Hanging Gardens: Vertical Walls From Images To Fine-Scale 3D Reconstructions

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Vertical and overhanging walls in complex deep-sea environments can harbour high biodiversity and host Vulnerable Marine Ecosystems, to which they provide natural protection from human activities such as trawling. Traditional ship-board multibeam systems cannot adequately replicate the complete 3D structure of vertical habitats, and towed video systems are challenging to operate in these rugged environments. In this study, we combine front-mounted ROV multibeam sonar data and ROV video imagery to examine vertical walls from the Rockall Bank Slide Complex and the Whittard Canyon, Northeast Atlantic. High resolution point clouds of bathymetry are extracted from sonar data, but, to obtain even higher resolutions, photogrammetry techniques (structure from motion) are applied to create 3D representations of video transects along the walls. With these reconstructions, it is possible to interact in 3D with extensive sections of video footage which cannot otherwise be visualized in their entire context. The videos, once georeferenced and scaled, can be used to ground-truth the broader scale geological setting of the wall (as obtained from ROV multibeam); they also allow very accurate positioning and measurement of individual organisms. Moreover, derived terrain variables can now be extracted on scales similar to those experienced by megabenthic individuals (<20cm for sonar and <1cm for photogrammetry) and employed to explain fine-scale habitat selection. The most commonly observed species in this study include Acesta clams, cerianthids, the cup coral Desmophyllum, the soft coral Primnoa and cold-water corals such as Lophelia pertusa, Madrepora oculata and Solenosmilia variabilis. A key finding is that vertical walls with different lithologies harbour different species assemblages, and fine scale structures such as ledges and overhangs were preferentially selected by certain species. The heterogeneity generated by individual coral colonies was also resolvable and used to examine associated fauna. These new technologies are allowing us, for the first time, to map the physical 3D structure of previously inaccessible walls, and are demonstrating the complexity and conservation importance of these habitats.

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