IH303: The biology and ecology of coral reefs in turbid and highly sedimented environments, Indonesia

Dan Exton

Scleractinian corals are the ecosystem architects for complex and highly valuable coral reef ecosystems. They therefore provide the foundations on which the highly diverse associated communities thrive. In particular, the high degree of structural complexity (or topographic diversity) formed by coral growth provides high microhabitat diversity, and thus the range of niches available to other organisms. This is particularly true for those corals growing in colony morphologies with a more complex 3D structure, such as branching, tabulate and foliose. This further increases the niche availability for associated fauna, particularly fish and macroinvertebrates.

Corals exhibit slow growth rates, even under optimal conditions, with some species growing by only a few centimetres in a year. Therefore, when environmental conditions stray from optimal, coral growth rates are compromised. This can have significant consequences for recovery potential after disturbance events, as well as for the overall development of the reef system. This in turn impacts on the associated biodiversity which relies on the scleractinian corals for their own survival, often leading to severe shifts in fish and invertebrate community structure as the supporting coral community changes.

Turbidity refers to the loss in water clarity associated with suspended particles in the water column. This diminishes light availability for the corals as suspended particles absorb a proportion of the light energy before it reaches the reef. This significantly reduces the ability of autotrophs such as symbiotic zooxanthellae to gain energy, which in turn impacts the energy budget of their coral hosts. This leads to a reduction in coral growth, as well as a shift in coral community structure to those species and growth morphologies more suited to lower light environments. However, research has shown that some corals possess the plasticity required to alter their feeding strategies to favour heterotrophy under conditions of reduced light, thus reducing their reliance on photosynthesis. In some cases, corals on turbid reefs are 10-20 times more heterotrophic than con-specifics on more pristine reefs.

Sedimentation is another factor impacting on coral reefs, and is partly a consequence of turbidity. It refers to the settling out of suspended particles onto the benthos, and occurs when water movement is not sufficient to maintain them in suspension. One of the main threats to corals from sedimentation is the smothering of their polyps, and the wider consequences of it include declines in coral diversity, cover, growth rates and recruitment. Species vary in their ability to clear settled particles from their surface, meaning that the community assemblage of corals changes. This, combined with an overall drop in reef accretion, can ultimately lead to a collapse of the coral ecosystem, as refuges typically provided by the reef framework are lost.

Causes of sedimentation can vary, but a major source is coastal development and land use change, which can increase runoff of particles into the coastal marine environment. In some cases, however, particular reefs are naturally more turbid due to hydrological factors, for example sheltered lagoon reefs.

Research into the effects of turbidity and sedimentation on coral reef biology and ecology can focus on a number of specific areas. Detailed environmental studies could be carried out to characterise the conditions present at a number of sites, which can then be used to compare various aspects of their communities. This could include reef architecture in the form of growth morphologies, to explore whether certain growth forms are favoured by corals under varying levels of turbidity. Surveys of associated fish and macroinvertebrates could also be performed, to assess the impact of turbidity on their abundance and diversity. This would provide valuable information into the expected impact of future increases in turbidity on reef community structure. Finally, data from previous years could be added to new data sets, to allow temporal patterns to be identified on low-light turbid reefs when compared to those under optimal conditions. This will allow researchers to determine whether negative rates of change are increased in highly turbid environments.

Reading List

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