ADAPT ISLAND

Study of the coral bleaching phenomenon in Guadeloupe from 2019 to 2020 - Synthesis

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Titre	Study of the coral bleaching phenomenon in Guadeloupe from 2019 to 2020 - Synthesis LIFE Adapt'Island Project - [LIFE 18 /CCA/FR/001184]
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1. Introduction

In the Caribbean, corals living on reefs tolerate a maximum sea water temperature of about 29°C. Any long-term rise in temperature beyond this limit causes stress to these organisms, which results in a "bleaching" phenomenon, the severity of the consequences of which is linked to the extent of the rise in temperature as well as to the duration of the phenomenon. The frequency and extent of this phenomenon are directly linked to global warming.

The first significant bleaching events observed in the French West Indies happened from 1984 and 1987, linked to "El Niño" phenomena. Their effects were minimal on the reefs as the temperature rise wasn't important. The next significant episode occurred in 1998. On this occasion, 56% of the corals in Guadeloupe and 59% in Martinique were affected. Depending on the sites, the consecutive mortality had affected 20 to 30% of the bleached colonies. In September 1999, a new bleaching phenomenon affected nearly 50% of the corals in the Guadeloupe archipelago. Its evolution was masked by the damage caused by Hurricane Lenny in November of the same year. The most important episode occurred in 2005, leading to a coral bleaching episode of exceptional magnitude. This event affected the Lesser and Greater Antilles in a major way and more moderately the rest of the Caribbean region. In the French West Indies, nearly 80% of corals bleached. They were affected in 2006 by a massive mortality phenomenon that caused a decrease of 40 to 60% of the coral cover depending on the site.

In September 2019, a new phenomenon of coral bleaching has appeared on the reefs of Guadeloupe. A preliminary study, conducted on the three maritime coasts of Guadeloupe, showed that nearly half of the coral species living in the leeward coast, as well as in the bays of the Petit and Grand Cul-de-Sac Marin were affected by this phenomenon. This is the most important bleaching phenomenon observed since 2005.

Following these observations, a new study of the coral bleaching phenomenon was commissioned by Guadeloupe Port Caraïbes and conducted by the engineering office Caraïbe Aqua Conseil. The following report presents the results of observations made between October 2019 and March 2020 (date of the beginning of the containment related to coronavirus 19 in Guadeloupe).

2. Method

Within the framework of the long-term monitoring of coral reef evolution (GCRMN1), four sites in Guadeloupe, respectively located surrounding Pigeon Islets, on the Grand Cul-de-Sac Marin Barrier Reef, in the Passe-à-Colas and offshore Port-Louis City, have been regularly studied since the beginning of the year 2000. On each of these sites, fixed transects have been permanently installed on the bottom to count and measure the corals present, as well as to estimate their state of health in a reproducible way from one year to the next. This device had already allowed the monitoring of the impact of the 2005 coral bleaching phenomenon.

The present work focused on:
-1) Monitoring of these sites that were surveyed in October 2019. These data opportunely constitute a reference point for this bleaching event;

-2) the realization of a new follow-up between January 2020 and March 2020. At this time, the drop in water temperature marks the end of the development of the bleaching phenomenon. This work allowed identification of all the coral colonies that have bleached.
-3) The monitoring was also renewed in June 2020. It confirmed the end of the bleaching episode and the appearance of a new disease affecting the corals; the Stony Coral Tissue Loss Disease (SCTLD).

Each coral colony intercepted by the transects is identifiable from one year to the next. Thus, it is possible to estimate precisely the rate of bleached colonies for each coral species during the bleaching phenomenon, as well as to follow the long-term evolution of these colonies (recovery, death…). At the end of the bleaching period, the death of colonies on the transects allows evaluation of the loss in coral numbers and in coral cover linked to the phenomenon.

To obtain information on a larger spatial extent than the transects, semi-quantitative surveys were carried out ("roving technique"). The aim is to establish a list of coral species living on the site and, for each of them, to estimate on a semi-quantitative scale from 0 to 5 the rate of colonies showing signs of bleaching. This scale is established as follows: 0: no bleaching; 1: 1 to 25%; 2: 26 to 50%; 3: 51 to 75%; 4: 76 to 99%; 5: 100% of the colonies of the species considered show signs of bleaching. The median of each class is then used to estimate the percentage of bleached individuals for each species, i.e.: Class 0: 0%; Class 1: 13%; Class 2: 38%; Class 3: 63%; Class 4: 87.5%; Class 5: 100%.

Further detailed information regarding the scientific data acquisition protocol is available in the original report. That information is not detailed here as it doesn’t impact results reading.

3. Results

In the Caribbean region, the maximum sea water temperature tolerated by corals is 29°C. Excursions beyond this temperature can lead to a state of stress of the corals which leads them to expel their symbiotic algae and results in a bleaching phenomenon. The importance of the phenomenon depends on the duration of the period when the temperature exceeds 29°C and the maximum reached. These two factors will condition the importance of the induced coral mortality which generally appears in the year following the bleaching.

Data shows that the coral bleaching phenomenon seems to have started in mid-October 2019. Indeed, no signs of bleaching appeared in surveys conducted in September in Passe-à-Colas, on the outer reef slope at Fajou Islet and at Gri Gri Point. Bleaching appeared in observations made at Islet Pigeon and offshore Port Louis between October 15 and 19, 2020. From this period, it was generalized to all the surveys.

The bleaching phenomenon seems to have ended after the month of March when it was still present (outer slope of Fajou Islet, March 1).

A curious aspect, however, is that no bleached coral colony remained in June. Indeed, during previous bleaching periods, some colonies took several months, even years, to recover their Zooxanthellae and to recolour. Two explanations appear possible: 1) the current corals and their symbiotic algae, which survived the previous bleaching episodes, would be better adapted

to higher sea temperature levels and would have acquired a better resilience; 2) from May 2020, an episode of SCTLD affects the corals of the French West Indies and thus induces a very important mortality of them. It is possible that bleached coral colonies, already physiologically weakened, were preferential victims of the disease and thus disappeared.

Among the 65 species of corals identified in Guadeloupe, 48 are present on the different sites surveyed during this study. Overall, 50.0 ± 7.1 % of the coral species were affected by the bleaching phenomenon. Among the 24 species affected, the average percentage of individuals affected was 26.3 ± 4.2 %. However, some corals were found to be more susceptible than others. The coral species can be subdivided into three groups (except for the 24 that remained insensitive):
- The most affected species (between 45 and 71% of the affected colonies). These are, in decreasing order of importance: *Orbicella faveolata, O. annularis, O. franksi, Agaricia agaricites* and *Siderastrea siderea*. With the exception of *A. agaricites*, an opportunistic specie, these corals are major bioconstructive species of the reefs;
- A group of corals whose bleaching frequency affects 17-30% of colonies: *Pseudodiploria strigosa, Porites porites, Montastrea cavernosa, Meandrina meandrites, Porites porites* and *P. astreoides*. Among these, *Pseudodiploria strigosa* and *Montastrea cavernosa* are key bioconstructive species;
- A set of 14 species with a colony assignment frequency of about 13%: *Millepora alcicornis, M. complanata, M. squarrosa, Stephanocoenia intersepta, Madracis decactis, Agaricia lamarcki, Porites divaricata, Diploria labyrinthiformis, Colpophyllia natans, Meandrina Jacksoni, M. danae, Dichocoenia stokesi, Mycetophyllia aliciae* and *Eusmilia fastigiata*. This last group includes millepores which are not corals *stricto sensu*, but Hydrocoralliarids also living in symbiosis with zooxanthellae algae.

Among the invertebrates living in symbiosis with zooxanthellae and consequently sensitive to the bleaching phenomenon, were observed during this study the Gorgonaria *Erythropodum caribaeorum* (43.2 % of bleached individuals) and the Zoantharia *Palithoa caribaeorum* (23.5 % of bleached individuals).

1. Conclusion

The coral bleaching event that occurred between October 2019 and April - May 2020 is the most important one that has occurred since the one in 2005.

This episode did not reach the magnitude of the one in 2005, but is rather close to the ones in 1998 and 1999. Half of the coral species were affected and, among these, the average rate of bleached colonies was about 26%. However, a group of five species proved to be particularly sensitive to the phenomenon with 50 to 71 % of bleached colonies. Four of these are "key" reef bioconstructor species that play a major ecological role in the reef ecosystem.

Contrary to what happened during previous bleaching events, and especially during the 2005 bleaching event, coral mortality appears to have been very low. Also, the absence of bleached colonies in June 2020 at the study sites suggests that corals, as well as their symbiotic hosts, that survived previous bleaching events are better adapted to the increase in sea temperature and have acquired a better resilience that would allow them to recover more quickly. The

possibility of the existence of such a phenomenon has been raised by some authors including Buddemeier and Fautin (1993), Rowan (2004) and Carilli et al. (2012). However, it has been disputed by other authors, (Ainsworth et al., 2016 and Hughes et al., 2017) in light of the latest mass coral bleaching event in the Great Barrier Reef of Australia in 2016. Scientific investigations in this area would be relevant to understanding the fate of corals in the face of future ocean warming.

The present bleaching event does not appear to have affected the reef fish community, either in terms of numbers or biomass composition. Insofar as the coral cover of the reefs by corals did not significantly decrease, this result is not surprising.