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Local oceanographic influences on distribution and phylogenetic community structure of deep-sea corals on seamounts in the Anegada Passage (Eastern Caribbean)

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The Caribbean Sea and Deep-sea Coral Biogeography

- Cold-water coral species below 50m depth are poorly known compared to shallower warm-water coral communities in the Caribbean Sea.
- The Caribbean Basin is thought to be a transition zone or filter for deep-water species due to topographic constraints on deep-water flow.
- Seamounts, present in the Greater-Lesser Antilles Transition Zone, bridge the transition between shallow, mesophotic, and deep-water coral communities and provide an optimal environment for exploring depth-specific zonation patterns.
- Recent work has found that deep-water mass strata within the region are significant factors influence benthic fauna distribution with elevated species turnover occurring predominantly in the upper 1200m (Quattrini et al 2017).

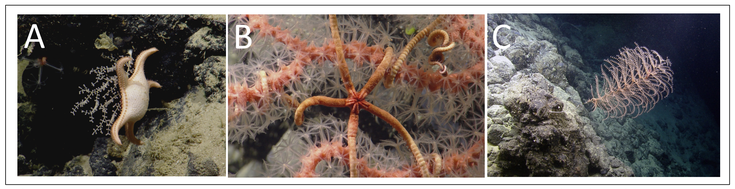


Figure 1: Common deep-water corals from the Anegada Passage. A) Primnoid octocoral, *Candidella imbricata*, preyed upon by a goniasterid seastar. B) *Paragorgia* sp. and brittle star (*Asteroschema* sp.) associate. C) A large *Iridogorgia splendens* from Conrad Seamount.

Objectives

1) Investigate the influence of abiotic water mass variables on deep-water coral species distribution.

2) Construct a regional phylogeny of deep-water corals corals from available records in the Western Atlantic, Caribbean, and Gulf of Mexico regions to determine if water masses can be used to predict community assemblage structure.

Water Mass Analysis

Water column profiles were obtained using vehicle-mounted CTD profiles and oxygen optode. The data were explored using Ocean Data View 4 (Fig. 3). Based on records reported by Morrison & Nowlin (1982), Anegada Passage seamounts were found to be bathed in Atlantic Sub-tropical Underwater, Sargasso Sea Water (SSW), Tropical Atlantic Central Water (TACW), Antarctic Intermediate Water (AAIW), and North Atlantic Deep Water (NADW). For the purposes of this analysis NADW was a combination of upper and lower NADWs. Water column minimum oxygen levels were consistent with the depth of the impinging TACW.

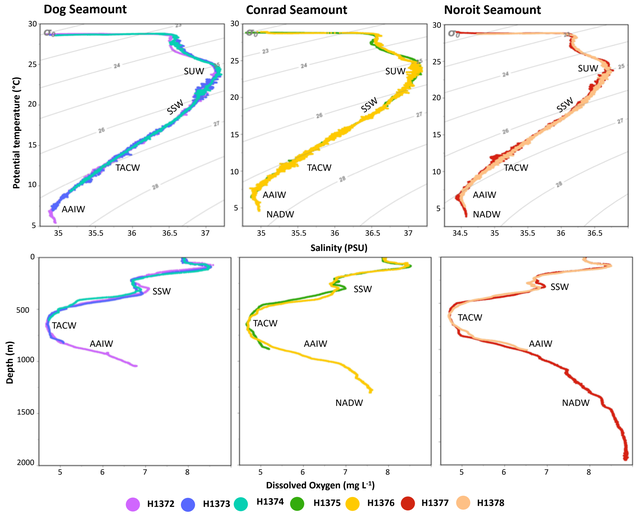


Figure 3: Water column T-S profiles at Dog, Conrad, and Noroit Seamounts. Oxygen profiles through each dive max depth are shown below. Line colors indicate profiles for each dive track.

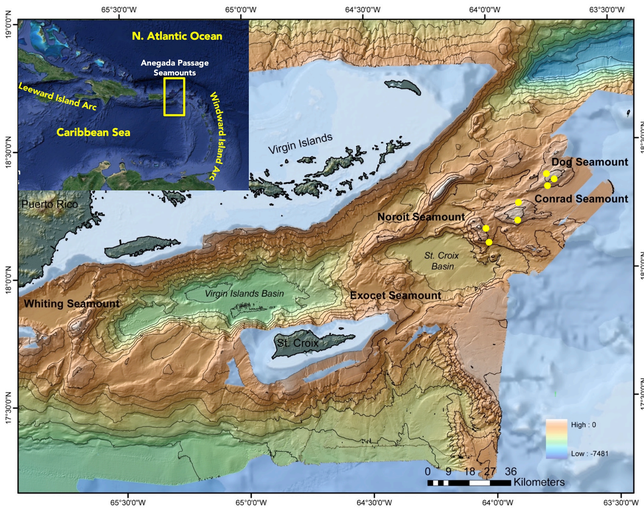
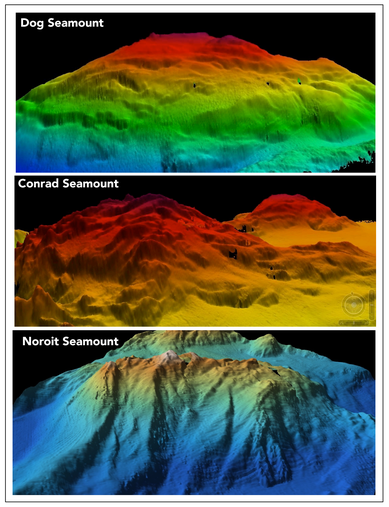


Figure 2: Locations of seamount surveys in the Anegada Passage. Yellow circles indicate ROV transect sites. Map adapted from Chaytor & ten Brink 2015. Multibeam bathymetry from Dog, Conrad and Noroit Seamounts indicates geomorphology relative to the surrounding seafloor.



Local Oceanography Influences Species Distribution

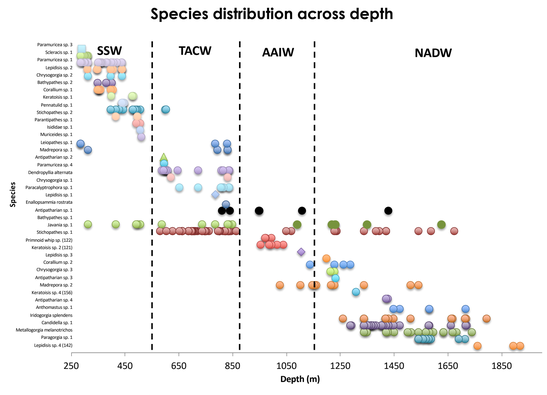


Figure 4: Locations of sites surveyed in the Anegada Passage. Species ranges are arranged along the y-axis by the mean depth of their occurrence across their distribution. Vertical dashed lines are indicative of water mass transition zones. SSW (Sargasso Sea Water), TACW (Tropical Atlantic Central Water), AAIW (Antarctic Intermediate Water), NADW (North Atlantic Deep Water).

- Deep-water corals were present on all seamounts from as shallow as 250m to a maximum observed depth of 1920m.
- In all, 41 coral morphotypes were observed primarily from the Plexauridae, Chrysogorgiidae, Isididae, Antipatharia, and Scleractinia.
- The widest distributions were observed among black coral species, *Stichopathes sp.,* and solitary cup corals.
- The depth of impinging water mass transitions is consistent species turnover, particularly shallower than 1100m depth.
- Species turnover was most abrupt between SSW, TACW, and AAIW. Species deeper than 1000m generally had wider depth ranges than shallower species.

Scleractinian corals and carbonate saturation state

Scleractinian (reef-forming) deep-water corals are important ecosystem engineers for structuring benthic biodiversity. In the Anegada Passage at least 3 species of hard corals were present: *Enallopsammia* spp., *Madrepora* spp., and *Dendrophyllia* sp. Deep-water corals living at or near the limits of carbonate dissolution are important for evaluating biogeographic changes for these communities with deep-water ocean acidification.

- Moderate sized colonies of live *Madrepora* spp., along with extensive debris fields, were the most common species present.
- At least 2 species were found to be segregated by depth, *M. cf. carolina* and *M. cf. oculata* (Fig. 5)
- *M. carolina* is present at aragonite saturation levels (Ω) of 2.7-1.2 while *M. oculata* was found below 1.2 to a minimum of 1.13

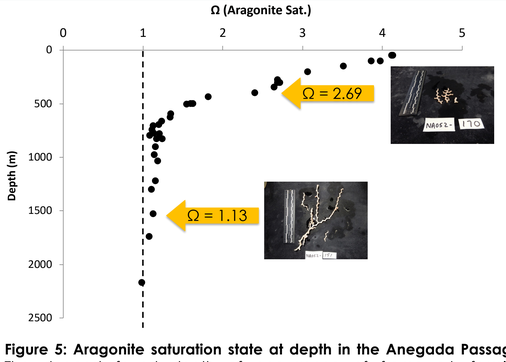
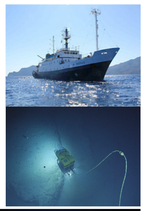
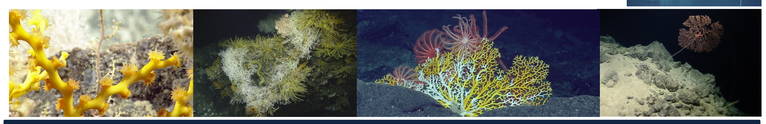


Figure 5: Aragonite saturation state at depth in the Anegada Passage. The deepest found depth of occurrence of framework forming scleractinian corals was 1524m.

Methods

- Surveys were completed during August-September 2014 on the EV Nautilus using the ROV Hercules.
- In all, 106hr of bottom time video was assessed across 7 dive sites. Depth of surveys ranged from 276-2157m.
- Collections resulted in 56 deep-water coral specimen samples, primarily from the octocorallia and scleractinia.
- Water masses present in the area were identified from CTD casts based on temperature, salinity, and dissolved oxygen measurements.





Phylogenetic Community Assembly

Phylogeny construction was based on molecular barcodes of the mitochondrial gene *MutS* (~720bp). Barcodes were obtained following the methodology of McFadden et al. (2011).

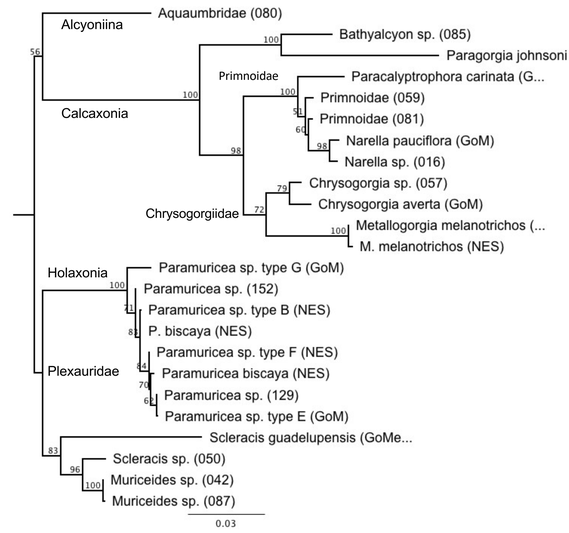


Figure 6: Maximum-likelihood phylogenetic comparison of seamount octocorallia from the Anegada Passage as well as field ID and sample identifier (e.g. Paramuricea sp. (129). Bootstrap confidence values are presented at each node. The tree is rooted at its midpoint. Specimens obtained from GenBank for adjacent Western Atlantic provinces include the Gulf of Mexico (GoM) and New England Seamounts (NES). Alignments and tree construction was conducted using MEGA v.7.

Take-Home Points

- **Seamounts in the Anegada Passage contain a diversity of octocoral fauna, not previously quantified *in situ*.**
- **Distribution patterns suggests species turnover is consistent with water mass boundaries. This pattern is most strongly observed in the upper 1100m.**
- **Colonial scleractinians (*Madrepora spp.*) observed down to 1524m (Ω ≅ 1.1) appear to be most tolerant to low carbonate saturation states.**
- **Octocoral molecular barcodes hint to shared species between the Gulf of Mexico and New England Seamounts**

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