

Bioinvasions and climate change shift Levant reefs into an alien world

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The eastern Mediterranean is perhaps one of the most changed marine regions globally. It is simultaneously exposed to extensive ocean warming, massive bioinvasions—mostly of thermophilic alien species—and overfishing, acting together to transform ecosystems. Until recently, quantitative data of reef communities in the southeastern Mediterranean (the Levant), that would enable following these impacts, have been extremely rare. Extensive ecological surveys and monitoring of both intertidal and subtidal reefs between 2009-2015, including also a marine reserve, and accompanied by experimental studies in the field and in the lab (microcosms and mesocosms aimed for testing performance ranges and sensitivity to warming and acidification) reveal several highly-disturbing patterns. These include (1) near extinction of several highly important species (ecosystem engineer, predator, herbivores) and potentially many more, (2) complete domination of non-indigenous species in several important groups such as molluscs, (3) rarity of brown algae (canopy-forming) meadows and instead the domination of turf barrens (areas overgrazed by alien fish) and meadows of alien macroalgae, (4) reefs almost empty of large predators due to overfishing (almost an order of magnitude more commercial fish species inside the reserve compared to outside), (5) high sensitivity of native species to ocean warming and acidification, evident by a greatly-reduced physiological activity of several still-abundant native species when exposed to peak and future summer temperatures. The ecological implications of the ecosystem phase shift (caused by species collapses and invasions), including their effects on ecosystem functions, must be profound and are now under study. We expect that with additional warming, species collapses and invasions will advance westward and impact the rest of the Mediterranean—and potentially its ecosystem functions and services.