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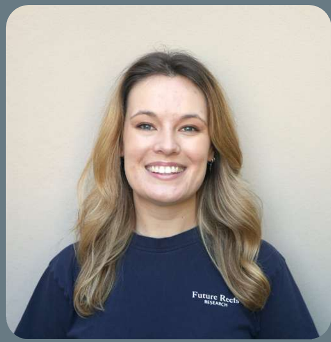


Coral ‘Conversations’: Can Corals Communicate With Each Other via Chemosignaling Under Stress?

Natasha Bartels

Coral reefs are vibrant underwater cities, bustling with colourful fish, sleepy turtles waking from their slumber, rays gliding gracefully, and sharks cruising with cautious curiosity. Now, imagine an inhospitable wasteland of stark-white coral skeletons and algae-covered rubble. Without urgent climate action and active reef conservation and restoration, this is the fate the Great Barrier Reef faces under anthropogenic climate change. It is all coral scientists are talking about – but could the corals themselves be talking about it too?!

The Impacts of Climate Change on the Great Barrier Reef

Climate change continues to decimate coral reefs around the globe, with ~20 percent of all marine species and ~85 percent of coral species assessed on the Great Barrier Reef listed as vulnerable to critically endangered on the *International Union for Conservation of Nature’s Red List of Threatened Species*. Several of these corals have recently been identified as endemic to the Great Barrier Reef, and the increasing frequency and severity of bleaching events threaten the extinction of these species. In the face of such devastating losses to biodiversity, we increasingly turn to new protection and restoration techniques to rebuild reefs, aid survivorship, and preserve high-value areas.

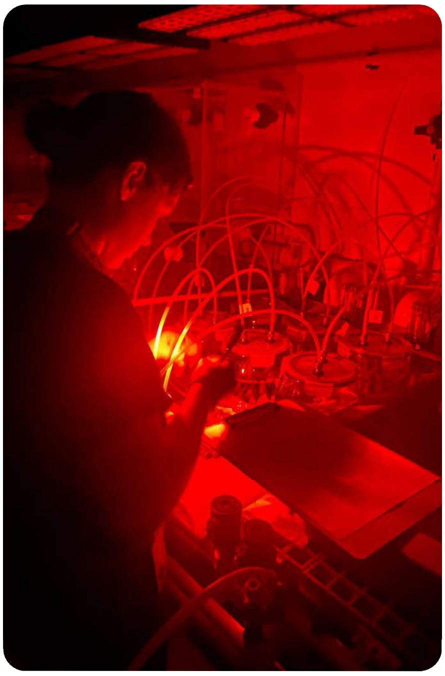
For reef restoration to be successful, it must be underpinned by knowledge of coral biology and how corals interact with one another, other organisms, and their environment. For example, coral ‘gardening’ recognises that light and temperature play a critical role in coral health and that, consequently, site selection needs to consider and balance both factors. Similarly, ‘tentacle warfare’, during which corals sting (and can ultimately kill) each other, dictates the minimum spacing between individuals of certain species on nursery frames. The distance between nursery frames and natural reefs with beneficial algae-eating fish that can help reduce coral–algae competition is also essential. While these considerations encompass the broader environmental and physical interactions supporting coral health, they do not consider potential chemical interactions. The question of if and how corals engage in chemical communication and the consequences of chemosignaling for coral health remains largely unexplored.

Are Corals Talking to Each Other?

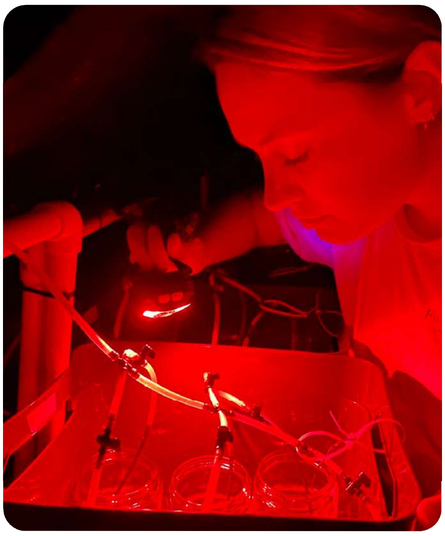
Although corals can have hundreds to thousands of mouths across a single colony, they do not possess the ability to *speak*. However, they do *communicate; we* recently discovered that corals communicate with each other during sexual reproduction using chemical compounds in a process called chemosignaling.

Researchers have long suspected that chemical cues may play a role in coral mass spawning – the remarkable, large-scale, highly synchronised event during which corals release their sperm and eggs on a single night

Coral releasing sperm and egg bundles during coral mass spawning. Image: Dr Paige Strudwick.



Natasha measured the compounds produced by gravid corals directly before they released their gametes. Image: Dr Jennifer Matthews.



Natasha Bartels monitoring gravid corals for signs of spawning after administering spawning chemical cues. Image: Dr Jennifer Matthews.

and the sole opportunity for sexual reproduction each year for many species. As corals are fixed in place, the timing of this event is crucial to reproductive success. The timing of spawning has well-documented links to several environmental factors, including seawater temperature, the lunar phase, and daily light cycles. However, when corals of the same species and origin are placed in separate tanks, spawning can become desynchronised; colonies in one tank are often observed to spawn at a different time to colonies in another tank, even if all of those critical conditions (temperature, light etc.) remain the same. We hypothesised that chemical communication might be the final piece of the spawning synchronisation puzzle. Upon investigation, we found that chemical compounds released by corals directly before they release their sperm and egg bundles could induce spawning in other colonies of the same species.

Chemical Communication Beyond Coral Spawning

The discovery that corals communicate with each other during sexual reproduction raises the question: is spawning the only time corals have these chemical 'chats' with each other?

Our next aim is to investigate whether corals communicate with one another under stress. During a marine heat wave, could corals at a shallower depth (that gets warmer first) send out 'warning' signals to their neighbours deeper below? Could these warning signals allow the deeper corals to prepare themselves for impending thermal stress and potentially improve their survival? Conversely – and indeed noxiously – could the chemicals released by the stressed coral instead cause harm to their neighbour and negatively affect their performance under heat stress?

Both outcomes have considerable implications for management strategies on Australian reefs. If the stress of one individual can negatively impact others, coral gardening restoration programs may need to consider greater spacing when stocking coral nursery frames. Similarly, these adverse effects may be especially noticeable between certain species or genera, requiring them to be placed on separate nursery frames altogether, and the same principle could also apply when outplanting nursery-grown fragments of different species back onto the reef.

However, these cues may alternatively serve as an 'early warning system' that encourages neighbouring corals to ready themselves (for example, corals can make specific changes to their metabolism that aid their survival under stress) before the stress is even present. Conservation efforts may focus on manipulating these chemical cues prior to predicted marine heat waves. Previous restoration efforts have administered reef pre- and probiotics before and after heat stress events; in this case, the chemical cues could be dispersed instead.

Finally, if we can identify chemical cues, understanding how far-reaching they are could be an essential factor when making predictions on coral bleaching through modelling; perhaps the impacts of bleaching may extend beyond areas where higher water temperatures are observed.

An Experimental System Supported by The Australian Wildlife Society

These questions can be answered through the development of an experimental system funded by the Australian Wildlife Society. 'Stressed' corals will be maintained at a relatively high (sub-lethal though stress-inducing) temperature, and the chemical compounds released into the surrounding water by this coral under stress will then be delivered to colonies maintained at a normal growth temperature. Over one month, the photosynthesis, metabolism, and chemical signatures of the corals held at normal growth temperature will be measured to determine whether they, too, show signs of stress (despite the absence of heat stress). Alternatively – and perhaps more intriguingly – they may fare better than corals that have not received the same stressed coral chemicals, suggesting that corals may 'warn' each other of impending disturbances.

Funds provided by the Australian Wildlife Society were used to develop the experimental system, which consisted of twelve chamber pairs for the minimum replication required to carry out this research. The funds were also used to source coral material.

A bleached coral colony surrounded by unbleached colonies. Image: Hadley England.

Hope for The Future

This research is incredibly timely, considering the mounting threats that corals face worldwide. Earlier this year, reefs around the globe faced a detrimental mass bleaching event – the fifth event for our own Great Barrier Reef. First and foremost, we must take rapid climate action to reduce carbon emissions drastically. In the meantime, research like this provides a promising new avenue to explore for safeguarding Australia's iconic reefs. We can think of this method as 'Google Translate' for corals; they speak a chemical language, and now we have a way to understand them. Perhaps we will discover that, if we listen closely enough, they are telling us precisely what they need to give them the best shot at surviving in this ever-changing world.

Coral bleaching across a depth gradient. Could the stress of neighbouring corals affect the response of those yet to bleach? Image: Dr Paige Strudwick.