BlueDiversa: Marine biodiversity and ecosystem function of benthic habitats in a changing ocean using novel underwater imaging approaches

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Abstract

The twin crises of biodiversity loss and climate change have profound effects on coastal benthic habitats, including macroalgal forests, seagrass meadows, and rocky habitats, which harbour high biodiversity in the Mediterranean Sea. Quantifying species, communities, and ecosystems, along with their ecological processes, is fundamental for assessing, predicting, and mitigating potential outcomes in terms of biodiversity loss, ecosystem functioning, and overall ecosystem health under global change. Meanwhile, the emergence of new technologies offers unprecedented opportunities for coastal science and marine conservation. **Aim:** This project seeks to understand and assess how marine biodiversity and ecosystem processes of benthic communities evolve in the context of global environmental change using novel underwater 3D photomosaics and AI-assisted software. **The objectives:** 1) to compare traditional underwater photography surveys (2D) and novel underwater 3D imaging techniques with AI-assisted software; 2) to quantify change in benthic communities using 3D habitat mapping and relate it to ecosystem processes (e.g. photosynthesis, respiration, and calcification) at colony level; and 3) to scale up from colony-level to ecosystem-level processes using 3D habitat mapping to ocean acidification and warming. **Methodology:** Fieldwork will be conducted at unique natural volcanic CO2 vent systems, which cause local acidification of seawater along the coast of Ischia, and locations exposed to variable seasonal temperatures and marine heatwave events. BlueDiversa will integrate i) underwater 3D photomosaic maps, ii) species identification and pattern recognition (e.g. dead tissue after thermal stress) from AI-assisted image segmentation software, iii) relate imagery information to ecosystem processes, and iv) linking species trait variability (*e.g.* height, weight, thickness calcareous skeleton) with ecosystem processes. **Intellectual merit and broader impacts:** This interdisciplinary and international project will significantly contribute to career development and professional maturity, fostering independence and critical thinking for the young researcher. Training will be provided on basic methods, software, equipment, and theories. Opportunities for other internal and external training beneficial to the project and the candidate's career skills will also be pursued. The outcomes will contribute to acquire valuable insights into marine biodiversity and ecosystem functioning, with broader implications for conservation and ocean sustainability.