

IH270: The importance of different coral growth forms to overall reef biodiversity and potential consequences of large scale changes to reef architecture in Indonesia

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Hermatypic coral species, otherwise known as reef-building or hard corals, are often the dominant component of tropical reef systems. The various colony morphologies, which are genetically determined but also environmentally regulated, provide the physical complexity that characterizes coral reefs. The complexity provided by reef building corals is a key driver of the high biodiversity associated with coral reefs. In this sense reef building corals are often referred to as 'ecosystem architects', which provide diverse habitats and enhance niche differentiation between coral reef species. Colony formation is a result of calcification, the rates of which vary greatly between species and between environments with higher light environments providing faster growth conditions compared to growth of the same species in lower light environments. However, high light can also be damaging to reef building corals and most species exist within a range of environmental conditions which in turn provide a gradient of growth rates.

In addition to growth, often measured through estimation of colony linear extension, the colony shape and/or architecture can vary for the same species existing in different environments. Light and levels of exposure are considered to be the key drivers of colony morphology as well as growth, although across global spatial scales, temperature also plays a role. Despite such environmentally regulated variations in overall coral morphology, reef building corals are often functionally and not taxonomically classified by their dominant growth form. Such growth forms include a) massive corals b) branching corals c) submassive corals, d) foliose corals, e) tabulate corals f) digitate corals and g) encrusting corals. These different growth forms can be readily identified across reefs world-wide and the contribution to overall reef complexity is varied with some growth forms providing long-term stable structures but low complexity (e.g. "massive" species) and other forms providing relatively short-term high complexity (e.g. "branching" species). Thus, the overall architecture of a reef and hence its physical complexity, topographic diversity and habitat availability is dependent on the composition and abundance of the different coral growth forms.

The influence of colony growth form on reef architecture does however vary within a species along with colonies' linear extension rates. For example, a high level of sedimentation combined with high turbidity restricts the number of tabulate corals and increases the relative abundance of both massive and encrusting species. Consequently, the overall physical complexity of a reef is decreased with a concomitant decrease in the biodiversity of associated species such as fish and invertebrates. Also, the colony architecture of a single species can change radically with environmental conditions with the more tabulate coral species tending to a more arborescent growth form in highly sedimented reefs whereas growth remains tabulate in clear water sites. A similar response is found across the different growth forms and thus the morphology or colony contribution to overall reef architecture is said to be environmentally regulated. Again, this has major consequences for associated biodiversity but despite this, the actual implication for changes to or even loss of certain architectural types for the biodiversity of reefs within the coral triangle has not been quantified.

"How important is colony architecture for associated biodiversity, which colony types support the highest biodiversity and what are the characteristics of the association?"

The answers to such questions have conservation implications. Reefs around the world are declining in both habitat quality (as quantified through the percentage cover of live coral) and biodiversity. The Indo-Pacific is experiencing approximately 1% coral loss per year (Bruno 2007). This would be bad enough if this loss was spread across all colony types but unfortunately the colony archetypes that provide the greatest level of complexity appear to be most vulnerable to both anthropogenic and naturally occurring stress events. Also, many different experiments have shown that massive coral species have a relatively high tolerance of environmental anomalies (i.e. bleaching caused by elevated temperatures during El Niño or La Niña events) while the fast growth and physically complex branching species do not. Consequently, environmental anomalies have a disproportionate impact on reef complexity and therefore the species richness of a particular reef. Other studies have also considered the implications of climate change on coral species abundance if not physical complexity. Again, it seems most likely that it is the fast growing architecturally complex branching and tabulate species that will be most impacted. Therefore, both in the short-term, mid-term, and long-terms the relative abundance of the most complex species will decrease and therefore the physical complexity of coral reefs will also decrease. But what are the implications for coral biodiversity and the ecosystem services provided by coral reefs? This question cannot be answered unless we gain a much better understanding of the species associated with different coral forms both from a more facultative stand point and residential and transiency perspective. This research activity, which could provide the rationale for numerous research dissertations, therefore aims at understanding which coral morphologies are most susceptible to environmental changes and how this might influence species diversity.

Suggested Reading

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