was proposed for exploration by the NOAA Ship Okeanos during its April 2015 mission in Puerto Rico. Two additional (Alt - alternative) stations were surveyed in Mona Passage within similar depths and substrate characteristics than those provided by fishermen in order to maximize the efficiency of the sampling operation with additional observations of the seafloor. Two more sampling stations were occupied within the 200 – 300 m depth range down the insular slope off La Parguera, in the southwest coast of Puerto Rico. The locations of sampling stations are shown in Figures 1 and 2. Information on geographic location and dive schedule at sampling stations is presented in Table 1.

Digital photographic documentation of the seafloor in areas reported to be fishing grounds of the queen snapper and other deep water snappers/groupers of commercial value was accomplished with a SeaBED Autonomous Underwater Vehicle (AUV). The technical features and surveying capabilities of the SeaBED AUV are detailed in Singh et al. (2004). AUV deployments were made from the UPRM R/V Sultana (Plate 1). The SeaBED AUV was rigged with an underwater camera, light strobes, a CTD, an ADCP and a transponder to allow georeferences of all photographic, depth and physical (salinity/temperature) data. The camera was oriented vertically to prioritize sessile-benthic components of the seafloor and programmed to take photos at three-second intervals. A total of seven (7) successful SeaBED AUV dives were achieved between December 2014 and February 2015.

Biological data was acquired from the analyses of digital photos taken along transects by the AUV. A series of non-overlapping frames were analyzed to provide a taxonomic inventory of the

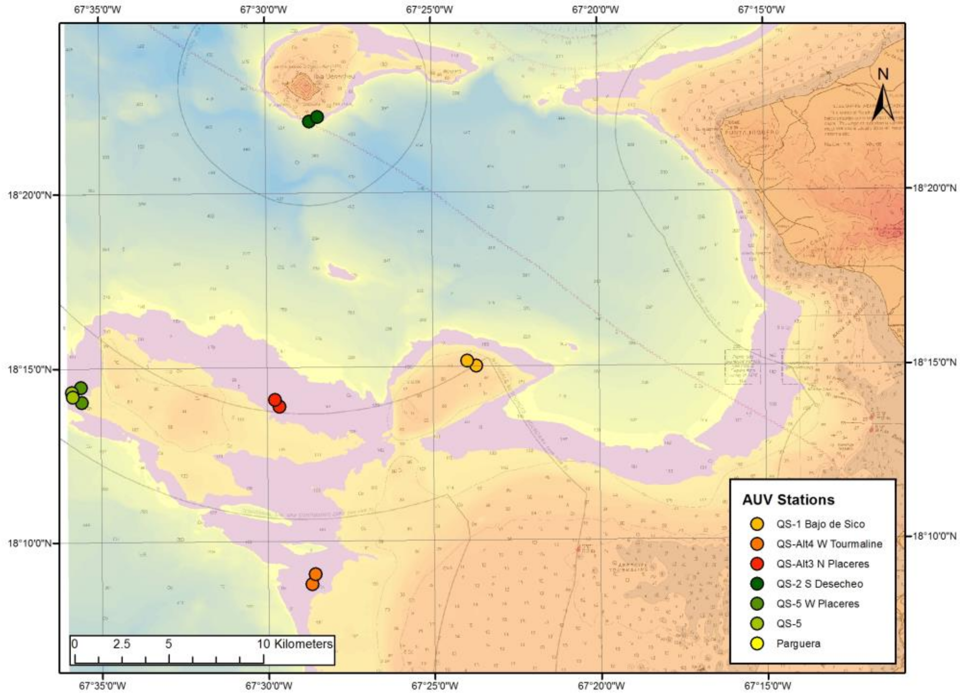


Figure 1. Location of SeaBED AUV Queen Snapper (QS) transect surveys in Mona Passage during 2014-15

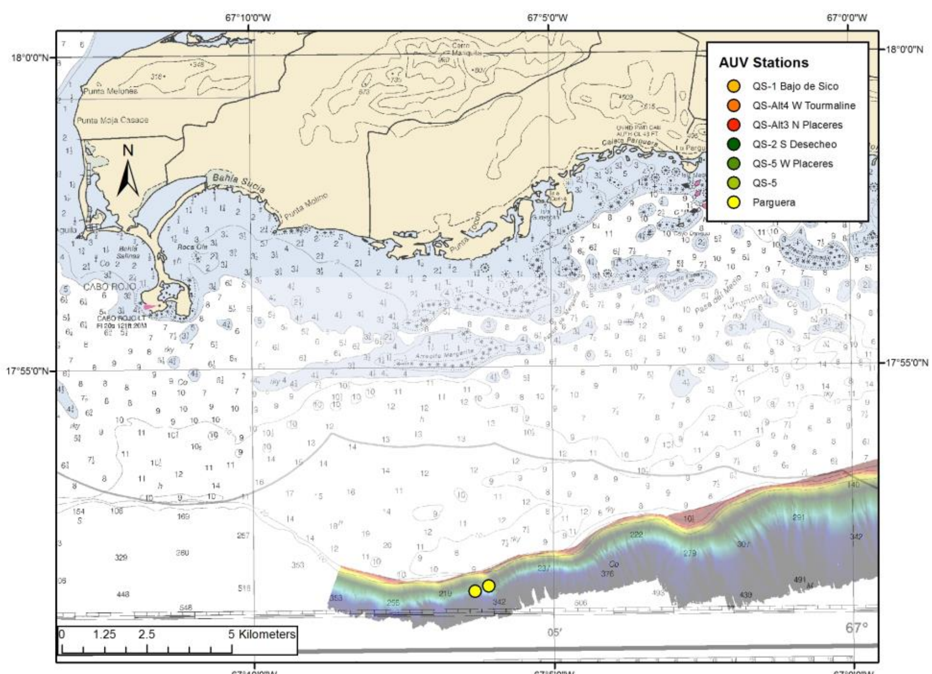


Figure 2. Location of SeaBED AUV Queen Snapper (QS) transect surveys off La Parguera Insular slope during 2015

Table 1. Geographic location and dive schedule of the SeaBED AUV survey in Mona Passage and La Parguera, 2014-15.

Station	Description	Date	Lat In	Long In	Lat Out	Long Out
QS - 1	Bajo de Sico	6-Dec-14	18° 15.02	67° 23.70	18° 15.17	67° 23.97
QS Alt-4	Tourmaline W	6-Dec-14	18° 8.78	67° 28.68	18° 9.07	67° 28.58
QS Alt-3	Placeres N	7-Dec-14	18° 13.89	67° 29.63	18° 14.08	67° 29.76
QS - 2	Isla Desecheo S	10-Feb-15	18° 22.07	67° 78.67	18° 22.19	67°28.43
QS - 5	Placeres W (S-N)	11-Feb-15	18° 14.02	67° 35.58	18° 14.46	67°35.60
QS - 5	Placeres W (N-S)	11-Feb-15	18° 14.32	67° 35.87	18° 14.19	67°35.85
QS - 6	La Parguera S	12-Feb-15	17° 51.50	67° 06.09	17° 51.42	67° °6.32

Plate 1. SeaBed AUV and mother vessel UPRM - R/V Sultana

observed biota, estimate the percent substrate cover and/or density of the predominant sessile-benthic organisms and substrate categories. A total of 1,006 photos of the seafloor were analyzed from the seven transects surveyed (mean: 144 photos/transect). Distance covered by transects ranged between 0.3 – 1.2 km. The AUV had technical problems during the dive on transect QS – 5 (S-N) and the dive was aborted, nevertheless 28 photos of the seafloor were rescued and the station data was included for analyses. AUV Photos were taken from a constant (fixed) distance to the seafloor (3.0 m) controlled by the AUV Acoustic Doppler Current Profiler (ADCP). Each photo covered a mean surface area of 7.18 m^2. All motile and sessile megabenthic invertebrates and fishes were identified to the lowest possible taxon and enumerated.

Density determinations were produced from whole counts of organisms recognized in each photo divided by the photo area in transects QS-2, QS Alt 4, and QS – 6. Whole counts were obtained because sections of the seafloor were mostly uncolonized and only few isolated organisms were present. Densities were estimated from their % cover on each photo divided by the photo area where biological colonization of the seafloor exceeded 5 %, and the number of organisms increased, such as in QS – 1, QS Alt – 3, and QS – 5.. Determinations of % cover by reef substrate categories were based on a 50 random point overlay on each photo using the Coral Point Count with Excel Extensions software (CPCe). The number of points over each substrate category or taxa were divided by the total number of overlaid points and multiplied by 100 to reach the percent unit. In addition to organisms included in the 50 point overlay, all new taxa recognized on each photo was included in a general taxonomic inventory of each photo transect.

Results and Discussion

QS – 1. Bajo de Sico

The SeaBed AUV dove on the north section of Bajo de Sico during December 6, 2014. It reached bottom at a depth of 78 m and traveled SE along a sloping terrace down to a maximum depth of 108 m (Figure 3) covering a linear distance of 0.55 km. The temperature and salinity (TS) profiles exhibited a strong thermocline and halocline at 40 m, indicative of the surface mixed layer depth boundary in the water column (Figure 4). Salinity increased with depth reaching a maximum of 36.6 su near the bottom at 75 m, consistent with the upper margin of the Sub-tropical Underwater. Benthic communities, which include a variety of scleractinian and antipatharian corals were exposed to a temperature of 25.6 ^{o}C at 75 m.

At depths of 75 – 108 m the prevailing benthic habitat at Bajo de Sico was a vast deposit of algal nodules, or rhodolith reef (see Photo Album 1). Garcia-Sais et al. (2007) reported that rhodolith reef was the prevailing benthic habitat at depths of 45 – 50 m and commented on its visually deeper distribution in Bajo de Sico. This observation extends the range of this habitat to at least 108 m. Crustose coralline algae was the dominant biotic component in terms of reef substrate cover with a mean of 31.2 % within the transect surveyed. These encrusting red algae are probably the primary builder of the rhodolith nodules. Rhodoliths were also heavily colonized by turf algae (23.0 %) and calcareous (*Halimeda sp*.) macroalgae (10.8 %). The benthic algal assemblage had a combined reef substrate cover of 68.0 % (Table 2). Sponges had the highest reef substrate cover and the highest species richness among sessile-benthic invertebrates with 9.7 % and 32 species within the photo-transect surveyed. The taxonomic inventory of sponges within this depth range at the rhodolith habitat of Bajo de Sico is certainly much higher, but as with many other taxa their comprehensive description will require a major collection effort. The giant barrel sponge, *Xestospongia muta* (0.93 ± 0.27%) and orange elephant ear sponge, *Agelas clathrodes* (0.64 ± 0.21%) were the most prominent species in terms of reef substrate cover (Plates 2 and 3).

Live scleractinian corals were represented by seven (7) species and a combined reef substrate cover of 2.28 ± 0.41%, which is impressive within this mesophotic depth range. Lettuce corals, *Agaricia spp*. were the numerically dominant species with a mean density of 5.9 colonies/100 m^2. The lettuce coral assemblage included *A. lamarki* and *A. fragilis*. It is possible that other species were present but could not be identified. Small isolated coral colonies prevailed within this benthic habitat, but several groups of colonies growing together were observed (Plates 4 and 5). Live Boulder Star Coral, *Orbicella franksi* was documented growing at a maximum depth of 78 m (257 feet), which is possibly the deepest record of its distribution range. One unidentified antipatharian (black coral) was present in the transect. Abiotic substrates had a mean cover of 19.5 % (Table 2), but evidenced an increasing trend towards the deeper end of the transect where sandy sections prevailed.

Fishes were not observed at this station. There were Acanthuridae (7 in total), lionfish (5 in total) and a school of small fish observed at the end of the transect (Plate 6 and 7).

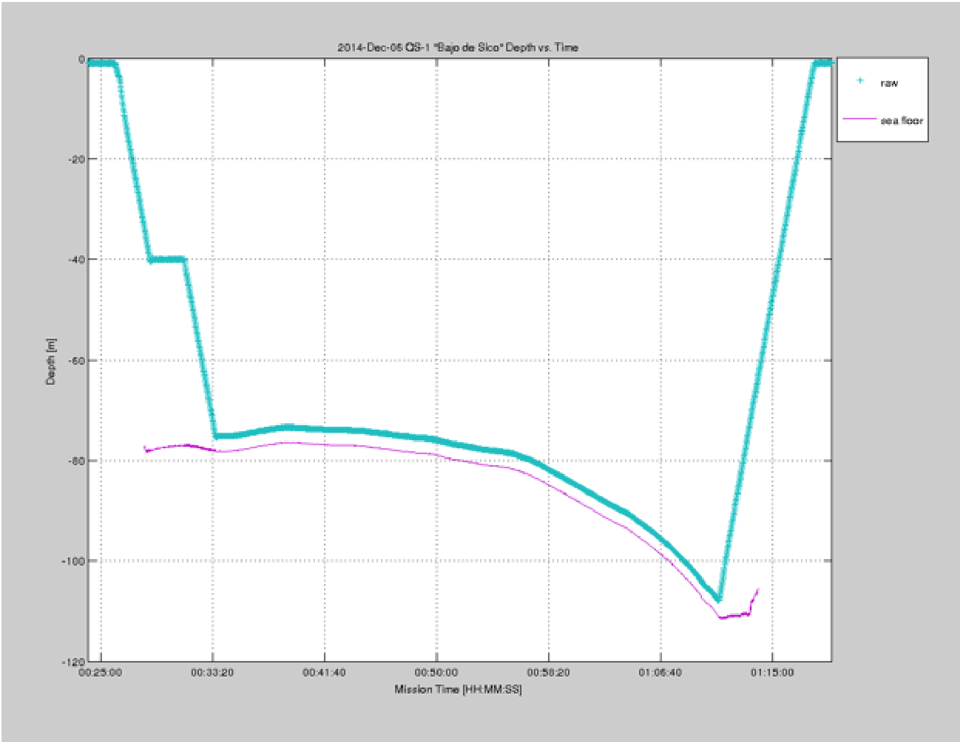


Figure 3. QS – 1. Depth profile of the SeaBed AUV dive at Bajo de Sico Seamount during Dec 2014.

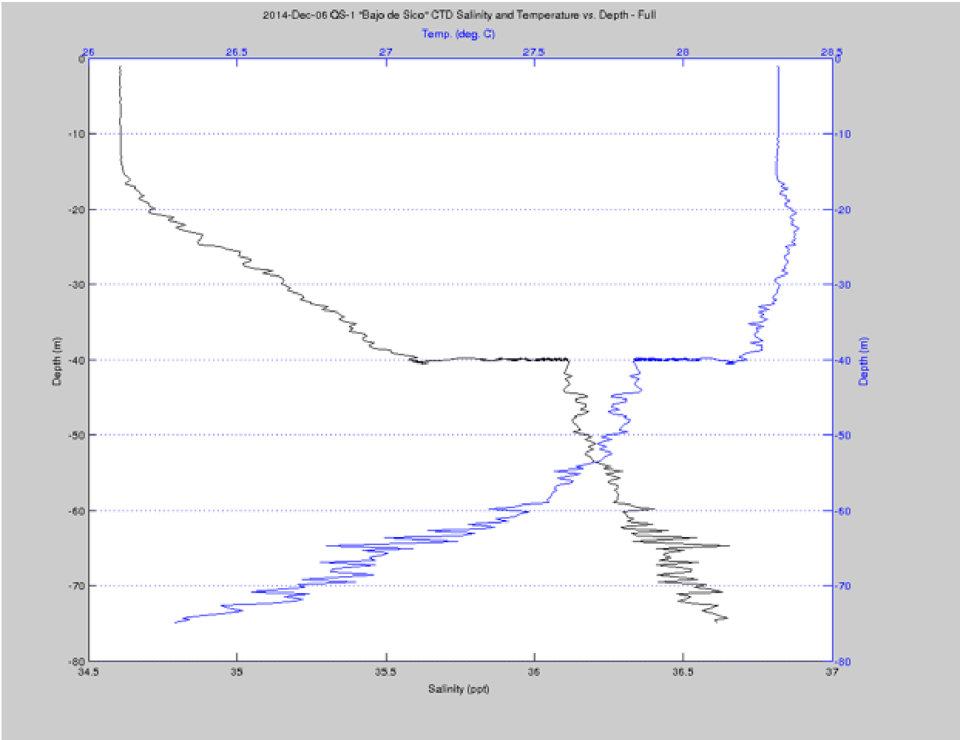


Figure 4. Temperature (^{o}C) and salinity (ppt) profiles produced by the SeaBed AUV – CTD dive at Bajo de Sico during Dec 2014.

Table 2. QS – 1. Bajo de Sico. Percent cover by substrate categories and densities of predominant biota within the transect area photographed by the SeaBed AUV at Bajo de Sico during Dec 2014. Depth range: 78 – 108 m.

Total photos analyzed: 129 **Total Area: 926.2 m^2**

SUBSTRATE CATEGORY	**% Substrate Cover** **Mean**	**Density** (# colonies/100m^2)
SUBSTRATE CATEGORY		
Abiotic		
Sand	18.98	
Rubble	0.44	
Pavement	0.04	
Total Abiotic	**19.46**	
Benthic Algae		
Crustose coralline alga	31.15	
Turf-algae (mixed assemblage)	22.97	
Halimeda sp.	10.78	
Lobophora variegata	2.96	
Dictyota sp.	0.13	
Total Benthic Algae	**67.99**	
Sponges		
Unknown sponge	5.22	36.8
Xestospongia muta	0.93	6.6
Agelas clathrodes	0.64	4.5
Plaktoris sp.	0.47	3.3
Agelas sceptrum	0.44	3.1
Orange branching	0.34	2.4
Agelas citrina	0.33	2.3
Xestospongia deweerdtae	0.28	2.0
Spheciospongia vesparium	0.19	1.3
Aplysina cauliformis	0.15	1.1
Aplysina fistularis	0.14	1.0
Petrosia weinbergi	0.11	0.8
Spirastrella coccinea	0.07	0.5
Ircinia strobilina	0.07	0.5
Verongula rigida	0.06	0.4
Callyspongia tenerrima	0.06	0.4
Petrosia pellasarca	0.06	0.4
Agelas cervicornis	0.04	0.3
Smenospongia conulosa	0.04	0.3
Verongula reiswigi	0.04	0.3

Total Sponges	**9.69**	**68.3**
Octocorals		
Unknown octocoral	0.16	1.1
Total Octocorals	**0.16**	**1.1**
Antipatharia	**0.42**	**3.0**
Live Corals		
Unknown coral	1.24	8.7
Agaricia sp.	0.83	5.9
Montastraea cavernosa	0.09	0.6
Porites astreoides	0.08	0.6
Total Corals	**2.28**	**16.1**

Additional species QS - 1

Category	***Species***
Antipatharian	Black coral
Coral	*Agaricia fragilis*
Coral	*Agaricia lamarki*
Coral	*Agaricia* sp.
Coral	*Leptoseris* sp.
Coral	*Montastraea cavernosa*
Coral	*Orbicella franksi*
Coral	*Porites astreoides*
Invertebrate	*Condylactis gigantea*
Macroalgae	*Halimeda* sp.
Octocoral	*Ellisella* sp.
Sponge	*Agelas cervicornis*
Sponge	*Agelas citrina*
Sponge	*Agelas clathrodes*
Sponge	*Agelas conifera*
Sponge	*Agelas dispar*
Sponge	*Agelas sceptrum*
Sponge	*Aplysina archeri*
Sponge	*Aplysina cauliformis*
Sponge	*Aplysina fistularis*
Sponge	*Aplysina lacunosa*
Sponge	Black sponge
Sponge	*Callyspongia tenerrima*
Sponge	*Callyspongia vaginalis*
Sponge	*Geoidia neptuni*
Sponge	Gray sponge
Sponge	*Ircinia strobilina*

Sponge	Massive black sponge
Sponge	*Myrmekioderma gyroderma*
Sponge	Orange barrel sponge
Sponge	Orange branching
Sponge	Orange bulbous sponge
Sponge	*Petrosia pellasarca*
Sponge	*Petrosia* sp.
Sponge	*Petrosia weinbergi*
Sponge	*Plaktoris* sp.
Sponge	*Smenospongia conulosa*
Sponge	*Spheciospongia vesparium*
Sponge	*Spirastrella coccinea*
Sponge	*Svenzea zeai*
Sponge	*Verongula gigantea*
Sponge	*Verongula reiswigi*
Sponge	*Verongula rigida*
Sponge	*Xestospongia muta*
Sponge	*Xestospongia deweerdtae*

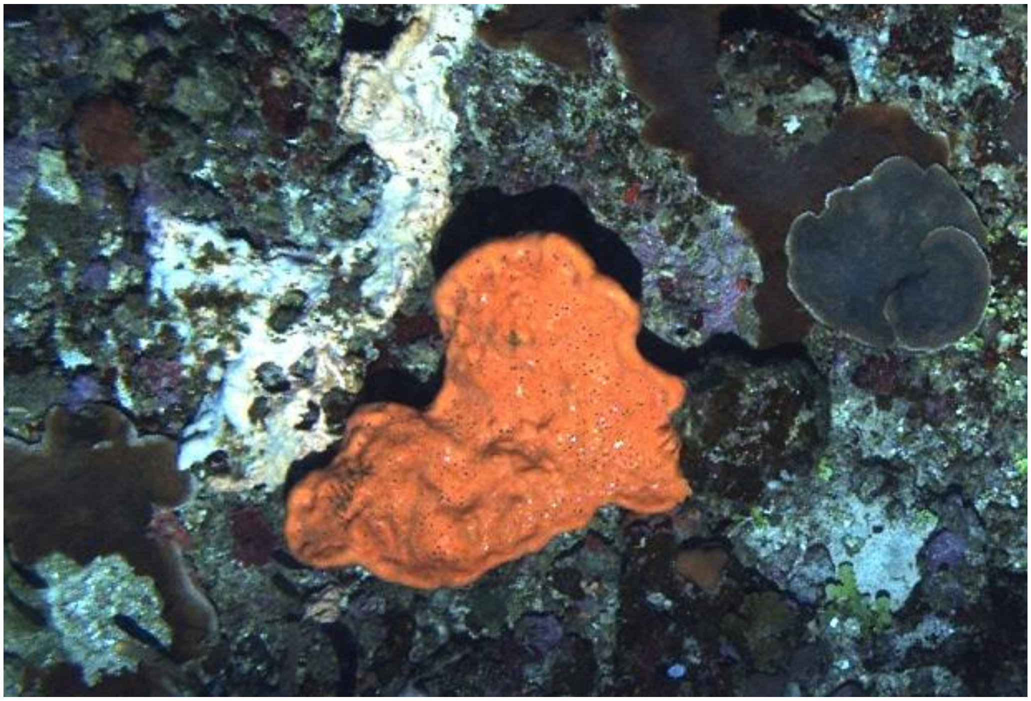


Plate 2. *Agelas clathrodes*

Plate 3. *Xestospongia muta*

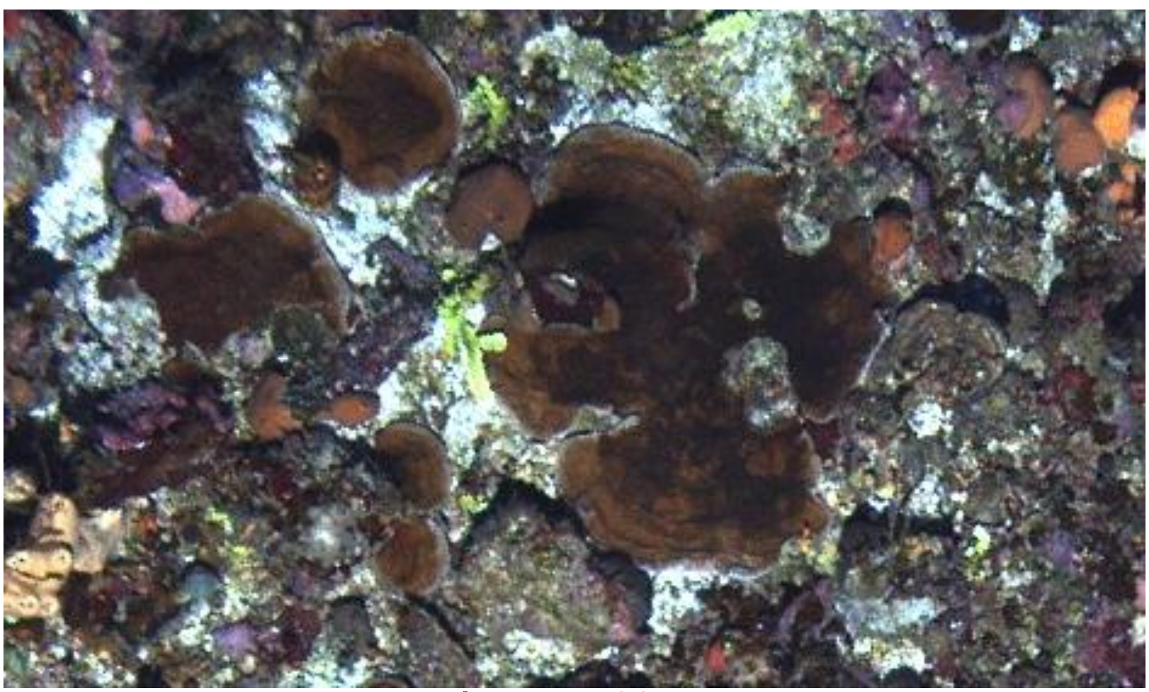


Plate 4. *Agaricia* sp.

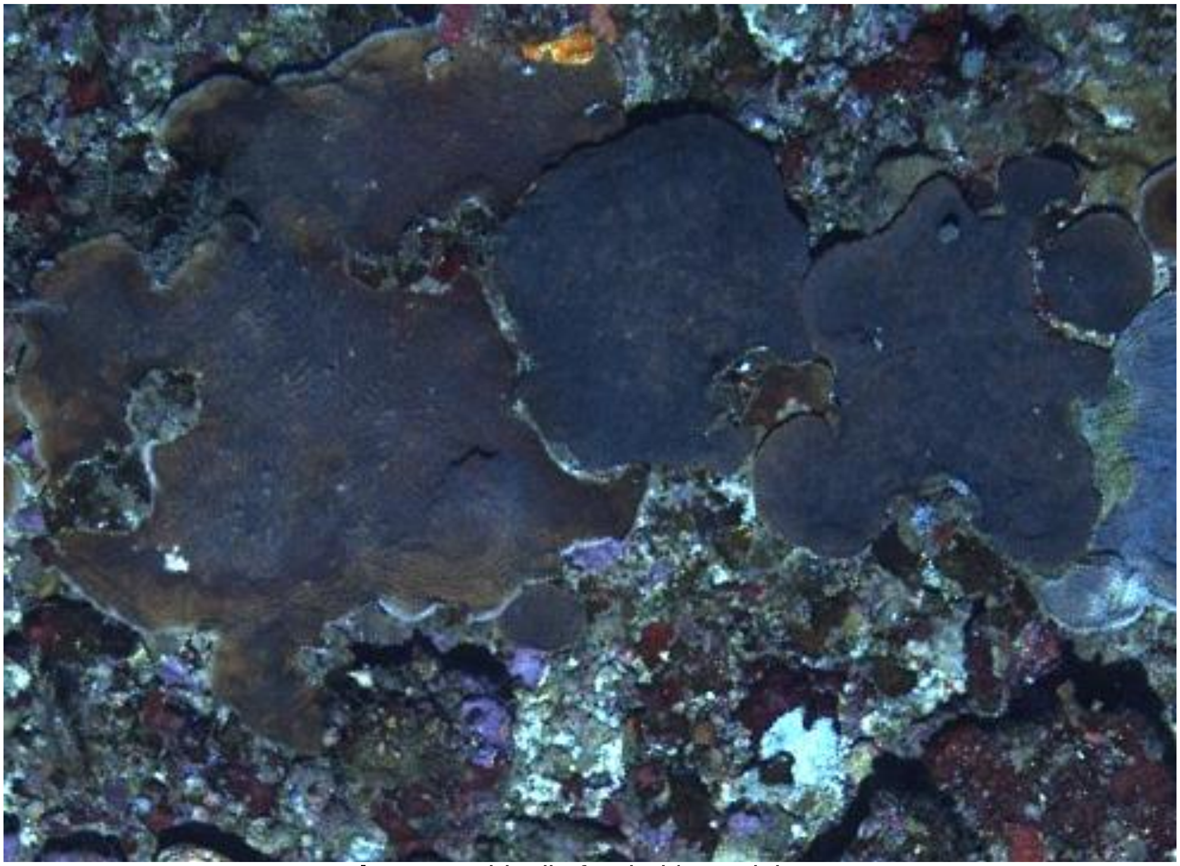


Plate 5. *Orbicella franksi* / *Agaricia sp*.

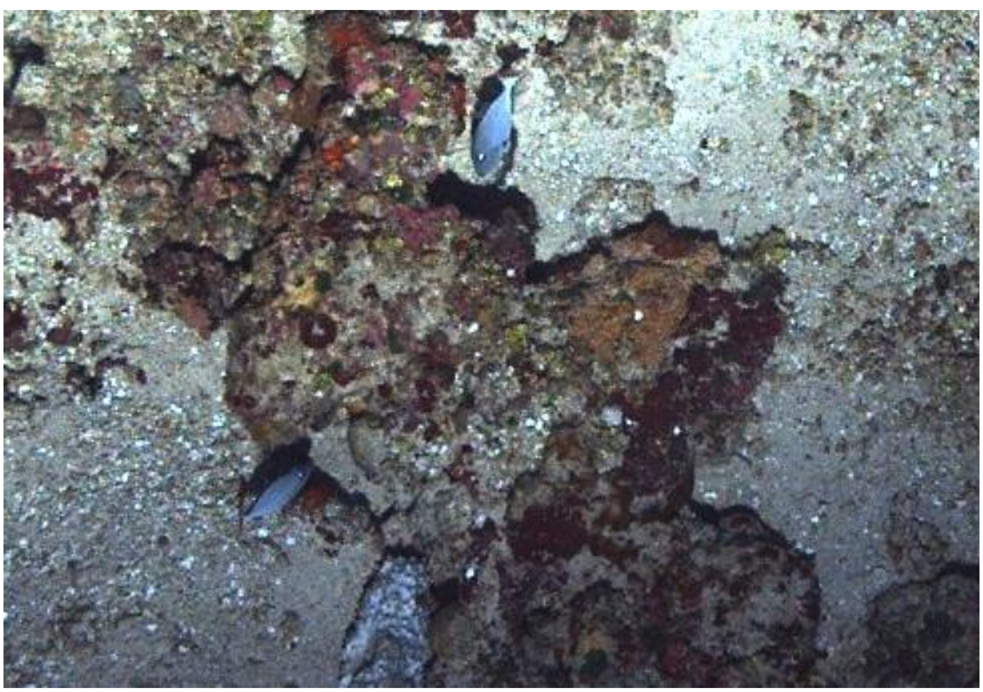


Plate 6. Acanthuridae

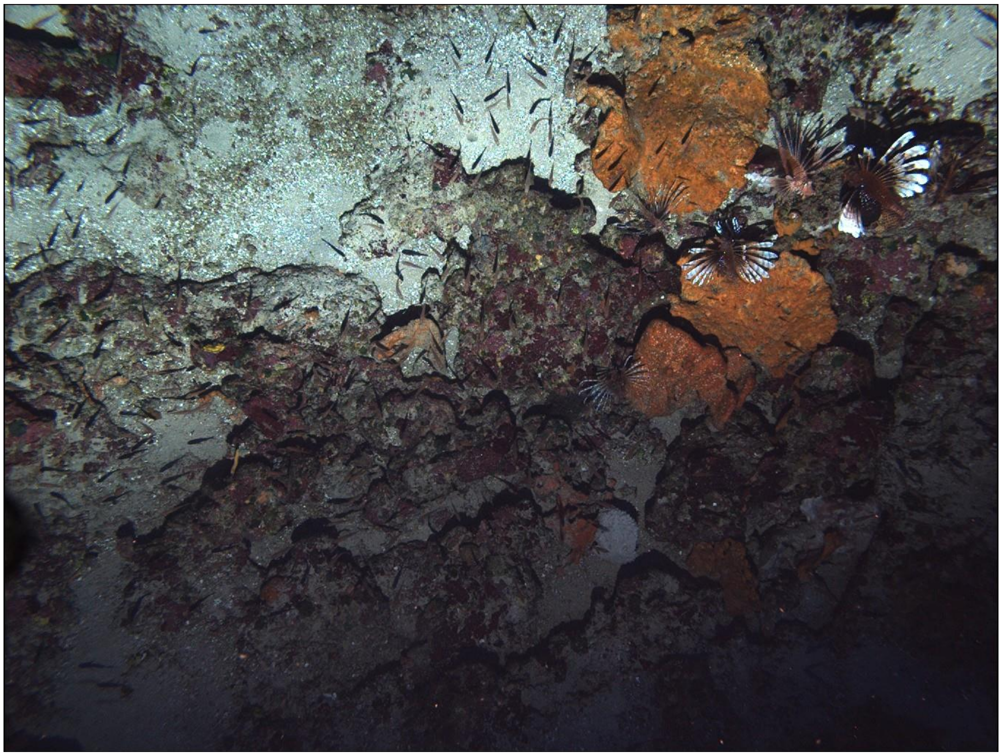
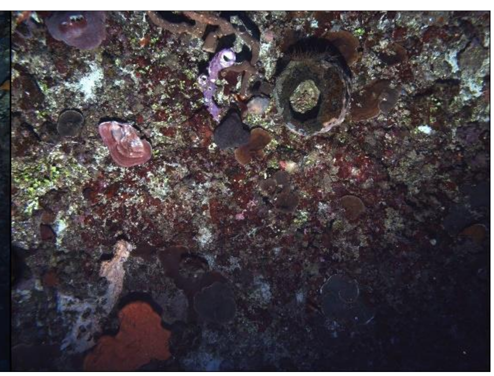
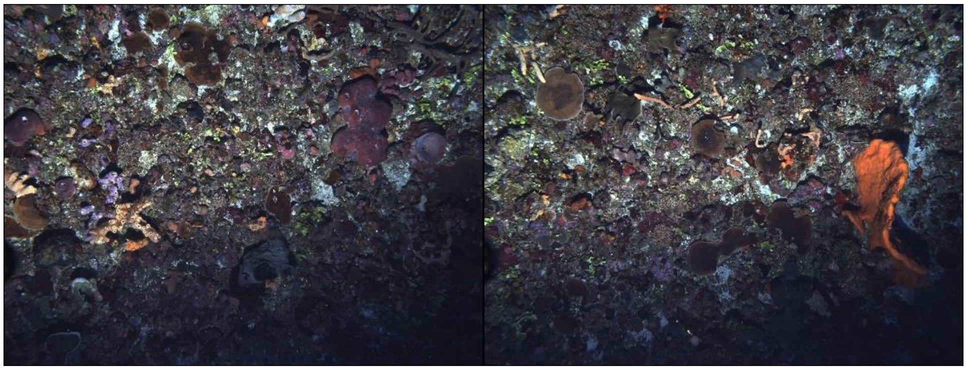
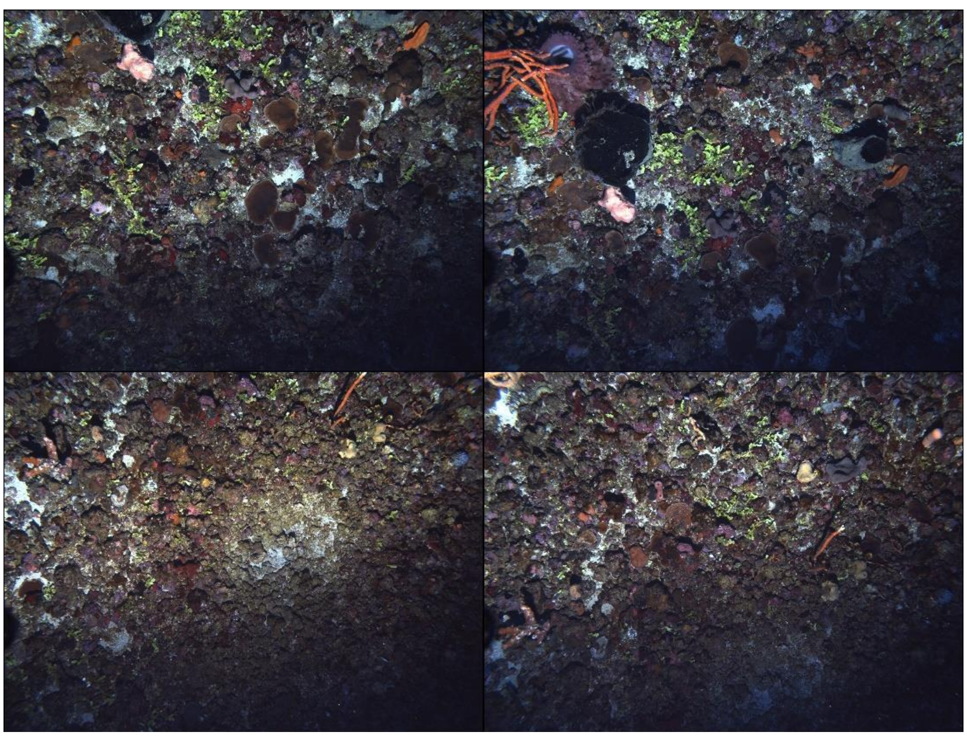


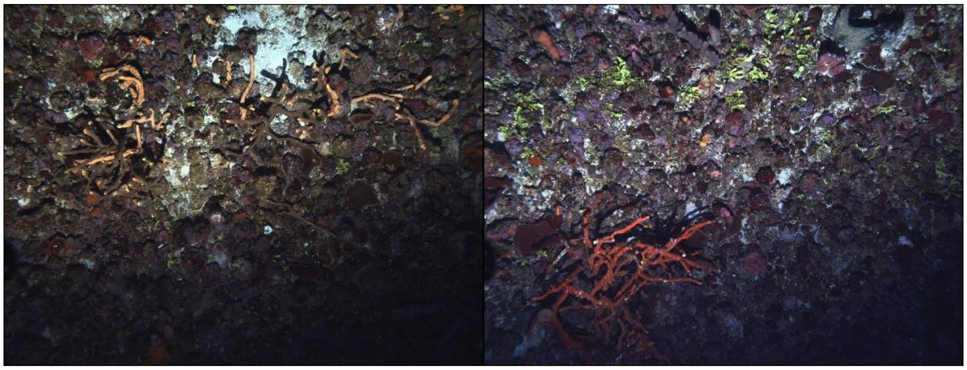
Plate 7. Lionfish and large school of small fish

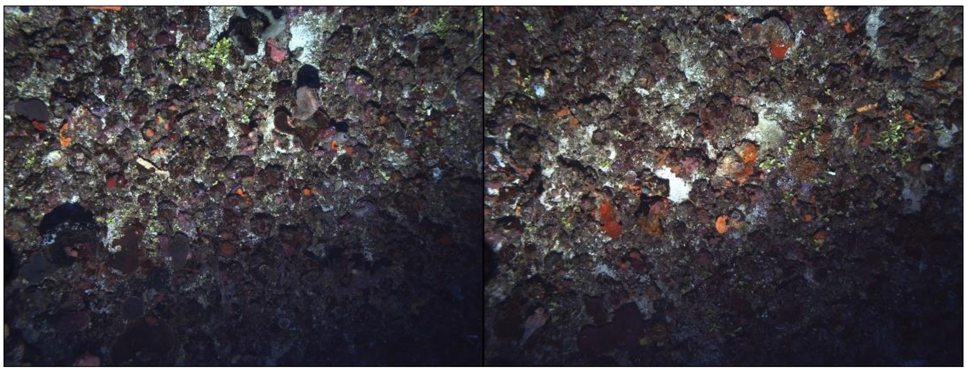
Photo Album 1. QS – 1 Bajo de Sico

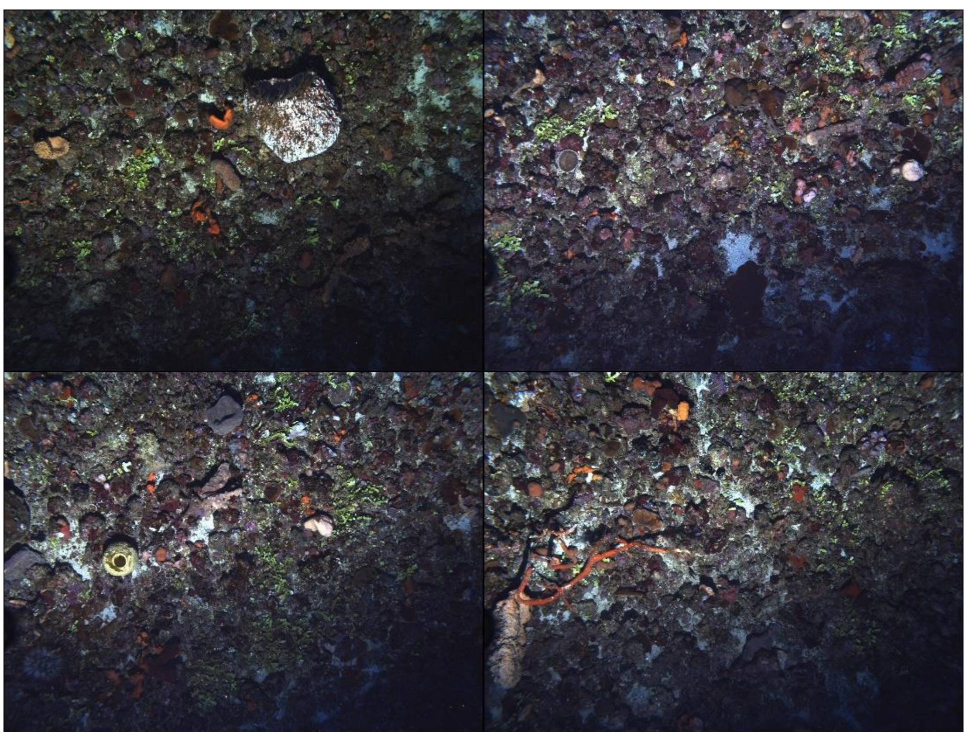


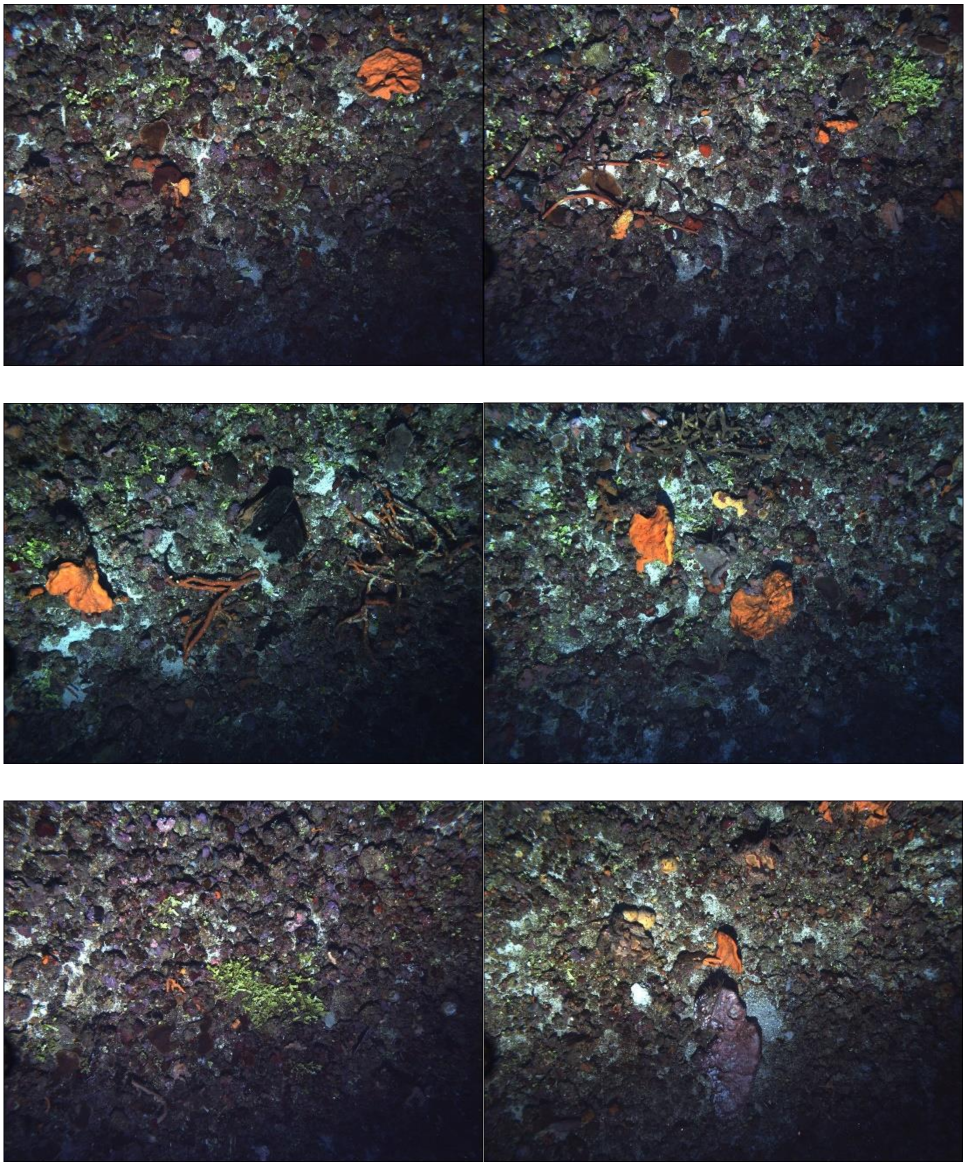












QS Alt – 4 Tourmaline W

Station QS Alt 4 is located at the base of the insular slope west of Tourmaline Reef (Figure 1). The SeaBed AUV dove to a depth of 275 m and travelled north approximately 0.56 km along an essentially flat platform, reaching a maximum depth of 283 m (Figure 5). Temperature and salinity profiles evidenced a well-defined surface mixed layer with thermocline and halocline coincident at 40.0 m (Figure 6). The salinity profile clearly exhibited the Sub-tropical Underwater signature salinity of 37.2 ppt at depths between 100 – 150 m. Temperature near the bottom, or the temperature to which organisms were exposed reached a minimum of 17.3 ^{o}C.

The seafloor along this photo-transect was mostly abiotic, what appeared to be a flat pavement covered by a thick layer of sand (see Photo Album 2). Small scattered rocks and exposed flat hard ground were observed throughout the transect. Most of the benthic organisms observed were concentrated on this consolidated substrate sections, except echinoderms, which were observed over the sandy sediments. Echinoderms, numerically dominated by an unidentified stalked crinoid (46 individuals) (Plate 8) were the invertebrates observed in higher densities with 3.7 Ind/100 m^2 (Table 3). A large black urchin typically inhabiting the sandy substrate was represented by five individuals and a density of 0.4 Ind/100m^2. Soft corals or gorgonians, were present throughout the transect (47 Ind) with a combined density of 3.8 Ind/100m^2. The Devil's Sea Whip, *Ellisella sp. (barbadensis)* was observed growing with vertical projections attached to hard ground substrates. Sponges were represented by at least eight (8) species with a combined density of 1.9 Ind/100 m^2 (Table 3). The glass sponge, *Farrea occa*, presented the highest density. Scleractinian coral were not observed. A hydrocoral that appears to be *Stylaster* sp. was observed growing as small vertically projected colonies over hard ground sections (Plate 9). A total of 47 colonies of the hydrocoral were present with a density of 3.8 colonies/100 m^2 (Table 3).

Three flounders (Paralichthyidae) were observed over sandy bottom (Plate 10) along the transect. Unfortunately, the distance precludes a clear observation of the fish characteristics, but the pigment pattern suggests that it is the "Elongated whiff", *Citharichthys dinoceros*.

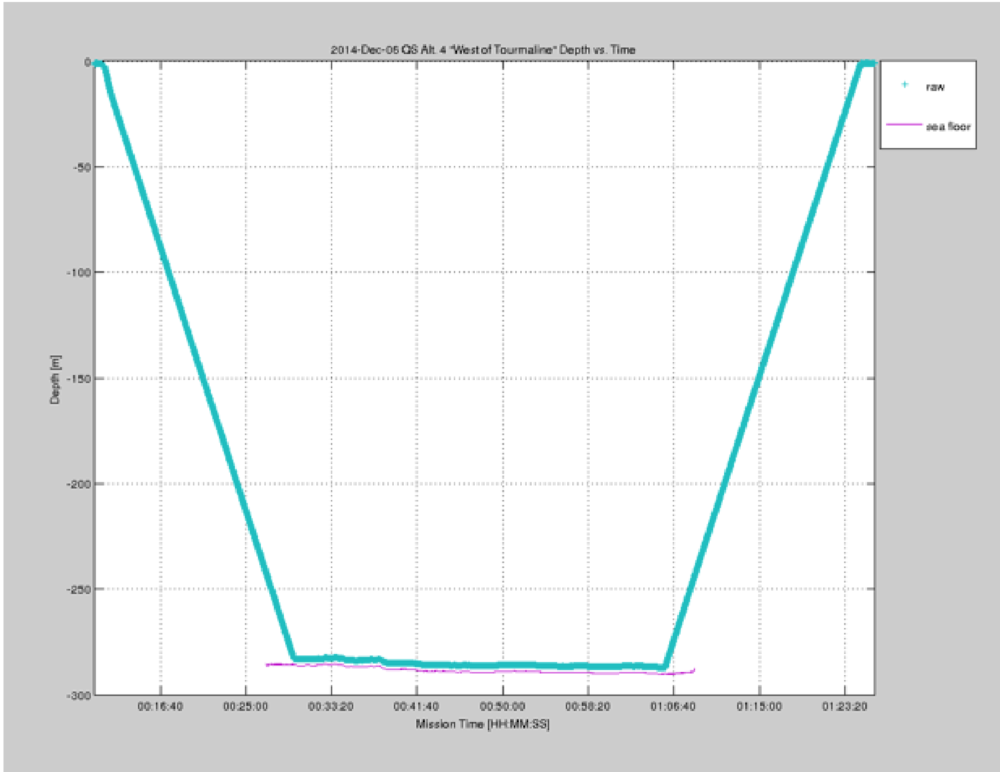


Figure 5. QS Alt 4. Depth profile of the SeaBed AUV dive at Tourmaline W during Dec 2014.

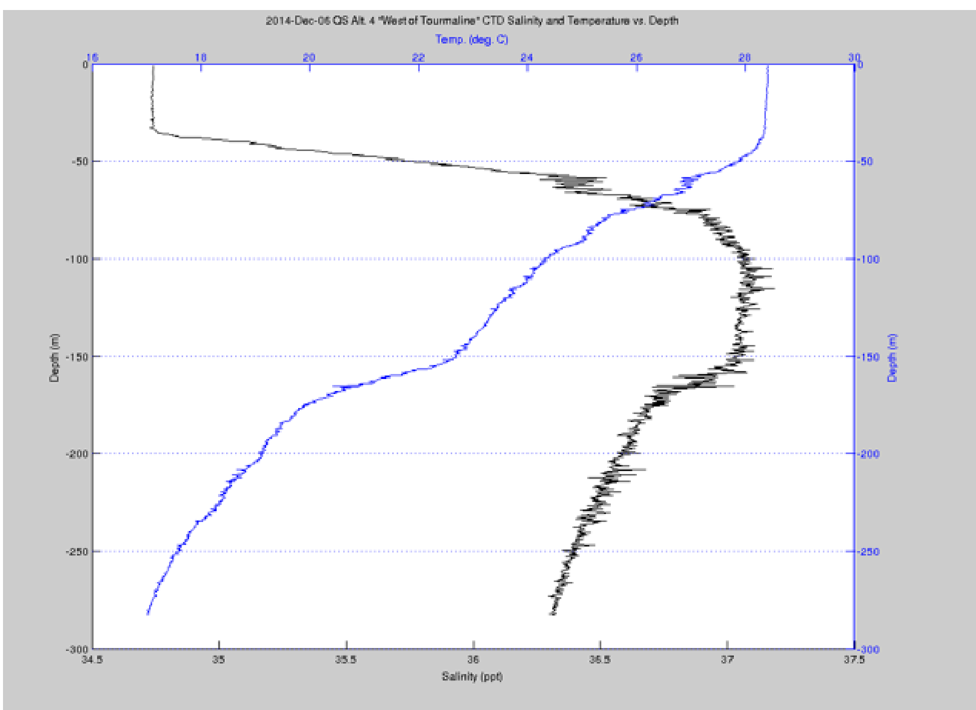


Figure 6. Temperature (^{o}C) and salinity (ppt) profiles produced by the SeaBed AUV – CTD dive at Tourmaline W during Dec 2014.

Table 3. QS Alt 4. Tourmaline W. Taxonomic composition and densities of sessile-benthic biota identified from photos taken by the SeaBed AUV during Dec 2014. Depth range: 275 – 283 m.

Total photos analyzed: 174 **Total Area: 1,249 m^2**

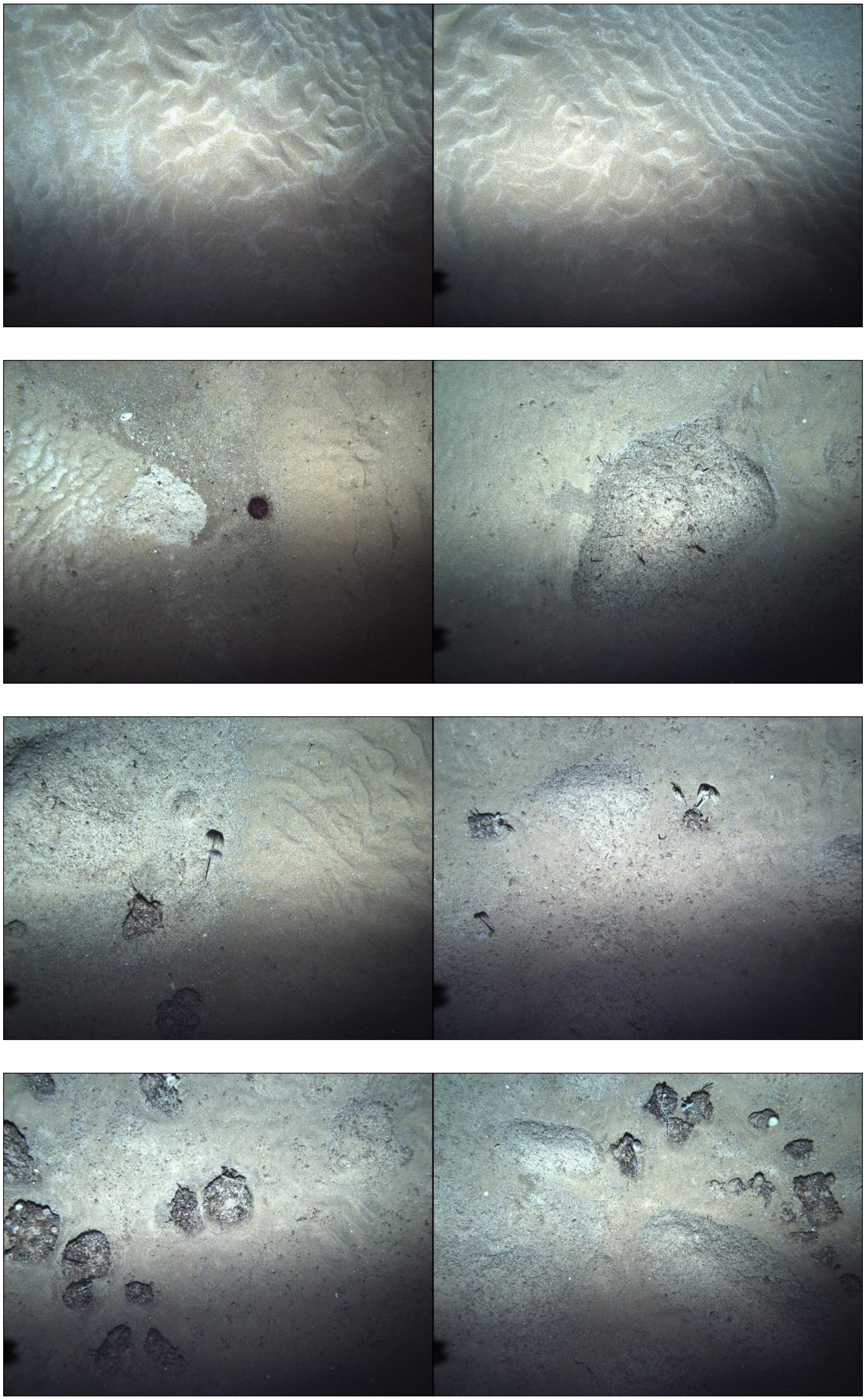
SUBSTRATE CATEGORY	**Total # of Individuals or colonies**	**Density** (# col/100m^2)
Echinoderms		
Stalked crinoid	46	3.68
Black echinoid	5	0.40
Yellow Solasteridae	2	0.16
Crinoid	1	0.08
Cidaroid (echinoid)	1	0.08
White Solasteridae	1	0.08
Goniasteridae	1	0.08
Total Echinoderms	**58**	**4.64**
Soft Corals		
Unknown soft coral	26	2.08
Ellisella sp. (barbadensis)	16	1.28
Iridogorgia?	5	0.40
Orange soft coral	4	0.32
White soft coral	3	0.24
Paramuricea?	3	0.24
Yellow soft coral	1	0.08
Total Soft Corals	**47**	**3.76**
Sponges		
Farrea occa	14	1.12
White barrel sponge	6	0.48
Pink cup	6	0.48
White sponge	5	0.40
Small red cup	4	0.32
Glass sponge	1	0.08
Pointed sponge	1	0.08
Encrusting pink sponge	1	0.08
Total Sponges	**24**	**1.92**
Cnidarians		
Stylaster sp.	47	3.76
White sea anemone	3	0.24
Total Cnidarians	**50**	**4.00**
Total Unidentified	**64**	**5.12**
Fishes		
Citharichthys dinoceros	**3**	**0.24**

Plate 8. Stalked crinoid

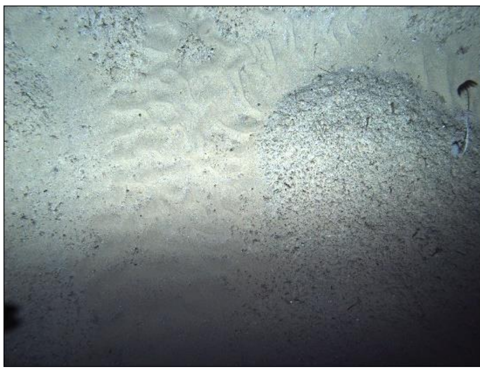
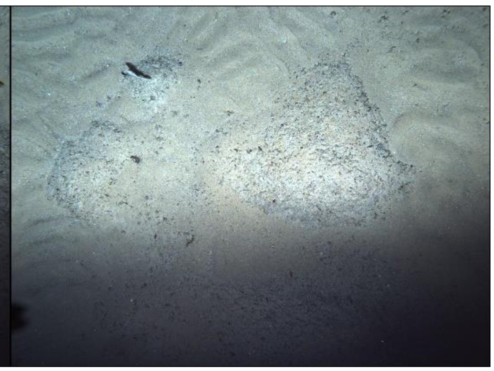
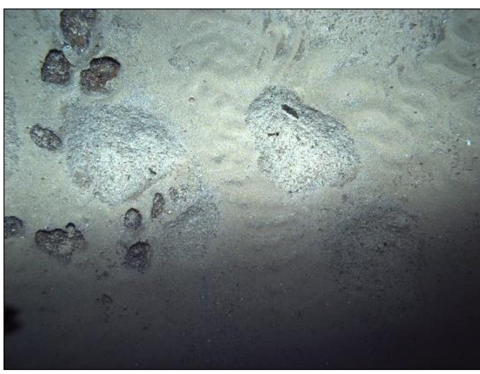
Plate 9. Hydrocorals (*Stylaster* sp)

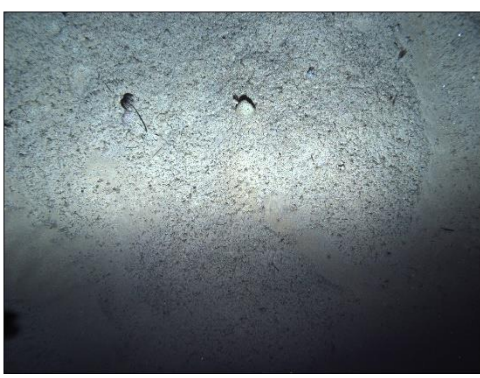
Plate 10. *Citharichthys sp. (dinoceros*) ?

Photo Album 2. QS Alt 4 Tourmaline W








QS Alt 3 Bajo Placeres N

Bajo Placeres is a seamount that rises from a depth of about 300 m to 61 m from the surface approximately 10 kilometers northwest of the Tourmaline Reef shelf-edge in Mona Passage. The AUV dove to a depth of 280 m and travelled north across a relatively flat platform to a maximum depth of 290 m (Figure 7). The temperature and salinity profiles exhibited very strong stratification with a thermocline at 75 m and halocline at 35 m (Figure 8). QS Alt 3 exhibited a shallower halocline with lower salinity within the surface mixed layer and a deeper thermocline than other stations closer to the western shelf. At a depth of 280 m, water temperature at the seafloor was measured as 16.6 ^{o}C.

The benthic habitat at Placeres N was characterized by an essentially flat colonized pavement with interspersed sand plains (see Photo Album 3). The total abiotic substrate, comprised by uncolonized pavement (59.8 %), with sand (20.0 %) represented 79.8 % of the total transect area. Sponges, represented by at least 12 (identified) species were the main sessile-benthic taxa colonizing hard ground at Placeres N with a mean substrate cover of 16.0 % and a density of 112.0 colonies/100 m^2 (Table 4). Unidentified yellow and white encrusting sponges were the main taxa, representing almost 70% of the total colonies present within the transect area. Soft corals had the second highest cover (2.1%) among sessile-benthic assemblage colonizing hard substrate at Placeres N. The Devil's Sea Whip, *Ellisella sp*. (*barbadensis ?*) (Plate 11) was the most abundant with a mean cover of almost 2% and a density of 13.8 colonies/100 m^2 (Table 4). Antipatharians (black corals) were highly abundant over hard ground sections of the transect at Placeres N with a mean substrate cover of 1.1 % and a density of 7.9 colonies/100m^2. The density of antipatharians was probably underestimated due to their small size and vertical projection (Plate 12).

Echinoderms were abundant throughout the transect at Placeres N with a combined density of 3.4 Ind/100m^2 (Table 4). Crinoids were the most abundant with combined densities of 3.1 Ind/100m^2. Cidaroid urchins was also present and highly aggregated (Plate 13). Sea urchins were observed in many photos aggregated on top of sponges, especially one that has been preliminarily identified as *Plaktoris sp*.

One (1) small shark, possibly the Antillean catshark, *Galeus antillensis* was observed lying on the bottom (Plate 14). One (1) unidentified fish was also observed (Plate 15).

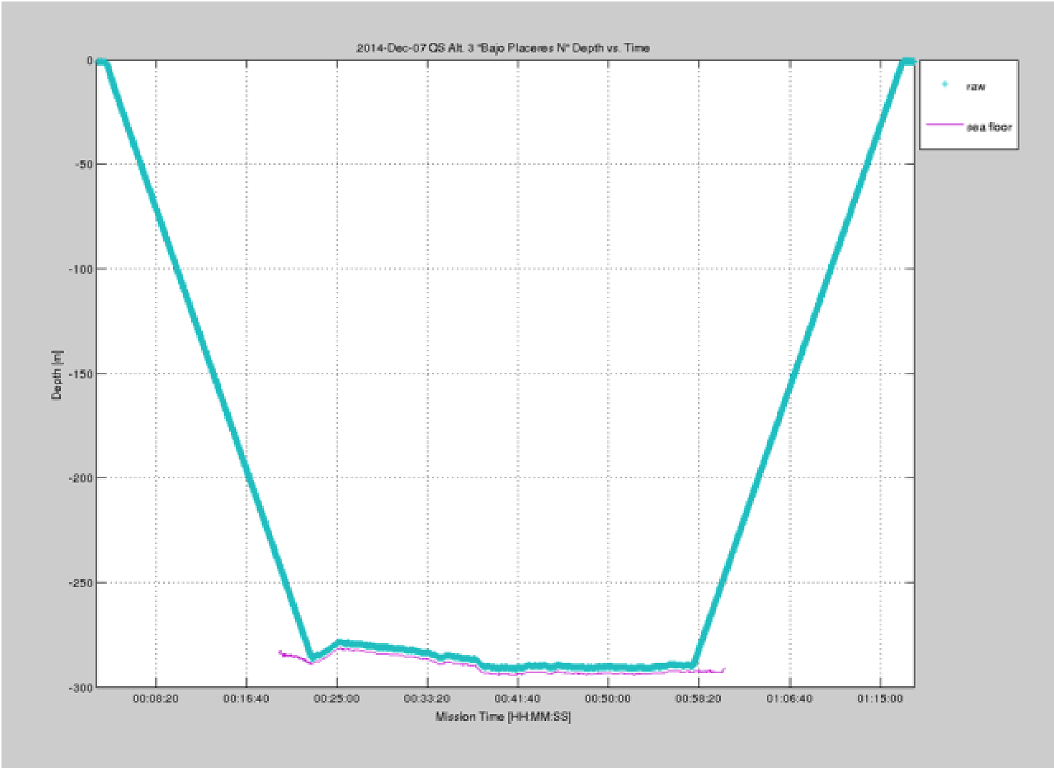


Figure 7. QS Alt 3. Depth profile of the SeaBed AUV dive at Placeres N during Dec 2014.

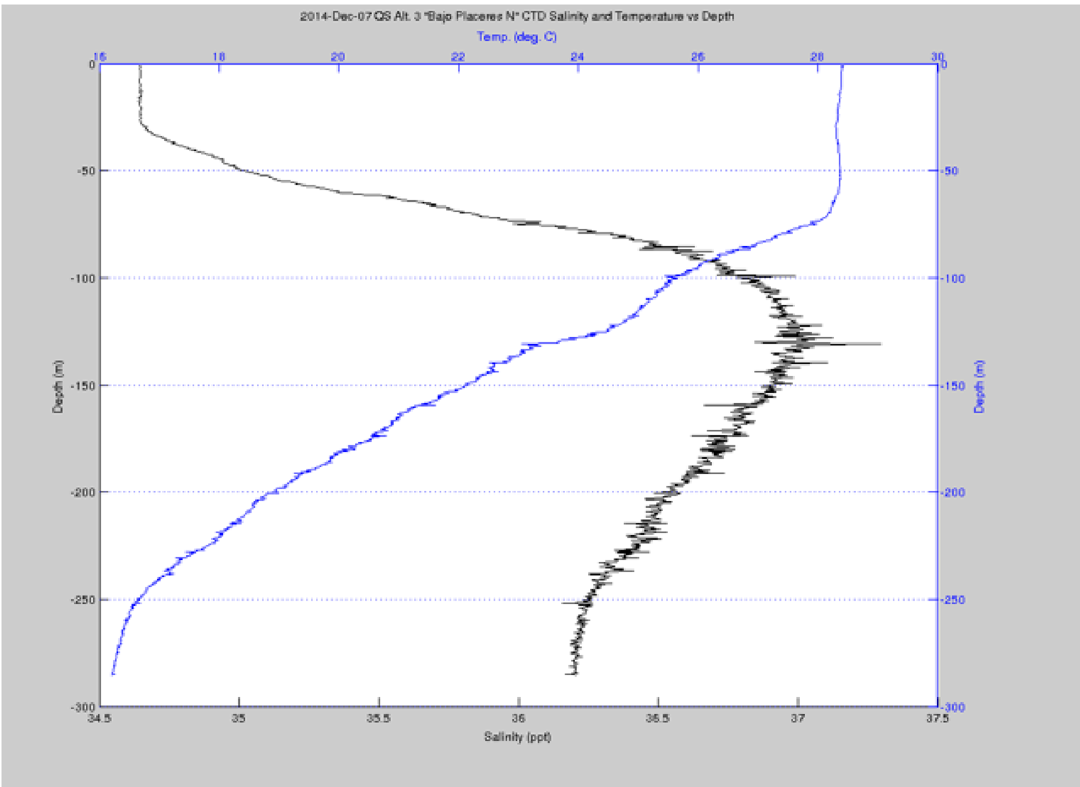


Figure 6. Temperature (^oC) and salinity (su) profiles produced by the SeaBed AUV – CTD dive at Placeres N during Dec 2014.

Table 4. QS Alt 3. Placeres N. Percent cover by substrate categories and densities of predominant biota within the transect area photographed by the SeaBed AUV at Placeres N during Dec 2014. Depth range: 280 – 290 m.

Total photos analyzed: 143 **Total Area: 1,018 m²**

SUBSTRATE CATEGORY		**% Substrate Cover** Mean	**Density** (# col/100m²)
Abiotic			
	Pavement	59.82	
	Sand	19.97	
Total Abiotic		**79.79**	
Echinoderms			
	White crinoids	0.32	2.25
	Stalked crinoid	0.07	0.49
	Crinoid	0.05	0.35
	Cidaroid sea urchin	0.03	0.21
	Goniasteridae	0.02	0.14
Total Echinoderms		**0.49**	**3.44**
Sponges			
	Yellow encrusting sponge	6.69	46.99
	White encrusting sponge	4.38	30.76
	Plaktoris?	3.25	22.83
	Unknown sponge	0.44	3.09
	Geoidia?	0.31	2.18
	Glass sponge	0.25	1.76
	Ball sponge	0.21	1.47
	Brown bulbous sponge	0.17	1.19
	Massive white sponge	0.14	0.98
	Orange encrusting sponge	0.09	0.63
	Pointed sponge	0.01	0.07
Total Sponges		**15.95**	**112.03**
Soft Corals			
	Ellisella sp. (barbadensis)	1.97	13.84
	Unknown soft coral	0.07	0.49
	Orange soft coral	0.04	0.28
	White soft coral	0.02	0.14
Total Soft Corals		**2.11**	**14.82**
Antipatharia		**1.13**	**7.94**
Other Cnidarians			
	Stylaster sp.	0.22	1.55
	Black sea anemone	0.04	0.28
	Renilla reniformis	0.26	1.83
Total Cnidarians		**0.52**	**3.66**

Additional species QS – Alt 3 (Placeres N)

Taxa	Species
Anemone	Black Sea Anemone
Echinoderm	Stalked feather star
Echinoderm	Crinoid
Echinoderm	Unknown echinoderm
Echinoderm	Cidaroid sea urchin
Echinoderm	Goniasteridae
Echinoderm	Light orange Solasteridae
Echinoderm	Orange Solasteridae
Echinoderm	White feather star
Echinoderm	White Solasteridae
Soft coral	Unknown soft coral
Soft coral	Orange soft coral
Soft coral	*Ellisella* sp.
Soft coral	White soft coral
Sponge	Ball sponge
Sponge	Blue encrusting sponge
Sponge	*Geoidia*?
Sponge	*Plaktoris*?
Sponge	Massive white sponge
Sponge	Orange encrusting sponge
Sponge	Unknown sponge
Sponge	Brown bulbous sponge
Sponge	Nipple sponge
Sponge	Glass sponge
Sponge	White encrusting sponge
Sponge	Yellow encrusting sponge
Coral	*Stylaster* sp.
Antipatharia	Black coral sp.

Fishes

Antillean Catfish	*Galeus antillensis*
	Unidentified red fish

Plate 11 Devil's Sea Whip, *Ellisella sp*. (*barbadensis* ?)

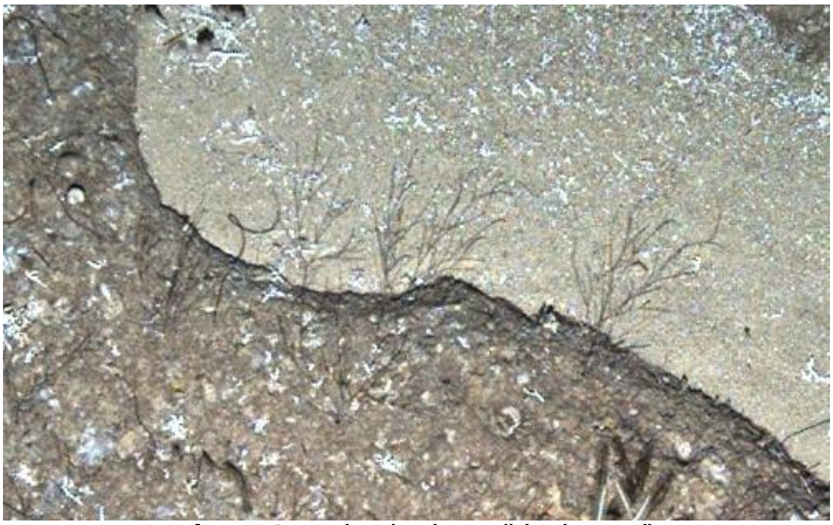


Plate 12. Antipatharians (black coral)

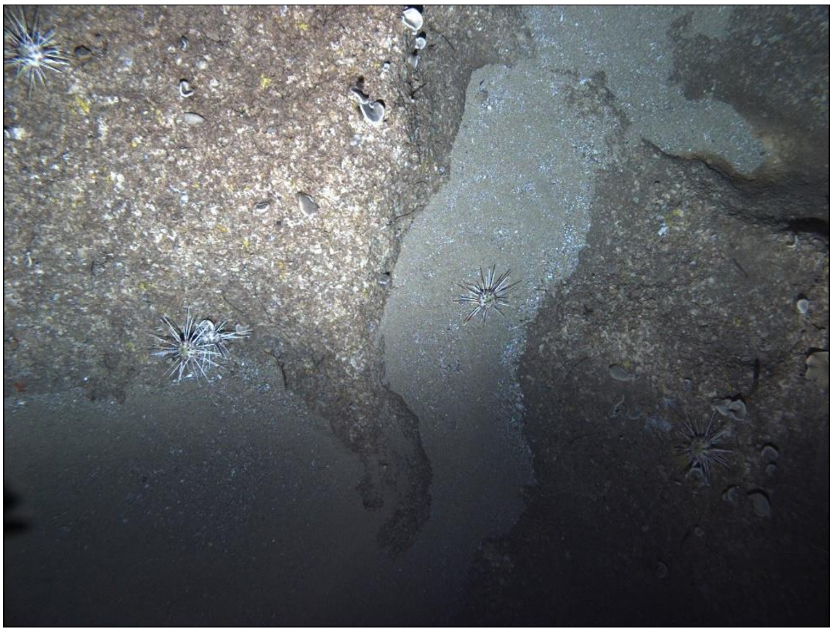
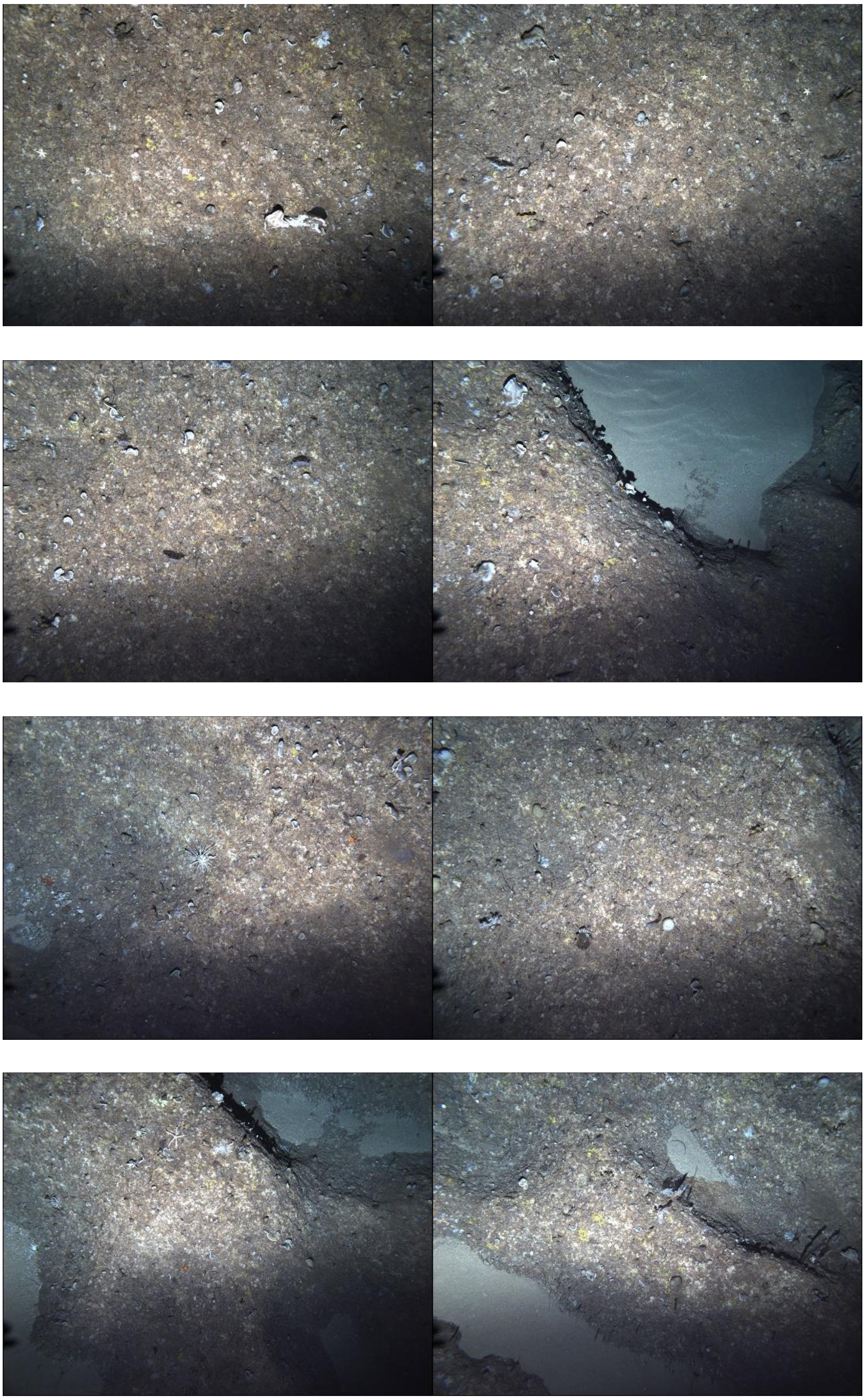


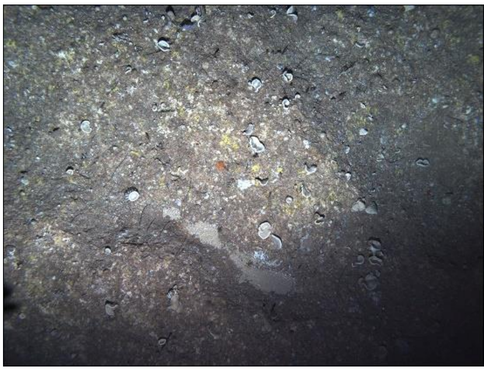
Plate 13. Cidaroid Sea Urchins

Plate 14. Antillean Catfish (*Galeus antillensis)*?

Plate 15. Unidentified fish and sponges

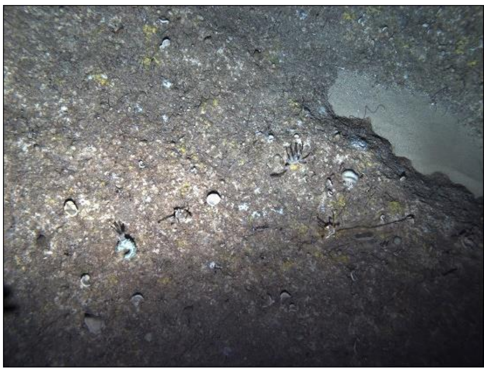
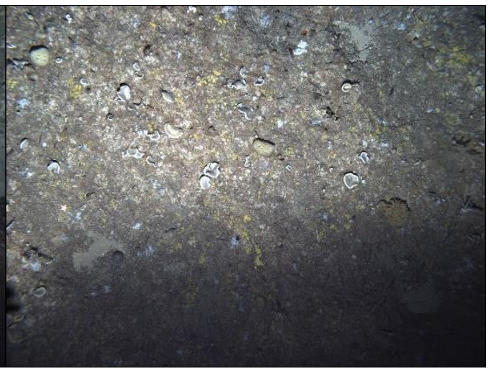
Photo Album 3. QS Alt 3 (Placeres N)

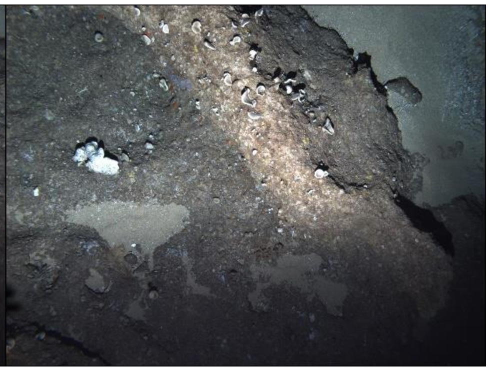
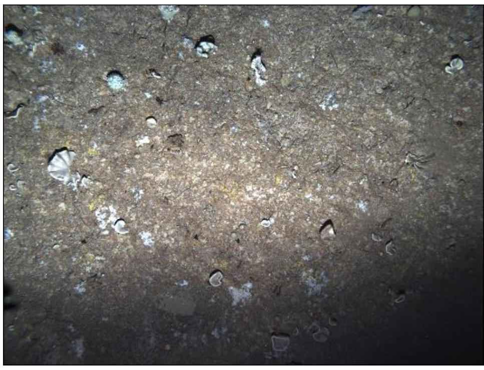


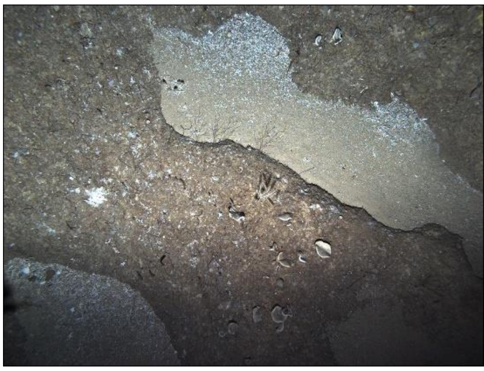









QS – 2 Isla Desecheo S

The SeaBed AUV dove down the insular slope off the south coast of Isla Desecheo on February 10, 2015 reaching bottom at 339 m and travelled approximately 0.48 km up the slope to a depth of 270 m (Figure 9). Temperature and salinity profiles evidenced strong stratification of the water column with a thermocline close to 60 m and a very sharp halocline at 40 m (Figure 10). Both warmer temperature and higher salinity separate the surface mixed layer from a more dense water mass known as the Sub-tropical Underwater (STU). The salinity profile clearly exhibited the STU signature salinity of 37.2 ppt at depths between 120 – 160 m. At the bottom the temperature (to which organisms were exposed) reached a minimum of 15.8 ^{o}C.

The seafloor along the transect up the Isla Desecheo insular slope appeared to be mostly of hard ground overlaid with a thin layer of sand. Topographic relief was relatively flat with small interspersed low relief rock outcrops. Sand plains with ripples were observed in some sections of the transect as well. The available consolidated substrate was lightly colonized. Sponges, with at least 14 species present and a total of 659 individuals (combined total density: 0.4 Ind/100 m^2) were the most abundant taxa colonizing the hard substrate (Table 5). Glass sponges, particularly *Farrea occa* (71% of total) were the numerically dominant among the sponge assemblage (Plate 16). Encrusting sponges were also common within the transect, representing 8% of the total abundance. Scleractinian corals and gorgonians were present in relatively low species richness and densities (Table 5). The Devil's whip, *Ellisella* (*barbadensis*?) was the most abundant with a total of 12 colonies present within the transect (0.008 Ind/100 m^2).

Echinoderms included both sessile (crinoids, stalked stars) and motile megabenthic (urchins, brittle stars) components, for a combined density of 0.07 Ind/100 m^2 (Table 5). At least eight species of echinoderms were present in the transect. Stalked feather stars were the most abundant (Plate 17), followed by crinoids and orange brittle star (Plate 18). An unidentified branching organism was abundant throughout the transect (0.056 Ind/100 m^2).

A total of 22 fish (unidentified) were observed along the Isla Desecheo insular slope (Plates 19 – 21).

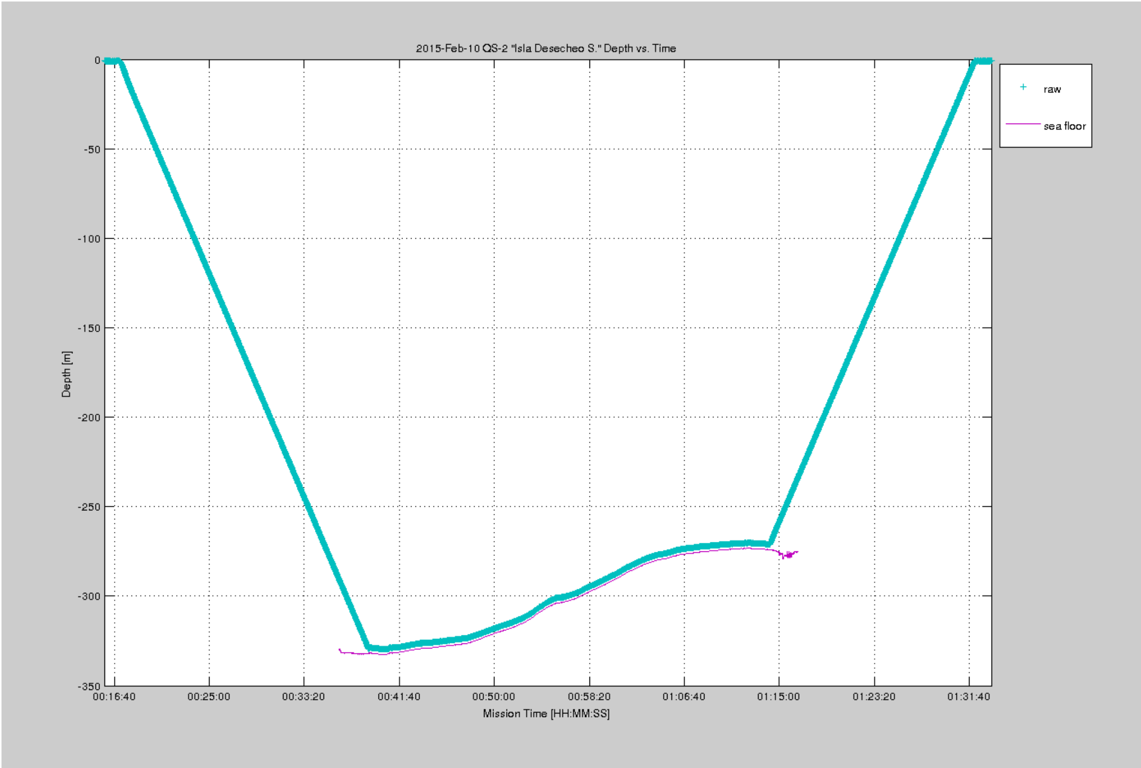


Figure 9. QS 2. Depth profile of the SeaBed AUV dive at Isla Desecheo N during February 2015.

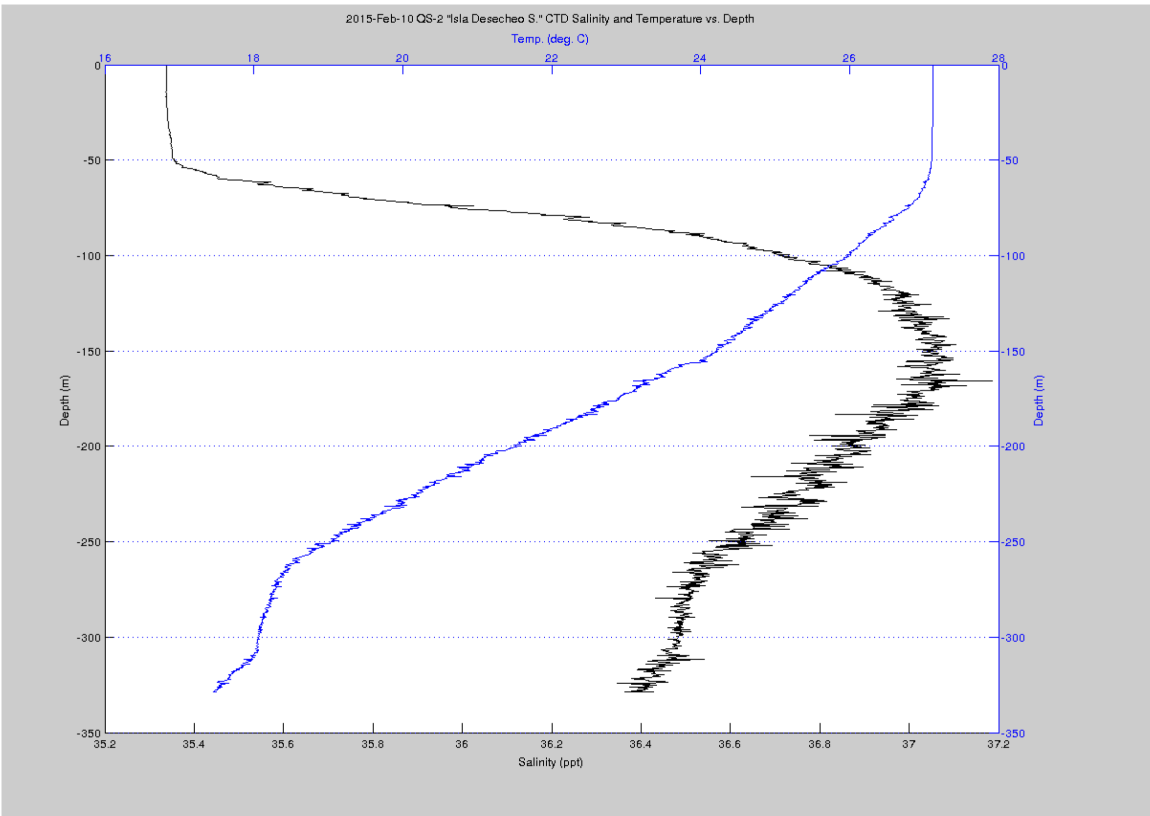


Figure 10. Temperature (^{o}C) and salinity (su) profiles produced by the SeaBed AUV – CTD dive at Isla Desecheo N during February 2015

Table 5. QS - 2. Isla Desecheo S. Taxonomic composition and densities of sessile-benthic biota identified from photos taken by the SeaBed AUV during Feb 2015. Depth range: 270 – 339 m.

Total photos analyzed: 224 **Total Area: 1,594.9 m²**

SUBSTRATE CATEGORY	**Total # Individuals or colonies**	**Density (# col/100m²)**
Echinoderms		
Stalked sea feather	41	2.6
Crinoid	34	2.1
Orange brittle star	17	1.1
Cidaroid sea urchin	10	0.6
Black anemone	6	0.4
Sea pen	2	0.1
Orange Solasteridae	1	0.1
Echinus sea urchin?	1	0.1
White anemone	1	0.1
Total Echinoderm	**113**	**7.1**
Crustaceans	**2**	**0.1**
Gastropods	**5**	**0.3**
Polychaete		
Tube worm	3	0.2
Orange bristle worm	1	0.1
Total Polychaetes	**4**	**0.3**
Sponge		
Farrea occa	467	29.3
Glass sponge	53	3.3
Orange encrusting sponge	42	2.6
Small white sponge	26	1.6
Cup sponge	17	1.1
Orange ball sponge	11	0.7
Red encrusting sponge	9	0.6
Petrosia?	8	0.5
Thorny white sponge	8	0.5
Geodia?	7	0.4
Brown branching sponge	6	0.4
Yellow encrusting sponge	3	0.2
Ball sponge	1	0.1
Tall glass vase sponges	1	0.1
Total Sponges	**659**	**41.3**
Corals		
Yellow coral	7	0.4
Small white coral	5	0.3
Orange small coral	3	0.2

Madrepora oculata?	1	0.1
Total coral	**16**	**1.0**
Soft coral		
Unknown soft coral	13	0.8
Whip corals	12	0.8
Paramuricea?	1	0.1
Total Soft Coral	**26**	**1.6**
Other Cnidarians		
Stylaster sp.	10	0.6
Renilla reniformis	3	0.2
Total Cnidarians	13	**0.8**
Antipatharians	**2**	**0.1**
Unknown branching organism	**89**	**5.6**
Other unknown	**18**	**1.1**

Plate 16. Glass sponge, *Farrea occa*

Plate 17. Stalked feather star

Plate 18. Orange brittle star **(***Ophiuoridea***)**

Plate 19

Plate 20

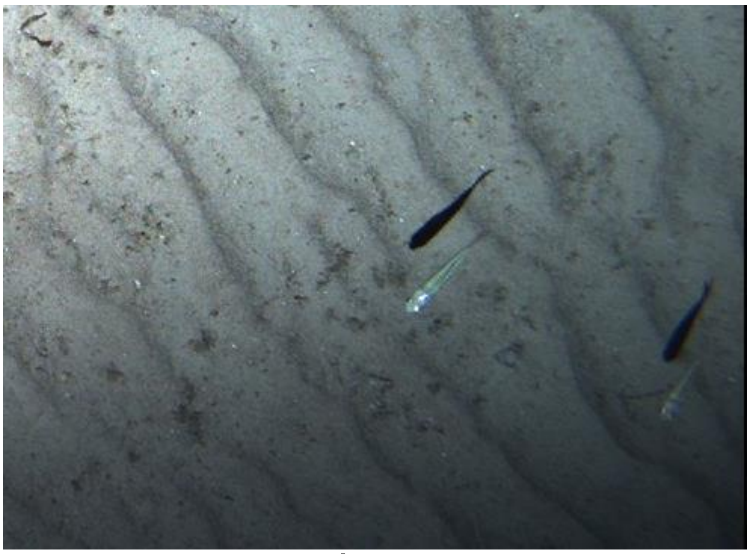
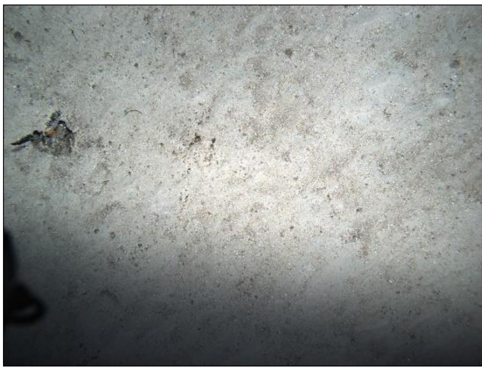
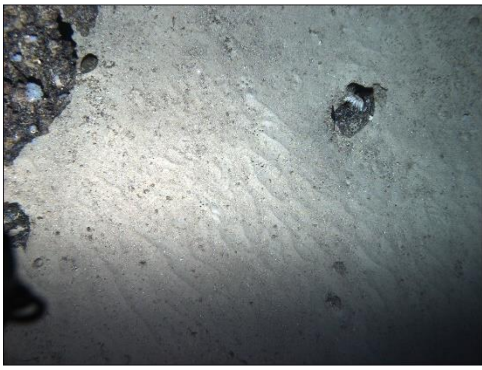
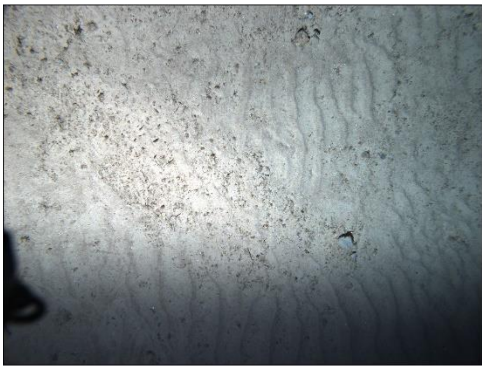


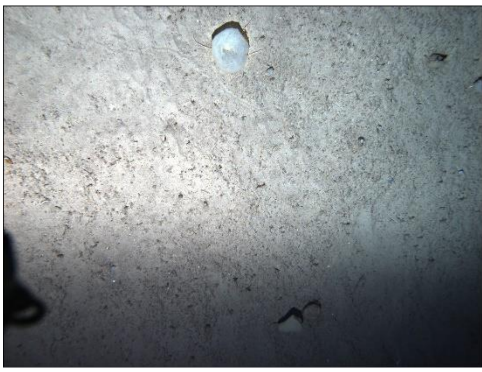
Plate 21

Photo Album 4 (Isla Desecheo S)

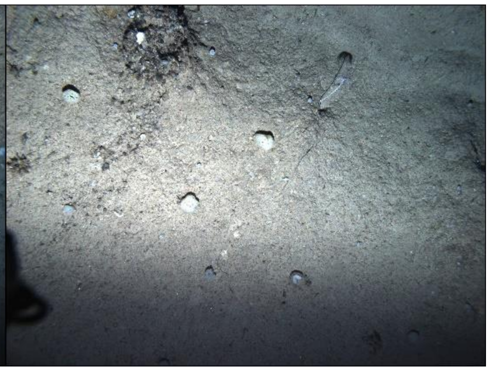




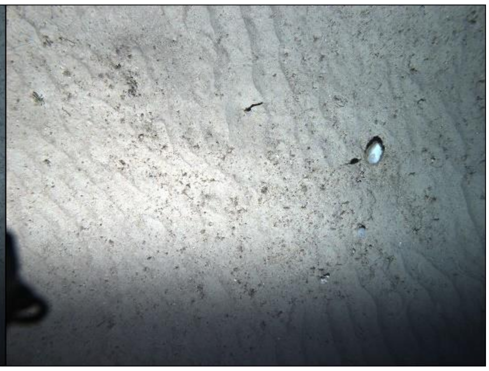
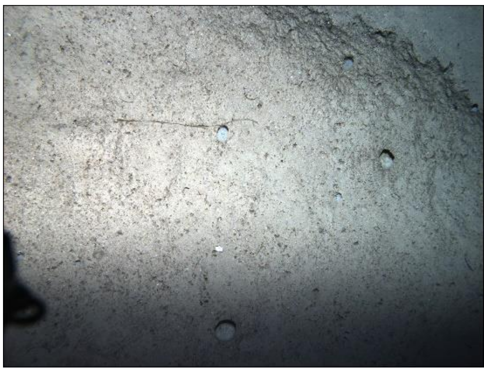








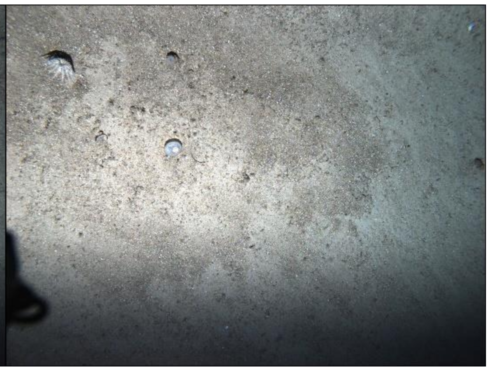


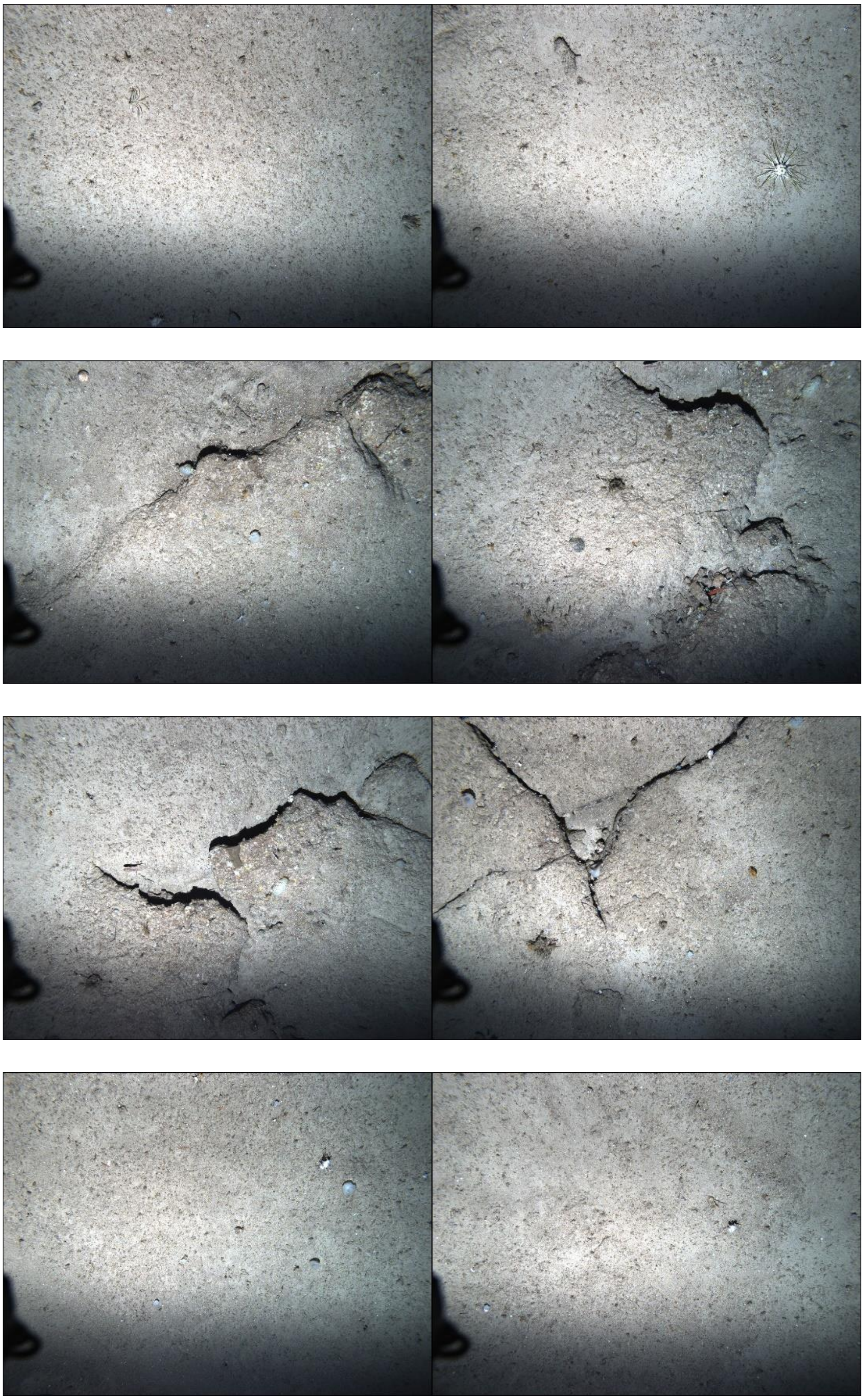













QS - 5 Bajo Placeres West (South to North)

On February 11, 2015 the SeaBed AUV dove down to a platform of moderate relief located to the west off Bajo Placeres in Mona Passage (Figure 1). The AUV reached a transect survey depth (3 m from the seafloor) of 270 m and travelled north, a distance of approximately 0.24 km when a mechanical malfunction was detected and the dive was aborted. Nevertheless, a short transect with 28 photos of the seafloor was achieved. The dive profile encompassed depth between 270 – 280 m (Figure 11). The temperature and salinity profiles at station QS – 5 evidenced strong stratification with a thermocline at 80 m and a sharp halocline at 38 m (Figure 12). The rapid increment of salinity with depth is indicative of the presence of the Sub-tropical underwater, a more dense water mass that lies below the surface mixed layer. Water temperature at the bottom was 17.1 ^{o}C.

Rock outcrops of variable dimensions and topographic relief emerging from an otherwise sandy bottom were the main seafloor features at QS – 5 (S – N). Sand comprised 49% of the total transect area. Consolidated substrate was heavily colonized by reef biota (see Photo Album 5). Sponges were the most abundant and diverse sessile-benthic taxa colonizing hard substrates at QS 5 (S – N) with at least 17 species present and a combined reef substrate cover of 6% (Table 6). The sponge assemblage was characterized by both massive (Plate 22) and encrusting species, with a white massive sponge having the highest cover (2.6 %), followed by a white encrusting sponge (1.2 %). The combined density of sponges was 42.1 colonies/100 m^2 (Table 6).

Live scleractinian aposymbiotic coral presented a combined substrate cover of 5.5 %, which implies a cover of almost 11% over available hard substrate, since 49% of the substrate at this transect was unconsolidated (sand). There were large colonies of possibly *Enallopsammia profunda* (Plate 23) with a mean cover of 2.2 %. Other corals within the transect area appear to be *Lophelia* sp., *Oculina* sp., and *Madrepora oculata*. Both *Lophelia* (*pertusa*) and *Oculina* sp. are known to be aposymbiotic reef builders in cold water aphotic environments. Antipatharians (or black corals) were highly abundant, with 2.3 % substrate cover and 16. 4 colonies/100m^2 (Table 6). The black coral assemblage was numerically dominated by what appears to be colonies of *Bathypathes* sp. (Plate 24). Hydrocorals (*Stylaster* sp.) and soft corals (*Paramuricea* sp.?) (Plate 25) contributed an additional 0.5 %, for a total live coral cover of 8.3 %, equivalent to 16% of the consolidated substrate.

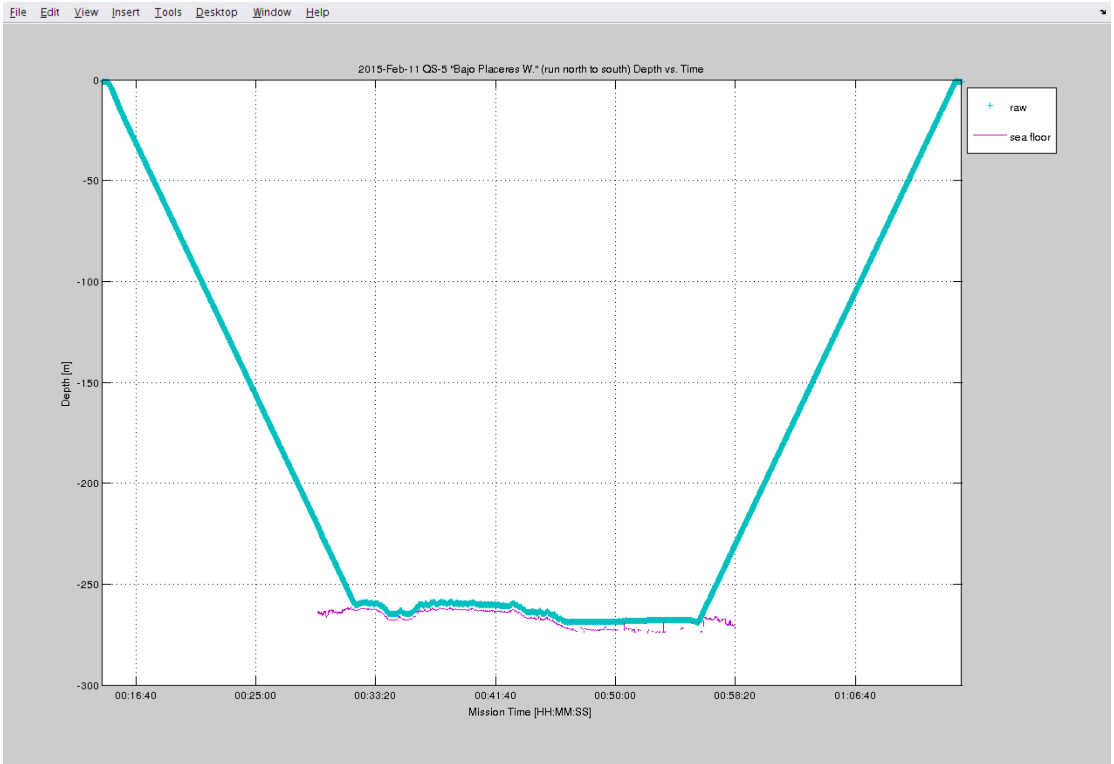


Figure 11. QS 5. Depth profile of the SeaBed AUV dive at Bajo Placeres W (S – N) during February 2015

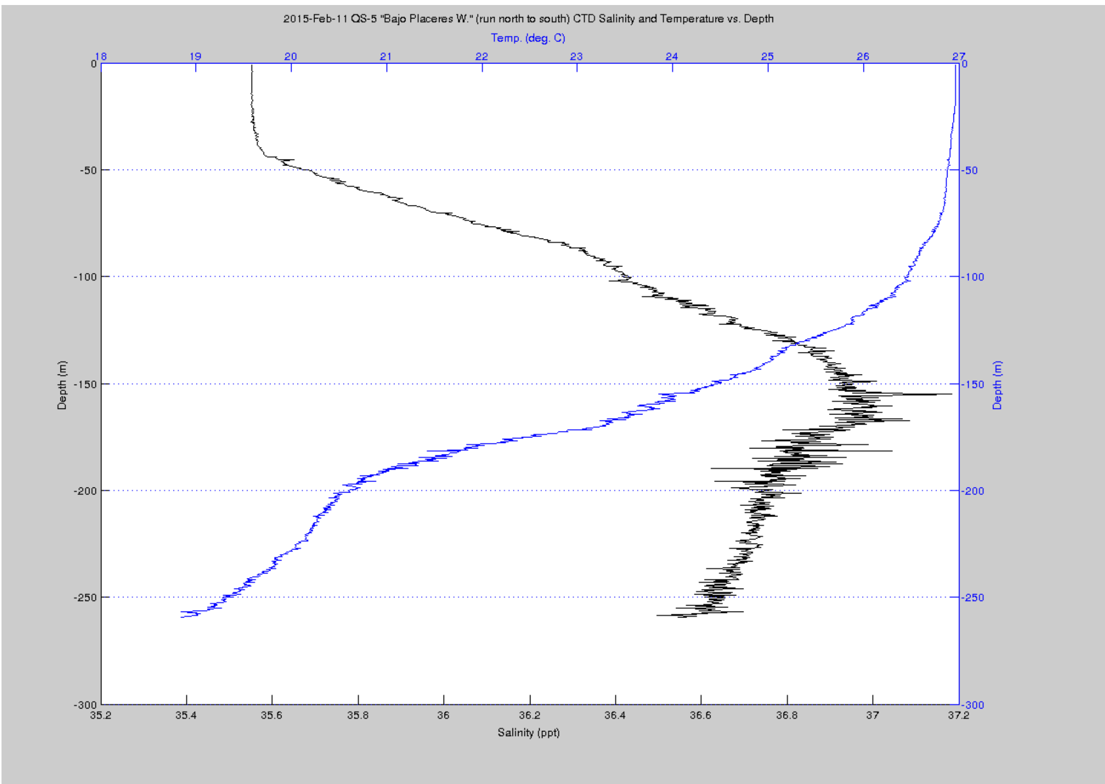


Figure 12. Temperature (°C) and salinity (su) profiles produced by the SeaBed AUV – CTD dive at Bajo Placeres W (S – N) during February 2015

Table 6. QS – 5 (S – N). Placeres W. Percent cover by substrate categories and densities of predominant biota within the transect area photographed by the SeaBed AUV at Bajo Placeres W during Feb 2015. Depth range: 270 – 280 m.

Total photos analyzed: 28 **Total Area: 199.4 m^2**

SUBSTRATE CATEGORY	**% Substrate Cover** **Mean**	**Density** (# col/100m^2)
Abiotic		
Sand	49.16	
Pavement	32.89	
Total Abiotic	**82.05**	
Echinoderms		
Unknown	0.7	4.91
Goniasteridae	0.09	0.63
Total Echinoderms	**0.79**	**5.55**
Sponge		
Massive white sponge	2.63	18.47
White encrusting sponge	1.17	8.21
Unknown sponge	0.84	5.90
Geoidia?	0.63	4.42
Brown massive sponge	0.33	2.32
Yellow encrusting sponge	0.17	1.19
Ball sponge	0.15	1.05
Hexactinellida	0.08	0.56
Total Sponge	**6.0**	**42.13**
Coral		
Enallopsammia profunda?	2.23	15.66
White polyps	1.28	8.99
Lophelia or *Oculina*?	1.21	8.50
Unknown coral	0.38	2.67
Madrepora oculata?	0.37	2.60
Total Coral	**5.47**	**38.41**
Dead Coral	**2.85**	**20.01**
Soft Coral		
Paramuricea?	**0.15**	**1.05**
Other Cnidarians		
Stylaster sp.	**0.37**	**2.60**
Antipatharia		
Bathypathes sp.	2.26	15.87
Unknown	0.07	0.49
Total Antipatharia	**2.33**	**16.36**

Additional species identified along transect QS - 5 (S - N)

Category	Species
Coral	Bamboo coral
Coral	Unknown
Coral	*Enallopsammia profunda*
Coral	*Lophelia* or *Oculina*
Coral	*Madrepora oculata*?
Coral	*Solenosmilia variabilis*
Coral	White polyps
Cnidarian	*Stylaster* sp.
Soft Coral	*Paramuricea?*
Soft Coral	Whip coral
Soft Coral	Unknown
Sponge	Ball sponge
Sponge	Blue encrusting sponge
Sponge	Brown cup sponge
Sponge	Brown massive sponge
Sponge	*Farrea occa*
Sponge	Massive white sponge
Sponge	Orange encrusting sponge
Sponge	*Petrosia*?
Sponge	Unknown
Sponge	Thorny white sponge
Sponge	Hexactinellida
Sponge	Vase Hexactinellida
Sponge	White encrusting sponge
Sponge	Yellow encrusting sponge
Sponge	Yellow massive sponge
Sponge	Brown branching sponge
Sponge	Brown bulbous sponge
Antipatharians	*Bathypathes* sp.
Antipatharians	Unknown
Echinoderm	Black echinoid
Echinoderm	Crinoid
Echinoderm	Orange Solasteridae
Echinoderm	Unknown
Echinoderm	Stalked crinoid
Echinoderm	Cidaroid (echinoid)
Echinoderm	*Echinus* sp.
Echinoderm	Solasteridae
Echinoderm	Orange Ophiuroid
Echinoderm	Holothuroid

The high percent of substrate cover by live corals of different species and growth shapes contributed significantly to the benthic habitat complexity and reef topographic relief along with its implications for microhabitat availability and ecosystem biodiversity, consistent with the classification of this benthic habitat as a coral reef.

Echinoderms were represented by at least 10 species identified within the transect at QS – 5 with a combined 5.6 Ind/100 m^2 (Table 6). The assemblage included crinoids, echinoids (sea urchins), ophiuroids (brittle stars) and holothuroids (sea cucumber). No fishes were observed.

Plate 22. *Geodia* sp.?

Plate 23. *Enallopsammia profunda*

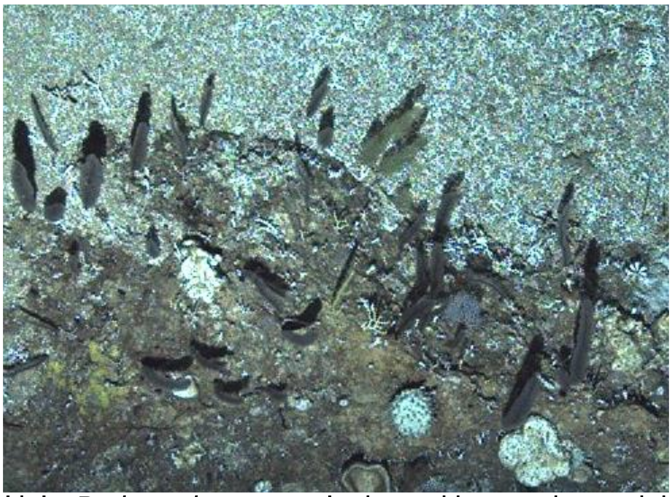


Plate 24. Multiple *Bathypathes* sp. colonies, with massive and thorny sponge

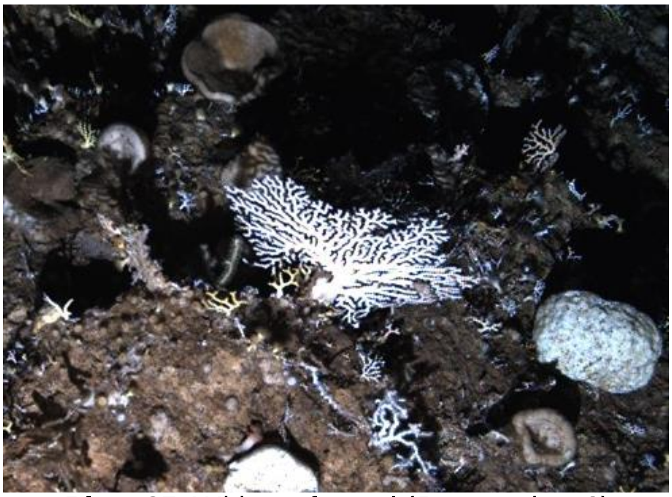
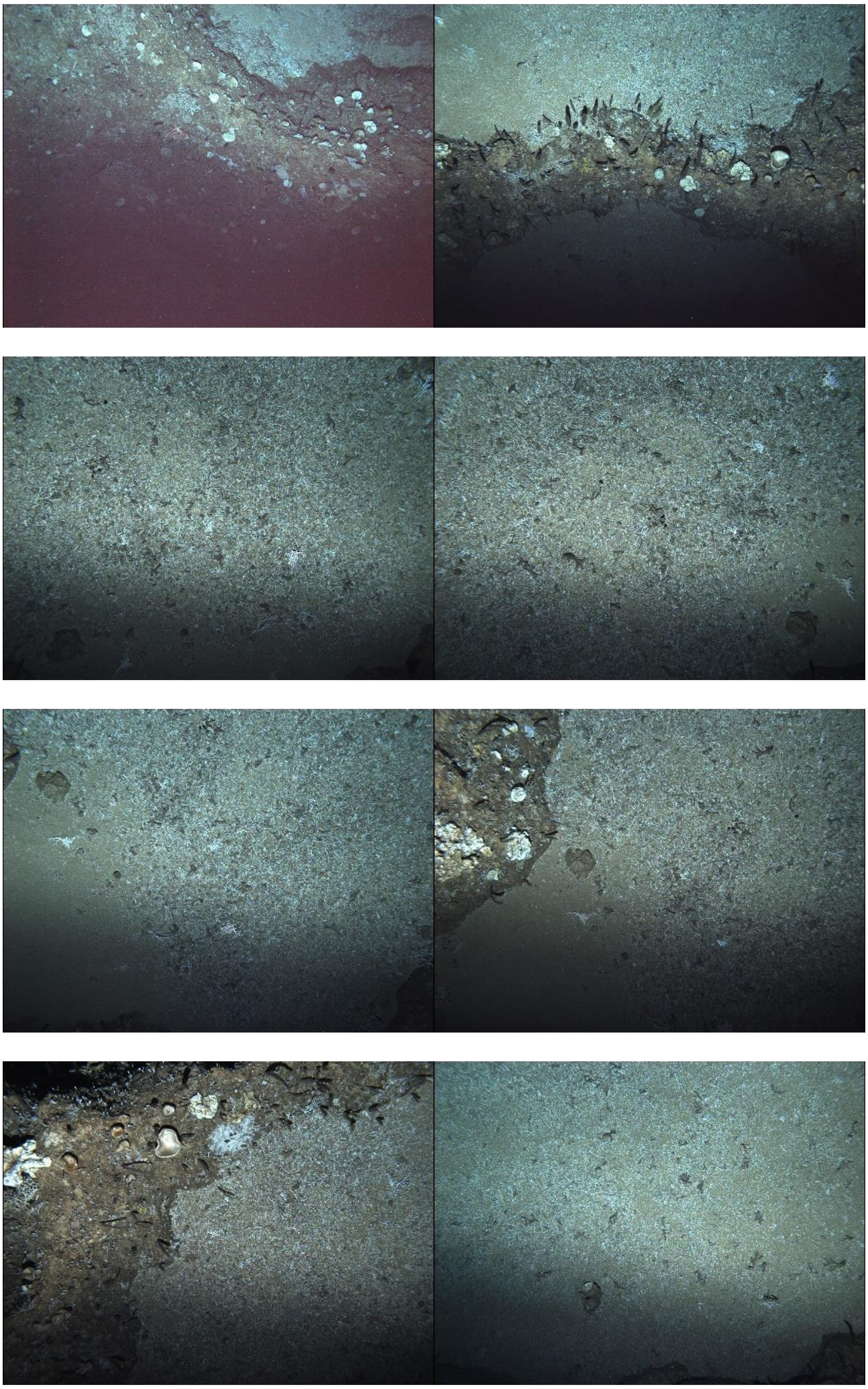
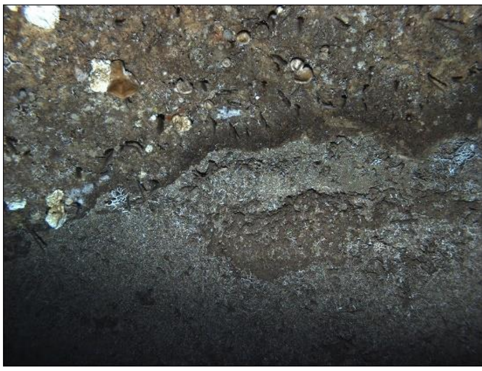
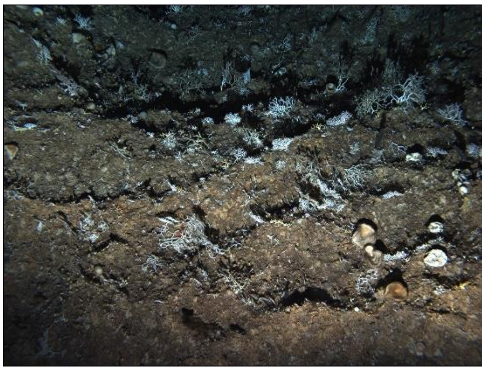


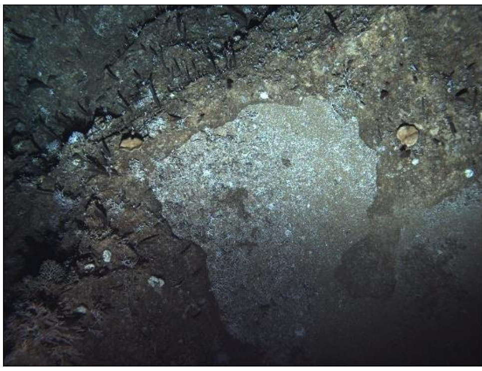
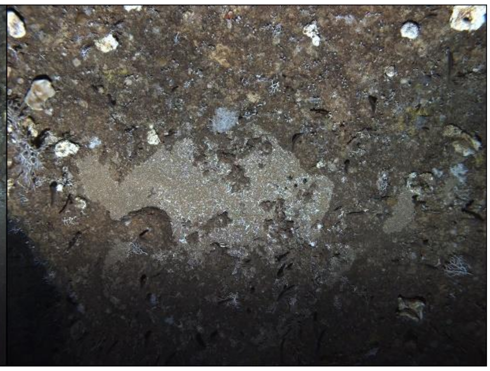
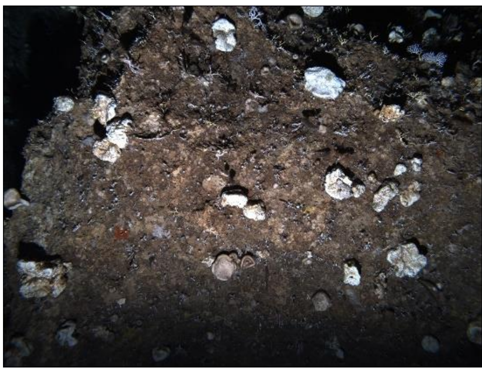
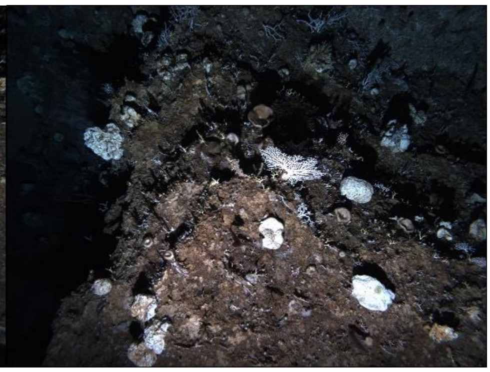
Plate 25. White soft coral (*Paramuricea?)*

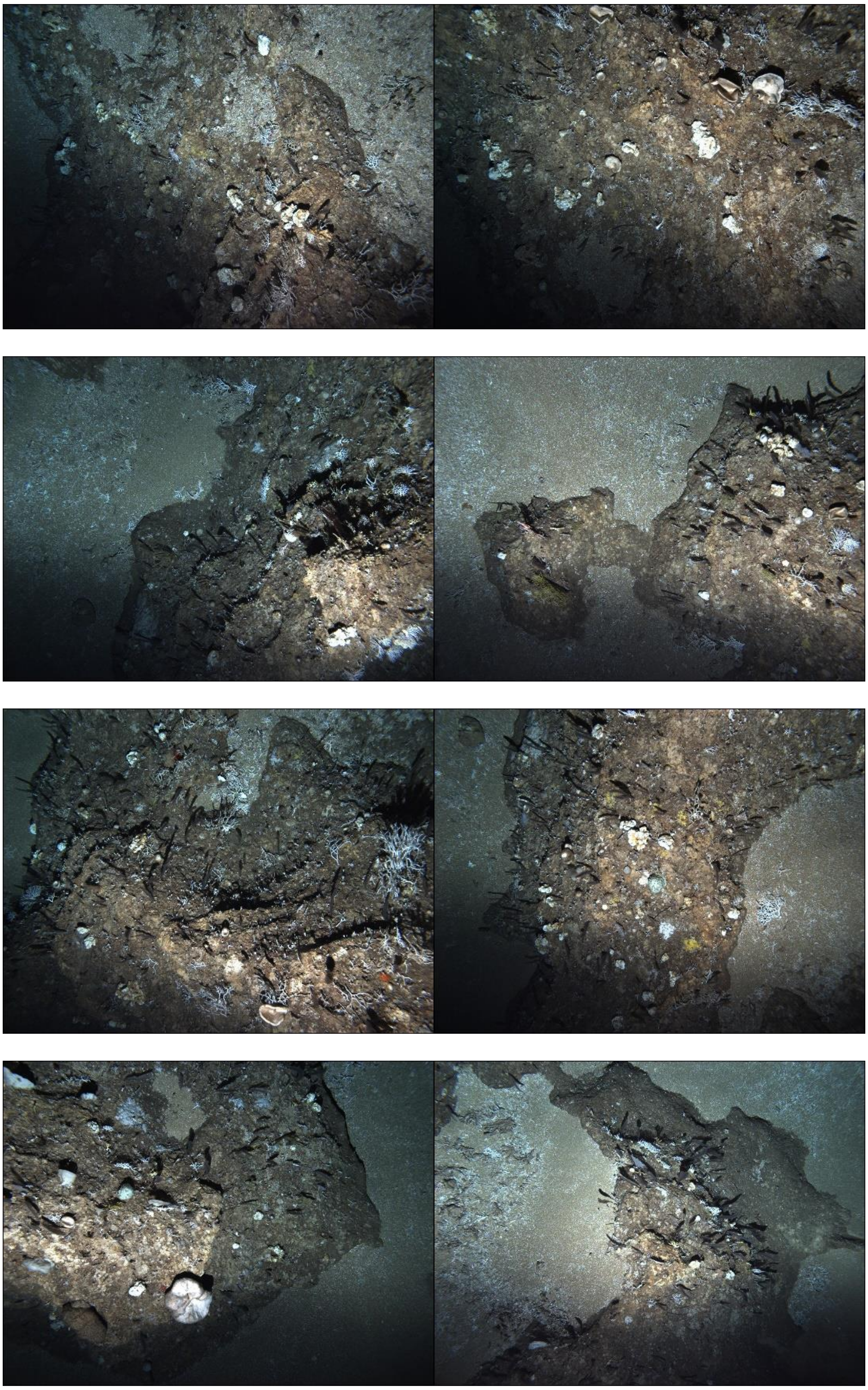
Photo Album 6. QS – 5 Bajo Placeres W (S – N)









QS - 5 Bajo Placeres West (North to South)

Bajo Placeres West was sampled by two replicate transects on February 11, 2015 since the SeaBed AUV confronted technical problems while running the initial transect at this station. The AUV dove to a depth of 265 m and travelled south approximately 0.78 km to a maximum depth of 280 m (Figure 13). During its southerly run the AUV entered a zone of very high relief and got trapped in the bottom which forced the abortion of the dive and was surfaced. A total of 93 photos of the seafloor were acquired and analyzed. Temperature and salinity profiles are presented in Figure 14. The data mirrors the one previously described for station QS – 5 (S – N). Water temperature at 260 m was measured as 18.6 ^{o}C, 1.5 ^{o}C degrees higher than at 270 m, resulting from the abrupt thermocline within this depth range.

The seafloor at QS – 5 was surveyed in the general vicinity of the previous transect, but in an N – S direction. The photo-transect revealed substrate discontinuity features associated with rock outcrops emerging from an otherwise sandy bottom as in the previous transect, but encountered much more hard ground (86.9 %) and less sand (13.1 %). Topographic relief was much higher because the height of the substrate discontinuities appeared to be greater producing a highly irregular topography with vertical walls, ledges, gaps and crevices (see Photo Album 7).

The benthic habitat exhibited a similar taxonomic structure of the previously described transect within this locality, but the percent coral cover was more than duplicated (11.5 %), and the density of coral colonies almost doubled as well (Table 7), consistent with the higher proportion of consolidated substrate and availability of appropriate coral attachment surface area. The numerically dominant coral taxa could not be identified from the photographs due to the relatively small size of the colonies and long camera to object distance. Small white colonies, which could be either *Lophelia* or *Oculina* species (Plates 26 - 27), and colonies of what may be *Enallopsammia profunda* were abundant throughout the reef. Black corals (Antipatharia), represented by at least five species (Plate 28) were also a major component of the reef benthic community in hard ground substrates with a (underestimated) substrate cover of 3.4 % and a density of 23.5 colonies/100 m^2 (Table 7). Hydrocorals (mostly *Stylaster* sp) and soft corals contributed an additional 0.6 % for a total reef substrate cover by live corals of 15.5 %. Areas of dead coral skeletons were prominent with a mean cover of 14.5 %. Sponges were represented by at least 11 species, with a reef substrate cover of 5.8 % and 40.4 Ind/100 m^2.

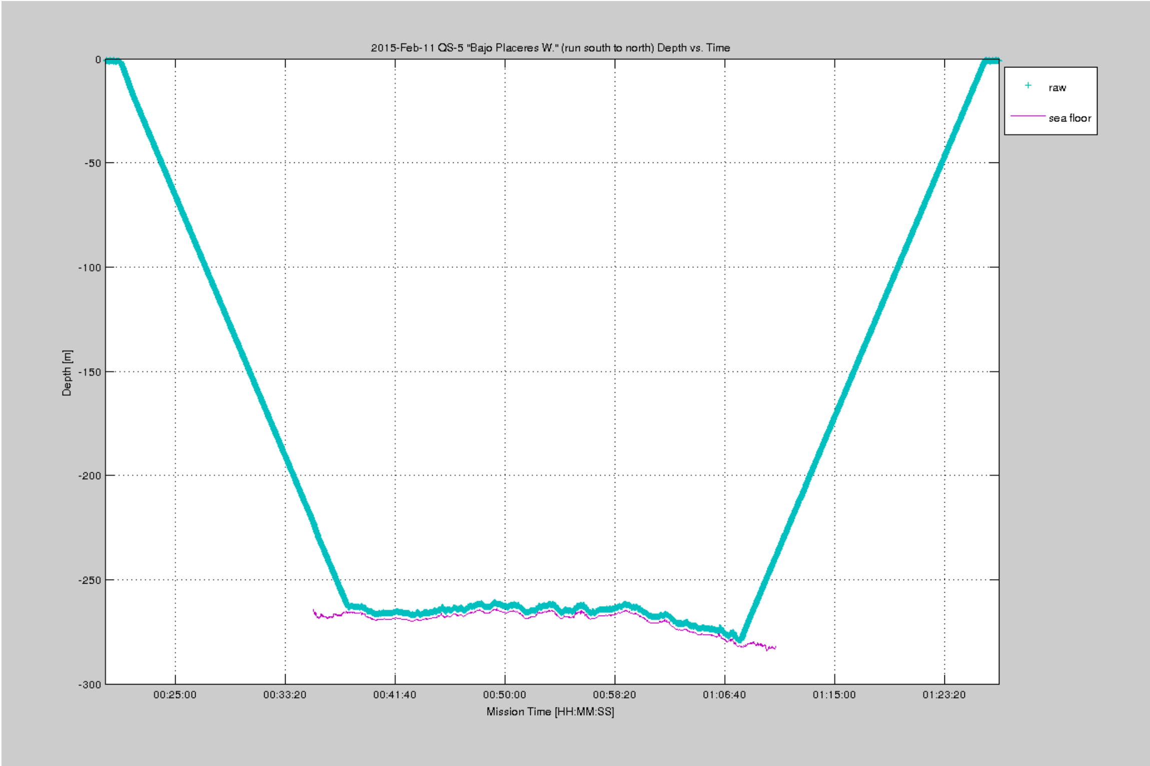


Figure 13. QS 5. Depth profile of the SeaBed AUV dive at Bajo Placeres W (N – S) during February 2015

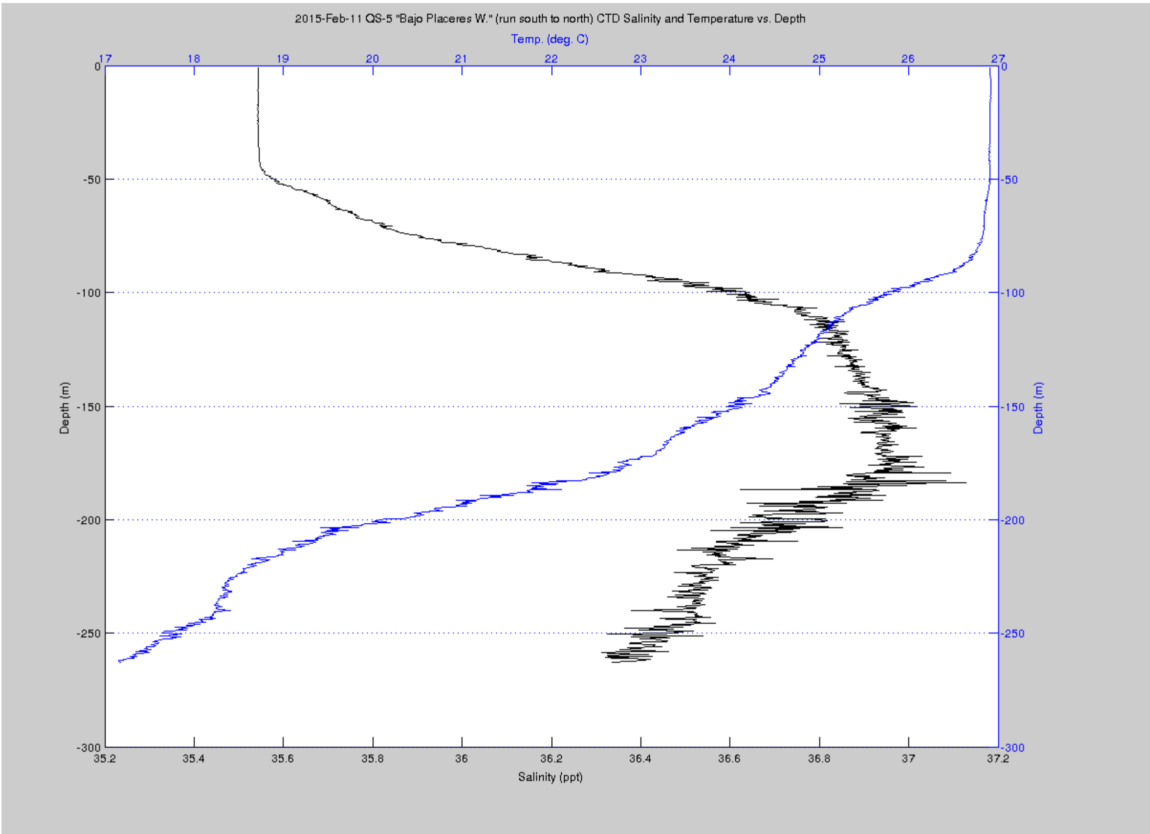


Figure 12. Temperature (^{o}C) and salinity (su) profiles produced by the SeaBed AUV – CTD dive at Bajo Placeres W (N – S) during February 2015

Table 7. QS – 5 (N – S). Placeres W. Percent cover by substrate categories and densities of predominant biota within the transect area photographed by the SeaBed AUV at Bajo Placeres W during Feb 2015. Depth range: 26 – 280 m.

Total photos analyzed: 91 **Total Area: 647.9 m^2**

SUBSTRATE CATEGORY	**% Substrate Cover** **Mean**	**Density** (# col/100m^2)
Abiotic		
Pavement	50.77	
Sand	13.13	
Total Abiotic	**64.02**	
Echinoderms		
Unknown	0.18	1.26
Solasteridae	0.03	0.21
Goniasteridae	0.02	0.14
Echinus sp.?	0.02	0.14
Total Echinoderms	**0.26**	**1.83**
Sponge		
Massive white sponge	1.57	11.03
White encrusting sponge	1.16	8.15
Unknown	0.8	5.62
Geoidia ?	0.71	4.99
Yellow encrusting sponge	0.43	3.02
Hexactinellida	0.36	2.53
Brown cup sponge	0.18	1.26
Thorny white sponge	0.17	1.19
Brown massive sponge	0.14	0.98
Yellow massive sponge	0.12	0.84
Petrosia ?	0.11	0.77
Total Sponges	**5.75**	**40.38**
Coral		
Unknown	4.74	33.29
Lophelia or *Oculina*	2.95	20.72
White polyps	1.81	12.71
Enallopsamma profunda	1.53	10.74
Madrepora oculata	0.34	2.39
Bamboo coral	0.1	0.70
Total Coral	**11.47**	**80.55**
Dead coral	**14.47**	**101.62**
Soft Coral		
Paramuricea?	0.15	1.05
Unknown	0.02	0.14
Total Soft Coral	**0.15**	**1.05**

Other Cnidarian		
Stylaster sp.	0.26	1.83
Renilla reniformis	0.21	1.47
Total Cnidarians	**0.47**	**3.30**
Antipatharians		
Bathypathes sp.	2.66	18.68
Unknown	0.62	4.35
Planular black coral	0.05	0.35
Short bushy black coral	0.03	0.21
Tall bushy coral	0.03	0.21
Total Antipatharians	**3.38**	**23.74**

Additional species identified along transect QS - 5 (N - S)

Category	**Species**
Coral	Bamboo coral
Coral	Unknown
Coral	*Enallopsamma profunda*
Coral	*Lophelia* or *Oculina*
Coral	*Madrepora oculata*?
Coral	*Solenosmilia variabilis*
Coral	White polyps
Cnidarian	*Stylaster* sp.
Soft Coral	*Paramuricea?*
Soft Coral	Whip coral
Soft Coral	Unknown
Sponge	Ball sponge
Sponge	Blue encrusting sponge
Sponge	Brown cup sponge
Sponge	Brown massive sponge
Sponge	*Farrea occa*
Sponge	Massive white sponge
Sponge	Orange encrusting sponge
Sponge	*Petrosia*?
Sponge	Unknown
Sponge	Thorny white sponge
Sponge	Hexactinellida
Sponge	Vase Hexactinellida
Sponge	White encrusting sponge
Sponge	Yellow encrusting sponge
Sponge	Yellow massive sponge
Sponge	Brown branching sponge
Sponge	Brown bulbous sponge
Antipatharians	*Bathypathes* sp.
Antipatharians	Unknown
Echinoderm	Black echinoid
Echinoderm	Crinoid

Echinoderm	Orange Solasteridae
Echinoderm	Unknown
Echinoderm	Stalked crinoid
Echinoderm	Cidaroid (echinoid)
Echinoderm	*Echinus* sp.
Echinoderm	Solasteridae
Echinoderm	Orange Ophiuroid
Echinoderm	Holothuroid

Motile-megabenthic invertebrates were mostly represented by echinoderms with a combined density of 1.8 Ind/100 m^2 (Table 7). Sea stars (Solasteridae) and echinoids were the most common (Plates 29 – 30). One fish was observed within photo-transect areas.

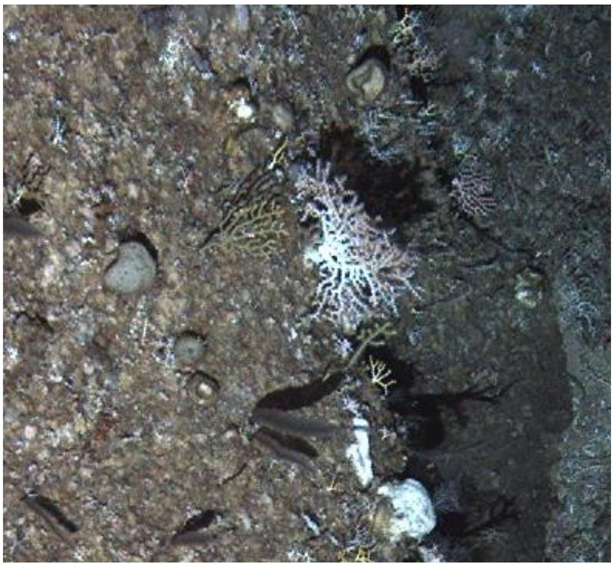


Plate 26. Bamboo coral and yellow soft coral

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Plate 27. White coral (*Lophelia* or *Oculina*) and yellow soft coral

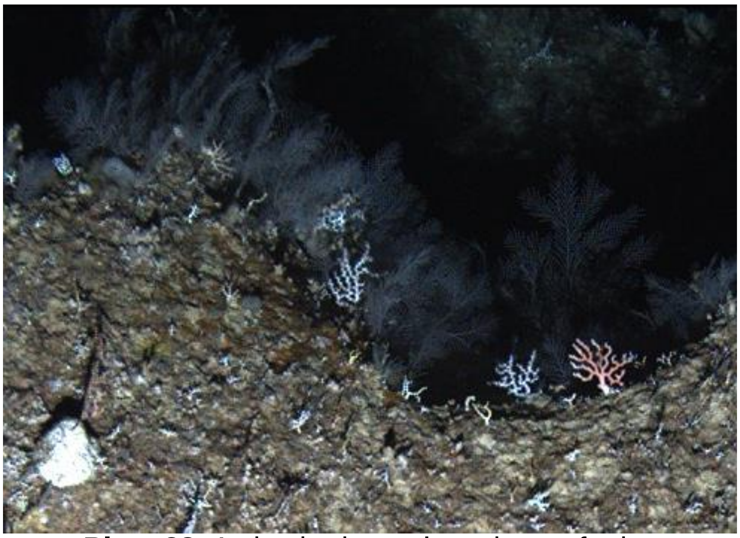


Plate 28. Antipatharians along the reef edge

Plate 29. Solasteridae

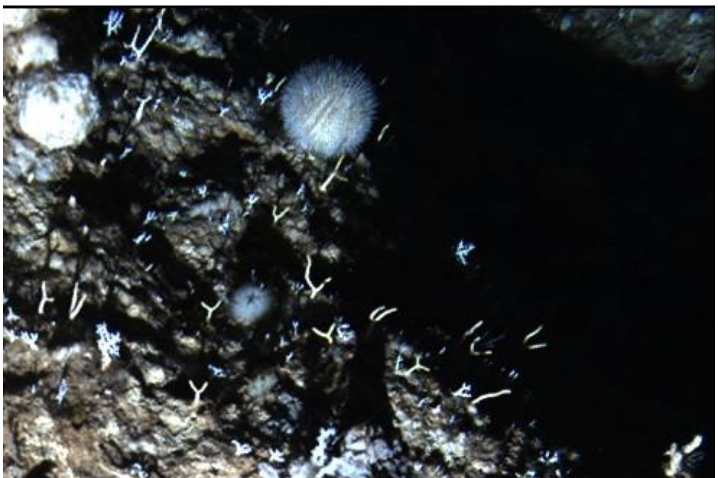
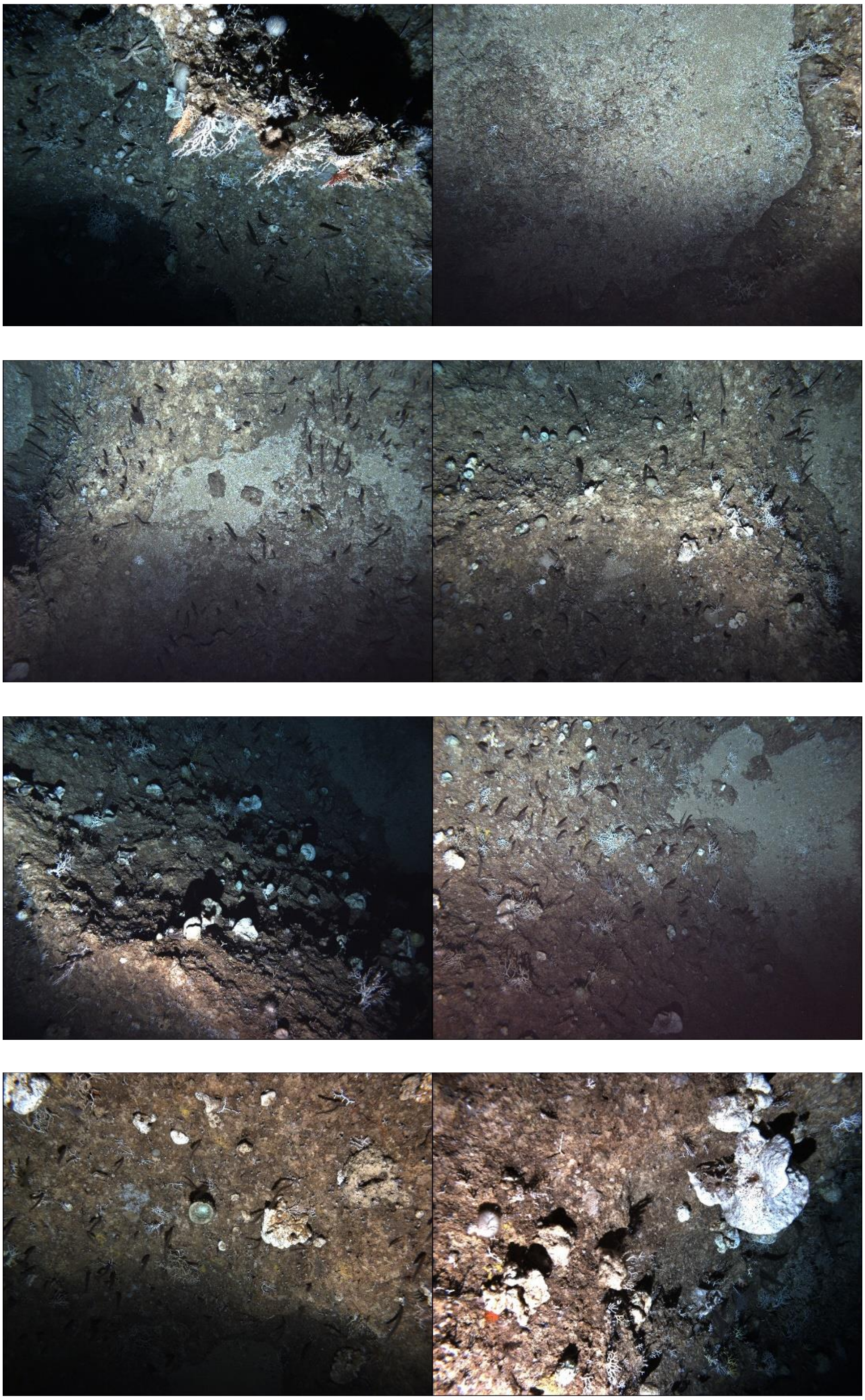
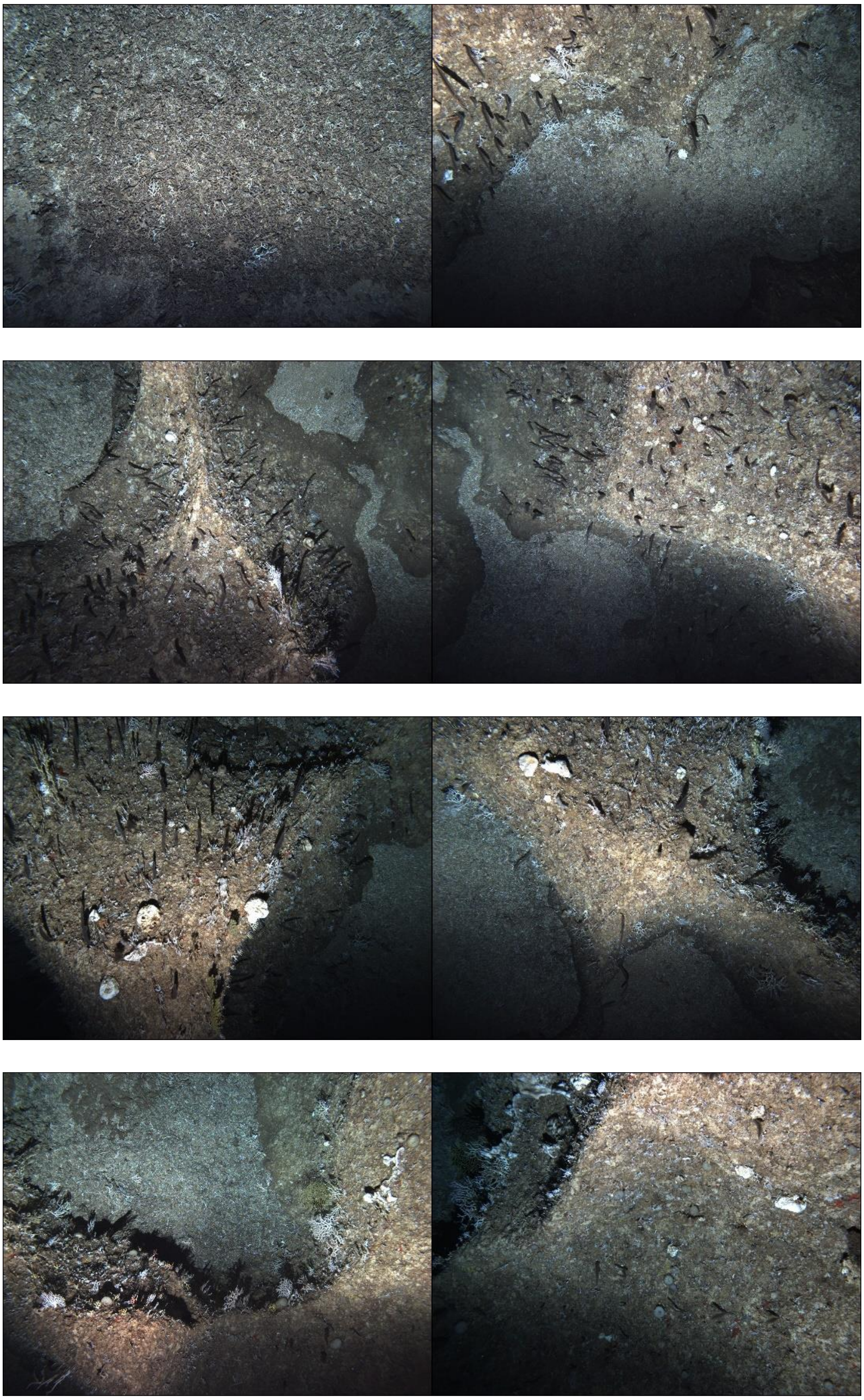
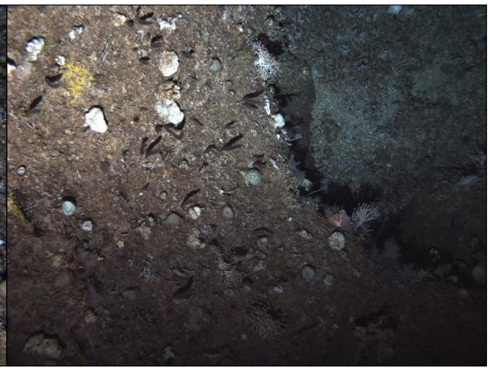


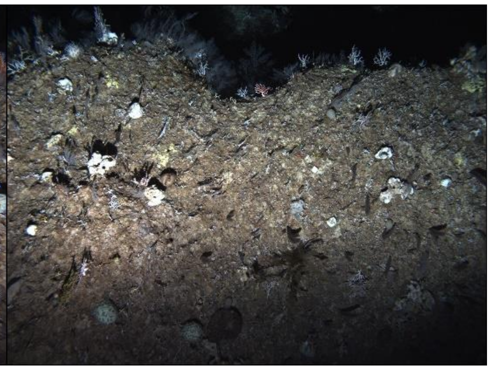
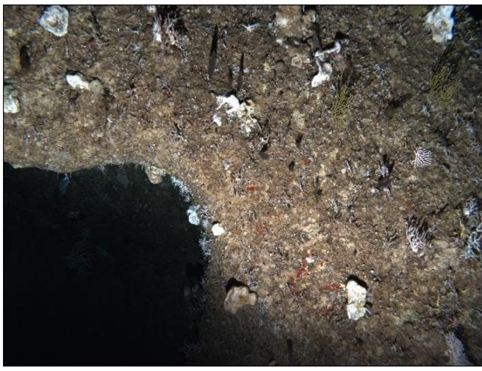
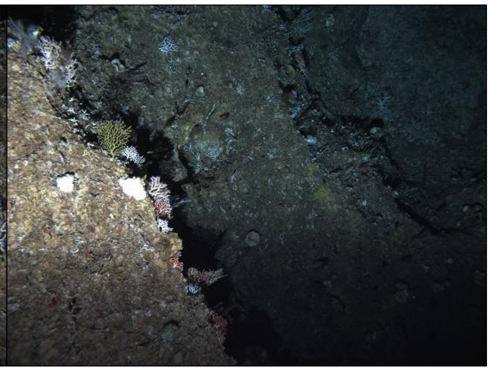
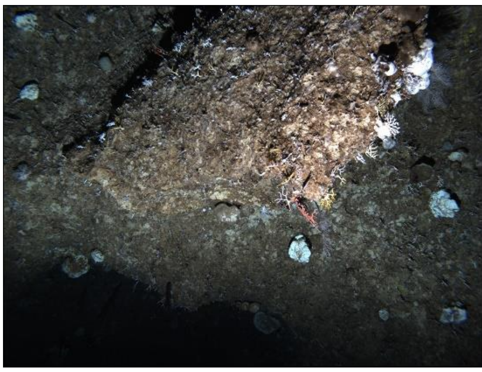
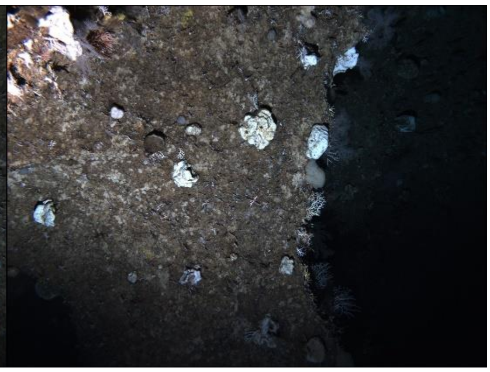
Plate 30. *Echinus* sp. at QS - 5

Photo Album 6. QS – 5. Bajo Placeres West





QS – 6 La Parguera S

The last mission of the SeaBed AUV for this study was an exploratory dive off the La Parguera insular slope during February 12, 2015. An active year-round artisanal deep-sea snapper fisheries is known to take place along the southwest insular slope from the submarine canyons off Guanica Bay to El Faro, at the southwest tip off La Parguera. La Parguera insular slope is very steep within the 250 – 400 m queen snapper depth range, with no flat areas to run horizontal transects. Thus, the approach was to run transects in slope sections with angles of 30^o or more in the vicinity of areas with Co (coral) substrate denominations in the NOAA nautical chart, avoiding vertical walls. The SeaBed AUV dove down the slope to a depth of 418 m and started a transect up the slope to a depth of 250 m, then dove again to 515 m and photographed another section of the slope up to a depth of 200 m (Figure 15). Another dive was attempted down the slope, but the dive was aborted when the AUV detected the bottom at 540 m and photographic documentation was impossible due to the steepness of the slope. Temperature and salinity profiles of the La Parguera insular slope taken by a CTD in the SeaBed AUV are presented in Figure 16. Well defined thermocline and halocline define a surface mixed layer and the underlying Sub-tropical underwater mass with its signature salinity of 37. 2 su. Water temperature within the 400 – 250 m depth ranged from 14.9 and 18.8 ^oC (Figure 16).

The seafloor of the La Parguera insular slope along the transect surveyed by the SeaBed AUV was mostly featureless with respect to topographic anomalies or discontinuities. Benthic substrate was mostly a flat pavement covered almost throughout by a layer of sand/silt, with occasional small relief outcrops present evidencing the underlying hard ground features of the slope (see Photo Album 7). Abiotic cover was clearly over 99 % of the total area surveyed.

Sponges and soft corals (gorgonians) were the main biotic taxa colonizing the slope area surveyed with densities of 28.4 and 22.3 colonies/100 m^2, respectively (Table 8). The sponge assemblage (439 Ind) was represented by at least 13 species with massive sponges, such as *Petrosia*? and *Geodia*? representing 64% of the total individuals or colonies. There was also high abundance of glass (Hexantinellida) (Plate 31) and other massive sponges. Soft corals, comprised by at least five species presented the second highest density. Many of the soft corals appear to be representatives of the Paramuricea. The Devil's Sea Whip, *Ellisella (barbadensis)* was present with a density of 3.4 colonies/100 m^2 (Table 8) (Plate 32).

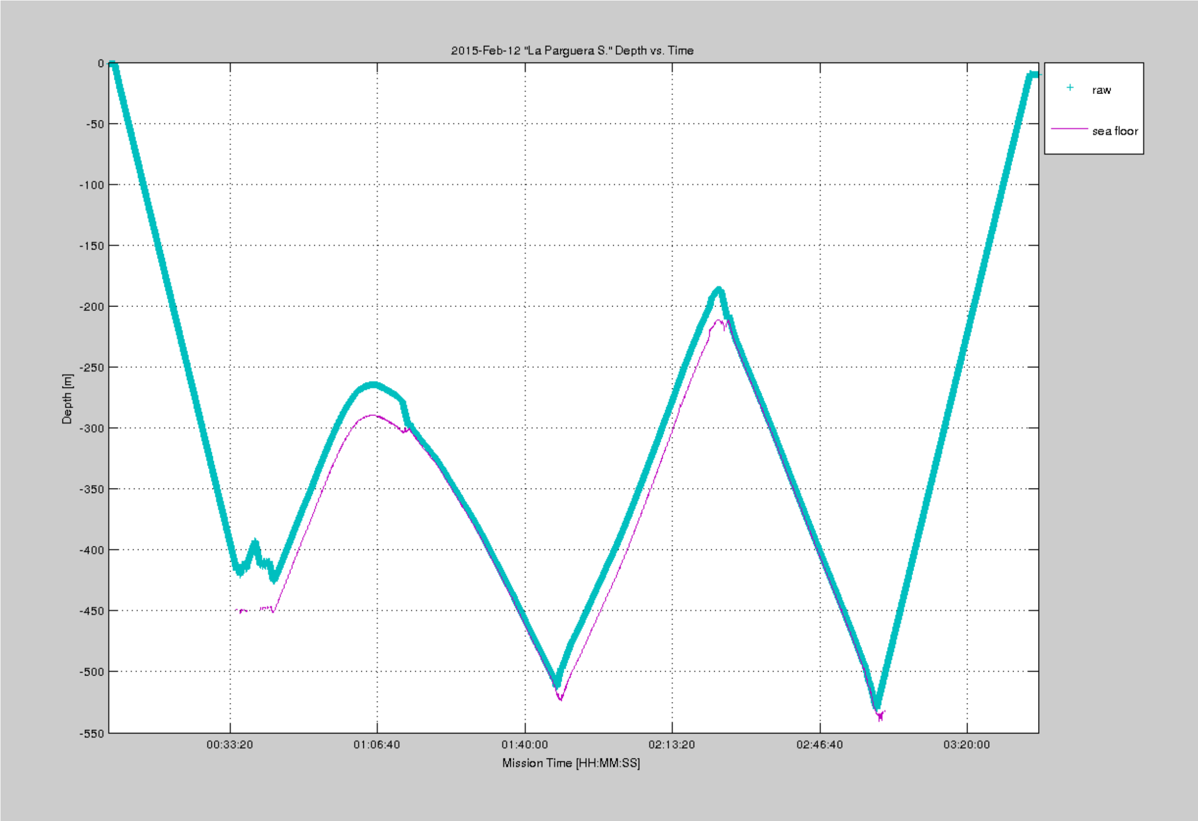


Figure 15. QS 6. Depth profile of the SeaBed AUV dive off La Parguera during February 2015

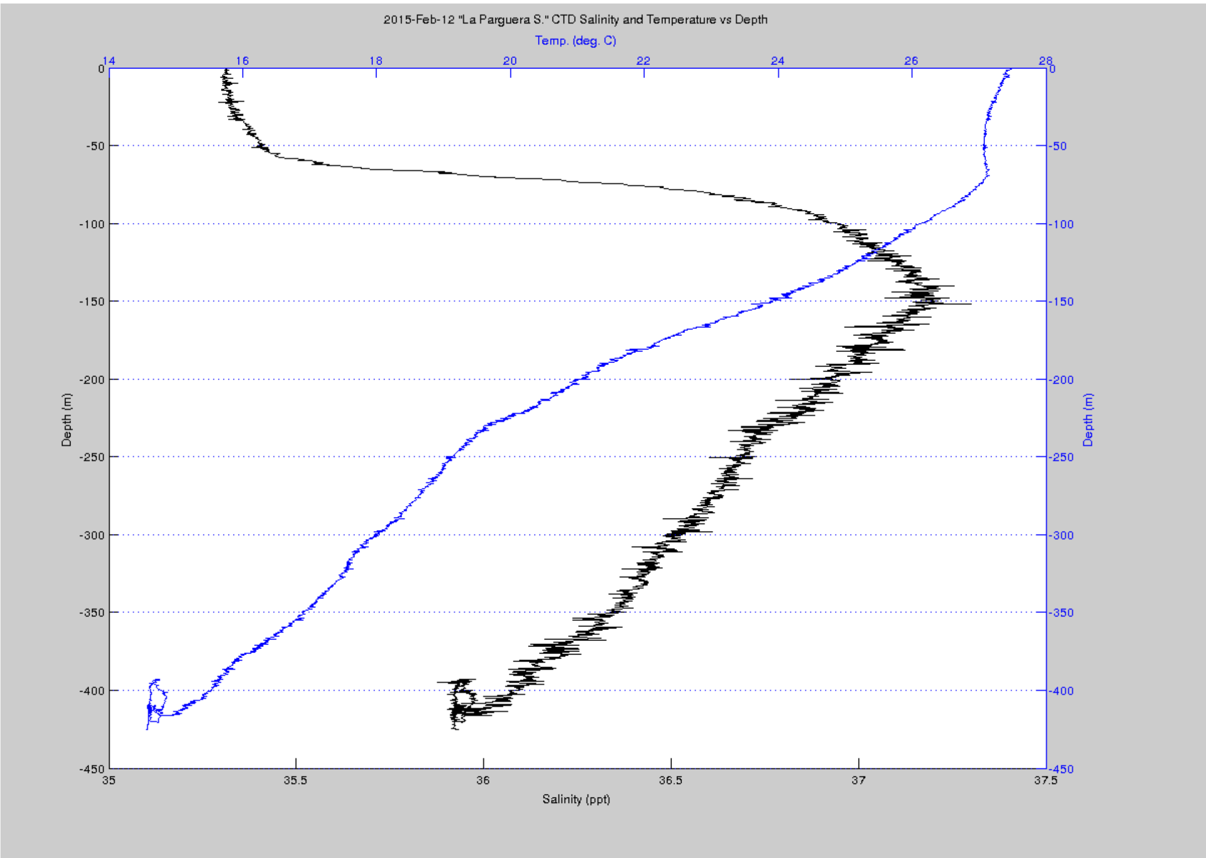


Figure 16. Temperature (^{o}C) and salinity (su) profiles produced by the SeaBed AUV – CTD dive off La Parguera during February 2015

Table 5. QS - 6. La Parguera S. Taxonomic composition and densities of sessile-benthic biota identified from photos taken by the SeaBed AUV during Feb 2015. Depth range: 250 – 415 m.

Total photos analyzed: 217 **Total Area: 1,545.0 m^2**

SUBSTRATE CATEGORY	Total # Individuals or colonies	Density (# col/100m^2)
Echinoderms		
Orange brittle star	20	1.29
Echinus sea urchin?	12	0.78
Crinoid	4	0.26
Sea cucumber	2	0.13
Cidaroid sea urchin	2	0.13
Total Echinoderms	**40**	**2.59**
Soft Corals		
Unknown	270	17.48
Ellisella (barbadensis ?)	52	3.37
Yellow soft coral	12	0.78
Orange soft coral	5	0.32
Purple soft coral	5	0.32
Total Soft Corals	**344**	**22.27**
Corals		
Lophelia pertusa?	**7**	**0.45**
Other Cnidarians		
Renilla reniformis	**1**	**0.06**
Sponges		
Petrosia?	165	10.68
Geodia?	117	7.57
Hexantinellida (glass sponges)	69	4.47
White massive sponge	38	2.46
Small white sponge	22	1.42
Vase white sponge with small *Osculum*	11	0.71
Barrel sponge	5	0.32
White glass barrel sponge	5	0.32
Pointed sponge	3	0.19
Unknown	2	0.13
Red encrusting sponge	1	0.06
Yellow massive sponge	1	0.06
Total Sponges	**439**	**28.41**
Antipatharians		
Bushy black coral	2	0.13
Unknown	1	0.06
Total Antipatharians	**3**	**0.19**

Crustacean			
	Lobster?	**2**	0.13
Unknown			
	Brown branching organism	70	4.53
	Orange round organism	2	0.13
Total Unknown		**72**	**4.66**

Hard aposymbiotic corals were observed in very low density and species richness, with what appears to be the cold water coral *Lophelia pertusa* (Plate 33) the only species present within the transect surveyed. Antipatharians were represented by three individuals and two species. There was an unknown brown branching organism that was observed throughout the transect and it had a relatively high abundance (70 total counted).

Among the motile megabenthic invertebrates, echinoderms were the most abundant with a combined density of 2.6 Ind/100 m^2 (Table 8). An orange brittle star (Plate 34) was the most abundant echinoderm and was observed hiding under sponges. A crustacean with shrimp form (Plate 35) was witnessed twice along the transect. Fishing lines were observed in a few of the photographs. Two fish were observed along this transect, one of which appears to be a lizardfish (Synodontidae), probably *Synodus saurus* (Plates 36-37).

Plate 31. Glass sponge (Hexantinellida)

Plate 32. Devil' Sea Whip (*Ellisella sp*)

Plate 33. Aposymbiotic coral (*Lophelia pertusa* ?)

Plate 34. Orange brittle star

Plate 35. Crustacean

Plate 36. Synodontidae (*Synodus saurus*?)

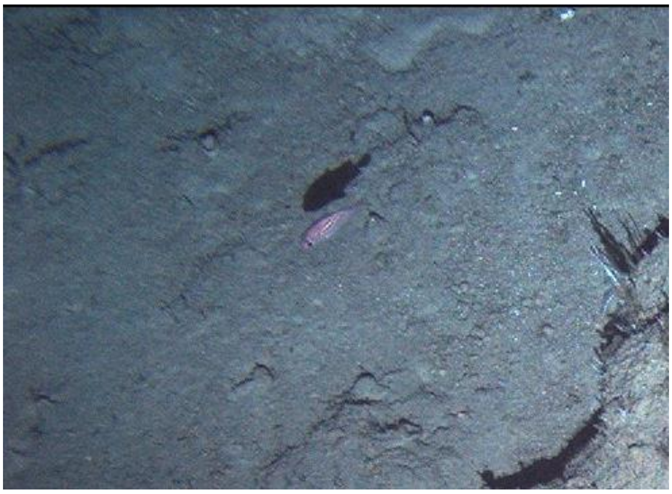
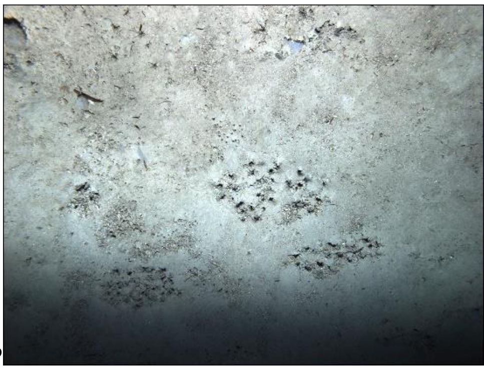


Plate 36. Fish

Photo Album 7. QS – 6. La Parguera

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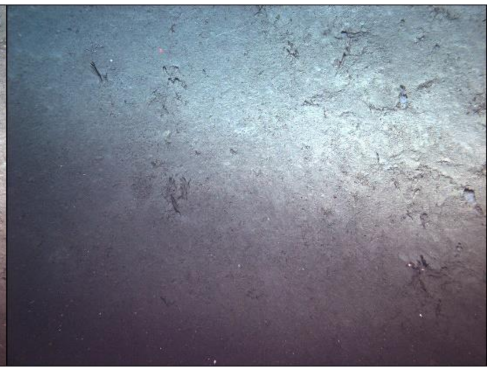


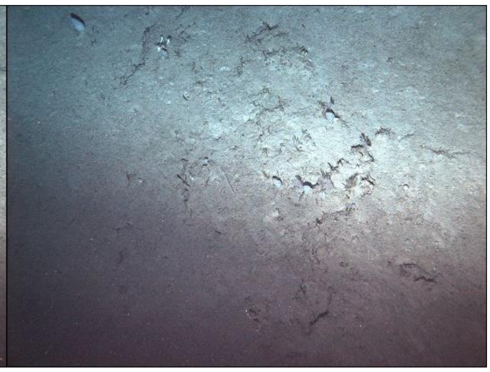




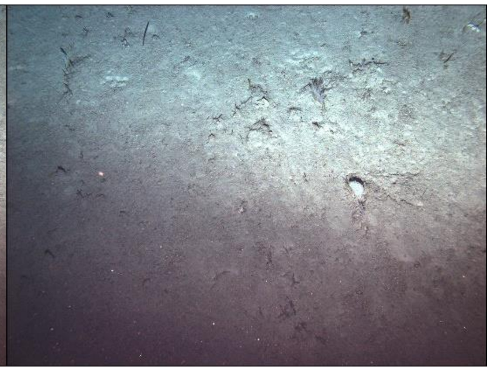

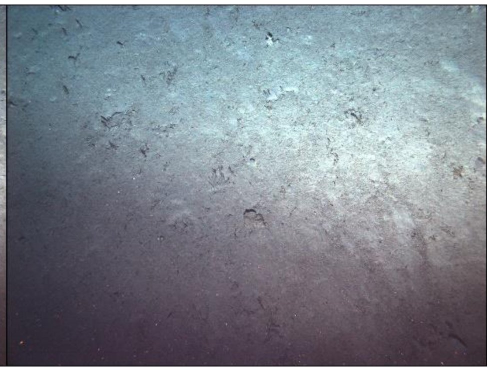
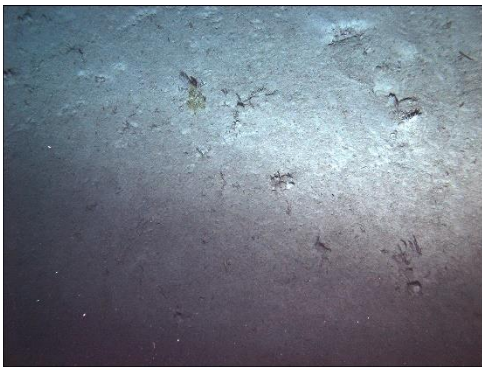


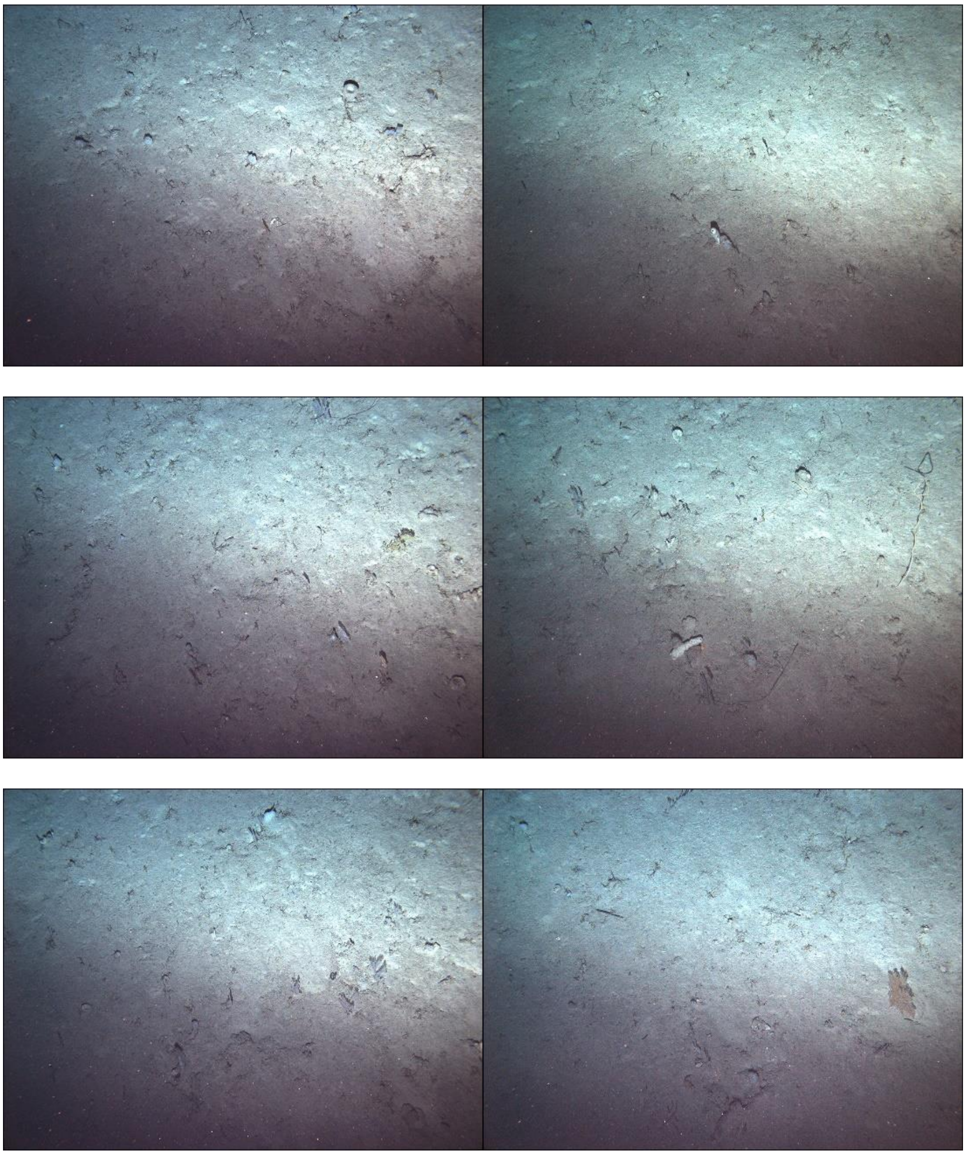

Comparative Analysis of Community Structure Between Stations

Density estimates of major taxonomic groups observed within transect survey areas are presented in Table 9. The density and relative composition of sessile-benthic and motile megabenthic invertebrates colonizing deep-reef habitats in Mona Passage and La Parguera varied markedly. Availability of hard bottom, depth, slope and distance from shore are here suggested as factors potentially regulating sessile-benthic community structure. Understanding of community structure patterns relative to these variables will require more geographic coverage of these benthic habitats and assessment of sampling spatial variability, as well as a much more comprehensive knowledge of the taxonomy of the benthic communities. Our data allows for elucidation of general patterns of community structure and provides the first quantitative assessment of biological colonization by sessile-benthic and motile megabenthic invertebrate taxa in aphotic reefs of Puerto Rico.

The benthic community at Station QS – 1, surveyed to the northeast of Bajo de Sico at mesophotic depths within the 78 – 108 m range was markedly different from all other stations. Biotic cover at QS – 1 was 80.5 %, more than twice as high as any other station. Benthic algae were the main biological component colonizing the seafloor with a reef substrate cover of 68%, whereas (as expected) aphotic reef stations were devoid of benthic algae. Also, the numerically dominant scleractinian corals at QS – 1 were symbiotic species, such as Lettuce Corals, *Agaricia spp*., Mustard-hill Coral, *Porites astreoides* and Great Star Coral, *Montastraea cavernosa*, whereas coral taxa from aphotic stations were all aposymbiotic. Thus, the prevalence

Table 9. Densities (Ind/100m^2) of major taxa colonizing deep reef areas in Mona Passage and La
Parguera surveyed by the SeaBed AUV during 2014-15.

Survey Stations	Scleractinian Coral	Antipatharian Coral	Octocorals	Sponges	Echinoderms	Total Biotic Cover (%)
QS - 1	16.1	3.0	1.1	68.3	0	80.5
QS - 2	1.0	0.1	1.6	41.3	7.1	<1.0
QS Alt - 3	1.2	7.9	14.8	112.0	3.4	20.0
QS Alt - 4	0.0	0.0	3.8	1.9	4.6	<1.0
QS - 5 (a)	38.4	16.4	1.5	42.1	5.6	18.0
QS - 5 (b)	80.6	23.7	1.0	40.4	1.8	36.0
QS - 6	0.4	0.2	22.3	28.4	2.6	<1.0

of benthic algae and photosynthetic endosymbionts in corals at QS – 1 evidences that light penetration was a factor regulating major differences of community structure relative to other deeper aphotic stations included in this study. A most remarkable finding from QS – 1 was that at 78 m (257 feet) this may be the maximum depth distribution record of *O. franksi*.

The density and relative composition of sessile-benthic biota colonizing deep-reef habitats in Mona Passage and La Parguera varied markedly. Availability of hard bottom, depth, slope and distance from shore are proposed as factors potentially regulating sessile-benthic community structure. The benthic community at Station QS – 1, surveyed to the northeast of Bajo de Sico at mesophotic depths within the 78 – 108 m range was markedly different from all other stations. Biotic cover at QS – 1 was 80.5 %, more than twice as high as any other station. Benthic algae were the main biological component colonizing the seafloor, whereas aphotic reef stations were devoid of benthic algae. Also, the numerically dominant scleractinian corals in terms of reef substrate cover and density of colonies were hermatypic taxa, whereas corals from aphotic stations were all aposymbiotic (ahermatypic) types. Thus, the prevalence of benthic algae and photosynthetic endosymbionts in corals at QS – 1 is evidence that light penetration was a factor regulating major differences of community structure relative to other deeper, aphotic stations included in this study. Boulder Star Coral, *Orbicella franksi* was photographed growing at a depth of 78 m (257 feet) in QS – 1, which may be the maximum depth distribution record for the species.

Densities of aposymbiotic corals were higher at station QS – 5 (Bajo Placeres West) than at any other station in the study. The combined substrate cover by scleractinian, antipatharian, hydrocorals and soft corals was 15.5 % over the total transect area (64% sand), but 43.0% over hard ground at QS – 5 (n-s). Such level of reef substrate cover by live ahermatypic corals is higher than that of hermatypic (symbiotic) assemblages from most coral reef systems in the Natural Reserves of Puerto Rico. The high percent of substrate cover by live corals of different species and growth shapes contributed significantly to the reef topographic relief and benthic habitat complexity, along with its implications for enhanced benthic productivity, microhabitat availability and ecosystem biodiversity, consistent with the classification of this benthic habitat as an ahermatypic coral reef system. QS – 5 was the only "high relief" station (accidentally) surveyed by the AUV in this study, but from the limited bathymetric data available, this type of irregular, high topography seafloor features appear to be common throughout the Antillean Ridge, suggesting that ahermatypic coral reefs may have a widespread distribution and contribute significantly to the biodiversity and fisheries production of Mona Passage.

Marked gradients of substrate colonization and community structure were evidenced from stations QS – 5, QS-Alt 3 and QS-Alt 4, spaced along an offshore - onshore gradient from Mona Passage to the west coast shelf-edge. Scleractinian and antipatharian corals, as well as the total density of sessile-benthic colonies increased offshore towards Mona Passage. Soft corals (gorgonians), particularly sea whips (*Ellisella sp*) were more abundant at stations QS Alt – 3 and also presented relatively high density at QS - 6, both stations with relatively low topographic relief and high cover by sediments. Amongst motile megabenthic invertebrates, echinoderms were by far the most abundant at all aphotic stations. These were mostly observed over unconsolidated, particularly sandy substrates and thus, their density appeared to be influenced by the prevalence of sand.

A total of 29 fish individuals, distributed in what appear to be five or six species were observed within transect areas. Most (22 out of 29) were observed aggregated in schools over hard ground at QS – 2 (Isla Desecheo), but none could be positively identified. The down-looking camera system of the AUV was not designed to provide quantitative estimates, nor to optimize detection of pelagic taxa. Therefore, the fish photographic records obtained from the AUV should be considered mostly incidental and/or descriptive of demersal, if not epibenthic species, such as what appear to be an Antillean Catfish (*Gadus antillensis*), the Bluestriped Lizardfish, *Synodus saurus* and the Elongated Whiff flounder (*Citharichthys dinoceros*). Relationships between benthic community structure and the fish taxonomic composition and abundance will require additional survey components that may include a combination of direct (fishing) and indirect (photographic/acoustic) approaches.

One of the main findings of this baseline study is that dense biological colonization of the hard ground substrate by ahermatypic corals and other taxa, consistent with the classifications of these benthic habitats as coral reefs, appear to be concentrated in areas of marked substrate discontinuities and high topographic relief, but that were mostly avoided because the AUV limitations for surveying of irregular, high relief areas. Thus, alternative approaches must be considered for exploration of these benthic habitats that may represent some of the most extensive, yet unexplored coral reef resources of Puerto Rico and perhaps of fundamental relevance for the deep sea snapper and grouper fishery.

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