

Biomechanical functional space, a tool to characterize species functions in ecosystems

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Understanding processes leading to changes in biological communities require accessing functioning of ecosystems. Not all species within ecosystems fulfill the same role nor do they have the same sensitivity to environmental changes, therefore species function need to be quantified. However, characterizing species functions presents a challenge because it is time consuming and complex, even if we focus only on a single trait for a single species. Moreover, the overwhelming number of species present in tropical marine ecosystems, for example, make functional consideration almost prohibitive. But we can find loophole to this difficulty. Intuitively, tall people are naturally fitter than short people to play competitive basketball; this intuition takes root in the rules of biomechanics. Such rules can be used to understand what species can do in an ecosystem. We propose to use this approach to quantify functionality within tropical fish assemblages. To this end, we measured various anatomical features, such as mandible mechanical advantage (correlated to biting force), caudal fin shape (correlated to the type of locomotion), and eye focal-number (correlated to the quality of vision). These trait metrics were subsequently used to build a functional space, which is a sort of multidimensional map of fish functions in an ecosystem. To test the relevance of this functional space, two other spaces were built: one based only on fish shape and another only on ecological information. Simulated fish assemblages that were subsequently degraded to highlight a reduction in functional redundancy, erosion, or shift in ecosystems, were used to test which functional space was more appropriate to detect changes. Results showed that every space detected drastic ecosystem changes (species disappearance), but only biomechanics-based functional space allowed to accurately quantify subtle changes. These functional spaces were subsequently used to analyses the relationship assemblages/habitat on different oceanic reefs within the Mozambican channel.