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Advancements in the Study and Conservation of Coralligenous Bioconstructions: Integrating ROV-Based Sampling, Geobiology and Geochemistry

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Among the bioconstructed habitats of the Mediterranean Sea, Coralligenous is undoubtedly the most important ecosystem because of its extent, complexity and heterogeneity, which supports very high levels of biodiversity. Coralligenous is a hard-biogenic substrate mainly produced by the superposition of several generation of calcareous red algae, living in dim light conditions. Coralligenous contributes to seascape shaping through geological times, producing various morphotypes and causing geomorphological changes of the seafloor. Nevertheless, these bioconstructions are characterized by a low accretion rate and a high sensitivity to natural and anthropic impacts, including climate changes. For all these reasons, Coralligenous has since long time been the object of special interest by the UNEP RAC/SPA and considered among the priority habitats for monitoring and conservation by the EU. Recent technological advances have enhanced the study and preservation of these ecosystems. An innovative minimally invasive ROV-based coring systems have been developed under the "FISR- CRESCIBLUREEF" project and upgraded in the frame of the project "Tech4You PP2.3.1 Action 1 (CUP H23C22000370006) with integration of robotic and AI-based computer vision technologies for accurate 3D reconstruction, sampling, and mapping of these marine bioconstructions.

Using the protocol proposed by Cipriani et al. (2024), coralligenous core samples, collected from Marzamemi (Sicily, Italy) with ROV-based technologies, were compared with data obtained from coralligenous build-ups sampled in the same area by scuba-divers. Comparison between microfacies of core-samples and those of "*tale quale*" build-ups revealed no significant differences in term of abundance and relationship between skeletal frame-builders and non-skeletal carbonate components, despite the much smaller size of the core sample. These results allow to consider the ROV-based system as a powerful tool to obtain representative samples of bioconstructions for geobiological, environmental and paleoenvironmental studies without making invasive sampling, which would damage these fragile and delicate ecosystems.

Moreover, an integrated geochemical/geobiological approach has been utilized in order to identify possible proxies for short- and long-term environmental studies. This multidisciplinary approach showed an evident relationship between chemical composition of the carbonate minerals and the waters in which Coralligenous forms. Positive anomalies in heavy metals were found in bioconstructions and surrounding seawaters. Such enrichments could result from pollutants introduced into the marine system by human activities and recorded by the components of the bioconstructions. These data allow to consider coralligenous build-ups as environmental database that continuously record environmental disturbance, enabling temporal reconstruction of the marine environment over time.

Although coralligenous bioconstructions are present along almost all Mediterranean continental shelf, their distribution is still underestimated and has been mapped only in few areas. For this reason, a protocol for benthic habitat mapping were also proposed and tested in shallow coastal waters of Isola Capo Rizzuto Marine Protected Area (Calabria, Italy). The method has proven capable not only of identifying coralligenous bioconstructions, but also of quantitatively defining their 3D distribution in terms of covered surface, volume and thickness. Combining this mapping protocol with minimally invasive sampling systems and geobiological-geochemical characterization of marine bioconstructions, a potent instrument for monitoring, protecting and enhancing these delicate ecosystems could be obtained.