ME57 The conservation of and improvement of Caribbean coral reefs

Reef restoration through plantation of *Acropora cervicornis*

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Marine global climate change threatens coral reefs, and it is likely that corals will be extinct in the wild by the end of the century. Rising sea temperature has caused unprecedented coral bleaching events, which are occurring more frequently than ever expected. Local threats such as removal of herbivores, increased nutrients, and human disturbance, exacerbate global scale changes, causing catastrophic phase shifts on coral reefs. In the Caribbean coral cover has drastically decreased in recent decades, whilst there has been a massive increase in macroalgae species. Loss of herbivorous fish populations and invertebrates such as sea urchins has allowed algal populations to smother areas of coral reef, killing the delicate polyps of coral colonies.

Coral reef ecosystem services depend upon the reef-building Scleractinian corals. They secrete calcium carbonate which forms the structure of the coral reef, providing protection to the coastline and creates habitat for other species. The solid structure of the reef acts as a wave breaker, absorbing over 90% of storm energy before it reaches the shore. In the Caribbean, the key species are *Acropora cervicornis* (staghorn coral) and *Acropora palmata* (Elkhorn coral). They are considered ecosystem architects, as their branching form creates complexity and space for other organisms to inhabit. Acroporids have a fast growth rate (10 – 15cm a year), which along with their ability to fragment to form new colonies has allowed them to survive storms and dominate coral reefs in the Caribbean for millennia.

Part of their success is down to their ability to reproduce asexually. 'Fragmentation' occurs when a branch or fragment falls from the main colony, fuses to the reef substrate and grows a new colony. In this way they are able to survive disturbance and even proliferate when intense storms and wave action break up colonies and spread fragments. It is via this process that Acroporids were once so successful in the Caribbean reef ecosystem. Today however, poor conditions on the reef such as excess algal cover or sedimentation, prevent the corals from fusing to the substrate. Often fragments are left on the sea bed and will die within a few weeks if they are unable to affix to the reef.

Adult colonies sexually reproduce via sass spawning events which occurs just 1-2 nights per year in the Caribbean. Within a geographical area, all colonies will spawn at the same time to increase the probability of fertilisation. AS this is environmentally cued it is also at risk from climate change. Decreases in the numbers of colonies on the reefs and reduction in genetic variation of the population lowers the rate of fertilisation. Once gametes fertilise they must survive in the water column as free-swimming larvae for several days before they settle onto the substrate. Survival of coral larvae is threatened by warming oceans and acidification.

Since the 1970s *Acropora* populations have been decimated, with reductions of approx. 90% across the Caribbean, and complete loss of colonies at some sites. White band disease initially affected the population and recovery has been hindered by changing marine conditions. Many extant populations have been found to be clonal, i.e, no genetic variation, indicating that these populations were produced via fragmentation. This limits the resilience of the population, and reduces their chances of producing sexually, as genetically identical colonies are unable to have viable offspring.

In response to the decline of key coral species, scientists and communities are developing coral restoration techniques with the objective to return balance to the coral reef ecosystem. Reef restoration is a proactive conservation approach, meaning that practitioners are making hands-on visible changes to the ecosystem.

Coral restoration practices can involve either or both a/sexual reproduction to regenerate populations. Most commonly, coral fragments are collected by divers or snorkelers from the seabed and propagated in coral nurseries. Branches are clipped to create new colonies which are then transplanted, or re-fragmented. The in-situ coral nurseries provide optimum conditions for growth, i.e high light and low sedimentation, promoting high survival and quick growth. Regular cleaning of coral nurseries controls any algal overgrowth.

Recently, the importance of including sexually produced coral recruits in reef restoration programs has received much attention, and there is hope that understanding more about the reproductive cycle of key species will allow practitioners to advance the science of coral restoration for long-term results and scaling up of these activities.

At our research site in Akumal, we are collecting data at two nursery sites and monitoring corals which have been transplanted onto the reef. A local community initiative involving scientists, dive professionals and stakeholders are working with *in-situ Acropora* fragmentation nurseries and assisted fertilisation of coral spawn to establish the first restoration project of it's kind in the region.

Operation Wallacea's reef restoration research has the following themes:

1. Acropora nursery growth
2. The long-term impact of restoration activities
3. Mapping the status and health of the natural Acropora population
4. Coral population recovery via sexual reproduction

Operation Wallacea research divers will be trained to identify Scleractinian coral species, key fish species and invertebrates. They will conduct coral reef monitoring to generate annual datasets for comparison. Using SCUBA, research assistants will use transects to map the Acropora population of Akumal, including the size and health of colonies to identify hotspots for reproduction. Fragments in the coral nurseries and transplants on the reef will be measured to evaluate different methodologies and our analysis will guide future restoration planning in Akumal. Volunteers may also have the unique chance to help with the coral spawning laboratory preparations and night-time observations of coral spawning. We will use underwater videography and photography, as well as traditional scientific diving methods to collect extensive data on the coral reef sites.

Reading List

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