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When anemones bleach, clownfish suffer

The bleaching of corals is a well-known consequence of climate change. What is less widely known is that sea anemones suffer the same fate, and this reduces the fertility of the clownfish living in these anemones, as researchers from the Centre de recherches insulaires et observatoire de l'environnement (CRIOBE, a laboratory jointly managed by the CNRS, the EPHE and Université de Perpignan Via Domitia) have just demonstrated in French Polynesia. Following a 14-month study, they are publishing their results in *Nature Communications* on October 10, 2017.

Like corals, sea anemones are animals that live in symbiosis with microscopic algae, which gives them their color, as well as with certain species of fish. Clownfish protect themselves from predators by sheltering among the anemones' tentacles, and each month lay eggs at their base. Equally, the anemones are also protected by the clownfish that they host.

Every other day, from October 2015 to December 2016, researchers and students visited thirteen pairs of clownfish and their host anemones in the coral reefs of Moorea Island (French Polynesia). This monitoring was conducted before, during, and after the El Niño event that in 2016 triggered a warming of the Pacific Ocean[1] and a coral bleaching episode worldwide. Half of the anemones monitored in this study bleached as they lost their microalgae. Among the clownfish living in the bleached anemones, the scientists observed a drastic fall in the number of viable eggs (-73%). These fish were laying eggs less frequently and they were also laying fewer and less viable eggs—while these parameters remained unchanged among fish hosted by unbleached anemones.

Blood samples taken from the pairs of clownfish[2] showed a sharp increase in the level of cortisol, the stress hormone, and a significant drop in the concentrations of sex hormones (the equivalents of testosterone and oestrogen). The bleaching of the anemones due to increased sea surface temperatures is thus a stressor that reduces the levels of sex hormones and thus the fertility of the fish. These links have been found for the first time in the natural environment in which the fish live.

The health of the anemones and the fish improved between three and four months after the end of the warming event, long after the temperatures had returned to normal. But would this have been the case had the warming episode been more intense, or longer? And, faced with a new warming episode, will the clownfish that have already suffered this initial stress be better acclimatized, or on the contrary more

[1] +2°C on Moorea Island compared to the 2007–2015 average. This increase is a combined effect of ongoing global warming and the El Niño episode.

[2] Taken from 52 pairs, including the 13 previously mentioned.

fragile? To provide some answers to these questions, the team has decided to continue to monitor each individual[3] during the next El Niño episode.

The clownfish are not an isolated case: 12% of the coastal fish in French Polynesia depend on anemones or corals to feed or to find protection from predators. In cases of prolonged bleaching, like that of the Australian Great Barrier Reef in 2016 and 2017, the renewal of all of these populations could be affected, and with them the stability of the ecosystems.

Clownfish and anemones in the reefs around Moorea Island.

The golden color of the anemones is due to the microalgae present in their tentacles.

During high temperature episodes, the microalgae living in symbiosis with the corals are expulsed, which causes the corals to bleach.

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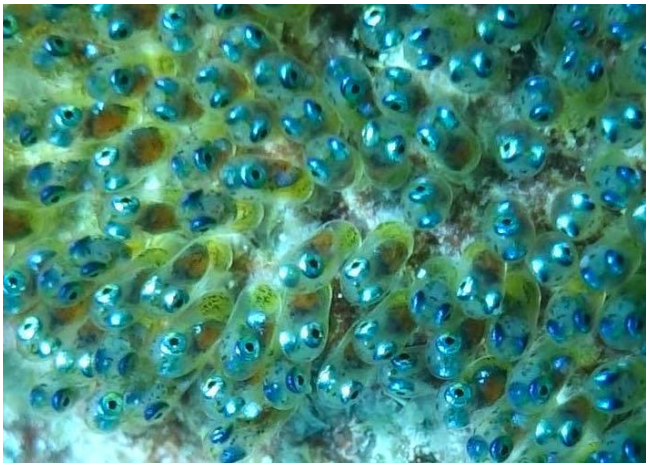

Clownfish spawn at the base of their host anemones

For this study, around 500 photos of spawn were taken and half a million eggs were counted one by one.

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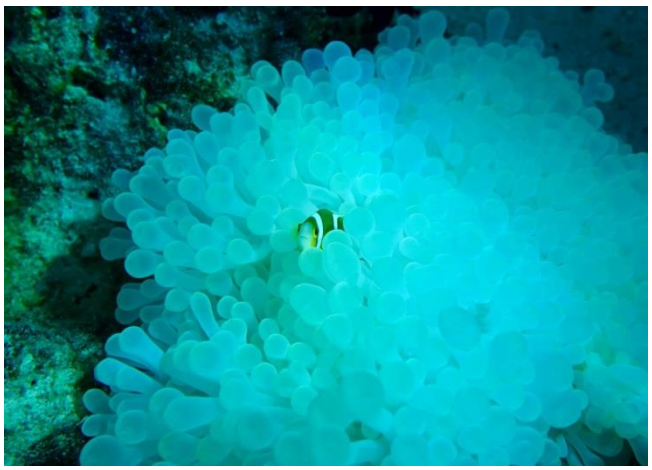
[3] Such monitoring is possible due to the fact that clownfish have a fairly long life expectancy and are sedentary (they move very little from their host anemone).



Juvenile clownfish sheltering in the tentacles of its—bleached—anemone host.

Some pairs of clownfish did not have the option of moving to another host anemone, since there is a high risk of being predated upon if they venture outside the protection of the anemone tentacles.

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Other photos are available upon request.

Bibliography

Cascading fitness effects of thermally-induced anemone bleaching on associated anemonefish hormonal stress response and reproduction, Ricardo Beldade, Agathe Blandin, Rory O'Donnell, Suzanne C. Mills. *Nature Communications*, October 10, 2017. DOI: 10.1038/s41467-017-00565-w

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