Marine Animal Forests as functional engines: Biotic filtering overrides biogeographic variability in the Mediterranean

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Abstract

Aim: Understanding how local biotic filters imposed by habitat-forming species interact with regional species pools across broad biogeographic gradients is a central challenge in community ecology and biogeography. We evaluated the engineering role of the red gorgonian *Paramuricea clavata*, testing whether its biotic filtering drives functional convergence in coralligenous understorey assemblages, thereby overriding regional biogeographic variability, while concurrently assessing its thermal vulnerability under ongoing climate stress.

Location: Western-Central Mediterranean Sea (Italy), spanning a depth gradient of 20-40 m.

Methods: We assessed the benthic assemblages associated with *P. clavata* forests and adjacent unforested areas through photographic sampling ($N = 1300$ quadrats). Taxonomic structure and functional identity (via Community-Weighted Mean trait values) were analysed using a mixed multifactorial PERMANOVA design across regions, locations, forest condition (Inside *vs.* Outside), depth layers, and sampling times (T0: Summer; T1: Autumn). Eight functional traits capturing resource acquisition, life-history strategies, and space occupation were assigned to all taxa. Multivariate dispersion (PERMDISP) was used to assess beta-diversity patterns. Tissue necrosis of *P. clavata* was quantified through fixed video transects at T0 and T1.

Results: Taxonomic structure exhibited strong regional and depth-related turnover. In contrast, functional identity converged consistently within forests regardless of region, location, depth, or time, with *Condition* emerging as the primary driver. Assemblages inside the forest were dominated by heterotrophic, long-lived, and colonial organisms, while outside by opportunistic autotrophs. Beta-diversity was significantly lower inside the forest at the among-site scale. Concurrently, *P. clavata* tissue necrosis nearly doubled over a single summer.

Main Conclusions: *Paramuricea clavata* acts as a "functional engine" that decouples species composition from ecosystem functioning, overriding biogeographic variability across regions and depth. However, this cross-scale buffering capacity is threatened by accelerating thermal stress. Our findings provide strong empirical support for prioritising habitat-formers in conservation frameworks aimed at preserving ecosystem functioning across broad biogeographic gradients.