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Life after death? Fossil survival strategy rediscovered in living corals

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ABSTRACT

Corals are impacted by climate change worldwide. Monitoring the Mediterranean coral Cladocora caespitosa during 16 yrs allowed us to discover that some colonies were able to recover after warming-induced death. The recovery was possible thanks to rejuvenescence, a survival strategy only known from extinct fossil corals. It was described for the first time in a living coral.

Cladocora caespitosa colony in the Columbretes Islands Marine Reserve.
Image credits: D. K. Kersting

Water warming is killing corals, but not only in tropical seas as most people know. In temperate seas like the Mediterranean summer heatwaves are causing mass mortalities in many marine organisms, corals included.

The Mediterranean Sea hosts a single reef-builder coral: *Cladocora caespitosa*. In the past, this coral used to build vast reefs throughout the Mediterranean coasts. Some of them are still present as fossils. Those big reefs no longer exist in the modern Mediterranean. Currently, only a few sites harbor big colonies of this coral. The Columbretes Islands, a tiny volcanic archipelago off the coast of Spain, are one of those locations. Being such an essential place for the species, we started monitoring a permanent transect with 243 colonies of Cladocora in 2002. Permanent means that we have been observing the same colonies annually, and we know very precisely what has happened in their lives during the past 16 years. Why? Our primary objective was to describe and quantify coral mortalities associated with water warming. For that purpose, in our annual visits, we have assessed the coral cover loss by checking the percentage of each colony's area that has died during the summer.

Unfortunately, heatwaves are happening with increased frequency in the Mediterranean Sea, and so does coral mortality. After several years, many coral colonies in our transect were wholly or partially dead, not showing recovery signs and covered by algae. Cladocora is a slow-growing coral with low recruitment rates, traits that make it very vulnerable to catastrophic events. This means that the coral cover lost during the mortality events (25% in 2003, for example) could hardly be recovered in the short-term through recruitment and growth. And there was an additional problem: those mortality events were recurrent—a very discouraging scenario for the species.

But a pleasant surprise was awaiting us…we detected living polyps covering colonies that were considered to have died many years ago. We took a closer look at those colony areas and discovered the occurrence of small polyps inside denuded calyces (calyx is the upper part of the coral skeleton). The polyp's tissue usually covers the calyx, but in these cases, the polyp was tiny and was found hiding inside it. Our first hypothesis was that the living polyps were recruits colonizing dead colonies. Still, the analysis of coral skeletons using computed tomography showed us that we were face to an exciting discovery.

Computed tomography allows us to scan the inner skeletal structures without having to cut or break the fragile skeleton build-up by the polyp, also called corallite. We can have the corallite digitally dissected in many consecutive sections and explore its inner structure with high precision and detail. The scans unraveled the origin of these mysterious revivals. The inner skeletal structures showed us that the little polyp was the same one that once used to cover the whole calyx. However, it had drastically reduced its size, partially abandoning its skeleton and retreating into the now denuded calyx.

Of course, we started searching the literature for similar processes in other coral species. Still, to our surprise, we found that this phenomenon was only described in fossil corals, mainly in Rugosa, an extinct genus of corals that lived hundreds of millions of years ago. It had never been described in a living coral!

Paleontologists had called this process rejuvenescence. It is a survival strategy that would allow ancient corals to withstand periods of stress. Well, the same was occurring in Cladocora. Summer heatwaves killed most polyps in the colony. Still, some of them, or sometimes only one, reduces its size, partially abandons the skeleton, and waits for better conditions adopting a kind of transitory resistant form. When conditions improve, the polyp grows back to its original size and starts budding, eventually recolonizing dead areas.

Our findings are significant because they link for the first time rejuvenescence between living and fossil corals. They provide, of course, some hope for the survival of this endangered coral, but unfortunately, the process is too slow facing the increased frequency and intensity of heatwaves. In the best cases, it took colonies at least ten years for near-full recoveries.

These pieces of evidence are showing us that Nature has solutions. However, they are not enough in the current rapid context of anthropogenic climate change and environmental degradation. We need to take urgent action!