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Intercontinental patterns in intertidal biodiversity

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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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"Climate is what we expect, weather is what we get"

- Mark Twain

ABSTRACT

Biogenic habitats are important conservation management tools across all ecosystems. The role of the traits of biogenic habitats (e.g. biomass) in facilitating biodiversity is well documented, particularly at local scales. However, patterns in habitat morphology can vary across broad spatial scales, which may have consequences for associated biodiversity. Moreover, biodiversity itself can vary with a range of spatially distributed environmental conditions (e.g. latitude) independent of habitat. However, little is known about how habitat-heterogeneity and spatial scale interact to determine biodiversity. To quantify the value of specific habitat-forming species we must consider: (1) how the morphology of habitats vary throughout their distribution, and (2) how spatially distributed abiotic conditions contribute to diversity patterns – whether indirectly via altering habitat traits, or by directly altering diversity patterns. The first aim of this study was to quantify variation in the morphology of a suite of temperate rocky-intertidal habitats (macro-algae) at multiple spatial scales (e.g. country, latitude, site). The second aim was to identify how changes in algal morphology and abiotic conditions influence the diversity of their associated invertebrate communities across the same spatial scales. To achieve this, I investigated patterns of algal traits and associated biodiversity in four intertidal macrophytes; *Hormosira banksii* and Coralline (Australia and New Zealand), *Sargassum* spp. (Australia only), and *Cystophora* spp. (New Zealand only). In total, I sampled 18 sites spanning over 2,000 km, along two coastlines, sharing similar latitudes in Australia (n=10) and New Zealand (n=8). I used PERMANOVA and DISTLM (distance based linear models) to investigate the influence of spatial proxies (latitude, exposure, vertical shore height) and abiotic conditions (e.g. sea surface temperature, air temperature) on multivariate algal traits. The same analyses were used to investigate the influence of habitat identity, habitat traits (length, biomass, patch size, percentage cover) and spatial proxies (country, latitude, longitude, site exposure, vertical shore height) on multivariate community assembly. The macro-algae occurring in both countries (*H. banksii* and Coralline) varied most strongly at large scales (e.g. latitude). Both large and small spatial scales

(latitude vs. exposure, shore height) were important to *Cystophora* spp. in New Zealand, whereas in Australia, *Sargassum* spp. varied mostly at small-scales (exposure, shore height). Habitat identity was the strongest predictor of biodiversity with each habitat housing its own unique community. However, habitat-diversity relationships varied across multiple spatial scales, and the relative importance of each scale was particular to individual habitats. Thus, in order to conserve biodiversity and possibly ecosystem function, conservation strategies should aim to maintain high habitat diversity and consider both idiosyncratic spatial variation in habitat traits and the additive effects of environmental conditions on habitats and their associated biodiversity.