Tropical fish recruitment success varies among temperate reef habitats, potentially impacting their range expansion

by

Hayden John Beck

BSc(Marine Sc), BEnvSc(Hons), MSc(Res)

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School of the Environment

University of Technology, Sydney

Ultimo, NSW, Australia, 2007

Certificate of original authorship

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Date:

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General abstract

Climate change is leading to poleward range expansions of tropical fishes. But to shift poleward with warming waters, species need habitats at higher latitudes with suitable abiotic conditions, resources and communities. This thesis provides the initial empirical evidence that recruitment success of tropical reef fishes varies considerably among temperate reef habitats, encountered at forefronts of their range expansion. Global Positioning System (GPS) - tracked roaming surveys were firstly established as a preferable method for quantifying these rare and sparsely distributed range-expanding fishes, offering reliable density estimates, maximised sightings and improved efficiency compared to traditional belt transects (Chapter 2). GPS-tracked roaming surveys were then conducted in two hotspots of warming, southeastern Australia and western Japan, revealing that spatial variance in biogenic structure and wave regime between reefs may strongly organise, and even limit where tropical fishes recruit (Chapters 3 and 4). Shelter was a key limiting factor, with embayed reefs supporting greater richness, diversity and densities of new recruit and early juvenile tropical fishes than adjacent wave-exposed reefs (Chapter 3). Both habitat generalists (e.g., planktivores, herbivores and omnivores) and specialists (i.e., obligate coral feeders) were more abundant and diverse on embayed reefs. Factors structuring higher recruitment of tropical fishes on embayed reefs were the greater shelter from wave action and branching coral cover (coral-obligate habitat users only). On finer spatial scales, greater densities, diversity and species richness of tropical fish recruits associated with non-macroalgal than macroalgal reef (Chapter 4). Aquarium experiments indicated that non-macroalgal reef (no branching algae) were preferred temperate settlement habitat for tropical fish larvae. However, the abundance and composition of native predator communities impacted feeding activities of a tropical damselfish (*Abudefduf vaigiensis*; Chapter 5), suggesting that even if suitably structured reefs are available for recruiting tropical fishes, temperate predators may constrain their survival by limiting food intake. Feeding activities of *A. vaigiensis* were reduced in presence of a high predation threat, both *in situ* and in an aquarium experiment. Such predator-driven reductions in feeding were accentuated in summer, but diminished in cool winter waters, when poor metabolic performance of this warm-adapted species lowered their feeding activities independent of predation threat. This thesis shows that temperate reef structure and predator

densities, and human modification of these factors, need to be considered along with dispersal factors and water temperature to accurately predict geographic responses of many tropical fishes to climate change and impacts of this redistribution on temperate marine ecosystems.